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45th Range Squadron Operations Manual Volume: 1 Revision: 3

OPR: 45 RANS/DOO

DISPOSITION INSTRUCTIONS: Destroy when superseded, obsolete or no longer needed.

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SECTION 1

GENERAL INFORMATION

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1-1 NOTES, CAUTIONS AND WARNINGS

1.1.1 NOTE

An essential operating or maintenance procedure, condition, or statement which requires awareness.

1.1.2 CAUTION

An operating or maintenance procedure, practice, condition, or statement which, if not strictly observed, could result in damage to, or destruction of equipment or loss of mission effectiveness.

1.1.3 WARNING

An operating or maintenance procedure, practice, condition, or statement which, if not strictly observed, could result in injury to or death of personnel.

1-2 SPACELIFT OPERATIONS

1.2.1 OVERVIEW

United States Government space policies identify "assured access to space" as the need to guarantee the availability of critical space capabilities for executing space missions. This key concept supports and implements National Security Strategy, United States Space Transportation Policy, National Military Strategy, National Space Policy and Air Force (AF) doctrine. These policies indicate assured mission capability for critical space systems can be achieved only through assured and protected access to space. For additional details in this section, please refer to Air Force Space Command Instruction (AFSPCI) 10-1208, *Launch Operations*.

1.2.2 SPACE LAUNCH MANIFEST

Space lift is a key enabler that establishes and supports a broad range of space capabilities. Space lift includes two complementary strategies: current routine launch operations and future responsive launch operations. The US uses routine launches to populate satellite constellations on a scheduled basis and will develop responsive launch operations, or on-demand launch capabilities, to support more time-critical space support operations. Routine launches are planned and executed within the Space Launch Manifest, a product of the Current Launch Schedule Review Board (CLSRB) process. Routine launch is predominantly used to deploy and sustain force enhancement constellations, but is also used to support, deploy, or advance a variety of research and development and other test missions.

1.2.3 MISSION ASSURANCE RESPONSIBILITIES

The AFSPC/CC has an inherent authority and legal responsibility for all activity that occurs on the Eastern Range (ER) and Western Range (WR). The AFSPC/CC delegates safety, range operations, and base operating support elements to the 14 AF/CC, who in turn delegates them to the launch wing commanders. AFSPC/CC exercises responsibility for flight worthiness certification through either SMC/CC or the launch wing commander depending on the category of space lift mission. By leveraging the Federal Aviation Administration (FAA) licensing process to meet Air Force Space Command (AFSPC) obligations, AFSPC will satisfy our objectives of facilitating commercial launch activity and streamlining access to space.

1.2.4 FLIGHT WORTHINESS CERTIFICATION RESPONSIBILITIES

All launch agencies operating on the ER and WR will provide a flight worthiness certification acceptable to the wing commander prior to initiating Day of Launch (DoL) activities. Launch agencies fall under one of three categories. (1) Department of Defense (DoD) missions launching Space and Missile Center (SMC) procured spacecraft on SMC-procured launch vehicles; (2) National Reconnaissance Office (NRO) missions launching NRO-procured spacecraft on SMC-procured launch vehicles; and (3) All other DoD, civil, and commercial (both FAA licensed and non-FAA licensed) procured missions not addressed in the previous two categories.

1.2.4.1 Category 1 missions

AFSPC/CC delegates flight worthiness certification authority to the Space and Missile Center Commander (SMC/CC). The SMC/CC will certify flight worthiness for DoD missions launching SMC-procured spacecraft on SMC-procured launch vehicles. AFSPC/CC authorizes Direct Liaison Authorized (DIRLAUTH) between applicable SMC systems wings and 14 AF launch wings to allow launch base support for accomplishing flight worthiness certification tasks. The wing commander will normally receive the SMC Mission Director (MD) flight worthiness certification during the commander's launch readiness review (LRR).

1.2.4.2 Category 2 missions

DNRO (or designated representative) will certify flight worthiness for NRO missions launching NRO-procured spacecraft on SMC-procured launch vehicles. The SMC/CC will certify Launch Vehicle (LV) flight worthiness to Director of the NRO (DNRO) as part of the DNRO's mission certification. The wing commander will normally receive the NRO's flight worthiness certification during the commander's LRR.

1.2.4.3 Category 3 missions

Launch agencies will perform flight worthiness certification processes. Those processes will be sufficiently robust and acceptable to provide the launch wing commander a sufficient level of confidence that launch vehicle performance presents an acceptable risk to safety and launch base infrastructure and security. The wing commander will normally receive the launch agency's flight worthiness certification during the LRR for United States Government (USG) and Test and Evaluation (T&E) activity. For commercial activity the FAA's licensing process will be used to meet AFSPC obligations.

1.2.5 GENERAL RESPONSIBILITIES

AFSPC operates the Launch and Test Range System (LTRS) on the Eastern Range (ER) and Western Range (WR) to meet launch agency requirements and ensure public safety and safe passage of vehicles to, through and from space. The primary responsibilities of the ER and WR are outlined in DoDI 3100.12, Space Support. In addition, the ranges provide Test and Evaluation support to DoD activities In Accordance With (IAW) DoDD 3200.11, Major Range and Test Facility Base.

1.2.5.1 LTRS

LTRS is managed by the Spacelift Range System Division within the Launch and Range Systems Directorate of the Space and Missile Systems Center, Los Angeles AFB, California. The LTRS mission is to provide DoD, National Air and Space Administration (NASA), Missile Defense Agency (MDA), national and commercial customers a highly reliable, integrated system to support spacecraft launch, ballistic missile, and aeronautical testing.

1.2.5.1.1 LTRS Functions

The LTRS performs the following functions:

- Range Safety - protecting people, property and the environment
- Launch Vehicle Tracking and Assessment - supporting DoD, civil, commercial, and national sub-orbital, orbital and interplanetary launches with optics, telemetry, and radar assets
- Positive Control - collecting, processing and distributing data for command and control
- Communications - linking instrumentation sites, control centers, ranges, facilities and range customers
- Weather - providing mission-tailored processes and products supporting launch and test activities
- Area Surveillance - ensuring situational awareness for safe launch and test operations

1.2.5.1.2 LTRS Interrelated Subsystems

LTRS is used to support spacelift and test missions, and is composed of eleven interrelated subsystems:

- Command Destruct - The Command Destruct subsystem allows the Mission Flight Control Officer (MFCO) to destroy flight vehicles which violate Range Safety specific guidelines established by Range Safety for an operation.
- Communications - The Communications subsystem transports voice, video, and data to and from remote and local Range System instrumentation and control stations through landlines, fiber optics circuits, and radio communication links (including microwave and satellites).
- Data Handling - Data handling includes functions such as data formatting and Automated Data Processing Equipment.
- Flight Safety - Safety performs flight operations and flight analysis functions necessary to protect people and property. Range Operators use this function to make decisions as to the safe operation of vehicles on their respective ranges.
- Optics - The imaging subsystem collects optical imagery and metric data of spacelift vehicles, missiles, and aeronautical test vehicles and their background from liftoff through staging and fairing separation.
- Planning & Scheduling - This subsystem provides for range resource scheduling and asset planning and tasking.
- Radar - The Radar subsystem tracks launch vehicles, space objects, and aeronautical vehicles. Radar tracks debris, and provides images of debris or jettisoned items.
- Surveillance - Detects air, sea and Radio Frequency hazards within the controlled launch areas and controls hazard areas in support of operations. Also coordinates rail traffic through WR during LTRS operations.
- Timing & Sequencing - The Timing and Sequencing subsystem provides precise time and time interval signals and data to range instrumentation and to some Range Users
- Telemetry - The Telemetry subsystem receives signals from launch vehicles, space objects, and aeronautical vehicles to determine object position and performance.
- Weather - The Weather subsystem collects meteorological data, images, and other products from local instrumentation and remote data sources (satellites and national centers).

1.2.5.2 Major Range and Test Facility (MRTFB)

The designated core set of DoD T&E infrastructure and associated workforce that must be preserved as a national asset to provide T&E capabilities to support the DoD acquisition system. For additional details, please refer to DoDD 3200.11, DoDD 3200.18, and Annex A Section A.1.2.1.

1.2.5.3 Safety and Resource Protection

AFSPC retains public safety and resource protection responsibilities for all activities on Vandenberg Air Force Base and Cape Canaveral Air Force Station. For commercial launches, the FAA remains statutorily responsible for public health and safety, the safety of property, and national security or foreign policy interests of the United States under 51 USC the CSLA. Additionally, the commercial provider conducting the launch also retains responsibility for public safety of any launch it conducts from an AF range. Regardless of the type of activity (including commercial launches), AFSPC/CC, through his/her launch wing commanders, has an inherent responsibility and legal authority for the conduct of operations on the range. Services provided by AFSPC in support of commercial activity will be performed IAW Air Force processes and standards. This will include a go/no-go on DoL is service performed is a safety mandatory launch requirement. If service is to meet an LV requirement it can be waived IAW commercial provider processes.

1.2.5.4 Contracting

All launch and range operations employ contracted, non-DoD personnel. To ensure proper mission conduct and contractor compliance, AF personnel should understand government rights and responsibilities embodied in contracts and their provisions. A general understanding of the contract between the AF and the contractor is of particular importance for commanders and mission personnel. Individuals seeking guidance on contracts should contact the cognizant government contracting office.

1.2.5.5 Safety

Safety is paramount in all aspects of launch and range operations and involves following regulatory guidance as well as meeting safety requirements detailed in operations directives, instructions, manuals, plans, and procedures. All personnel must comply with applicable technical, procedural, safety, security, and resource protection requirements, instructions, and directives. These include AFSPCI 91-701, *Launch Safety Program Policy*, AFSPCMAN 91-711, *Launch Safety Requirements for AFSPC Organizations*, and AFSPCMAN 91-710, *Range Safety User Requirements*.

1.2.5.6 Training, Evaluation, and Operations

Mission success requires experience, effective training and certification programs, workforce management, and technical excellence. Organizations and personnel will comply with all applicable training, evaluation, crew force management, and civilian personnel instructions, directives, requirements, and supplements. These include AFMAN 36-2234, *Instructional System Development*, AFH 36-2235V11, *Information for Designers of Instructional Systems Application to Unit Training*, AFI 36-2201V3, *Air Force Training Program on the Job Training Administration*, AFI 63-1201, *Life Cycle Systems Engineering*, AFSPCGM 2016-13-1, *Space Operations Crew Force Management*, *Training, Standardization and Evaluation* and, AFSPCI 21-202V2, *Space Launch Maintenance Roles and Responsibilities*, and applicable Career Field Education and Training Plans (CFETP).

1-3 ROLES, MISSIONS, AND RESPONSIBILITIES

1.3.1 COMMAND ROLES AND RESPONSIBILITIES

1.3.1.1 Air Force Space Command (AFSPC)

AFSPC/CC has overall responsibility and authority for safety, range operations, base operating support, and flight worthiness of USG and T&E launches from the ER/WR and AFSPC missions launching from other ranges. For AFSPC/CC delegates launch execution to the 14 AF/CC and space flight worthiness to the SMC/CC (for all AFSPC LVs and Space Vehicle (SVs)). AFSPC has two active Numbered Air Forces (NAFs): 14th Air Force and 24th Air Force. In addition, Space and Missile Systems Center (SMC), Air Force Network Integration Center (AFNIC), and Air Force Spectrum Management Office (AFSMO) are units under AFSPC. For additional details, please refer to AFSPCI 10-1208, *Spacelift Operations*, and AFI 10-1211, *Space Launch Operations*. AFSPC responsibilities include:

- Define space system requirements.
- Organize, train and equip AFSPC space forces for spacelift and range operations.
- Implement Federal, National, DoD and Headquarters United States Air Force (HQ USAF) launch and range policy and guidance
- AFSPC/CC or AFSPC/CV reviews/approves all staff packages for Orbital Debris Exception Requests. Then, the staff package will be coordinated through the Under Secretary of the Air Force (USECAF) to the Office of the Secretary of Defense (OSD) for final approval.

1.3.1.2 Space and Missile Systems Center (SMC)

The Space and Missile Systems Center, a subordinate unit of Air Force Space Command (AFSPC), is the center of technical excellence for developing, acquiring, fielding and sustaining military space systems. SMC's mission is to deliver resilient and affordable space capabilities. The center is responsible for on-orbit check-out, testing, sustainment and maintenance of military satellite constellations and other Department of Defense space systems. For additional details, please refer to AFSPCI 10-1208, *Spacelift Operations*, and AFI 10-1211, *Space Launch Operations*.

1.3.1.2.1 SMC Major Directorates and Program Offices

- Military Satellite Communications Systems Directorate - Develops, acquires and sustains space-enabled global communications capabilities in support of our nation.
- Global Positioning Systems Directorate - Acquire and sustain survivable, effective, and affordable global positioning, navigation and timing services for military and civil users.
- Remote Sensing Directorate - Develops, deploys and sustains surveillance capabilities in support of missile warning, missile defense, battle space awareness, technical intelligence and environmental mission areas.
- Launch Enterprise Directorate - Develops and acquires expendable launch systems and manages launch integration, mission assurance and launch campaigns.
- Space Superiority Systems Directorate - Develops, delivers and sustains unrivaled space control systems to ensure space control capabilities to guarantee space superiority for the nation.
- Advanced Systems and Development Directorate - Drives future space capabilities through collaborative innovation, development planning and demonstrations.
- Range and Network Systems Division - Modernizes and sustains the world-wide Air Force

Satellite Control Network as well as the nation's Launch and Test Range System located at Vandenberg AFB, Calif. and Cape Canaveral AFS, Fla.

1.3.1.3 614th Air and Space Operations Center (614 AOC) Responsibilities

612 AOC responsibility is to calculate conjunction assessments to avoid collisions between launch vehicles and on-orbit objects for all launches as provided in AFI 91-217. Provide conjunction assessment data to the appropriate launch and/or launch and systems wing for use in developing collision avoidance analysis. This requirement exists for all launch activity on the ER and WR.

1.3.2 SPACELIFT AREAS OF RESPONSIBILITY

Assured Access to Space consists of two main aspects: Mission Assurance and Public Safety.

1.3.2.1 Mission Assurance

An integrated engineering-level assessment of analysis, production, verification, validation, operation, maintenance, and problem resolution processes performed over the life cycle of a program by which an operator/user determines that there is an acceptable level of risk to employment of a system or end item to deliver an intended capability in an intended environment. The objective of the assurance process is to identify and mitigate design, production, test and operational deficiencies that could impact mission success.

1.3.2.2 Public Safety

Safety involving risks to the general public of the United States or foreign countries and/or their property (both on and off-base); includes the safety of the people and property that are not involved in supporting a launch along with those that may be within the boundary of the launch site.

1.3.3 RANGE OPERATIONS

1.3.3.1 14th Air Force (14 AF)

The 14th Air Force (Air Forces Strategic) is responsible for the organization, training, equipping, command and control, and employment of Air Force space forces to support operational plans and missions for U.S. combatant commanders and their subordinate components and is the Air Force Component to U.S. Strategic Command for space operations. For the 14 AF responsibilities, please refer to AFSPCI 10-1208, *Spacelift Operations.*

1.3.3.2 45 Space Wing (45 SW)

The 45th Space Wing (45 SW), a subordinate unit of the 14 AF, conducts space and missile launch and test operations from the ER as part of the LRTS and the Major Range and Test Facility Base (MRTFB). For additional information on the 45 SW responsibilities, please refer to AFSPCI 10-1208, *Spacelift Operations.* The 45 SW is composed of the 45th Operations Group (45 OG), 45th Launch Group (45 LCG), 45th Mission Support Group (45 MSG), and the 45th Medical Group (45 MDG), as well as staff agencies. The 45 SW has four mission areas and they are:

- Eastern Range Operations - Provide the activities and resources for safety of flight, range instrumentation, infrastructure, and scheduling required to support and assure space and ballistic launches, and other operations.
- Launch Operations and Support – Provide reliable launch infrastructure, launch teams, and seamless partnership with launch and satellite programs.
- Expeditionary and Contingency Readiness – Provide trained people, equipment, and processes ready to support wartime and contingency operations.

- Base and People Support - Provide base infrastructure, health care services, security, information systems, morale/welfare activities, workforce safety, human resources, financial services, logistics services, and environmental stewardship to support present and future missions.

1.3.3.2.1 45 SW/CC Responsibilities

The 45 SW/CC is accountable for safety resource protection, and environmental protection for all personnel, systems, government facilities, and equipment throughout all phases of launch and range operations. For commercial launch activity will provide support as requested by the launch provider and leverage the FAA-licensing process to meet obligations. If at any time the SW/CC believes commercial activity presents an unacceptable risk to people, property, or activity of others on the range, they will maintain a process to halt offending activity until resolution can be reached. The wing commander may withhold services or resources from commercial entities if necessary. Additionally, the SW/CC can engage directly with the FAA as the consultation process is a continuous activity from time of license submittal through approval and ultimately launch. For additional details on the 45 SW/CC responsibilities, please refer to AFSPCI 10-1208, *Spacelift Operations.*

1.3.3.2.2 45th Space Wing Safety Office (45 SW/SE)

The Space Wing Safety Office contains the following sections: Safety Assessment, Launch Safety, Flight Safety, Ground Safety, and Weapons Safety. The sections that primarily support the Launch Safety mission are the Safety Assessment Section and the Launch Safety Section. The Safety Assessment Section develops and enforces the system safety criteria pertinent to the design, inspection, test, and operations of launch vehicles, payloads, airborne FSSs, in addition to the associated ground support equipment (GSE) and facilities and structures. The Launch Safety Section are agents of the SW/CC, Wing Safety, through its Launch Safety Program, ensures that the public, launch site personnel (government and contractor), and range infrastructure are protected from the inherent hazards of launch vehicles, payloads, and their associated supporting systems and facilities. These inherent hazards are posed both by the course of normal operations and because of anomalies. In this role of assessing and minimizing the danger posed by launch and pre-launch operations, Wing Safety is also known as Range Safety. For more information on Launch Safety requirements, please refer to AFSPCMAN91-711, *Launch Safety Requirements for Air Force Space Command Organizations.*

Figure 1-3-1: *45th Space Wing Safety Office*

The Chief of Safety (SE) performs the following functions:

- Serves as senior safety advisor on Day of Launch (DoL)
- Enforces launch safety requirements IAW the AFSPCIAN 91-701 and AFSPCMAN 91-710 or EWR 127-1, as applicable.
- Reports directly to the SW/CC, providing an independent safety assessment to the 45 SW/CC IAW AFSPCI 91-701 and advising commanders on safety requirements for all operations.
- Provides subject matter experts on safety policies, requirements, procedures, launch commit criteria, risk assessment, and systems for safety recommendations on operational issues and Day of Launch (DoL) activities
- Establishes operational safety criteria and establish display, tracking, and data processing parameters.
- Conducts risk analysis and advises commanders of in-flight impact (i.e., Collision Avoidance (COLA) closure times), explosive, toxic (in conjunction with CE and weather), laser, radiological, and acoustic hazards.

The Launch Safety Program consists of the following functions at AFSPC ranges: Systems Safety, Pad Safety, Flight Analysis, and support to Flight Operations. The Space Wing Safety Office contains the following sections: Safety Analysis (SEA), Launch Safety (SEL), Flight Safety (SEF), Ground Safety (SEG), and Weapons Safety (SEW). The sections that primarily support the Launch Safety mission are the Safety Assessment Section and the Launch Safety Section.

The Space Wing Safety Office contains the following sections: Safety Assessment (SEA), Launch Safety (SEL), Flight Safety (SEF), Ground Safety (SEG), and Weapons Safety (SEW). The sections that primarily support the Launch Safety mission are the Safety Assessment Section (SEA) and the Launch Safety Section (SEL). We will discuss these sections in greater detail.

1.3.3.2.2.1 Safety Analysis (SEA)
SEA is responsible for ensuring that public, launch area, and launch complex safety and resource protection are adequately provided by and for all programs using the Range. SEA is composed of Launch Vehicle Safety (SEAL), Safety Engineering (SEAE), and Pad Safety. SEA develops and enforces the system safety criteria pertinent to the design, inspection, test, and operations of launch vehicles, payloads, and airborne Flight Safety Systems (FSSs, to include the Range Tracking System, the Flight Termination System, and the Telemetry Data Transmission System), in addition to the associated ground support equipment (GSE) and facilities and structures. In conjunction with its role of implementing policy regarding these identified items, this section also provides comments and guidance on using the system safety order of precedence as a means of reducing the hazard potential of a specific design or operation.

1.3.3.2.2.2 Launch Safety (SEL)
SEL is responsible for the development of Launch Safety Launch Commit Criteria (LCC), requirements for range systems, and flight safety policy and requirements including the development and interpretation of mission rules to support the MFCOs.

1.3.3.2.2.3 Policy and Requirements (SELP)
The Policy and Requirements function includes:

- The development of flight safety policy and requirements including the development and interpretation of mission rules to support the MFCO.
- Performance as a MFCO and/or as liaison between Wing Safety and the MFCOs.
- Serving as Launch Safety Technical Advisors (STAs) to the SE and SW/CC providing pre-launch and DoL recommendations on Launch Safety issues such as anomaly resolution or waiver actions.
- Establishment of Launch Safety requirements for range systems.
- Participation in the operational acceptance of AFSPC range safety systems.
- Approval of Skyscreen site locations.
- The development and maintenance of the Range Safety Operations Requirement (RSOR).

1.3.3.2.2.4 Risk Analysis (SELR)
SELR assesses the risk of launch vehicle toxics/blast/debris hazards to mission-essential personnel and the general public. The Risk Analysis function includes:

- The development of launch vehicle databases.
- The performance of launch risk analysis for debris, toxic, distant focusing overpressure (DFO), and radiation hazards. These will be discussed in greater detail in another lesson.
- The review of data involving the launch of payloads containing radioactive material (including advising the SW/CC).
- The determination of operational requirements for risk analyses, the development and management of risk models.
- The development of Launch Safety decision or Launch Commit Criteria (LCCs).

1.3.3.2.2.5 Flight Analysis (SELF)
The Flight Analysis function involves:

- The review and approval of flight plans: SELF uses Range User provided launch vehicle and trajectory data and incorporates instrumentation coverage to perform a risk assessment of the proposed flight plan.

- Development of criteria used to exercise positive control of launch vehicle flight: The results of the trajectory and instrumentation analysis are used to build mission and display data bases to build simulations for risk assessment and to develop Range Safety background displays which enable real-time display of Instantaneous Impact Point (IIP), Present Position (PP), debris patterns, impact limit lines and other data that allow the MFCOs to determine if destruct actions are necessary. This data is also used to build simulations for MFCO training.
- Recommending the need for a Flight Termination System (FTS) (for launch vehicles and/or payloads) based on the analyses of the launch vehicle capabilities and trajectory, assessing the proposed FTS configuration, and performing the required analyses of the FTS.
- Aiding in the development and coordination on mission rules.
- Identification and evaluation of risk reduction measures.
- Performing near real-time risk assessments in support of launch operations.
- Development of mathematical models to help perform these tasks.

1.3.3.2.3 45th Operations Group (45 OG)

The 45 OG operates the Eastern Range, oversees the development of range support contracts, and ensures a structured training and certification program is developed, documented and maintained for key personnel supporting launch operations. The 45 OG consists of five squadrons, the Standardization and Evaluation section (OGV) and two detachments, which perform all ER launch operations including Delta IV, Atlas V, Falcon 9, and Pegasus space launch vehicles. The OG also provides support for Naval Ordnance Test Unit (NOTU) operations.

1.3.3.2.3.1 1st Range Operations Squadron (1ROPS)

MISSION

Operate, maintain and sustain the assets of the Eastern Range through all phases of launch and landing while delivering fully integrated, innovative, agile, and responsive support to current and future launch operations and tests.

VISION

A fully integrated world-class team providing assured access to space.

The 1st Range Operations Squadron (1 ROPS) is the operations unit of the 45 OG. 1 ROPS manages, directs, and controls range resources to support launch operations. One of the primary functions of the 1 ROPS is to provide customer support to launch operations on the ER. 1 ROPS provides this support by documenting customer requirements, scheduling the operations, acting as the lead range to coordinate support from other ranges, providing command and control of agencies supporting the launch, and coordinating ER instrumentation operations. The 1 ROPS is comprised of two operations flights, a scheduling flight, a program management flight, and an engineering and technical support flight. These flights have the following responsibilities:

- Operations Flight (DOO): The Operations Flight provides fully trained and certified personnel to perform range operations and enforce public safety for all missions.
    - DOOA: Responsible for managing “non-crew” mission support functions. Also, manages the Space Launch Intrusion Prevention System (SLIPS) to ensure safe

maritime operations during launches. Additionally, provides Sea Surveillance Camera Operators who gain visual confirmation of maritime intruders and track launch vehicle ascent. Lastly, DOOA are range ambassadors, providing orientation services to distinguished visitors and families.

- DOOB: Responsible for managing Operational Documentation that governs how operators execute pre-launch and day of launch operations on the Eastern Range. In addition, we are responsible for ensuring Pubs & Forms and mission planning requirements are adequate and current.
- DOOC: Responsible for managing the 1 ROPS crew force. In addition to drafting the crew schedule, DOOC ensures that leading up to each mission, each crew member is properly trained and certified in their position, has received appropriate crew rest, and is medically cleared to sit on console.).
- DOOD: Responsible for committing Range Instrumentation for all launches on the Eastern Range. This includes Radars, Telemetry, Optics, and Range Safety Display systems for tracking, Command for flight termination, as well as Meteorological, Communications, Timing, and Area Surveillance systems. We evaluate the status of Range Instrumentation and provide the impact of failures to the Range Team.
- DOT: Responsible for conducting training and creating training products for the crew force. We ensure that before each mission, the crew members on console have received the training they need to proficiently carry out the duties of their position.

- Range Scheduling Flight (DOUS): DOUS serves as the wing single point of contact for range scheduling. DOUS prepares and deconflicts all ER ops and launch schedules in conjunction with other national ranges. DOUS schedules resources, airspace, frequencies, and equipment and de-conflicts between all the operations, tests, and training that must occur with Range assets.
- Program Management Flight (DOUF): DOUF is responsible for providing a Program Support Manager (PSM) for users as the primary Point of Contact (POC) for range support. The PSM is responsible for managing range requirements after issuance of the Statement of Capability IAW UDS requirements and providing mission support by coordinating with other ranges IAW DoDD 3200.11 MRTFB.
- Range Sustainment (MAS) and Management Ops (MAO): Provides range systems engineering, operations, and maintenance expertise to ensure mission success. The flights provide the expertise required to keep the Eastern Range Green for launch operations and executes the 45th Space Wing's Chief of Maintenance responsibilities for the Launch and Test Range System. Assigned responsibilities include contract surveillance, requirements management, and operations acceptance for range systems. The squadron's personnel serve as technical experts who direct anomaly resolution, commit instrumentation for launch, and produce engineering analyses.

1.3.3.2.3.2 45th Operations Support Squadron (45 OSS)

The 45th Operations Support Squadron provides combat capabilities and assured access to air and space through support of launch range and expeditionary operations. In fulfilling its mission, the 45th OSS provides a variety of functions directly related to 45th Space Wing's launch operations. It consists of four flights:

- Current Operations (OSO): The Current Operations Flight manages a variety of programs on Patrick Air Force Base and Cape Canaveral Air Force Station, Fla. This flight manages the 45th Space Wing's Crisis Action Team by preparing for crisis events, training senior leaders and staff, and developing policies and procedures to guide the wing in emergencies. It also manages the 45 OG/CC's Operation Status brief for all senior leaders and launch customers on the Eastern Range, creating a common operation picture for the launch enterprise. Lastly, the Training section of the flight provides wing training policy and guidance for more than 60 space launch operators. They coordinate instructor training for all 45th Operations Group mission-ready personnel, as well as directly assist the operations squadrons in improving their unit training programs. The training team serves as the Operations Group interface with higher headquarters on all new training requirements and procedures.

- Weapons and Tactics Flight (OSK): The Weapons and Tactics flight is comprised of both MR operators and Intelligence personnel. The flight is the wing's steward in many facets to include support to 14th Air Force and U.S. Strategic Command exercises, Space Warfighter Education courses, Post Operation Launch Assessments, Operation Review Boards, Integrated Range Countdown Rehearsals and Unclassified Read Files and Current Intelligence Briefs. Also, they retain personnel with instructor and evaluator status who support operational and advanced training to develop tactics, techniques and procedures in support of Space Mission Force (SMF) objectives.
- Airfield Operations Flight (OSA): The 45th Airfield Operations Flight manages the Patrick AFB and CCAFS airfields and provides air traffic control services in support of the space launch range, tenant units, and the National Airspace System. Airfield Management oversees the overall quality and safety of the airfield. They also provide transient and base-assigned aircraft and flight crew services and has supported numerous multi-service deployments and humanitarian missions.
- Maintenance Flight (OSM): The 45th Maintenance Flight manages the Air Traffic Control and Landing Systems (ATCALS), Transient Alert, and Aerospace Ground Equipment maintenance activities. The ATCALS section maintains the Patrick, Cape and Kennedy airfield control and landing systems along with day of launch support at 15 different facilities across over 2,500 miles with an account valued at over $7.2M in assets. The TA and AGE sections are contracted services surveilled by dedicated Contract Officer Representatives (CORs). The two COR's oversee all aircraft and aerospace ground equipment maintenance activities for Patrick The Cape; including support of all scheduled and unscheduled aircraft support, day of launch support, national defense and President of the United States (POTUS) missions with equipment valued at over $3.7M in assets.

1.3.3.2.3.3 45 OG Standardization & Evaluation (45 OGV)/1 ROPS Standardization and & Evaluation (DOV)

The primary mission of OGV is to evaluate operations crew member performance and provide feedback to unit commanders on operational readiness and effectiveness of mission ready training. In addition, OGV also standardizes Day of Launch processes and procedures for the 45th Operations Group. To accomplish this broad mission, OGV develops, maintains, and implements a robust standardization and evaluation program for 7 mission ready positions, and oversees evaluations in 4 specialized training certification positions and 5 on-the-job training positions. In addition, OGV ensures compliance with AF, AFSPC, and NAF Spacelift operations policy and procedures via Inspections, Launch Operations, Mission Dress Rehearsals, and Integrated Crew Exercises. Finally, OGV manages the quarterly Group Operations Review Panel and serves as the group monitor for the self-assessment program. 1 ROPS DOV shares and supports the responsibilities of 45 OGV.

1.3.3.2.3.4 45th Weather Squadron (45 WS)

The 45th Weather Squadron provides a 'Go/No-Go' weather recommendation for every space launch from Cape Canaveral Air Force Station and Kennedy Space Center. The 45th WS coordinates weather operations requirements with Department of Defense, National Reconnaissance Office, National Aeronautics and Space Administration (NASA), and commercial launch agencies to provide tailored weather services and equipment to support all phases of launch operations: generation, execution, and recovery. The 45th WS also provides 24/7 weather warnings and forecasts for the Eastern Range. This includes weather support for aviation operations at Patrick Air Force Base and Cape Canaveral Air Force Station. The squadron is organized in an Operations Flight, a Training Flight, and a Systems Division.

- The Operations Flight provides weather support for the generation, execution, and recovery phase of all operations that take place on the Eastern Range, along with airfield forecasts and around-the-clock resource protection for Patrick AFB, Cape Canaveral, and Kennedy Space Center, ensuring 25,000 people and $20B worth of buildings and assets are safe.
- The Training Flight sets the foundation for everything that happens within the squadron, by training and evaluating all squadron members, forecasting and enforcing future training requirements, and ensuring compliance will all applicable rules and regulations.
- The Systems Division is responsible for monitoring the maintenance of a $80M weather super-system, while continually developing requirements for new equipment and pursuing new and diverse avenues to correct operational deficiencies that enhance operational weather support, along with scientific services such as climatology, developing new forecast techniques, and technical consultation to the 45th Space Wing and Kennedy Space Center.

1.3.3.2.3.5 45th Space Communications Squadron (45 SCS)

The 45 SCS serves as single communications integrator for PAFB, CCAFS and the ER. The 45th Space Communications Squadron is responsible for guaranteed, protected access to a full range of data, information and services while providing a climate of trust, respect and equal opportunity emphasizing accountability, recognition and improvement of people and processes. The 45th Space Communications Squadron is composed of three flights.

- The Operations Flight maintains mission-ready Command, Control, Communications, Computers, and Intelligence (C4I) including closed-circuit television, wideband communications and client training, and provides protected communications and information infrastructure including voice, video, network and customer services.
- The Plans and Resources flight manages communications plans, programs and policies facilitating system integration, architecture and office automation.
- The Spectrum Mission Flight executes the 45 SW Commander's spectrum management mission as well as conducts frequency control, surveillance and analysis for spacecraft transport and day-of-launch operations to include special electromagnetic missions.

1.3.3.2.3.6 45 OG Detachments

- Detachment 2 (Det 2) operates and maintains Ascension Auxiliary Air Field. Det 2 also supports ER launches by collecting and disseminating radar and telemetry tracking data. Det 2 also support US Strategic Command (USSTRATCOM) Space Surveillance Network (SSN) by providing radar tracking data for locating and cataloging space objects. Det 2 is responsible for airfield operations and supports US global reach missions by providing en-route refueling or basing as required. Det 2 also support tenant units including the 50 SW Global Positioning System (GPS) ground station and the

AMC High Frequency (HF) Global Communication System ground station.

- Detachment 3 (Det 3) is responsible for coordinating astronaut rescue and recovery, contingency landing site support, payload security, medical support, coordination of airlift/sealift for contingency operations, as well as other support services required in the event of a spacecraft emergency. The office further develops functional/operational documents with USSTRATCOM and coordinates with elements of the military departments, combatant commands, DoD agencies, and other USG agencies, and then monitors the status of those forces during mission execution.

1.3.3.2.4 45th Launch Group (45 LCG)

The 45 LCG mission is to vigorously pursue mission success through seamless partnerships with launch and satellite systems directorates to satisfy National, Civil and Combatant Commander requirements for space access. The 45th LCG responsible for conducting Launch Vehicle Mission Assurance (LVMA), Space Vehicle Mission Assurance (SVMA) and risk assessment for the LRSD and the Satellite System Wings via the DIRLAUTH relationships. The 45 LCG performs launch site integration for LV, SV, facility, and infrastructure operations and oversees safety, security, environmental compliance, and resource protection for LV, SV, and facilities that the 45 SW/CC has been assigned flight worthiness and LVMA/SVMA responsibilities. The 45 LCG consists of two units:

- 5th Space Launch Squadron (5 SLS): The 5th Space Launch Squadron provides world-class mission integration, technical surveillance and risk assessment of Atlas V and Delta IV launch vehicle processing, scheduling and operations in pursuit of 100% mission success from Cape Canaveral Air Force Station, Fla.
- 45th Launch Support Squadron (45 LCSS): The 45th Launch Support Squadron delivers a broad array of organic launch and launch support capabilities. In partnership with the satellite system directorates, 45 LCSS provides launch-base mission assurance for satellites by overseeing spacecraft hardware arrival, launch preparations, testing and launch. In addition, the squadron contains a program management office which ensures delivery of mission-critical facilities, launch support services such as training and ordnance management, and programmatic resources to Eastern Range customers. Finally, 45 LCSS provides a single interface for emerging DoD, civil, and commercial launch providers to access 45th Space Wing services and successfully bring new launch capabilities to the United States.

1.3.3.2.5 45th Mission Support Group (45 MSG)

The 45th Mission Support Group delivers full spectrum support to assure success of launch, range and expeditionary operations. The 45th MSG provides world-class mission support for range and launch operations ensuring the vitality of national space activities for the Department of Defense, National Aeronautics and Space Administration and commercial entities. It consists of the 45th Civil Engineering Squadron, 45th Contracting Squadron, Detachment 1, 45th Force Support Squadron, 45th Logistics Readiness Squadron, and 45th Security Forces Squadron.

1.3.3.2.6 45th Medical Group (45 MDG)

The 45th Medical Group (45 MDG) provides medical and dental services to military members and families. The 45 MDG provides medical support to keep crew force medically qualified for console operations.

1.3.4 MISSION PARTNERS

There are many mission partners that the 45 SW works with in support of DoD, civil and commercial launches.

1.3.4.1 Federal Aviation Administration (FAA)

The Federal Aviation Administration (FAA) is primarily responsible for overseeing safety of commercial space launch and reentry. It has the responsibility and authority to oversee the conduct of all licensed launches and may prohibit, suspend, or end immediately a licensed launch prior to flight, if at any time, it determines such launch is detrimental to public health and safety of property, or any national security or foreign policy interest of the US.

1.3.4.2 National Aeronautics and Space Administration (NASA)

The National Aeronautics and Space Administration (NASA) pioneers the future in space exploration, scientific discovery and aeronautics research. The ER provides support to NASA's Launch Services Program. The Launch Services Program was established at Kennedy Space Center (KSC) for NASA's acquisition and program management of expendable launch vehicle missions. The objectives of NASA's Launch Services Program are to provide safe, reliable, cost-effective and on-schedule processing, mission analysis, and spacecraft integration and launch services for NASA and NASA-sponsored payloads (such as National Oceanic Atmospheric Administration's (NOAA) Geostationary Operational Environmental Satellites (GOES)) needing a mission on expendable launch vehicles. The Launch Services Program supports launches from CCAFS, VAFB, NASA's Wallops Flight Facility, North Pacific's Kwajalein Atoll in the Republic of the Marshall Islands, and Kodiak Island in Alaska.

1.3.4.3 Naval Ordnance Test Unit (NOTU)

The Naval Ordnance Test Unit (NOTU) is a field activity of Navy Strategic Systems Programs and is responsible to the Commander-in-Chief, U.S. Atlantic Fleet. NOTU exists to support ballistic missile tests and submarine operations for the U.S. and United Kingdom at Cape Canaveral. This includes conducting Trident II D-5 missiles launches from a submarine at a launch point in the Atlantic Ocean.

1.3.4.4 National Reconnaissance Office (NRO)

The NRO Office of Space Launch (NRO/OSL) is responsible for the acquisition of NRO launch vehicles, launch vehicle integration, transport of satellites, launch-base processing, and infrastructure support for NRO payloads. The NRO/OSL is headquartered in Chantilly, Virginia but has detachments at each launch base to oversee launch base processing and launch. NRO/OSL personnel get involved early in the mission concept design phase of a satellite system—as early as five to ten years prior to launch, to ensure launch aspects are a part of the spy satellite's system design trades. For LV processing, the NRO/OSL works with and relies on the AF Launch and Range Systems Wing to conduct "pedigree" reviews on flight-critical booster hardware items and to ensure that configuration changes to the LV fleet do not add technical risk to a specific mission. It also relies on 45 LCG personnel to oversee LV processing at the launch base. For NRO SV processing, the NRO/OSL functions in much the same way as the 45 LCSS does for other DoD payloads, performing management, oversight, maintenance, and sustainment of satellite processing facilities and overseeing all SV processing and countdown activities.

1.3.4.5 United Launch Alliance (ULA)

United Launch Alliance (ULA) is a joint venture owned by Lockheed Martin and Boeing that was created to provide reliable, cost-efficient spacecraft launch services for the U.S. government including the DoD, NRO and NASA. It conducts launch operations with the Lockheed Martin Space Systems Atlas V and the Boeing Integrated Defense Systems Delta IV launch vehicles at CCAFS and VAFB. ULA program management, engineering, test and mission support functions are headquartered in Denver, Colorado. Manufacturing, assembly and integration operations are located at Decatur, Alabama; Denver, Colorado; Harlingen, Texas; and San Diego, California. Under the terms of the joint venture, both Delta and Atlas rockets are available for individual missions. This ensures that government customers are able to make decisions based on launch vehicle and launch site availability options to meet the goal of assured access to space. The ULA team carries out all mission activities, including launch vehicle integration, payload processing, launch operations and mission support. Commercial customers can procure Atlas V launch services through Lockheed Martin Space Systems and Delta IV launch services through Boeing Integrated Defense Systems.

1.3.4.6 Space Exploration Technologies Corporation (SpaceX)

The Space Exploration Technologies Corporation (SpaceX) is a space-transportation headquartered in Hawthorn California, and was established by Elon Musk. The company was founded in 2002 to revolutionize space technology, with the ultimate goal of enabling people to live on other planets. Under a $1.6 billion contract with NASA, SpaceX is flying numerous cargo resupply missions to the International Space Station, for a total of at least 20 flights under the Commercial Resupply Services contract. In 2016, NASA awarded SpaceX a second version of that contract that will cover a minimum of 6 additional flights from 2019 onward. In the near future, SpaceX will carry crew as part of NASA’s Commercial Crew Program as well. Dragon was designed from the outset to carry astronauts and SpaceX is in the process of upgrading Dragon to make it crew-ready. SpaceX is the world’s fastest-growing provider of launch services and has over 70 future missions on its manifest, representing over $10 billion in contracts. These include commercial satellite launches as well as NASA and other US Government missions. Currently under development is the Falcon Heavy, which will be the world’s most powerful rocket. All the while, SpaceX continues to work toward one of its key goals—developing reusable rockets, a feat that will transform space exploration by delivering highly reliable vehicles at radically reduced costs.

1.3.4.7 Orbital Sciences Corporation (OSC)

The Orbital Sciences Corporation ((OSC), though commonly referred to as Orbital) is a Dulles, Virginia Company which specializes in satellite launch and manufacture. Its Launch Systems Group is heavily involved with missile defense launch systems. Orbital is an industry leader in small space and rocket systems, including lightweight launch vehicles that transport satellites into orbit, target rockets used to test missile defense systems, and interceptor booster vehicles that are deployed to protect against enemy missile attack. Their launch vehicles include the Minotaur, Pegasus, and Antares launch vehicles. Orbital has conducted several Pegasus launches from the company's Stargazer L-1011 carrier aircraft from within ER airspace.

1-4 THE EASTERN RANGE

1.4.1 OVERVIEW OF THE EASTERN RANGE

The Eastern Range is one of two Air Force ranges that make up the Launch and Test Range System (LTRS). Spanning more than 15 million square miles, ER consists of the launch head at Cape Canaveral AFS (CCAFS) and a network of instrumentation sites in a chain along the east coast of the United States as well as remote sites located in the Atlantic Ocean. In addition, the ER may use other DoD sites and/or the NASA facility at Wallops Island, Virginia. Mobile equipment/systems are dispatched as necessary to the downrange and uprange sites. For southeasterly space launches, the ER extends south to the Jonathan Dickinson Missile Tracking Annex (JDMTA) and down range to Ascension Auxiliary Airfield in the South Atlantic Ocean. For northerly space launches, the ER extends north to Wallops Islands, Virginia (NASA) to ensure contiguous coverage throughout the launch corridor. The ER supports satellite launches into low to mid inclination orbits, Submarine Launch Ballistic Missile (SLBM) tests, and space tracking support to the Space Surveillance Network (SSN). The launch sites on Kennedy Space Center (KSC) and CCAFS are capable of supporting most launch azimuths from 37° to 114 ° with some excluded for safety restrictions.

Figure 1-4-1: *The Eastern Range*

1.4.1.1 Numerical Designators

Most of the instrumentation sites utilized by the ER have been assigned numerical station designators that are used to identify particular equipment and its site location. The numerical designations for the ER sites are as follows:

- 0 – Patrick AFB
- 1 – Cape Canaveral AFS (CCAFS)
- 12 – Ascension Auxiliary Airfield
- 19 – Kennedy Space Center (KSC)
- 28 – Jonathan Dickinson Tracking Annex (JDMTA)
- 86 – Wallops Flight Facility (WFF)

For example, the Command Destruct site at JDMTA may be referred to as JDMTA Command or Station 28 Command.

1.4.1.2 Color Coding

In addition, there are color codes assigned to instrumentation systems or their associated personnel which are used in conjunction with their site's numeric designators to make up their on-net call signs. This helps personnel to quickly identify the equipment or personnel and their site location while coordinating actions and reporting status or outages on the voice nets. The color codes of particular interest are:

- Gold – C-Band Radars
- Silver – Telemetry
- Bronze – Command
- Lemon – Instrumentation Data Processing (IDP)/Real Time Computers
- Platinum – Missile Tracking Instrumentation Systems (MTIS)

For example, JDMTA Command's call sign is "Bronze 28" and the IDP System Controller's call sign is "Lemon 1." In addition, letters are used at the end of the color-coded call sign when a site has more than one of a particular equipment type or to identify particular components or personnel of a Super System. For example, Radar 19.14's call sign is "Gold 19" while Radar 19.39's call sign is "Gold 19B." These call signs will be covered in more detail later in this manual when discussing the specific instrumentation systems.

1.4.1.3 Cape Canaveral Air Force Station (CCAFS)

CCAFS is the primary launch head of the ER. It is bordered on its east side by the Atlantic Ocean, on the north and west by KSC and to the south by Port Canaveral, the Coast Guard Station, the Navy Wharf, and the Navy Trident (submarine) Turning Basin. The Cape's boundaries encompass complete assembly and launch facilities to store, process, checkout, and launch solid and liquid fueled vehicles and their associated satellites. There are more than 20 active and abandoned launch complexes (also referred to as Space Launch Complexes or "SLCs"; pronounced "Slicks") spread along the CCAFS Atlantic coastline including four active launch complexes for the Atlas V, Delta IV, and Falcon launch vehicles. The Cape also has facilities for storing rocket motors, ordnance devices, and commodities such as liquid propellants, liquid hydrogen, oxygen, and nitrogen. The Cape includes various range instrumentation to support launches from the ER to include radar, command sites, camera and optical sites, data processing and display systems, meteorological systems, and various communications systems. The Cape also has control centers for the launch vehicle, spacecraft, and the Range for command and control functions during pre-launch testing and launch. The Cape also has an Industrial Area, a large service complex located on the center west side of CCAFS adjacent to the Indian River.

The Cape also has a runway, referred to as the Cape Canaveral AFS Skid Strip. It has an asphalt paved runway designated 13/31 and measuring 10,000 x 200 ft. (3,048 x 61 m). The Skid Strip was originally used by NASA transport aircraft carrying the S-IVB upper stage for the Saturn IB and Saturn V rockets used in Project Apollo. Today, it is predominantly used by aircraft transporting flight hardware to include launch vehicle components (such as the Atlas V booster and Centaur upper stage) and satellite payloads to CCAFS for mating with launch vehicles. It is also used by the Navy Firescout and U.S. Customs and Border Protection for conducting the Unmanned Aerial Vehicles (UAV) operations.

Figure 1-4-2: *Cape Canaveral AFS*

The Cape Skid Strip can also be scheduled to support other operations to include Pegasus/L1011 operations.

The ER also has special use airspace to include restricted and warning areas that can be activated for ER operations. The special use airspace may be activated in support of other ER operations as required. This airspace is typically activated for:

- Launch operations
- Conducting U.S Customs and Border Protection UAV Operations

1.4.1.4 Kennedy Space Center

KSC is the other launch head on the ER, functioning as the NASA field center that manages and operates America's astronaut launch facilities. It contains the processing and support facilities, launch control center, and launch complex. KSC also includes processing facilities that are used to process components and payloads for the International Space Station (ISS). KSC is also responsible for overseeing launches of unmanned NASA spacecraft from CCAFS. KSC also has an Industrial Area, which includes the Headquarters Building and processing and checkout facilities for payloads for the ISS or expendable launches vehicles launching from CCAFS. KSC also provides direct radar, optics, telemetry and communications support for the ER. There are two ER radars and an ER optics site on KSC property to provide metric tracking data. KSC is home to Tel-4, the ER central telemetry acquisition, processing, and distribution center.

1.4.1.5 Patrick Air Force Base

Patrick AFB is the headquarters for the ER. It provides administrative and logistics support to the organizations and personnel at CCAFS. It has a radar site and a metric optics site to provide metric tracking data to CCAFS. Patrick AFB is also home to the 920th Rescue Wing (920 RQW), part of Air Force Reserve Command. The 920 RQW is a search and rescue organization operating the HC-130P/N "King" variant of the C-130 Hercules and HH-60G Pave Hawk helicopter. This unit is comprised of AF Reserve personnel and provides aircraft support for Range Safety surveillance operations for ER launches.

1.4.1.6 Jonathan Dickinson Missile Tracking Annex

Jonathan Dickinson Missile Tracking Annex (JDMTA) is located 100 miles south of CCAFS at Tequesta, Florida. It is in an isolated corner of the 10,284 acre Jonathan Dickinson State Park. The site provides radar, telemetry, command destruct, and Global Positioning System (GPS) metric tracking support. JDMTA provides back-up coverage for CCAFS during pad launches, covering gaps in CCAFS radar and telemetry coverage due to signal attenuation from the launch vehicle exhaust plume. JDMTA is the primary tracking site during Navy Trident II operations. It has the capability to simultaneously track two separate missiles.

1.4.1.7 Ascension Auxiliary Air Field

Ascension Auxiliary Air Field, located on Ascension Island, and is the farthest south of any of the range facilities. Ascension Island is a British territory located in the South Atlantic more than 5,090 miles southeast of Patrick AFB and about 500 miles south of the equator--halfway between South America and Africa. Small and volcanic, the island has the appearance of a rough circle with an estimated diameter of six miles and an area of 34 square miles. The tracking instrumentation at Ascension Auxiliary Air Field includes both radar and telemetry assets. It continues to support Navy Ballistic Missile Testing and the upper stage tracking and burn data requirements for some orbital launches. The radar site at Ascension also supports the USSTRATCOM Space Surveillance Network by providing radar tracking data for locating and cataloging space objects.

1.4.1.8 Wallops Flight Facility

The Wallops Flight Facility (WFF), located on the Eastern Shore of Virginia, is operated by NASA's GSFC, primarily as a rocket launch site, to support science and exploration missions for NASA and other U.S. government agencies. WFF includes a Research Range which supports launches of more than a dozen types of sounding rockets, small expendable suborbital and orbital rockets, and high altitude balloon flights carrying scientific instruments for atmospheric and astronomical research. It also includes a Research Airport which supports flight tests of aeronautical research aircraft including unmanned aerial vehicles. The WFF provides support to the ER to provide coverage for missions using northern launch trajectories. The instrumentation at WFF that is available for support include radar and telemetry sites. WFF is composed of three areas: the Main Base, the Mainland, and the Wallops Island Launch Site.

1.4.2 RANGE SCHEDULING RESOURCES

At times, there are many agencies competing with each other to launch satellites from the ER and the WR. These agencies include the DoD, NRO, NASA, and commercial users. To determine which agency/satellite has priority over the others and when it will be launched is determined by the Current Launch Schedule Review Board (CLSRB). The CLSRB is a quarterly forum chaired by 14 AF/CC and attended by senior officers, program managers and commercial representatives from the launch community. The purpose of the CLSRB is to solidify the

Current Launch Schedule (CLS) and produce an executable launch schedule based on national priorities. The CLSRB process includes assessing LV and SV readiness and available resources to assign launch opportunities and launch dates to specific missions.

The CLS is a 24-month projection of launches from the ER and WR, approved by the 14 AF (AFSTRAT)/CC at the CLSRB. It includes the Executable Launch Schedule. An "Executable Launch Schedule" consists of range approved dates and is a subset of the 0-24 month CLS. The Executable Launch Schedule provides direction to the space wing commanders to execute approved Unified Combatant Commands (UCC) missions and support for other approved government, civil, and commercial missions.

The National Launch Forecast (NLF) is a fiscal forecast extending nine years beyond the CLS. It includes all national launches (DoD, NRO, Civil, and Commercial) from the ER and WR. The NLF is a collection of launch requirements provided by the Point of Contact (POC) for each program. AFSPC/A3 is responsible for the NLF. Prior to each CLSRB, missions are transferred from the NLF to the CLS.

1.4.2.1 1 ROPS Scheduling Section (DOUS)

The 1 ROPS Scheduling Section (DOUS) is the single scheduling authority for all launch, launch associated tests and internal range activities requiring ER and 45 SW support resources excluding base support and 45 SW Safety Office functions. Their mission objective is to ensure that all launches, operations and associated tests are fully supported on the dates and times requested by the range customer, or as close to the requested date and time as possible. 1 ROPS/DOUS is the 45 SW Office of Primary Responsibility (OPR) for consolidating and providing 45 SW launch status updates to 14th Air Force (AFSTRAT) and the CLSRB. DOUS produces the official Range Operations Schedule. This includes the schedule for the instrumentation, personnel, frequency usage or protection, airspace, and facilities. DOUS schedules all of these resources using the Range Automated Tasking System (RATS). The RATS system will send e-mail notifications to range personnel when an operation requires someone in their applicable crew position.

1.4.2.2 Maintenance and Operations Coordination Center (MOCC)

The Range schedule can be viewed at the Maintenance and Operations Coordination Center (MOCC) Webpage. The MOCC web site is managed by DOUS at URL: https://emocc.patrick.af.mil and was established to provide range schedule and launch status information while reducing operational impacts. It provides range status to 45 SW leadership and is a readily accessible tool for all range users. The website is available to personnel with 45 SW Local Area Network access. Range crew members can utilize the MOCC webpage to find pre-mission tests associated with their assigned mission that will require their support. Range crew members can find this information on the MOCC webpage by referencing missions Operation Number (OPNR). Each operation is assigned a unique OPNR which is a five-digit alphanumeric designator assigned to all operations scheduled on the Range. This number is used to identify, track and apply charges for support. In some cases, OPNRs are referenced to avoid any inadvertent reference to mission information such as for classified launches.

1.4.3 DAY OF LAUNCH ROLES AND RESPONSIBILITIES

On launch day, there are several Key Range and Range User positions that perform critical functions. Day of launch roles and responsibilities differ between Autonomous Flight Safety

System (AFSS) missions and non-AFSS. Figure 1-4-7 illustrates the lines of authority for non-AFSS launch day operations. Figure 1-4-8 illustrates the lines of authority for AFSS launch day operations. It does not necessarily reflect the reporting flow on launch day.

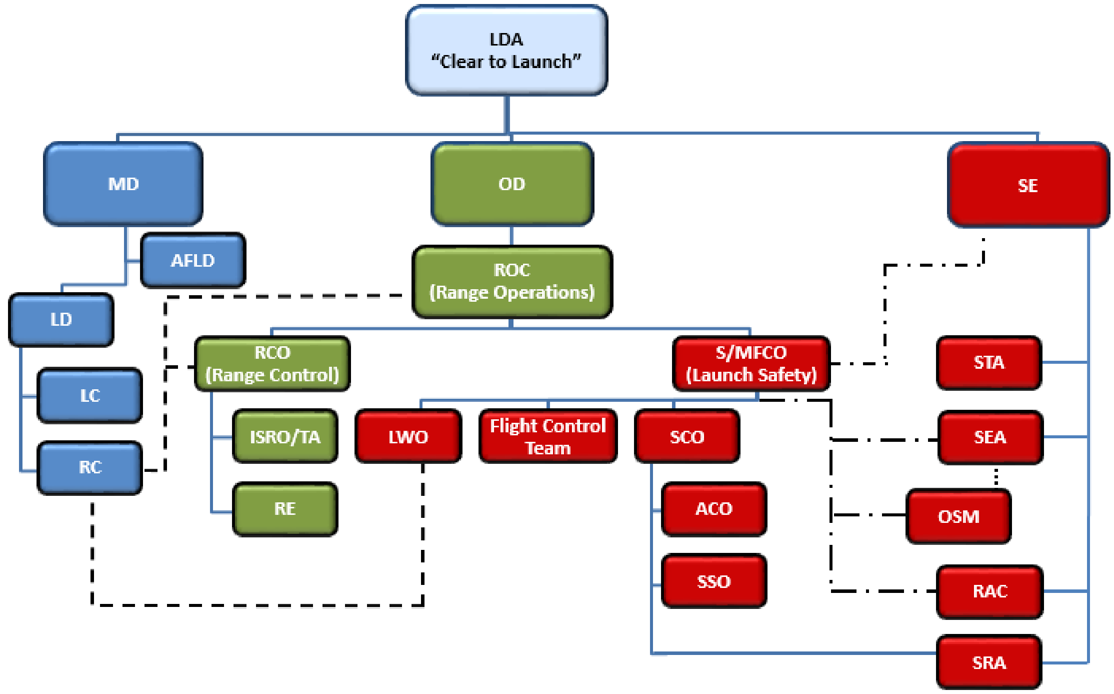

Figure 1-4-3: *Non-AFSS Day of Launch Lines of Authority*

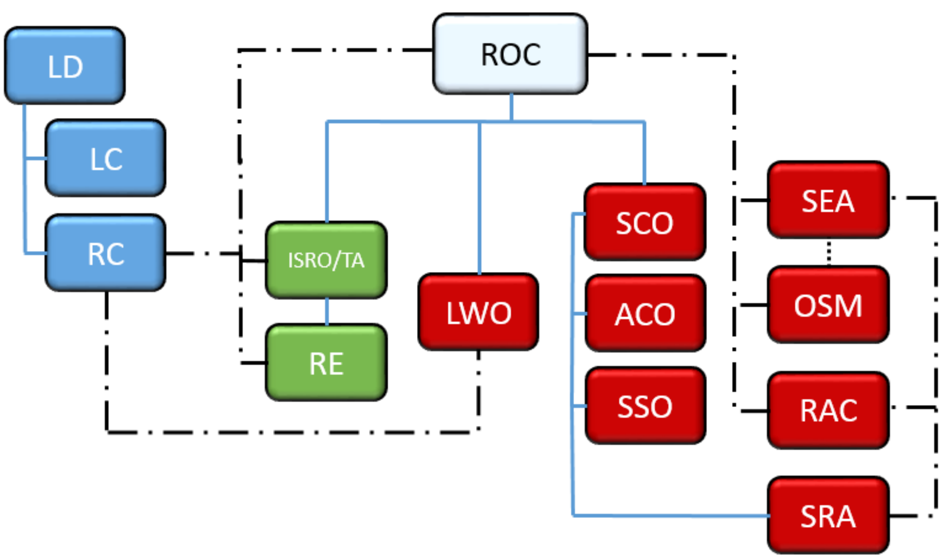

Figure 1-4-4: *AFSS Day of Launch Lines of Authority*

1.4.3.1 Launch Decision Authority (LDA)

Normally, the 45 SW/CC serves as the Launch Decision Authority (LDA) or delegates the LDA function to a trained and certified LDA. The 45 SW/CC is normally the LDA, the responsibilities of the LDA are not the same as the responsibilities of the 45 SW/CC. The LDA is accountable to 14 AF/CC (specifically Range Operations, Safety, and Base Support Operations) and launch execution. For all operations, the LDA ensures the safety of the public and protection of resources. The LDA assesses inputs from Mission Director (MD), Operations Director (OD), and Chief of Safety (SE), and issues the "Final Clear to Launch." The "Final Clear to Launch" is given based on the LDA's authority delegated by the 14 AF/CC and is based on:

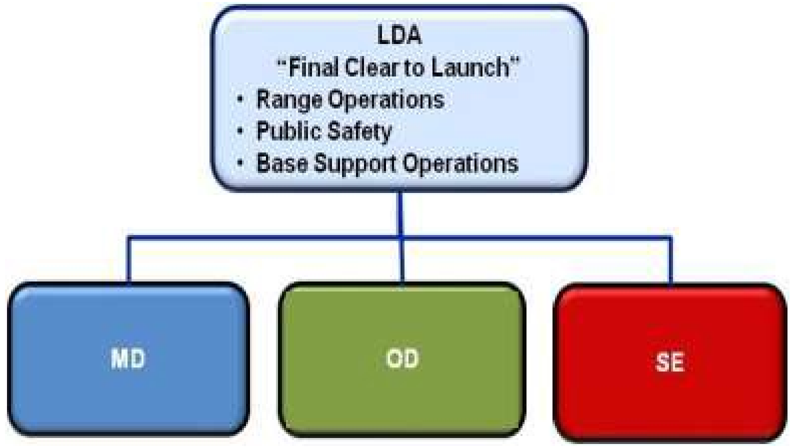

Figure 1-4-5: *LDA Final Clear to Launch Rational Chart*

- The ability of the ER to meet Launch Safety Launch Commit Criteria to include the ability to track the launch vehicle, to send command functions if required, and to clear personnel from hazardous launch areas
- The ability of the ER to meet Range User Instrumentation requirements
- LDA may not override a "No-Go" decision of the MD. The LDA has waiver authority for mandatory launch safety requirements (only for DoD launches).

1.4.3.2 Commander's Advisory Board (CAB)

The Commander's Advisory Board (CAB) is comprised of 45 SW senior leadership or their representatives who provide information and advice to the LDA. The CAB may also assume Commander Senior Staff responsibilities as required. Nominally, the CAB will consist of the OD, 45 SW/CD, 45 SW/SE, 45 LCG/CC, 45 MSG/CC and the FAA. The Range Operations Commander (ROC) is the interface between the CAB and the Range.

1.4.3.3 Operations Director (OD)

The Operations Director (OD) is responsible for overseeing the countdown and advising the LDA on range operational issues. The OD ensures all range resources are capable and ready to support range operations. The OD provides "Go/No-Go" status to the LDA during the Final Clear to Launch Poll. Normally, the 45 OG/CC serves as the OD or delegates the OD function to a trained and certified OD.

1.4.3.4 Chief of Safety (45 SW/SE)

The Chief of Safety (45 SW/SE) serves as the LDA's primary advisor on all public and launch site safety issues. The SE assesses safety risks, advises the LDA on waivers to Launch Safety requirements, and provides "Go/No-Go" status to the LDA during the Final Clear to Launch Poll.

1.4.3.5 Range Operations Commander

The Range Operations Commander (ROC) is the MR position that serves as the overall range operations lead during ER launch operations and provides command and control of the MOC. The ROC coordinates operational briefings and range anomaly resolution actions and assesses operational impacts. The ROC provides operations- related information and advice to the LDA and OD which includes anything that affects Range Status, countdown progression, or a nominal plus count. The ROC determines Range readiness based on RCO and MFCO status. The ROC determines Range Status. The ROC is the Day of Launch interface to the launch agency for strategic issues.

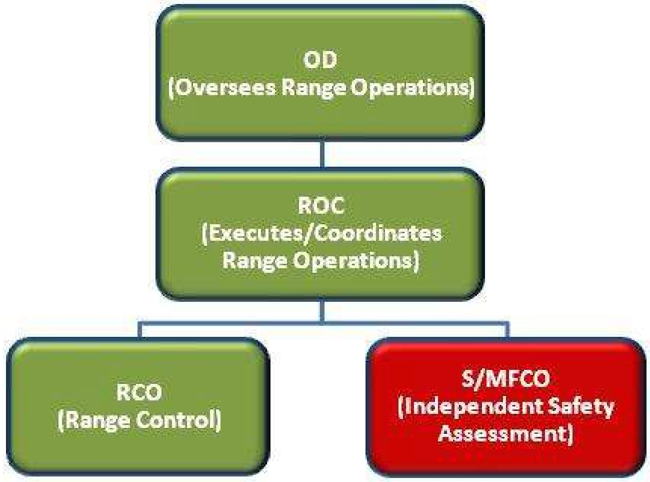

Figure 1-4-6: *ROC Relational Chart*

1.4.3.5.1 AFSS ROC

The ROC during AFSS missions assumes additional responsibilities due to crew reduction. The ROC is responsible for Range Status Declaration, Range Instrumentation Monitoring, and Final Range Readiness Determination. Below are the roles that the ROC covers in an AFSS mission.

- Range Operations Commander (ROC): The ROC remains the main interface with the launch customer throughout the count for range status. Final readiness status will be reported by the ROC during the launch provider's Go/No-Go poll.
- Range Control Officer's (RCO): Due to the lighter instrumentation footprint associated with AFSS, the RCO responsibility to ensure ER instrumentation is configured and able to meet User and Range Safety requirements is transferred to the ROC.
- Mission Flight Control Officer (MFCO): The ROC assumes the MFCO instrumentation monitoring responsibilities previously accomplished during the minus count. The AFSS itself inherently undertakes post flight MFCO actions and responsibilities.

1.4.3.6 Range Control Officer (RCO)

The Range Control Officer (RCO) is the position that executes the Range Control mission with support from various government and contractor personnel. The purpose of the RCO mission is to ensure the coordinated employment of all range assets and processes during test and launch operations to safely and efficiently achieve program, mission, or test objectives. The RCO ensures ER instrumentation or network assets are configured and able to meet User and Range Safety requirements and reports Range Instrumentation "Go/No-Go" to the ROC. The RCO may declare additional range equipment as mandatory to meet Range User requirements and is authorized to initiate launch holds during the countdown if ER instrumentation or network assets are unable to meet User and Range Safety requirements. The RCO is the DoL interface to the launch agency for instrumentation. The RCO is responsible for coordinating range configuration and testing, Range Status, and anomaly resolution/contingency actions between the Range Team, the Instrumentation Superintendent of Range Operations (ISRO), and base support personnel. The RCO is delegated responsibility for determining Range Status when the ROC is not on console. The RCO also interfaces with the Launch Correlation Unit to keep them informed of the status of the mission.

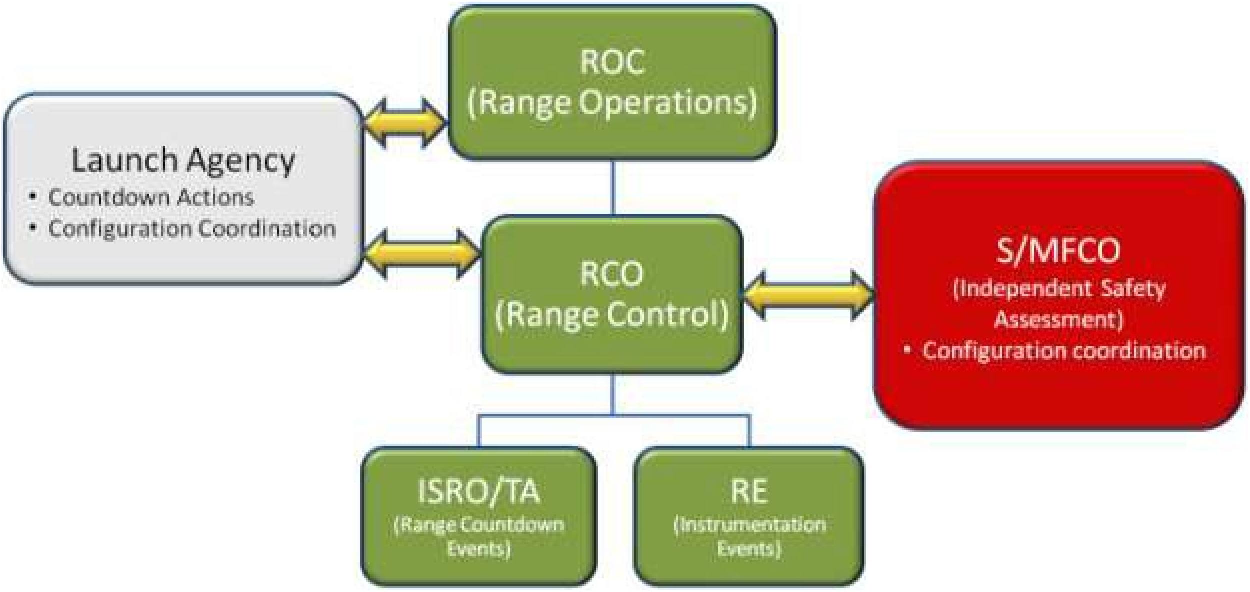

Figure 1-4-7: *RCO Relational Chart*

1.4.3.7 Range Generation Next (RGNext)

There are many people who perform functions as part of RGNext contract to checkout and operate the range instrumentation on launch day. The Instrumentation Superintendent of Range Operations (ISRO) is the RGNext contractor who interfaces directly with the instrumentation supersystem controllers supporting a launch. If the ER is lead range, the ISRO also receives Air Force Satellite Control Network (AFSCN) and Tracking and Data Relay Satellite System (TDRSS) network status from Network Operations (DoD Track). The ISRO conducts the range instrumentation countdown and notifies the RCO of nominal instrumentation configuration events. The ISRO receives site status through the supersystem controllers and determines instrumentation capability with Range Engineer (RE) concurrence. The Technical Advisor (TA) is the RGNext advisor to the RCO on console during operations. The TA's role is to provide advice and support to the RCO on technical issues. The Range Safety Display (RSD) Coordinator is the RGNext contractor who provides range safety display support to the MFCOs. This includes coordinating on the configuration of the RSD systems during training and launch operations

1.4.3.7.1 Network Operations

Network Operations, call sign DoD Track, is the ER interface for the supporting networks or Ranges. This includes such networks as the Air Force Satellite Control Network (AFSCN) or Goddard Space Flight Center's Space Network which utilizes the Tracking and Data Relay Satellites (TDRS). It also includes supporting ranges as the Western Range (WR) and the Wallops Flight Facility (WFF). DoD Track's responsibilities vary depending on the mission and also depending on the type of support requested by the use. For example, for expendable launch vehicle missions, DoD Track coordinates support and monitors the status of the AFSCN and or TDRSS network systems and reports status to the ISRO. Depending on the mission, DoD Track may interact directly with the Range User, relaying mission mark events, network status, or track data and acquisition messages.

1.4.3.8 Launch Weather Team

On launch day, the Launch Weather Team (LWT) supports both the Range and Launch Teams by evaluating Range Safety and User weather LCC. Those members include the following:

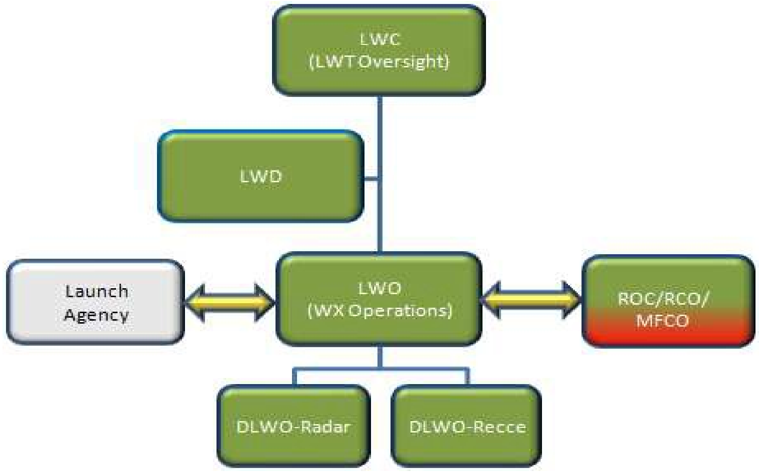

Figure 1-4-8: *Launch Weather Team Relational Chart*

- Launch Weather Commander (LWC): This is a MS position that is usually filled by the 45 WS/CC or Director of Operations (DO). The LWC provides oversight to the LWT and high-level technical support and advice to the LDA. The LWC provides final approval of NO GO to GO LCC status. This approval authority is delegated to the Launch Weather Director (LWD) when the LWC is not present in the Range Weather Operations Center.
- Launch Weather Director (LWD): This position is filled by a certified LWO. The LWD supervises LWT members and orchestrates the operation of the LWT during the launch countdown. The LWD assumes senior weather officer duties in the absence of the LWC.
- Launch Weather Officer (LWO): This is a MS position. The LWO is the 45 WS individual who is assigned as the lead to provide all weather support for the launch. The LWO observes, forecasts, and evaluates weather (including upper air wind profiles, severe weather advisory and warning services, etc.) with respect to Range Safety and Range User launch commit criteria. The LWO provides Weather “GO/NO GO” status to the User and Range teams.
- Deputy LWO Radar (DLWO-Radar): This position is filled by a certified LWO. The DLWO-Radar monitors weather radar and lightning equipment and immediately provides inputs to the LWO if or when any violations of weather criteria occur.
- Deputy LWO Reconnaissance (DLWO-Recce): This position is filled by a certified LWO. Coordinates support from a contract weather reconnaissance aircraft. The DLWO-Recce directs aircraft to areas of interest and uses aircraft reports, in combination with the DLWO-Radar, to validate weather conditions observed by radar equipment and provides inputs to the LWO.

1.4.3.9 Range Engineer (RE)

The Range Engineer (RE) is a representative of 1 ROPS. On day of launch, the RE monitors the range instrumentation tests and receives reports and recommended status for ER instrumentation from the ISRO and the supersystem controllers. The RE serves as the AF technical expert on range instrumentation, assessing the impacts of instrumentation failures, overseeing recovery actions, and committing restored systems to operational use. The RE can authorize emergency configuration changes to range instrumentation to meet mission requirements if required. The RE determines whether instrumentation is Fully, Partially, or Non-Mission Capable for launch and reports instrumentation failure outages to the MFCO, RCO, and ROC.

1.4.3.10 Senior/Mission Flight Control Officer (S/MFCO)

The Senior Mission Flight Control Officer/Mission Flight Control Officer (SMFCO/MFCO) are the Mission Ready (MR) positions responsible for executing the operational elements of the Launch Safety mission with support from various government and contractor personnel. The Launch Safety mission is to protect the public, launch base personnel (government and contractor), third party personnel and range infrastructure from the hazards associated with AFSPC launch and range operations. The MFCOs are responsible for the launch commit decision from a Launch Safety perspective during the minus count. The launch commit decision is based on the ability of range instrumentation to meet minimum Launch Safety requirements and a real-time assessment of public safety impacts based on compliance with Launch Safety Launch Commit Criteria (LCC). The MFCOs report Launch Safety GO/NO-GO status to the ROC based on Range Safety instrumentation/network requirements, Surveillance Control, Safety Weather, launch vehicle Range Safety Tracking Systems status, launch vehicle Flight Termination System status reported by the OSM, and Distance Focusing Overpressure (DFO)/Toxics/Debris status. The MFCO may upgrade required Launch Safety requirements to mandatory, unless specified differently in the mission rules and is authorized to initiate launch holds during the countdown for violations of LCC. During flight the MFCOs make the real-time decision to activate destruct systems and terminate a non-nominal missile or space vehicle flight, executing the flight safety program as developed by Wing Safety and implemented by the LDA. The MFCOs implement post-destruct procedures to protect the public in areas threatened by impact from debris and notify appropriate agencies of non-nominal operational events. The SMFCO is an experienced MFCO who has supported as the MFCO on at least five prior launches. The SMFCO assesses MFCO in-flight termination recommendations and provides final decision for in-flight actions unless certain time-critical circumstances do not permit the MFCO and SMFCO to coordinate their actions.

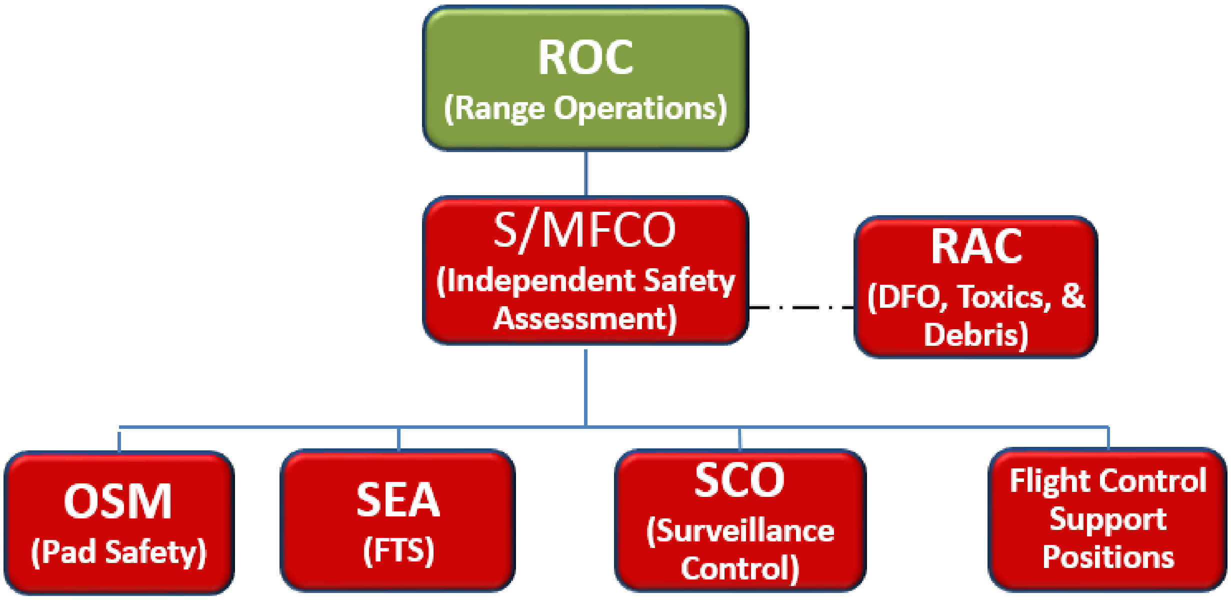

Figure 1-4-9: *Range Safety Relational Chart*

1.4.3.10.1 Flight Control Support Positions

There are several Flight Control positions which support the MFCO.

- Telemetry Systems Officer (TSO) monitors vehicle telemetry measurements and reports vehicle status to the MFCO during the countdown and flight. During the countdown, the TSO monitors the vehicle telemetry to ensure proper functioning of the vehicle Flight Termination System (FTS). During flight, the TSO monitors the vehicle telemetry and evaluates vehicle performance, assesses command receiver signal strength parameters, and reports nominal plus count events (staging events, engine shutdowns, etc.) or any anomalous behavior to the MFCO.
- Command Systems Officer (CSO) is responsible to the MFCO for monitoring the status of the ground portion of the Command Destruct System (CDS) during the countdown and flight, and performing contingency procedures during CDS or launch vehicle failures. This includes monitoring command carrier switching, performing manual carrier switching as required, reporting command site elevation angles, verifying command functions if sent, and reporting any observed abnormalities. The CSO reports all status to the MFCO.
- Video Systems Officer (VSO) monitors mission events through optical video data sources displayed on Close-Circuit Television monitors and reports visible vehicle behavior to the MFCO.
- Training Officer/Video Systems Officer (TO/VSO) organizes OD16A for the MFCOs.
- The Forward Observer – Ground (FOG) reports visual vehicle behavior to the MFCO from ignition through loss of visual contact. The FOG also reports boats, vehicles or personnel located in the launch hazard area.

1.4.3.11 Surveillance Control Team

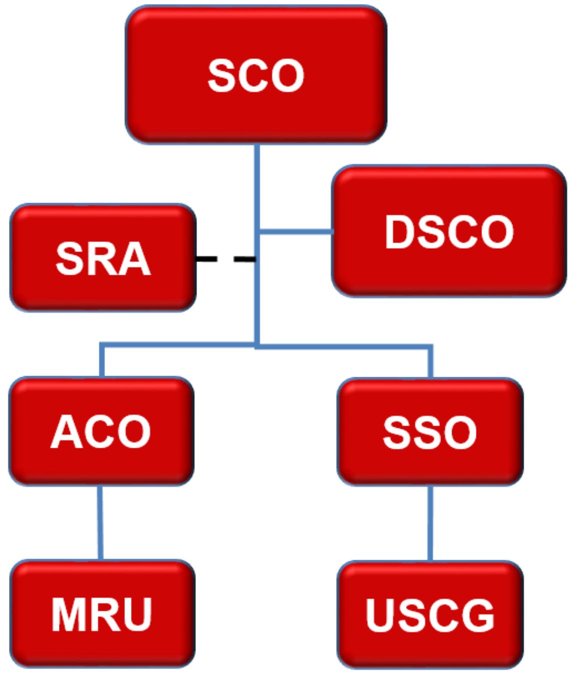

Figure 1-4-10: *Surveillance Relational Chart*

The SCO is ultimately responsible for Launch Area Surveillance of the Launch Danger Zones (LDZs) (including aircraft hazard corridors). The Surveillance Control Officer (SCO) ensures those areas are clear of unauthorized aircraft prior to giving the final Air Surveillance Control GO/NO-GO status for launch. The Surveillance Risk Analyst (SRA) via the Risk Assessment Center (RAC) gives the GO/NO-GO for sea borne vessels risk criteria. The SCO directs and coordinates activities in the Surveillance Control Room, assesses mission impact based on the Aerospace Control Officer (ACO) and the Sea Surveillance Officer (SSO) status, and reports status to the rest of the Range Operations Team. The SCO is in charge of the surveillance room and is the primary contact for anyone having issues that relate to the Surveillance Room. Any persons wishing to enter the Surveillance Room that are not affiliated with the operation have to clear it through the SCO. All communication in and out of the Surveillance Room to the rest of the Range Team is funneled through the SCO. This communication includes:

- Reporting safety/surveillance issues to the MFCO, RCO, and ROC.
- Receiving status notifications (Range Status, vehicle status, emergency action events, etc) from the ROC.
- Notifying the ROC of aircraft status (Weather 1 status, delays in aircraft takeoff time, or if any of the aircraft are grounded for the day) as required.
- Reporting Communication/Console failures to the RCO.

1.4.3.11.1 Deputy SCO (DSCO)

The DSCO assists the SCO in performing their duties to include status and information relay and reporting. The Deputy SCO position is filled by personnel who have successfully performed duties as an SSO and have shown the necessary leadership/proficiency to progress to the position. If the SCO needs to leave the Surveillance Room, the DSCO performs the duties of the SCO until they return.

1.4.3.11.2 Aerospace Control Officer (ACO)

The ACO is the operations lead for executing air surveillance operations. The ACO performs airspace monitoring and coordinates support aircraft operations conducted on the range during launch operations. The ACO reports status to the SCO. The ACO's duties include:

- Coordinating airspace operations including special use airspace for launches and advisory information to the Military Radar Unit (MRU) Controller and other Air Traffic Control (ATC) facilities.
- Detecting intrusions into restricted or special use airspace and coordinating with the MRU to divert unauthorized aircraft out of the airspace.

- Predicting the location of intruder aircraft at T-0 and coordinating with the MRU to divert targets to a safe location prior to launch.
- Reporting Fouled Range situations that occur after L-10 minutes to the SCO.
- Ensuring support aircraft are at pre-planned mission support positions prior to T-0.
- Reporting GO/NO-GO status to the SCO based on the predicted conditions at T-0.
- When directed by the SCO due to a catastrophic launch event, ensuring “break away” instructions are provided to support aircraft by either making the announcements or ensuring the MRU Controller makes the announcements.

1.4.3.11.3 Military Radar Unit (MRU)

The Military Radar Unit (MRU) Controller is an EG&G Technologies contractor who is designated to provide military command and control functions within airspace which has been released to the unit by an appropriate ATC facility. An MRU is not a commissioned ATC facility and, therefore, is not authorized to provide air traffic control services. The MRU Controller duties include but are not limited to:

- Controlling and monitoring mission support aircraft during launch operations to ensure safe, expeditious and timely movement in accordance with ER and NASA safety requirements.
- Passing flight information prior to aircraft entering/leaving special use airspace.
- Assisting participating aircraft in avoiding observed nonparticipating traffic by issuance of radar traffic information.
- Coordinating with other ATC facilities to divert aircraft out of restricted or special use airspace.
- Coordinating with the ACO on all aircraft activity in assigned special use airspace.

1.4.3.11.4 Sea Surveillance Officer (SSO)

The SSO is the operations lead for executing sea surveillance operations. SSO duties include:

- Monitoring sea traffic in the LDZ and coordinating the movement of vessels through surveillance control aircraft, supporting radars and the United States Coast Guard
- Predicting the location of vessels at T-0 and only diverting at the discretion of the SRA after risk calculations or after entering T-15 mins in which the SSO will redirect vessels out of the T-15 mins Restricted Area contour.
- Ensuring support vessels are at pre-planned mission support positions prior to T-0
- Reporting GO/NO-GO status to the SCO based on the predicted conditions at T-0
- In case of a post-destruct scenario, directing the U.S. Coast Guard to broadcast warnings to ships and boats when instructed by the SCO

Typically there are at least two SSO personnel assigned to each launch, with one exception: the SSO does not support for Trident missile launches.

1.4.3.11.5 United States Coast Guard

There are at least two USCG representatives in the Surveillance Control room during launch operations. These representative support sea surveillance operations by coordinating with supporting USCG vessels and the Captain of Port Canaveral to prevent boats and ships from entering or diverting them from the LDZ when applicable. The USCG representative report status to and coordinate actions with the SSO.

1.4.3.11.6 Surveillance Risk Analyst (SRA)

The Surveillance Risk Analyst (SRA) is an analyst from SELR who acts as an advisor to Surveillance Ops Personnel for contingency situations that cannot be resolved by the standard fouled range procedures. Their duties include:

- Verifying the correct contours are loaded on Surveillance Control Display System (SCDS).
- Providing technical advice on relocating targets or selecting alternate Mission Support Point (MSPs) as required.
- Since large vessel contours are not loaded, when a larger vessel is encountered, SELR will assist real-time.

1.4.3.12 Systems Safety (SEA)

On launch day, Systems Safety (SEA) provides technical oversight to Pad Safety during launch operations. SEA monitors any issues with the launch vehicle's Flight Termination System, provides advice in troubleshooting actions as required, and reports status to the MFCO. SEA also provides technical oversight to the support contractor's Operations Safety Disaster Control Team through the Launch Emergency Operations Center's Safety Technical Representative.

1.4.3.13 Operations Safety Manager (OSM)

Operations Safety Manager (OSM) is a Support Contractor on the Range Safety Team.
The OSM, also known as "Pad Safety," is responsible for:

- Observing, evaluating, and enforcing compliance with Launch Safety requirements by all personnel within launch complexes, assembly and checkout areas, propellant and ordnance storage areas, and other areas deemed appropriate.
- On launch day sits as Pad Safety in the Launch Control Center monitoring hazardous or safety critical positions.
- Ensures personnel are clear of the launch pad and hazardous areas prior to hazardous operations and provides clearance for personnel to re-enter the areas where it is safe.
- Reports to MFCO and SEA verifying the status of holdfire tests, Flight Termination System (FTS) status, and clearance of hazardous areas.
- Activates the “Launch Enable” switch, which allows the firing signal to be sent to the launch vehicle, when the vehicle’s FTS is verified to be fully operational during the final minutes of the countdown.
- In the event of a launch abort or misfire, the OSM ensures the FTS remains configured in a manner that will enable the MFCOs to initiate destruct actions in the event of an unforeseen launch, and reports to the MFCO when the launch vehicle is no longer in a launch configuration.
- The OSM also provides safety technical inputs to the Launch Emergency Operations Center (LEOC) Director in the event of a launch incident.

1.4.3.14 Risk Analysis

On launch day, several members of Risk Analysis (SELR) sit in room 148 of the MOC (next to the Weather Center) as part of the Risk Assessment Center (RAC). The main factors that RAC looks at on launch day are the chemicals present, the winds (speed, direction, and shear), and temperature inversions. Using this data and the applicable LCCs, the RAC reports GO/NO GO status for launch, and recommends the evacuation or sheltering of personnel and the positioning of the LEOC. In the event of a catastrophic event, the RAC serves as the Wing interface with the Brevard County Emergency Management representative.

1.4.3.15 Flight Analysts

The Flight Analysts from 45 SW/SELF are responsible for developing criteria for the control of errant vehicle flight to provide for public safety. They provide this function through the MFCO's destruct lines and through safety mission rules. On launch day, SELF analyzes launch day wind information to determine the appropriate Range Safety displays to be utilized and to provide the time the launch vehicle debris circle will be clear of the beach. SELF also distributes Safety Collision Avoidance (COLA) analysis data from the 614th Air and Space Operations Center (AOC) to the Range and Launch teams for launch window management.

1.4.3.16 Mission Director

On launch day, the MD leads the LV and SV teams through countdown, launch, and satellite separation. The MD ensures space flight worthiness (both LVMA and SVMA) and provides Mission "Go/No-Go" status to the LDA which includes the status of the launch vehicle, spacecraft, and support facilities and equipment. The MD has waiver authority for launch agency requirements. The personnel who serve in the MD role depend on the type of mission:

- For Combatant Command (COCOM) missions, the MD is appointed, trained, and certified by the SMC/CC. This is usually the LRSW/CC.
- For National/RDT&E missions, the MD is a flag officer/program director representing the agency owning the mission payload. For the NRO, the MD is the NRO/OSL Director.
- For Civil and FAA licensed missions, the MD is filled by the launch contractor's Launch Director (LD).
- For Trident II missions, the MD is the NOTU Commander or a designated representative.

1.4.3.17 Air Force Launch Director

The Air Force Launch Director (AFLD) controls the 5th Space Launch Squadron (SLS) launch team activities during countdown operations, ensuring all booster, spacecraft and facility systems are ready for launch. The AFLD provides a Mission "Go/No-Go" recommendation to the MD for DoD/civil launches or to the Launch Director (LD) for FAA licensed missions based on the readiness of launch facilities and, as applicable, booster and spacecraft for launch. The 5 SLS/CC normally serves as the AFLD or delegates the AFLD function to a trained and certified AFLD.

1.4.3.18 Launch Vehicle Contractor Team (LD, LC, RC)

The Launch Director (LD) is filled by a senior member of the launch vehicle contractor team and has the responsibility for the contractor's execution of the overall launch vehicle/spacecraft countdown and launch. The LD receives vehicle status from the Launch Conductor (LC) and range status from the Range Coordinator (RC). For DoD missions, the LD reports directly to the MD that the launch vehicle is ready for launch and requests permission to launch. Following the "GO" for launch, the LC directs the LC to proceed with the launch. For Civil and FAA licensed missions, the LD performs the MD function.

The Launch Conductor (LC) is a member of the launch vehicle contractor team who oversees and directs launch vehicle operations (i.e. propellant loading, gas pressurization, guidance tests, final arming, etc). The LC reports the status of the countdown to the LD. The LC has the authority to call a hold and direct recycle or abort operations, as required. The LC is supported by console operators, data observers, control engineers, pad safety, and others as prescribed in the countdown manual.

The Range Coordinator (RC) is the primary interface between the Range User and the Range for expendable launch vehicle operations. The RC interfaces with the RCO and ROC to receive Range Status updates, to provide Range User status, to coordinate vehicle Radio Frequency (RF) clearances, and to coordinate a new T-0 if required. The RC coordinates information from the Range to the LD and the LC. The RC also to interfaces with the LWO for Range Customer Weather Launch Commit Criteria and with DoD Track for network support during DoL operations.

1.4.3.19 Contingency Response

Contingency Response involves the actions taken in the event of a catastrophic launch event. This includes the actions taken to safe and secure the accident site and to preserve evidence as well as the investigation to determine the cause of the mishap. There are many different agencies and teams that perform contingency response actions.

Figure 1-4-11: *Mishap Steps*

There are several teams at the launch base that respond in the event of a launch mishap or catastrophic event. As soon as a mishap occurs, the first response team is the Launch Emergency Operations Center (LEOC). The LEOC is chartered to save lives and render the site safe for on-land impacts on CCAFS. Once this is accomplished, responsibility shifts to the Interim Safety Board which is responsible for preserving evidence and preparing for the arrival of an independent Safety Investigation Board from outside the 45 SW. Immediate actions for MR members are addressed in the Non-nominal procedures.

1.4.3.19.1 Launch Emergency Operations Center

The Launch Emergency Operations Center (LEOC) is a group of First Responders (such as fire, security, Explosives Ordnance Disposal (EOD)) that deploy immediately to the disaster scene in the event of a launch catastrophe. Immediately following a mishap, the LEOC takes cover and then establishes command, control, and communications. This includes establishing a direct line with the 45 SW/CC. The LEOC transfers the custody of wreckage and other physical evidence to the Interim Safety Board (ISB)/ Safety Investigation Board (SIB) president, but retains control of site during investigation up through and including site restoration. The LEOC Director turns responsibility over to the Recovery Action Team Commander once the impact area is safe, and approval is granted by the ISB President.

1.4.3.19.2 Interim Safety Board President (ISBP)

Once the site is safe, responsibility is formally handed over to the Interim Safety Board President (ISBP). The 45 SW/CC appoints an ISBP prior to each government, civil or commercial launch, regardless of mishap accountability for that launch. The ISB duties for AF launches cover all launch phases until payload separation from launch vehicle components, to include upper stages, or through ground impact for objects not achieving orbital velocity. The ISBP is available in the MOC on launch day. Their job is to preserve the evidence, identify potential witnesses, and ensuring range data is impounded and authorizes release of impounded data upon arrival of the permanent investigation board. A permanent board is identified by the convening authority and is brought within approximately 3 days of the mishap.

1.4.3.19.3 Recovery Action Team

The Recovery Action Team (RAT) is appointed prior to each launch and is comprised of launch vehicle and space vehicle personnel. The RAT coordinates the collection, identification, and storage of physical evidence for the Range User following a launch mishap.

1.4.3.19.4 Safety/Accident Investigation Boards (SIB/AIB)

There are two kinds of boards that can convene. The first is the Safety Investigation Board (SIB). The SIB is charged with determining the root cause of an accident to prevent future mishaps. This is a team of individuals from outside the 45th Space Wing who are appointed to provide an independent review. The SIB is unique in that it is non-punitive in nature; it does not place blame on an individual and cannot legally be used for any sort of administrative or legal action against anyone who may have been causal in a mishap. “Privilege” may be offered to a witness in exchange for testimony that will not be shared outside official safety channels. This is done so a witness may come forward with information critical to the investigation without fear of retribution. This only applies to Air Force investigations. There can also be an Accident Investigation Board (AIB) if deemed necessary. The AIB, if formed, is a legal board to determine culpability for a mishap.

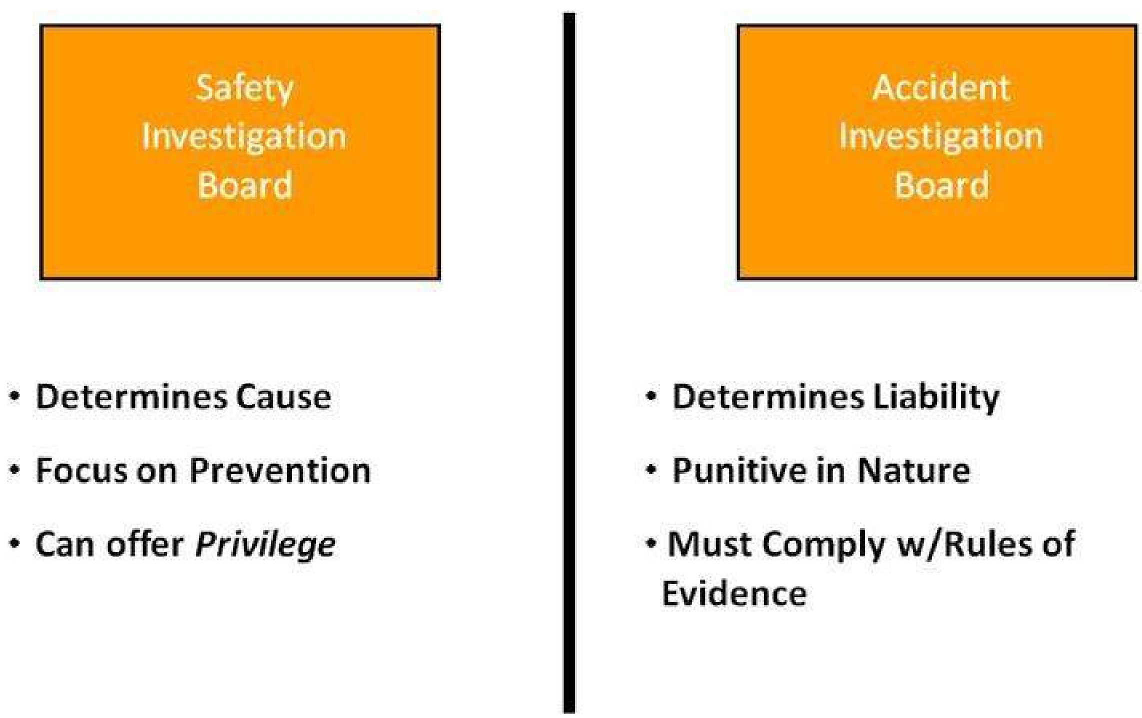

Figure 1-4-12: *Mishap Boards*

1.4.3.19 MOC Center Supervisors

Within the MOC on DoL, Center Supervisors (CS) maintain overall responsibility for operations within their centers of responsibility. CSs are assigned as follows:

- ROC – MCR 1 and 2 including CABs, CAB conf room, and rooms 167/168/173/174
- SCO – Surveillance Room 160
- MFCO – RSD Room 159
- LWO – Weather Room146.1
- RCO – Instrumentation (Conceptual-ISRO and Sites)

The CS concept not only identifies the crew position with overall responsibility for their center, but also identifies who will accomplish specific steps of certain checklists. Each of the emergency checklists, as well as the Communication/Console/SCDS Failure/Recovery checklist uses the CS concept. In each of those checklists, steps assigned to "CS" will be accomplished by the appropriate CS.

1.4.4 Morrell Operations Center (MOC)

It is important to understand the layout of the MOC; the following figure shows its layout.

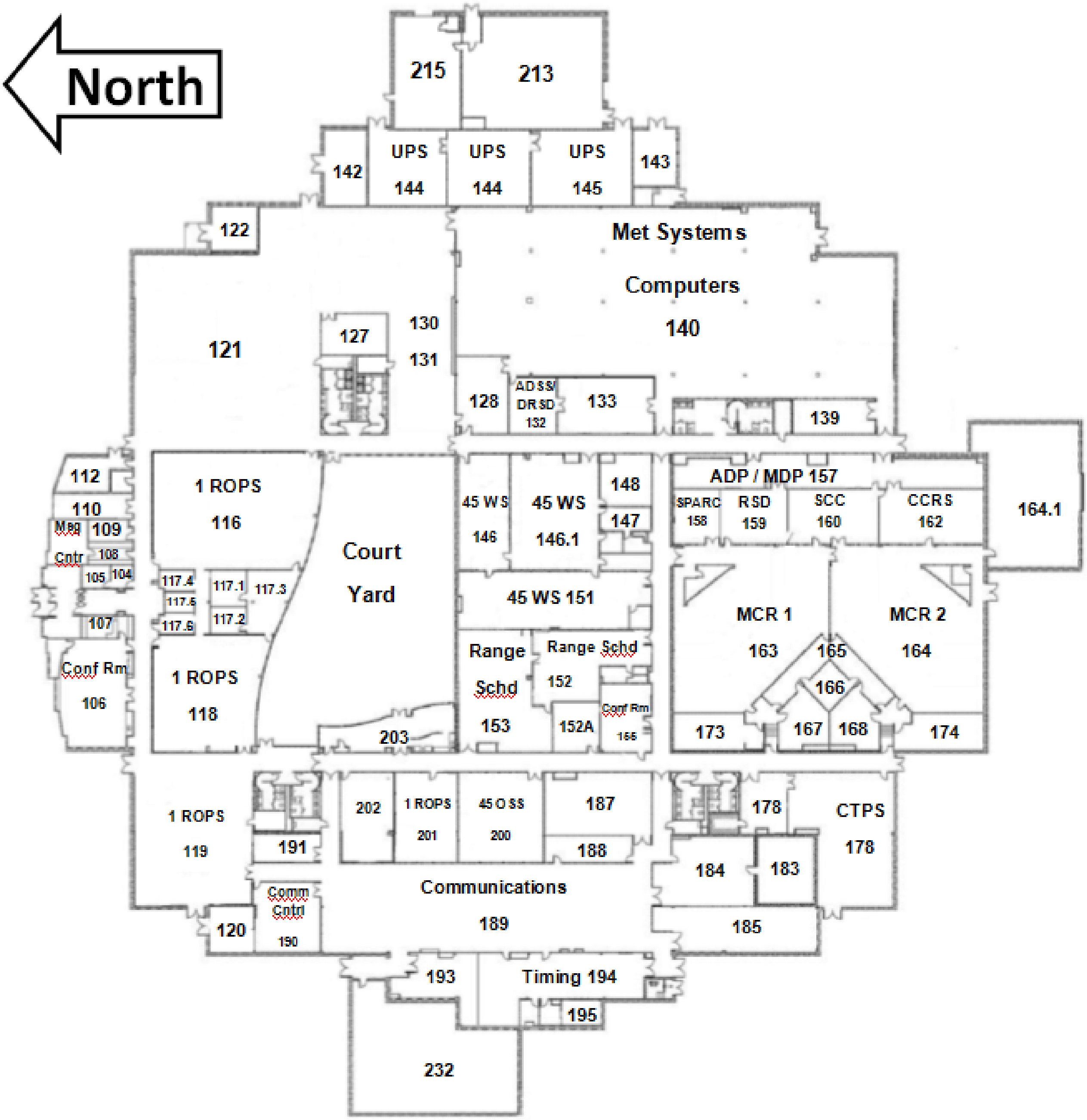

Figure 1-4-13: *MOC Layout*

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1 ROPS OPS MANUAL, Vol. 1
SECTION 2

RANGE SYSTEMS

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2-1 LIMES AND VISION

2.1.1 LIMES

LIMES (https://limes/) is a Range Generation Next (RGNEXT) developed website. You can also get to the Vision website through here. This is where you will find launch documentation to support launch operations.

2.1.1.1 LIMES Main Page

Most links can be found from the home page by going to Search Tools dropdown tab at the top left of the page. The only exception is the Vision link which can be found on the bottom left of the home page.

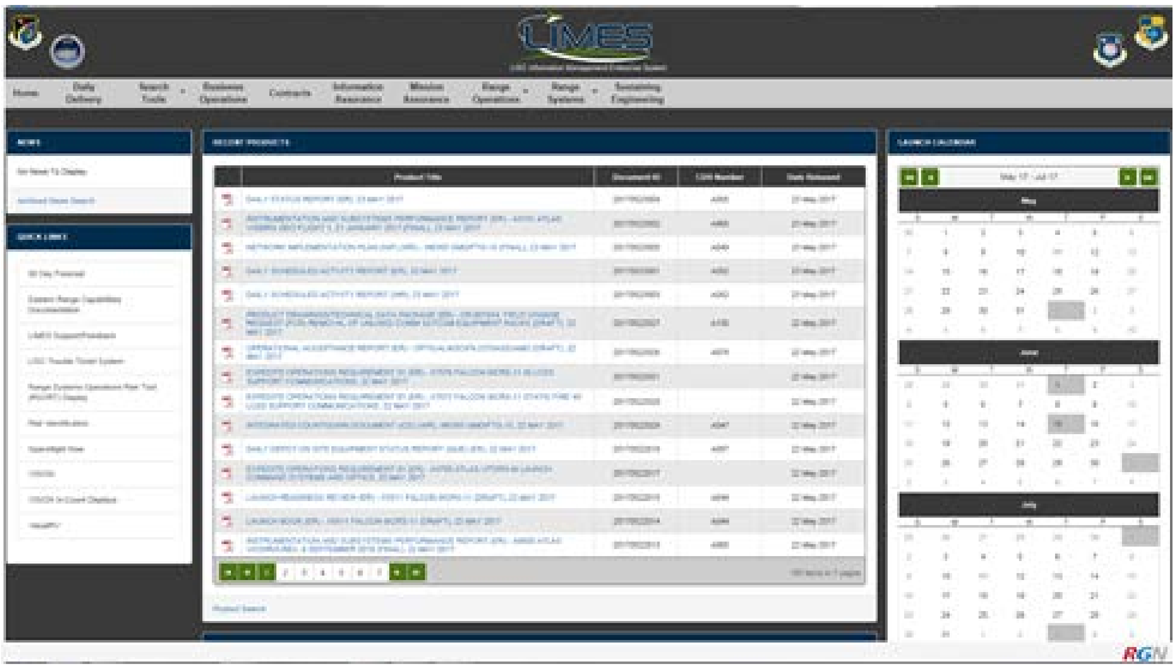

Figure 2-1-1: *LIMES Main Page*

2.1.1.2 LIMES Missions Link

The Missions link features a breakdown of information on launch missions, and they are sorted either by year or by launch vehicle. Active Launch Programs are featured in a light gray shade. Inactive Launch Programs, such as Titan IV, are shaded in dark gray.

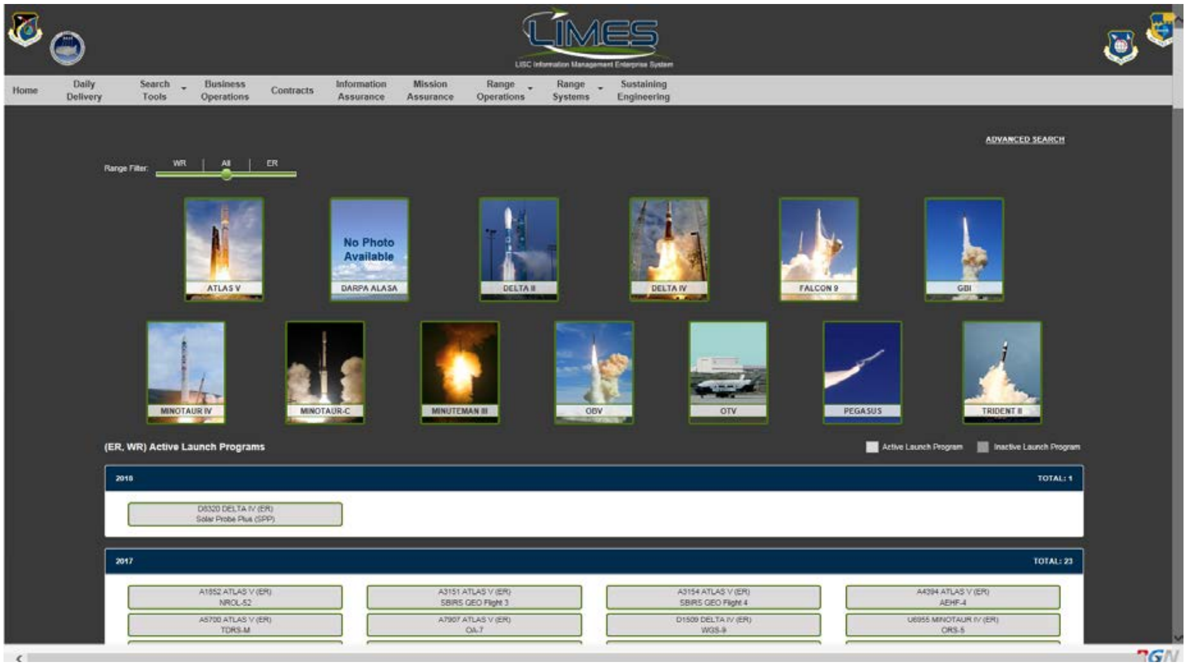

Figure 2-1-2: *LIMES Missions Link*

2.1.1.3 LIMES Systems Link

The Systems link displays instrumentation sites by their location (i.e. Patrick, Ascension, CCAFS, etc.) or by their range super-system. Accepted instrumentation is shaded in light gray, and New/Not Accepted instrumentation is shaded in dark gray. Any instrumentation that is "Out of Accepted Configuration," are shaded in turquoise.

Figure 2-1-3: *LIMES Systems Link*

2.1.1.4 LIMES Universal Documentation Link

The UDS Documentation link archives all documentation for ER launch operations including

Program Introduction (PI), Statement of Capability (SC), Program Requirements Document (PRD), Program Support Plan (PSP), Operations Requirements (OR), and the Operations Directive (OD).

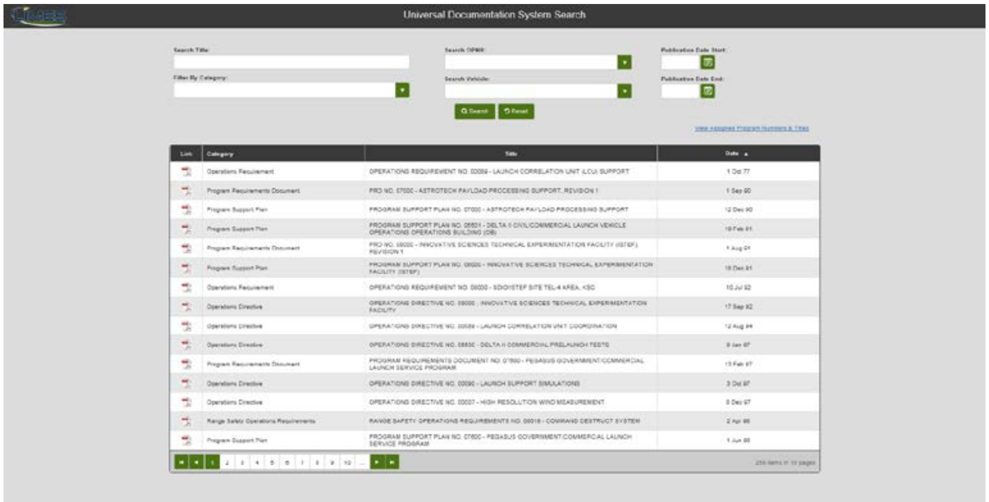

Figure 2-1-4: *LIMES UDS Link*

2.1.1.5 Eastern Range Capabilities Documentation

Eastern Range Capabilities Documents– This web-based application provides access to the ER Capabilities Documentation. These products contain information about the technical capabilities of the instrumentation and communications systems employed by the 45 SW to meet the mission requirements of the ER, the interconnectivity between these systems and the interfaces outside the Range, and the physical location of key sensors and systems. As system availability, capability and configuration are subject to change, this information should not be used for mission planning or decision making purposes without verification by the 45 SW.

- Eastern Range Instrumentation Handbook (ERIH)–The ERIH is Volume I of the three volume set of technical handbooks that describe ER operational systems and capabilities. The purpose of the ERIH is to provide an accurate, ready reference of the configuration, capabilities, and limitations of ER instrumentation. Updates to the ERIH are published quarterly.
- Eastern Range Operational Configuration Handbook (EROCH)–The EROCH is Volume II of the three-volume set of technical handbooks that describe ER operational systems and capabilities. Provides descriptions of vehicle-specific Range interfaces for all ER sites using block diagrams and data flow diagrams. Data flow diagrams show sources and end points with some intermediate nodes. The configurations are generally functional except where physical presentation is needed for clarity. Inter-Range sources and ends are shown with a lesser level of detail, generally, than ER information. Updates to the EROCH are published quarterly.
- 45 SW Geodetic Coordinates Manual (GCM)–The GCM is Volume III of the three-volume set of technical handbooks that describe ER operational systems and capabilities. Contains the official and authorized list of geodetic coordinates for launch, sensor, telemetry, navigation, and other facilities supporting assigned range projects. 45 SW/ER data products will be produced based on the geodetic data listed in the Department of Defense World Geodetic System 1984 (WGS 84) section of this manual. The National Geospatial-Intelligence Agency (NGA), formerly the National Imagery and

Mapping Agency (NIMA), Florida Survey Office (NGA/PRGA4) provided the listed geospatial information. Updates to the GCM are published annually.

- Eastern Range Instrumentation and Associated Targets (ERIAT)–A fourth instrumentation document, ERIAT, is compiled of several tables showing the line-of-sight (LOS) relationship between ER instrumentation and associated targets, and the Field of View (FOV) requirements for instrumentation. ER instrumentation includes the major instrumentation (Radar, Telemetry, Command Destruct, Optical, Meteorological and Communications) located on Patrick Air Force Base (PAFB), Cape Canaveral Air Force Station (CCAFS), Kennedy Space Center (KSC), Cocoa Beach, Melbourne Beach, and Malabar. The primary targets are the various launch vehicles, while on the launch complex, prior to launch. Updates to the ERIAT are published annually.

2.1.2 VISION

The primary purpose of VISION is to provide varying levels of detail pertaining to each ER instrumentation system, including ongoing corrective action activity and countdown step completion details during a launch or rehearsal. VISION makes integrated, complex, and rapidly changing mission and system status data readily available through a single interface and provides a real-time feedback mechanism so inaccurate or incomplete information can be quickly identified and corrected.

2.1.2.1 VISION Home Page

The VISION Home Page contains links to an abundance of information on planning a launch operation. Most information can be accessed prior to and during a launch operation via this page. However, the Instrumentation Plan is only available to Range Generation Next (RGNext) Instrumentation Planners until the plan is approved for release.

The Home Page has five major areas: Main Menu, Launch Calendar, ER Instrumentation Systems, Upcoming Launches, and Upcoming Meetings.

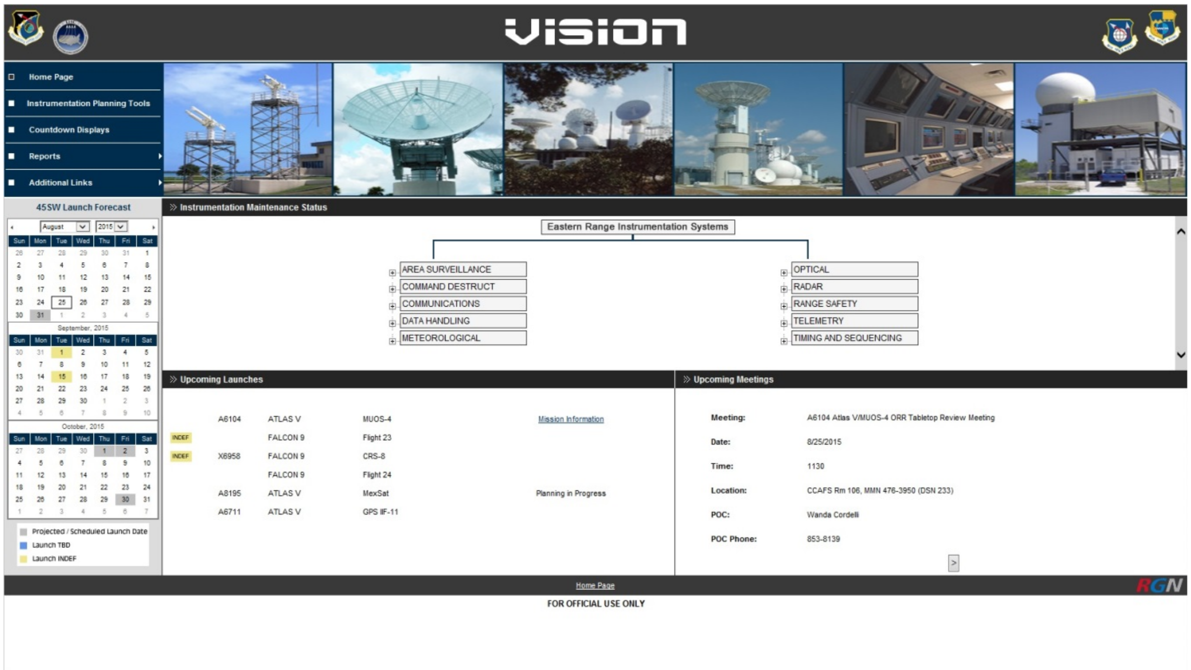

Figure 2-1-5: *Vision Homepage*

2.1.2.2 VISION Main Menu

The VISION Main Menu provides access to the following information, reports, and applications:

- Home Page - Returns to the VISION Home Page
- Instrumentation Planning Tools - Access to Projected Launches, Instrumentation Planning, and Instrumentation Status web pages
- Countdown Displays - Access to the displays available from the start of an actual launch countdown or associated operation such as a RGNext Mission Rehearsal or CAB ICE
- Reports - Access to reports including the Instrumentation Maintenance Status, Instrumentation Plan, Launch Book Instrumentation Tables, 45 SW Launch Forecast, and Mission Critical Instrumentation Status
- FAQ/Additional Links - Access to frequently asked questions and answers, as well as commonly used applications external to VISION, such as LIMES,

Under the Reports Menu, real-time instrumentation status and the Range Countdown status can be tracked on launch day. Selecting the Instrumentation Plan for a particular launch under the Upcoming Launches section is useful for identifying which systems are mandatory or required to support the launch at the start of the range count. However, if any instrumentation problems occur during the minus count, new instrumentation may become mandatory. The analysis necessary to determine new mandatories will be explained in subsequent sections of this manual.

2.1.2.3 VISION Countdown Displays

This menu item provides access to the Countdown Displays, which provide the following new capabilities and enhancements for in-count monitoring:

- Header: Displays the specific information pertaining to the launch operation in progress, such as Operation Number (OPNR), vehicle, mission, attempt number, and scheduled T-0

- Range Status Panel: This capability provides insight into overall range status during a launch countdown. Changes to range status due to instrumentation, range customer, range clearance, and weather events are reported in accordance with ROI OPS Reporting Range System Status During Launch and Landing Operations and Mission Rehearsals and are reflected within the panel
- Tabs: This new capability allows viewers to monitor the three main in-count VISION displays (Events, Range Countdown, Timeline) within one window, as well as up to three additional user selected web pages

VISION displays are accessible at all times; however, the information shown on the Countdown Displays is not available until the start of an actual launch countdown or for associated operations, such as a RGNext Mission Rehearsal, Mission Dress Rehearsal (MDR), or Commander Advisory Board (CAB) Integrated Crew Exercise (ICE), when requested. It can be accessed via the VISION Home Page, "Countdown Displays" selection.

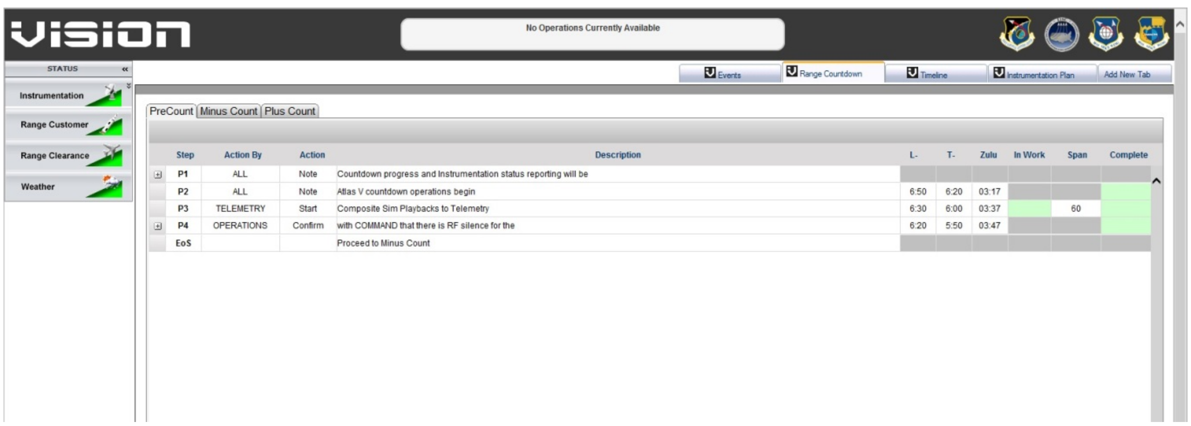

Figure 2-1-6: *VISION Countdown Displays*

2.1.2.4 VISION Events Tab

During a launch countdown, this tab displays information for each event reported over Instrumentation Net 2 as required by ROI OPS-Reporting Range System Status During Launch and Landing Operations and Mission Rehearsals. This information is captured by RGNext's Launch Performance Analyst (LPA), located in the RGNext's Mission Management Room located in the Morrell Operations Center (MOC), Room 168.

The following information is displayed for each Event:

- Event: The event number. If the event number is preceded with a "P," this represents a pre-count event imported at the beginning of the count. If there is more than one attempt per mission, the attempt number will be displayed immediately following the event number
- Time Reported: The time reported on Instrumentation Net 2, as captured by the LPA Analyst
- System Status: Fully Mission Capable (FMC), Partially Mission Capable (PMC), or Non-Mission Capable (NMC)
- Range Status: Displays "Red" for an Event resulting in a Range NO-GO period

- Event Status: Open, Closed, or Deferred
- Report Details: Additional information regarding the problem (e.g., Problem Statement; Last Update; Impact; System; Supersystem; Circuit)

Estimated Time to Return to Operations (ETRO)/ Next Update: ETRO/next planned update as reported by RGNext's System Controller. However, sometimes the ETRO and the Next Update is left blank.

If there is a "+" sign next to the left of the events number, the event can be maximized to see all updates to the event. In Events 1 and 2 have been maximized to reflect all the updates. To minimize the updates click the "-" next to the left of the event number. Red time will be reflected in the expanded data for all events causing the range NO-GO situation. The system status is colored coded to represent the status. FMC is reflected in green, PMC is reflected in yellow and NMC is reflected in red.

Event Status Column:

- Open Status–indicates the issue is being worked
- Closed Status–indicates the issue has been closed. The term "Closed" will start flashing and after a specific period of time will disappear from the Events tab
- Deferred Status–indicates the issue has been deferred to be worked after mission. The term "Deferred" will start flashing and after a specific period of time will disappear from the Events tab

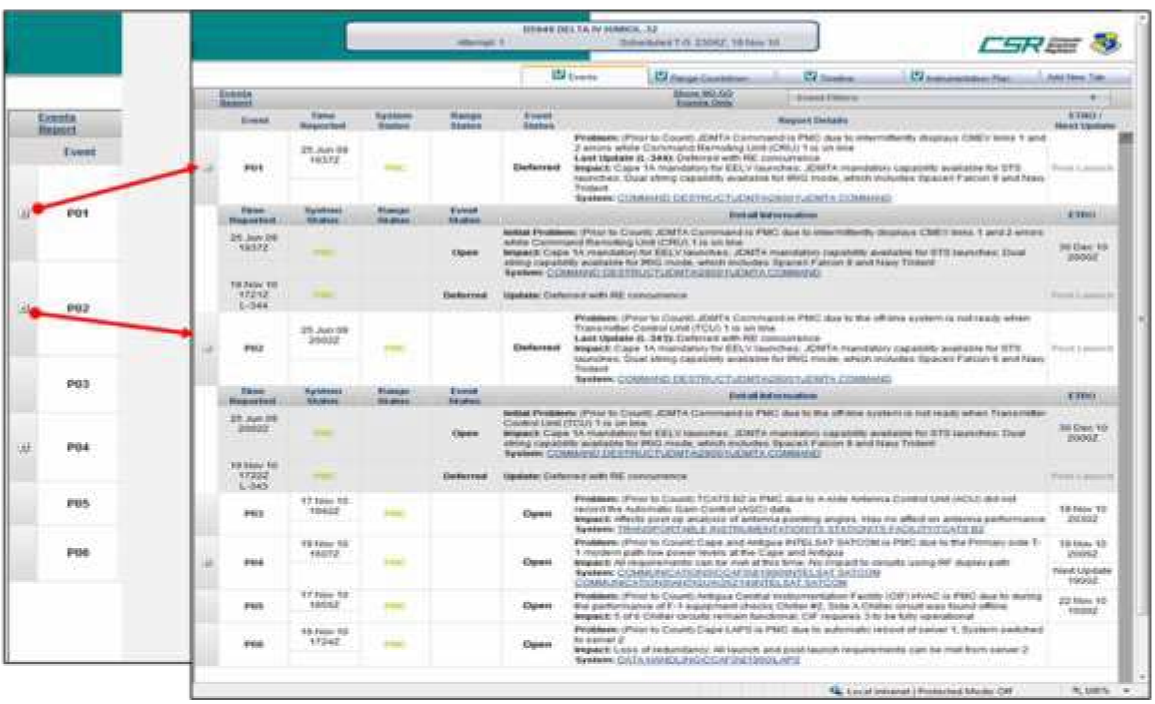

Figure 2-1-7: *VISION Events tab cont.*

Report Details:
The details of the event are reported in the "Reports Details." This information is reported over Instrumentation Net 2. The initial report includes as much information as possible; however, due to reporting requirements, all information may not be known at the

time of initial report. The information should be updated or completed as soon as known by the RGNext Systems Controller.

The following areas are represented in this column:

- Problem: The problem is defined using the script outlined in ROI OPS-Reporting Range System Status during Launch and Landing Operations and Mission Rehearsals. The problem will be started by identifying the Eastern Range Designators (ERD) Alias
- Last Update: The information reflected here is the latest information reported on the event. The time reported (L-) indicates when the update was posted to LPA VISION by the LPA after reported over the Instrumentation Net 2
- Impact: This reflects the initial impact reported for the event. This is updated as required by the RGNext Systems Controller. This information may not be known at the time of initial report; however, should be updated as soon as it is known

System:

This information represents the ERD for the system the event is reported. It also indicates who will be working the problem. However, there could be more than one system listed with both RGNext System Controllers working the resolution of the issue. Frequency Control Analysis (FCA) Vans are a perfect example.

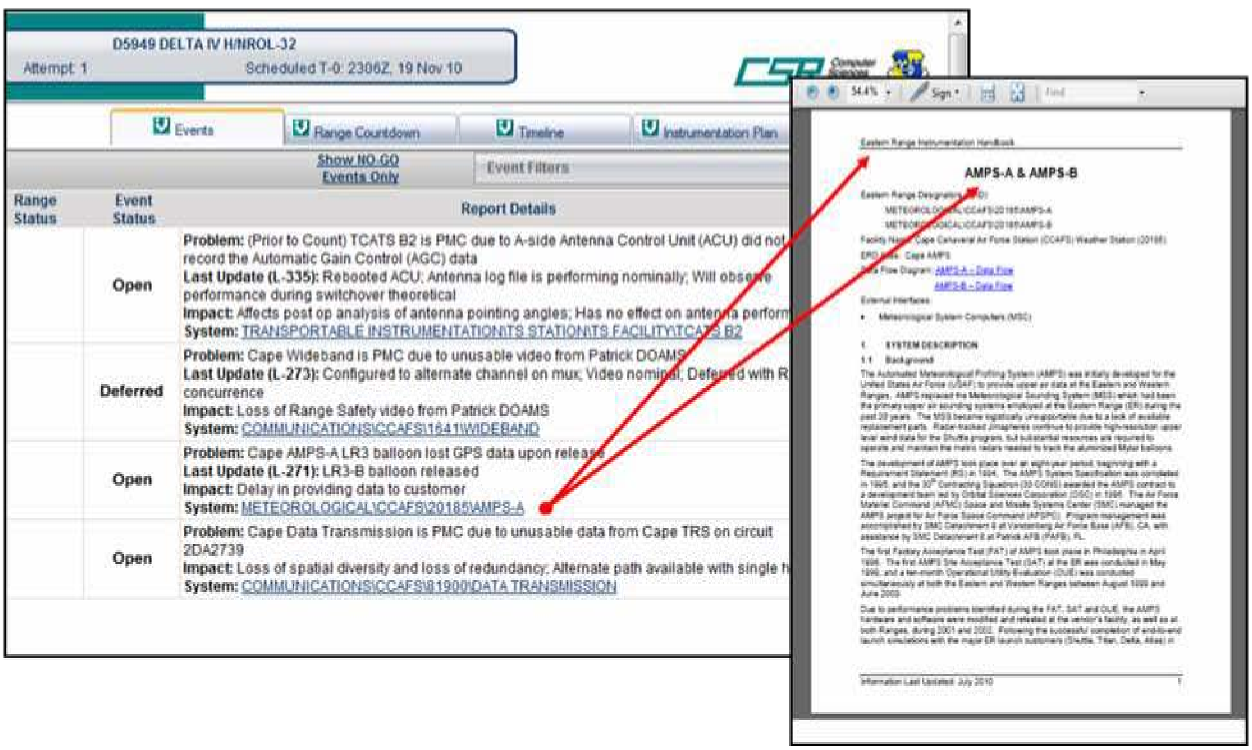

Figure 2-1-8: *VISION Events Tab Report Details*

The dark gray bar immediately below the tabs provides additional filter options. These options allow the VISION user to obtain information or to categorize and display the information in a way most beneficial to the user. The bar options are: Events Report, Show NO-GO Events Only, Events Filters, and Reset Filters.

Events Reports–this option allows the user to create and print an Events report. Using Microsoft Word format, a report is generated using the information from the countdown in progress. The information is only valid based on the date and time it is printed. The report will be inaccurate once an update or new event has been reported.

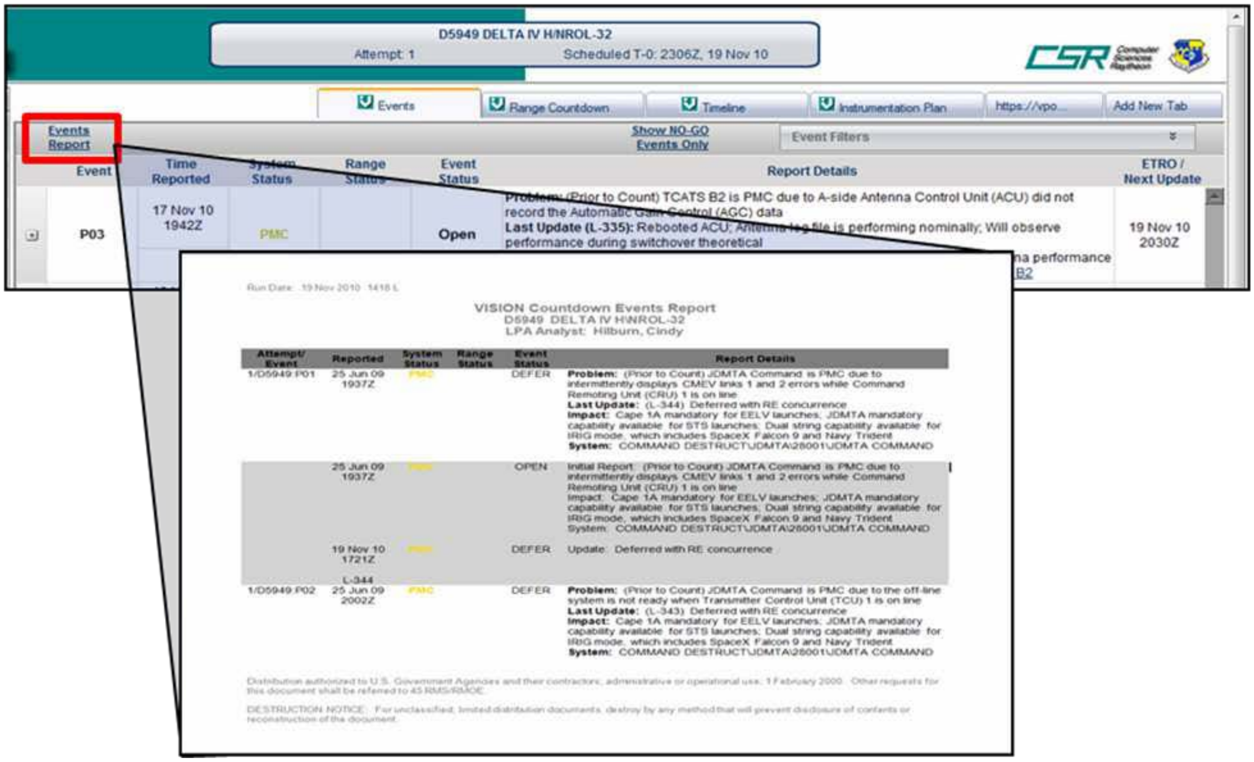

Figure 2-1-9: *VISION Events Report*

Show NO-GO Events Only–This option provides the capability for the user to limit all events to only those that have a NO-GO status. In Figure 2-1-14, the Range is NO-GO for the Customer. The Event identifier is in “Red” (Event column) and starts with an “R” followed by 001, indicating this is the first “Red” event during this launch attempt. The Event Filters option allows the user to view the events based on personal preference. Some of the options for filtering are:

- Supersystem–select all desired systems
- System Status–select all desired statuses
- Red/Holds–select all desired options
- Event Status–select all desired statuses
- Additional Filters–select all desired statuses

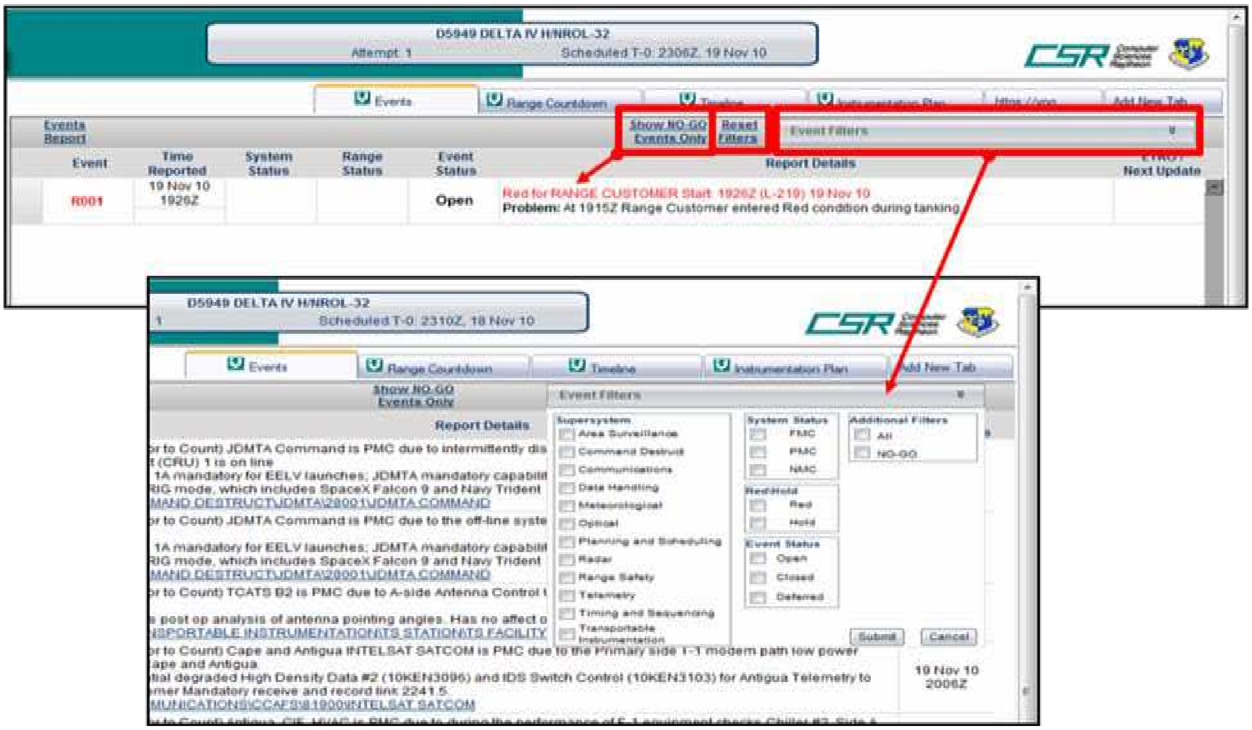

Figure 2-1-10: *VISION Event Filters*

RED Status:

The sample, in Figure 2-1-15, reflects when a red status is changed to green status. In this sample, the launch had scrubbed for the day. The red status was terminated due to the scrub.

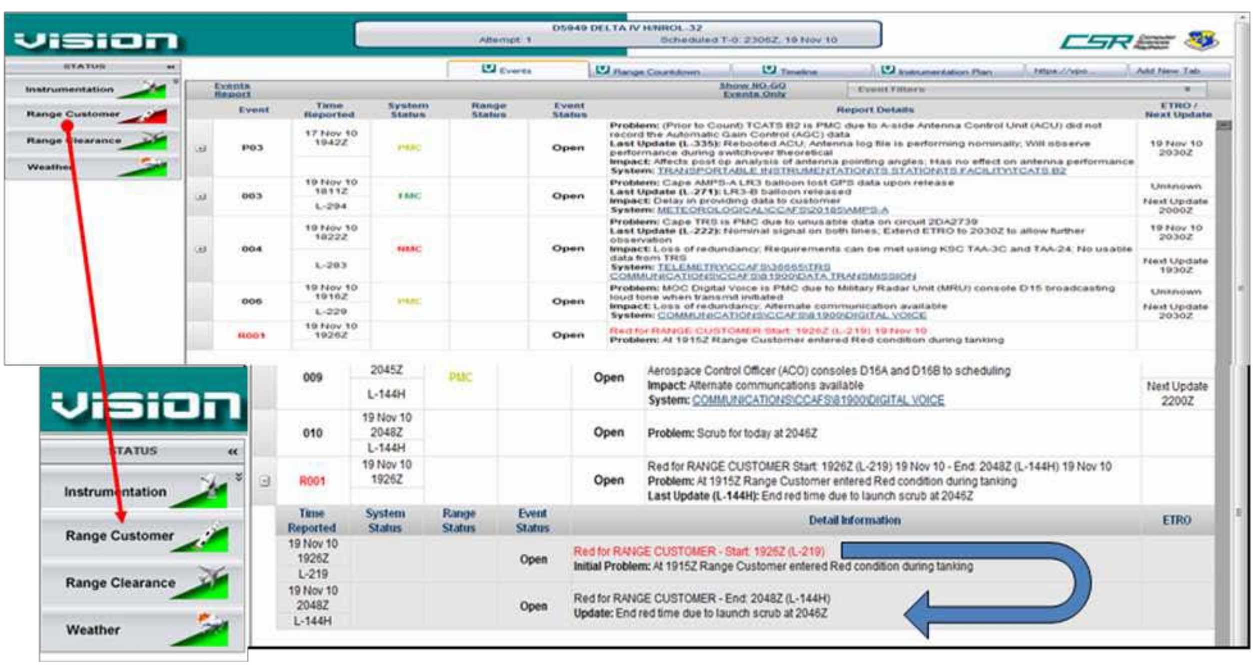

Figure 2-1-11: *VISION Red Status*

2.1.2.5 VISION Range Countdown Tab

The Range Countdown tab provides real-time visibility into the progress of the steps required to ensure ER instrumentation system readiness at T-0. The approved Range

Countdown is incorporated into VISION. The Range Countdown is developed, reviewed, approved, and distributed as outlined in ROI OPS-Range Instrumentation Countdown.

The Range Countdown:

- Lists the Range Instrumentation Readiness Tasks, Range Customer Readiness Tasks, and other necessary steps required to successfully conduct the ER portion of launch and landing operations
- May expand or revise the Operations Directive (OD) Section 1630, Customer Test Countdown, and will supersede that section in case of conflict
- Lists required instrumentation and customer readiness tasks and steps sequentially, but it does not commit support for an operation
- Lists duration of Range Instrumentation Countdown for launches per vehicle type. The duration of any Range Instrumentation Countdown will be determined by Range Operations
- Is prepared and maintained using consistent terminology and step sequencing for all launch vehicles and programs and will conform to the standard Countdown template developed for each vehicle. Range Instrumentation Countdowns will be maintained by RGNext's Range Operations.

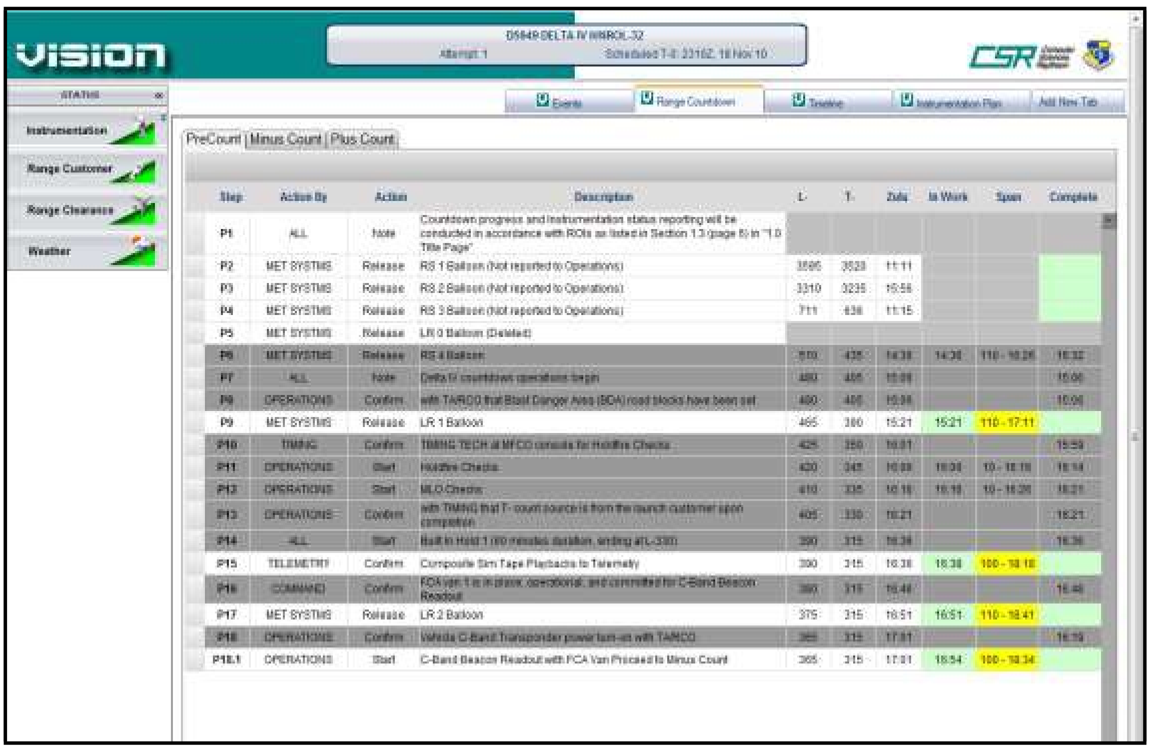

Figure 2-1-12: *VISION Range Countdown Display*

As Controllers report progress of countdown steps on Instrumentation Net 2, RGNext's Technical Advisor (TA) enters data, which is then captured and displayed via this tab.

- Pre Count–List of any activities being accomplished prior to the Range Countdown.
- Minus Count–List of activities being accomplished from start of Range Countdown until T-0.
- Plus Count–List of activities being accomplished from T-0 to end of mission.

Typical range countdown starts at L-6 hours, with the exception of Navy, which starts at L-4 hours. Rows will be shaded out when the event has been completed. Click the “+” to the left of the step to obtain further information.

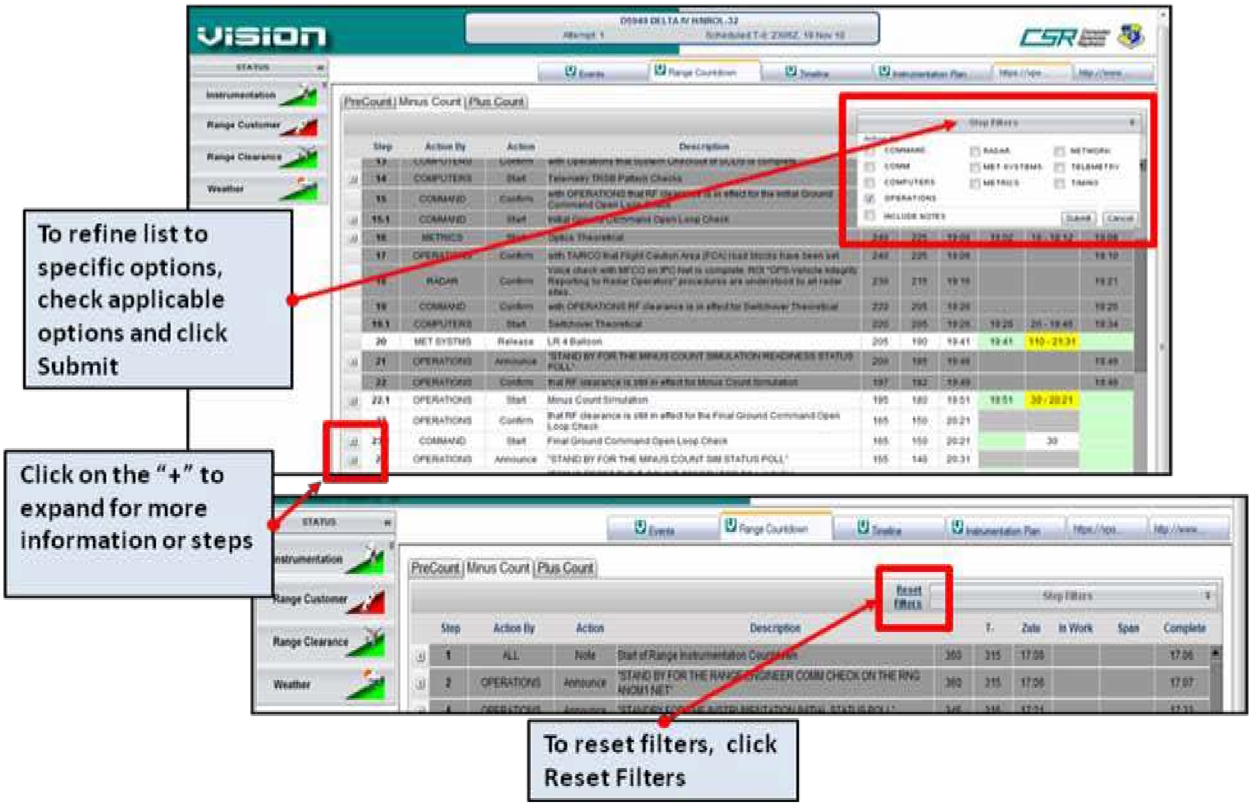

Figure 2-1-13: *VISION Range Countdown cont.*

2-2 RADAR SYSTEMS

2.2.1 INTRODUCTION TO RADAR SYSTEMS

The Eastern Range (ER) utilizes radar as one of its primary sources in tracking a launch vehicle's position and velocity. The Radar Supersystem uses a specific application of radar principles to monitor and analyze real-time launch vehicle position in flight. Radar principles include the use of transmitting devices on missiles, launch vehicles, spacecraft, or earth satellites and receivers at ground instrumentation stations to monitor vehicle and analyze performance.

2.2.2 REQUIREMENTS

Safety requires that range tracking instrumentation data be available to provide the MFCO with:

- Real-time information on in-flight vehicle position
- Positive knowledge of vehicle position through the end of range safety responsibility

This tracking data is used to compare actual and nominal flight trajectories, verify position in conjunction with telemetry, and identify violations of destruct lines. In addition, the data also provides designate to the downrange sites. The designate is used to point radar and telemetry antennas at the vehicle until they can autotrack and also to point the command antennas at the vehicle throughout flight. In addition, Higher Headquarters (HHQ) guidance levies certain requirements on the tracking sources to ensure accuracy and redundancy. It states that tracking from at least two adequate and independent range instrumentation data sources is mandatory throughout each phase of powered flight from launch to establishment of the final impact point for launch vehicles with suborbital trajectories or to the end of range safety responsibility for space launch vehicles. The Range's responsibility stops after +70 nautical miles. To be considered as an adequate tracking source, each tracking source must provide real-time state vectors (position and velocity) to a specified accuracy, timeliness, and reliability. To be considered as an independent tracking source, each tracking source must be electrically, mechanically, and structurally separate from the vehicle guidance and telemetry systems and any other tracking source, so that no hardware or software single point of failure will deny the MFCO the capability to directly monitor an in-flight launch vehicle.

2.2.3 PURPOSE

The purpose of the Radar Supersystem is to provide metric quality vehicle position data to the Range Safety Supersystem for real-time display and monitoring of vehicle flight. In addition, radar data is recorded for post-mission analysis of system performance. All radars are capable of providing metric quality data in skin or beacon track modes. The Eastern Range (ER) Radar Supersystem is comprised of five ER C-band metric tracking radars, four non-ER C-band metric tracking radars, and the Cape Single Point Acquisition Radar Control (SPARC) consoles located in the Morrell Operations Center (MOC) at Cape Canaveral Air Force Station (CCAFS).

NOTE: The Patrick 0.134 radar, located at Patrick Air Force Base (PAFB), is known as Radar Open Systems Architecture (ROSA).

Table 2-2-1: *Supersystem Radars*

RADAR	TYPE	LOCATION	CUSTODIAL AGENCY
Cape 1.16	AN/FPS-16	CCAFS	ER
KSC 19.39	AN/MPS-39	KSC	ER
KSC 19.14	AN/FPQ-14	KSC	ER
Patrick 0.134	AN/FPS-134	PAFB	ER
Ascension 12.15	AN/FPQ-15	Ascension	ER
Wallops 86.18	RIR-706	Wallops Island	NASA
Wallops 86.16R	RIR-716	Wallops Island	NASA
Wallops 86.16I	RIR-716	Wallops Island	NASA
Wallops 86.16M	RIR-778C	Wallops Island	NASA

The SPARC system monitors interfaces with the Range Safety Supersystem, all position data and various mode and track indicators output by the ER radars, and provides control over the routing of all acquisition data. The SPARC controllers are also responsible for operational coordination of all the radars. This duty includes passing the beacon readout from the FCA van to the radars. On F-1 and launch day, the FCA van is responsible for monitoring the RF environment on the ER, as well as performing beacon readouts and measurements of the launch vehicle’s C-band beacon operating characteristics. Accurate beacon readout is necessary for the radars to effectively beacon track the launch vehicle.

2.2.4 DEFINING RADAR

Radar is an acronym for RAdio Detection And Ranging. Radar is a system or technique used for detecting the position, movement, and nature of a remote object by means of radio waves reflected from its surface. It involves the transmission of pulses of electromagnetic waves by means of a directional antenna; some of the pulses are reflected by objects that intercept them. The reflections are picked up by a receiver, processed electronically, and analyzed to determine characteristics of the object such as position and velocity with respect to the radar unit.

- The range of the object is determined by measuring the time it takes for the radar signal to reach the object and return
- The object's location with respect to the radar unit is determined from the direction in which the pulse was received (azimuth and elevation angles)
- The velocity of the object is measured by applying the Doppler principle: if the object is approaching the radar unit, the frequency of the returned signal is greater than the frequency of the transmitted signal; if the object is receding from the radar unit, the returned frequency is less; and if the object is not moving relative to the radar unit, the

return signal will have the same frequency as the transmitted signal

Although most radar units use microwave frequencies, the principle of radar is not confined to any particular frequency range. Radar systems utilizing microwaves at ultrahigh frequencies in the C-band range (4-8 gigahertz [GHz]) as ER radars are tasked to operate between 5.4 GHz and 5.9 GHz only.

For Range Safety, the launch vehicle's position must be known while the launch vehicle poses a threat to people or property. Radar launch data is used to verify both the vehicle position and size. Positional data is obtained by ranging the vehicle with a RF pulse and extracting azimuth and elevation data from the antenna position. This AER data is then converted to EFG coordinates by the radar site computer and is transmitted to the Range Safety Supersystem. The data is transmitted from the Radar Supersystem via a High Density Data (HDD) 2400 bits per second (bps) circuit for routing by SPARC.

A vehicle's size and characteristics are determined from the Signal-to-Noise Ratio (S/N) and a quality bit (Q-bit). The S/N is a measure to quantify how much a signal is corrupted by noise. Environmental interferences (i.e. system loss and noise, transmitting medium, and bandwidth selections) can be controlled through filtering. Target size is particularly significant in the calculating of the S/N. Large targets have large Radar Cross-Section (RCS) values which make the vehicle's signal considerably stronger than noise corruptions and thus, easier to acquire and track. The RCS of a target is the hypothetical area required to reflect energy isotropically so that the energy received at the radar's antenna is equal to that from the target. This parameter is also known as the backscattering coefficient or the effective echoing area.

2.2.5 PHASED ARRAY RADARS

There are two types of radar systems at the ER: Phased Array and Non-Phased Array Radars. The only phased array radar in use at the ER is Kennedy Space Center (KSC) 19.39, a Multiple Object Tracking Radar (MOTR). Phased array radars have a small number of omni-directional antennas referred to as elements, usually arranged in a flat plate. The phased array antenna assembly is a 12-foot diameter array with the lens fed by a phase-array multimode horn cluster.

Figure 2-2-1: *KSC 19.39 (MOTR) Phased Array Radar*

2.2.6 NON-PHASED ARRAY RADARS

Non-phased array radars use a mechanically steerable parabolic "dish" to create a tight broadcast beam, using the same dish as the receiver. Non-phased array radars track single targets with high precision and at long distances. Non-phased array radars are installed at both uprange and downrange locations. In uprange locations, they provide the primary source of vehicle metric data. In downrange locations, they are allocated to be the primary space track and ballistic missile weapon support radars. With exception of Radar 19.39, all radars used by the Eastern Range are non-phased array.

2.2.7 TRACKING MODES

2.2.7.1 Skin Tracking

Skin mode is used for non- cooperative (skin) targets which require the radar to illuminate the target with its transmitter pulse and track the reflection. In the skin mode, the radar's transmitted signal is reflected and tracked by the Radar Supersystem. ER radar systems are capable of outputting different transmitter pulse widths at C-band. When outputting a particular pulse width in the skin mode, it is advantageous to know the expected results prior to outputting a particular pulse width. For range resolution, it is best to use the narrowest pulse width; however, not much power is transmitted and received when using the narrowest pulse width. To track a target to its maximum range, it is more advantageous to use the wider pulse widths.

2.2.7.2 Beacon Tracking

Beacon mode is used for cooperative (beacon) targets that have a transponder, which responds to a coded pulse from the radar and actively transmits a return signal of either the same frequency (coherent) or of different frequency (non-coherent). In beacon mode, the radar tracks a transponder pulse from the vehicle which is triggered by the radar transmitted pulses. ER Radar systems are capable of outputting a dual transmitter pulse width train consisting of a coded pulse (separated in time). This coded pulse, when properly spaced, is received by a transponder on the vehicle or satellite. When the expected coded pulses are received by the transponder, the transponder outputs a pulse which is received and tracked by the radar. This is the preferred tracking mode for Range Safety.

Skin tracking is less desirable because a clear return signal is not received and the radar may track the wrong object during staging. This is the reason for the EWR 127-1 requirement for a transponder system or GPS to aid in tracking the vehicle. The beacon system is normally committed through staging events.

Figure 2-2-2: *Cape 1.16 (AN/FPS-16)*

2.2.7.3 Optical Tracking

ER Radar systems have two optical modes available: Designate Angles and Auto Range (DAAR) and Mark- 51 Gun director (MK-51). For more information, please refer to Annex A.

2.2.7.4 Other Tracking Modes

The ER radars have free-fall/on-axis, powered flight/on-axis, and/or autotrack capabilities The basic difference between on-axis and autotrack modes is in the routing and processing of the sensed RF errors. In autotrack mode, positional errors from the receiver are passed directly to the system servos in a fundamentally "raw" condition. These errors are handled by the antenna position servos and delivered to the antenna drive system to correct the position errors as accurately as the system is designed. For more information on other modes, please refer to the ERIH.

2.2.8 Frequency Control Analysis VANS

The FCA vans are a mobile Radio Frequency (RF) monitoring and direction finding asset for Day of Launch (DoL) as well as payload transports. The FCA vans are able to provide RF surveillance for the frequencies responsible for command destruct, telemetry/GPS metric track, C-band radar, and they can even detect GPS jamming. The vans are used during FTS open-loop checks as well as C-band beacon checks (which is a legacy technology, but the capability still exists) and provide valuable baseline information to the user and range engineer.

During DoL activities, if interference is detected, the vans provide a lot of information about the signal such as the frequency, power, bandwidth, and even modulation type. Using our direction finding antenna, our fixed system, as well as the second van we can triangulate the location of the signal, which can help determine potential ownership so that our spectrum management office can contact the license holder and have them terminate transmission. However, if the signal's ownership cannot be determined, the vans are able to collect a large amount of data to later analyze and potentially track down at later time.

On DoL, the vans are required to stay in a fixed location since they are usually behind the Blast Danger Area (BDA) roadblocks and therefore cannot move about in search of RF interference (RFI). However, with the collected data on DoL, the vans can be utilized to search out the RFI by detecting the signal and drawing a bearing line to that signal from one location and then moving closer and readjusting our course. When two vans are doing this at the same time, it becomes relatively easy to isolate the exact source of the RFI.

During payload transports, two vans are called up, one to lead the convoy and one to bring up the rear. The purpose of the vans and the placement of the vans is to provide surveillance of the RF spectrum before the payload and after the payload. Certain Radio Frequencies at a high enough power output can damage extremely sensitive electronics, such as those that can be found on a payload. Therefore, FCA vans provide surveillance for any specific RF that could damage the payload in attempts to ensure that the payload does not drive through damaging RF.

2.2.9 RADAR SUBSYSTEMS

The radar subsystems and functions are as follows:

- **Antenna/Pedestal –** Radiate energy in direction of vehicle
- **Computer/Data Handling –** Process/distribute radar data
- **Console –** Provide for operator interface and control of the radar
- **Receiver –** Receive and convert RF energy to useful signal levels
- **Angle Tracker –** Track the vehicle in the azimuth and elevation dimensions
- **Transmitter –** Generate RF energy and pulses
- **Range Tracker –** Track the vehicle in the Range dimension

There are some differences in the ER C-band radars, such as differences in transmitters and data handling subsystems and other names used for the subsystem; however, the overall basic functions are identical. Each individual radar section can be referenced for further description of these differences. For additional details, please refer to Annex A.

2.2.10 RADAR SITES

2.2.10.1 ER Sites

The ER uses a variety of sites to receive the vehicle position throughout flight in order to determine vehicle performance and anomalies. ER land-based radar facilities consist of five mainland and two downrange stations:

- **Cape 1.16 AN/FPS-16 –** Located on CCAFS. This site serves as the launch-head acquisition radar for vehicles on the pad as well as balloons released from the weather station.
- **KSC 19.14 AN/FPQ-14** – Located on KSC near Kennedy Athletic Recreational and Social Park (KARS). This radar is used as the primary radar for vehicles later in flight after optics is no longer viewable. This radar is also the prime phasing radar to ensure that all C-band radars are in their proper beacon sequencer slots so there is no interference between the radars during tracking events.
- **KSC 19.39 AN/MPS-39 (MOTR)** – Located on KSC near Central Telemetry Station (Tel-4). This radar is used primarily for multiple tracking capability. It can provide up to 10 track files real time but can track up to 40 targets. The radar has two HDD lines with redundant data on each.
- **Patrick 0.134 AN/FPS-134 (ROSA) –** Located east of A1A on PAFB property. The coastal location allows the radar to track ER launches with minimal physical obstructions.
- **Ascension 12.15 AN/FPQ-15 –** Located outside the continental United States. It has an antenna pedestal with a 40-foot reflector, which is the largest reflector used on the ER. It is a main sensor for the Space Surveillance network. The radar is used 24 hours a day, 7 days a week, except during short maintenance times.

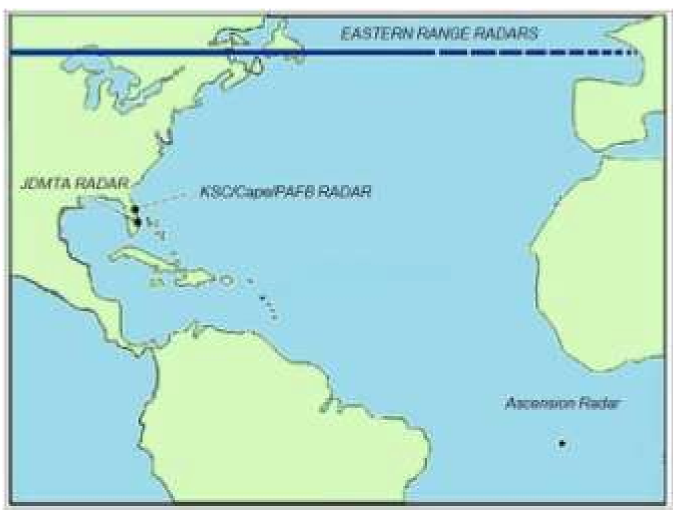

Figure 2-2-3: *Eastern Range Radar Sites*

2.2.10.2 Non-ER Radar Sites Wallops Island

- There are four Wallops radar systems that can be used on the ER. Although these systems are not operated or maintained by the ER, they are approved for use during vehicle flight. These radars include two each AN/FPS-16, a mobile AN/FPS-16, and an AN/FPQ-6.

Figure 2-2-4: *Wallops 86.18 AN/FPQ-6 Radar*

2-3 TELEMETRY SYSTEMS

2.3.1 OVERVIEW

The Telemetry Supersystem receives, records, and relays signals from launch vehicles, satellites, and other aeronautical vehicles to determine position and performance. Signals are collected and processed by Telemetry, and data is provided to Range Safety and Range Customers (RS/RC). It allows for data to be transferred from the launch vehicle and received by Eastern Range (ER) assets to be utilized by the RS and RC to determine vehicle performance and anomalies.

ER land-based telemetry facilities consist of three mainland and two downrange stations. Please refer to section 2.3.3.1 for additional details. All Telemetry operations are controlled and monitored by the telemetry controllers located at the Morrell Operations Center (MOC). Telemetry sites are configured to track and receive S-band (2.2-2.4 gigahertz [GHz]) downlinks onto which are modulated various performance and status data ("baseband" data) gathered from the subsystems of the launch vehicle, upper stage, and/or payload. Additional links received by telemetry include GPS MT, National Television Systems Committee (NTSC) (RocketCam) analog video and digital video. The raw data is received, recorded, and relayed to meet Range Safety and Range Customer mission requirements. Digital telemetry data is converted from demodulated, unconditioned Pulse Code Modulated (PCM) and Frequency Modulated (FM) baseband signals into synchronous bit streams, and routed through the Post Detection Telemetry Subsystem (PDTS) from each site to Tel-4 and the MOC. Desired parameters may be demodulated from the carrier and "separated" from other measurements in real time. This stripped data creates a variety of analog page displays for Range Safety and the Range Customer. Range Safety uses this data to monitor critical parameters such as vehicle attitude, rocket motor chamber pressures, and Command receiver automatic gain control (AGC) voltages. Vehicle events such as Solid Rocket Booster (SRB)/Solid Rocket Motor (SRM) separation, staging, payload fairing jettison, and spacecraft separation are also detected in this data stream. Telemetry Inertial Guidance (TMIG) and GPS MT data is received by ER telemetry antennas or non-ER assets (received and processed by Tel-4 and/ or Cape Centralized Telemetry Processing System (CTPS)). This data is considered by Range Safety to provide Time Space and Position Information (TSPI) adequate enough for processing and display as a valid Range Safety source.

2.3.2 TELEMETRY FUNDEMENTALS

2.3.2.1 Launch Vehicle Telemetry

Telemetry is the transmission of signals (such as launch vehicle data) for the purpose of automatically indicating or recording measurements at a distance from the measuring instrument (such as a ground station). In spacelift applications, telemetry consists of baseband data from the launch vehicle modulated onto an S-Band frequency carrier in the 2.2 gigahertz (GHz) to 2.4 GHz range that is transmitted to the ground to be received, recorded, and retransmitted by ground stations for use by Range Customers and Range Safety.

2.3.2.2 Baseband Data

Baseband data consists primarily of three types of data:

- Performance Data: Data such as vehicle engine chamber pressure, fuel pressure, accelerometer outputs, steering information, and discrete events such as staging and payload or reentry vehicle release.

- Guidance Data: Data such as position data, velocity data, guidance phase and internal cycle status (for example, major and minor cycles), steering commands, accelerometer inputs and sums, malfunction detection indicators, and discreet initiations.
- Flight Termination System (FTS) Data: Data such as received signal strength (for example: Command Receiver Decoder (CRD) Automatic Gain Controls [AGC]) and decoded outputs or commands.

Performance and Guidance data is utilized by the Range Customer or launch agency to determine the performance of a launch vehicle and to establish the nominal, operational, and redline parameter values for vehicle subsystems and components. Range Safety utilizes guidance data as a tracking source to determine if a vehicle is approaching the destruct lines established to protect people and property. Range Safety also monitors range safety critical data extracted from the Performance data for early detection of vehicle malfunctions or failures. FTS data is monitored by the launch agency and Range Safety to verify the performance of the CRDs and ensure that the vehicle can be destroyed if necessary. The baseband data signal takes the form of a change in voltage or current over time and can take the representation of either analog or digital format.

2.3.2.2.1 Analog Signals

An analog data signal represents a physical quantity that is considered to be continuously variable and has a magnitude directly proportional to the data or to a suitable function of the data. Examples are engine chamber pressures and steering information.

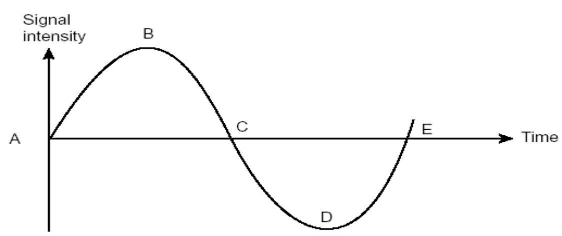

Figure 2-3-1: *Analog Signal (sine wave)*

2.3.2.2.2 Digital Signals

The other type of electrical signal is a digital signal shown in Figure 2-3-2 (same type used in a computer). Unlike the (analog) sine wave signal, which varies gradually between its high points and low points, a digital signal is one which varies instantaneously between two electrical values. For all practical purposes, there are no values between the high and low levels in a digital signal. Notice there are only two signal levels: up and down (high and low).

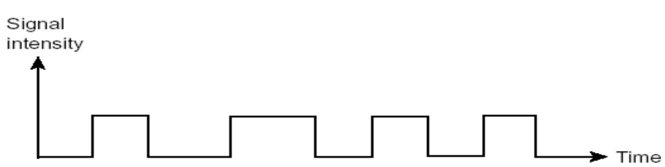

Figure 2-3-2: *Digital Signal*

A digital data signal represents a discrete value or condition, such as separation/staging events, payload or reentry vehicle release, or Command signal Pilot Tone.

2.3.2.3 Launch Vehicle Telemetry Systems

The typical telemetry system is essentially composed of instrumentation sensors, navigation sensors (accelerometers and gyros), an Inertial Navigation Unit (INU) or guidance computer, a Master Terminal Unit (MTU), one or more Remote Terminal Units (RTU), and transmitters. The instrumentation sensors detect performance and FTS data measurements. Instrumentation sensors include switches or transducers that indicate separation events, thrust chamber pressures, and receiver AGCs. The instrumentation sensors send their data directly to the MTU, or to a RTU, if on a separate vehicle stage than the MTU. The RTU uses a multiplexer to combine the data and send it to the MTU. The accelerometers and gyros gather information on the motion of the vehicle in all three dimensions and provide their information to the INU, which records the information and determines the roll, pitch, and yaw rates, the position of the vehicle, as well as the velocity. The MTU uses a multiplexer to combine the performance, FTS, and guidance data gathered directly from the instrumentation sensors, the RTUs, and the INU into a serial bit stream. The MTU then uses a modulator to modulate the data onto a carrier signal and sends the data to the transmitters for transmission to either ground stations or to the Tracking and Data Relay Satellite System (TDRSS).

A launch vehicle may have more than one set of S-Band antennas to transmit data on more than one telemetry link or frequency. For example, a vehicle may use one telemetry data link to transmit first and second stage data and a second telemetry data link to transmit third stage data. Also, the payload will use an additional telemetry data link to transmit its health and status information.

2.3.2.4 Multiplexing

The number of sensors providing the performance, navigation, and FTS data may number in the hundreds or thousands. The cost to transmit the data from each sensor through a separate channel would be prohibitive. Therefore, a process called multiplexing is used to combine the different launch vehicle data parameters into the same baseband data stream before modulation onto a carrier signal and transmission to the ground. Simply stated, multiplexing is a process in which several inputs or data channels are combined for transmission over the same signal path. Multiplexing is performed by a device known as a multiplexer or commutator and is achieved by sharing frequency spectrum or time with techniques called Frequency-Division Multiplexing (FDM) and Time-Division Multiplexing (TDM), respectively. For additional details, please refer to Annex A.

2.3.2.5 Modulation

Once the launch vehicle data has been multiplexed into a baseband data stream, the data stream is then impressed onto a carrier signal to transmit the information to the ground. The impression of the baseband data upon the transmitted carrier wave is accomplished by a process called modulation. Modulation is the process of varying a characteristic of a carrier, in accordance with an information-bearing signal. The type of modulation used is defined by the characteristic that is changed. The primary characteristics that are changed by the modulating signal are the *Amplitude*, *Frequency*, and *Phase*. For additional details, please refer to Annex A.

2.3.2.6 Antenna Polarization

Once the baseband data has been modulated onto the carrier signal, the signal is transmitted to the ground. The type of antenna used to transmit the signal determines the *polarization* of the signal. An electromagnetic wave, or signal, has an electric field vector component and a magnetic field vector component that are perpendicular to each other and to the direction of travel. The polarization of an electromagnetic wave is the property that describes the orientation (i.e., time-varying direction and amplitude) of the electric field vector perpendicular to the direction of propagation. The polarization of a signal is important because it determines how resistant the signal will be to signal degradation. There are two categories of polarization: *Linear* and *Circular* polarization. For additional details, please refer to Annex A.

2.3.2.7 Telemetry Components

Telemetry sites receive telemetry from the launch vehicle, separate the vehicle data from the telemetry link, process the raw data for recording or display, and distribute the data to Range and Launch Customers. There are three primary subsystems used at a typical telemetry site:

- Antenna/Receiver Subsystem
- Recording Subsystem
- Separation Subsystem

2.3.2.7.1 Antenna/Receiver Subsystem

Telemetry auto-tracking antennas acquire the launch vehicle telemetry signal and track the launch vehicle in flight. This subsystem consists of four major components.

- Antenna: A typical telemetry site antenna uses a parabolic reflector with an azimuth over elevation pedestal for moving the antenna.
- Site Computer: A telemetry site computer is usually shared by the site's antennas and is comprised of a System Engineering Laboratories (SEL) computer or the COMPRO Gateway computer, a TRIO computer and a Microcomputer Buffer System (MBS).
- Receiver: Receivers are used to collect telemetry data from S-Band carrier frequencies, down-convert intelligence to a useable frequency, and to amplify the intelligence to make it available for recording or further processing.
- Combiner: Combiners are used to take the signal components of the Pre-D or Post-D primary data outputs from the receivers, weight the Left-Hand Circular Polarized (LHCP) and Right-Hand Circular Polarized (RHCP) signals in accordance with the AGC data from the receivers, and combine the signals to maintain an optimal output signal level. The primary purpose of the combiner is to produce an optimal composite Intermediate Frequency (IF) signal (using Pre-D data) or an optimal composite video signal (using Post-D data) in which losses due to fluctuations in one polarization or to polarization mismatch between the incoming signal and the receive antenna are compensated for and the signal may be completely recovered.

2.3.2.7.1.1 Antenna - Tracking Modes

There are several tracking modes used to acquire and track a launch vehicle in flight:

- **Manual**: This mode allows the operator to control antenna movement using hand wheels or thumb switches
- **Encoder (or Synchro) Slave Mode**: Pointing data is derived from another tracking device's (i.e., radar or telemetry tracking antenna) encoder or synchro devices
- **Autotrack**: Antenna pointing data is derived and provided by the antenna's automatic tracking subsystem by detecting azimuth and elevation variances/errors in the received radio frequency (RF) signal
- **Computer Designate (or Computer Drive)**: Antenna mount is driven by the antenna-pointing data from the Telemetry/Radar Input/Output (TRIO)/Gould/System Engineering Laboratories (SEL) system or the COMPRO Gateway computer system. (Note: The COMPRO Gateway computer system is at Tel-4.)
- **Slew**: Antenna movement is controlled by and proportional to the deflection of a joystick

2.3.2.7.2 Recording Subsystem

Recorders are used to record and reproduce telemetry signals from the receivers and/or the combiners for Range Customers and for internal configuration checks, data quality monitoring, and local testing. Analog data recorders and digital data recorders are the two types of data recording that are used. Typically, Launch Customers primarily want the telemetry sites to record the Pre-D data collected from the combiners. They may also request that the sites record the Pre-D data from the LHCP and RHCP components of the signal collected directly from the receivers on an as-obtainable basis. For additional details, please refer to Annex A.

2.3.2.7.3 Separation Subsystems

The purpose of the separation subsystem is to separate (demultiplex and/or decommutate) individual telemetry parameters from the telemetry downlink for subsequent processing and/or display. Separation is done by converting the raw Post-D signals from the combiner into binary, digital data. The separation subsystem also prepares data for retransmission to the MOC over the Post Detect Telemetry System (PDTS). For additional details, please refer to Annex A.

2.3.3 Eastern Range Telemetry Sites and Antennas

The ER uses a variety of telemetry ground stations and antennas to receive the vehicle telemetry throughout flight in order to determine vehicle performance and anomalies. ER land-based telemetry facilities consist of three mainland and two downrange stations.

2.3.3.1 Telemetry Sites

The ER uses a variety of telemetry ground stations and antennas to receive the vehicle telemetry throughout flight in order to determine vehicle performance and anomalies. ER land-based telemetry facilities consist of three mainland and two downrange stations.

- **Tel-4 (Central Telemetry Station) (Station 19) –** near the Banana River on the grounds of Kennedy Space Center (KSC), serves as the central telemetry acquisition, processing, and distribution center, as well as the primary tracking and receiving site during the early stages of a typical ER launch. A 24 foot (ft) KSC Telemetry Autotracking Antenna [TAA]-24A and 33 ft KSC TAA-3C autotracking antennas are located on site. Tel-4 also receives data from Cape Telemetry Retransmission System (TRS), a stationary receiving site located between Space Launch Complex (SLC)-37B and SLC-41. Tel-4 also receives, records, and relays data from non-ER assets, including Air Force Satellite Control Network (AFSCN) sites and Tracking and Data Relay Satellite System (TDRSS). Tel-4 has one Telemetry Autotracking Antenna (TAA)-24A, one TAA-3C antenna, and one TAA-20 antenna.
- **The Cape Centralized Telemetry Processing System (CTPS) (Station 1) –** is located at the Morrell Operations Center (MOC) at CCAFS. Cape CTPS processes real-time or recorded telemetry and Global Positioning System (GPS) Metric Tracking (MT) data that is provided to RS/RC. Analog page display parameters are generated and distributed to Range Safety (Cape Flight Operations Version 1 (FOV1) and Cape Distributed Range Safety Displays (DRSD) and Cape Display.
- **Jonathan Dickinson Missile Tracking Annex (JDMTA) (Station 28) –** is located approximately 100 miles downrange at Tequesta, Florida. JDMTA can provide back-up coverage to Tel-4 during land-based operations, is the primary telemetry tracking site during Navy operations, and is able to acquire and track up to four spatially separated sea-launched radiating bodies as required per mission scenario. Four 50 ft autotracking antennas (JDMTA TAA-50-1, JDMTA TAA-50-2, JDMTA TAA-50-3, JDMTA TAA-50-5) are at the site.

- **Ascension (Station 12) –** Located Outside the Continental United States (OCONUS), it possesses two 33 foot (Ascension TAA-3C-1 and Ascension TAA-3C-2) autotracking antennas that allow the site to perform tracking and data collection during terminal re-entry, transfer orbit mark events, or payload orbital passes.

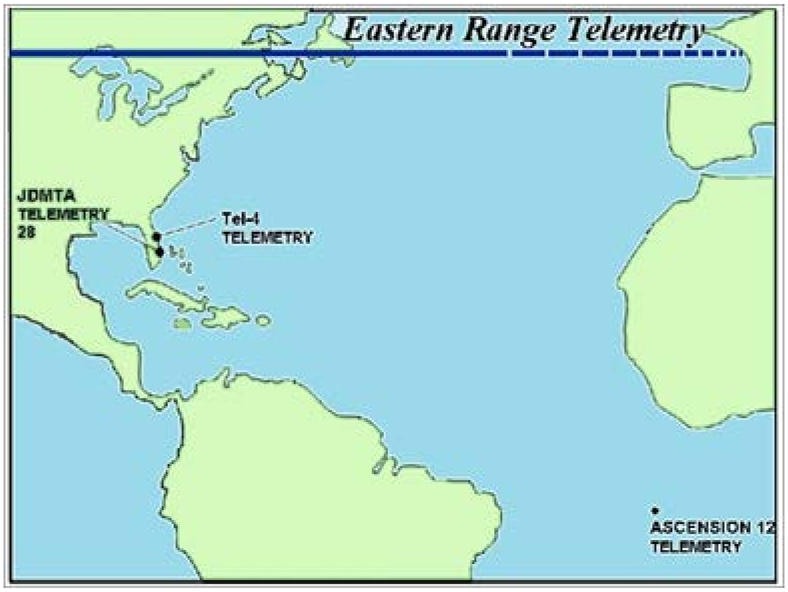

Figure 2-3-3: *Eastern Range Telemetry Sites*

2.3.3.2 Telemetry Antennas

There are five main types of Telemetry Autotracking Antennas used by the ER:

- **TAA-3C:** The TAA-3C antenna is widely used at the ER. It consists of a 33-foot (ft) parabolic dish with a prime focus, pseudo-monopulse feed horn. It has an azimuth-over-elevation pedestal and a Right-Hand Circular (RHC) and Left-Hand Circular (LHC) polarized antenna. Its pointing error is $\pm$ 0.1 degrees and it has a beamwidth of 0.88 degrees. TAA-3C antennas are located at Tel-4 and Ascension.
- **TAA-24A:** The TAA-24A antenna is an older, lower performance telemetry antenna. It consists of a 24-ft parabolic dish with a conical monopulse feed horn. It has an azimuth-over-elevation pedestal and a RHC- and LHC-polarized antenna. It has a pointing error of $\pm$ 0.1 degrees and beamwidth of 1.2 degrees. There is one TAA-24A antenna located at Tel-4.
- **TAA-20:** The TAA-20 antenna is new on the ER. It consists of a 20-ft parabolic dish with a variable rate CONSCAN feed horn. The TAA-20 has an azimuth-over-elevation pedestal and a RHC- and LHC-polarized antenna. It has a pointing error of $\pm$ 0.05 degrees and a beamwidth of 1.4 degrees. The antenna is environmentally protected with a Radome. There is one TAA-20 antenna located at Tel-4.
- **TAA-50A:** The TAA-50 antenna is a highly sensitive telemetry antenna with high slewing/tracking rates used primarily for Trident II launches, but it is also used to support other launches from the ER. The antenna has a 50-ft parabolic dish with a cassegrain, pseudo-monopulse feed horn. It has an azimuth-over-elevation pedestal and a RHC- and LHC-polarized antenna. It has a low pointing error of $\pm$ 0.05 degrees and a beamwidth varying from 0.55 degrees to 0.57 degrees. There are four TAA-50 antennas located at JDMTA.
- **Telemetry Retransmission System (TRS):** In addition to the typical telemetry antennas, Tel-4 also makes use of another telemetry antenna called the TRS shown in Figure 2-3-25.

The TRS is a satellite facility to Tel-4 located on Phillips Parkway just south of the KSC/Cape Canaveral Air Force Station (CCAFS) border. It consists primarily of four S-Band antennas installed on a 115-ft-tall concrete pole located on the east side of Phillips Parkway and two equipment racks in the North Gate Terminal Building (NGTB) on the west side of Phillips Parkway. The TRS supplements Tel-4's coverage during the first 15 seconds of the plus count for Delta IV and Atlas V launches. The TRS receives the telemetry signals from Delta IV and Atlas V vehicles and retransmits the signals to Tel-4 via communication fiber optic modems for processing and recording.

Figure 2-3-4: *KSC TAA-3C at Tel 4*

Figure 2-3-5: TAA-50-2 at JDMTA

Figure 2-3-6: *TRS S-Band Antenna*

2.3.4 Tracking and Data Relay Satellite System (TDRSS)

TDRSS is a network of communications satellites called TDRS and ground stations used by NASA for space communications. The goal was to increase the time spacecraft were in communication with the ground and improve the amount of data that could be transferred.

The term TDRSS is analogous to Space Network.

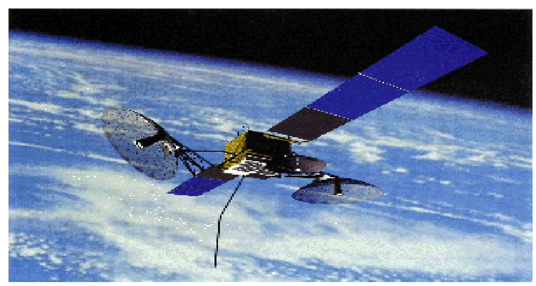

Figure 2-3-7: *Tracking and Data Relay*

TDRSS is composed of three segments: the ground, space, and user segments. These three segments work in conjunction to accomplish the mission. An emergency or failure in any one segment could have catastrophic impact on the rest of the system. For this reason, however, all segments have redundancy factored into the system. For additional details, please refer to Annex A.

2.3.5 Air Force Satellite Control Network (AFSCN)

The AFSCN provides support for the operation, control, and maintenance of a variety of United States Department of Defense (DoD) and some non-DoD satellites. Support includes such items as the execution of tasks involved in Tracking, Telemetry, and Command (TT&C), and providing prelaunch simulation, launch support, and early orbit support while satellites are in initial or transfer orbits and require maneuvering to their final orbit. Additionally, the AFSCN provides tracking data to help maintain the catalog of space objects and distributes various data such as satellite ephemeris, almanacs, and other information.

The AFSCN consists of satellite control centers, tracking stations, and test facilities located around the world. Mission Control Centers (MCC) are located at the Consolidated Space Operations Center (CSOC) and Onizuka Air Force Station. These centers are manned around the clock and are responsible for the command and control of their assigned satellite systems. The control centers are linked to remote tracking stations (RTS) around the world. The remote tracking stations provide the link between satellite and its control center and are needed to maintain frequent communications with the satellite. Without RTSs, the control centers would only be able to contact a satellite when it came into the control center's view. Some satellites, especially those in geostationary orbits, never come within view of their control center. Each antenna at an RTS is referred to as a "side." Side A is normally a 60-foot diameter antenna which is best for TT&C of a geosynchronous satellite because of the distance to the satellite and the fact that the large antenna does not need to move quickly to maintain contact with the satellite. Side B is either a 46-foot or 33-foot diameter antenna, commonly used for TT&C of low earth orbit satellites which can move more quickly across the sky, are more responsive, and require less energy to control.

2.3.6 Centralized Telemetry Processing System (CTPS)

The CTPS in the MOC processes, distributes, and displays TMIG data and analog parameters for the Flight Operations Version 1 (FOV1) and Distributed Range Safety Display (DRSD) systems. CTPS consists of two strings of equipment, designated side A and side B, which are essentially mirror images of each other. The noted exceptions are that the B-side only has two Telemetry Stations (TS) and the A-side has three TS, and the B-side Control Server depends on the A-side Control Server for network information services. For additional details, please refer to the ERIH.

CTPS receives Post-D telemetry data from the MOC Wide Area Network Interface Unit (WANIU) which receives Post-D telemetry data from several sources:

- Tel-4 antenna data through the Asynchronous Transfer Mode (ATM) landlines
- JDMTA data routed through the XY Facility
- Ascension data from the INTELSAT SATCOM links
- TDRSS and Wallops Island data routed through Hangar AE
- AFSCN and TDRSS data routed through the EVCF and/or the Technical Support Facility (TSF)
- Portable Shipboard Instrumentation Package (POSIP) data from the Launch Area Support Ship (LASS) through the INMARSAT Satellite Communications (SATCOM) links for Trident missions

The telemetry signals then undergo frame synchronization and decommutation. The resultant telemetry parameters are used to generate analog telemetry pages in the CTPS area that are remotely displayed on the Telemetry Systems Officer (TSO) console in the Range Safety Display (RSD) area of the MOC.

The telemetry parameters are also assembled into 4.8 kbps Range Safety outputs that are forwarded to the FOV1 and DRSD systems for further processing and display. Each side of CTPS provides data through a primary and back-up data line (A1 and A2, B1 and B2) to the Data Buffer Units (DBU) which route the data to the FOV1 Guidance Processor-Front End Processors (GP-FEP) and the DRSD FEPs. The FOV1 and DRSD systems process the TMIG data to be used as a tracking source and display the telemetry generated Instantaneous Impact Point (IIP) and the vehicle CRD AGC levels on their screens at the MFCO consoles.

CTPS automates as much of the configuration process as possible. Most of the connectivity and hardware setups within CTPS are stored within configuration files that are loaded at the beginning of an operation. This greatly reduces the turnaround time to transition from one launch vehicle setup to another. However, there has been some manual capability added to CTPS to simplify real-time switching. The Broad Access Pesa Switch (BAPS) is the primary example of this. BAPS is a 144 inpurt/96 output routing switcher that can route digital telemetry to, from, and within Cape CTPS. BAPS is used to cross-connect A-side and B-side assets, to ingest external interface data, and to allow operators to select different sources to feed the 4.8 kbps outputs to FOV1 and DRSD. The operators and analysts at the Telemetry Processing and Display (TPD) workstations may also run UNIX commands to real-time select different sources to feed the Analog Telemetry pages or to change values of parameters inserted into the Telemetry Range Safety Buffer (TRSB) outputs.

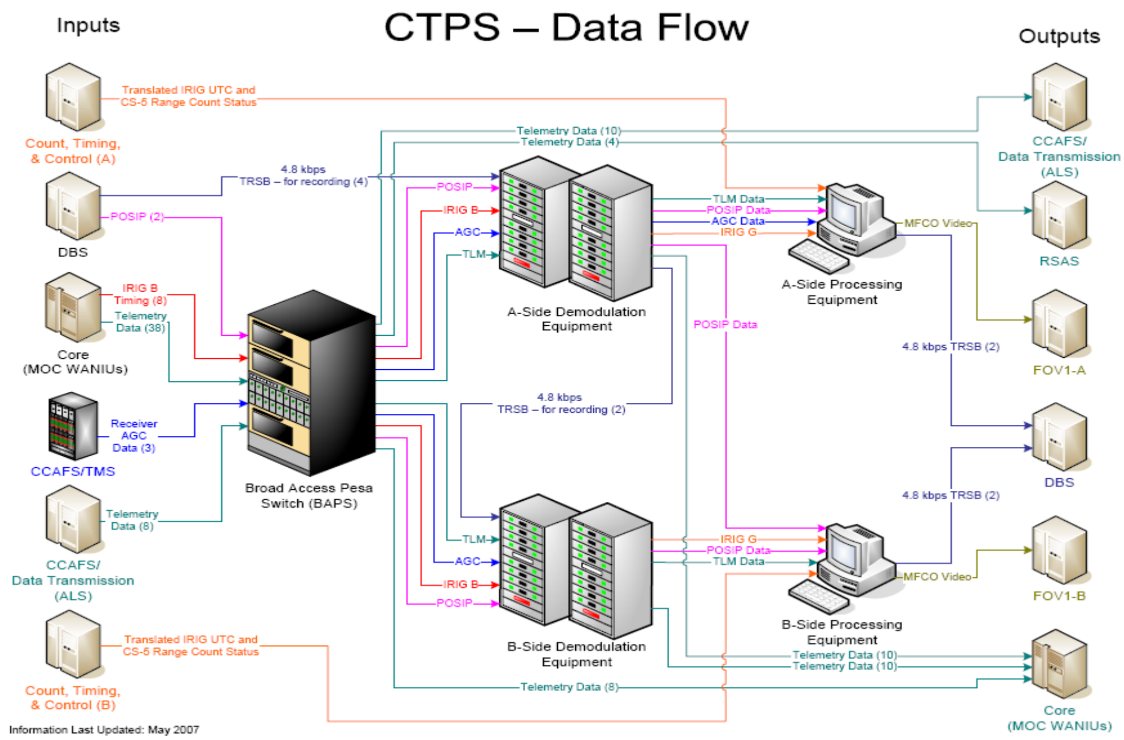

Figure 2-3-8: *CTPS Data Flow*

2-4 OPTICS SYSTEMS

2.4.1 OVERVIEW

Optical systems provide two-dimensional position-versus-time data. The Optical systems include both mobile and fixed trackers. The mobile trackers include the Advanced Transportable Optical Tracking System (ATOTS) and Cinetheodolites. The fixed trackers include the Patrick Air Force Base (PAFB) Distant Object Attitude Measurement System (DOAMS), and Kennedy Space Center (KSC) DOAMS. The Eastern Range (ER) has 24 Universal Camera Sites (UCS) that can accommodate most of the Range mobile optics systems. The main function of the sites is to provide communications, video, power distribution, and a surveyed location from which the trackers can operate. The Optics Supersystem consists of mobile and fixed optical sites that can provide imagery and positional data during the first few minutes of the flight of a launch vehicle.

2.4.2 REQUIREMENTS

2.4.2.1 Range Safety and Customer Requirements

- Range Safety Video: The Optics sites also provide video imagery to the MFCO for evaluation of launch vehicle attitude and integrity. During the planning phase, the Metric Optics Planners must consider that not every Universal Camera Site (UCS) has video transmission capabilities.
- Customer Data: In addition to being used for metric tracking for Range Safety, the ER optical systems produce several types of imagery data for customer requirements that can be used to verify the integrity of the vehicle during flight, document a launch campaign, or be used in engineering analysis or anomaly resolution in the event of an abnormality or failure early in flight.

2.4.2.2 Optical Systems

Range classifies Optical Systems into two basic types of instrumentation (for additional details refer to the Eastern Range Instrumentation Handbook (ERIH)):

- Fixed Optical Trackers: The fixed site’s main optics have long focal length systems with a 24-inch (61 centimeters) main aperture. They provide both metric data and long-range optical imaging capabilities for Range Safety and engineering sequential coverage.
- Fixed Optics sites include: Kennedy Space Center (KSC) Distant Object Attitude Measurement System (DOAMS) at Playalinda Beach, and Patrick Air Force Base (PAFB) DOAMS.
- Transportable (Mobile) Optical Trackers: The mobile optical trackers have main optics with 18-inch main apertures (Advanced Transportable Optical Tracking System [ATOTS], or 7-inch main apertures (Cinetheodolites). Transportable optical systems include: ATOTS-1, ATOTS-2, Cinetheodolites number 402, 405, 406, and 407.

2.4.2.3 Range Interfaces

2.4.2.3.1 UCS Facilities

The UCS facilities provide a smooth, level, surveyed pad for mobile Optical tracking systems. Although the UCS sites are not technically Range interfaces, they are the facilities that provide connectivity to the Range interfaces. The UCS facilities provide connections for communications, timing, video, and alternating current power distribution. In the event of a power outage, the mobile trackers can be operated with portable generators.

2.4.2.3.2 Common Optical Subsystems

The ER Optics sites are comprised of seven major subsystems (For additional details, please refer to Annex A:

- Environment (Astrodome) Subsystem - Responsible for protecting the optical and electronic equipment inside the astrodome from environmental elements. Composed of the Astrodome, Astrodome Rotation Servo, and Air Conditioner/Heater components
- Optics Subsystem - Responsible for gathering, magnifying, and focusing light, and providing it to image capture devices. Composed of one Acquisition Telescope and one or two Main Telescopes
- Mount Subsystem - Responsible for supporting and stabilizing the Optics subsystem, changing the optical pointing direction using track errors from the operator or Computer subsystems, and reading mount position
- Video Subsystem - Responsible for the generation, recording, distribution, and monitoring of video images from the light received from the Acquisition and Main telescopes in the Optics Subsystem. This includes a wide-angle video camera used to provide the site operator with wide-angle video for launch vehicle acquisition
- Film Subsystem - Responsible for recording imagery from the light received from the Optics Subsystem onto motion picture film. Cinetheodolites do not have a Film Subsystem
- Computer Subsystem - Receives data from the Mount, Communications, Timing, and Video subsystems. It processes this data, allows for operator-data interface, and provides this data to the Communications, Mount, and Optics subsystems. The Optical Site Computer System (OSCS) is a specialized rack mount that has custom mission software for controlling Optical tracking systems on the ER.
- Power Distribution Subsystem- This subsystem routes either 3-phase or single-phase power to the appropriate components, No source of backup is available

2.4.2.3.3 Optical Solution

The Optical Solution is an estimate of the vehicle position, based on data gathered from Optical sites. Each Optical system provides two-dimensional position-versus-time data to the Flight Operations Version 1 (FOV1) and the Distributed Range Safety Displays (DRSD). Note: FOV1 and DRSD are part of the Range Safety Supersystem. An Optical Solution is composed of Time, Azimuth, and Elevation (TAE) data from at least four Optical sites with closure angles between 30° and 150° from T-0 to the end of the Optical commitment period. See figure 2-4-1.

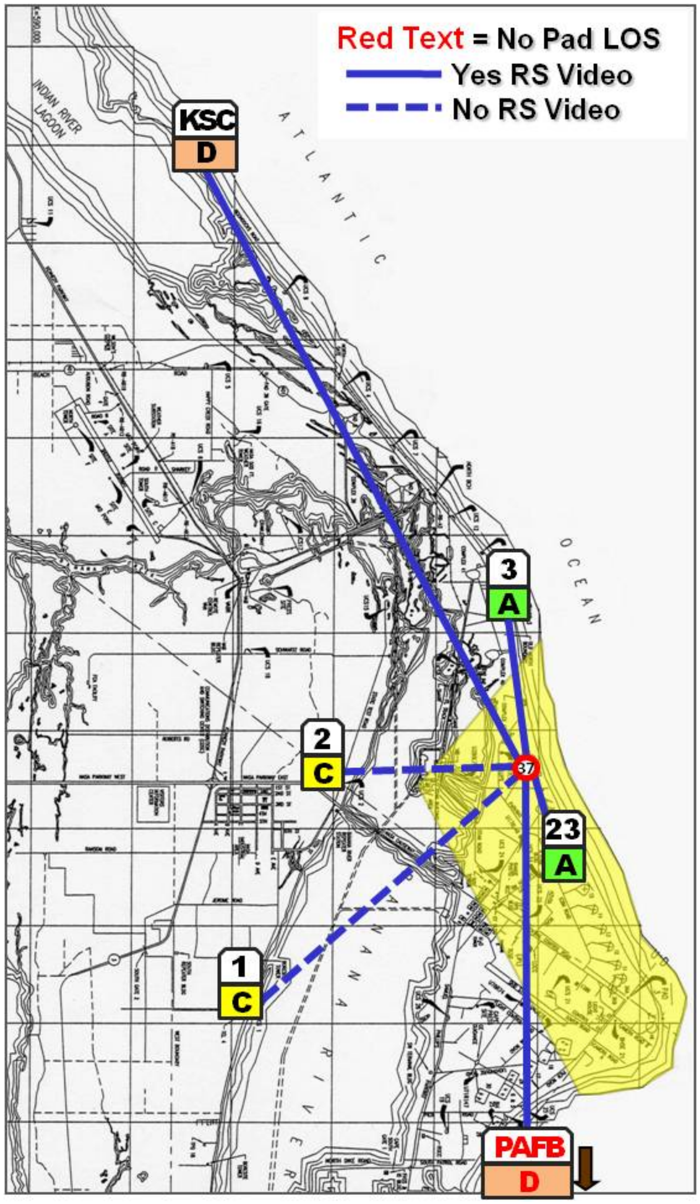

Figure 2-4-1: *Example of Delta IV Optics Site Configuration*

2.4.3 Optics Limiting Factors

2.4.3.1 Closure Angles

A single Optical tracker provides information on its azimuth and elevation pointing angles, but cannot independently provide range information. This constitutes a single vector with an undefined magnitude. In order for vehicle position to be determined, a second vector from another Optical tracker is required. Where the two vectors intersect, theoretically, is the location of the vehicle. The angle between the vectors is known as the closure angle. Closure angles close to 90° yield the smallest amount of position uncertainty. However, during launches the closure angles are rarely 90°, and then only for a short period of time. See figure 2-4-2.

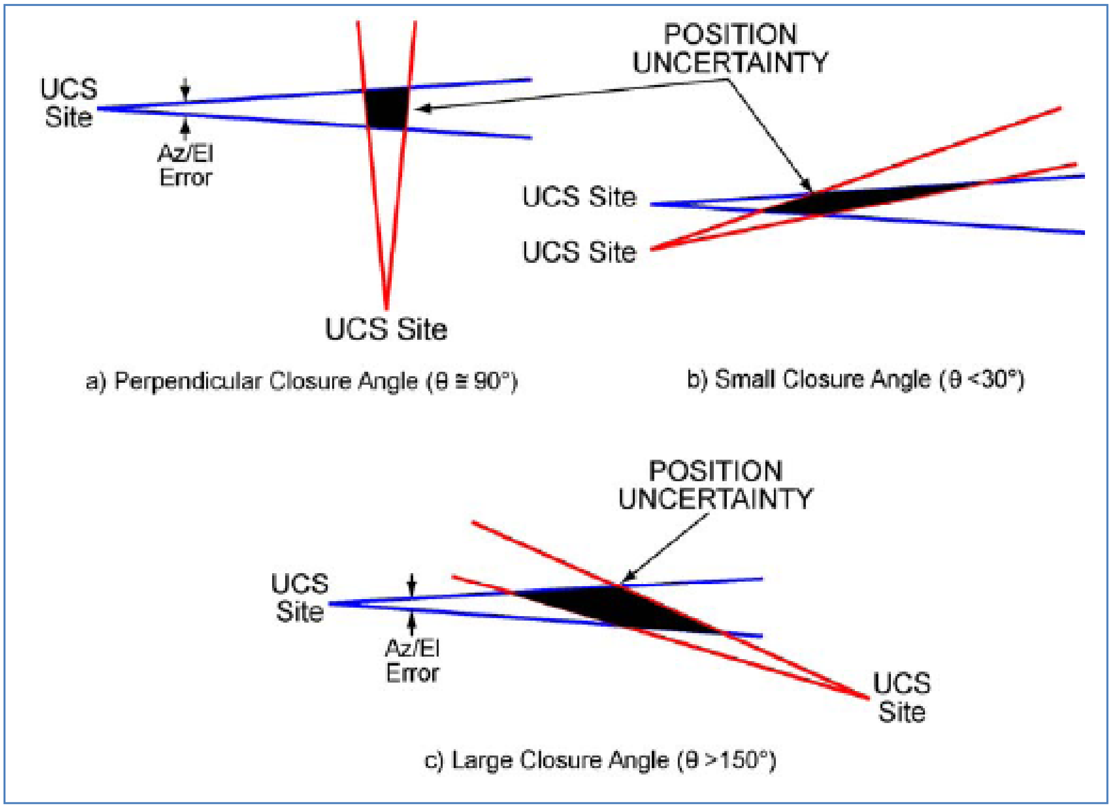

Figure 2-4-2: *Variation of Launch Vehicle Position Uncertainty due to Changing Closure Angles*

Each Optical tracker has some uncertainty in its mount azimuth and elevation measurements due to the physical mount characteristics as well as encoder accuracy. This translates into inaccuracy in the vector information being computed. The resultant position uncertainty (error) caused by errors in azimuth and elevation measurements is minimized if the two vectors are perpendicular (i.e., 90°). The figure represents different closure angles. The resultant position uncertainty of each is represented by the shaded areas where the vectors intersect. The closure angles must be greater than 30° and less than 150° to generate an adequate Optical Solution.

2.4.3.2 Key Reference Site

The crucial element needed to provide and maintain accurate position data is geometry. Mobile Optical trackers are placed at various sites to maintain closure angles between 30° and 150° with other mobile trackers and fixed-site trackers. A typical launch support configuration will have trackers at sites to the north and south of the launch pad, with at least one key reference site to the west. The northern and southern sites are located at varying distances from the pad along the coast. When compared to each other, these sites will have closure angles that are too small or too large to generate an adequate optical solution. When a key reference site is added to the set of northern and southern sites, it creates closure angles between 30° and 150°. If the tracker at a key reference site fails, the solution built around that site becomes invalid because that tracker's azimuth and elevation data is rejected from the Optical Solution. The Metric Optics Planners attempt to place the trackers in a configuration with two sites each to the south, north and west. This configuration provides the best redundancy for the solution. In this configuration, the Optics solution is not dependent on an individual site. All of the sites play an equal role in creating the proper closure angles. If there is a single key reference site, then the entire Optical Solution depends on that one site. This situation creates a single point of failure (SPOF) in the solution. Redundancy ensures a quality solution if the tracker at one or two sites were to fail.

2.4.3.3 Planning and Control

- **Sun Interference:** Sun interference is checked during the planning process using AutoSTK. Due to the always changing atmospheric conditions (clouds, glare, etc.), it is not possible to determine the exact point that a tracker would lose the vehicle due to the Sun's saturation of the sensors. For planning purposes a value of 4° is used to determine if a tracker will have to drop track to avoid sensor damage. An Operations Control Instruction (OCI) will be submitted showing the Sun interference times through the launch window. This will only have an effect on one site at a time, but may affect multiple sites throughout the window.

2.4.3.4 Effect of a Losing Site

The geometric location of the Optical trackers is critical for obtaining a good Optical Solution. The impact on the Optical Solution of a tracker becoming non-mission capable (NMC) differs depending on the tracker's location in relation to the remaining trackers.

Excluded Site Coverage Time Matrix
N/A = No valid solution * Key site

Site	6	8	11	23	PAFB	KSC
*6	10/163	N/A	30/92	42/86	N/A	10/93
8	N/A	0/109	10/69	10/109	0/83	10/59
11	30/92	10/69	0/92	10/86	0/81	10/66
23	42/86	10/109	10/86	0/109	0/66	10/86
PAFB	N/A	0/83	0/81	0/66	0/83	0/59
KSC	10/93	10/59	10/66	10/86	0/59	0/93

Figure 2-4-3: *Example of Delta IV's Excluded Site Coverage Time Matrix*

Figure 2-4-3 is an example of site coverage for Delta IV launches. During the planning process, the Optics planners use AutoSTK to evaluate the impact of non-committed sites. The Time Matrix charts show the resulting impact to the commitment time from the loss of any one or two sites. Since only six Optics sites are used to support launch operations, there is no need to evaluate beyond the loss of any two sites, because this would leave Optics with less than the required four site minimum. Using figure 2-4-3 to determine the impact of a losing site, the Optics planners find the intersection of the row and column for the failed site. The first number in each intersection shows the beginning of good Optical coverage (good closure angles) and the second number shows when the closure angles cease being within the required parameters. The period when the closure angles are expected to be good is known as the Commitment Period. Using Site 8 on the chart as an example, the row and column intersection for Site 8 reflects, "0/109." This means, if Site 8 alone fails, there would be no impact to the beginning of the coverage, but the end of the coverage would be limited to T+109 seconds. The intersection for both Sites 8 and 6 shows, "N/A." This means, if Sites 8 and 6 both fail, there would be no period with good coverage angles and Metric Optics instruments would not be able to provide any Optical Solution. Figure 2-4-3 shows that Site 6 is a key reference site. The intersection for Site 6 reflects, "10/163." If Site 6 alone were to fail, no Optical Solution could be provided until T+10 seconds.

2-5 GPS TRACKING SYSTEMS

2.5.1 GPS METRIC TRACK (GPS MT) OVERVIEW

For launch vehicles equipped with a GPS receiver or translator, GPS Metric Track (MT) data can be used to meet Range Safety tracking requirements. GPS MT systems utilize data from the GPS constellation to provide real-time Range Safety state vector (positional) data. There are two types of GPS MT systems on the Eastern Range (ER): the Evolved Expendable Launch Vehicle (EELV) GPS MT System and the Translated GPS Range System (TGRS).

2.5.2 GPS MT FUNDAMENTALS

GPS is a space-based, radio-positioning, and time transfer system, which nominally consists of a constellation of at least 24 orbiting satellites (Figure 2-5-1), which provides navigation and timing information to military and civilian users worldwide. GPS is funded, launched, operated, and maintained by the DoD.

2.5.2.1 GPS Signals

GPS works by using the triangulation of at least three satellites to determine the user's position by determining the intersection of the spheres defined by the radii of each satellite and then taking measurements from a fourth satellite to factor out time errors.

Each GPS satellite transmits signals centered on three microwave L-band frequencies:

- 1575.42 megahertz (MHz), referred to as L1
- 1227.6 MHz, referred to as L2
- 1381 MHz, referred to as L3

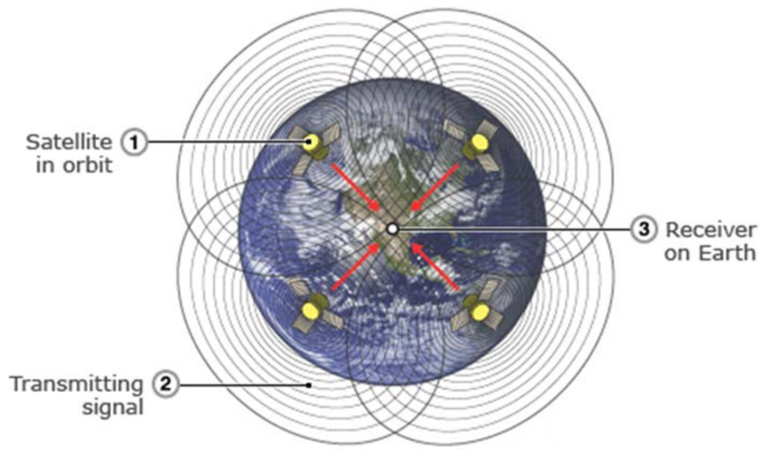

Figure 2-5-1: *GPS Constellation*

L1 and L2 are used for positioning; L3 is used for system testing. GPS MT systems utilize the L-Band signals from at least four GPS satellites to calculate the vehicle's state vector. Equipment on the launch vehicle receives the GPS L-Band signals and either: 1) processes the GPS data to calculate the vehicle's state vector (ex: EELV GPS MT System) *or* 2) translates or converts the GPS signals from an L-Band frequency to an S-band frequency (ex: TGRS). The vehicle then transmits the calculated GPS MT state vector data or the translated GPS signals on an S-Band downlink.

2-6 SPARC SYSTEMS

2.6.1 INTRODUCTION TO SPARC SYSTEMS

The Single Point Acquisition and Radar Control (SPARC) system is part of the Radar Supersystem and monitors the interface with the Range Safety Supersystem. SPARC monitors and displays all position data, various mode, and track indicators output by the Eastern Range radars. The SPARC system enables the Radar Systems Controller (RSC) to monitor Range data and to control the selection of circuits from Radar, Telemetry, Computers, and Radar to Command. For additional information on SPARC, please refer to the Eastern Range Instrumentation Handbook (ERIH). The RSC directs the routing of data from one instrumentation site to another. Should an instrumentation site lose track, the RSC can route data from another tracking site to aid the first in reacquiring track. This routing ability is critical in non-nominal flights when nominal trajectory data is unusable. A break-up of an in-flight vehicle is verified through radars by the RSC, who then directs and coordinates the routing of instrumentation data to the Multiple Object Tracking Radar (MOTR) data files.

2.6.2 PURPOSE

The primary purpose of SPARC is to route launch critical designate data to remote instrumentation sites. Additionally, SPARC monitors tracking performance, circuit status, instrumentation configuration, and individual sites track data. It superimposes track data from two tracking sites in one nominal target display for comparison. SPARC is composed of two subsystems: Switch Control (SC) and Radar Graphics (RG).

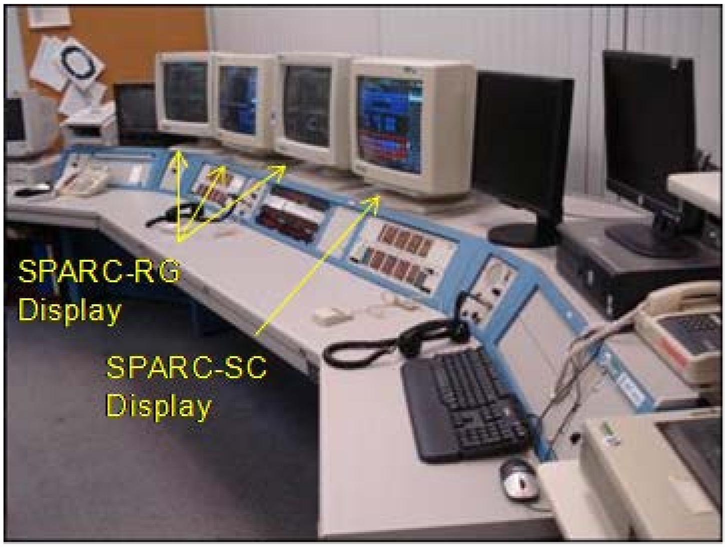

Figure 2-6-1: *Cape SPARC Console*

2.6.3 CAPABILITIES

The SPARC system provides the following capabilities:

- Monitoring of data and control of the selection of circuits.
- Acquisition processing, which accepts updated pointing data from tracking sources.
- Data handling, which selects source inputs for display.
- Data display processing, which accepts operator input and controls the display of data for selected sources.
- Switching control, which provides downrange station switch control and communications path control of data to uprange and downrange customers.

- Switching control to accommodate the assignment of source inputs based on operation classification.
- Aid in debris tracking during launch anomalies.

2.6.4 SWITCH CONTROL DISPLAY

The SPARC-SC subsystem is a real-time point–to-point data switch controller, employing a mouse selectable computer display interface that displays interchangeable sources, paths, and customers. It is the central switching element and controls a maximum of 64 instrumentation sources and 80 customers. The SPARC system is an effective tool during launch anomalies when nominal designate data is not applicable and real-time tracking data becomes the primary designate source to aid the tracking sites in Range Safety debris tracking. The SPARC-SC display has four distinct functional areas (for additional information, please refer to Annex A Section A2.6.4.1 thru A2.6.4.5):

- System status – area displays Range time, countdown time, operating mode, logging status, local switch status, downrange switch status, OPNR, and auto-switching.
- Sources and customers – source is an instrumentation site that is capable of producing tacking, designate, or Compressed Theoretical Trajectory (COTT). Customer is a site that is capable of accepting source data.
- Data Paths – a circuit connection from a source to a customer.
- Switches – the switch control receives switch status via FOV1 Front End Processors (FEPs).

2.6.5 RADAR GRAPHICS DISPLAYS

The SPARC-RG subsystem is a real-time, mouse selectable, display. It provides monitor and control of Radar tracking performance. The SPARC-RG subsystem interconnects with the Flight Operations-Front End Processors (FO-FEPs) and receives data as selected by the SPARC-SC. The RSC configures the RG to accommodate the particular operational requirements for optimum monitoring effectiveness. For additional details on SPARC-RG and data flow, refer to the ERIH and Annex A Sections A2.6.5.2 thru A2.6.5.7.

2.6.5.1 Displays

The Radar Graphics subsystem data is displayed in two formats:

- Alpha-numerical bar chart, commonly referred to Bars – displays a maximum of 16 columns/sources of data. Comparing relative differences of tracking locations provides the RSC a measurement of track accuracies among various sites.
- Geographical present position (PP) and impact position (IP) – consist of two monitors that can display one or four maps each. Maps are of two types: trajectory and geographical. Trajectory maps display a nominal trajectory line. Geographical maps are strictly location based and do not display nominal lines.

2.6.6 Other Functions – Designate Source Select Switch

SPARC switching commands are processed by the Range Safety computer systems, FOV1-A and FOV1-B. The Distributed Range Safety Display (DRSD) is a Range Safety system that does not interface with the SPARC system. The FOV1 Acquisition Data Processor (ADP) Operator uses the Designate Source Select Switch (DSSS) to select one of the Range Safety systems (FOV1-A, FOV1-B or DRSD) as the primary source. If DRSD is selected as the designate source, the RSC loses all routing capabilities and the MOTR loses the ability to receive external designate data.

2-7 RANGE SAFETY SYSTEMS

2.7.1 OVERVIEW

Range Safety systems process and display ER instrumentation tracking data and vehicle telemetry data to monitor vehicle performance as well as provide tracking and acquisition data to supporting systems. Additionally, these systems allow the termination of an errant vehicle should a malfunction occur.

During the critical launch phase, two Flight Operations Versions 1 (FOV1) systems (FOV1-A and FOV1-B) and the Distributed Range Safety Display (DRSD) system process and display ER instrumentation tracking data and vehicle telemetry data, and provide tracking and acquisition data to supporting systems, i.e., radar, optics, telemetry, command destruct and range customers.

These systems generate flight path and predicted Instantaneous Impact Point (IIP) displays using the instrumentation data to monitor vehicle performance. Using system generated graphical displays, the Mission Flight Control Officer (MFCO) determines the risk of violating pre-defined mission rules and destroys any vehicle that violates these rules.

The FOV1-A and FOV1-B systems have identical software, which makes the FOV1 systems vulnerable to a latent software defect. Therefore, DRSD is used as a tertiary Range Safety system.

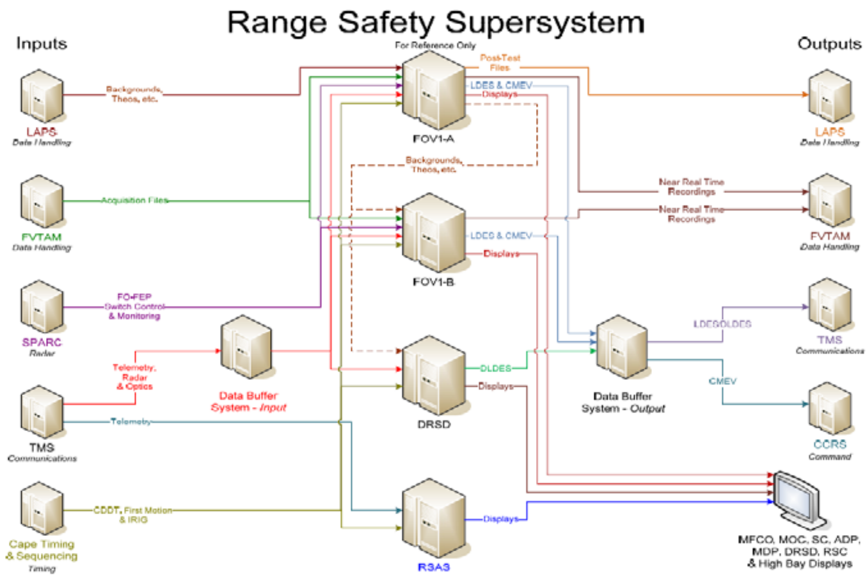

Figure 2-7-1: *Range Safety Supersystem*

2.7.1.1 Data Handling and Range Safety Supersystems

The Data Flow Diagram (DFD) reflects other supersystems that are closely related to the Range Safety Supersystem. The supersystems, such as Command Destruct, Communications, Data Handling, Radar and Telemetry will only be represented to the extent that they interface with the Range Safety Display (RSD) systems.

The diagram in Figure 2-7-1 shows the inputs and output systems of the Range Safety Supersystem.

Inputs
- Launch Analysis Production System (LAPS)-Data Handling
- FOV1 VAX Team-Based Acquisition Message (FVTAM)-Data Handling
- Single Point Acquisition and Radar Control (SPARC)-Radar
- Transport Management System (TMS)-Communications
- Cape Timing and Sequencing Timing

Outputs
- LAPS–Data Handling
- FVTAM–Data Handling
- TMS–Communications
- CCRS – Command Destruct

There are several systems that fall under the Data Handling Supersystem that have a close relationships to Range Safety systems and should be reviewed to fully comprehend the Range Safety Supersystem. These systems will be covered below.

2.7.1.1.1 FVTAM
Near Real-Time (NRT) system used to create acquisition files, inter-range vectors (IRV), and improved IRV (IIRV) to assist the tracking sites with target acquisition.

2.7.1.1.2 FADSS
Generates IRVs for Navy support.

2.7.1.1.3 NASCOM Interface Personal Computer (NIPC)
Serves as a message interface between the NASA Communication (NASCOM) Network and FVTAM. The NIPC transmits IIRV data to NASA sites and receives inter-center vector (ICV) data from Johnson Space Center (JSC) during Human Space Flight.

2.7.1.1.4 LAPS
Provides the major portion of data processing during the post-mission phase of the ER operations. The LAPS also provides support during the pre-mission and launch countdown phases, including receiving the in-count winds data from the weather station and the theoretical trajectory update files from the launch customer.

2.7.1.1.5 SHARPS
Provides the Range Safety backgrounds via compact disk-read-only memory (CD-ROM). SHARPS also provides the Collision Avoidance (COLA), the Range Safety Impact Predictor (RSRSIP) and the Range Safety Wind Check (RSRSWC).

In addition to the vehicle launches, the Range Safety Systems perform other activities, such as pre-launch preparation, continuation training, mission specific training, OD 16A, evaluations, post-launch archival, diagnostic, analysis and test activities.

2.7.1.2 Systems of the Range Safety Supersystem
The Range Safety Supersystem consists of the following systems:

2.7.1.2.1 Data Buffer System

The Range Safety system that ingests the incoming site data and provides that data to FOV1 and DRSD. Although FOV1 and DRSD receive the incoming site data simultaneously from the data buffer system (DBS), only the primary system can output data to external instrumentation sites.

2.7.1.2.2 Designate Source Select Switch (DSSS)

Used to assign which system's High Density Designate (HDD) output is used. The FOV1-A Acquisition Data Processor (ADP) Operator uses the DSSS to select a system to be primary.

2.7.1.2.3 FOV1

Provides a Range Safety function to monitor launch vehicle performance. The FOV1 and DRSD systems provide designate data, in the form of HDD, to instrumentation sites via the DBS. The FOV1-A system has an additional subsystem, the Mission Continuation Display (MCD), to monitor vehicle performance. The MCD provides an independent, telemetry only IIP display to the MFCO. The MCD design and programming language is completely different from the two FOV1 systems, thus eliminating a software Single Point of Failure (SPOF).

2.7.1.2.3 DRSD

The system, with its independent hardware and software design, provides a backup in the event of either an FOV1-A or FOV1-B system failure.

2.7.1.2.4 Range Safety Advisory System

Range Safety Advisory System (RSAS) is an Eastern Range developed and integrated telemetry processing and analysis system. RSAS is an independent system used specifically for missions containing nuclear payloads or Pegasus operations.

2.7.2 REQUIREMENTS

The Eastern and Western Range (EWR) 127-1 and Air Force Space Command Manual (AFSPCMAN) 91-711 requires a RSD system to be used as the primary information display system for the MFCO to evaluate launch vehicle flight. It also requires flight analysis to provide RSD requirements, instructions, and data necessary for display generation to the Range Operations Squadron or the ERTS Contractor.

EWR 127-1 and AFSPC Manual 91-711 also levies requirements for a real-time impact prediction system to provide data to the RSD system:

- PP and IIP solutions are provided for display on RSD
- The data is computed from data supplied by the tracking sources identified in the Range Safety Operational Requirements (RSOR) or Operations Supplement (Ops Sup) as applicable
- PP and IIP computation and display are single failure tolerant

At the ER, the following systems are used to meet these requirements:

- FOV1-A
- FOV1-B
- DRSD consists of one hardware string and is utilized as a tertiary or secondary system

To ensure EWR 127-1 and AFSPC Manual 91-711 RSD requirements are met, the RSOR ops supplement for each mission states that two of three RSD systems (FOV1-A, FOV1-B, and DRSD) are mandatory for each launch.

2.7.3 DATA BUFFER SYSTEM

The DBS is an interface between the ER instrumentation sites and the FOV1 and DRSD systems in the Morrell Operations Center (MOC).

The DBS receives the raw site data from the ER instrumentation sites and distributes the data to the FOV1 and DRSD systems. DBUs are used to receive the raw site data and to output data to external instrumentation sites. Once the data is routed to the appropriate processor, it is recorded and decoded. The System Controller (SC) determines which system is prime and directs the FOV1 ADP operator to select that system via the Designate Source Select Switch (DSSS). The DSSS controls the designate output to the external sites through the DBU.

The DBS consists of four DBU cabinets, the DSSS, and seven DRSD-2 Buffer Units. The DBS is an unmanned system that runs 24 hours a day. Data Buffering Units:

- 2 Units for Classified (Red – DBU Cabinets 4577 and 4578)
- 1 Unit for Unclassified (Black – DBU Cabinet 4581)
- 1 Unit is dedicated to Centralized Telemetry Processing System (CTPS) Telemetry Range Safety Buffer (TRSB) (DBU Cabinet 4719)

2.7.3.1 Data Buffer Units

Each Data Buffer Unit (DBU) has two buffers. Each buffer has the capability to transmit and receive data to and from a single instrumentation site, so that each DBU has the ability to communicate with two individual instrumentation sites (Figure 2-7-2). The DBU Rear Panel Schematic (pictured) shows a rear panel diagram of a Model 831914 DBU which contains two data buffers housed in one assembly. Each DBU has one Clock Port and one Control Port. The Clock Port is used to provide timing information to the DBU. Through selective use of port pins, each buffer can be provided with different timing information. The Control Port connects each DBU to the Data Output Remote Control (DORC). Additionally, a DBU has two Site Ports, one for each buffer to connect to a radar site, an optical site, a telemetry site, or to the Translated GPS Range System (TGRS) system.

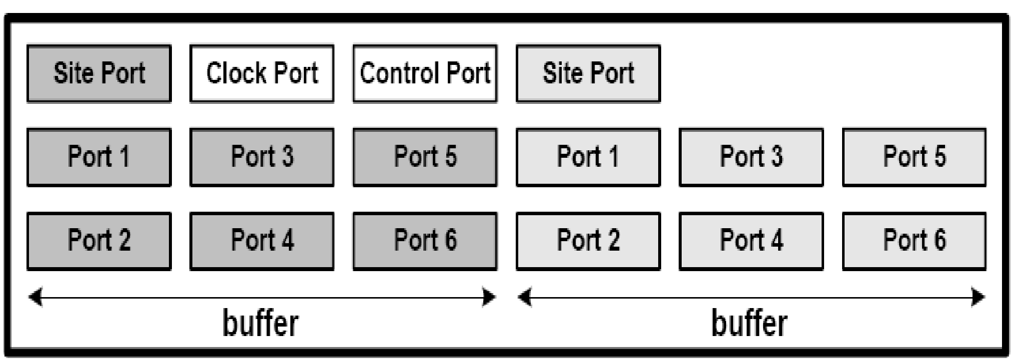

Figure 2-7-2: *DBU Rear Panel Schematic*

The DSSS selects which port (FOV1-A, FOV1-B, or DRSD) to transmit output designate data to a site.

2.7.3.2 Input

DBUs receive raw site data (radar, optical, telemetry, and TGRS) from the ER instrumentation sites and distribute the data to the FOV1 and DRSD systems. The figure below shows the data flow from the individual systems, through the DBU cabinets, and to the Range Safety systems.

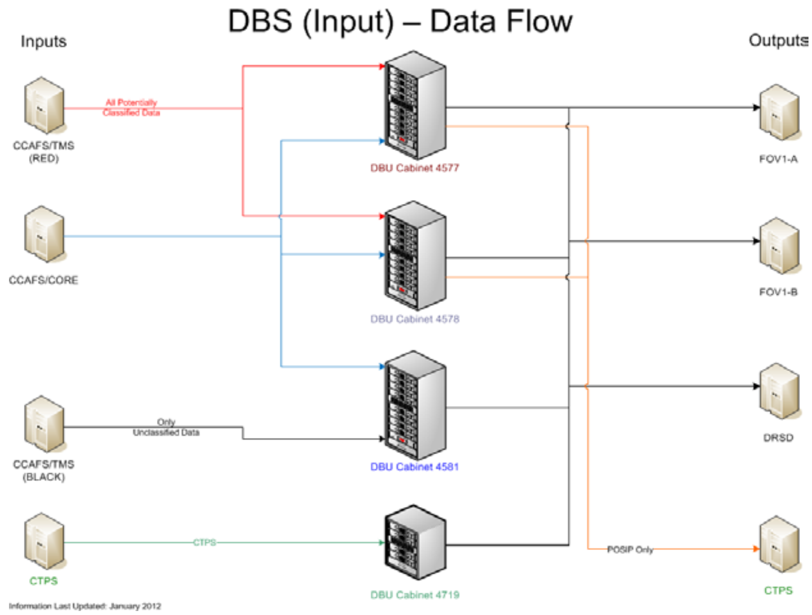

Figure 2-7-3: *Cape DBS Input Flow*

2.7.3.3 Output

The DBUs are also used to output data, such as designate data for track acquisition, to the external instrumentation sites. Although FOV1-A, FOV1-B, and DRSD receive data simultaneously from the DBUs, only the prime system can output designate data to the external sites. Once the Range Safety Systems receive the data flow from the individual systems, the information is then distributed through the DBU Cabinets and to the individual systems.

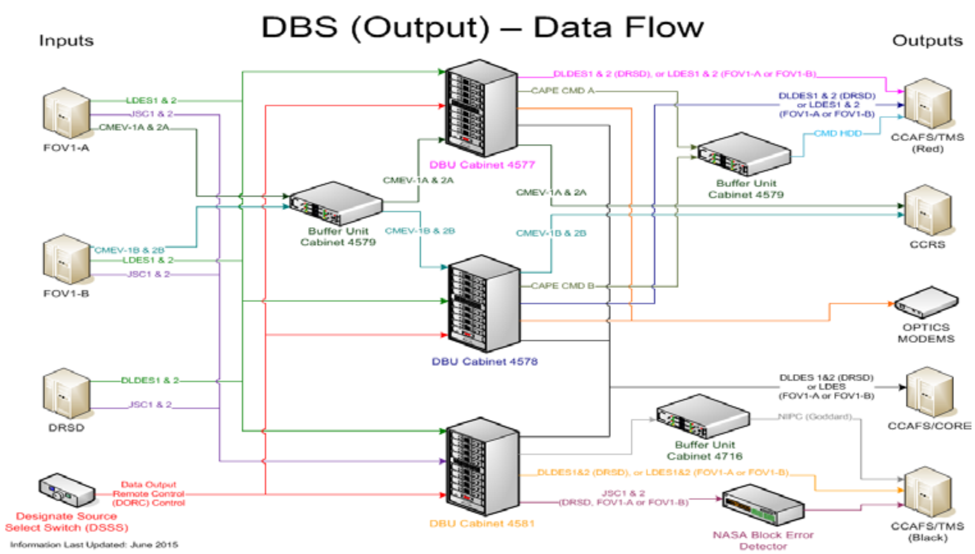

Figure 2-7-4: *Cape DBS Output Flow*

2.7.4 FLIGHT OPERATIONS VERSION 1 (FOV1)

2.7.4.1 FOV1 System

FOV1 is the primary Range Safety real time system.

FOV1-A and FOV1-B (Figure 2-7-4) are two independent and nearly identical hardware systems that provide a Range Safety function and monitors launch vehicle performance. The system acquires and processes instrumentation data from the ER, NASA, and off-Range sites to generate flight path and predicted Impact Point (IP) displays.

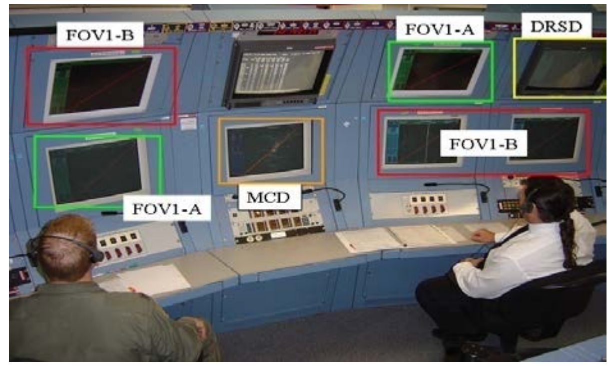

Figure 2-7-5: *FOV1 System*

The FOV1-A and FOV1-B systems consist of common components, which provide control or process data.

The components for FOV1-A and FOV1-B systems are *nearly* identical.

FOV1-A has the following components, which FOV1-B does not:

- Control and Management Display Workstation
- MCD
- RSD6: This is the video distribution to the Launch Decision Authority's (LDA) console in Room 159 of the MOC. This display output is provided by FOV1-A only

FOV1-A has additional network connectivity capabilities; it can connect to LAPS at the MOC. If connectivity is lost between the two, there is a 9-track tape drive on FOV1-A which can be used for data transfers.

2.7.4.2 Data Flow into the FOV1-A System

The FOV1 system accepts data from the various instrumentation sources and uses the data to generate the vehicle's present position (PP) and IIP during flight.

There are two major data paths on each system in the FOV1 system:

- One for Metric Track data
- One for Telemetry data

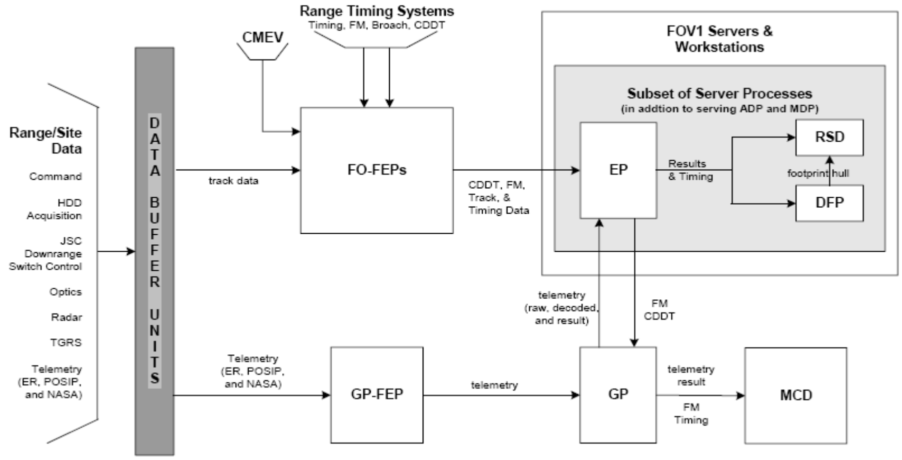

Figure 2-7-6: *FOV1 Data Flow Overview*

The FOV1 Data Flow Overview diagram (Figure 2-7-5) illustrates the data flow through the FOV1 systems.

Metric Track Data-Flight Operations-Front End Processor (FO-FEP)

Telemetry Data Flow-Guidance Processor-Front End Processor (GP-FEP)

FOV1–Local Area Network (LAN)

EP-Estimation Processor. This is the Metric Server. However, the function is estimation processor and the common reference EP

2.7.4.3 Metric Track Data Flow Diagram

Radar or optical site data (Metric Track Data), TGRS data, and timing data enters the FOV1 system in a serial line data format from the DBUs into the serial ports of the FOV1 FO-FEP. The FO-FEPs perform a data classification check to determine if the data is classified (such as for Navy launches) or if it is unclassified, converts into a LAN message format, and broadcasts it continuously on the FOV1 Ethernet LAN.

2.7.4.4 FO-FEPs

The FO-FEPs are rack mounted Personal Computers (PC) which are used to ingest and distribute radar, optical, TGRS, and timing data into the FOV1 systems. The FO-FEPS are also used to output designate data from ADP, through the FOV1 LAN, through the FO-FEPs to the DBUs and out to the external instrumentation sites.

2.7.4.5 Telemetry Data Flow

Telemetry data from the CTPS, Jonathan Dickinson Missile Tracking Annex (JDMTA) TRSBs, the POSIP, and/or NASA telemetry source data (Merritt Island Launch Annex [MILA]) enters the FOV1 system in a serial data format from the DBUs into the serial ports of the FOV1 GP-FEP. The GP receives and decodes the telemetry data. It broadcasts Telemetry Inertial Guidance (TMIG), Automatic Gain Control (AGC), and raw and decoded telemetry data over the FOV1 LAN where it is accessed and utilized by the Metric Server/Estimation Processor, MDP, DFP, ADP, and the RSDS. On FOV1-A, the GP also broadcasts the newest TMIG data over the MCD LAN to the MCD for display to the MFCOs.

2.7.4.6 Data Processing

A combination of processors, servers, and software are utilized to process and display the PP, IP, and debris footprint of a launch vehicle in real time.

2.7.4.7 Guidance Processor

After receiving telemetry data from the GP-FEP, the GP decodes the data, separating the data into its components according to the vehicle specific telemetry decoding formats. The GP then checks for checksum errors, which is a quality check to determine if data has been lost or altered during transmission. The GP then uses the data to compute TMIG state vectors and AGC values. The GP also selects the telemetry source with the newest data and sends it to the MCD for display. It creates a plus time for the MCD display by using the received first motion time from the EP.

The real-time data processing performed by the Range Safety systems should not be confused with the data process accomplished by the Data Handling Supersystem. FOV1 and DRSD perform real time data processing while the Data Handling Supersystem provides near-real time, pre-flight and post-flight data processing support.

2.7.4.8 Metric Server/Estimation Processor

The Metric Server, or EP as it is commonly referred to, is the primary data processor of the FOV1 systems. It is used to process ER site data to generate a PP and IP of the launch vehicle for display for the MFCOs (Figure 2-7-7).

2.7.4.9 Radar

Radar data enters FOV1 at a high data rate (10 Hz) in the form of EFG coordinates derived from ranging the vehicle with a radio frequency (RF) pulse and extracting azimuth and elevation data from the antenna position.

2.7.4.10 Optical

Optical data enters FOV1 at 10 pulses per second (pps) in the form of azimuth and elevation data from the different optical sites.

2.7.4.11 Telemetry-TMIG

Unlike radar and optical data, FOV1 does not Filter TMIG data since the TMIG data provides position ***and*** velocity information. The FOV1 systems' processing is limited to decoding, low-level checks, line selection, and generation of a covariance estimate. Most of the TMIG decoding and processing takes place in the GP, while time adjustments, source evaluation, and selection take place in the EP.

2.7.4.12 Telemetry–TGRS

Like TMIG data, TGRS data processing is limited to decoding, low-level checks, line selection, and covariance estimate generation. TGRS data is treated as classified and is not filtered by FOV1. In most cases, TGRS data arrives on multiple lines; the EP selects the newest TGRS data for further processing.

2.7.4.12.1 Timing Adjustment

The EP then performs a time adjustment on all of the different types of data (radar, optical, TMIG, and TGRS) so that all data displayed is extrapolated to the current wall clock time.

An IIP uncertainty ellipse (an ellipse that appears around the IIP for each source) gives a visual representation of this covariance estimate.

2.7.4.12.2 IP Calculation

The EP then uses an impact algorithm to propagate the PP data into instantaneous impact coordinates, utilizing a worst case scenario by assuming there is no drag induced on the vehicle due to wind.

2.7.4.13 Agreement Check

Next an agreement check is performed to ensure that only sources that are actually tracking the same target are included in the composite output. The results of the agreement check are used to adjust the grades of the independent sources. Sources that are not in agreement are less likely to be selected as the best or second best source.

2.7.4.14 Forming a Composite Solution

The composite solution is used as another independent source by the FOV1 system. Because the composite solution is developed from the independent sources that agree with each other, the displayed composite IP will always be within the group of independent source IPs. The amount of influence that an individual source (for example Radar 1.16) has in forming the composite solution is based upon the amount of error in the measurements of the source, which is modeled in its covariance estimate. In other words, a source that has smaller measurement errors than the other sources will have more influence or "weight" in forming the composite solution. As a result of this process, the composite solution will always have a smaller associated error and will usually be utilized as the best source over the independent sources.

2.7.4.15 Best and Second Best Sources

The FOV1 systems select a Best Source and a Second Best Source for display on the Range Safety Displays. The EP selects the Best source from a list of available sources, called the Best source schedule, based on the product of the cross range and downrange errors for each source, which is determined through the use of the grades or covariance estimates of the individual sources. The source with the lowest product is selected for the Best source. The Second-Best source uses the same criterion, except that the Second-Best source schedule is used and the already selected Best source is removed from the list. FOV1 will never automatically select the same source as Best and Second-Best.

In non-Navy missions, FOV1 uses agreement with the composite as part of its scoring process for evaluating independent sources. FOV1 selects the Acquisition 1 and 2 (ACQ1 and ACQ2) sources using the same scores computed for the Best and Second-Best RS sources. The ACQ1 and ACQ2 sources provide the designate data necessary for use by the downrange sites to acquire the vehicle in flight.

2.7.4.16 Continuous Mode

The continuous mode is characterized by <u>*single footprint*</u> *(Figure 2-7-8)*, or hull, that models an impact envelope for up to ten drag pieces resulting from the theoretical malfunction of a vehicle. The single hull encompasses the impact dispersion ellipses of the debris pieces used in the calculations. The hull is displayed on the IP map in conjunction with the IIP, and, therefore, appears to continuously move with the vehicle. The selected Best source is used as the tracking source for the predictions. This mode models the entire integrated stack and thus is only utilized up until solid rocket booster (SRB) separation.

Figure 2-7-7: *Continuous Debris Footprint*

2.7.4.16.1 Catastrophic Mode:

Figure 2-7-8: *Catastrophic Debris Footprint*

Upon vehicle breakup or command destruct, the MFCO can direct the MDP operator to manually invoke catastrophic mode. The catastrophic mode predicts where the debris pieces for up to <u>*three separate debris sets*</u> will land based upon the last known good state vector that can be manually selected. The catastrophic footprint consists of circular impact dispersion areas centered on the predicted drag and wind corrected impact points for up to ten vehicle debris key pieces.

The three separate debris sets model different combinations of the ten pieces from the three primary components of the integrated stack:

- Set 1: Consists of two Orbiter pieces, a SRB piece and seven External Tank pieces
- Set 2: Consists of two Orbiter pieces and eight External Tank pieces
- Set 3: Consists of a single Orbiter piece (the crew cabin), six SRB pieces, and three External Tank pieces

Only one debris set is displayed on the IP display. The MDP operator or MFCO can choose which debris set to display based on the time in flight of the catastrophe or the pieces of interest. The dispersion areas are computed using forecast winds and the real-time vector at the time of the catastrophe. The MDP operator chooses which source to use to get the real-time vector information. Unlike the continuous mode, the catastrophic mode can be utilized after SRB separation.

2.7.4.17 Range Safety Display Server and Range Safety Display Workstations

Once the instrumentation site data has been processed, it must be displayed in format that is useful to the MFCO. The FOV1 system accomplishes this through the use of the RSDS and the RSD workstations.

2.7.4.17.1 RSDS

There is one RSDS on each FOV1 system. The RSDS does the following:

- Receives IP and PP information from the EP
- Receives DFP information from MDP
- Records and archives the received information
- And then sends the data to the RSD workstations for display to the MFCO

2.7.4.17.2 RSD

There are seven RSD workstations on FOV1-A and six workstations on FOV1-B. There are three workstations at the MFCO console, one at the Range Safety Controller's console, two at the MDP console, and FOV1-A has an additional video distribution to the LDA console in Room 159 of the MOC. Each FOV1 system provides the MFCOs with three monitors and a function key panel with a joystick for operator selections. At each MFCO console, there are two displays at the bottom of the workstation which display data processed by the same system of FOV1 while a third monitor at the top of the workstation displays data processed on the other system. This layout provides the MFCO with a redundant monitor in the event of a failure of either FOV1-A or FOV1-B.

2.7.4.18 Mission Continuation Display

The MCD system is only connected to FOV1-A and uses a separate data processing pathway (from the GP) to provide an independent Telemetry only IIP display to the MFCO. The MCD utilizes a completely different impact algorithm from the two FOV1 systems in an effort to eliminate a SPOF that could cause a loss of all data. The MCD receives the newest TMIG data from the GP for display. Since the EP and not the GP performs all of the time adjustment of the instrumentation data, there is no extrapolation or interpolation for data shown on MCD. The MCD may be used as a last resort to allow a good missile to fly and will be used only if all other displays fail or lose track, and the MCD has agreed with other displays prior to loss of track on the other systems.

2.7.4.19 Metric Data Processor

The MDP is the primary operator interface for the FOV1 systems. Both FOV1-A and FOV1-B MDPs have a desktop graphical user interface (GUI) that allows the MDP operator to initialize, configure, and control the FOV1 system processors such as the FO-FEPs, MCD, GP, RSD, and the DFP. The MDPs can configure the software according to the type of launch vehicle and push the software to the other FOV1 system processors to configure and control the processors. The MDP operator position is staffed by ERTS personnel.

The MDP workstation allows the MDP operator to perform the following functions:

- Initialize subsystems on FOV1, select countdown clocks, reset first motion, and setup RSD playbacks
- View health and status of FOV1 system traffic
- View the source status for all metric data such as EFG coordinates, on-track status, and Quality-bit (Q-bit) status, and other status information

- Provide source control including viewing source data information, rejecting/forcing sources into the independent filter, reinitializing the independent filter, rejecting sources from the composite solution, and overriding Best/Second-Best source selection
- Utilize file utilities to convert PREX/PROX files, events files, theoretical files, and wind files for use on FOV1
- Select wind files and parameters for DFP processing
- Record and prepare files for near-real time recording
- View and configure launch/broach status for multiple missile missions

2.7.4.19.1 Acquisition Data Processor

ADP is the central point for preparing and distributing acquisition data to instrumentation sites. The ADP workstation communicates with the MDP and GP processors and Debris Server 1 via the FOV1 LAN. The ADP serves as the interface to the Data Processing System (DPS), SPARC, FVTAM, and FADSS. Only one ADP operator position is required to control both FOV1 systems. There is one DSSS assembly at the ADP consoles that is used to assign which system's HDD output is used, FOV1-A, FOV1-B, or DRSD. Typically FOV1-A will be designated as "prime" for HDD output to the ER sites with FOV1-B and then DRSD being utilized as back-ups.

2.7.4.19.2 Debris Servers (DFP)

There are two Debris Servers (commonly referred to as DFP servers) on each system of FOV1, DFP 1 and DFP 2. DFP 2 only contains the database utilized by MDP to perform the DFP calculations. DFP 1 on each system of FOV1 is utilized to perform ADP processing and applications and to send data to ADP for display. DFP 2 on each FOV1 system is utilized to perform MDP processing and applications and to send data to MDP for display.

2.7.4.20 Pre-Mission and Post-Mission Data

There are certain data files that are generated by Wing Safety and applicable Launch Agencies that are loaded onto the FOV1 system to assist in the generation of background displays or to perform data processing functions.
These Files include:

- Weather product files for use in FOV1 DFP calculations FOV1 PTFG files which are used by the DPS for post-test analysis and data product generation
- Background files (such as destruct lines, continental lines, etc.), theoretical trajectory files, and trajectory adjust files (theoretical trajectory files adjusted for winds) which are used by FOV1 for launch support

2.7.5 DISTRIBUTED RANGE SAFETY DISPLAY (DRSD)

DRSD is a tertiary Range Safety system that provides IP and VP displays. The DRSD system is completely independent from the two FOV1 systems and is used as a backup for one FOV1 system. DRSD is written primarily in the Ada programming language, except for a small amount of assembly language hardware control code. (Figure 2-7-10)

The DRSD system is composed of five subsystems:

- Front End Processor (FEP)
- Unified Controller Processor (UCP)
- Estimation Processor (EP)

- Display Processor (DP)
- Debris Footprint Processor (DFP)

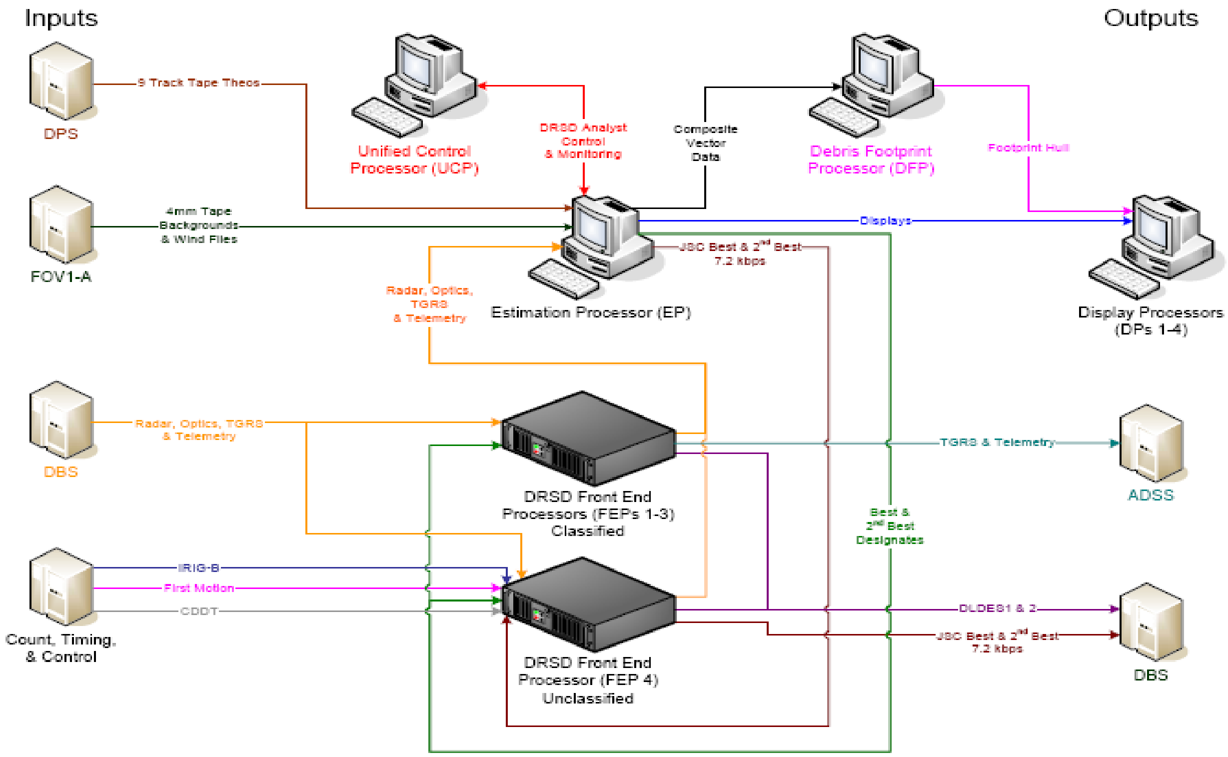

Figure 2-7-9: *DRSD Data Flow*

2.7.5.1 Front End Processor

- DRSD utilizes FEPs in a way similar to the FO-FEPs of the FOV1 system.
- Four FEPs which receive, record, and decode raw instrumentation data from the DBUs and then broadcast both raw and decoded data to the other DRSD subsystems through the DRSD Ethernet LAN.
- DRSD FEPs are utilized to route HDD to the instrumentation sites through the DBUs
- The primary differences between the DRSD FEPs and the FOV1 FO-FEPs are that the DRSD FEPS also process TMIG data and actually decode the data unlike the FO-FEPS which only perform a classification check

2.7.5.1 Unified Control Processor (UCP)

The UCP is the operator station for the DRSD system, similar to the MDP workstation for FOV1. This workstation provides status views of the DRSD system and the tracking data reaching the FEPs.

The UCP allows the DRSD operator to:

- Start DRSD processing
- Include, exclude, or remove scheduled sources from the composite solution
- Record data
- Play theoretical trajectories
- Force First Motion or broach

- Generate state vectors for use in DFP
- Observe raw and decoded data from the instrumentation sites
- Playback recordings

The DRSD operator can also visually evaluate the quality of each source and provide the MFCOs with a display of multiple targets.

2.7.5.2 Estimation Processor

Similar to the FOV1 system, the EP converts the decoded tracking data, received from the FEPs, into independent and composite estimates of the tracked vehicle's state (i.e., position and velocity). Various filtering algorithms are used to compute both individual source and composite solution sets of independent IIPs. For non-Navy vehicles, the EP uses position data from metric radars, pointing data from optical mounts, and TMIG position and velocity. The alpha beta (αβ) filters are used to pre-qualify site measurements for use in subsequent computations, and only accepts radar data with valid Q-bit. The alpha beta gamma (αβγ) filters process radar position data to produce smoothed position and velocity estimates for each eligible radar. An optical Kalman Filter receives data from many optical sites and produces a single optical output. Another Kalman Filter processes all available and qualified measurements to produce a composite state vector estimate. For DRSD, this composite output is the default source and is the only source displayed on the DRSD. For Navy vehicles, TGRS and TMIG data are used as the Best and Next-best solutions, respectively, and no composite solution is formed.

2.7.5.3 Display Processor

Three DP subsystem components provide a graphical display of the state vectors computed by the EP. One DP (DP1) is the Ultrix workstation server located at the DRSD operator position in Room 132 of the MOC. The DP2 and DP3 workstations and extra slave monitors are located at the MFCO consoles.

2.7.5.4 Display Footprint Processor

Like FOV1, the DRSD DFP provides the MFCO with information concerning catastrophic failures during Human Space Flight operations utilizing the same two modes of operation as FOV1, continuous and catastrophic. These two modes operate the same way in DRSD as they do in the FOV1 system. The catastrophic mode allows the DRSD analyst to perform impact calculations based on specific state vectors in the event of an actual failure. The result is a data page indicating the predicted impact location in latitude and longitude, impact radius, Zulu time of impact, and time to impact of each piece. Also computed are two Tactical Air Navigational systems (TACAN) Range and Bearing measurements to the key piece impact location.

2-8 COMMAND DESTRUCT

2.8.1 OVERVIEW

To ensure continued access to space, the Air Force must be able to protect life and property of the general public during a space vehicle's powered flight. This is accomplished by establishing and maintaining the capability to destroy a vehicle should it become errant. Errant is defined in AFSPCMAN 91-711 as "a launch vehicle that, during flight, violates established flight safety criteria and/or operates erratically in a manner inconsistent with its intended flight performance." The Range Commander's Council (RCC) Document 319-07 *Flight Termination System Commonality Standard*, Eastern and Western Range 127-1 (EWR 127-1), Air Force Space Command Manual (AFSPCMAN) 91-710, AFSPCMAN 91-711 and the *Combined Command Destruct System Range Safety Requirements (CCDSRSR) for the 30th and 45th Space Wings* establish the flight safety criteria for the systems for controlling errant vehicle flight to meet the objective of minimizing risks to the public, launch area, and launch complex personnel and resources. These documents specify the requirements for the two major components used in terminating the flight of an errant vehicle: the airborne Flight Termination System (FTS) and the Ground Command Destruct System (CDS). Together the airborne FTS and ground CDS provide positive control of the launch vehicle. Upon initiation by the MFCO, commands are up-linked by the ground CDS and processed by the airborne FTS to terminate flight of an errant vehicle.

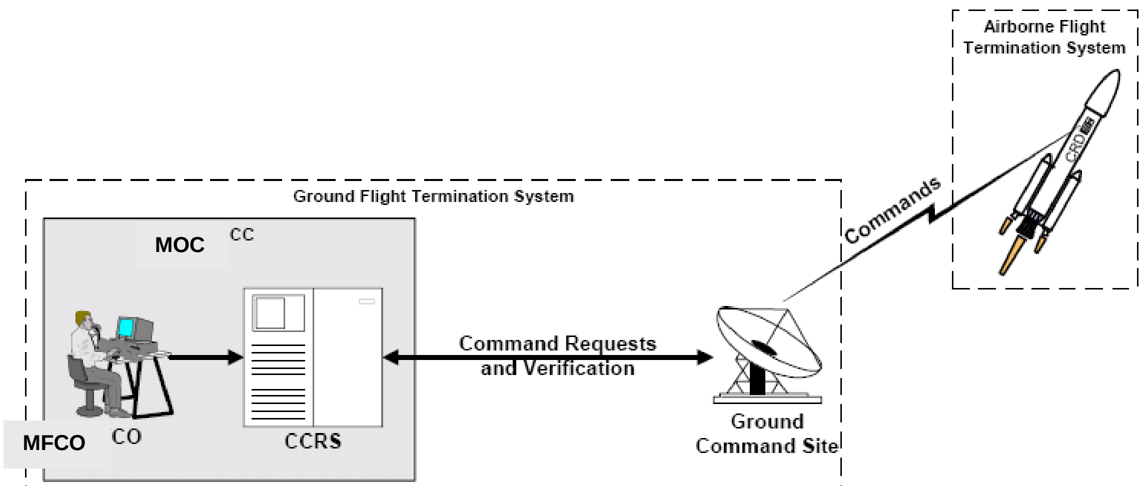

Figure 2-8-1: *Airborne Flight Termination and Ground Command Destruct Systems*

2.8.2 COMMAND DESTRUCT FUNDAMENTALS

In order to understand how the ground and airborne components of a FTS function, it is essential to have an understanding of the fundamental concepts of the radio frequency (RF) signals used in a FTS.

2.8.2.1 Command Carrier

The command carrier is a RF signal transmitted by a ground command site to capture and send command functions to the airborne FTS receivers on a launch vehicle. The Eastern Range (ER) and Western Range (WR) FTS systems are authorized to utilize UHF frequencies 421.0 MHz, 425.0 MHz, and 429.5MHz. The frequencies 421.0 MHz and 425.0 MHz are the operational frequencies used for launch vehicle pre-launch testing and launch operations. The primary operational frequency on the ER is 421.0 MHz. The maintenance frequency, 429.5 MHz, is available for use by the Command Destruct ground system in the event that there is RF protection on all the operational frequencies and urgent maintenance for troubleshooting requires RF transmission.

Command function audio tones are impressed onto the command carrier through frequency modulation (FM) for transmission to the launch vehicle. The carrier is shifted about the command carrier frequency (421.0 MHz) at an interval equal to the command function audio tone frequency or the root-mean-square (rms) sum of the tones when more than one tone is used. The distance that the carrier is shifted is equal to the amplitude of the command function audio tone or the rms sum of all the tones.

Example: The tone frequency is 8.00 kHz and the amount of deviation is 30 kHz. The carrier is shifting at a rate of 8.00 kHz and a distance of 30 kHz.

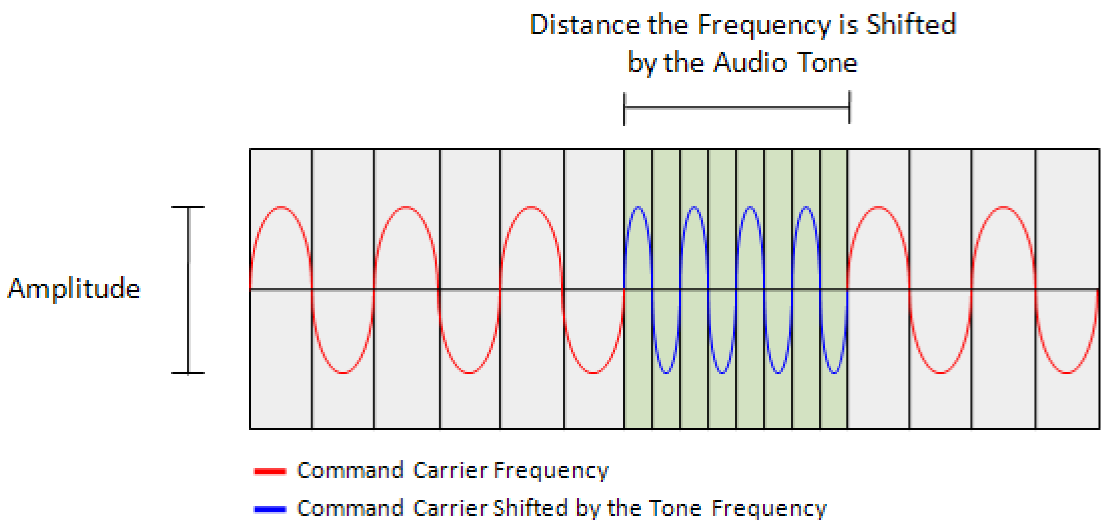

Figure 2-8-2: *FM Modulated Carrier*

2.8.2.2 Capture Ratio

The capture ratio quantifies the capacity of a CRD to receive and execute a command when an interfering continuous-wave (CW) carrier is simultaneously input to the CRD. A primary advantage of the FM command carrier link is the protection provided by the capture ratio. EWR 127-1 Chapter 7, para 7.7.1.e and AFSPCMAN 91-711 para 6.8.5 require that when the launch vehicle airborne FTS receiver is active and ordnance is electrically connected, a command site shall be radiating at the proper frequency to capture the vehicle's Flight Termination System Receivers or Command Receiver/Decoders (CRDs). Capturing the receiver refers to the ability of the command transmitting site to provide a sufficient signal level or signal strength to prevent an inadvertent response of the FTS due to noise effects or undesired radio frequency (RF) signal inputs or interference from other sources. The inherent qualities of FM receivers assure that the unit will stay locked on the strongest signal. This means that any interference must overcome the power imparted by the ground transmitting site in order to interfere with the command link. The capture ratio is the ratio of the desired signal strength to the interfering signal strength at the time of capture. EWR 127-1 Chapter 4, para 4.8.2.2.9 and AFSPCMAN 91-710 volume 4, para 3.14.2.4 require that the CRDs have a capture ration of 0.8. In other words, it requires that the CRD's design ensures that no transmitter with less than 80 percent of the power of the range command transmitter could capture or interfere with the receiver decoder. The ER employs high power (kilowatt range) transmitters to ensure the capture of the vehicle's CRDs.

2.8.2.3 PAVE PAWS RF Interference (RFI)

Transmissions from the Perimeter Acquisition Vehicle Entry Phased Array Weapon System (PAVE PAWS) radar located at Cape Cod Air Force Station (AFS), Massachusetts can interfere with the FTS receivers on vehicles launched from the ER. The PAVE PAWS is an Early Warning Radar. In the surveillance mode, the PAVE PAWS radar randomly hops through frequencies. In this mode, random interference can be expected which is not a mission threat to either standard or secure receivers. In the track mode, the PAVE PAWS radar will randomly select a single frequency. If the selected frequency is near the FTS receiver's frequency, the RFI from the radar could prevent or delay the FTS receiver from responding to commands transmitted on the command carrier. RF De-confliction procedures have been developed with the 6th Space Warning Squadron (6 SWS) to prevent the PAVEPAWs radar from transmitting on or around 421.0 MHz during ER launches. To determine if RF de-confliction procedures are required for a mission, analysis must be conducted on the FTS receiver performance characteristics and the vehicle flight trajectory. RF De-confliction procedures are not required for Atlas V and Delta IV launches as long as additional time (360 ms) is added into the destruct line budget to account for the extra ARM/DESTRUCT commands required to achieve the acceptable reliability required by AFSPCMAN 91-710 and EWR 127-1 for the FTS. RF De-confliction procedures are required for vehicles using IRIG (Standard receivers) that are launched from the ER.

2.8.2.4 Automatic Gain Control (AGC)

The strength of the command carrier signal will fluctuate because of changes in propagation conditions, which can include interference due to precipitation or multipath off of nearby objects. As a result, the CRDs on the launch vehicle include automatic gain control (AGC) circuitry to maintain the signal at the input to the receiver at a constant value despite fluctuations in the signal strength at the antenna. This is accomplished by adjusting the gain of the receiver, which is the ratio of the output power to the input power of the signal strength. The AGC circuitry ensures that the CRD hears a reasonably constant volume as the propagation conditions change. The value of the adjustment of the gain of the receiver (referred to as the AGC voltages or AGCs) is directly proportional to the amount of RF signal the CRD is receiving. As a result, the receiver AGCs are included in the vehicle telemetry link and are used as a measure of the signal strength of the command carrier at the receiver. AGCs are typically displayed in bar graph form, one for each CRD, scaled from 0 to 5 Vdc on the analog telemetry displays at the Telemetry System Officer (TSO) consoles and on the Range Safety displays (FOV1-A, FOV1-B, and DRSD). The higher the AGC value, the stronger the signal received by the CRD. A drop in AGC values while the vehicle is on the launch pad indicates a problem with the CRD's ability to receive the command carrier signal, either due to a CRD failure, a command site problem, or to outside interference.

2.8.2.5 Range Commander's Council (RCC) Audio Tones

Audio tones are tone frequencies that are used to encode commands for transmission to a launch vehicle. An audio tone may be used individually for a specific purpose (i.e. Pilot Tone or a Check Channel) or combined with another audio tone or combination of audio tones to form command "words" or "functions." The RCC established two types of audio tones to be used for a FTS: Standard tones and Secure tones.

2.8.2.5.1 Standard Tones

Standard tones are a group of 20 standard tone frequencies used in non-secure receivers that are specified in RCC Document 313 Supplement, *Test Standards for Flight Termination Receivers/Decoders Supplement* (For Official Use Only) and are listed in EWR 127-1 Chapter 4 and AFSPCMAN 91-710 Volume 4. Standard tones are used in pairs to form command functions or words. Non-secure tones or tone sequences can be RF transmitted (open-loop) in the prelaunch period to verify receipt of signal and proper operation.

2.8.2.5.1.1 Check Channel

Check Channel is a representative tone (typically RCC standard tone 4) that is modulated to validate command destruct link integrity of the complete RF path from the command site transmitter to the RF input of a standard flight termination receiver. Check Channel is “filtered out” after the receiver where it then appears as an output signal on the CRD. It is digitally represented in the vehicle telemetry stream as being either “on” or “off” and is displayed on the analog telemetry display pages at the TSO consoles. When enabled prior to activating the command carrier, Check Channel will be automatically modulated on the command carrier when that system's carrier is activated. When a command function such as ARM or DESTRUCT is requested, the command site will remove Check Channel from the command carrier before the command function is sent. At this time, Check Channel can only be transmitted from the Cape 1A Command system.

2.8.2.5.2 Secure Tones

Secure tones are a unique set of 8 tone frequencies used for secure receivers that are specified in *Supplement to IRIG Standard 313-01*, *Test Standards for Flight Termination Receivers/Decoders* (For Official Use Only) and are listed in EWR 127-1 Chapter 4 and AFSPCMAN 91-710 Volume 4. Secure tones are used to form "high-alphabet" commands wherein two audio tone combinations are combined to form a single "letter" in a much longer command "word". The combination and sequence of tones (codes) for secure flight missions are assigned by the National Security Agency (NSA). During vehicle processing and pre-launch testing, this sequence is handled with special requirements. The tone sequence is loaded into the launch vehicle’s CRDs, ground flight control consoles, and ground transmitters using NSA-approved secure loading devices that inject the information directly into the respective devices. Pre-launch end-to-end tests use program-specific test codes; operational codes (e.g. ARM, DESTRUCT and OPTIONAL commands) are never transmitted via RF open-loop in the pre-launch period. End-to-end, open-loop testing is accomplished by use of a test command (SELF TEST) that has no impact on the mission or FTS reliability. This approach assures that the mission-assigned codes are fully protected and restricted to authorized use.

2.8.2.5.2.1 Pilot Tone

Pilot Tone is a representative tone (RCC secure tone 8) that is modulated to validate command destruct link integrity of the complete RF path from the command site transmitter to the RF input of a high-alphabet (secure) flight termination receiver. Pilot Tone is “filtered out” after the receiver where it then appears as an output signal on the CRD. It is digitally represented in the vehicle telemetry stream as being either “on” or “off” and is displayed on the analog telemetry display pages at the TSO console. When enabled prior to activating the command carrier, the Pilot Tone will be automatically modulated on the command carrier when that system's carrier is activated. When a command function such as ARM or DESTRUCT is requested, the command site will remove Pilot Tone from the command carrier before the command function is sent. At this time, Pilot Tone can only be transmitted from the Cape 1A Command system.

2.8.2.6 Command Functions

Command functions are messages transmitted by a command destruct site to a launch vehicle in order to initiate a certain function or sequence by the airborne FTS. Command functions are comprised of a set of RCC audio tones that are arranged in a certain message format and according to a certain message timing standard that are specified in RCC 319. The command functions include SELF TEST, RESET, SAFE, ARM, DESTRUCT/TERMINATE, W, X, Y, and Z.

2.8.2.6.1 ARM

The ARM command is the signal that performs a variety of functions depending on the type of launch vehicle. The ARM command is a pre-terminate logic function for the DESTRUCT command. In other words, ARM must be sent prior to the DESTRUCT command for the destruct ordnance to be initiated. Typically, the ARM command closes a circuit that allows the signal, sent by the CRD upon receipt of a DESTRUCT command, to pass through the circuit to initiate the destruct ordnance. For liquid propellant vehicles, the ARM command initiates engine cutoff by closing the propellant valves. For both liquid and solid propellant vehicles, this command terminates any further sequencing actions (such as staging/separation events or engine ignition) and arms the destruct devices.

2.8.2.6.2 DESTRUCT/TERMINATE

The DESTRUCT command (also known as the TERMINATE command depending on the method used for flight termination) is the signal which when received and decoded will cease the flight profile of an airborne vehicle. For space launch vehicles, the DESTRUCT command activates the destruct devices on the launch vehicle. It causes the CRD to send an output to the destruct ordnance and initiates the ordnance chain. For liquid propellant vehicles, the DESTRUCT command can cause the ignition of a charge on the liquid fueled stages that penetrates the propellant tanks and causes the propellants to quickly burn or disperse, or can cause fuels to cease flowing. For solid propellant vehicles, the DESTRUCT command causes the ignition of a linear charge on the solid rocket motor that splits the motor casing, destroying the pressure integrity of the motor and causing the remainder of the solid fuel to ignite

2.8.2.6.3 SAFE

The SAFE command (also known as the RF DISABLE command) is a command, typically used with secure receivers, which deactivates or “safes” the vehicle’s command receivers, and is normally sent during tests or prior to the loss of command coverage for a nominal launch. It works by transferring the CRD power from internal to external power. If external power is not available, then the CRD is simply powered off with this command.

2.8.2.6.4 SELF TEST

The SELF TEST is a secure code command used to initiate the CRD’s built-in self-test diagnostic routines and verifies that the CRD’s microprocessor is operating correctly. A failure of the self-test will indicate that the CRD microprocessor is either not operating properly or its memory has failed. This command and the associated self test verify the ability of the CRD to decode and process a unique secure command. The SELF TEST command includes at least one occurrence of all 7 tones. The SELF TEST command is used in end-to-end, open-loop testing to test the performance of the ground and airborne components of the FTS and to preclude the compromise of the secure codes for the SAFE, ARM, and DESTRUCT commands.

2.8.2.6.5 RESET

The RESET command is a secure code command used to unlatch a command output (such as sending a signal to close propellant lines or to initiate destruct ordnance) that has been latched by a command function (such as a decoded ARM or DESTRUCT command). The RESET command is only used for pre-launch day checks using maintenance codes and must be erased from the flight CRD prior to launch. On the ER, the RESET command is only used for Delta IV launch vehicles.

2.8.2.6.6 W, X, Y, Z

For Trident II Submarine Launched Ballistic Missile (SLBM) missions, the ARM and DESTRUCT functions are contained in a single five character command message which is initiated by a single FTU switch. When the FTU switch is activated, both the ARM and DESTRUCT tone combinations are ordered. The FTU switches are labeled W, X, Y, and Z with each switched assigned to radiate the combined ARM and DESTRUCT message for a specific missile.

2.8.2.7 Message Encoding

RCC audio tones are encoded in a certain message format and timing standard for a certain mode of operation as specified in RCC 319. There are two basic types of modes: Standard Mode Message Encoding and Secure Mode Message Encoding.

2.8.2.7.1 Standard Mode Message Encoding

In Standard Mode Message Encoding, RCC standard tones are used in pairs to form command functions or message. Table 2-8-1 shows the standard receiver command sequence logic to be used unless otherwise approved.

Table 2-8-1: *Standard Mode Message Encoding*

LOGIC SEQEUNCE	DECODER OUTPUT
TONE 5	MONITOR
TONE 4	CHECK CHANNEL
TONE 2 AND 5 ON	OPTIONAL OR SAFE
TONE 1 AND 5 ON	ARM
TONE 1 AND 5 ON FOLLOWED BY TONE 5 OFF THEN TONE 2 ON	ARM ARM DESTRUCT/TERMINATE

Each message consists of a “steady state” modulation. The ARM command is created by applying RCC tones 1 and 5. The DESTRUCT command is created by removing RCC tone 5 and applying RCC tone 2.

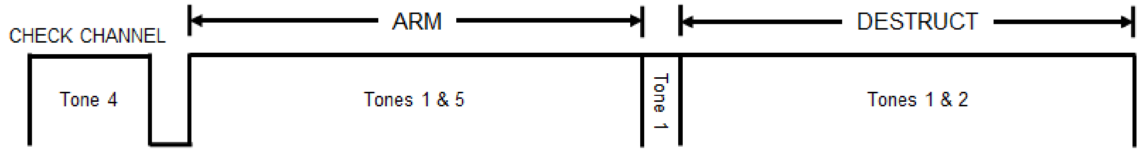

Figure 2-8-3: *Standard Mode ARM and DESTRUCT Messages*

Note that during the transition from the ARM to the DESTRUCT command, the tone 1 modulation will persist during the tone 5 off and tone 2 on transition. Removal of RCC tone 5 during the transition from the ARM to the DESTRUCT command will not cause the loss of the ARM output from the receiver. There may be a tone overlap during transition; that is, tone 2 can be applied before tone 5 is removed. If overlap occurs, neither the ARM nor the DESTRUCT command will be lost or inhibited. Once the DESTRUCT command is activated, it will be continuous as long as tone 1 and tone 2 are being applied.

RCC tones 2 and 5 together can be used for an optional command such as the SAFE command. RCC tone 4 (Check Channel) or tone 5 (Monitor) may be applied during any of the sequences without any effect on the desired output.

2.8.2.7.1.1 Trident Mode Message Encoding for Multiple Missiles

For Trident II missions in which multiple missiles are launched using non-secure/standard receivers and tones, the standard receiver command sequence logic is used for Missile W with the entire tone sequence, including both the ARM and DESTRUCT commands, being sent with the activation of a single switch.

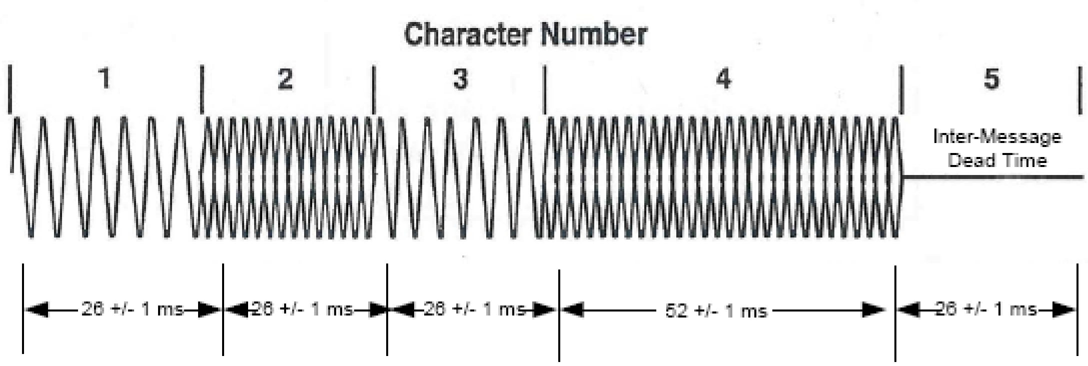

Figure 2-8-4: *Trident Message Format including both ARM and DESTRUCT*

For Missiles X, Y, and Z, different RCC standard tones are used to create variations in the ARM and DESTRUCT characters of the Trident message.

Table 2-8-2: *Trident Mode Message Encoding for Multiple Missiles*

COMMAND NAME	CHARACTER NUMBER	TONE SEQUENCE
W	1 2 3 4 5	TONE 1 TONES 1 AND 5 TONE 1 TONES 1 AND 2 NO TONES
X	1 2	TONE 5 TONES 5 AND 3

	3 4 5	TONE 5 TONES 5 AND 2 NO TONES
Y	1 2 3 4 5	TONE 4 TONES 4 AND 6 TONE 4 TONES 4 AND 2 NO TONES
Z	1 2 3 4 5	TONE 3 TONES 3 AND 4 TONE 3 TONES 3 AND 2 NO TONES

2.8.2.7.2 Secure Mode Message Encoding

Secure Mode Message Encoding uses a "high-alphabet" command code, wherein two RCC secure audio tone combinations are decoded as a single "letter" or character in a much longer command "word." Each command word (ARM, DESTRUCT, SAFE, SELF TEST, RESET) consists of 11 characters, with each character comprised of 2 audio tones. The “high-alphabet” destruct code is comprised of the ARM and DESTRUCT words. Therefore, the “high alphabet” destruct code consists of 22 characters created from various combinations of 21 possible unique tone pairs, with 21^{22} possible permutations. Thus the security of the destruct code is not achieved by encryption, but instead by the difficulty in determining the correct sequence of the tone pairs from the large number of possible permutations.

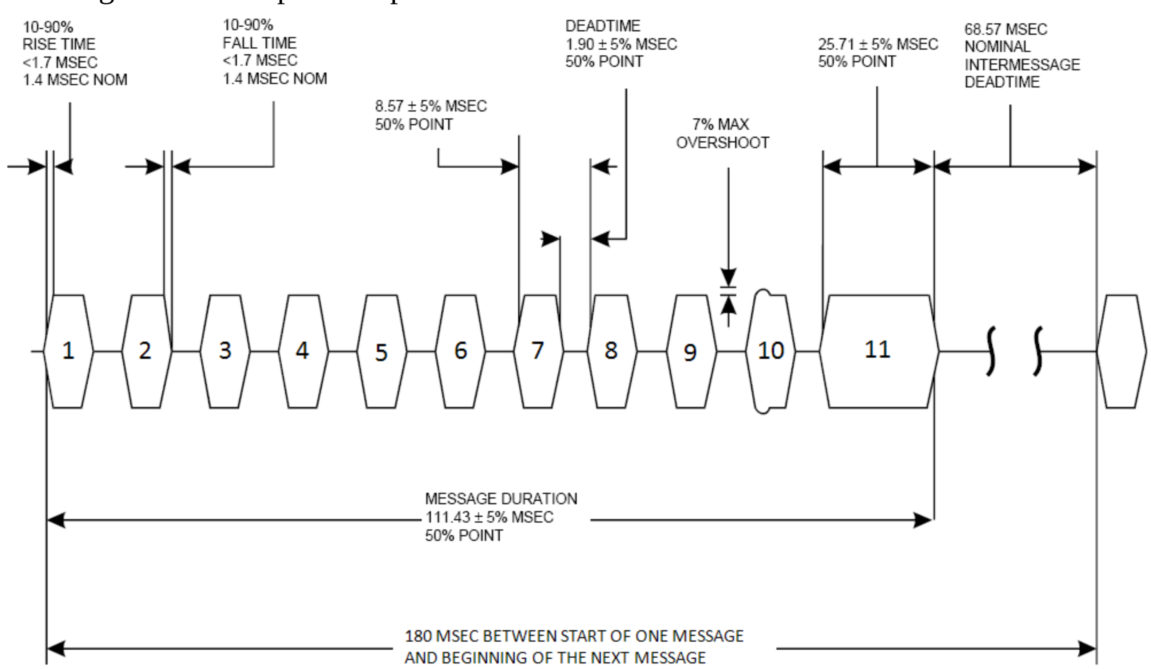

Figure 2-8-5: *Secure Message Command Word Encoding*

The transmission of a secure command word consists of 11 bursts. Each burst is comprised of an audio tone combination for the respective character in the command word. The first ten bursts are each approximately 8 milliseconds long. The 11^{th} burst is approximately 25 milliseconds long.

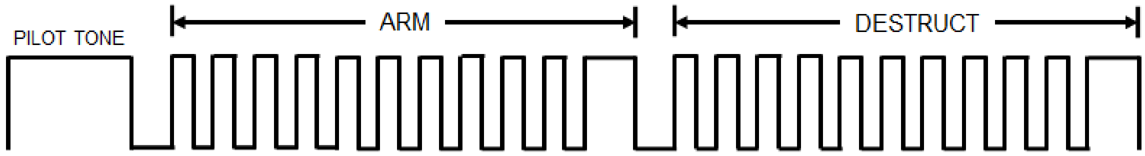

Figure 2-8-6: *Secure Code ARM and DESTRUCT Messages*

There are two types of secure codes used by Secure CRDs: Flight Codes and Maintenance Codes.

2.8.2.7.2.1 Flight Codes

Flight codes are the secure codes used for launch operations. A different set of flight codes are used for each launch. When pre-launch testing of the FTS is conducted after the flight codes have been loaded into the CRDs, the SELF TEST command is the only flight code that is radiated to test the performance of the ground and airborne components of the FTS. This is to preclude the compromise of the secure codes for the SAFE, ARM, and DESTRUCT commands.

2.8.2.7.2.2 Maintenance Codes

Maintenance Codes are secure codes used for pre-mission testing of the ground command destruct sites and of the secure CRDs on the launch vehicle. A maintenance code is issued for every corresponding secure flight code command. The maintenance codes are used to test the CRD’s output function for each command code without having to compromise the secure flight codes. The maintenance codes include every secure tone to ensure the ground command sites can properly transmit each tone and that the CRD can process every tone that could be utilized. Typically, the same maintenance codes are used for every mission for a particular launch vehicle.

2.8.3 AIRBORNE FLIGHT TERMINATION SYSTEM (FTS)

The FTS is the entire system on an airborne vehicle used to terminate flight. Flight termination may be performed with ordnance destruct, liquid engine shutdown or aerodynamic instability depending on the type of vehicle. The FTS includes all wiring, power systems, safing systems and ordnance initiation. EWR 127-1 Chapter 4 and AFSPCMAN 91-710 vol 4 require that all vehicles launched on the ranges be equipped with a FTS that is capable of terminating thrust on all stages from liftoff through Range Safety responsibility. The FTS may a Command Termination System (CTS), an Automatic Termination System (ATS), and/or a Fail-Safe System. Ideally a FTS consists of at least a CTS and an ATS.

2.8.3.1 Airborne FTS Functional Requirements

RCC Document 319-07, EWR 127-1 Chapter 4 and AFSPCMAN 91-710 vol 4 establish the functional requirements for the airborne FTS. The goals of the FTS are to disable thrust and to result in a termination action that minimizes the debris footprint. The FTS is required to minimize significant lateral or longitudinal deviation in the impact point.

When initiated, whether by command from the MFCO or other means, such as automatically in the event of a vehicle failure, an FTS is required, where applicable, to perform the following:

- Ensure the flight-terminated vehicle’s debris impact, resulting from residual lift or drift under worst case wind conditions, will not endanger any protected area. When termination is initiated, it shall be irrevocable

- Render each propulsion system that has the capability of reaching a protected area incapable of propulsion. This includes each stage and any strap on motor or propulsion system that is part of any payload
- Terminate the flight of any inadvertently or prematurely separated propulsion system capable of reaching a protected area
- Destroy the pressure integrity of any solid propellant system and terminate all thrust or ensure that any residual thrust causes the propulsion system to tumble without significant lateral or longitudinal deviation in the impact point
- Disperse any liquid propellant, whether by rupturing the propellant tank or other equivalent method. Note that the design goal is to initiate burning of any toxic
- liquid propellant. Shutdown and/or parachute systems may be used in lieu of rupturing propellant tanks if the risks posed by an intact impact are acceptable. Determination of shutdown-only systems will be range and vehicle dependent
- Result in aerodynamic control surface manipulation that makes a vehicle unable to glide or autorotate (for RPVs, Sub- and Full-Scale Aerial Targets, and RLVs). An analysis is required to demonstrate that for these types of termination systems, any residual lift or drift under worst case wind conditions will not result in the flight-terminated vehicle endangering any protected area

For manned vehicle, the FTS is required to comply with all of the airborne FTS requirements with the exception that the manned portion of the vehicle is not required to have FTS capability. If manned vehicles are flown unmanned, the FTS is required to comply with all of the airborne FTS requirements.

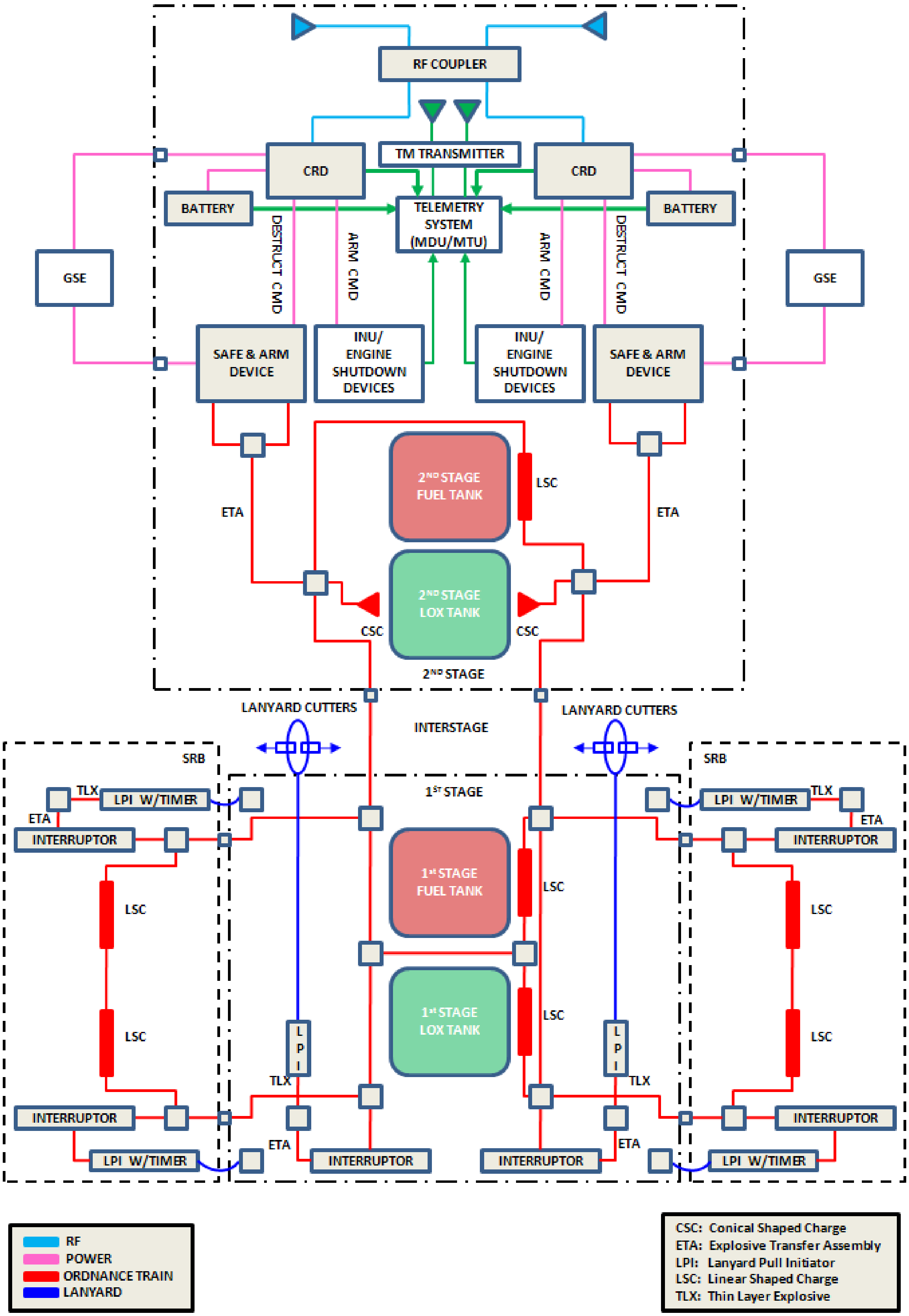

Figure 2-8-7: *Typical Launch Vehicle FTS*

2.8.3.2 Command Termination System (CTS)

The CTS is an airborne system that receives a ground initiated flight termination control signal which terminates flight of the launch vehicle. On the ER, the CTS is used to enable the MFCO to send commands to terminate thrust and destroy a vehicle in flight.

2.8.3.2.1 CTS Requirements

RCC Document 319-07, EWR 127-1 Chapter 4, and AFSPCMAN 91-710 vol 4 levy the following requirements on a launch vehicle CTS:

- For each launch, the CTS shall have its RF components on or above the last vehicle stage capable of reaching a populated or other protected area before the end of Range Safety responsibility for the launch
- The initiation of the CTS shall result in accomplishing all the FTS functions
- For each launch, at any point along the nominal trajectory from liftoff/release until the end of Range Safety responsibility, the CTS shall operate with an RF input signal that has an electromagnetic field intensity of 12 dB below the intensity provided by the command transmitter system under nominal conditions over 95 percent of the radiation sphere surrounding the vehicle
- The CTS shall survive the breakup of the vehicle until the system accomplishes all its flight termination functions or until breakup of the vehicle, including the use of any automatic or inadvertent separation terminate system, accomplishes the required flight termination
- The CTS shall receive and process a valid ARM command before accepting a DESTRUCT command
- For a liquid propellant vehicle, the CTS shall provide for an external command to non-destructively shut down any thrusting liquid engine as a command (i.e. ARM command) before terminating the vehicle

2.8.3.2.2 CTS Design

A CTS includes all receiving antennas, receiver decoders, safe and arm devices, explosive initiating and transmission devices, and ordnance necessary to achieving termination of a flight vehicle. Each CTS consists of two redundant and independent strings.

2.8.3.2.2.1 UHF Antenna

Two UHF antennas are used to receive the FTS signals from the ground command transmitting sites and provide the signals to an RF coupler. Various types of antennas may be used but typically narrow band antennas are used and are spaced 180^{o} apart to provide maximum reception of the command signal as the vehicle maneuvers during flight.

2.8.3.2.2.2 RF Coupler

The RF coupler is a passive device used to combine the RF signals inputs from each UHF antenna and distribute the required signal level to each command receiver. The RF coupler acts as a power divider or power splitter. It equally splits the input RF signal from each UHF antenna and delivers half the signal power to each CRD. The purpose of this device is to preclude the possibility that, in the event of an antenna failure, the RF signal would be greatly attenuated or cut off entirely from one or both CRDs. This ensures that the FTS will operate as required.

2.8.3.2.2.3 Command Receiver Decoder (CRD)

The CRD is the component of the airborne FTS unit that receives the RF carrier, demodulates the carrier to obtain its information, interprets the command, and outputs an analog signal to the applicable equipment to perform the command function (engine shutdown, destruct ordnance initiation, etc). For secure codes, the CRD verifies that the uplinked code corresponds to a loaded code for one of the preprogrammed functions prior to outputting the associated analog signal. Note that the CRD will not respond to a DESTRUCT command until it has received the ARM command. For more information on CRD components and functions, reference Annex A Section A.2.8.2.

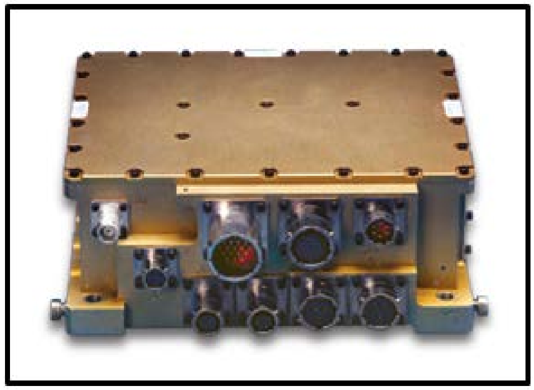

Figure 2-8-8: *Delta IV CRD-120*

There are two types of CRDs: Non-Secure (Standard) and Secure.

2.8.3.2.2.3.1 Non-Secure (Standard) CRD

A Non-Secure or Standard CRD recognizes, or decodes, commands sent as two simultaneous audio tones. Non-Secure receivers utilize the standard RCC tones. The Pegasus and Minotaur launch vehicles as well as the Trident II SLBM use Non-Secure CRDs. Trident CRDs are called Destruct Radio Frequency Units (DRFUs).

2.8.3.2.2.3.2 Secure CRD

A Secure CRD uses a "high-alphabet" command code, wherein two RCC secure audio tone combinations are decoded as a single "letter" or character in a much longer command "word." The Atlas V and Delta IV use Secure CRDs.

2.8.3.2.2.4 FTS Battery

EWR 127-1 Chapter 4 and AFSPCMAN 91-710 vol 4 require an independent power source for each of the redundant flight termination paths. As a result, there is a dedicated FTS battery for each vehicle CRD. Typically Silver-Zinc or Nickel-Cadmium batteries are used. Each FTS battery is required to have a total amp hour capacity of no less than 150 percent of the capacity needed during flight plus the capacity needed for load and activation checks, preflight and launch countdown checks, and any potential launch hold time. For a launch vehicle that uses any solid propellant, the analysis shall demonstrate that the battery capacity allows for an additional 30-minute hang-fire hold time. Typically 1 Amp-Hour batteries are used.

2.8.3.2.2.5 Safe and Arm Device (S&A or SAD)

The Safe and Arm Device, referred to as an S&A or SAD, is used in launch vehicles for the safing and arming of FTS ordnance and solid motor ignition ordnance. The S&A is a mechanical or electromechanical device that provides mechanical interruption (safe) or alignment (arm) of the explosive train and electrical interruption (safe) or continuity (arm) of the firing circuit.

A typical S&A contains a pair of EEDs as the initiators of the explosive train and connection ports for the explosive transfer assembly (ETA) of the destruct ordnance train. The S&A design

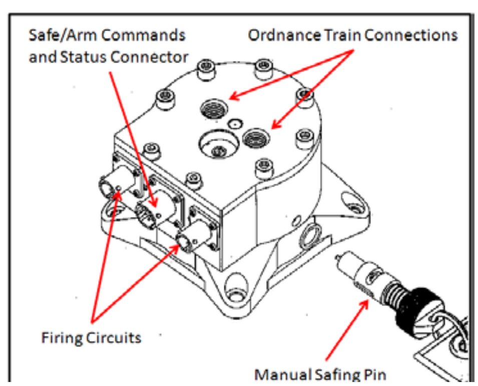

Figure 2-8-9: *Safe & Arm Device*

includes a physical barrier that, when positioned between the output of the EEDs and the inputs of the ETA, inhibits explosive energy transfer. The destruct ordnance trained is “Safed” when the S&D barrier is positioned between these elements so that explosive energy transfer is inhibited. It is “Armed” when the barrier is positioned to allow explosive energy transfer. The device may be remotely Safed and Armed by electrical signals from the launch control center (LCC) and may be manually Safed by means of the safing pin. The safing pin is a fail-safe mechanical device that inhibits remote or manual arming of the SAD during launch vehicle processing. When installed, the safing pin prevents the S&D barrier from being positioned to “Armed” and it cannot be removed when the electrical circuits are commanded to position the SAD barrier to “Armed.” The safing pin only allows for manual safing or the prevention of inadvertent arming. It does not allow for manual arming. The safing pin is removed prior to launch to allow electrical arming of the S&A. The Arm/Safe status of the S&A may be determined remotely by electrical indications or visually by a visual status indicator.

2.8.3.2.2.6 Destruct Ordnance Train

The destruct ordnance train is an explosive train which consists of all the components responsible for the initiation, transfer, and output of an explosive charge. The destruct ordnance train components include initiators, explosive transfer assemblies, and destruct charges. For more information on the Destruct Ordnance Train, reference Annex A Section A.2.8.3.

2.8.3.3 Automatic Termination System (ATS)

An ATS is an independent FTS that is installed on each propulsion system on the launch vehicle, including stages, upper stages, and payload systems, that renders the powered stage non-propulsive in the event of an inadvertent breakup of a vehicle.

2.8.3.3.1 Types of ATS

There are two types of ATS: Automatic Destruct Systems (ADS) and Inadvertent Separation Destruct Systems (ISDS).

2.8.3.3.1.1 Automatic Destruct System (ADS)

An ADS is a type of ATS that is installed on each powered stage not containing a CTS. The ADS functions autonomously during flight to render the powered stage non-propulsive in the event of the inadvertent breakup of a vehicle.

2.8.3.3.1.2 Inadvertent Separation Destruct System (ISDS)

An ISDS is a type of ADS, used on certain vehicles, that employs mechanical means to activate the FTS as a result of an inadvertent separation during flight. This system is typically used on launch vehicles which utilize solid motors or strap-on boosters in order to initiate destruct of the solid motor or strap-on booster if it inadvertently separates from the launch vehicle during flight. An ordnance delay timer is used to delay the initiation of the destruct ordnance train on the solid motor or strap-on booster to reduce the probability of fragment impact from the destruction of the booster or solid motor on the rest of launch vehicle.

2.8.3.3.2 ATS Requirements

RCC Document 319-07, EWR 127-1 Chapter 4, and AFSPCMAN 91-710 vol 4 require that an airborne FTS include an automatic or inadvertent separation termination system for each stage or strap-on motor capable of reaching a protected area before the end of Range Safety responsibility for each launch if the stage or strap-on motor does not possess a complete command termination system, including all RF components. In addition, these documents levy the following requirements on a launch vehicle ADS:

- The initiation of an automatic or inadvertent separation termination system shall result in accomplishing all FTS functions that apply to the stage or strap-on motor on which it is installed
- An inadvertent separation termination system shall include a device that senses any vehicle breakup or premature separation of the stage or strap-on motor on which it is located and activates the system
- The Range User shall locate an automatic or inadvertent separation termination system so that it will survive vehicle breakup until the system activates and accomplishes all its flight termination functions
- For any electrically initiated automatic or inadvertent separation termination system, each power source that supplies energy to initiate the termination ordnance shall be on the stage or strap-on motor with the system

2.8.3.3.3 ATS Design

Like the CTS, the ATS consist of redundant and independent strings. A typical ATS string consists of a power source, control logic, activation device (lanyard, microswitch, break wires, etc), arming device, destruct charge, and associated circuitry. Typically the ATS initiates the same destruct ordnance train as that initiated by the CTS.

2.8.3.3.4 ATS Activation Systems

The ATS is typically activated by mechanical initiators, such as pull lanyards or break wires running along the length of the vehicle. If the vehicle fails structurally and breaks up or a solid motor separates prematurely, the lanyard pulling or wire breaking serves as a trigger for ordnance activation, without the need for a human manual action (i.e., MFCO flight termination commands).

2.8.3.3.4.1 Break Wire Activation System

A break wire activation system typically uses an Automatic Destruct Unit (ADU) to monitor for inadvertent stage separation or launch vehicle breakup via break wire sensing, and to output commands that are used to terminate the flight vehicle should it be necessary. The ADU interrogates two independent break wire continuity loops routed through the launch vehicle. If a launch vehicle breakup occurs after the break wire circuits are armed, the breakup of the vehicle will break the continuity loops, thus opening the circuit. The ADU detects the breakup of the launch vehicle through the breaking of the continuity loops and initiates the destruct outputs. The ADU also issues data to the launch vehicle telemetry system on the health and status of the ADU, continuity loops and associated equipment and functions. The ADU responds to redundant Arm/Safe commands for the breakwire circuits from the ground equipment and redundant safe commands from the airborne equipment (such as the guidance system).

2.8.3.3.4.2 Lanyard Activation System

A lanyard activation system utilizes mechanical Lanyard Pull Initiators (LPIs) connected to lanyards that are routed along the sides of the launch vehicle for an ADS or between the launch vehicle and a strap-on motor or booster for an ISDS. The separation force of a launch vehicle breakup or strap-on motor/booster separation pulls the lanyard(s). This lanyard action pulls the LPI firing pin against a spring. When pulled far enough, the pin is released from the lanyard and plunges into the LPI primer, initiating the destruct ordnance train. Prior to launch, the LPI incorporates a safing pin, inhibiting motion of the firing pin and precluding inadvertent firing of the device. The LPI is specifically designed with the lanyard weaker than the safing pin and thus, the lanyard will fail before the device is initiated whenever the safing pin is installed. Prior to normal separation, the ATS is safed by ordnance initiated lanyard cutters which cut the ATS lanyard prior to separation. This prevents the normal separation of the launch vehicle stages or strap-on solids/boosters from pulling the lanyard and initiating the LPIs. Typically an ISDS uses a lanyard activation system to initiate the destruct ordnance in the event of an inadvertent separation. The separation of the booster or solid motor pulls the lanyard and activates the LPI which initiates the ordnance delay timer on the strap-on motor/ booster.

2.8.3.4 Fail-Safe System

A Fail-Safe system is a method built into some flight termination systems that will activate a termination output upon the loss of positive FTS control such as a loss of FTS power or a loss of a RF signal and/or tone. This type of a system is typically used for remotely piloted vehicles (RPVs), subscale aerial targets, reusable launch vehicles (RLVs), and full-scale aerial targets.

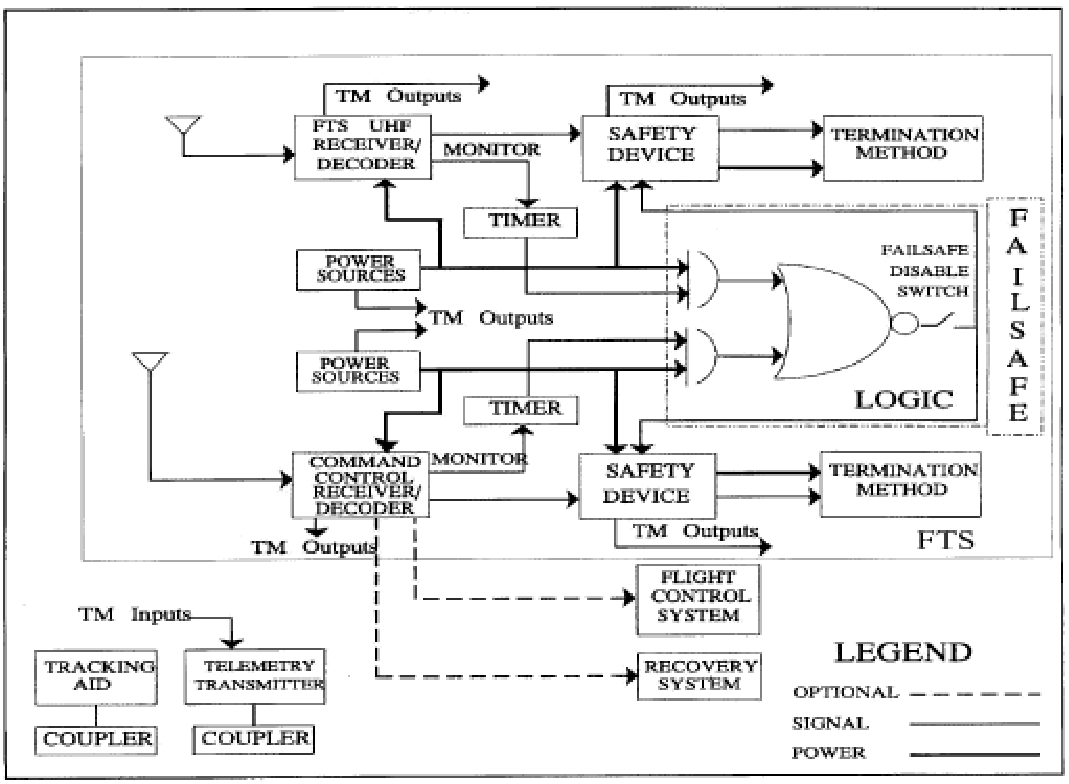

Figure 2-8-8: *Vehicle FTS with a Fail-Safe System*

In the case of the loss of FTS power, if the power source voltage of the Fail-Safe system falls to a predefined level (based on the minimum specified operating voltage for all FTS components) for a defined duration, the system will initiate flight termination. In the case of a loss of the RF signal, the signal(s) used may be the vehicle’s own command and control uplink signal and/or a Monitor tone modulated on a command carrier transmitted by a command site to be demodulated by the vehicle’s CRD(s). Depending on if the vehicle is controlled by line-of-sight or if it has an auto-pilot capability, the Fail-Safe FTS may consist of command flight termination capability in the vehicle’s uplink command-control system, a combination of the vehicle uplink command-control system and a dedicated FTS uplink (Monitor Tone), or two dedicated FTS uplinks. If the vehicle command-control system and/or CRD(s) detect a loss of the command link/and or Monitor Tone for more than a pre-determined time period (based on vehicle performance characteristics), the systems will initiate the flight termination method. If multiple links (command-control uplink and a dedicated FTS Link or two dedicated FTS links) are used to detect loss of FTS control, both links must be lost for the pre-programmed time for the system to initiate flight termination.

When loss of positive FTS control is detected, the Fail Safe system actives an ARM and TERMINATE output which initiates fuel shutoff and control surface deflection to insure instability. This results in an unstable vehicle which is unable to glide or auto-rotate so that it descends to the ground or water surface and stays within a prescribed hazardous evacuation area. The Range User may include a parachute system to recover the vehicle in the event of flight termination.

2.8.3.5 FTS Arming and Safing

EWR 127-1 Chapter 4 and AFSPCMAN 91-710 Vol 4 require that an airborne FTS provide for safing and arming of all FTS ordnance through the use of a mechanical barrier or other positive means of interrupting power to each of the ordnance firing circuits to prevent inadvertent initiation of ordnance.

2.8.3.5.1 FTS Arming

The FTS must be armed, to include arming each FTS ordnance initiation device or arming device and turning all electronic FTS components (CRDs, ADUs, etc) before arming any vehicle or payload propulsion ignition circuits. Prior to leaving the launch pad, technicians will electrically connect the ordnance lines of the destruct ordnance train and remove the safing pins from the S&As and the initiators of the ADS and the ISDS. During the launch countdown, the electronic FTS components will be turned on and transferred to internal power and the S&A's will be remotely armed prior to arming the propulsion ignition circuits. Note that the command carrier must be brought up prior to turning on the CRDs in order to capture the CRDs.

2.8.3.5.2 Preflight Safing

In the event of a scrub, the FTS is safed after the launch vehicle propulsion system ignition circuits have been safed. To safe the FTS, the S&A's are safed, and the electronic FTS components are transferred to external power. In this condition the launch vehicle is considered to be in a safe, non-launch condition. The pad safety representative will verify these actions and report to the MFCO when the vehicle is safed. After the CRDs are powered down, the pad safety representative will notify the MFCO and the command carrier can then be brought down. Technicians will re-install the safing pins on the S&As and the initiators of the ADS and the ISDS when pad safety authorizes personnel to return to the launch pad.

2.8.3.5.3 In-Flight Safing

The airborne FTS can be safed during flight after the period of Range Safety responsibility. The FTS may be safed automatically by the launch vehicle systems or the Range User may request that the MFCOs send the SAFE command during flight to safe the FTS. If the FTS is safed automatically, EWR 127-1 Chapter 4 and AFSPCMAN 91-710 Vol 4 require that the onboard vehicle hardware or software used to automatically safe the FTS be single fault tolerant against inadvertent safing. In addition, any automatic safing of the FTS during flight has to satisfy all the following constraints:

- Automatic safing shall occur only when the flight of the vehicle satisfies the safing criteria for no less than two different safing parameters or conditions, such as time of flight, propellant depletion, acceleration, or altitude. The safing criteria for each different safing parameter or condition shall ensure that the FTS on a stage or strap-on-motor can only be safed once the stage or strap-on motor attains orbit or can no longer reach a populated or other protected area
- If operation of the vehicle could result in meeting the safing criteria for one of the two safing parameters or conditions before normal thrust termination of the stage or strap-on motor to which the parameter or condition applies, the Range User shall demonstrate that the greatest remaining thrust, assuming a three-sigma maximum engine performance, cannot result in the stage or strap-on motor reaching a populated or other protected area

If the Range User requests that the MFCO send the SAFE command to safe the FTS, RCC Document 319-07, EWR 127-1 Chapter 4, and AFSPCMAN 91-710 Vol 4 require that the range command transmitter used for the in-flight safing be single fault tolerant against inadvertent transmission of a safing command.

2.8.3.6 FTS Data Monitoring

RCC Document 319-07, EWR 127-1 Chapter 4, and AFSPCMAN 91-710 Vol 4 require that the airborne FTS interface with the vehicle's telemetry system to provide the data that the MFCO and the OSM need to monitor end-to-end command link closure and to evaluate the health and status of the FTS before and during flight. The telemetry data is provided to ensure the health, readiness and functionality of the FTS. This data includes:

- Signal strength for each CRD
- Power status to each flight termination subsystem
- Status of output commands for each flight termination receiver and each automatic or inadvertent separation termination system
- Safe and arm status of each S&A device
- Voltage for each FTS battery
- Current for each FTS battery
- Status of any electrical inhibit at the system level that is critical to the operation of an FTS
- Status of any firing unit, including arm input, power level, firing capacitor charge level, and trigger capacitor charge level
- Temperature of each FTS battery, whether monitored at each battery or in the immediate vicinity of each battery so that each battery's temperature can be derived
- Status of each switch used to provide power to an FTS, including any switch used to change from an external power source to an internal power source
- Shutdown valve position where shutdown is the primary means of positive control

These telemetry requirements are not necessarily all-inclusive. The number and type of FTS parameters that are required for telemetering depend on the final configuration of the FTS. The OSM monitors all of these telemetry parameters. The MFCO's Range Safety Displays (RSD) and analog telemetry displays typically only allow for monitoring of the signal strength of each CRD and the decoding/recognition of Pilot Tone on the command carrier.

2.8.4 GROUND COMMAND DESTRUCT SYSTEM (CDS)

The CDS is defined as the total set of ground assets (i.e., Command Generation System (CGS), Central Command System (CCS), Network Segment (NETSEG) and Vehicle Uplink System (VUS)) required to perform the vehicle uplink function, which interfaces with the vehicle FTS. The CDS is made up of the hardware, software, and manpower required to perform the uplink function. It starts with the carrier control and flight termination activation equipment at the MFCO console and ends at each command-transmitting antenna.

The CDS has two tasks:

- The reliable transmission of flight termination messages to aerodynamically unstable or errant missile vehicles in response to MFCO requests that are originated at the launch head
- To provide sufficient signal level to provide capture of the launch vehicle's CRDs during flight in order to prevent inadvertent response of the airborne FTS due to noise effects or undesired RF signal inputs from other sources

2.8.4.1 ER Ground Command Destruct System Overview

The ER Ground Command Destruct Supersystem (CDS) consists of a network of three UHF radio transmitters, located at CCAFS (Cape 1A and Cape 1B) and the Jonathan Dickinson Missile Tracking Annex (JDMTA), linked to a Central Command Remoting System (CCRS) located in the Morrell Operations Center (MOC) at CCAFS. The Ground CDS provides the capability to issue commands from the MFCO consoles at the MOC and to transmit those commands, via the CCRS, through any of the three command sites.

2.8.4.1.1 Command System Controller Net (CSC.NET)

The coordination net for the Command Destruct Supersystem personnel is the Command System Controller Net (CSC.NET). The command sites use the color callsign "Bronze" along with their station number to identify themselves on the CSC.NET. Table 2-8-3 lists the command sites and their associated callsigns.

Table 2-8-3: *ER Command Sites and Callsigns*

Command Site	Callsign
Cape Canaveral AFS, Florida	
Cape 1A	Bronze 1A
Cape 1B	Bronze 1B
Jonathan Dickinson Missile Tracking Annex (JDMTA), Florida	Bronze 28

2.8.4.1.2 Command System Controller (CSC)

The Command System Controller (CSC) is the System Controller for the CDS and operates the CCRS. The CSC coordinates system tests and status with the command sites on the CSC.NET, the CSC uses the call sign "Dog 1." Assisting the CSC is the CCRS CME/V Tech, callsign "Cherry 1", who helps to conduct Ground Command Destruct System tests from the MFCO and CSO consoles. The CSC coordinates countdown task execution and status with the ISRO on Instrumentation Net 2 (INST 2) using the callsign "Command." When coordinating with the

MFCO on configuration of the command system or during the Final Combined Command Open Loop test on FCO.LCL, CSC uses the callsign “CSC.”

The CSC is also the Frequency Control Analysis (FCA) Controller for coordinating frequency control issues with the FCA vans. When working in this capacity, the CSC uses the callsign “Commute 1” when coordinating with FCA assets on the FCA Net and uses the callsign “RF” when reporting status to the ISRO on INST 2.

2.8.4.2 Ground FTS Functional Requirements

For the ground system, EWR 127-1 Chapter 7 and AFSPCMAN 91-711 require the following:

- A dual command site be available from launch through the period of Range Safety responsibility: A dual command site is defined as two transmitters (or strings) connected by an automatic failover control mechanism. The back-up transmitter is required to have the same signal strength at the receiver as the primary transmitter. This requirement is designed to prevent a single point of failure at the command site and ensure that the command site can transmit destruct functions
- Two command data links (also referred to as command remoting links or CMEV links) be available from launch through the period of Range Safety responsibility.
- The dual transmitter sites shall be connected to central command in the MOC
- The CDS shall be capable of operating in both secure and non-secure modes in order to support all programs

In addition, the *Combined Command Destruct System Range Safety Requirements (CCDSRSR) for the 30th and 45th Space Wings* levies requirements on the design and performance of the ground CDS. To ensure redundancy, the CCDSRSR requires that the entire ground CDS be designed such that there are two or more independent hardware paths (including but not limited to power sources, MFCO interfaces, Central Command Systems, remoting/communications links, designate data pathways, station systems, and antennas) capable of transmitting functions to a vehicle FTS. For additional detailed CDS performance requirements, reference the CCDSRSR.

2.8.4.3 Central Command Remoting System (CCRS)

The CCRS, located in the MOC, can be described as the nerve center of the Command Destruct System, linking the MOC to all of the command destruct sites. From six operator control device located at the MFCO, CSO, and CSC consoles, operators can control remote command system equipment, request activation of the command carrier, and initiate command requests.

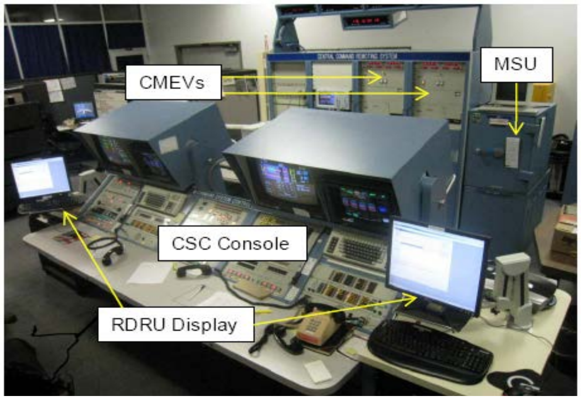

Figure 2-8-10: *CSC Console, CMEVs, and MSU located in CCRS at the MOC*

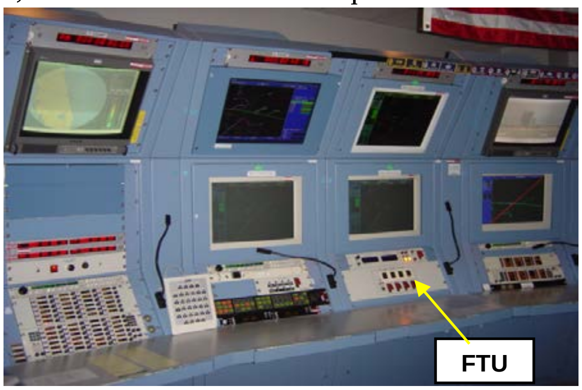

Figure 2-8-9*: MFCO console with FTUs*

The major functions of the CCRS are to:

- Maintain overall control of the Command Destruct System
- Provide a user interface for the MFCO and CSO
- Process requests from the MFCO, CSO or CSC to activate/de-active the command carrier and to send commands
- Determine the operating mode and the system configuration
- Monitor the health and status of each transmitting command site
- Specify the carrier and command message addressing priority and routing. This includes specifying which command site is selected to radiate the carrier, which command to send if multiple commands are requested, and which command site(s) will receive the command message for transmission to the launch vehicle
- Format the command message and check for errors
- Automatically determine which command site should have its transmitter activated (in autocarrier mode only)
- Transmit messages to the addressed command site for action
- Receive confirmation of requested actions from the command site

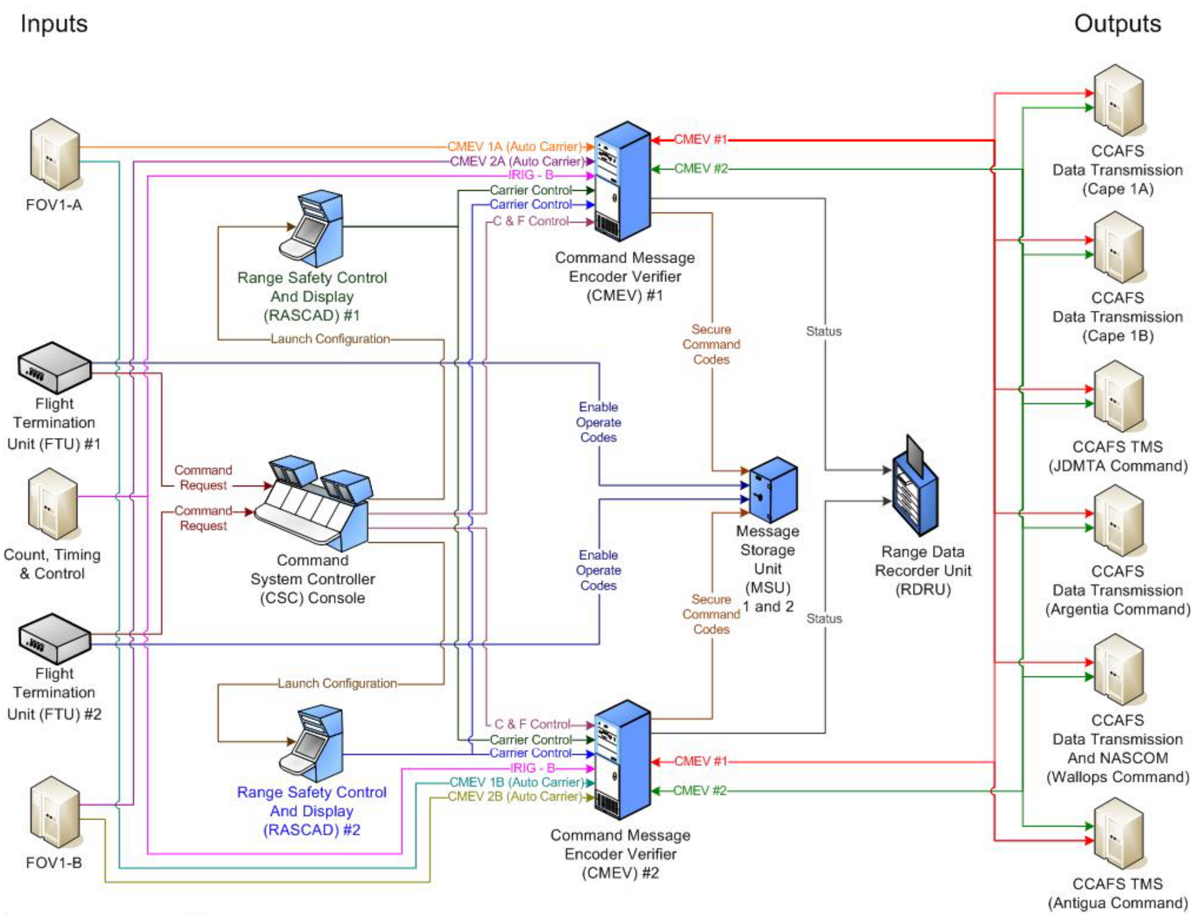

Figure 2-8-11*: CCRS Data Flow*

The major elements of the CCRS and its interfaces are depicted in Figure 2-8-15. They consist of the:

- Command Message Encoder Verifier (CMEVs)
- Command System Controller (CSC) Consoles

- Flight Termination Units (FTUs)
- Message Storage Units (MSUs)
- RASCADs

2.8.4.3.1 CCRS Mission Modes of Operation

The CCRS has two mission modes, the Eastern Test Range (ETR) Inter-Range Instrumentation Group (IRIG) mode and the Digital Range Safety (DRS) mode. Within these two modes are two sub modes. Table 2-8-4 shows the different mission modes for the various launch vehicles and the CDS transmitter sites which support these modes.

Table 2-8-4: *CCRS Mission Modes*

MISSION MODES		VEHICLE TYPE	COMMAND SYSTEM		
			CAPE 1A	CAPE 1B	JDMTA
ETR-IRIG	Normal	Pegasus	X		X
		Minotaur	X		X
	Trident II	D5	X		X
DRS	Unmanned Secure (UMS)	Atlas V	X	X	X
		Delta IV	X	X	X

2.8.4.3.1.1 Eastern Test Range (ETR) IRIG Mode

The ETR-IRIG mode is used to support all launches of vehicles using standard/non-secure receivers. The ETR-IRIG mode supports up to 16 command functions. Since this mode can support Trident missile launches using missile identifications (IDs) of W, X Y, and Z, the 16 command functions are divided into four sets of four, one set for each missile (W1 through W4, X1 through X4, Y1 through Y4, and Z1 through Z4). Within each set, commands are prioritized with the first command in each set (DESTRUCT) having the highest priority.

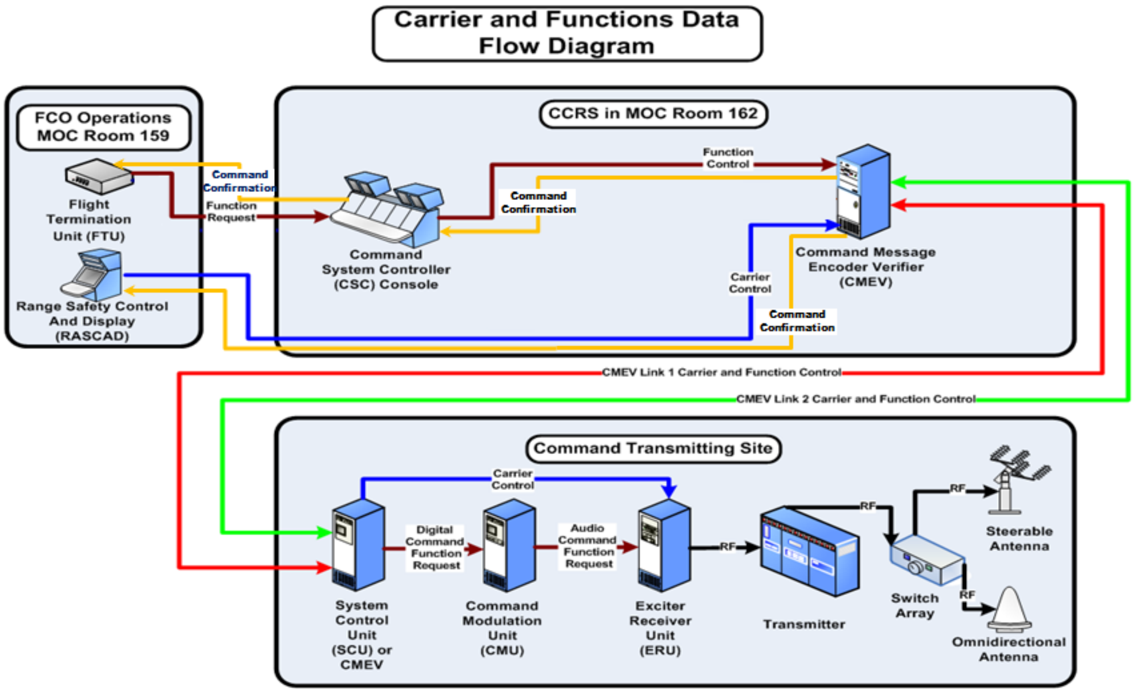

Figure 2-8-12: *ETR-IRIG Mode Data Flow*

For Standard receivers, the tones that are used for tests are the same tones that are used for flight. Uplink command functions can be sent from the CSC console and the FTUs when the CSC console is in the TEST Mode, but functions can be only sent from the FTUs when the CSC console is in the OPERATE Mode. In the ETR-IRIG mode, when a command function is initiated from the FTU or CSC console, the CMEV transmits a message to all of the active command sites to tell them which command to send. The Central CMEV transmits the message three times after which the next ordered priority instruction can be handled. Upon receipt of two of the three messages, the command site that is radiating the carrier will send a verification message to the Central CMEVs to indicate that it received the command. If the verification message is not received by the Central CMEV within an allowable time, the system will continue to send command transmission requests, three messages at a time, until it receives a verification message. After verifying that it has received two command message requests, the site then generates the standard tones to build the message for that command function and transmits the requested function to the in-flight vehicle. When the command site has transmitted the command function, the site will send a confirmation message back to the CMEVs for display on the RASCADs and the FTUs. Although the command site will continue to transmit the command as long as it is requested, the site will only send three confirm messages.

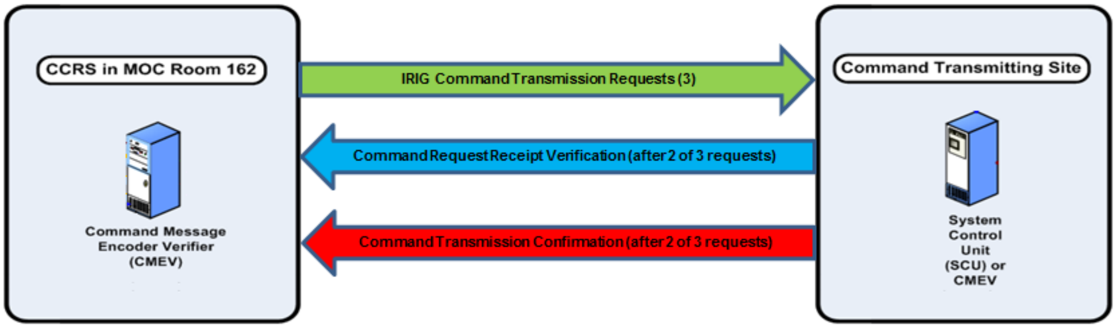

Figure 2-8-13: *ETR-IRIG Command Request/Confirmation Data Flow*

The Cape 1A and JDMTA command sites can support the ETR-IRIG mode. The ETR-IRIG mode has two sub modes: the Normal and Operational Trident modes.

2.8.4.3.1.1.1 ETR-IRIG Normal Mode

The ETR-IRIG Normal mode supports expendable launch vehicles using standard receivers such as the Pegasus and Minotaur launch vehicles. In this mode, commands are continuously transmitted when they are requested until they are removed or a higher priority command is requested. The priority in transmitting commands is from highest to lowest: DESTRUCT, ARM, SAFE (if used), and Check Channel. Note that since DESTRUCT can be sent without sending an ARM command, if DESTRUCT is requested prior to an ARM command, the system will not transmit the ARM command.

2.8.4.3.1.1.2 ETR-IRIG Operational Trident Mode

The ETR-IRIG Operational Trident (OT) mode supports Trident II D5 launches. This mode can be used to support multiple missile launches at the same time. The Trident mode uses a message format that combines the ARM and DESTRUCT commands into a single command message using standard RCC tones. When requested, the command is continuously transmitted until it is removed. As the command message is continuously radiated, it results in the ARM and DESTRUCT tone combinations being alternately radiated. This capability is referred to as “Multi-Cycle DESTRUCT” and increases the chances that the message is received and processed by the missile. The Trident mode also has the capability to send a “Single-Cycle DESTRUCT” in which only a single message with the ARM and DESTRUCT tone combinations is transmitted. This capability is used for dockside tests in the port to prove that the missile’s CRD, called a Destruct Radio Frequency Unit (DRFU), is sensitive enough to receive a single destruct message. The configuration to transmit a Single-Cycle DESTRUCT command is made at the command site.

The Trident mode can radiate command functions for up to four missiles (W, X, Y and Z) in flight at the same time. The combined ARM/DESTRUCT command message is configured to be initiated by a single FTU switch, allowing for the FTUs to be configured to send functions on four different vehicles. Although the CMEVs have the capability to support Trident missile configurations W, X, Y, and Z; only missile configurations W and X will be flown due to the Navy’s transition to the Low Cost Test Missile Kit (LCTMK).

2.8.4.3.1.2 Digital Range Safety (DRS) Mode

The DRS mode is used for to support all launches of vehicles using secure receivers. To utilize the maintenance codes during pre-launch tests, the FTUs are configured in the DISABLE mode and the CSC Console is configured in the TEST mode. This limits the CMEV's access to the maintenance codes in the MSU TEST memory. To utilize the flight codes during pre-launch testing and launch operations, the FTUs are configured in the ENABLE Mode which disables an interlock that is used to prevent the CMEV from accessing the flight codes from the MSU OPERATE memory. In addition, the CSC Console is configured in the OPERATE mode. This changes the DRS Memory Address selector switch on the CSC console to the OPERATE memory, allowing the CMEV to access the MSU OPERATE memory, and locks out the CSC Console, which allows commands to only be sent from the FTUs. The system can be configured to allow the CSC console to send functions using the flight codes if required for pre-launch testing. To do this, the FTUs are configured in the TEST mode, the CSC Console is configured in the TEST Mode, and the CSC has to manually switch the DRS Memory Address selector switch from the TEST memory to the OPERATE memory.

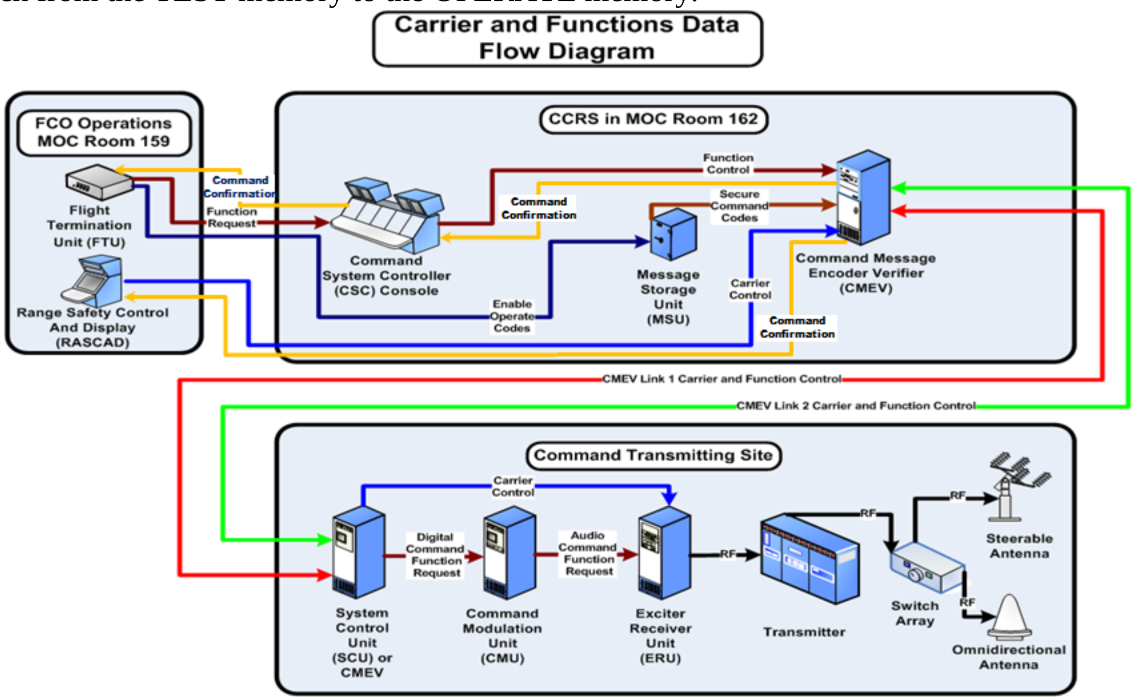

Figure 2-8-14: *DRS Mode Data Flow*

The DRS mode supports five functions (what they are depends on the submode). When a command function is initiated from the FTU or CSC console, the signal is sent through the CSC console to the CMEVs which then extracts the corresponding function codes from the MSU and transmits the message only to the command site that is radiating the carrier. The message sent to the command site sends the actual tone pairs to be transmitted rather than designating which command function to send. The command site generates the secure tones to build the message and transmits the requested function to the in-flight vehicle.

In the standard DRS mode configuration, the CMEVs will not send a DESTRUCT command to the command site unless an ARM command has been requested and the command site has confirmed that it has sent the ARM command. If a DESTRUCT command is requested without an ARM command, the CMEV will not act until it receives a request for the ARM command. It will then send the ARM command, await confirmation from the command site that the ARM command was sent, and then send the DESTRUCT command. To improve mission assurance when the ARM and DESTRUCT commands are requested, the DRS mode will transmit four sequential ARM commands prior to transmitting the DESTRUCT command. In addition, the

DRS mode will not allow the carrier to be switched to another command site if an ARM command is active.

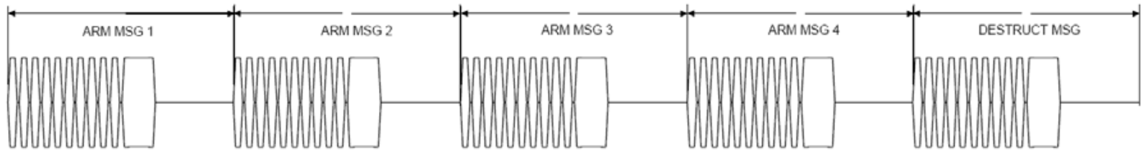

Figure 2-8-15: *DRS Arm and Destruct Uplink*

2.8.4.3.1.2.1 DRS Sub-Mission Modes

The DRS mode has two sub-mission modes: Unmanned Secure (UMS) and Space Transportation System (STS) modes. For more information on the DRS - Manned Secure Mode (STS), reference Annex A Section A.2.8.4.

2.8.4.3.1.2.1.1 DRS - Unmanned Secure Mode (UMS)

The DRS-UMS mode supports expendable launch vehicles using secure receivers such as the Atlas and Delta launch vehicles. In this mode, the Central CMEV transmits the message three times to the command site that is radiating the carrier after which the next ordered priority instruction can be handled. Upon receipt of two of the three messages, the command site that is radiating the carrier will send a verification message to the Central CMEVs to indicate that it received the command. If the verification message is not received by the Central CMEV within an allowable time, the system will continue to send command transmission requests, three messages at a time, until it receives a verification message. After verifying that it has received two command message requests, the site then generates the secure tones to build the message and transmits the requested function to the in-flight vehicle. When the command site has transmitted the command function, the site will send a confirmation message back to the CMEVs for display on the RASCADs and the FTUs. In the DRS-UMS mode, commands are continuously transmitted when they are requested until they are removed or a higher priority command is requested. The command site will send a command transmission confirmation message every time the command is sent. The priority in transmitting commands is from highest to lowest: DESTRUCT, ARM, SELF TEST, RESET, SAFE and Pilot Tone. The Cape 1A, Cape 1B, and JDMTA command sites can support the DRS-UMS mode.

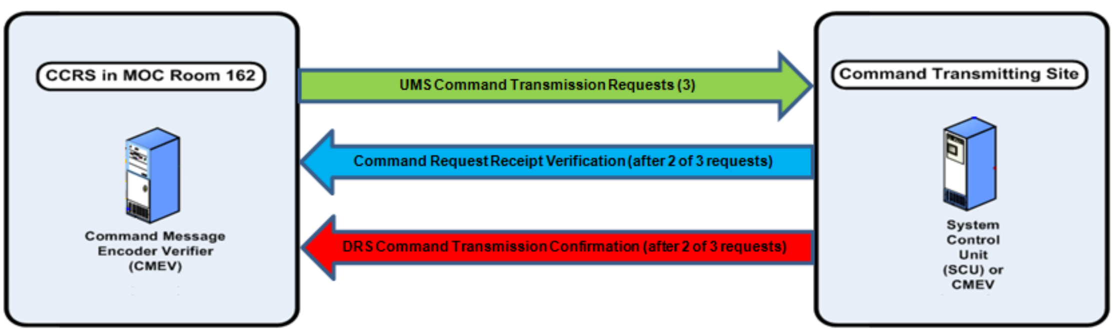

Figure 2-8-16: *DRS-UMS Command Request/Confirmation Data Flow*

2.8.4.3.1.2.2 DRS Special Test Modes

The DRS mission mode has two special test modes that can be used during pre-launch testing: the Pad Test mode and the Secure Checkout mode.

2.8.4.3.1.2.2.1 Pad Test Mode
When using the maintenance codes, the Pad Test mode allows the DESTRUCT command to be transmitted to a launch vehicle without having to first send an ARM command. To do this, the CSC Console must be in the TEST mode and the Pad Test mode must be enabled. This mode can only be utilized with the Cape 1A or Cape 1B command site.

2.8.4.3.1.2.2.2 Secure Checkout Mode
The Secure Checkout mode is used to conduct closed loop checks with the CRDs at the Cape 1A and Cape 1B command sites in order to verify the integrity of the flight codes loaded in the MSUs. In the Secure Checkout mode, all downrange command remoting links, except those to Cape 1A and Cape 1B, are inhibited. The system will not allow a command carrier request to be transmitted to the sites. Command functions can only be sent to Cape 1A or Cape 1B and only if the site is in closed loop mode.

For DRS mode missions, the Secure Checkout mode is utilized during the countdown for an additional set of ground CDS checkouts, the Initial and Final Ground Command Closed Loop checks with Cape 1A and 1B, to verify the integrity of the flight codes in the MSU prior to launch.

2.8.4.3.2 Command Message Encoder Verifier (CMEV)

Figure 2-8-17: *CMEV*

There are two redundant CMEVs, located in room 162 of the MOC, that are the master control units for the CCRS. The CMEVs process/encrypt commands, generate and process carrier on/off requests, receive health and status of the sites, receive command echoes, send out carrier site switching mode changes (auto/manual), and determine priority and routing. The CMEVs interface with six operator control devices: two FTUs at the MFCO consoles in the RSD area, two RASCADs at the CSO consoles in the RSD area, and two CSC consoles in the CCRS area. Each CMEV is connected to each of the operator control devices by two separate hardware lines or links. Each CMEV also has a single hardware link to a dedicated MSU in order to extract the secure codes during DRS (STS or UMS) missions. The CMEVs are connected to each command site by two command remoting or CMEV links. Currently the CMEVs are connected to three command sites but they have the capability to be connected to up to six different command sites. The CMEVs are also connected to the Flight Operations – Front End Processors (FO-FEPS) of the FOV1-A and FOV1-B system which provide the CMEVs with the plus count time and the associated elevation angles to an inflight vehicle for each of the command sites.

The CMEVs are configured to run in a prime/backup mode. The prime, or on-line, CMEV handles all message requests to the remote systems and manages the CCRS control panel indicators. The on-line CMEV verifies on/off requests for carrier and command functions from the operator control devices by monitoring and comparing the requests received on the two separate hardware lines. Both the prime and backup systems receive the same inputs from the command systems and from all console switches. A CMEV switchover can be forced by the controller or, if properly configured, may occur automatically if an error condition is detected.

The two CSC Consoles and the two RASCADs are normally configured to operate redundantly, through the on-line CMEV, in support of a single mission. However, if the control devices are configured appropriately, the on-line CMEV can simultaneously support up to four separate checkout operations, such as dry-run tests.

Both CMEVs are mandatory for launch. In order to troubleshoot any problems with a CMEV, the CSC Console must be in the TEST mode and the command carrier cannot be active. If a failure of a CMEV occurs on launch day prior to the Final FTS Open Loop Checks, the checks will have to be delayed until the problem is resolved. If the carrier is active at the time of the CMEV failure, the vehicle CRDs will have to be turned off and the command carrier will have to be brought down.

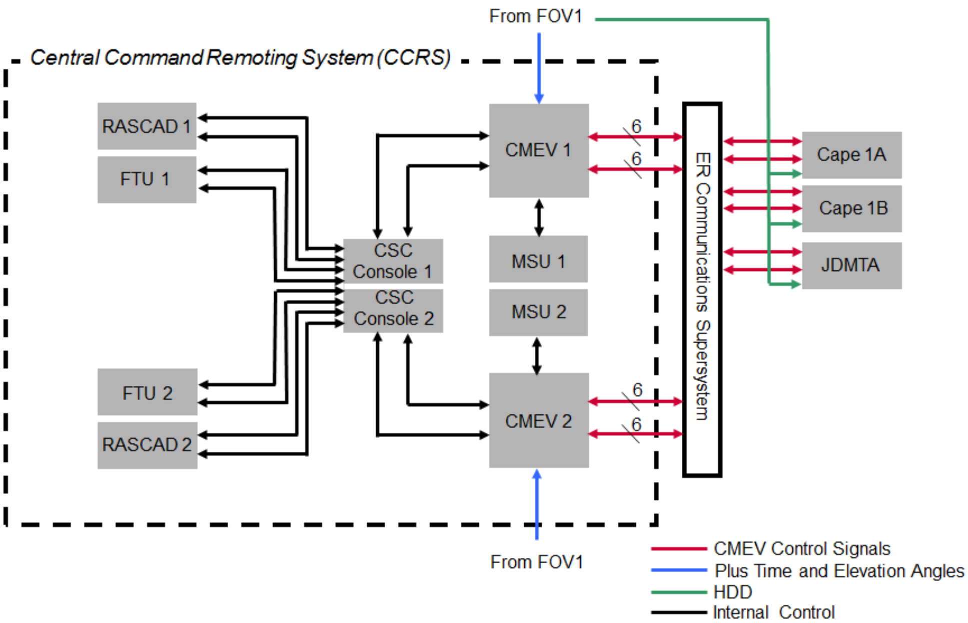

Figure 2-8-18: *CMEV Interfaces*

2.8.4.3.2.1 CMEV Operating Modes

The CMEVs have two operating modes: the TEST mode and the OPERATE mode.

2.8.4.3.2.1.1 CMEV TEST Mode

In the TEST mode, the CMEV that is selected to be on-line will stay on-line as long as it has power unless a CMEV switchover is forced by the controller. If the online CMEV detects a mis-compare between the requests from the operator control devices that are received on the two separate hardware lines, it will treat the request as an invalid request. The TEST mode is only used for troubleshooting problems with the CCRS, especially problems affecting the CMEVs.

2.8.4.3.2.1.2 CMEV OPERATE Mode

In the OPERATE mode, a failure of the prime or on-line CMEV will cause an automatic CMEV switchover. The backup CMEV becomes prime and takes over with no loss of continuity. In the OPERATE mode, a mis-compare between the requests from the operator control devices that are received on the two separate hardware lines forces a CMEV switchover. If the new on-line CMEV also sees a disagreement, the request is treated as invalid. The OPERATE mode is the typical CMEV configuration and is used on launch day and for pre-launch day vehicle tests.

2.8.4.3.2.2 Carrier Control Modes

During the flight of a launch vehicle, it is sometimes necessary to change the command site that is radiating the command carrier, or in other words, to transfer the carrier from one command site to another in order to ensure adequate command coverage throughout flight. The CMEVs have two different control modes for use in determining which command site will transmit the carrier: Automatic (Auto) or Manual carrier modes.

2.8.4.3.2.2.1 Automatic (Auto) Carrier Mode

In Auto Carrier Mode or Auto Mode, carrier selection by manual control is inhibited, and the CMEV utilizes an algorithm utilizing a 16 bit word to perform a real-time analysis of several criteria to determine which command site has the best coverage. The station with the highest selection value is the best choice to transmit the command carrier. For more information on the Auto Carrier Switching Algorithm, reference Annex A Section A.2.8.6.

2.8.4.3.2.2.2 Manual Carrier Mode

In Manual Mode, carrier switching can be accomplished from either of the RASCAD touch screens by the CSO console or from either of the CSC control panels at the CSC console, depending on the current position of the key-lock switch on the CSC console. The carrier is initially brought up for launch during the minus count by the CSO using the Manual Mode.

There are several reasons why Manual Mode may be used during flight instead of the Auto Mode. The Manual Mode is always used for Navy Trident II launches due to mission unique factors such as the possibility of having more than one missile in the air and the utilization broadbeam antennas. It may also be used to react to problems with vehicle orientation or flame attenuation. If the TSO reports that the AGC levels displayed on the analog telemetry displays are low, the MFCO may direct the CSO to manually transfer the carrier to another available command site to insure CRD capture from a site that is not degraded by vehicle orientation or flame attenuation. In addition, the Manual Mode may be used due to a CDS failure prior to or after liftoff. Remember that a dual command site and two remoting links are required through the period of Range Safety responsibility; however, a command site only has to have one good remoting link and one complete command string to qualify as a healthy site in the Auto Mode algorithm. If a command site that is not radiating the carrier experiences a remoting link or command string failure, the CSO will use the Manual Mode to prevent the carrier from switching to that command site. If a command site that is radiating the carrier experiences a remoting link or command string failure, the CSO will switch to the Manual Mode to transfer the carrier to a dual command site with two remoting links, if available. For missions with a payload utilizing a Radioisotope Thermoelectric Generator (RTG), the Manual Mode is used at liftoff in order to be able to switch to another command site if a CDS failure occurs while attempting to send command functions early in flight.

2.8.4.3.2.3 Carrier Switching Modes

There are three types of carrier-switching modes. When supportable by the CMEV software, these modes can be used in both the Auto and Manual Carrier control modes.

2.8.4.3.2.3.1 Single Carrier with Overlap Mode

In this mode, only one command site may have its carrier on at a time, and during a transfer, the new command site's carrier will be turned on before the old one is turned off. This is mode is required for all launches by the CCDSRSR document for the 30/45 SWs. For all secure missions, both the Auto and Manual Carrier Control modes must be configured in this mode. The CMEV software program will reject any other carrier mode will in the DRS (STS or UMS) mission mode.

2.8.4.3.2.3.2 Single Carrier Without Overlap Mode

In this mode, only one command site may have its carrier turned on at a time, and during a transfer the old command site's carrier is turned off before the new one is turned on. Note that this mode is no-longer supported by the CMEV software program.

2.8.4.3.2.3.3 Multiple Carrier Mode

In this mode, multiple command sites may have their carrier on at a given time.

2.8.4.3.3 Command System Controller (CSC) Consoles

Figure 2-8-21: *CSC Consoles*

The CSC consoles, located in room 162, are used to configure the components of the CCRS and to verify the functionality of the CCRS and the supporting command sites in support of pre-launch day tests and launch operations. There are two CSC consoles: CSC 1 or Console H1 and CSC 2 or Console H2. Prior to pre-launch day tests and during the minus count of each launch mission, the controllers utilize the CSC consoles to access both CMEVs to configure the CDS and verify system performance during system checkouts. After all pre-launch checks have been completed, a key-lock switch on the CSC console is locked, thereby restricting control of the command carrier and function requests to the CSO and MFCO through the RASCADs 1 and 2 and the FTUs. Two of the four carrier control consoles (RASCAD 1 and 2 and the two CSC Consoles) are mandatory for launch. If either of the RASCADs in the RSD area should become unusable, the MFCO can send the CSO to room 162 to unlock the CSC console and continue carrier control from the CSC position as an emergency backup.

2.8.4.3.3.1 CSC Console Operating Modes

The CSC Consoles are used to configure and checkout the Command Destruct systems prior to supporting operations and to perform system functions and monitoring during operations. To perform these functions, the CSC consoles have two operating modes: the TEST mode and the OPERATE mode.

2.8.4.3.3.1.1 CSC Console TEST Mode

The TEST mode of the CSC console is used to perform the initial set-up of the CCRS, to perform ground CDS or vehicle FTS checkouts using the maintenance codes, and to perform troubleshooting for the Ground CDS. When configuring the CCRS in the TEST mode, the controllers can perform the following functions:

- Determine the CCRS mission mode (ETR-IRIG Normal, ETR-IRIG OT, or DRS-UMS)
- Select which command sites are supporting the operation
- Configure which command function is on each of the MFCO FTU switches
- Select the carrier switching mode (Single Carrier with Overlap, Single Carrier without Overlap, or Multiple Carrier)
- Pre-program carrier switching times within the auto-switching algorithm (if required)

- Switch between Closed-Loop and Open-Loop modes (in DRS modes only)
- Initialize the Central CMEVs
- Determine the CMEV configuration (TEST Mode or OPERATE Mode)
- Select which CMEV is online
- Select which consoles (CSC and/or the RASCADS) are in control of the carrier

When operating the CSC Console in the TEST mode, the controllers can perform the following functions:

- Control the command carrier
- Enable/send Pilot Tone or Check Channel
- Send command functions
- Select which CMEV is online
- Re-initialize the CMEVs
- Enable/Send Pilot Tone or Check Channel
- If configured properly at the command sites, the CSC Console can switch between antennas (Omni or Steerable)

ETR-IRIG commands and DRS maintenance code commands can be sent from the CSC consoles when in the TEST mode. DRS flight codes can be sent from the CSC consoles if the FTUs are configured in the TEST mode, the CSC Console is configured in the TEST Mode, and the CSC manually switches the DRS Memory Address selector switch from the TEST memory to the OPERATE memory.

2.8.4.3.3.1.2 CSC Console OPERATE Mode

The OPERATE mode of the CSC Console is used to support pre-launch day vehicle FTS tests, checkouts of the CDS using the secure fight codes, and to operate the CDS during launch operations.

After all pre-launch day ground CDS checkouts have been performed, the CSC console is switched to the OPERATE mode by use of a key-lock switch on the console. This performs four functions:

- It forces both Central CMEVs to the OPERATE mode (if not already configured). This will force the Central CMEVs to switch or failover when the system detects a fault within the online CMEV
- It forces the RASCADs to be enabled for control of the command carrier
- It disables or locks out the CSC consoles, preventing them from being able to control the command carrier or to send command functions
- When in the DRS mode in conjunction with the FTUs being enabled, it changes the DRS Memory Address selector switch to the OPERATE memory, allowing the CMEV to access the MSU OPERATE memory

When this switch is made, it effectively restricts the ability to send command functions to the MFCO's FTUs and control of the command carrier to the CSO's RASCADs. In this mode, CSC Console capabilities are limited to:

- Selecting which CMEV is online
- Re-initializing the CMEVs
- Enabling/Sending Pilot Tone or Check Channel

- If configured properly at the command sites, the CSC Console can switch between antennas (Omni or Steerable)

The controllers are unable to make any other configuration changes after the CSC Consoles are in the OPERATE mode. The CSC Console key is then removed from the key-lock switch and delivered to the MFCOs, officially handing control of the CDS over to the MFCOs.

2.8.4.3.3.2 CSO Back-up Capability

If the CSO is directed by the MFCO to re-locate to the CSC console due to a RASCAD failure, the CSO will take the CSC console keys to the CSC console. The CSC will switch the console to the TEST mode which will enable the CSC Console. If requested by the MFCO, the CSC can also enable the remaining RASCAD console, if available. If the system is in the DRS mission mode, the CSC will manually switch the DRS Memory Address selector switch from the TEST memory to the OPERATE memory to allow the CMEVs access to the flight codes.

2.8.4.3.4 Flight Termination Unit (FTU)

The FTU is the interface by which the MFCO initiates the transmission of command functions. There is one FTU at each of the MFCO and SMFCO consoles. Each FTU is connected to the Central CMEVs through two hardware links. The FTUs are connected in parallel; therefore, either the MFCO or the SMFCO may send functions independently. Each FTU has a set of four guarded toggle switches which can be assigned to any of 16 different command functions, however, not more than four of these commands can be programmed into the FTUs at any one time. Each FTU switch is a two pole switch. When raised in the “active” position, the switch contacts at two poles, completing two circuits. Each circuit sends the command request through one of the two separate hardware links to each Central CMEV. The online CMEV must receive the command request through both of these hardware lines in order to send the function. If one of the switch contact poles fails, then only one command request will be sent to the CMEV and the command will not be sent. This is done to prevent the inadvertent transmission of a command function due to a switch failure. The FTUs have three operating modes: the ENABLE mode, the DISABLE mode, and the TEST switch mode.

Figure 2-8-19: *FTU*

2.8.4.3.4.1 ENABLE Mode

The ENABLE Mode is used in the DRS Mission modes. When the FTU is in the ENABLE Mode, it disables an interlock that is used to prevent the CMEV from accessing the flight codes from the MSU OPERATE memory. This allows the DRS Memory Address selector switch to be changed from the TEST memory to the OPERATE memory when the CSC Console is configured to the OPERATE Mode or when manually selected by the CSC. This allows the CMEV to access the MSU OPERATE memory. When the FTUs are in the ENABLE mode, they are the only operator interface that can be used to initiate commands using the flight codes. When the FTUs are in this mode, they are said to be “enabled.”

2.8.4.3.4.2 DISABLE Mode

The DISABLE Mode is used in the DRS and ETR-IRIG modes. When the FTU is in the DISABLE Mode in the DRS modes, it engages the interlock that prevents access to the OPERATE memory in the MSUs. This configuration is used in order to use the maintenance codes in the CMEV TEST memory during pre-launch day tests that occur prior to the loading of the secure flight codes. When the FTUs are in the DISABLE mode and the CSC console is in the TEST Mode, both the FTUs and the CSC console can initiate commands using the maintenance codes.

When the CCRS is in one of the ETR-IRIG mission modes, the FTUs are always in the DISABLE mode since there is no need to access codes in the MSUs. In this configuration, the activation of a FTU switch will initiate the ETR-IRIG command request to the command site where the site will use the standard IRIG tones to create the applicable command message. When the FTUs are in the DISABLE mode and the CSC console is in the OPERATE Mode, only the FTUs can initiate ETR-IRIG commands. When the FTUs are in the DISABLE mode and the CSC console is in the TEST Mode, both the FTUs and the CSC console can initiate ETR-IRIG commands. When the FTUs are in this mode, they are said to be “disabled.”

2.8.4.3.4.3 TEST Mode

The TEST Mode is used in the DRS modes to allow the CSC console to initiate commands using the secure flight codes. When the FTU is in the TEST Mode, it disables an interlock that is used to prevent the CMEV from accessing the flight codes from the MSU OPERATE memory. This allows the DRS Memory Address selector switch to be changed from the TEST memory to the OPERATE memory when manually selected by the CSC. This allows both the FTUs and the CSC console to initiate commands using the secure flight codes. The TEST mode is used to perform closed loop tests with Cape 1A and/or Cape 1B after the flight codes have been loaded into the MSUs to ensure that the CMEVs can access the codes from the MSU.

2.8.4.3.5. Message Storage Unit (MSU)

Each MSU, located in room 162 of the MOC, is a Motorola 6809-based computer installed in a National Security Agency (NSA) approved safe adjacent to the CMEVs. CMEV#1 is connected to MSU #1 and CMEV#2 is connected MSU#2. The MSUs are used only in the DRS mission modes.

Figure 2-8-20: *MSU*

Each MSU contains protected memory for storing two sets of function codes for up to twelve launch pads. The pad configurations were established with the designations of the launch vehicle programs and launch pads, plus a few spare configurations, which were in use at the time that the MSUs were brought online. Table 2-8-6 lists the MSU program/pad designations and the current launch vehicle programs which they support. The designators in the first two columns are displayed on the RASCADs when they are configured for launch support. The CSC controller specifies the applicable launch vehicle codes to be used for an operation via switches in the MSUs.

Table 2-8-5: *MSU Pad Configurations*

LAUNCH PROGRAM	PAD DESIGNATION	CURRENT PROGRAM
DELTA	PAD 17A	Formerly Delta II. No longer used.
	PAD 17B	Formerly Delta II. No longer used.

ATLAS	PAD 36A	Formerly Atlas II/III. No longer used.
	PAD 36B	Formerly Atlas II/III. No longer used.
STS	PAD 39A	Formerly STS. No longer used.
	PAD 39B	Formerly STS. No longer used.
TITAN	PAD 40	Formerly Titan IV. No longer used.
	PAD 41	Formerly Titan IV. Currently used for Atlas V.
SPARE	SPARE 1A	Undefined
	SPARE 1B	Undefined
SPARE	SPARE 2A	Undefined
	SPARE 2B	Currently used for Delta IV.

The MSUs protected memory is divided into two sections: TEST memory and OPERATE memory. At any given time, only one group of five function codes, from either the TEST memory or the OPERATE memory, is accessible by the CMEV. The CSC controller specifies which memory type to use by configuring the CSC console in either the TEST or the OPERATE mode or by using the DRS Memory Address selector switch on the CSC console.

2.8.4.3.5.1. TEST Memory

The TEST memory of the MSU is used to store the maintenance codes for up to twelve pads. The CMEVs access the TEST memory of the MSUs to extract the maintenance codes for use during pre-launch open loop or closed loop non-operational testing to check out equipment and function code combinations prior to the loading of the secure flight codes into the launch vehicle, the MSUs, and the CRDs/Integrated Receiver Decoders (IRDs) at the Cape 1A and Cape 1B command sites. The TEST memory can accommodate as many as four groups of five command functions for each launch pad, however, not more than four of these function codes can be programmed into the FTUs. Typically, each of the applicable launch vehicle programs keeps the same maintenance codes loaded in the TEST memory of the MSU for all missions. The TEST memory can be selected through the DRS Address Memory selector switch on the CSC console and it is the default memory address when the CSC console is in the TEST Mode.

2.8.4.3.5.2 OPERATE Memory

The OPERATE memory of the MSU is used to store the flight codes for up to twelve pads. The CMEVs access the OPERATE memory of the MSUs to extract the secure flight codes for use during a particular launch operation. The OPERATE memory can be used to store up to five launch support command functions for each launch pad, however, not more than four of these function codes can be programmed into the FTUs. All secure flight codes are stored into the OPERATE memory of the MSU with a KYK-13 unit, which has been loaded by the Range User for the vehicle being launched. These flight codes are the same codes loaded into the launch vehicle CRDs and the CRDs/IRDs at the Cape 1A and Cape 1B command sites. Prior to liftoff for DRS missions, the flight codes from the OPERATE memory are used during initial and final Ground Command Closed Loop checks to prove they are identical to the sets of the same codes stored in the CRDs/IRDs located at the Cape 1A and Cape 1B command sites. In addition, the SELF TEST command from the OPERATE memory is sent during the countdown as part of the Final FTS Open Loop

Figure 2-8-24: *RASCAD*

checks. To access the OPERATE memory, the FTUs must be in the ENABLE or TEST mode and the DRS Memory Selector Switch must be in the OPERATE position. For launch operations in the DRS mission mode, the OPERATE memory can be accessed when the FTUs are in the ENABLE mode and the CSC console is in the OPERATE mode (this automatically switches the DRS Memory Selector Switch from TEST to OPERATE. For ground command closed loop tests after a secure code load has been performed, the OPERATE memory can be accessed when the FTUs are in the TEST mode, the CSC console is in the TEST mode, and the CSC manually selects the OPERATE memory from the DRS Memory Address selector switch.

2.8.4.3.6 Range Safety Control and Display (RASCAD)

The RASCAD is Cathode-Ray Tube (CRT) touch screen display that functions as the CSO’s primary interface to control and monitor the configuration of the CDS network. There are two RASCADs (RASCADs #1 and #2) in the RSD area, Room 159, of the MOC. From these displays, the CSO can request command carrier activation at any of the supporting command sites, select either manual or automatic carrier switching mode, monitor calculated command antenna elevation angles at each supporting site, determine which consoles are in control of the command carrier (The RASCADs and/or the CSC consoles), determine which central CMEV is online, monitor command transmitter site health status, and verify that command functions were transmitted by the applicable command site. Both RASCAD touchscreens are simultaneously on-line, communicating with the on-line CMEV via modems through two hardware links. Figure 2-8-28 is an example of the RASCAD display for an Atlas V mission.

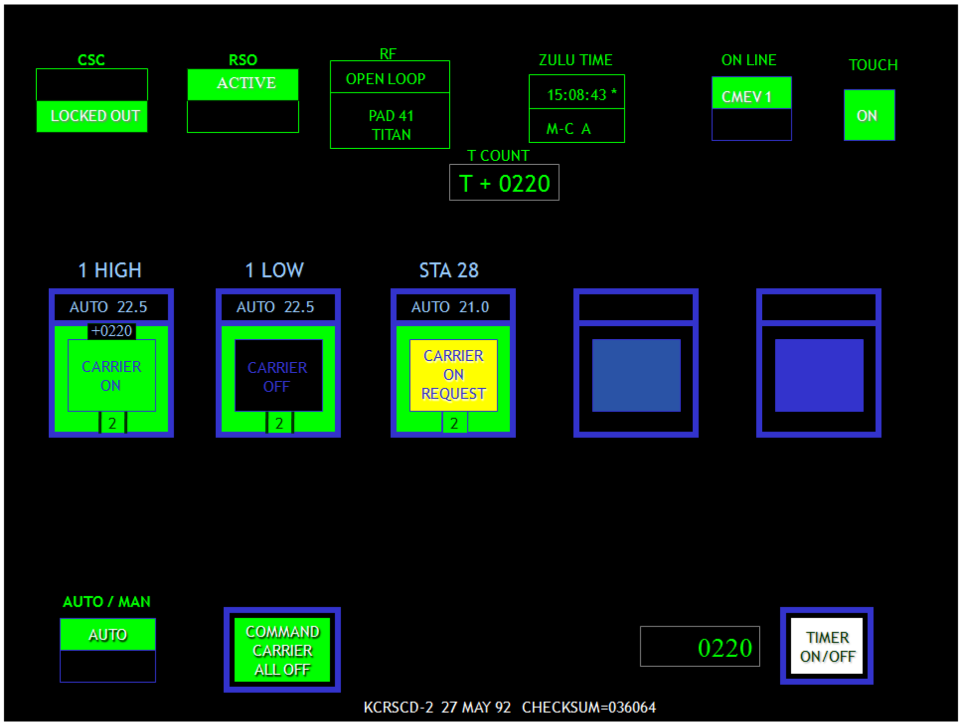

Figure 2-8-21: *RASCAD Display for an Atlas V Mission*

2.8.4.4 Command Communication Links

There are several different communication links which connect the CCRS and the command sites to each other and to equipment from other supersystems. These links are used to provide critical data to the various components of the CDS. These links include:

- Command Remoting Links

- High Density Data (HDD)
- First Motion
- Audio Plus-Count (APC)

2.8.4.4.1 Command Remoting Links
Command remoting links are bi-directional data links between the Central CMEVs of the CCRS in the MOC and the site CMEVs at each of the command system sites that are utilized by the Eastern Range. As a result, these links are also referred to as “CMEV links.” CMEV link status is continuously monitored at CCRS and the command sites. When carrier and function information is not on the line, a constant keep-alive signal is sent to monitor the connectivity of the links.

There are different types of data messages or requests that are passed over these links between the CCRS and the command sites.

2.8.4.4.1.1. CCRS Data
The online Central CMEV receives requests from the CCRS operator control devices (FTUs, RASCADs, and the CSC Consoles) and transmits the requests to the command sites through the command remoting links. These requests include:

- **Carrier On/Off Requests**: The CSO or CSC can initiate requests to bring up or bring down the command carrier from either the RASCADs or the CSC Consoles
- **Pilot Tone/Check Channel Requests**: CSC can send a request to have Cape 1A transmit the Pilot Tone or Check Channel when the command carrier is brought up or upon CSC request
- **Command Function Requests**: The MFCOs or the CSC can initiate requests to send command functions from either the FTUs or from the CSC Consoles
- **Omni/Steerable Antenna Switching**: If configured properly at the Cape 1A or Cape 1B command sites, the CSC Console can initiate a request to switch between omni and steerable antennas

2.8.4.4.1.2. Command Site Data
The command site CMEVs receive data from the various components of the command sites and transmits the data to the CCRS. This data includes:

- **Health and Status Data:** The command sites send health and status data of the various command site components through the remoting links to the CCRS for display on the RASCADs and the CSC Consoles
- **Verification/Confirmation Messages:** The command sites send verification or confirmation messages to the CCRS of requested actions such as Carrier On/Off requests, Pilot Tone/Check Channel requests, command function requests, and omni/steerable antenna switching requests

2.8.4.4.2 High Density Data (HDD)
The Front End Processors (FEPS) of the Range Safety systems (FOV1-A, FOV1-B, and DRSD) provide HDD to the command sites through two redundant and diversely routed HDD links referred to as HDD 1 and HDD 2 or Launch Designate (LDES) 1 and LDES 2. The command sites use this data to point the command steerable antennas at the launch vehicle during flight. If the steerable antennas at a command site are mandatory, then both HDD links to that site are also mandatory to prevent a single point of failure in the pointing of the steerable antennas. In the

event of a loss of HDD data from CCAFS, JDMTA Command can also be pointed by HDD from the local Missile Precision Instrumentation Radar (MIPIR), Radar 28.14, through the Intelligent Data Switch (IDS) on the secondary HDD line (HDD 2).

The FOV1 FEPs (FO-FEPS) of the FOV1-A and FOV-1B Range Safety systems also provide HDD to the Central CMEVs. The Central CMEVs utilize the HDD to determine the antenna elevation angles at each of the command sites for use in the Auto Carrier algorithm. The Central CMEV also displays these HDD-derived elevation angles at the RASCADs and the CSC Consoles.

2.8.4.4.3 First Motion

The command sites utilize First Motion to start their stored nominal theoretical trajectory data for use in pointing the steerable antennas in the event of a loss of HDD data. A First Motion bit is imbedded into the HDD for all command sites. Central Timing also supplies a “hard line” First Motion signal to the Cape 1A and JDMTA Command sites as a back up to the imbedded First Motion bit in the HDD data.

2.8.4.4.4 Audio Plus-Count (APC)

Central Timing transmits an audio plus-count (APC) on the Range Countdown Net (RCD.1) to the instrumentation sites. In the event of a loss of HDD or stored nominals, command site personnel can listen to the APC while referencing printed antenna look angles and manually steer the command antennas without having to reference a clock display.

2.8.4.5 Command Sites

As mentioned previously, EWR 127-1 and AFSPCMAN 91-711 require that a dual command site and two command data links be available from launch through the period of Range Safety responsibility. To fulfill this requirement, the ER maintains three Command Destruct System sites on the Florida mainland to provide command destruct capability for northern and southern flight trajectories. Currently the ER maintains CDS sites at Station 1 (CCAFS; Cape 1A, Cape 1B) and Station 28 (JDMTA Command). Additional command destruct sites were previously located at Antigua Air Station on the island of Antigua in the West Indies; Wallops Island, Virginia; and Argentia, Newfoundland. These sites have now been deactivated.

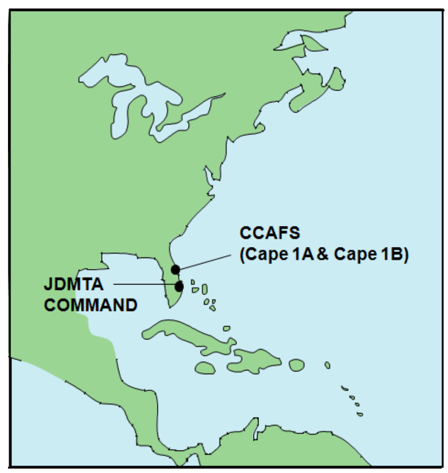

Figure 2-8-26: *ER Command Sites*

2.8.4.5.1 Command Site Operating Modes

The command sites have two operating modes: Local Mode and Remote Mode.

2.8.4.5.1.1 Local Mode

In local mode, the command site personnel retain control of the command carrier and functions. This mode is only used for local checkout of the site and is not used for launch operations unless command site personnel need to perform troubleshooting or need to re-load/switch the stored nominals, such as for missions with multiple azimuths. Note that in order for a command site to switch from remote mode to local mode, it cannot be transmitting the carrier. If a command site that is transmitting the carrier must be switched back into local mode, the carrier must be either removed or transferred to another command site.

2.8.4.5.1.2. Remote Mode

After all pre-launch checks have been completed, the command site is placed in remote mode to lock out control by the command site personnel. This enables remote control of the carrier and command functions from the CCRS. Once in remote mode, command site personnel are prohibited from returning to the local mode by means of strict operational discipline. The system remains in this configuration until released from the mission or released to perform troubleshooting or to re-load/switch the stored nominals.

2.8.4.5.2. Command Site Subsystems

While no two command sites are identical, each site is comprised of four primary subsystems:

- Digital/Command Processing Subsystem
- Radio Frequency (RF)/Transmission Uplink Subsystem
- Antenna Subsystem
- Recording Subsystem (For more information on the Recording Subsystem, reference Annex A Section A.2.8.7).

Most equipment is redundant to ensure the highest possible system integrity. System redundancy is obtained with two separate, but identical, hardware strings.

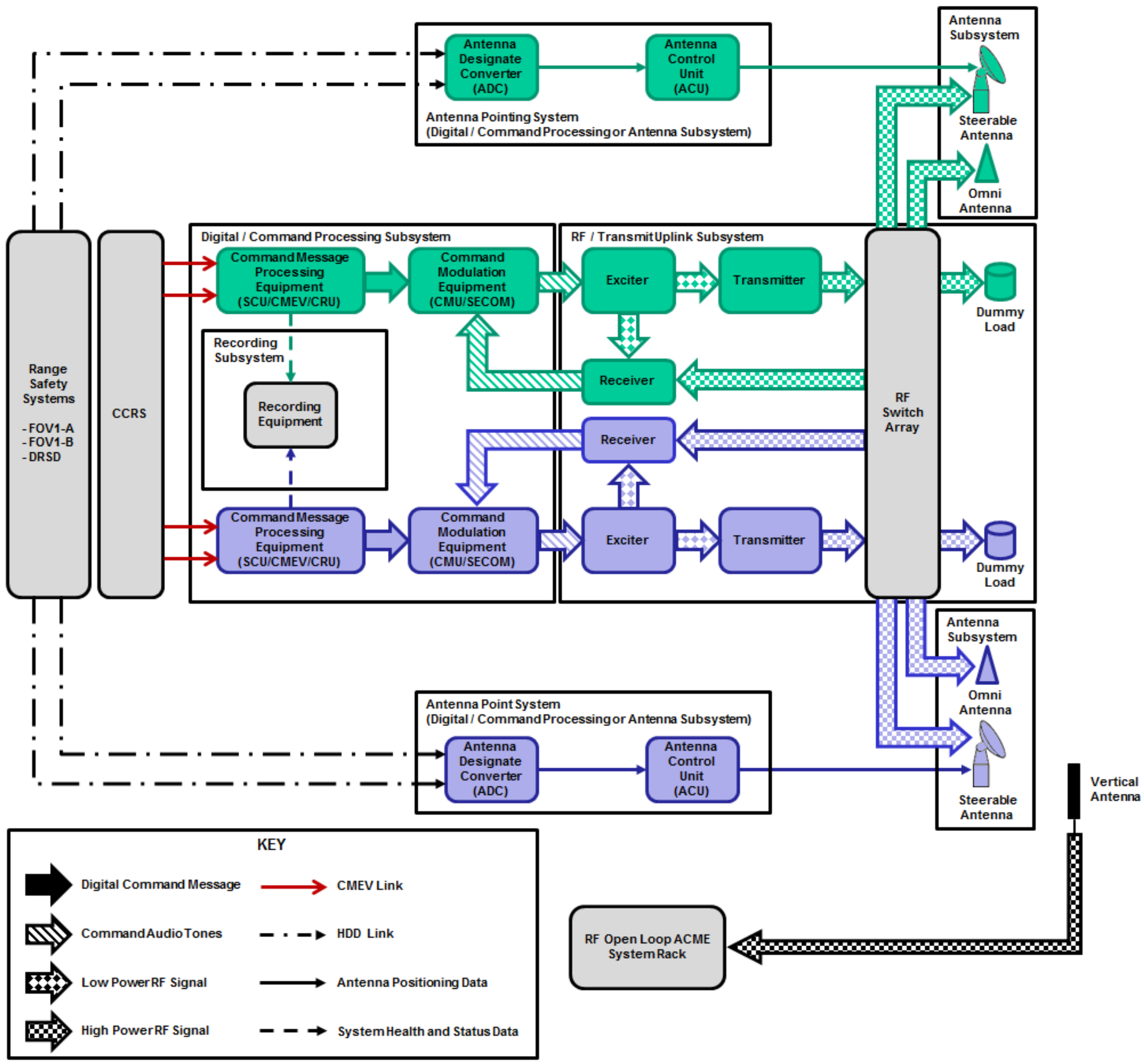

Figure 2-8-22: *Common Command Site Systems*

2.8.4.5.2.1 Digital/Command Processing Subsystem

The Digital or Command Processing subsystem typical consists of redundant command message processing equipment and command modulation equipment. The command message processing equipment are in the form of two System Control Units (SCUs), two Command Message Encoder/Verifiers (CMEVs), or two Command Remoting Units (CRUs) and are generally referred to as the site CMEVs. The command modulation equipment are in the form of two Command Modulation Units (CMUs) or two Secure Command Units (SECOMs). The functions of the Digital/Command Processing subsystem are to:

- **Monitor System Health and Status:** The subsystem receives health and status information from the various command site subsystems. Upon detection of a system fault or error in the primary command string, the subsystem will initiate a failover to the back-up command string.
- **Interface with the CCRS:** The subsystem accepts requests for carrier control, command control, and system control from the CCRS at the MOC. Typical requests include carrier on and off requests, Pilot Tone/Check Channel requests, and command function requests. The subsystem is also responsible for reporting system health and status to the CCRS for display to the CSC, MFCO, and or CSO. Such reports include

confirmation of carrier activation/de-activation, confirmation of the transmission of command functions, and notification of component failures.

- **Process Command Messages**: The subsystem receives the digital command function request and converts it into analog audio tones which are used to modulate the command carrier. The subsystem also analyzes a sample of the de-modulated command signal provided by the RF/Transmit Uplink subsystem and detects timing, amplitude, and frequency errors.
- **Process Secure/Flight Codes:** In the DRS modes of operation, the secure flight codes for the mission are loaded and stored at CCRS. When a command function is received, the subsystem pairs up and sequences the audio tones that make up the applicable command function.

At Cape 1A and JDMTA Command, the Digital subsystem also includes the Antenna Pointing System for the site's steerable antennas. The Antenna Pointing System provides antenna health and status information, processes antenna pointing information, and allows for manual control of the steerable antennas.

2.8.4.5.2.2 RF/Transmission Uplink Subsystem

The RF or Transmission Uplink subsystem typically consists of two exciters, two receivers, two transmitters, an RF Switch assembly, and two dummy loads. The functions of the RF/Transmission Uplink subsystem are to:

- **Generate the Command Carrier:** The exciters are used to generate the command carrier at the command frequency of 421.0 MHz and then amplify the command carrier to a suitable power level to drive or excite the transmitters. The transmitters then amplify the command carrier signal to the operational power level. Prior to activation of the carrier at the site, the command carrier signal is routed from the transmitter, through the RF Switch Array, to a dummy load which absorbs the command carrier's RF energy and dissipates it by converting it into heat. The dummy load simulates an electrical load on the transmitter, allowing the transmitter to be accurately tested and adjusted without radiating into the open air and interfering with RF receivers in the area. When the command carrier is requested to be transmitted from the site, the command carrier signal is routed from the transmitters, through the RF Switch Array, to the Antennas subsystem for transmission to the launch vehicle.
- **Modulate the Command Carrier:** The exciters use the audio tones received from the Digital/Command Processing subsystem to modulate the command carrier and create the command message.
- **Amplify the Modulated Command Message**: The exciters amplify the modulated command message to a suitable power level to drive or excite the transmitters. The transmitters amplify the modulated command message to the operational power level and send it through the RF Switch Array to the Antenna subsystem for transmission to an in-flight vehicle.
- **Demodulate a Sample of the Modulated Command Signal for Message Validation:** The receivers demodulate a sample of the modulated command signal provided by either the RF Switch Array in Open Loop mode or from the exciter in Closed Loop mode and provide the demodulated audio component to the Digital/Command Processing subsystem for message validation and error detection.

2.8.4.5.2.3 Antenna Subsystem

The Antenna subsystem consists of the antennas which are used to radiate the FM command signal from the transmitters to an in-flight vehicle. At Cape 1B, the Antenna subsystem also includes the Antenna Pointing System for the site's steerable antennas. The Antenna Pointing System provides antenna health and status information, processes antenna pointing information, and allows for manual control of the steerable antennas. There are three types of antennas used at the ER command sites: 1) steerable antennas, 2) omni antennas, and 3) broadbeam antennas. All ER antennas use left-hand circular polarization to mitigate signal degradation due to surface reflectivity, atmospheric absorption, signal phasing, multi-path and line of sight issues.

2.8.4.5.2.3.1. Steerable Antennas

Each CDS site has at least two narrow beam steerable antennas. These antennas can provide long range coverage and help minimize multi-path problems at the launch pad due to their high gain. The antennas have to be pointed at the in-flight vehicle. Each steerable antenna is interfaced to an ADC via an associated ACU, which also has remote controls to enable manual steering and control by the command site operators. The steerable antennas are driven to the vehicle's position by the HDD data from the FOV1-A, FOV1-B, or DRSD system. If HDD data from the RSD systems is unavailable, the following are the alternate antenna pointing methods in order of preference:

- **1) Local Track:** A local radar can be used to feed pointing data directly to the command transmitting station at that site. This method can be used for JDMTA Command if Radar 28.14 is tracking the vehicle by routing Radar 28.14 data through the site's Intelligent Data Switch (IDS). Note: this is a requirement not currently utilized or supported by day-of-launch configuration.
- **2) Prediction Track:** A prediction algorithm using the last known state vector information can be used to predict the trajectory of the launch vehicle and point the command transmitting station antennas toward the predicted position. Currently, only Cape 1B has this capability.
- **3) Stored Nominal (Nominal flight only):** If flight was on the nominal trajectory prior to loss of data, the stored nominal trajectory can be used to point the command transmitting station antennas.
- **4) Manual Steering (Nominal flight only):** The operator at the command transmitting station can manually point the antennas by referencing the printed look angles and the audio plus count.

2.8.4.5.2.3.2. Omni Antennas

Omni-directional antennas are fixed with no steering capabilities and do not require designate data. These antennas are advantageous for destruct scenarios early in flight because they radiate the command signal in all directions and increase the chance that the launch vehicle will receive destruct functions even if its flight is erratic. Although the omni antennas can broadcast the command functions over a greater area than the steerable antennas, the signals are effective over a shorter range. Cape 1A and Cape 1B have omni antennas.

2.8.4.5.2.3.3. Broadbeam Antennas

The JDMTA Command site has two broadbeam antennas that are used for Trident II missions. Similar to the omni antennas at Cape 1A and 1B, the broadbeam antennas radiate the command functions over a larger area than the steerable antennas to increase the chances that a missile experiencing erratic flight shortly after broach will receive the DESTRUCT commands.

Although the broadbeam antennas can broadcast the command functions over a greater beamwidth than the steerable antennas, the signals are effective over a shorter range.

2.8.4.5.3. Automated Command Message Evaluation (ACME) System

The ACME system is a redundant, standalone test system that provides an independent verification of the quality of transmitted command messages. The systems are used to establish compliance with the performance requirements of the CCDSRSR, prior to the site being committed for launch support. In accordance with Range Safety criteria, the ACME system is not connected to the equipment it is analyzing. During the range countdown, the ACME system captures the command messages that are transmitted from the command site during the Initial and Final Ground Command Open Loop Checks using redundant, omni-directional, vertically mounted antennas outside each of the designated command systems. The ACME system then demodulates, archives, and analyzes the command messages to determine time and frequency-domain message characteristics, such as message duration, inter-message time, character amplitude, tone frequency, character rise/fall time, and inter-character spacing. Message rise/fall time is based on measurements at 10% and 90% points. Message character on/off timing is based on 50% measurement points. It then evaluates them against performance specifications in the CCDSRSR and flags out-of-tolerance conditions to the operator. The ACME system can analyze functions in the DRS and the IRIG-ETR mission modes. For more information on the ACME subsystems, reference the Eastern Range Instrumentation Handbook (ERIH).

Figure 2-8-28: *Cape ACME Displays*

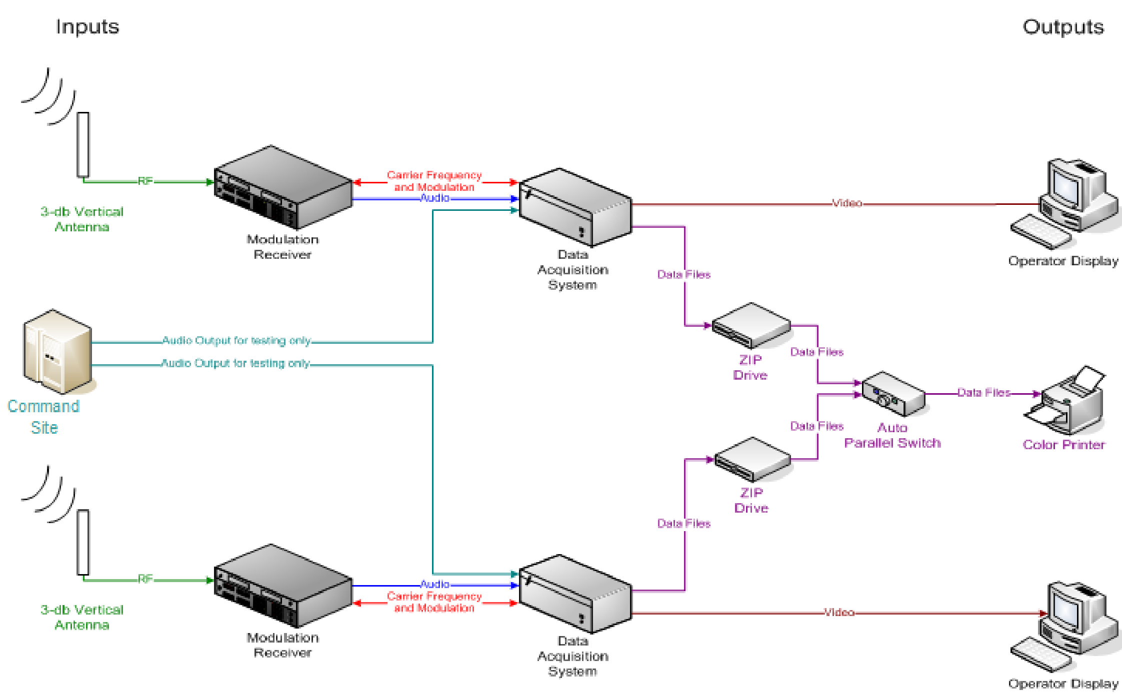

Figure 2-8-23*: ACME Data Flow*

2.8.4.5.4 Cape 1A Command Site

The Cape 1A command site, also referred to as Station 1A or Bronze 1A, is one of two completely independent command systems at CCAFS. It is located in the Command Control Building, Building 81560, adjacent to the Cape 1B command site, just north of the MOC.

Figure 2-8-24: Cape 1A and Cape 1B Command Sites

2.8.4.5.4.1 Cape 1A Subsystems/ Equipment

Cape 1A system redundancy is obtained with two separate, but identical, hardware strings. Each string is comprised of a System Control Unit (SCU), a Command Modulation Unit (CMU), an Exciter/Receiver Unit (ERU), a 10kW Klystron Transmitter, an Antenna Designate Converter (ADC), a steerable antenna, a steerable Antenna Control Unit (ACU), and an omnidirectional antenna. Additional redundancy is provided at key points in each string via automatic failover when anomalous conditions are detected. Manual override of hardware switching is also available. The Cape 1A system consists of four subsystems: the Digital subsystem, the RF subsystem, the Antenna subsystem, and the RF subsystem. For more information on the Cape 1A subsystems, reference the ERIH.

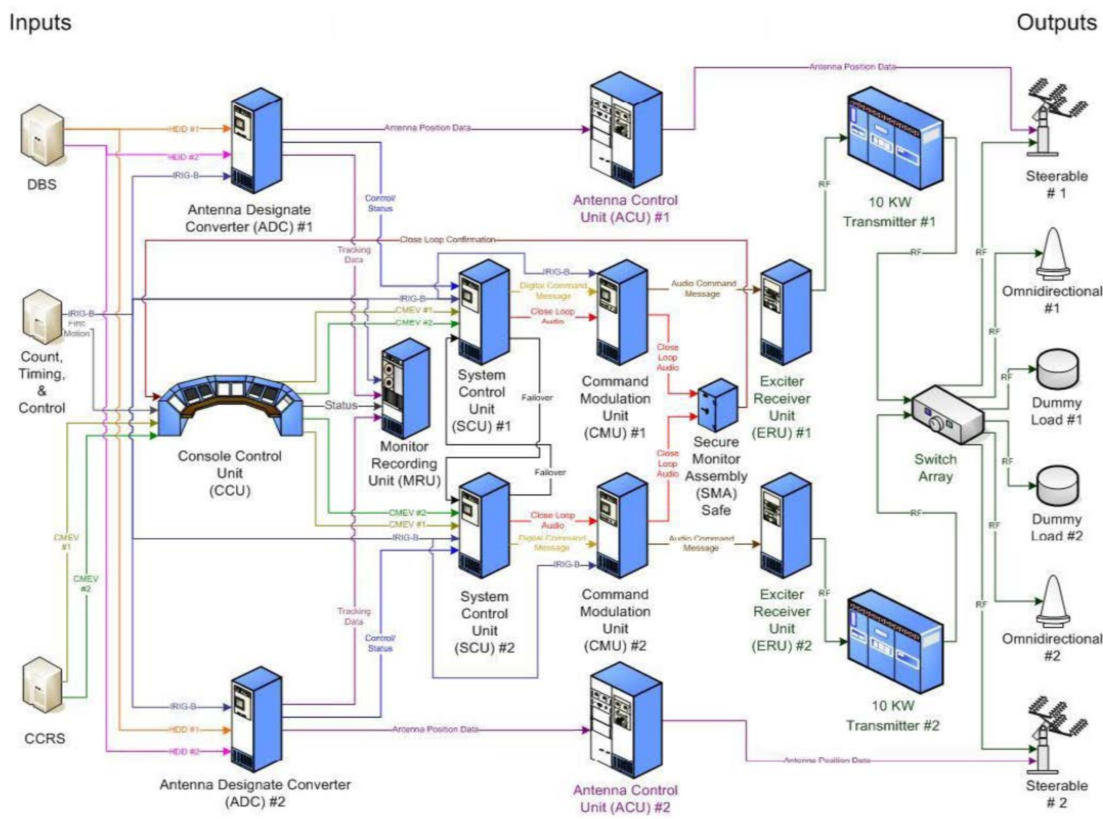

Figure 2-8-25: *Cape 1A Data Flow*

2.8.4.5.4.2 Mission Capabilities

Cape 1A supports all DRS and ETR-IRIG Command modes. It is the only command site that has Pilot Tone and Check Channel capability. Cape 1A is the primary command site for all pad launches and also supports all Trident II missions. It is used for pre-launch day and launch-day checkouts of the launch vehicle FTS.

2.8.4.5.4.2.1 Antennas

During operations, the Cape 1A steerable antennas are positioned at 9 degrees in elevation above the applicable launch pad and are not engaged to drive off of incoming HDD until the vehicle's track takes it above 9 degrees in elevation from Cape 1A. This is done to minimize multi-path at the pad and is based on the Antenna #A2 beamwidth of approximately 18 degrees which will allow coverage down to 0 degrees in elevation.

2.8.4.5.4.2.2 Command Receiver Decoders (CRDs)

At Cape 1A, two CRDs are used during pre-launch checkouts to simulate the roles of Atlas and Delta vehicle secure CRDs. The CRDs are used only for pre-launch checks and are not operational during the launch phase of a mission. The function of these CRDs is to facilitate an "end to end" closed loop internal system checkout between the CCRS and the Cape 1A system while configured in the DRS Unmanned Secure operational mode. Since an open-loop check of the classified flight codes is not possible without compromising the codes, a closed-loop check is necessary. During a closed-loop checkout, a command function request is initiated at the FTUs and sent to the CCRS CMEVs. The CCRS CMEV extracts the current mission's classified function codes from the MSU. The CCRS CMEV then generates a secure function request message and sends it to the SCU which relays the request to the CMU. The command message is processed directly from the CMU to the ERU and then to the CRD, and the transmitters are bypassed. If the CRD determines that the function codes in the message agree with those that have been pre-stored into the CRD, then a confirmation message is sent to the SCU, which in turn sends a confirmation message to the CCRS. Each CRD is housed in a National Security Agency (NSA)-approved Secure Monitor Assembly (SMA) safe. Associated with each CRD is a CRD Monitor Drawer. This unit serves to amplify the audio signal to the operative CRD, provide a visual indication of CRD command message confirmations, and transmit CRD status and command message confirmations to the SCU for processing.

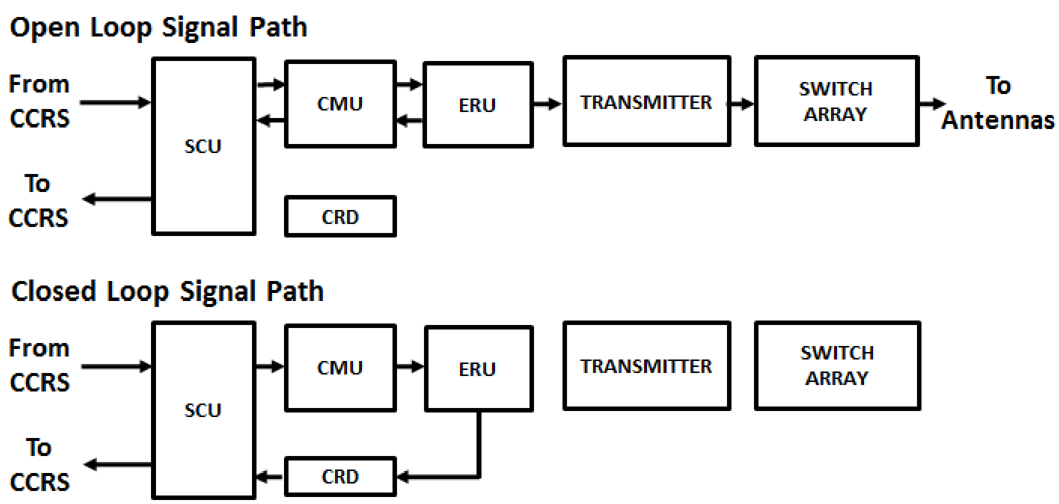

Figure 2-8-26: *Cape 1A Open and Closed Loop Signal Paths*

2.8.4.5.4.3 Site Capabilities in Remote Mode

Once Cape 1A has been remoted to CCRS, local control by the command operators is limited to switching strings and antennas. This allows the operators to switch strings and antennas in support of Open Loop Pad tests, to switch from the omni antennas to the steerable antennas during nominal flight, and to switch strings if directed by the MFCO due to a command contingency during non-nominal flight. In addition Command operators can manually control the steerable antennas in the event that HDD from the MOC is lost or degraded and the stored nominal theoretical has also failed.

2.8.4.5.4.4 Site Failover and Cross-Switch Capability

String 1 is the primary command string at Cape 1A. The carrier can be brought up on either string. It is typically brought up on String 1 unless the site was previously configured to be on String 2. Any failure of a component in String 1 will trigger an automatic transfer to String 2 to include the antennas, resulting in a complete string transfer. The system can be configured from the CCU to allow antenna cross-switching, allowing String 1 to cross connect to the String 2 antennas and vice versa; however, this capability is not enabled during launch operations. Note that if the steerable antennas are selected to transmit the carrier and both steerable antennas fail, the system will not transfer to the omni antennas. Both strings at Cape 1A must be configured for either omni or steerable antennas. One string cannot be configured on the omni antenna while the other is configured on the steerable antennas.

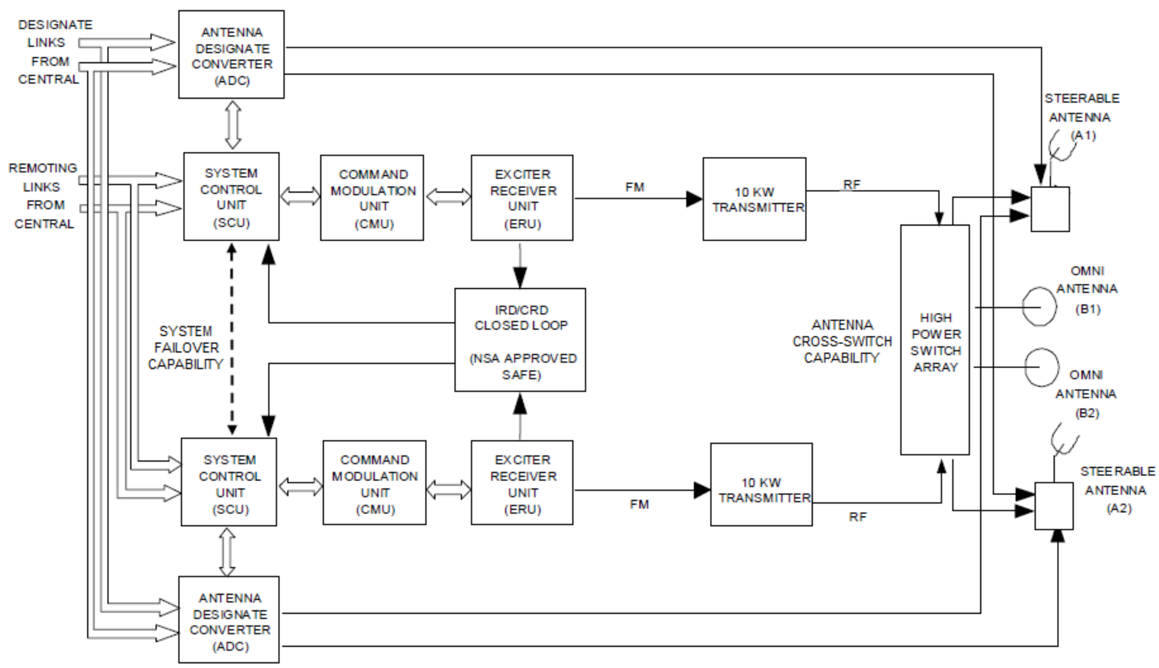

Figure 2-8-27*: Cape 1 A Failover/Cross-switch Capability*

2.8.4.5.4.5 Multi-Target Antenna Management

The ADCs at Cape 1A have a multi-target mode which is used for Trident II missions. In this mode, the SCU specifies the selection of the applicable antenna(s) and targets(s) based on:

- Missile broach status
- DESTRUCT requests

2.8.4.5.4.5.1 Missile Broach Status

In multi-target mode, both steerable antennas are designated to the same target at all times. When no DESTRUCT commands are requested, the missile broaches are used for antenna selection. With no missiles broached, both steerable antennas default to the designate data for

Missile W. With one missile broached, both steerable antennas will select the broached missile. With two missiles broached, both antennas track the most recently broached missile.

2.8.4.5.4.5.2 DESTRUCT Requests

When DESTRUCT commands are requested, antenna management varies depending on whether DESTRUCT was requested for a single missile or two missiles.

2.8.4.5.4.5.2.1 Single Missile DESTRUCT

When DESTRUCT is requested for at least one missile, the missile broaches are ignored. When DESTRUCT is requested for a single missile, both steerable antennas will be designated to the DESTRUCT requested missile until the DESTRUCT request message is either taken away or another DESTRUCT request message becomes active.

2.8.4.5.4.5.2.2 Multi-Missile DESTRUCT

When DESTRUCT is requested for two missiles, the ADC services the active DESTRUCT messages in the reverse order of broach (i.e., the one with the last broach time is first). If a new DESTRUCT request message is received, the ADC services it immediately and then returns to servicing the active DESTRUCT request messages in the above-mentioned sequential order. To ensure that a target with an active DESTRUCT message is properly serviced, the ADC dwells the antenna on the target with an active DESTRUCT message long enough to for that missile to receive two DESTRUCT messages before moving on to the next target that has an active DESTRUCT.

2.8.4.5.5 Cape 1B Command Site

The Cape 1B command site, also referred to as Station 1B or Bronze 1B, is one of two completely independent command systems at CCAFS. It is located in the Command Control Building, Building 81550, adjacent to the Cape 1A command site, just north of the MOC.

2.8.4.5.5.1 Cape 1B Subsystems/Equipment

Cape 1B system redundancy is obtained with two separate, but identical, hardware strings. Each string is comprised of a site Command Message Encoder/Verifier (CMEV), a Secure Command Unit (SECOM), a Transmitter Status and Control Unit (TSC), System Controller circuits, an Exciter unit, a Receiver unit, Drive Control circuits, a 10 kW Solid State Transmitter, an Antenna Designate Computer (ADC), a Designate Asset Controller (DAC), a steerable antenna, a steerable Antenna Control Unit (ACU), an Antenna Servo Control Unit (SCU), and an omnidirectional antenna. Additional redundancy is provided at key points in each string via automatic failover when anomalous conditions are detected. Manual override of hardware switching is also available. The Cape 1B system consists of three subsystems: the Command Processing subsystem, the Transmit Uplink subsystem, the Antenna subsystem, and the Recording subsystem. For more information on the Cape 1B subsystems, reference the ERIH.

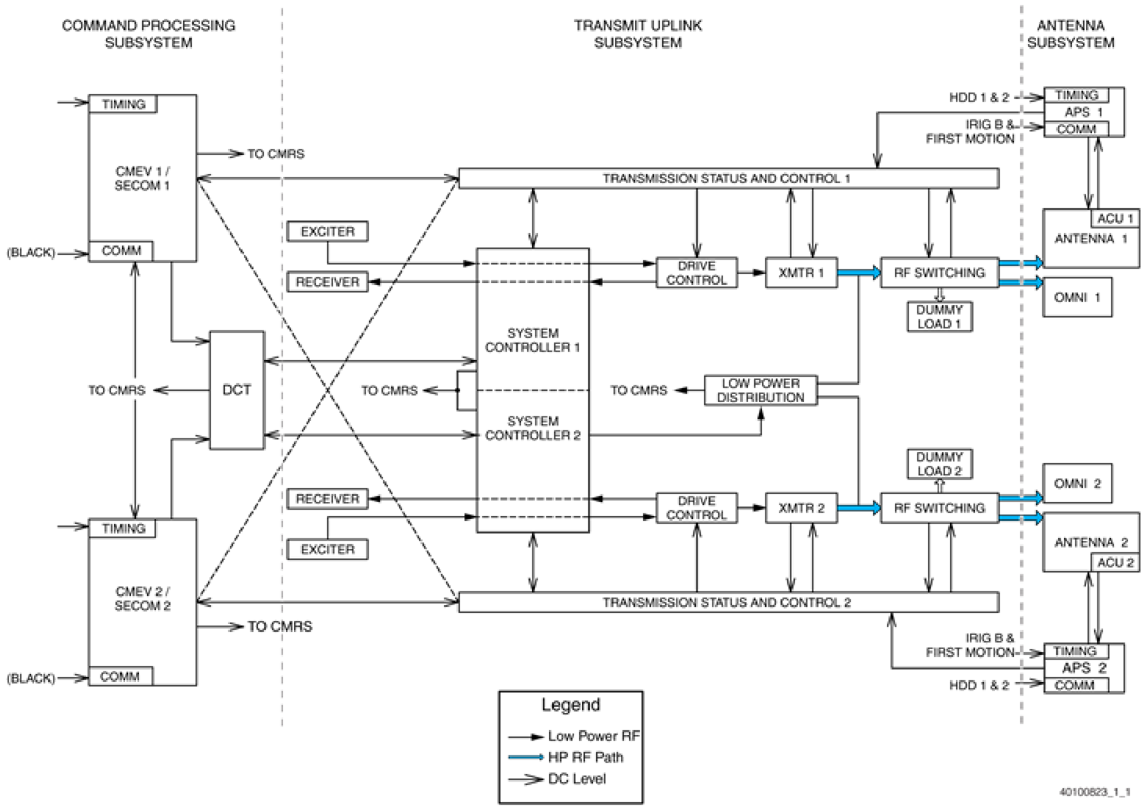

Figure 2-8-28: *Cape 1B Data Flow*

2.8.4.5.5.2 Mission Capabilities

Cape 1B supports all DRS Command modes. Cape 1B does not have Pilot Tone or Check Channel capability. Cape 1B is currently used for Delta IV and Atlas V launches and is used for pre-launch day and launch-day checkouts of the launch vehicle FTS.

2.8.4.5.5.2.1 Antennas

During operations, the Cape 1B steerable antennas are positioned at 5 degrees in elevation above the applicable launch pad and are not engaged to drive off of incoming HDD until the vehicle’s track takes it above 5 degrees in elevation from Cape 1B. This is done to minimize multi-path at the pad and is based on the 10 degree beamwidth of the steerable antennas which will allow coverage down to 0 degrees in elevation. The Rozendal omni antenna has a higher gain than the Melpar omni antenna. Depending on the vehicle trajectory, the Rozendal antenna typically provides more command coverage than the Melpar antenna.

2.8.4.5.5.2.2 Command Receiver Decoders (CRDs)

At Cape 1B, two CRDs are used during pre-launch checkouts to simulate the roles of Atlas and Delta vehicle secure CRDs. The CRDs are used only for pre-launch checks and are not operational during the launch phase of a mission. The function of these CRDs is to facilitate an “end to end” closed loop internal system checkout between the CCRS and the Cape 1B system while configured in the DRS Unmanned Secure operational mode. Since an open-loop check of the classified flight codes is not possible without compromising the codes, a closed-loop check is necessary. During a closed-loop checkout, a command function request is initiated at the FTUs and sent to the CCRS CMEVs. The CCRS CMEV extracts the current mission's classified function codes from the MSU. The CCRS CMEV then generates a secure function request message and sends it to the Cape 1B CMEV which relays the request to the SECOM. The command message is processed directly from the SECOM to the CRD for decoding, and the transmitters are bypassed. If the CRD determines that the function codes in the message agree with those that have been pre-stored into the CRD, then a confirmation message is sent to the Cape 1B CMEV, which in turn sends a confirmation message to the CCRS. Each CRD is housed in a National Security Agency (NSA)-approved Secure Monitor Assembly (SMA) safe. Associated with each CRD is a CRD Monitor Drawer. This unit serves to amplify the audio signal to the operative CRD, provide a visual indication of CRD command message confirmations, and transmit CRD status and command message confirmations to the Cape 1B CMEV for processing.

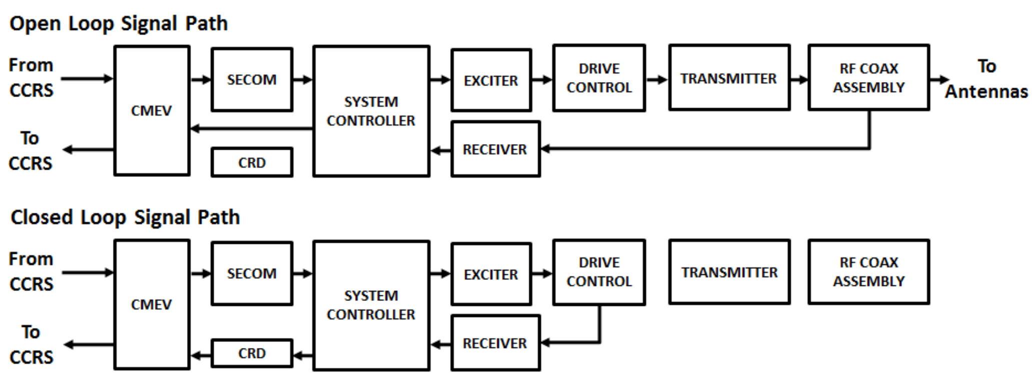

Figure 2-8-29: *Cape 1B Open and Closed Loop Signal Paths*

2.8.4.5.5.3 Site Capabilities in Remote Mode

Once Cape 1B has been remoted to CCRS, local control by the command operators is limited to switching strings and antennas. This allows the operators to switch strings and antennas in support of Open Loop Pad tests, to switch from the omni antennas to the steerable antennas during nominal flight, and to switch strings if directed by the MFCO due to a command contingency during non-nominal flight. In addition Command operators can manually control the steerable antennas in the event that HDD from the MOC is lost or degraded and the stored nominal theoretical has also failed.

2.8.4.5.5.4 Site Failover and Cross-Switch Capability

String 1 is the primary command string at Cape 1B. When the carrier is brought up at Cape 1B, the site will default to String 1. To transfer the carrier to String 2, the site has to be induce a failure in String 1, which will cause the system to failover to String 2. When the carrier is up on String 2, it will be displayed as a string failure on the RASCADs. Any failure in String 1 will result in an automatic switch to String 2. When String 1 is reinitialized after a failover to String 2, the system will default back to the omni antennas. If the steerable antennas are to be utilized, the site will have to be directed to switch to the steerable antennas. Note that both the omni and steerable antennas are dedicated to their associated strings and cannot be cross connected to the other command string. Both strings at Cape 1B must be configured for either omni or steerable antennas. One string cannot be configured on the omni antenna while the other is configured on the steerable antennas.

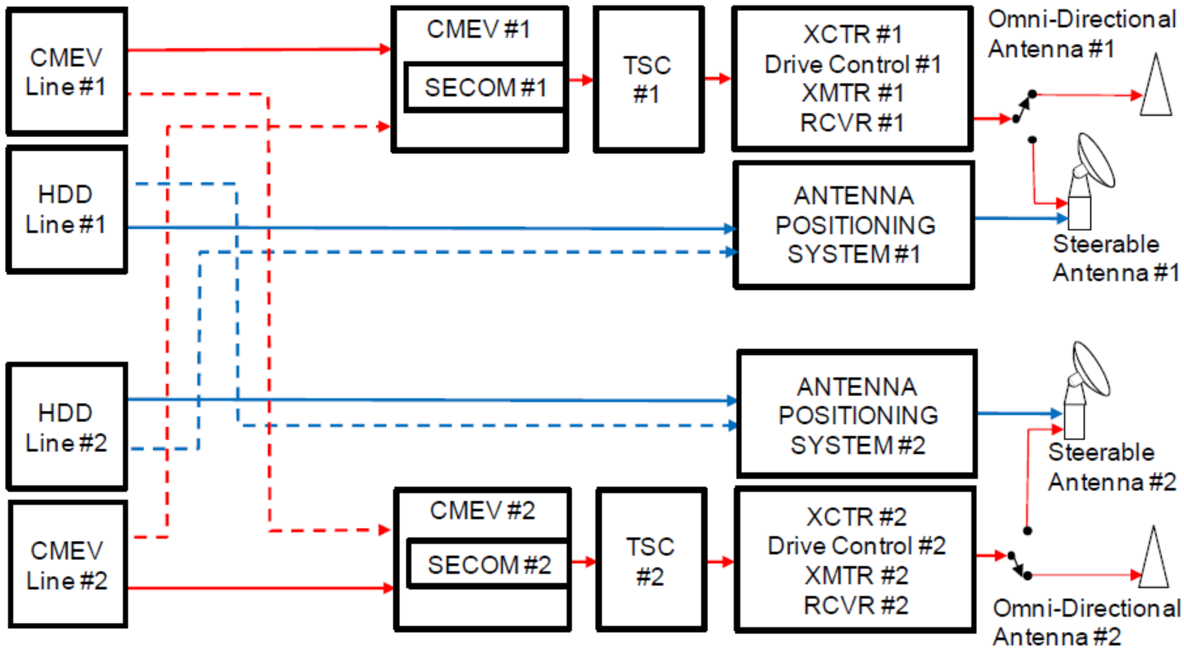

Figure 2-8-30: *Cape 1B Simplified Block Diagram*

2.8.4.5.6. Jonathan Dickinson Missile Tracking Annex (JDMTA) Command Site

The JDMTA Command Site, also referred to as Station 28 or Bronze 28, is a completely independent command site at Jupiter Florida. It is located in the Consolidate Instrumentation Facility (CIF), Building 28001, at the center of the JDMTA complex.

Figure 2-8-31: *JDMTA Command Site*

2.8.4.5.6.1 JDMTA Subsystems/ Equipment

JDMTA system redundancy is obtained with two separate, but identical, hardware strings. Each string is comprised of a Command Remoting Unit (CRU), a Transmitter Control Unit (TCU), a Command Modulation Unit (CMU), an Exciter/Receiver Unit (ERU), a 10 kW Transmitter, an Antenna Designate Converter (ADC), a broadbeam antenna, a broadbeam Antenna Control Unit (ACU), a steerable antenna, and a steerable ACU. Additional redundancy is provided at key points in each string via automatic failover when anomalous conditions are detected. Manual override of hardware switching is also available. The JDMTA Command system consists of four subsystems: the Digital subsystem, the RF subsystem, the Antenna subsystem, and the RF subsystem. For more information on the JDMTA Command subsystems, reference the ERIH.

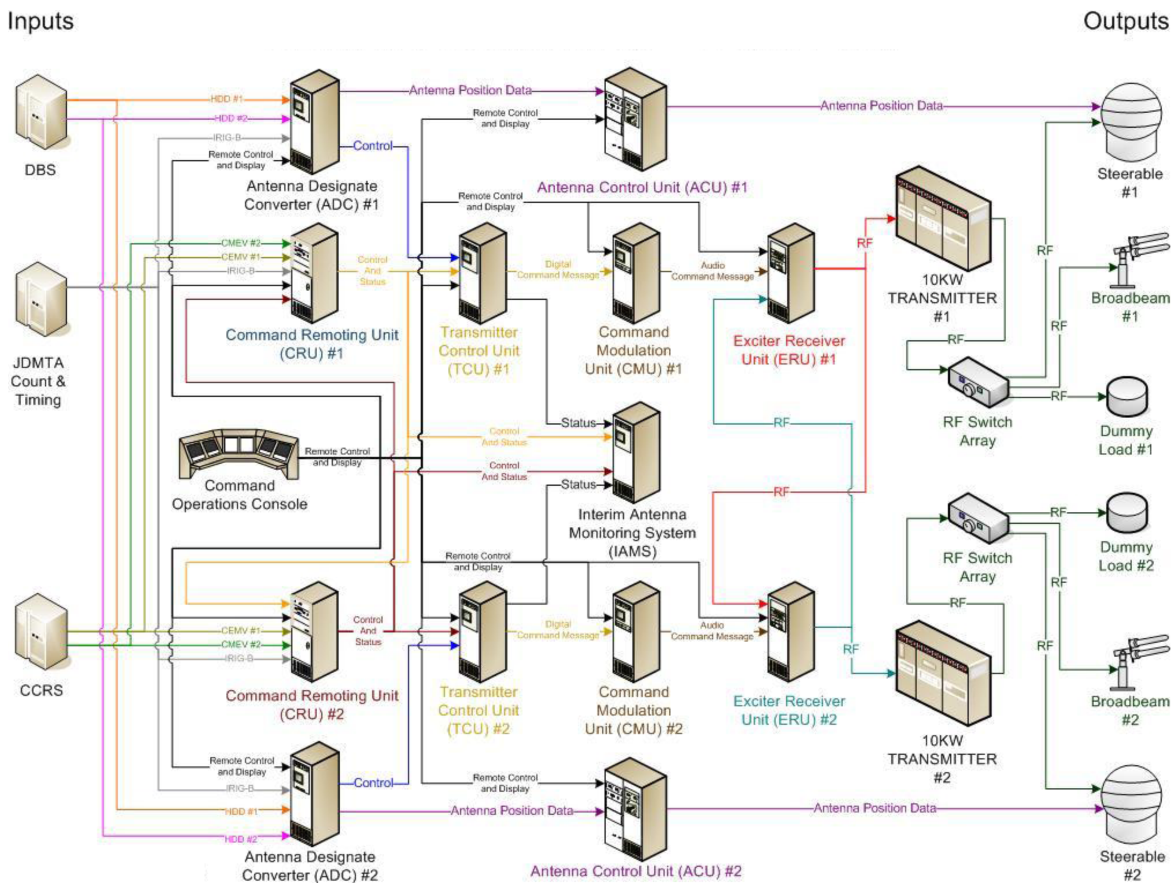

Figure 2-8-32: *JDMTA Command Data Flow*

2.8.4.5.6.2 Mission Capabilities

JDMTA Command supports all DRS and ETR-IRIG Command modes. JDMTA Command does not have Pilot Tone or Check Channel capability and does not support vehicle pad tests. JDMTA Command is used for all pad launches, augmenting Cape 1A and Cape 1B by providing off-axis command coverage. JDMTA Command is also used for all Trident II launches. During operations, the JDMTA steerable antennas are positioned at 0 degrees in elevation and are engaged to drive off of incoming HDD when the vehicle track breaks the horizon from JDMTA. For DASO missions, either steerable antennas or broadbeam antennas can be used; however due to a limitation in the ADC software, both types of antennas cannot be configured to support. The steerable antennas are prime for DASO missions. The broadbeam antennas are available for use as a back-up in the event of a steerable antenna failure; however, this requires that the ADC be configured to ADC Mode 2 and the steerable antennas to be locked out/disabled. For FCET missions, both the broadbeam and steerable antennas are configured for use. For these missions, JDMTA Command is typically used as the primary command site due to the capabilities of the broadbeam antennas.

2.8.4.5.6.3 Site Capabilities in Remote Mode

Once JDMTA has been remoted to the CCRS, local control by the command operators is limited. Command operators can still switch strings while the site is remoted. This allows the operators to switch strings to perform contingency transmitter switching actions if required by the MFCO during non-nominal flight. In addition Command operators can manually control the steerable antennas in the event that HDD from the Range Safety Systems is lost or degraded and the stored nominal theoretical has also failed.

2.8.4.5.6.4 Site Failover and Cross-Switch Capability

String 1 is the primary command string at JDMTA Command. The carrier can be brought up initially on either string but is typically brought up on String 1. Any failure in String 1 will result in an automatic switch to String 2. The exception to this is the CRU. A failure in a CRU will result in the CRU switching, not the entire string. Cross-switching from one string’s transmitter to the other string’s antenna (Transmitter #1 with Broadbeam #2 or Steerable #2) is not an automatic function and can only be done manually with the Switch Array.

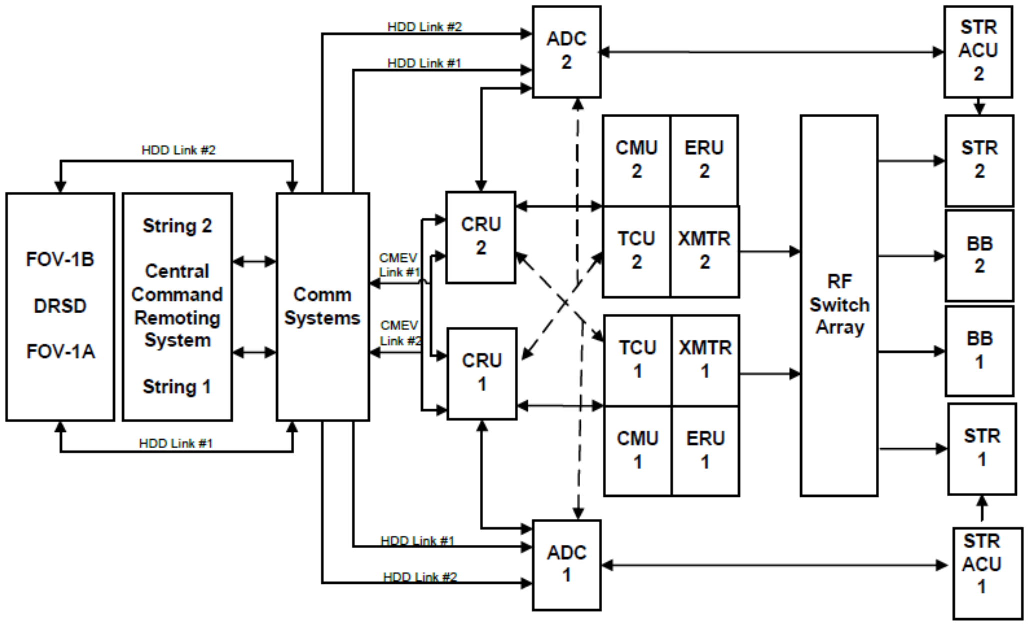

Figure 2-8-33: *JDMTA Failover/Cross-switch Capability*

2.8.4.5.6.5 Multi-Target Antenna Management

The ADCs at JDMTA Command have two multi-target mode, ADC Mode 2 using broadbeam and steerable antennas and ADC Mode 3 using steerable antennas only, which are used for Trident II missions. In these modes, antenna and missile selection is based on:

- Missile broach status
- Missile azimuth, elevation, and range
- DESTRUCT requests
- Thumbwheel mode selection
- The Broadbeam Lockout Switch
- Antenna position feedback
- The ADC Touchscreen configuration

2.8.4.5.6.5.1 Broadbeam Antennas

In ADC Mode 2, the carrier is brought up on broadbeam antennas. The broadbeam antennas will remain online unless one of the following occurs:

- The DESTRUCT selected missile angles are outside of the broadbeam limits (reference Figure 2-8-40) ***or***
- The DESTRUCT selected missile range is beyond 956 nm ***or***
- The steerable antennas are manually selected from the ADC Touchscreen

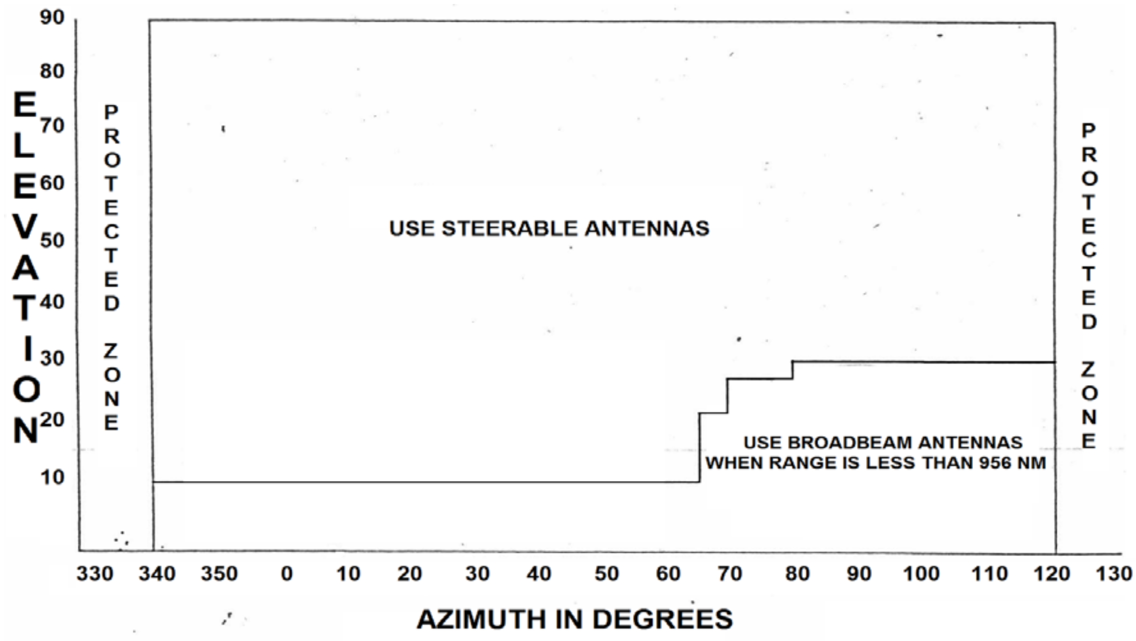

Figure 2-8-34: *JDMTA Antenna Radiation Zones*

The antenna switching may be inhibited by selecting the Broadbeam Lock option (either from the CCRS or locally) or by selecting the broadbeams manually from the ADC Touchscreen.

2.8.4.5.6.5.2 Steerable Antennas

In either multi-target mode, both steerable antennas are designated to the same target at all times. Prior to the first broach they are designated to the initial position for Missile W. In ADC Mode 2, the steerable antennas select the first missile broached. In ADC Mode 3, the steerable antennas will select the most recently broached missile. In both ADC modes, the steerable antennas will continue to follow the selected missile until one of the following events occurs:

- The current misssile plus time exceeds 850 seconds. (At this point, the target is expected to be below 2.0 degrees of elevation. A missile is no longer considered to be broached when its elevation goes below 2 degrees.)
- A DESTRUCT request is received for a different missile, and, if ADC Mode 2 is in effect, that missile is not within broadbeam capability.
- Re-designation is forced by operator intervention.
- A multiple DESTRUCT request is received.

If a DESTRUCT request is turned on, then off, the missile is considered destroyed and the other broached missile is selected. If the other missile has not yet broached, the steerable antennas will point toward the launch point awaiting the broach of the next missile. If both missiles are destroyed, then the steerable antennas will default back to the first broached missile when in ADC Mode 2 and the last broached missile when in ADC Mode 3.

When DESTRUCT commands are requested for two missiles, the steerable antennas will cycle through all DESTRUCT request missiles not covered by the broadbeam antennas, as applicable. Once the steerable antenna is within 3 degrees of the ordered position, the antenna will come online and stay on that missile for a half second before moving to the next position for the next missile. Three seconds after all missile DESTRUCTs have been serviced, the missile selection cycle will be re-initiated. This process continues until all the requests are removed.

2-9 COMMUNICATIONS SYSTEMS

2.9.1 SUPERSYSTEM OVERVIEW

The Eastern Range (ER) generally consists of the following stations: Cape Canaveral Air Force Station (CCAFS), Kennedy Space Center (KSC), Patrick Air Force Base (PAFB), Jonathan Dickinson Missile Tracking Annex (JDMTA), and Ascension Auxiliary Airfield (AAF). Station at Wallops Island, Virginia is also available to support alternate trajectories. These supporting stations are typically equipped with Radar, Telemetry, and Command Destruct instrumentation, which requires an extensive communications infrastructure for normal operation.

The ER uses an extensive network consisting of satellite communications (SATCOM), microwave, High Frequency Global Communications subsystem (HFGCS), High Frequency (HF) radio, Ultra High Frequency (UHF) radio, Very High Frequency (VHF) radio, and terrestrial landline links to connect instrumentation sites and stations with each other and to the various global users. This network provides the flexibility, reliability, and redundancy necessary to conduct all operations supported by the ER. Additionally, the ER must be capable of providing secure communications for certain applications.

The ER receives mission support communications services from, or provides communications services to, agencies such as National Aeronautics and Space Administration (NASA) and the Unites States Navy (USN). The ER also provides services on both a temporary and a continuing basis to the U.S. Army, U. S. Air Force (USAF), the State Department, and other U.S. Government agencies, as well as certain commercial carriers. The ER infrastructure must also interface with other major communications systems, such as the Tracking Data Relay Satellite System (TDRSS), the Air Force Satellite Control Network (AFSCN), the NASA Communications system (NASCOM), and the commercial environment.

Operational control of the ER network is exercised by CCAFS Communications Control, located in Room 190 at the Morrell Operations Center (MOC). Cape Communications Control is supported by the Control centers at each major station. These centers allocate, monitor, and maintain transmission quality for all the circuits for each respective station. The MOC at CCAFS is a major node for the ER, acting as a cross connection point between the ER and the rest of the world. Ascension Island is the nodal point for ship and aircraft operations in the South Atlantic and Indian Ocean areas. For specific details on the communications systems, please reference the ERIH.

2.9.2 CORE

The Cape Core system is the major communication structure of the Eastern Range (ER). The Cape Core is comprised of five major subsystems that work cohesively to route voice, data, and video around Cape Canaveral Air Force Station (CCAFS) and Kennedy Space Center (KSC). This includes telemetry and video from the downrange stations of Jonathan Dickinson Missile Tracking Annex (JDMTA) and Ascension to the MOC.
The CORE is comprised of five major subsystems:

- CORE Access Concentrators (ACs)
- Asynchronous Transfer Mode (ATM) Core
- CORE Data
- CORE Video
- Inverse Multiplexers

2.9.2.1 ATM Core Subsystem

The ATM Core is a Virtual Path Ring (VPR) network configuration which has been designed to transport voice, data, and video using ATM/SONET technology. The virtual path design reflects a dual, redundant ATM/SONET ring with ATM access at each of the nodes. Four rings with five primary nodes form the VPR. The primary nodes are the MOC, XY Facility, Southwest Terminal Building (SWTB), and the East Terminal Building (ETB). The ATM Core also includes sub-tended nodes at numerous facilities on CCAFS. The ATM Core provides the bulk transport for the Core ACs, Core Video, and Core Data subsystems.

2.9.2.2 CORE Data Subsystem

The Core Data subsystem is a major component of the Cape Core. A primary component of this subsystem is the WANIU. These are used for the transmission of Post Detection Telemetry Subsystem (PDTS) data to the Centralized Telemetry Processing System (CTPS). The WANIUs transport telemetry data from Ascension, Atlas V Space Operations Center (ASOC), Delta Operations Center (DOC), and Central Telemetry Station (Tel-4) to the MOC. The WANIU controller is located in Room 190 of the MOC.

2.9.2.3 Inverse Multiplexers

The Inverse Multiplexers (IMUX) subsystem provides the interface between the MOC WANIU and the JDMTA WANIU. The Inverse Multiplexer splits single signals generated by the WANIUs into multiple T-1s for transport across the Microwave system and commercial carrier T-1s to the XY Facility at CCAFS. The T-1s are extended to the MOC where the data is routed through Inverse Multiplexers and then routed to WANIUs located at the MOC.

2.9.2.4 CORE Access Concentrators

The CORE Access Concentrators (ACs) are ATM switches that can accept ATM and non-ATM traffic. They are primarily used to adapt non-ATM traffic to ATM traffic format for transfers onto the Core SONET fiber optic system. The ACs receive and adapt a wide variety of data inputs to include voice, HDD, and CMEV data. The ATM Core cannot be used to directly transport low speed Range Safety metric tracking (HDD) and command system (CMEV) data. These low speed circuits must be aggregated into a T-1 circuit for ATM Core transport.

2.9.2.5 CORE Video Subsystem

The Core Video subsystem provides all equipment necessary to record, digitize, encode, decode, switch video inputs and provides for archiving of launch video. The Core Video subsystem also provides for the archiving of voice and video data.

2.9.3 DIGITAL VOICE

The Digital Voice system provides voice communications in support of ER operations. This is part of a multi-node voice network that interconnects the stations, facilities, and personnel supporting the ER. The Digital Voice system consists of two major subsystems: The Range Tandem Switch (RTS) and a network of Digital Range Communications Switches (DRCS). While the RTS and DRCSs are very similar in design, their functions are quite different.

2.9.3.1 Digital Range Communication Switches (DRCS)

The DRCS switches are located throughout the ER in multiple facilities. The DRCS functions as a rapidly configurable redundant interconnect system providing voice communication services for Conferencing Networks, Direct Lines, Intercommunication, and Standard Telephone

Operations. The MOC DRCS switches has both non-secure comm (Black DRCS) as well as secure/encrypted comm (Red DRCS) capabilities.

All information (e.g., voice, signaling, lamp illumination) is transmitted and received in a digitized format by the DRCS equipment. This equipment forms the information and then distributes to the end users and to other interconnected subsystems. These predefined networks are configured and controlled by network controllers or administrators by utilizing three major functional elements that make up the DRCS.

Those elements are:

- End Instrument (EI) The DRCS's primary function is to provide users an EI (Figure 2-9-3) which provides the operator interface for voice communications and monitoring. Each EI is programmed to support a particular mission

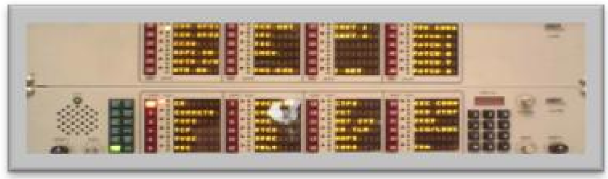

Figure 2-9-1: *Orion Panel*

- Digital Communications Conference Switch (DCCS) provides the interconnect component for all the connectivity functions allowing for voice conferencing. It makes the virtual connections to extend the voice nets onto the T1s, which connect to the RTS. This enables a user at the MOC to talk to a user at an Operations Building (OB, such as the DOC, ASOC, etc) from one EI to another
- Administrative Control Facility (ACF) provides the primary control and administrative functions to configure and control the DRCS. It is used to configure the EIs and establish system connectivity.

2.9.3.2 Range Tandem Switch (RTS)

The RTS, located at the XY Building, is responsible for controlling most non-secure voice connectivity on the ER. It is a Communications Conference Switch (CCS), which provides a voice teleconference and switching facility for use in a variety of critical applications, such as test range and launch communications. The CCS interconnects multiplexer channel circuits in both point-to-point (VDLs, Voice Direct Lines) and conference networks. This provides for a variety of communication circuit arrangements. The RTS's primary function is to provide inter-DRCS connectivity of T1 lines. For example, there are over 10 T1s lines connecting the XY DRCS to the MOC DRCS, which provide over 300 individual voice channels for conferencing. RTS is not merely a connection medium, but also provides conferencing, allowing three or more DRCS switches to simultaneously access the same voice net.

2.9.4 RADIO

The Radio system provides the ER with air-to-ground, ship-to-shore, and point-to-point radio voice in support of launch operations. It is comprised of the following:

- Air/Ground Ultra High Frequency (UHF)/Very High Frequency (VHF) subsystem
- High Frequency Global Communications subsystem (HFGCS)
- Land Mobile Radio (LMR) subsystem
- AN/WSC-3 Satellite Radio subsystem (reference Annex A for additional details)

2.9.4.1 UHF/VHF Subsystem

The ER maintains an extensive inventory of VHF and UHF air-to-ground radio transceivers. The majority of these transceivers are located at the CCAFS receiver site, which is just east of the MOC. However, some of the VHF and UHF air-to-ground radio transceivers are located at the 500 foot (ft) Timing tower and the Skid Strip Tower. The VHF and UHF air-to-ground radio transceivers support several different Range assets: Range Safety Surveillance Aircraft, Range Weather Aircraft, Airborne Security, and United States Coast Guard.

The 500 ft Timing tower has five transceivers, which are tuned to the following frequencies:

- 143.725 VHF – This is used by the Sea Surveillance Officer (SSO) as the primary frequency for communication with sea surveillance aircraft
- 298.2 UHF – This is also used by the SSO as the secondary frequency for communication with sea surveillance aircraft
- 282.40 UHF – This is used for Navy operations. It is also known as Net 1C.

The antennas at the 500 ft Timing tower are located above 300 ft, which allows the transceiver better line-of-sight for propagation. The SSO is able to communicate when the aircraft is over 50 miles out flying at very low altitudes. The Skid Strip has two transceivers, which are tuned to the following frequencies and are used for:

- 121.50 VHF – the Civilian Guard frequency used by aircraft in an emergency
- 243.00 UHF –the Military Guard frequency used by aircraft in an emergency

The Skid Strip also has two tunable transceivers: a VHF transceiver, which the tower can tune between 115 MHz – 150 MHz and a UHF (GRC-171) transceiver, which can be tuned between 225 MHz – 400 MHz. The remaining transceivers are located at the receiver site. The receiver site has a 90 ft tower with antennas to support all of the remaining VHF/UHF requirements.

2.9.4.2 HFGCS Subsystem

The HFGCS subsystem is capable of providing air-to-ground, ship-to-shore, and point-to-point non-secure voice transmission. While this equipment can transmit low-rate data, this capability is not configured. The current HFGCS subsystem is equipped with ALE capability, which is computer-assisted automatic frequency selection. The HFGCS subsystem is capable of being interfaced with the Digital Range Communications Switch (DRCS); this allows HF transmission, monitor, and receive capability to be extended to any DRCS end instrument.

2.9.4.3 LMR Subsystem

The vast majority of ground-to-ground radio communication at CCAFS is provided by LMR. This is an interconnected network of components located at CCAFS, KSC, and PAFB. This network of radios provides a virtual umbrella of coverage over the Space Coast. LMR radios are primarily used for supporting ground forces such as the Launch Emergency Operations Center, Security Police, Pad Safety, Utility workers, Fire Department, etc. In addition, LMR is used as a backup or contingency means of communications with the Forward Observer-Ground (FO-G) and the optics site controllers when they are located within the Flight Hazard Area (FHA).

2.9.5 MICROWAVE

There are two CCAFS microwave links. The first microwave link is between CCAFS and JDMTA. The second microwave link is between CCAFS and Tel-4.

The microwave link between CCAFS and JDMTA is the primary communications path to and from JDMTA. Due to the distance between JDMTA and CCAFS (115 miles), a total of 5 repeater towers are required. There are repeater towers at PAFB, Malabar, Wabasso, Fort Pierce, and Stuart, Florida. The distance between repeater towers varies slightly, but is typically around 20 miles. The towers must maintain line-of-sight to ensure signal quality.

The microwave link between CCAFS and Tel-4 is the secondary communication path to and from Tel-4. Because the Tel-4 to CCAFS microwave link is only 5.1 miles, there is no need for microwave repeaters. The microwave to Tel-4 is still in minimal use at this time; however, it provides a diverse path for the CORE devices at Tel-4. The primary path for communication to and from Tel-4 is the fiber-optic link provided by the KSC cable plant.

Each microwave station consists of two Microwave Digital Radios (MDRs), except Tel-4 and JDMTA, which are the end of their respective paths. Each MDR uses frequency diversity where transmit and receive data is simultaneously sent and received on different frequencies. With the use of diverse frequencies, the microwave system has built-in redundancy.

As with any typical microwave system, precipitation or adverse atmospheric conditions may cause signal fading. However, due to the diverse frequencies employed by the MDRs, only severe conditions can cause an interruption in service.

2.9.6 COMMERCIAL LEASED LINES

Commercial Leased Lines are an important component of the ER communications infrastructure. While the ER primarily utilizes their own assets to transport voice, data, and video between ER instrumentation and facilities, Commercial Leased Lines provide additional connectivity from CCAFS.

Cape Commercial Leased Lines are an important component of the Eastern Range (ER) communications infrastructure. This system utilizes extensive commercial networks that incorporate the use of fiber, microwave, copper, and Satellite Communications (SATCOM) to provide global connectivity. There are five subsystems in the Commercial Leased Lines system: Ascension AFWET connections, Cape off-site connections, external connections, JDMTA connections, and WFF connections. Leased landlines are capable of carrying data and voice of varying capacity pending requirements and lease agreements. Since the ER is a government user, the commercial leases are arranged through the Defense Information Systems Agency (DISA).

2.9.7 CABLE PLANT AND CONDITIONING

The Eastern Range (ER) employs the Cable Plant and Conditioning system to transport analog and digital data from facility to facility. This system is comprised of four major subsystems: Cable Plant, Technical Control, Fiber Optic Cables, and Universal Camera Site (UCS) Communication (Comm) Boxes. The components of the Cape Cable Plant and Conditioning system are capable of transporting low data rates for analog voice to megahertz (MHz) rates for the wideband transmission cables. The system also employs protection elements such as the lightning protection devices employed on twisted wire pair telephone cables.

2.9.8 REIN

Cape Range External Interface Network (REIN) is designed to provide external Launch Customers access to Eastern Range (ER) electronically obtained Weather data products utilizing a security based perimeter network interface that does not compromise the security of ER systems. In the interest of providing a secure network interface, Cape REIN is organized into three zones of equipment configuration: an internal zone, a demilitarized zone, and an external zone. Cape REIN incorporates two independent and identical strings of equipment for redundancy with manual failover capability. Cape REIN equipment is located at the Cape Canaveral Air Force Station (CCAFS) Communications Building (XY, Building 1641), with management terminals in the XY facility, Morrell Operations Center (MOC, Building 81900), and the CCAFS Weather station (Building 20185).

2.9.9 DATA TRANSMISSION

The Cape Data Transmission system is a composite of subsystems and equipment located at the launch area which encompasses CCAFS, Kennedy Space Center (KSC), and Patrick Air Force Base (PAFB). These subsystems transport digital data to and from the Eastern Range (ER) instrumentation and Range Customer sites. The Cape Data Transmission subsystems are Black Data Transmission, Cryptographic (Crypto), and Digital Message Network Element (DMNE). Data transmission is transported between facilities via the Asynchronous Transfer Mode (ATM) Core.

2.9.10 INSTRUMENTATION SITES

2.9.10.1 TEL-4

There are two comm paths to and from Tel-4. The primary comm path is via a KSC-supplied fiber-optic cable into the CORE. Telemetry data is sent through this path and is all redundant utilizing an “A” and “B” WANIU. Voice data, Red TMS data with HDD 2 data and telemetry data, including telemetry from all the ER and off range sites is sent to Tel-4 through this path and voice data, Tel-4 antenna data and best-source select data is sent out of Tel-4 through this path (Figure 2-9-2).

The secondary comm path is a microwave length between Tel-4 and the XY Building. This is minimally used but provides a diverse route for the CORE devices at Tel-4. The Red TMS data including secure data and HDD 1 data is travels through this path.

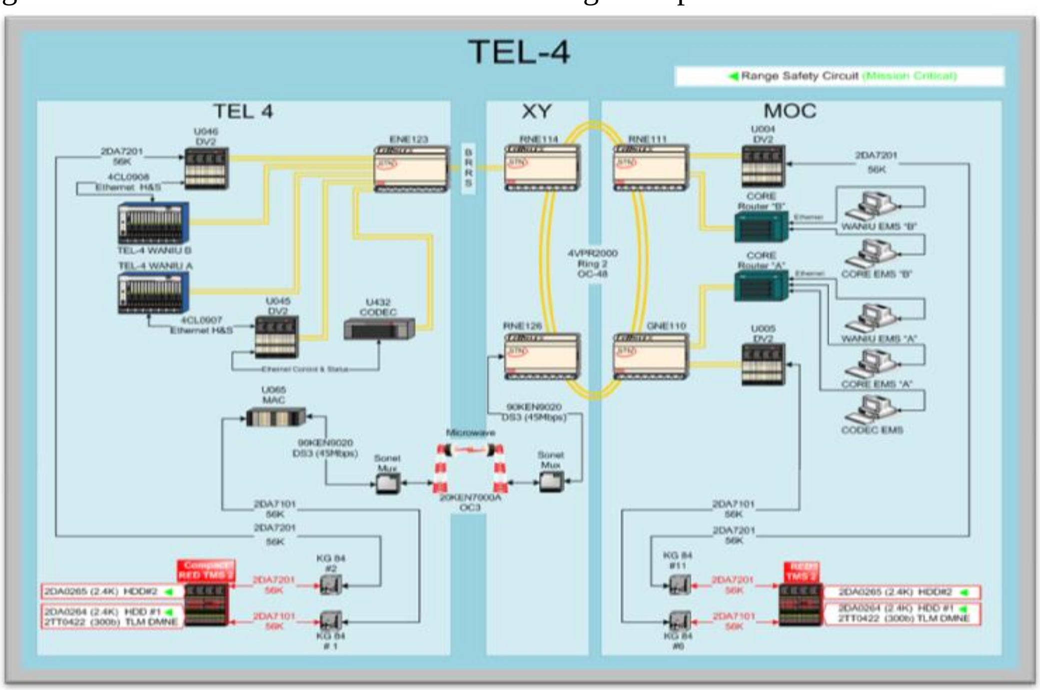

Figure 2-9-2: *Tel-4*

2.9.10.2 JDMTA

There are three data paths to and from JDMTA. The primary communication path connecting JDMTA to CCAFS is the microwave link. The data on this comm path consists of telemetry data from WAINU A (and WANIU C if used) and TMS 1 data. TMS 1 data includes HDD 2, CMEV 1, two lines of TGRS data at 128 Kbs, and NGTP 2 data. HDD 2, TGRS, and NGTP 2 data are transported on the Red TMS 1 circuit and CMEV 1 is transported on the Black TMS 1 circuit (Figure 2-9-3).

The secondary communication path for HDD, CMEV, TGRS, and NGTP data between JDMTA to CCAFS is the 7DPP commercial leased line. The data on this comm path consists of the TMS 2 data which includes HDD 1, CMEV 2, two lines of TGRS data at 19.2 Kbs, and NGTP 1 data. HDD 1, TGRS, and NGTP 1 data are transported on the Red TMS 2 circuit and CMEV 2 is transported on the Black TMS 2 circuit. Note that the HDD 1, CMEV 2, the primary line of TGRS data at 19.2, and NGTP data will automatically be re-routed through the microwave line if a degradation occurs on the commercial leased line.

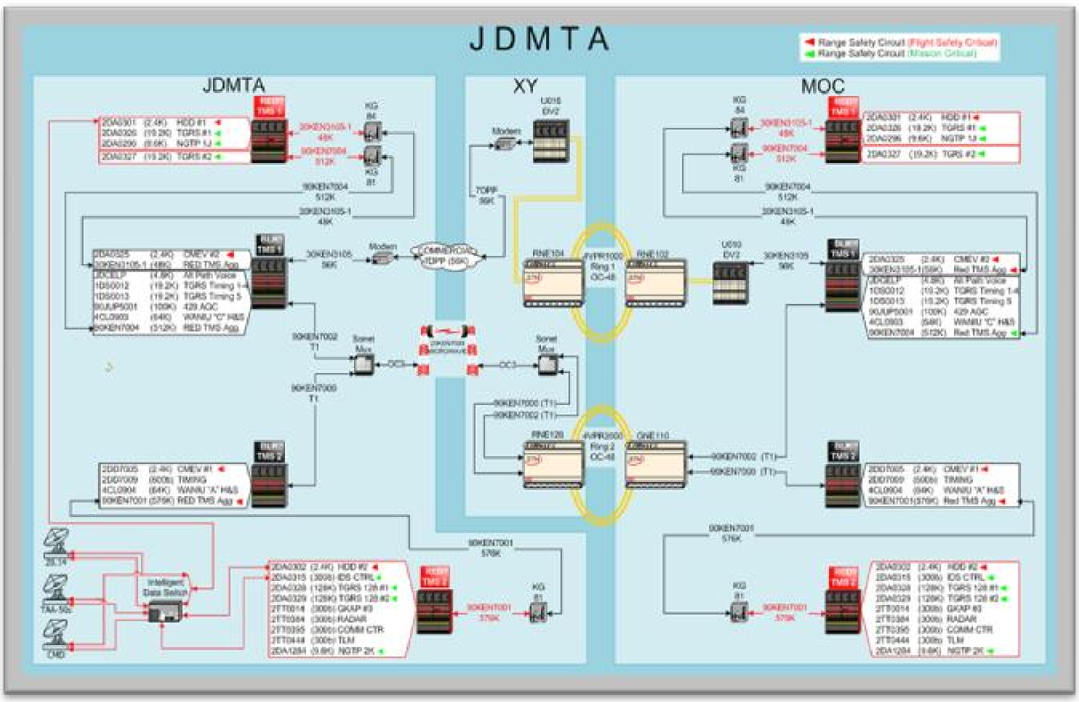

Figure 2-9-3: *JDMTA*

The remaining two WANIUs utilize four commercially leased lines to provide a redundant and diverse path to and from CCAFS entities. The four lines are multiplexed to supply WANIU B and WANIU D a path. WANIU C and D are only used during a two-missile Navy test without a wait between launches. Because WANIU D rarely supports launches, all four lines are typically configured to provide WANIU B support.

JDMTA also has an Intelligent Data Switch (IDS). The IDS system provides a switched signal path for routing of HDD to and from Radar 28.14, JDMTA Command, and JDMTA Telemetry. Radar, Command, and Telemetry all receive a direct line of HDD 1. The IDS allows a switch between HDD 1, HDD 2, or Radar 28.14 track data (if the radar is tracking). The IDS is controlled by the Single Point Acquisition and Radar Control (SPARC) in the MOC through the Red TMS 2 circuit.

Figure 2-9-4 is a graphical representation of how Command data is sent to and from JDMTA. TMS 1 utilizes the microwave path. TMS 2 utilizes a Commercial Leased Line (CLL) to and from CCAFS. Command Message Encoder Verifier (CMEV) lines are diversely routed via Black TMS circuits. HDD lines are diversely routed via Red TMS circuits. This is how 2 diverse independent paths provide system redundancy. This also means that if the CLL or Microwave go down, so does a string of HDD and CMEV data.

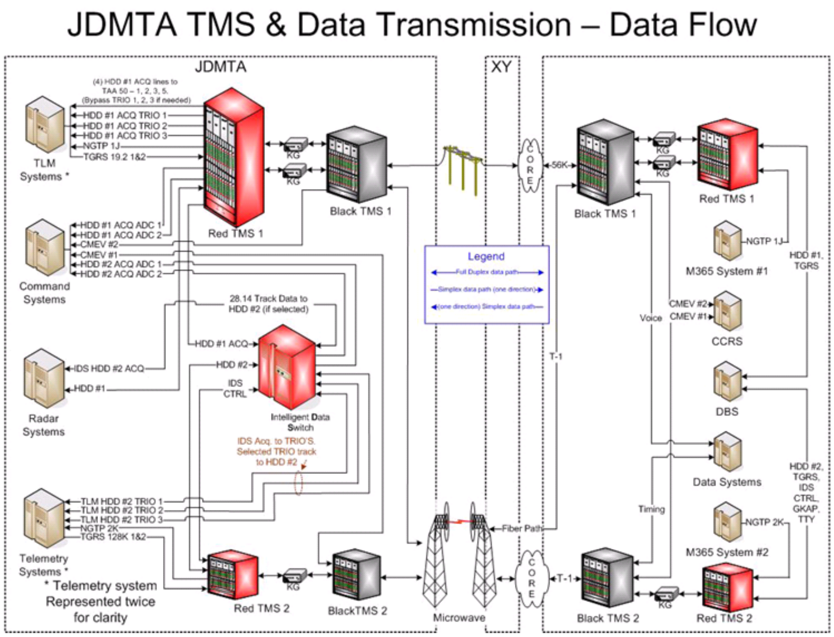

Figure 2-9-4: *JDMTA Communications Data Flow*

Understanding the previous information, Figure 2-9-5 shows is how comm begins to create additional mandatories. When JDMTA command becomes mandatory, so does: Data Transmission, Microwave, and TMS for HDD and CMEV routing.

SITE	STATUS	CUSTOMER	RANGE
Station 28 (JDMTA)			
Analog Voice	●	R	R
Cable Plant & Conditioning	●	R	R
CORE	●	R	R
Data Transmission	●	R	M
Digital Voice	●	R	R
Microwave	●	R	M
Radio	●	R	R
TMS	●	R	M

Figure 2-9-5: *JDMTA Communications Mandatories*

2.9.10.3 Metric Optics

Communications has two primary missions when it comes to supporting the Metric Optic vans and sites.

Communications provides a video circuit that transports video from the Metric Optics site throughout the Range. The video circuits vary from site to site depending on the available medium. Most CCAFS sites are fiber-optic from the site to the XY Facility, which delivers a higher quality video picture. However, some of the Universal Camera Sites (UCS) on KSC are wideband circuits, which are more susceptible to interference from external influences such as corrosion and faulty grounds. Once the video signal has arrived at the XY Facility, it is input into a CODEC for transport across the CORE. The CODEC can multicast the video from a single input to multiple outputs, allowing any facility requiring the video to receive it (Figure 2-9-6).

More importantly, communications provides each site with data connectivity for HDD. Because the Metric Optic vans change locations depending on the rocket and launch azimuth, each UCS site has a cable plant connection to the XY Facility via copper cable. Due to the extended distances between the UCS sites and the XY Facility, modems are used to modulate the encrypted digital HDD signal, allowing the now modulated signal to travel over greater distances.

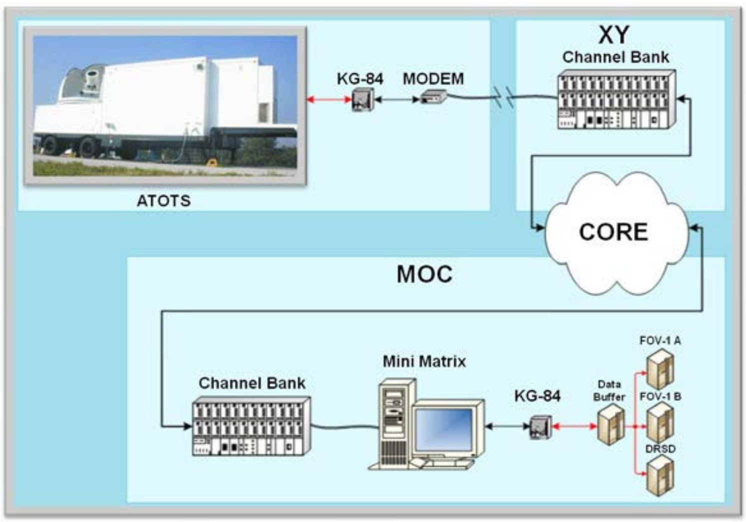

Figure 2-9-6: *Metric Optics*

2.9.10.4 Radar Sites

The mainland Radar sites all utilize the Red TMS for transporting HDD. Each mainland Radar site receives HDD and an encrypted DMNE circuit, which allows the receipt of classified messages. Because a single mainland Radar site is rarely mandatory for launch, most sites only receive one HDD line. The one exception is Radar 19.39, also known as Multiple Object Tracking Radar (MOTR). Radar 19.39 has a compact Red TMS node, which makes HDD 1 available to the Radar. Additionally, HDD 2 is sent to Radar 19.39 via an encrypted single non-TMS circuit for redundancy.

All mainland Radar sites have been upgraded to DRCS voice communications units.

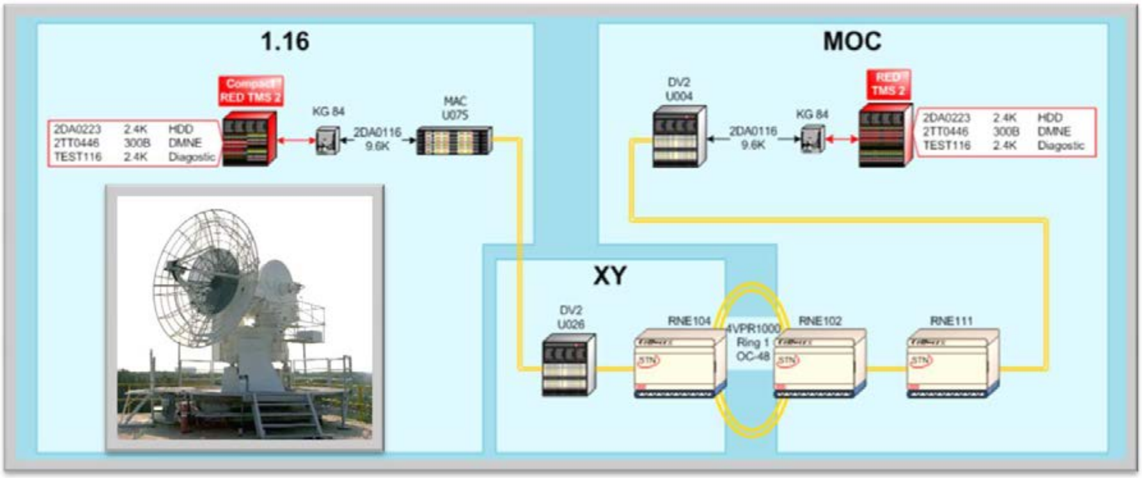

Figure 2-9-7: *Radar Sites*

2.9.10.5 CCAFS Command

CCAFS Command has a simple design. No CORE devices or TMS are used for CCAFS Command, just simple modems and copper cable plant. This design is a trade-off in maintainability. Because there is less equipment populating the CCAFS Command circuits, there is a lower percentage of circuit failures. However, when a failure does occur, the repair time is greater. This is why there are dedicated spare circuits to CCAFS Command that can be patched into use.

Communications provides two circuit types to CCAFS Command: CMEV circuits and HDD circuits. For Cape 1A Command, Communications provides 3 HDD lines: HDD 1, HDD 2, and a spare. For Cape 1B Command, Communications provides 2 HDD lines: HDD 1 and a spare. There are 6 total CMEV lines feeding CCAFS Command. Three CMEV circuits go to Cape 1A (CMEV 1, CMEV 2, and a spare) and 3 CMEV circuits go to Cape 1B (CMEV 1, CMEV 2, and a spare).

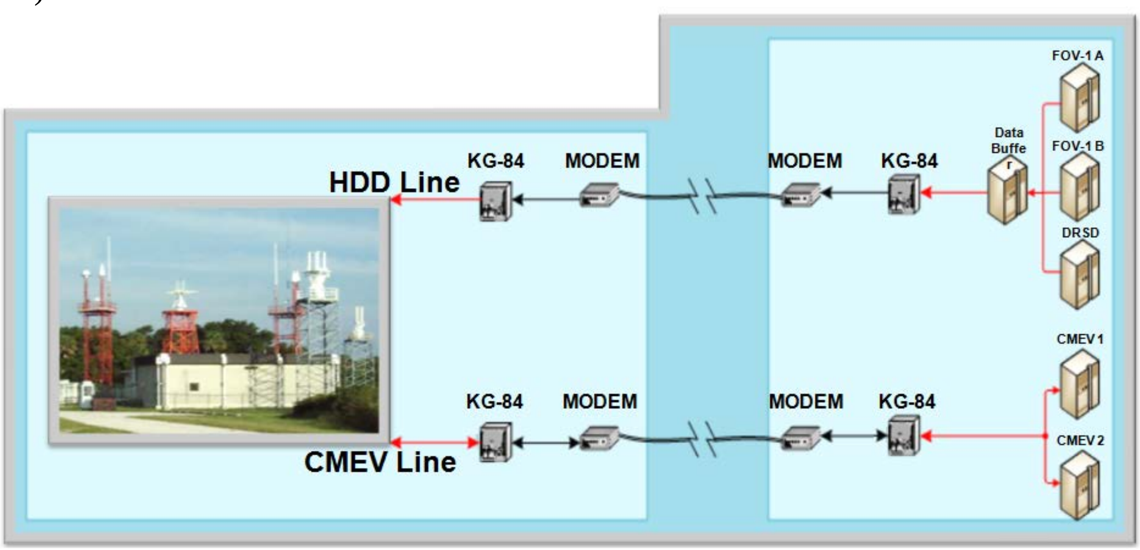

Figure 2-9-8: *CCAFS Command*

2-10 TIMING AND SEQUENCING SYSTEMS

2.10.1 OVERVIEW

The Eastern Range (ER) Timing and Sequencing supersystem uses an extensive network of satellite, High Frequency (HF) radio, L-Band radio, and landline links to connect ER sites and stations with each other and with external resources. This network provides the flexibility and dependability necessary to transport the timing, synchronization, count, holdfire and first motion signals needed to carry out supported ER operations.

The ER Timing and Sequencing supersystem performs its functions using a variety of systems and subsystems at the following ER locations: Cape Canaveral Air Force Station (CCAFS), Kennedy Space Center (KSC), Patrick Air Force Base (PAFB), Jonathan Dickinson Missile Tracking Annex (JDMTA), and Ascension.

Operational control of this supersystem is exercised by ER Central Timing located in the Morrell Operations Center (MOC) at CCAFS. ER Central Timing equipment allocates and monitors the distribution of those signals using both manual and automatic means. Although many signals at individual ER sites and stations are generated and distributed independently to prevent any failure at ER Central Timing from cascading throughout the ER, those signals still reference the source signals transmitted from ER Central Timing.

2.10.2 DEFINITIONS

2.10.2.1 How is Count Defined?

Count is defined as a discontinuous time scale that counts down to an event, and then counts up from that event. First Motion (a.k.a. liftoff) is the event that centers the count time scale during a launch operation. Countdown holds, recycles, and the first motion event make the time scale discontinuous. There are multiple count formats currently generated and distributed to the ER that are used for display.

2.10.2.2 Count Formats

2.10.2.2.1 CS-5246 Count Format

Count information is depicted in days, hours, minutes, and seconds (DDD:HH:MMM:SS.SSS). Used by most Range users (Referred to as “CS-5”).

2.10.2.2.2 Firing Data Multiplexer Equipment (FDME) Count Format

The Firing Data Multiplexer Equipment (FDME) count format is an amplitude-modulated 345 Hertz (Hz) signal depicted in minutes and seconds (MMM:SS), having a range from T-999:59 to T+999:59. The FDME format is in the process of being replaced range-wide by CS-5246.

2.10.2.3 Terminal (T) Count

A time scale usually referenced to the opening of the launch window. The count is halted at predetermined times and durations referred to as Built-In-Holds (BIHs). The use of T-Counts with BIHs is a launch customer preference primarily used to ensure there is enough time built into a countdown to address unexpected issues. The T-Count is needed to effectively interface with the launch customer according to their timeline.

User countdown actions are based off of the T-Count. Typically generated by the user, range clock is slaved to the user's T-clock.

2.10.2.4 Launch (L) Count

The L-Count is different than the T-Count in that it is the absolute time prior to the scheduled launch time. The L-Count is typically referenced to the opening of the launch window and runs continuous throughout the count. Standard practice is to remove the L-Count at the point where it equals the T-Count, leaving a single countdown through the launch.

The ER uses both T and L-Counts. The L-Count is important because it provides a true time reference to the scheduled liftoff time. This reference is essential to the Range in order to accomplish all minus count activities in preparation for launch. L-Count is beneficial because it provides a reference to how much time is available for troubleshooting problems. If the user does not have a built-in hold in their countdown, the user and ER will only use a T-count. L-count is independently generated at the different facilities.

2.10.2.5 T-X Time

The latest time in the count when the launch sequence can be stopped and not create a more hazardous situation than if the launch proceeded.

2.10.2.6 First Motion Time

First Motion Time provides demarcation of exact launch vehicle liftoff time. This is the time of liftoff event that is provided to the Range in the form of Time of Vehicle First Motion (TVFM) and/or a discrete first motion signal.

Initiation of First Motion.

- Pad launches: sent by pad sequencer.
- Mission lift off (microswitch, breakwire, or pin & lanyards).
- Launch commit (engine test/criteria; Atlas V).
- Trident II: Broach of the missile from the ocean; initiated manually by the Launch Area Support Ship (LASS).
- Air launched missions (Pegasus): Initiated manually by central timing based on observation of chase plane video.

Importance of First Motion

- To provide a precise start time to initiate Range Safety processing, recorders & cameras, processing of stored nominals in the event EFG designate data is lost.

2.10.2.7 Back-up/Forced First Motion

In the event Broach from the LASS or First Motion from the count sequencers fail, the ER has set up additional means to initiate a backup or Forced First Motion

First Motion can be initiated manually using information from:

- Camera views of the launch vehicle on the pad
- Visual count displays
- Sequencer count status displays
- Audio status from the FOV1 Metric Data Processor

The Range Safety system controller has the ability to manually send a backup first motion to initiate dependent processes (e.g., nominal trajectory data and recordings).

The Range Safety system controller closely monitors pad video for launch vehicle movement as an indication that liftoff has occurred. If the primary first motion is not received by the liftoff time and is observed by the controller, a manual first motion button is depressed.

Audio-plus count

- An audio plus-count transmitted by Central Timing on the Range Countdown Net to the instrumentation sites
- Initiated when the First Motion Signal is received or initiated by Central Timing
- Transmitted during the period of Range Safety Responsibility
- Counts up in the 10 sec increments until T+10 minutes, then counts up in 1 minute increments
- Used by instrumentation sites to allow personnel to perform plus-count actions without having to reference a clock display (Command, optics)
- Originally developed to allow command site personnel to reference printed antenna look angles and manually steer the antennas without having to reference a clock display

2.10.2.8 Holdfire

Holdfire is the intentional interruption of the launch vehicle ignition circuit by key launch team personnel to prevent an unsafe launch. The holdfire requirement is mandatory for all pad launches and can be met using the holdfire subsystem or designated voice circuit(s).

The legacy holdfire subsystem utilizes DC voltages, transported over copper circuits, for holdfire notification and status. This subsystem enables select mission operators to electronically issue a holdfire via a switch on their console. The mission operators with this capability are the Mission Flight Control Officer (MFCO), Operations Safety Manager (OSM), the Range Control Officer (RCO), and the launch vehicle test conductor.

2.10.2.9 Inter-Range Instrumentation Group (IRIG) Timecode

Modern day electronic systems such as communication systems, data handling systems, and missile and spacecraft tracking systems require time-of-day and year information for correlation of data with time.

Standardization of time codes is necessary to ensure system compatibility among the various ranges, ground tracking networks.

IRIG time codes were created by the TeleCommunications working group of the Inter-Range Instrumentation Group, the standards body of the Range Commanders Council.

Timecodes defined in the Standard have alphabetic designations. A, B, D, E, G, & H are the standards currently defined by 200-04. The main difference between codes is their rate, which varies between one pulse per minutes and 10,000 pulses per second.

2.10.2.10 Timing

One component of ER operations is to provide highly accurate, time-correlated event monitoring, and precise, positive control of hazardous operations. The Central Timing subsystem performs this operation by providing Inter-Range Instrumentation Group (IRIG) precision frequencies and repetitive pulse signals distributed from the ER timing systems for ensuring highly accurate timing correlation between the various instrumentation and communications systems. The accuracy of all ER clocks can be traceable to the Department of Defense (DoD) Master Clock maintained by the US Naval Observatory in Washington D.C. This is accomplished by way of the Two Way Satellite Time Transfer subsystem (TWSTT).

2.10.2.10.1 TWSTT Subsystem

Utilized to measure the accuracy of the ER clocks against the DoD Master Clock and to compute phase adjustments for the cesium beam frequency standards. The Range Master Clock in MOC Central Timing is synchronized within 100 nanoseconds (ns) of the DoD Master Clock, while the downrange clocks at JDMTA, and Ascension are synchronized within 100 ns of the Range Master Clock.

2.10.2.10.2 Universal Time Coordinated (UTC)

A time standard based on International Atomic Time scale that serves as the basis for timekeeping for most of the world. UTC is a 24-hour timekeeping system. The hours, minutes, and seconds expressed by UTC represent the time of day at the Earth’s prime meridian (0° longitude) on which Greenwich, England is located.

2.10.2.10.3 Zulu Time

The military designator for Time Zone “Z”. Zulu is equivalent to the civilian designator Greenwich Mean Time (GMT), and is used interchangeably with UTC.

All Range elements schedule operational activities in Universal Time Coordinated and administrative activities in local time. Universal Time (UT) is the mean solar time on the Greenwich Meridian and is based on the average motion of the sun. UT1 is derived by correcting UT for the observational effects of polar motion. UT2 is derived by correcting UT for the seasonal variations in the earth's rotation. Coordinated Universal Time (UTC) combines the uniformity of Atomic Time (AT) and the functionality of UT. UTC is the reference provided by LORAN-C, WWV, WWVH, WWVB, and the Global Positioning System (GPS). All Range Station Precision Time and Time Interval (PTTI) Systems will be referenced to UTC.

Use the designator “ZULU” after the time in all conversations relating to operational matters.

2.10.3 ATLAS V

Figure 2-10-1: *Atlas V*

2.10.3.1 Count Distribution and Identifier

The Range Count Signal Generators (RCSG) outputs two count formats, CS-5246 and FDME. Count signals are selected to one of four Eastern Range Count Nets (ERCN) for distribution on the ER.

2.10.3.2 T-Count Determination

The count generation of the Atlas V is determined by the launch customer's Digital Group Multiplexers (DGM) 4000 Pad Count Generator (PCG) located at the Atlas Spacelift Operations Centers (ASOC) and provides the master T-Count during Atlas V launches.

2.10.3.3 L-Count Generation

The ER utilizes a third RCSG in MOC Central Timing to generate the L-Count, providing an absolute time reference until T-0.

2.10.3.4 Primary First Motion

Atlas V first motion is based on the launch commit command originating from the launch customer's Computer Controlled Launch System (CCLS) at the ASOC. The launch commit is received by a PCG and an Event Capture Unit (ECU), both located at the ASOC, as a discrete +28 vdc signal.

2.10.3.5 Pre-Mission First Motion Checks

Checkout of primary first motion with the launch customer is normally performed during the following pre-mission operation: Integrated Systems Test (IST). Checkout of backup first motion is performed in conjunction with the ER F-1 Day Instrumentation Checkout in accordance with Operations Directive (OD) 12A.

2.10.3.6 Launch Day First Motion Checks

Checkout of primary first motion check is performed during the ER minus count simulation at L-3 hours and 15 minutes. A backup first motion check is performed at L-2 hours and 30 minutes.

2.10.4 DELTA IV

2.10.4.1 T-Count Determination

The launch customer's ESE 3500 PCG, located at the Delta Operations Center (DOC), provides the master T-Count during Delta IV launches.

Figure 2-10-2: *Delta IV*

2.10.4.2 L-Count Generation
The ER utilizes a third RCSG in MOC Central Timing to generate the L-Count, providing an absolute time reference until T-0.

2.10.4.3 Count Distribution
The RCSG output is in two count formats: CS-5246 and FDME. Count signals are selected to one of four ERCN for distribution on the ER.

2.10.4.4 Primary First Motion
Delta IV first motion is based on the Missile Liftoff (MLO) signal originating from the launch CCLS at the DOC. MLO is received by a PCG and an ECU, both located at the DOC, as a discrete +28 vdc signal. The signal is time tagged upon receipt by both units and transmitted over the Core on redundant circuits as TVFM to two RCSG in MOC Central Timing.

2.10.4.5 Backup First Motion
In the event that the primary first motion is not received from the launch customer, the Range Safety system controller has the ability to manually send a backup first motion to initiate dependent processes (e.g., nominal trajectory data and recordings).

The Range Safety system controller closely monitors pad video for launch vehicle movement as an indication that liftoff has occurred. If the primary first motion is not received by the time liftoff is observed by the controller, a manual first motion button is depressed.

The reason is that first motion is used by Command and tracking (Radar, Telemetry) systems to initiate stored nominal trajectory data to facilitate acquisition during launch operations. First motion is also used to start data recorders and provide a time reference for vehicle liftoff in data products used during post launch analysis and delivered to launch customers. The inability to insert a backup first motion in the CS-5246 count status data stream could result in a degraded vehicle acquisition capability for systems relying in CS-5246 for TVFM to start stored nominal trajectory data, as well as a potential loss of data recordings and degraded data products.

2.10.4.6 Pre-Mission Checks

Checkout of primary first motion with the launch customer is normally performed during the following pre-mission operation: Flight Program Verification (OD 5044B).

Checkout of backup first motion is performed in conjunction with the ER F-1 Day Instrumentation Checkout (OD 12A).

2.10.4.7 Launch Day Checks

A primary first motion check is also performed during the minus count simulation at L-3 hours and 15 minutes. A backup first motion check is performed at L-2 hours and 30 minutes.

2.10.4.8 Holdfire Subsystem Configuration

The Delta IV launch program utilizes the EELV holdfire subsystem to transmit ER holdfire commands to the launch customer CCLS in the DOC. A holdfire select panel in MOC Central Timing is configured by RGNext personnel to establish connectivity between the MOC holdfire switches and the DOC.

The status of MFCO, RCO and OSM holdfire, as well as Range ready is available on indicator panels at each of the holdfire switch locations.

The CCLS is programmed to respond to holdfire commands between times mutually agreed upon by 45 SW Safety and the launch customer. Per RSOR 5500, holdfire is active between T-5 minutes to T-1 second. A holdfire initiated from any of the 45 SW positions during this time will result in the removal of Range ready and an immediate countdown hold.

Since the holdfire switches are active down to T-1 second (T-X Time), the requirement for holdfire capability can be met with either the holdfire subsystem or voice communication.

2.10.5 TRIDENT

2.10.5.1 Count Generation

The counts distributed on the ER during Trident launch operations are generated by the RCSG located in MOC Central Timing.

Trident launches do not typically utilize built-in-holds; therefore the only count generated is a T-Count. The one exception is the United Kingdom (UK) Demonstration and Shakedown Operation (DASO) program, where a 60 minute built-in-hold is incorporated at T-5 hours (L-6 hours). At the end of the hold, the L-Count is no longer necessary and is removed.

2.10.5.2 Count Distribution

The RCSGs output two count formats that are distributed on the ER: CS-5246 and FDME.

Customers receive count signals on four ERCNs. The T-Count for missile W is selected to ERCN-1 for distribution while the T-Count for missile X is selected ERCN-2 for distribution. For the brief time that an L-Count is required during UK DASO operations (L-6 to L-5 hours), ERCN-3 will be utilized.

Select customers receive the CS-5246 count status in a multiplexed format (CS-5246x4). The multiplexed data stream carries up to four counts, each having a unique identifier. During Trident operations, the T-Count identifier will correspond to the missile identifier (i.e., W or X).

2.10.5.3 First Motion Identifier

A broach message, containing missile identifier W or X, will be received in the Portable Shipboard Instrumentation Package (POSIP) data once launch occurs. The message will be processed by a First Motion Time Decoder (FMTD) which will output a missile identifier and broach time to the RCSGs in MOC Central Timing.

Figure 2-10-3: *Trident*

The RCSGs output CS-5246/TVFM and a discrete first motion for distribution to instrumentation systems.

- **Voice**-call from SCO based on observations.
- **Forced**-MOC range safety system operators manually selected
- **Estimated**-Initial automatic processing of vehicle telemetry data
- **Estimated Corrected**-Confirmation of estimated broach using additional telemetry messages/data
- **Corrected**-Final conformation and correction of Broach using additional telemetry messages/data

2.10.5.4 Backup First Motion

A backup first motion capability is not available for Trident launch operations.

2.10.5.5 Pre-Mission Checks

The broach/first motion distribution capability will be verified in conjunction with the L-3 hour and 40 minute data link end-to-end check during the Dress Rehearsal at Sea (DRAS).

2.10.5.6 Launch Day Checks

The broach/first motion distribution capability will be verified in conjunction with the L-3 hour and 40 minute data link end-to-end check on day of launch. There is no requirement for scheduling first motion checks during a Trident launch operation.

Additionally there should be no difference in the checks performed for Trident DASO and Trident Follow-on Commander Evaluation Test (FCET), other than the number of missile candidates. DASO being a single missile, while the FCET may be multiple missiles.

2.10.5.7 Trident Holdfire Capability

There is no automatic holdfire capability for Trident launch operations. If a hold condition is recognized by either the RCO or MFCO, verbal notification is made to the Test Conductor (TC) on the Launch Area Support Ship. The TC will advise the submarine Commander and Permission to Fire will be removed.

2.10.6 PEGASUS

2.10.6.1 Count Generation

The count distributed on the ER during a Pegasus launch operation is generated by a RCSG located in MOC Central Timing.

Built-in-holds are not utilized during Pegasus launch operations; therefore the only count generated is a T-Count.

Figure 2-10-4: *Pegasus*

2.10.6.2 Count Distribution

The RCSG output two count formats that is distributed on the ER: CS-5246 and FDME.

Customers receive count signals on four ERCN. The T-Count is selected ERCN-3 for distribution on the ER.

Select customers receive the CS-5246 count status in a multiplexed format (CS-5246x4). The multiplexed data stream carries up to four counts each having a unique identifier. During Pegasus operations, the T-Count identifier will be "P."

Refer to pages 15 and 16 for a listing of the Communications ERDs necessary to transport count and timing signals from MOC Central Timing to mainland and downrange stations.

2.10.6.3 First Motion Generation and Identification

Pegasus first motion is generated manually from a RCSG in MOC Central Timing. An equipment operator will initiate first motion upon observing the Pegasus launch vehicle drop from the L-1011 transport aircraft on closed circuit television.

The RCSG will output CS-5246/TVFM and a discrete first motion for distribution to ER instrumentation systems.

2.10.6.4 Backup First Motion

A backup first motion capability is not available for Pegasus launch operations.

2.10.6.5 First Motion Pre-Mission Checks

Manual first motion distribution procedure will be exercised during the launch rehearsal.

2.10.6.6 Launch Day Checks

Manual first motion distribution procedure will be exercised during the minus count simulation on day of launch. There are no scheduling requirements for first motion checks.

2.10.6.7 Holdfire Capability

There is no automatic holdfire capability for Pegasus launch operations. If a hold condition is recognized by either the RCO or MFCO, verbal notification is made to the Launch Conductor.

2.10.7 FALCON 9

2.10.7.1 Count Generation

Falcon 9 uses CS-5246 data.

The T-count is generated by Space X with an identifier of K.

2.10.7.2 First Motion Pre-Mission Checks

First motion is checked out on static fire.

2.10.7.3 Verbal Holdfire Capability

At T-5 min Verbal Holdfire capability is tested.

Figure 2-10-6: *Falcon 9*

2-11 METEOROLOGICAL SYSTEMS

2.11.1 OVERVIEW
Inclement weather at or around the Eastern Range (ER) has a direct impact on the ability to launch a vehicle, protect equipment, or safeguard personnel as they performing their daily duties. The Meteorological Supersystem provides real-time weather data that allows the Range Weather Operations (RWO) center to provide severe weather warnings or alerts.

2.11.2 METEOROLOGICAL SUPERSYSTEM

2.11.2.1 Functions
The ER Meteorological Supersystem is used to:

- Provide local weather forecasts used in planning.
- Protect personnel and equipment by monitoring local weather for approaching thunderstorms, lightning, tornadoes, or strong winds so that severe weather warnings or alerts can be issued for affected work areas.
- Provide the information required to evaluate the weather-related Launch Commit Criteria (LCC), toxic plume dispersion and probable vehicle debris fields, and vehicle wind loading and trajectory shaping for all vehicle launches.

2.11.2.2 Focal Point
The focal point for the ER Meteorological Supersystem is the Range Weather Operations (RWO), which is located in the MOC on CCAFS. At the RWO, meteorologists and 45 Weather Squadron (WS) forecasters utilize a variety of system displays to access and manage the data from each measurement system.

2.11.2.3 Weather Stations
The ER includes four weather stations that serve as official reporting sites for surface or upper air soundings critical to launch and daily operations. Station KTTS is the official reporting site for uprange surface observations and Station KXMR is the official reporting site for uprange upper air soundings. Station FHAW (surface observations are performed and documented by the British at FHAW) is the official reporting site for downrange surface observations and Ascension Auxiliary Air Field (AAAF) is the official reporting site for downrange upper air soundings.

2.11.2.4 Equipment
To fulfill its mission, the ER utilizes an extensive assortment of systems to process meteorological information from local, national, international, and satellite sources. The majority of these systems are operated and maintained by the 45 SW; however, the ER also utilizes data from instrumentation sources that are operated and maintained by other government agencies.

The ER Meteorological Supersystem represents one of the largest concentrations of meteorological instrumentation in the world. The density of sensors, combined with state-of-the-art technology and 24 hours/day, 7 days/week data collection provides a multitude of specialized measurements that help the Air Force and its launch customers to successfully complete their missions in a variety of weather conditions. Additionally, this unique and comprehensive meteorological data set is also available to academic and government research scientists.

2.11.2.5 Weather Data Information

The meteorological systems ingest, process, manage, distribute, and archive meteorological information obtained from numerous sources. Types of data include upper air soundings, surface weather, weather sensors, lightning, thunderstorms, and real-time meteorological and toxic diffusion/blast hazard model outputs. The Meteorological Interactive Data Display System (MIDDS) is the primary data collection, management, and display tool used by the 45 WS to provide weather analysis, forecast, and warning support to the Range Customers and Launch Customers.

2.11.2.6 Primary Data Users

The data is used for a variety of purposes by different users:

- Applied Meteorology Unit (AMU) – data is used to provide support in leveraging and transitioning proven emerging technology into the operational meteorological environment.
- 45 SW/SE – data is used to evaluate toxic plume dispersion and vehicle blast debris predictions.
- Contractors for various launch vehicles – data is used for vehicle wind load analysis and trajectory shaping (vehicles such as Atlas, Delta, Falcon, and Trident).

2.11.3 RANGE DATA ASSETS

2.11.3.1 Upper Air Soundings Systems

Upper Air Soundings is one of the most important types of data provided at the ER, which are used to generate profiles of wind and thermodynamic data from the surface to 30 kilometers (km). The upper air data is provided by a combination of the Automated Meteorological Processing System (AMPS), radar-tracked Jimspheres, and the Meteorological System Computers (MSC). The Doppler Radar Wind Profilers (DRWPs) also provide wind profiles up to 18 km. The AMPS are located at Ascension and CCAFS, the MSC is located at CCAFS, and DRWPs are located at CCAFS and KSC.

Weather conditions from the surface to 150 meters (m) are supplied by a network of instrumented weather towers known as the Weather Information Network Display System (WINDS). The WINDS provides a comprehensive, real-time description of the weather conditions (wind speed and direction, lapse rate, temperature, and relative humidity) using a network of towers distributed over a 2,500 km^2 area.

2.11.3.2 Surface Weather Observations Systems

The surface weather observation systems include sensors, procedures, and transmission capability used to satisfy Air Force and Range Customer requirements to record and disseminate surface weather observation data in support of both daily and launch operations. The data is used by the 45 WS, Range Customers, and Air Force Weather Agency (AFWA). The surface weather observations are conducted on CCAFS and KSC.

2.11.3.3 Weather Sensors System

The FMQ-19 System is a commercial-off-the-shelf (COTS) integrated system of multiple sensors and data automation components that continually measure environmental conditions. The FMQ-19 is located at CCAFS Skid Strip and its air field weather data is primarily used by the 45 WS to support airfield operations and safety, and secondarily supports ER daily launch operations. The FMQ-19 data is also disseminated via New-Tactical Forecast System (N-TFS) globally to all AFWA meteorological centers.

2.11.3.4 Lightning Detection Systems

The ER uses an array of thunderstorm and lightning detection systems to protect personnel and equipment during both daily ground support activities, as well as during launch operations. Lightning detection and location systems include the Launch Pad Lightning Warning System (LPLWS), the 4 Dimensional Lightning Surveillance System (4DLSS), and the National Lightning Detection Network (NLDN). Data from both the LPLWS and 4DLSS is sent to Meteorological Interactive Data Display System (MIDDS) to provide the real-time status of flashes and lightning potential to the RWO. Due to the broad regional and national coverage provided by the NLDN, the data is used to augment data received from the LPLWS and 4DLSS. All the information is used by the Launch Weather Officer (LWO) to evaluate LCC and safety requirements.

2.11.3.5 Growth and Movement of Thunderstorms System

The ER also utilizes Weather Surveillance Radar (WSR) 74C to monitor the growth and movement of thunderstorms. The WSR 74C provides real-time assessment data on the location, intensity, and movement of precipitation within 250 km of PAFB to the 45 WS. The WSR 74C is located at PAFB.

2.11.3.6 Forecasting Local Meteorological Conditions and Distant Focusing Overpressure (DFO) and Toxic Dispersion Modeling Capabilities System

The Eastern Range Dispersion Assessment System (ERDAS) acquires, processes, and disseminates near real-time data, and toxic diffusion and DFO hazard model output. The ERDAS provides display and forecast of local meteorological conditions plus DFO hazard and toxic dispersion modeling capabilities for several different user groups on the ER, to include the 45 SW/SE and the 45 WS. The ERDAS is located in the MOC on CCAFS.

2.11.3.7 Meteorological Interactive Data Display System

MIDDS is the primary data collection, management, and display tool used by the 45 WS. MIDDS can ingest and manage a large variety of data type from both ER and non-ER sources, and overlay products in a single display. Available data products include satellite imagery, and alphanumeric and graphics displays, and are also available to authorized Range Customers and Launch Customers via a network of MIDDS workstations.

2.11.4 OFF-RANGE DATA ASSETS

2.11.4.1 Upper Air Soundings System

Upper Air Soundings is one of the most important types of data provided at the ER, which is used to generate profiles of wind and thermodynamic data. The NASA/KSC 50 megahertz (MHz) DRWP provides wind profiles to 18 km.

2.11.4.2 Growth and Movement of Thunderstorms

The ER also utilizes WSR 88D to monitor the growth and movement of thunderstorms. The WSR 88D (located at National Weather Office [NWS] Weather Forecast Office [WFO] in Melbourne Florida) provides back-up data to the WSR 74C (located at PAFB). The WSR 88D is not owned or operated by the ER.

2.11.4.3 Real-Time Airborne Weather Observations

The weather reconnaissance aircraft (WRA) is used during expendable rocket launches to make real-time observations of local weather in the KSC and CCAFS area.

2.11.4.4 Weather Analysis and Forecasting System

The N-TFS is a weather analysis and forecasting system, it is a critical tool used by the Air Force weather forecasters, weather observers, and air traffic controllers to generate local observations and forecasts, disseminate severe warnings and advisories, and provides weather briefings to aircrews.

2.11.5 AUTOMATED METEOROLOGICAL PROFILING SYSTEM

At CCAFS, two completely independent and redundant AMPS (AMPS-A and AMPS-B) provide the ER with upper-atmosphere data, using Low-Resolution (LR) radiosonde instruments flown on latex balloons and High-Resolution (HR) instruments flown on clear Jimsphere balloons. This data consists of winds (LR and HR) and thermodynamic data (LR only) provided at 100-foot (ft) increments. This data is transmitted via serial connection to the MSC at the CCAFS Weather Station. Each AMPS system consists of a Ground Element (GE) and the expendable Flight Element (FE) or radiosonde.

System Capabilities

Because of the use of the digital, narrow-band receivers, one of the primary capabilities of AMPS is the ability to track multiple flight packages. Each GE can collect and process wind and thermodynamic data from up to six radiosondes at one time. It should be noted that although each AMPS GE has the capability to track up to six radiosondes at one time, the capacity of the Weather Station's MSC computers to process and distribute the data is limited. The MSC can process six radiosondes in batch mode, but if real-time quality control is required, the Upper Air System Coordinator (UASC) can only manage three active flights at one time.

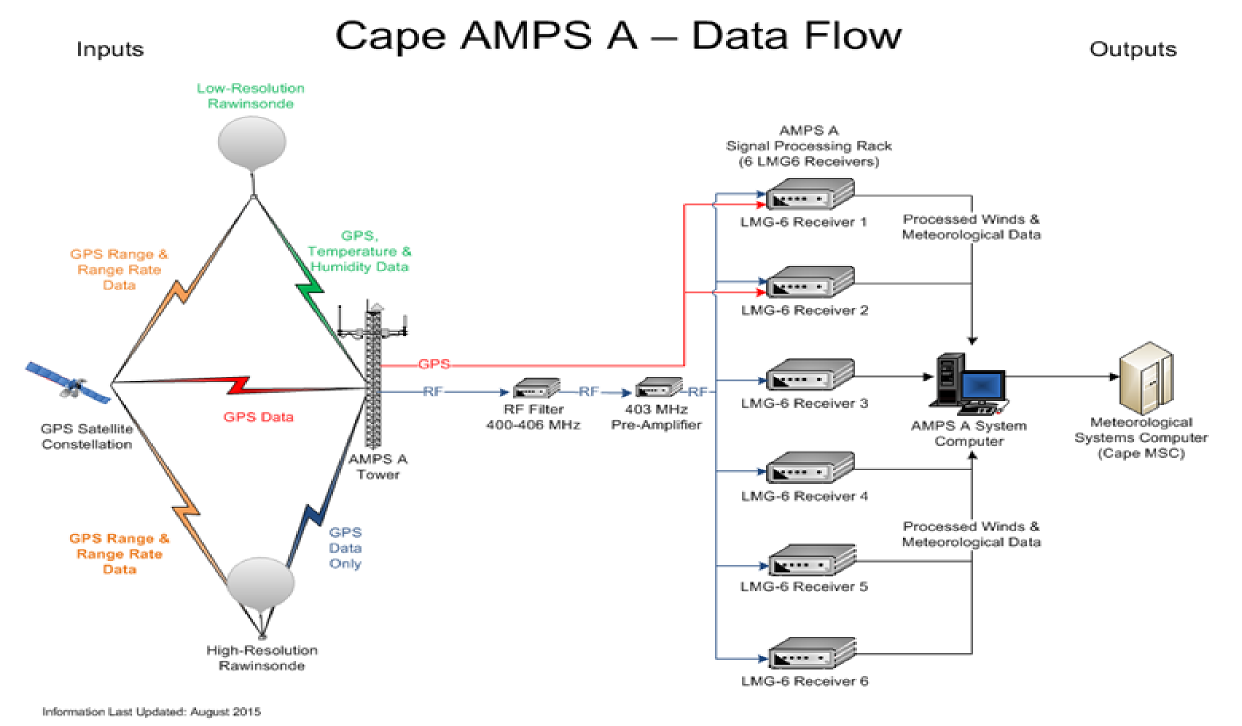

Figure 2-11-1: *AMPS Data Flow*

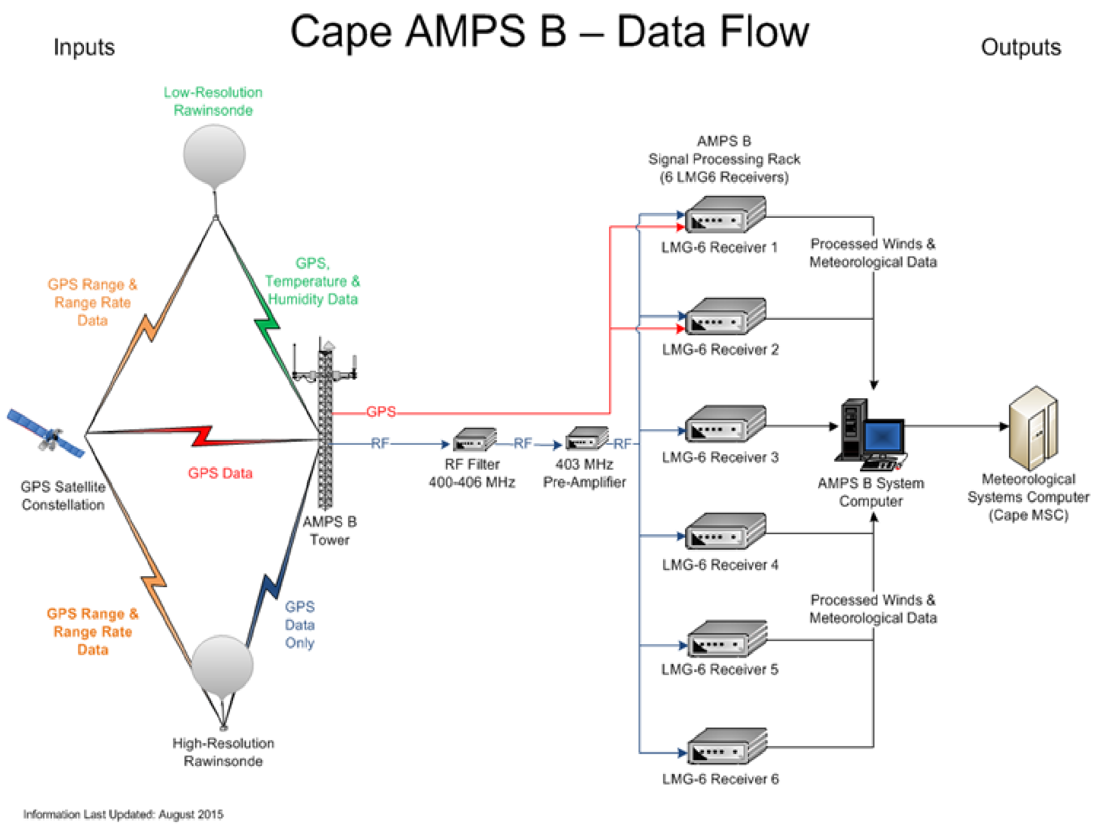

Figure 2-11-2: *AMPS-B Data Flow*

2.11.6 METEOROLOGICAL SYSTEM COMPUTERS

Two Dell PowerEdge R710 servers, two Perle terminal servers and ancillary routers, switches, and patch panels function as the Cape Meteorological System Computers (MSC) (MSC1 and MSC2) computers, located at the CCAFS Weather Station, are the core of the ER upper air data processing system. The MSCs host a series of applications programs that receive, process, and store data from two upper air measurement systems (Jimsphere or AMPS), and then transmit processed meteorological profiles to Range Customers or other designated Range systems.

External Interfaces:

- Range External Interface Network (REIN)
- Meteorological Interactive Data Display System (MIDDS)
- Eastern Range Dispersion Assessment System (ERDAS)
- Single Point Acquisition and Radar Control (SPARC)

2.11.6.1 Communications

The MSC has multiple external interfaces that carry data into and out of the system. Input data is received from the two CCAFS dedicated AMPS tracking systems, and Range Metric radars. The AMPS data is in Transmission Control Protocol/Internet Protocol (TCP/IP) text format and the radar data is in binary format. The CCAFS AMPS tracking systems are connected via direct connection while the Ascension AMPS and two metric radar data lines are connected via asynchronous modems.

Output data is transmitted via fiber optical lines to Cape REIN, available by externally accessing Cape REIN for external Range Users and by Air Force Network (AFN) at Tinker Air Force Base (AFB) to receive upper air data. There are also three dedicated circuits: one for Cape MIDDS, one for Cape ERDAS, and one for Cape LAPS. All the circuits are used to transmit unclassified upper air data to on-Range and off-Range customers.

2.11.5.2 Data Processing

Both MSCs operate under the Red Hat Enterprise Linux Operating System that supports multitasking. The MSC applications software suite was developed by RGNext and consists of approximately 10 formula translation (FORTRAN) applications that control the collection, processing, quality control, archiving, and retransmission of all upper air data.

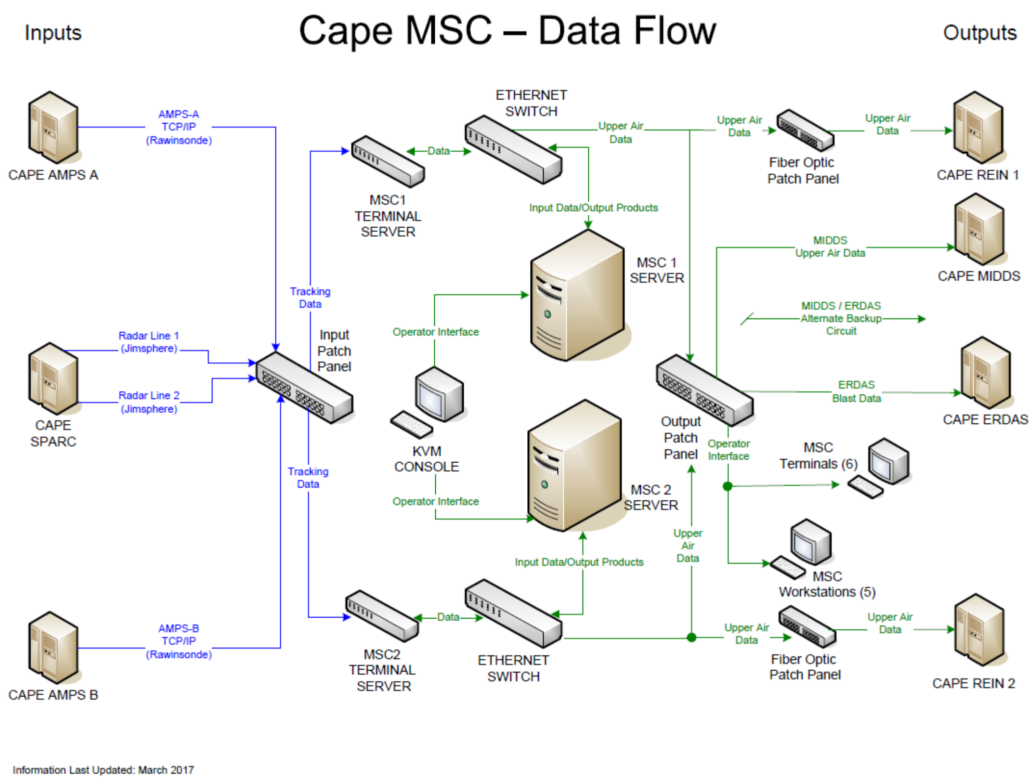

Figure 2-11-3: *MSC System Data Flow*

2.11.7 DOPPLER RADAR WIND PROFILERS

DRWP Theory of Operation: The DRWPs are atmospheric remote sensing instruments that produce information about a volume of the atmosphere above the radars. The radars transmit pulses of electromagnetic energy into the atmosphere and when a pulse encounters a target, the electromagnetic energy is scattered. A portion of the scattered energy will return to the radar and be used to compute the distance to the target via the time delay between transmission and reception and the speed and direction using the Doppler shift.

915 MHz DRWP

The 915 megahertz (MHz) Doppler Radar Wind Profiler Network consists of five Vaisala Inc. Lap®-3000 DRWPs. Of the five DRWPs, one is located on Cape Canaveral Air Force Station

(CCAFS) (South Cape), three are located on Kennedy Space Center (KSC) (False Cape, Merritt Island, and Mosquito Lagoon), and one is located at the Titusville/Cocoa Airport (TICO).

Capability

The 915 MHz DRWP provides estimates of the horizontal and vertical wind components every fifteen minutes. The system provides a continuous characterization of the lower atmosphere between the top of the tall Weather Information Network Display System (WINDS) towers and the lower level of the 50 MHz DRWP. The 915 MHz DRWPs are configured with 100 m range gates and are capable of reaching a vertical range of 5 km for wind measurements. The upper limit of the vertical range is also dependent on the current atmospheric conditions above the radar. Vendor documentation indicates the DRWPs provide wind speed accuracy of <1 meters per second (mps) and wind direction accuracy of <10°.

2.11.8 WEATHER SURVEILLANCE RADARS

The Weather Surveillance Radar (WSR) TDR 43-250 is the Eastern Range's (ER) first Doppler weather surveillance radar. The WSR is a mission-critical system which provides the 45th Weather Squadron (45 WS) with a real-time capability to utilize Doppler radar technology to acquire particle velocity data in addition to range, direction, and reflectivity data within 300 kilometers (km) of its location on Deseret Ranch in Orange County, Florida. This information is critical to the evaluation of launch area weather constraints and for the early detection and warning of adverse weather needed to protect the human and physical resources of the 45th Space Wing (45 SW).

The Weather Surveillance Radar 1988, Doppler (WSR 88D) is the second-generation, operational meteorological radar replacing the non-Doppler meteorological radars of the National Weather Service. The Eastern Range does not own or operate a WSR 88D radar. The WSR 88D located at the NWS Weather Forecast Office in Melbourne, FL is utilized by the 45th Weather Squadron primarily as a backup for the ER's dedicated weather surveillance radar.

2.11.9 WEATHER INFORMATION NETWORK DISPLAY SYSTEM (WINDS)

The WINDS collects, processes, archives, and disseminates data from approximately 317 weather sensors contained within 29 instrumented meteorological towers located at CCAFS, NASA KSC, and remote sites surrounding CCAFS and KSC. Collectively, these towers are equipped with 262 meteorological sensors that make up 12,660 independent measurements each minute. Cape WINDS also collects, processes, archives, and disseminates data from five Range Customer Towers located at Space Launch Complex (SLC)-39B and SLC-41. These towers are equipped with 52 meteorological sensors that make 2400 independent measurements each minute. The combination of the core Cape WINDS towers and Range Customer towers provide 15,060 independent measurements each minute, which are averaged over one minute. The sensor data is transmitted a Virtual Address Extended (VAX) 3800 (base station) with 16 megabytes (MB) of main memory and 400 MB of disk storage. Here the data is collected, processed, archived, and distributed. Tower and sensor, location and implementation, is based on the operational requirements for each tower.

Collectively, data from the WINDS provides the 45 WS, Range Safety, and NASA Safety with a comprehensive, real-time description of the weather conditions from the surface to 150 m in and around CCAFS and KSC. WINDS is considered to be the one of the most densely instrumented meteorological meso networks in continuous operation in the United States.

WINDS Towers

For easy review the towers can be divided into several categories:

Forecast Critical – 19 Towers

The Forecast Critical towers are used by the forecasters in the RWO in the MOC. They are located up to 30 miles north, west, and south of the launch complexes. These towers all have wind speed and direction at the 54 ft level and temperature and relative humidity at the 6 ft level.

Safety Critical – 14 Towers

The Safety Critical towers are used by the Range Safety systems MARSS/ ERDAS. They provide sensor data for Range Safety calculations needed for toxic exhaust, accidental spillage, containment, etc. These towers are configured with wind speed and direction sensors at the 54 ft and 12 ft levels, and temperature sensors at 54 ft and 6 ft levels.

Launch Critical – 7 Towers

The Launch Critical towers are used by various customers. They are at various heights and the sensors are uniquely configured for their operational requirements.

Launch and Safety Critical – 4 Towers

The Launch and Safety Critical towers are used by various customers and Range Safety. They are dual instrumented with identical sensors at opposite corners of the tower and at various levels. The default selection of sensors is "auto select" and selects the sensors most directly on the windward corner of the tower. The leeward corner is not selected. The sensors on either corner of the tower can be forcibly selected if a need arises.

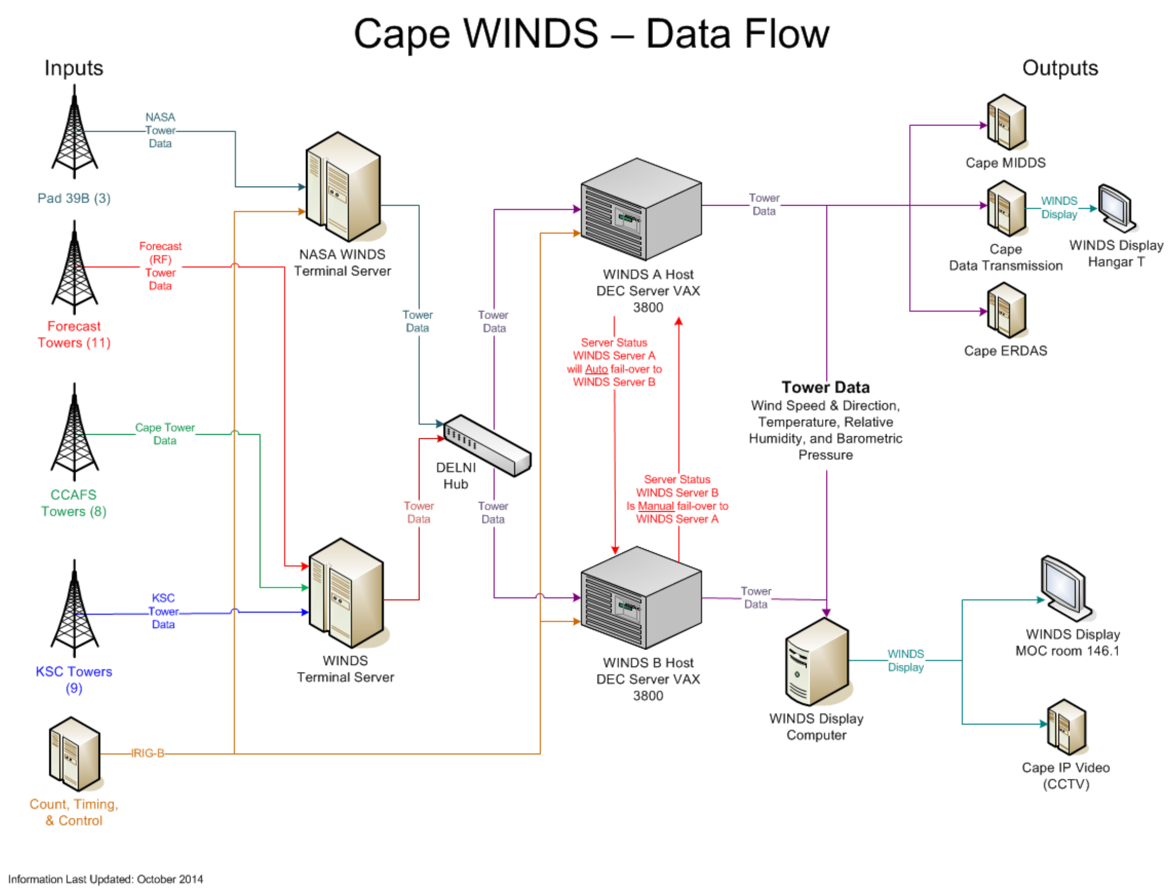

Figure 2-11-4: *WINDS Data Flow*

2.11.10 SURFACE WEATHER OBSERVATION

The Surface Weather Observation system includes the sensors, procedures, and transmission capability used to satisfy requirements to record and disseminate surface weather observation data in support of both daily and launch operations. The data is used by 45 WS, Range Customers, and AFWA.

Required data for the surface observations include:

- Wind speed and direction
- Max wind speed
- Visibility
- Ambient air temperature
- Dew point temperature
- Sky conditions
- Station pressure (Altimeter reading)
- Weather (e.g., precipitation) or obstruction to visibility (e.g., fog, smoke)
- Remarks that provide additional information for clarity or safety

There are two weather stations located on the ER; the CCAFS and KSC Weather Stations.

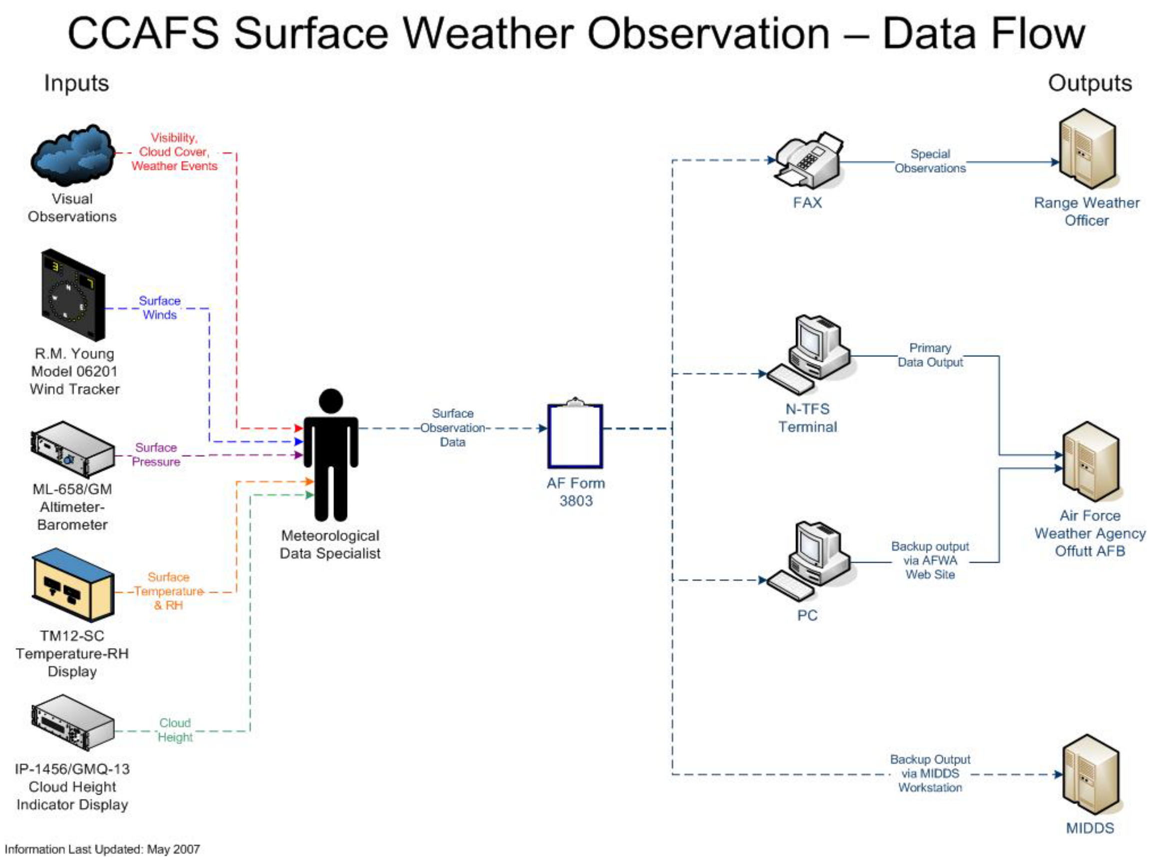

Figure 2-11-5: *CCAFS Surface Weather Observation Data Flow*

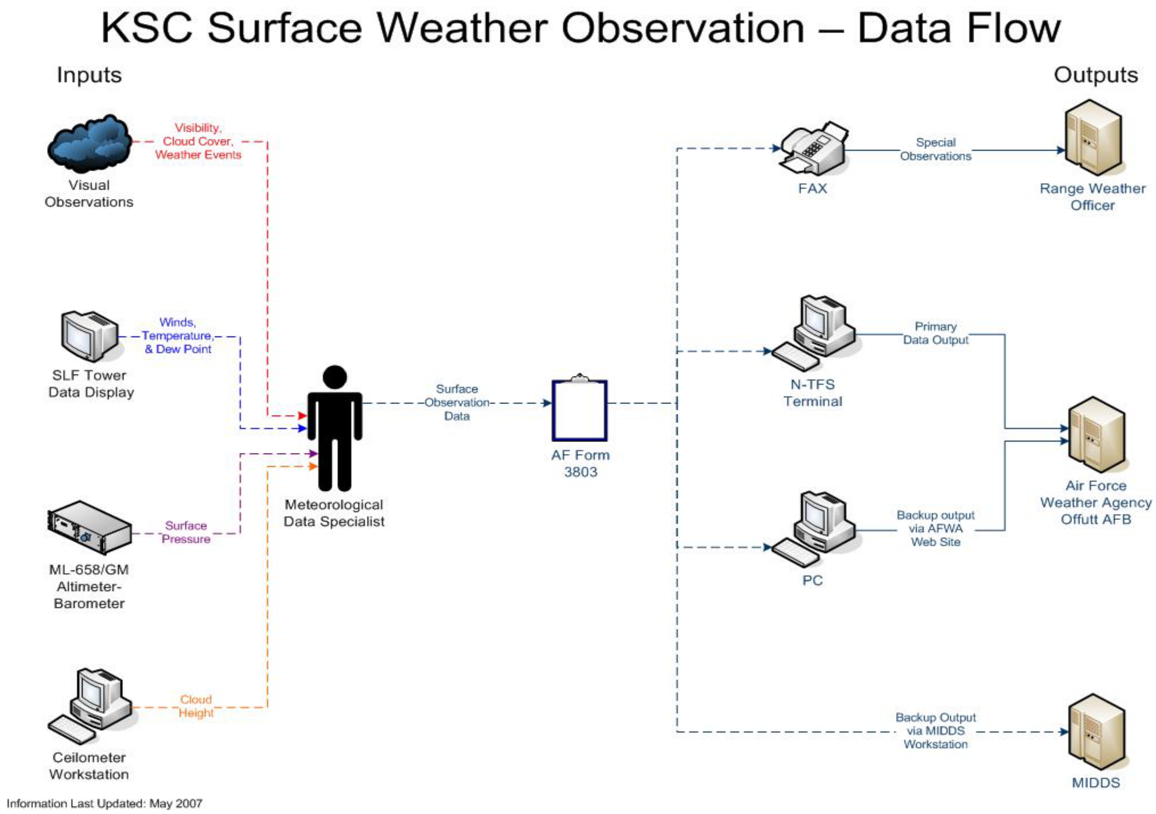

Figure 2-11-6: *KSC Surface Weather Observation Data Flow*

2.11.11 LAUNCH PAD LIGHTNING WARNING SYSTEM

The LPLWS system consists of 31 field mills scattered about the KSC and CCAFS complexes. Lightning and Tropical Rainfall Measuring Mission (TRMM) data is collected from the field mills by the Base Station Computer (BSC). It is then transferred to the Host Computer Function (HCF) for processing and archiving. Once the data is processed, it is sent to the Display Computer Function (DCF) and to MIDDS for data collection to provide real-time status of flashes and lightning potential to the RWO. The 50 hertz (Hz) unprocessed data is sent directly to NASA along with the TRMM data.

The LPLWS was designed to measure the electric field intensity at ground level. The field mill network consists of 31 electric field mill sites, with one mill located at each site. Measurements of

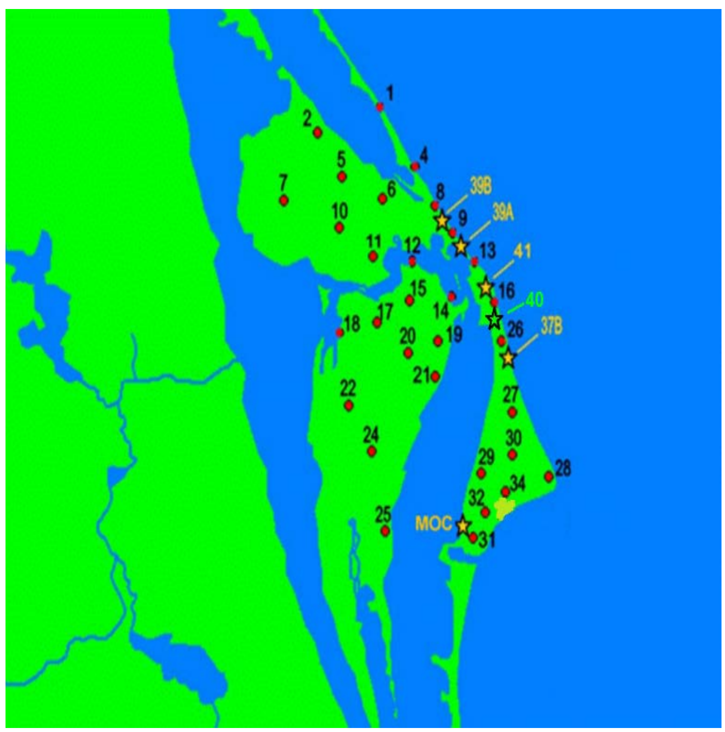

Figure 2-11-7: *KSC/CCAFS LPLWS Site Locations vs. Layout*

the surface electric field intensity are sampled at a rate of 50 Hz at each field mill site and passed to the BSC once each second. The network includes 23 sites at KSC and 8 sites at CCAFS. An illustration of the LPLWS field mill site layout is shown in Figure 2-11-7.

LPLWS gathers, displays, and archives measurements of the surface electric field in support of CCAFS and KSC operations including launches, propellant transfer and loading, pad operations, and general personnel safety. Operationally, field mills within 5 nautical miles (nmi) of a launch site are termed “launch critical” sites and are expected to be operational during the pre-launch countdown in order to evaluate the potential for natural or triggered lightning. Such sites may be specially tagged by LPLWS for alarm conditions.

2.11.11.1 Data Flow

- The Inter-Range Instrumentation Group Format B (IRIG-B) timing signal triggers the event that starts the LPLWS data processing. The timing signal is sent to the Base Station every second. The base station processes are event driven.
- IRIG-B signal creates an event in the master CPU for a data request and the master then relays it to the slave CPU. The slave then formats a data request and sends it to all the field mills requesting data and awaits for the response.
- Field mills respond to data request and send data that they have been sampling from its sensor. A field mill samples its data at a 50 Hz rate.
- The slave CPU receives data and notifies the master CPU which alerts all requesters that data is available.
- The Base Station Tape Archive program, one of the data requesters, archives the raw data to tape.
- The strip printers, another data requester, will print the raw data to its charts.
- HCF, another data requester, retrieves the 50 Hz raw data from the Base Station via a Berkeley socket.
- The HCF then relays the raw 50 Hz and TRMM data to NASA via T1.
- The HCF is also reduces the raw data from 50 Hz to 10 Hz by averaging every 5 samples.
- The HCF processes the 10 Hz data into 1 minute averages, 1 minute grids, and asynchronous flashes.
- The HCF archives three types of data to tape; the reduced 10 Hz raw data, archive (ARC), and FLASH data to tape.
- HCF sends the processed data to the DCF for display in the RWO.
- HCF sends the processed data to MIDDS.

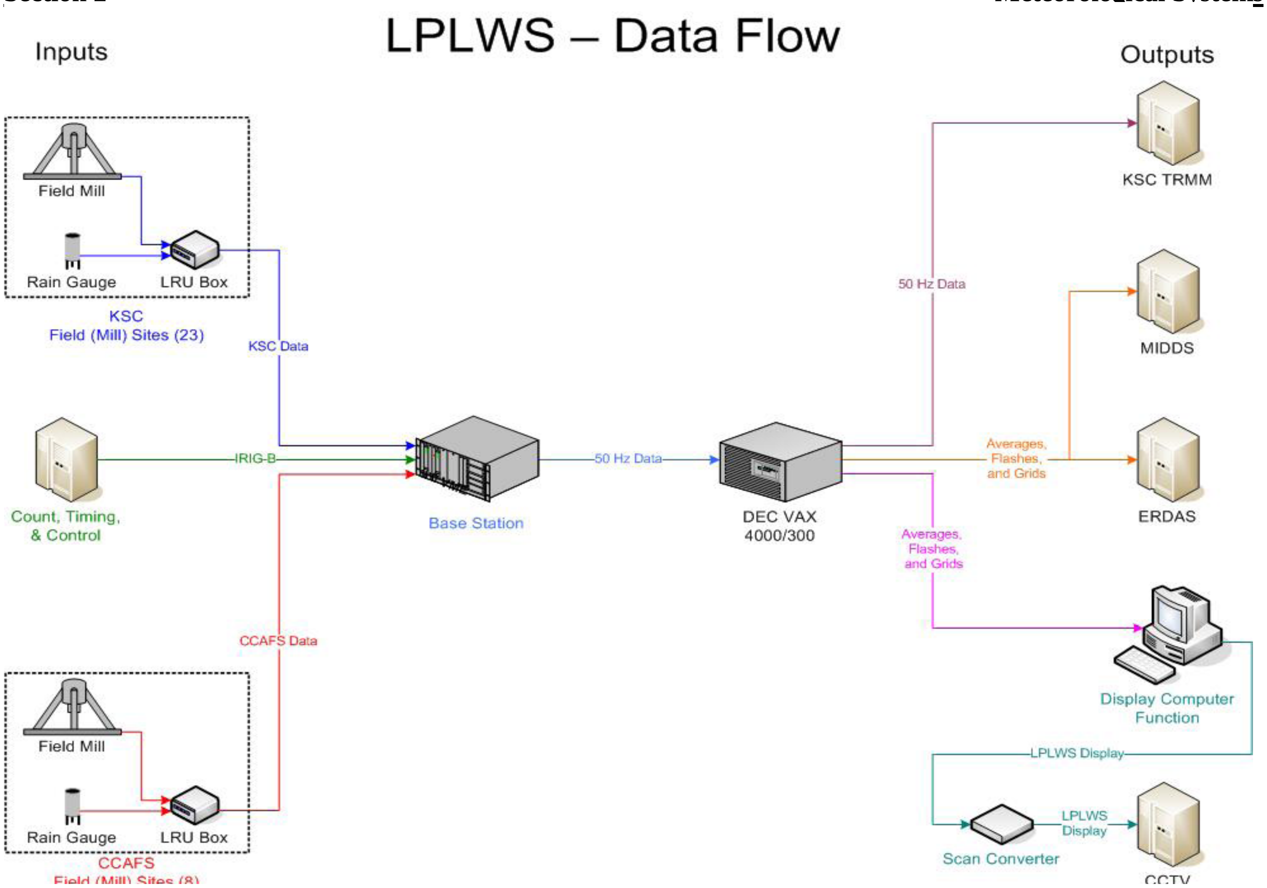

Figure 2-11-8: *LPLWS Data Flow*

2.11.11.2 Operational Impact

Impact to the LPLWS System when various components fail:

- HCF Computer – Impact Critical
- No lightning data from the 31 field mills. NASA will not see any TRMM data.
- Base Computer – Impact Critical
- No lightning data from the 31 field mills. NASA will not see any TRMM data.
- IRIG-B Timing to Base Station – Impact Critical
- No data from the 31 field mills. NASA will not see any TRMM data.
- DCF Computer – Impact Critical
- No data displayed to the RWO. Lightning alerts and alarms will not sound.
- Field Mills – Impact Critical/Moderate
- If the field mill is within 5 nmi of launch pad it is most likely launch critical. Outside of the 5 nmi launch pad criteria, not critical.
- Strip Printers – Impact Minor
- No hard copy printout will be provided. Hard copies are not usually required.
- Maintenance Control Station – Impact Minor
- Hangar T Meteorological Maintenance Facility – Hangar T will lose LPLWS connection, field mill maintenance testing ability, and local strip chart configurability.
- Maintenance Control Station – Impact Minor
- MOC – RWO will lose LPLWS connection, field mill maintenance testing ability, and local strip chart configurability.

- DEC Server/LPLWS Terminal Server – Impact Minor
- Office terminal will be non-functioning and require System Administrator to move to a working terminal.

2.11.11.3 Field Mills Distances

Figure 2-11-9 is a table that reflects the distances between field mills and launch pads. The yellow denotes 5 nmi or less from the launch pad for each launch vehicle. Additionally, field mills provide the same function in the vicinity of areas where propellant loading or handling work on elevated metal structures or similar Range activities require the early forecast of potential lightning.

Field Mill Site	17A	17B	37B	39A	39B	40	41
1	16.3	16.4	11.7	6.7	5.2	9.8	8.5
2	16.6	16.6	12.5	7.7	6.3	10.6	9.5
4	13.6	13.7	8.9	3.8	2.4	7.0	5.7
5	14.5	14.6	10.4	5.8	4.5	8.7	7.6
6	13.0	13.0	8.6	3.9	2.6	6.8	5.7
7	15.2	15.2	11.7	7.8	6.7	10.2	9.4
8	11.9	12.0	7.2	2.1	0.7	5.2	3.9
9	10.7	10.8	5.9	0.8	0.8	3.9	2.6
10	12.8	12.9	9.1	5.2	4.3	7.5	6.7
11	11.1	11.2	7.3	3.7	3.1	5.7	5.0
12	10.1	10.2	5.9	2.0	1.8	4.1	3.3
13	9.4	9.5	4.5	0.9	2.2	2.5	1.2
14	8.2	8.3	3.7	1.8	3.0	1.9	1.4
15	8.8	8.9	5.0	2.8	3.2	3.6	3.2
16	7.7	7.8	2.7	2.6	4.0	0.8	0.7
17	8.9	8.9	5.9	4.4	4.7	4.9	4.8
18	9.7	9.7	7.4	6.1	6.1	6.6	6.5
19	6.8	6.9	3.1	3.6	4.7	2.4	2.8
20	7.1	7.1	4.3	4.5	5.3	3.8	4.1
21	5.6	5.7	3.1	5.0	6.1	3.2	4.0
22	7.7	7.7	7.0	7.7	8.2	7.0	7.4
24	6.1	6.1	6.7	8.7	9.5	7.3	8.0
25	5.4	5.3	8.3	11.5	12.4	9.4	10.4
26	6.1	6.2	1.1	4.0	5.5	0.9	2.2
27	3.4	3.5	1.7	6.8	8.2	3.7	5.0
28	2.1	2.2	4.7	9.8	11.2	6.7	8.0
29	1.4	1.4	4.2	8.8	10.1	6.0	7.3
30	1.7	1.8	3.4	8.4	9.7	5.3	6.6
31	2.1	2.0	6.8	11.3	12.5	8.5	9.8
32	1.0	0.9	5.7	10.4	11.6	7.5	8.8
34	0.2	0.3	4.9	9.8	11.1	6.8	8.1

Figure 2-11-9: *Field Mills Distances from Launch Pad*

2.11.11.4 Tape Archiving

- Base Station – Raw 50 Hz data collected from the field mills including TRMM data.
- HCF
- Reduced raw 10 Hz data (five samples averaged into one and no TRMM data).
- Processed 1 minute averages and grids.
- Asynchronous flashes.

2.11.12 MESOSCALE EASTERN RANGE LIGHTNING INFORMATION NETWORK (MERLIN)

The Cape Mesoscale Eastern Range Lightning Information Network (MERLIN) is the replacement for the legacy Cape 4-Dimensional Lightning Surveillance System (4DLSS). Cape MERLIN is used by the 45th Weather Squadron (45 WS) to support real-time data collection of lightning events required to support the evaluation of Lightning Launch Commit Criteria (LLCC), launch vehicle and payload protection, and daily operations.

Cape MERLIN is comprised of two Total Lightning Processors (TLPs), Fault Analysis and Lightning Location System (FALLS) server which contains the Total Lightning Database (TLD) module, ten Total Lightning Sensors (TLS) and six client workstations -- the Cloud-to-Ground (CG), Cloud-to-Cloud (CC), and FALLS displays are in Range Weather Operations (RWO), one in the Applied Meteorological Unit (AMU), one at the Hangar T Maintenance Facility, and one at the NWS in Melbourne. The system also includes a feed from a satellite dish outside the MOC and a receiver for the reception of raw data from a subset of ten NLDN sensors.

The ten Cape MERLIN TLS sensors detect inter-cloud and intra-cloud lightning using very high frequency (VHF) interferometry and detect cloud-to-ground lightning using low frequency (LF) combined magnetic direction finding and time-of-arrival (TOA) technology. All of the remote sites communicate with the TLP server via T1 dedicated communications lines. The Satellite Boulevard (Blvd) site is unique as it is powered by solar energy and has a 4.4 Gigahertz (GHz) hardened wireless communications link between the site and the KSC 500-foot (ft) tower (also known as Cape Weather Information Network Display System (WINDS) Tower 0313). This band of frequencies is restricted by the Federal Communications Commission (FCC) and National Telecommunications and Information Administration (NTIA) for Federal Government use only.

Typically within any lightning flash event, there are multiple ground strokes, each of which transfers charge from the cloud to the ground. A flash is typically comprised of two to four strokes, but may contain as few as one and as many as fifteen or more strokes. The number of strokes in a flash is frequently referred to as the flash multiplicity. The TLS sensor has sufficient time resolution and sensitivity to detect the individual strokes. For many flashes, the subsequent strokes (strokes which occur after the first stroke of a flash) contact the earth at the same strike point as the first stroke because they travel through the channel established by the first stroke. However, 30 to 50 percent of all flashes contain strokes that produce different ground strike points, separated by a few hundred meters to several kilometers or more. For practical purposes, researchers have defined a flash as consisting of all CG discharges which occur within 10 km of each other and within a one-second time interval.

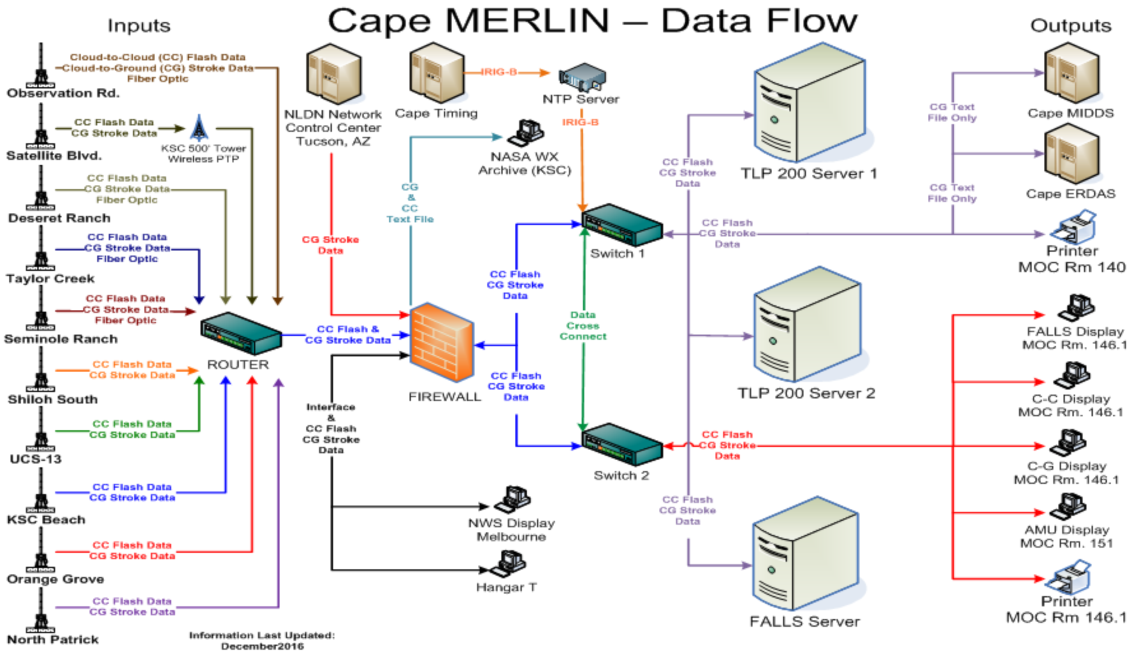

Figure 2-11-10: *MERLIN Data Flow*

2.11.12.1 Cloud-to-Ground

CG Remote Sites

The ten TLS sensors in the Cape MERLIN network have the capability to detect Cloud-to-Cloud (CC) lightning using interferometry and Cloud-to-Ground (CG) lightning strike points using TOA and magnetic direction-finding technology.

2.11.12.2 Cloud-to-Cloud Sensors

The VHF antenna assembly includes five dipole antennas integrated into the TLS sensor and measure VHF radiation emitted by CC lightning sources between 111 to 117 Megahertz (MHz). Using interferometry, the CC sensor measures phasing differences between the closely spaced VHF antennas to determine azimuth (direction of arrival) of the CC lightning source. Using triangulation with two or more sites, the differences between the arrival times can easily be translated into precise distance from the source (latitude/longitude). It should be noted that altitude (height) of the CC lightning source cannot (currently) be processed with the Cape MERLIN system.

Figure 2-11-11: *Typical Cloud-to-Cloud Sensor Site*

Displays

The Lightning Tracking Software LTS2005 client workstation is a CC/CG lightning display and warning system that receives processed data from the TLP server. The data received by the workstations can be used to monitor an area of concern or warning area, to alert and notify appropriate personnel of lightning activity within a specific warning area and used to display and plot lightning activity in the area. The LTS2005 software application allows storage, display, and replay of lightning data. It can also be used to:

- Display user-configured warning areas over an area map
- Define and configure specific warning areas for monitoring
- Configure Alert conditions for warning areas
- Compute and display lightning density
- Compute and display lightning cells and core based on density
- Replay and view archived lightning over an area map
- Configure color keys (used for the visualization of lightning activity based on a time-period selection)

Figure 2-11-12: *MERLIN Remote Site Sensor Locations*

The LTS workstation software operates on the Windows 7 operating system platform. There are a total of five Dell Precision Model T3500 LTS2005 workstations: three are located at the MOC (two in the RWO and one in the AMU), one is located in Hangar T and one is located in the NWS Melbourne Office.

2.11.12.3 Total Lightning Processor (TLP) Servers

The TLPs are the single most important element in MERLIN. TLP #1 (primary) and TLP #2 (hot standby) process raw lightning data received from each of the ten Cape MERLIN TLS sensor sites and from the subset of data from nearby southeastern NLDN sensors via the satellite feed from Vaisala Incorporated in Tucson, Arizona. Based on these signals, the TLPs calculate the lightning location and TOA for CG and CC lightning events and displays lightning information to the various workstations and displays on the MERLIN network as well as external data sources.

The TLP provides MERLIN data to the FALLS server in the MOC Room 140, CC and CG LTS2005 workstations in the MOC RWO, LTS2005 workstation in the MOC AMU area, LTS2005 workstation in Hangar T and a LTS2005 workstation at the NWS in Melbourne, Florida. The TLP also provides CG tabular data only to the MIDDS and ERDAS internal serial connections.

Each TLP (located in Room 140 of the MOC) is configured with a Dell PowerEdge R710 Server with Red Hat Enterprise Linux (RHEL) Version 5.5 as the operating system environment. The TLPs also utilize two hot-swappable 3.5-inch 1-Terabyte (TB) removable Hard Drives, a Redundant Array of Independent Disks-1 (RAID-1) configuration and two hot-swappable 400W Server Power Supplies in primary and hot-spare configuration.

The major functions of the TLP include:

- Process raw sensor data and calculate lightning event locations
- Create stroke and flash data in default and custom data formats
- Provide lightning solution data for remote displays
- Command and control of sensors
- Sensor and network performance monitoring
- Storage and archiving of raw and processed data
- Reprocessing of raw data

2.11.13 NATIONAL LIGHTNING DETECTION NETWORK (NLDN)

The NLDN is a commercial provider of lightning data, owned and operated by Vaisala, Inc. The network consists of over 100 sensors located throughout the contiguous 48 states. The sensors are remote ground-based IMProved Accuracy from Combined Technology (IMPACT) and Enhanced Sensitivity and Performance (ESP) lightning sensors. The 45 SW has a lease agreement with Vaisala, Inc. to access this information and to display it in near real-time at the RWO in the MOC.

NLDN detects CG lightning flash and stroke information, including:

- Time
- Location
- Polarity
- Amplitude
- Flash Multiplicity (flash data only)

The current system only provides **FLASH** data. Flash detection efficiency is 95 percent and median location accuracy is 500 m.

Vaisala, Inc. is responsible for the operation and maintenance of NLDN. However, as the data flow diagram illustrates, equipment within the dashed lines represents the ER’s maintenance boundary, where RGNext performs the maintenance to the Line Replaceable Unit (LRU) level. The items includes the antenna, receiver, DigiPort terminal server, and the computer processing and display equipment located at the MOC.

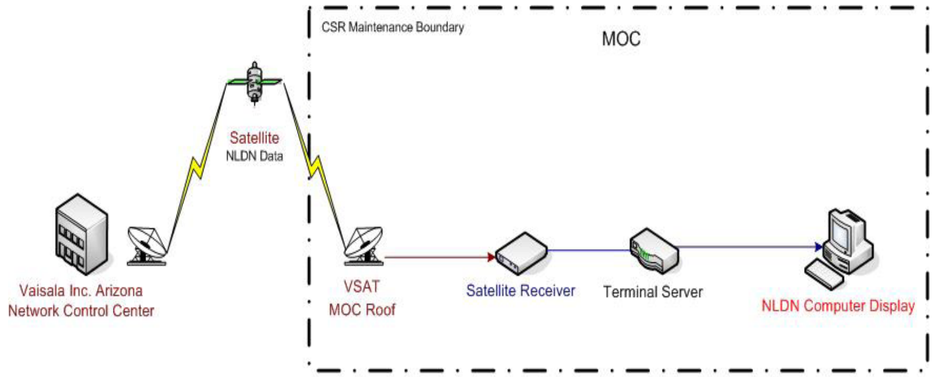

Figure 2-11-13: *NLDN Data Flow*

2.11.14 EASTERN RANGE DISPERSION ASSESSMENT SYSTEM (ERDAS)

The Cape Eastern Range Dispersion Assessment System (ERDAS) is an extension and enhancement of the Meteorological and Range Safety Support (MARSS) system. It combines MARSS with a previously separate Cape ERDAS system. The MARSS portion of the system is designed to acquire, process, and disseminate near-real-time meteorological data and toxic diffusion/blast hazard model output. This functionality consists of two primary Computer Software Configuration Items (CSCI), the Preprocessor (PPR or PPRO) WEMPPR, and the Monitoring and Display Station (MDS) WEMMDS. Data acquisition is performed by the Preprocessor, which reads the data streams, applies quality control analysis to the meteorological data, and disseminates all results to MDS workstations. The Preprocessor also monitors the communications status with all workstations in the network. When a previously disabled workstation comes back online, the preprocessor retransmits data to it. Preprocessors also archive data. Data is saved online for five weeks and should be saved to 4 millimeter (mm) tape once a month, under system administrator command.

Additionally, the Preprocessor maintains a set of controlled files, which, when updated by the system administrator, are distributed to all active workstations in the network.

MDS workstations receive meteorological data from a preprocessor, allowing them to create meteorological and range safety displays. Meteorological data also feeds the REEDM and BLASTX (Blast Damage Assessment) models available on each MDS. Each MDS retains the capability to display output results generated by BLASTX and REEDM as executed on the Range computer, although this functionality is no longer used.

2.11.15 WEATHER RECONNAISSANCE AIRCRAFT

2.11.15.1 System

The WRA, a fleet of aircraft owned by Jet Management, Incorporated (JMI), provides airborne real-time observation and reporting of weather phenomena associated with LCC to the 45 WS. The WRA may be requested to deploy during any expendable rocket launch to make observations of local weather in the KSC and CCAFS area.

Figure 2-11-14: *Weather Reconnaissance Aircraft*

The WRA usage is committed via the ER Scheduling process, at the request of the LWT. During the launch countdown, the WRA is in continuous communication with the LWO, via VHF or ultra-high frequency (UHF) radio. The WRA pilot receives a mission objectives briefing from the LWO no later than 2.5 hours prior to launch and obtains clearance to proceed to the requested location from the applicable Air Traffic Control agency. The operational mission scenarios depend largely on the expected or current weather conditions and the types of aircraft available.

If threatening or anomalous weather patterns warrant, the WRA may be sent far from the launch site, and have been sent as far away as the Tampa Bay area in West Central Florida. The WRA has the capability of remaining on station for up to 5 hours, depending on the type of aircraft and the distance from its base-of-operations to the launch site. Local landing and refueling operations may be utilized, depending on aircraft range and required time on-station.

The WRA primarily supplies visual observations via pilots to the Deputy LWO stationed in the MOC at CCAFS. Only the pilot or trained observer reports are provided and they are first-hand observations of the height of cloud bases and tops, cloud transparency, ground distance from cloud edge to pad, and the presence of precipitation. Other observations may be requested as needed to verify that weather conditions are safe for launch.

2.11.15.2 Operations

The WRA is capable of operating under all weather conditions, at any time of day, up to an altitude of 40,000 feet. Its minimum rate of climb is 3300 feet per minute, and is capable of speeds up to 400 knots. The aircraft is in compliance with all required Federal Aviation Administration (FAA) standards, and maintains all required FAA certifications. Instrumentation Flight Rule (IFR) flight plans are filed with the Saint Petersburg Flight Service Station (FSS), which contain the required altitude reservation (ALTRV) of the mission and an Identification Friend or Foe (IFF) code.

2.11.15.3 Limitations

The WRA are based at the Sanford International Airport. The WRA must be clear of the launch danger area by L–4 minutes, which also limits their effectiveness in reporting launch pad weather conditions near the time of launch.

At present, the information is relayed via voice communication over Range networks. This can be accomplished from any of several communication consoles in the RWO. Currently, the WRA is unable to communicate via UHF since the airborne and ground equipment is not available. The equipment is on order and will be installed upon receipt. An estimated completion date has not been established.

2.11.16 METEOROLOGICAL DATA DISPLAY SYSTEM (MIDDS)

2.11.16.1 System

The Meteorological Data Display System (MIDDS) is the primary data collection, management, and display tool used by the 45 WS to provide weather analysis, forecast, and warning support to the Range Customers and Launch Customers.

The Range Customers and Launch Customers include:

- AMU at the MOC
- CCAFS
- NWS (Melbourne office)
- NASA
- JSC (NASA)
- MSFC (NASA)

The ER MIDDS is also a critical meteorological data source for the 45 WS/SE for toxic plume dispersion and vehicle blast debris prediction calculations and is essential to Range Customers for vehicle wind loads analysis and trajectory shaping.

Figure 2-11-15: *GOES Antenna at the MOC*

2.11.16.2 Capabilities

ER MIDDS provides an extensive array of capabilities to retrieve, analyze, and display alphanumeric (tabular), graphic, and image data.

Essential local applications:

- Management and display of satellite imagery from the Geostationary Operational Environmental Satellite (GOES) spacecraft. Overlays of other meteorological data on the satellite imager can be generated.
- Management and display of National Center for Environmental Prediction (NCEP) numerical model initial analyses and forecasts. The NCEP model products are received four times a day for the North American Mesoscale (NAM), Global Forecast Model (GFS), and other models.
- Analysis and display of meteorological observations. This provides forecasters with the capability to graphically display and analyze surface and upper air data.
- Retrieval of meteorological observations and bulletins in text format. This provides the forecasters with the capability to retrieve and review virtually any meteorological observation and bulletin in text format.
- Provides the LWO and forecasters with the information needed to develop mission-specific briefings for both launch and routine operations, which are disseminated Range-wide via closed-circuit television (CCTV).

2.11.16.3 Inputs

- The National Oceanic and Atmospheric Administration PORT (NOAAPORT) and GOES are received via antennas at the MOC.
- MSC data new file formatted radiosonde is serial.
- JSC and MIDDS are connected using Transmission Control Protocol/Internet Protocol (TCP/IP) over a dedicated line.
- WSR 74C sends Tagged Image File Format (TIFF) files to MIDDS using a remote copy.
- 50 MHz and the five 915 MHz radar wind profilers data is serial.

2.11.15.4 Outputs

- JSC has access to all ER data, real-time. Without a connection to JSC the ER would lose model point data, which is used for weather briefings.
- MSFC gets real-time data sent through the firewall.

- ERDAS is sent a suite of weather products. Only 50 MHz and 915 MHz profiler data is needed for launch operations. While not truly a requirement, it nicely bridges the data between surface winds (0-500 ft) and radiosonde data (1600 ft and up).
- Titan workstations provide the full suite of meteorological products to CCAFS, KSC, and Patrick weather stations.
- Shuttle workstations provide the full suite of meteorological products to forecasters and LWO in the RWO. Each Shuttle workstation has two displays and a CCTV output. The LWOs scrutinize satellite images, gridded model data, surface observations, and other products specific to each mission. The LWOs make launch recommendations based on specific criteria for each mission.
- Although there are four workstations for complete coverage and minimization of network load, if a workstation went down during a mission, other neighboring workstations would be available for double duty.

2.11.16.4 Limitations

- For MIDDS users, the program is difficult to learn and constant use is required to maintain proficiency, and therefore, the full capabilities of MIDDS may never be utilized.
- The MIDDS ingests high volumes of data, which may cause response times to be slow. Additionally, based on the constantly evolving needs of the MIDDS community, the program requires regular modifications and updates. However, there is minimal staffing available to assist in maintaining and upgrading the software and hardware.
- Limited ability to obtain down converters for lightning protection. The vendor no longer supports the operational down converters. Once the supply of down converters has been exhausted, the work around is to download satellite images from the JSC MIDDS.

2-12 AREA SURVEILLANCE SYSTEMS

2.12.1 OVERVIEW

The 45th Space Wing Safety (45 SW/SE) establishes special use airspace; warning areas, restricted areas and launch hazard areas. The Federal Aviation Administration (FAA) and United States Coast Guard (USCG) issue special warnings (Notice to Airmen and Notice to Mariners) prior to launch activities. The EWR 127-1, AFSPCMAN 91-710, and AFSPCMAN 91-711 require that these areas be monitored to protect the public and launch vehicles.

2.12.2 AREA SURVEILLANCE SUPERSYSTEM

The Area Surveillance supersystem is designed to detect vessels or aircraft that will or have intruded into the Launch Danger Zone (LDZ). The EWR 127-1, AFSPCMAN 91-710, and AFSPCMAN 91-711 require launch area air and sea surveillance of the portions of the LDZ within the coverage capabilities of local land based radars or support aircraft. The LDZ is a hazardous launch area that is defined as the combination of the sea surface area and air space measured from the launch point and extending downrange along the intended flight azimuth.

The Area Surveillance supersystem provides surveillance data on the location and movement of sea surface vessels and aircraft, enabling the Surveillance Control crew to direct support assets to intercept and divert aircraft and vessels out of the LDZ. The Area Surveillance supersystem consists of two air surveillance radars, two sea surveillance radars, an Automatic Identification System (AIS) receiver, and the Surveillance Control Display System (SCDS).

2.12.3 ASR-11/GPN-30 AIR SURVEILLANCE RADAR

The Air Surveillance Radar-11 (ASR-11)/GPN-30 is a tower mounted, unattended S-Band radar that is designed to detect, track, and identify air targets. There are two of radars utilized in the Area Surveillance supersystem.

The ASR-11 is a non-ER asset located at Melbourne International Airport that provides air surveillance coverage of Melbourne, Patrick AFB, and surrounding areas. It is used by the Melbourne Tower for approach and departure control and for air surveillance during launch operations.

Although the ASR-11 is a non-ER controlled asset, the ER still receives a data feed from the radar. The GPN-30 is an ER asset located at the Shiloh Mobile Intercept Ground Optical Recorder (MIGOR) site on Kennedy Space Center (KSC) and provides air surveillance coverage for KSC, Cape Canaveral Air Force Station (CCAFS), and surrounding areas. It is used by the SLF tower for approach and departure control and for air surveillance during launch operations.

Figure 2-12-1: *Shiloh GPN-30*

These radars integrate a primary Doppler radar that tracks airborne targets, and a secondary radar that tracks and identifies airborne targets while providing air surveillance data to a range of roughly 60-120 nm. Control of these radars is executed at facilities near the radar. The GPN-30 is controlled from the SLF Tower facility.

The ASR-11 and GPN-30 are comprised of:

- A Primary Surveillance Radar (PSR) system with weather channels
- A Monopulse Secondary Surveillance Radar (MSSR) system.

The Primary Surveillance Radar (PSR) system is a basic search radar system that provides aircraft target and weather detection. It uses a single frequency to perform skin tracking, transmitting a signal to bounce off targets and receiving the reflected returns. It provides target range and azimuth data within a 60 nm radius. An advantage of this system is that it can detect aircraft with or without a beacon transponder system, however, it also false target returns such as weather.

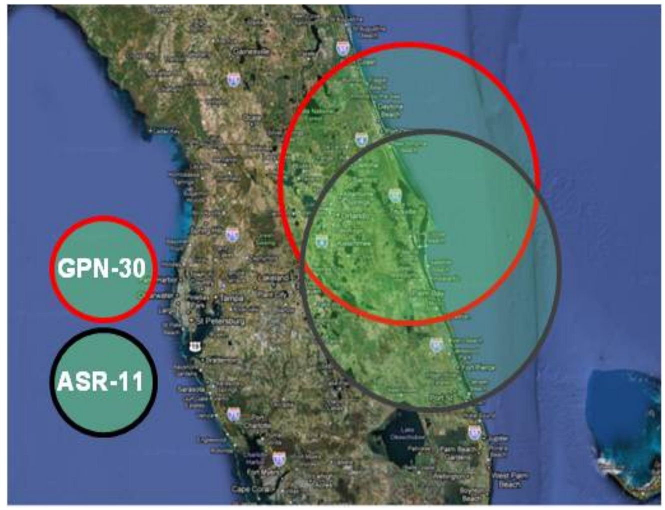

Figure 2-12-2: *Primary Surveillance Radar Coverage (PSR)*

The Monopulse Secondary Surveillance Radar (MSSR) system is a secondary radar or beacon system that provides cooperative aircraft target detection and identification. The MSSR uses two frequencies to interrogate an aircraft's transponder and receive pulse-coded replies via the beacon antenna system. Beacon radar signal strength is much greater than the reply from a primary radar system. Consequently, the power required at each end of the link (interrogator and transponder) is much less than is required with a primary radar system, allowing for a greater detection range. The MSSR provides the range, azimuth, beacon code identity, and pressure altitude of transponder-equipped aircraft operating within a 120 nm radius.

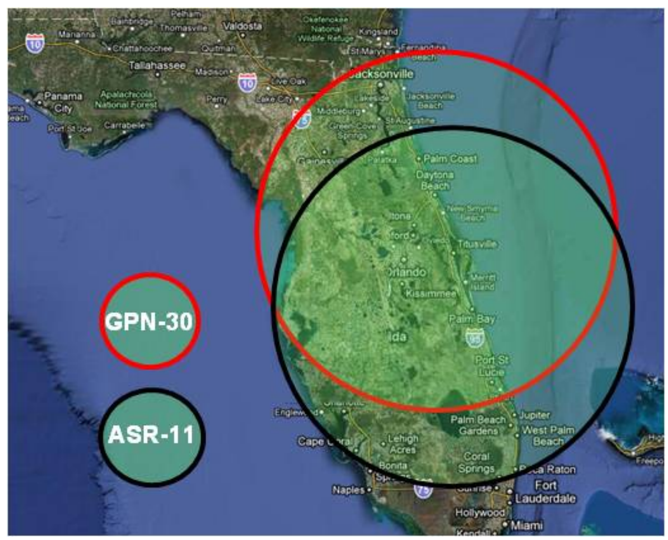

Figure 2-12-3: Monopulse *Secondary Surveillance Radar Coverage (MSSR)*

In order for an aircraft to be detected, it must have an operational transponder capable of responding. Not all aircraft are equipped with transponders, while some transponders may malfunction.

The MSSR transmitter generates distinctive RF transmissions called interrogations. Interrogations are the transmission of a series of 8 μs pulse pairs. The spacing between pulses determines the Mode of interrogation. The interrogator transmissions activate the transponder in the aircraft, causing it to produce RF bursts (coded pulses) up to 2,000 watts peak power, which are received by the MSSR receiver. The MSSR interrogator is capable of interrogating in four different modes.

- **Mode 2**: Mode 2 is only used if the interrogator is at a joint use site (FAA/DoD). Mode 2 is two 0.8 µs pulses spaced 5 µs apart (only used by military)
- **Mode 3/A**: Mode 3/A provides the aircraft's identity code. Mode 3/A is two 0.8 s pulses spaced 8 µs apart
- **Mode C**: Mode C provides the aircraft's pressure altitude. Mode C is two 0.8 µs pulses spaced 21 µs apart
- **Mode B**: Mode B is only used for testing purposes. Mode B has a spacing of 17 µs that is used with the MSSR Remote Site Monitor (MRSM) or parrot site. The MRSM is typically located 0.5 nmi to 10 nmi from the radar site and has a clear line-of-sight to the Large Vertical Aperture (LVA) antenna. The MRSM is basically a transponder used to check the accuracy of the interrogator. The site location of the MRSM is surveyed, so its exact location is known

Normally, the MSSR alternates between transmissions of Mode 3/A for identity code and Mode C for altitude.

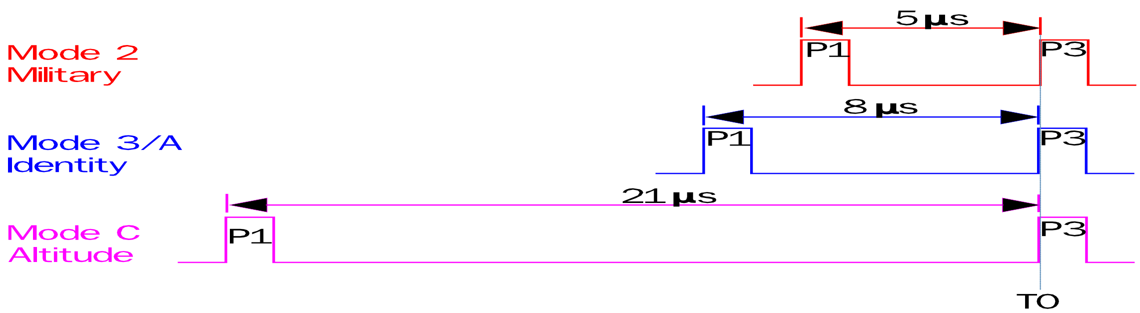

Figure 2-12-4: *MSSR RF Bursts*

The MSSR system is slaved to the PSR system to:

- Allow display of radar and beacon information on a common display or radar scope
- Use the data from both systems to positively identify radar returns as aircraft

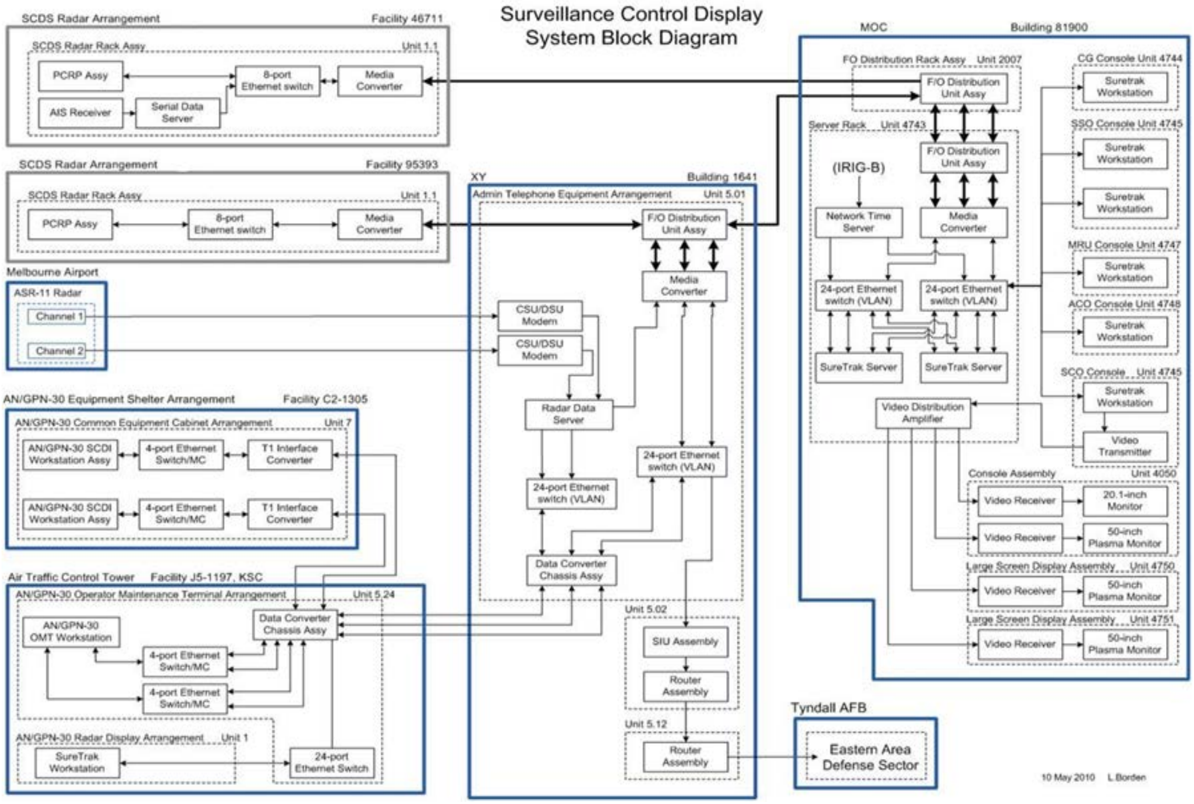

Figure 2-12-5: *SCDS Block Diagram*

Air surveillance data from the GPN-30 radar and the ASR-11 at Melbourne International Airport are transmitted to SCDS displays at the MOC and the SLF.

GPN-30 air surveillance data is sent from the GPN-30 Equipment Shelter to a Data Converter Chassis Assembly at the SLF. The Data Converter Chassis Assembly sends the air surveillance data to an SCDS operator display workstation in the SLF and also sends the data though T1 lines to a similar Data Converter Chassis Assembly in the XY Facility. The Data Converter Chassis Assembly sends the data to a 24-port Ethernet Switch VLAN Assembly. ASR-11 air surveillance data is sent from Melbourne International Airport through two 56 kbps circuits to modems in the XY Facility. The modems transmits that data by two serial cables to a Radar Data Server. The Radar Data Server then sends the data to a 24-port Ethernet Switch VLAN Assembly to the Data Converter Chassis Assembly.

From the XY Building, air surveillance data is distributed to the MOC and the SLF. The Data Converter Chassis Assembly sends ASR-11 data to the SLF and to another 24-port Ethernet Switch VLAN Assembly. This 24-port Ethernet Switch VLAN Assembly sends the GPN-30 and ASR-11 data to the media converter and the Fiber Optic Distribution Unit Assembly for distribution to the MOC.

2.12.4 SEA SURVEILLANCE RADAR (SSR) NORTH/SOUTH

The Sea Surveillance Radar (SSR) is a tower mounted, unattended X-Band radar that is designed to detect and track surface targets such as boats and ships off the coast of CCAFS and KSC. Its primary use is sea surveillance for launch operations with a secondary mission to detect security intrusions on CCAFS and KSC when the security zone is active. There are two of these radars utilized in the Area Surveillance supersystem. The SSR North is located across from SLC 41 and provides coverage of the northern areas around complexes 37B, 39A/B, 40, and 41. The SSR South is located approximately 0.06 miles south of Complex 25 on CCAFS and provides coverage of the southern areas to include Port Canaveral.

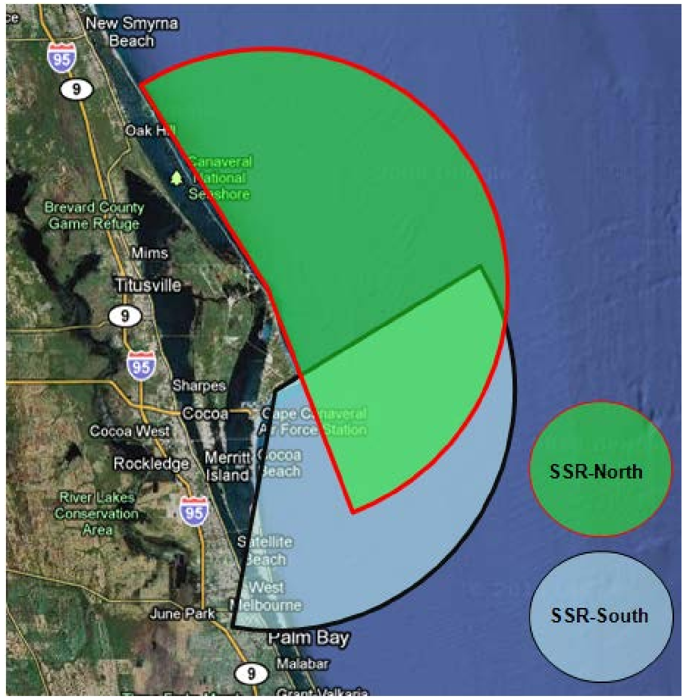

Figure 2-12-6: *Sea Surveillance Radar Coverage*

The maximum theoretical range of each SSR radar is 17.7 nm, however, the radar transmitters are blanked over the land and launch complexes in the software configuration setup at each site. This is done to prevent facilities and flight hardware at CCAFS and KSC from being radiated and possibly damaged. For SSR-South, the blanking is from 192 degrees to 60 degrees and for SSR-North, it is 157 degrees to 345 degrees.

Each SSR can be locally controlled at a SSR Equipment Shelter at the base of each radar tower during maintenance actions, however, under normal condition the SSRs are remotely controlled from SCDS workstations in the MOC. The SSR sites are normally powered-down until launch support is required.

Sea surveillance data from the SSRs are sent to the SCDS workstations in the MOC and control signals are sent from the MOC to the SSRs. The sea surveillance data is distributed by media converters in the SSR Equipment Shelters. Control signals from the SCDS workstations in the MOC are routed through the Suretrack Servers back through the same data paths to the SSRs

2.12.5 AUTOMATIC IDENTIFICATION SYSTEM (AIS)

The Automatic Identification System (AIS) is a short range coastal tracking system used on ships and by Vessel Traffic Services (VTS) for identifying and locating vessels by electronically exchanging data with other nearby ships and VTS stations. Only self-propelled commercial vessels over 65 feet in length are required to install and use AIS. AIS information supplements, but does not replace, marine radar, which continues to be the primary method of collision avoidance for water transport. AIS works by having transponders on board vessels which automatically broadcast information, such as the vessel’s position, speed, and navigational status, at regular intervals via a VHF transmitter built into the transponder on two VHF maritime channels, 87B (161.975 MHz) and 88B (162.025 MHz). The information originates from the vessel's navigational sensors, typically its global navigation satellite system (GNSS) receiver and gyrocompass. Other information, such as the vessel name and VHF call sign, is programmed when installing the equipment and is also transmitted regularly. Ships underway transmit AIS identification data every 2 to 10 seconds, depending on the ship's speed. Ships at anchor transmit every 3 minutes. The VHF radio transmissions have a range of about 20 nmi. The signals are received by AIS transponders fitted on other vessels or on land based systems, such as VTS systems. The received information can be displayed on a screen or chart plotter, showing the other vessels' positions in much the same manner as a radar display.

In Surveillance Control operations, AIS is used to detect large vessels outside the range of the sea surveillance radars. An AIS antenna and dual receiver are installed on the same tower as the SSR-South. The AIS antenna data is routed into the SCDS SureTrak surveillance application which associates the AIS identification data with sea surveillance radar plots.

2.12.6 SURVEILLANCE CONTROL DISPLAY SYSTEM (SCDS)

The Surveillance Control and Display System (SCDS) is a multi-sensor surveillance and information management system. It allows operators to monitor air and sea traffic from the surveillance radars and AIS and to plot data provide by support assets.

The SCDS uses the Regional Maritime Awareness Capability-Integrated Traffic Management System (RMAC-ITMS) software which is also known as *SureTrak*. The software was designed to provide seaports and test ranges with an effective and reliable means of monitoring critical air/surface operations.

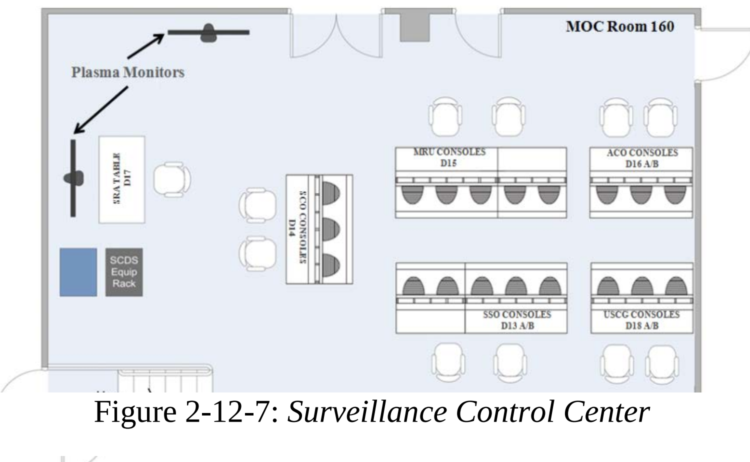

Figure 2-12-7: *Surveillance Control Center*

There are seven SCDS workstations in the Surveillance Control Center (SCC):

- One Surveillance Control Officer (SCO) Workstation
- One Aerospace Control Officer (ACO) Workstation
- One Military Radar Unit (MRU) Workstation
- Two Sea Surveillance Officer (SSO) Workstations
- One U.S. Coast Guard Workstation
- One Safety Risk Analyst (SRA) Workstation

There are also six display monitors slaved to the SCO Workstation:

- Two display monitors in the Surveillance Control Center
- One display monitor in the Commander's Advisory Board (CAB) area
- One display monitor at the Range Operations Commander (ROC) console
- One display monitor at the Weather Deputy LWO console
- One display monitor in 1 ROPS Scheduling

The SCDS Workstations allow operators to:

- Remotely control the SSRs
- Display ER hazardous and restricted areas

- Monitor targets from the surveillance radars and the AIS receiver
- Plot stationary targets and dead-reckoning tracks for targets reported by support assets beyond the range of the surveillance sensors
- Project where the targets will be at a selected time in the future including at T-0
- Determine possible courses of action to re-direct targets of interest
- Record and replay radar data

2-13 DATA HANDLING SYSTEMS

2.13.1 OVERVIEW

The Data Handling Supersystem contains systems that support pre-mission and post-mission data processing of all vehicles launched from the Eastern Range (ER). Pre-mission support begins with the Range Customer providing initial trajectory data to the 45 Space Wing (SW) Range Safety organization. Range Safety uses this data for the processing of a Flight Plan Approval request and the preparation of flight safety criteria to protect critical areas on the ER while not endangering a vehicle performing within normal limits. Range Safety utilizes the Data Handling systems to develop safety criteria and displays for the Mission Flight Control Officer (MFCO) to use in real-time operations. These displays are designed to ensure protection for defined critical areas, ships, and aircraft. Post-mission, the Data Handling systems are used to produce required data products that are utilized in the evaluation of the performance of the Range Safety and instrumentation systems utilized during the mission. Data handling systems are located at CCAFS and PAFB.

2.13.2 SAFETY HAZARD AND RISK PROCESSING (SHARP)

2.13.2.1 Responsibilities

The Safety Hazard and Risk Processing (SHARP) system is the property of the 45 SW. Configuration management and sustainment are the responsibility of 45 Space Wing Safety (45 SW/SE). Additionally, the 45 SW/SE is responsible for the SHARP sub-network design, initial setup, and its sustainment. Configuration is maintained by the 45 SW Launch Safety Office (45 SW/SEL) to provide ER Range Safety systems with critical data products for launch vehicle support.

2.13.2.2 Background Displays

SHARP produces background displays used by the Flight Operations Version 1 systems (FOV1-A and FOV1-B) and the Distributed Range Safety Displays (DRSD) system. The 45 SW Safety Flight Analysis section (45 SW/SELF) provides all background files necessary for verification. In preparation for a launch, analysis is done by the 45 SW/SELF to evaluate the nominal and various off-nominal missile trajectories in order to protect life and property from any possible malfunctioning missile. From this analysis, parameters are set to constrain the missile flight so that an errant vehicle could not cause damage to protected areas. This data is prepared with the wind strengths assumptions that apply to all destruct criteria calculations. This data includes impact limit lines, vertical plane (VP) and impact point (IP) destruct lines, VP destruct angles, chevron lines, and green numbers that are used for destruct criteria. Background data also includes nominal and 3 sigma IP, Present Point (PP), and VP trajectories, nominal velocity versus time information, map scales and centers, and event markers.

2.13.2.3 Trajectory Data

SHARP generates trajectory data and debris footprint fields used by the Cape LAPS to process Range Safety Training Theoretical.

The real-time track data are presented against these backgrounds data to give the MFCO the needed information to decide whether to permit continued missile flight or to send the destruct commands.

Figure 2-13-1: *RRAT background display*

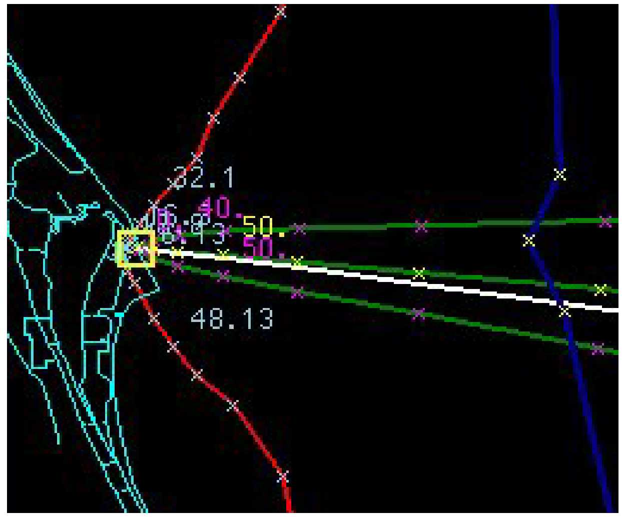

Figure 2-13-2: *RRAT background display*

A representative of the 45 SW/SELF will monitor the displays to verify each specific file necessary for launch support. In all cases, all strings of FOV1 and DRSD will be required.

The information required by the Instrumentation Data Processing (IDP) personnel to generate the FOV1 and DRSD displays is contained in the Range Safety requirements letter provided to the IDP systems controllers.

2.13.2.4 Operations Directive 16, Annex A (OD 16A) Flight Analysis (FA) Utility

The SHARP Utility program computes off-nominal present position trajectories (left or right turns, pitch-ups or pitch-downs, or combinations of turn and pitch) from a nominal trajectory to use for OD16A exercises. These data are forwarded to LAPS via compact disk (CD) for use in the Theoretical Tape Generator Computer Software Components (CSC) (CNTHEO) program to generate the training theoretical.

2.13.2.5 Impact Probabilities

SHARP computes impact probabilities and ship/ aircraft hit probabilities in order to generate impact contours used by the Surveillance Control Display System (SCDS). The Ship Hit Probability program calculates coordinates that define specified probability contours for both planned and unplanned debris impacts.

2.13.3 LAUNCH ANALYSIS PRODUCTION SYSTEM (LAPS)

The LAPS provides non-real-time pre-mission, in-count, and post-mission data analysis products in predefined formats. LAPS provides a major portion of data processing during the pre-launch and post-mission phase of the ER operations. LAPS also provides support for trajectory adjust and receives the in-count winds data during launch countdown phase. For further detail into LAPS please refer to the ERIH

2.13.3.1 Networks

LAPS is comprised of both a Black Network and a Red Network. The Black Network processes unclassified data and the Red Network processes classified data.

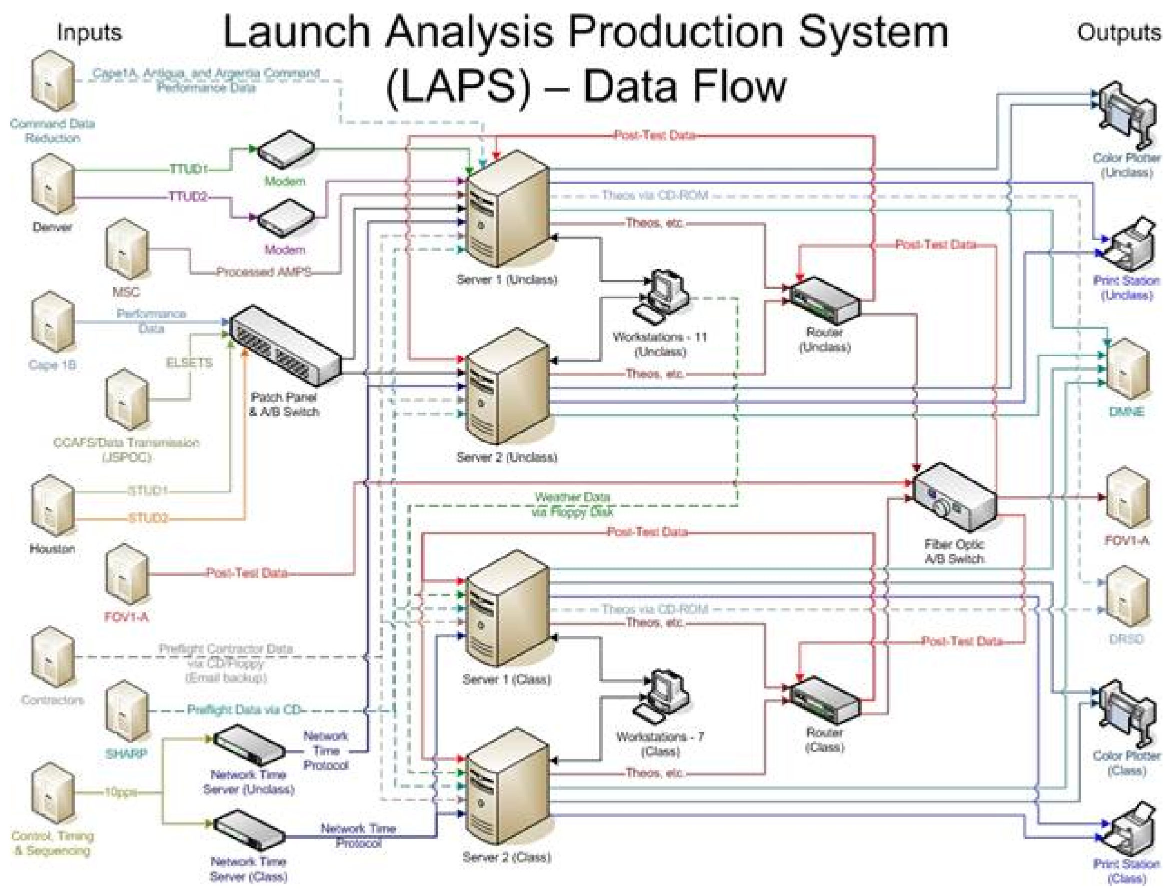

Figure 2-13-3: *LAPS Data Flow*

2.13.3.2 External Data Transfer

Unclassified data may be exchanged between the LAPS Black Network and:

- FOV1 Subsystem
- Theoretical Trajectory Update Delta (TTUD)
- Weather Information Network Display System (WINDS)
- Digital Message Network Element (DMNE)
- NORAD Command

Classified data may be exchanged between the LAPS Red Network and:

- FOV1
- DMNE
- NORAD

Both Black and Red Networks receive data from DMNE and NORAD. The Black Network also receives data from STUD, TTUD, and WINDS. WINDS data can be transferred from the Black Network to the Red Network by “sneakernet.”

2.13.3.3 Pre-Mission Data Products

ER requirements for pre-flight planning and acquisition data vary considerably between launch campaigns depending on a number of factors peculiar to each type of missile launched. Each operation is unique and only those parameters necessary to meet the requirements for each test are computed and issued to the organizations which request them. Generally speaking, these requirements may be broken into two main categories: trajectory processing and instrumentation planning data.

All trajectory and antenna pattern data are received from the Customer via Program Managers (PM) from RGNext's Range Operations Program Management and Scheduling Section.

Pre-Mission Data Products:

- Generate ground tracks
- Generate Command, Radar, Telemetry and Optical data
- Look Angles (Azimuth, Elevation and Range referenced to a given site)
- Vehicle Aspect Angles
- Signal Strength (computes expected signal level to be received by a given station)
- Spatial (computes angular separation of given sites)
- Optical Closure Angles (provides realistic coverage by optical trackers)
- Generate antenna pattern data
- Generate theoretical

2.13.3.3.1 Generate Antenna Pattern Data

Antenna data is supplied to the range for radar, telemetry, and command antennas used on each type of missile.

2.13.3.3.2 Generate Theoreticals

Theoretical files are created for FOV1, DRSD, Translated Global Positioning System (GPS) Range System (TGRS), and Wallops. A data requirement will be received to build a 10 pulse per second (pps) and 1 pps nominal theoretical, 10 pps training theoretical, 10 pps verification theoretical, 1 pps SRB and Re-entry Body (RB) theoreticals, and TGRS motion files for Navy launches.

The purpose of the program Theoretical Tape Generator (THEO) is to produce theoretical tapes (files) from contractor's data or initial condition vectors. In the generation of simulated data, radar and telemetry site data are computed, as well as various corrections for refraction, noise, and biases. Telemetric data is also simulated and encoded corresponding to data from the contractor's tape, and or previously defined mission and missile parameters.

The Range Customer is responsible for providing Range Safety with the trajectory of the nominal missile. Also, other trajectories are provided, such as 3 sigma left, 3 sigma right, 3 sigma high, etc. The trajectories are provided in binary files along with an information file that are available to the pre-flight Range Safety programs.

2.13.3.3.3 FOV1 Post Test File Generation (PTFG)

The purpose of PTFG is the generation of a Real-time Acquisition and Impact Display for non-Navy or Trident Acquisition and Impact Locator for Navy operations formatted files provided to the LAPS for use by the Data Processing System (DPS) utilities used for post-test analysis and data product generation.

All launch and landing operations require that post-test file generation be performed. All data recorded on FOV1 must be converted. The purpose of PTFG is the generation of a LAPS compatible file for use by the DPS utilities. These procedures may be performed from the Metric

Data Processor (MDP) or Acquisition Data Processor (ADP) console, but must be performed on String A.

2.13.3.3.4 Best Estimate of Trajectory (BET)

BET is defined as that best statistical estimate of a trajectory derived from several individual tracking system trajectories. The BET includes the inertial guidance data and the radar tracking data recorded on the FOV1 real-time composite file known as PTFG. The BET and its related products are utilized by RGNext’s Systems Engineering and Analysis to evaluate the performance of the ER radar, telemetry (TGRS), and command instrumentation systems and to ensure these systems meet all coverage and accuracy requirements. This reduction is processed on LAPS.

Two types of BETs can be produced: Radar Only and Radar and Inertial Guidance (IG) data. The IG data is used in computer program N-interval Trajectory Estimation CSC (GPNITE) to produce a much smoother BET than is possible with a radar only BET utilizing GPNITE.

2.13.3.3.5 Radar

After a launch, digital data recordings from metric radar sites are collected and processed. The site data recordings are read, converted to LAPS raw binary formats, and placed on CD by the LAPS operators using the Tape Conversion Unit (TCU) system.

The resulting sets of data products like Time, Azimuth, Elevation, and Range (TAER), and the Position, Velocity, and Acceleration (PVA) data provide feedback to both the launch customer and the systems analysts.

2.13.3.3.6 Telemetry

The telemetry data collected at the sites is processed on LAPS. The purpose is to decode and scale telemetry mount data from the files created from magnetic tapes formatted by the Gould Systems Engineering Laboratories (SEL) computer at each telemetry site. The output is in tabular and binary forms. The following data is output in tabular form:

- Mount azimuth and elevation
- Mount telemetry EFG position and velocity coordinates; EFG position coordinate differences between telemetry and time synchronized designate source
- Selected status bits each time at least one bit has changed
- Means and standard deviations for differences in azimuth and elevation between mount and designate computed over 10-second time spans
- Scaled automatic gain control (AGC), auto track error, and drive volts
- Designate source EFG position coordinates for both incoming high-density data (HDD) lines
- Designate angles
- Compute the plus time

This data is compared against the BET using GPNITE and the results are utilized by RGNext’s Systems Engineering and Analysis Department to evaluate the performance of the ER telemetry tracking systems and to ensure these systems meet all coverage and accuracy requirements.

2.13.3.3.7 Command Destruct

The command data collected at the sites is processed on the Command Data Reduction system. The data is provided to RGNext's Systems Engineering and Analysis Department and to LAPS for additional processing.

This data is compared against the BET using GPNITE. The results are BET comparison residuals and along with the data for the Command Data Reduction are utilized by RGNext's Systems Engineering and Analysis Department to evaluate the performance of the ER command instrumentation systems and to ensure these systems meet all coverage and accuracy requirements.

2.13.4 FLIGHT OPERATION VERSION 1 (FOV1) VAX BASED TRAJECTORY ESTIMATION AND ACQUISITION MESSAGE (FVTAM)

The FVTAM system uses radar and telemetry data to meet specific Range and Range Customer Near-Real Time (NRT) launch, and post-launch requirements.

The NRT capabilities are currently provided by the FVTAM system. NRT activities comprise a segment of MOC operations that deal with the analysis of trajectory data.

Broadly stated, these analyses are performed for the purposes of:

- Providing downrange tracking stations and stations on other ranges with accurate data to acquire and track a vehicle
- Estimating the impact points of sub-orbital bodies

The provision of acquisition data to tracking stations is done by the generation of acquisition messages, which are standard format messages sent over a teletype messages system to the receiving stations, and by the generation of acquisition data for the real-time programs, which can send data over a high-speed connection to the site. NRT activities represent Range Customer requirements, as opposed to those requirements driven by the Range Safety function of the Range.

Figure 2-13-4: *FVTAM*

2.13.4.1 Hardware Overview

The FVTAM console is located in Room 132 of the MOC. Two terminals allow access to the processor, FVTAM programs, and control files. Other terminals are available to monitor data from other systems. The FVTAM processor is not a member of the real-time processors, but has connectivity to them via the FOV1 Gateway.

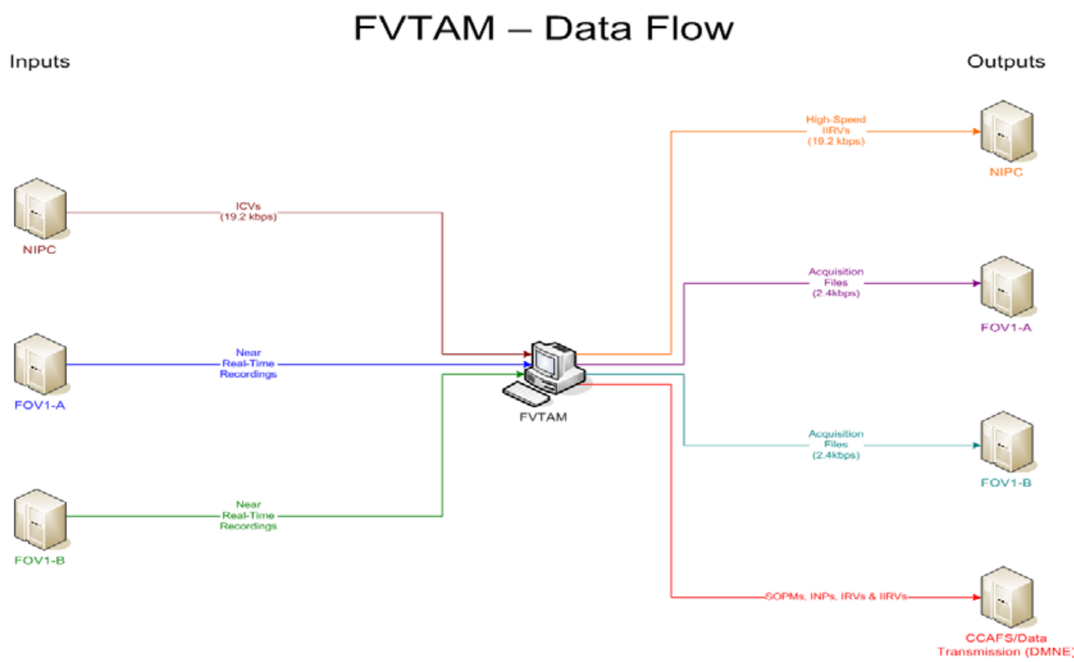

Figure 2-13-3: *FVTAM Data Flow*

2.13.4.2 Messages

2.13.4.2.1 Inter-Range Vector

An IRV contains the position and velocity of a spacecraft at a given time in rotating geocentric coordinates. IRVs may be used to compute pointing angle information for any known antenna location. IRVs are not usually restricted to a specific pass but may be used over a limited period of time which is determined by the orbit of the satellite.

2.13.4.2.2 Improved Inter-Range Vector

IIRVs contain the spacecraft position and velocity vectors for the given epoch time, as well as information about the type of vector and additional spacecraft parameters. IIRVs may be used to compute pointing angle information for any known antenna location. They are not usually restricted to a specific pass but may be used over a limited period of time which is determined by the orbit of the satellite or vehicle. The means of transmission may be either low-speed teletype (DMNE) or high-speed NASCOM block (NIPC). The IIRV format is also used for Inter Center Vector (ICV) exchange of acquisition data in NASCOM 4800-bit blocks.

2.13.4.2.3 Standard Orbital Parameter Message (SOPM)

A SOPM is an informational message, which is normally requested by the launch customer. The message provides position, velocity, and extensive set of descriptive parameters for an orbit for a specified Epoch. SOPM messages contain an extensive set of descriptive parameters for an orbit. The SOPM can be generated either from a telemetry vector or from a "least squares fit solution" of radar data.

2.13.4.2.4 Impact Message

Impact message provide the point on the surface of the Earth where a projectile is expected to impact. In addition to the impact point, this message also contains error ellipse and miss distances from aiming point. These messages are used to predict impact points for SRBs or SRMs, and they are usually generated as a post-test requirement.

2.13.5 RADAR VIDEO PROCESSING (RVP)

The RVP system is a set of workstation-based equipment that digitizes recorded radar video data in post-mission to produce data products required for subsequent analysis.

This Full Range Video concept provides an inexpensive method for storing radar signal data for subsequent viewing and, if necessary, detailed analysis. The Digital Acquisition System (DAS) and Signal Analysis Subsystem (SAS) are complementary components that together provide a fast and reliable data analysis system to assist with critical radar data reduction.

The DAS system simply digitizes the radar video and writes it to disk drive files. Along with the radar data is information that allows the SAS program to determine where head switches, caused by the video cassette recorder (VCR) occurred, and the exact IRIG time of these events. From this information, the SAS system can competently provide compensated Range Time Intensity (RTI) to the screen and printer.

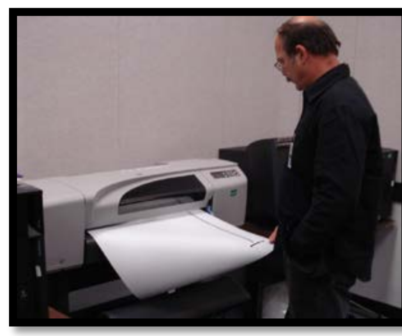

Figure 2-13-4: *Radar Video Processing. DAS (left)*

2.13.5.1 Output Data Products

RVP output data products include hardcopy charts along with the digitized signal strength products, required for debris analysis. Shown in figure 2-13-9.

The hard copy plot generated on continuous roll paper is a “quick look” data product that is a deliverable to the range user and RGNext’s Systems Performance Section of the Systems Engineering and Analysis Department. It is used to roughly view events, either planned or unplanned, that occurred during a radar’s track of an object during a mission. It is a tool to help visually determine if events occurred nominally or if there was an anomaly. With this information available to a trained radar data analyst, a decision can be made to further investigate the area of interest using more sophisticated analysis techniques.

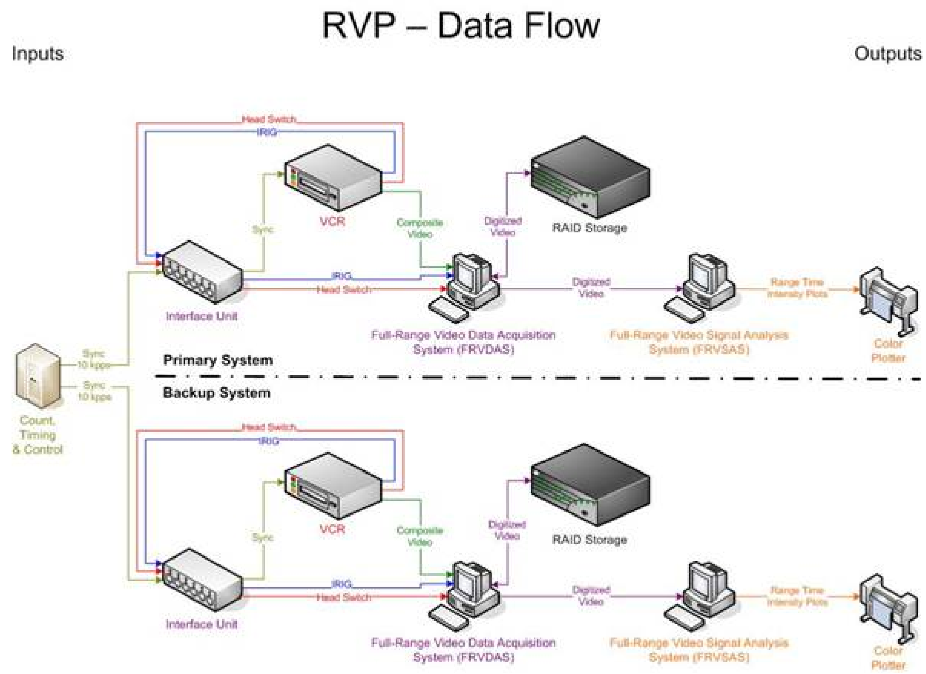

Figure 2-13-5: *RVP Data Flow*

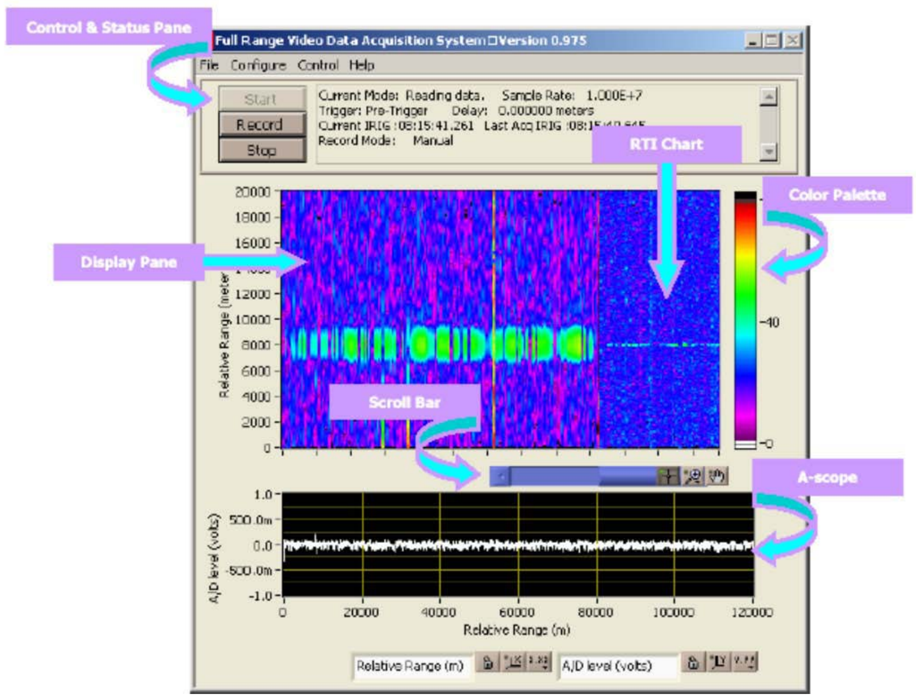

Figure 2-13-6: *RVP Data Product*

2.13.6 COMMAND DATA REDUCTION

The Command Data Reduction's function is post-mission processing of the Command Destruct System performance parameters for the Cape 1A and Cape 1B systems.

The system is used for the Cape 1A Command Destruct systems data written by the Command Site Tape Monitor Recorder Unit CSCI (KSCMRU). The KSCMRU writes data to a 9-track tape in blocks. Data from Jonathan Dickinson Missile Tracking Annex (JDMTA), Cape 1B, and Wallops Island is not recorded in a format that is reducible using the Command Data Reduction system.

2.13.6.1 Decode Command Monitoring Modernization Program (KGDCMM)

The KGDCMM decodes the data recorded at the Cape Command (Cape 1A) Command site. This data includes the status of the following Command Modernization System segments:

- System Control Unit (SCU)
- Antenna Designate Converter (ADC)
- Command Modulation Unit (CMU)
- HDD
- Synchro data from the Antenna Control Unit (ACU)

Output of the KGDCMM consists of the command site data, a summary of events, command tone data, and a dump of the HDD.

These reports are ASCII formatted files copied to 3½-inch floppy disks for use by LAPS operators for further data reduction and for use by the Systems Performance Section of RGNext's Systems Engineering and Analysis to generate the mission's System Performance Report (SPR).

Figure 2-13-7: *Decode Command Monitoring Modernization Program (KGDCMM)*

1 ROPS OPS MANUAL, Vol. 1
SECTION 3

LAUNCH VEHICLE SYSTEMS

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3-1 ATLAS V

3.1.1 LAUNCH AGENCY

The Atlas V, developed under the US Air Force Evolved Expendable Launch Vehicle (EELV) Program contract, is the newest Atlas launch vehicle and builds upon the design innovations that were demonstrated on the Atlas III. The Atlas V is launched by United Launch Alliance (ULA). Insight into the Atlas V program and risk assessment is provided to the Air Force by the 5th Space Launch Squadron.

3.1.2 LAUNCH FACILITIES

The Atlas V is launched from SLC-41, which consists of the: Vertical Integration Facility (VIF), Payload Support Van (PVan), Mobile Launch Platform (MLP), launch pad, and the Atlas Space Flight Operations Center (ASOC).

Launch vehicle processing in the VIF includes: stacking booster(s) and Centaur, performing launch vehicle subsystem checks and system verification, installing the encapsulated spacecraft, performing integrated system verification, final installations, and vehicle closeouts. The Payload Support Van provides electrical, gas, and communication interfaces between the spacecraft ground support equipment and the spacecraft; initially at the VIF for prelaunch testing, and subsequently at the pad during launch. The launch complex uses a "clean-pad" launch processing approach whereby the launch vehicle is fully integrated off-pad on the MLP in the VIF, and the launch pad is used only for RP-1 and cryogenic propellant loads and launch countdown. There are no provisions for spacecraft access while the MLP is on the launch pad. (All final spacecraft access activities, including removal of ordnance safe and arm devices, are made in the VIF).

The ASOC is a multifunctional facility supporting launch vehicle hardware receipt and inspection, horizontal testing, and launch control. The Launch Operations Center (LOC) in the ASOC provides launch vehicle interfaces for command, control, monitoring, readiness reviews, anomaly resolution, office areas, and day of launch viewing. The main areas of the LOC include the Launch Control Center, the Mission Operations Center, the Spacecraft Operations Center, the Engineering Operations Center and the Customer Support Facility.

3.1.3 LAUNCH VEHICLE DESCRIPTION

There are two different Atlas V configurations, the Atlas V 400 series and 500 series:

The Atlas V 400 consists of a Common Core Booster (CCB), up to three strap-on solid rocket boosters (SRB), a Single-Engine Centaur (SEC) or Dual-Engine Centaur (DEC), and a 4-m diameter payload fairing with three different lengths available: the 12.0 m (39.3 ft) Large Payload Fairing (LPF), the 12.9 m (42.3 ft) Extended Payload Fairing (EPF), or the 13.8 m (45.3 ft) Extended EPF (XEPF).

The Atlas V 500 series consists of a CCB, up to five SRBs, a SEC or DEC Centaur, and a 5-m diameter payload fairing with three different lengths available: the 20.7 m (68 ft) short, the 23.5 m (77 ft) medium, or the 26.5 m (87 ft) long payload fairing. A three-digit (XYZ) naming convention was developed for the Atlas V 400 and 500 series to identify its multiple configuration possibilities:

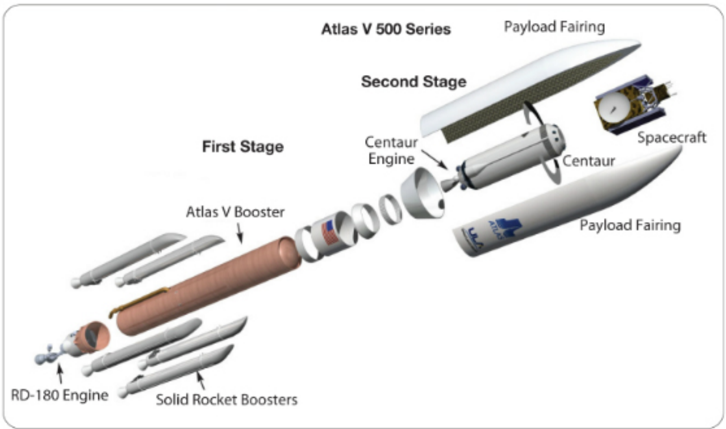


Figure 3-1-1*: Atlas 500 Series*

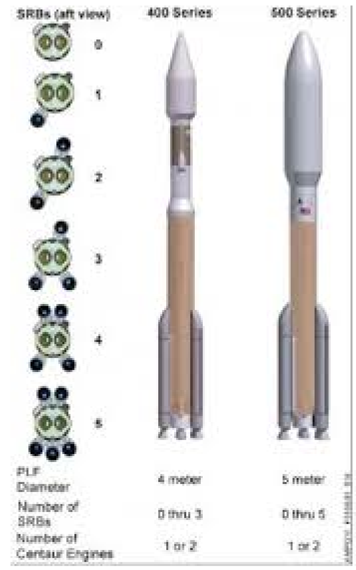


Figure 3-1-2*: Atlas V 400 & Atlas V 500*

3.1.4 TELEMETRY SYSTEM

All Atlas V EELVs will be equipped with RF telemetry S-Band transmission subsystem consisting of high power S-Band (2211.0 MHz) digital telemetry. This subsystem transmits all the vehicle primary instrumentation for the Atlas and Centaur stages.

Additional telemetry systems may be flown on selected Atlas V Launch Vehicles (LVs) to provide vehicle data for Research and Development (R&D) and mission satisfaction purposes.

3.1.5 FLIGHT TERMINATION SYSTEM (FTS)

The Atlas V Flight Termination Subsystem provides the capability to destruct the vehicle (Centaur, Atlas and SRBs) and payload (if a payload destruct system is used) in the event of a vehicle break-up or inadvertent stage separation.

The FTS consists of four subsystems that interface with each other in order to first terminate thrust followed by a destruct action by the detonation of explosives connected to each stage.

The Command Destruct System (CDS) provides redundant (two) secure radio receivers and Command Receiver/Decoders (CRDs) on the Centaur stage that can be activated by supporting ground stations in the event of an errant vehicle flight path. The receivers operate on 421.0 MHz. The flight of the vehicle is monitored by Range Safety (RS) where the MFCO makes the decision to send functions to an errant vehicle. The CRDs accept four commands: Self-test, Disable, ARM, and Destruct.

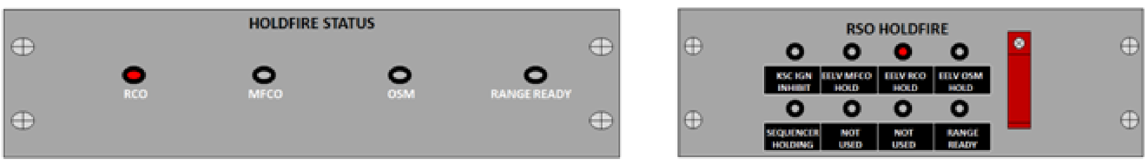
- Self-test command causes the CRD to perform a reset and firmware checksum and while doing so toggles a discrete output to “high” and is reported in vehicle telemetry.
- Disable (Safe) command causes the CRD to switch to external ground power (which is unavailable in flight) thus turning-off the CRDs. This command is sent after RS period of responsibility.

- The ARM command shuts down the Atlas or Centaur stage engines (depending on phase of flight) by outputting two digital discretes to the FTINU. The FTINU performs the engine shutdown sequence. Two discretes must be detected by the FTINU from either CRD or both.
- The Destruct command causes the CRD to output a high current pulse to the Electro-explosive Devices (EED) with the Safe and Arm (S/A) device that initiate ordnance to destroy the Atlas, SRBs (if flown) and Centaur stages. Ordnance may also be connected to the payload on a mission peculiar basis.

3.1.6 HOLDFIRE CHECKS (TEST EXECUTION)

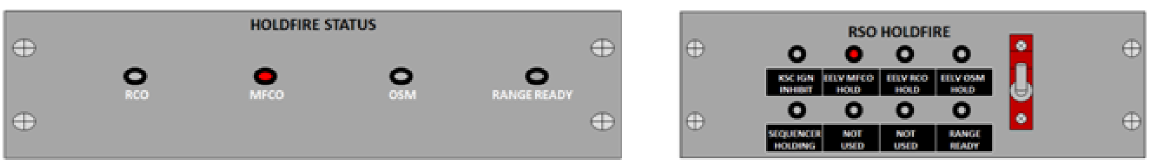
When a holdfire is sent during the Holdfire Checks, the following indications should be received on the RCO and MFCO Holdfire Panels:

- The green Range Ready indicator light will no longer be illuminated.
- With the exception of the OSM, the red indicator light for the applicable console position (RCO or MFCO) will be illuminated. The red OSM indicator light will not be illuminated when the OSM sends a holdfire.



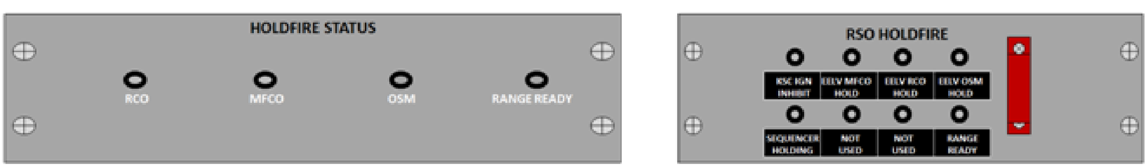
RCO Holdfire Indications MFCO Holdfire Indications

Figure 3-1-3: *RCO initiated Holdfire Indications for Atlas V*



RCO Holdfire Indications MFCO Holdfire Indications

Figure 3-1-4: *MFCO initiated Holdfire Indications for Atlas V*



RCO Holdfire Indications MFCO Holdfire Indications

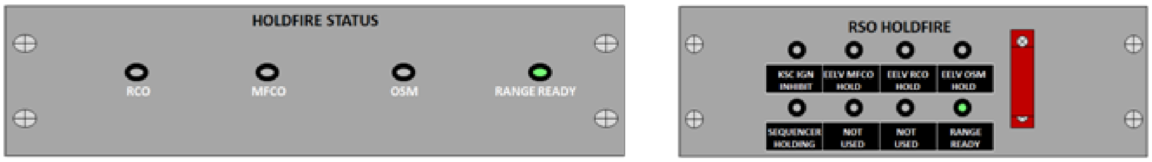
Figure 3-1-5: *OSM initiated Holdfire Indications for Atlas V*

After the applicable position has activated their holdfire switch, the FC will verify that the holdfire was received in the ASOC. When polled by the TC for receipt of the holdfire indications:

- The RCO will report: “Range Not Ready was Received” or any anomalies.
- The MFCO will report: “Range Not Ready was Received” or any anomalies.
- The OSM will report: “Range Not Ready was Received” or any anomalies.

After receipt of the holdfire indications has been confirmed, the FC will direct the applicable console position to remove their holdfire. The RCO and MFCO will verify removal of the holdfire by referencing the EELV Holdfire Indicator lights on their Holdfire Panels. When a holdfire is removed during the Holdfire Checks, the following indications should be received:

- The red indicator light for the applicable console position (RCO or MFCO) will no longer be illuminated.
- The green Range Ready indicator light will be illuminated.



RCO Holdfire Removal Indications **MFCO Holdfire Removal Indications**

Figure 3-1-6: *Atlas V Holdfire Removal Indications*

After the holdfire has been removed, the FC will verify the Range Holdfire System has been reset in the ASOC and will poll the RCO, MFCO, and OSM to verify that they received indications that the holdfire was removed. When polled by the FC for removal of the holdfire indications:

- The RCO will report: “Range Ready Status is GO” or any anomalies.
- The MFCO will report: “Range Ready Status is GO” or any anomalies.
- The OSM will report: “Range Ready Status is GO” or any anomalies.

The FC will verify that the final launch countdown sequence (Option 910) is executed prior to directing the next console position to send their holdfire. The FC will repeat this process until the RCO, MFCO, and OSM holdfire switches have all been tested. Once the RCO, MFCO and OSM holdfire switches have been verified, the FC will release the RCO and MFCO from the test. If the vehicle configuration for the mission includes the use of solid motors, the FC and the OSM will test the SRB Ignition Enable circuits. Finally, the FC will transfer to Channel 1 and, in coordination with the LC, will test the connectivity of the LC holdfire switch.

3.1.7 TELEMETRY CHECKS

Telemetry checks are performed during pre-launch tests and the minus count when requested by the range user. These checks measure the radio frequency (RF) characteristics of the telemetry links; for example, the center frequency, deviation, and signal strength.

3.1.8 PRE-LAUNCH OPERATIONS

3.1.8.1 LVRT (Launch Vehicle Readiness Test)

LVRT consists of the FTS CRD Open Loop Test. It is scheduled in sections, not all at one time. The RCO will support S-Band Test and Range Safety Flight Termination Test.

3.1.8.2 Release Sequence Test

This test verifies the complete launch release system. This test will be scheduled.

3.1.8.3 S-Band Test
An open loop S-band transmitter will be tested with range assets. A closed loop S-band test will not require range support.

3.1.8.4 Range Safety Flight Termination test
This test will be run with the range command transmitters and the Atlas V Centaur antennas open loop. Ordnance circuits are tested with flight batteries and squib simulators.

3.1.8.5 Launch Vehicle Simulated Flight Test
The launch vehicle is operated in a countdown sequence to demonstrate, on an integrated basis without the Space Craft (SC), that the launch vehicle systems perform satisfactorily through a countdown and simulated flight (plus-count) sequence.

3.1.8.6 IST (Integrated System Test)
RF closed loop testing, Telemetry open loop transmission, SC simulated flight, and Power on stray voltage checks are all performed during this test. The launch vehicle and ground support equipment (GSE) is operated in a countdown sequence in system level simulated flight to demonstrate launch readiness of booster, Centaur and spacecraft. The flight termination system is tested closed loop. The simulated flight sequence with the umbilicals remaining connected, begins at T-0 and proceeds through Centaur/spacecraft separation and Centaur CCAM (Collision/Contamination Avoidance Maneuver). This test will use range resources on request only.

3.1.8.7 Secure Code Loading
This test will be scheduled to load FTS codes prior to flight. This is typically performed at the end of LVRT if used.

3.1.8.8 Payload Transport
This operation will transport the encapsulated payload and associated GSE from the payload processing facility to the VIF. This operation will use range resources on request only. The User will request RF silence.

3.1.9 OPERATIONS PROCEDURES

3.1.9.1 Launch Countdown Procedures
The user interface for Atlas operations will be the ULA Range Coordinator. Coordination between the user and the RCO on Range Operations issues will be handled over Complex 41 Channel 5. The Range Countdown for an Atlas launch is 6 hours (usually with two built-in holds) and begins at L-6 hours.

3.1.9.2 Launch Contingency Procedures
The Atlas V countdown, recycle, and contingency procedures are contained in the X45-LC***XXX***-SLC ***WDR/Launch Countdown*** (Note: This procedure is issued and numbered for each mission. The "LC***XXX***" will be labeled according to the vehicle number. For further information regarding Operations Procedures, reference the assigned User Procedures for each mission.

3.1.9.3 Scrub Procedures

The Atlas V X45-LC***XXX***-SLC procedure is the primary countdown document and directs personnel to execute certain procedures in other documents to configure and secure the different systems on the vehicle. The Atlas V program can perform a 24-hour turnaround if the countdown is aborted and scrubbed prior to T-7 seconds. In this case, the launch agency will utilize X45-LCXXX-SLC Sequence 14.0 – ***24 Hour Recycle Sequences***. In this procedure, the LC directs the RC to reschedule Range and Subcontractor support for a 24 hour turnaround. This is when the RC will contact the ROC to report the scrub and request a 24 hour turnaround.

If the launch attempt was scrubbed after the loading of LOX and LH_2 onboard the vehicle, the LC will direct personnel to detank and secure the vehicle using X45-LC***XXX***-SLC Sequence 5.0 – ***Cryo Detanking, Pad Re-entry and Securing.*** Near the beginning of this sequence, the T-Clock will be adjusted to T+5 minutes and the clock will start counting upward. Then the LC will direct the OSM to establish the Blast Danger Area (BDA) roadblocks and open the Flight Hazard Area (FHA). Typically at this time, the OSM will be able to report to the MFCO that the vehicle is in a safe, non-launch condition. The MFCO will then be able to release Range Safety special use airspace and non-contingency support assets. **Note** that the MFCO may not receive a call from the OSM at this time and may have to contact the OSM to ensure that the Range Safety special use airspace can be released.

After the initiation of LOX and LH_2 detanking, the LC will direct the applicable personnel to secure RF and telemetry per X45-LCE***XX***-SLC Sequence 11 – ***FTS and RF Securing Operations***. The first step in the sequence executes a command option, referred to as Option 646 FTS_SAFE which will safe all Safe and Arm Devices (SADs) and Automatic Destruct Units (ADUs), place the CRDs to external power if required, safe the SRB Ordnance Safe and Arm Devices (OSAs), place the ADUs to external power if required and secure the CRDs and ADUs if required. This command option may take several minutes to execute. Once this sequence is complete, the OSM will notify the MFCO that the CRDs are off and the MFCO will then coordinate with the RCO to remove the command carrier. The RCO can then contact the RC to coordinate with the launch agency to remove the command carrier.

T-Time	Event	Impact/Minimum Recycle Time
Prior to T-4 min & Counting	Preps or Cryo Tanking	Extend hold time as required to work issues. Can safely remain in T-4 min hold until end of window.
T-4 min & Counting	Pickup Terminal Count	Required to reset option 910 and poll launch team. 15 minutes to recycle (Approx)
T-3 min	Close Booster LO2 Vent Valve	Recycle time driven by requirement to recondition Booster LO2. 15 minutes to recycle (Approx)
T-1 min and 50 sec	Secure Centaur LH2/Centaur LO2 Topping	Required to restart Centaur topping and perform previous steps. 15 minutes to recycle (Approx)
T-1 min and 20 sec	FCS Start Count	INU Abort – requires 26 seconds. Enveloped by previous steps. 15 minutes to recycle (Approx)
T-8 sec	Go Inertial	Must realign INU. 60 minutes minimum recycle
T-7 sec	Vent Door Firing	Scrub for the day. Must replace Vent Door pyro pin puller. 96 hour recycle minimum
T-5 sec	Pull Aft Plate	Scrub for the day. Must replace Centaur tank pressurization and CEC pyro isolation valves. This is off nominal abort processing. 96 hour recycle minimum
T-2.72 sec and after	RD180 Start Bottle Press	Hot fire abort. Scrub for the day. Same steps and concerns as above plus RD-180 readiness tasks. 13 days recycle minimum

Table 3-1-1: *Atlas V Recycle/Scrub Time*

3-2 DELTA IV

3.2.1 LAUNCH AGENCY

The Delta IV, developed under the US Air Force EELV Program contract, is the newest member of the Delta family. The Delta IV evolved from the Delta II and Delta III launch vehicles, providing even more capability at a lower cost by incorporating heritage hardware and processes with a new robust propulsion system derived from the Space Shuttle Main Engine (SSME). The inaugural launch of the Delta IV Medium+ 4, 2 vehicle lifted a commercial Eutelsat payload to orbit on 20 November 2002. The Delta IV is launched by ULA with insight into the Delta IV program and risk assessment provided to the Air Force by the 5th Space Launch Squadron.

3.2.2 LAUNCH FACILITIES

All Delta IV launch operations will be controlled from the launch control center (LCC) in the Delta Operations Center (DOC). A spacecraft control room and office adjacent to the LCC is available during launch. Communication equipment in the computer room provides signal interface between the LCC, the launch pad, and the Payload Processing Facility (PPF).

The Delta IV eastern launch site is Space Launch Complex 37 (SLC-37) at Cape Canaveral Air Force Station (CCAFS), Florida. This site can accommodate flight azimuths in the range of 42˚ to 110˚, with 95˚ being the most commonly flown.

SLC-37 is located in the northeastern section of CCAFS between SLC 36 and SLC 41. It consists of one launch pad (pad B), a mobile service tower (MST), a fixed umbilical tower (FUT), a common support building (CSB), a support equipment building (SEB), ready room, shops, and other facilities needed to prepare, service, and launch the Delta IV vehicles.

Although not part of the SLC-37 complex, the Horizontal Integration Facility (HIF) is used to process the launch vehicles after their transport from the receiving and storage facility. Work areas are used for assembly and checkout to provide fully integrated launch vehicles ready for transfer to the launch pad. The HIF has two bays to accommodate four single-core Delta IV-M and Delta IV-M+ process areas or two single-core Delta IV-M and Delta IV-M+ process areas and a Delta IV-H process area. The Mission Director Center (MDC), located on the fourth floor of the DOC, provides the necessary seating, data display, and communication to observe the launch process. Seating is provided for key personnel from the launch vehicle team.

3.2.3 LAUNCH VEHICLE DESCRIPTION

The Delta IV is the world's first all cryogenic vehicle and consists of a newly developed first-stage, called the common booster core (CBC) using cryogenic propellants (LOX/LH2) and the Rocketdyne RS-68 engine with throttling capability, a 4 or 5-m upper stage utilizing the Pratt & Whitney RL10B-2 engine (derived from the RL10A engine used on the Centaur upper stage), and a 4 or 5-m payload fairing. The Delta IV second stage is derived from the Delta III second stage using the same RL10B-2 engine, but with two sizes of expanded fuel and oxidizer tanks, depending on the vehicle configuration. Like the Atlas V and Delta II, payload performance can be increased by adding two or four strap-on solid rocket boosters (SRBs) or two additional CBCs. The Delta IV comes in five vehicle configurations: the Delta IV Medium (Delta IV-M), three variants of the Delta IV Medium-Plus (Delta IV-M+), and the Delta IV Heavy (Delta IV-H).

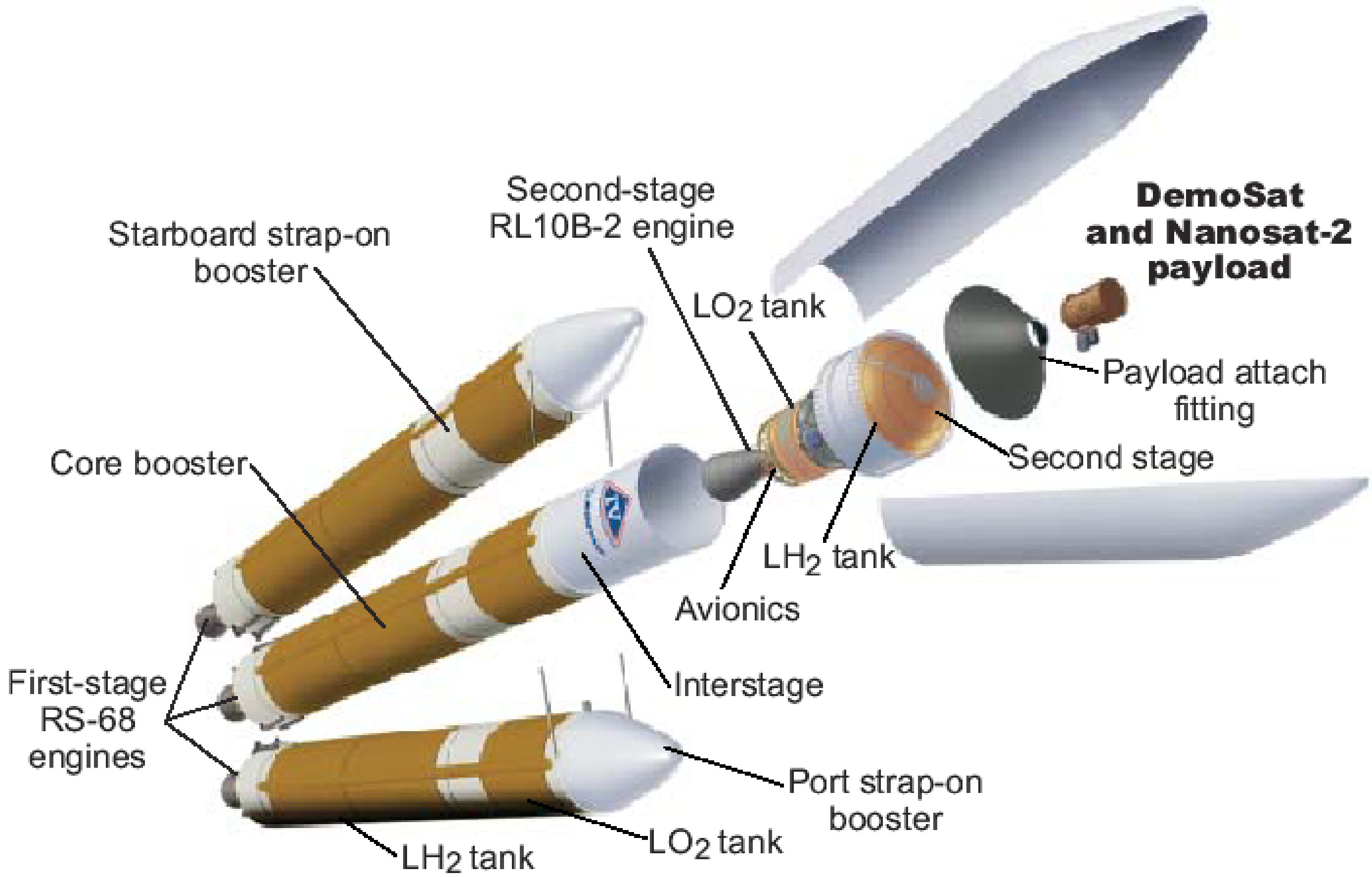


Figure 3-2-1: *Delta IV Heavy Launch Vehicle*

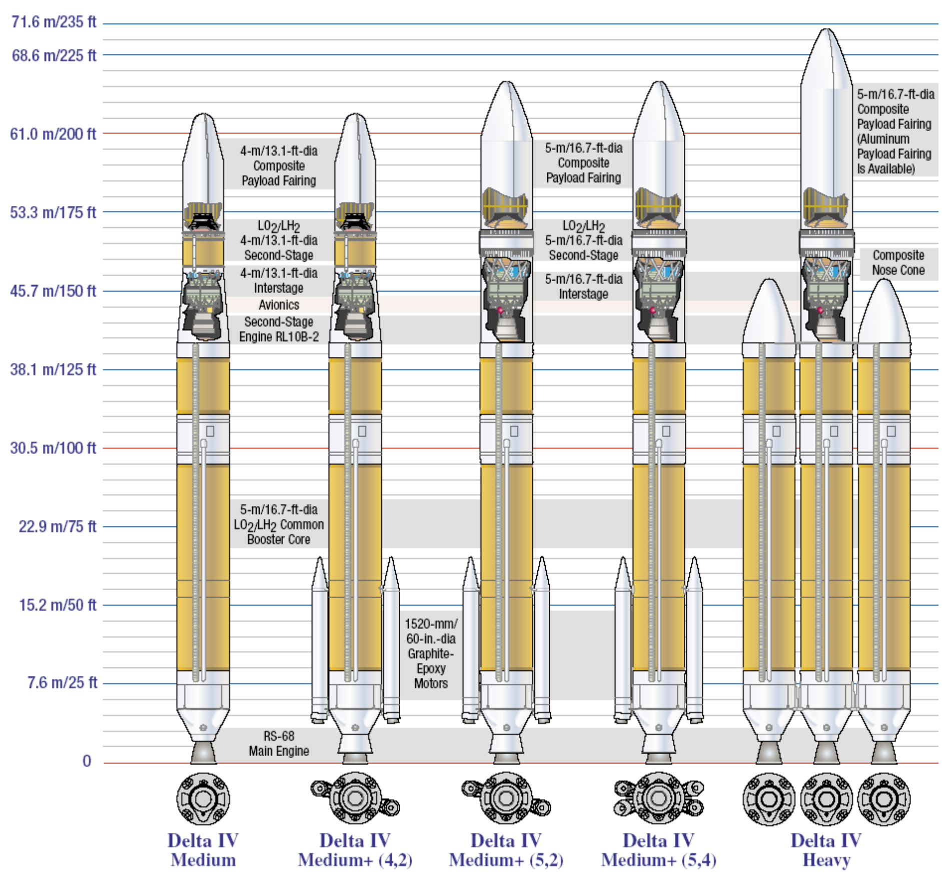


Figure 3-2-2: *Delta IV Family of Launch Vehicles*

The Delta IV-M employs a first-stage CBC, a 4-m (157.5-in.) -dia cryogenic second stage, and a 4-m (157.5-in.) -dia composite payload fairing (PLF).

The Delta IV-M+ comes in three different configurations that are annotated with a unique numerical convention in parenthesis. The first digit in parentheses refers to the diameter of the second stage in meters, and the second digit refers to the number of strap-on SRBs.

- Delta IV-M+ (4,2): This configuration uses two strap-on SRBs to augment the first-stage CBC, a 4-m (157.5-in.) -dia cryogenic second stage, and a 4-m (157.5-in.) -dia composite payload fairing (PLF)
- Delta IV-M+ (5,2): This configuration uses two strap-on SRBs to augment the first-stage CBC, a 5-m (200-in.) -dia cryogenic second stage, and a 5-m (200-in.) -dia composite payload fairing
- Delta IV-M+ (5,4): This configuration uses four strap-on SRBs to augment the first-stage CBC, a 5-m (200-in.) -dia cryogenic second stage, and a 5-m (200-in.) -dia composite payload fairing

The Delta IV-H employs two additional CBCs as strap-on liquid rocket boosters (LRBs) to augment the first-stage CBC, a cryogenic 5-m second stage, and either a 5-m composite fairing or a 5-m metallic fairing.

3.2.4 TELEMETRY SYSTEM

First/second stage Pulse Code Modulation/Binary Phase-Shift Keying (PCM/BPSK) (link 1). This link sends data from transducers and ice boxes located on both the first and second stages and from the redundant inertial flight control assembly (RIFCA) and AUX PSC box located on the second stage. The data transmitted is at mission dependent rate. The transmitter is located on the second stage and the four antennas are located on the second stage.

The LV will transmit special spacecraft data through a separate transmitter.

Second Stage S-Band Frequency: 2241.5 MHZ

3.2.5 FLIGHT TERMINATION SYSTEM (FTS)

The Delta IV launch vehicle contains two independent flight termination systems. Two command receiver/decoders (CRD) are mounted on the equipment shelf located on the second stage. The receiver/decoders receive and decode range–transmitted, high alphabet, radio command signals to accurate FTS devices. Each command receiver/decoder is powered from a separate dedicated battery.

The antenna system consists of two folded monopole antennas located on the second stage which are coupled to the receivers through a power divider. Each CRD is connected to a Safe and Arm (S&A) mechanism located on the second stage. The FTS operates when a destruct command is sent to the CRD from range safety. The CRD will cause engine thrust termination and disable sequencing. The CRD will also send a destruct command.

Automatic destruct action is supplied by a redundant mechanical lanyard pull initiator (LPI) system located on the core vehicle (referred to as the automatic destruct system (ADS), and a redundant LPI system for each solid motor and each strap-on CBC (referred to as the inadvertent separation destruct system (ISDS)). These systems initiate destruct action in the event of vehicle breakup, inadvertent stage 1/2 separation, or inadvertent solid motor separation. Range safety ground transmitters have the capability to issue destruct commands using secure coded radio command signals. Each FTS S&A has 24.9 OHM resistors across each firing line to allow CRD monitoring of S&A connect status.

Command Receiver Frequency: 421 MHZ.

3.2.6 PRE-MISSION TESTS

3.2.6.1 Holdfire Checks

Holdfire checks are performed during the minus count to verify the connectivity of the holdfire circuit between the launch pad sequencer, OSM, RCO, MFCO, and the Range User. The RCO and a Timing Tech support the Delta IV Holdfire Checks. The MFCO does not support the Delta IV Holdfire Checks because the Holdfire Checks occurring prior to the MFCO's arrival on-console. The Range User's Launch Conductor (LC) performs the test conductor function on launch day. The Holdfire checks are conducted at approximately L-5:30:00 IAW with the Range User's Launch Preparation Document (LPD) EL005 Task 2: ***Terminal Countdown***. The comm channel that is used for the launch day Holdfire Checks is Channel 1. During the Holdfire Checks, the RCO and the Timing Tech will reference the T-Clock and the EELV Holdfire indicator lights to verify receipt of a holdfire and to verify who sent the holdfire.

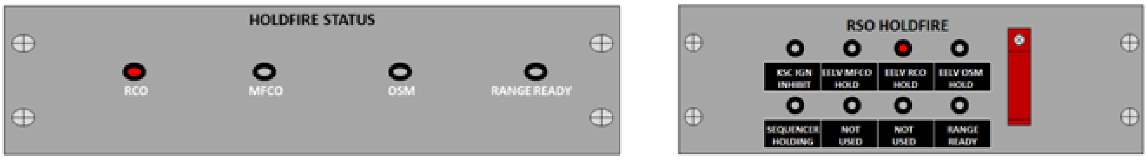
3.2.6.1.1 Pre-Test Actions

Depending on the checks, the TC or LC will poll the RCO, MFCO (Timing Tech), OSM, the Control Room Tech 1 (CT1), and the sequencer operator (TIMER1) for readiness to perform the holdfire checks. When directed by the TC/LC, the OSM will enable the launch vehicle ignition (Launch Enable) circuit. This allows the OSM to verify that the circuit is interrupted when a holdfire is received. The TC/LC will ensure the applicable console personnel enables the Range Holdfire System, allowing the launch sequencer to respond to a holdfire.

3.2.6.1.2 Test Execution

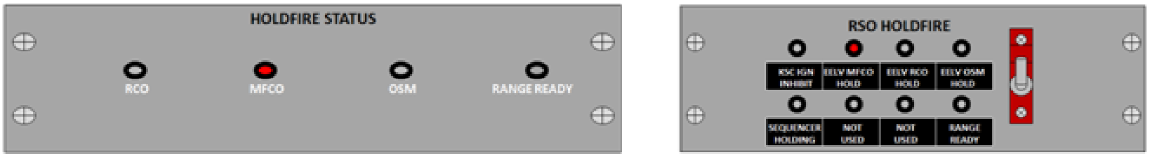
To initiate the test, the TC/LC will verify that the TC holdfire switch is ready to support the test by verifying that it is in the closed or inactive position. The TC/LC will then poll the RCO, MFCO (Timing Tech), and OSM to verify that their holdfire switches are ready to support the test. The TC/LC will then test the connectivity of the MFCO, RCO, LC/TC, and OSM holdfire switches by asking each console position to send their holdfire. The RCO and Timing Tech will verify receipt of the holdfire by referencing the T-Clock and the EELV Holdfire Indicator lights on the Holdfire Panels. When a holdfire is sent during the Holdfire Checks, the following indications should be received on the RCO and MFCO Holdfire Panels:

- The T-Clock will stop.
- The green Range Ready indicator light will no longer be illuminated.
- The red indicator light for the applicable console position (RCO, MFCO, or OSM) will be illuminated.



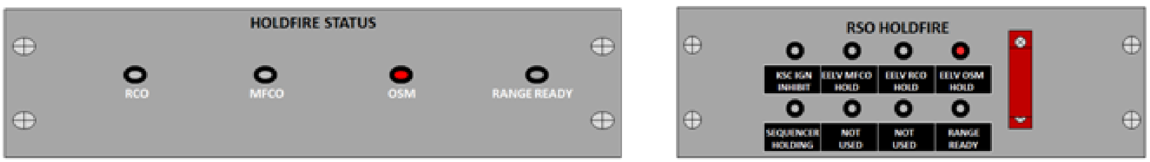
RCO Holdfire Indications MFCO Holdfire Indications

Figure 3-2-3: *RCO initiated Holdfire Indications for Delta IV*



RCO Holdfire Indications MFCO Holdfire Indications

Figure 3-2-4: *MFCO initiated Holdfire Indications for Delta IV*



RCO Holdfire Indications MFCO Holdfire Indications

Figure 3-2-5: *OSM initiated Holdfire Indications for Delta IV*

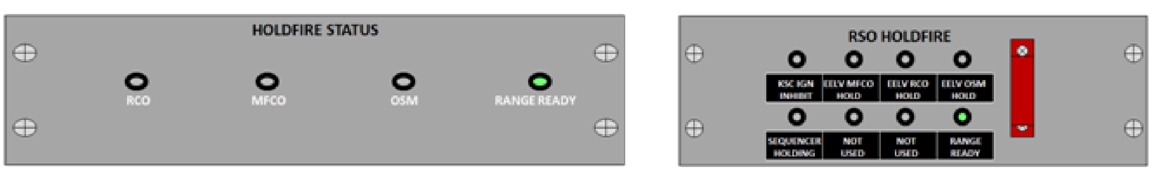
After the applicable position has activated their holdfire switch, the TC/LC will poll the MFCO (Timing Tech), RCO, and OSM to verify receipt of the holdfire. When polled by the TC/LC for receipt of the holdfire indications:

- RCO, MFCO, OSM will report: "Red"
- LC will report: "Range ready is red"

After polling the MFCO (Timing Tech), RCO, and OSM, the TC/LC will report: "LC Red, Sequencer Stopped" or any anomalies.

After receipt of the holdfire indications has been confirmed, the TC/LC will direct the applicable console position to remove their holdfire. The RCO and Timing Tech will verify removal of the holdfire by referencing the T-Clock and the EELV Holdfire Indicator lights on their Holdfire Panels. When a holdfire is removed during the Holdfire Checks, the following indications should be received:

- The T-Clock in the MOC will resume counting.
- The red indicator light for the applicable console position (RCO, MFCO, or OSM) will no longer be illuminated.
- The green Range Ready indicator light will be illuminated.



RCO Holdfire Removal Indications MFCO Holdfire Removal Indications

Figure 3-2-6: *Delta IV Holdfire Removal Indications*

After the holdfire has been removed, the TC/LC will direct the sequencer operator to restart the sequencer and will poll the MFCO (Timing Tech), RCO, and OSM to verify that they received indications that the holdfire was removed. When polled by the TC/LC for removal of the holdfire indications:

- The Timing Tech will report: “Range Ready” or any anomalies
- The RCO will report: “Range Ready” or any anomalies
- The OSM will report: “Range Ready” or any anomalies

After polling the MFCO (Timing Tech), RCO, and OSM, the TC/LC will report: “Range Ready, Sequencer Running” or any anomalies.

The TC/LC will repeat this process until the MFCO, RCO, LC/TC, and OSM holdfire switches have all been tested. Once all of the holdfire switches have been verified, the TC/LC will poll the sequencer operator (TIMER1), OSM, RCO, and MFCO (Timing Tech) to determine if they are satisfied with the Holdfire Checks

3.2.6.2 Flight Termination Checks

EWR 127-1 Chapter 4 and AFMAN 91-710 Vol 4 require that open loop tests be performed on the vehicle’s FTS prior to launch to prove the integrity of the ground and airborne command transmitter system. This includes the Range Command transmitter systems, vehicle antenna systems, and the Command Receiver/Decoders (CRDs). These regulations specify the configuration and codes to be utilized in these tests for both Secure CRDs using encrypted codes and Non-Secure or Standard CRDs using Inter-Range Instrumentation Group (IRIG) tones.

The Delta IV uses secure CRDs. The FTS check procedures are led by the MFCO.

3.2.6.3 First Motion Checks

The purpose of the first motion subsystem of the Eastern Range Sequencer System is to provide an input to the sequencer and initiate timed events relevant to the launch time. The purpose of first motion checks is to validate first motion circuitry from the sequencer in the applicable blockhouse or Launch Control Center to all locations required to receive a first motion signal (i.e. instrumentation sites, launch pads, first motion displays, etc.).

The Delta IV program tests the first motion signal early in the minus count.

3.2.6.4 Telemetry Checks

Telemetry checks are performed during pre-launch tests and the minus count when requested by the range user. These checks measure the radio frequency (RF) characteristics of the telemetry links; for example, the center frequency, deviation, and signal strength.

3.2.7 PRE-LAUNCH OPERATIONS

Pre-launch operations involve myriad test vehicle tests and checks in preparation for launch day. Various range resources (radars, telemetry, command, etc.) and personnel (RCO, MFCO, ISRO, controllers, etc.) are involved in these operations to ensure the vehicle meets its required parameters. Many of the pre-launch operations for the Delta IV vehicle launched from the

Eastern Range are described in this section. These are not all inclusive, but describe those operations where range personnel are directly involved.

The MFCO supports all tests for Delta that have command checks as part of the test. The Delta IV pre-launch tests are designed to check out the vehicle onboard Instrumentation, Flight Control, Guidance, Ordnance and Propellant Loading System to ensure all systems are tested, validated and in a state of launch readiness.

3.2.7.1 Vehicle Guidance, Control, Transponder and Range Safety Checks

This test is the L -1 day check of the Vehicle Flight Control, Guidance, Instrumentation and Range Safety Systems. Closed and open loop command destruct checks and telemetry system checks are performed. An open loop (optional self test) command destruct check will be run if Range Support is available. Mission objective is to test and evaluate launch vehicle flight systems to ensure launch readiness. This test is normally scheduled on L -1 Day. The Range Schedule will specify the telemetry frequencies to be read out and the support times for RF silence, FCA Van, RCO, Tel-4/CTPS and command carrier support.

3.2.7.2 Flight Program Verification Test

A Simulated Launch Vehicle Countdown is conducted with all Instrumentation Systems powered up. Telemetry readouts are performed and the Command Destruct System is checked during the minus count using the Boeing Command Test Set. The Vehicle Guidance System is also checked. All systems are transferred to vehicle internal power prior to T -0. A simulated first motion is initiated at T -0 and the guidance computer starts the flight program. The Transponder and Command Systems are turned off at approximately plus 30 minutes and the flight program continues through termination. “Power On” stray voltage checks are then performed using the Boeing test set. This test is normally scheduled on L -5 Day with a duration of approximately 16 hours. The Range Schedule will specify support times command for RF silence, FCA Van, RCO, OSM, and Tel-4/CTPS.

3.2.7.3 Simulated Flight Sequence Test

Launch vehicle second stage Telemetry and Command Receiver Decoders are powered up along with the Guidance Control, Engine Start and Ordnance Sequencing Systems. The Checkout Flight Program is used to drive the guidance computer through a simulated flight. This test validates the airborne guidance computer software and operation. This test is normally scheduled on L -6 Day with a duration of approximately 11 hours. The Range Schedule will specify the telemetry frequencies to be radiated and RF protection from Cape Command on the appropriate command frequency. RCO, FCA Van and Tel-4 (if required) support times will also be specified.

3.2.7.4 Telemetry Data Flow Test

ER Stations 91 (ANT) 28 (JDMTA) and 12 (ASC), as scheduled, will transmit simulated telemetry data to Tel-4/CTPS, Building AE and DOC. The telemetry systems and data circuits will be in launch day configuration. Objective is to validate the telemetry and data transmission systems. This test is normally scheduled on L -7 Day with a duration of approximately six hours.

3.2.7.5 RFI/EMI Test

Vehicle Instrumentation Systems will be powered on (external power). The Service Tower will be retired (launch position). The ER Radars and the High Power Command Transmitter will be requested to radiate toward the Pad. This will be conducted in a controlled sequence. Vehicle telemetry readouts will be performed. Objective is to determine the presence or absence of RF interference between the Range or Launch Vehicle electronic systems. The Range Schedule will specify the telemetry frequencies and the support times for Command carrier, radars, FCA Van and RCO. This test will be scheduled only when there is a possibility of RF interference affecting vehicle instrumentation system performance.

3.2.7.6 Vehicle Guidance and Control Qualifications

The launch vehicle guidance system, RIFCA, second stage Telemetry and Command are powered up. System checkouts are performed on the guidance system, RIFCA, first and second stage ordnance circuits, as well as telemetry systems. Objective is to verify the operation of the launch vehicle systems. This test is normally scheduled on L -10 Day with a duration of approximately 8 hours. The Range schedule will specify the RF clearances and support times for the FCA Van, RCO and Tel-4, if required.

3.2.7.7 Cryogenic Systems Leak Checks

Liquid oxygen or hydrogen is transferred into the first stage or second stage propellant tanks and engine systems. Objective is to qualify the first and second stage and aerospace ground equipment (AGE) interfaces, it is necessary to successfully accomplish cryogenic loading and pressurization and verify vehicle capability to accept and retain cryogenics (Liquid Oxygen and Hydrogen) at preflight pressures. This test is normally scheduled on L -10 Day with a duration of approximately eight hours.

3.2.7.8 Wet Dress Rehearsal/Crew Certification Test

Simulated launch vehicle countdown is conducted with instrumentation systems powered up. LOX and liquid hydrogen loading and leak checks are performed along with vehicle systems internal power checks, simulated holds, recycles, de-tanking and shutdown. This test provides training for the launch crew and will normally be scheduled for each launch. This test will have a duration of approximately 12 hours. The Range schedule will specify RF clearances, and the support times for the Command carrier, RCO, FCA Van and Tel-4.

3.2.7.9 Secure Code Loading

Command Destruct secure codes will be loaded into the Range Command system and the launch vehicle. Objective is to transfer the Command destruct secure codes into the Boeing portable code storage and transfer test set, vehicle CRDs, CCRS message storage unit and Cape Command CRDs.

Delta IV Pre-Launch Tests					
TEST	**DAY**	**INSTRUMENTATION**	**TIME**	**MFCO**	**RCO**
Secure Code Loading	L-10-15	Comm, Command	4 hrs	Yes	Yes
Wet Dress Rehearsal/Crew Certification Test	L-10-15	Comm, Timing, Command, Telemetry, FCA	12 hrs	Yes	Yes
Cryogenic Systems Leak Checks	L-10	Comm	8 hrs	No	No
Vehicle Guidance and Control Qualifications	L-10	Comm, Telemetry, FCA	8 hrs	No	Yes
RFI/EMI Test	As Req	Comm, Command, Telemetry, Radar, FCA	8 hrs	Yes	Yes
Telemetry Data Flow Test	L-7	Comm, Timing, Telemetry	6 hrs	No	Yes
Simulated Flight Sequence Test	L-6	Comm, Telemetry, FCA	11 hrs	No	Yes
Flight Program Verification Test	L-5	Comm, Timing, Telemetry, FCA	16 hrs	No	Yes
Second Stage Servicing	L-3	Comm, WX	8 hrs	No	No
Vehicle Guidance, Control, Transponder and Range Safety Checks	L-1	Comm, Command, Telemetry, FCA	8 hrs	Yes	Yes

Table 3-2-1: *Delta IV Pre-Launch Tests*

3.2.8 OPERATIONS PROCEDURES

3.2.8.1 Launch Countdown Procedures

The user interface for Delta operations will be the ULA Range Coordinator (RC) for commercial missions. Coordination between the user and the RCO on Range Operations issues will be handled over Channel 1/2 (Countdown 1/2) or Channel 5 (Range Net). The Range Countdown for a Delta launch is 6 hours and begins at L-6 hours. However, the RCO is required to support beginning at L-6 hours and 30 minutes to coordinate clearance for command system preps and RF silence for pad preparations.

3.2.8.2 Launch Contingency Procedures

The Delta IV launch countdown manual is the Launch Preparation Document (LPD) EL005 Task 2: ***Terminal Countdown***. The Delta IV Misfire/Hangfire/MECO procedures are contained in EL005 Task 2 Item 34 **–** ***Scrub Securing after T-8.5 Seconds Including Engine Abort/Cutoff***. Once the scrub securing procedures are complete, the LC will direct personnel to EL005 Task 2 Item 38 **–** ***Post-Test Securing – Continued Recycle from T-4 Minutes***. For further information regarding Operations Procedures, reference the assigned User Procedures for each mission.

3.2.8.3 Scrub Procedures

The launch vehicle scrub turnaround times depend upon the vehicle configuration and when the decision to scrub is made in relation to the launch countdown. Reference Table 3-2-2 for scrub turnaround times.

T-Time	Event	Impact/Minimum Recycle Time
Prior to T-4:00 M	Preps or Cryo Tanking	Extend hold time as required to work issues. Can safely remain in T-4 min hold until end of window.
T-4:00 M to T-3:33 M	Pickup Terminal Count Avionics transfer to Internal	Required to recycle to L-7/T-4 min and holding and poll launch team. ❑13-17 minutes to new T-0
T-3:32 M to T-3:08 M	CBC Propellant tank securing started	Time driven by requirement to recondition CBC LO2 and LH2. ❑14-20 minutes to new T-0
T-3:07 M to T-2:01 M	CBC Tank Pressurization CBC Umbilical Securing Vehicle Ordnance Arming	Time driven by requirement to refill umbilicals and perform previous steps. ❑14-22 minutes to new T-0
T-2:00 M to T-1:21 M	SS LO2 Propellant tank securing started TPA Spin Started LOX GSE Secured	Time driven by requirement to recondition SS LO2 and perform previous steps. ❑15-23 minutes to new T-0
T-1:20 to T-0:23 sec	SS LH2 Propellant tank securing started	Time driven by requirement to recondition SS LH2, restore LOX GSE, and perform previous steps. ❑15-25 minutes to new T-0
T-22.5 sec	SRM Blowdown	Scrub for the day. Must service SRM hydraulic system. ❑72 hour recycle minimum for Medium + Vehicle configuration
T-14.5 sec	ROFI Ignition	Scrub for the day. Must replace ROFIs. ❑72 hour recycle minimum for Heavy Vehicle configuration
T-8.5 sec	RS-68 Pre Start	Scrub for the day. RS-68 and CBC thermal inspections required. ❑ 72 hour recycle minimum
T-5.5 sec and after	RS-68 Start	Hot fire abort. Scrub for the day. RS-68 inspection; torque checks; igniter replacement; leak checks; FTP & OTP push-pull checks required. ❑7 days recycle minimum
Note: Recycle times do not reflect the time required for resolution of issues or extended T-0 coordination discussions. Recycle time range is dependent on topping stabilization cycles.		

Table 3-2-2: *Delta IV Recycle/Scrub Times*

The Delta IV scrub procedures are contained in EL005 Task 2 Item 38 – ***Post-Test Securing – Continued Recycle from T-4 Minutes***.

One the decision to scrub has been made; the RC will notify the RCO of the scrub decision and may provide a reschedule request, depending when in the countdown the decision was made to scrub. The LC will also direct personnel on where to start in EL005 Task 2 Item 38 depending upon when in the countdown the decision was made to scrub. If holding at T-4 minutes, the LC will direct personnel to the beginning of the procedure.

The first steps of this procedure place the vehicle in a safe, non-launch condition to include disabling the ignition firing circuit, safing the S&As, and safing the destruct ordnance. The vehicle CRDs are already on external power at this point in the procedure because they do not go on internal power until T-4 minutes and the recycle procedures back to T-4 minutes place them back on internal power.

At this time, the OSM will be able to report to the MFCO that the vehicle is in a safe, non-launch condition. The MFCO will then be able to release Range Safety special use airspace and non-contingency support assets.

Note that the MFCO may not receive a call from the OSM at this time and may have to contact the OSM to ensure that the Range Safety special use airspace can be released.

The next major item in the EL005 Task 2 Item 38 is the de-tanking of the launch vehicle. The LC will direct the Assistant Test Conductor #1 (ATC1) and the required personnel to switch to Channel 14 to perform Common Booster Core (CBC) and upperstage (US) LH2 de-tanking per the appropriate Contingency Procedures section.

The LC will also direct ATC1 and the required personnel to switch to Channel 13 to perform CBC and US LO2 detanking per the appropriate Contingency Procedures section. Meanwhile the LC will direct the Assistant Test Conductor #3 (ATC3) and the required personnel to switch to Channel 11 to proceed with partial Avionics power down starting with Item 74 **–** ***CRD 1&2 Power Turn-Off*** through Item 77 **–** ***EMA Power Turn-off***.

When the CRDs have been turned off per Item 74 **–*****CRD 1&2 Power Turn-Off***, the OSM will notify the MFCO and the MFCO will then coordinate with the RCO to remove the command carrier. The RCO can then contact the RC to coordinate with the launch agency to remove the command carrier.

3-3 FALCON 9

3.3.1 LAUNCH AGENCY

Established in 2002 by Elon Musk, the founder of PayPal and the Zip2 Corporation, SpaceX has already developed two brand new launch vehicles, established an impressive launch manifest, and been awarded COTS funding by NASA to demonstrate delivery and return of cargo to the International Space Station.

3.3.2 LAUNCH FACILITIES

The Falcon 9 is launched from SLC-39A or SLC-40 which also happens to be the former home of the Space Shuttle and Titan IV, respectively. The Falcon 9 is integrated in a hanger and then rolled out and erected with the Transport Erector. The Strongback is left up as support for the vehicle and is lowered 12.5 degrees on Day of Launch at T-50 minutes.

At the launch site, the stages will be checked out horizontally in the SpaceX Integration Facility for approximately two weeks, and then mated horizontally. In parallel, the payload will undergo processing in a processing facility for up to two months as required by the payload. The payload processing facility will either be a commercially available facility near Cape Canaveral Air Force Station (CCAFS), or a SpaceX furnished processing facility. The payload will be fueled in the processing facility, and then encapsulated in the vehicle fairing. The encapsulated payload will then be transported to the SpaceX Integration Facility by road approximately 6 to10 days prior to launch. There it will be mated with the launch vehicle in the horizontal position. Shortly after, the integrated launch vehicle will be moved out to the launch pad (at approximately L-6 days) on the vehicle erector/strongback system. At the pad, the vehicle will be connected to the stand, and to site propellant systems and further processed horizontally.

Upon arrival at CCAFS, the launch vehicle will be placed in the Integration Facility to begin checkout. The launch vehicle stages will be leak checked, function checked, and then mated. After mating, ordnance will be connected (if required), and a full simulation flight will be conducted. This checkout activity is expected to take no more than one week. Most on-pad checkouts of the vehicle systems will be conducted horizontally at the pad. The Eastern Range (ER) will support a variety of pre-launch checkout tests as described in this Operations Directive (OD).

3.3.3 LAUNCH VEHICLE DESCRIPTION

The Falcon 9 space launch vehicle is a two-stage, liquid launch vehicle in the medium launch class. The propellants for the vehicle itself (both stages) are Liquid Oxygen (LOX) and rocket propellant No. 1 (refined kerosene). The Second Stage de-orbit system and payloads may carry quantities of these or other propellants including:

Nitrogen Tetroxide (N_2O_4), Monomethyl hydrazine (MMH), solid propellants, and other standard spacecraft (SC) propellants.

The first stage of the Falcon 9 is approximately 12 feet by 100 feet, weighs approximately 30,000 pounds (dry), and includes nine M1C engines, the same engine used on the first stage of the Falcon 1. The second stage is approximately 12 feet by 41 feet, not including the fairing and payload, which weighs 7,000 pounds, and uses one M1C engine. The Dragon simulator will be used. The first stage consists of LOX and kerosene tanks that hold 146,000 liters (38,600 gallons) of LOX and 94,000 liters (24,800 gallons) of kerosene. The second stage consists of 27,600 liters (7,300 gallons) of LOX and 17,400 liters (4,600 gallons) of kerosene in tanks with a common bulkhead.

The Falcon 9 launch vehicle uses helium gas stored in high pressure, composite over wrapped cylinders to pressurize the propellant tanks. Quantities of helium required for Falcon 9 processing are 59 kilograms (130 pounds) for first stage pressurization, engine spin start and purging, and 24.6 kilograms (54 pounds) for second stage pressurization.
Gaseous nitrogen (GN_2) is used on board for attitude control system utilizing cold gas thrusters.

At the pad, the vehicle will be connected to the stand and to site propellant systems and further processed horizontally. The Falcon 9 launch vehicle will be erected approximately three hours prior to launch. Once vertical, communications checks will occur, as well as a final systems check. The erector/strongback will remain next to the vehicle until about 30 minutes prior to launch. Propellant loading will begin approximately two hours prior to launch. Pad backout crews will be evacuated to a designated fallback location approximately one hour prior to launch.

The Falcon 9 also is able to recover its first stage by flying it to a barge in the ocean, or back to land on Landing Zone 1 (LZ-1) formerly known as SLC-13. Due to the increased risk of flying a vehicle back to CCAFS, OSM will sit on console for LZ-1 flyback missions. OSM does not sit on console for flyback to the barge or expendable Falcon 9 launches.

3.3.4 FLIGHT TERMINATION SYSTEM
The Falcon 9 is equipped with an autonomous flight safety system (AFSS). This has eliminated all range tracking and FTS requirements resulting in a 62% reduction in the crew force necessary for missions.

3.3.5 PRE-LAUNCH OPERATIONS

3.3.5.1 Static Fire Test
The Falcon 9 will be configured to prevent inadvertent flight and the safety controls may require Range support to send Arm (but not Destruct).
The Static Fire test includes a brief ignition of the first stage engines. The Static Fire Test no longer requires the support of range personnel beyond scheduling and de-confliction.

3.3.6 OPERATIONS PROCEDURES

3.3.6.1 Launch Countdown Procedures
The user interface for Falcon 9 operations will be the SpaceX Range Coordinator. Coordination between the user and the ROC on Range Operations issues will be handled over Complex 40 Channel 25. The Range Countdown for a Falcon 9 launch is 2 hours and begins at L-2 hours.

3.3.6.2 Launch Contingency Procedures
The LC will direct the Terminal Count Abort sequence without waiting for direction in the event of an abort or hold within 10 minutes of T-0. In the event of an abort during the engine start

sequence, the LC shall direct a Network Abort to force engine shutdown and verify the flight computer is not in “startup” mode.

Once the vehicle and ground systems are in a safe and stable configuration, the troubleshooting process begins. The vehicle may remain in this safe (“known”) state indefinitely while issues are resolved and a recycle is planned. Follow-up actions are dispositioned (as required) and a countdown restart step and approximate new launch time are determined. The LC will determine if the launch will proceed or a launch scrub is required. If the launch countdown is to continue, the crew will re-enter the launch procedure at the Final Launch Preparations and Recycle Point of the launch procedure.

3-4 TRIDENT

3.4.1 LAUNCH AGENCY
Submarine Launched Ballistic Missiles (SLBMs) have been an integral part of the strategic deterrent for six generations, starting in l956 with the U.S. Navy Fleet Ballistic Missile (FBM) Polaris (A1) program. Since then, the SLBM has evolved through Polaris (A2), Polaris (A3), Poseidon (C3), Trident I (C4) and today’s force of Trident II (D5). Each generation has been continuously deployed at sea as a survivable retaliatory force and has been routinely operationally tested and evaluated to maintain confidence and credibility in the deterrent.

The Trident II (D-5) is the sixth generation member of the U.S. Navy's FBM program. The first deployment of Trident II was in 1990 on the USS Tennessee Ballistic Missile Submarine (SSBN 734). While Trident I was designed to the same dimensions as the Poseidon missile it replaced, Trident II is larger in both diameter and length. The Trident II is manufactured by Lockheed Missiles and Space Co. and operated by the U.S. Navy. Trident II missiles are deployed in Ohio-class (Trident) submarines, each carrying 24 missiles. The Trident II missile is also provided to the United Kingdom (UK) which equips the missile with UK warheads and deploys the missile on Vanguard Class UK submarines.

3.4.2 LAUNCH FACILITIES
The Navy Ordnance Test Unit (NOTU) conducts test launches of Trident II (D5) SLBMs in the Atlantic Ocean off of the coast of Florida. These launches are conducted from the D4 or LP5 launch areas with impacts into designated Portable Impact Location System (PILS) impact areas in the Atlantic Ocean.

3.4.2.1 M465 Range Safety Communications System (RSCS)
The M465 RSCS is a redundant system and consists of two independent paths, System One and System Two. Service coverage is provided by a commercial Ku-Band Satellite that provides a path for each string of 128 kilobits per second (kbps) between the Launch Area Support Ship (LASS) and the MOC. System One provides a path for secure voice nets 1 and 1A, Navy Global Positioning System Translator Processor (NGTP) data 1J and 1K, and Telemetry Processing Unit (TPU) data 1G. System Two transports secure voice nets 2 and 2A, NGTP data 2J and 2K, and TPU data 2G.

The LASS M465 terminal equipment is divided into Above-Deck Equipment (ADE) and below-deck equipment (BDE). The ADE consists of two Ku-Band stabilized antennas protected by radomes. The M465 uses one antenna pair (MOC and LASS) per full-duplex SATCOM link. The two sets of antenna pairs provide for redundant M465 SATCOM capability thus satisfying the Range Safety requirement. The BDE consists of redundant racks containing the BDE power supply, antenna system control processor, RF electronics and SATCOM modems. In addition, the BDE has redundant multiplexers that accept the M345 data output, as well as KG-84 encryption devices. The BDE also processes compass data from the ship that allows for stabilization of the antennas.

3.4.2.2 Launch Area Support Ship
The LASS is a surface ship instrumented with the M345 Ship’s Instrumentation Package and an Operational Control Center (OCC) for support of Fleet Ballistic Missile demonstration and operational flight tests in the broad ocean area.

3.4.3 LAUNCH VEHICLE DESCRIPTION

The Trident II is an inertial guided FBM with three solid propellant stages and a separable maneuverable equipment section from which the reentry vehicles are ejected. The missile consists of a first stage section, an interstage (IS) section, a second stage section, an Equipment Section (ES) which also contains the third stage, a Nose Fairing (NF) section, and a nose cap section with an aerospike. The ES houses the major guidance and flight control electronics packages. The Trident II has a range of more than 4,000 nautical miles (4,600 statute miles) and has a significantly greater payload capability than the Trident I (C4) due to improvements in rocket motor performance and reductions in the weight of the missile's components. All three stages of the Trident II are made of lighter, stronger, stiffer graphite epoxy, whose integrated structure results in considerable weight saving. The missile’s range is further increased by the aerospike, a telescoping outward extension that reduces frontal drag by about 50 percent.

3.4.3.1 Follow-On CINC (Commander-in-Chief) Evaluation Test (FCET)

The FCET program was established to obtain, under representative tactical conditions, valid operational readiness, reliability, accuracy, and other performance planning factors, including those on missile in-flight performance. It provides data for use by the Joint Chiefs of Staff in Single Integrated Operational Plan (SIOP) () generation, provides evaluation of weapons system performance characteristics in an operational environment, determines the adequacy of tactical procedures, and provides diagnostic information leading to system improvement and crew training. COMSUBLANT/ COMSUBPAC OPLAN 2193 is the authoritative document for Atlantic Ocean CETs.

CETs are conducted using missiles which are representative of the deployed force with respect to modifications, exposure to patrol environment, configuration, etc. CET missiles are randomly selected from on board “ready” missiles and “In-Tube” converted (ITC) to test missile configuration. The ITC process is also used in Demonstration and Shakedown Operations (DASO).

3.4.3.2 Demonstration and Shakedown Operations

DASO was established to determine the readiness of the complete weapons system for operational deployment. The DASO program exercises each weapons system in a comprehensive series of subsystem and system tests designed to provide performance data on the weapons system operated in as near a fleet operational environment as is practically achievable. Each submarine is tested in DASO following construction, and again following periodic shipyard overhaul periods.

The general objective of DASO is to demonstrate the readiness of a weapons system for deployment. This objective is met by testing each SSBN weapons system under conditions where SSBN, missile, and Range instrumentation provide sufficient data to permit a high confidence assessment of system performance.

An additional goal in planning is to develop scenarios so the DASO flight test results will be as representative of an operational mission as possible. This means making the DASO and CET scenarios as nearly alike and as close to operational mode as the differing DASO and CET objectives will allow. In particular, the attempt will be made to make the missile subsystem (including guidance) handling, testing, and conversion procedures as near operational as possible.

DASO launch operations are similar to those used in CET launches, the major exception being the use of a pre-selected launch schedule vice using the SSBN's receipt of a launch message to define T-0. Additionally, the differing purposes of the two exercises dictate the use of a highly structured procedure with additional supporting personnel and a well-groomed onboard fire control system as well as a highly instrumented missile for DASOs.

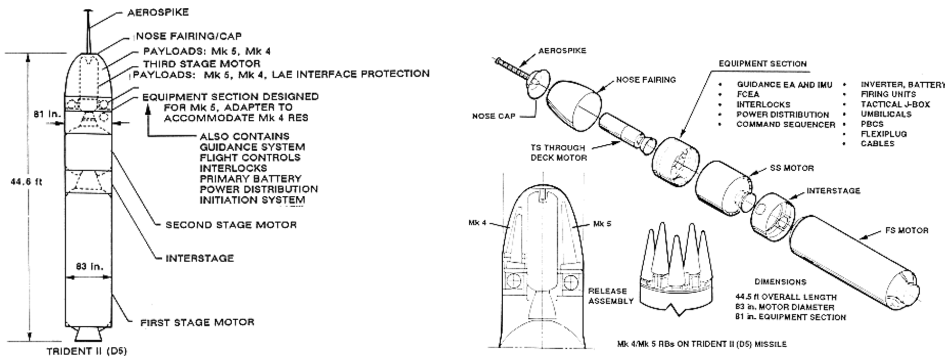


Figure 3-4-1: *Trident II Vehicle Specifics*

3.4.4 TELEMETRY SYSTEM

Missile body and reentry body measurements are digitally encoded and transmitted on every flight in the form of telemetered analog and digital data. All missile body and reentry body (RB) telemetry links, including the GPS translators, operate in the 2200-2300 MHz band. Various modulation and encoding techniques, such as Pulse Code Modulation/Frequency Modulation (PCM/FM) are used on the telemetry links. Guidance telemetry data and GPS translator data are used by FOV1 and DRSD to create the Range Safety solutions. Missile body, RB and GPS translator telemetry link frequencies are as follows:

MISSILE				D-LINK	A-LINK	TRANSLATOR DOWN LINK
W				2205.5	2227.5	2273.5
X				2210.5	2249.5	2283.5
Y				2242.5	2224.5	2258.5
Z				2217.5	2201.5	2235.5

MK4 RB	LAUNCH LINK	REENTRY LINK	MK5 RB	LAUNCH LINK	REENTRY LINK
ENTB-1/2F-1	2288.5	2230.5	ENTB-1/JTA-1	2288.5	2230.5
ENTB-2/2F-2	2268.5	2246.5	ENTB-2/JTA-2	2252.5	2213.5
ENTB-3/2F-3	2263.5	2221.5	ENTB-3/JTA-3	2246.5	2268.5
ENTB-4/2F-4	2252.5	2213.5	ENTB-4/JTA-4	2263.5	2221.5

Table 3-4-1: *Trident Telemetry Links*

3.4.5 TRACKING AIDS
A GPS frequency translator, located on the missile body equipment section, is flown on all flights as a Range Safety tracking source. Data from the GPS translators is received by the TAA-50 antennas at Jonathan Dickinson Missile Tracking Annex (JDMTA), demodulated and input into the Translated GPS Range System (TGRS), also located at JDMTA. Each of the four TGRS GPS Translator Processors (GTP) independently derive a real-time Range Safety state vector or Time Space and Position Information (TSPI) based on the launch vehicle GPS translator data. TGRS is designed to process and record data for up to four Trident missiles simultaneously. The data is available from Acquisition of Signal (AOS) plus 5 seconds until Equipment Section Burn Out (ESBO).

3.4.6 FLIGHT TERMINATION SYSTEM
To ensure protection of life and property from an errant missile, Flight Termination Systems (FTS), consisting of Command Receiver Decoders (CRD) and ordinance initiation devices are carried on the Trident D5 missiles through all propulsive stages of flight. The CRDs receive flight termination functions from Eastern Range (ER) Command Destruct System (CDS) assets on a frequency of 421 MHZ. The Trident D5 CRDs are unique on the ER as they utilize a specialized version of the standard four tone Inter-Range Instrumentation Group (IRIG) command destruct system as defined in Range Commander’s Council (RCC) document 319-99.

3.4.7 PRE-MISSION TESTS

3.4.7.1 Holdfire Checks
Trident launches have no electronic holdfire capability. The only way to call a hold for a Trident launch is verbally. Therefore, holdfire checks are not accomplished for these missions.

3.4.7.2 Flight Termination Checks
EWR 127-1 Chapter 4 and AFMAN 91-710 Vol 4 require that open loop tests be performed on the vehicle’s FTS prior to launch to prove the integrity of the ground and airborne command transmitter system. This includes the Range Command transmitter systems, vehicle antenna systems, and the Command Receiver/Decoders (CRDs). These regulations specify the configuration and codes to be utilized in these tests for both Secure CRDs using encrypted codes and Non-Secure or Standard CRDs using Inter-Range Instrumentation Group (IRIG) tones.

The Trident II SLBM uses non-secure CRDs. The FTS check procedures are led by the RCO.

3.4.7.3 Beacon Checks
The purpose of Beacon checks is to test the launch vehicle’s C-band beacon(s) to ensure compatibility with range radars.

The Fleet Ballistic Missile program does not require radar track of vehicles in flight; the tracking requirement is met using the Flight Test Support System (FTSS), a GPS-based inertial guidance system. As a result, the FBM does not carry a beacon.

3.4.7.4 First Motion Checks
The purpose of the first motion subsystem of the Eastern Range Sequencer System is to provide an input to the sequencer and initiate timed events relevant to the launch time. The purpose of first motion checks is to validate first motion circuitry from the sequencer in the applicable

blockhouse or Launch Control Center to all locations required to receive a first motion signal (i.e. instrumentation sites, launch pads, first motion displays, etc.).

NAVY does not use a mechanical first motion system because of the unique submarine method of launching the missile. First motion time for a SLBM is received along with the missile ID at the moment of first stage ignition. After the missile clears the surface and begins to fall backwards onboard accelerometers detect the motion and ignite the solid rocket first stage which sends the first motion signal.

3.4.7.5 Data Flow Checks

Data flow checks are performed for naval launch operations to ensure the operational capability and quality of the satellite communications and telemetry data links between the Launch Area Support Ship (LASS) and CCAFS.

IP-132 (Instrumentation Procedure 132) Data Link Bit Error Test:

Before conducting naval launch operations, the range must verify SATCOM links between the LASS and CCAFS. The links are checked via naval instrumentation procedure 132, which is comprised of a bit error test performed by the ISRO. The LASS Initiated Link Test (LILT) checks the circuit from the LASS to CCAFS using the M345 and M465 on the LASS.

At approximately L-4 hours, the ISRO completes the IP-132, data link bit error test per the Range Countdown. The ISRO verifies that the LASS Ship's Instrumentation Manager (LSIM) and Real Time Computer System (RTCS) are ready to support the test. Upon readiness confirmation, the ISRO notifies the LSIM that the range is ready for the LILT. The LILT is initiated by the LSIM and runs until the ISRO notifies the LSIM that the test was received by the RTCS. Once the test is complete, the results (satisfactory or unsatisfactory) and the average error count is relayed to the LSIM from the ISRO. The test is unsatisfactory if the bit error rate is greater than 300 for a 2400 bps test.

Once both tests are complete the ISRO notifies the RCO that IP-132 Data link bit error test is complete and reports the results. The RCO notifies the Test Coordinator (TC) upon completion of the Data Link Bit Error Test and of the results obtained. The RCO is to log all actions and results.

IP-133 (Instrumentation Procedure 133) Data Link End-To-End Test:

In order to verify the readiness of the Eastern Range to support Naval Launch operations, a data link interface test is performed. The IP-133 test verifies the transmission, reception and processing of missile data from the LASS to the range and within the range by playback of missile telemetry and trajectory tapes from the LASS and selected range stations simultaneously. After the SATCOM link test (IP-132) the ISRO performs the Data Link End-to-End Test (IP-133) per the Range Countdown.

The ISRO will ensure all stations are operational and in launch configuration before starting this test, after the test all stations will remain in launch configuration until the launch is terminated. The stations included in the test are Real Time Computer Systems, Radar, Telemetry, Communications, Command, Timing, and LASS. The Data Link End-to-End Test is a simulated countdown that will be run as many times as necessary to ensure both primary and secondary

sides of all stations are operational. After confirming all stations are prepared to support the test, the ISRO will coordinate a T-0 time with the LSIM and initiate the simulated countdown.
Once the test(s) is/are complete, the ISRO informs the RCO and LSIM of the results. The RCO notifies the TC upon completion of the Data Link End-to-End Test (IP-133) and of the results obtained. The RCO is to log all actions and results.

3.4.8 PROGRAM SPECIFICS

SATCOM communications links are essential during a Navy missile test in order to relay voice and telemetry data from the launch area back to the Cape. Those SATCOM Links provide the Range safety computers with the data needed to track the missiles early in the flight. Accomplishment of the Data Flow Tests ensures that the SATCOM Links will be in place and functioning correctly for launch. Data Flow checks only apply to the Navy program.

3.4.9 PRE-LAUNCH OPERATIONS

Pre-launch operations involve myriad test vehicle tests and checks in preparation for launch day. Various range resources (radars, telemetry, command, etc.) and personnel (RCO, MFCO, ISRO, controllers, etc.) are involved in these operations to ensure the vehicle meets its required parameters. Many of the pre-launch operations for the Navy launches from the Eastern Range are described in this section. These are not all inclusive, but describe those operations where range personnel are directly involved.

3.4.9.1 Combined E-T-E

This test includes exercising the destruct system by issuing RF commands from the range transmitter and monitoring correct responses from each of the destruct initiation units on board the missile being monitored. Auto destruct checks verify proper operation of the self-destruct design which ensures all stages of the missile will attain flight termination status when any one stage auto destructs. Test also includes exercising telemetry transmitters for all available links, monitoring instrumentation data at the Ground Support Station, and performing functional checks on transmitter frequency and deviation. RCO required.

3.4.9.2 Command Range Frequency Unit (RFU)

This test includes sending destruct RF Commands from the range transmitter and verifying safe, arm destruct logic, and destruct output on the M250 (Equipment installed on SSBN to test/verify the operability of the Telemetry, Tracking, and Flight Termination Systems). These checks are performed on destruct external power only. RCO required.

3.4.9.3 DRAS (Dress Rehearsal At Sea)

Performed on DASOs around L-2 days, the DRAS is a full run of launch day procedures (excluding launch) with range support positions and includes RFU checks prior to the start of the range count. The entire range crew is required with the exception of MFCO support personnel and surveillance personnel; however, MFCO support personnel and surveillance personnel are recommended depending on simulation requirements.

3.4.9.4 F-1 Day Simulation

Same as DRAS, but for FCET operations and usually performed on L-1 day. RCO required.

3.4.9.5 Preliminary E-T-E

This procedure is designed to provide a preliminary test of telemetry links, and destruct RFU signals with the Range during the DASO PREPs period. Telemetry signals are transmitted and destruct signals received simultaneously during the test. RCO required.

Navy Pre-Launch Tests					
TEST	**DAY**	**INSTRUMENTATION**	**TIME**	**MFCO**	**RCO**
DASO					
Prelim E-T-E	L-10	Comm, Command	4 hrs	No	Yes
Command RFU	L-2	Comm, Command	4 hrs	No	Yes
DRAS	L-2	All	8 hrs	Yes	Yes
Combined E-T-E	L-1.5	Comm, Command	4 hrs	No	Yes
FCET					
F-1 Day Simulation	L-1	All	8 hrs	Yes	Yes

Table 3-4-2: *Navy Pre Launch Tests*

3.4.10 OPERATIONS PROCEDURES

SSP OD 56513:
OD 56513 consists of the Atlantic Test Missile Launch Standard Operating Procedures. This can be considered the User's countdown and contains several Weapons Operating Procedures (WP):

WP 5100 - The Master Range Countdown for FCET Launches.

WP 5200 - The Master Range Countdown for DASO and Dress Rehearsals At Sea Launches from the LP-5 Launch Point.

WP 5201 - The Master Range Countdown for DASO and DRAS Launches from the D-4 Launch Point.

SSP OD 56509:
OD 56509 consists of the user procedure for DASO Trident II (D5) pre-launch Range Tests. This procedure book contains WP 3205-3209.

WP 3205 - Combined Range End to End Destruct and Telemetry Test: This procedure contains detailed instructions for verification of the destruct system. This test includes exercising the destruct system by issuing RF command from the range transmitter and monitoring correct responses from each of the destruct initiation units. Auto destruct checks verify proper operation of the self-destruct design which ensures all stages of the missile will attain flight termination status when any one stage auto destructs.

This test also includes exercising transmitters for all available links, monitoring instrumentation data at the Ground Support Station, and performing functional checks on transmitter frequency and deviation.

WP 3206 - Range End-To-End Destruct Test: This procedure contains detailed instructions for verification of the destruct system. This test includes exercising the destruct system by issuing RF commands from the range transmitter and monitoring correct responses from each destruct initiation unit. Auto destruct checks verify proper operation of self-destruct design which assures all stages of missile will attain flight termination status when any one stage auto-destructs.

WP 3207 - Ground Support Telemetry Test: This procedure contains detailed instruction for verification of the telemetry system. This test includes exercising all available link transmitters, monitoring selected instrumentation data, and performing functional check on transmitter frequency and deviation.

WP 3208 - Preliminary Range Telemetry/Destruct Test: This procedure is designed to provide a preliminary test of telemetry links, and destruct Radio Frequency Unit signals with the Range during the DASO PREP's period. Telemetry signals will be transmitted and destruct signals received simultaneously during this test.

WP 3209 - Range Command Destruct RFU Test: This procedure contains detailed instructions for verification of the destruct RFU operation in the test mode. This test includes sending destruct signals.

3.4.11 COMMUNICATIONS PROCEDURES

For Navy operations, communications protocol is different. At the end of transmission, conclude with a terminating word such as "OVER" or "OUT". It is incorrect to conclude any communication with "OVER and OUT." The person receiving the information will repeat it. This practice is NOT acceptable during all other launch operations except when necessary to clarify a transmission. Otherwise, this habit is not to be used due to the time it takes and additional chatter on the nets. Another peculiarity for Navy operations is when making a call to individuals on the Launch Area Support Ship or the submarine (e.g. TC, TD), don't wait for a reply before continuing with your transmission (see examples below).

NET 1A is read, "NET 1 ALPHA."

Common Words	**MEANING**
"Over"	Communication is complete and a response is expected. A response could just be an acknowledgment that it was received or an answer.
"Out"	Communication is complete, no acknowledgment is expected.
"Copy"	I received your message satisfactorily and understand.
"Understand"	The following is my interruption of last communication.
"Roger"	Agree with last communication.
"Break"	Used to break continuity in a transmission by the speaker so that the listener(s) will know that the speaker has changed subjects.
"Interrogative"	The following communication will be a question.

Table 3-4-3: *Standard Navy Communication Words*

The following is how to ask the TC a question:

"TC, RCO, NET 1; Interrogative, XXXXXXXXX, Over. "Receive information:

		RCO	TC	NET 1	(45)Inform: “LASS ready to support launch operations.”

TC says, “RCO, TC, NET 1; LASS ready to support launch operations, Over.”
RCO replies, “TC, RCO, NET 1; LASS ready to support launch operations, Roger, Out.”

Pass information:

		TC	RCO	NET 1	(61) Inform: "Clear Range predicted at launch time."

RCO says, “TC, RCO, NET 1; <DO NOT wait for reply>, Clear Range predicted at launch time, Over.”
TC replies, “RCO, TC, NET 1, Clear Range predicted at launch time, Roger, Out.”

3.4.12 LAUNCH COUNTDOWN

Normally, two D5 candidate flight missiles will be loaded for each exercise and in-tube converted to test configuration at NOTU. There are two types of tests conducted by NOTU: Demonstration and Shakedown Operations (DASOs) and Commander-In-Chief (CINC) Evaluation Test/Follow-on CINC Evaluation Test (CET/FCET)

The primary objective of a DASO is to determine the readiness of the complete FBM SSBN Weapon System for tactical deployment and provide realistic training for the SSBN crew. DASOs are completed following each FBM SSBN overhaul. Trident DASOs are single missile operations launched from an SSBN in the D4 or LP5 launch area. The primary objective of an FCET is to determine the operational performance factors of the Strategic Weapons System under tactically representative conditions and to assess the capability to launch missiles under operational conditions. In addition, missile reliability and accuracy performance is determined with relation to the effects of prolonged missile patrol environment and/or storage. FCETs consist of multiple launches from an FBM SSBN with a maximum of a two-missile ripple launch or a two-wait-two launch.

Each test missile carries a missile body telemetry system, a FTS, a GPS translator and normally one or more instrumented RB(s). Depending on the mission, the missile may also carry instrumented or non-instrumented experimental RB(s). Nominally, United Kingdom DASO missiles will not carry instrumented RBs.

The Trident II is launched by the pressure of expanding gas within the launch tube. When the missile attains sufficient distance from the submarine, the first stage motor ignites, the aerospike extends and the boost phase begins. Within about two minutes, after the third stage motor kicks in, the missile is traveling in excess of 20,000 feet (6,096 meters) per second.

The Navy provides additional communication and data equipment, including a Launch Area Support Ship (LASS) to supplement ER tracking assets, and P3 Orion aircraft to deploy the Portable Impact Location System (PILS) array. The LASS provides broach and missile location information prior to the missile being visible to ER tracking assets.

The Navy also developed the Missile Tracking Instrumentation System (MTIS), a network of diverse instrumentation systems, to assist the ER in supporting up to four simultaneous Trident D5 missiles. However, the requirement for four simultaneous missiles in the air is no longer valid and the combination of ER and Navy assets currently has the ability to support two simultaneous missiles in the air. The MTIS incorporates NAVSTAR Global Positioning System (GPS) Satellites, Flight Test Support System (FTSS III), M465 KU-Band Satellite communication system, Missile Translator and Telemetry Transmitter, and Eastern Range Support Equipment and Facilities.

The FTSS equipment aboard the LASS fulfills many functions. Its most important function for Range Safety is to detect missile broaches. During LP5 launches, it also transmits SSBN “delta” latitude and longitude information so that a determination can be made whether the SSBN is located within an acceptable distance from the nominal launch point. At approximately T-9 minutes, the FTSS is used to transmit a “LASS Ready” indication to the Range. Once final Clear to Launch is given, the FTSS transmits a “Mission Mode” bit to the MOC and JDMTA to indicate that a broach is imminent. The FTSS can acquire and track missiles through first stage burnout, receive and record missile body and guidance telemetry data, de-commutate the data, and transmit range safety data to the eastern range via the M465 KU-Band Satellite communication system. The 2400 bps telemetry data channel is multiplexed with communication signals and routed through the KU-Band satellite to a ground terminal at the MOC. At this time, the Navy is developing a next generation FTSS IV that is due to replace the FTSS III system in FY12. The FTSS IV will provide more reliable and accurate information. During Navy operations, it is a safety mandatory requirement to maintain secure voice communication between the SSBN, the LASS, and CCAFS. This is accomplished through the same M465 and KU-Band Satellite system that provides data transmission between the LASS and the Range. 9600 bps secure voice channels (NET1/2/1A/2A) are multiplexed and uplinked to the satellite and relayed back down to the MOC.

The primary function that the M465/FTSS fulfills for Range Safety is to alert the Mission Flight Control Officer (MFCO) that a missile is in the air. When a broach occurs, tracking antennae on the LASS detect missile radio frequency signals and outputs a broach message to the M465/FTSS which is transmitted to CCAS. This message initiates plus counters and provides data to the High Density Designate data stream in order to initialize appropriate instrumentation systems. Range Safety also utilizes the ranging signals from the missile to derive instantaneous impact predictions data used by the MFCO to determine if destruct action is necessary. Analog and inertial guidance telemetry data transferred via M465 is processed and displayed at the Range Safety Displays for use by Range Safety personnel.

The user interface for Navy operations is the Test Director (TD). For certain call outs, the RCO also talks to the Test Conductor (TC), aboard the Launch Area Support Ship (LASS). There are two primary communications links used between the range crew and the users. Both are INMARSAT secure links. Net 1 is the primary communications link from the RCO to the TC/TD. Net 2 is its backup. Net 1A is the primary communications link from the ISRO to the instrumentation controller aboard the LASS (call sign LSIM). Net 2A is its backup. Because Navy launches involve operational Navy crews and because they use sat communication links, they have unique communications requirements and protocols. Reference 1ROPS Operations Manual section 7-1 for a description of these requirements and protocols.

Navy launches are either Demonstration and Shakedown Operations (DASO) or Follow-on CINC Evaluation Tests (FCETs). A DASO is a launch using new or test equipment and crews. Its purpose is to shakedown and validate procedures and equipment. FCETs, on the other hand, are conducted with an operational submarine and crew. They are meant to provide the Fleet CINC a spot check of his forces' ability to receive and execute launch orders.

In either case, their countdown is approximately 300 minutes long. There are no built in holds. Key points in the counts include: initial INMARSAT communications checks (L-5 hours and 10 minutes), the IP-132 Data link Bit Error Rate Test (L-5 hours), the IP-133 Data Link End-to-End Test (L-4 hours and 40 minutes), Verification the submarine has achieved condition 2SQ (L-1 hour), LASS ready call (L-10 minutes), Clear to Launch (L-7 minutes), and Permission to Fire (L-1 minute and 30 seconds). T-10 minutes are the users preferred recycle point.

The Test Conductor is normally issued a clear to launch at T-7 minutes. If the RCO is unable to give a clear to launch by T-5 minutes and 30 seconds, they will call a hold. SP 205 will call a hold at T-5 minutes if clear to launch has not been received.

Upon receiving the T-1 hour call for either an FCET or DASO launch, the RCO will provide a voice report via **SECURE** means to the LCU/DO at DSN 268-3050 (STE). This information will only be passed during the T-1 hour call; all other unsecured communications will **EXCLUDE** the Launch Azimuth. Missile Current Ops is the primary LCU in Cheyenne Mountain and has identified the following items as required pieces of information to do their job in support of Navy launches:

- Operations Number
- Range Status
- Count Status
- Launch Azimuth to within +/- $1/10^{th}$ of a degree **(remains CLASSIFIED)**
- First Motion/ Broach Time
- Flight Status: Nominal/non-nominal
- Final Nominal Time

Referencing ER OD 900 Trident Missile Flight Testing. Launch Azimuth if unknown can be found in OR Expedite number one for the specific mission. This expedite defines mission specific items not outlined in ER OD 900. Classification on this expedite is SECRET and therefore it can be located in the NAVY Safe in Room 116 of the MOC.

There are several items regarding Navy operations that are classified. The RCO must be familiar with the security classification guide to prevent security violations. This is especially true when dealing with submarine positions and intended launch/impact points.

3.4.13 LAUNCH CONTINGENCY PROCEDURES

Due to the nature of the launch sequence for SLBM operations, hangfires and misfires are defined differently based on whether the triple alloy steam system, which ejects the missile from the launch tube, is initiated. If the initiation signal is not sent or it is sent but does not reach the ejection system, it is classified as a misfire. If the initiation signal is sent to the ejection system, but the system does not activate and eject the missile, it is classified as a hangfire. Because the submarine cannot leave the launch tube hatch open for a 30 minute wait time, the missile is immediately powered down. If the ejection system ejects the missile from the tube after it has been powered down, the missile will fall into the ocean and sink to the bottom. As a result, the 30 minute wait time does not apply for a hangfire situation during a Trident II mission. If a misfire or hangfire occurs, the User will call a hold on Net 1. After all stations have been notified of the hold, the User will come back up on Net 1 to report the situation that caused the hold.

Since the Trident missile is a solid motor vehicle and does not have an engine, it cannot have a premature MECO. However, if the missile is ejected from the launch tube and the first stage solid motor fails to ignite, the missile will fall into the ocean and sink to the bottom. The missile will not ignite once it has splashed into the ocean because the missile’s guidance system is looking for the vehicle to have a certain upward velocity before igniting the solid motor

3.4.14 SCRUB PROCEDURES

The Navy does not have any specific scrub procedures in their launch countdown documents. Although the missile is armed before being ejected from the tube by the triple alloy steam system, there are several safety mechanisms that can deactivate the missile should the ejection system fail. In addition, there are OSM personnel on-board the submarine who will verify that the missile is safed, however, they do not have any means to directly communicate with the MFCO. As a result, the MFCO is not required to verify the status of the vehicle with the OSM prior to releasing Range Safety instrumentation. Since there is not a C-band transponder or the Trident II missile, there is no need for the RCO to coordinate with the launch agency to cease C-Band interrogation. In addition, since the RFDUs are not captured by the command carrier until after the missile is in flight, there is no need for the RCO to coordinate with the launch agency to bring down the command. Upon notification of the scrub, the MFCO can just coordinate removing the command carrier with the RCO. When the RCO requests a release for range instrumentation from the launch agency, the Test Director (TD) will typically grant the release of all range instrumentation except for comm. The launch agency typically requests that the communication configuration be maintained until the sub is underway back to the port.

3-5 PEGASUS

3.5.1 LAUNCH AGENCY

On August 10, 1989 Orbital Sciences Corporation (Orbital) rolled out the first commercially developed airborne space launch vehicle for providing satellites to low earth orbit.

3.5.2 LAUNCH FACILITIES

Pegasus's air-launched design vastly increases launch point flexibility. Some ground support is required to insure the safety of the people and property, to communicate with the carrier aircraft and to provide data collection and display. This support is usually provided by a federal Major Range and Test Facility Base (MRTFB) such as the Eastern Range, Patrick AFB, FL; Western Range, Vandenberg AFB, CA; and Wallops Flight Facility, VA.

All major vehicle subassemblies are delivered from the factory to the Vehicle Assembly Building (VAB) at Orbital’s integration sites. Orbital's primary integration site is located at Vandenberg Air Force Base (VAFB), California. Through the use of the Orbital Carrier Aircraft (OCA), this integration site can support launches throughout the world.

Orbital furnishes and operates the OCA. After integration at Orbital’s West Coast integration site at VAFB, the OCA can provide polar and high-inclination launches utilizing the tracking, telemetry, and command (TT&C) facilities of the WR. The OCA can provide lower inclination missions from the East Coast using either the NASA or ER TT&C facilities, as well as equatorial missions from the Kwajalein Atoll or Alcantara, Brazil. The OCA is made available for mission support on a priority basis during the contract-specified launch window.

The unique OCA-Pegasus launch system accommodates two distinctly different launch processing and operations approaches for non-VAFB launches. One approach (used by the majority of payload customers) is to integrate the Pegasus and payload at the VAB and then ferry the integrated Pegasus and payload to another location for launch. This approach is referred to as a “ferry mission.” The second approach is referred to as a “campaign mission.” A campaign mission starts with the build up of the Pegasus at the VAB. The Pegasus is then mated to the OCA at VAFB and then ferried to the integration site where the Pegasus and payload are fully integrated and tested. At this point, the launch may either occur at the integration site or the integrated Pegasus and payload may be ferried to another location for launch.

The OCA also has the capability to ferry Pegasus trans-continentally or trans-oceanically (depending on landing site) to support ferry and campaign missions.

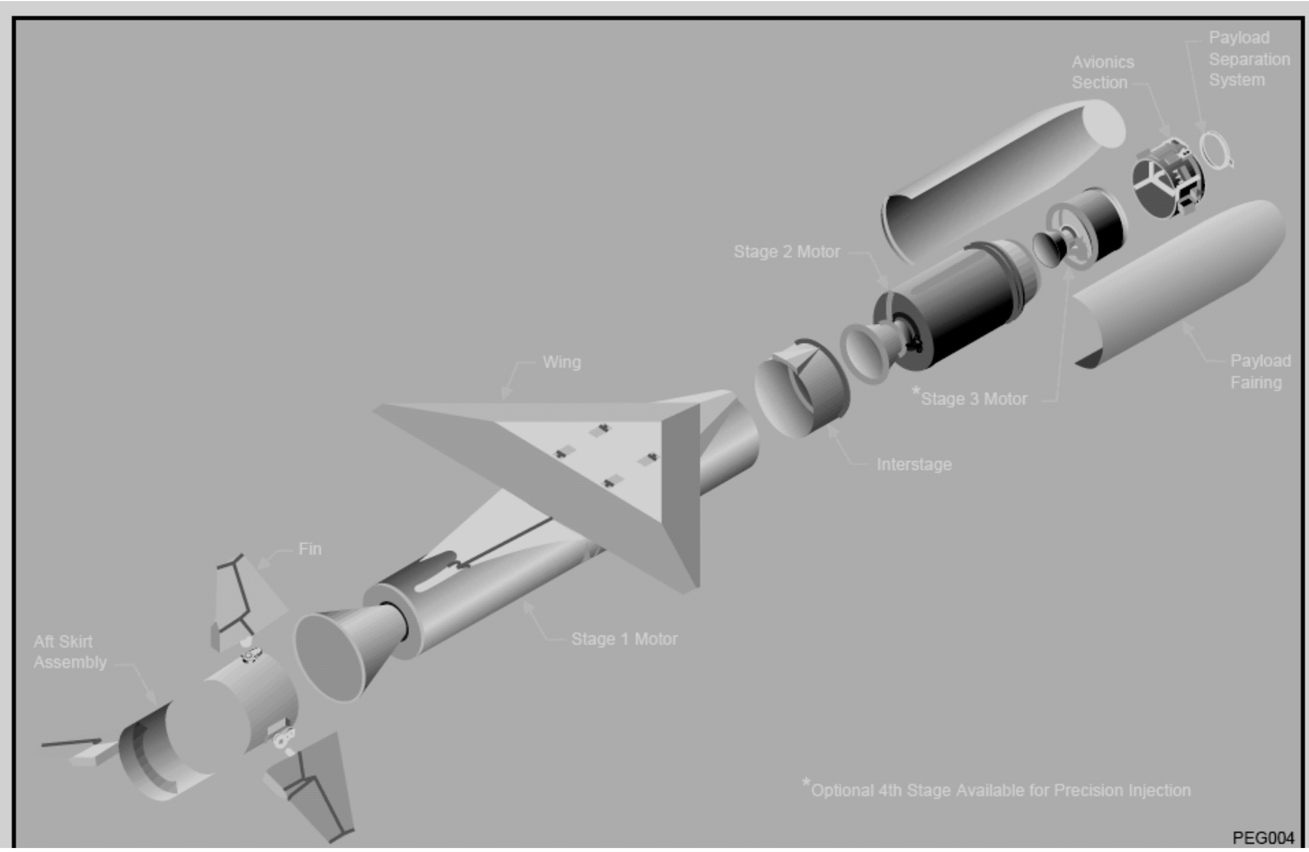


Figure 3-5-1: *Pegasus Launch Vehicle*

3.5.3 LAUNCH VEHICLE DESCRIPTION

Pegasus XL is a winged, three-stage, solid rocket booster which weighs approximately 23,130 kg (51,000 lb) and measures 16.9 m (55.4 ft) in length and 1.27 m (50 in) in diameter and has a wing span of 6.7 m (22 ft).

Pegasus is lifted by the OCA to a level flight condition of about 11,900 m (39,000 ft) and Mach 0.80. Five seconds after release from the OCA stage 1 motor ignition occurs. The vehicle's autonomous guidance and flight control system provide the guidance necessary to insert payloads into a wide range of orbits.

The vehicle incorporates eight major elements:

- Three solid rocket motors
- A payload fairing
- An avionics assembly
- A lifting wing
- Aft skirt assembly including three movable control fins
- A payload interface system

Pegasus also has an option for a liquid propellant fourth stage, Hydrazine Auxiliary Propulsion System (HAPS).

3.5.4 TELEMETRY SYSTEM

The Pegasus XL telemetry system provides real time health and status data of the vehicle avionics system, as well as key information regarding the position, performance and environment of the Pegasus XL vehicle. This data may be used by Orbital and the range safety personnel to evaluate system performance.

Pegasus contains two separate telemetry systems. The first provides digital data through telemetry multiplexers (MUXs) which gather data from each sensor, digitize it, then relay the information to the flight computer. This Pegasus telemetry stream provides data during ground processing, checkout, captive carry, and during launch. During captive carry, Pegasus telemetry is downlinked to the ground and recorded onboard the OCA. Some payload telemetry data can be interleaved with Pegasus data as a non-standard service. The second system provides analog environments data which are transmitted via a wideband data link and recorded for post-flight evaluation.

Pegasus downlinks telemetry data in the S-band and upper S-band frequency range (2,200-2,300 and 2,300-2,400 MHz). The link used at the ER is 2288.5 MHz. A telemetry system must be capable of tracking, receiving and recording this data. The OCA has onboard video cameras and this data is transmitted via a telemetry system that operates in the upper S-band range. A chase aircraft is normally used and it also downlinks telemetry. A separate telemetry system is required to track, receive and record this data.

3.5.5 TRACKING AIDS

Instrumentation Systems consist of a C-Band Radar Tracking Transponder (Link 5765.0/5690.0 MHz). The C-band Radar Tracking Transponder is provided as the primary Range Safety tracking device. It uses redundant C-band antennas mounted on Stage 3 using the exact configuration and components as Pegasus (Stage 2 - Orion 50XL).

Air to ground communications are required to communicate with the carrier aircraft during the launch operations. This can be in the HF, VHF or UHF frequency range.

3.5.6 FLIGHT TERMINATION SYSTEM (FTS)

The Pegasus Flight Termination System supports ground-initiated command destruct as well as the capability to sense inadvertent stage separation and automatically destruct the rocket. The FTS is redundant, with two independent safe and arm devices, receivers, logic units, and batteries.

Pegasus is equipped with command receivers that operate at either 416.5 or 425.0 MHz. They are capable of receiving commands utilizing the standard four tone alphabet. The command transmitter system must meet federal standards as described in EWR 127-1.

3.5.7 PRE-MISSION TESTS

3.5.7.1 Flight Termination Checks

EWR 127-1 Chapter 4 and AFMAN 91-710 Vol 4 require that open loop tests be performed on the vehicle’s FTS prior to launch to prove the integrity of the ground and airborne command transmitter system. This includes the Range Command transmitter systems, vehicle antenna systems, and the Command Receiver/Decoders (CRDs). These regulations specify the configuration and codes to be utilized in these tests for both Secure CRDs using encrypted codes and Non-Secure or Standard CRDs using Inter-Range Instrumentation Group (IRIG) tones. The Pegasus uses non-secure CRDs. The FTS check procedures are led by the RCO.

3.5.8 PRE-LAUNCH OPERATIONS

Pre-launch operations involve myriad test vehicle tests and checks in preparation for launch day. Various range resources (radars, telemetry, command, etc.) and personnel (RCO, MFCO, ISRO, controllers, etc.) are involved in these operations to ensure the vehicle meets its required parameters. Many of the pre-launch operations for the Pegasus vehicle launched from the Eastern Range are described in this section. These are not all inclusive, but describe those operations where range personnel are directly involved. The MFCO supports all tests for Pegasus that have command checks as part of the test.

3.5.8.1 Data Flow

The purpose of this is to check out the data circuit's communication configuration and strip chart set up.

3.5.8.2 Ferry Flight

The ferry flight will be scheduled to transport the OCA with attached Pegasus vehicle from VAFB, CA to CCAFS, FL. During the flight Orbital plans to overfly CCAFS and continue through the planned flight profile to the launch point. This will provide an opportunity to exercise the instrumentation systems to verify coverage during the captive carry portion of the mission. Command system checks will be accomplished both on approach to the launch point (arm checks) and again once the OCA is parked at the skid strip (arm and destruct). HF communications with the OCA will be required until is close enough for VHF and/or UHF communications to be established.

3.5.8.3 Mate and Demate

The purpose of this is to provide the Base Support services required during the mate/ demate activities.

3.5.8.4 Transport/Escort

The purpose of this is to provide the Base Support services required during the transport of the rocket from the skid strip to a payload processing facility and back to the skid strip after the payload is mated.

3.5.8.5 FTS End-to-End Test

This test will be conducted while the rocket is in the processing facility at KSC. A van will be positioned outside the facility and used to relay the open loop carrier and commands from the Command Transmitter Site (CTS) to the rocket. Telemetry displays will be local and in Building AE.

3.5.8.6 Combined Systems Test (CST)

This test will be scheduled after the OCA arrives at the ER to verify the health and status of the rocket and payload and their interfaces with the Range.

3.5.8.7 Rehearsal

This annex will be scheduled to provide the Range User personnel console experience at the ER. This test will utilize the Launch checklist. This test may be run with or without the OCA.

Pegasus Pre-Launch Tests					
TEST	**DAY**	**INSTRUMENTATION**	**TIME**	**MFCO**	**RCO**
Data Flow	L-7	Comm, Telemetry	2 hrs	No	Yes
Ferry Flight	L-7	Comm, Command, Timing, Radar, Weather, Telemetry, RTCS	8 hrs	Yes	Yes
Mate and Demate	L-6	Weather	6 hrs	No	No
Transport/Escort	L-6	Weather	6 hrs	No	No
FTS End-to-End Test	L-3	Comm, Command, Timing, FCA	4 hrs	Yes	Yes
Combined Systems Test (CST)	L-3	Comm, Telemetry, FCA	4 hrs	No	Yes
Rehearsal	L-1	Comm, Telemetry	4	Yes	Yes

Figure 3-5-2: *Pegasus Pre-Launch Tests*

The Data Flow and Ferry Flight can occur approximately two weeks earlier if Mate/Demate and Transport/Escort occur at KSC for payload processing.

3.5.9 OPERATIONS PROCEDURES

For Pegasus, the Launch Conductor (LC) is normally issued a clear to launch at T-5 minutes.

1 ROPS OPS MANUAL, Vol. 1
SECTION 4

DOCUMENTATION
&
REQUIREMENTS

4-1 UNIVERSAL DOCUMENTATION SYSTEM

4.1.1 PURPOSE

The Universal Documentation System (UDS) is a documentation system composed of pre-formatted pages to provide a standardized method for our customers to supply us with their program, mission, and test requirements and for us to supply our customers with our plan to support their operations on the range. Essentially, this is the method by which customers come to the range to launch a vehicle, perform a test, or conduct research and development in space or aeronautical areas. Range Squadron personnel own this process and must understand UDS processing and timetables in order to fully understand our commitments to our customers.

4.1.2 DEFINITIONS

4.1.2.1 Lead Range Agency

The Range Customer, also known as the Range User, is any organization with authority to use range resources. For multiple customers and multiple support agencies, the recommended approach is to use a Lead Range Agency (LRA) to coordinate all the customer and support agency documents. The LRA is the range that is responsible for coordination of total support planning and operations for a particular program, mission, or test. After initial program acceptance by the 45 Space Wing (45 SW), the customer submits detailed needs to the lead range. The lead range identifies the support required from other agencies and coordinates the total support effort.

001-029/111-129	Range Operations Tests
030-059/130-139 /151-159	Range Engineering Tests
060-099/160-199	Special Projects Test
061-064	SNC STARS Support
0100-110	UK Torpedo Program
140-150	RSA
200-300	JStars
500-549	LEAP
550-559	Brilliant Pebbles
900	Trident
1900	GPS Control
2200	Inertial Upper Stage (IUS)
3500	USAF Spacetrack
3800	DOD SPACE Programs
3900	DSCS III
4000	USAF Spacetrack II
4100	Complex 40 Activation For Titan Pgm
4200	PAGE
4300	Titan IV/Centaur/IIUS/NUS
4400	Titan IV Centaur
4500	Titan IV IUS
4600	DoD Payloads
4700	Titan IV NUS
4800	Delta II
4900	GPS Delta II
5000	Delta IV (EELV)
5100	Atlas V (EELV)
5300	Commercial Atlas IIAS
5400	Commercial Atlas IIIA
5500	Commercial Delta II/III
5600	Commercial Athena (formerly LMLV)
6000	DoD Atlas II
7000	Commercial Payloads
7600	Pegasus
8000	ISTEF/ARES/RISO
30000	International Space Station

Table 4-1-1: *45SW Program Numbers*

4.1.2.2 Support Agency & Support Range Agency

A Support Agency (SA) provides limited support to the LRA, while a Support Range Agency provides significant support to the LRA. An SA is an agency which commits its resources in support of LRA program, mission or test requirements. The Goddard Space Flight Center (Bermuda) is considered to be an SA in support of lead range requirements. A Support Range Agency is a Major Range Test Facility Base (MRTFB) or operational facility that provides support services to qualified customers as determined by current directives. The Kennedy Space Center (KSC) is considered a Support Range for the Lead Range Agency, 45 SW.

4.1.2.3 45 SWI 99-101, Mission Program Documents

45 SWI 99-101 identifies key terms, abbreviations and acronyms, security measures, an overview of each UDS document, development timelines, and the process flow used by the 45 SW.

4.1.2.4 RCC 501-97, UDS Handbook

The UDS Handbook is a product of the Range Commanders Council and provides an introduction to the UDS. It discusses the objectives of the UDS, relationships between customers and support organizations, and outlines the UDS flexibility. This document is used in training personnel involved with UDS documentation preparation. The UDS Handbook also provides a description of UDS flows, forms, revision procedures, and form preparations.

It also contains requirement formats and instructions, and is considered the customer's handbook because it gives guidance and format on all customer-generated documents. These documents include the Program Introduction (PI), Program Requirements Document (PRD), and Operations Requirements (OR).

The Handbook also contains response formats and instructions, and is considered the support agency's handbook as well because it gives guidance and format on all support-generated documents that the range provides to the user. These documents include the Statement of Capability (SC), Program Support Plans (PSP), and Operations Directives (OD).

4.1.3 PARTICIPANTS/RESPONSIBILITIES

1 ROPS personnel own this process and must understand UDS processing and timetables in order to fully understand our commitments to our customers.

4.1.4 OVERVIEW

The UDS was developed by the Range Commanders Council Documentation Group to create a standard communications medium between the launch customer and range agencies. The UDS endeavors to standardize the efforts of all agencies seeking support in conducting operations on any of the major ranges. The UDS formally documents customer program requirements, and support agency capabilities and commitments to support these requirements.

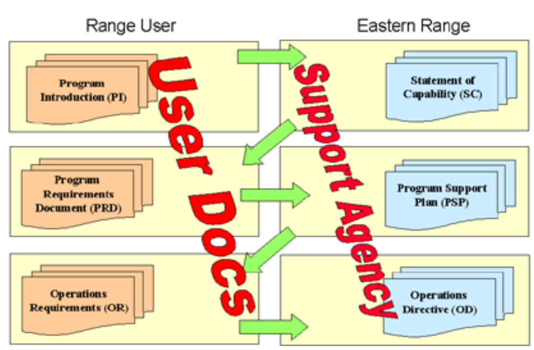


Figure 4-1-1: *UDS Flow*

There are four major objectives of the UDS. The first objective is to establish a standardized communication process to increase the effectiveness of communication between customer and support agencies.

The second objective is to enable support agencies to plan and develop support activities. Without long range planning, a mission could conceivably be developed and not supported by the support agencies. The support agency must be able to plan for meeting new challenges.

Providing a scheduling medium is the third objective. With a standardized system, the requirements of a mission are known in advance. Timelines are created and cross-referenced for conflict resolution and lists of supportable requirements are provided to the customer.

The last objective is to provide a standard yet flexible and dynamic system that meets the requirements and support needs of both simple and complex programs. The UDS provides standardization, but is flexible enough to support any level of complexity. Each support agency has the ability to implement the UDS in their own way.

Without standard requirements or a support and documentation system, a range customer must develop totally new documentation that may vary according to format and content for each operation and each range. This would lengthen the documentation timeline and enable mission critical requirements to be overlooked. A common structure enables customers to employ a basic format with a common language when providing requirements to support agencies. The UDS document formats related support plans to requirements in a clear and concise fashion.

The UDS consists of requirement documentation and support documentation. The customer generates the requirements documentation to illustrate the specific support necessary to meet program, mission, or test objectives. Support documentation is a reply by the support agency, primarily the 45 SW, on capability and feasibility to support the customer’s requests.

4.1.5 REQUIREMENTS DOCUMENTATION

There are three user requirements and three corresponding support documents utilized within the UDS: User documents include the PI, PRD, and the OR and their associated support documents the SC, PSP, and the OD.

4.1.5.1 Program Introduction (PI)

The PI is the initial planning document submitted to 45 SW/XP (Wing Plans) by a potential customer upon identification of the scope and duration of program activity. The potential customer submits the PI using the best available information to enable the 45 SW/XP to initiate resource and technical planning. This information is used by the 45 SW and other support agencies in determining the scope of the program and associated support requirements that are outlined in the Statement of Capability (SC).

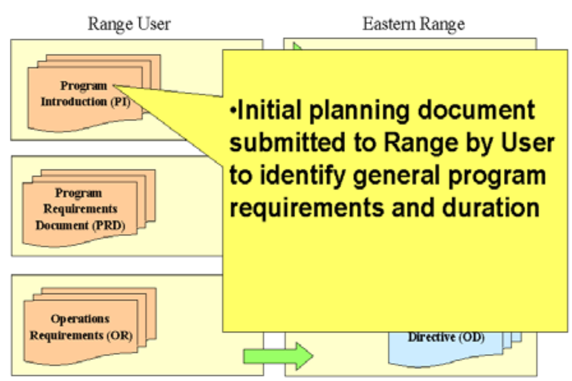


Figure 4-1-2: *Program Introduction*

4.1.5.2 Program Requirements Document (PRD)

The PRD is a detailed user requirement. The Range Squadron will use this document to initiate support planning and development of a detailed budget.

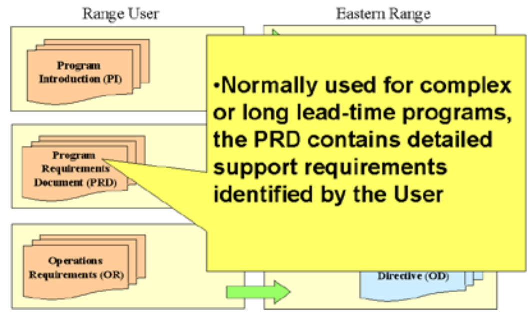


Figure 4-1-3: *Program Requirements*

4.1.5.3 Operations Requirements (OR)

The OR is the last user document. The OR is a mission-oriented document describing in detail the requirements for each mission, special test, or series of operations. The OR must be a complete document capable of standing alone, and must not reflect any new requirements not previously stated in the PI or PRD. Additional requirements or changes or deletions must be submitted as an Expedite OR.

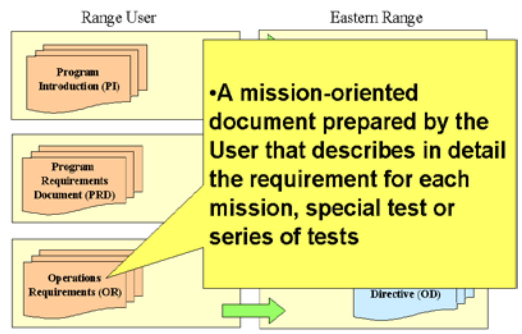


Figure 4-1-4: *Operations Requirements*

4.1.6 SUPPORT DOCUMENTATION

There are three support documents: the Statement of Capability (SC), Program Support Plan (PSP), and the Operations Directive (OD).

4.1.6.1 Statement of Capability (SC)

The SC is the 45 SW/XP response to the PI. This document identifies initial support conditions, qualifications, resources, and other initial considerations. It serves as a baseline for further support agreements. When signed by the 45 SW/CC, the SC is evidence that the Eastern Range (ER) has accepted a program for support. The PI and SC complement each other by initiating program support planning between users and support agencies.

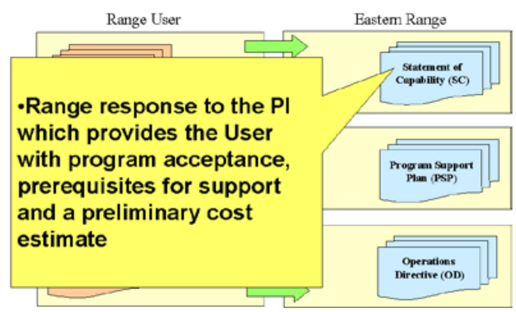


Figure 4-1-5: *Statement of Capability*

4.1.6.2. Program Support Plan (PSP)

The PSP is the 45 SW response to the requirements presented in the PRD. This response indicates those PRD requirements that can be met from existing resources, those that can only be met through alternatives or programming new resources, and those which cannot be met by the range. A refined budget estimate is also provided to the customer.

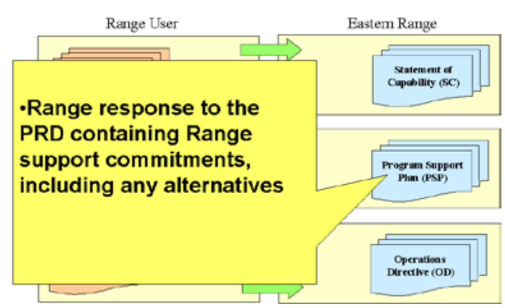


Figure 4-1-6: *Program Support*

4.1.6.3 Operations Directive (OD)

The OD is the 1 ROPS response to the OR and is the finalized plan for implementation of support for a specific operation. The OD is the ultimate action documentation of the UDS. All previous documentation, including the OR, exists to create and publish this document. The OD contains specifics concerning all support required and how it is to be implemented. This document is the basis for scheduling the mission or what is known as the "first use date."

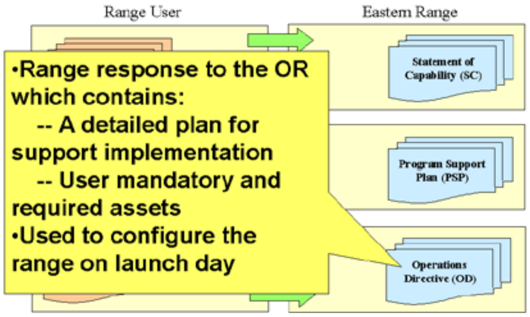


Figure 4-1-7: *Operations Directive*

4.1.7 DOCUMENT LEVELS

Each UDS program document can also be classified as a Level I, II, or III document. Level I documents are used to initiate program support planning between customers and support agencies, specifically, the PI and the SC. Level II documents are required to provide additional or more detailed program information, the PRD and the PSP. Level III documents are used to plan for specific operations conducted in support of a program, the OR and the OD. Levels of UDS documentation are also characterized by time differences. Level I documents are usually prepared four to five years prior to the anticipated launch. Level II documents are developed approximately two to three years prior to the anticipated launch. Level III documents are published ten to twenty months in advance of the launch. This process may be much quicker, even less than a year, for some programs known as "Fast Track Programs" which may or may not require the extensive resources that a major launch campaign needs.

Table 4-1-2: UDS Levels

DOCUMENT	LEVEL	ORIGINATOR	REQUIRED BY
Program Introduction (PI)	I	CUSTOMER	45 SW/XP
Statement of Capability (SC)	I	45 SW/XP	CUSTOMER
Program Requirements Document (PRD)	II	CUSTOMER	1 ROPS
Program Support Plan (PSP)	II	1 ROPS	CUSTOMER
Operations Requirements (OR)	III	CUSTOMER	1 ROPS
Operations Directive (OD)	III	1 ROPS	45 SW

Table 4-1-3: UDS Document Lead and Production Times

Document*	Eastern Range	Remarks
PI		1 to 3 years
SC	125	After receipt of PI (Note 7)
PRD		6 months to 3 years
PSP	110	After receipt of PRD (Note 4)
OR ORE	70 5	Prior to First Use Date Prior to Mission Execution (Note 3) After receipt of OR (Note 2)
OD	10	Prior to First Use Date (Note 6).
RSOR (Draft) RSOR (Final) RSOR Ops Sup	30 60 15	After receipt of PRD Prior to mission execution Prior to Mission Execution
Customer Countdown	30	Prior to Mission Execution (Note 5)

NOTES: * Lead and production times are in calendar days

1. The range will assist with any draft reviews.
2. An Expedite OR should be used for any change in operational requirements within 30 days of launch. This includes mandatory hold letters that must be formally received by L-20 days.
3. For OREs, ten days are included for 1 ROPS signature, printing, and distribution
4. For PSPs, 20 days are included for 45 SW review, signature, printing, and distribution
5. Countdown changes are not accepted after rehearsal or simulation without coordination and approval of the customer, range operations, and safety. For countdown changes submitted after the 30-day time line prior to mission execution, coordinated approval must be obtained from the 1 ROPS.
6. The OD and the OD response to the ORE must be available 10 days prior to the First Use Date.
7. If requirements are not revised and funding is still available.

4.1.8 UDS CHANGES AND MODIFICATIONS

Following final publication of the OD, there are additional documents utilized to make modifications, last minute updates, or one-time changes.

4.1.8.1 Operations Requirements Extracts (ORE)

The official means for any range to levy requirements for operational support on another range or support agency is with an ORE. The ORE contains requirements extracted by the range from the customer's OR with supplementary requirements added and forwarded to one or more support ranges to request their support. 1 ROPS instructs the Eastern Range Technical Services (ERTS) to review the OR and the PRD Extract and prepare the ORE as well as the OD. The ORE is prepared using the prescribed UDS formats. An ORE will have the same number as the customer's OR and will always have an OD in response. The ORE will be forwarded to 1 ROPS within 15 days of receipt of the OR. The OD response to the ORE is separate from the launch OD.

4.1.8.2 Expedite OR (EOR)

An EOR may be prepared when required for immediate support or one-time changes to support for a specific mission, in unusual cases when processing and publication of an OR Revision would seriously impact program objectives. These requirements are implemented by the use of Operations Control Instructions (OCI) or other immediate means as required to meet customer demands. Expedites shall be numbered consecutively starting with "01" and chronologically numbered. If the expedite becomes a permanent change to the OR, then an OR revision must be submitted to revise the OR. An Expedite OR should be used for any change in operational requirements within 30 days of launch. This includes mandatory hold letters which must be formally received by L-20 days.

4.1.8.3 Operations Control Instructions (OCI)

These are last-minute or one-time changes to the OD. The RTS contractor furnishes copies of all OCIs to the appropriate 45 SW and range customer offices. (45 SWI 99-101) OCIs may be responses to EORs, RS Ops Supp, last minute changes to the OD, etc.

4-2 EASTERN AND WESTERN RANGE (EWR 127-1) & AFSPCI 91-7## SERIES REGULATIONS

4.2.1 OVERVIEW: EWR 127-1

EWR 127-1 was developed to establish the safety requirements and procedures used at the Eastern & Western Ranges for processing, launching and recovering space launch vehicles and spacecraft. It implements the Commander's safety responsibilities and defines the "Range Safety Program". It establishes the launch risk level at not more than:

- 30 casualties in 1 million (30 x 10^{-6}) for the general public (which is the same risk level for day-to-day activities amongst the public).
- 300 casualties in 1 million (300 x 10^{-6}) for essential launch area personnel.

EWR 127-1 also gives the ER Commander the responsibility to approve the proposed flight plan for every launch, indicating risks are acceptable. In exceptional cases, the Commander can approve a higher risk level based on the Commander's knowledge of the mission or national priorities.

4.2.2 AFSPC 91-7XX SERIES

The AFSPC 91-7XX series applies to newer vehicles, such as the Falcon 9. It incorporates and updates information from EWR 127-1 and divides it up among three sets of documents:

- AFSPCI 91-701 *Launch Safety Program Policy* defines and implements AFSPC Launch Safety policy and responsibilities for AFSPC. It provides a brief overview and summary of the requirements that are detailed in the other two documents.
- AFSPCMAN 91-710 *Range Safety User Requirements* applies to Range Users conducting ops on AFSPC ranges. It consists of seven volumes that cover specific areas.
- AFSPCMAN 91-711 *Launch Safety Requirements for AFSPC Organizations* describes authorities and responsibilities of AFSPC units.

Please consult the EWR 127-1 and AFSPC 91-7XX Series for more detailed information.

4-3 RANGE SAFETY OPERATIONS REQUIREMENT

4.3.1 OVERVIEW

The Range Safety Operations Requirement (RSOR) is a Wing Safety document that supplements EWR 127-1 or the applicable AFSPCMAN 91-700 series document and outlines specific safety criteria for a specific launch vehicle program (Atlas V, Delta IV, etc). The RSOR documents exceptions to the standard provisions of EWR 127-1 or the applicable AFSPCMAN 91-700 series documents and may also levy additional safety requirements peculiar to a launch vehicle series.

4.3.2 CONTENTS

Launch Safety (45 SW/SEL) writes the RSOR for each applicable launch vehicle program which is then approved by the Chief of Safety or his designated representative and distributed no later than L-60 days. The RSOR establishes the operational safety requirements for each launch vehicle program. Although these requirements will vary from vehicle to vehicle, the following provides some of the generic operational safety requirements.

Range instrumentation configuration and requirements to include:

- **Tracking data requirements:** The RSOR requires radar, telemetry and optics data to be required for expendable and habitable vehicle present-position (PP) and impact-prediction (IP) displays. It states that radar will normally be the principle tracking source and that telemetry will normally compete for the alternate tracking source.
- **Range Safety Display (RSD) configurations and requirements:** The RSOR specifies which components on an RSD string are mandatory if that string is mandatory. It also specifies which space vehicle event information (staging events, min Main Engine Cutoff (MECO)/Booster Engine Cutoff (BECO), NLE, Destruct Gates, etc) are to be provided on the displays.
- **Visual imaging requirements:** The RSOR requires that visual imaging information (typically video imaging) be available to the MFCO, SMFCO, and VSO consoles from prior to Main Engine start, through lift-off, until launch vehicle integrity can no longer be reasonably assessed from the visual image. The RSOR also requires that at least two “Quad” displays (four visual images on each display) be generated from the visual image sources available with the selected sources providing visual information from geographically diverse locations. The RSOR also specifies the site locations for the Flight-line and Program video Television Skyscreen (TVSS) cameras which are both required to be located within ± 15° of a line extending from the launch point, perpendicular to the flight azimuth.

Command Destruct System (CDS) requirements: The RSOR levies mandatory requirements on the CDS to include:

- Central CMEV 1 and 2
- Dual Command System Control consoles (RASCADs, 2 of 4)
- Flight Termination Units (FTUs, 2 of 2)
- Two command remoting links from the Central CMEVS to the various site CMEVs from liftoff to through the period of Range Safety Responsibility (Orbital insertion or end of powered flight)

The RSOR provides direction for the configuration of the FTUs, to include which command functions will be available and to which FTU switch they will be assigned.

Frequency Control and Analysis Requirements (FCA): The RSOR requires that two FCA vans will be required during the minus count to monitor for any unauthorized radiation on the applicable command destruct frequency or any source of RF interference and to perform C-band beacon readout.

Analog telemetry display requirements: The RSOR provides direction on configuration requirements for the analog telemetry displays for Telemetry System Officer (TSO). It specifies the parameters that will be displayed (angular rates, chamber pressures, CRD AGCs, etc), their operational limit values and associated color codes (Green, Yellow, or Red), the expected mission event schedules and actual mission discretes (separation events, engine ignition, engine shutdown, etc)

Weather Launch Commit Criteria (LCCs): The RSOR defines the LCCs for weather such as the Anvil Cloud, Debris Cloud, Disturbed Weather, Thick Cloud, and Smoke Plume rules.

Holdfire Capability: The RSOR requires operational holdfire switches are at each MFCO console position, at the OSM console and at the RCO console for pad launches. The switches are required to cause an interruption in the launch sequence causing the countdown to stop and preventing the ignition sequence.

T-X time: The RSOR established the T-X time for the applicable vehicle, which is the time late in the minus count after which a hold will not be called because it will create a more hazardous to keep the vehicle from launching than to let it launch.

Surveillance Control requirements: The RSOR requires the use of air and sea surveillance radars and the use of aircraft to perform sea surveillance.

Communications requirements: The RSOR may levy comm panel configuration requirements for wing safety personnel (such as the STA, SEA, and SELF) and requires that all nets and direct lines on the MFCO comm panels be recorded.

Collision Avoidance (COLA) analysis requirements: The RSOR specifies when COLA calculations will be performed in support of a launch.

Data submission and documentation timelines: The RSOR specifies timelines for the submission of data requirements by the Range User to 45 SW/SE. It also specifies timelines for the distribution of countdown documents to include the Range Countdown, the Range User Countdown, and the OSM Countdown Checklist.

Day of Launch reporting requirements: The RSOR directs personnel performing or supporting a range safety function (to include the OSM, SEA, and LWO) to monitor certain tests or assess certain LCC criteria and report status to the MFCO.

The RSOR Operations Supplement is a supplement to this document for a specific launch. It will be discussed in a later section.

4-4 RSOR OPERATIONS SUPPLEMENT

4.4.1 OVERVIEW

The Range Safety Operations Requirement (RSOR) Operations Supplement (Ops Sup) modifies the corresponding launch vehicle RSOR, Combined Command Destruct System (CCDS, as applicable) and EWR 127-1/AFSPCMAN 91-700 series documents for a specific mission (e.g. Atlas V/WGS F2). The Ops Sup identifies additional safety requirements particular to a given launch not contained in the RSOR and EWR 127-1/AFSPCMAN 91-700 series documents.

4.4.2 CONTENTS

The Safety Technical Advisor (STA) for the mission develops and publishes the Ops Sup for that mission. The MFCOs for the mission and the Operations Group Commander (45 OG/CC) coordinate on the document and it is signed by the Chief of Safety (45 SW/SE). The Ops Sup provides direction to the Launch Integrated Support Contract (LISC) contractor and the Range Control Officer (RCO) for the use and configuration of range instrumentation to meet safety requirements including the designation of equipment as mandatory for launch. It also outlines instructions for Holdfire/Hangfire procedures to the RCO, identifying critical hold points in the countdown where the RCO must ensure the count does not proceed if a NO-GO condition exists. The Ops Sup is used to levy additional requirements not contained in RSOR or EWR-127-1/AFSPCMAN 91-700 series documents or to provide corrections to these documents due to equipment changes or changes to range safety policy until the applicable document(s) can be updated. The RSOR typically consists of eight sections:

- **Section 1 – EWR 127-1/AFSPCMAN 91-700 Series Modifications**
- **Section 2 – RSOR Modifications**
- **Section 3 – Mission Rules**: This section usually references the applicable 45 SW/SELF Mission Rules Letter.
- **Section 4 – Mandatory Instrumentation Systems:** This section will specify which assets are mandatory for launch to include MOC systems (Range Safety Display, SPARC, Timing, Comm, and CCRS requirements), command destruct sites, telemetry, radar, and optics.
- **Section 5 – Mandatory Support Requirements:** This section established the generic requirement for such things as Launch Area Surveillance, Sea surface surveillance by airborne assets, and compliance with applicable weather constraints.
- **Section 6 – Special Instructions:** This section allows for the MFCO to provide specific instructions to Eastern Range Technical Service (ERTS) contractor personnel or other console personnel to meet specific mission requirements. These instructions could include specifying range instrumentation configuration requirements or establishing countdown or contingency procedures that are specific to the mission.
- **Section 7 – Launch Status and Holdfire Instructions/Procedures:** This section provides direction for Hangfire/Holdfire procedures to console personnel to include the RCO and OSM, as required. This section typically includes the following:
  - **Critical Hold/Scrub Times:** This includes a list of the critical holds for the launch vehicle as well as the pre-coordinated last Range Hold point (for coming out of the last built-in hold with Range “NO-GO” status) and the T-X time.
  - **Holdfire Procedures:** This specifies when the holdfire switches are active, how the hold will be called, and when the hold can be released.

- **Holdfire Override Procedures (as required):** This includes the procedures that will be utilized if a holdfire has to be overridden due to a failure in the holdfire system.
- **Hangfire/Misfire/Scrub Procedures:** This section provides instruction to the RCO to not release any instrumentation, to include the Command Destruct System, until the OSM has verified to the MFCO that the vehicle is in a safe configuration. It may provide additional direction as required by the mission.

- **Section 8 – Other Miscellaneous Requirements and Special Considerations:** This section may be used to document other mission specific requirements or procedures, such as sending the SAFE command for Atlas vehicles per user request, or for documenting the tailoring or "Meets Intent" Certification actions performed by 45 SW/SELF for missions that do not meet all requirements in EWR 127-1 or the AFSPCMAN 91-700 series documents.

4-5 USER MANDATORY HOLD CRITERIA

4.5.1 OVERVIEW

The User Mandatory Hold Criteria (UMHC) is the document which outlines what on and off-range assets the User has deemed mandatory for launch. If the document says that a certain coverage time is mandatory, then the Expected Coverage Plans (ECPs) must be utilized to determine which pieces of instrumentation are necessary to meet the requirement.

4.5.2 CONTENTS

If issued, this document outlines the final specific instructions from the launch agency such as holdfire/hangfire procedures and preferred hold instructions. This is treated as an expedite to the Launch Agency Operations Requirement (OR), and replaces mandatory requirements stated in the OR, but it does not require an Operations Control Instruction (OCI) response from the range. It identifies critical user hold points in the countdown and describes the user-preferred method for the RCO to stop the count should a user-specified NO-GO condition exist. The RCO posts this document in the mission folder prior to launch.

4-6 INSTRUMENTATION COVERAGE PLANS

4.6.1 OVERVIEW

The Launch Integrated Support Contract (LISC) contractor produces Instrumentation Coverage Plans (ICP) which contain vehicle coverage times for all ER instrumentation types including radar, telemetry, command, optics and GPS metric tracking. It is used when the range crew conducts launch operations. They provide the official ER support commitments provided in response to launch agency and Range Safety requirements for instrumentation scheduled for launch, midcourse, and orbital support and are produced for all types of range instrumentation and are tailored for each launch. ICPs are produced at approximately L-21 days.

Final support commitments are provided by 1 ROPS after review of proposed commitments, issued by the LISC contractor.

4.6.2 PROCEDURES

The LISC contractor will deliver ICPs approximately 21 days before the launch. When the ICPs arrive, review them to gain a comprehensive understanding on how the range will track, command, and capture telemetry from the vehicle in flight. ICPs are the basis to determine what instrumentation and communications are mandatory, particularly when instrumentation malfunctions occur that limit the number of sites available to support the operation.

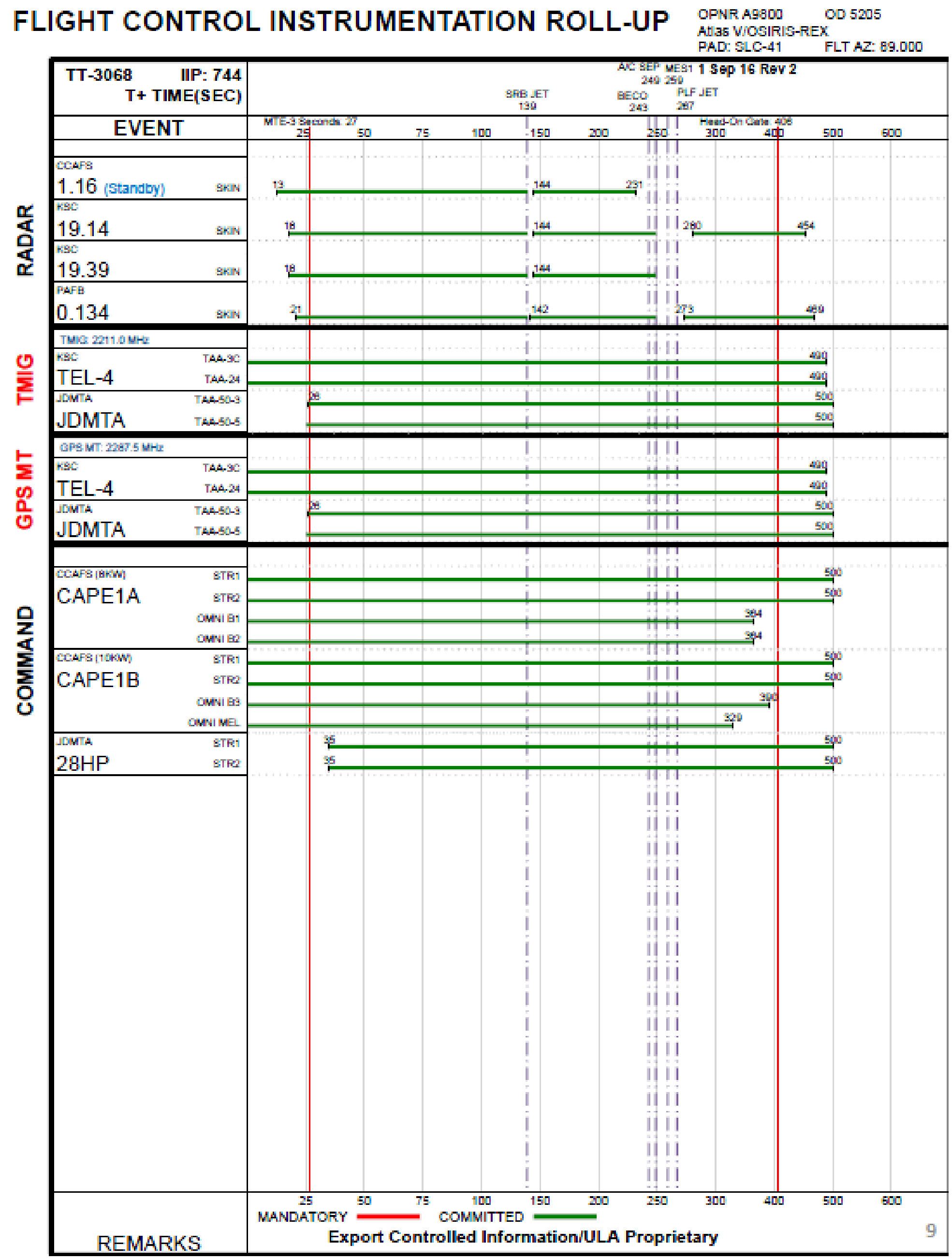


Figure 4-6-1: *ICP Summary Chart*

The ICP package will be delivered as a PDF or PPT package and contain several key tools to "view" the coverage for a particular operation. The supersystems providing the antenna or optics tracking capability (radar, command, telemetry, optics) are broken out into individual pages, however, a summary chart is provided to give the crews a one page overview of the coverage for a particular mission. Figure 4-6-1 is an example of this summary chart.

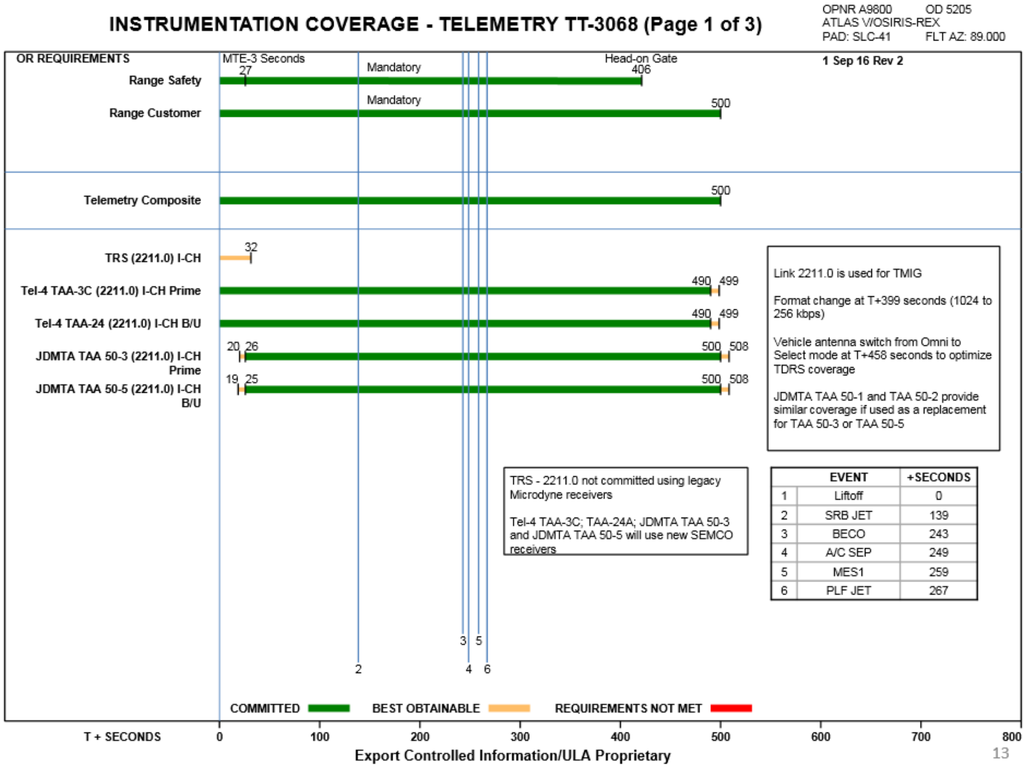


Figure 4-6-2: *ICP for Telemetry*

The individual supersystem pages contain a more detailed breakdown for that particular tracking system. Figure 4-6-2 is an example of such a chart for telemetry. The color of the lines reflects the quality of the data during specific times in the plus count. Only "committed" coverage times are used to determine if requirements for Range Safety and the range customer can be met without other mitigating actions (ie. waivers, equivalent levels of safety).

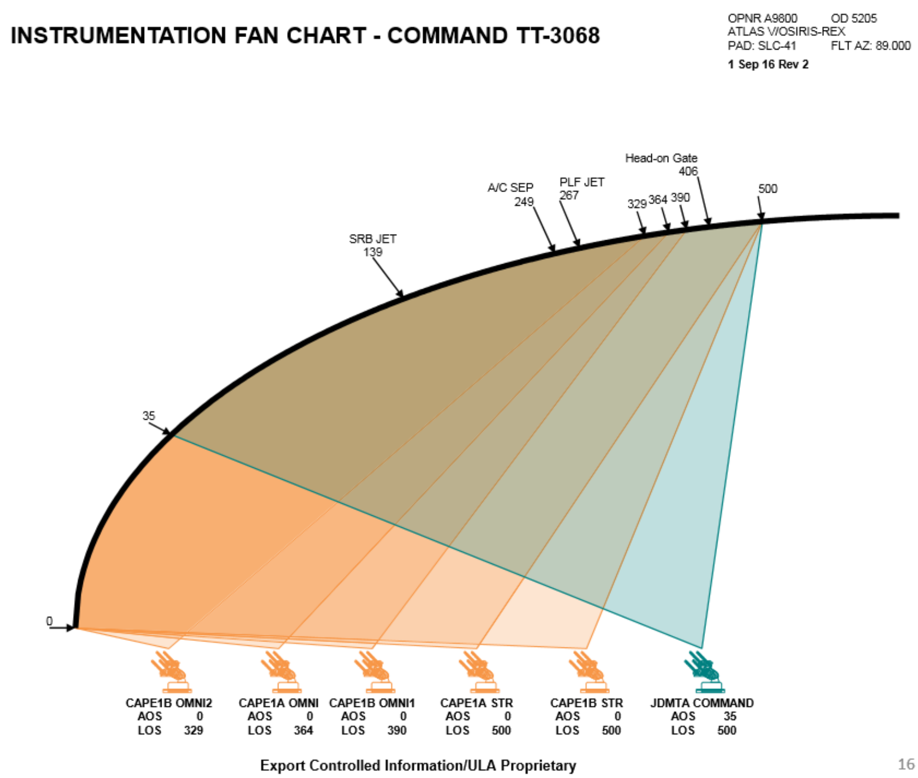


Figure 4-6-3: *ICP Fan Chart for Command*

The final part of the ICP package are the "fan charts", providing a visual indication of coverage following the vehicle in flight. This is the same information contained in the individual system chart, only displayed in a format emphasizing the timeline for key plus count events and instrumentation "overlap." Figure 4-6-3 is an example of a fan chart. The Instrumentation Coverage Plan depicts the coverage for each asset that is scheduled to support the launch. The key thing to remember is that only Green lines are sufficient to meet all Range and User mandatory requirements.

4-7 WING SAFETY DOCUMENTATION

4.7.1 OVERVIEW

Wing Safety Documentation is developed and initiated by the Wing Safety Office and sent to the various agencies involved in a particular launch to provide guidance, instruction or approval. Copies of the applicable documentation should be kept for each mission by the Mission Flight Control Officer (MFCO) in the respective launch vehicle mission folder under the MFCO drive for historical reference. Although the RSOR is generated by Wing Safety, it was already covered in a previous section and will not be discussed in this section.

4.7.2 COMBINED COMMAND DESTRUCT SYSTEM (CCDS)

The Combined Command Destruct System (CCDS) Range Safety Requirements for the 30th and 45th Space Wings (referred to the CCDS) is the result of a joint effort between the 30 SW/SE and 45 SW/SE organizations to develop a set of standardized requirements for Integrated Missile Flight Control Ground Systems at both the 30th and 45th Space Wings. The purpose of the CCDS is to help minimize safety risks and maximize efficiency of the modernization and sustainment of the command destruct ground transmitting, processing and control system. The CCDS superseded the Western Range Safety Integrated Missile Flight Control Ground System WRR 127-9, dated 30 August 1993 and the 45 SW RSOR CDS1 for Command Destruct Systems (CDS), dated 08 April 1998 in their entirety. It also supersedes all elements of the ground Flight Termination System (FTS) in EWR 127-1 dated 31 October 1997. All legacy ground command destruct systems and associated modifications/upgrades fielded prior to the signature date of the CCDS have to comply with the superseded documents as appropriate, however, they will have to meet the requirements in the CCDS for any other upgrades or modifications. The CCDS is a good reference document for MFCOs, RCOs, and ROCs to use to develop a strong understanding of ground CDS requirements and systems.

4.7.3 FLIGHT PLAN APPROVAL

Approval of the Range User’s proposed flight plan by the 45 SW/CC is a pre-requisite for every mission proposed on the ER. The acceptance of a proposed flight plan by the 45 SW/CC indicates that the risks associated with the launch are at an acceptable level. The Range User is required to provide data packages to flight analysis (45 SW/SELF) for analysis in order to receive approval to establish that the proposed program is acceptable from a safety standpoint.

Flight Plan Approval (FPA) is an approval process that results from a written application by the Range User to 45 SW/SELF to verify that the proposed trajectory of the vehicle meets all safety constraints. FPA is applicable to the following programs: ballistic missile and space vehicles; cruise missiles and remotely piloted vehicles; small unguided rockets or probes; aerostats or balloon systems; projectiles, torpedoes, non-propulsive air-dropped bodies, or any small devices to be flight tested. FPA is a two-phase approach stemming from a Preliminary Flight Plan Approval (PFPA) and a Final Flight Plan Approval (FFPA). The PFPA is generally issued well before the operation (typically six months to a year prior to launch) for existing programs and two years prior to launch for new programs and is based on the best preliminary flight plan data available, the Preliminary Flight Data Package (PFDP). The PFDP leads to the development of the Final Flight Plan Approval (FFPA) which is based on more detailed analysis of the operation’s objectives, vehicle performance, and other data items as required typically contained in the Final Flight Data Package (FFDP). The FFPA is issued when it has been determined that a specific operation can be supported within the limits of flight safety control capabilities to provide protection to life and property.

In each FPA phase, Range Safety responds to the Range User's written request for approval in one of the following ways: (1) by issuing a letter of approval, (2) by issuing a letter of disapproval, (3) by requesting that a change in the proposed plan be made or evaluated, or (4) by requesting additional data. After all the requested data have been provided and evaluated, the Range User is given an "approval," "conditional approval," or "disapproval" letter. If the flight plan or mission is approved, the letter specifies the conditions of approval pertaining to such things as launch azimuth limits, trajectory shaping, wind restrictions, locations of impact areas, times of discrete events, and number of operations for which the approval applies. The approval is final as long as the operation(s) remain within the stated conditions. If significant changes to the flight plan occur after approval has been granted, further analysis of the revised plan may be necessary. The Range User is responsible for advising Range Safety of any such changes or anticipated changes as early as possible.

The MFCOs assigned to a mission will review the PFPA and the FFPA to assess operational impacts to flight control procedures and range safety equipment configuration. After review of each product, the MFCOs provide a 1 ROPS recommendation for approval or disapproval to the 45 OG/CC.

4.7.4 MISSIONS SUPPORT PLAN LETTER

The Mission Support Plan Letter is a letter developed by 45 SW/SELF that clearly defines the Mission Support Positions (MSPs) for aircraft or seacraft supporting a launch. A MSP is a designated location at which a mission support aircraft or seacraft must be by T-0 where the risk to the aircraft/seacraft is within acceptable levels. 45 SWI 13-201 *Eastern Range Airspace Management Procedures* requires that Range Users submit an Intended Support Plan (ISP) for mission support aircraft at least 21 working days prior to launch. The ISP is a detailed description of a support aircraft's flight profile to and from its MSP. It includes aircraft designation and type, number of aircraft, staging location, all planned checkpoints, holding patterns, altitudes, speeds and headings during ingress, egress, and assigned mission support positions. For downrange support, the ISP will depict all activities within 200 nautical miles of the MSP. There is not a similar regulation for seacraft, however, similar information is required. 45 SW/SELF reviews the ISP and responds with the MSP letter, which approves or modifies the ISP, by L-5 working days. The MSP letter identifies the MSPs in degrees of latitude and longitude and depicts the location(s) in relation to the nominal trajectory, hazard areas, and the Impact Limit Lines, (ILLs) associated with a specific operation or launch. It also provides direction for the aircraft or seacraft to take if breakaway instructions are issued due to a launch catastrophe.

4.7.5 HAZARDOUS AREA LETTER

AFSPCMAN 91-711 requires 45 SW/SELF to evaluate the launch vehicle's performance and associated flight hazards and to define the appropriate launch day safety clearance zones associated with each launch vehicle and launch complex. It also requires 45 SW/SELF to provide descriptions of the required hazardous launch areas to the range offices that perform surveillance and clearance activities, or disseminate that information to affected range organizations. 45 SW/SELF does this by issuing a Hazardous Area Letter, which defines the air and sea hazard areas and their associated closure times for a specific operation/launch. It identifies hazardous impact areas due to staging events (to include impact areas for up range and/or downrange solid rocket motor nozzles and cases, first stage boosters, and payload fairings) for possible debris impact areas due to a catastrophic launch event. It also defines which special use airspace to include the applicable restricted areas (R2932, R2933, R2934, or R2935), warning areas (W497A or W497B), and any Air Traffic Control Assigned Airspace (ATCAA; such as NASA A, B or C) that are to be closed to air traffic. It also includes the time period in minutes in which these impact areas and airspace must be closed to air and sea traffic for a nominal launch and in the case of a catastrophic event or malfunction. The Hazardous Area Letter also details the 45 SW/SELF request for the ERTS contractor to run the COLA program for particular on-orbit inhabited/habitable objects in support of the operation/launch. The SCO, ACO, and SSO should reference this document to determine when after a launch to release these areas to air and sea traffic.

4.7.6 OPERATIONS SAFETY PLAN (OSP)

Systems Safety (45 SW/SEA) publishes an OSP, prepared by Pad Safety/OSM , for all hazardous operating areas, including launch complexes and associated areas and facilities. OSPs are developed for unique, but frequently repeated, operations and are intended to clarify and provide detailed safety requirements that are particular to the operating area or operation in question. The OSP contains a scaled map of the operating area that identifies hazardous and safety critical systems/locations/features, a list of all hazardous or safety critical operations or tasks performed in the operating area, required safety clearance zones, personnel loading requirements, required PPE, any special safety requirements, and identification of those operations or tasks that may be run concurrently.

The Blast Danger Area (BDA) is defined as the area around a launch pad inside of which personnel are endangered by the blast overpressure and fragment hazards resulting from the explosion of a fueled launch vehicle. Access to the BDA is strictly controlled to keep the number of personnel within the BDA to an absolute minimum. The BDA is unique for each launch pad.

The Flight Hazard Area (FHA) is defined as the controlled surface area and airspace about the launch pad and flight azimuth where individual risk from a malfunction during the early phase of flight exceeds 1×10^{-5}; because the risk of serious injury or death from blast overpressure or debris is so significant, only launch-essential personnel in approved blast-hardened structures with adequate breathing protection are permitted in this area during launch.

4.7.7 OSM COUNTDOWN CHECKLIST

The OSM Countdown Checklist is a consolidated checklist for pad safety personnel to use on launch day. It consists of all the steps that OSM performs in the countdown to ensure the safety of pad personnel and that the Range Safety Systems onboard the vehicle are operating properly. It includes such tasks as conducting holdfire checks, clearing personnel from the pad before hazardous operations (ordnance arming and pressurizing pneumatic/pressurization tanks), clearing personnel from the BDA before LOX loading, coordinating status with the MFCO, monitoring FTS checks, coordinating positioning of the LEOCAT, and verifying the positioning of switches that enable ignition and arming functions (Launch Enable, Solid Motor Ignition Enable, S&A Arming, and ordnance arming switches). The MFCO references this checklist and provides feedback to OSM to coordinate status reporting from the OSM to the MFCO.

4.7.8 RSD REQUIREMENTS LETTER

The RSD Requirements letter, also refer to as the “Zero-Cycle” letter, is generated by the 45SW/SELF for the ETRS contractor system controllers. It provides the controllers information needed to set up the Range Safety displays and the telemetry console displays for each mission. For the Range Safety displays, it describes which telemetry tapes to use to set up the nominal flight trajectory, mark events, backgrounds, the scale and center point of the IP and PP maps, and which instrumentation sites can be used as primary and back-up data sources. The MFCOs can review this letter to find out which mark events and data sources they can expect to see on the Range Safety Displays. The TSO can review this letter to find out which events will be listed for the Next Event/Last Event indicators and when the engines and solid motor chamber pressures will be blanked out when the data displayed is no longer useful (such as after tailoff / burnout).

4.7.9 MISSION RULES

Mission Rules are a documented set of mission-specific rules developed by the Range User and the 45 SW/CC or his/her designated representative which specifies, in detail, those flight control requirements and procedures to be applied during the launch mission, in particular the application of flight control and flight termination criteria or special conditions for continuing the mission. In addition, the mission rules may define other more specific rules such as launch hold criteria and procedures, emergency procedures, and evacuation procedures of the flight control center during the countdown and in-flight. The 45 SW/SELF works with the Range User to develop and document the mission rules and the 45 SW/CC approves them. Attachment 1 of the document identifies the generic mission rules which are routinely observed for the specified vehicle. Examples include obviously erratic flight, unknown performance, violation of established flight safety criteria (destruct line, critical angles), stopped impact point, Destruct Gate considerations, and the Command Coverage Contingency Rule. Attachment 2 of the document lists the rules which are specific to the mission and the vehicle’s performance. Examples include the Min MECO/Min BECO Rule, Restart of the Centaur upper stage, SRM non-ignition, sending the “SAFE” Command if required.

4.7.10 GREEN NUMBERS TABLES

At a minimum, 45 SW/SELF will provide two hard copy tables, for the “A” wind profile RSD displays, of the green numbers throughout the trajectory of the vehicle. The VSO monitors the charts during flight to help the MFCOs react to possible failures of the Range Safety Display systems. In addition, for variable flight azimuths (VFA) in which the flight azimuth varies for different times within the launch window (ex: some NRO missions), 45 SW/SELF will provide a hard copy table of the green numbers for the different azimuths within the launch window. If launch for a VFA mission does not occur at the opening of the window, the MFCOs will need the VSO to reference the table and report the green number if track is lost during flight.

4.7.11 ALTITUDE VS. TIMETABLE

For each mission, 45 SW/SELF will provide a hard copy of the altitude vs. time table, which provides the expected altitude, based on the nominal trajectory, at each second for the first 100 seconds of flight. The MFCOs may reference this chart as a sanity check to ensure that the range safety optics solution commitment received by the RCO matches with the cloud ceiling provided by the LWO. For Shuttle missions, this check could result in the ability to received observations from the Forward Observer-Air to become mandatory for launch.

4.7.12 END GREEN NUMBERS (END GN)

For VFA missions, 45 SW/SELF will also provide hard copy tables of the END GN times for the different azimuths within the launch window. If launch for a VFA mission does not occur at T-0, the MFCOs may need the VSO to reference the table and report the END GN time for the applicable trajectory.

4-8 USER COUNTDOWN PROCEDURES

4.8.1 OVERVIEW

The user countdown is a checklist of activities that the user completes during the minus count. In many cases, the Launch Support Plan (LSP) is incorporated into the user countdown to produce a single countdown document the user can reference to complete tasks and track the completion of others. The user countdown covers all tests and actions that are required to ready the booster for flight. The LSP either references or includes 1 ROPS tasks that are in the user countdown (beacon readouts, command checks, call-outs, etc.).

4.8.2 CONTENT

While the Range Countdown and the Launch Support Plan primarily cover Range events, the User Countdown focuses on the launch vehicle and pad operations. Some of the major operations that occur IAW the user countdown are: tower roll, cryogenic fuel loading, readiness polls, system checkouts, etc.

The user countdown procedures are usually provided to the Program Support Manager (PSM) from the user one or two weeks prior to launch, then distributed to the 1 ROPS team.

4-9 RANGE COUNTDOWN

4.9.1 OVERVIEW

The Range Countdown document is produced by the Eastern Range Technical Services (ERTS) for each mission. It is a countdown script for instrumentation sites that contains significant Range countdown events in which the instrumentation controllers participate. The Range Countdown is a significant ingredient in building the Launch Support Plan (LSP).

4.9.2 CONTENT

While the user countdown deals primarily with launch vehicle and pad operations, the Range Countdown ensures all Range instrumentation requirements are met prior to launch. Some of the major events that occur IAW the Range Countdown are: open and closed loop command checks, switchover theoretical, minus count simulation, telemetry checks, holdfire checks, beacon checks, backup first motion checks, final computer load, balloon releases, etc.

The Range Countdown can be found electronically in Vision. On launch day, the Instrumentation Superintendent of Range Operations (ISRO) or Technical Advisor (TA) will annotate start and stop times for each Range Countdown event in Vision. The Range Countdown lists Range and launch vehicle function times during operations requiring a countdown. It may expand or revise the Operations Directive (OD) paragraph 1630, Customer Test Countdown, and will supersede that paragraph in case of conflict. It lists events and time information sequentially, but it does not commit support for an operation. The start and duration of a Range Countdown will be determined by Eastern Range instrumentation support requirements. Range Countdowns will be prepared and maintained using consistent terminology and step sequencing for all launch vehicles and programs.

4-10 LAUNCH SUPPORT PLAN

4.10.1 PURPOSE

The purpose of the Launch Support Plan (LSP) is to create a consolidated range checklist of nominal events that key range personnel must execute, or be aware of during a launch countdown. The LSP includes a coordination sheet, the procedure steps, and attachments (if required) that assist crews in managing Eastern Range assets It is a combination of at least five sources of information:

- Historical precedent
- The Range Countdown
- The User Procedures for launch countdown operations
- Leadership direction
- Unique facts that apply to only one specific launch attempt

This chapter provides the RCO comprehensive step-by-step procedures to create the LSP, and successfully integrate these sources of information.

The LSP can be compiled and modified using Microsoft Word using a template for each launch vehicle and then formatted into an electronic version by incorporating the LSP into Microsoft OneNote. Using the five sources of information listed above, an RCO can compile an accurate, well formatted LSP.

4.10.2 PARTICIPANTS/RESPONSIBILITIES

4.10.2.1 Operations Officer (1 ROPS/DO)

The 1 ROPS/DO ensures an LSP is developed for every launch and supported by 1 ROPS personnel. The 1 ROPS/DO ensures the LSP is reviewed by the ROC, RCO, OGV, MFCO, and RGNext prior to operational use. The final LSP is approved by 1 ROPS/DO after coordination with the senior supervisor of RGNext Operations.

4.10.2.2 Range Operations Commander (ROC)

The ROC makes sure the LSP meets operational requirements, that it is produced on time, and ensures the overall accuracy of the LSP. The ROC is the leader of the Range team and therefore needs to supervise and assist the RCO in the creation of the LSP as necessary.

4.10.2.3 Range Control Officer (RCO)

The RCO develops, coordinates and distributes the LSP. Additionally, the RCO is responsible for the accuracy of all RCO and Launch User steps. This is one of the main functions of the RCO. Developing the LSP is the RCO’s largest pre-launch task.

4.10.2.4 Mission Flight Control Officer (MFCO)

The MFCO verifies accuracy of MFCO countdown checklist against the LSP.

4.10.2.5 Surveillance Control Officer (SCO)

The SCO verifies accuracy of SCO related steps in the Surveillance Operations Checklist (SOC).

4.10.3 PROCEDURES/CHECKLISTS

4.10.3.1 Timeline

Reference Table 4-10-1 as a guide for review and approval of the LSP. Remember to adjust the timeline to compensate for weekends, holidays, and late receipt of documentation.

Table 4-10-1: LSP Processing Timetable

L-8 days	**RCO provides a draft copy of the LSP to all 1 ROPS and RGNext crew personnel for review.**
L-3 days	**LSP finalized.**
L-2 days	**LSP is distributed to all crew personnel and included in all launch books.**

4.10.3.2 Compiling Information for the LSP

As mentioned earlier, the LSP is a combination of five sources of information. Each of these are a valuable source for building an LSP, and failure to consult any one of these may result in an incomplete LSP. The RCO is responsible for researching each source to extract necessary information.

Historical Precedent:

Awareness of historical precedent can help prevent recurrence of past mistakes. Historical precedent can be assembled from the following sources:

- Previous RCOs
- Previous mission LSPs
- Launch Crew (ROC, ACO)
- The Program Support Manager (PSM)
- RGNext Technical Advisor (TA)
- Instrumentation Superintendent of Range Operations (ISRO)

Range Countdown

Review the Range Countdown provided by the ISRO for inputs into the LSP.

Review the User Procedures

Review the user procedures for launch countdown steps that involve the range.

Leadership Direction

The LSP is used by the OD and LDA on launch day. They may have additional steps for inclusion into the LSP. Leadership may also direct other changes pertaining to operational procedures. This may be due to standardization, or even temporary fixes until approved procedures are developed.

Unique events for a Specific Launch Attempt

Every launch campaign is unique; specific circumstances may generate changes in procedures. These actions may apply only in a single launch attempt and possibly never utilized again. Reasons could include one-time waivers, special launches (e.g. John Glenn, Mars launches, Cassini), or other reasons. Be prepared to make last-minute changes.

4.10.3.3 Format

Before integrating information into the LSP, it is important to know the format that should be used to incorporate that information. 1 ROPS uses Microsoft Word templates that are vehicle specific.

LSP Word Template

LSP Templates are located on the 45 RANS share drive; locate the LSP of the most recent launch of the same vehicle type when creating/formatting an LSP.

The header will include classification (if applicable), the Operations Number (OPNR), booster type, mission, and column headers.

The LSP consists of a header and six columns. The columns include:

- Step
- Time (L & T time in minutes)
- To
- From
- Comm Channel
- STEP

NOTE: For classified launches, an OPNR attached to the LSP makes the LSP a classified document. Do not attach a cover letter to the LSP that contains an OPNR.

The **STEP** column consists of a sequence number for each step and an underscore (5 characters). The step number will increment for each step. The user procedure's associated step number will be listed in parentheses in the Command/Task column

The **L-TIME/T-TIME** is the expected L-COUNT and T-COUNT times at which each step should take place during a countdown. When several steps occur at the same time, a new L-CNT and/or T-CNT is not required unless it occurs on the first step of a new page. If the step is not time dependent, the individual responsible for the step can accomplish it sooner or later than the expected time listed in the LSP.

The **TO** column lists the position the call-out or step is going to.

The **FROM** column lists the position responsible for completing the step.

The **COMM CH** column lists the method of communication. This column could list the network (NET), voice direct line (VDL), secure communication channel, or administrative phone number.

The **STEP** column includes all the steps, NOTES, WARNINGS, CAUTIONS, and lead-ins required in the countdown. These actions follow the guidelines for developing checklists listed in SR 55-11 Volume II and the following:

Do not place NOTES, WARNINGS, CAUTIONS, and lead-ins at the bottom of a page. Enclose all announcements or steps that require exact verbiage in quotes.

The footer will include the classification markings (if applicable), revision date, and page number.

4.10.3.4 Coordination

When the LSP is finalized, the RCO signs the cover page and submits the LSP to the reviewers.

The coordination sheet includes **Prepared by** and **Reviewed by** blocks, the Range crew, approval blocks, references, and appropriate classification markings.

The LSP must be reviewed by the following: ROC, RCO, SCO, SMFCO, PSM, and RGNext TA. The reviewer may review the LSP as many times as necessary, however they must review the LSP after each draft copy is updated. When satisfied with the LSP, the reviewer signs the LSP in the **Reviewed by** block, and returns the LSP to the RCO.

The RCO will send the reviewed LSP to the 1 ROPS/DO for final signature. The final LSP is approved by 1 ROPS/DO after coordination with the senior supervisor of RGNext Operations.

The approved LSP will be filed in the mission folder and the LSP share drive and becomes a reference for the next mission of the same vehicle type. The finalized LSP will also be loaded onto the Roadmap to Launch website.

4.10.3.5 Distribution

The RCO is responsible for ensuring the LSP is updated and accurate in the Electronic Launch Book (ELB) for all ULA missions; it is the ROC's responsibility for Falcon 9 missions. The LSP is available for access by all Range Crew Members and RGNext Personnel from the ELB. Furthermore, the LSP will be made available to the crew via paper format in the event computing systems go down.

4.10.3.6 Last Minute Changes

The 1 ROPS/DO or Range Operations Commander (ROC) are the approval authority for last minute changes. The ROC will ensure the change is coordinated with the entire 1 ROPS crew and all crew positions affected (e.g. User and Safety) as necessary. The RCO may also update the LSP in the Senior Staff's launch books.

4.10.3.7 Post Launch

The RCO ensures that DOOB Flight is informed of any post launch changes by completing the "Day of Launch Change Request Form." The original LSP used for the launch will be placed into the mission folder.

X4542 Flight 42 LSP 7 Sep

Thursday, August 03, 2017 10:00 AM

LAUNCH SUPPORT PLAN	OPNR 4542
FALCON 9 Flight 42	

STEP	TIME (HH:MM:SS)	TO	FROM	COMM CH	STEP
					NOTES: **1. COMM CHANNELS:** **CD.NET = COUNTDOWN 1** **RNG.OPS = RANGE OPERATIONS NET** **2. WEATHER BALLOON SCHEDULE WILL PROCEED BY THE ZULU CLOCK IN THE EVENT OF UNSCHEDULED HOLDS OR DELAYS. THE ROC WILL NOTIFY THE RC OF ANY BALLOON RELEASE DELAYS.** **3. REFERENCED PROCEDURES:** **RCD = RANGE COUNTDOWN** **USER = 1.160 Launch procedure** **SOC = Surveillance Ops checklist**
☑ 1	T-02:30:00		ROC RE ISRO RAC SCO ACO		Console M&O.
☑ 2	T-02:30:00	AFLIO ISRO	ROC	RCO.LOOP	(RCD P2) Confirm/Report LZ-1 Flight Caution Area (FCA) road blocks have been set. Established as of: 1006Z
☑ 3	T-02:30:00		ROC		OD 6020 LC-39A Launch LZ-1 Landing **Date:** 7 Sep 2017 **Attempt:** 1
☑ 4	T-02:20:00	SCO	ROC	RCO.LOOP	Obtain/Pass Initial Status: SCO: WX Aircraft ☐ **TAKE-OFF :** ☑ **STAND-BY** ☐ **RELEASED** **1300Z Soonest Take-Off** **-Conference to take place at 1230Z**
☑ 5	T-02:00:00	OSM	LC	CD.NET	(USER) SpaceX Initial Readiness Poll (Report logged in and ready to proceed)
☑ 6	T-02:00:00	ALL	ROC	RCD.1	Announce: "Your attention please: we have picked up the Range Count on OPNR 4542, T-2 hours and counting."
☑ 7	T-02:00:00		ROC	(2-5789)	Announce: "Your attention please, all PA announcements in the MOC will be restricted to emergency use only from now until launch plus 20 minutes."

LSP Page 1

Figure 4-10-1: *Example LSP Page*

4-11 MFCO GENERATED DOCUMENTATION

4.11.1 OVERVIEW

The MFCO is responsible for generating numerous documents prior to each launch. The RSOR Ops Supplement was already covered in a previous section. This section will address the MFCO Countdown Checklist, Mission Data Sheet, Flight Control Instrumentation Worksheet (FCIW), Pre-Operations Briefing, and MFCO Mission Binder.

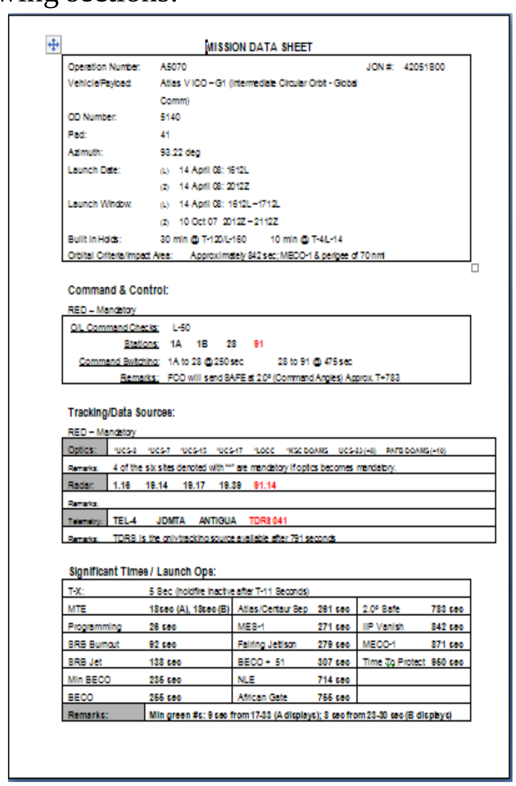
4.11.2 MFCO COUNTDOWN CHECKLIST

The MFCO Countdown Checklist is a Flight Control consolidated countdown utilized by the MFCOs and the MFCO support positions (TSO, CSO, VSO, FO-G, FO-A) that is used on console during day of launch. This checklist documents all required steps that need to be completed by the Flight Control team during the launch countdown. This includes performing comm/status checks, monitoring the Range Minus Count Simulation, performing the Final Combined Command Open Test, configuring the Range Safety Displays and Command Destruct System for launch, and polling personnel and verifying status for launch. The MFCO assigned to the mission reviews the MFCO Countdown Checklist for the applicable launch vehicle and verifies it against the RGNEXT Range Countdown, the draft of the Launch Support Plan (LSP), the Range User's Launch Vehicle countdown procedure, the OSM Countdown Checklist, and the Surveillance Operations Checklist. If changes are required to the MFCO Countdown Checklist, the MFCO coordinates those changes with 1 ROPS/DOOB.

4.11.3 MISSION DATA SHEET (MDS)

The Mission Data Sheet (MDS) one page summary of mission details created by the MFCO assigned to the mission. It provides a quick reference for the MFCOs and their associated support positions while on console. It consists of the following sections:

- **Overall Mission Information:** This section contains general information such as the op number, vehicle and payload, OD number, launch pad, flight azimuth, launch date and T-0 (in local and Zulu times), launch window (also in local and Zulu times), and the built in holds in the countdown.
- **Command and Control:** The Command and Control Section lists which command sites are supporting the launch, which sites are mandatory, the time in the countdown that the final FTS checks will be performed, command site autocarrier switching times (received from CSC after pre-launch day testing), and specific remarks such as when the CRDs will be safed.
- **Tracking/Data Sources:** This section lists which metric tracking sites (optics, radar, telemetry, or TGRS as required) will be supporting Range Safety tracking requirements and which are mandatory for



MISSION DATA SHEET

Operation Number:	A5070	JON #: 42051800
Vehicle/Payload:	Atlas V ICO – G1 (Intermediate Circular Orbit - Global Comm)	
OD Number:	5140	
Pad:	41	
Azimuth:	93.22 deg	
Launch Date:	(L) 14 April 08: 1612L (Z) 14 April 08: 2012Z	
Launch Window:	(L) 14 April 08: 1612L – 1712L (Z) 10 Oct 07 2012Z – 2112Z	
Built In Holds:	30 min @ T-120/L-160	10 min @ T-4/L-14
Orbital Criteria/Impact Area:	Approximately 842 sec; MECO-1 & perigee of 70 nm	

Command & Control:

RED – Mandatory

O/L Command Checks:	L-50
Stations:	1A 1B 28 91
Command Switching:	1A to 28 @ 250 sec 28 to 91 @ 475 sec
Remarks:	FCO will send SAFE at 2.0° (Command Angles) Approx. T+783

Tracking/Data Sources:

RED – Mandatory

Optics:	*UCS-2 *UCS-7 *UCS-15 *UCS-17 *LOCC *KSC DOAMS UCS-23 (+0) PATS DOAMS (+10)
Remarks:	4 of the six sites denoted with "*" are mandatory if optics becomes mandatory.
Radar:	1.16 19.14 19.17 19.39 91.14
Remarks:	
Telemetry:	TEL-4 JDMTA ANTIGUA TDRS 041
Remarks:	TDRS is the only tracking source available after 791 seconds

Significant Times / Launch Ops:

T-X:	5 Sec (holdfire inactive after T-11 Seconds)				
MTE	18sec (A), 18sec (B)	Atlas/Centaur Sep	261 sec	2.0° Safe	783 sec
Programming	28 sec	MES-1	271 sec	IIP Vanish	842 sec
SRB Burnout	92 sec	Fairing Jettison	279 sec	MECO-1	871 sec
SRB Jet	138 sec	BECO + 51	307 sec	Time To Protect	850 sec
Min BECO	235 sec	NLE	714 sec		
BECO	255 sec	African Gate	755 sec		
Remarks:	Min green #s: 9 sec from 17-33 (A displays); 8 sec from 23-30 sec (B displays)				

Figure 4-11-1: *Mission Data Sheet*

flight. Again there are remarks sections for each tracking source category for vehicle or mission specific issues.

- **Significant Times:** This section lists the nominal times for various mission events, including events the support positions will report to the MFCO as they occur. Examples include programming, min MECO/BECO, stage separations, engine starts/shutdowns, IIP vanish (orbital time), destruct gate times, and Time to Protect.

4.11.4 PRE-OPERATIONS (PRE-OP) BRIEFING

Prior to each launch, the MFCO will conduct a Pre-Operations or Pre-Op Briefing with the mission crew to discuss the mission details/updates and to discuss operating instructions. During this briefing, the MFCO will provide specific reporting instructions to the other launch personnel as required. In addition, the MFCO will notify personnel of any vehicle or mission unique expected issues or events during nominal phases of flight and how they are expected to impact data displays and/or procedures. If launch personnel have any questions about mission events or procedures, the Pre-Op briefing is the time to address them. The Pre-Op Briefing consists of the following sections:

Manning: This section specifies who will be filling the various console positions for the launch including the MFCO and MFCO support positions, the Range Ops positions (LDA, OD, ROC, RCO, SCO, DSCO, and ACO), the Range Safety positions (SE, STA, STD, SEA, OSM, and SELF) and the PSM.

Operational Data

This section includes the general mission data to include the op number, OD number, launch pad, flight azimuth, payload, window (in local and Zulu times), and the JON number to use for accounting purposes.

Vehicle Configuration

This section provides details of the launch vehicle and spacecraft configurations for the mission. This information is usually extracted from the Launch Book or mission PRD.

Mission Description: This section provides a synopsis of the objectives of the mission as well as an overview of the flight path and ground trace for the mission. This information is usually extracted from the Launch Book.

Significant Times

This section typically directs personnel to reference the MDS as they are briefed to the team.

Instrumentation

This section provides details for the instrumentation requirements for the mission. Some areas in the section refer to the FCIW or the Ops Sup. Details are provided in this section on mandatory items, command switching, telemetry display configuration, and RSD screens.

Reporting Instructions

This section details reporting instructions and actions to be performed by specific console positions. The console positions that are typically included are the SMFCO, MFCO, SCO, ACO, CSO, TSO, VSO, FOG and FOA.

Holdfire

This section provides details on when the holdfire switches are active and provide direction for initiating a hold. It also provides the T-X time for the mission.

Recycle Procedures

This section typically references the range user recycle procedures, however, special instructions for a recycle would be briefed in this section.

On Console Times
This section lists the on console times for the MFCOs and the MFCO support positions.
Support Aircraft/Ships
This section provides details on the number and type of aircraft supporting the launch and which functions they will perform. It also provides details on how many boats and their associate organizations that are supporting the launch.
Mission Rules
This section references the applicable 45 SW/SELF Mission Rules letter.

4.11.5 MFCO MISSION BINDER

Mission Binders are divided into five sections and are used to store all information relevant to a specific launch. They are used on console during a launch or associated operation and are started approximately L-30 days, or upon assignment to a given launch.

Section I
MFCO Countdown Checklist and the RGNEXT Range Countdown.

Section II

- ECPs
- FCIW
- MDS
- Ops Sup
- Pre-Op Briefing
- Mission rules
- Green Numbers Tables
- Time vs Altitude Table
- Hazardous Area Letter
- SCO Box
- Zero Cycle letter

Section III
RSOR and the RGNext Launch Book.

Section IV
Contingency checklists such as Hangfire/Misfire Checklist, the Post Destruct checklists and the Errant vehicle checklist.

Section V

- Command Switching times sheet (generated by RGNEXT during pre-launch tests)
- Flight Plan Approval
- OSM Countdown Checklists
- Any other mission unique documentation

4-12 SCO/SSO/ACO GENERATED DOCUMENTATION

4.12.1 OVERVIEW

The Surveillance Team is responsible for reviewing and generating three documents prior to each launch. These documents include the Surveillance Operations Checklist (SOC), the SCO Box Chart, and the Surveillance Pre-Operations Briefing.

4.12.2 SURVEILLANCE OPERATIONS CHECKLIST

The Surveillance Operations Checklist (SOC) is a consolidated countdown utilized by the SCOs, ACOs, and SSOs on console during day of launch. This checklist documents all required steps that need to be completed by the Surveillance Control team during the launch countdown. It includes the nominal air and sea surveillance procedures as well as the fouled range procedures for the Surveillance crew. The SCO and DSCO assigned to the mission reviews the SOC and verifies it against the draft of the Launch Support Plan (LSP) and the MFCO Countdown Checklist.

4.12.3 SCO BOX CHART

The SCO Box Chart is developed by the 45 SW/SELR. The SCO Box is designed around the probability hit contours for boats and ships, known impact areas of jettisoned stages, and the flight azimuth of the mission. It defines the area to be scanned by the HH-60s (or Jollies) and the USCG vessels to clear boats and ships away from the contours and the azimuth.

4.12.3.1 Boat and Ship Probability Hit Contours Chart

The boat and ship probability hit contours chart is created by 45 SW/SELR. The contours can be obtained from SELR usually no earlier than L-14 days. You will use this chart to design the SCO Box around the contours and the azimuth. The chart may also be used on launch day to plot surface targets in the event of an SCDS failure.

4.12.3.2 45 SW/SELF Hazardous Areas Letter

The 45 SW/SELF Hazardous Areas Letter is used to plot out any known impact areas of jettison stages that may be within the surveillance capabilities of the support assets.

4.12.4 SURVEILLANCE PRE-OPERATIONS (PRE-OP) BRIEFING

Prior to each launch, the Surveillance Team develops a Surveillance Pre-Operations (Pre-Op) Briefing to provide to the support personnel at the Aircrew Briefing. The Surveillance Pre-Op Briefing is a quick reference document that is a consolidation of the mission details and support requirements for the Surveillance personnel. The Surveillance Pre-Op Briefing consists of the following sections:

- **Manning:** This section specifies who will be filling the various console positions for the launch to include the SCO, DSCO, ACOs, SSOs, MRUs, USCG personnel, and the SRAs.
- **Operational Data:** This section includes the general mission data to include the op number, OD number, launch pad, flight azimuth, and the JON number to use for accounting purposes.
- **Launch Window:** This section provides the launch window in local and Zulu times and the duration of the window.

- **On Console Times:** This section provides the on-console times for the SCO, DSCO, ACOs, SSOs, MRUs, USCG personnel, and the SRAs.
- **SCDS Contour Files:** This section lists the file names for the boat, ship and aircraft probability hit contours. If the vehicle uses strap-on solid motors, this section will also list the file name for the solid motor impact probability hit contours.
- **Weather:** This section provides the weather details for the mission or will refer to the 45 WS Launch Mission Execution Forecast (LMEF).
- **Airspace Operations:** This section lists the airspace and support aircraft that will be used in the mission. It also provides details on aircraft MSPs and aircraft instructions to include airspace and breakaway procedures.
- **Sea Space Operations:** This section includes details on the SCO Box, support vessels, and U.S. Coast Guard enforcement zone activation times.
- **Recycle Procedures:** This section typically references the range user recycle procedures, however, special instructions for a recycle would be briefed in this section.
- **Hazardous Area Closures:** This section lists the hazardous areas for the mission and the associated nominal and malfunction closure times. This information is extracted from the 45 SW/SELF Hazardous Areas Closure letter.

4-13 LAUNCH BOOK

4.13.1 PURPOSE

The Launch Book is an executive summary of mission data produced under contract by Range Generation-Next (RG-Next) Documentation Services. It serves as an on-console reference for the CAB, ROC, RCO, ACO, Range Engineer (RE), OGV Representative, Program Support Manager (PSM), and System Safety and Interim Safety Board President (for non-Navy), and, for EELV missions, the AFLD.

4.13.2 PARTICIPANTS/RESPONSIBILITIES

4.13.2.1 RG-Next

Produces the Launch Book and LRR slides.

4.13.2.2 Range Operations Commander (ROC)

Attend the working group and provide necessary data to update the Launch Book.

4.13.2.3 Range Control Officer (RCO)

Attend the working group and provide necessary data to update the Launch Book. The RCO is responsible for inserting a final LSP into the Launch Book prior to launch day. The RCO also coordinates any last minute changes to the Launch Book with RG-Next and ensures all launch books are returned to RG-Next after the mission is complete. As an associated task, the RCO produces an executive mission folder for each mission. The 1 ROPS CC uses this to track basic information and issues for each mission.

4.13.2.4 Surveillance Control Officer (SCO)

Attend the working group and provide necessary data to update the Launch Book and LRR slides.

4.13.2.5 Program Support Manager (PSM)

Schedule and attend the working group. Provide necessary data to update the Launch Book.

4.13.2.6 Program Manager (PM)

Attend the working group and provide oversight to the RG-Next drafter.

4.13.2.7 Mission Flight Control Officer (MFCO) and Range Engineer (RE)

Attend the working group and provide necessary data to update the Launch Book and LRR slides.

4.13.3 OVERVIEW

Once the Launch Book is produced, it is placed on LIMES.

The Launch Book provides a good overview of mission data. It is produced by RG-Next for every launch and is broken into 11 sections. These are described below:

A - Mission Overview – The overview describes the mission (mission synopsis), as well as the launch vehicle and launch windows.

B - Countdown - The 1 ROPS LSP is inserted here.

C - Instrumentation Summary - A ground track and elevation angle chart, ICPs, and the Range Instrumentation Plan (also on VPORT) are in this section.

D - Aircraft and Ship Support - Contains a list of supporting aircraft and take off times, Mission Support Point locations, aircraft time on station, and other pertinent data.

E - Personnel - Lists personnel involved in the mission, their office and console phone numbers.

F - User Mandatory Hold Letter - Contains the conditions and procedures for holding the count as outlined in the User Mandatory Hold Letter.

G - Safety - Contains the Range Safety Mission Rules, the RSOR Ops Supplement, mission OPLAN (for BDA/FCA clear), and the Road Block Access letter.

H – Weather - Contains a balloon release schedule.

I - Public Affairs - Lists important PA information to be used in the event of a launch mishap.

J - Not Used

K – Communications Console Operations Guide – Contains the console areas and locations in both of the mission control rooms and RSD. This section also shows the layout of the communications panel and the function of each button on the panel.

L - Miscellaneous - Contains any data not easily grouped in the other sections (e.g. associated operations). An Associated Operation is any operation conducted to **support** the objective of a major milestone event or launch related activity as its basic source. (i.e. – An RF collection system is collecting spacecraft data for post-mission analysis by the spacecraft community.) An External Operation is an **independent operation** that is not part of the objectives of the launch. The intent is to operate on a non-interference basis while using the launch to fulfill requirements stipulated by the External Operation's objectives. (i.e. – A new instrumentation system shadowing a launch for the purpose of operational acceptance on the ER.). The official Launch Books will be delivered to the 1 ROPS by a RG-Next courier approximately 1 week before launch day.

Once the mission is complete, the RCO will return them to RG-Next.

4-14 MISSION FOLDER

4.14.1 OVERVIEW

Mission folders, divided into at least six parts, are used to store all information relevant to a given launch. Examples of these items are the Ops Sup, Flight Control Instrumentation Worksheet (FCIW), Launch Countdown Checklist, and Mission data sheet. They are used on console during a launch or associated operation and are started roughly L-30 days, or upon assignment to a given launch. It will be used as both a historical record of all pre-mission preparation, and as an actual on-console document.

4.14.2 CONTENTS

The mission folder will eventually contain, at a minimum, the Range Countdown, Operations Control Instructions (OCIs), the DO signed and approved Launch Support Plan (LSP), the RSOR Ops Supplement, Expected Coverage Plans (ECPs), balloon release schedule, and records of pre-mission checks. Some launches will have specific requirements, or associated operations and these will also have to be included in the folder. Operations that used a variable flight azimuth; the flight azimuth vs. time charts were also included in the folder. Most of this information is provided in a Launch Book, published by the contractor, which is used on console. The cover is labeled with the booster/payload and Operation Number (OPNR) only when UNCLASSIFIED.

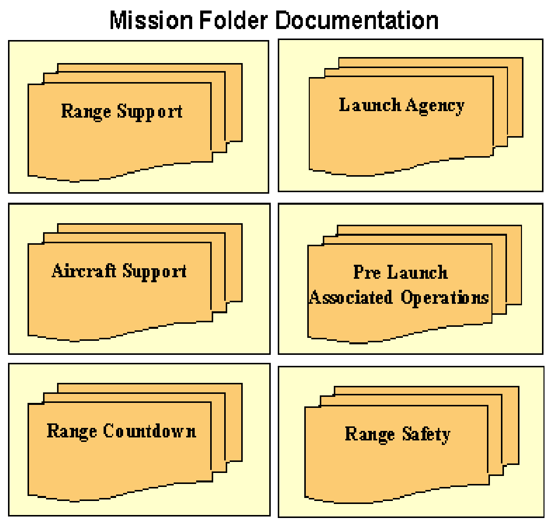


Figure 4-14-1: Mission Folder Organization

Miscellaneous Range Support

- Operations Control Instructions (OCIs)
- Scheduling Notifications
- Network Briefing Message
- Off-Range Support Messages
- All other Teletype Messages
- Orbital Expected Coverage Plans

Figure 4-14-2: *Range Support Documentation*

Aircraft Support Documentation

- Aircraft Bingo charts
- Intended Support Plans (ISPs) and Approval Letters
- Aircrew Guide
- Airfield Support Requests
- Support Aircraft Schedule

Figure 4-14-3: *Aircraft Support Documentation*

Range Countdown or Instrumentation Documentation

- Launch Support Plan (LSP)
- Expected/Committed Coverage Plans (ECP)
- Time vs. Altitude Chart
- Instrumentation Coverage Chart (ICC)
- Balloon Release Schedule
- Range Countdown
- Range Logs and Resource Outage Worksheets
- Instrumentation Summary
- Post Launch Report

Figure 4-14-4: *Range Countdown Documentation*

Launch Agency Documentation

- User Mandatory Hold Letter
- Expedited Operations Requirements (EOR)
- High Priority Recovery and Hazardous Materials List
- Payload/Upper Stage Information
- Flight Test Support Plan
- Secondary Payload Information
- Best Estimate of Trajectory
- Launch Window Listing
- Roadblock and Instrumentation Site Access
- Test Support Plan
- User Countdown

Figure 4-14-5: *Launch Agency Documentation*

Pre-Launch and Associated Operations

- Pre-Launch Test Logs (final ordnance load, DASO, F-1, WDR, CST, etc.)
- Launch Book
- Launch Base Services (LBS) support information
- Associated Operations
- Reference Material (site maps, policy letters, etc.)

Figure 4-14-6: *Pre-Launch/Associated Documentation*

Range Safety Documentation

- Collision Avoidance (COLA) Closures
- Impact Limit Lines letter
- Operations Supplement to RSOR
- Notice to Airmen and Mariners (NOTAM)
- Hazardous Area and COLA Inputs Letter
- MFCO Checklist

Figure 4-14-7: *Range Safety Documentation*

A list of these requirements will be posted on the inside of the front cover.

After the launch, the range crew folders will be consolidated into the RCO mission folder. The PSM may elect to keep his/her materials separately. Mission folders will be kept for at least one year. Once complete, the mission folder should be submitted to DOOB for filing IAW 1 ROPS file plan.

4-15 RANGE STATUS, CONSTRAINTS, AND WAIVERS

4.15.1 OVERVIEW

This section encompasses information that is considered before, during, and after a launch. Range status, constraints, and waivers are equally important and provide for flawless operations.

4.15.2 RANGE STATUS

Range Status is determined by the Range Operations Commander (ROC) and is the capability of the Range to meet all mandatory launch agency and Range Safety requirements. The Range Control Officer (RCO) can determine Range Status if the ROC is not on console. Range Status is defined as follows:

- **Proceeding:** Range Status is Proceeding when the Range is continuing count procedures toward T-0 with no constraints violated.
- **Proceeding with the following exceptions:** Range Status is Proceeding with exceptions when one or more mandatory constraints are not met, but the Range is continuing to process toward T-0 or an established hold point. When one mandatory constraint is violated, the ROC will state “Range Status is Proceeding with the exception of (state the Range issue/ constraint violated).” When two or more mandatory constraints are violated, the ROC will state “Range Status is Proceeding with the following exceptions of (list the Range issues/constraints violated).”
- **Not Proceeding:** Range Status is Not Proceeding when the Range is holding at an established hold point or the mission is scrubbed. Range Status is automatically “Not Proceeding” upon extension of a built-in hold or execution of an unscheduled hold.
- **Green:** Range Status is Green when the vehicle C-band beacon and S-band telemetry systems are on internal power, the Flight Termination System (FTS) is on internal power and armed, the Range is configured for launch AND any pending issues have been resolved.
- **Red**: Range Status is Red if a mandatory constraint is violated within the terminal count *and* the “Range Green” call has already been passed to the launch agency. A Red condition will result in a “HOLD” call and a recycle to an established hold point. Once the recycle is complete, Range status reverts to “Not Proceeding”.

Range Status is based on Range Instrumentation status, Flight Safety status, the establishment of a Range approved T-0, and confirmation that the vehicle RTS and FTS has successfully transferred to internal power. The Range Status Matrix in Table 4-15-1 provides guidance for determining Range Status when a Range or launch agency issue causes contingency countdown actions such as a Built-in Hold (BIH) extension, an unscheduled hold, or results in picking up the countdown when Launch Commit Criteria (LCCs) are violated.

Situation	Range Status when the situation is due to a Range issue	Range Status when the situation is due to a Launch Agency issue
When the need for a BIH Extension is determined:	Range Status is Proceeding with the exception of (Range Issue) or Range Status is Proceeding with the following exceptions (List the Range Issues)	Range Status is Proceeding
Once the BIH occurs:	Range Status is Not Proceeding due to (Range Issue)	Range Status is Not Proceeding due to an unknown T-0
If an unscheduled hold occurs:	Range Status is Not Proceeding or RED [After Range Green has been passed] due to (Range Issue)	Range Status is Not Proceeding due to an unknown T-0
Once the count is recycled:	Range Status is Not Proceeding due to (Range Issue)	Range Status is Not Proceeding due to an unknown T-0
When the situation which caused the hold is resolved:	Range Status is Not Proceeding due to an unknown T-0	Range Status is Not Proceeding due to an unknown T-0
When a New T-0 has been approved:	Range Status is Proceeding	Range Status is Proceeding
If the count will be picked-up in a NO-GO condition:	Range Status is Proceeding with the exception of (Range Issue)	Range Status is Proceeding

Table 4-15-1: *Range Safety Matrix*

4.15.2.1 Positional GO / NO-GO Status

During the countdown, the Range crew members will report their positional status as either "GO" or "NO-GO" based on their assessment of the impact of countdown events on the respective LCCs. The various Range crewmembers report their positional status to the MFCO, RCO, and/or ROC. The RCO assesses the impact of the various countdown events/reports to determine Range Instrumentation "GO"/"NO-GO" status. The MFCO assesses the impact of the various countdown events/reports to determine Flight Safety "GO"/"NO-GO" status. The ROC factors in Range Instrumentation status as reported by the RCO and Flight Safety status as reported by the MFCO when determining Range Status.

4.15.2.1.1 Range Instrumentation Status

In order for the RCO to declare "Range Instrumentation is GO", all mandatory launch agency and Range Safety assets must be Fully Mission Capable (FMC) or Partially Mission Capable (PMC) and able to meet all mandatory requirements.

4.15.2.1.2 Flight Safety Status

In order for the Mission Flight Control Officer (MFCO) to declare "Flight Safety is Go", the following conditions must be met:

- All Range Safety mandatory assets must be Full Mission Capable (FMC) or Partial Mission Capable (PMC) and able to meet all mandatory requirements

- Launch Area Surveillance is GO as declared by the Surveillance Control Officer (SCO)
- Range Safety Weather LCCs are GO as declared by the Launch Weather Officer (LWO)
- Distant Focusing Overpressure (DFO), Toxics, and Debris conditions are GO as declared by the Risk Assessment Center (RAC)
- Airborne Flight Safety System requirements must be met as verified by the Operations Safety Manager (OSM) and Safety Analysis (SEA)

4.15.2.2 Range Green Status

For all launches except for Trident II launches, the ROC reports Range Green status to the launch agency in the terminal countdown as the final approval to launch. The Range Green call is given after the vehicle has transferred to internal power and signifies that RTS and FTS checks on internal power are complete and satisfactory, the FTS is armed, the Range is configured for launch, and any pending Range issues have been resolved. The Range Green call is typically provided by the ROC at T-1 minute (Atlas V and Delta IV) or T-2 minutes (Falcon 9) after receiving “Clear to Launch” from the Launch Decision Authority (LDA), “RCO Green” from the RCO and “MFCO Green” from the MFCO.

4.15.2.2.1 RCO Green

For all launches except for Trident II launches, the RCO will report “RCO Green” status to the ROC after both of the following conditions have been met:

- Range Instrumentation Status is “GO”
- If applicable, the Instrumentation Superintendent of Range Operations (ISRO) has reported “Beacon GO on internal power” to the RCO. The ISRO provides this call to the RCO after receiving notification from the Radar Supersystem Controller that the launch head radar(s) or FCA Van are successfully able to interrogate the launch vehicle’s C-Band beacon after it has switched to internal power.

Note that if either of these two criteria are not met, the RCO will not report “RCO Red” but instead will initiate hold actions.

4.15.2.2.2 MFCO Green

For all launches except for Trident II launches, the MFCO will report “MFCO Green” status to the ROC after all of the following conditions have been be met:

- Flight Safety Status is “GO”
- The TSO has confirmed that the Automatic Gain Control (AGC) values for the launch vehicle’s Command Receiver Decoders (CRDs) are satisfactory after the FTS has been transferred to internal power.
- The OSM has reported that the FTS is armed.

If the above criteria are not met the MFCO will either throw the holdfire or call for a hold on the user net. The MFCO will only be “MFCO Red” after already declaring “MFCO Green,” but after violate one of the above criteria.

4.15.3 REQUIREMENT AND RANGE/NETWORK ASSET CATEGORIES

Requirements and Range/Network assets are categorized and prioritized according to their criticality to accomplishing mission objectives.

4.15.3.1 Requirement Categories

A priority must be defined to evaluate requirements on an overall program, mission, or test basis. RCC Document 501-08, the Universal Documentation System (UDS) Handbook, defines three categories of requirements: Mandatory, Required and Desired. On the Eastern Range (ER), only the Mandatory and Required terms are used. These terms are used to define both Range Safety and launch agency requirements.

4.15.3.1.1 Mandatory Requirements

A mandatory requirement is the minimum requirement essential to achieve program, mission, or test objectives. A failure to meet a mandatory requirement is a “NO-GO” condition and can result in a Built-in Hold Extension or an Unscheduled Hold. A launch will not occur if a mandatory requirement is violated, unless the requirement is waived by the proper waiver authority. Mandatory requirements can include weather, DFO, toxics, debris, launch agency, Range Safety specific issues, range instrumentation, and network instrumentation.

4.15.3.1.2 Required Requirements

Required items materially aid in achieving all objectives and are necessary for detailed analysis of system performance. These type of requirements typically consist of data gathering requirements which are not critical to the success of the launch or mission objectives. Examples of required requirements may include the real-time relay of telemetry data to the launch agency or the use of a radar to track the launch vehicle to detect any possible debris shedding off of the launch vehicle.

4.15.3.2 Range Asset Categories

Range assets and off-range assets are categorized according to the requirements for which they are tasked to meet. This allows the console operators to quickly recognize the loss of the ability to meet a mandatory requirement and to prioritize actions, especially during critical points during the countdown. Note that an asset may be utilized to meet both Range Safety and launch agency requirements. As a result, it may be categorized differently for the Range and the launch agency, depending on the requirements it is being utilized to meet.

4.15.3.2.1 Mandatory Assets

An asset is categorized as a mandatory asset when it is the only asset available to meet a mandatory requirement. Unless a waiver is granted for the applicable mandatory requirement(s), all mandatory assets must be FMC or PMC and able to meet all mandatory requirements in order for launch to occur.

4.15.3.2.2 Required Assets

An asset is categorized as a required asset when it is either being utilized to meet a required requirement or it is providing redundancy to meet a mandatory requirement. Note that a required asset may be upgraded to be a mandatory asset due to the failure of another required asset or assets.

4.15.4 LAUNCH AGENCY REQUIREMENTS AND CONSTRAINTS

4.15.4.1 Launch Agency Requirements and Constraints Overview

Launch agency constraints are in place to protect the launch vehicle and ensure mission success. Launch agency constraints will change from one mission to another based on the primary and/or secondary mission requirements and the launch trajectory. These requirements are documented in a variety of documents many of which are internal to the User. The documents of particular interest to Range personnel are the source documents for the requirements levied on the Range by the launch agency. These are primarily documented in the Operations Requirement (OR) and the User Mandatory Hold Letter (UMHL). These requirements are used to build the Operations Directive (OD), which documents how Range systems will be configured and operated to meet launch agency requirements. There is a launch vehicle OD for all launches from the ER. If the spacecraft has additional requirements for Range and network assets than those required by the launch vehicle, the spacecraft community may also submit UDS documentation resulting in a spacecraft OD. The launch vehicle OD and spacecraft OD (if applicable) are important for Range personnel to reference to understand how the Range is meeting launch agency requirements. If there are additional requirements or changes/deletions to requirements, the launch agency will submit an Expedite OR and the OD will be modified with Operational Change Instructions (OCIs).

If the launch agency issues a UMHL, then this document will list the final specific instructions from the launch agency to the RCO, and sometimes the LWO, to include the launch agency mandatory requirements to be protected by the Range and the preferred hold instructions.

4.15.4.2 Launch Agency Constraints

Launch Agency constraints include:

- The Launch Window
- Range Instrumentation and Network Requirements
- Launch Vehicle/Space Vehicle Redline Limits
- Support Facility Constraints
- Weather Constraints
- Mission Assurance Collision Avoidance (COLA) Constraints

4.15.4.2.1 Launch Window

The launch window is the block of time available for launching into a specified orbit. A variety of factors go into determining the size of the launch window including the Earth's rotation, the latitude of the launch site, sun angles in relation to the spacecraft, booster performance, and tracking and communications capability. Depending on these factors, launch windows can range from an instantaneous window (on the second) to several hours.

4.15.4.2.2 Range Instrumentation and Network Requirements

There are three main areas of launch agency mandatory instrumentation: Telemetry, Communications and Meteorological Support.

4.15.4.2.2.1 Telemetry Requirements

Range and network (such as the Air Force Satellite Control Network (AFSCN) and Tracking and Data Relay Satellite System (TDRSS)) telemetry assets are used by the launch vehicle and spacecraft communities in order to monitor vehicle systems and performance. There are typically two sets of telemetry requirements: Launch vehicle requirements and spacecraft requirements. Typically it is a mandatory requirement to receive and record launch vehicle telemetry data during all phases of powered flight through spacecraft separation. In addition, some launch vehicle programs may have a mandatory requirement for real-time relay of the telemetry data to the launch agency. In some cases, the spacecraft community may have mandatory requirements to collect spacecraft telemetry during launch or for early orbit support. The requirements may be met by Range and/or off-range assets. Depending on the off-range assets that are utilized, the ER may not be tasked to call a hold for a loss of mandatory off-range telemetry assets.

4.15.4.2.2.2 Communications Requirements

Communications requirements typically include launch base communication systems to provide inter- and intra-facility voice and data communication required to exchange critical information and status such as launch decision flow and polling (GO/NO GO), hold calls, recycle and scrub decisions, and T-0 coordination. These requirements may also include communication with off-range assets and facilities in order to transfer data and to communicate the ability of off-range assets to meet mandatory flight data collection requirements.

4.15.4.2.2.3 Meteorological Systems Requirements

Meteorological systems requirements enable other launch agency weather constraints, such as ground level and upper level winds, to be assessed or met. The launch pad wind towers are used to measure ground level winds and to ensure that they are within constraints. Meteorological System Computer (MSC) and Automated Meteorological Profiling System (AMPS) capability is mandatory until usable data is obtained to support launch agency assessments of upper level winds to ensure they are within constraints. This data is also used to develop the launch vehicle load relief file which is uploaded into the launch vehicle's flight program. This file adjusts the launch vehicle's flight profile to minimize the aerodynamic loads on the vehicle due to upper level winds. Note that this data is only valid for a certain period of time. If an AMPS or MSC failure occurs, an assessment will have to be made with the launch agency to see for how long a time period is the current available data valid.

4.15.4.2.3 Weather Constraints

Launch Agency weather constraints are designed to protect the launch vehicle on the ground and in flight. These constraints include:

- **Ground level winds:** High ground level winds can prevent the User from being able to roll the Mobile Service Tower (if they have one) or cause the launch vehicle to tip over on the pad or drift into support structures during liftoff.
- **Upper level winds:** High upper level winds can cause the launch vehicle to experience high aerodynamic loads, become uncontrollable, or cause solid motors to collide with the launch vehicle during separation events.
- **Lightning:** A lightning strike too close to the launch vehicle can cause damage to the vehicle avionics and flight termination systems.
- **Flight through precipitation:** Some vehicles using cryogenic propellants have flight through precipitation constraints to prevent ice from forming on the cryogenic stages and causing damage to the insulation or hindering the performance of the launch vehicle.

4.15.4.2.4 Mission Assurance Collision Avoidance (COLA) Constraints

Collision Avoidance is a process designed to prevent collisions between on-orbit tracked objects and launched vehicles (including spent stages)/payloads. The Collision Avoidance process includes establishing launch wait periods in the launch window, called COLA closures, based on validated conjunction assessments. A Conjunction Assessment (CA) is a process for determining the point and time of the closest approach between a tracked orbiting object and a launched vehicle based on a specified miss distance screening criteria or the corresponding probability of collision. A launch agency may choose to have Mission Assurance COLAs developed for their missions to protect the integrated launch vehicle/spacecraft stack from a collision with an on-orbit object. The Space and Missile Systems Center (SMC) and the National Reconnaissance Office (NRO) typically contract the Aerospace Corporation to develop Mission Assurance COLAs for their missions. The criteria used to develop Mission Assurance COLAs are not necessarily the same criteria as that used in the development of Range Safety COLAs. The launch agency may use different hit-probability criteria or calculate hit-probabilities through the first several orbits. As a result, launch opportunities may be influenced by cutouts from Range Safety and Mission Assurance COLAs utilized for a specific launch.

4.15.4.3 Launch Agency Waivers

The waiver process varies between launch vehicle programs and often varies from mission to mission due to the different satellite programs. The Range Users develop anomaly and waiver processes to deal with launch vehicle issues, spacecraft issues, and integrated launch vehicle and spacecraft issues.

The launch team management may have an anomaly team formed to assess the impact of the failure on mission requirements, and depending upon the situation, determine to submit a waiver request to the Mission Director (MD). The user would submit a waiver request through their chain to the MD. The MD would either grant or deny the waiver and the decision would be passed to the Range through the user's Range interface.

4.15.5 RANGE SAFETY POLICY, REQUIREMENTS, AND CONSTRAINTS

4.15.5.1 Range Safety Policy, Requirements, and Constraints Overview

Air Force Space Command (AFSPC) operates the ER and the Western Range (WR) under DoDD 3200.11, for all users having a valid need for launch and test range capabilities. Operation of these Major Range Test Facility Base (MRTFB) ranges carries with it specific responsibilities for public and Launch Safety.

Space launch is a potentially dangerous business. On May 11, 1949 President Harry S. Truman signed legislation entitled Public Law 60 which established the national range system and the Joint Long Range Proving Ground at Cape Canaveral. Over the years, the launch vehicles have grown dramatically in size and capability and the population of Brevard County has increased to approximately 600,000 residents. This growth in population and the proximity of population centers to the ER has made Launch Safety more critical now than ever on the ER.

4.15.5.2 Space Safety Policy

The Air Force (AF) operates responsibly with due regard for the safety of the general public, AF personnel, space support personnel and public (non-commercial launch system operator-owned) resources. The AF level instruction, Air Force Instruction (AFI) 91-217 *Space Safety and Mishap Prevention Program* provides overarching space safety, mishap prevention and mission effectiveness guidance for acquisition, testing, and operations of terrestrial, launch, orbital and kinetic/directed energy space systems.

AFI 91-217 defines Space Safety as a dynamic process designed to improve operational effectiveness by preventing close calls and mishaps and to provide for mission assurance throughout the life cycle of a space system. Space Safety consists of launch/range safety, orbital safety, space control safety, system safety, integrated effects of combined systems, software safety, risk management, and mishap investigations and reporting.

4.15.5.2.1 Risk Responsibility

AFI 91-217 requires units to use risk management measures throughout all phases of a space system's lifetime to provide protection for the public and space systems and their mission effectiveness. To that end, AFI 91-217 breaks down the launch vehicle and spacecraft safety risk responsibility into the different mission flight phases associated with launches. It then assigns the risk responsibility for each mission flight phase to either the spacelift wing commander, the acquisition organization, or the operational organization.

4.15.5.2.1.1 Spacelift Wing Commander Risk Responsibility

The appropriate spacelift wing commander (30 SW/CC or 45 SW/CC) is responsible for all flight risk to the general public, launch area personnel and other mission support personnel, commencing at liftoff, up through orbital insertion or until final impact of suborbital vehicles or jettisoned components. In addition, the spacelift wing commander is responsible for enforcing launch COLAs to prevent the collision of launch vehicles with on-orbit spacecraft.

4.15.5.2.2 Launch Safety Officer (LSO)

AFI 91-217 requires units which acquire, test, or operate space systems to have a Space Safety Officer (SSO). The 30 SW and 45 SW are required to have a Launch Safety Officer (LSO) with the appropriate training to serve as the Space Safety Officer. The LSO is required to be trained in System Safety and space mishap prevention and investigation. Duties for the LSO include reporting potential safety issues to the SW/CC, performance as an investigation officer, assessing mishap prevention measures, and conducting Space Safety training.

4.15.5.3 Launch Safety Policy

The goal of the Launch Safety program is to allow Range Users to conduct their missions with minimal interference while maintaining a mutual strong commitment to public safety.

4.15.5.3.1 Launch Safety Regulations

Launch Safety policy has evolved and matured over time. Launch Safety is rooted in Public Law 60. One sentence--"From a safety standpoint, they (guided missiles) will be no more dangerous than conventional airplanes flying overhead"--provided the basis for the concept of Range Safety. Both of the Ranges developed and implemented several documents describing Range Safety requirements from 1949 until joint HHQ regulations were developed.

4.15.5.3.1.1 Current Launch Safety Regulations

Today, Launch Safety Policy is established in several regulations. Commercial Launch Safety Policy is established in the Code of Federal Regulations (CFR) Title 14 *Aeronautics and Space,* Chapter III *Commercial Space Transportation.*

AFI 91-217 Chapter 4 *Launch, System Deployment, and Reentry* provides the overarching guidance to the various Air Force agencies which are responsible for aspects of safety within the different sub-phases of the space system deployment life-cycle phase. It outlines safety responsibilities and tasks for the space system deployment life cycle phase which includes: transportation from the factory to the launch site or operating location; assembly and checkout; for flight hardware, pre-launch/launch/early-orbit deployment and checkout. It also includes: reentry safety responsibilities and requirements for launch vehicles/components; reentry launch vehicles/components, and reusable launch vehicles/components including their jettisoned components.

AFSPC provides guidance for the Launch Safety programs at the ER and the Western Range (WR) through EWR 127-1 and the AFSPC 91-700 series of documents. EWR 127-1 defines the Launch Safety program for all programs established at the ER or WR prior to 1 July 2004. The AFSPC 91-700 series defines the Launch Safety program for all programs established at the ER or WR after 1 July 2004. It incorporates and updates information from EWR 127-1 and divides it up among three sets of documents:

- Air Force Space Command Instruction (AFSPCI) 91-701 *Launch Safety Program Policy* defines and implements AFSPC Launch Safety policy and responsibilities for AFSPC. It provides a brief overview and summary of the requirements that are detailed in the other two documents
- Air Force Space Command Manual (AFSPCMAN) 91-710 *Range Safety User Requirements* applies to Range Users conducting ops on AFSPC ranges. It consists of seven volumes that cover specific areas
- AFSPCMAN 91-711 *Launch Safety Requirements for AFSPC Organizations* describes authorities and responsibilities of AFSPC units

Reference Section 4-2 of this Ops Manual for detailed information on EWR 127-1 and the AFSPC 91-700 series of documents.

4.15.5.3.1.2 Tailoring

Tailoring refers to the process used at AFSPC ranges beginning at program introduction (PI) where Range Safety organizations and a Range User review each safety requirement in EWR 127-1 or AFSPCMAN 91-710 and jointly document whether or not the requirement is applicable to the Range User; and if it is applicable, whether or not the Range User will meet the requirement as written or achieve an Equivalent Level of Safety (ELS) through an acceptable alternative. If developed, the tailored edition is placed on the Range User’s contract or applied through a Commercial Space Operations Support Agreement. The tailoring process may include deletions, changes, or additions to a requirement:

- **Deletion of a Requirement:** When a requirement is not applicable to a Range User program, the requirement shall be deleted.
- **Change to a Requirement:** A change is allowed to tailor the requirement to a particular system as long as the intent of the requirement is met and the ELS is maintained.
- **Addition to a Requirement:** An addition to a requirement is allowed when there are no existing requirements addressing new technology, when unforeseen hazards are discovered, when federal or industry standards change, and for other similar reasons.

4.15.5.3.2 Commercial Launch Safety Policy

The Federal Aviation Administration (FAA) is the licensing agency of commercial launch operators (Range Users). The launch operator is expected to be in compliance with the terms of the license or will have monetary fines imposed and/or have their launch license revoked. FAA authority is retained at their HQs in D.C. FAA-licensed launch operators launching from the ER or WR are responsible for compliance with AFSPC Launch Safety requirements and FAA license requirements.

4.15.5.3.3 AFSPC Launch Safety Program

The SW/CC has the authority and responsibility for public safety and the Launch Safety program at his/her range from liftoff until orbital insertion and for landing of reentry vehicles at his/her range. The SW/CC is responsible for establishing, maintaining, and enforcing a Launch Safety program with responsibilities ranging from program introduction through launch, including impact or orbital insertion or attainment of earth escape velocity and/or end of programmed Range Safety control. The concept of an independent safety assessment is critical to the program. To ensure an independent safety assessment, Range Safety organizations are required to report directly to the SW/CC.

The Launch Safety program is a two-part program:

- Part One: Implementation and enforcement of AFSPC policies and requirements that Range Users must meet to be approved to perform operations on and from the ranges. The SW/CC or his/her designated representatives must ensure the Range User utilizes the UDS as the means to establish their launch requirements, including the requirement to comply with AFSPCMAN 91-710 or EWR 127-1. The SW/CC or his/her designated representatives are delegated the authority to prepare and approve tailored versions of AFSPCMAN 91-710 or EWR 127-1 for each program and to approve Equivalent Levels of Safety (ELS) determinations or waivers to Launch Safety requirements
- Part Two: Development and implementation of internal Space Wing (SW) infrastructure, requirements, processes, and procedures necessary to establish and support the Launch Safety program. The guidance for this part of the program is established in AFSPCMAN 91-711 or EWR 127-1

4.15.5.3.3.1 Launch Safety Program Strategies

To deal with the numerous hazards associated with launches from the ER, two different strategies are utilized under the Launch Safety program: containment and risk.

4.15.5.3.3.1.1 Containment

Containment involves defining launch hazard areas and clearance requirements around the launch site and Atlantic basin and then establishing very specific criteria for prelaunch, launch, flight, and termination activities. Essentially this means that there are defined areas where hazards are permitted to exist and actions are taken to ensure that the vehicle and any potential debris stay within those boundaries. In order to do this, the vehicle must be constantly tracked in flight. Containment is the preferred method of hazard abatement since it is simple and straight forward and defines where the hazards are going to be and the area from which people must be kept out. It provides protection against both the likely and unlikely hazards. Impact limit lines, destruct lines and the uses of COLAs are examples of the containment strategy.

4.15.5.3.3.1.2 Risk Management

Not all hazards due to launches can be contained within the fence line of Cape Canaveral Air Force Station (CCAFS) or within the hazard areas. If a planned mission cannot be accomplished using a containment approach, a risk management approach may be authorized by the SW/CC or the designated representative. In a risk management approach, a certain predefined level of risk is accepted in order to accomplish the mission.

4.15.5.3.3.2 Range Safety Responsibility

When defining launch safety constraints, a key term that is used is “Range Safety Responsibility.” Range Safety Responsibility is the period of time during the flight of a launch vehicle or a missile in which the Range is required to have the capability of controlling erratic vehicle flight to meet the objective of managing risks to the public and foreign countries. This includes the ability to track the vehicle and to send destruct commands to the vehicle, if required. If a particular launch profile exceeds public safety aggregated risk criteria, the SW/CC may elect to extend capabilities with augmented assets, relocate at-risk on-base populations, or waive the risk within published limits of SW/CC waiver authority.

4.15.5.3.3.3 Launch Safety Constraints

Launch Safety constraints are in place to protect life, property, and equipment. The MFCO is responsible for enforcing Launch Safety LCC and initiating countdown holds if required. Various personnel and agencies are responsible for assessing these constraints and reporting status to the MFCO. Launch Safety constraints include:

- Instrumentation Constraints
- Airborne Flight Safety System Constraints
- Weather Constraints
- Hazardous Areas
- Launch Area Surveillance
- DFO/Toxics/Debris Constraints
- Collision Avoidance (COLA) Constraints

4.15.5.3.3.3.1 Instrumentation Constraints

Instrumentation Constraints are based upon the EWR 127-1, AFSPCMAN 91-710, and AFSPCMAN 91-711 requirements for the Ground Range Safety Systems necessary to monitor, track, aid decision making, and destroy an erratic launch vehicle.

4.15.5.3.3.3.1.1 Tracking Constraints

For all pad launches, one adequate tracking source is mandatory from liftoff until MTE-3 (3 seconds prior to the Minimum Time to Endanger). MTE is the minimum thrusting time during which a launch vehicle can move from a state or condition of nominal flight to a condition where the launch vehicle’s inert and explosive debris endangers a protected area. It is also known as the Green Number off the pad. This constraint is IAW a 9 Feb 2012 45 SW/CC memorandum titled “Implementation of Change to Range Safety Tracking Policy.” It was developed in response to the reduction in tracking system assets as a result of the LET Initiative. It was designed to improve launch availability without impacting public safety. As long as an erratic vehicle is terminated at or before MTE, the risk to the public does not increase.

For all launches, two adequate and independent tracking sources are mandatory from 3 seconds prior to MTE through the end of Range Safety Responsibility.

Adequate is defined by error statistics for each source. *Independent* is defined as having no common components or systems between the vehicle and the front-end computers in the Morrell Operations Center (MOC) such as to create a common failure mode or single point of failure (SPOF).

These tracking sources can include radars, optics, Telemetry Inertial Guidance (TMIG) data and Global Positioning System (GPS) tracking data. Note that tracking sources at downrange sites must be able to receive designate date from the Range Safety systems to acquire the launch vehicle in order to be committed for launch. Designate data is not required for tracking sources which can acquire the launch vehicle off of the pad.

4.15.5.3.3.3.1.1.1 Radar as a Tracking Source

Each radar is an individual tracking source. Two radars can be used to meet the requirement for two adequate and independent tracking sources from 3 seconds prior to MTE through the end of Range Safety Responsibility. Either beacon or skin track can be used to meet tracking requirements; however, skin track is not committed through staging events.

4.15.5.3.3.3.1.1.2 Optics as a Tracking Source

Optics is a single tracking source. The individual sites alone do not meet the *adequate* tracking source criteria. The data from all of the tracking sources are combined together to develop a composite optics solution which meets the *adequate* tracking source criteria.

4.15.5.3.3.3.1.1.3 Telemetry as a Tracking Source

Telemetry Inertial Guidance (TMIG) is a single tracking source. Two telemetry antennas or sites do not meet the definition of *independent* tracking sources since they both rely on the vehicle's inertial guidance and telemetry transmission systems to receive data. When telemetry is a mandatory tracking source and there are multiple telemetry antennas and/or sites that are available to provide the coverage, it is identified as "Telemetry as a source" is mandatory. If Telemetry as a source is mandatory, then one of two sides (A or B) of the Centralized Telemetry Processing System (CTPS) is mandatory in order to process and distribute the telemetry data from the sites to the RSD systems.

4.15.5.3.3.3.1.1.4 GPS as a Tracking Source

GPS metric tracking is a single tracking source. Two sites providing GPS metric data do not meet the definition of *independent* tracking sources since they both rely on GPS receiving equipment and S-band transmission equipment on the vehicle to send the data to the receiving sites on the ground. The S-band GPS data links are received by the same antennas that are used to receive the vehicle's S-band telemetry links. As a result, telemetry and GPS metric data can be used together to meet tracking requirements; however, to meet the definition of *independent* tracking sources, they would have to be received by two telemetry antennas to prevent a SPOF. If the telemetry antennas are downrange of the launch head and cannot acquire the vehicle off the pad, they must have separate SEL/TRIOs or Telemetry Radar Acquisition Computer (TRAC)/TRIOs to prevent a SPOF.

If the Translated GPS Ranging System (TGRS) is being utilized as a mandatory tracking source, then one GPS Translator Processor (GTP) and one TGRS Data Formatter are mandatory for each missile that will be in the air at one time.

4.15.5.3.3.3.1.2 Command Destruct System (CDS) Constraints

CDS constraints are defined to ensure the reliable transmission of flight termination messages to aerodynamically unstable or errant missile vehicles in response to MFCO requests that are originated at the launch head. They include the requirements for a dual command site, two redundant and diversely routed command data links, and Central Command Remoting System (CCRS) constraints.

4.15.5.3.3.3.1.2.1 Dual Command Site Requirement

A dual command site is mandatory through the end of Range Safety Responsibility. A dual command site is defined as two transmitters connected by an automatic failover control system, also referred to as a station guardian. This requirement is designed to prevent a SPOF at the command site and ensure that the command site can transmit destruct functions. In addition, if steerable antennas are required to be used at the mandatory dual command site to meet the mandatory coverage requirement, then redundant and diversely routed High Density Designate (HDD) to the site is also mandatory in order to point the steerable antenna.

4.15.5.3.3.3.1.2.2 Command Data Links Requirement

The command sites are connected to the CCRS in the MOC through the command data links. Two redundant, diversely routed command data links are mandatory through the end of Range Safety Responsibility. This requirement prevents a single point of failure between the MOC and the command site to ensure that data can be relayed to and from the command site. The command data links requirement can be met by either having two links routed to the same dual command site or to two different command sites with redundant coverage. If only one command site is available to provide command coverage, then the two command data links to the command site must be routed through diverse or different paths to prevent a SPOF. The command data links requirement can also be met through separate links to two different command sites which can provide redundant command coverage such as Cape 1A and Cape 1B. In this situation, ***Command Capability*** at each command site is mandatory. This means that the command site must have at least one command data link and one complete command string (to include one site CMEV, one transmitter, and one antenna) in order to transmit command functions. Cross-strapping between the two strings at a command site can be utilized to meet the command capability mandatory requirement. Note that, in this situation, at least one of the two command sites must meet the Dual Command Site requirement. Also note that if Command Capability with a steerable antenna at a command site is mandatory, then a single HDD link to that command site is also mandatory.

4.15.5.3.3.3.1.2.2 Central Command Remoting System (CCRS) Requirements

In order to meet the command destruct system requirements without any SPOFs, the following components of the CCRS are mandatory:

- Two of two Central Command Message Encoder Verifiers (CMEVs)
- Two of two Flight Termination Units (FTUs)
- Two of four Range Safety Control and Displays (RASCADs)

4.15.5.3.3.3.1.3 Range Safety System Constraints

Two complete and independent Range Safety computer systems are mandatory for launch in order to display vehicle impact position data to the MFCOs and to provide designate to the instrumentation sites. At the ER, this means that two of three between the FOV1-A, FOV1-B, and DRSD systems are mandatory for launch. The Mission Continuation Display (MCD) on

FOV1-A relies on the GP and GP-FEP of the FOV1-A system and therefore does not qualify as an independent range safety system string.

There are a few caveats as to which components on a string of FOV1 are mandatory if the string is mandatory:

- Two MFCO display monitors on the string is mandatory if the string is mandatory to prevent a SPOF in the display of tracking data.
- If Telemetry as a source is mandatory, then the Guidance Processor (GP) and the GP Front End Processor (GP-FEP) on the string are mandatory.
- For expendable launch vehicle missions, the gateway on the FOV1 string is mandatory until SPARC Switch Control (SPARC-SC) is in an acceptable launch configuration.
- The RSD Server on the string of FOV1 is mandatory until the Final Load is complete. Once this is done, the display backgrounds are established and the string will still be able to perform real-time processing even if the server fails. A RSD Server failure after Final Load will only result in the loss of archive and playback capability.

4.15.5.3.3.3.1.4 Holdfire Capability

Each launch system is required to provide a positive, controlled capability that allows the initiation of a hold-fire to prevent a launch in the event of loss of a safety critical system or violation of mandatory launch commit criteria. This capability can be satisfied through the switched activated Holdfire system or through a verbal hold called over the net.

4.15.5.3.3.3.1.5 SPARC-SC

SPARC-SC is used to establish the local (FOV1 Front End Processors or FO FEPS) and downrange (Intelligent Data Switch or IDS) switch settings for the routing of incoming track data to and outgoing designate data from the RSD systems. As a result, SPARC-SC is mandatory until the switch settings are in an acceptable launch configuration. Typically SPARC-SC establishes the final launch configuration at L-2 hours and 30 minutes, however, if a failure occurred before the launch configuration could be established, an assessment would have to be made on which switch settings were completed prior to the failure to see if the mandatory tracking and designate requirements can be met.

4.15.5.3.3.3.1.6 Central Timing

Central Timing in the MOC is mandatory in order to distribute Inter-Range Instrumentation Group-B (IRIG-B) timing to the range safety systems and the instrumentation sites. This allows for the synchronizing of actions among the range systems during the countdown and for the time tagging of data at the instrumentation sites. The time tagging of data is critical for the range safety systems to detect the latency of the incoming instrumentation site data and to determine if the data will be used in range safety processing.

4.15.5.3.3.3.1.7 First Motion

The launch vehicle First Motion signal is mandatory in order to initiate Range Safety processing and to signal the downrange sites when to initiate their stored nominals. This can be provided by a signal sent from the pad, by data distributed in the user's Count Status (CS)-5 count, or by the Back-up or Forced First Motion Signal initiated by the Range Safety system controllers. Note that for non-pad launches such as Trident II and Pegasus, the Back-up or Forced First Motion capability is mandatory.

4.15.5.3.3.3.1.8 Communications Requirements

Launch Safety communications requirements support other launch safety requirements by providing the exchange of critical inter- and intra-facility voice and data communication.

4.15.5.3.3.3.1.8.1 Voice Communications Requirements

Voice communication is critical to launch safety requirements in order to exchange critical information and status, to initiate countdown holds, and to direct personnel to take cover due to a catastrophic event.

MFCO console communications capability is mandatory for all launches. Specifically this means that one of the three comm panels at the MFCO, SMFCO, and VSO consoles is mandatory. These comm panels allow the MFCOs to communicate while still having the ability to initiate a countdown hold, reference the range safety displays, and have access to the FTUs.

Voice comm circuits to the range user are mandatory when voice holdfire capability is mandatory. Voice holdfire capability and the associated comm circuits are mandatory when there has been a failure of the range holdfire system, when the range holdfire system becomes inactive prior to T-X, or when the range holdfire system is not available due to the mission type.

Voice comm is critical for Launch Area Surveillance operations in order to receive target reports from the support assets and to provide breakaway or take cover notifications to the support assets. For Trident II missions, voice comm to the support assets in the terminal area is mandatory in order to receive targets reports from and provide breakaway instructions to the support assets.

4.15.5.3.3.3.1.8.2 Data Communications Requirements

Comm circuits between the MOC and the downrange sites are critical for the exchange of designate, command destruct, and timing information. These circuits may be in the form of the fiber optic core, commercial leased lines, microwave links, and/or SATCOM links. Comm circuits between the MOC and an instrumentation site may become mandatory in order to:

- Provide designate to a mandatory downrange tracking site or redundant, diversely routed designate to a mandatory command site.
- Provide redundant, diversely routed command remoting links to one or more command sites.
- Provide tracking data from a mandatory tracking site. In some cases, multiple comm circuits between the MOC and a downrange site may be mandatory in order to provide diversity in the routing of mandatory tracking data from two different tracking sources at that site.
- Provide First Motion and IRIG timing to a mandatory tracking site

4.15.5.3.3.3.1.9 Meteorological Systems Requirements

MSC, AMPS, Eastern Range Dispersion Assessment System (ERDAS), and Weather Information Network Display System (WINDS) capability is mandatory until usable data is obtained to support RAC assessments of DFO, Toxics, and Debris LCCs. Note that this data may only be valid for a certain period of time. If a failure occurs, an assessment will have to be made with the RAC to see for how long the current available data is valid.

4.15.5.3.3.3.2 Airborne Flight Safety System Constraints

All vehicles launched from or onto AF ranges are required to have a positive, SW/CC approved, method of controlling erratic vehicle flight to meet the objective of managing risks to the public and foreign countries. This includes an airborne Flight Safety System to allow the vehicle to be tracked and to allow the flight to be terminated if required.

4.15.5.3.3.3.2.1 Airborne Flight Termination System (FTS)

4.15.5.3.3.3.2.1.1 Airborne FTS Requirements

An airborne FTS is required for all powered flight stages of a launch vehicle. This includes the requirement for a Command Terminate System (CTS), for activation by MFCO initiated destruct commands, to be installed on or above the last (uppermost) propulsive stage of the vehicle that is capable of violating Range Safety criteria. It also requires an Automatic Destruct System (ADS) to be installed on each powered stage or strap-on motor not containing a CTS to be activated upon launch vehicle break-up or premature separation of the individual powered stage or strap-on motor. A final airborne FTS open-loop test must be performed while on airborne power just before launch to verify the performance of the FTS. The OSM and SEA are responsible for verifying the flight configuration and performance of the FTS and reporting status to the MFCO.

4.15.5.3.3.3.2.1.2 Autonomous Flight Safety System (AFSS)

AFSS provides the capability to not only reduce reliance on aging range infrastructure, but enhances the ability to support more launches by expediting range turnaround times with more stringent safety standards and fewer people on console while reducing overall launch costs.

A self-contained, independent system mounted to the launch vehicle, AFSS determines if the launch vehicle poses an unacceptable hazard to people or property by using pre-established, programmed mission rules developed by Range Safety Flight Analysts. These configurable software-based rules are reliant on redundant flight processors using data from Global Positioning System and inertial measurement unit navigation sensors. If necessary, AFSS has the ability to destroy the rocket to ensure public safety. This system is crucial to increase overall range throughput to keep pace with the growing demands for providing assured access to space.

AFSS provides greater positive control in flight further downrange with a faster response time. It also increases over-the-horizon capability, which means there’s no longer limitations by ground equipment line-of-sight. AFSS also supports multiple objects in simultaneous flight, which is crucial as companies build rockets with the intention to land multiple boosters simultaneously.

4.15.5.3.3.3.2.1.3 Airborne FTS RF Interference (RFI) Constraints

The growth of traffic in the RF spectrum has increased the likelihood of encroaching signals interrupting or degrading the ability of the launch vehicle FTS receivers to respond to commands transmitted on the command carrier. As a result certain procedures and criteria have been developed to mitigate or prevent a launch if RFI could potentially interfere with the launch vehicle FTS receivers.

4.15.5.3.3.3.2.1.2.1 Launch Head RFI Constraints

At the launch head, one of the Frequency Control and Analysis (FCA) vans is dedicated to monitoring the RF environment and detecting any potential interference to the command carrier. A second FCA van, which is typically dedicated to the checkout of the C-band beacon, can be released to provide additional information on the source of the interference. The FCA vans will only report signals inside the guard band (reference Table 4-15-3) which exceed -60 dB referenced to the nominal command carrier signal as determined by historical data.

Program	Receiver	Center Frequency (MHz)	Guard Band (KHz)

Atlas V	CRD-126	421	+/- 360
Delta II/IV	CRD-120A	421	+/- 180
Falcon	CR-123	421	+/- 180

Table 4 - 15 - 2: *Radio Frequency Interference Reporting Guidelines*

For Atlas V, Delta II, and Delta IV, the 45 SW will not launch if the FCA vans report a possible interfering signal and the MFCO detects dropouts in Pilot Tone. The 45 SW may launch if the FCA vans report a possible interfering signal and:

- No Pilot Tone dropouts are reported, and
- There is nominal receipt and processing of the SELF TEST command with the encroaching signal present, and
- The signal is verified to not be within +/- 90 degrees of the flight azimuth

For Falcon 9, the 45 SW will not launch if the FCA van reports a possible interfering signal because the Falcon 9 does not have an open-loop self-test capability.

4.15.5.3.3.3.2.1.2.2 PAVE PAWS RFI Constraints

Transmissions from the Perimeter Acquisition Vehicle Entry Phased Array Weapon System (PAVE PAWS) radars located at Cape Cod Air Force Station (AFS), Massachusetts and Beale AFB, California can interfere with the FTS receivers on vehicles launched from the ER and the WR. The RFI from these radars can be mitigated by blanking certain frequencies of emissions from the PAVE PAWS sites. To accomplish this, the 1 ROPS and the 2 ROPS contact the 6th Space Warning Squadron (6 SWS) and the 7 SWS, respectively, to coordinate a time in the countdown to begin blanking out the applicable frequencies near 421 MHz from their transmissions.

Depending on analysis of the FTS receiver performance characteristics and the vehicle flight trajectory, launches may be supported without frequency mitigation if additional time (360 ms) is added into the destruct line budget to account for the extra ARM/DESTRUCT commands required to achieve the acceptable reliability required by AFSPCMAN 91-710 and EWR 127-1 for the FTS. Analysis shows that this is acceptable for the FTS receivers used on the Atlas V and the Delta IV launch vehicles

For vehicles launched from the ER using standard receivers (such as Falcon 9 and Trident II), mitigation of the PAVE PAWS radar transmissions is mandatory. As a result, confirmation from the 6 SWS that their mitigation procedures are in effect must be received in order for the launch to occur.

4.15.5.3.3.3.2.2 Airborne Range Tracking System (RTS)

An airborne RTS is required for all launch vehicles. This includes tracking aids such as a C-Band transponder, GPS receiver/translator, or TMIG. If a C-Band transponder is used and is mandatory, then interrogation from a FCA Van or launch area radar is mandatory until T-0 to verify the status and performance of the transponder.

4.15.5.3.3.3.3 Weather Constraints

Launch Safety constraints are based on natural and triggered lightning LCCs. Both natural and triggered lightning can cause a malfunction of the launch vehicle, to include possible damage to the airborne FTS, or even destruction of the launch vehicle. Triggered lightning is the phenomena associated with launch vehicles affecting the atmosphere during flight so that, under certain meteorological conditions, lightning is triggered and attracted to the launch vehicle. The natural and triggered lightning LCCs are defined by a set of ten rules developed to ensure the avoidance of natural and/or triggered lightning during space/ballistic launch operations. Each of these ten rules involves various conditions and constraints including but not limited to temperature, distance from the flight path, and time.

4.15.5.3.3.3.3.1 LCC Rule #1: Surface Electric Field Rule

The Surface Electric Field Rule deals with the strength of the electric field within 5nm of the pad as measured from a surface field mill. If this rule is violated, a launch cannot occur until 15 minutes after the electric field measurement has returned to acceptable limits.

Figure 4 - 15 - 1: *S.E.F. Rule*

4.15.5.3.3.3.3.2 LCC Rule #2: Lighting Rule

The Lightning Rule applies if a lightning strike has occurred within 10nm of the flight path. If this rule is violated, a launch cannot occur until 30 minutes after the last lightning strike.

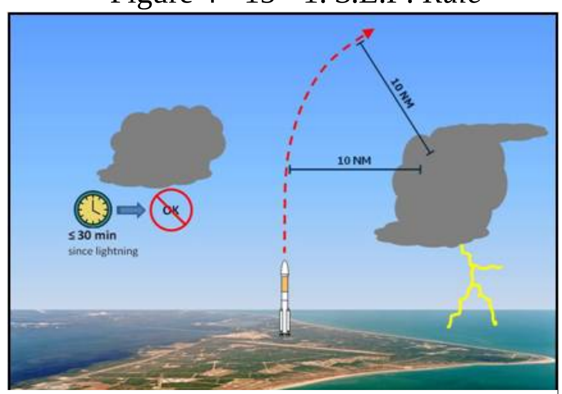


Figure 4 - 15 - 2: *Lightning Rule*

4.15.5.3.3.3.3.3 LCC Rule #3: Cumulus Cloud Rule

The Cumulus Cloud Rule applies if a cumulus cloud is within or in the vicinity of the flight path. There is no time constraint with this weather rule.

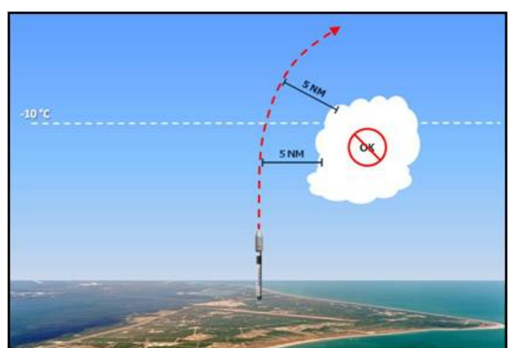


Figure 4 - 15 - 3: *Cumulus Cloud Rule*

4.15.5.3.3.3.3.4 LCC Rule #4: Attached Anvil Cloud Rule
The Attached Anvil Cloud Rule deals with an attached anvil cloud in the vicinity of the flight path and any associated lightning strikes. This rule has various conditions and constraints with the least restrictive being that launch can occur when the rule is no longer violated and the most restrictive being that launch cannot occur until 3 hours after the last lightning strike.

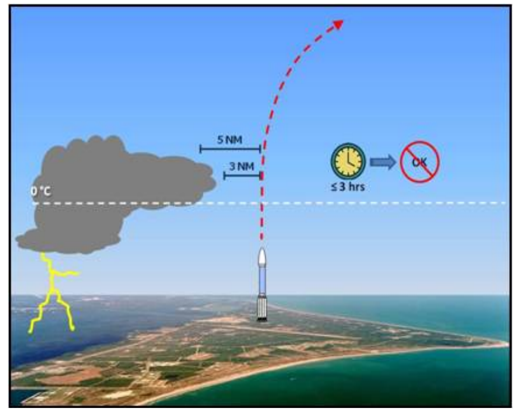


Figure 4 - 15 - 4: *Attached Anvil Rule*

4.15.5.3.3.3.3.5 LCC Rule #5: Detached Anvil Cloud Rule
The Detached Anvil Cloud Rule deals with an anvil cloud in the vicinity of the flight path that has detached from a parent cloud and any associated lightning strikes. Similar to the Attached Anvil Cloud Rule, there are varying conditions and time constraints depending on the elapsed time since the detachment from the parent cloud and/or any lightning strikes.

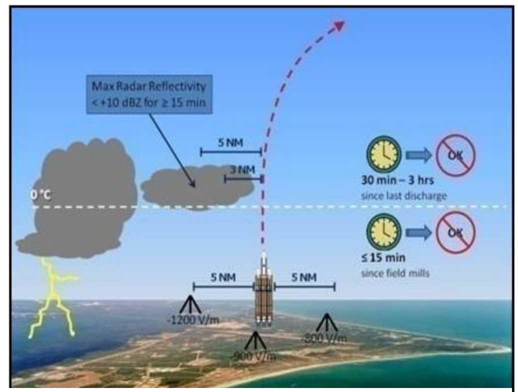


Figure 4 - 15 - 5: *Detached Anvil Rule*

4.15.5.3.3.3.3.6 LCC Rule #6: Debris Cloud Rule
The Debris Cloud Rule deals with a "debris" cloud in the vicinity of the flight path that has detached from a parent cloud or formed from the collapse of the parent "cloud top". Once violated, a launch cannot occur until 3 hours from the detachment or formation of the debris cloud.

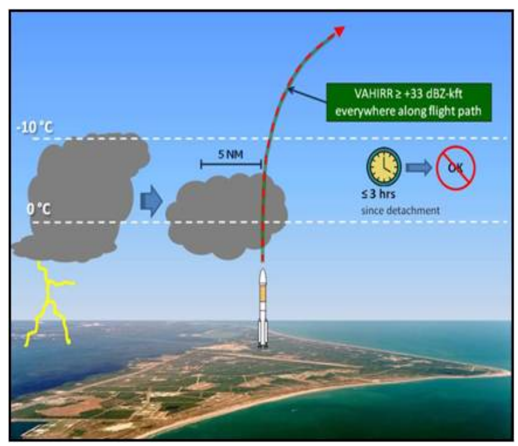


Figure 4 - 15 - 6: *Debris Cloud Rule*

4.15.5.3.3.3.3.7 LCC Rule #7: Disturbed Weather Rule
The Disturbed Weather Rule deals with a cloud within the flight path that is associated with disturbed weather such as fronts, troughs, and squall lines. There is no time constraint with this weather rule.

Figure 4 - 15 - 7: *Disturbed Weather Rule*

4.15.5.3.3.3.3.8 LCC Rule #8: Thick Cloud Rule

The Thick Cloud Rule deals with a cloud with thick cloud layers within a specific temperature range that is within or in the vicinity of the flight path. There is no time constraint with this weather rule.

Figure 4 - 15 - 8: *Thick Cloud Rule*

4.15.5.3.3.3.3.9 LCC Rule #9: Smoke Plume Rule

The Smoke Plume Rule deals with a cumulus "cloud" within the flight path that developed from a smoke plume and is attached to the smoke plume or that has been detached from the smoke plume for 60 minutes or less. A launch can occur when the cloud is no longer in the flight path; however, if it has been detached from the smoke plume for over 60 minutes, the Cumulus Cloud Rule applies.

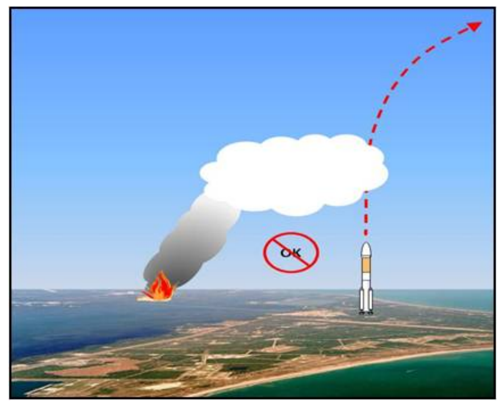


Figure 4 - 15 - 9: *Smoke Plume Rule*

4.15.5.3.3.3.3.10 LCC Rule #10: Triboelectrification Rule

The Triboelectrification Rule deals with triggered lightning caused by a vehicle traveling at 3,000 ft/sec or slower through a cloud with a temperature of -10° C or less. Note that this rule does not apply to a launch vehicle if it has been treated for surface electrification or if tests or analysis has demonstrated that electrostatic discharges on the surface of the launch vehicle caused by "triboelectrification" will not be hazardous to the airborne flight termination system. There is no time constraint with this weather rule.

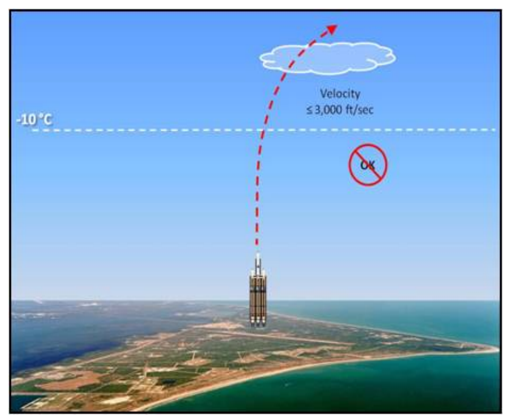


Figure 4 - 15 - 10: *Triboelectrification Rule*

4.15.5.3.3.3.4 Safety Clearance Zones

45 SW/SE or his/her designated representatives are required to define and control hazardous launch areas and develop procedures to protect the public on land, at sea, and in the air for each launch and launch vehicle that operates on the ranges. Safety Clearance Zones are restricted areas designated for day-to-day prelaunch processing and launch operations to protect the public, launch area, and launch complex personnel. These zones are established for each launch vehicle and/or payload at specific processing facilities to include launch complexes. Safety Clearance Zones include Hazardous Clear Areas and Hazardous Launch Areas. Hazardous Clear Areas are Safety Clearance Zones for ground processing that are defined in the Operations Safety Plan for each operating facility. Hazardous Launch Areas are Safety Clearance Zones used during launch operations.

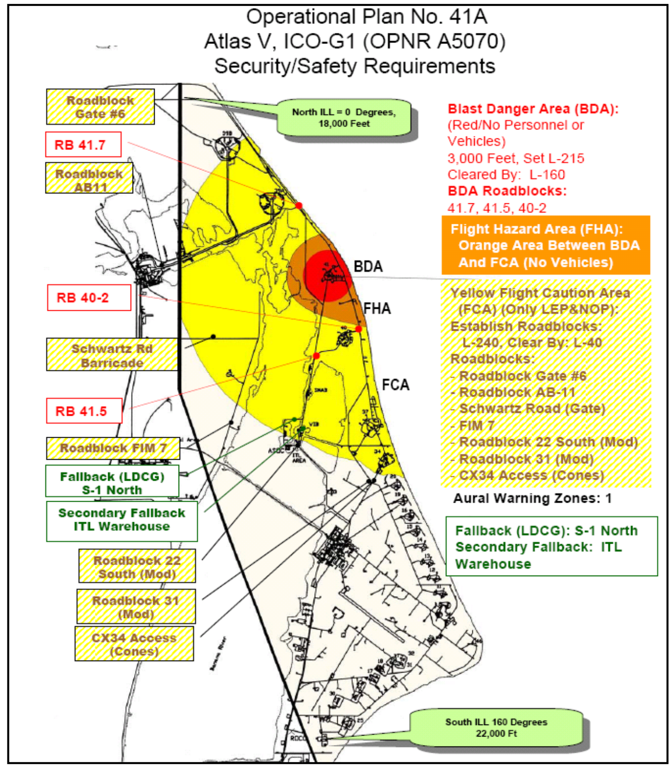


Figure 4 - 15 - 11: *Safety Clearance Zones*

There are five safety clearance zones that are enforced on launch day. They are:

- The Blast Danger Area (BDA)
- The Flight Hazard Area (FHA)
- The Flight Caution Area (FCA)
- The Impact Limit Lines (ILLs)
- The Launch Danger Zone (LDZ)

The OSM is responsible for enforcing the clearing of personnel from the BDA, FHA, and FCA. The OSM coordinates with security personnel to establish safety roadblocks and roving patrols to clear the BDA, FHA, and FCA. OSM reports clearance of these areas to the MFCO. The SCO is responsible for enforcing the clearing of boats, ships and aircraft from the LDZ and reporting clearance of these areas to the MFCO.

4.15.5.3.3.3.4.1 Blast Danger Area (BDA)

The Blast Danger Area (BDA) is a hazardous clear area that is used for both day-to-day prelaunch processing and launch operations. This is the area subject to fragments and direct overpressure resulting from the explosion of the booster/payload. The BDA must be clear of personnel prior to the establishment of a major explosive hazard such as vehicle fuel/oxidizer load and pressurization.

4.15.5.3.3.3.4.2 Flight Hazard Area (FHA)

The Flight Hazard Area (FHA) is a hazardous occupiable area outside the evacuated launch complex which includes an area bound by the contour of individual casualty expectation (Pc) resulting from a catastrophic event calculated to be greater than or equal to 1 x 10^{-5} extended to include an area of uncertainty. Only personnel who are categorized as LEP may remain in the FHA during launch. Because the risk of serious injury or death from blast overpressure, debris, or exposure to toxicants is so significant, personnel who must occupy stations inside the FHA must have appropriate contingency response training and Personal Protective Equipment (PPE) to lower their risk from launch hazards (i.e. debris, DFO, toxics and radiation) to the acceptable launch-essential individual risk exposure limit of 1 x 10^{-5}.

4.15.5.3.3.3.4.3 Flight Caution Area (FCA)

The Flight Caution Area (FCA) is a hazardous occupiable area outside the defined FHA where the mean individual casualty expectation (Pc) from a catastrophic event is predicted to be less than 1 x 10^{-5} and greater than or equal to 1 x 10^{-6} extended to include an area of uncertainty. Since this risk exceeds the acceptable individual public risk exposure limit, access inside the FCA is controlled via activation of roadblocks prior to the scheduled hazardous operation. Only personnel who are categorized as LEP or NOP may remain in the FCA during launch. Personnel who must occupy stations inside the FCA must have appropriate contingency response training. If they cannot seek shelter in an approved launch shelter, they must have PPE to lower their risk from launch hazards (i.e. debris, DFO, toxics and radiation) to the acceptable launch-essential individual risk exposure limit of 1 x 10^{-6}. Appropriate PPE may be required based on the potential toxic hazard corridor. On CCAFS, organizations having questions about potential toxic hazards can 45 SW Risk Analysis at 494-3287, and questions regarding the appropriate level of breathing protection can be directed to the 45 AMDS/SGGB (Bioenvironmental Engineering) at 494-5435. Generally speaking the appropriate PPE is a Self-Contained Breathing Apparatus (SCBA). If the collective risk of LEP inside the FCA would cause the overall launch area and overflight risk to exceed the 300 x 10^{-6} limit, then higher headquarters acceptance of the risk must be obtained IAW AFSPCMAN 91-710 in order for launch to occur.

4.15.5.3.3.3.4.4 Impact Limit Line (ILL)

The Impact Limit Line (ILL) is a hazardous launch area that is the boundary within which trajectory constraints and flight termination systems are used to contain an erratic launch vehicle and vehicle debris. Personnel who are categorized as LEP or NOP are permitted within the ILLs. With 45 SW/CC approval, non-essential personnel may be permitted within this area; however, the collective aggregate risk shall not exceed established criteria for the general public.

4.15.5.3.3.3.4.5 Launch Danger Zone (LDZ)

The Launch Danger Zone (LDZ) is a hazardous launch area that is defined as the combination of the sea surface area and air space measured from the launch point and extending downrange along the intended flight azimuth. The size of the LDZ is based on the potential hazard to ships and aircraft. The LDZ is based on hit-probability contours, including known impact areas of jettisoned stages/bodies and destruct debris resulting from malfunction scenarios. Individual and collective 1 x 10^{-5} surface vessel hit-probability contours are developed for ships (500’ x 60’) and boats (55’ x 17’). A 1 x 10^{-6} aircraft hit-probability contour is developed for a “standard” commercial aircraft, and a similar hit-probability contour is made for specific support aircraft.

4.15.5.3.3.3.5 Launch Area Air and Sea Surveillance

EWR 127-1, AFSPCMAN 91-710, and AFSPCMAN 91-711 require launch area air and sea surveillance of the portions of the LDZ within the coverage capabilities of local land based radars or support aircraft. The goal is to clear any air and sea traffic from within the LDZ and prevent any traffic from entering the LDZ.

A launch will not be allowed to occur until the area has been adequately surveyed and it has been verified that the actual or predicted location of air and sea traffic does not violate individual or collective hit probabilities. For boat and ship traffic, the sum total of the individual hit probabilities of all targets plotted within, or predicted to be within, the established hit-probability contours must not exceed 10^{-5}. For aircraft, the expected position of the aircraft must not be within the 10^{-6} hit-probability contour for a "standard" commercial aircraft, and specific support aircraft must be clear of its similar hit-probability contour at T-0. Area surveillance is covered in more detail in Section 7-3 of this manual.

4.15.5.3.3.3.6 Distant Focusing Overpressure (DFO), Toxics, and Debris Constraints

The hazards associated with propellants, ordnance, radioactive material, and other hazardous systems associated with launch operations cannot all be confined within the CCAFS fence line. Aggregate risk LCC for various population categories are provided in AFI 91-217. Updates to EWR 127-1, AFSPCMAN 91-710 will be forthcoming to reflect the change in risk criteria as documented in AFI 91-217.

AFI 91-217 states that the aggregate risk to the general public shall not exceed 100 x 10^{-6} (one-hundred in one million) from lift off until orbital insertion, while a separate aggregate risk of 100 x 10^{-6} is allowed for every reentering object. Risk to the general public associated with toxics dispersion shall not exceed 30 x 10^{-6} at the ER. For commercially licensed launches, the FAA risk criteria of 30 X 10^{-6} for each hazard from liftoff until reentry is enforced.

The Risk Assessment Center (RAC) is responsible for performing the analysis by utilizing real-time weather data, vehicle-specific databases, population data, and failure rates and assessing the results against the LCC. The RAC notifies Range and user personnel of the results, and recommends any mitigating actions or waivers as applicable.

4.15.5.3.3.3.6.1 Distant Focusing Overpressure (DFO)

DFO is the intermediate hazardous range effects of a shock wave from an inadvertent detonation, such as from a launch vehicle malfunction, impact, or destruction. DFO poses a threat to on and off base personnel during the early stages of flight. DFO is extremely meteorologically driven and can occur when a launch vehicle accident, such as an intact impact or tip over, results in a large explosion and the atmospheric conditions of the day allow for the blast waves to be bent and focused back to the ground, amplifying the overpressure levels in certain areas. This could lead to windows being broken miles away from the actual explosive event. The risks of this hazard can be mitigated by having personnel move away from windows five minutes prior to launch.

Figure 4 - 15 - 12: *DFO Effects*

4.15.5.3.3.3.6.2 Toxics

Toxic dispersion hazards on launch day come from the use of hypergolic propellants and solid rocket motors that can affect the public. For hypergolic propellants, the concerns are the various hydrazines that are used as fuels and nitrogen dioxide (NO_2) which results from dinitrogen tetroxide (N_2O_4) that is used as an oxidizer. For solid rocket motors, the concern is hydrogen chloride (HCl). Over the years, launch vehicles have moved away from using hypergolic propellants and are now largely dependent upon cryogenic propellants, Rocket Propellant 1 (RP-1), and solid rocket motors. As a result, HCl is currently the main launch day toxic dispersion

concern. If a launch vehicle is not using these commodities, toxic modeling may not be conducted on launch day.
Toxic hazards can be a concern both on and off base. Dispersion characteristics of a plume are highly dependent upon atmospheric conditions, such as wind direction/speed and temperature profiles, and the failure mode of the launch vehicle – it's location in flight, how much propellant was still on the vehicle, etc. Risk associated with this hazard can be mitigated by on-base sheltering or evacuating personnel from the area (see 45 SWI 91-204 and 206). However, while the AF can control the on-base population, it does not have that luxury off-base.

4.15.5.3.3.3.6.3 Debris

The risk of debris results from a catastrophic abort of a launch vehicle and is not just assessed in the launch area. Since populated downrange landmasses can be over flown before the LV is in orbit, aggregate risk LCC applies from liftoff through orbital insertion, including planned impact for an orbital launch, and through final impact for a suborbital launch.

There are two basic types of debris: inert and explosive. Inert debris has no explosive potential and poses a danger from either direct impact or impact with a shelter that causes secondary effects on personnel. Explosive debris, such as unexpended solid motor fuel, causes injury plus explosive overpressure and fireband. This can result in significant damage to a shelter and can present a significant hazard to any occupants.

Aggregate risk analysis takes into account the launch vehicle break-up characteristics, failure probabilities, vehicle trajectory, and population categories/densities and types of facilities in an area. Typically launch area debris risk is managed through the use of the ILLs, the FCA, and the FHA.

4.15.5.3.3.3.6.4 Aural Warning Zones

CCAFS is divided into eight Aural Warning Zones (AWZs) which are utilized to notify personnel of DFO, toxic, and debris hazards affecting CCAFS. On launch day, the RAC will perform real-time DFO risk analysis along with forecasted to T-0 risk analyses for debris and toxics (if required due to the vehicle configuration), during the countdown. If mitigating actions are needed to bring the risk within launch commit criteria, the RAC will direct Cape Support to make the applicable scripted announcement, IAW 45 SWI 91-204, over the Cape Aural Warning System (CAWS). These announcements will direct personnel in the affected aural warning zones to take appropriate action depending on the hazard of concern. Cape Support will broadcast appropriate announcements at pre-coordinated times IAW 45 SWI 91-204

Figure 4 - 15 - 13: *Aural Warning Zones*

4.15.5.3.3.3.7 Collision Avoidance (COLA) Constraints

AFI 91-217 also requires the Ranges, in conjunction with the Joint Space Operations Center (JSpOC), to protect on-orbit manned spacecraft, active satellites, and inactive debris from collision with launched objects IAW DoDD 3100. COLA is a process designed to prevent collisions between on-orbit tracked objects and launched vehicles (including spent stages)/payloads. In addition to damaging or destroying objects in space, collisions generate large quantities of hazardous debris that can lead to further collisions, potentially rendering some orbits unsafe for years. The COLA process includes establishing launch wait periods in the launch window, called COLA closures, based on validated conjunction assessments. A Conjunction Assessment (CA) is a process for determining the point and time of the closest approach between a tracked orbiting object and a launched vehicle based on a specified miss distance screening criteria or the corresponding probability of collision. Per AFI 91-217 MAJCOM requirements the SWs must obtain CAs from the JSpOC to establish COLA holds in the launch windows to ensure safe separation criteria at a minimum from on-orbit manned objects and active systems.

4.15.5.3.3.4 Noncompliances, Equivalent Levels of Safety (ELS), and Waivers

Situations may arise from any time during the tailoring process to even on launch day in which the Range User and/or even Range agencies are unable to meet Launch Safety requirements. Depending on the situation, Equivalent levels of safety (ELS) or waivers may be used to deal with these noncompliant situations in order to allow the mission to proceed.

4.15.5.3.3.4.1 Noncompliances

A noncompliance is a noticeable or marked departure from requirements, standards, or procedures. There are three types of noncompliances: Public Safety, Launch Area Safety, and Launch Complex Safety noncompliances.

4.15.5.3.3.4.1.1 Public Safety Noncompliance

Public safety noncompliance deals with safety requirements involving risks to the public, including foreign countries, their personnel and/or their resources.

4.15.5.3.3.4.1.2 Launch Area Safety Noncompliance

Launch area safety noncompliance deal with safety requirements involving risks that are limited to personnel and/or resources on AFSPC ranges, including CCAFS and Vandenberg Air Force Base (VAFB) and may be extended to KSC. Launch area safety involves multiple licensed users, government tenants, or USAF squadrons.

4.15.5.3.3.4.1.3 Launch Complex Safety Noncompliance

Launch complex safety noncompliances deal with safety requirements involving risk that is limited to the personnel and/or resources under the control of a single licensed user, full time government tenant organization, or USAF squadron/detachment (control authority). Launch complex safety is limited to risks confined to a physical space for which the single control authority is responsible.

4.15.5.3.3.4.2 Equivalent Levels of Safety (ELS)

An ELS is a determination that is made when literal compliance with an EWR 127-1 or AFSPCMAN 91-710 requirement cannot be met; however, compensating factors exist which can be shown to provide an equivalent level of safety. An ELS may involve a change to the level of expected risk that is not statistically or mathematically significant as determined by qualitative or quantitative risk analysis. ELS determinations made by AFSPC ranges have been referred to in

the past as *meets intent certifications*. ELS determinations are normally incorporated during the tailoring process.
ELSs may be approved for a limited period of time or a limited number of launches depending on the method by which equivalent safety is accomplished. Lifetime ELSs are allowed provided equivalent safety is maintained. Range Users who have ELSs that are not granted for the life of a program are required to provide a plan to meet the requirements in question by the time the approved effectivity expires. Range Users who have ELSs that are granted for the life of the program are required to provide Range Safety a definition of “program life” intended for the scope of the ELSs.

4.15.5.3.3.4.3 Waivers
A waiver applies where a failure to satisfy a safety requirement involves a statistically or mathematically significant increase in expected risk as determined through quantitative or qualitative risk analysis, and the activity may or may not exceed the public risk criteria. Waivers are granted only in extremely unique or compelling circumstances and only when the mission objectives of the Range User cannot otherwise be achieved. The FAA is included in the waiver process for licensed programs at AFSPC ranges per the memorandum of agreement between HQ AFSPC and FAA/AST on Resolving Requests for Relief from Common Launch Safety Requirements.

Waivers are typically approved for a limited period of time or a limited number of launches. The time constraint is normally determined as a function of cost, impact on schedule, and the minimum time needed to satisfactorily modify or replace the noncompliant system or to modify the noncompliant operation. Lifetime waivers are undesirable and are limited to those situations where it is virtually impossible to meet the requirement or meet the intent of the requirement. Every applicable waiver is reviewed for validity prior to each launch or launch cycle.

4.15.5.3.3.4.4 Range Safety Waiver Authority
Prior to launch day, the SW/CC has the authority to tailor or waive any requirement in the EWR 127-1 and the AFSPC 91-710 and to accept the risks. The SW/CC shall approve or disapprove all waivers affecting public safety. The Chief of Safety or designated representatives shall approve or disapprove all waivers other than those affecting public safety.

On launch day, the LDA is the Range Safety Waiver Authority. There are no concrete guidelines when a waiver should or should not be granted. The LDA may grant the waiver based upon the recommendation of the safety experts and his/her comfort with the identified risk if the risk has been calculated such as for DFO, toxics, debris, and COLA issues. A calculated risk value will not always be available, as is the case for instrumentation failures. In these cases, the failure may be assessed in relation to flight events such as staging events, green numbers, and the Head-On Gate. The LDA’s comfort level could be affected by the critical nature of the mission and historical precedence. The level of safety risk tolerated for a critical NRO payload might be much higher than the acceptable level for a commercial satellite.

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4-16 Mission Planning Aid (MPA)

4.16.1 PURPOSE

All pre-mission tasks, tests, briefings, and meetings for operations crewmembers are broken down in the Mission Planning Aid (MPA). The purpose of the MPA is to serve as a reference guide for managing the timeline of events leading to launch.

4.16.2 OVERVIEW

All pre-mission briefings and activities for each crew position will be managed through the implementation of the MPA. This checklist includes steps for each crew member assigned to the launch to ensure that pre-launch activities are on track. The checklist is maintained by 1 ROPS/DOOB. Contact DOOB to propose changes to the MPA.

	1 ROPS Launch Ops Task Checklist (1 Sep 16)	
	POSITION: ROC	
NAME: WGS-8	VEHICLE: Delta IV	MISSION: D1508
Time	Action	Status & Date
	Contact 1 ROPS/DOO to propose a change to the LOTC or LSP. L-Times are for reference only. This guide is to act as a reference, some steps may not be included in this document. If products are not delivered by L-Time, then query OPR.	
L-30 Days		
	Review launch documentation (OD, RSOR, MFRs, OCIs)	☑
	Update LRR slides & Confirm that final range ICP has been received from RE	☐
	Obtain & review user launch documentation: Check accuracy & compatibility with range procedures (range countdown, balloon schedule, aircraft support schedule, LSP internal steps, etc.) (Delta IV - use procedure EL005)	☐
L-21 Days		
	Attend WDR if applicable/requested (Delta IV - use procedure EL150 & Atlas V). Ensure SQ/OG/WG notified.	☐
L-18 Days		
	Prepare for 45 SW CAB ICE - academics slides, LSP, launch book, & on-console support (if LDA & OD is supporting this ICE ensure documentation is sent 3 days prior for read-ahead - launch book, academic slides, LSP, etc.) (See Attachment #2 on setting up a Launch Book)	☐
	Review ORR slides (ensure accuracy of outside agency slides i.e. mandatories)	☐
L-14 Days		
	Finalize/coordinate range countdown procedures (LSP, MFCO C/L, SCO C/L) Distribute final LSP, MFCO CL, & SOC CL following 1 ROPS/DO signature in coord process (Note: Ensure SCO has most up-to-date SOC for launch and if changes need to be made provide master template to SCO)	☐
	45 SW CAB ICE academics & on-console support. Ensure SQ/OG/WG notified.	☐
	Brief 14 AF ORR	☐
	Review user mandatory hold letter (file UMHL in launch book)	☐
L-7 Days		
	Generate ROC crew brief (w/ MFCO Pre-op)	☐
	Review/Update MDR academics slides	☐
L-5 Days		
	Review Final LRR slides and update instrumentation status (Color in to represent current instrumentation status) Also ensure that current CIFs are up-to-date and that this information is presented in the slide show (on an independent slide).	☐
L-2 Days		

Figure 4-16-1: *Mission Planning Aid*

4.16.3 PROCEDURES

As the team lead, the ROC is responsible for the overall handling of the MPA. The ROC should review recent and upcoming activities on the MPA during each crew brief and ensure all activities are accomplished prior to launch during the final crew brief. Prior to each mission, it is the responsibility of the RCO to ensure that a template MPA is included in the mission folder. The MPA notebook contains a tab unique to each position and serves as a guideline for activities and briefings as early as L-60 days prior to launch, and includes post-launch activities. Steps may be duplicated for those positions that have similar tasks during a launch, while some steps may not be accomplished or may be omitted depending on the mission. Crew members should review the MPA for accuracy by verifying the template date and begin referencing it for actions upon receiving a mission assignment. The checklist contains fields for identifying the crew member, launch vehicle, and mission at the top. The left column details requirements and actions by L-day. The checklist acts only as a guide and the L-days serve as approximate completion dates. The middle column specifies actions to be completed by the crew member, to include key milestones, briefings, and pre-mission activities on the launch timeline. The right column denotes task completion by inserting the initials of the crew member and checking the box, which will auto-generate a timestamp. In the event of inaccurate or missing steps, crewmembers should notify DOOB to ensure appropriate updates are made. The MPA will help to ensure all required actions are accomplished from the generation phase, through the execution phase, and concluding with the recovery phase of a mission.

4.16.3.1 Attachments

There are several attachments within the MPA notebook that aid crew members during specific portions of the mission. These are the Launch Support Plan (LSP) Checklist Attachment and the Electronic Launch Book (ELB) Checklist Attachment.

- The LSP Checklist Attachment is used to ensure accuracy, completeness, and standardization of LSPs between launch vehicles and missions. 1 ROPS/DOO maintains the LSP templates and will provide the template to the RCO upon mission assignment. Crewmembers are not authorized to make changes to the LSP without DOO approval.
- The ELB Checklist Attachment guides the RCO regarding actions necessary to construct the ELB prior to launch and verify they are mission-ready. It specifies the each section and details the content within each section necessary for the launch.

4-17 CREW BRIEFINGS, MEETINGS, & REHEARSALS

4.17.1 OVERVIEW
There are numerous meetings, briefings and pre-mission tests and checkouts that occur for each mission. It is critical that crewmembers maintain awareness of these activities. There are numerous tools the crew can utilize to ensure all activities are tracked and accomplished satisfactorily, including the Mission Planning Aid (MPA) and Enhanced Maintenance Operations Center (EMOCC). This section will identify the meetings and activities associated with each launch. The sections following this will cover each crewmember's pre-mission requirements.

4.17.2 LAUNCH BOOK WORKING GROUP
The PSM works directly with RGNEXT 3100 Program Control, who is responsible for developing the Launch Book used on console during day-of-launch operations. The purpose of collaboration is to identify mission requirements (instrumentation, personnel, safety documentation, etc.) and ensure they are included in the launch book. Once the book is complete, the book is electronically published to https://limes.

4.17.3 OPERATIONS READINESS REVIEW
The Operations Readiness Review (ORR) is a top level briefing involving Range, 45 LCG, and SMC personnel presented to the 14 AF/CC via video conferencing, typically for DoD and NSS payloads. The ROC is responsible for preparing and briefing the Range portion with a focus on range instrumentation, associated operations, and Range and crew readiness. The PSM and 1 ROPS DO are responsible for consolidating the slides from 45 LCG and 45 SE and forwarding the entire slide package to 14th AF. A representative of 45 SE briefs the Safety portion, while the Flight Mission Lead (FML) from the 45 LCG briefs the mission portion. 45 SW sections are as follows: Mission Parameters (briefed by 14th AF), Orbit Trace, Mission Profile & Processing Milestones (briefed by 45 LCG or PSM – mission dependent); Range crew, Instrumentation assets, and Range Items of Interest, which include first use items, Range outages, and associated/external operations (briefed by ROC); Range Safety Waivers/Concerns and Destruct Lines/Impact Areas (briefed by 45 SE) Other briefers include 14th AF, 50 SW, 614 AOC, 460 SW, and 21 SW.

4.17.4 LAUNCH READINESS REVIEW
The 45th Space Wing Launch Readiness Review (LRR) is a decision forum used to examine readiness to proceed with launch and is presented to the LDA, typically a day or two prior to the launch. The PSM, ROC, and the contractor build the briefing slides. The ROC briefs the Range Operations portion of the slides. Other briefers include 45 LCG, SE, Weather, Interim Safety Board President (ISBP), and Emergency Management personnel. The ROC works with the PSM to develop the Range Operations portion of the LRR. The LRR generally includes the following sections:

- Launch Operations Status – Includes booster status, mission parameters, mission profile, orbit trace, mission assurance risk map, mission assurance measures, and processing milestones/timelines (briefed by 45 LCG FML)
- Spacecraft Status – Includes spacecraft mission overview, spacecraft status and open action items (briefed by 45 LCG/LCSS)
- Weather Operations – Includes satellite imagery, surface forecast chart, illustration of

primary LCC of concern, operations forecast, 24 hour delay operations forecast and exposure forecast (briefed by 45 WS)
- Wing Safety Readiness – Includes launch risk status, overall risk, debris risk, hazard zones, DFO risk, toxic dispersion risk, CCAFS aural warning zones, and range safety waivers/concerns (briefed by 45 SW/SELR)
- Range Operations – Includes range countdown summary, ER instrumentation tasking, breakdowns of each supersystem identifying required and mandatory items, range safety mandatory items, and associated/external operations (briefed by the ROC)
- Mission Support Group – Includes LEOC activation slide, current operational plan, and Institutional Base Support Restructure (IBSR) readiness (briefed by Det 1, 45 MSG)
- Public Affairs - Details public affairs support (briefed by 45 SW/PA)
- Open Action Items – Includes open action items from previous missions which relate to the current mission (briefed by 45 OSS/OSK)
- Interim Safety Board – Includes Operations Directive (OD) 400 option recommendation (briefed by ISBP)
- Readiness Poll - Includes SE, MSG, LCG, OD, MD (SV and LV), and LDA

4.17.5 1 ROPS CREW BRIEFING & MFCO PRE-OP BRIEFING

The ROC schedules a final crew briefing within one to two days prior to the LRR to clarify any issues and procedures. At this meeting, the ROC will brief about the status of the mission, any Range items of interest, and any open issues. During this meeting, the MFCO will present to the crew the Flight Safety portion of the briefing.

- The ROC's portion includes the following: Key mission parameters to include OPNR, OD, launch pad, azimuth, range count pickup time, launch window, planned T-0, and RSOR Ops Sup date; On-console times/crew rest requirements, which directs the crew members to review pertinent information and reporting times on the crew rest letter (developed by 1 ROPS/DOOB); significant countdown events; special interest items to include pending pre-mission tasks, open CIF items, instrumentation outages (verified by the Range Engineer and the daily SitRep), schedule changes, open issues, and the date, time, and location of the LRR; and, finally, the readiness poll. The ROC can utilize a previous version of the crew brief as a template to build the presentation.
- The MFCO's portion includes the following: Crew assignment which identifies personnel working in each crew position, to include MFCOs and MFCO support positions; Operational data similar to the key mission parameters from the ROC portion of the briefing; Vehicle configuration; Mission description; ground tracks with event times and elevation angles; Range Safety waivers; Significant times; Instrumentation to include coverage peculiarities, mandatory items, weather, radar intercept times, command switching, telemetry displays, and RSD; Reporting requirements for MFCOs and MFCO support positions; Holdfire requirements; Recycle procedures; Warning areas; Mission rules; and launch windows for subsequent days.

4.17.6 OD-16 MFCO TRAINING REHEARSAL

The MFCO training rehearsal (OD-16A and/or OD-20016A) is a training exercise to ready the MFCO and MFCO support team for anomalies which may arise following launch and during flight of the vehicle. The exercise, typically scheduled within one week prior to launch, utilizes RSD and presents several flight profiles, including anomalous profiles, to prepare the Flight

Safety team for day of launch.

4.17.7 RGNEXT OPERATIONS READINESS REVIEW (ORR)

The RCO and ROC should attend the RGNEXT ORR. Even though it is a contractor meeting, attendance allows the ROC and RCO to field any questions and ensure that Air Force operations are synchronized with the contractor operations. System Controllers review what they will do during the launch with an in-depth review of all supporting instrumentation assets, and resolve last minute issues that may have occurred. Generally, the ORR is conducted the week of the launch and is chaired by the ISRO.

4.17.8 LDA SAFETY BRIEFING

The LDA Safety Briefing is a briefing presented to the LDA and is provided by the 45 SW/SE office, typically for new or unique missions or at the request of the LDA. The briefing covers vehicle and mission specific issues, to include new and legacy safety waivers and changes to mission rules. This briefing usually occurs approximately 1-2 weeks prior to launch.

4.17.9 INTEGRATED CREW EXERCISE (ICE)

The ICE typically occurs during the Generation Phase of the launch cycle. A Rehearsal Anomaly Team (RAT), which consists of facilitators and instructors from the Range, develops scripted events for the Launch and Range Crews allowing them to exercise their procedures in resolving anomalies. Users may have separate ICEs that require minimal or no range support. Prior to the ICE, an academics session is usually held to brief the launch and range teams on status and initial conditions for the exercise. The Range RAT and LWO may be asked to brief an overview of their status during the academics session.

4.17.10 COMMANDERS ADVISORY BOARD (CAB) ICE

The CAB ICE is a range-focused activity used for the readiness of the integrated Range team. Launch agency positions are typically simulated. The RAT will consist of Operations Group trainers and instructor personnel.

4.17.11 MISSION DRESS REHEARSAL (MDR)

The MDR usually occurs within one week prior to launch, but can be as early as 30-60 days prior to launch. The purpose of the MDR is to simulate day of launch activities and allow crew members the opportunity to practice processing Range and User anomalies (i.e. Spacecraft or Launch vehicle issues, instrumentation outages, weather anomalies, etc.). Not all launch customers will elect to conduct an MDR. Depending upon the request, the LDA/OD, RCO, ROC, MFCO, LWO, and SCO are considered key players for the rehearsal.

4.17.12 WET DRESS REHEARSAL (WDR)

The Wet Dress Rehearsal (WDR) includes actual launch vehicle fueling. It usually occurs approximately 30 days prior to launch as a final check of fully incorporated launch documentation and procedures. The launch vehicle is operated in a countdown sequence to verify system operational performance and compatibility under cryogenic tanking, radio frequency (RF), and actual launch environment conditions. The participants in the WDR vary depending on the scheduling request and not all launch customers will elect to conduct a WDR. The WDR tests nominal processing and will not contain scripted anomalies. RAT teams are not involved in the preparation or execution of the WDR.

4-18 ROC AND RCO PRE-MISSION PROCEDURES

4.18.1 OVERVIEW

As stated in section 4-18, there are numerous pre-mission meetings and activities that occur prior to each launch, which are captured in the MPA. This section will cover the ROC's and RCO's pre-mission tasks and responsibilities.

4.18.2 PURPOSE

The purpose of pre-mission procedures is to ensure that the Range team is informed and thoroughly prepared for each mission. This involves a deliberate and systemic review of the mission documentation, participation in pre-mission meetings and checks, and completion of events and activities IAW the MPA.

4.18.3 ROC PRE-MISSION AND DAY OF LAUNCH RESPONSIBILITIES

The ROC is responsible for the Range team and acts as a crew commander during the launch. The ROC will review critical mission documentation, facilitate crew meetings, as stated in section 4-18, and provide updates to the LDA and OD, as required. This will ensure every crew member is informed and prepared to perform their assigned duties.

Additionally, the ROC is responsible for MOC Mission Control Room (MCR) access control during launch operations. If the mission is classified, the ROC will work with the 1 ROPS Security Manager to make arrangements for controlling access to classified information/areas. Communicate changes in access to the appropriate Wing and Group personnel prior to the launch (i.e. controlled entry points, combination changes, etc.). Check with the operations flight regarding visitors or distinguished visitor tours to the MOC.

Regarding the CAB, the ROC is responsible for CAB setup prior to launch and rehearsal activities. The RCO can help the ROC ensure the CAB area is ready to receive senior staff members. This includes general clean up, administrative checks (i.e. crew logs and documents in place, administrative supplies/bags, etc.), and CAB communications checked (including Secure Telephone Equipment (STEs)) and headsets at each console. The key to the CAB conference room, as well as the STE keys, can be checked out from Range Scheduling.

4.18.4 RCO PRE-MISSION AND DAY OF LAUNCH RESPONSIBILITIES

The RCO is the single point of contact for the Eastern Range during a launch operation or test. As such, it is important to check the Range schedule daily for updates or changes to pre-mission tests and operations. The RCO should also remain in contact with the ISRO/TA and the PSM regarding updates or changes.

4-19 SCO/SSO/ACO PRE-MISSION PROCEDURES

4.19.1 OVERVIEW

There are numerous meetings, briefings and pre-mission tests and checkouts that occur for each mission. It is of critical importance that crewmembers stay on top of the activities to ensure nothing is missed. DOOB maintains the Mission Planning Aid (MPA) for each crew position, it is used to assist each crew member while conducting pre-launch tasks for each vehicle launched on the ER. The MPA is an all-inclusive document in one note that is created for each launch and contains launch specific steps when applicable.

4.19.2 PURPOSE

SCO, SSO, and ACO pre-mission procedures are used to ensure the surveillance team is informed and has thoroughly prepared for the mission. Through a deliberate and systemic review of mission documentation and participation in pre-mission meetings, tests, and operations the surveillance team will be well prepared to meet all mission tasks.

4.19.3 NOTICE TO AIRMEN

The ACO should coordinate with 1 ROPS Airspace Manager in DOUS to ensure the Notice to Airmen (NOTAM) for restricted airspace is requested. NOTAMs are typically received from Miami ARTCC Military Operations Office by fax approximately 24 hours prior to launch.

4-20 MFCO PRE-MISSION PROCEDURES

4.20.1 OVERVIEW

There are numerous meetings, briefings and pre-mission tests and checkouts that occur for each mission. It is of critical importance that crewmembers stay on top of these activities to ensure nothing is missed. DOOB maintains the Mission Planning Aid (MPA) for each crew position; it is used to assist each crew member while conducting pre-launch tasks for each vehicle launched on the ER. The MPA is an all inclusive document that can be used for any launch; it contains vehicle specific steps where necessary.

4.20.2 PURPOSE

MFCO pre-mission procedures assist the MFCO in preparing for each mission. Through a deliberate and systematic review of mission documentation and participation in pre-mission meetings and checks, the MFCO ensures MFCO launch support crewmembers are prepared and pre-mission tasks are complete. The MFCO's pre-mission preparation and efforts to ensure the launch safety support team is ready will dictate the level of success. The MFCO should be prepared to brief the status of the mission at any time, know the instrumentation status, understand the operational impacts, and assist in work-arounds as necessary. The MFCO ensures all information flows freely between themselves and the launch support crew; they must stay apprised of all issues leading up to launch.

4.20.3 MFCO LAUNCH OPERATION PREPARATION GUIDE

Pre-mission activities normally start about 30 days prior to the scheduled launch date. The MFCO is lead for the launch support team and acts as a crew commander during a launch operation. The MFCO is responsible for reviewing all mission documentation and meeting with each member of the launch support crew prior to the operation. This helps ensure members of the launch team are informed and carrying out their assigned duties. Teamwork and crew synchronization are essential to confirm that every member of the team possesses complete situational awareness and is prepared for the mission.

There are support aircraft requirements to meet both user and safety requirements for security, weather, surveillance, communications, and contingencies. Knowledge and familiarity with the role of each aircraft's, timelines, mission support positions, criticality (mandatory vs. required) and backup plan is essential. The ACO and safety analyst will provide the MFCO with all aircraft mission support requirements. Additionally, there may be special program aircraft such as NASA's WB-57 for mission specific photography, which may collect data for their respective programs. The PSM can provide details of these arrangements.

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SECTION 5

CONSOLE/EQUIPMENT OPERATIONS

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5-1 COMMUNICATION EQUIPMENT OPERATIONS

5.1.1 OVERVIEW

This section provides the range crew with information and operational procedures for the communication equipment located at various crewmember consoles. This equipment includes the ORION communications console and the STE.

5.1.2 ORION RED/BLACK CONSOLE OPERATOR END INSTRUMENT

The ORION is a console mounted multi-line phone instrument used for secure and non-secure digital voice communications. The ORION is a 24-line button unit that can be combined with an expansion panel to provide an additional 24 lines. The ORION COEI provides the ability to communicate via Nets, Voice Direct Lines, or Admin Lines. Each of these are outlined below.

5.1.2.1 Nets

Nets are communication networks that allow two or more users to communicate on the same communication line at the same time. Users may have talk capability or monitor only capability. For example, RCO.LOOP is a communications net used by the ROC, MFCO, RCO, SCO, RAC, LWO, RE and ISRO.

5.1.2.2 Voice Direct Line (VDL)

Voice direct lines are communication lines that allow one-to-one communication by pushing one button rather than dialing a telephone number.

5.1.2.3 Admin Line

Admin lines are communication lines that work just like a regular phone.

5.1.3 SECURE TERMINAL EQUIPMENT (STE)

The STE provides voice and data encryption on digital and analog networks. Allows backward compatibility with the STU-III. National Security Agency (NSA) certified for operational traffic at classification levels up to Top Secret.

5.1.3.1 FORTEZZA Card

The STE utilizes a FORTEZZA Card. These cards are stored in the Range Scheduling Office. When classified information must be discussed/passed, the range crew will use the STE.

5.1.4 PROCEDURES

5.1.4.1 Orion Comm. Panel Operations (Procedure 10)

Procedure 10, the Orion Comm. Panel Operations procedure, is used when it is necessary to operate the ORION Communication Panel or the telephone/intercom equipment. Upon manning the console for an operation, the crew must perform a checkout on all communication equipment that will be used to ensure it is operating properly. The communications checkout should include a check of both transmit and receive capability on all nets/Voice Direct Lines (VDLs) to be used. Procedure 10 provides basic instructions for operating the communications equipment to include selection and deselection of communications channels as well as detailed instructions on controlling volumes of each channel. It provides basic operating instructions for the ORION Comm Panel and Telephone/Intercom.

5-2 FLIGHT CONTROL CONSOLE/EQUIPMENT OPERATIONS

5.2.1 OVERVIEW
Flight Control Operations are conducted in the Range Safety Display (RSD) Area, Room 159 of the Morrell Operations Center (MOC). From this control center, the MFCOs, with support from their Flight Control Team Control, enforce Range Safety Launch Commit Criteria (LCC), assess whether the launch or vehicle flight should continue, and hold the count or terminate flight as required.

5.2.2 CONSOLE OVERVIEW
The RSD area contains consoles for the:
- MFCOs
- Video Systems Officer (VSO)
- Telemetry Systems Officer (TSO)
- Command Systems Officer (CSO)
- RSD Coordinator

Figure 5-2-1*: Console and Range Safety Displays*

5.2.2.1 MFCO Consoles
The MFCO and SMFCO consoles are mirror images of each other. At the MFCO Console (D7), the bottom two RSD monitors display data from FOV1-A and the top two RSD monitors display data from FOV1-B and DRSD. At the SMFCO console, the bottom two RSD monitors display data from FOV1-B and the top two RSD monitors display data from FOV1-A and DRSD. In the middle of the two consoles is the Mission Continuation Display (MCD). The console layout allows the MFCOs to make a comparison of the data on the FOV1-A, FOV1-B, DRSD, and MCD and provides redundancy in the event of a failure of one or more RSD systems.

The MFCO consoles consist of seven console bays containing:
- Range Safety Displays (RSDs)
- RSD Keysets & joystick
- Video monitors
- Timers
- Comm panels
- Flight Termination Units (FTUs)
- Holdfire switches

Figure 5-2-2: *MFCO Console*

5.2.2.1.1 Section 1-3 MFCO Console D7

Section 1 - At the top of Section 1 is a Countdown clock used to display the T-Count in HH:MM:SS. Below the T-Clock is a CCTV video monitor which is used by the MFCO and VSO to monitor mission events and visible vehicle behavior on video from the various optics sites and the Programming and Flightline video cameras. Below the CCTV video monitor is a bay containing the DRSD Display Processor (DP) #2 for the DRSD display monitor at the top of Section 2. Below the DRSD DP #2 bay is a set of countdown clocks used to display up to four configurable counts in HH:MM:SS. For Expendable Launch Vehicle (ELV) missions, operators will typically only see three of these clocks used to display the L-Count, the T-Count, and the current T-0. Below the CCTV Video Keyset Panel is the MFCO's Orion comm panel.

Figure 5-2-3: *MFCO Console D7 Section 1*

Figure 5-2-4: *MFCO Console D7 Section 2*

Section 2 - At the top of Section 2 is a Countdown clock used to display the L-Count in HH:MM:SS. Below the L-Clock is the MFCO's DRSD display monitor. Mounted between Section 1 and Section 2 of the MFCO console is the DRSD keyset which is used to configure the MFCO's DRSD display. Below the MFCO's DRSD monitor is the FOV1-A Monitor #2. Per the configuration file, this display is configured to display the Vertical Plane (VP) display when the FOV1-A system is brought up. Below is the MFCO's FTU panel. Below the FTU Panel is the FOV1-A keyset panel which is used to configure the display monitor connected to the FOV1-A system.

Section 3 - At the top of Section 3 is a Countdown clock used to display the current Zulu time in HH:MM:SS. Below the Zulu Clock is the MFCO's FOV1-B Monitor #3. Per the configuration file, this display is configured to display the Impact Point (IP) display when the FOV1-B system is brought up. Below the MFCO's FOV1-B Monitor #3 is the FOV1-A Monitor #1. Per the configuration file, this display is configured to display the IP display when the FOV1-A system is brought up. Below the FOV1-A Monitor #1 is the Electronic Holdfire panel. This panel is not in use. Below the Electronic Holdfire panel are two manual timers which display time only in seconds. Below the two manual timers is the MFCO's Holdfire panel (panel marked as "RSO").

Figure 5-2-6: *MFCO Console D7 Section 3*

Figure 5-2-5: *VSO Console D11*

5.2.2.1.2 VSO Console D11

Section 4 - At the top of Section 4 is a Countdown clock used to display the current local time in the 24 hr format in HH:MM:SS. Below the Local Time Clock is a CCTV video monitor which is used by the MFCO and VSO to monitor mission events and visible vehicle behavior on video from the various optics sites and the Programming and Flightline video cameras. Below the CCTV video monitor is the Mission Continuation Display (MCD) monitor. This display is the only MCD display at the MFCO consoles. It is centrally located to be used by both the MFCO and the SMFCO to compare MCD data with the data displayed from the FOV1-A, FOV1-B, and DRSD systems. MCD only provides a telemetry IP display. Below the MCD Display monitor is the CCTV Video Keyset panel which is used to configure the CCTV video monitor at the top of this section. Below the CCTV Video Keyset Panel is the VSO's Orion comm panel.

5.2.2.1.3 Sections 5-7 SMFCO Console D8

Section 5 - At the top of Section 5 is a Countdown clock used to display the current Zulu time in HH:MM:SS. Below the Zulu Clock is the SMFCO's FOV1-A Monitor #3. Per the configuration file, this display is configured to display the IP display when the FOV1-A system is brought up. Below the SMFCO's FOV1-A Monitor #3 is the FOV1-B Monitor #1. Per the configuration file, this display is configured to display the IP display when the FOV1-B system is brought up. Below the FOV1-B Monitor #1 is the Electronic Holdfire panel. This panel is not in use. Below the Electronic Holdfire panel are two manual timers which display time only in seconds. Below the two manual timers is the SMFCO's Holdfire panel.

Figure 5-2-7: *SMFCO Console D8 Section 5*

Section 6 – At the top of Section 6 is a Countdown clock used to display the L-Count in HH:MM:SS. Below the T-Clock is the SMFCO's DRSD display monitor. Mounted between Section 6 and Section 7 of the SMFCO console is the DRSD keyset which is used to configure the SMFCO's DRSD display. Below the SMFCO's DRSD monitor is the FOV1-B Monitor #2. Per the configuration file, this display is configured to display the VP display when the FOV1-B system is brought up. Below is the SMFCO's FTU panel. Below the FTU Panel is the FOV1-B keyset panel which is used to configure the display monitor connected to the FOV1-B system.

Figure 5-2-8: *SMFCO Console D8 Section 6*

Section 7 – At the top of Section 7 is a Countdown clock used to display the T-Count or L-Count in HH:MM:SS. Below the T-Clock is a CCTV video monitor which is used by the SMFCO and VSO to monitor mission events and visible vehicle behavior on video from the various optics sites and the Programming and Flightline video cameras. Below the CCTV video monitor is a bay containing the DRSD DP #3 for the DRSD display monitor at the top of Section 7. Below the DRSD DP #3 bay is a set of countdown clocks used to display up to four different counts in HH:MM:SS. Below the Shuttle Controllability Indicator panel is the

CCTV Video Keyset panel which is used to configure the CCTV video monitor at the top of this section. Below the CCTV Video Keyset Panel is the SMFCO's Orion comm panel.

Figure 5-2-9: SMFCO Console D8 Section 7

Figure 5-2-10: *Auxiliary Console Carts*

5.2.2.1.4 Auxiliary Console Carts

There are also three auxiliary console carts with equipment for use by the MFCOs.

The cart to the left of the MFCO console consists of:

- A Range Safety Advisory System (RSAS) Display: for use on missions with nuclear payloads or any other mission type where prevention of an intact impact is critical.
- A MFCO desktop computer: for referencing mission documentation and the RGNext Vision Displays
- Three Emergency Life Support Apparatus (ELSAs): to aid in the escape of the MFCOs and LDA if a fire occurs in the MOC during a launch.

The cart to the right of the SMFCO console consists of:

- A RSAS Display
- Three ELSAs

The cart behind the SMFCO console consists of: a desktop computer for: Mission documentation and RGNext Vision Displays.

5.2.2.1.5 Range Safety Displays (RSD) Coordinator's Console

Behind the MFCO Consoles is the RSD Coordinator's Console D12. The RSD Coordinators consoles has two main sections which can display data from FOV1 and CTPS. The left side of the console displays data from FOV1-A and CTPS-A. The right side of the console displays data from FOV1-B and CTPS-B. The keysets and joysticks at the bottom of the console are used to configure the various FOV1 displays on the monitors at the top of the console. The A-B-D video switches at the top of the console are used to configure the monitors to display data from either FOV1 or the analog telemetry display pages from CTPS.

There is one ORION panel assembly split across the two halves of the console. The main ORION panel is on the left side of the console and the expansion panel is on the right side of the console.

To the left of the RSD Coordinator's console is the Control and Management Display (CM&D) workstation. This workstation is part of FOV1-A system and is used to configure and distribute FOV1-A display pages to the displays in the CAB area and to CCTV. The RSD Coordinator configures these displays with guidance and direction from the MFCOs.

5.2.3 RANGE SAFETY DISPLAYS

The Range Safety Displays are the primary source of information used to determine launch vehicle performance.

5.2.3.1 Instantaneous Impact Point (IIP) Display

This is the primary display used by the MFCOs during the plus count. The primary purpose of the IIP display is not to show where the vehicle is, but rather where it would impact if the vehicle loses thrust at that point in time; assumes vacuum conditions apply.

The IIP Display shows:

- Launch point
- Nominal trajectory (center green line)
- Three sigma dispersion (adjacent green lines) showing nominal vehicle envelope
- Destruct line (red line) that ensures significant debris and damaging overpressures from destruct action do not violate Impact Limit Lines (ILLs)
- Chevron line (dynamic red line)
- Color-coded information from the two primary sources of data (primary is cyan, secondary is magenta).

Figure 5-2-10: *Instantaneous Impact Point Display*

The IIP composite display uses different tracking data sources (e.g. radar, optics, and/or TMIG) that are selected automatically. TMIG presently not allowed as a primary tracking source.

5.2.3.2 Vertical Plane (VP) Display

This is the primary display used by the MFCO during the plus count as vehicle leaves the launch head. Composite uses two or more different tracking data sources (e.g. radar, optics, and/or TMIG) that are selected automatically or an individual source. The VP shows vehicle position on two vertical planes (XZ and YZ). Abnormal indications on this display include straight-up vehicle, pitching vehicle, programming up-range, and depressed or high inclination trajectory.

Safety criteria is violated when track of the vehicle becomes parallel to one of the red destruct lines. The determination of the vehicle track becoming parallel to a destruct line as aided by an alphanumeric destruct angle display. The VP switches to IP display when the vehicle's present position moves off of the display.

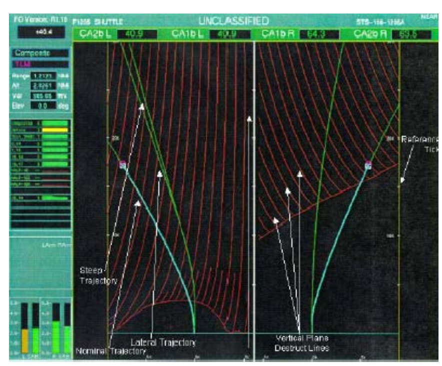


Figure 5-2-11: *Vertical Plane Display*

5.2.3.3 Velocity vs. Time (VT)

The VT display indicates how the propulsion system is performing. The Green line is the nominal velocity profile. The primary (v) and secondary tracking sources (^) show how the vehicle is actually performing. The slope of line indicates acceleration. Coast periods between stages are shown as a short horizontal line. The V/T display does not contain destruct criteria, but is a helpful tool for MFCO in checking vehicle performance.

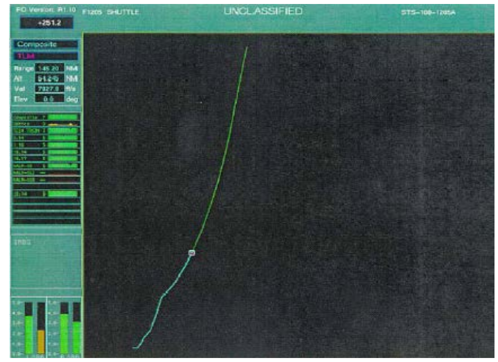


Figure 5-2-12: *Velocity vs Time*

5.2.3.4 Present Position Display (PP)

The Present Position display shows the vehicle's present position on both the vertical and horizontal planes. The vertical plane is oriented as if the observer is looking at the pad from the south, with the vehicle moving to the right (downrange). The horizontal plane is oriented as if the observer is looking from space. The PP display includes the nominal trajectory lines and three sigma dispersion lines. The PP display contains no destruct criteria, but is useful for confirming a straight-up or pitching vehicle.

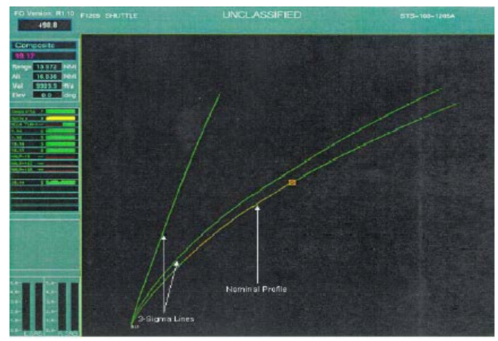
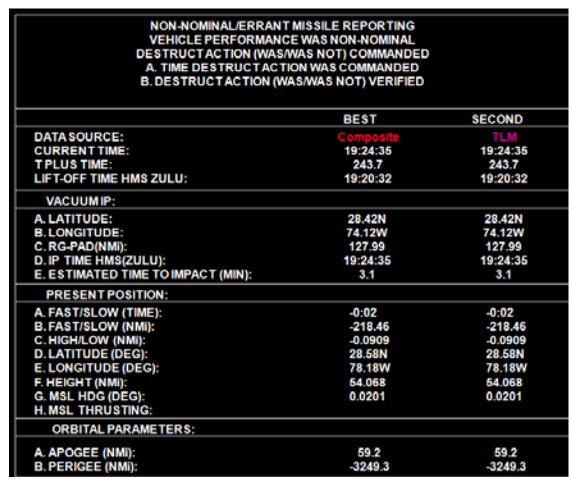


Figure 5-2-13: *Present Position Display*

5.2.3.5 Vehicle Data Page

The Vehicle Data Page provides alphanumeric information regarding vehicle performance. It lists the position and performance characteristics of the IIP and PP. This data page also provides data on the orbital parameters of the tracked vehicle. Information on this page can also be used to pass vehicle post-destruct and errant vehicle data.



NON-NOMINAL/ERRANT MISSILE REPORTING
VEHICLE PERFORMANCE WAS NON-NOMINAL
DESTRUCT ACTION (WAS/WAS NOT) COMMANDED
A. TIME DESTRUCT ACTION WAS COMMANDED
B. DESTRUCT ACTION (WAS/WAS NOT) VERIFIED

	BEST	SECOND
DATA SOURCE:	Composite	TLM
CURRENT TIME:	19:24:35	19:24:35
T PLUS TIME:	243.7	243.7
LIFT-OFF TIME HMS ZULU:	19:20:32	19:20:32
VACUUM IP:		
A. LATITUDE:	28.42N	28.42N
B. LONGITUDE:	74.12W	74.12W
C. RG-PAD(NMI):	127.99	127.99
D. IP TIME HMS(ZULU):	19:24:35	19:24:35
E. ESTIMATED TIME TO IMPACT (MIN):	3.1	3.1
PRESENT POSITION:		
A. FAST/SLOW (TIME):	-0:02	-0:02
B. FAST/SLOW (NMI):	-218.46	-218.46
C. HIGH/LOW (NMI):	-0.0909	-0.0909
D. LATITUDE (DEG):	28.58N	28.58N
E. LONGITUDE (DEG):	78.18W	78.18W
F. HEIGHT (NMI):	54.068	54.068
G. MSL HDG (DEG):	0.0201	0.0201
H. MSL THRUSTING:		
ORBITAL PARAMETERS:		
A. APOGEE (NMI):	59.2	59.2
B. PERIGEE (NMI):	-3249.3	-3249.3

Figure 5-2-14: *Vehicle Data Page*

5.2.3.6 Flight Operations Version 1 (FOV1)

The FOV1 displays are divided into three sections.

5.2.3.6.1 Top Status Border

- **Software Version Identifier -** Text field that displays the software and version number currently executing the display. Default text color is white.
- **Countdown Indicator/Plus Time -** Text field that displays the L-time and plus time from range timing. The field displays the minus time before launch and plus time after launch. The count indicator also serves as a heart-beat indicator that lets the MFCO know

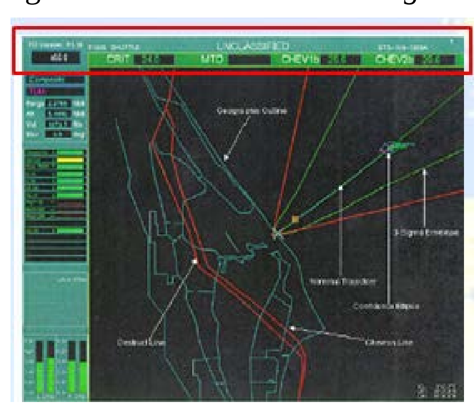


Figure 5-2-15: *Top Status Border*

whether the display is active.

- **Security Classification Indicator -** Colored area that displays the classification level for the operation. The colored banner and text indicate the classification level. The classification levels FOV1 supports are Unclassified, For Official Use Only (FOUO), Secret/Formerly Restricted Data (FRD), and Secret. For a classified display, the indicator border will be red for easier recognition.
- **Operation Number -** Text field that displays the operation number initialized on FOV1. It is displayed in the upper left corner. Default text color is white.
- **Vehicle Identifier -** Text field that displays the vehicle type for the operation. It is displayed to the immediate right of the Operation Number field. Default text color is white.
- **Map ID -** Text field that displays the map number currently displayed. Default text color is white.
- **Mission Identifier -** Text field that displays the missile currently displayed on the FOV1 window. This field is only used during multiple missile operations. The choices are W, X, Y, and Z. Default text color is white.
- **Warning Bar -** The Warning Bar is the area that contains the critical numbers for range safety. The background in the bar changes color based on the critical numbers displayed in the area. Green if numbers are above 5, Amber if the values are between 5 and 0, Red if the values are less than 0.
  - **Calculated Critical Time (CRIT) -** Calculated Critical Time (CRIT) is the minimal time until a nominal vehicle's IIP could cross the nearest destruct line if the vehicle at that moment makes a worst-case turn towards the nearest destruct line. CRIT is calculated based on nominal azimuth performance and are not recalculated based on actual performance. This number begins counting down if vehicle track is lost. The text in the data field is green when the number is counting down, but the value is above 5 seconds, amber when the value counts down to between 5 and 0, and red when the value is below 0. This number only displays on the IP View.
  - **MFCO Time to Destruct (MTD) -** MFCO Time to Destruct (MTD) is activated when the metric tracking data is lost. This data field is blank until activated, either when all track is lost, or manually. The MTD continues to count down until the MFCO determines the metric data quality is restored and resets MTD. When MTD is reset, it takes the same value as the CRIT number. The MTD value is displayed in the default color green while the value is greater than five seconds. The MTD value is displayed in the default color amber while the value is between five and zero seconds. The MTD value is displayed in the default color red when the value is equal to or less than zero. This number only displays on the IP View.
  - **Chevron (CHEV 1B and CHEV 2B) -** The CHEV numbers represent the time until the chevron line is downrange of the IP. CHEV 1B represents the chevron number for the best source and CHEV 2B represents the chevron number for the second best source. The Chevron numbers are displayed in green while the value is above five seconds. The value is displayed in amber while the value is between five and zero seconds. The value is displayed in red while the value is equal to or less than zero. This number only displays on the IP View.
  - **Critical Angles (CA)** - A critical angle is the difference between the slope of the destruct line and the slope of the vehicle velocity vector projected into the vertical plane. There are four critical angles, in degrees, which are displayed at the top of the VP display. Two are displayed on the right (XZ) for the first and second best sources

(CA1b R and CA2b R) and two on the left (YZ) for the first and second best sources (CA1b L and CA2b L). The critical angles are displayed in green while the value is above five degrees. The value is displayed in amber while the value is between five and zero degrees. The value is displayed in red while the value is equal to or less than zero degrees.

5.2.3.6.2 Side Status Bar

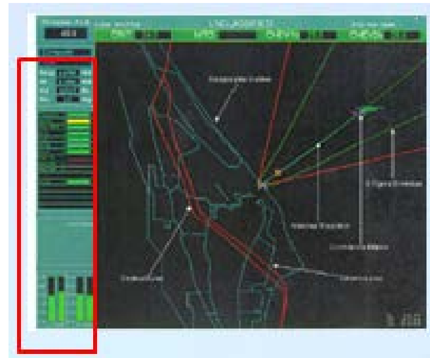


Figure 5-2-16: *Side Status Bar*

- **Range Metric Source Indicators -** These indicators include the best and second best source currently selected, the numeric data, the history, and the data quality for the range sources.
- **Best/Second Best (Prime/Alternate) -** The source area displays the IDs of the sources currently selected as Best and Second Best. The Best source ID is shown in cyan and the Second Best source ID is shown in magenta.
- **Numeric Data -** The fields in the source area display the range, altitude, velocity, and elevation angle values for the Best or Second Best source, depending on which source the operator selected for tracking. The color of the text in the display fields indicates which source's values is displayed. Note that elevation angles are not available for display for the composite solution, telemetry, and optics.
- **Status History (Bar) Area -**The Status History display element contains the source ID, a mode flag, and a scrolling history bar that indicate the general health and contribution of the range source to the display solution. The mode flags vary for the type of source, and status. The History Bar shows a continuous display of the quality of the tracking status for the source. The height of the History bar indicates the relative degree of agreement between the source and the Best Source. A full height bar indicates full agreement with the Best Source.

The History Bar has several colors that indicate the status of the source:

- Green = High Quality
- Yellow = Medium or Low Quality
- Red = Not Available
- Blue = Coasting
- Purple = Raw Data
- Orange = Rejected

- **Command Receiver AGC Bars -** The Command Receiver AGC area displays a bar chart to indicate the signal strength at each command receiver on the vehicle. The bar's default color is green if the value is above the command receiver's guaranteed level. The color is amber if the value is between the guaranteed and threshold levels. The color is red if the value is below the threshold level.

5.2.3.6.3 Display Area

This display area is the largest area on the RSD. Its purpose is to display one or more of the many graphical views. When a RSD is first initialized with an operation, this area will initially display the default view configured for it. The operator can manually enable or disable a view for a RSD by selecting the appropriate key from the keyset. A red diagonal bar will be displayed in this area when all sources are off track or are not available.

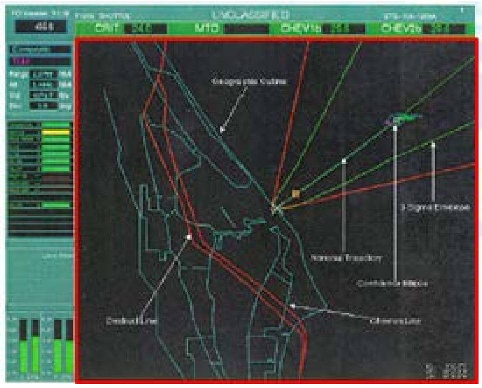


Figure 5-2-18: *Display Area*

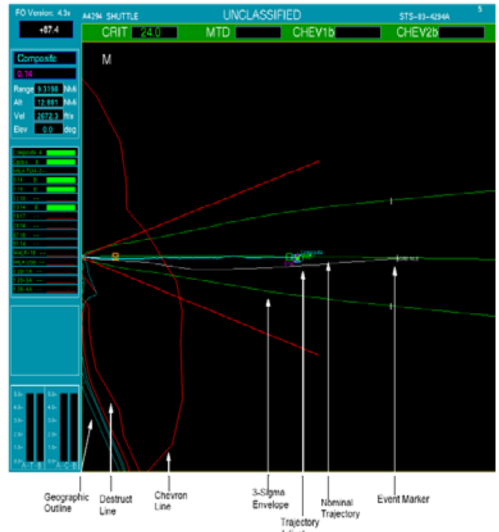


Figure 5-2-17: *Impact Point View*

- **Impact Point View -** The purpose of the Impact Point (IP) view is to provide a graphical representation of the vehicle's current and previous positions and estimated impact points relative to the Earth's surface. This view displays a geographic map containing the nominal trajectory line, nominal box, submissile point, 3-sigma lines, and other destruct criteria that help determine if a vehicle is in a situation that can endanger life, limb, or property. The IP view can display the vehicle's data in manual or automatic mode. In manual mode, the operator will use the joystick and the keyset to manually select, pan, and zoom a map to view the vehicle's data. In automatic mode, the operator has a choice of automatically tracking the vehicle using the map switch or the pan and zoom algorithm. Both algorithms ensure that the vehicle's Best, Second Best, or Nominal IIP and its debris footprint, if one is present, will always be visible during the vehicle's sub-orbital flight. The pan and zoom algorithm keeps the IIP centered on the display at all times. It dynamically pans and zooms the map as the vehicle progresses down range to keep the IIP and the debris footprint visible. The map switch algorithm displays the IIP and debris footprint on a static non-zooming map. It automatically switches to a larger scale map when the IIP or debris footprint reaches the edge of the current map. For an orbital launch, the pan and zoom and the map switch algorithms will track the IIP until the vehicle is in orbit. When this occurs, the IIP will disappear and the algorithms will begin tracking the vehicle's submissile point (i.e., the present position or PP). The IP view consists of several layers that include both static and dynamic elements.

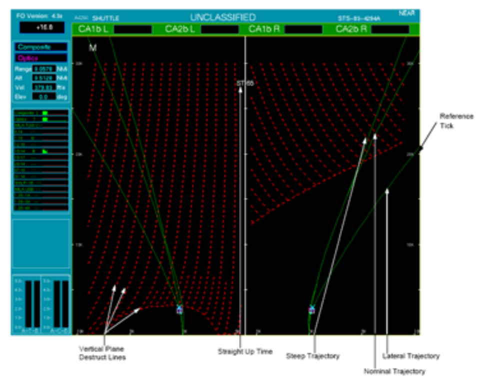


Figure 19: *YZ Plane XZ Plane*

- **Vertical Plane View -** The projections of the present position trajectory are displayed on two vertical planes, known as the XZ and YZ. The vertical planes are displayed using a near map and a far map. The current map type is displayed in the Map ID area of the Top Status Bar. The VP view starts in the near map and switches to the far map as the vehicle's present or nominal position surpasses the near map's altitude and range limits. The VP view will then switch to the IP view when the altitude and range limits of the far map have been exceeded. The altitude and range limits of the near and far maps are determined from pre-generated data in the PREX file. The operator can manually switch between the near and far maps by using the keyset. The XZ vertical plane is aligned normal to the northern ILL. The YZ vertical plane is aligned normal to the southern ILL.

- **Profile View -** The Profile view is the present position display of the vehicle in the vertical (XZ) plane. The Profile view consists of a near and far map. A launch initially begins in the near map and switches to the far map as the vehicle progresses down range. The operator can also manually switch between the near and far map by using the keyset. The X-axis is aligned along the vehicle flight azimuth. The Y-axis is cross range to the X-axis. The Z-axis is normal to the XY plane.

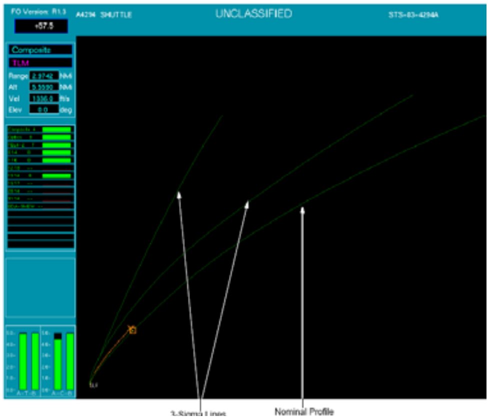


Figure 5-2-20: *Profile View*

- **Overhead View -** The Overhead View displays the present position of the launch vehicle in the horizontal (XY) plane. This view displays data from the launch point to the thrust termination for suborbital launches, or to orbital insertion for space launches. The X-axis is aligned along the initial vehicle flight azimuth. The Y-axis is cross range to the X-axis. The Z-axis is normal to the XY plane. The Overhead View displays several static and dynamic data elements. The Overhead View presents the nominal overhead trajectory, 3-sigma lines, Best Source PP, Second Best Source PP, and the Dynamic Nominal PP.

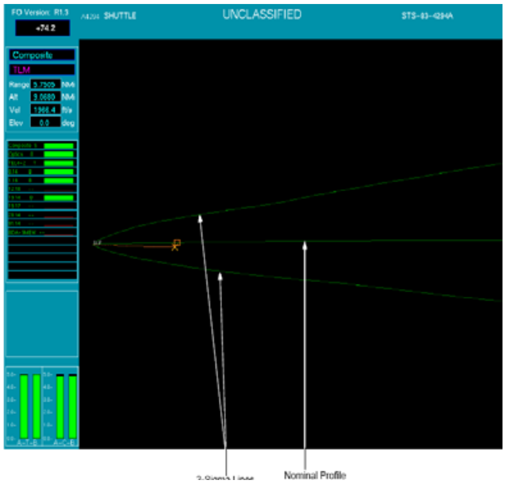


Figure 5-2-21: *Overhead View*

- **Velocity vs. Time View -** The Nominal Velocity Versus Time View is the plot of the launch vehicle's expected velocity throughout powered flight.
- **Data Page View -** The Data Pages provide alphanumeric information regarding vehicle performance and catastrophic events.

5.2.3.6.4 FOV1 Keyset

- **Display Area -** The Display Area of the FOV1 screens are configured by the use of a programmable keyset at the bottom of the MFCO console.
- **Programmable Function Keyset -** The keyset controls allow the operators to select the various view options on the FOV1 monitors. Only one keyset is required to control all the FOV1 monitors for a particular system (FOV1-A or FOV1-B). The MFCOs select the corresponding key for the monitor they want to control.

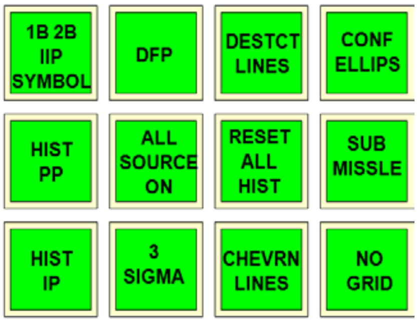


Figure 5-2-22: *Details Selection Keys*

- **Key States –** There are four possible key states: Not Programmed, Not Selectable, Selectable, Already Selected.
- **View Details Selection Keys -** The View Details Selection keys allow the operator to select data details for a particular view. Some examples of these data details include Destruct Lines (DLs), Debris Footprint (DFP), Impact Limit Lines (ILLs), and IP History traces. The keys activate or deactivate these details on the graphic views. The View Details Selection keys fall into two general categories, those that affect dynamic data view details, and those that affect static view details.
- **View Selection Keys -** The View Selection Keys activate different MFCO display views. Most of the views can be viewed at the same time on the same display monitor. The only two views that are mutually exclusive are IP view and Vertical Planes view. FOV1 allows the operator to overlay the Profile view, the Velocity vs. Time view, and the Overhead views without visually overlapping. The View Details Selection keys become active when the operator selects a View Selection key.

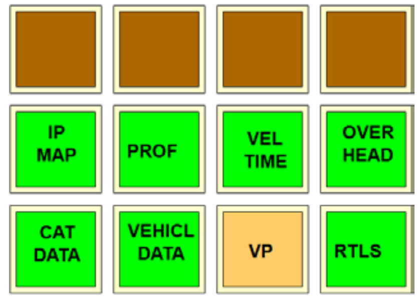


Figure 5-2-23: *Selection Keys*

- **Missile Selection Keys -** For Trident II missions, these keys allow the operator to select displays pages for a specific missile. The Missile Selection Keys are labeled identically to the missile IDs, which are W, X, Y, and Z. Navy operations always provide four missile IDs in the data stream. If FOV1-A is configured for an operation that does not have multiple missiles, these keys are in the Not Programmed state.

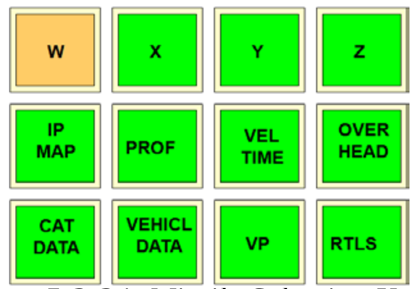


Figure 5-2-24: *Missile Selection Keys*

- **View Behavior Selection Keys -** The View Behavior keys allow the operator to determine how the graphic displays pan, zoom, and switch on the maps. Some of these key labels share the same physical key, for example MAN and AUTO, and their labels change depending on the current selection. For example: when the operator selects PAN ZOOM, the key label changes to MAP SWITCH.
- **Joystick Controls -** The Programmable Function Keysets also include a joystick to control pan and zoom on the graphic displays. To operate the pan control, the operator uses the joystick's pivot motion: To pan NORTH, pivot the joystick up. To pan SOUTH, pivot the joystick down. To pan EAST, pivot the joystick right. To pan WEST pivot the joystick left.

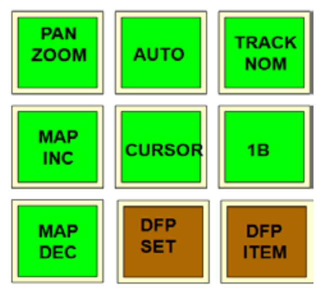


Figure 5-2-25: *Behavior Selection Keys*

- **Playback Control Keys -** The Playback Control keys allow the operator to start, stop and otherwise control the playback of an operation's data on the RSD. The keys allow the operator to change the direction of the playback, the speed of the playback, go to the end or beginning of the file, and to step backwards through the playback in small intervals. These keys are selectable for every RSD view when the MDP operator initializes the RSD in RSD Simulation or RSD Playback modes.

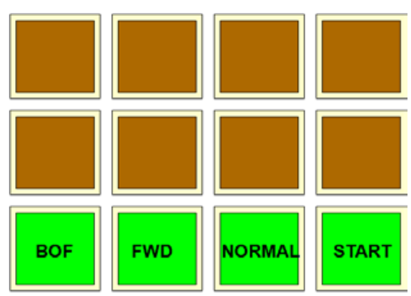


Figure 5-2-26: *Playback Control Keys*

- **Display Selection Keys -** This group of keys allows the operator to select which FOV1 display monitor to control. Only one monitor can be controlled from the keyset at a time. However, changing the keyset to control another display only requires the operator to select the numbered key for the desired monitor. These keys are mutually exclusive. When another display selection key is selected, the previously selected key is deselected.

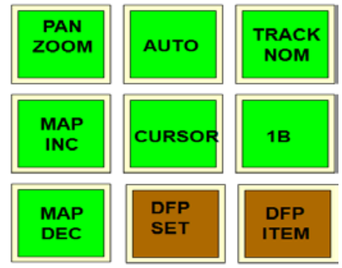


Figure 5-2-27: *Display Selection Keys*

5.2.3.7 Distributed Range Safety Display (DRSD)

The DRSD displays are divided into four sections.

5.2.3.7.1 Top Status Border

- **Security Classification Indicator -** Displays the classification level for the operation. The colored banner and text indicate the classification level. The classification levels DRSD supports are Unclassified, For Official Use Only (FOUO), Secret/Formerly Restricted Data (FRD), and Secret. For a classified display, the indicator border will be red for easier recognition.
- **Map ID -** Text field that displays the map number currently displayed. Default text color is white.
- **Vehicle Identifier -** Text field that displays the vehicle type for the operation. It is displayed to the immediate right of the Operation Number field. Default text color is white.
- **Mission Identifier -** Text field that displays the missile currently displayed on the DRSD window. This field is only used during multiple missile operations. The choices are W, X, Y, and Z. Default text color is white.

5.2.3.7.2 Bottom Status Border

The Bottom Status Border contains the Warning bar for the DRSD system. The Warning Bar includes the Green Numbers and the Critical Angles.

- **Green Numbers -** The Green Number is displayed in the middle of the border on both the IP and VP displays. This number begins counting down if vehicle track is lost. The text in the data field is green when the number is counting down, but the value is above 5 seconds, amber when the value counts down to between 5 and 0, and red when the value is below 0.
- **Critical Angles -** A critical angle is the difference between the slope of the destruct line and the slope of the vehicle velocity vector projected into the vertical plane. There are two critical angles, in degrees, which are displayed at the bottom of the DRSD VP display for the selected DRSD source. One is displayed on the right (XZ) of the display and one is displayed on the left (YZ) of the display. These indicators will appear once the present position enters the red destruct line region of the display. The critical angles are displayed in green while the value is above five degrees. The value is displayed in amber while the value is between five and zero degrees. The value is displayed in red while the value is equal to or less than zero degrees.

5.2.3.7.3 Side Status Bar

- **Software Version Identifier -** Text field that displays the software and version number currently executing the display. Default text color is white.

- **Countdown Indicator/Plus Time -** Text field that displays the L-time and plus time from range timing. The field displays the minus time before launch and plus time after launch. The count indicator also serves as a heart-beat indicator that lets the MFCO know whether the display is active.
- **Range Metric Sources Indicators -** Contains the source ID, a mode flag, and a scrolling history bar that indicate the general health and contribution of the range source to the display solution.
- **Command Receiver AGC Values -** Indicate the signal strength at each command receiver on the vehicle.

5.2.3.7.4 Display Area

The display area of the DRSD includes the Impact Position (IP) display, Vertical Plan (VP) display, and Velocity vs. Time (VT) display.

The Display Area of the DRSD screens are configured by the use of a keyset mounted next to the center panel of each MFCO console. The keyset controls allow the operators to select the various view options on the DRSD monitors. Each keyset is dedicated to a single DRSD display. The functionality of this keyset is similar to the FOV1 keysets.

- **Mission Continuation Display (MCD)** - The MCD display is divided into three sections:
  - **Top Status Border** - The Top Status Border contains the following:
  - **Software Version Identifier:** Text field that displays the software and version number currently executing the display. Default text color is white.
  - **Operation Number:** Text field that displays the operation number initialized on FOV1. It is displayed in the upper left corner. Default text color is white.
  - **Vehicle Identifier:** Text field that displays the vehicle type for the operation. It is displayed to the immediate right of the Operation Number field. Default text color is white.
  - **Security Classification Indicator:** Colored area that displays the classification level for the operation. The colored banner and text indicate the classification level. The classification levels FOV1 supports are Unclassified, For Official Use Only (FOUO), Secret/Formerly Restricted Data (FRD), and Secret. For a classified display, the indicator border will be red for easier recognition.
  - **User Identifier:** Text field that displays the user ID as read from the (Pre-exercise) PREX file. Default text color is white.
  - **Countdown Indicator/Plus Time:** Text field that displays the L-time and plus time from range timing. The field displays the minus time before launch and plus time after launch. The count indicator also serves as a heart-beat indicator that lets the MFCO know whether the display is active.
- **Side Status Bar -** The Side Status Border contains vehicle numeric data from the selected telemetry source to include the range, altitude, and velocity. The Side Status Bar also includes the command receiver AGC values.
- **Display area -** The Display Area of the MCD consists of a telemetry only IIP display. The MCD does not require any display configuration actions by the MFCO.

5.2.4 FLIGHT TERMINATION UNIT (FTU)

The FTUs are located on the center panel of the MFCO and SMFCO consoles.

5.2.4.1 The FTU Switches

There are four guarded toggle switches on the FTU which are used to transmit command functions. To request a function, the protective cover is raised and the toggle switch is raised in the "active" position. To remove a function, the protective switch cover is closed, which disengages or lowers the toggle switch. Each FTU switch is a two pole switch. When raised in the "active" position, the switch contacts at two poles, completing two circuits. Each circuit sends the command request through one of two separate hardware lines to each Central CMEV. The online CMEV must receive the command request through both of these hardware lines in order to send the function. If one of the switch contact poles fails, then only one command request will be sent to the CMEV and the command will not be sent. This is done to prevent the inadvertent transmission of a command function due to a switch failure.

Figure 5-2-28: *Flight Termination Unit*

Figure 5-2-29: *FTU Switches*

5.2.4.2 The FTU Switch Indicators

There is a switch indicator above each FTU switch. Each FTU switch indicator is illuminated by the CMEV with a label identifying its function, according to the setup in the configuration drawer. When an FTU switch is activated to request transmission of a function, the CMEV color-codes the illuminated label to indicate when the request is being processed and when it has been sent. When the CMEV is processing the request, the word "REQST" will appear with a yellow background on the FTU display. Upon receipt of the confirmation from the site that the function has been transmitted, the word "XMIT" will appear with a red background on the FTU display. When the function is removed, the background of the FTU display will no longer be illuminated and the word "XMIT" will disappear from the FTU display.

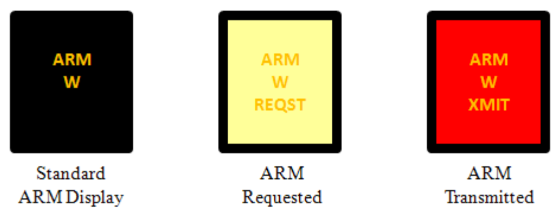


Figure 5-2-30: *FTU Switch Indicator*

5.2.4.3 The FTU Key Switch

There is a key switch located to the left of the FTU switches which is used to enable the applicable operator interface to send command functions in conjunction with the associated CSC console configuration and CCRS operating mode. There are three key-lock positions corresponding to the three FTU operating modes: ENABLE, DISABLE, and TEST. The configuration of the FTUs can be visually verified by looking at the position of the key-lock. The FTU is configured for a particular operating mode when the key-lock indention on the metal circle at the center of the key switch is aligned with the key-lock indention for the label operating mode on the outer ring of the key switch.

- **Enable Key-Lock Position -** The key switch is in the ENABLE position when the FTU is being utilized in the Digital Range Safety (DRS) modes during tests using flight codes and launch. Above the ENABLE key switch position are two red "ENABLE CME/V" indicator lights. If the system is in the DRS mode and the FTUs are enabled, the two red "ENABLE CME/V" indicator lights will illuminate when an FTU switch is activated and the Central CMEVs access the MSUs. This confirms that the CMEVs have extracted the secure codes for the requested function. When the command function is removed, the two red "ENABLE CME/V" indicator lights will go out.

- **Disable Key-Lock Position -** The key switch will be in the DISABLE position when the FTU is not being utilized, when it is being utilized in the Eastern Test Range (ETR)-IRIG mode, or when it is being utilized in the DRS modes during tests using maintenance codes.
- **Test Key-Lock Position -** The key switch is in the TEST position if the CSC console is being utilized in the DRS modes to initiate commands for vehicles using secure receivers during tests using flight codes.

5.2.5 VIDEO CCTV DISPLAYS

There are three 20-inch Sony CCTV monitors, one each at the MFCO, SMFCO, and VSO consoles, which provide video data from skyscreen TV sites, contraves video, and other optical sources.

Figure 5-2-31: *20-inch Sony CCTV Monitor*

5.2.5.1 Keyset Panel

- **Control Knob -** On the far left side of the panel is a control knob which is used to switch modes and select input or destination sources

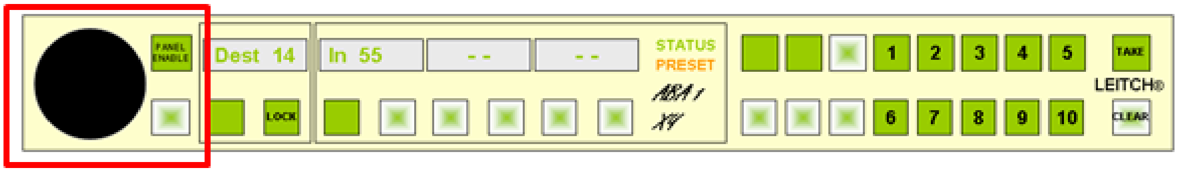


Figure 5-2-32: *Control Knob*

- **Panel Enable Button** - The "PANEL ENABLE" button to the right of the knob enables the panel to be utilized to configure its corresponding CCTV monitor.
- **Display Screens -** The display screens to the right of the control knob allow the user to see the destination output and source input connected to the panel.
- **Destination Output (Dest) Display -** The Destination Output or "Dest" Display indicates the CCTV monitor that is displaying the data.
- **Lock Button -** The keyset button to the right of the "Select Destination" button is the "LOCK" button.

Figure 5-2-33: *Display Screens*

- **Source Input (In) Display -** The Source Input or "In" Display indicates the video channel that has been selected for display on the CCTV monitor listed on the destination panel.

Figure 5-2-34: *"In" Display*

- **LED Indicators -** There are two LED indicators to the right of the displays screens which display the status of the input source listed on the Source Input Display.
  - **"PRESET" LED -** The orange "PRESET" LED is illuminated when the panel is in the Preset mode.
  - **"STATUS" LED -** The green "STATUS" LED is illuminated when the input source listed on the Source Input Display has been selected and is currently being displayed on the CCTV monitor.

Figure 5-2-35: *LED Indicators*

- **Source Select Keyset Enable Button -** The "Source Select Keyset Enable" button is the keyset button located to the right of the LED indicators. This button is illuminated when the panel is in the Source Select Mode.

Figure 5-2-36: *Source Select Keyset Enable Button*

- **Destination Select Keyset Enable Button -** The "Destination Select Keyset Enable" button is located to the right of the "Source Select Keyset Enable" button. This button is illuminated when the panel is in the Destination Select Mode. When this button is selected, it enables and illuminates numeric keyset buttons on the right side of the panel, however, it will only enable and allow the user to select, in order, the numeric keyset buttons of the destination output channel for the monitor to which that panel is connected.

Figure 5-2-37: *Destination Select Keyset Enable button*

- **Numeric Keyset Buttons** - The numeric keyset buttons are utilized to select the source input channel that the operator wants to display on the CCTV monitors.

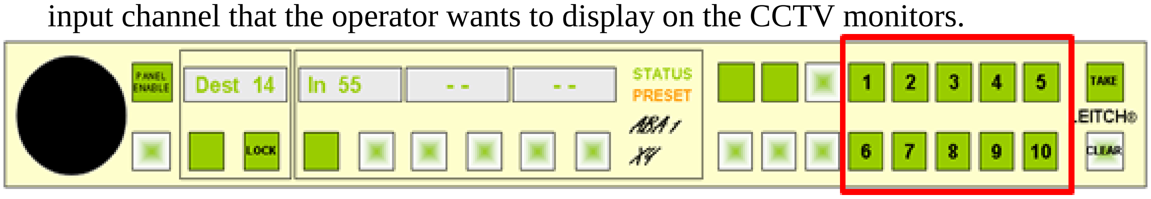


Figure 5-2-38: *Numeric Keyset Buttons*

- **"TAKE" Button -** The "TAKE" button is used to accept the source input channel that has been selected for display on the CCTV monitor. The "TAKE" button begins flashing when the Source Select Keyset Enable Button or the Destination Select Keyset Enable Button is selected. When the keyset button is selected, the selected source input channel will be displayed on the CCTV monitor, the "STATUS" LED indicator will be illuminated, and the Source Select Keyset Enable button will be illuminated.

Figure 5-2-39: *"TAKE" Button*

- **"CLEAR" Button** - The "CLEAR" button is used to clear or blank out the Source Input display and re-enable the Source Select Keyset Enable button. This allows the operator to clear out the source input channel if it was entered in error and select another source input channel. Note that this keyset button is never illuminated.

Figure 5-2-40: *"CLEAR" Button*

- **CCTV Configuration -** To configure the CCTV monitors, enable the panel by pressing the "ENABLE PANEL" button. The button will be illuminated green when the panel is enabled. Next, enable the Source Select Mode by pushing the control knob or the "Select Destination" button to enable the SOURCE SELECT mode, which is indicated when the left keyset button under the Source Input or "In" display and the keyset button to the right of the "PRESET" are illuminated green. From this point there are two different methods which can be used: the Keyset Method or the Scrolling Method.
- **Keyset Method -** If the desired channel is known, the operator can use the numeric keyset buttons to select the desired source input channel.
- **Scrolling Method -** This method can be used scroll to the desired channel or it can be used to scroll through the channels if the desired channel number is not known.

5.2.6 MANUAL TIMERS

There are two manual timers on the right MFCO console panel and on the left SMFCO console panel. One of the manual timers at each console is initiated by the MFCOs at liftoff in order to note the time of certain mission events during flight. The MFCOs may utilize the other timer for certain events in flight in which the MFCO may need to take action within a certain time frame or after a certain period of time has expired. Each timer counts up in seconds from Zero (00 00) to 9,999 seconds (99 99).

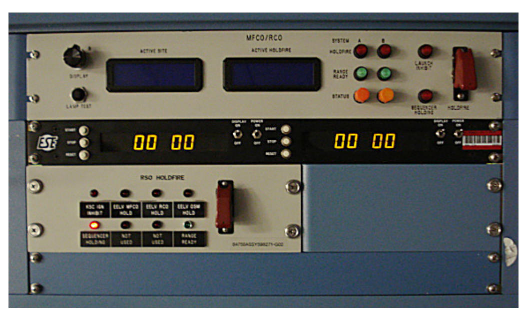


Figure 5-2-41: *Manual Timers*

5-3 SURVEILLANCE CONTROL CONSOLE/EQUIPMENT OPERATIONS

5.3.1 OVERVIEW

Surveillance Control Operations are conducted in the Surveillance Control Center (SCC), Room 160, within the Morrell Operations Center (MOC). From the SCC, Surveillance Control personnel conduct air and sea surveillance control operations from console utilizing the Surveillance Control Display System (SCDS) workstations.

5.3.2 SURVEILLANCE CONTROL CENTER (SCC)

The Surveillance Control Center (SCC), in Room 160 of the MOC, consists of console assemblies for the Surveillance Control Officer (SCO), Deputy SCO (DSCO), Aerospace Control Officer (ACO), Military Radar Unit (MRU), Sea Surveillance officer (SSO), and U.S. Coast Guard Personnel as well as a table and communication panel for the Sea Surveillance Camera Operator (SSCO).

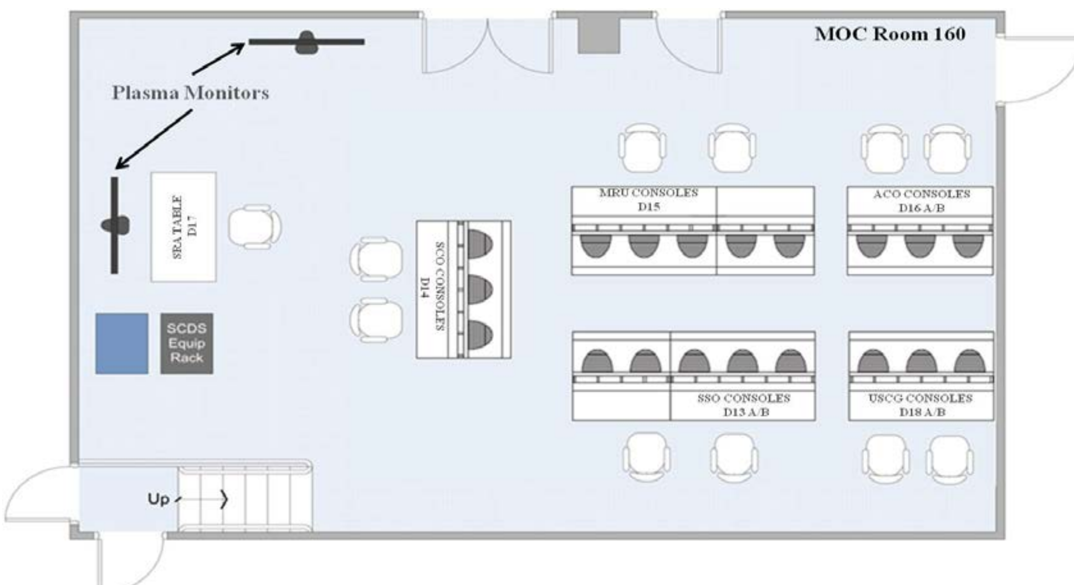


Figure 5-3-1: *Surveillance Control Center Diagram*

5.3.2.1 SCO/DSCO Console

The SCO and DSCO Console is a four-bay Operator Console Assembly consisting of two Red/Black Console Operator End Instrument (COEI), two console operator expansion panels, two Communication Speaker Headset Panels, and one SCDS Workstation with two LCD monitors. The left SCDS workstation monitor has a default configuration for air surveillance. The Right SCDS display has a default configuration for sea surveillance. The video from this display is distributed to be

Figure 5-3-2: *SCO/DSCO Console*

displayed on the two SCC LCD displays, the Commander Advisory Board (CAB) display monitor, the Range Operations Commander (ROC) console display monitor and the scheduling office.

5.3.2.2 SSO Consoles

The SSO consoles are contained in a five-bay Operator Console Assembly consisting of two Red/Black COEIs, two console operator expansion panels, two Communication Speaker Headset Panels, and two SCDS Workstations with three LCD monitors. The left SCDS workstation has two monitors and the right SCDS Workstation has one monitor. The SSO SCDS displays are defaulted to be configured for sea surveillance.

Figure 5-3-3: *SSO Consoles*

5.3.2.3 USCG Consoles

The USCG consoles are contained in a three-bay Operator Console Assembly consisting of two Red/Black COEIs, two Communication Speaker Headset Panels, one SCDS Workstation with a LCD monitor, two digital Desksets with a HF Radio CPU Assembly (COAM) which allow the Coast Guard to monitor maritime frequencies and to communicate with Coast Guard patrol vessels and target surface vessels on the maritime frequencies. The USCG SCDS display is defaulted to be configured for sea surveillance.

Figure 5-3-4: *USCG Consoles*

5.3.2.4 ACO Consoles

The ACO Consoles are contained in a three-bay Operator Console Assembly consisting of two Red/Black COEIs, two console operator expansion panels, two Communication Speaker Headset Panels, one SCDS Workstation with a LCD monitors, and a STE Phone. The ACO SCDS display is defaulted to be configured for air surveillance.

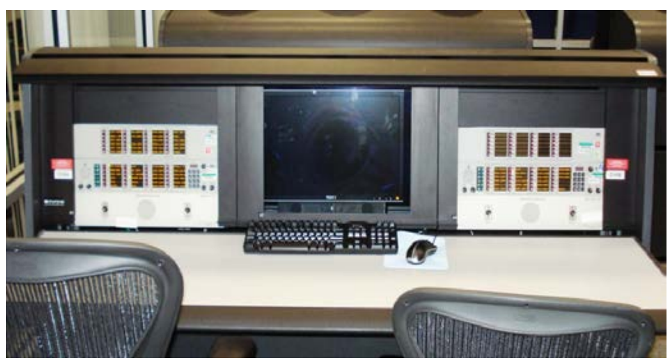


Figure 5-3-5: *ACO Consoles*

5.3.2.5 MRU Console

Figure 5-3-6: *MRU Console*

The MRU Console is contained in a five-bay Operator Console Assembly consisting of one Red/Black COEI, one console operator expansion panel, one Communication Speaker Headset Panel, two Touch Entry Display (TED) Communications Panel Assemblies designed specifically for the air traffic control environment gives the MRU access to air-to-air and air-to-ground radios and land-line telephones, two Air Traffic Control (ATC) Central Processing Unit (CPU) Assemblies, and one SCDS Workstation with two LCD monitors. The MRU SCDS displays are defaulted to be configured for air surveillance.

5.3.2.6 Sea Surveillance Camera Operator (SSCO) Table

The SSCO Table is located behind the SCO/DSCO console. It consists of one Red/Black COEI, one console operator expansion panel, one Communication Headset Panel, one 50-inch Plasma Display Monitor slaved to the SCO's right SCDS Display, workspace with LAN access for the SSCO's laptop computer and one STE for use by the SCO or DSCO.

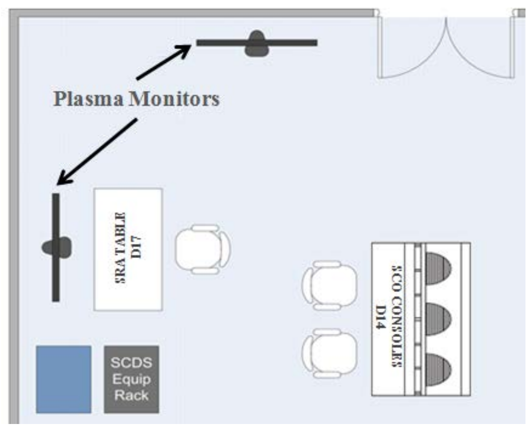


Figure 5-3-7: *SSCO Table*

5.3.3 SURVEILLANCE CONTROL DISPLAY SYSTEM (SCDS)

5.3.3.1 Overview

The Surveillance Control and Display System (SCDS) is a multi-sensor surveillance and information management system. It uses the Regional Maritime Awareness Capability-Integrated Traffic Management System (RMAC-ITMS) software which is also known as *Sure Trak*. The software was designed to provide seaports and test ranges with an effective and reliable means of monitoring critical air/surface operations. It uses Windows/Windows 2003/XP style pull-down menus to provide a fast and familiar interface to the user.

The SCDS Display is used by the surveillance crew to:

- Display and plot Sea and Air traffic data tracks from the surveillance radars, the Automatic Identification System (AIS), and the support assets
- Display area maps to monitor air and sea traffic restrict areas
- Display overlays of local area reference points and hazardous areas
- Display safety provided contours and NOTAM/NOTMAR areas

- Provide user the ability to input track data

5.3.3.1.1 Data Tracks

SCDS Data tracks consists of up to four components:

- Track Icon: The track icon indicates the track's type and location
- Data Block: The track's data block provides certain information on the target. The information that is displayed depends on the type of target
- Speed Leader: If the target is moving, the track will have a speed leader which is a solid line pointing in the direction of the track's motion. It provides a visual indication of the track's speed and an approximation of where it will be after a certain time interval
- History Points: If the target is moving, the track will have history points which are a trail of small dots behind the track icon. The history points provide a visual indication of where the track has been. History points are typically used by the MRU when monitoring aircraft tracks.

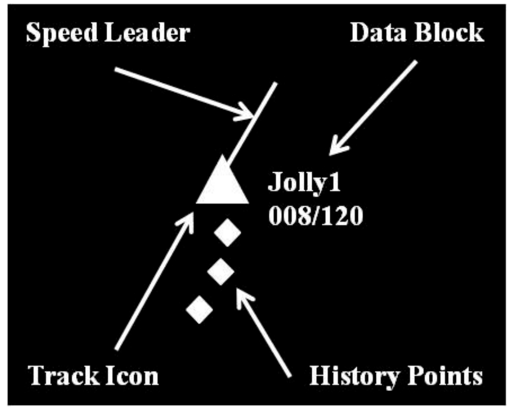


Figure 5-3-8: *Date Tracks*

Data tracks have different colors and icon shapes due to the type of track and/or tracking source. There are four types of SCDS data tracks used on the Eastern Range (ER): Air Surveillance Radar tracks, Sea Surveillance Radar tracks, Automatic Identification System (AIS) tracks and Simulated (Sim) tracks.

- **Air Surveillance Radar Tracks -** There are two types of air surveillance radar tracks: Skin Tracks and Identification Friend or Foe (IFF) Beacon Tracks.
- **Skin Tracks** - Skin Tracks, also referred to as Radar Plots, are created by aircraft without a beacon, tall structures, or weather returns. These tracks are represented by a square green icon. The skin tracks do not include a data block but they will have a speed leader if the track is moving
- **Identification Friend or Foe (IFF) Beacon Tracks (Mode 3/A Tracks) -** IFF Beacon tracks or Mode 3/A tracks are created by aircraft with a beacon transponder. These tracks are represented by a white triangle icon. The default data block info for these tracks includes:
- The aircraft's squawk code or call sign. The applicable call sign can be assigned to the corresponding mission squawk code by the SCDS operator so that the call sign is displayed on the IFF track instead of the squawk code

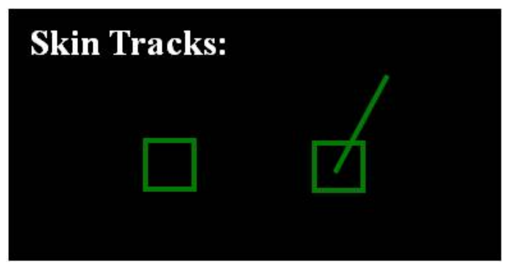


Figure 5-3-9: *Skin Tracks*

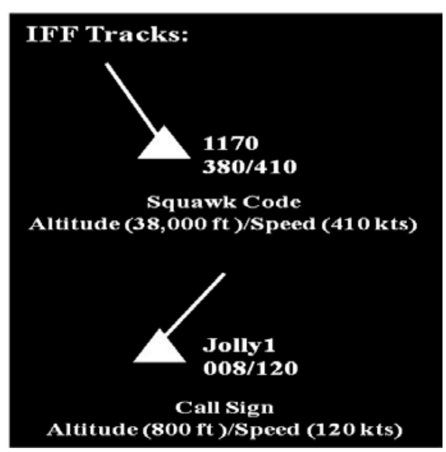


Figure 5-3-10: *Identification Friend or Foe Beacon Tracks*

- The aircraft's altitude in hundreds of feet. For example, 380 represents an altitude of 38,000 feet and 008 represents an altitude of 800 feet
- The aircraft's speed in knots

Additional track information can be displayed if the mouse is used to "hover" the cursor over the track. The mouse hover data block info for these tracks includes: the aircraft's squawk code or call sign, the aircraft's altitude in hundreds of feet, the aircraft's speed in knots, and the aircraft's position in latitude and longitude.

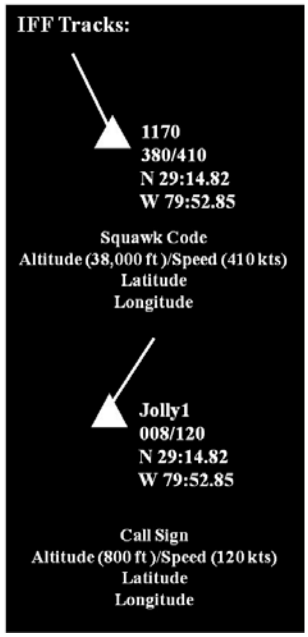


Figure 5-3-11: *Air Surveillance Radar Tracks*

- **Sea Surveillance Radar Tracks** - Sea Surveillance Radar Tracks are surface returns detected by the Sea Surveillance Radars (SSRs) for which the SSRs have a solid track return. These returns include returns from boats/ships, the sea state, and weather. Note that the SSRs may not be able to acquire a track and provide data on all of the surface targets within range due to the strength of the return signal. Returns that cannot be tracked will be displayed as irregular shapes. Returns that can be tracked will be displayed with a diamond icon and assigned an ID number. The radar images from each SSR are displayed in a user assigned color. SSR North images are displayed in green while SSR South images are displayed in yellow. Reference figure 5-3-12. The default data block for sea surveillance tracks include (reference figure 5-3-13).
- The radar assigned ID number or the vessel's name. The applicable SSR will automatically assign a five character alpha-numeric ID number to the surface track which will be displayed with the surface track. The ID number consists of the letter "U" followed by a four digit number, such as "U3883". The SCDS operator can assign a vessel name to the

Figure 5-3-12: *Sea Surveillance Radar Tracks*

surface track to be displayed instead of the radar ID number. Note that if the radar loses and then re-acquires track of the target, the vessel name will be lost and the radar will assign and display a new ID number for the track
- The vessel's heading in degrees
- The vessel's speed in knots

Additional track information can be displayed if the mouse is used to "hover" the cursor over the track. The mouse hover data block info for these tracks includes (reference 5-3-14).
- The radar assigned ID number or the vessel's name
- The vessel's position in latitude and longitude
- The vessel's heading in degrees
- The vessel's speed in knots

Note that the operator will have to compare the data block info and the track's behavior to detect false targets. If the track's heading is erratically changing and/or the track indicates a speed but the track is not moving, then the track is most likely due to weather or the sea state.

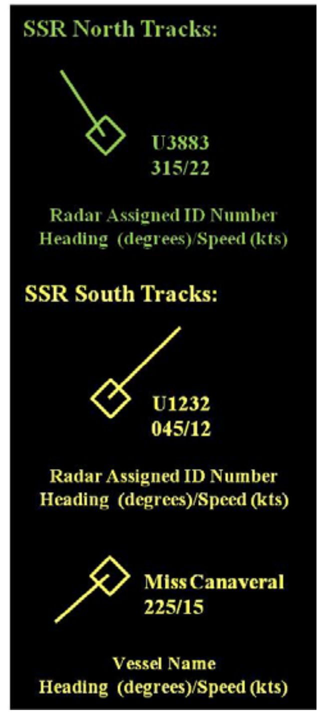


Figure 5-3-13: *Default Data Block*

Automatic Identification System (AIS) Tracks

AIS Tracks are created from information provided by AIS transmissions from surface vessels within range of the AIS receiver mounted with SSR South. These tracks can only be displayed on the SCO, SSO, and USCG consoles. These tracks are represented by an orange square icon. The default data block for these tracks include (reference 5-3-15):
- The vessel's name
- The vessel's heading in degrees
- The vessel's speed in knots

Note that some of the data that is available for display depends on what is configured to be transmitted by the vessel's operator. Additional track information can be displayed if the mouse is used to "hover" the cursor over the track. The mouse hover data block info for these tracks includes:
- The vessel's name
- The vessel's heading in degrees
- The vessel's speed in knots
- The Vessel International Maritime Organization (IMO) Number (Vin) if a Vin is assigned to the vessel
- The vessel's Maritime Mobile Service Identity (MMSI), if assigned
- The vessel's dimensions in meters if it is configured by the vessel's operator

Figure 5-3-14: *Mouse Hover Data Block*

In addition, hovering the cursor over the track also displays:

Figure 5-3-15: *Automatic Identification System Tracks*

- A scaled representation of the vessel's dimensions and orientation if the vessel operator configured the transmitter with the vessel's dimensions
- The approximate location of the vessel's position sensor/transducer, which is providing the information on the location of the vessel, if configured by the vessel's operator

The SCDS operator can also select additional information to display, if configured by the vessel operator, to include:

- Navigation status: Options include "moored", "at anchor", "under way using engine", and "not under command"
- Type of position fixing device: Includes various options from differential GPS to undefined
- Position Accuracy: Defines the accuracy of the vessels position information due to the type of position fixing device
- Type of ship/cargo
- Callsign
- Destination
- Estimated Time of Arrival (ETA)
- Max Draught
- **Simulated (Sim) Tracks** - Simulated tracks allow the operator to mark the location or predict the location of vessels that are outside of radar coverage or vessels for which the radars are having trouble tracking. They are created based on information provided by the support assets. They are represented by a blue triangle icon. There are two types of simulated tracks: Parked (PRK) Tracks and Dead Reckoning (DR) Tracks. Reference figure 5-3-18.

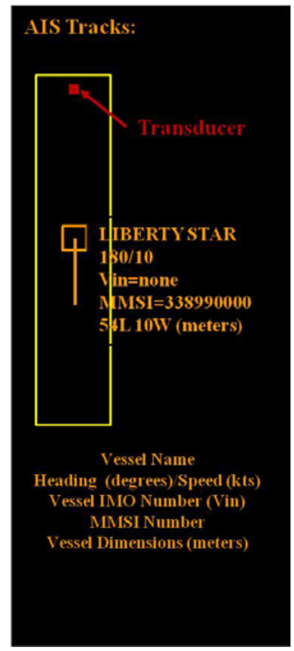


Figure 5-3-16: *Automatic Identification System Tracks*

- **Parked (PRK) Tracks** - A PRK Track is used to mark the location of an anchored vessel. It is created based upon an operator defined position. A PRK track has a sim track type mark of "PRK" displayed near it. The default data block for these tracks include (reference figure 5-3-19).
- The system assigned vessel number or the vessel's name. The system software will automatically assign a five character alpha-numeric ID number to the surface track which will be displayed with the surface track. The ID number consists of the letter "U" followed by a four digit number, such as "U0114". The SCDS operator can assign a vessel name to the sim track to be displayed instead of the system assigned vessel number
- A vessel heading and speed of "0."

Hovering the cursor over the track also displays the vessel's position in latitude and longitude

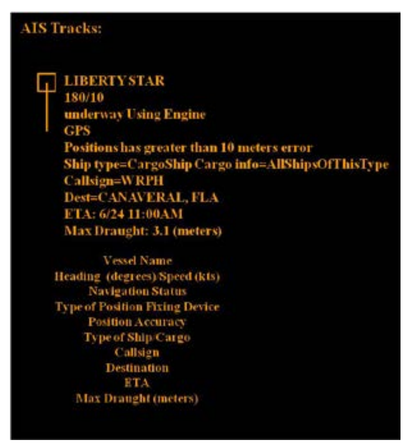


Figure 5-3-17: *AIS Tracks Additional Information*

Dead Reckoning (DR) Tracks - A DR Track is used to simulate the track of a moving vessel. It is created based upon an operator defined position, course and speed. A DR track has a sim track type mark of "DR" displayed near it. The default data block for these tracks include:

- The system assigned vessel number or the vessel's name. The system software will automatically assign a five character alpha-numeric ID number to the surface track which will be displayed with the surface track. The ID number consists of the letter "U" followed by a four digit number, such as "U0114". The SCDS operator can assign a vessel name to the sim track to be displayed instead of the system assigned vessel number.
- The vessel's heading in degrees
- The vessel's speed in knots

In addition, hovering the cursor over the track also displays:

- The vessel's position in latitude and longitude
- The value set by the operator for the speed leaders of the surface tracks

Figure 5-3-19: *Simulated Tracks*

Figure 5-3-18: *Parked Tracks*

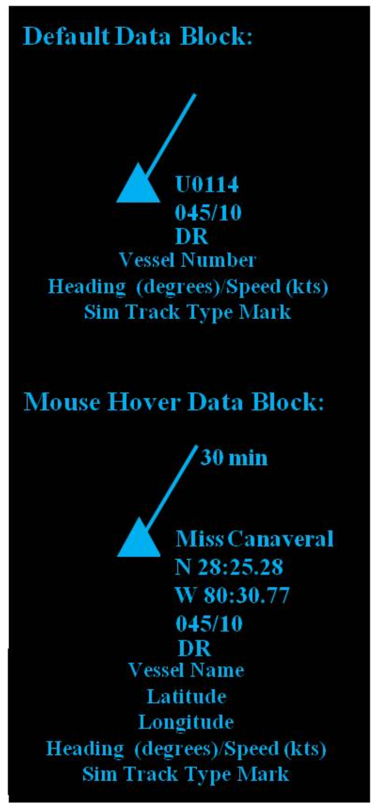


Figure 5-3-20: *Dead Reckoning Tracks*

5.3.3.1.2 Radar Control Icons

Radar control icons are used to control the display of surface radar data and to provide the operator indications on the status of the radar data. There is a radar control icon for each SSR. Double clicking the left mouse button on an icon for a particular site either enables or disables that site's radar data for display at the workstation. When the icon is solid green, it indicates that the display of radar data from that site has been enabled. When the icon is solid red, it indicates that the display of radar data from that site has been disabled. Right clicking the icon provides access to the SSR control panel.

The color of the icon can also provide an indication of problems with the site data. A solid blue icon indicates that the main processor is receiving data outside the system latency tolerance of 3 seconds. A solid yellow icon indicates that the radar image data is older than the system warning threshold level of 30 seconds. A solid black icon indicates that no data from the radar site is available. This could indicate a problem at the site or that the received data from the side is outside the blanking threshold of 60 seconds.

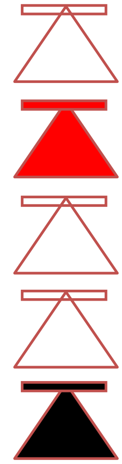


Figure 5-3-21: *Radar Control Icons*

5.3.3.1.3 Maps

The SCDS can be configured to display maps of various air and sea areas to aid the surveillance crew in detecting intrusions into restricted air and sea space by air and sea traffic. These maps include:

- The Florida coastline
- ER Airspace
- The Cape Security Zone
- The USCG Safety Zones
- Local area runways
- Laser operations hazard areas

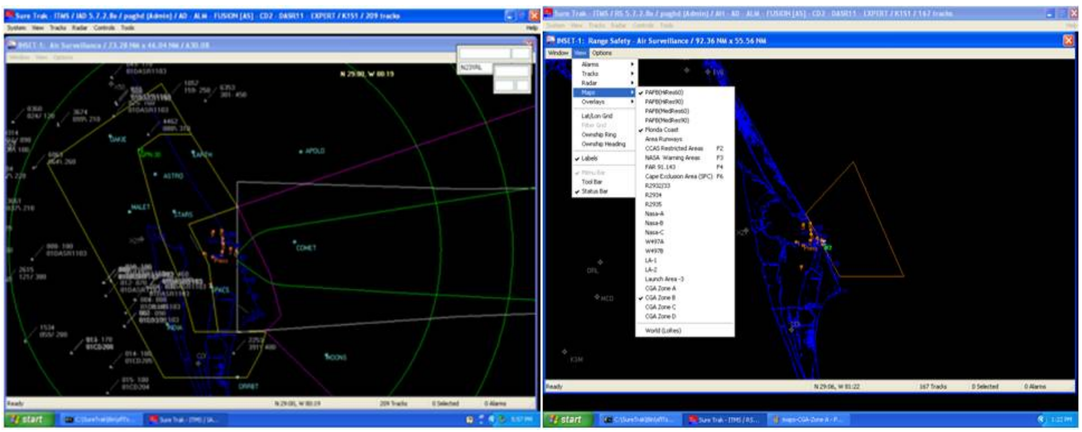


Figure 5-3-22: *Maps*

5.3.3.1.4 Overlays

The SCDS can be configured to display overlays to provide points of reference to the surveillance crew and to aid the surveillance crew in detecting intrusions of hazardous areas by air and sea traffic. These overlays include:

- Launch Contours
- The SCO Box
- Buoys
- Air Navigation Waypoints
- Air Surveillance Radar locations
- Airport locations
- Kennedy Space Center (KSC) Helipad locations

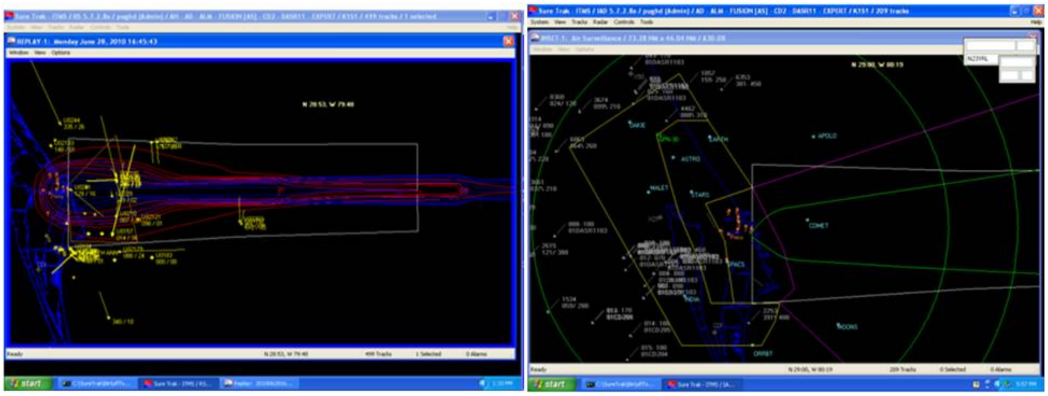


Figure 5-3-23: *Overlays*

5.3.3.1.5 System Alarms

The SureTrak software allows the operator to display and control several types of audio and visual alarms. These alarms alert the operator when tracked aircraft or surface vessels violate established geographic boundaries or other user-defined conditions. The alarms can be presented to the operator in a number of different ways including colored circles, blinking icons, audible announcements, and textual descriptions. Operators may designate one or more inset windows for automatic display of track alarms.

There are four types of system alarms: proximity alarms, boundary alarms, exclusive use area alarms, high-dynamic notification alarms.

Figure 5-3-24: *Proximity Alarm*

- **Proximity Alarm** - A Proximity alarm is an alarm that occurs when two aircraft approach within a specified distance and altitude of each other. Proximity alarms are only displayed for named tracks. Proximity alarms are indicated by red range rings around the aircraft in the alarm condition

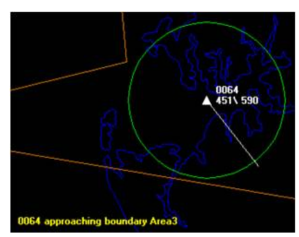


Figure 5-3-25: *Boundary Alarm*

- **Boundary Alarm** - A Boundary alarm is an alarm that occurs when any aircraft or surface track is within a specified distance or altitude (aircraft) of a boundary area (airspace or closed polygon). Boundary alarms are not currently used on the ER SCDS.
- **Exclusive User Area Alarm** - An Exclusive Use Area alarm is an alarm that occurs when any aircraft or surface vessel is within a defined volume of airspace or a defined surface area. Exclusive Use Area alarms are not currently used on the ER SCDS

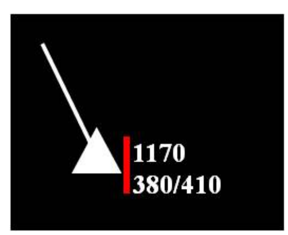


Figure 5-3-26: *High-Dynamic Notification and Alarm*

- **High-Dynamic Notification and Alarm** - The system will expand the alarm criteria to accommodate high-dynamic aircraft. Allowances are made for horizontal and vertical velocities and for directional rate-of-turn. All parameters are configurable. The system identifies high-dynamic aircraft for the operator by a red vertical bar to the left of the aircraft data block.

5.3.3.1.6 Modes of Operation

The RMAC-ITMS Integrated Track Management System has two configurable operational modes: 1) The Range Safety mode for ground and ocean-going vessels and Integrated Air Display (IAD) mode for aircraft.

- **Range Safety (RS) Mode** - On the ER, the RS mode is utilized on the consoles that are used for performing sea surveillance to include the SCO, SSO, and USCG consoles. The RS mode includes the following features:
- **Track Alarms** - All track alarms are based on surface tracks. Other track sources may be displayed but are not alarmed. In the RS mode, the operator can define Boundary and Exclusive Use Area alarm conditions **Speed Leaders** - Surface track speed leaders can be set to a specified time interval or synched to a launch countdown timer. In addition, the speed leaders for simulated tracks are linked to surface track speed leaders
- **SSR Control** - The RS mode also allows the operators to remotely control the SSRs
- **Integrated Air Display (IAD) Mode -** On the ER, the IAD mode is utilized on the consoles that are used for performing air surveillance to include the ACO, MRU, and Shuttle Landing Facility (SLF) consoles. The IAD mode includes the following features:
- **Track Alarms -** All track alarms are based on IFF tracks. Other track sources may be displayed but are not alarmed. In the IFF mode, the operator can define all of the types of system alarm conditions
- **Speed Leaders -** Air track speed leaders can be set to a specified time interval. They cannot be synched to a launch countdown timer. In addition, the speed leaders for simulated tracks are linked to air track speed leaders. The IAD mode allows the user to correct an air track's (IFF based) Mode C altitude with the reported altimeter setting for the geographic region
- **Altitude Correction -** The IAD mode allows the user to correct an air track's (IFF based) Mode C altitude with the reported altimeter setting for the geographic region
- **Altitude Filtering** - The IAD mode allows the user to utilize Altitude Filtering. When enabled, only the aircraft within a set altitude range are visible on the display
- **Geo-Filtering** - The IAD mode allows the user to utilize Geo-Filtering. When enabled, only aircraft within certain geographic areas are visible on the display
- **Beacon Select Window** - The Beacon Select window appears on the IAD display and will always remain on top of other windows. It allows the operator to quickly identify "select" tracks to the system. The operator can enter a 2 or 4 digit code. Tracks whose IFF codes begin with the 2 digit code or exactly match the 4 digit code become "select" tracks. Entering a 2 or 4 digit code already in the list removes that code from the list. Pressing the "+" key on the numeric keypad automatically places focus in this window or the operator can simply click within the window
- **Acquisition/Drop List Window -** The Acquisition/Drop List window appears on the IAD display and will always remain on top of other windows. It allows the operator to input a specific callsign and IFF code for aircraft pending acquisition by the system. When the discrete IFF code of an aircraft in the acquisition list appears in the system, the associated operator entered callsign will appear with that code. If tracks in this list are no longer reported and have temporarily dropped from the display they remain in this "drop list". When they reappear in the system, it automatically re-associates the aircraft callsign with that code. Entering a callsign in the Acquisition Drop List and pressing the "Enter" key will automatically assign that name to the next

code available as determined in the Next Code Configuration. Aircraft in the drop list may be deleted as a group by pressing the Shift and Delete keys together. Pressing the "F12" key automatically places focus in this window or the operator can simply click within the window.

5.3.3.1.6 System Access

SCDS accounts are managed by 1 ROPS. Personnel who need SCDS accounts have to contact 1 ROPS personnel to establish a username and password. 1 ROPS personnel also determine the appropriate level of system access for each individual. There are four levels of system access:

- **External User:** This level of access limits the operator to only be able to view data on the system
- **Operator:** This level of access limits the operator to basic system operation capabilities
- **Supervisor:** This level of access allows the operator to be able to perform basic system operation plus allows access to system settings and configuration data
- **Administrator:** This level of access allows the operator to have full system level access

System capabilities beyond the user's access level are grayed out. Surveillance crewmembers are given the Operator level of access. This lesson will focus on system capabilities at the Operator level of access.

5.3.3.1.7 System Start-Up and Logon

When the operator arrives at the SCDS workstation, the RMAC-ITMS application should already be up and the Sure Track Logon Graphical User Interface (GUI) should be present. If the application is not active, the user can start the application from the Windows Start menu by clicking Start - Programs - Startup - Sure Track (Client) icon. Once the Sure Track Logon GUI is present, personnel can logon to SCDS by entering their assigned username and password and clicking "OK" or pressing the Enter key.

Figure 5-3-27: *System Logon*

5.3.3.2 Display Components

Each SCDS workstation display consists of a PC Workstation clock, System Menu Bar, and Inset Windows.

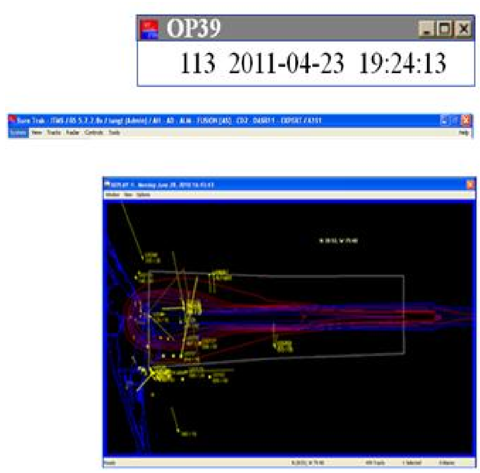


Figure 5-3-28: *Workstation Display*

5.3.3.2.1 PC Workstation Clock

The PC Workstation Clock resides on the workstation PC and is not part of the SCDS software application. The PC Workstation Clock displays the name of the workstation and the workstation timing information to include the Julian Day, the date in YYYY-MM-DD format and the Zulu time in HH:MM:SS format. Note that if the workstation’s Zulu time does not match the Zulu time of the wall clocks in the SCC, then the workstation may have trouble displaying data from the sea surveillance radars due to the data not meeting the system latency or threshold limits.

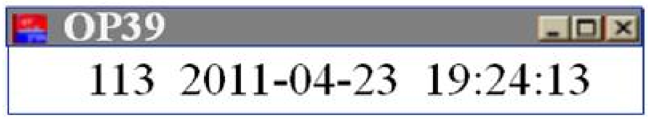


Figure 5-3-29: *Workstation Clock*

5.3.3.2.2 System Menu Bar

The System Menu bar provides system configuration information and submenu options that are global in nature in that they affect all inset windows. The top portion of the System Menu bar provides information on the current system configuration. The bottom portion provides a number of submenu options to include: System, View, Tracks, Radar, Controls and Tools.

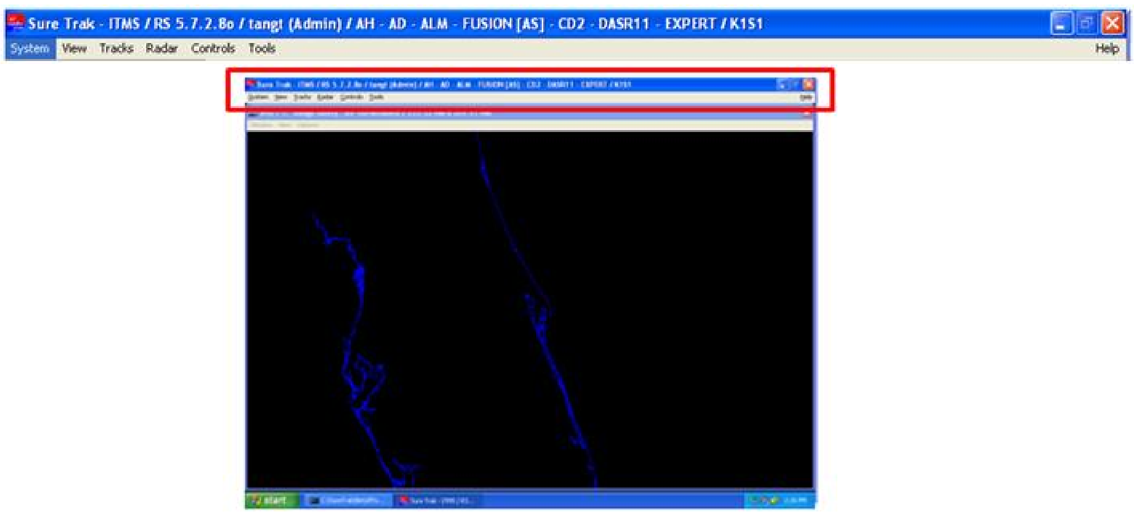


Figure 5-3-30: *System Menu Bar*

5.3.3.2.3 System Submenu

The System Submenu item includes the following options: “New Inset Window”, “Settings”, “Logoff”, “Save” and “Exit”

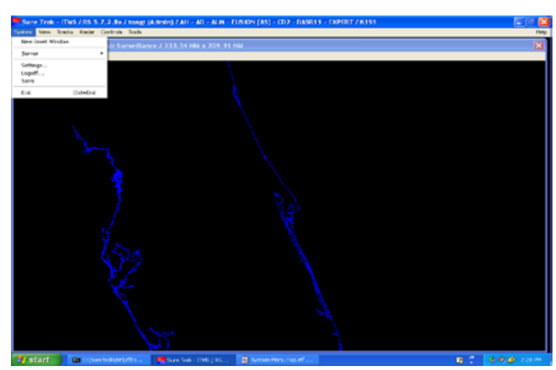


Figure 5-3-31: *New Insert Window Option*

- **New Inset Window Option** - The New Inset Window options allows for a new inset window to be generated. The maximum number of inset windows that can be displayed is 10. Note that system performance may be affected if an excessive number of inset windows are open
- **Server Option** - The Server option allows the

ability to switch between the primary and stand-by server. When selected, the primary server will undergo a gradual shutdown process and the stand-by server transitions to primary status. This option is not available to the average user. If a switchover is required, it will be performed by ERTS personnel.

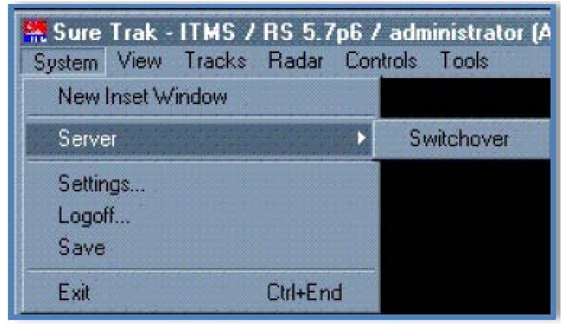


Figure 5-3-32: *Server Option*

Another item to note is under the "Settings" menu item. You will want to select "Settings", followed by the "Tracks" Tab and verify that the box next to the phase "Auto-Hide Non-Moving Datablocks" is not checked. This will allow you to see the information on "Parked" simulated tracks.

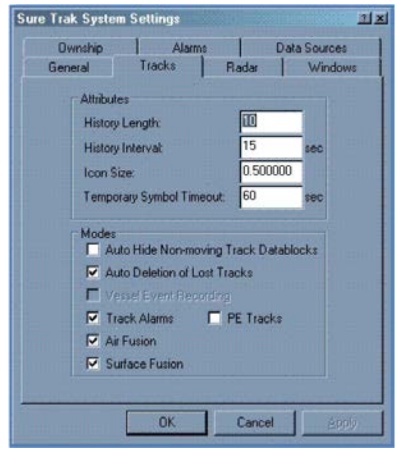


Figure 5-3-33: *Settings Option*

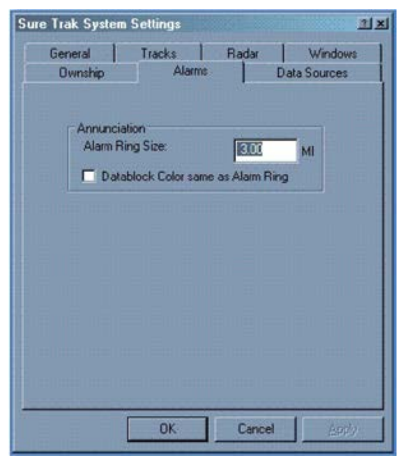


Figure 5-3-34: *Alarms Tab*

- **Settings Options** - The Settings option pops-up the multi-tabbed System Settings GUI. Each tab within the GUI is used to configure a specific aspect of the SCDS System. There are a couple of tabs of interest on this GUI.
- **Tracks Tab** - The Tracks tab is used to configure the track displays. The User should ensure the "Auto-Hide Non-Moving Datablock" box is not checked. This allows users to see target information such as vessel name, heading, and speed on parked surface radar and simulated tracks. If this box is checked, the user will not be able to see the name of the vessel when the track is parked. The use should also ensure that the "Track Alarms" box is checked. This enables all alarm features.
- **Alarms Tab** - The Alarms Tab allows the user to re-define two aspects of the alarm areas. The Alarm Ring Size Numeric Text Box allows users to define the size of the ring displayed around a track when it enters into an alarm condition. The track alarm ring will disappear when the track is no longer in the alarm condition. Checking the "Datablock Color same as Alarm Ring" box will change the track's Datablock color to the color of the alarm ring when the track enters into an alarm condition. The color will change back to the default color when the track ring disappears and the track is no longer in the alarm condition.
- **Logoff Option** - The Logoff option allows the user to logoff of the system.
- **Save Option** - The Save option allows the user to save or capture the system configuration settings to disk.
- **Exit Option** - The Exit option allows the user to exit or close the RMAC-ITMS application.

5.3.3.2.4 View Submenu

The View Submenu item includes the following options. “Information Window”, “Value Display Formats”, and “Cursor Modes”.

Information Window Option - The Information Window displays messages concerning software processes and commands and is used for system analysis and debugging. The Information Window option is not used for surveillance operations.

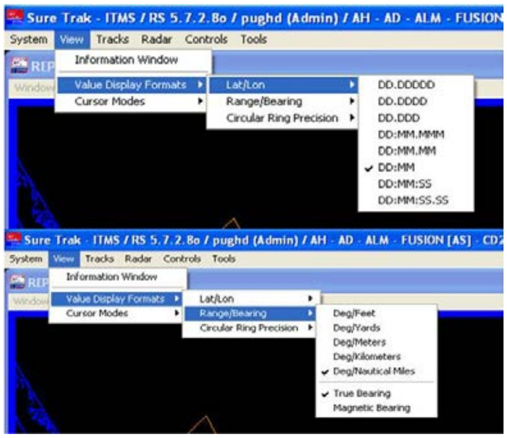


Figure 5-3-35: *Value Display Formats*

- **Value Display Formats Option** - The Value Display Formats option allows the user to select the data format for Latitude/Longitude and Range Bearing information. For Surveillance options, DD:MM:MM are used for Latitude/Longitude, nautical miles are used for Range, and True Bearing is used for Bearing. Selecting the Circular Ring Precision option displays the Circular Ring Precision Format Submenu which allows the user to select the distances for a set of four range rings available for use in the Cursor Modes option.
- **Cursor Modes Option** - The Cursor Modes option allows the user to select the data that is displayed with the cursor.

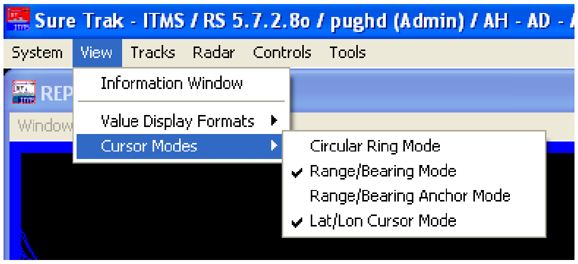


Figure 5-3-36: *Cursor Modes Option*

- **Circular Ring Mode** - The Circular Ring Mode allows the user to enable or disable a movable display of four increasingly larger range rings (numbered from innermost to outermost). It allows the user to approximated distances between targets and other inset window objects.
- **Range/Bearing Mode** - The Range/Bearing Mode allows the user to measure the distance (range) and direction (bearing) between any two points on an inset window. To do this, the user draws a line between the points by clicking the left mouse button on the first point and dragging the line to the end point while continuing to press the left mouse button. The range and bearing of the end point from the first point is displayed along the line. The line can be rotated to any other location as long as the user continues to press the left mouse button. When the left mouse button is released, the line disappears. This mode is typically used for surveillance operations.

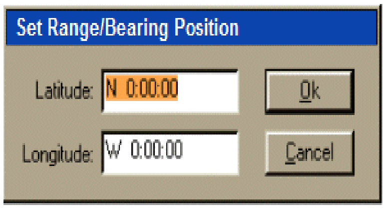


Figure 5-3-37: *Lat/Long Cursor Mode*

- **Range/Bearing Anchor Mode** - The Range/Bearing Anchor Mode allows the user to determine the range and bearing of any object from one established anchor point. The user does not have to hold down the left mouse button. When utilized, a "Set Range/Bearing Position" GUI appears and allows the user to establish an anchor point in latitude and longitude. The user can then use the cursor to draw a line to any point and determine its range and bearing from the established anchor point. To remove the line, the user has to de-select the mode option.
- **Lat/Long Cursor Mode** - The Lat/Lon Cursor Mode allows the latitude and longitude of the cursor position to be displayed. This mode is typically used for surveillance operations.

5.3.3.2.5 Tracks Submenu

The Tracks Submenu item includes options which allow the user to create simulated tracks and configure how track data is displayed. Not all of the options under this menu are available to personnel with the Operator level of access.

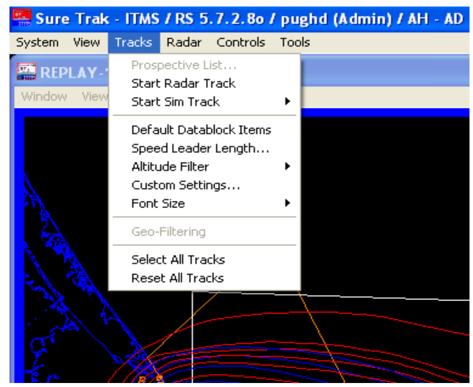


Figure 5-3-38: *Tracks Submenu*

- **Start Radar Track Option** - The Start Radar Track option allows a user to manually start a radar track on a surface vessel. This option is not used for ER surveillance operations because the system is configured to auto-acquire and display the speed and heading information for all surface vessels within range of the sea surveillance radars.
- **Start Sim Track Option** - The Start Sim Track option allows the user to create a simulated DR or PRK track. Selecting either DR or PRK will pop up an associated start track GUI. The GUI allows the operator to enter a position in latitude and longitude, a speed in knots, and a direction or bearing in degrees.
- **Speed Leader Length Option** - The Speed Leader Length option allows the user to determine a length of the speed leader for air ad surface tracks. Selecting the Speed Leader Length option pops-up the Speed Leader Options GUI. The speed leader length or time can be configured separately for air and surface tracks. For air and surface targets, the user can select a whole number value and the desired units of seconds, minutes, or hours for the speed leader. Note that the speed leader length must be entered as a whole number, not a decimal. Using decimals will crash the RMAC-ITMS application. The speed leader value is not applied until the user selects "OK". This will also close out the Speed Leader window. The user has to re-open the Speed Leader Option GUI in order to change the speed leader value.

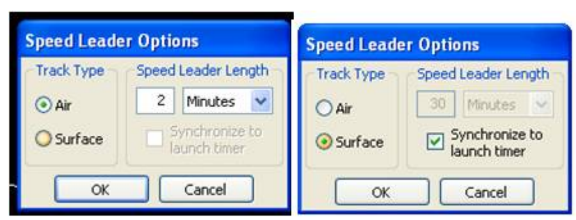


Figure 5-3-39: *Speed Leader Option Box*

In addition, surface targets can be synchronized to a launch countdown timer. This option alters the speed leaders in response to a launch countdown timer, providing an estimated position for all vessels at T-0.

Figure 5-3-40: *Speed Leader Option*

The speed leaders for DR tracks are affected differently depending on the workstation operating mode. In the RS mode (SCO/DSCO, SSO, and USCG consoles), DR track speed leaders are changed by adjusting the speed leader for surface tracks. In the IAD mode (ACO, MRU, and SLF consoles), DR track speed leaders are changed by adjusting the speed leader for air tracks. If there are a lot of DR tracks due to surface targets during launch operations, the ACO and MRU can disable the ability to display DR tracks to avoid confusion when adjusting the speed leaders for air targets.

- **Altitude Filter Option** - The Altitude Filtering option is only available in the IAD mode. When selected, it displays the Altitude Filter Submenu which allows the use to configure the placement of the altitude filter readout with the inset window and the font color of the readout when altitude filtering is used.
- **Font Size Option** - The Font Size option allows the user to change the font size of the information in the data blocks for each track. Selecting this option will display a two-item menu with Decrease and Increase options. Each option is grayed out when the font size can no longer be increased or decreased.
- **Geo-Filtering Option** - The Geo-Filtering option is only available in the IAD mode. When this option is selected it allows the user to use the Edit Filter Grid option in the Inset Window Option menu.
- **Select All Tracks Option** - The Select All Tracks option allows the user to select each and every track in the inset windows.
- **Reset All Tracks Option** - The Reset All Tracks option allows the user to reset all tracks to their default values and to delete all lost or stale tracks from the map display. Any active tracks remaining after the reset command will reappear on the map display.

5.3.3.2.6 Radar Submenu

The Radar Submenu item contains options that affect various elements of sea surveillance radar operation and configuration. Not all of the options under this menu are available to personnel with the Operator level of access.

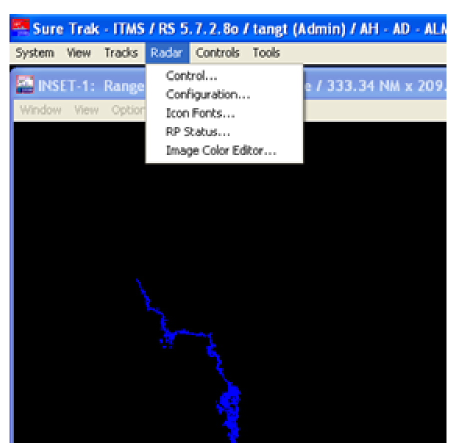


Figure 5-3-41: *Radar Submenu*

- **Control Option** - The Control option displays the Radar System Site Select GUI which allows the user to select the radar site to be configured. When the desired Site Name is selected from the Radar System Site Control Panel, and the “OK” Pushbutton is selected, the Radar System Site Control Panel is displayed. The Radar System Site Control Panel enables the user to control the radar display for the selected site.

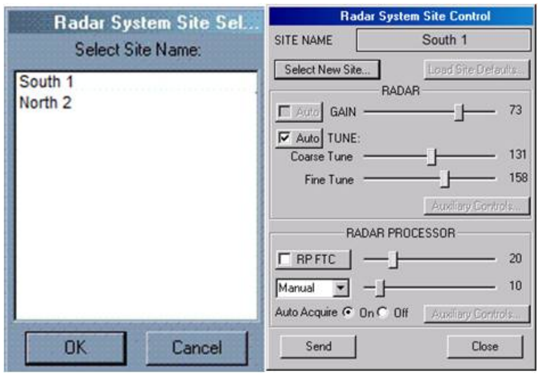


Figure 5-3-42: *Radar System Site Control Panel*

- **Configuration Option** - The Configuration option allows for detailed configuration of surface radar parameters for a selected available site. This option is not configurable at the Operator level of access.
- **Icon Fonts Options** - The Icon Fonts option displays the Font GUI which allows the user to configure the fonts used in the SSR tracks.

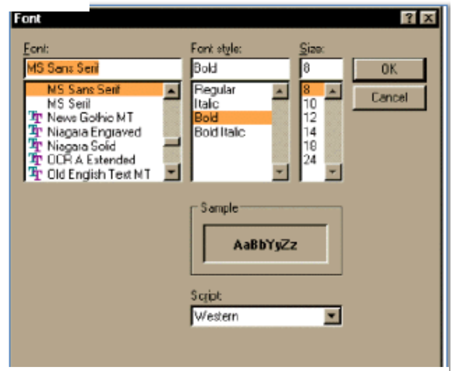


Figure 5-3-43: *Font GUI*

- **RP Status Option** - The RP Status option displays the RP Status Window which contains information reported to the system by each SSR. This information includes:
- The radar mode (auto, short pulse 1 & 2, medium pulse 1 & 2, or long pulse).
- Current radar state (off, standby, rotate, rotate and radiate)
- Tune Indicator
- Detections per scan (echoes above the detection level; tracker sensitivity sets this detection level)
- Targets (centroids that have been through clutter rejection processing)
- Tracks (number of tracks passed to the RMAC-ITMS system by this SSR)
- Total time with transmit on (hours:minutes:seconds)
- Total time with power on (hours:minutes:seconds)
- Countdown seconds until available for transmit (from off to standby takes 60 seconds)

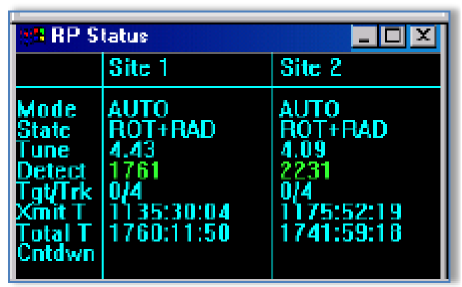


Figure 5-3-44: *RP Status Window*

The RP Status Window is used by the ERTS contractor to verify the performance of the SSRs.

- **Image Color Editor Option** - The Image Color Editor Status option is used to select the color for the radar images that are displayed from each SSR. Selecting the Image Color Editor Status option displays the Edit Radar Image GUI which allows the operator to select the desired SSR site. When a site is selected and the Edit pushbutton is left-

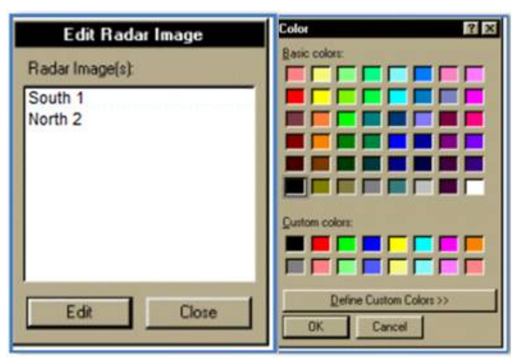


Figure 5-3-45: *Color GUI*

clicked, the Color GUI is displayed which allows the operator to choose a desired color for the selected site.

Note that for surveillance operations on the ER, the North SSR radar images are default selected to be green and the South SSR radar images are default selected to be yellow. The operator should not change these colors.

5.3.3.2.7 Controls Submenu

The Controls Submenu item contains options that affect the configuration of various display elements of the SCDS system. Not all of the options under this menu are available to personnel with the Operator level of access.

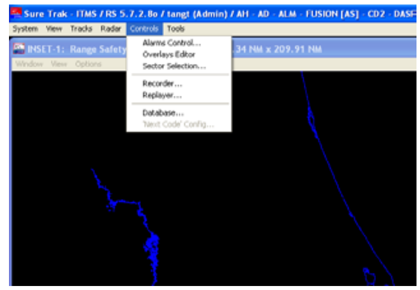


Figure 5-3-46: *Controls Submenu*

- **Alarms Control Option** - The Alarms Control option displays the Alarms Control Interface GUI. Pushbuttons for two types of alarms, Boundary Alarms and Exclusive Use Area alarms are displayed in two columns in the GUI. Column 1 pushbuttons are labeled with the Region Name of the alarm. Clicking with the left mouse button on a Column 1 pushbutton toggles the pushbuttons for both columns of an alarm between active and inactive status for that alarm. Boundary Alarms toggle in color between yellow (active) and light-gray (inactive), while Exclusive Use Area Alarms toggle in color between red (active) and dark-gray (inactive).

Column 2 pushbuttons are labeled with the current flight levels (in hundreds of feet) for the alarm. The flight levels may be changed dynamically by clicking with the left mouse button on Column 2 for a particular alarm and then entering six successive numeric digits. Entering non-numeric characters is not permitted. The flight levels are accepted in a range from low to high values, so that even if the user enters a higher value for the first three digits and then a lower value for the last three, the system will reverse the digits and put them in proper order (Ex: if 200100 is entered, the flight level will appear as 100-200 on that pushbutton). Finally, changing the flight level automatically activates the alarm, so that if the alarm is initially inactive it turns active and if it is already active, it remains so.

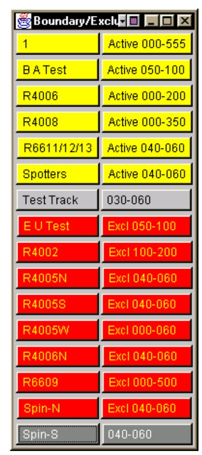


Figure 5-3-47: *Alarms Control Interface GUI*

Note that no operational Boundary or Exclusive Use Areas alarms are currently established in the system

- **Overlays Editor Option** - The Overlays Editor option displays the Overlays Editor GUI which is used to create and modify overlays, including graphical objects such as symbols and text as well as zones such as alarm areas, hazard patterns, and traffic lanes. The Overlays Editor is primarily used by the system administrators to create the overlays in the system, however, operators do have the ability to selectively enable or disable some overlays that are loaded into the system by checking or un-checking the “Make Visible” box for the applicable overlay. The overlays are ordered into groups, to include Alarm Areas, Graphics & Text, Hazard Patterns, Launch Contours, Radar Areas, Safety Zones, Swing Circles, and Traffic lanes.

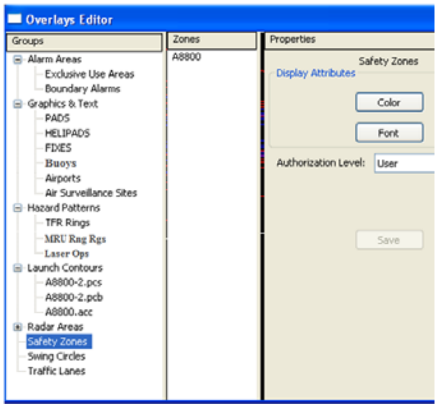


Figure 5-3-48: *Overlays Editor GUI*

- **Alarm Areas Group** - The Alarm Areas group is used to create, delete, and view the details of Exclusive Use Areas and Boundary Alarms. This group is not configurable at the Operator level of access.
- **Graphics & Text Group** - The Graphics & Text group is are used to create, delete, and view custom symbols and text subgroups for such things as launch pads, helipads, navigation waypoints/fixes, buoys, airports and air surveillance sites. Most options in this group are not configurable at the Operator level of access, however, the operator can enable or disable the display of some of the subgroups.
- **Hazard Patterns Group** - The Hazard patterns group is used to create zones around a geographical point. On the ER, the subgroups include:
- **TFR Rings:** This subgroup was used to display the Temporary Flight Restriction (TFR) airspace for Shuttle operations. This subgroup is no-longer used.
- **MRU Range Rings:** This subgroup is used by the MRU Controller to display range rings around the SLF tower for use during air operations on the ER and KSC. The operator can enable or disable the display of these rings.
- **Laser Ops:** This subgroup is used to create and display the Nominal Ocular Hazard Distance (NOHD) Box for use during laser operations. The operator can configure the size and orientation of this box.
- **Launch Contours Group** - The Launch Contours group is used to display the probability hit contours for aircraft, boats, and ships. This group is not configurable at the Operator level of access.
- **Radar Areas Group** - The Radar Areas Group is used to create auto acquisition areas, track masks, and land masks for the SSRs. This group is not configurable at the Operator level of access.
- **Safety Zones Group** - On the ER, the Safety Zones group is used to display the SCO Box for a particular mission. This group is not configurable at the Operator level of access.
- **Swing Circles Group** - The Swing Circles group is not used on the ER.
- **Traffic Lanes Group** - The Traffic Lanes group is not used on the ER
- **Sector Selection Option** - The Sector Selection option is used to activate and display the Sector Selection GUI. This is used if the RMAC-ITMS software is divided into sectors to handle large geographical areas or for facilities where multiple operators are required to control differing operational aspects. The different sectors are used to limit access to certain equipment groups and/or prevent alarm events from one sector

from being display in another sector. The ER SCDS is not divided into sections and this option is not accessible at the Operator level of access.

- **Recorder Option** - The Recorder option displays the Record Dialog GUI which displays the status for processed data being recorded from the server from the ingested data types. This option is not accessible at the Operator level of access.

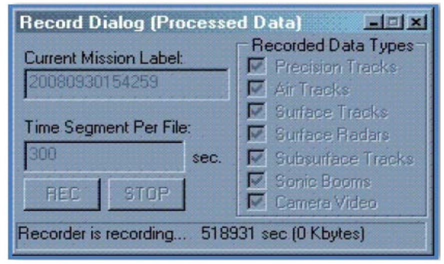


Figure 5-3-49: *Record Dialog GUI*

- **Replayer Option** - The Replayer option displays the Replay Dialog GUI with which the user may replay the processed data, which has been recorded from the server. This option is not accessible at the Operator level of access

Figure 5-3-50: *Replay Dialog GUI*

- **Database Option** - The Database option permits access to administrative configuration parameters and numerous database functions normally associated with maritime agencies exercising operational control over vessel traffic. The Database option is not configurable at the Operator level of access

5.3.3.2.8 Tools Submenu

The Tools Submenu item contains a number of miscellaneous options and utility programs. Not all of the options under this menu are available to personnel with the Operator level of access.

Figure 5-3-51: *Tools Submenu*

- **Site Unique Data Option** - The Site Unique Data option is used to edit the configuration files for a specific site. This menu option is not configurable at the Operator level of access.
- **Calculator Option -** The Calculator option enables the calculator function. It is available in both standard and scientific format
- **Print Window Option** - The Print Window option functionality is not currently implemented in the RMAC-ITMS software
- **Launch Countdown Option** - The Calculator option enables a launch countdown timer. A minus sign before the number indicates that the timer is set to count down. The Options submenu item allows the operator to choose to have the timer stop or to count up when it reaches zero. The Timer submenu item allows the operator to set, start, and stop the timer. The default value for the timer is 10 minutes. The operator can enter the desired time in hours, minutes, and seconds (HH:MM:SS) or can enter the desired time in hundreds of minutes or hundreds of seconds. Note that the use of multiple launch countdown timers will produce inconsistent results.

5.3.3.2.9 Inset Windows

The Inset Windows provide the display areas of the SCDS for the data tracks, maps, and overlays. The Inset Window Menu bar provides inset window configuration information and submenu options. The top portion of the Inset Window Menu bar lists the name and number of the inset window and the dimensions of the displayed area in nautical miles. The bottom portion consists of three submenu options: Window, View and Options.

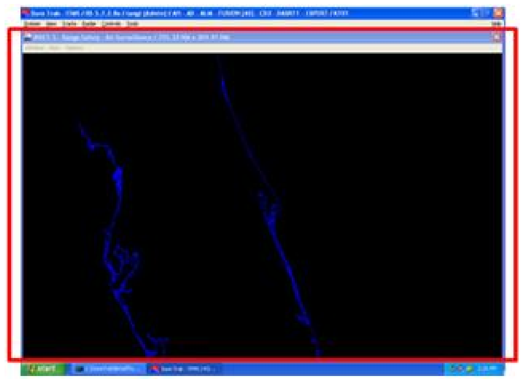


Figure 5-3-52: *Inset Windows*

5.3.3.2.10 Window Submenu

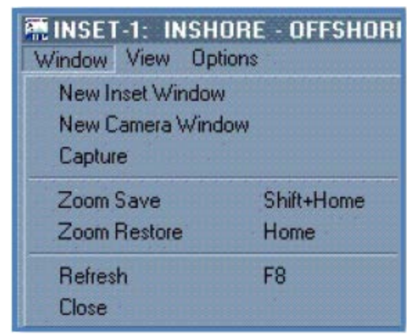


Figure 5-3-53: *Window Submenu*

The Window Submenu item contains options that allow the operator to open and close inset windows and to establish certain inset window settings. Not all of the options under this menu are available to personnel with the Operator level of access.

- **New Inset Window Option** - The New Inset Window option allows for a new inset window to be generated. The maximum number of inset windows that can be displayed is 10. Note that system performance may be affected if an excessive number of inset windows are open.
- **New Camera Window Option** - The New Camera Window option allows for a camera window to be generated. The ER SCDS does not currently have this capability.
- **Capture Option** - The New Capture option creates a printable time-stamped bitmap file with an image of the current inset window. The file is created in the system Replay directory under a date-stamped folder.
- **Zoom Save Option** - The Zoom Save option saves the current inset window positioning so that when the Home key is pressed or the Zoom Restore option is selected, the current inset window returns to the saved position.
- **Zoom Restore Option** - The Zoom Restore option returns the active inset window to its position at the time of the last Zoom Save.
- **Refresh Option** - The Refresh option refreshes the current inset window.
- **Close Option** - The Close option closes or deactivates the current inset window.

5.3.3.2.11 View Submenu

Figure 5-3-54: *View Submenu*

The View Submenu item contains several capabilities related to viewing objects on the Inset Window. Not all of the options under this menu are available to personnel with the Operator level of access.

- **Alarms Option** - The Alarms option allows the user to view Boundary Alarm Areas and Exclusive Use Areas on the active Inset Window. Selecting either the Boundary Alarm Areas option or Exclusive Use Areas option allows the user to enable or disable the display of the applicable areas in the inset window

- **Tracks Option** - The Tracks option allows the user to select and configure the tracks for display on the inset window.
- **Air Surveillance Option -** The Air Surveillance option allows the user to enable or disable the display of IFF Beacon and Radar Plots tracks.
- **Surface Surveillance Option** - The Surface Surveillance option allows the user to enable or disable the display of Surface Radar and Surface AIS tracks. Note that Surface AIS tracks can only be displayed on the SCO, SSO, and USCG consoles.

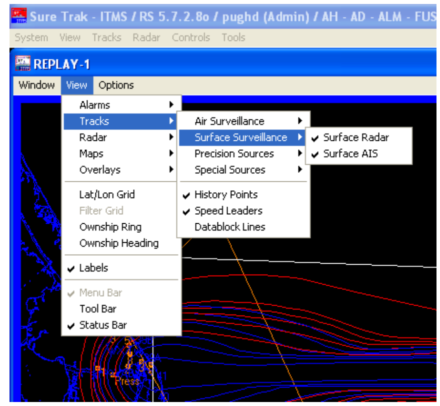


Figure 5-3-55: *Surface Surveillance Option*

- **Precision Sources Option** - The Precision Sources option allows the user to enable or disable the display of precision sources sensors. This option is not used on the ER SCDS.
- **Special Sources Option** - The Special Sources option allows the user to enable or disable the display of simulated DR and PRK tracks. Selecting the DR option under the Special Sources option enables the display of both DR and PRK tracks.
- **History Points Option** - The History Points option allows the user to enable or disable the display of history points on all tracks selected for display on the inset window.
- **Speed Leaders Option** - The Speed Leaders option allows the user to enable or disable the display of speed leaders on all tracks selected for display on the inset window**.**
- **Datablock Lines Option** -The Datablock Lines option allows the user to enable or disable the display of datablock lines on all tracks selected for display on the inset window. Datablock lines are lines connecting the datablocks to their corresponding tracks. This option is typically not used on the ER SCDS.
- **Radar Option** - The Radar option allows the user to enable or disable the display of certain aspects of the SSRs on the inset window
- **Auto Acquisition Areas Option -** The Auto Acquisition Areas option allows the user to enable or disable the display of SSR auto acquisition areas
- **Land Mask Areas Option** - The Land Mask Areas option allows the user to enable or disable the display of SSR land mask areas

Figure 5-3-56: *Radar Option*

- **Track Mask Areas Option** - The Track Mask Areas option allows the user to enable or disable the display of SSR track mask areas
- **Control Menu Icons Option** - The Control Menu Icons option allows the user to enable or disable the display of the SSR control menu icons. This option also enables and disables the display of the SSR images. When this option is unselected, the radar images disappear from the inset window and reappear when it is selected

- **Image Data Option** - The Image Data option is used to enable the display of the radar images from a specific SSR. Selecting the Image Data option displays the Select Radar Image GUI which allows the operator to select the radar images from the desired SSR site. When a site is selected and the OK pushbutton is left-clicked, the SSR images are activated.
- **Maps Option** - The Maps option allows the user to enable or disable the display of map overlays on the inset window. The map options that are available depend on the console position. There are four categories of maps: Coastline, Airspace, Area Runways, and Sea Space maps.
- **Coastline Maps** - There are three types of coastline maps that can be displayed on the inset window:

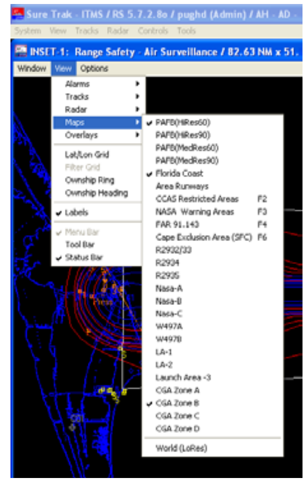


Figure 5-3-57: *Maps Option*

- World: This map displays a low resolution map of all of the continents on the globe
- Florida Coast: This map displays a map of the coastline of the Florida peninsula
- PAFB: There is a set of four maps of the east coast of Florida around Patrick AFB and CCAFS. They consist of different combinations of two different resolutions (medium and high) and two different sizes (60 nm and 90 nm)
- **Airspace Maps** - The airspace maps consist of individual maps for each of the ER airspace and consolidated maps of several areas of airspace. The individual airspace maps are available only at the SCO, ACO and MRU Controller consoles. There are two consolidated maps are available at all of the console positions. The CCAS Restricted Areas map consists of the ER restricted areas: R2932, R2933, R2934, and R2935. The NASA Warning Areas map consists of W497A, W497B NASA A, NASA B, NASA C, Launch Area 1, Launch Area 2, and Launch Area 3
- **Area Runways Map** - The Area Runways map displays the length and orientation of several local runways to include:
- Patrick AFB
- CCAFS Skid Strip
- Shuttle Landing Facility (SLF)
- Space Coast Regional Airport in Titusville
- **Sea Space Maps** - The sea space maps consists of the CCAFS Security Zone and the USCG Safety Zones. The CCAFS Security Zone is depicted individually on a map labeled as the Cape Exclusion Area (SFC) where "SFC" stands for "surface." The USCG Safety Zones are depicted individually on 4 maps listed as CGA Zone A, CGA Zone B, CGA Zone C, and CGA Zone D. Note that the USCG Safety Zones are only available at the SCO, SSO, and USCG consoles.
- **Overlays Option** - The Overlays option allows the user to place a variety of graphic objects on an inset window. These graphic objects have been created or manipulated by the Overlays Editor under the Controls submenu under the Systems menu. Note

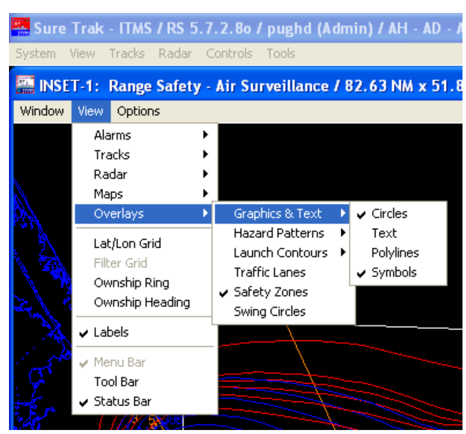


Figure 5-3-58: *Overlay Option*

that the “Make Visible” box within the Overlays Editor needs to be checked for each applicable overlay in order for it to be displayed on the inset window. There are six main items under the Overlays Option: graphics & text, hazard patterns, launch contours, traffic lanes, safety zones, and swing circles.

- **Graphics & Text Option** - The Graphics & Text option allows the user to enable or disable the display of graphics and text on the inset window. On the ER, the Graphics & Test option is used to display such things as launch pads, helipads, navigation waypoints/fixes, buoys, airports and air surveillance sites. Under the Graphics & Text Option, two options are used on the ER: Circles and Symbols. The Circles option is used to enable or disable the display of circles at the location of the active launch pad on the inset window. The Symbols option is used to enable or disable the display of all of the other symbols and text under the Overlays Editor on the inset window if their “Make Visible” boxes in the Overlays Editor is checked.
- **Hazard Patterns Option** - The Hazard Patterns option allows the user to enable or disable the display of hazard patterns on the inset window. On the ER, the Hazard Patterns option is used to display the Shuttle TFR Rings (no longer used), the SLF Range Rings, and the Laser Ops NOHD Box. Under the Hazard Patterns Option, two options are used on the ER: Ellipses and Gunfire. The Ellipses option is used to enable or disable the display of the Shuttle TFR Rings and/or the SLF Range Rings on the inset window if their “Make Visible” box in the Overlays Editor is checked. The Gunfire option is used to enable or disable the display of the Laser Ops NOHD box on the inset window if the “Make Visible” box in the Overlays Editor is checked
- **Traffic Lanes Option** - The Traffic Lanes option allows the user to enable or disable the display of traffic lanes on the inset window. This option is not used on the ER
- **Safety Zones Option** - The Safety Zones option allows the user to enable or disable the display of all safety zones under the Overlays Editor on the inset window if their “Make Visible” box in the Overlays Editor is checked. On the ER, this option is used to enable or disable the display of the SCO Box.
- **Swing Circles Option** - The Swing Circles option allows the user to enable or disable the display of swing circles on the inset window. This option is not used on the ER
- **Launch Contours Option** - The Launch Contours option allows the user to enable or disable the display of probability hit contours for aircraft, boats, and ships on the inset window. There are three options under the Launch Contours option that are used on the ER: PCB Contours, ACC Contours, and PCS Contours. The PCB Contours option is used to enable or disable the display of the probability hit contours for boats on the inset window. The ACC Contours option is used to enable or disable the display of the Aircraft Corridor on the inset window. The PCS Contours option is used to enable or disable the display of the probability hit contours for ships on the inset window.
- **Lat/Long Grid** - The Lat/Lon Grid option allows the user to enable or disable the display of a latitude/longitude grid on the inset window
- **Filter Grid Option** - The Filter Grid option applies to air systems only and is disabled for surface systems. This option is not used on the ER SCDS
- **Ownship Ring Option** - The Ownship Ring option applies to shipboard use only. This option is not used on the ER SCDS.
- **Ownship Heading Option** - The Ownship Heading option applies to shipboard use only. This option is not used on the ER SCDS.

- **Labels Option** - The Labels option allows the user to enable or disable the display of labels associated with graphics from the Overlays Editor.
- **Menu Bar Option** - The Menu Bar option is enabled by default and displays the inset window menu at the top border the inset window.
- **Tool Bar Option** - The Tool Bar option allows the user to enable or disable the display of control buttons for pan and zoom functions and ownship options for heading up and north up. The ownship options are not used on the ER SCDS.
- **Status Bar Option** - The Status Bar option allows the user to enable or disable the display of the cursor latitude and longitude at the lower border of the inset window.

5.3.3.2.12 Options Submenu

The Options Submenu Item consists of several options for data display modes for the inset window. These functions are not typically used during ER operations.

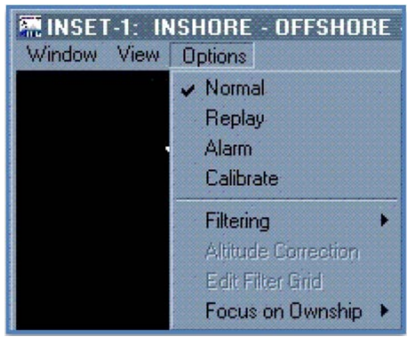


Figure 5-3-59: *Options Submenu*

- **Normal Option** - The Normal option allows the user to activate the normal display configuration for the inset window and will de-select or deactivate the Replay, Alarm, and Calibrate options. This mode is the normal operation and display mode.
- **Replay Option** - The Replay option allows the user to activate the replay display configuration for the inset window and will de-select or deactivate the Normal, Alarm, and Calibrate options. In the REPLAY mode, the inset window does not receive any live radar or track data. All other inset windows are not affected and will continue to display live data. When the Replay Option is selected, the border of the inset window appears blue and the word REPLAY appears in the title bar along with the date and time readout of the replay data.
- **Alarms Options** - The Alarm option allows the user to activate the alarm display configuration for the inset window and will de-select or deactivate the Normal, Replay, and Calibrate options. With the Alarm option selected, the window will center on each new alarm event.
- **Calibrate Option** - The Calibrate option allows the user to activate the calibration configuration for the active inset window and will de-select or deactivate the Normal, Replay, and Alarm options. This mode allows the user to see the computed offset between two tracks that are being reported for the same object by clicking on the two tracks and then opening an Information Window to view the computed offset. This option is not typically used during ER operations.
- **Filtering Option** - The Filtering option is only available in the IAD mode. When selected, it displays the Filtering Submenu which allows the use to enable or disable altitude filtering and to reconfigure the altitude filter

- **Altitude Filtering Sub-Option** - The Altitude Filtering sub-option allows the user to enable or disable altitude filtering. When altitude filtering is enabled for an inset window, only the aircraft within an altitude filter range are visible in that inset window. When enabled, there will be a yellow border around the inset window.
- **Set Altitude Filter Sub-Option** - The Set Altitude Filter sub-option allows the user to set a specific altitude range for display within the active inset window by using the keypad and typing the forward slash (/) followed by 6 numbers for the upper and lower limits of the altitude filter. For example, entering the characters "/100200" from the numeric keypad would enable the altitude filter for 10,000 to 20,000 feet inclusive.
- **Altitude Correction Option** - The Altitude Correction option is only available in the IAD mode. The Altitude Correction option allows the user to apply the system altimeter setting to an air track (IFF based) Mode C altitude. This correction applies to all aircraft in the inset window. The system altimeter is displayed in the inset title bar. The user can enter the system altimeter using the numeric keypad by typing '*' followed by the 4 digits of the reported altimeter for the geographic region.
- **Edit Filter Grid Option** - The Edit Filter Grid option is only available in the IAD mode. The Edit Filter Grid option allows the users with the supervisory level of access or higher to selectively enable or disable the processing of air tracks within certain geographic areas. If the Geo-Filtering option in the Tracks submenu is enabled and the Edit Filter Grid option is selected, a geographic filter grid is displayed in the inset Window. All tracks within the defined grid are processed by RMAC-ITMS. Tracks outside the filter grid are discarded prior to further processing. Users with the supervisory level of access or higher can toggle individual grid boxes on/off by clicking in them, much like a checkbox GUI object. The users may also toggle larger areas by holding down the plus or minus key (on the numeric keypad) while dragging a box around the area.
- **Focus on Ownship Option** - The Focus on Ownship option applies to shipboard use only. This option is not used on the ER SCDS.

5.3.3.3 Special Action Menus

Special Action Menus are those which are displayed by right clicking in a particular location or context within an Inset Window. These menus allow the user to quickly access certain system functions within an inset window.

5.3.3.3.1 Quick Action Menu (QAM)

The Quick Action Menu (QAM) is displayed by right clicking in an open area of the inset window and is removed by left clicking in an open area of the inset window. This menu allows the user to quickly access the following system menu functions: Start Radar Track, Start Sim Track, Range/Bearing Mode, Lat/Lon Cursor Mode, and Reset All Tracks.

Figure 5-3-60: *Quick Action Menu*

Figure 5-3-61: *Aircraft Action Menu*

5.3.3.3.2 Track Action Menus

The Track Action Menus allow the user to process and inspect both live and simulated tracks. The Track Action Menus are displayed by right-clicking on a track and are removed by left clicking in an open area of the inset window. There are two kinds of Track Action Menus: the Aircraft Action Menu (AAM) and the Vessel Action Menu (VAM).

Aircraft Action Menu (AAM) - The Aircraft Action Menu allows the user to process and inspect aircraft tracks.

Figure 5-3-60: *Datablock Items Option*

- **Displayed Track Name/Number -** The name or number of the track is displayed at the top of the AAM. It is not selectable.
- **Set Callsign Option -** The Set Callsign option allows the user to change the displayed track name using the Vessel Name Editor GUI. This option can be used to label an aircraft with its callsign
- **Datablock Items Option** - The Datablock Items option displays the Datablock Items Submenu which allows the user to select the information to be displayed in the track's datablock. Options included but are not limited to the track's callsign, IFF Mode3A code, altitude/speed, position in latitude/longitude and the sensor that is tracking the target. The Datablock Visibility option allows the user to enable or disable the display of the track's datablock
- **Center On Target Option** - The Center On Target option allows the user to enable or disable the centering of the associated track on the inset window. With this option enabled, the inset window map will seem to move and the centered track will seem to remain stationary. This option only applies to a single selected target and cannot be applied to a group of targets
- **Create Marker Option** - The Create Marker option allows the user to create a positional marker, in the form of a simulated parked track, for the associated aircraft track on the inset window
- **Range Circle Option -** The Range Circle option allows the user to enable or disable the drawing of a range circle around the associated track. The circle has the radius selected using the Circular Ring Precision option in the View submenu of the System Menu
- **Ignore Alarm Option** - The Ignore option allows the user to disable display of a specific alarm on an air track. This feature is useful for disabling the proximity alarm between refueling aircraft or for disabling an exclusive use area alarm for individual aircraft. The user can cancel all exceptions to alarm criteria by selecting the Reset All Tracks option from the QAM

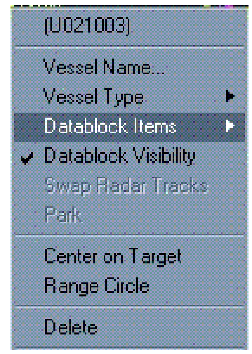


Figure 5-3-61: *Vessel Action Menu*

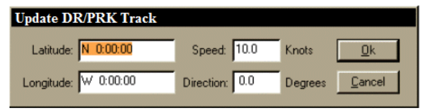


Figure 5-3-62: *Update Option*

- **Drop Option** - The Drop option allows the user to disassociate the operator entered data from an air track. The aircraft datablock will change to the default settings (IAD Mode only).
- **Vessel Action Menu (VAM)** - The Vessel Action Menu allows the user to process and inspect SSR, AIS, and simulated (DR/PRK) tracks
- **Displayed Track Name/Number** - The name or number of the track is displayed at the top of the VAM. It is not selectable
- **Update Option** - The Update option is only displayed on VAMs for DR and PRK tracks. It allows the user to update the position, heading, and speed for DR and PRK tracks. Reference figure 5-3-64
- **Vessel Name Option** - The Vessel Name option allows the user to change the displayed track name using the Vessel Name Editor GUI. This option can be used to label a SSR or simulated track with the vessel's name. This option is not available for AIS tracks
- **Vessel Type Option** - The Vessel Type option displays the Vessel Type Submenu to allow the user to select the desired vessel for type to activate the type for the track. This option is not available for use on the ER SCDS
- **Datablock Items Option** - The Datablock Items option displays the Datablock Items Submenu which allows the user to select the information to be displayed in the track's datablock. Options included but are not limited to the vessel name, position in latitude/longitude, heading/speed, which sensor is tracking the target, and the speed leader value. For AIS tracks, the options also include the Vin and the MMSI
- **Datablock Visibility Option** - The Datablock Visibility option allows the user to enable or disable the display of the track's datablock
- **Swap Radar Tracks Option** - This option is not used on the ER SCDS
- **Park Option** - This option is not used on the ER SCDS
- **Center On Target Option** - The Center On Target option allows the user to enable or disable the centering of the associated track on the inset window. With this option enabled, the inset window map will seem to move and the centered track will seem to remain stationary. This option only applies to a single selected target and cannot be applied to a group of targets
- **Range Circle Option** - The Range Circle option allows the user to enable or disable the drawing of a range circle around the associated track. The circle has the radius selected using the Circular Ring Precision option in the View submenu of the System Menu
- **Delete Option** - The Delete option is only available for SSR and DR/PRK tracks and allows the user to delete the associated track
- **Show Additional Info Option** - For AIS tracks, the VAM options also include the Show Additional Info Option and the Acquire Radar Track Option. This option allows the user to enable or disable the display of additional track information that is provided by the AIS receiver
- **Acquire Radar Track Option** - This option is not used in ER surveillance operations

5.3.3.4 Inset Window Keyboard Shortcut/"Hot" Keys

The Inset Window Keyboard Shortcut or "Hot" keys allow the user to quickly perform certain display functions within the select inset window

- PAGE UP = Course zoom in
- PAGE DOWN = Course zoom out
- CURSOR UP = Course pan up
- CURSOR DOWN = Course pan down
- CURSOR LEFT = Course pan left
- CURSOR RIGHT = Course pan right
- SHIFT + PAGE UP = Fine zoom in
- SHIFT + PAGE DOWN = Fine zoom out
- SHIFT + CURSOR UP = Fine pan up
- SHIFT + CURSOR DOWN = Fine pan down
- SHIFT + CURSOR LEFT = Fine pan left
- SHIFT + CURSOR RIGHT = Fine pan right
- HOME = Restores the window zoom to the window zoom bookmark
- SHIFT + HOME = Sets the window zoom bookmark
- F2 = Toggles the CCAS Restricted Areas Map (R2932/3/4/5)
- F3 = Toggles the NASA Warning Areas Map (W497A/B, NASA A/B/C, and Launch Areas 1/2/3)
- F4 = Toggles the FAR 91.143 Map
- F6 = Toggles the Cape Exclusion Area (SFC) Map (CCAFS Security Zone)
- F9 (IAD Mode only) = Toggles the display of non-discrete codes (1200 squawk codes) in the datablock for the applicable tracks. Note that the track's altitude and speed are still displayed in the datablock
- F11 (IAD Mode only) = Toggles altitude filtering on and off
- F12 (IAD Mode only) = Automatically places focus in the Acquisition/Drop List Window
- Keypad "+" Key (IAD Mode only) = Automatically places focus in the Beacon Select Window
- Keypad "/" Key followed by 6 numbers (IAD Mode only) = Enables and sets the altitude filter limits
- Keypad "*" Key followed by 4 digit altimeter entry (IAD Mode only) = Sets the altimeter value used by the system for altitude correction
- ALT+ Left Mouse Button Drag = Allows the user to re-position a track's data block
- Right CONTROL Key + Left Mouse Button Drag = Allows the user to create a box over an area and zooms in on the center of the box
- Left CONTROL Key + Left Mouse Button Drag = Allows the user to create a box around a fixed point and zooms in on the fixed point

5.3.3.5 Plotting Simulated Tracks

The user can plot simulated tracks, based on information from the support assets, to mark the location or to predict the location of vessels that are outside of radar coverage or vessels for which the radars are having trouble tracking. To plot simulated targets, the user can utilize the following steps:

Figure 5-3-63: *Plotting Simulated Tracks*

Step 1: Select the Start Sim Track option from the QAM or the Tracks submenu from the System Menu. This displays the Start Sim Track Submenu

Step 2: Select DR or PRK from the Start Sim Track Submenu for the applicable track type. This pops-up the associated start track GUI

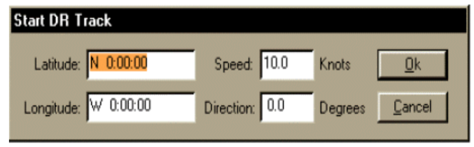


Figure 5-3-64: *Start Track*

Step 3: Enter the applicable track information into the Start Track GUI

- Position in latitude/longitude: There are three options available to the user. The user can 1) enter the information into the GUI, 2) Use the mouse to left click on the exact location in the inset window, or 3) Use the mouse to left click in the vicinity of the support asset and make corrections in the GUI
- Speed in knots: The default value for DR tracks is 10 kts. The default value for PRK tracks is 0 kts. Note: providing a value for PRK tracks will change it to a DR track
- Direction in degrees: The default value for DR and PRK tracks is 0 degrees.

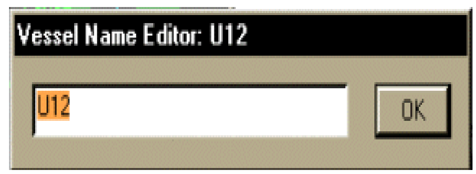


Figure 5-3-65: *Update Vessel Name*

Step 4: Use the VAM to update the Vessel Name and track information as required. The user can select the Vessel Name option to assign the vessel name or a vessel type/description (i.e. Sportfisher) in the Vessel Name Editor GUI. The user can also select the Update option to update the track information as required.

5.3.3.6 Radar System Site Control Panel

The Radar System Site Control Panel functions as the operator's interface to the SSRs. It is used by the ERTS contractor to initially set up the SSRs in support of a launch operation. It is also used by the SSOs to adjust the configuration of the SSRs to account for the weather conditions and/or the sea state to optimize the performance of the SSRs. The panel can only be accessed by workstation which is in the Range Safety mode of operation which includes the SCO, SSO, and USCG consoles. Only one workstation at a time can control a particular SSR.

The Radar System Site Control Panel consists of four groupings each containing objects for setting radar control parameters: site selection group, radar group, radar processor (RP) group.

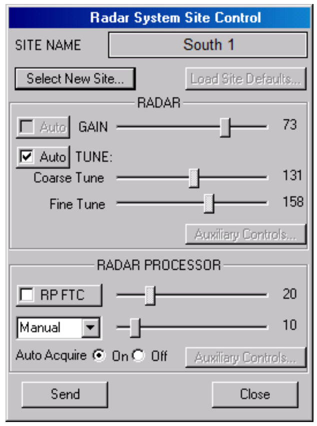


Figure 5-3-66: *Radar System Site Control Panel*

5.3.3.6.1 Site Selection Group

The Site Selection Group displays the current site selected and allows the user to change sites for configuration.

- **Site Name Display Block** - The Site Name display block which displays the current site that is being configured
- **Select New Site Pushbutton** - The Select New Site pushbutton opens up the Radar System Site Select GUI and allows the user to choose the other SSR site for configuration
- **Load Site Defaults Pushbutton** - The Load Site Defaults pushbutton is currently disabled and not utilized by the software

5.3.3.6.2 Radar Group

The Radar Group allows the user to control some aspects of the transmitter and receiver subsystems. This group is utilized by the ERTS contractor to initially set up the SSR for launch operations. This group is not utilized by the SSOs during launch operations.

- **Radar Gain Control** - The Gain control is used to adjust the sensitivity of the receiver, and thus the strength of the echoes as they appear on the display. The gain is changed by adjusting the Gain slide bar to the left to decrease the gain and to the right to increase the gain. The gain is set to 95 by the ERTS contractor to provide maximum receiver sensitivity without saturating the receiver. The SSOs should not adjust the radar gain during launch operations. The GAIN Auto Checkbox is currently disabled
- **Radar Tune Control** - The TUNE control is used to tune the receiver to the frequency of the transmitter. The tune is changed by adjusting the Coarse Tune and Fine Tune slide bars to the left and right. Adjustments to the receiver tune are not normally required. The ERTS contractor performs the initial tuning of the SSRs and then checks the Tune Auto Checkbox to enable automatic tuning by the system. When the TUNE Auto Checkbox is checked, the Course Tune and the Fine Tune Slide bars are disabled. The SSOs should not adjust the radar tuning during launch operations

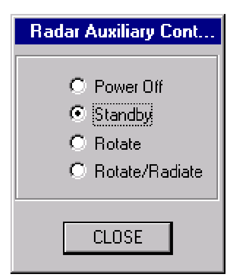


Figure 5-3-67: *Auxiliary Controls Pushbutton*

- **Auxiliary Controls Pushbutton** - The Auxiliary Controls Pushbutton pops up the Radar Auxiliary Controls GUI which is used to control the operating status of the SSR. It consists of four buttons.

- **Power Off:** This option powers off the transmitter
- **Standby:** This option warms up the high voltage power supply which takes a certain amount of time
- **Rotate:** In this option, the high voltage power supply is off, but the antenna is rotating
- **Rotate/Radiate:** In this option, the transmitter is on and the antenna is rotating

The ERTS contractor will perform these functions. No action is required by the operator.

5.3.3.6.3 Radar Processor (RP) Group

The Radar Processor Group allows the user to control some aspects of the radar processor. This group is utilized by the ERTS contractor to initially set up the SSR and by the SSOs to adjust the configuration of the SSRs to account for the weather conditions and/or the sea state.

- **Fast Time Constant (FTC) Control** - The Radar Processor Fast Time Constant (RP FTC) is used to attenuate the effects of weather to include rain, mist, and fog. Checking the RP FTC Checkbox turns on the FTC function and enables the RP FTC slide bar. The FTC is changed by adjusting the RP FTC slide bar to the left to decrease the FTC and to the right to increase the FTC. The range of values for FTC for ER operations is 4-20.
- **Sensitivity Time Constant (STC) Control** - The Radar Processor Sensitivity Time Constant (RP STC) is used to attenuate the effects of clutter near the radar site, specifically the sea state. The STC selectable pull-down list of radar states include
- Off
- Manual
- Auto (Used for ER operations)
- Moving Target Detector (MTD)

The STC is changed by adjusting the RP STC slide bar (located below the RP FTC slide bar) to the left to decrease the STC and to the right to increase the STC. The range of values for STC for ER operations is 4-12

- **Auto Acquire Button** - The Auto Acquire button allows the operator to enable or disable the auto acquire tracking capability of the SSR
- **Auxiliary Controls Pushbutton** - The Auxiliary Controls Pushbutton pops up the RP Auxiliary Control GUI. The RP Auxiliary is used by the ERTS contractor to set up and calibrate the SSRs

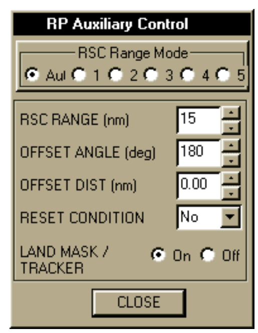


Figure 5-3-68: *Bottom Pushbutton Group*

5.3.3.6.4 Bottom Pushbutton Group

The Button Pushbutton Group is used to send commands the SSRs and to close out the Radar System Site Control Panel.

- **Send Pushbutton** - The Send pushbutton allows the operator to transmit the commands to the intended SSR site
- **Close Pushbutton** - The Close pushbutton allows the operator to close the control panel and retain the settings

5.3.3.6.5 Radar System Site Control Panel Basic Procedures

The basic procedures for utilizing the Radar System Site Control Panel are:

Step 1: Access the Radar System Site Control panel by selecting the Control option from the Radar System menu and selecting the site from the Radar System Site Select GUI or by right clicking on the radar control icon and selecting the Control option.
Step 2: Change the settings on the control panel as desired. Note: Do not change the values on the control panel in intervals greater than 10 in order to ensure smooth operation of the system.
Step 3: Click the Send button to transmit the changes to the SSR.

5.3.3.6.6 FTC and STC Adjustment Procedures

Poor weather conditions and a high sea state can result in false radar returns on the displays. The LISC contractor will set up the FTC and STC values based on the initial weather conditions and sea state.

5-4 HOLDFIRE PANELS

5.4.1 OVERVIEW

The ER holdfire System is used for all non-AFSS pad launches and is initiated by utilizing holdfire panels at the Range Control Officer (RCO), Mission Flight Control Officer (MFCO), Operations Safety Manager (OSM)/Pad Safety and Launch Conductor (LC) consoles.

5.4.2 HOLDFIRE PANEL

There are four holdfire panels in the MOC. The RCO Console B6, the MFCO console, and the SMFCO console each have a holdfire panel. A fourth holdfire panel is located at Console A6 in MCR 1 and is used by the RCO during pre-launch day operations when MCR 2 is not available. Each holdfire panel in the MOC consists of a holdfire switch on the right of the panel and eight holdfire indicator lights to the left of the holdfire switch.

Figure 5-4-1: *Holdfire Panel*

5.4.2.1 Holdfire Switch

The holdfire switch is a guarded toggle switch on the holdfire panel that is used to initiate a countdown hold. To initiate a hold, the protective cover is raised and the toggle switch is raised in the “active” position. To remove the hold, the protective switch cover is closed, which disengages or lowers the toggle switch.

Figure 5-4-2: *Holdfire Switch*

Figure 5-4-3: *Activated Hold Fire Switch*

5.4.2.2 Holdfire Indicator Lights

The holdfire indicator lights are used to indicate that a holdfire has been initiated or to indicate which console position initiated the hold. During holdfire checks and the countdown, the RCO and MFCO monitor these lights in conjunction with the countdown clock, as required, to verify that a holdfire was initiated. The indicator lights that are used depend on the launch vehicle. The holdfire indicator lights consists of three EELV holdfire indicators, a KSC IGN INHIBIT indicator, a Sequencer Holding indicator, two spares and the RANGE READY indicators.

5.4.2.2.1 EELV Holdfire Indicators
The EELV holdfire indicators are part of the EELV holdfire subsystem which is utilized for Atlas V and Delta IV missions. They consist of a Range Ready Indicator and three Console Holdfire Initiation Indicators.

5.4.2.2.1.1 Range Ready Indicator
The Range Ready indicator light is a green Light Emitting Diode (LED) that is illuminated when the panel is receiving a “Range Ready” signal from the Range User’s launch sequencer, indicating that it is not detecting a holdfire from any of the console positions and that the countdown sequence is proceeding. This indicator will not be illuminated when the panel is no longer receiving a “Range Ready” signal from the launch sequencer, indicating that the countdown sequence has been halted and the launch vehicle ignition circuit has been inhibited.

5.4.2.2.1.2 Console Holdfire Initiation Indicators
The console holdfire initiation indicators include red LEDs for the RCO, MFCO and OSM positions. When one of these indicators is illuminated, it indicates that the panel is receiving an indication from the Range User’s Holdfire Transmission Unit (HTU) in the launch control center that the applicable console position initiated the holdfire signal.

<u>Note when the OSM activates the holdfire for Atlas V missions, the RCO and MFCO holdfire panels will not receive an indication from the Air Support Operations Center (ASOC) HTU that the OSM initiated the holdfire.</u>

During Atlas V holdfire checks, the removal of the Range Ready indicator light is used by the RCO and the MFCO to verify receipt of the OSM holdfire.

5.4.2.2.2 KSC Ignition Inhibit Indicator
The KSC Ignition Inhibit (KSC IGN INHIBIT) indicator is part of the Legacy Holdfire subsystem that was previously used for STS and Ares launches from KSC. It is a red LED which illuminates when the panel is receiving a KSC Ignition Inhibit (Hold) signal from NASA’s Ground Launch Sequencer (GLS) system. If the GLS detects a Range holdfire or a violation of launch commit criteria monitored by the GLS, it will issue a KSC Ignition Inhibit signal. As a result, illumination of this light indicates a Range holdfire has been initiated or other launch commit criteria have been violated. Note that this indicator does not indicate that the T-count has stopped.

5.4.2.2.3 Sequencer Holding Indicator
The Sequencer Holding indicator light is part of the Legacy Holdfire subsystem. It is a red LED which illuminates when the panel is receiving a launch inhibit signal from the launch sequencer, indicating that the sequencer is holding. This includes countdown holds in response to a holdfire.

5.4.2.2.4 Spare Holdfire Indicators
There are two spare, red LED indicators. These spare indicators allow for future expansion. They are not currently used and are thus labeled “NOT USED”.

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SECTION 6

RANGE SYSTEM CHECKS

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6-1 HOLDFIRE CHECKS

6.1.1 PURPOSE

Holdfire checks are performed during pre-launch day tests and during the minus count for non-AFSS pad launches to verify the connectivity of the holdfire circuit between the launch pad sequencer, OSM, RCO, MFCO, and the Range User. EWR 127-1, AFSPCMAN 91-710 Vol 6, and AFSPCMAN 91-711 require that the holdfire capability be checked out during the countdown at a mutually agreed time as close to launch as practical with OSM present and that OSM will report the results of the checkout to the MFCO. The time at which the Holdfire Checks are conducted on launch day depends on the launch vehicle program.

6.1.2 PARTICIPANTS and/or RESPONSIBILITIES

6.1.2.1 Range Control Officer (RCO)

The RCO supports Holdfire Checks for all pad launched non-AFSS missions. The RCO ensures that the Range is ready to support the Holdfire Checks by either verifying that the MFCO is ready to support the Holdfire Checks or verifying with the Timing System controller, through the ISRO, that a Timing technician has been sent to the MFCO's console to support the Holdfire checks, as applicable. When directed by the Test Conductor, the RCO will send and remove the RCO Holdfire and verify that holdfire indications are received and removed in the MOC and on the RCO Holdfire Panel. The RCO will notify the ISRO of any problems encountered during the Holdfire Checks.

6.1.2.2 Mission Flight Control Officer (MFCO)

The MFCO supports the Holdfire Checks for missions in which the checks occur after the MFCO arrives on-console. Currently the MFCO only supports Holdfire Checks for Atlas V missions. The launch day Holdfire Checks for all other pad launched non-AFSS missions are performed prior to the MFCO arriving on console. For these missions, a Timing System technician supports the Holdfire checks from the MFCO's console. When directed by the Test Conductor, the MFCO will send and remove the MFCO Holdfire and verify that holdfire indications are received and removed in the MOC and on the MFCO Holdfire Panel. The MFCO will notify the RCO of any problems encountered during the Holdfire Checks.

6.1.2.3 Instrumentation Superintendent of Range Operations (ISRO)

The ISRO is the interface between the RCO and the Timing Controller. The ISRO ensures that the Timing Supersystem and personnel are ready to support the Holdfire Checks, including verifying with the Timing Controller that a Timing technician has been sent to the MFCO's console to support the Holdfire checks when applicable. If any problems are reported by the RCO, the ISRO will relay the information to the Timing Controller.

6.1.2.4 Timing Supersystem Controller

The Timing Supersystem Controller coordinates with the Timing Technicians to configure the Holdfire System for the applicable launch program, to ensure a Timing technician has been sent to the MFCO's console to support the Holdfire Checks as applicable, and to perform troubleshooting if problems are encountered during the checks.

6.1.2.5 Range User
The Range User for non-AFSS missions is responsible for providing the capability that allows Range Safety to initiate a holdfire to prevent a launch in the event of a loss of a Range Safety critical system or a violation of mandatory Range Safety launch commit criteria. The Range User, in coordination with the OSM, is responsible for developing the Holdfire System test procedures and providing copies of the procedures to OSM and the Range. The Range User is also responsible for scheduling the required range support for the Holdfire Checks. A member of the Range User team will usually act as the Test Conductor for the Holdfire Checks. Note that the console position performing the Test Conductor function varies between launch vehicle programs and between pre-launch day tests and launch day. Reference the applicable sub-section in Section 3 of this manual for the specific details for each launch vehicle program. During the checks, the Range User will enable the Holdfire System, set up a countdown sequencer, request each applicable position to send and remove their holdfire, and poll personnel to confirm the applicable indications.

6.1.2.6 Operations Safety Manager (OSM)
The OSM, also known as Pad Safety, supports the Holdfire Checks for all missions and is responsible for verifying the functionality of the Holdfire System. The OSM reviews and approves the Holdfire Checks procedures developed by the Range User. The OSM enables the launch vehicle ignition circuit (also referred to as the Launch Enable circuit) for the Holdfire Checks. When directed by the Test Conductor, the OSM will send and remove the OSM Holdfire and verify that the holdfire and launch ignition circuit interrupt indications are received and removed in the Launch Control Center (LCC). Note that for Falcon 9 missions, the OSM performs the Test Conductor function. On launch day, the OSM reports the results of the Holdfire Checks to the MFCO.

6.1.3 PROCEDURES
The Holdfire Checks procedures can be categorized into three sections: Pre-Test Actions, Test Execution, and Post-Test Actions.

6.1.3.1 Pre-Test Actions
Below are the pre-test actions to configure equipment for holdfire checks:”

- Enabling the Launch Vehicle Ignition Circuit
- Enabling the Holdfire System
- Configuring the Countdown Sequencer.

6.1.3.1.1 Enabling the Launch Vehicle Ignition Circuit
The OSM will enable the launch vehicle ignition circuit (Launch Enable circuit). This allows the OSM to verify that the circuit is interrupted when a holdfire is received

6.1.3.1.2 Enabling the Holdfire System
The OSM or Range User enables the Range Holdfire System. This allows the Launch Sequencer to respond to a holdfire.

6.1.3.1.3 Configuring the Countdown Sequencer
The Test Conductor will direct the sequencer operator to configure the countdown sequencer. The sequencer operator sets the countdown sequencer to a specified time per the Range User’s countdown procedures. The time varies for each launch vehicle program. Depending on the

launch vehicle program, the personnel in the MOC may not be able to see the countdown clock during the pre-launch day and/or launch day Holdfire Checks. Reference the applicable launch and operational documentation for each launch vehicle program.

6.1.3.2 Test Execution

The procedures for performing the Holdfire Checks consist of:

- Sending Holdfire
- Verifying Holdfire Indications Received
- Removing Holdfire
- Verifying Holdfire Indications Removed

This process is repeated until all of the Holdfire switches have been tested.

6.1.3.2.1 Sending Holdfire

The Holdfire switches are each tested individually. The Test Conductor will direct the applicable console position to send their holdfire. The preferred method for initiating the holdfire is for the respondent to verbalize their actions then activate the holdfire switch and state: “Holdfire sent.” This provides a clear indication of when the holdfire switch was activated and helps other personnel to know when to expect to receive the indications at their consoles.

6.1.3.2.2 Verifying Holdfire Indications Received

After the holdfire has been sent, the Test Conductor polls each position to verify receipt of the holdfire. The RCO and the MFCO or Timing Tech will reference the T-Clock and/or the Holdfire Indicator lights on their Holdfire Panels, as required for the applicable launch vehicle program, to verify receipt of the holdfire. The holdfire indications vary for each launch vehicle program. Reference the applicable chapter in Section 3 of this manual for the specific details for each launch vehicle program.

6.1.3.2.3 Removing Holdfire

After receipt of the holdfire indications has been confirmed, the Test Conductor will direct the applicable console position to remove their holdfire. The preferred method for removing the holdfire is for the respondent to verbalize their actions, then lower the protective cover over the switch and state: “Holdfire removed.” This provides a clear indication of when the holdfire switch was de-activated and helps other personnel to know when to expect to see the indications at their consoles.

6.1.3.2.4 Verifying Holdfire Indications were removed

After the holdfire has been removed, the Test Conductor polls each position to verify that they received indications that the holdfire was removed. The RCO and the MFCO or Timing Tech will reference the T-Clock and/or the Holdfire Indicator lights on their Holdfire Panels, as required for the applicable launch vehicle program, to verify removal of the holdfire. These indications vary for each launch vehicle program. Reference the applicable sub-section in Section 3 of this manual for the specific details for each launch vehicle program.

6.1.3.3 Post Test Actions
After the Holdfire Checks have been performed, there are several post-test actions that are taken to secure the equipment and to report the results of the Holdfire Checks. They include:

- Disabling the Launch Vehicle ignition Circuit
- Disabling the Holdfire System
- Securing/Resetting the Countdown Sequencer
- Reporting Holdfire Checks results to the MFCO

6.1.3.3.1 Launch Vehicle Ignition Circuit
The OSM will disable the launch vehicle ignition circuit (Launch Enable) circuit. On launch day, the circuit will be enabled again prior to the terminal countdown to allow for the launch to occur.

6.1.3.3.2 Holdfire System
The OSM or Range User will disable the Range Holdfire System. On launch day, the Holdfire System will be enabled again prior to the terminal countdown.

6.1.3.3.3 Securing/Resetting the Countdown Sequencer
The sequencer operator will secure the countdown sequencer or reset the T-Clock for the current T-0.

6.1.3.3.4 Reporting Holdfire Checks results to the MFCO
On launch day, the OSM will report the results of the Holdfire Checks to the MFCO. This report will typically be included in the OSM's initial status report to the MFCO.

6.1.3.4 Problem Reporting
Problems can arise during the Holdfire Checks and prevent the completion of the test. These problems could be detected by a failure to receive the proper indications on the Holdfire panels when a holdfire is sent and removed. The problem could be in the equipment in the MOC, in the LCC, or a communication problem between the two facilities. Reporting these problems and the associated indications can help to isolate and resolve the problem. The RCO and the MFCO will report any problems using the Comm/Console/SCDS Failure/Restoral Checklist 10. On launch day, the OSM will report problems to the MFCO.

6-2 FLIGHT TERMINATION SYSTEM CHECKS

6.2.1 PURPOSE

EWR 127-1 Chapter 4 and AFMAN 91-710 Vol 4 require that open loop tests be performed on the vehicle's Flight Termination System (FTS) prior to launch to prove the integrity of the ground and airborne command transmitter system. This includes the Range Command transmitter systems, vehicle antenna systems, and the Command Receiver/Decoders (CRDs). These regulations specify the configuration and codes to be utilized in these tests for both Secure CRDs using encrypted codes and Non-Secure or Standard CRDs using Inter-Range Instrumentation Group (IRIG) tones. These tests are performed during pre-launch day tests and on launch day.

6.2.2 PARTICIPANTS AND/OR RESPONSIBILITIES.

6.2.2.1 Range Control Officer (RCO)

During pre-launch day FTS Open-Loop testing for all vehicles, the RCO obtains the test configuration from the Range User and passes it to the Mission Flight Control Officer (MFCO). For pre-launch day and launch day tests, the RCO will verify that the MFCO is ready for the FTS Open Loop checks prior to notifying the Range User of the Range's readiness for the checks. For pre-launch day tests, the RCO monitors the test to ensure the Range User does not violate the established Radio Frequency (RF) clearance times and ensures the Range User contacts Range Scheduling to extend the RF clearance times, if required. When the test is complete, the RCO obtains release of command personnel and equipment from the Range User.

6.2.2.2 Mission Flight Control Officer (MFCO)

The MFCO is responsible for the activation of the command carrier, directing the command sites to select the appropriate command transmitters, transmitting the required command functions, and for the removal of the command carrier.

6.2.2.3 Instrumentation Superintendent of Range Operations (ISRO)

The ISRO is the interface between the RCO and Command System Controller (CSC). The ISRO ensures that CSC and the command sites are ready to support pre-launch and launch-day open-loop testing of the vehicle FTS.

6.2.2.4 Command System Controller (CSC)

CSC participates in all pre-launch testing involving the Ground Command Destruct System (CDS). They conduct pre-test checks on the Central Command Remoting System (CCRS) and the command sites to ensure the systems are configured and operating properly prior to the FTS tests. The CSC verifies and reports the configuration of the command sites to the MFCO. The CSC sends the Pilot Tone or Check Channel as required and transmits the RESET command for Delta missions when directed by the MFCO.

6.2.2.5 Command System Officer (CSO)

The CSO uses the Range Safety Control and Display (RASCAD) consoles to monitor and control the Ground CDS. When directed by the MFCO, the CSO activates the command carrier from the appropriate command site carrier, verifies when functions are sent and removed, and removes the command carrier.

6.2.2.6 Range User

The Range User is responsible to provide and maintain a FTS on its launch vehicle in accordance with EWR 127-1 Chapter 4 and AFMAN 91-710 Vol 4. This includes ensuring that the FTS is compatible with the Range ground support and monitoring equipment. The Range User, in coordination with the Operations Safety Manager (OSM), is responsible for developing FTS test procedures and providing copies of the procedures to OSM and the Range. The Range User is also responsible for scheduling the required range support for FTS tests including ground command system equipment and frequency clearance. During the tests, the Range User requests that the MFCO activate the command carrier, transmit the required command functions, and remove the command carrier in accordance with the test procedures or the countdown manual.

6.2.2.7 Operations Safety Manager (OSM)

The OSM, also known as Pad Safety, is responsible for verifying the functionality of the vehicle airborne FTS. OSM reviews and approves FTS test procedures developed by the Range User. During FTS open-loop testing, OSM monitors the test to ensure the procedures are followed correctly and reviews the telemetry data to ensure that all FTS components meet range safety operating requirements.

6.2.3 OVERVIEW

For any FTS that uses a Secure or Standard CRD, EWR 127-1 Chapter 4 and AFMAN 91-710 Vol 4 require that two types of open loop tests be performed on the vehicle's FTS prior to launch to prove the integrity of the ground and airborne command transmitter system. The initial test for each type of receiver is conducted prior to launch day. The final test is performed during the countdown on launch day. The configuration and test requirements depend on the type of CRD (Secure or Non-Secure/Standard) utilized by the launch vehicle.

6.2.3.1 Secure CRD Open Loop Tests

At a minimum, the Secure CRD open loop tests consists of an initial Secure CRD open loop test using maintenance codes that is conducted prior to launch day and a final Secure CRD open loop test using flight codes that is conducted on launch day.

6.2.3.1.1 Initial Secure CRD Open-Loop Tests.

Any FTS that uses a secure high-alphabet command receiver decoder is required to undergo an open-loop RF test to demonstrate the integrity of the system between the command control transmitter system and launch vehicle RF system from the antenna to the command receiver decoders, up to the point at which the flight destruct initiators will be electrically or optically connected. The configuration and performance requirements for this test are as follows:

- Destruct initiator simulators are installed in place of the flight initiators to verify that sufficient energy is delivered by the FTS CDS to initiate destruct.
- Each CRD will be powered by either the ground or launch vehicle power sources.
- Each CRD on the vehicle is loaded with the appropriate maintenance codes.
- All CRD commands required by the program (SELF TEST, ARM, DESTRUCT, SAFE and RESET as applicable) are transmitted to the vehicle open loop by the Range command transmitters using maintenance codes.
- All CRDs and primary and backup components in the range Command transmitter system are verified as operational.

6.2.3.1.2 Final Secure CRD Open-Loop Tests.

Any FTS that uses a secure high-alphabet command receiver decoder is required to undergo a final open-loop RF test no earlier than 60 minutes before flight, to validate the entire RF command terminate link from the command control transmitting system to launch vehicle antenna. The configuration and performance requirements for this test are as follows:

- The FTS will undergo the test in its final flight configuration with all flight destruct initiators connected and in a safe condition.
- The CRDs will be powered by flight batteries.
- The test will exercise the self-test function of each command receiver decoder, by using the command control system transmitters in their flight configuration to transmit the SELF TEST command. **NOTE:** The other commands are not transmitted open-loop to prevent the flight codes from being compromised.
- All CRDs and the primary and backup Range Command transmitter systems are tested and verified as operational.

The Range User will typically conduct this test at least once prior to launch day and on launch day. Following a successful open-loop test on launch day, the CRDs (powered from flight batteries) and primary Range Command transmitter remain on through launch. If any CRD is turned off, the FTS is required to undergo the final open-loop test again before flight.

6.2.3.2 Non-Secure (Standard) CRD Open Loop Tests

At a minimum, the Non-Secure (Standard) CRD open loop tests consists of an initial Non-Secure (Standard) CRD open loop test that is conducted prior to launch day and a final Non-Secure (Standard) CRD open loop test that is conducted on launch day.

6.2.3.2.1 Initial Non-Secure (Standard) CRD Open-Loop and Automatic FTS End-to-End Tests.

For Non-Secure CRDs, an End-to-End Verification Test of the vehicle's Automatic Destruct System (ADS), as well as the CDS, is required during launch vehicle processing after the installation of the FTS but prior to the electrical and/or optical connection of the flight destruct initiators. This test is conducted to prove the integrity of the ground components (CCRS and command destruct sites) and airborne components (CRDs, flight batteries, engine shutdown valves, and automatic destruct system) up to the point at which the flight destruct initiators will be electrically connected. This test is conducted no earlier than 48 or 72 hours prior to launch, depending on the applicable regulation. The configuration and performance requirements for this test are as follows:

- Destruct initiator simulators are installed in place of the flight initiators to verify that sufficient energy is delivered by both the CDS and ADS circuits to initiate the FTS ordnance.
- The FTS Command and Automatic Destruct systems are powered by flight batteries.
- All CRD commands are transmitted to the vehicle open-loop by Range transmitters.
- All primary and redundant components and circuits in the vehicle command and automatic FTS systems and the Range Command transmitter system are verified as operational.

6.2.3.2.2 Final Non-Secure (Standard) CRD Open-Loop Tests.

For any FTS that uses a non-secure command receiver decoder, a final RF open-loop test of the FTS is conducted no earlier than 60 minutes prior to launch to validate the entire RF command terminate link, providing the final prelaunch assurances that the ground and airborne components of the FTS are functioning properly. The configuration and performance requirements for this test are as follows:

- All FTS arming/initiation devices are to remain in a safe condition.
- All CRDs are powered by flight batteries.
- All CRD commands except DESTRUCT shall be transmitted open-loop to the vehicle by Range Command transmitters.
- All CRDs and primary and backup Range Command transmitters shall be tested and verified as operational.

Following a successful open-loop test, the CRDs (powered from flight batteries) and primary Range Command transmitter remain on through launch.

6.2.4 PROCEDURES

The pre-launch day FTS open loop test procedures are documented in Procedure 9-1: FTS Open Loop Checks. The launch day FTS open loop test procedures are integrated in the Launch Support Plan (LSP) and the MFCO Countdown Checklist for the applicable launch vehicle.

6.2.4.1 Procedure 9-1: FTS Open Loop Checks

Procedure 9-1 is designed to capture the actions required of Range personnel for FTS Checks. Each launch vehicle program has its own way of conducting these open loop tests, and depending on the tests, will require different equipment configurations and combinations. For example, the user may want to use just Cape 1A with both the Master and Standby transmitters or just Cape 1A and one transmitter. As a result, the procedure has been designed with generic steps for the different configurations, combinations, and commands that could be requested. On launch day, if a configuration change in the Ground CDS is required due to a system failure, the MFCO can reference Procedure 9-1 to perform the configuration change.

6.2.4.1.1 Test Preparation

Once assigned to a mission, it is important that the MFCO and the RCO both check the Program OD and the applicable launch vehicle chapter in Section 3 of this Ops Manual to determine which tests involve the vehicle FTS and require RCO and MFCO support. The MFCO and RCO will then need to look for these tests on the Range schedule, located at the Maintenance and Operations Coordination Center (MOCC) website (https://emocc.patrick.af.mil). The schedule requests for these tests should specify:

- The RCO and MFCO support times
- Which command sites are required (Cape 1A, 1B or both)
- For secure receivers, which codes will be used (Maintenance/Test or Flight codes)
- Open-loop frequency clearance times on 421.0 MHz

Although the MFCO and RCO should receive an e-mail notification for these tests from the RATS system, it is a good practice to check the schedule at the beginning and at the end of the each day in order to detect any last minute additions or changes to the Range Schedule.

Prior to the test, the RCO and the MFCO will need to get a copy of the User procedure for the test in order to help determine which functions, transmitters, and command sites the user will be requesting. The RCO and the MFCO will also need to review Procedure 9-1 FTS Open Loop Checks to get familiar with the applicable steps to properly configure the ground command equipment and to send the required commands. It is a good practice to have the Senior MFCO (SMFCO) and/or the CSO for the mission to assist if possible.

Prior to the FTS checks, CSC must perform a Ground Command Open Loop Test and for secure receivers a Ground Command Closed Loop Test to check out the CDS equipment and verify that the systems are ready to support the FTS checks. CSC will perform these checks prior to the scheduled time requested by the Range User to perform the FTS checks.

6.2.4.1.2 Overall Cautions and Notes

Frequency clearance on 421.0 MHz is required in order to send functions. The MFCO and RCO should reference the MOC Schedule for the frequency clearance times and record this time on their logs to help ensure commands are not sent outside of the clearance window. If the test is delayed, the Range User may have to request an extension of their frequency clearance from range scheduling. The RCO may have to remind the Range User when their frequency clearance time expires.

It is important that the destruct command is not sent unless the user has requested the command. The MFCO should reference the user checklist to determine which commands will be requested and in which order.

6.2.4.1.3 Test Configuration Verification

The following steps are performed to verify the test configuration for the FTS checks.

STEP 1: The RCO will obtain or verify with the Range User the test configuration for the FTS Checks to include:

- The communications channel that will be utilized for the command checks
- For vehicles with secure receivers, the type of codes that will be used for tests (Flight or Maintenance)
- The Command site(s) to be used (1A, 1B, or both)
- The transmitter(s) to be used (Master, Standby or both)
- The type of antenna (Directional/Steerable or Omni) to be used.
- For Trident II tests, the Destruct mode that will be used at Cape 1A (Single-Cycle, Multi-Cycle, or both)

The MFCO will obtain or verify the test configuration with the RCO. This information should be recorded on the log. The MFCO will verify the type of antenna that will be used with CSC in other steps later in the checklist. In some Delta IV tests, the Range User may ask the MFCO to indicate the power used (High or Low Power) and the type of antenna used (Directional/Steerable or Omni). The reference to the power used is a holdover from the days when Cape 1A was known as Station 1 High Power and Cape 1B was known as Station 1 Low Power.

STEP 2: If the MFCO has the communication channel for command checks on his/her panels, he/she will perform a communications check with the user. If the communication channel is not on the panels, the MFCO must notify the RCO to have the communication channel added to panels D3, D7, and D8 in the RSD Area. The MFCO should perform a communications check with the user when the channel comes up on the panels.

6.2.4.1.4 Console Equipment Configuration

Steps 3 through 14 are used to verify the configuration of the MFCO, CSC, and CSO consoles prior to conducting the FTS Open Loop checks. The steps that are used depend on the type of CRDs utilized by the launch vehicle and, in the case of secure receivers, which codes are used. For tests using standard receivers, perform Steps 3 through 6. For tests using secure receivers with maintenance codes, perform Steps 7 through 10. For tests using secure receivers with flight codes, perform Steps 11 through 14.

6.2.4.1.4.1 Standard Receiver Tests

For FTS checks utilizing standard receivers, the MFCO will perform Steps 3 through 6 to verify the equipment configuration at the MFCO, CSC, and CSO consoles.

STEP 3: The MFCO will verify the following equipment configurations at their consoles:

- The Flight Termination Units (FTUs) are configured with each of the applicable command functions: ARM, TEST, SAFE, DESTRUCT, W and/or X.
- The FTUs are disabled for Eastern Test Range-Inter-Range Instrumentation Group (ETR-IRIG) support.
- The communication panels have the required user channels.
- The RASCADS are operable.

STEP 4: The MFCO will establish the initial status and test configuration with CSC by performing the following:

- Perform a communications check with CSC on the Direct Line.
- Coordinate and perform a test count on FCO.LCL with CSC and the command sites. The MFCO will verify with CSC that the applicable command site(s) is/are standing by on FCO.LCL for the test count. Once CSC has confirmed that the site(s) is/are standing by, the MFCO will perform the test count on FCO.LCL by announcing: “Attention all stations on FCO.LCL, this is the MFCO with a test count. Test 1, 2, 3, 4, 5, 5, 4, 3, 2, 1, test out.” Since the command sites have monitor only capability on FCO.LCL, CSC will verify that the sites heard the test count and will notify the MFCO over FCO.LCL or the Direct Line.
- Provide the coordinated test configuration information to CSC.

The MFCO will also verify or obtain equipment configuration information with CSC to include:

- Verifying that the CSC console is in the OPERATE mode so that commands can only be sent by the FTUs at the MFCO console.
- Determining which antenna will be used (Omni or Steerable).
- Verifying that the CCRS is remoted to the MFCOs and can only be controlled by the FTUs and the RASCADS in the Range Safety Display (RSD) area.
- Verifying that CCRS keys have been delivered to the MFCO to ensure that the CCRS configuration cannot be changed without permission from the MFCO.

STEP 5: The MFCO will verify the following command equipment configuration with the CSO:

- The CSC console is Locked Out.
- The RSO RASCADs are Active at the CSO console in order to allow the CSO to control the command carrier.

- The RASCADs are in Manual Mode to allow the CSO to bring up the command carrier at the applicable command site(s).
- The Command Carrier is off.

STEP 6: After verifying the console equipment configuration in the previous steps, the MFCO will report readiness for the FTS Open Loop checks to the RCO.

After completing Steps 3 through 6, the MFCO will go to Step 15 and standby for initiation of the FTS Open Loop Checks.

6.2.4.1.4.2 Secure Receiver Tests with Maintenance Codes

For FTS checks utilizing secure receivers with maintenance codes, the MFCO will perform Steps 7 through 10 to verify the equipment configuration at the MFCO, CSC, and CSO consoles.

STEP 7: The MFCO will verify the following equipment configurations at their consoles:

- The FTUs are configured with each of the applicable command functions: ARM, TEST, SAFE, and DESTRUCT. The RESET command will not be configured on the FTUs. This will be explained later.
- The FTUs are disabled to engage the interlock that prevents access to the flight codes memory in the Message Storage Units (MSUs).
- The communication panels have the required user channels.
- The RASCADS are operable.

STEP 8: The MFCO will establish the initial status and test configuration with CSC by performing the following:

- Perform a communications check with CSC on the Direct Line.
- Coordinate and perform a test count on FCO.LCL with CSC and the command sites. The MFCO will verify with CSC that the applicable command site(s) is/are standing by on FCO.LCL for the test count. Once CSC has confirmed that the site(s) is/are standing by, the MFCO will perform the test count on FCO.LCL by announcing: "Attention all stations on FCO.LCL, this is the MFCO with a test count. Test 1, 2, 3, 4, 5, 5, 4, 3, 2, 1, test out." Since the command sites have monitor only capability on FCO.LCL, CSC will verify that the sites heard the test count and will notify the MFCO over FCO.LCL or the Direct Line.
- Provide the coordinated test configuration information to CSC.

The MFCO will also verify or obtain equipment configuration information with CSC to include:

- Verifying that the CSC console is in the TEST mode to allow the Command Message Encoder Verifiers (CMEVs) to access the maintenance codes in the MSU.
- Determining which antenna will be used (Omni or Steerable).

NOTE: For Delta IV tests, the CSC Console must be Active in order to send the RESET command

STEP 9: The MFCO will verify the following command equipment configuration with the CSO:

- The CSC console is Active or Locked Out, as applicable. Typically, the CSC Console will be Locked Out; however for Delta IV tests, the CSC console will need to be Active in order for CSC to send the RESET command.
- The RSO RASCADs are Active at the CSO console in order to allow the CSO to control the command carrier.
- The RASCADs are in Manual Mode to allow the CSO to bring up the command carrier at the applicable command site(s).
- The Command Carrier is off.

STEP 10: After verifying the console equipment configuration in the previous steps, the MFCO will report readiness for the FTS Open Loop checks to the RCO.

After completing Steps 7 through 10, the MFCO will go to Step 15 and standby for initiation of the FTS Open Loop Checks.

6.2.4.1.4.3 Secure Receiver Tests with Flight Codes

For tests using Flight Codes, the MFCO will perform Steps 11 through 14 to verify the equipment configuration at the MFCO, CSC, and CSO consoles.

STEP 11: The MFCO will verify the following equipment configurations at their consoles:

- The FTUs are configured with each of the applicable command functions: ARM, TEST, SAFE, and DESTRUCT.
- The FTUs are enabled to disengage the interlock and allow access to the flight codes memory in the MSUs.
- The communication panels have the required user channels.
- The RASCADS are operable.

STEP 12: The MFCO will establish the initial status and test configuration with CSC by performing the following:

- Perform a communications check with CSC on the Direct Line.
- Coordinate and perform a test count on FCO.LCL with CSC and the command sites. The MFCO will verify with CSC that the applicable command site(s) is/are standing by on FCO.LCL for the test count. Once CSC has confirmed that the site(s) is/are standing by, the MFCO will perform the test count on FCO.LCL by announcing: “Attention all stations on FCO.LCL, this is the MFCO with a test count. Test 1, 2, 3, 4, 5, 5, 4, 3, 2, 1, test out.” Since the command sites have monitor only capability on FCO.LCL, CSC will verify that the sites heard the test count and will notify the MFCO over FCO.LCL or the Direct Line.
- Provide the coordinated test configuration information to CSC.

The MFCO will also verify or obtain equipment configuration information with CSC to include:

- Verifying that the CSC console is in the OPERATE mode to allow the CMEVs to access the flight codes in the MSU.
- Determining which antenna will be used (Omni or Steerable).
- Verifying that the CCRS is remoted to the MFCOs and can only be controlled by the FTUs and the RASCADS in the RSD area.

- Verifying that CCRS keys have been delivered to the MFCO to ensure that the CCRS configuration cannot be changed without permission from the MFCO.

STEP 13: The MFCO will verify the following command equipment configuration with the CSO:

- The CSC console is Locked Out.
- The RSO RASCADs are Active at the CSO console in order to allow the CSO to control the command carrier.
- The RASCADs are in Manual Mode to allow the CSO to bring up the command carrier at the applicable command site(s).
- The Command Carrier is off.

STEP 14: After verifying the console equipment configuration in the previous steps, the MFCO will report readiness for the FTS Open Loop checks to the RCO.

After completing Steps 11 through 14, the MFCO will hold at Step 15 and standby for initiation of the FTS Open Loop Checks.

6.2.4.1.5 Activating the Command Carrier

This section in the procedure involves the steps that are accomplished to activate the command carrier at the various command sites.

STEP 15: When the Range User announces readiness to initiate the FTS Open Loop checks, the RCO will announce "Command Alert" to the MFCO. "Command Alert" indicates that all parties are ready for the FTS Open Loop checks and to remain alert for the Range User's request to activate the command carrier. The MFCO will relay "Command Alert" to alert the CSO and CSC. Note that the FTS checks may be one of many tasks that the Range User is conducting that day and the Range User may not give the RCO much notice that they are ready to perform the FTS checks. As a result, the RCO may not receive enough advance notice to perform Step 15.

The general notes in this section remind the crew that during the tests, the MFCO will multi-broadcast callouts on the Range User channel and FCO.LCL while CSC will only verify requests on FCO.LCL. The RCO should monitor FCO.LCL in order to hear the progress of the test. If an unplanned change in the configuration of the ground CDS is required and would affect the command carrier, the MFCO will need to coordinate with the User prior to making the configuration change. This is done so that the User is aware of any changes and can correlate any indications they may observe from the airborne FTS to the changes in the Ground CDS.

For Cape 1B carrier activation and site configuration, reference Steps 16 through 18. For Cape 1A carrier activation and site configuration, reference Steps 19 through 22.

6.2.4.1.5.1 Cape 1B Carrier Activation

Steps 16 through 18 are used to bring up the command carrier on the applicable transmitters and antennas at Cape 1B. The notes in this section remind the crew that Cape 1B does not have Pilot Tone/Check Channel or IRIG mode capability. They also remind the crew that when the carrier is brought up at Cape 1B, the site will default to the Master Transmitter. To transfer the carrier to the Standby Transmitter, the site has to induce a failure in the Master Transmitter. If required to be on the Standby Transmitter, the MFCO will direct the site to switch to the Standby Transmitter.

STEP 16: When the Range User requests, the MFCO will bring up the command carrier at Cape 1B:

- The MFCO will acknowledge the Range User’s request to bring up the command carrier and then alert all areas to standby for Cape 1B (Station 1B) carrier activation.
- The MFCO will then direct the CSO to bring up the carrier at Cape 1B (Station 1B).
- The CSO will acknowledge when the RASCADs indicate that Cape 1B is transmitting the carrier.
- If the user requested that the carrier be brought up on the standby transmitter, the MFCO will direct Cape 1B (Bronze 1B) to failover to the standby transmitter. Note that the RASCADs will show a yellow box with a “1” at the bottom of the Station 1B icon (listed as 1 LOW) when this is accomplished.
- If the user requested that the carrier be brought up on the standby transmitter, CSC will notify the MFCO when the command carrier is up on the standby transmitter at Cape 1B.
- The MFCO will notify the Range User that the carrier is up at Cape 1B and will specify which transmitter is active.

NOTE: To transfer the carrier from the Standby to the Master Transmitter, the site must re-initialize the Master Transmitter. When this occurs, the site will default to the omni antennas. If utilizing the steerable antennas, the MFCO will direct Cape 1B to switch to steerable antennas.

STEP 17: When the Range User requests, the MFCO will switch the active transmitter at Cape 1B:

- The MFCO will acknowledge the Range User’s request to switch the command transmitter and will direct Cape 1B (Bronze 1B) to switch to the applicable transmitter (Master or Standby).
- CSC will notify the MFCO that the command carrier is up on the applicable transmitter at Cape 1B.
- If the steerable antennas are being utilized for the FTS checks, the MFCO will direct Cape 1B (Bronze 1B) to switch to steerable antennas.
- If the MFCO directed Cape 1B (Bronze 1B) to switch to steerable antennas, CSC will notify the MFCO that the command carrier is up on the steerable antennas at Cape 1B.
- The MFCO will notify the Range User that the command carrier is up on the applicable transmitter at Cape 1B.

STEP 18: When the Range User requests, the MFCO will switch the active antenna at Cape 1B:

- The MFCO will acknowledge the Range User’s request to switch the command antenna and will direct Cape 1B (Bronze 1B) to switch to the applicable antenna (Omni or Steerable).
- CSC will notify the MFCO that the command carrier is up on the applicable antenna at Cape 1B.
- The MFCO will notify the Range User that the command carrier is up on the applicable transmitter and antenna at Cape 1B.

After requesting Cape 1B command carrier activation and/or configuration actions, there are many actions that the Range User may request the MFCO to perform to include sending and removing command functions or even removing the command carrier. To send or remove command functions, reference Steps 25 through 28. Reference the command function notes as required. To remove the command carrier, go to Step 31.

6.2.4.1.5.2 Cape 1A Carrier Activation

Steps 19 through 22 are used to bring up the command carrier on the applicable transmitters, antennas, and Destruct Cycle mode (as required) at Cape 1A. The notes in this section remind the crew the carrier can be brought up at Cape 1A on either the Master or Standby Transmitter. The carrier will be brought up on the Master Transmitter unless the site was previously configured for the Standby Transmitter. If required, the MFCO will direct the site to switch to the Master or Standby Transmitter.

STEP 19: When the Range User requests, the MFCO will bring up the command carrier at Station 1A:

- The MFCO will acknowledge the Range User's request to bring up the command carrier and then alert all areas to standby for Station 1A carrier activation.
- If Pilot Tone or Check Channel was requested by the Range User, the MFCO will then direct CSC to enable Pilot Tone so that it will be transmitted when the carrier is activated at Cape 1A.
- CSC will report when Pilot Tone or Check Channel has been enabled.
- The MFCO will then direct the CSO to bring up the carrier at Cape 1A (Station 1A).
- The CSO will acknowledge when the RASCADs indicate that Cape 1A is transmitting the carrier.
- If required due to the site's configuration and/or the transmitter requested by the user, the MFCO will direct Cape 1A (Bronze 1A) to switch to the applicable transmitter. Note that the RASCADs will not indicate when Cape 1A is on the standby transmitter since it does not have to be "forced" to failover to the standby transmitter.
- If the MFCO directed the site to switch transmitters, CSC will notify the MFCO when the command carrier is up on the applicable transmitter, with the Pilot Tone or Check Channel (as applicable), at Cape 1A.
- The MFCO will notify the Range User that the carrier is up, with the Pilot Tone or Check Channel (as applicable), at Cape 1A and will specify which transmitter is active.

STEP 20: When the Range User requests, the MFCO will switch the active transmitter at Cape 1A:

- The MFCO will acknowledge the Range User's request to switch the command transmitter and will direct Cape 1A (Bronze 1A) to switch to the applicable transmitter (Master or Standby).
- CSC will notify the MFCO that the command carrier is up, with the Pilot Tone or Check Channel (as applicable), on the applicable transmitter at Cape 1A.
- The MFCO will notify the Range User that the command carrier is up, with the Pilot Tone or Check Channel (as applicable), on the applicable transmitter at Cape 1A.

STEP 21: When the Range User requests, the MFCO will switch the active antenna at Cape 1A:

- The MFCO will acknowledge the Range User's request to switch the command antenna and will direct Cape 1A (Bronze 1A) to switch to the applicable antenna (Omni or Steerable).
- CSC will notify the MFCO that the command carrier is up, with the Pilot Tone or Check Channel (as applicable), on the applicable antenna at Cape 1A.
- The MFCO will notify the Range User that the command carrier is up, with the Pilot Tone or Check Channel (as applicable), on the applicable transmitter and antenna at Cape 1A.

STEP 22: When the Range User requests, the MFCO will switch the active destruct cycle modes at Cape 1A (Trident II missions only):

- The MFCO will acknowledge the Range User's request to switch the destruct cycle mode and will direct Cape 1A (Bronze 1A) to switch to the applicable mode (Single-Cycle or Multi-Cycle).
- CSC will notify the MFCO that the command carrier is in the applicable mode (Single-Cycle or Multi-Cycle).
- The MFCO will notify the Range User that the command carrier is up on the applicable transmitter and destruct cycle modes at Cape 1A.

After requesting Cape 1A command carrier activation and/or configuration actions, there are many actions that the Range User may request the MFCO to perform to include sending and removing Pilot Tone/Check Channel, sending and removing command functions, or even removing the command carrier. To send or remove Pilot Tone/Check Channel, reference Steps 23 through 24. To send or remove command functions, reference Steps 25 through 28. Reference the command function notes as required. To remove the command carrier, go to Step 31.

6.2.4.1.6 Command Functions

This section in the procedure involves the steps (23 through 28) that are accomplished to send and remove Pilot Tone/Check Channel and command functions to the vehicle. The first note in this section reminds the MFCOs that there are a variety of commands that may be sent and varying combinations of these commands. The user procedure should document the commands for a particular vehicle and test. For combinations of commands other than the ones listed in the FTS Checks Procedures, the RCO and MFCO should coordinate with the ISRO and CSC to ensure acceptable terminology is used. The next note states that for DRS Mission Modes, the DESTRUCT command cannot be sent unless the ARM Command is also being sent. This is not a problem for the Atlas V, since that program requests that the ARM command be continuously sent, then requests that the MFCO continuously send DESTRUCT and then requests that both functions be removed. This is an issue when performing Delta IV tests since this program requests that the MFCO send commands for one second. When the MFCO is requested to send one second DESTRUCT, the MFCO will need to send ARM, then send DESTRUCT for one second, and then remove both functions. The next note reminds the MFCOs that they will have to direct CSC to send Pilot Tone, Check Channel or the RESET command if they are requested by the Range User. The last note reminds the MFCO that, prior to sending a command, the MFCO will verify with the SMFCO that the switch cover has been raised for the correct FTU switch for the applicable command function. This is designed to allow the SMFCO to verify that the MFCO has selected the correct FTU switch and the correct command function will be sent.

STEP 23: When the Range User requests, the MFCO will direct CSC to send Pilot Tone/Check Channel.

- The MFCO will direct CSC to send pilot tone/check channel.
- CSC will notify the MFCO that Pilot Tone/Check Channel has been sent.
- The MFCO will notify the Range User that Pilot Tone/Check Channel has been sent.

STEP 24: When the Range User requests, the MFCO will direct CSC to remove Pilot Tone/Check Channel.

- The MFCO will direct CSC to remove Pilot Tone/Check Channel.
- CSC will notify the MFCO that Pilot Tone/Check Channel has been removed.
- The MFCO will notify the Range User that Pilot Tone/Check Channel has been removed.

STEP 25: When the Range User requests, the MFCO will send continuous command functions. A continuous command function is one that is sent for an indefinite period of time and then removed upon the Range User request.

- The MFCO will acknowledge the Range User's request, perform a countdown mark and send the command.
- The CSO will confirm the command was sent.
- The MFCO will report to the Range User that the command was sent.

STEP 26: When the Range User requests, the MFCO will remove continuous command functions.

- The MFCO will acknowledge the Range User's request, perform a countdown mark and remove the command.
- The CSO will confirm the command was removed.
- The MFCO will report that the command was removed to the Range User.
- In addition, the MFCO will direct CSC to send Pilot Tone for tests utilizing Station 1A with Pilot Tone/Check Channel. When functions are modulated onto the command carrier, the Pilot Tone/Check Channel signal modulation is removed from the carrier. In order to re-transmit the Pilot Tone/Check Channel, the MFCO must direct CSC to resend Pilot Tone/Check Channel once the command functions are cleared off the carrier.
- CSC will notify the MFCO that Pilot Tone/Check Channel has been sent.
- The MFCO will notify the Range User that Pilot Tone/Check Channel has been sent.

STEP 27: When the Range User requests, the MFCO will send timed command functions. A timed command function is one that is only sent for a short period of time (a few seconds) and then removed. One example is the one second commands used for the Delta IV launch vehicle. This step can also be utilized during Atlas V tests when the Range User requests the MFCO to send and then immediately remove the SAFE command. NOTE: When sending a timed DESTRUCT command, send ARM prior to sending DESTRUCT.

- The MFCO will acknowledge the Range User's request, perform a countdown mark and send the command. The MFCO will report to the Range User that the command was sent, remove the command after the requested period of time, and report to the Range User that the command was removed. A good technique to use when sending a one second DESTRUCT command, is to send ARM when stating the number 1 during the countdown mark and then to send DESTRUCT upon stating word "Mark." This will ensure that ARM is sent prior to DESTRUCT.

- The CSO will confirm that the command was sent and removed when confirmed on the RASCAD. The MFCO should not wait for CSO confirmation that the command was sent before reporting to the Range User and removing the command. There is a time delay between when the command is sent and when the RASCAD display confirms that the command was sent. This time delay could cause the command to be sent for a longer time period than requested if the MFCO waited for confirmation from the CSO before reporting the command was sent and then removing the command. This could cause a problem with the test for the Range User. A good technique is to send the command, report to the Range User that the command was sent, count to yourself "one-one thousand" up the requested time period, remove the command, and then report to the Range User that the command was removed. If the request was for one second, this technique will cause the command to be sent slightly longer than one second (approximately a second and a half) but will not cause the command to be sent too long for the Range User and yet allow for 15 cycles of the command to be transmitted so that the site's ACME will get enough data to verify the signal and the command.
- The MFCO will direct CSC to send Pilot Tone/Check Channel once the command has been removed.
- CSC will notify the MFCO that Pilot Tone/Check Channel has been sent.
- The MFCO will notify the Range User that Pilot Tone/Check Channel has been sent.

STEP 28: When the Range User requests, the MFCO will send the RESET command which is used for Delta IV launch vehicle tests using maintenance codes. The RESET command must be sent by CSC due to the limited number of switches on the MFCO FTUs.

- The MFCO will acknowledge the Range User's request, perform a countdown mark and direct CSC to send the command.
- CSC will report both when the command has been sent and removed.
- The MFCO will relay each report to the Range User. The sending and removing of the RESET command will not show up on the RASCAD.
- The MFCO will direct CSC to send Pilot Tone/Check Channel once the command has been removed.
- CSC will notify the MFCO that Pilot Tone/Check Channel has been sent.
- The MFCO will notify the Range User that Pilot Tone/Check Channel has been sent.

After requesting for command functions to be sent, there are many actions that the Range User may request the MFCO to perform to include switching the carrier to another command site, switching command transmitters, and/or removing the command carrier. If the User requests that the carrier be transferred to Cape 1B, go to Step 16. If the User requests to switch the transmitters at Cape 1B, go to Step 17. If the User requests that the carrier be transferred to Cape 1A, go to Step 19. If the User requests to switch the transmitters at Cape 1A, go to Step 20. If the User requests that the carrier be removed, go to Step 31. If the FTS Open Loop Checks are complete and the User requests that the carrier remain active, continue on to Step 29.

6.2.4.1.7 Post-Test Actions

This section in the procedure deals with actions after the FTS Open Loop Checks are complete to include removing the command carrier and releasing Range Personnel.

STEP 29: Once the Range User is satisfied that the test is complete, the MFCO will notify the RCO and CSO that the FTS Open Loop checks are complete. The Range User may then give the RCO or MFCO clearance to bring down the carrier at that point, or they may want the carrier to remain up as they continue with other tasks or a simulated countdown. If the carrier is to stay up, the MFCO will direct the CSO to leave the carrier up and will specify the equipment configuration. The MFCO will then notify the RCO of the actions that are being taken.

STEP 30: If the Range User has not already given clearance to remove the command carrier, the RCO will coordinate with the Range User to release the command carrier. The RCO will then notify the MFCO that the carrier can be removed.

STEP 31: Once the Range User has requested or given clearance to remove the command carrier, the MFCO will direct the CSO to bring down the carrier. The CSO notify the MFCO when RASCAD confirms the carrier is down. The MFCO should log the time that the carrier is removed.

STEP 32: The MFCO will notify the Range User and/or the RCO, as applicable, that the carrier has been removed.

Some Range Users, such as the Navy, may request that the command carrier be removed before the FTS Open Loop checks are complete. As a result, the Range User may request that the MFCO perform other actions to support the remainder of the checks. If the User requests that the carrier be transferred to Cape 1B, go to Step 16. If the User requests that the carrier be transferred to Cape 1A, go to Step 19. If the User requests to switch to Single-Cycle or Multi-Cycle Destruct Mode at Cape 1A, go to Step 22. If the FTS Open Loop Checks are complete, continue to Step 33.

STEP 33: Once the Range User no longer needs Command support, the RCO will coordinate for the release of Command instrumentation and personnel and will notify the MFCO and the ISRO.

STEP 34: The MFCO will contact CSC via VDL to coordinate returning the CSC Console keys.

STEP 35: The MFCO will verify with the CSO that CSC is Active and RSO is Locked Out on the RASCAD.

When the MFCO and RCO are ready to leave the console, they should annotate it on the logs and file the log with their mission documentation. The MFCO may elect to give the MFCO log to the RCO for inclusion into the Mission Folder.

6.2.4.2 Launch Day FTS Open Loop Checks

The launch day FTS open loop test procedures are derived from Procedure 9-1 FTS Open Loop checks and the User Countdown procedures and then integrated in the LSP and the MFCO Countdown Checklist for the applicable launch vehicle. The launch day FTS Open Loop Checks procedures can be categorized into three sections: Pre-Test Actions, Test Execution, and Post-Test Actions.

6.2.4.2.1 Pre-Test Actions

There are several pre-test actions that are taken to configure equipment in order to conduct the FTS Open Loop Checks. They include:

- Verifying with the OSM that the Blast Danger Area (BDA) is Clear for the CRD Function Test
- Determining Safety Analysis (SEA) Status for the FTS Open Loop Checks
- Obtaining the Command Report from CSC
- Performing a Test Count on FCO.LCL
- Verifying the Command Configuration from the CSO
- Verifying Range Safety Readiness for the FTS Open Loop Checks
- Issuing "Command Alert"

These actions begin approximately 5 minutes prior to the scheduled start time in the countdown procedures for the FTS Open Loop Checks.

6.2.4.2.1.1 Verify BDA is Clear for CRD Function Test

The MFCO will contact the OSM on the Direct Line and request verification that the BDA is clear for the CRD Function Test. The OSM coordinates with security personnel to clear personnel from the BDA prior to the pressurization of bottles and loading of propellants on the launch vehicle. If personnel are clear of the BDA, the OSM will report "BDA is clear." If personnel have not been cleared from the BDA, the OSM will notify the MFCO and the test will not be initiated until all personnel have been cleared from the BDA.

6.2.4.2.1.2 Determine SEA Status for the FTS Open Loop Checks

The MFCO will contact SEA on the Direct Line and request their status for the FTS Open Loop Checks. If SEA is not working any issues with the FTS, the SEA will report "GO" status. IF the SEA is working an issue with the FTS and are not ready for the FTS Open Loop checks to be initiated, the SEA will report "NO-GO" status and the test will not be initiated.

6.2.4.2.1.3 Obtain the Command Report from CSC

The MFCO will contact the CSC on the Direct Line and request his Command Report to include:

- Verifying that the Command Switch checks (Ground Command Open Loop checks) are complete.
- Verifying that the Auto carrier check is complete.
- Verifying that the CCRS is remoted to the MFCOs and can only be controlled by the FTUs and the RASCADS in the Range Safety Display (RSD) area.
- Verifying that CCRS keys have been delivered to the MFCO to ensure that the CCRS configuration cannot be changed without permission from the MFCO.
- Verifying that the FTS are enabled for vehicles using secure receivers or disabled for vehicles using non-secure (standard) receivers. For vehicles using secure receivers, the FTUs should be enabled to disengage the interlock and allow access to the flight codes memory in the MSUs. For vehicles using non-secure (standard) receivers, the FTUs should be disabled for ETR-IRIG support.

Note that once CSC has completed their checkout of the Ground CDS and are ready to transfer the system to the MFCOs, CSC may contact the CSC on the Direct Line to perform this step earlier than when it is documented in the MFCO Countdown Checklist.

6.2.4.2.1.4 Perform a Test Count on FCO.LCL

After obtaining the command report from the CSC, the MFCO will coordinate and perform a test count on FCO.LCL with CSC and the command sites. The MFCO will verify with CSC that the applicable command site(s) is/are standing by on FCO.LCL for the test count. Once CSC has confirmed that the site(s) is/are standing by, the MFCO will perform the test count on FCO.LCL by announcing: "Attention all stations on FCO.LCL, this is the MFCO with a test count. Test 1, 2, 3, 4, 5, 5, 4, 3, 2, 1, test out." Since the command sites have monitor only capability on FCO.LCL, CSC will verify that the sites heard the test count and will notify the MFCO over FCO.LCL or the Direct Line.

6.2.4.2.1.5 Verify the Command Configuration with CSO

The MFCO will verify the following command equipment configuration with the CSO:

- The CSC console is Locked Out. Note that if the CSO has had to re-locate to the CSC console, then CSC console should be Active.
- The RSO RASCADs are Active at the CSO console in order to allow the CSO to control the command carrier.
- The RASCADs are in Manual Mode to allow the CSO to bring up the command carrier at the applicable command site(s).
- The Command Carrier is off.

6.2.4.2.1.6 Verify Range Safety Readiness for FTS Open Loop Checks

Approximately 2 minutes prior to the scheduled start time in the countdown procedures for the FTS Open Loop Checks, the RCO will contact the MFCO on RCO.LOOP and verify Range Safety readiness for the FTS Open Loop Checks. Note that all of the previous pre-test actions must be successfully completed before the MFCO can report Range Safety readiness for the FTS Open Loop checks. If the MFCO has been able to successfully complete all of the pre-test actions, the MFCO will report readiness for the FTS Open Loop checks. If the MFCO has not been able to successfully complete the pre-test actions, the MFCO will report "Not Ready" and explain the issue or problem. The RCO will notify the Range User of the problem and the need to delay the test.

6.2.4.2.1.7 Command Alert

If the Range User is still on track to perform the FTS Open Loop checks and the MFCO has reported Range Safety readiness for the checks, then the RCO will announce "Command Alert" to the MFCO. "Command Alert" indicates that all parties are ready for the FTS Open Loop checks and to remain alert for the Range User's request to activate the command carrier. The RCO will also announce "Command Alert" to the ISRO who will relay it to CSC. The MFCO will relay "Command Alert" to the CSO and CSC (to ensure CSC is notified) on FCO.LCL. The MFCO will then instruct the SMFCO to answer all calls during the command checks. This is done to allow the MFCO to focus on performing the FTS Open Loop checks.

6.2.4.2.2 Test Execution

The execution of the FTS Open Loop checks varies among the various launch vehicle programs. Reference the applicable sub-section in Section 3 of this manual for the specific details for each launch vehicle program. Although the exact procedure varies from program to program, the generic procedure consists of:

- Bringing up the command carrier on the standby transmitter at the applicable command sites(s)

- Sending the SELF TEST or ARM command, as applicable, depending on the type of receiver used on the launch vehicle
- Switching the carrier to the Master Transmitter at the applicable command sites(s)
- Sending the SELF TEST or ARM command, as applicable, depending on the type of receiver used on the launch vehicle

For vehicles using non-secure (standard receivers), this process will only be conducted with the Cape 1A command site since Cape 1B cannot support the ETR-IRIG mode For vehicles using secure receivers, the carrier will initially be brought up on the Cape 1B Standby Transmitter and the checks will be conducted on both the Standby and Master Transmitters. The carrier will then be transferred to the Cape 1A Standby Transmitter and the process repeated using the Cape 1A command site. Note that the Master Transmitter is brought up last in the sequence in order to leave the Ground CDS in the configuration that will be used for launch, which is typically on the Cape 1A Master Transmitter.

6.2.4.2.3 Post-Test Actions

Once the FTS Open Loop checks are complete, the MFCO will notify the CSO that the FTS Open Loop checks are complete and direct the CSO to keep the carrier up on the applicable command site. The MFCO will then notify the RCO that the FTS Open Loop checks are complete and which command site will continue to transmit the carrier. Note that if a change in the configuration of the ground CDS is required and would affect the command carrier, the MFCO will need to coordinate with the User, through the RCO, prior to making the configuration change. This is done so that the User is aware of any changes and can correlate any indications they may observe from the airborne FTS to the changes in the Ground CDS. Also note that the MFCO can reference Procedure 9-1 FTS Open Loop Checks, as required, to perform any required Ground CDS configuration changes.

6.2.4.3 Problem Reporting

Problems can arise during the FTS Open Loop Checks and prevent the completion of the test. These problems could be detected by a failure to receive the proper indications on either the airborne FTS or the Ground CDS equipment and could indicate a problem with the CCRS, the applicable command site, the airborne FTS, or multipath. Reporting these problems and the associated indications can help to isolate and resolve the problem. The RCO and the MFCO will report any problems using the Comm/Console/SCDS Failure/Restoral Checklist 10. On launch day, the OSM will report problems to the MFCO. Note that depending on the problem, the MFCO may need to confer with the OSM, SEA, and/or the STA.

6-3 BEACON CHECKS

6.3.1 PURPOSE

The purpose of Beacon checks is to test the launch vehicle's C-band beacon(s) to ensure compatibility with range radars. At the time of this document, C-band beacon is scheduled be used on the Minotaur IV vehicle only. All previous C-band beacons have been phased out.

6.3.2 DEFINITIONS

6.3.2.1 C-Band Beacon

The C-band beacon is an electronic component installed on launch vehicles that emits an electronic signal when interrogated by a radar source. The beacon is used as a tracking source when the vehicle is in flight.

6.3.2.2 C-Band Beacon Compatibility Procedures (Beacon Checks)

Beacon Checks test the ability of the launch vehicle's beacon to respond, within set tolerances, when interrogated by multiple radar sources.

6.3.2.3 Frequency Control and Analysis (FCA) Van

The FCA van is the only range asset capable of determining beacon compatibility with the Eastern Range.

6.3.3 PARTICIPANTS/RESPONSIBILITIES

6.3.3.1 Range Control Officer (RCO)

The RCO is responsible for ensuring beacon checks are performed during pre-launch and launch-day testing of the launch vehicle. The RCO, as the interface between the user and the range, makes requests for beacon checks through the Instrumentation Superintendent of Range Operations (ISRO), and reports results to the user.

6.3.3.2 Instrumentation Superintendent of Range Operations (ISRO)

The ISRO is the interface between the RCO and Radio Frequency (RF), and participates in all beacon checks. The ISRO ensures the radars and FCA vans are ready to support the checks and directs them to begin and stop when requested by the RCO. The ISRO completes the C-Band Readout Log Worksheet based on data from the FCA van and the radar sites.

6.3.4 OVERVIEW

A C-band beacon provides an additional source for range radars to track a vehicle in flight. The function of the beacon is to provide a steady and strong tracking source when interrogated by radar signals (it is more of a radar transponder than a true beacon). The major goals of the checks are to determine if the beacon is functioning properly (power output and other performance items are within specified tolerances from the Operations Directive (OD)), and to determine whether or not the beacon will function when interrogated by multiple sources (compatibility). Beacon checks are performed during pre-launch checks and during the minus count on launch day. These checks are scheduled and requested by the user IAW their countdown procedures.

Beacon checks are performed using range radars and/or an FCA van. The FCA van is the primary source for performing beacon checks. Once the beacon readout has been performed and logged, the RCO reports the data and the beacon's compatibility status to the user. If the ISRO reports that the beacon is incompatible, the RCO must alert the user and the MFCO (if supporting). The beacon is a safety mandatory item for launch IAW EWR 127-1.

6.3.5 PROCEDURES and/or CHECKLISTS

Beacon checks are requested by the user IAW their countdown/test procedure or as scheduled for pre-launch testing, per the vehicle specific OD. At the appropriate time in the user countdown/test procedure, the user will request the RCO conduct beacon readout checks and report results. Before starting the beacon checks, the RCO must wait a specified period of time before having the beacon interrogated. This delay is required for the beacon to warm up and is usually around two to five minutes. The RCO directs the ISRO to begin readout procedures after the warm-up delay period is over.

To start the readout, the ISRO will direct the RF System Controller or the Radar Controller to allow the source to begin interrogating the beacon. If more than one source is to be used for the readout (FCA van plus radar), it is important that only one source be used at a time. The ISRO, Radar Controller, and RF will work together to determine which source should go first. Other radar requirements, such as Jimsphere balloon tracking, must be taken into consideration when making this decision. Only one source may be used at a time as erroneous readings will result from multiple interrogations (the nominal values are based on single source interrogations).

Once the readout is done (it can take from 15-30 minutes), the van/radar operator will report the results to the RF, who will pass them to the ISRO. The ISRO will pass the results, logged on the C-Band Beacon Readout Log, to the RCO. The RCO will then report the results to the user. Most users want you to report or fax the entire readout log. Once the first source (van or radar) is complete, a second source is used for another check. The second readout will not begin until the first has completely ceased interrogation, and the first source will not cease interrogation until the second is ready to start interrogation. This ensures the beacon is being continually interrogated. If the van is the only source, then depending on user desires, it will either cease or continue interrogation until released. For example, during the actual countdown the van may stay continually active on the beacon to verify it is working.

If the FCA van reports the beacon as non-compatible, or if certain other erroneous indications appear (reference ROI 10-01-13), another readout may be attempted by another FCA van, if available, or another radar. If the beacon is still incompatible, the RCO will alert the user (and MFCO, if supporting) that the beacon is not committed for the operation. If the readings were taken with the Mobile Service Tower (MST) in place, the NO-GO will not be given unless the same readings occur after the MST is rolled back, or if a closed loop cable or calibrated re-radiating device was used for the readings.

OM Vol 2 Procedure 9-2 describes the basic procedure for Beacon Checks when not part of the DOL LSP procedure.

6-4 FIRST MOTION CHECKS

6.4.1 PURPOSE
The purpose of the first motion subsystem of the Eastern Range Sequencer System is to provide an input to the sequencer and initiate timed events relevant to the launch time.

6.4.2 DEFINITIONS

6.4.2.1 First Motion
First motion is an electronic signal sent from the launch pad through the sequencer to various locations when the launch vehicle lifts two inches off the pad. First motion is necessary for the correct sequencing of launch events. First Motion time will be displayed on the Closed Circuit Television (CCTV), and the sequencer.

6.4.2.2 First Motion Checks
First motion checks validate first motion circuitry from the sequencer in the applicable launch control center to all locations required to receive a first motion signal.

6.4.2.3 Sequencer
The sequencer is part of the sequencing system that controls starting and stopping the count, recycling, and auto starting. The sequencer contains a switch that provides a simulated first motion input for use in first motion checks.

6.4.2.4 Audio Plus Count
The audio plus count provides a synthesized audible voice plus count over the Public Address (PA) system. This plus count is helpful to sites that do not receive a first motion signal or personnel who cannot look at a plus-count clock.

6.4.3 PARTICIPANTS/RESPONSIBILITIES

6.4.3.1 Range Control Officer (RCO)
The RCO ensures the Instrumentation Superintendent of Range Operations (ISRO) initiates instrumentation first motion checks at the appropriate time in the countdown, and reports test results to the user.

6.4.3.2 Instrumentation Superintendent of Range Operations (ISRO)
The ISRO is the interface between the RCO and the communication and timing system controllers when performing first motion checks. The ISRO initiates first motion checks IAW the Operations Directive (OD) and/or user procedures and reports completion to the RCO.

6.4.3.3 Communications and Timing System Controllers
Communications and timing system controllers are contractor personnel responsible for coordination and performing first motion checks.

6.4.4 OVERVIEW
First motion is very important because it enables the range instrumentation sites to acquire track after lift-off. First motion synchronizes all supporting site activities and systems that must be timed precisely to the lift-off time, or to an exact moment in time after lift-off, by providing all

sites with the same time that the launch vehicle has lifted two inches off of the launch pad. First motion checks are performed during pre-launch system checks and during the actual launch countdown IAW the OD and/or user countdown procedure. First motion checks begin with approval from the user and are completed when all parties are satisfactory with the results.

6.4.5 PROCEDURES and/or CHECKLISTS

First motion check procedures are contained in range and user documentation for the RCO (Operations Directive, user countdown procedure). The RCO accepts the first motion check approval from the user and passes it to the ISRO. The ISRO confirms the Communication System Controller has activated the audio plus count, notifies all System Controllers over the Instrumentation Net of impending first motion checks, provides a terminal countdown (last 10 seconds), announces first motion to all sites, and receives verification from system controllers of receipt of the first motion signal. Next, the ISRO notifies the RCO of all actions and results. The RCO then relays results to the user. When the results are satisfactory, the ISRO will instruct the Communication System Controller to deactivate the audio plus count and direct the Timing and Communications System Controllers to reconfigure to launch configuration.

6-5 TELEMETRY CHECKS

6.5.1 PURPOSE

Telemetry checks are performed during pre-launch tests and the minus count when requested by the range user. These checks measure the radio frequency (RF) characteristics of the telemetry links; for example, the center frequency, deviation, and signal strength.

6.5.2 PARTICIPANTS/RESPONSIBILITIES

6.5.2.1 Range Control Officer (RCO)

The RCO receives requests from the range user to initiate telemetry checks (when required), and reports results to the range user.

6.5.2.2 Instrumentation Superintendent of Range Operations (ISRO)

The ISRO is the interface between the RCO and telemetry system controller. The ISRO coordinates telemetry checks with the telemetry system controller and reports results to the RCO.

6.5.2.3 User

The user schedules telemetry checks as required and analyzes results to confirm proper operation of the telemetry transmitter. The user also troubleshoots incorrect telemetry transmitter operation.

6.5.2.4 Telemetry System Controller

The Telemetry System Controller conducts telemetry checks and reports results to the ISRO.

6.5.3 OVERVIEW

Telemetry checks are performed during pre-launch tests and during the minus count IAW the Operations Directive (OD) and/or user countdown procedure. TEL-4 ensures that a telemetry antenna is locked onto the RF link and is feeding the signal to a receiver. The receiver then displays the center frequency, deviation, and signal strength (See Annex for definitions). If requested, Tel-4 can perform data quality analysis where the data on the telemetry link is decommutated and analyzed. If the link is encrypted, the only data quality check that can be performed is verification of the bitsync.

Note: When downrange telemetry sites are supporting a telemetry theoretical run, they can transmit the telemetry data via High Frequency (HF) or Satellite Communications (SATCOM) links.

6.5.4 PROCEDURES and/or CHECKLISTS

Telemetry check procedures are contained in range user documentation for the RCO (Operations Directive, user countdown procedure). The RCO accepts the telemetry check request from the user and passes it on to the telemetry system controller through the ISRO and reports results back to the user when the checks are complete. The procedures for telemetry operations & maintenance personnel are contained in LISC located on LIMES.

6-6 RANGE COUNTDOWN INSTRUMENTATION CHECKS

6.6.1 OVERVIEW

The final instrumentation checks that are accomplished prior to T-0 are the Range Countdown Instrumentation Checks. These checks are IAW the ERTS Contractor Provided Range Countdown Procedures. These are in addition to the previously discussed five major pre-mission checks: Holdfire Checks, Flight Termination Checks, Beacon Checks, First Motion Checks, and Telemetry Checks. The Range Countdown Instrumentation Checks are generally accomplished during F-1 day and/or day of launch. The aforementioned five major pre-mission checks may or may not be accomplished again on day of launch.

6.6.2 PURPOSE

ERTS contractor personnel, upon direction of the ISRO, conduct operational verifications during the minus count for launches conducted on the ER in order to ensure proper operation of supporting instrumentation. Each of these checks is detailed below. Additional checks can be found in the Annex. The following checks are in chronological order.

6.6.3 OPEN LOOP/CLOSED LOOP COMMAND CHECKS

6.6.3.1 Closed Loop Verification

Each vehicle that uses secure command messages (Atlas V, and Delta IV) have provided the Command Ground system a Command Receiver Decoder (CRD), which is a represented receiver that the vehicle uses in flight to receive the Command Functions.

Prior to the mission, the launch customer will conduct a “Code Load” where they load the encrypted flight termination functions (Test, Safe, Arm, and Destruct) into the MSU 1 and MSU 2 (Message Storage Unit) at Central Command Remoting System (CCRS) and the CRD at Cape 1A and Cape 1B. The encrypted functions are sent from the MSU to the CRD in a Closed Loop verification, meaning that they are not transmitted open air to avoid compromising the flight codes. This operational verification ensures that the same encrypted flight codes loaded on the vehicle match the flight codes loaded in the MSU at CCRS. The CRD at Cape 1A and 1B is the receiver used for that verification so that the encrypted flight codes are not compromised.

Note: The only encrypted function sent open air is the “Test” function during a pad test. For security purposes, “Test” is sent to prevent encrypted flight codes being broadcast open air.

6.6.3.2 Open Loop Verification

Open Loop verification is performed to ensure that the Command transmitting sites perform as designed and properly send Command Functions open air. Additionally, the Open Loop verification ensures that the functions sent meet Range Safety criteria as verified by the ACME (Automated Command Message Evaluation). Maintenance codes are used for the Open Loop verification and not the encrypted flight codes.

6.6.4 INITIAL GROUND COMMAND CLOSED LOOP CHECKS

This test is performed to verify the unique flight codes loaded into the Command Destruct system when operating in the secure mode for each mission. Copies of the flight codes are loaded into the Operate and Verify memories of the MSU for each Command Message Encoder Verifier (CMEV) as well as at the Cape 1A and Cape 1B CRD prior to Range F-1 checks. On launch day, CSC configures the Command Destruct system into closed loop mode, which precludes radiation of mission flight codes. Each required Function is transmitted from the CCRS to Cape 1A. Extensive cross checking is performed by the CCRS firmware to ensure that the same data exists in both the Operate and Verify memories for each Central CMEV as well as between Central CMEVs. The Function sent to Cape 1A is then verified with the copy stored at the Command site. Receipt of an "IRD Confirm" indication displayed on the CCRS console confirms that all verification checks have passed for that specific Function. Following verification of each Function between CCRS and Cape 1A, the process is repeated between CCRS and Cape 1B. The initial check is done early in the countdown to allow time for troubleshooting and correction of any identified deficiencies.

Objective: Verification of the unique flight codes loaded into the Command Destruct system when operating in the secure mode for each mission. The initial check is done early in the countdown to allow time for troubleshooting and correction of any deficiencies identified.

Execution: Copies of the flight codes are loaded into the Operate and Verify memories of the Message Storage Unit for each Central Command Message Encoder Verifier (CMEV) as well as at Cape 1A and Cape 1B Command Receiver Decoder (CRD) prior to Range F-1 checks. On launch day using the established checklist procedure, the Command System Controller configures the Command Destruct system into closed loop mode which precludes radiation of mission flight codes. Each required function is transmitted from the Central Command Remoting System (CCRS) to Cape 1A. Following verification of each function between CCRS and Cape 1A, the process is repeated between CCRS and Cape 1B.

6.6.5 OPTICS THEORETICAL

Objective: Perform a second-for-second simulation through the end of the optical solution commitment, to test the collective ability of participating metric Optics sites to contribute to the single Range Safety Optical tracking solution.

Execution: At the simulated T-0 mark, Range Safety processing components begin generation of output designate data based on the nominal theoretical trajectory. Each participating Optics site mount is driven on this designate data. As the Optics mounts drive along the trajectory, real-time mount angular position data is measured and returned to the Range Safety processing components for determination of the metrics Optics tracking solution. The Optics Theoretical will run through the end of the metric Optics Range Safety commitments.

6.6.6 INITIAL GROUND COMMAND OPEN LOOP CHECKS

This test is an end-to-end verification of the operation of the entire required Command Destruct Supersystem. Checks are performed from each Central CMEV through the corresponding string (site CMEV/System Control Unit (SCU), transmitter, antenna) at Cape 1A. In addition, checks are made from each Central CMEV through each combination of site CMEV/Command Remoting Unit (CRU), transmitter, and antenna for Cape 1B and JDMTA.

Objective: End-to-end verification of the operation of entire required Command Destruct Supersystem. The initial check is done early in the countdown to allow time for troubleshooting and correction of any deficiencies identified.

Execution: Checks are performed from each Central CMEV through the corresponding string (site CMEV/SCU, transmitter, antenna) at Cape 1A. In addition checks are made from each Central CMEV through each combination of site CMEV/CRU, transmitter and antenna for Cape 1B and JDMTA. Checks are accomplished by the utilization of maintenance codes at CCRS to request that each required function be radiated by the selected combination of equipment. As the requested functions are radiated, the Automated Command Message Evaluation (ACME) system is used to provide a standalone, redundant and independent verification of the quality of transmitted command message compliance with the performance requirements of EWR 127-1 and 91-7XX series regulations.

6.6.7 SWITCHOVER THEORETICAL

The purpose of this test is to verify the capability to switch between any of the three Range Safety Display systems (FOV1-A, FOV1-B, and DRSD) for processing and to designate output during a simulated plus count, involving Range Safety components and those supersystems which require designate data. At the simulated T-0 mark, the processing components begin generation of simulated inputs for all participating radar, telemetry inertial guidance (IG), and optics metric data sources, based on the nominal theoretical trajectory. At the direction of the System Controller, each Range Safety Display system is selected to provide designate data output to the systems with tracking antennas. The Command site antennas begin driving on incoming Launch Designate (LDES) from each of the Range Safety systems and compares it to the internally-stored nominal trajectory data. As the trajectory progresses downrange, the Autocarrier switching times are monitored to verify that the Central CMEV switching algorithm and any programmed Command site switching times cause the Command Carrier to be transferred among the supporting Command sites at the expected times.

Command receives High Density Designate Data (HDD) for pointing data from FOV1-A, FOV1-B and DRSD. CCRS uses this data in order to know the antenna elevation angles for all Command transmitters for input to the Autocarrier algorithm. The Command transmitter sites use the HDD to point the steerable antennas to the vehicle in flight. The switchover theoretical ensures that all sources (FOV1-A, FOV1-B, and DRSD) are outputting correct data to Command.

Objective: Verification of the capability to switch between any of the three Range Safety display systems for processing and designate output during a simulated plus count, involving Range Safety components and those Supersystems which require designate data.

Execution: Range Safety display components are placed in a launch configuration with backgrounds loaded, and processing components configured in a theoretical playback mode. Automatic sequencing and test execution, provided by the Range Safety processing components, begins at T-20 seconds. At the T-0 mark, the processing components begin generation of simulated inputs for all participating radar, telemetry inertial guidance (IG), and optics metric data sources, based on the nominal theoretical trajectory. At the direction of the System Controller, each Range Safety display system is selected to provide designate data output to the systems with tracking antennas. The theoretical playback ends with a Range Safety release.

6.6.8 MINUS COUNT SIMULATION

The purpose of this test is to perform a second-for-second simulation of the plus count, involving the entire launch instrumentation support complement as an end-to-end verification of all participating Range systems, including participating off-Range support assets. At the simulated T-0, the Range Safety systems begin processing of simulated tracking data from Telemetry, Optics, and Radars with off-pad commitments. These inputs are used both to drive MFCO displays and to compute LDES information for output to non-tracking instrumentation requiring pointing data (including Telemetry, Optical, and Command Destruct systems). As with the switchover theoretical, Command Destruct personnel verify that automatic carrier switching occurs at the expected times and that incoming LDES matches internally-stored nominal trajectory data. In addition, the personnel verify that First Motion and the Audio Plus Count (APC) are received from Timing.

During the Minus Count simulation, Command verifies the following:

- Carrier Control: Command systems will verify Carrier operation in either Autocarrier or Manual Carrier mode depending on the Carrier mode of operation required.
- Command Transmitting Site Steerable Antennas: Antenna pointing angles must be within 3 degrees between actual and ordered.
- First Motion: Command verifies a First Motion was received by all Command transmitting sites.
- HDD and CMEV Links: HDD and CMEV links are continuously monitored throughout the countdown. The Minus Count simulation is an opportunity to evaluate communication data links with actual data on the line.
- System Performance: Command systems evaluates all equipment performance at all participating sites. Any non-nominal equipment performance is reported during the Minus Count simulation status poll.

Objective: Perform a second-for-second simulation of the plus count, involving the entire launch instrumentation support complement as an end-to-end verification of all participating Range systems, including participating off-Range support assets.

Execution**:** For this test all participating instrumentation are placed in launch configuration. Test execution begins with a simulated terminal launch countdown sequence. At the T-0 mark, Timing generates a simulated first motion, and all instrumentation simulates their plus count activities.

6.6.9 FINAL GROUND COMMAND OPEN LOOP CHECKS

As with the Initial Ground Command Open Loop checks, this test is an end-to-end verification of the operation of the entire required Command Destruct Supersystem and is conducted the same way as the initial checks. The final check is done late in the countdown to confirm that nothing has failed since the initial check and minimize the time between the final check and operational use.

Objective: End-to-end verification of the operation of the entire required Command Destruct Supersystem. The final check is done late in the countdown to confirm that nothing has failed since the initial check and minimize the time between the final check and operational use.

Execution: Checks are performed from each Central CMEV through the corresponding string (site CMEV/SCU, transmitter, antenna) at Cape 1A. In addition checks are made from each Central CMEV through each combination of site CMEV/CRU, transmitter and antenna for Cape 1B and JDMTA. Checks are accomplished by the utilization of maintenance codes at CCRS to request that each required function be radiated by the selected combination of equipment. As the requested functions are radiated, the ACME system is used to provide a standalone, redundant and independent verification of the quality of transmitted command message compliance with the performance requirements of EWR 127-1.

6.6.10 BACK-UP FIRST MOTION

Objective: Verify the capability of the Computer Controller to manually initiate the First Motion signal to supporting instrumentation systems as a back-up in the event that the primary First Motion signal is not received from the launch complex. This check also serves as a second check of the APC distribution.

Execution: Test execution begins when the Computer Controller presses the First Motion button on the FOV1 Console. This generates a first motion signal which is distributed to the instrumentation systems and initiates the APC.

Timing and Sequencing: Timing receives the backup first motion signal which is distributed to the instrumentation systems and initiates the APC.

6.6.11 RANGE SAFETY THEORETICAL

Starts at approximately L-2 hours and 20 minutes. The Range Safety display components are placed in launch configuration with backgrounds loaded and processing components configured in a theoretical playback mode, automatic sequencing and test execution, provided by the Range Safety processing components begins at T-20 seconds. At the T-0 mark, the processing components begin generation of simulated inputs for all participating radar, telemetry IG, and optics metric data sources, based on the nominal theoretical trajectory.

Objective: Final MFCO functional verification of the Range Safety processing and display systems prior to the actual T-0. The simulated data is also used as a final MFCO familiarization activity of expected mission performance.

Execution: Range Safety display components are placed in a launch configuration with backgrounds loaded, and processing components configured in a theoretical playback mode. Automatic sequencing and test execution, provided by the Range Safety processing components, begins at T-20 seconds. At the T-0 mark, the processing components begin generation of simulated inputs for all participating radar, telemetry IG, and optics metric data sources, based on the nominal theoretical trajectory.
As the playback is performed, simulated data is looped-back into the critical Range Safety real-time components for processing and presentation on the MFCO displays. The theoretical playback ends with a Range Safety release.

6.6.12 FINAL GROUND COMMAND CLOSED LOOP CHECKS

As with the Initial Ground Command Closed Loop checks, this test is performed to verify the unique flight codes loaded into the Command Destruct system when operating in the secure mode for each mission, and is conducted the same way as the initial checks. This task is also used to verify the proper operation and configuration of the Flight Termination Units (FTUs) in the enabled mode prior to handing over the system to the MFCOs. Once the test is completed, the key-lock switch on the CSC console is locked and the Command sites are placed in remote mode. Therefore, only the MFCO/CSO may activate the Command Carrier and request transmission of Command Functions through the Range Safety Control and Displays (RASCADs) and the FTUs. The CCRS and the Command sites remain in this configuration until released from the mission or until the CSC console is unlocked by the CSO for use as an emergency backup. After lockout, the CSC console capabilities are limited to only the selection and initialization of the CCRS CMEVs and the selection of the Command site antennas.

Objective: Verification of the unique flight codes loaded into the Command Destruct system when operating in the secure mode for each mission. This task also verifies proper operation and configuration of the Flight Termination Units (FTU) in the enabled mode. The final check is done late in the countdown to confirm that nothing has failed since the initial check and minimize the time between the final check and operational use.

Execution: Copies of the flight codes are loaded into the Operate and Verify memories of the Message Storage Unit for each Central CMEV as well as at Cape 1A and Cape 1B CRD prior to Range F-1 checks. On launch day using the established checklist procedure, the Command System Controller configures the Command Destruct system into closed loop mode which precludes radiation of mission flight codes. Each required function is transmitted from the CCRS to Cape 1A. Following verification of each function between CCRS and Cape 1A, the process is repeated between CCRS and Cape 1B.

6.6.13 FINAL COMBINED COMMAND OPEN LOOP CHECK

Prior to launch, a final RF open-loop test of the CRDs is conducted to provide final prelaunch assurance that the Range Command transmitter systems, launch vehicle Flight Termination System (FTS) antenna systems, and CRDs are functioning properly.

The configuration and performance requirements for this test are as follows:

- All FTS arming devices remain in the Safe position.
- The CRDs are powered by flight batteries.
- The only command that is transmitted Open Loop to the vehicle CRDs by the Range Command transmitters is the Test command from the “Operate” set of codes. **Note:** If the CRD successfully receives and decodes this command, it will initiate a Self-Test
- All CRDs and primary and backup Range Command transmitter systems are tested and verified as operational.

Currently, the process is started when the Command System Officer (CSO) brings up the Command Carrier on the standby transmitter at Cape 1B to “capture” the CRDs as soon as they are turned on. Bringing up the Command Carrier before turning on the receivers provides greater assurance of receiver “capture” to protect against any undesired radiation on the same or adjacent frequencies. The “Test” command is then sent by the MFCO through Cape 1B. Once the user verifies that the vehicle received the command, the Carrier is switched to the master transmitter by the Cape 1B personnel and the MFCO sends the command again. Once the user verifies that the vehicle received the command, the Carrier is switched to standby transmitter at Cape 1A. The process is repeated at Cape 1A. Upon satisfactory completion of the test, the CRDs remain on and the Carrier is left up on Cape 1A until it is switched to another Command station during flight.

6.6.14 FINAL LOAD

Objective: Ensure the system is purged of any extraneous data from prior checks or troubleshooting. Verify that the system is configured to support launch operations.

Execution: To ensure the system is purged of any extraneous data from prior checks or troubleshooting all Computer Software Configuration Items (CSCI) - FOV1 Servers, Workstations, FO-FEPS, SPARC-SC, SPARC-RG, DRSD, FVTAM are recycled.

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OPERATIONS PROCEDURES

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7-1 COMMUNICATIONS PROCEDURES

7.1.1 PURPOSE

Communications procedures provide the range crew with guidance on proper use, checkout and back-up systems for the communications equipment used during an on-console operation. The range crew is responsible for ensuring their communications are set up IAW the applicable Operations Directive (OD) and for properly operating and checking-out all communications equipment that will be used during an on-console operation.

7.1.2 PROCEDURES

7.1.2.1 Proper Communications Syntax

Communication over any admin line, net, or Voice Direct Lines (VDL) must adhere to certain standards. It is important to keep communication short and concise, passing only necessary information. The less time spent passing information, the more time you are in position to respond to any new events such as a change in instrumentation status or an aircraft call out. Since several individuals share a net, the less time spent talking, the more time that resource is available for others to accomplish the mission.

The syntax for making a call on a **net**:

STEP	Time (Minutes)	TO	FROM	COMM CH	STEP
1	L- 02:35:00 T- 02:05:00	OD	ROC	CC.LCL	Inform OD the Range is ready to proceed with the Commander's Operations Briefing

Is read as follows:

Range Operations Commander (ROC) says, “Operations Director (OD), ROC, CC Local, <wait for reply>, Sir/Ma’am-The Range is ready to proceed with the Commander’s Operations Briefing.”

TO: The position you are calling. Use the call sign or name of the position.
FROM: Your position. Use the call sign or name of the position.
COMM CH: The line of communication.

The syntax for answering a call on a VDL is to simply state the call sign or name of your position. For example, if the ROC presses the Surveillance Control Officer (SCO) VDL button on their console, the ROC VDL button on the SCO console will flash red and ring. The SCO will press the ROC VDL button and respond “SCO.” The ROC will then begin the conversation.

When possible, use the following list of Pro-Words during communications. This list is a set of clearly defined words commonly used and well understood by many operators.

PRO-WORD	MEANING
"Affirmative"	Yes
"Negative"	No, or cannot verify.
"Break"	Used to break continuity in a transmission by the speaker so that the listener(s) will know that the speaker has changed subjects.
"Break-Break"	Used to break into a conversation by a station wishing to immediately use the net or to join in the conversation.
"Correction"	You have made a mistake. You should have said (or performed) or I have made a mistake: I should have said.
"Disregard"	Disregard what I have just said. It is not applicable or is in error.
"In work"	Respondent acknowledges action request and is in the process of performing action. Respondent will spontaneously acknowledge satisfactory completion over the net when there is a convenient break in the voice traffic.
"Go ahead"	I acknowledge, proceed with transmission.
"Repeat"	I am repeating the message for clarity.
"Say again"	Repeat your last communication.
"Copy"	I received your message satisfactorily and understand.
"WILCO"	I have received your message, understand it, and will comply (Implies action will occur).
"Stand by"	I must pause for a time, or wait a few moments if used as a reply. If spoken or commanded spontaneously over the loop, then it is intended to hold any further activity currently being performed. This type of stand-by requires further explanation by the requester prior to proceeding.
"Verify"	Check status or correctness.

Figure 7-1-1: *Communication Pro-Words*

7.1.2.2 Communications Check Procedures

Communications check procedures use a very specific communication protocol. Perform a communication check or test count to test the equipment of communication channel status. (e.g. "Mission Flight Control Officer (MFCO), Range Control Officer (RCO), RCO.LOOP with a communication check <MFCO will reply "I read you loud and clear, or weak but readable, or 5 by 5, or broken etc.>, RCO has you the same, etc) For a communication check of the Range Countdown Net, have the Instrumentation Superintendent of Range Operations (ISRO) confirm a tech at one of the Range sites is monitoring for the communication check. Then bring up the RCD.1 net and say, "This is a test of the Range Countdown Net. Testing 1,2,3,4,5,5,4,3,2,1, test out." Then the ISRO will tell you how the tech copied.

7.1.2.3 Common Communications Nets/Frequencies

7.1.2.3.1 Range Communication Nets/Primary Users

There are a number of communications nets used for each mission. It is imperative you understand which net to use for which purpose as well as who is on each net.

The following is a summary:

OPS.SUP: RCO, ROC, SCO, Risk Assessment Center (RAC), Launch Weather Officer (LWO), MFCO (Safety Technical Advisor (STA) monitors) – Used to pass non-nominal status other than instrumentation outages.

INST.STAT: ISRO, Range Engineer (RE), RCO, ROC, MFCO, (STA monitors) – Used to pass non-nominal instrumentation status.

RNG.ANOM: ISRO, RE, RCO, ROC, MFCO, STA, SCO, RAC, LWO – Used for Tier 4 anomaly discussions. (AFLIO can be invited to this net if an anomaly involves base support issues such as commercial/generator power).

RE.NET: ISRO, RE, RCO, ROC, MFCO, STA, SCO, RAC, LWO – Used as the backup channel to the RNG.ANOM primary channel.

RCO.LOOP: ROC, RCO, MFCO, SCO, RAC, LWO, ISRO, RE – Used for nominal communications.

CC.LCL: ROC, Commander's Advisor Board (CAB), LWO, Mission Director (MD), STA, RAC, RE, MFCO – Used for nominal leadership level communications.

SCO.NET: SCO, Sea Surveillance Officer (SSO), Aerospace Control Officer (ACO), Military Radar Unit (MRU), Coast Guard, Safety Analyst – Used for nominal communications in the Surveillance Room.

LCU.NET: RCO, Launch Correlation Unit (LCU) – Used for communication between the Launch Correlation Unit and the RCO after L-30 minutes

FCO.LCL: MFCO, SCO, Telemetry Systems Officer (TSO), Command System Officer (CSO), Video Systems Officer (VSO), Wire, CAB (Launch Decision Authority (LDA)), (Command System Controller (CSC), STA monitors) – Used for communication with the Flight Control team and for contingency events such as Non-Nominal and Errant Vehicles.

7.1.2.3.2 Frequencies/Primary Users:

143.725 VHF/298.2 UHF (BU): ACO, SSO, SCO; Jollies – Used for communication between the ACO and the surveillance aircraft
133.8 VHF/264.8 UHF (BU): MRU – Used for communication between the MRU (Military Radar Unit) and all aircraft (mandatory for all aircraft be able to communicate on this frequency)

123.225 VHF/225.05 UHF (BU): LWO, ACO – Used for nominal communication with supporting weather aircraft.

7.1.2.3.3 Launch Agency Communications Nets

It is also important to understand the channels in which the Range communicates with the Launch Agency. These are different depending on the vehicle that is being launched. Listed below are the basic channels where this communication takes place.

Atlas V/Delta IV Communications
- CH 1 - Countdown 1
- CH 2 - Countdown 2
- CH 5 - Range
- CH 12 - Flight Control
- CH 20 – FTS
- Anomaly net

Trident Communications
- Net 1 (countdown)
- Net 2 (b/u countdown)
- Net 1A/2A/6 (instrumentation/Net 6- Surveillance net)
- Pils Net/Pils HF Net

Falcon 9 Communications
- CD NET- Countdown Net
- RNG.OPS- Range Ops Net
- Anomaly Net

7-2 LAUNCH COUNTDOWN

7.2.1 PURPOSE

"Launch countdown procedures" is an all-encompassing term given to the actions taken by the range crew in managing the activities of a launch in the minus count. Examples include: use and preparation of documentation; equipment configuration and verification; use of safety, Launch Agency, aircraft, and network interfaces; and conduct of safety and user system checks.

7.2.2 DEFINITIONS

Collision Avoidance (COLA) Windows

COLA's are used to ensure that objects launched from CCAFS do not impact objects already on orbit. Safety COLAs are used to prevent a manned mission from impacting or being impacted by other objects. Mission Assurance COLAs are used to ensure unmanned launches reach their orbits without impacting unmanned objects on orbit. COLA closures are the times within a launch window that a booster may not be launched without danger of impacting another orbiting object. A closure period is expressed by two ZULU times which are the opening and closing times of the unsafe interval.

Errant Vehicle

An errant vehicle is a launch vehicle which fails to achieve its planned parameters, cannot be confirmed destroyed, and its predicted impact point can reasonably be assumed to be outside range safety destruct lines.

Final Nominal Time

Final nominal time is the time when a launch vehicle's final stage burnout occurs.

First Motion/Broach/Drop Time

First motion/Broach/Drop time is the time when a launch vehicle lifts 2 inches off the pad, a Submarine Launched Ballistic Missile (SLBM) broaches the surface, or release occurs for airborne launches.

Launch Correlation Unit (LCU)

The LCU is located in the Missile Warning Center at Cheyenne Mountain Air Station. It collects, consolidates, and provides the National Military Command Center information about all scheduled domestic military and civilian space and missile launches.

Manned and Operational (M&O)

M&O is a term used by operators to indicate that the operator is on station, set up, has completed all communications and equipment checks, has all necessary documentation, procedures and job aids, has read and signed all Crew Information Files (CIFs), and is ready to support. From the M&O time on, the operator is expected to be ready to support.

National Payloads

These are US Government (but not necessarily DoD) payloads whose owner, operator, mission, and identity will usually be classified. A national mission may have a Space and Missiles

Systems Center Wing involved in the procurement, and/or ownership, and operations of the satellite.

Nominal Vehicle
A nominal vehicle is a launch vehicle, which achieves its planned parameters.

Non-Nominal Vehicle
A non-nominal vehicle is a launch vehicle, which fails to achieve its planned parameters, but its predicted impact point (IP) remains within range safety destruct lines.

Range Safety Waiver Authority
Range Safety Waiver Authority is the ability of the LDA to waive a requirement that was originally identified as mandatory by safety, but under the current circumstances is no longer essential for launch.

Reportable Event
A reportable event is a domestic missile or space vehicle which could be perceived as a threat to or is expected to impact, over-fly, or come within 100 nautical miles of Russia.

Research, Development, Test, and Evaluation (RDT&E) Payloads
These missions are more common on the Western Range, but it is very possible they could be launched here. Usually smaller satellites, these could be USAF test missions of prototype satellite or other technology. An RDT&E mission may have a Space and Missiles Systems Center Wing as the procurer, owner, and operator of the satellite.

7.2.3 PARTICIPANTS/RESPONSIBILITIES
For participants and responsibilities, please refer to Section 1-4 of this Ops Man.

Launch Correlation Unit Duty Officer (LCU/DO)
The LCU/DO establishes contact with the RCO for traditional launches and ROC for Falcon 9 launches, initiates the LCU Conference Net, requests launch status information, and polls all conferees.

7.2.4 OVERVIEW
In order to provide adequate support to the Range user, Range personnel must ensure minus count activities occur in a timely and orderly fashion. The ROC and RCO coordinate with the user on all range issues that conflict with user scheduled activities to prevent unnecessary delays in their countdown.

The Range Countdown is developed by the Eastern Range Technical Services (ERTS) in order to prepare Range assets to support the planned T-0 time of a launch. The RCO will develop a Launch Support Plan (LSP) which outlines how the Range will support the launch activities; it includes many items from the Range Countdown, user launch countdown, coordination activities (briefings, announcements, establishment of roadblocks, etc.), and Safety checklists. This section is designed to provide the crew with a broad outline of the typical activities encountered during Range operations.

7.2.5 USER INTERFACE

The launch agency interface, although different for each program, has common responsibilities. The launch agency is the Range "customer". The RCO coordinates with the user on all range instrumentation issues and ensures all user mandatory instrumentation is available to support. The ROC is the Day of Launch (DoL) user interface for everything except instrumentation. The customer is responsible for keeping the Range Crew informed of all booster, payload, or facility status changes. The customer is also responsible for informing the Range of anticipated changes to the countdown timeline (i.e., hold additions, deletions or hold extensions). The ROC and customer work together to determine new T-0 times as necessary. Each vehicle has a different user representative who is the interface to the Range through the ROC and RCO. They are as follows:

Atlas V: Range coordinator…"RC"
Delta IV: Range Coordinator…"RC"
Navy: Test Director…"TD"
Pegasus: Launch Conductor…"LC"
Falcon: Range Coordinator…"RC"

Routine coordination with the Range Crew is typically conducted over the Range Ops communications channel.

7.2.6 RCO/TA RELATIONSHIP

The TA is the Range Contractor advisor to the RCO on console during operations. The TA role is to provide counseling and support to the RCO on technical and operational issues.

The Range crew will have full responsibility throughout the entire countdown. The TA will be responsible for providing advice and assistance to the RCO and ROC as required ensuring mission success. The level of on-console TA assistance desired by the RCO/ROC should be discussed with the TA prior to the operation.

7.2.7 LAUNCH CORRELATION UNIT

The primary mission of the Launch Correlation Unit (LCU) is to collect, consolidate, and provide the National Military Command Center (NMCC) information about all scheduled military and civilian space and missile launches. The LCU procedures are used to provide real-time information needed to assess and report an errant domestic missile or space launch. The NMCC, contacts Russia in the event of any domestic launch activity which may be perceived as a threat. NMCC is advised of such activity by United States Space Command (USSPACECOM) at Cheyenne Mountain, Colorado, which monitors the LCU. As part of the RCO's duties, the RCO provides real-time reports on the status of the launch countdown to the LCU via the LCU net (known as "LCU.NET"). In addition to nominal countdown status, the RCO will also report on holds, aborts, new T-0 times, and launch scrubs. If any problems arise with the LCU net (loss of net, bad static, loss of receive, etc.), the RCO reports these to the ISRO and the ROC. There are two important considerations to emphasize concerning LCU reporting. First, the LCU net is NOT mandatory in order to proceed with a launch; however, the RCO will initiate troubleshooting procedures if the net is not established on time. Second, the LCU conferees do not understand the difference between the L-count and T-count clocks. The day prior to the operation (L-1 day), the RCO will initiate a call to the LCU/DO to report launch status and verify the OPNR, booster, flight azimuth, mission, launch window, planned launch time, as well as the names and phone numbers for the countdown. The RCO may also utilize this opportunity to relay coordination times and any changes to procedures.

7.2.8 NOMINAL L-COUNT & T-COUNT MANAGEMENT

L-clock, controlled by the Range, is a countdown clock that runs continuously, progressing toward T-0. T-clock, controlled by the User, is a countdown clock that runs to T-0, but is stopped during scheduled holds. During built-in-holds (BIHs), the T-clock stops while the L-clock continues to count. The T-clock also stops/remains stopped for unscheduled holds or extensions of BIHs; however, in these cases, the RCO and ROC manage the L-clock to best support a given T-0.

For nominal countdowns, the L-clock runs from the pick-up of the range count until the terminal count begins. At that time, the T-clock becomes the sole countdown chronometer.

Procedures and techniques for dealing with the L & T counts in a non-nominal scenario (unscheduled holds, hold extensions, etc.) are covered in the sections addressing HOLD procedures.

7.2.9 PERFORM LAUNCH COUNTDOWN PROCEDURES

Typically, range support to launch can be broken up into three phases. First, instrumentation needs to be turned on and checked out. This is often tied to booster readiness activity and requires close coordination with the launch agency. Second, once the individual instrumentation systems are ready for launch, they are integrated and placed in final configuration for the plus count. Finally, readiness checks and polls are conducted to attain the necessary permission to execute the launch. Throughout this process, status reporting is conducted with all responsible agencies to ensure awareness of countdown progress and issues related to launch constraints.

7.2.9.1 Early Countdown Activities: Console M&O

The 1 ROPS crew assignment letter (CAL) and crew rest letter (CRL) will document who will comprise the Range crew for the launch, personnel on-console times, and crew rest requirements.

Personnel will man consoles approximately 15 minutes prior to the first required action in order to perform communications checks and get set up with appropriate documentation. Once these actions are complete, the position is considered Manned and Operational (M&O). The RCO and ROC are the first positions to be M&O, and this usually occurs from 6-7 hours prior to T-0 depending on the mission.

After the RCO is M&O, the RCO will check with the RE to find out the current status of all Range instrumentation. For the remainder of the count, the ISRO, RE, and RCO will track instrumentation problems. The RCO will pick up the Range count and notify appropriate agencies by making an announcement via the primary Range countdown net (RCD.1). Throughout the count the RCO will announce the start and end of all holds and, additionally, make countdown status announcements to keep the entire Eastern Range updated as to the progress of the count. All announcements made over RCD.1 will be made using T-time.

After performing communication checks, MFCO verifies with the RCO that the Range Safety Ops Supplement has been reviewed, passes the RSD display charts that will be used, as well as "time off the beach", and "time to protect" information. MFCO then verifies ROI 1-33 procedures in effect with the SPARC Controller (Call sign CAT-1) on the IPC net. Next, MFCO briefs reporting instructions with CSO, TSO, VSO and RSD.

7.2.9.2 Early Countdown Activities: Status Monitoring

Early in the count, the RCO monitors instrumentation outages and balloon releases, and receives notification of any communication problems. The RCO ensures the balloon releases happen on time with no problems, and reports that information to the user and safety. It is common for the RCO to handle communication outages early in the count. These can range from someone not having the appropriate channels on their console to excessive static on the lines. All communication problems are reported to the RCO, who notifies the ISRO, who then turns the problem in to Comm Control to be resolved.

The ROC ensures all Range crew and mission support positions are manned and operational. When the OD arrives, the ROC and RE will provide an initial status briefing. During the countdown, the ROC will keep the LDA and OD informed of the count progress and any problems experienced or anticipated.

The ACO will continuously monitor support aircraft status and keep the SCO informed. The ACO will ensure that the MRU makes all appropriate ATC notifications (L-1 hour and 30 minutes, L-1 hour, and L-30 minutes). These are notifications of launch status to Miami Air Route Traffic Control Centers (ARTCC) to ensure airspaces are or will be closed and aircraft rerouted as planned. When two ACOs are assigned to a mission, a single log will be maintained and all tasks will be pre-coordinated.

The SSO will continuously monitor sea surveillance status and keep the SCO informed.

7.2.9.3 Early Countdown Activities: System Checks

Early in the count, the RCO coordinates clearance for command system preparations. There will typically be a series of closed and open loop command system checks that must be coordinated with the launch agency to ensure that they do not interfere with pad activities or launch vehicle systems. As part of the command system preps, the RCO coordinates command frequency clearance with the pad. For pad launches, holdfire checks are conducted early in the count IAW user countdown procedures. Holdfire switches are used low in the count when there is not time to make the proper notifications to hold the countdown. Holdfire checks are conducted to ensure the holdfire switches are operating properly. These checks differ for each vehicle; however, all four switches will be checked: RCO, MFCO, Pad Safety, and the Launch Conductor. The RCO ensures first motion checks are performed. The first motion checks verify all communication and timing instrumentation are ready to support the launch. All sites are polled to ensure they receive first motion signals and audio plus counts. For Navy support, the ISRO verifies the operational capability of the Portable Impact Location System (PILS) and notifies the RCO.

7.2.9.4 Arrival of Launch Decision Authority and CAB

The LDA will arrival approximately at L-3 hours and 5 minutes. Most of the senior staff that make up the Commander's Advisory Board (CAB), including the OD, will already be present. At approximately L-3 hours and 5 minutes, the ROC and PSM will join the CAB in the CAB conference room for the LDA Pre-Brief to the CAB. The ROC and PSM will communicate all significant issues encountered during the "checkout" phase of the countdown.
The ROC is primarily responsible for orchestrating this activity and preparing the OD, RE, LWO, RAC, and LD/MD for the Commander's Operations Briefing at approximately L-2 hours and 30 minutes. This is a comprehensive briefing of all the range support and includes status of the range (instrumentation), network, manning, aircraft, weather, and launch vehicle. The Commander's Operations Briefing procedures are outlined in the Launch Support Plan (with applicable attachments).

7.2.9.5 Integrating The Systems: Final Configuration

L-2 hours and 20 minutes: Range Safety Theoretical occurs at approximately L-2 hours and 20 minutes. At this point in the countdown, Range instrumentation systems have been turned on, checked out, and configured for launch; the senior leadership has been briefed on current status; a full end-to-end data flow has been accomplished (Minus Count Simulation); and the team is ready to verify the Range Safety Displays at the heart of the MFCO activities in the plus-count. The open-loop verification of the Range command systems with the vehicle receivers will take place between L-1 hour and 30 minutes and L-45 minutes (typically), depending on the vehicle.

L-2 hours and 10 minutes: At approximately L-2 hours and 10 minutes, the Range countdown activities continue to focus on getting the teams and instrumentation postured for launch. One indication of this is the verification that the tracking and designate switch settings are complete. This translates into the removal of the "mandatory" designation for SPARC switch control. This is closely coordinated with the MFCO.

L-2 hours: At approximately two hours prior to the scheduled launch time, the Range crew will receive the collision avoidance (COLA) analysis products. COLAs are periods of time when the user cannot launch their vehicle due to potential impacts with orbiting objects. COLAs calculated out to the seconds will be rounded down to the nearest whole minute for the opening of the COLA and rounded up to the nearest whole minute for the close of the COLA unless the Launch Agency wishes to launch on the second. The ROC will verify receipt of the COLA worksheet with the OD, SE, and Launch Agency (e.g. the AFLD) and determine if a contingency plan is required (if the planned launch time coincides with a closure period). The Launch Agency will use this information to request new launch windows around the COLAs.

L-1 hour: At L-1 hour, the LCU/DO will normally establish initial contact with the RCO on an admin line. Upon receipt of this call, the RCO provides the LCU/DO with the operations number (OPNR), booster, planned launch/flight azimuth, mission payload, planned launch time, and launch window. The RCO must be careful to **NOT PASS CLASSIFIED LAUNCH AZIMUTH VIA UNSECURED MEANS** (CLASSIFIED launches will require the RCO to use a STE Secure Phone). The RCO should not become alarmed if he/she doesn't receive this call since this initial call is not mandatory.

At L-1 hour the RCO announces on the Range Countdown Net; "All non-essential personnel clear the Range Safety and Operational areas. Remain clear through launch plus 30 minutes. All mission support personnel are reminded to keep non-mission related discussions to a minimum." The RCO makes this announcement to remind people to remain clear of the Range Safety and the operations area. Range Safety personnel require a high level of concentration during the plus count of the mission. Keeping non-mission related discussions to a minimum helps keep the noise level down.

L-45 minutes: If the RCO doesn't receive a call from the LCU/DO by L-45 minutes, the RCO should initiate a call to the LCU/DO to provide the information normally passed at L-1 hour.

L-30 minutes: The LCU is established and the RCO reports applicable status when polled by the LCU/DO. Upon LCU/DO direction, the RCO provides net conferences with the OPNR and count status (e.g. "This is the Eastern Range RCO for OPNR xxxx. There are no holds or delays anticipated."), and answers any questions the conferees may have. If contact with the LCU/DO has not been established by L-20 minutes, the RCO should contact the LCU/DO via DSN and pass T-30 minutes status. (The LCU/DO has the responsibility to reestablish failed conferences or reconnect disconnected parties.)

L-25 minutes thru L-15 minutes: At about L-22 minutes, the MFCO verifies Command and RSD configurations followed by final reporting instructions to Support positions and safety (OSM, SEA, and RAC), SCO, CSO, VSO, and TSO.

At about L-16 minutes, the ROC will conduct the Clear to Launch Readiness Poll with the RCO and MFCO. This represents the final Range team readiness poll prior to the Final Clear to Launch Poll with the LDA.

7.2.9.6 FINAL CLEAR-TO-LAUNCH

The Final Clear-To-Launch (FCTL) is the LDA's verification to the Range team and the Launch Agency that the Eastern Range (ER) is ready to support launch operations and represents LDA's authorization to launch. The LDA monitors launch preparations during the last few hours of the count. No launch may occur without a Final Clear-To-Launch.

FCTL procedures are incorporated in the LSP. The FCTL poll is typically conducted during the last built-in-hold of the countdown usually at L-12 minutes. The exact L-clock time varies based on the launch vehicle. The FCTL procedure is a recorded final poll of the key responsible agencies (Range, Safety, Launch Agency) for readiness. The OD reports the overall GO or NO-GO status of Range Operations. The MD or LD reports on the status of the integrated Launch Vehicle/Space Vehicle "stack." Finally, the Wing SE reports a final Safety GO or NO-GO status for the launch operation. Based on this status, the LDA will then declare or withhold the FCTL as appropriate.

The ROC will notify the RCO and MFCO of the results of the FCTL poll, and relay a Range readiness to resume the launch countdown at the appropriate times in the Launch Support Plan.

Final Clear To Launch Following Resolution: The LDA has the option to pass a "Final Clear to Launch following resolution of: ______" whenever the Range is temporarily unable to meet a Range Safety or Launch Agency mandatory requirement. This situation could occur for mandatory Range instrumentation, network outages, weather constraints, or safety violations (e.g. aircraft violating restricted airspace, unauthorized personnel inside the launch danger area, etc.)

which are reasonably expected to be resolved prior to T-0. The polling and approval procedures are identical to nominal Final Clear to Launch, except the violating condition is cited as a constraint to launch.

If the LDA grants clear to launch with exceptions, it will be stated as, “Clear to Launch following resolution of ______.” Thus, it is clear to the team that upon resolution of the NO-GO condition, FCTL is granted and the launch may proceed to T-0.
If the LDA withholds Final Clear to Launch, the ROC will work with the Launch Agency and LDA/OD on a time to re-accomplish the FTCL poll.

The Launch Agency may launch following the FCTL is issued and upon the ROC passing “RANGE GREEN” IAW the LSP upon completion of all range and safety requirements and only upon resolution of any outstanding issues.

7.2.9.7 After Final Clear To Launch/Terminal Countdown
At L-11 minutes MFCO verifies with SCO that assets are at MSPs.

By L-9 minutes, the Range Countdown Net (RCD.1) should be patched to LCU.NET. This action will allow countdown call-outs from the RCO to be broadcast over the LCU net and relieve the RCO from needing to make the same call-outs to the LCU.NET. If RCD.1 is NOT patched to the LCU net, then minus count announcements are required by the RCO on both nets. This can be accomplished by multi-broadcasting on both the LCU net and RCD.1 during the terminal countdown, or dialing the number on another phone and making the announcements simultaneously on both headset and handset (this can also be done by a second qualified crewmember if available). Announcements are then made every minute from T-4 minutes to T-2 minutes, at T-1 minute and 30 seconds, T-1 minute, and T-15 seconds. At T-15 seconds, the RCO announces: "T-minus 15 seconds and counting, standby for terminal count." At T-10 seconds the RCO announces the terminal count: "10, 9, 8, 7, 6, 5, 4, 3, 2, 1. Upon liftoff, the RCO will report “Liftoff, stand-by for first motion time to the LCU/DO on LCU.NET.”

After exiting the final hold, the vehicle systems will be switched to internal power (there may be exceptions on when this switch occurs based on the booster and space vehicle constraints). This effects both the beacon and command antennas on the booster. The MFCO team is monitoring the command systems, and the ISRO will receive beacon GO/NO-GO on the switch to internal power from the RF (Radar) System Controller. The ISRO will relay this beacon status to the RCO. The MFCO will pass “MFCO GREEN” and the RCO will pass “RCO GREEN” to the ROC. The ROC will then pass “RANGE GREEN” to the Launch Agency.

At T-1 minute, the ROC and RCO will bring up the FCO.LCL channel to monitor vehicle performance in the plus count. Due to FCO.LCL being a net for safety personnel, the ROC and RCO will not monitor this net until late in the terminal countdown.

7.2.9.8 Plus Count Procedures
At T-0, all personnel watch for ignition and first motion on the overhead display screens or on the CCTV monitors. All personnel log first motion time.

On the LCU net, the RCO will report liftoff, First Motion/Broach/Drop time, and flight progress through Final Nominal at two minute intervals. After Final Nominal, the RCO will report the Final Nominal time and request a release from the LCU net. The LCU/DO will conduct a final roll call for questions before terminating the net.

The crew monitors vehicle flight during the plus count, and must be prepared to implement emergency procedures should the launch vehicle become non-nominal or errant. The ISRO will verify mark events during the plus count as they are announced over the instrumentation net by the Telemetry System Controller.

About 10 minutes after launch, the SCO will coordinate with the ROC for release of supporting assets, agencies, and airspace. After safety's "time to protect" has ended the RCO will obtain instrumentation release from BOTH the user and safety. The RCO will log both release times and coordinate release of instrumentation IAW the LSP.

The ROC is responsible for providing information on the launch to the Wing Command Post, as needed, or per the checklists. Job Aid 1 is used for any launch (nominal or non-nominal). If used for a non-nominal launch, the Non-nominal/Destruct Checklist will direct when to accomplish. For a nominal launch, the ROC will complete and fax/email (unencrypted) it to Wing Command Post. This job aid is used by Wing Command Post to pass all pertinent information up the chain of command.

7.2.10 MAINTAINING A CREW LOG

At a minimum, the log will annotate the names and positions of MR personnel conducting operations duties, significant communications to include changes in tasking, major system actions, adversary actions and results, and any system degradation or anomaly. Operations logs may be electronic or hard copy and will be maintained for a minimum of two years. 1 ROPS may start a log (45SW Form 1924) immediately after taking position on console for an operation (pre-mission and launch).

Events are normally logged as they occur. However, many events can occur within a short period of time causing an entry to be temporarily omitted from the log. Attempting to log omitted information at a later time, after other entries have been logged, will render an inaccurate log. A logging technique, known as Back Logging is one way you can maintain an accurate log even if entries were not logged in the proper time sequence. To do this; record the present time in ZULU, the term "BACKLOG", the actual time of the event, and all amplifying information about the omitted event.

7.2.11 CREW CHANGEOVER PROCEDURES

Crew changeover procedures are used to transfer duty responsibility between operational personnel when it is necessary to be relieved of duty by other operational personnel. These procedures are designed to efficiently aid an on-coming crewmember who relieves another crewmember mid-shift. They are primarily designed for situations when the launch countdown exceeds crew rest requirements for one crewmember. However, there are other situations when they could be used, such as an emergency situation causing a crewmember to be unexpectedly relieved.

Crew changeover procedures are outlined in the "Crewmember Changeover Checklist" (Checklist 17). The checklist is designed to provide a structure for ensuring the on-coming crew is ready to assume duties, ensures a thorough briefing covering all aspects of the countdown, and conveys other important information to the on-coming crewmember.

STEP 1: Prior to assuming on-console duties, crewmembers must, by regulation, review all new Temporary Procedures and Crew Information File (CIF) items. This ensures the crewmember is aware of any recent changes to previous policies or newly initiated procedures. If there are questions, the on-coming crewmember should ask an instructor or flight commander, if available, or the off-going crewmember.

STEP 2: Step 2 is the most comprehensive and flexible portion of the checklist, however, it is also the most important. The off-going crewmember is responsible for collecting data throughout the launch countdown and presenting it to the on-coming personnel. The on-coming crewmember must ensure he or she understands all status presented and ask for clarification, if necessary, prior to signing the log. This step may be tailored as required to only pass information applicable to each specific crew position.

The following are items which the crew should pay particular attention to when preparing or receiving the briefing:

Range Status—key to understand overall status.

Range Instrumentation Status—details will follow in the Outages and ETROs section.

Outages and ETROs—include instrumentation and communication outages, amplifying details on the nature of the outages, actions in work to resolve the problem, and the anticipated time outages are expected to clear.

Corrective/Preventative Maintenance—brief any maintenance issues which could impact the countdown.

Countdown Steps accomplished—brief steps accomplished; highlight those that were skipped. Additionally, highlight any non-nominal results from any of the steps previously accomplished.

Open Checklist(s) and step number(s) —brief any open checklist(s) and the step(s) at which the crew is holding to remind on-coming crewmember if all actions are not yet complete.

Anomalies encountered—describe any anomalies (such as non-nominal range tests, unexpected user procedures, system "work arounds", or problems encountered during the countdown).

Significant countdown events—brief any range status items not specifically covered by previous steps, such as mission assurance COLAs.

Weather Status—At a minimum brief any violations of Launch Commit Criteria and the expected status of weather constraints at T-0 (percentage chance of violation).

Flight Safety Status—Summarize current status of the OSM, SEA, RAC, and SCO. This will include information on Safety COLAs, key flight safety times (like “time to protect” and “time off the beach”), aircraft, sea surveillance assets, and SCO clear times.

User/Mission Status—Brief known issues for the booster, facilities, payload, and network assets. Any impacts to Range operations should be described in detail.

Security Status—Brief current threat conditions as applicable (FPCON, Covered Wagons, etc).
Special requirements—Brief the tracking number of the most current CIF item and TP by tracking number and date posted. This is also your opportunity to brief any additional information you think the on-coming crewmember may need which is not covered by any of the previous steps.

STEP 3: The on-coming personnel should ensure all classified documents and/or COMSEC materials (including STE cards) are positively accounted for and appropriately protected. Ensure the Standard Form 702 and AF Form 310 are filled out, as applicable.

STEP 4: The off-going crewmember should ensure the log is complete and all required entries are made. They should enter the current “Zulu” time and sign the line to signify termination of their duties.

STEP 5: The on-coming crewmember enters the “Zulu” time and signs their name to signify they have read and understand all changeover briefing items. From this point, the on-coming crewmember is responsible for all actions related to the countdown.

In summary, this procedure is simplified to prepare on-coming personnel for their on-console duties. It is important for off-going crewmembers to adequately brief their relief of the current status of the launch.

7-3 SURVEILLANCE CONTROL OPERATIONS

7.3.1 OVERVIEW

A critical role of the Eastern Range (ER) is to ensure the safety of the public during launch operations from the ER. The Surveillance Team ensures the safety of air and sea traffic during the execution of the Surveillance Control Mission.

7.3.1.1 Surveillance Control Mission

The Surveillance Control Mission is to ensure air and sea traffic do not violate predetermined hit-probability contours that are developed for all launch vehicles and payloads launched from the ER. EWR 127-1 and AFSPCMAN 91-711 state that the Mission Flight Control Officer (MFCO), acting for the SW/CC, is responsible for monitoring surveillance and control operations within launch surveillance areas to ensure the risks to people, aircraft, and surface vessels are within acceptable limits. The determination of a Launch Area Surveillance "GO/NO-GO" is provided by the appropriate launch countdown personnel to the MFCO who makes the final Launch Safety "GO/NO-GO" determination based on information from the above sources and any other sources available during the final phases of the launch countdown. At the ER, the person who provides the Launch Area Surveillance "GO/NO-GO" determination is the Surveillance Control Officer (SCO).

7.3.1.2 Surveillance Team

The Surveillance Team performs air and sea surveillance operations. It is composed of the SCO, Deputy SCO, one Aerospace Control Officer (ACO), two Military Radar Unit (MRU) Controllers, two Sea Surveillance Officers (SSOs), two US Coast Guard (USCG) Liaisons, two Surveillance Risk Analysts (SRAs), and support assets to include helicopters from the 301st Rescue Squadron (Jollies), and USCG vessels.

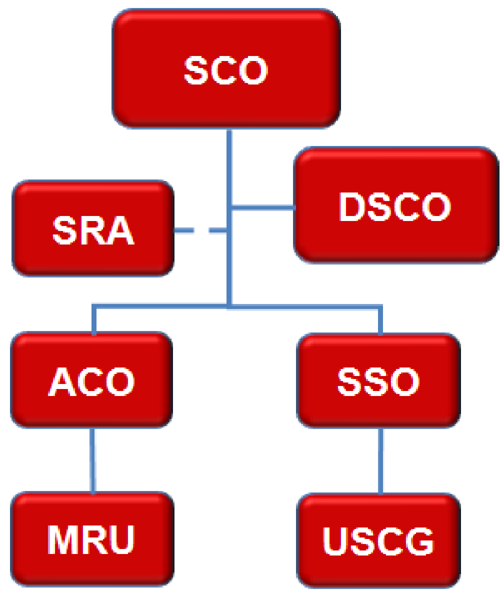


Figure 7-3-1: *Surveillance Team*

7.3.1.2.1 SCO

The SCO, aided by the Deputy SCO, leads the Surveillance Team. The SCO oversees launch area surveillance operations, coordinates efforts between the ACO and the SSO, and notifies the rest of the range team of surveillance issues.

7.3.1.2.2 ACO

The ACOs are the lead for executing air surveillance operations. The ACOs perform airspace monitoring and coordinate support aircraft operations with support from the MRU Controllers. The ACOs ensure that all aircraft, including intruder and support aircraft, will be clear of the aircraft hit-probability contour at T-0.

7.3.1.2.3 SSO

The SSOs are the lead for executing sea surveillance operations. The SSOs receive target reports and provide re-direct instructions to the US Coast Guard and the support assets. The SSOs ensure that surface vessels will not violate either individual or collective hit-probability contours at T-0.

7.3.1.2.4 SRA

If required by the SCO, the SRAs will provide real-time hit-probability analysis and alternate mission support positions.

7.3.1.2.5 Surveillance Control Center

The Surveillance Team operates from the Surveillance Control Center (SCC), Room 160 in the MOC. The Surveillance Team utilizes the Surveillance Control Display System (SCDS) as the primary means of monitoring the Range airspace and sea space. The SCDS Workstations allow the operators to:

- Monitor the hazardous and restricted areas
- Monitor targets from the air and sea sensors
- Plot targets and project their positions at T-0
- Control the sea surveillance radars

7.3.2 SAFETY CLEARANCE AREAS

45 SW/SE analysts identify areas that are hazardous to air and sea traffic that are located along the nominal trajectory and 3-sigma dispersions. These include the hazards associated with catastrophic launch events and known impact areas of jettisoned stages. The areas within the range of land-based radar and aircraft are surveyed. The areas outside surveillance capabilities are identified through public notices.

Figure 7-3-2: *Catastrophic Launch Event*

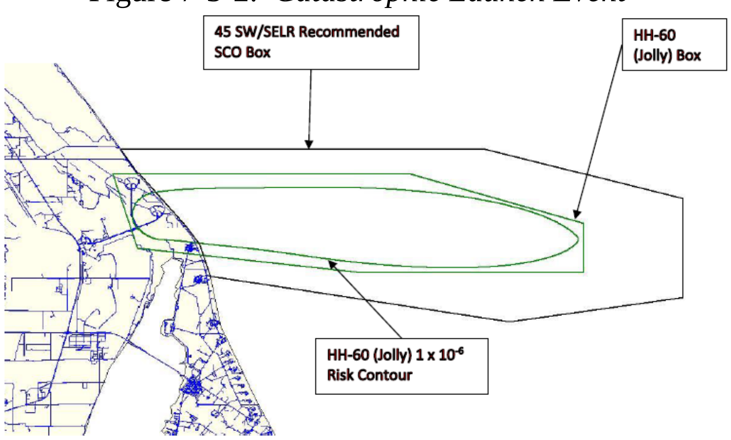


Figure 7-3-3: *Safety Clearance Areas*

7.3.2.1 Launch Danger Zone (LDZ)

The Launch Danger Zone (LDZ) is a hazardous launch area that is defined as the combination of the sea surface area and air space measured from the launch point and extending downrange along the intended flight azimuth. The size of the LDZ is based on the potential hazard to aircraft and surface vessels from impacting debris (inert/explosive). On the ER, the LDZ is defined by hit-probability contours.

7.3.2.2 Surveillance Areas

Hit-probability contours are areas measured from the launch point extending downrange along the intended flight azimuth which are developed in an effort to show where debris (inert/explosive) hazards may impact aircraft or surface vessels of a predetermined size at levels that exceed allowable hit-probability criteria. The contours are developed by 45 SW/SELR based on the following:

- The nominal trajectories
- The launch vehicle's structural limits
- The possible vehicle failure modes during the flight
- The probability of failure for each of the various failure modes
- The expected debris dispersions based on tumble turns, breakup velocities, seasonal wind profiles, and normal lateral deviations due to vehicle motion

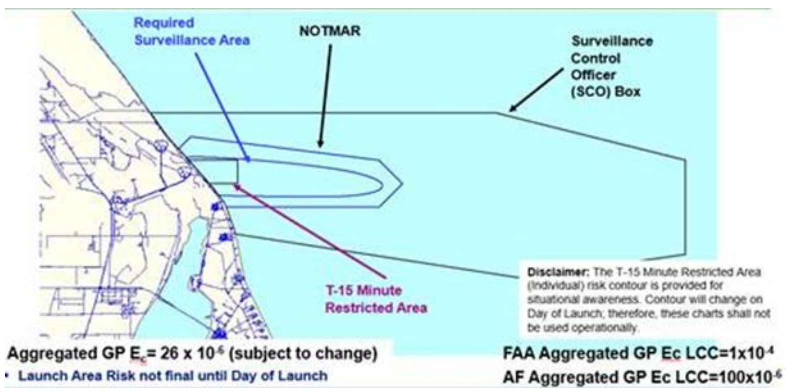


Figure 7-3-4: *Hit-Probability Contours*

7.3.2.2.1 Aircraft Contour (ACC)

The Aircraft Contour (ACC) is a region of airspace where the hit-probability of an individual aircraft of a predetermined size from debris exceeds established 1x 10^{-6} hit-probability criteria. The aircraft contour is measured from the launch point and extends downrange along the intended flight azimuth. The ACC is developed using the launch vehicle 3-sigma left and right trajectories, probability of failure/allocation of the launch vehicle, the resulting debris (inert/explosive), and a predetermined "standard representative" commercial aircraft information A "standard representative" commercial aircraft that transverses typical flight azimuths of vehicles launching from the Eastern Range is a 737 aircraft flying at 30,000ft. The 1x10^{-6} hit-probability contour established for a 737 at 30,000ft envelopes the 1x10^{-6} hit probability for smaller aircraft at lower altitudes. Launch Safety criteria is violated if an aircraft is projected to be within the ACC at T-0 and the countdown must be held.

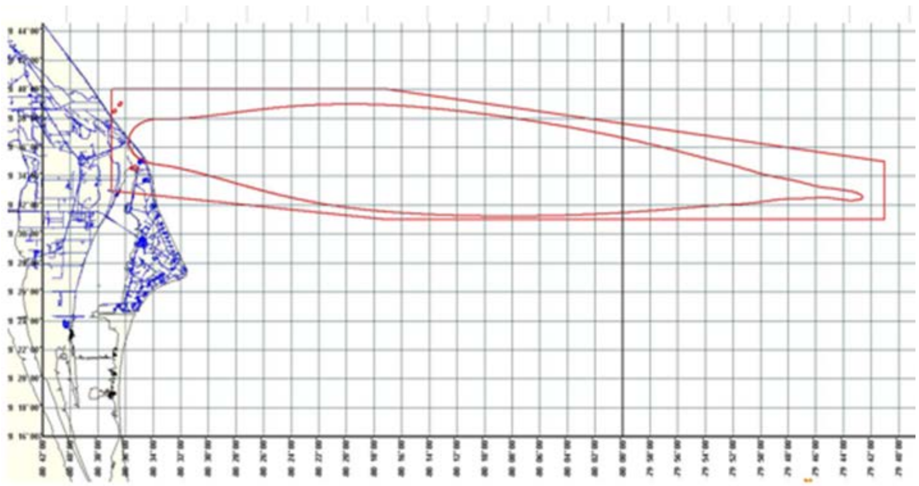


Figure 7-3-5: *Aircraft Corridor (ACC)*

7.3.3 SURVEILLANCE AREAS

45 SW/SELR personnel develop two surveillance areas for ships and boats. The “Required Surveillance Area” is calculated based on Aggregate risk criteria and is required to be surveyed. Any sea going vessel located in this area and is to be identified by the SSO/SCO and passed to the SRA for determination. The T-15 min restricted area is based on individual hit criteria. The same effort of identification is required and is to be passed to the SRA, however, the SCO is to provide redirect efforts if a vessel is identified to be within this area at T-0.

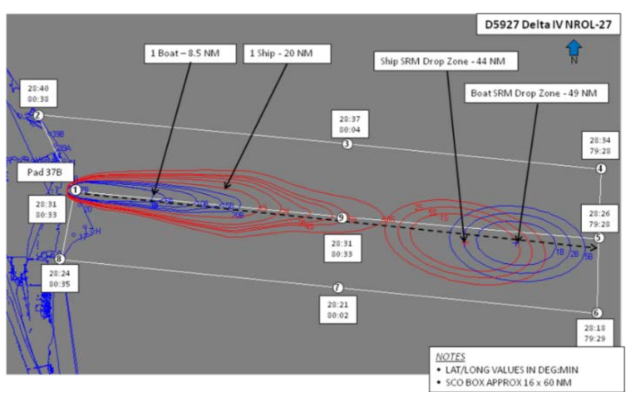


Figure 7-3-6: *Boat and Ship Contours*

7.3.3.1 Air Surveillance Areas

Air surveillance areas consist of the airspace that is activated and monitored on launch day to provide separation of support and non-support aircraft and to detect any possible ACC violations at T-0. There are two main classes of airspace utilized on the ER: Special Use Airspace and Other Airspace Areas.

7.3.3.1.1 Federal Aviation Administration

The Federal Aviation Administration (FAA) is an agency of the Department of Transportation which has the authority to regulate and oversee all aspects of civil aviation in the U.S. Among its many roles is the role to develop and operate a system of air traffic control and navigation for both civil and military aircraft.

7.3.3.1.2 Air Route Traffic Control Center (ARTCC)

An Air Route Traffic Control Center **(**ARTCC) is a facility established to provide air traffic control service to aircraft operating on Instrumentation Flight Rules (IFR) flight plans within controlled airspace and principally during the en route phase of flight between airport approaches and departures. There are 21 ARTCCs in the U.S. Miami ARTCC is responsible for the airspace in central and south Florida including the airspace above CCAFS and KSC. Jacksonville is responsible for the airspace north of CCAFS and KSC. Day to day, Miami ARTCC is the controlling agency for the ER airspace while the 45 SW is the using agency. In addition, Miami ARTCC provides air traffic control support during ER launches.

7.3.3.1.3 Special Use Airspace (SUA)

Special Use Airspace (SUA) exists where activities must be confined because of their nature. In special use airspace, limitations may be placed on aircraft that are not a part of the activities. On the ER, Special Use Airspace consists of Restricted Areas and Warning Areas.

Restricted Areas

Restricted areas denote the existence of unusual, often invisible hazards to aircraft such as artillery firing, aerial gunnery, or guided missiles. An aircraft may not enter a restricted area unless permission has been obtained from the using agency. Restricted areas are depicted on aeronautical charts and are published in the Federal Register. There are four restricted airspace areas associated with ER operations:

- **R-2932**: Surface to 4,999 feet altitude. This area is active at all times. It covers the area immediately above the launch pads on both KSC and CCAFS.
- **R-2933**: 5,000 feet to unlimited altitude. This area is active for all launches. It covers the same area as R-2932, just at higher altitudes.
- **R-2934**: Surface to unlimited altitude. This area is active for pad launches. It covers the area immediately West of R-2932 and R-2933.
- **R-2935**: 11,000 feet to unlimited altitude. It covers the area West of R-2934 over the Titusville-Cocoa Airport.

The 45 SW is designated as the using agency and Miami ARTCC as the controlling agency for each restricted area. R-2932 has and continues to be active 24 hrs /7 days via NOTAM. Since 9/11, R-2933 and portions of R-2934 have been continuously active (24/7) via NOTAM.

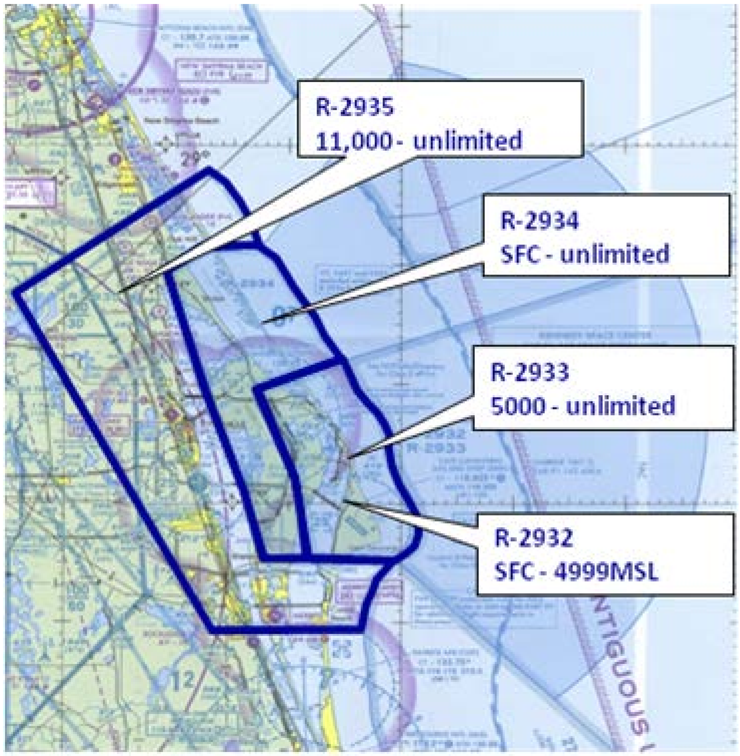


Figure 7-3-7: *Restricted Areas*

Warning Areas

Warning areas consist of airspace which may contain hazards to nonparticipating aircraft in international airspace. The activities may be much the same as those for a restricted area. Warning areas are established beyond the 3-mile limit from the coast. Warning areas are depicted on aeronautical charts. Pilots flying under Visual Flight Rules (VFR) can legally fly into a Warning Area. Warning areas W497A and W497B are active for all ER launches. Both are from the surface to unlimited in altitude and cover the offshore area off of CCAFS.

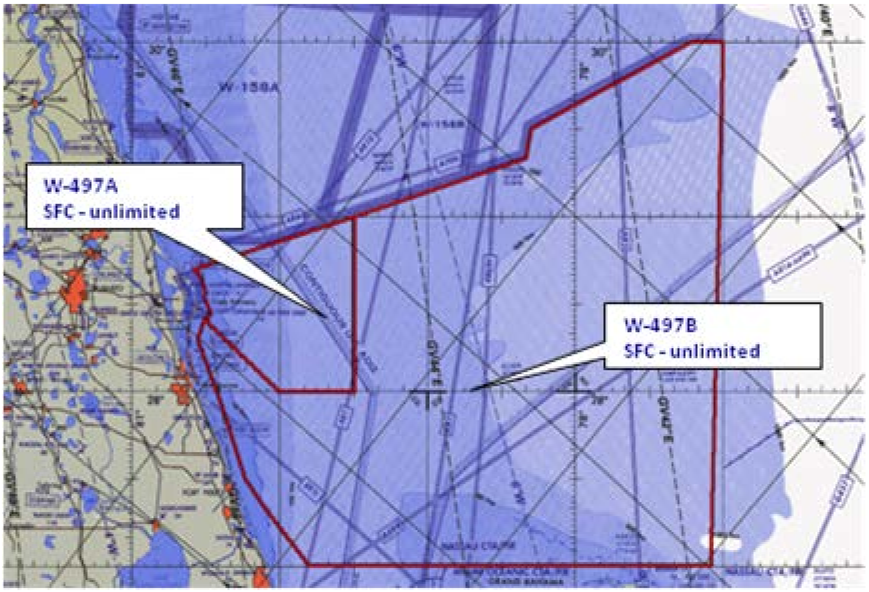


Figure 7-3-8: *Warning Areas*

Launch Areas 1, 2, and 3 are made up of airspace within the W157, W158, and W159 areas. They extend from the surface to unlimited altitude. The purpose of these areas is for additional airspace for launch protection. The areas are used per Letter of Agreement (LOA), known as the Miami LOA, which was signed by multiple agencies. The areas are controlled by the Fleet Area Control Facility (FACSFAC) Jacksonville, which is part of the United States Navy (USN). 45 SW/SE decides which area is required depending on the flight azimuth.

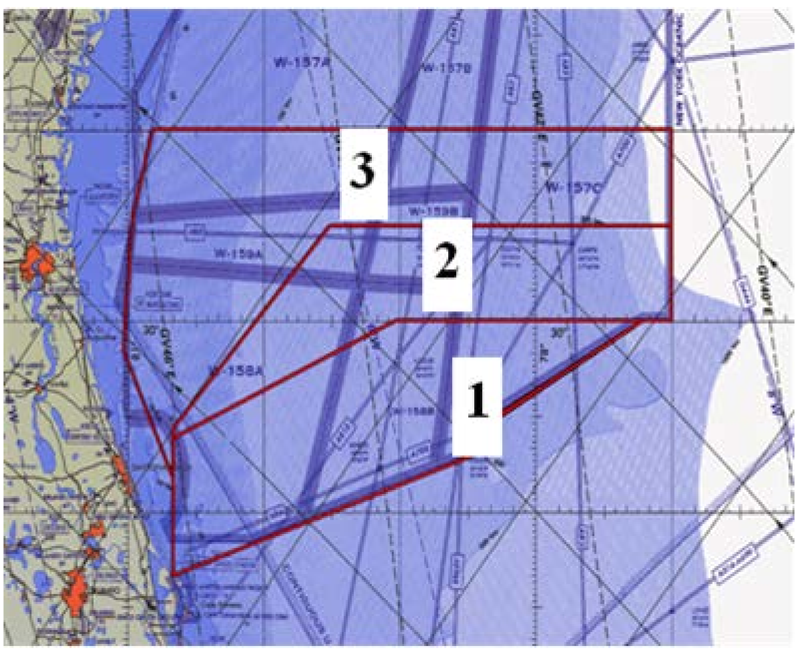


Figure 7-3-9: *Warning Areas (Launch Areas 1, 2, and 3)*

7.3.3.1.4 Other Airspace Areas

Other airspace areas (referred to by the DoD as "airspace for special use") is a general term referring to the majority of the remaining airspace. In this category the ER uses a Temporary Flight Restriction (TFR) and Air Traffic Control Assigned Airspace (ATCAA).

Temporary Flight Restrictions (TFRs)

TFRs are intended to restrict flight operations for specified amount of airspace, on a temporary basis, in order to provide protection of persons or property in the air or on the ground. TFRs have become more prevalent since 11 September 2001. Some of the primary purposes for establishing a temporary restriction for Eastern Range operations are:

- Provide a safe environment for space flight operations (14 CFR Section 91.143).
- Provide special security instructions if determined situation detrimental to interests of national defense (14 CFR Section 99.7).
- Provide a safe environment during disaster/hazardous situations (14 CFR Section 91.137); prevent an unsafe congestion of sightseeing aircraft above an incident or event, which may generate a high degree of public interest.

The parameters of the TFR (i.e. designated airspace, altitudes, and times) are at the discretion of FAA approval. Any non-participating aircraft entering an activated TFR are subject to FAA enforcement. Note that this enforcement is applicable to only US citizens, a registered US aircraft/company and/or a US licensed pilot. CFR 91.143 is a permanent TFR charted on sectional charts. It is used for all ELV launches and is activated for each launch by NOTAM, typically at L-30 minutes. The purpose of this TFR is limit flight in the proximity of space flight operations.

Figure 7-3-10: *CFR 91.143*

Air Traffic Control Assigned Airspace

Air Traffic Control Assigned Airspace **(**ATCAAs) are airspace of defined vertical/lateral limits, assigned by ATC, for the purpose of providing air traffic segregation between the specified activities being conducted within the assigned airspace and other Instrumentation Flight Rules (IFR) air traffic. These are not published on aeronautical charts.

The ER utilizes two ATCAAs:

- **Cape A –** This airspace extends from the surface to unlimited. It covers the area above KSC and the Cape. NASA-A is activated for WX 1 operations during ELV missions.
- **Cape B –** This airspace extends from surface to unlimited altitude.

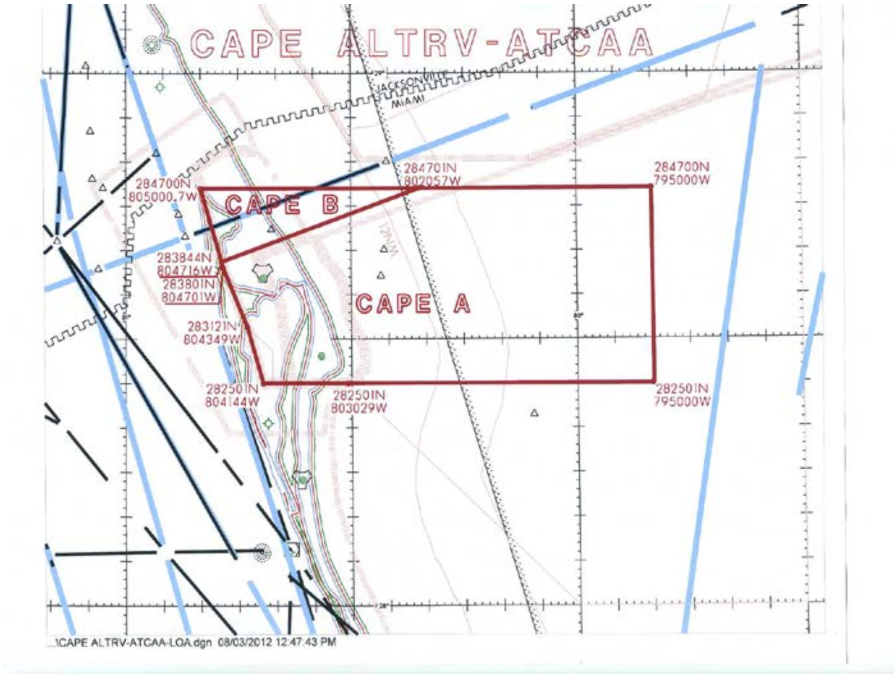


Figure 7-3-11: *Air Traffic Control Assigned Airspace (ATCAA)*

7.3.3.2 SCO Box

The SCO Box defines the area of sea space to be surveyed by sea surveillance assets. The support assets will report any targets detected within the box.

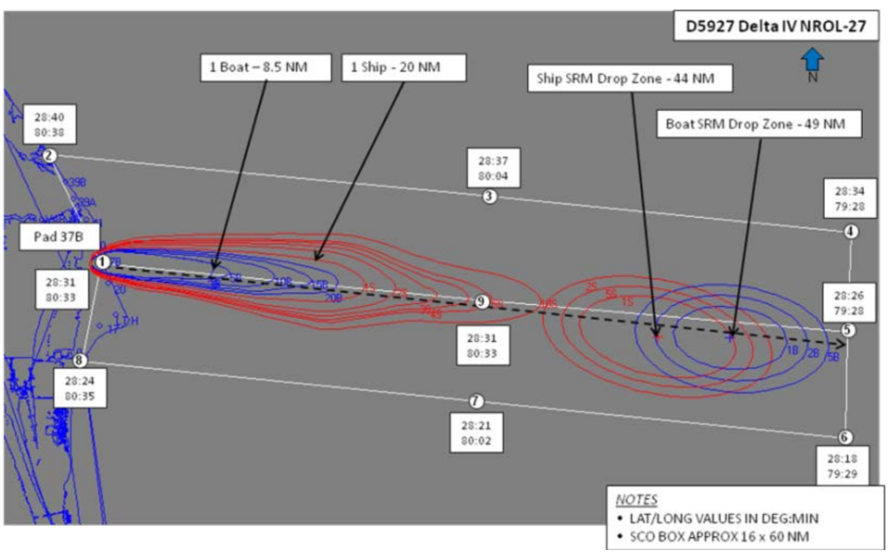


Figure 7-3-12: *SCO Box*

The SCO Box is developed by safety. It is designed around the probability hit contours for boats and ships as well as the flight azimuth of the mission. For some missions, the SCO Box may also be built around solid motor planned drop zones if these area are within the range of surveillance assets. The width of the SCO Box is designed to cover the 1 ship contour plus a minimum of 6 nm north and south of the 1 ship contour. The length of the SCO Box is typically 60 – 70 nm, which is considered the nominal surveillance range for the support aircraft, however, the length may be slightly shorter or longer depending on mission needs such as the length of the contours or the location of solid motor drop zones.

7.3.3.2.1 Security Zone

The Security Zone is an area that is designed to provide for the protection of personnel and critical infrastructure. It is defined by a line of buoys 3nm off the coast and extends all along the shoreline of CCAFS and KSC. It is activated 3 hours prior to launch for ELVs under 33 CFR 165.701, the USCG has jurisdiction and enforcement authority within the security zone. Violators of the security zone can be stopped and boarded by the USCG. They can be fined and repeat offenders may get jail time. If a violator has hostile intent, use of lethal force is authorized within this area.

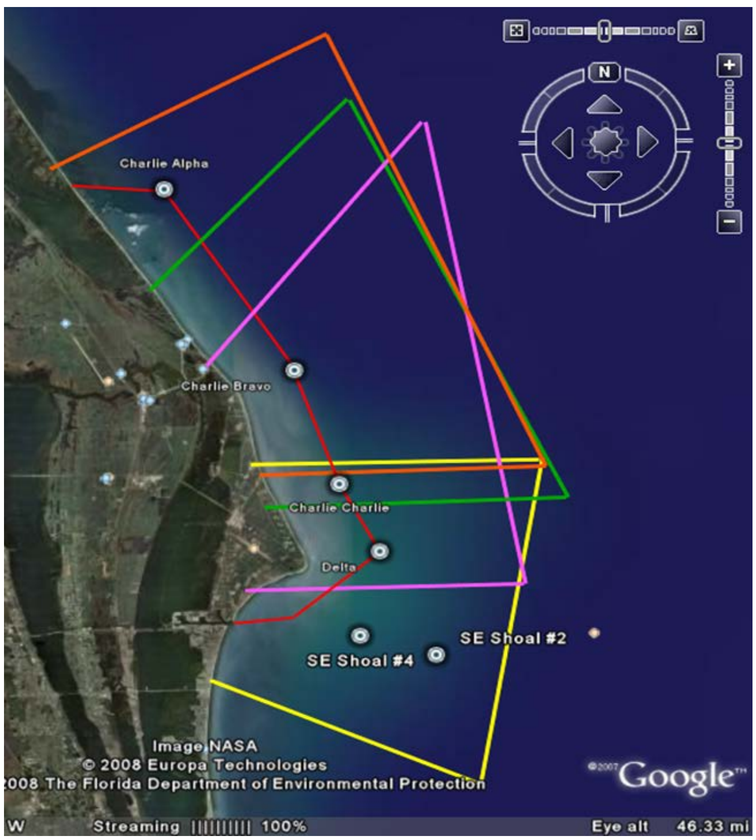


Figure 7-3-13: *Security Zone*

7.3.3.2.2 USCG Safety Zones

The USCG Safety Zones are areas designed to protect infrastructure and marine traffic as well as provide enforcement authority to protect the 1 boat and 1 ship contours during ER launches. There are four zones, labeled A through D from north to south, which can be activated. Each area is activated for a specific vehicle or vehicles:

- **USCG Safety Zone A**: Designed for use for launches from Complex 39A/B.
- **USCG Safety Zone B**: Activated for Atlas V and Falcon 9 launches.
- **USCG Safety Zone C**: Activated for Delta IV launches.

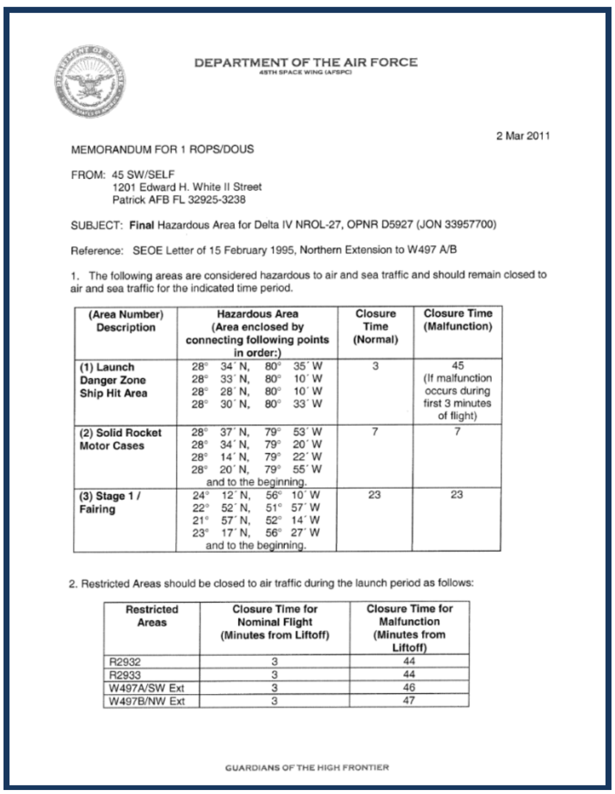
- **USCG Safety Zone D**: Activated for Delta II launches.

More than one zone can be activated if required due to the vehicle's flight azimuth. The safety zones extend from the shoreline to points approximately 12 nm offshore. The applicable USCG Safety Zone is activated 45 minutes prior to launch and is de-activated approximately 15 minutes after a successful launch under 33 CFR 165.775, the USCG has jurisdiction and enforcement authority within the safety zones. Violators of a safety zone can be stopped and boarded by the USCG and may receive fines.

7.3.4 PUBLIC NOTIFICATIONS

1 ROPS/DOUS coordinates with several different agencies in order to issue public notifications in order to protect air and sea traffic from launch hazards and to prevent launches from being delayed by intrusions by air and sea traffic into the hazardous areas. The notification process begins with the receipt of the 45 SW/SE Hazardous Area Letter, which occurs no later than L-10 days. It defines the air and sea hazard areas and their associated closure times for a specific operation/launch. Information from the Hazardous Area Letter is used in the following notification processes:

- Notice to Airmen (NOTAM)
- Notice to Mariners (NOTMAR)
- Space Launch Intrusion Prevention System (SLIPS)



DEPARTMENT OF THE AIR FORCE
45TH SPACE WING (AFSPC)

2 Mar 2011

MEMORANDUM FOR 1 ROPS/DOUS

FROM: 45 SW/SELF
1201 Edward H. White II Street
Patrick AFB FL 32925-3238

SUBJECT: **Final** Hazardous Area for Delta IV NROL-27, OPNR D5927 (JON 33957700)

Reference: SEOE Letter of 15 February 1995, Northern Extension to W497 A/B

1. The following areas are considered hazardous to air and sea traffic and should remain closed to air and sea traffic for the indicated time period.

(Area Number) Description	Hazardous Area (Area enclosed by connecting following points in order:)	Closure Time (Normal)	Closure Time (Malfunction)
(1) Launch Danger Zone Ship Hit Area	28° 34′ N, 80° 35′ W 28° 33′ N, 80° 10′ W 28° 28′ N, 80° 10′ W 28° 30′ N, 80° 33′ W	3	45 (If malfunction occurs during first 3 minutes of flight)
(2) Solid Rocket Motor Cases	28° 37′ N, 79° 53′ W 28° 34′ N, 79° 20′ W 28° 14′ N, 79° 22′ W 28° 20′ N, 79° 55′ W and to the beginning.	7	7
(3) Stage 1 / Fairing	24° 12′ N, 56° 10′ W 22° 52′ N, 51° 57′ W 21° 57′ N, 52° 14′ W 23° 17′ N, 56° 27′ W and to the beginning.	23	23

2. Restricted Areas should be closed to air traffic during the launch period as follows:

Restricted Areas	Closure Time for Nominal Flight (Minutes from Liftoff)	Closure Time for Malfunction (Minutes from Liftoff)
R2932	3	44
R2933	3	44
W497A/SW Ext	3	46
W497B/NW Ext	3	47

GUARDIANS OF THE HIGH FRONTIER

Figure 7-3-14: *45 SW/SE Hazardous Area Letter*

7.3.4.1 Notice to Airmen (NOTAM) (NOTAM)

A NOTAM is a notice containing information concerning the establishment, condition, or change in any aeronautical facility, service, procedure, or hazard. It is filed with an aviation authority to alert aircraft pilots of any hazards en route or at a specific location. The authority in turn provides a means of disseminating relevant NOTAMs to pilots.

NOTAMs for ER launch operations are used to notify pilots of launch operations, activate the special use airspace within the LDZ, and distribute information on Altitude Reservations (ALTRV) approved by the Central Altitude Reservation Facility (CARF).

04 Nov 08

FROM: 1ROPS/DOUS EASTERN RANGE SCHEDULING CAPE CANAVERAL AFS FL

SUBJ: ALTRV/AIRSPACE APREQ FOR EASTERN RANGE OP K0126, STS-126

1. Eastern range will be conducting hazardous operations surface to unlimited within the following areas.

A: FROM 2838N 8041W
TO 2855N 8021W
TO 2848N 8014W
TO 2830N 8035W
TO BEGINNING

B: FROM 3002N 7950W
TO 3053N 7902W
TO 3010N 7810W
TO 2926N 7908W
TO BEGINNING

2. Hazard periods for primary launch day and backup launch day;
Primary launch day: 15 / 0040Z THRU 15 / 0211Z Nov 08. T-0 IS 0040Z.
Backup launch day: 16 / 0014Z THRU 15 / 0145Z Nov 08. T-0 IS 0014Z.

3. Please advise of scheduling conflicts ASAP to POC.

4. MIAMI: Eastern Range will close W497A/B, R2933, R2934, SFC to unlimited at T-0: R2935 15,000 to unlimited at T-180; and W497A west of 80 deg 5000 feet and below at T-180. Request activation and exclusive use of NASA-A&C SFC FL450 and NASA B 15,000 to FL450 for weather support acft and activation of CFR 91.143 at T-180. Area includes AR-6. Portions of W497B may remain open IAW 45SW/SELF letter dated 16 Oct 08 which has been provided to ZMA/MOS.

5. CARF: FAX approval to 1 ROPS/DOUS DSN 467-7338, COM 321-853-7338

6: FACSFAC JAX: request exclusive use of Launch Area-3 During hazard periods. Please FAX approval to 1 ROPS/DOUS DSN 467-7338, COM 321-853-7338.

7. Participating support aircraft will operate IAW MARSA.

8. CARF, MIAMI, FACSFAC JAX please acknowledge receipt of this message to POC.

9. POC is 1 ROPS/DOUS DSN 467-5941 COM 321-853-5941

Figure 7-3-15: *Notice to Airmen (NOTAM)*

7.3.4.1.1 Altitude Reservation (ALTRV)

An ALTRV is a temporary reservation of airspace for operations that cannot be accomplished within normal air traffic procedures. An ALTRV is normally employed for the mass movement of aircraft or other special user requirements. ALTRVs may be stationary over one area or mobile, affecting many areas. For ER launches, a stationary ALTRV is used to reserve LDZ airspace. ALTRV requests must be approved by the CARF.

7.3.4.1.2 Central Altitude Reservation Function (CARF)

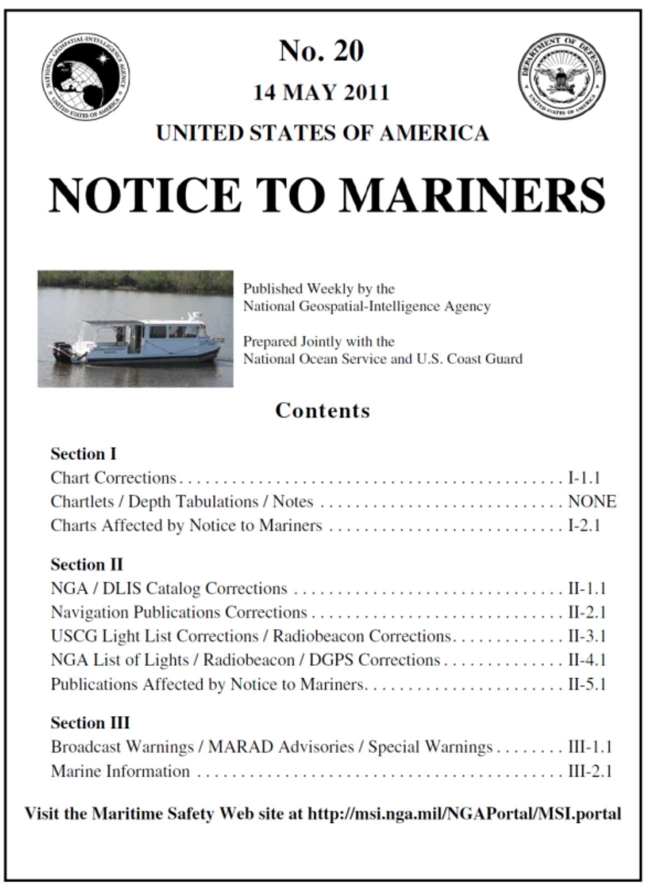
The CARF is the entity at the FAA's Air Traffic Control System Command Center (ATCSCC) that supports United States peace and war plan objectives and other special activities. It is responsible for coordinating military and civilian altitude reservations for operations within the

National Airspace System (NAS). For ER launch operations, the CARF approves the ALTRV request and forwards the approval to Miami ARTCC.

At L-10 days, 1 ROPS/DOUS sends an Altitude Reservation (ALTRV) request to the Central Altitude Reservation Facility (CARF) and sends a NOTAM request to the Miami ARTCC. The CARF issues the approved ALTRV approximately 24-36 hours prior to launch and sends 1 ROPS/DOUS a fax copy. Miami ARTCC incorporates the approved ALTRV, sends an international and US NOTAM 24 - 36 hours prior to launch, and sends 1 ROPS/DOUS a fax copy. Together the NOTAM and ALTRV provide redundant protection of possible debris impact areas and downrange staging impact areas and helps to capture all national and international airspace utilization agreements.

7.3.4.2 Notice to Mariners (NOTMAR)

A NOTMAR advises mariners of important matters affecting navigational safety, including new hydrographic information, changes in channels and aids to navigation, and other important data. The U.S. NOTMAR is published weekly by the National Geospatial –Intelligence Agency (NGA) and is prepared jointly with the National Ocean Service (NOS) and the USCG. It is comprised of three sections: 1) a chart corrections section, 2) a publication corrections section, and 3) a summary of broadcast navigation warnings and miscellaneous information. ER launches notifications and the sea surface areas of the LDZ are posted in Section 3 of the NOTMAR. 1 ROPS/DOUS sends the NOTMAR request for ER launches to the NGA and USCG District 7 at L-10 days.



No. 20

14 MAY 2011

UNITED STATES OF AMERICA

NOTICE TO MARINERS

Published Weekly by the
National Geospatial-Intelligence Agency

Prepared Jointly with the
National Ocean Service and U.S. Coast Guard

Contents

Section I

Chart Corrections I-1.1
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Section III

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Visit the Maritime Safety Web site at http://msi.nga.mil/NGAPortal/MSI.portal

Figure 7-3-16: *Notice to Mariners (NOTMAR)*

7.3.4.3 Space Launch Intrusion Prevention System (SLIPS)

SLIPS is a 45 SW program that was initiated as a result of the growing air and marine activities in central Florida. It is designed to provide mass media distribution of launch notifications to the public to prevent intrusions into airspace and marine hazardous areas during ER launch operations.

The SLIPS program consists of:

- Creating and distributing the user-friendly Launch Hazard Area (LHA) flyer
- The 45 SW LHA Hotline
- The 45 SW Public Website
- The National Oceanic and Atmospheric Administration (NOAA) Launch Broadcasts
- The Port Canaveral Alert Sign

7.3.4.3.1 Launch Hazard Area (LHA) Flyer

The LHA flyer is a user-friendly public notice flyer created from the 45 SW/SE Hazardous Area Letter by 1 ROPS/DOUS. It depicts the hazardous areas along with common reference points and provides mission information to include area clearance times. 1 ROPS/DOUS creates the flyer at L-10 days. The LHA flyer is distributed in many ways:

- It is forwarded to PA for distribution to local news outlets
- It is faxed to local participating marine outlets
- It is e-mailed to participating charter boat captains and fishing centers
- Handouts are distributed by 45 OG personnel at local boat ramps on launch day

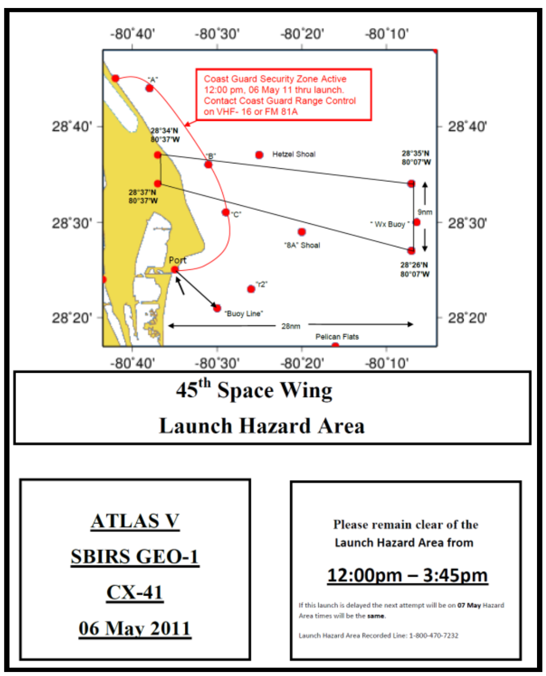
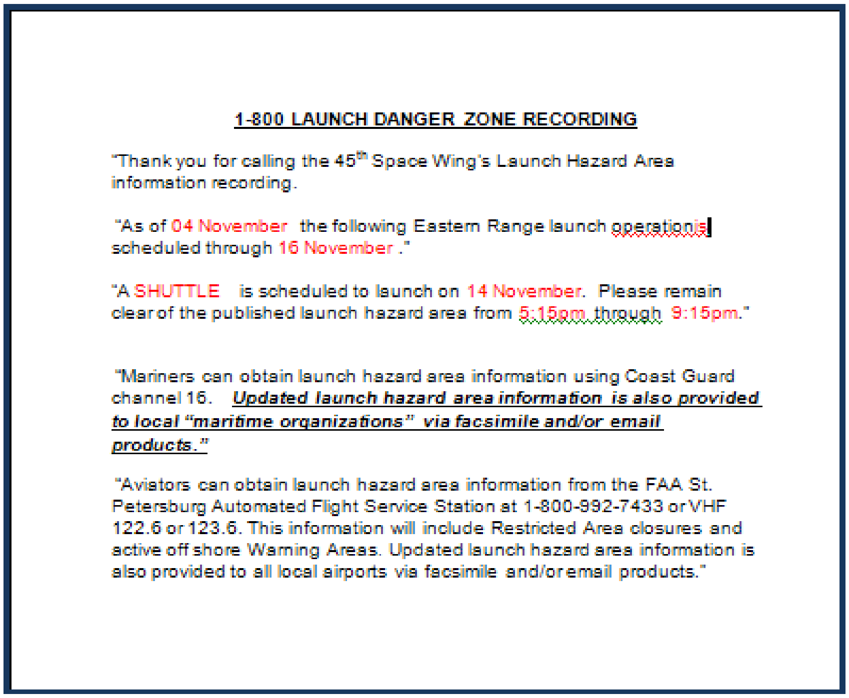


Figure 7-3-17: *Launch Hazard Area (LHA) Flyer*

7.3.4.3.2 45 SW LHA Hotline

The 45 SW Hotline is a 1-800 number that the public can call to get the details of an upcoming launch. 1 ROPS/DOUS fills out the hotline script at L-10 days and forwards it to the 45 SW Command Post. Command Post personnel use the script to create the Hotline recording. 1 ROPS/DOUS calls the hotline number and confirms the recording.



1-800 LAUNCH DANGER ZONE RECORDING

"Thank you for calling the 45th Space Wing's Launch Hazard Area information recording.

"As of 04 November the following Eastern Range launch operation is scheduled through 16 November ."

"A SHUTTLE is scheduled to launch on 14 November. Please remain clear of the published launch hazard area from 5:15pm through 9:15pm."

"Mariners can obtain launch hazard area information using Coast Guard channel 16. ***Updated launch hazard area information is also provided to local "maritime organizations" via facsimile and/or email products."***

"Aviators can obtain launch hazard area information from the FAA St. Petersburg Automated Flight Service Station at 1-800-992-7433 or VHF 122.6 or 123.6. This information will include Restricted Area closures and active off shore Warning Areas. Updated launch hazard area information is also provided to all local airports via facsimile and/or email products."

Figure 7-3-18: *Launch Danger Zone Recording*

7.3.4.3.3 45 SW Public Webpage

The 45 SW Public Webpage has links to allow the public to view and download information on an upcoming launch. The information includes the LHA Flyer and a map of the activated airspace. 1 ROPS/DOUS provides the LHA flyer and airspace map to PA who then posts it on the website.

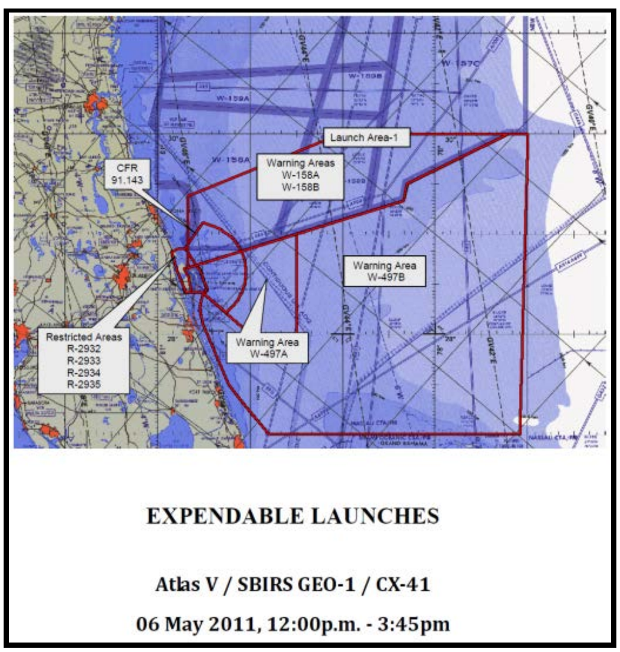


Figure 7-3-19: Airspace Map

7.3.4.3.4 NOAA Launch Broadcasts

NOAA broadcasts recorded information on upcoming launches on marine band radio channels. 1 ROPS/DOUS fills out the hotline script at L-3 days and forwards it to NOAA. NOAA uses the script to create the recording.

NOAA Launch Broadcasts Scripts:
NOAA Fax Number: 255-0791

INITIAL LAUNCH NOTIFICATION:

The U S Air Force, at Cape Canaveral has issued a local notice to mariners concerning a launch hazard area from
__4__ miles north of Port Canaveral to
__148__ miles northeast
.

The launch hazard area is active from 5:15pm until 9:15pm on 14 Nov 08.

Booster rockets will fall into the ocean downrange. All vessels transiting the vicinity of Cape Canaveral are urged to stay north, south or east of this area. Coast Guard vessels and Air Force helicopters will be patrolling the area. For updated information listen to Marine Radio Channel 16 or call (321) 868-4200.

This concludes the U S Air Force launch hazard area message.

Figure 7-3-20: *NOAA Launch Broadcasts Scripts*

7.3.4.3.5 Port Canaveral Alert Sign

The Port Canaveral Alert Sign is an electronic scrolling sign that is located in Port Canaveral near the Trident Basin. The purpose of the sign is to provide warning notices of launch operations to mariners as they are leaving the port. 1 ROPS/DOUS generates the script for the Port sign at L-1 day and forwards the script to Indyne. Indyne posts the message on the sign.

PORT SIGN LAUNCH SCRIPT

Please place the following message on the port sign on 13 Nov 08

"WARNING!! A SHUTTLE LAUNCH, 14 Nov 5:15pm until 9:15pm MONITOR CHANNEL 16 OR CALL 868-4200 OR 1-800-470-7232.

Figure 7-3-21: *Port Sign Launch Script*

Figure 7-3-22: *Port Canaveral Alert Sign*

7.3.5 SEA SURVEILLANCE SUPPORT ASSETS

Sea surveillance support assets provide critical support to surveillance control operations by scanning the sea surveillance areas, reporting the locations of any detected vessels, and relaying re-direct instructions to vector the vessels out of the LDZ. The typical complement of support assets include:

- Two HH-60G Pave Hawks from the 301st Rescue Squadron (RS): These helicopters provide surveillance for the majority of the SCO box including the areas beyond the coverage of the sea surveillance radars. Typically one will be on stations and one will be on standby.
- One or two response boats from the USCG Station Port Canaveral: These vessels provide surveillance around the port area to intercept vessels leaving the port and along the shoreline to detect any vessels underneath the radar coverage. Coast Guard Support is on a case by case bases based on the users requirements and Safety's recommendation.

7.3.5.1 HH-60G Pave Hawk

The Pave Hawk is a twin-engine medium-lift helicopter operated by the 301 RS. The primary mission of the HH-60G Pave Hawk helicopter is to conduct day or night personnel recovery operations into hostile environments to recover isolated personnel during war. The HH-60G is also tasked to perform military operations other than war, including civil search and rescue, medical evacuation, disaster response, humanitarian assistance, security cooperation/ aviation advisory, space flight support, and rescue command and control.

Figure 7-3-23: *HH-60G Pave Hawk*

The Pave Hawk crews use the "Jolly" call sign" (i.e. Jolly 1, Jolly 2). The Pave Hawk typically carries a crew of four. It has a max speed of 184 mph or 159 kts and nominally carries enough fuel to fly for approximately 2 hours; however, it can carry internal auxiliary fuel tanks to increase its range and flight time. There are two internal auxiliary fuel tank configurations:

- A 200 gallon tank which increases its flight time to 3hrs, 50 mins
- Dual 185 gallon tanks which increases its flight time to 4 hrs, 20 mins

The Pave Hawk has sea surveillance capabilities to include detection and communication capabilities. The Pave Hawk's detection capabilities include:

- Radar
- An Automatic Identification System (AIS) Receiver which is part of a ship transponder system. It receives position and navigation signals from ships equipped with AIS transmitters.
- Forward Looking Infrared (FLIR) capability

The Pave Hawk also has several capabilities for communicating with surface vessels to include:

- Marine Band Radio
- Loud Hailer system: There is one loud hailer or loud speaker system available to be carried on one of the Jollies. It is typically only carried when there is the expectation that there will be a lot of boats in the area, such as during fishing tournaments.
- Deployable streamers: A streamer is a note with re-direct instructions in a plastic bag which is weighted and has a colored streamer attached. The Jolly will fly slowly over the target and someone in the Jolly will throw the streamer down to the deck of the vessel.

7.3.5.2 45 ft Response Boat – Medium (RB-M)

The 45 ft RB-M is designed for search and rescue; ports, waterways, and coastal security; drug interdiction; and migrant interdiction. It carries a minimum crew of 4. Its capabilities include a max speed of 42.5 kts, a range of 250 nm at a speed of 30kts, and a towing capability of 100 tons. The vessel has a sea surveillance radar with a range up to 48 nm, an AIS receiver, and a FLIR equipment for detecting surface targets. The vessel has some operational limitations due to weather. It cannot operate in seas greater than 8 ft or winds greater than 30 kts and it cannot operate in breaking surf. There is one 45 ft RB-M at Port Canaveral, CG 45617.

Figure 7-3-24: *45 ft Response Boat – Medium*

7.3.5.3 25 ft Response Boat – Small (RB-S)

The 25 ft RB-S was developed as a direct response to the need for additional homeland security assets in the wake of the September 11th terrorist attacks and is designed to operate in shallow waters along coastal borders. It is designed for search and rescue; ports, waterways, and coastal security; drug interdiction; and migrant interdiction. It carries a crew of 4. Its capabilities include a max speed of 46 kts, a range of 150 nm at a speed of 25kts, and can tow vessels 35 ft in length and up to 10 tons. The vessel has a sea surveillance radar with a range up to 48 nm and an AIS receiver for detecting surface targets. The vessel has some operational limitations due to weather. It cannot operate in seas greater than 6 ft or winds greater than 25 kts and it is not operated greater than 10 nm offshore. There are two 25 ft RB-Ms at Port Canaveral, CG 25442 and CG 25777.

Figure 7-3-25: *25 ft Response Boat – Small*

7.3.6 MISSION SUPPORT POSITIONS

A MSP is a designated location at which a mission support aircraft or vessel must be by T-0 where the risk to the aircraft/vessel is within acceptable levels. For aircraft, both altitude and position in latitude and longitude may be used to define this position. MSPs are located outside of the Required Surveillance area for sea vessels and outside the Jolly ACC for the Jollies.

In the SCC, only the SCO is authorized to release support assets from MSP. The SCO will make the determination to send support assets back into the SCO Box to re-survey the box if required. For nominal launches, the SCO will release the support assets from MSP IAW the 45 SW/SE Hazardous Area Letter. In the event of a scrub or a hangfire/misfire, the SCO will not release assets from MSP until authorized by the MFCO or ROC for AFSS launches.

7.3.7 SURVEILLANCE CONOPS

The Surveillance Control CONOPS is to:

- Survey the surveillance areas to detect any target aircraft or vessels within or near the LDZ using a combination of land-based sensors and support assets
- Assess the location of any targets to determine if they will be a factor at T-0 and foul the range
- Pass the target information to the SRA for determination.
- Re-direct based on SRA recommendation.

Note that Surveillance Control operations are not focused on the current location of targets. The focus is on the prediction of the location of targets at T-0.

7.3.7.1 Target Aircraft/Vessel

A target aircraft or vessel, which may simply be referred to as a "target", is a non-support aircraft or vessel that is detected within or near the surveillance areas. Target information is available to the Surveillance Team through surveillance radar data, AIS data, or reports from the support assets. The position, movement, and size/type of a target must be assessed to determine if it is a factor.

7.3.7.2 Factor

A factor is a target aircraft or surface vessel whose predicted location at T-0 will violate a surveillance area. A target that is determined to be a factor may be vectored or re-directed based on SRA recommendation to a safe location prior to T-0 or the countdown must be held.

7.3.7.3 Fouled Range

A fouled range is a condition in which an aircraft or surface vessel is predicted to violate an aircraft or surface vessel surveillance area at T-0 and there is either no time to divert the aircraft/surface vessel or all options to divert the aircraft/surface vessel have been exhausted. A fouled range is cleared when the target's current position is no longer violating a surveillance area or its projected position will no longer violate at T-0.

There are different procedures that are used to clear a fouled range depending on whether it was caused by an aircraft or a surface vessel.

7.3.7.3.1 Fouled Range due to Aircraft

At L-10 minutes, the ACO begins monitoring the airspace for aircraft that will violate the ACC at T-0. L- 10 minutes is used as a demarcation line because the intentions of aircraft are difficult to accurately determine prior to that time due to the speeds and distances involved. Upon detection of an intruder aircraft, the MRU Controller will contact the applicable ATC facility and request re-direct assistance. The ATC facility will attempt to contact the intruder aircraft simultaneously on multiple frequencies. If all attempts to contact fail, the SCO will report "NO GO" status for a fouled range due to an intruder aircraft.

7.3.7.3.2 Fouled Range due to Surface Vessels

Upon detection of a surface vessel that will be a factor at T-0, the Jollies and/or the USCG will first attempt to make radio contact. If radio contact cannot be established and the target is close to the shore, the USCG may send their support vessel to intercept the target. If a Jolly cannot make contact with the radio, it may attempt to contact the vessel with the Loud Hailer system, if equipped. If the Jolly cannot hail the target by radio or the Loud Hailer, the Jolly may try to drop a streamer on the target. If required by the SCO, the SRAs will provide real-time analysis. If the situation cannot be resolved, the Risk Assessment Center will report "NO GO" status for surface vessel violations.

7.3.7.3.3 Fouled Range Reporting

Upon detection of a Fouled Range condition, the ACO and SSO notify the SCO of the Fouled Range over SCO.NET. The SCO will notify the MFCO, RCO, and ROC over the Ops Support Net using General Status Change Checklist (1-1) through a Tier 1 Report (i.e. "SCO is NO-GO due to a Fouled Range. There is an aircraft that will be a factor at T-0."). The SCO will provide additional details, if requested, to include what actions are being taken to resolve the issue and an expected clear time if contact cannot made, if possible. Note that in some cases, it may be impossible to determine an expected clear time, such as if a boat is violating a contour and is parked.

7.3.7.4 Surveillance Operations Countdown Overview

During a typical Expendable Launch Vehicle (ELV) countdown, the SCO, DSCO, and ACOs arrive on-console at L-4 hours for non AFSS missions and L-2.5 hours for AFSS missions. The ACOs will contact the 301 RS and the Deputy Launch Weather Officer-Reconnaissance (DLWO-Recce) to verify the status of the support aircraft. The SCO will provide initial status to the Range Team.

The SSOs arrive on-console at L-2 hours and 30 minutes which is 30 minutes prior to the arrival of the first surveillance aircraft. At L-2 hours and 30 minutes the MRU Controllers arrive on-console. At this time, the ACOs and MRUs begin monitoring the airspace as it is activated.

Jolly 1 arrives at the SCO Box at L-45 mins and Jolly 2 is typically on standby. Once the Jollies are in the SCO Box, they begin performing long-range scans using the Automatic Identification System (AIS), onboard radar, and visual scans.

At L-2 hours, the USCG Liaisons and asset(s) arrive on station and begin monitoring the Security Zone and any vessels close to the shore.

At L-20 minutes, the support assets begin heading in toward their MSPs. At L-11 minutes, the SCO verifies with the ACO and SSO that support assets are at MSP. The support assets nominally arrive at MSP by L-10 minutes. They may be delayed if the support assets are still intercepting targets, however the support assets must be at their MSPs or at an alternate MSP no later than T-0.

At L-10 minutes, the ACOs begin monitoring aircraft movement to detect any ACC violations at T-0. To do this, the ACOs use the SCDS speed leader to determine the aircraft positions at T-0.

7.3.7.5 SCO GO/NO-GO Status

SCO status is not based on current status of targets and support assets. The SCO bases his GO/NO-GO status on the prediction of the location of support assets and non-support aircraft and marine vessels at T-0 and the ability to clear these aircraft and vessels prior to T-0.

7.3.8 SURVEILLANCE CONTROL PROCEDURES

Surveillance Control Operations are essential to Range and Launch Operations to ensure air and sea traffic are not endangered during a launch. Surveillance Control procedures are divided into two categories: Air Surveillance procedures and Sea Surveillance procedures. These procedures are designed to be used by the surveillance team to monitor the movement of air and sea traffic within the Launch Danger Zone (LDZ) to determine if any aircraft or surface vessels will be a factor at T-0.

7.3.8.1 Surveillance Control Fundamentals

In order to perform surveillance operations, Surveillance personnel must have a strong understanding of some fundamental concepts.

7.3.8.1.1 Position (Latitude and Longitude)

Latitude and longitude are used as a geographic coordinate system to specify any location on the earth. The latitude of a location on the Earth is the angular distance of that location north or south of the equator. The latitude is an angle, and is usually measured in degrees (marked with °). The equator has a latitude of 0°, the North pole has a latitude of 90° north (written 90° N or +90°), and the South pole has a latitude of 90° south (written 90° S or −90°). Curves of constant latitude on the Earth (running east-west) are referred to as lines or parallels of latitude. The distance between the lines of latitude or in one degree of latitude is approximately 60 nm. ER surveillance operations occur primarily between 28° N and 30° N.

Longitude is the angular distance of a point's meridian from the Prime Meridian. Lines of longitude are often referred to as meridians. The line of longitude that passes through the Royal Observatory in Greenwich, England, establishes the meaning of zero degrees of longitude, or the Prime Meridian. Longitude is given as an angular measurement ranging from 0° at the Prime Meridian to +180° eastward (180° E) and −180° westward (180° W).

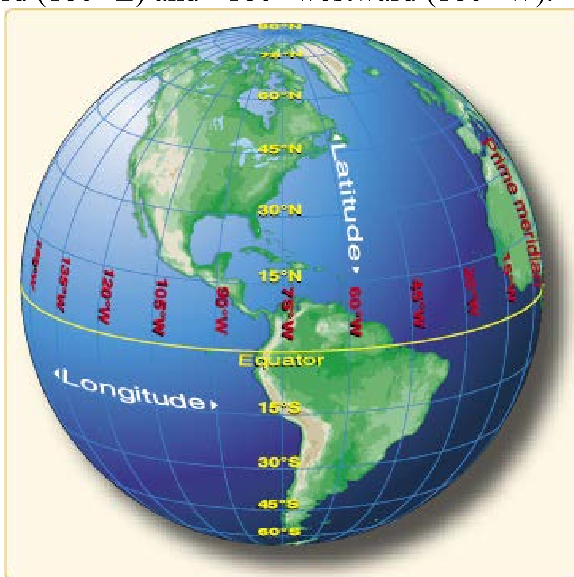


Figure 7-3-26: *Position (Latitude and Longitude)*

The distance between the meridians of longitude or in one degree of longitude varies depending on the latitude of the location. The distance in one degree of longitude is greatest at the equator where it is approximately 60 nm. The meridians of longitude converge as they approach the poles with the distance converging to 0 nm at 90° N and 90° S. ER surveillance operations occur primarily between 79° W and 81° W where the distance in one degree of longitude is approximately 52.5 nm.

7.3.8.1.2 Position (Degrees, Minutes, and Seconds)

Though latitude and longitude are measured in degrees, minutes and seconds are often used for finer measurements. A degree is divided into 60 minutes. One minute can be further divided into 60 seconds. For example, the MOC has a latitude of 28° 35′ 01″ N, where 28° refers to the number of degrees, 35′ refers to the number of minutes, and 01″ refers to the number of seconds. For greater precision, a decimal fraction can be added to the seconds. An alternative representation uses only degrees and minutes, where the seconds are expressed as a decimal fraction of minutes: the above example would be expressed as 28°35.02' N. Degrees can also be expressed singularly, with both the minutes and seconds incorporated as a decimal number and rounded as desired (decimal degree notation): 28.58361° N. Sometimes, the north/south suffix is replaced by a negative sign for south (−90° for the South Pole).

Target position reports during ER Surveillance Ops are typically made using the DD:MM.MM format, however, reports may be given in other formats such as DD:MM:SS or DD.DDDDD. The SCDS can be configured to use various different formats, however, you can also convert the formats by hand if required, such as in the event of a SCDS failure. To convert from decimal to minutes or seconds, multiply the decimal portion by .6. To convert from minutes or seconds to decimal form, multiply by 1.66. Job Aid 3 in Volume 2 of the 1 ROPS Ops Manual provides a quick reference conversion chart which can be utilized on console.

Decimal Reading	**Equivalent Reading in Minutes / Seconds**		**Decimal Reading**	**Equivalent Reading in Minutes / Seconds**
.00	**00**		**.55**	**33**
.05	**3**		**.60**	**36**
.10	**6**		**.65**	**39**
.15	**9**		**.70**	**42**
.20	**12**		**.75**	**45**
.25	**15**		**.80**	**48**
.30	**18**		**.85**	**51**
.35	**21**		**.90**	**54**
.40	**24**		**.95**	**57**
.45	**27**		**1.0**	**60**
.50	**30**			

Figure 7-3-27: *Position Conversion Chart*

7.3.8.1.3 Distance: Nautical Mile (NM)

Distance in surveillance ops is expressed in nautical miles (nm). A nautical mile is a unit of length corresponding approximately to one minute of arc of latitude along any meridian. As we previously mentioned, there are approximately 60 nm in one degree of latitude and 60 minutes in a degree. It is used by sea and air navigators worldwide because of its convenience when working with charts. By international agreement it is approximately 6,076.1 feet. By comparison, a statue mile is 5,280 ft.

7.3.8.1.4 Velocity: Knot (kt) or Knots (kts)

Velocity in surveillance ops is expressed in knots. The knot is a unit of speed equal to one nautical mile per hour, which is equal to approximately 1.151 mph. It is typically abbreviated as kt (singular) or kts (plural). It is used in meteorology, and as well as in maritime and air navigation.

7.3.8.1.5 Direction: Compass Rose

Direction in surveillance ops is expressed as a "course", "heading" or "bearing" in degrees. This is accomplished by utilizing the compass rose. The compass rose is used to display the orientation of the cardinal directions (north, east, south, and west) and to measure direction in degrees in a clockwise direction from true north, which is annotated as 360°. The compass rose is used in almost all navigation systems, including nautical charts and radio-navigation systems.

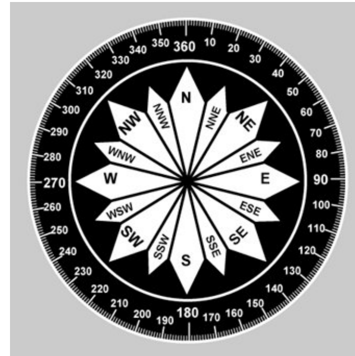


Figure 7-3-28: *Compass Rose*

7.3.8.1.6 Direction: True vs. Magnetic

When we are dealing with direction in surveillance ops, we use courses/headings/bearings in reference to true north, referred to as true courses/headings/bearings. Earth's geographic poles and magnetic poles, however, are not aligned. The north magnetic pole is located close to 71° N latitude, 96° W longitude and is about 1,300 miles from the geographic or true North Pole. The needle on the compass points to magnetic north. Aviators or mariners navigating by compass have to account for this difference. The angle between magnetic north and true north is called magnetic variation or magnetic declination. On the west coast of the United States, the compass needle points to the east of true north; on the east coast, the compass needle points to the west of true north. Because the Earth is not uniformly magnetized, magnetic variation varies both from place to place and with the passage of time. As a result, the exact amount of variation at thousands of selected locations in the U.S. has been carefully determined and is updated as required. At the launch head of the ER, the magnetic variation is approximately -6° or 6° W. During ER surveillance ops, it may be necessary to specify a true course or heading (i.e. 180° true) when re-directing targets.

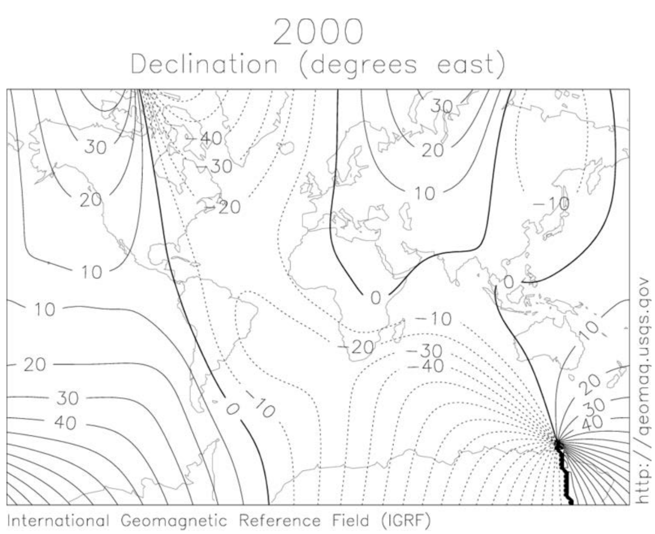


Figure 7-3-29: *Direction (True vs. Magnetic)*

Visual Flight Rules (VFR)
Visual Flight Rules (VFR) are a set of regulations which allow a pilot to operate an aircraft in weather conditions generally clear enough to allow the pilot to see where the aircraft is going. Under VFR, the pilot is primarily responsible for navigation, obstacle clearance and maintaining separation from other aircraft using the *see-and-avoid* concept and is generally not assigned routes or altitudes by Air Traffic Control (ATC). Pilots flying under VFR cannot fly through clouds.

Instrument Flight Rules (IFR)
Instrument Flight Rules (IFR) are regulations and procedures for flying aircraft by referring only to the aircraft instrument panel for navigation. IFR-rated pilots are authorized to fly through clouds. ATC procedures and airspace rules are designed to maintain separation from other aircraft.

7.3.8.1.7 Aircraft Transponders
In aviation, aircraft have transponders to assist in identifying them on radar and on other aircraft's collision avoidance systems. When the transponder receives a radar signal it sends back a transponder's squawk code, referred to as “Squawk” code or Mode 3/A code, which is displayed on the radar display.

7.3.8.1.8 Automatic Identification System (AIS) Transponders
The International Maritime Organization's (IMO) International Convention for the Safety of Life at Sea (SOLAS) requires AIS to be fitted aboard all self-propelled vessels of 65 feet or more in length, other than passenger and fishing vessels, in commercial service and on an international voyage.

Shipboard AIS transponders autonomously broadcast two different AIS messages: a “Position Report” which includes the vessels dynamic data (e.g. latitude, longitude, position accuracy, time, course, speed, navigation status) and a “Static and Voyage Related Report” which includes data particular to the vessel (e.g. name, dimensions, type) and regarding its voyage (e.g. static draft, destination, and ETA). Position reports are broadcasted very frequently (between 2-10 seconds-depending on the vessels speed-or every 3 minutes if at anchor), while static and voyage related reports are sent every six minutes.

Specifically, the Position Report includes:

- The vessel's Maritime Mobile Service Identity (MMSI) – a unique nine digit identification number.
- Navigation status – "at anchor", "under way using engine(s)", "not under command", etc.
- Rate of turn – right or left, from 0 to 720 degrees per minute
- Speed over ground – 0.1-knot (0.19 km/h) resolution from 0 to 102 knots (189 km/h)
- Positional accuracy:
- Longitude – to 0.0001 minutes
- Latitude – to 0.0001 minutes
- Course over ground – relative to true north to 0.1°
- True heading – 0 to 359 degrees (for example from a gyro compass)
- Time stamp – UTC time accurate to the nearest second when these data were generated

Specifically, the Static and Voyage Related Report includes:

- IMO ship identification number – a seven digit number that remains unchanged upon transfer of the ship's registration to another country
- Radio call sign – international radio call sign, up to seven characters, assigned to the vessel by its country of registry
- Vessel Name – 20 characters to represent the name of the vessel
- Type of ship/cargo
- Dimensions of ship – to nearest meter
- Location of positioning system's (e.g., GPS) antenna onboard the vessel - in meters aft of bow and meters port of starboard
- Type of positioning system – such as GPS, DGPS or LORAN-C
- Draught of ship – 0.1 meter to 25.5 meters
- Destination – max. 20 characters
- ETA (estimated time of arrival) at destination – UTC month/date hour: minute

7.3.8.1.9 Support Airfields

Although there are many airfields located near the ER, there are three key airfields which support ER surveillance ops: Patrick AFB (COF), the CCAFS Skid Strip (XMR), and the KSC Shuttle Landing Facility (SLF) (TTS).

Patrick AFB (COF)

Patrick AFB (COF) provides support to 920 Rescue Wing (RW) aircraft operations and the National Airborne Operations Center (NAOC) aircraft as well as services for transient aircraft.

Figure 7-3-30: *Patrick AFB (COF)*

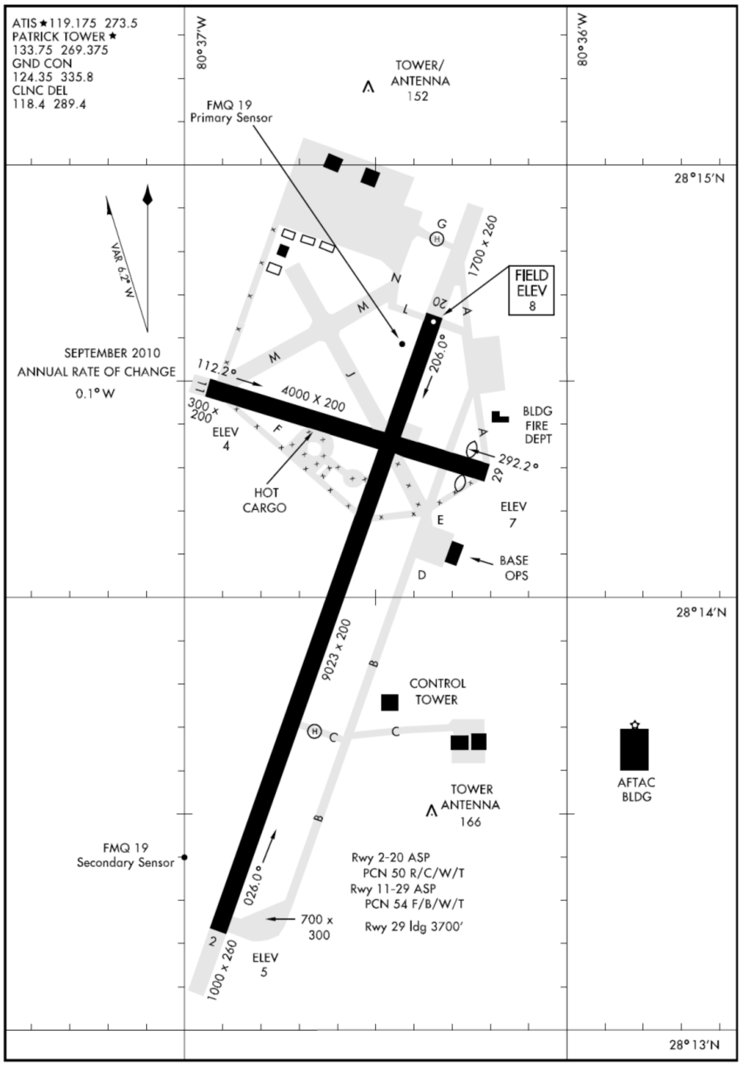


Figure 7-3-31: *Patrick AFB (COF) Layout*

The radio frequencies for Patrick Tower are 133.75 VHF and 269.375 UHF. Aircraft operating in the eastern half of Patrick AFB airspace have the potential to interfere with tracking operations during flight. Due to their proximity to the airfield, aircraft operating in this airspace may block the line of sight between Radar 0.134 and/or the Patrick DOAMS optics site and a vehicle in flight. As a result, Patrick Tower restricts aircraft operations to the western half of the Patrick AFB airspace from T-2 minutes to T+10 minutes. The ACO notifies Patrick Tower of the impending launch at T-5 minutes and that the launch is complete at T+10 minutes. The ACO notifies Patrick Tower if the launch is delayed or scrubbed, as required.

CCAFS Skid Strip (XMR)

The CCAFS Skid Strip (XMR) is used by U.S. Customs and Border Protection (CBP) Unmanned Aerial Vehicle (UAV) ops, aircraft delivering flight hardware and mission support aircraft. The primary radio frequencies for Cape Tower are 118.625 VHF and 239.5 UHF with back-up frequencies of 143.15 VHF and 270.0 UHF. There are no navigational aids located at the Skid Strip.

Figure 7-3-32: *CCAFS Skid Strip (XMR)*

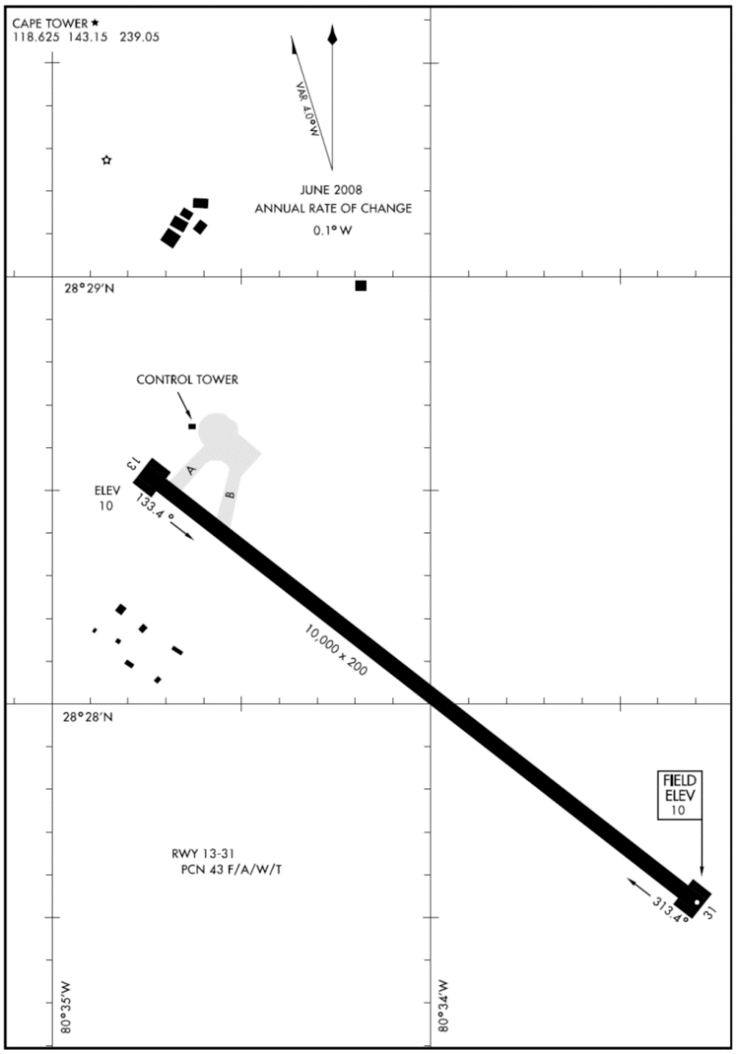


Figure 7-3-33: *CCAFS Skid Strip (XMR) Layout*

There are times when aircraft may be scheduled to land at the Skid Strip during launch operations, such as when VIPs are flying in to observe the launch. If not properly scheduled and de-conflicted, these arriving aircraft could interfere with support aircraft operations during critical times of the countdown. As a result, procedures have been developed to mitigate the disruption of ER surveillance ops with the demarcation line being 60 minutes prior to the planned T-0.

1 ROPS/DOUS will advise aircraft operators and scheduling agencies that aircraft can land no later than 1 hour prior to the launch operation's planned T-0. If a pre-approved inbound aircraft is delayed, the Cape Tower may authorize the aircraft to land after L-1 hour, but no later than L-40 minutes if approved by the SCO. Aircraft experiencing emergency conditions may land after L-1 hour if they cannot be safely diverted to an alternate airport based on the Pilot-in-Command's assessment of the situation. Cape Tower will notify the SCO of any emergency inbounds as soon as possible. Mission support aircraft operating in conjunction with launch operations may land or depart as required.

The CCAFS Airfield Manager will direct arriving aircraft crews to call the Risk Assessment Center (RAC) to ensure all aircrew and passengers remain clear of hazard areas. The aircrew and passengers are required to follow the instructions provided by the RAC.

KSC Shuttle Landing Facility (SLF) (TTS)

The SLF (TTS) supports NASA aircraft operations. It has one runway, Runway 15/33, which is 15,000 x 300 ft. The radio frequencies for NASA Tower are 128.55 VHF and 284.0 UHF.

Figure 7-3-34: *SLF (TTS)*

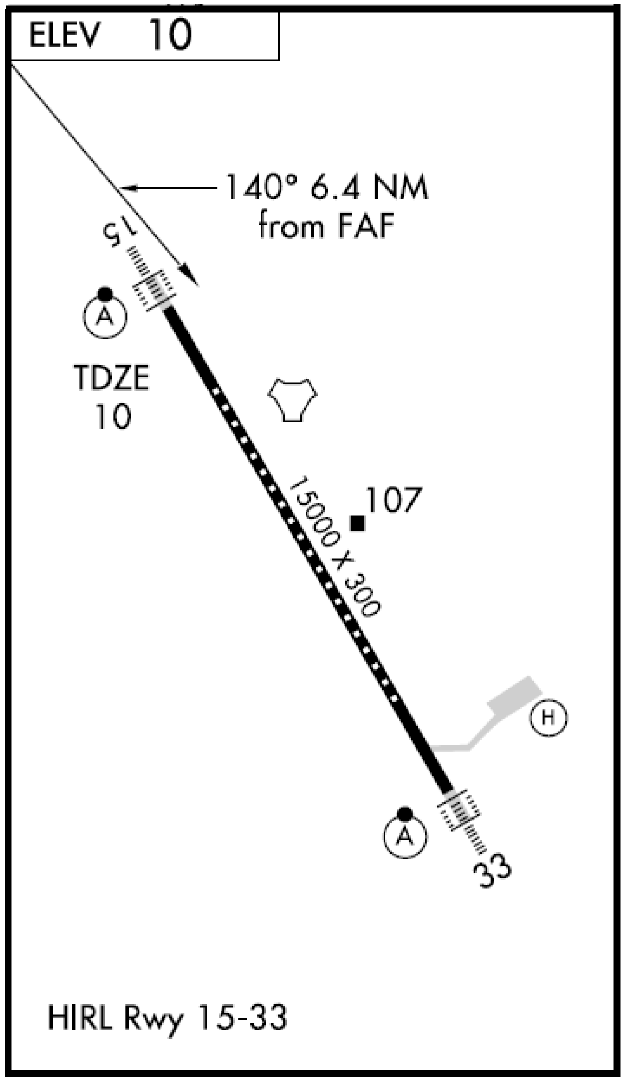


Figure 7-3-35: *KSC Shuttle Landing Facility (SLF) (TTS) Layout*

7.3.8.1.10 Emergency Radio Frequencies

There are radio frequencies that are dedicated to emergency communications for aircraft or vessels in distress. These frequencies are monitored 24/7. Although these frequencies are primarily used to broadcast distress calls, they may also be used to contact aircraft or vessels that have entered hazardous or restricted areas such as during ER surveillance operations.

Aircraft Emergency Radio Frequencies

There are two aircraft emergency frequencies, also referred to as “guard frequencies”, on the aircraft radio band reserved for emergency communications for aircraft in distress. The frequencies are 121.5 MHz for civilian, also known as International Air Distress (IAD) and 243.0 MHz for military use, also known as Military Air Distress (MAD). All pilots are strongly recommended to monitor 121.5 MHz at all times. As a result, if anaircraft violates ER restricted airspace and is not in direct communications with an Air Traffic Control (ATC) facility, such as an aircraft under VFR, the applicable ATC facility may contact the aircraft and provide re-direct instructions on 121.5 MHz.

Shipping/Maritime Emergency Radio Frequency

Marine band Channel 16 (156.8 MHz) VHF is the international distress frequency for shipping and maritime purposes. Channel 16 is also used to call up ships and shore stations. After an initial response, however, the call is to be switched to one of the working channels in order to keep Channel 16 available to others. Coast guards and others are permitted to broadcast short informative safety messages on Channel 16, such as notifications of hazardous areas for upcoming ER launches. Channel 16 is monitored 24 hours a day by coastguards around the world. In addition, all sea bound vessels are required to monitor Channel 16 when sailing, except when communicating on other marine channels for legitimate business or operational reasons. During ER surveillance operations, the USCG and the support aircraft will contact vessels on Channel 16 as required to re-direct them out of the LDZ.

7.3.8.2 Air Surveillance Procedures

Air Surveillance procedures are utilized by the ACO to monitor and assess the movement of air traffic within the Special Use airspace. These procedures include airspace monitoring, fouled range procedures, and support aircraft monitoring.

7.3.8.2.1 Airspace Monitoring

The ACO utilizes the SCDS to monitor the activated special use airspace in order to detect intrusions into the airspace by unauthorized aircraft. The ACO references the Notice to Airmen (NOTAM) and brings up the applicable airspace on the SCDS display based on the activation times. It is important to understand which airspace is active in order to detect violations. The airspace activation times can vary depending on the type of mission. However, there are typical activation times for expendable launch vehicles. As you may recall, R2932 is active 24/7 from the surface to 5,000 ft since 9/11.

The area of W497A west of 80 degrees longitude is active from the surface to 5,000 ft starting at L-3 hours. This airspace is utilized by the Jolly aircraft to scan the SCO Box. The first Jolly aircraft arrives in the area at L-2 hours.

The NASA Cape-A airspace is active from the surface to 18,000 ft starting at L-2 hours. This airspace is utilized, if required, by the WX-1 aircraft to perform cloud thickness and ceiling observations for the DLWO WX Recce.

The CFR 91.143 TFR is active from the surface to 18,000 ft starting at L-30 minutes. At T-0, R2933 is activated from 5, 000ft to unlimited, W497A is extended to unlimited, and R2934, the portions of W497A east of 80 degrees longitude, W497B, and Launch Area 1 are activated from the surface to unlimited. This is to clear all aircraft from these areas for launch. Note that the airspace activation times are dictated by NOTAMs, however, The MRU Controller will notify Miami ATC if the T-0 is delayed early in the countdown and will delay the L-1 hours and 30 minutes, 1 hour, and 30 minute ATC notifications accordingly. This will allow Miami ATC to route air traffic through the airspace if the T-0 has been sufficiently delayed.

The ACO will enable the IFF Beacon tracks and Radar Plots (skin) tracks on the SCDS to detect any aircraft inside or in the vicinity of the airspace. The ACO will monitor the movement of non-mission support aircraft in relation to the airspace, paying attention to the Mode 3/A codes and the aircraft altitude to detect airspace violations. Special attention is required for aircraft that are using a Mode 3/A code of “1200.” This indicates that the aircraft is operating under Visual

Flight Rules (VFR). Pilots flying under VFR may not be aware of the activated airspace and may accidentally violate the airspace. Note that when monitoring Radar Plots or skin tracks, some returns may be false targets due to weather or standing structures such as towers or launch complexes.

7.3.8.2.2 Fouled Range Procedures

From L-10 minutes to T-0, the ACO uses the speed leaders on the SCDS to predict the location of aircraft at T-0 to determine if any aircraft will violate the aircraft contour at T-0. Upon detection of an intruder aircraft, the ACO:

- Determines if the aircraft will be a factor at T-0
- Reports NO-GO status and the details of the Fouled Range to the SCO
- Coordinates with the MRU Controller to divert the unauthorized aircraft out of the airspace

The ACO can receive information of an intruder aircraft a couple of ways. Typically, the ACO will receive the target information from the air surveillance radar data displayed on the SCDS. The ACO may also receive a verbal report from the MRU Controller or an ATC facility of an aircraft approaching the area.

The report will typically include:

- The aircraft's Mode 3/A code
- The aircraft's position in the form of bearing and range from a navigation aid (such as a TACAN) or from some other fixed location such as a tower or the launch pad
- The speed of the aircraft
- The aircraft's altitude

In the event of a SCDS failure, the ACO will need to record this information to pass it to the SCO, who will in turn pass it to the Surveillance Risk Analyst (SRA). Note that a verbal report could be provided by the MRU controller or by an ATC facility prior to L-10 minutes.

The ACO will plot or correlate the target data by using the SCDS speed leaders to determine the target position at T-0. The ACO will establish a 10 minute air speed leader at L-10 minutes. Due to limitations in the SCDS software, the air speed leader cannot be synchronized to the launch countdown timer. As a result, as the countdown progresses under L-10 minutes, the ACO will need to adjust the speed leader length as needed or desired, such as incrementing the speed leader every minute. If a verbal report is provided by the MRU Controller or an ATC facility, the ACO will correlate the information with the air surveillance radar data in order to find the target on the SCDS display and establish or adjust the speed leader as required to determine if the target will be a factor.

In the event of a SCDS failure, the ACO will pass the information from any verbal reports by the MRU Controller or ATC facility to the SCO to pass to the SRA. The SRA will use the SRA laptop computer to manually enter the information into a program which contains the aircraft contour to determine if the aircraft will be a factor at T-0.

The ACO will determine if the target is a factor based on its position at T-0 in relation to the Aircraft Corridor (ACC) and will notify the MRU Controller on whether or not the target is a factor.

If a Fouled Range occurs, the ACO will perform the following actions:

Notify the SCO

The ACO will notify the SCO of the Fouled Range and provide the following information:

- **Target squawk code**
- **Location**
- **Altitude**
- **Expected Clear Time:** The expected clear time is the time that the aircraft is expected to clear the aircraft contour on its current heading. This time can be determined by adjusting the air speed leader to determine when the aircraft will be clear of the aircraft contour. Note that depending on the aircraft's location and heading, for example if the aircraft is approaching from the west and is heading due east, the ACO may not be able to determine an expected clear time.
- **Any additional details:** The ACO will also pass any available additional details, such as what actions will or are being taken to resolve the situation. The nature of the situation will dictate how much of the above information the ACO will be able to pass the SCO. The ACO will need to pass the information quickly so that the SCO can notify the rest of the Range team and the countdown can be held, if required.

Initiate Re-direct of Target

The ACO will then ensure the MRU Controller:

- **Notifies the support aircraft of the target's location:** The MRU Controller alerts the support aircraft of the new aircraft entering the area and ensures there is adequate separation between aircraft.
- **Provides ATC facilities target information and request re-direct assistance:** The MRU Controller will contact the appropriate ATC facility to request assistance in diverting the aircraft out of the airspace.

Notify the MFCO, RCO and ROC of the Fouled Range

The SCO will notify the MFCO, RCO, and ROC of the Fouled Range using the General Status Change Checklist 1-1.

Monitor Target Movement and Obtain/Provide Updates

The ACO will continue to monitor the target aircraft's movement on the SCDS and receive or obtain updates from the MRU Controller on the efforts to divert it out of the area. The ACO will provide any updates or changes in status to the SCO to keep him/her apprised of the situation. The SCO will provide updates, as required, to the MFCO, RCO, and ROC using the General Status Change Checklist 1-1.

Notify of Event Termination

When the target aircraft has been diverted away from the aircraft corridor or it travels through and exits the corridor, the ACO will notify the SCO and the MRU Controller and ensure the MRU Controller passes notification of the Fouled Range termination to the support aircraft and the ATC facilities. The SCO will notify the MFCO, RCO, and ROC of the Fouled Range termination using the General Status Change Checklist 1-1.

7.3.8.2.3 Support Aircraft Monitoring

The ACO monitors the movement and status of the mission support aircraft during range operations. Typically there are three mission support aircraft for ELV missions.

There are two sea surveillance aircraft that are HH-60G Pave Hawks from the 301st rescue squadron. Their callsigns are Jolly 1 and 2. Jolly 1 arrives on-station at L-2 hours and Jolly 2 arrives on-station at L-1 hour and 30 minutes. Jolly 1 and 2 receive direction from and provide information to the SSO, callsign Variety 1, on a primary frequency of 143.725 VHF with a back-up frequency of 298.2 UHF.

Figure 7-3-36: *Weather 1 (WX-1) Lear Jet*

There is also one weather reconnaissance aircraft, callsign WX-1 (typically a Learjet 31 aircraft based out of Orlando Sanford International airport). WX-1 is on-standby status at L-3 hours. If required for support, the Deputy LWO for Weather Reconnaissance (DLWO-Recce) will typically direct WX-1 to take-off at L-2 hours and will notify the ACO and the MRU Controller of the intended support plan (take-off time, work areas, altitudes, etc). WX-1 receives direction from and provides information to the DLWO-Recce on 123.225 VHF with a back-up frequency of 225.05 UHF.

Other aircraft may support the launch if required by the User to meet mission requirements. This support is typically arranged by the User. For example, the NRO requires aircraft to perform security sweeps of the pad for their missions. They typically coordinate with NASA to have their Bell UH-1 "Huey" helicopters, callsign Search 1, 2, or 3 to perform the security sweeps.

The SCO oversees and conducts the Aircrew Briefing for Expendable Launch Vehicles (ELVs). The SCO or ACO briefs the aircrews and reviews the aircraft support plans to include:

- Airspace activation times
- Take-off and on-station times
- Airspace entry and exit procedures
- Mission altitudes
- Mission frequencies
- Mission Support Positions (MSPs)
- Coordinate aircraft refueling requirements, if required.
- Breakaway procedures

If additional aircraft are added at the last minute, the SCO and ACO will ensure an Intended Support Plan (ISP) for each aircraft has been submitted to 45 SW/SE.

The MRU Controller, callsign Cape Control, is responsible for entry into the ER special use airspace and separation of the aircraft within the airspace under MARSA (Military Assumes Responsibility for Separation of Aircraft). The MRU Controller's primary frequency is 133.8 VHF with a back-up frequency of 264.8 UHF. The MRU Controller establishes contact with each aircraft prior to the aircraft entering range airspace and obtains the aircraft's take-off time, total amount of fuel onboard (usually reported in hours of fuel), the number of souls or personnel onboard and the aircraft's tail number. The MRU Controller passes this information to the ACO who records the information in Attachment 1 of the Surveillance Operations Checklist (SOC). The MRU Controller provides a range status briefing to each aircraft. The briefing will include the call sign, approximate location, and altitude (if known) of any other aircraft already operating in the range and any other scheduled range activity that will take place while the aircraft is scheduled in the range (i.e. laser activity, weather balloon releases, etc). The MRU Controller then clears the aircraft onto the range and directs the pilot to contact the appropriate mission support personnel on the assigned frequency.

As aircraft approach the restricted airspace and while they are operating within the airspace, the ACO verifies that the support aircraft are squawking the proper mission Mode 3/A code. The MRU Controller will link the mission Mode 3/A codes with the aircraft callsigns on the SCDS. As a result, the aircraft callsign will be displayed on the aircraft's IFF Beacon track on the SCDS instead of the code. If a support aircraft is not squawking the correct mission code, the ACO will first confirm that the aircraft is not squawking one of the emergency codes (7500, 7600, or 7700). The ACO will then notify the MRU Controller. If the aircraft is not squawking an emergency code, the MRU Controller will contact the pilot and direct him to squawk the correct code.

There may be instances in which the air surveillance radars do not receive a signal from the transponder. In these situations, only a Radar Plot for the aircraft will be displayed on the SCDS. This can occur if the aircraft is in a turn and the radar's line of sight with the beacon antenna is obstructed or if there is a problem with the aircraft's beacon. If the ACO detects the loss of a transponder return signal, the ACO should monitor the aircraft's movement to determine if line of sight with the antenna has been obstructed. If the transponder signal is not reacquired after a few moments, the ACO will notify the MRU Controller. The MRU Controller will contact the pilot and direct him to check the transponder to see if it is functioning properly. The pilot may be able to correct the problem by turning the transponder off and then back on again.

Due to mission requirements, mission support aircraft may drop below or fly beyond radar coverage. The ACO monitors the aircraft tracks and their associated mission frequencies to verify the status of the support aircraft. The ACO should log the time and location when an aircraft's track drops off the SCDS display and the time when/if the track is reacquired. If radar track is lost for more than 15 minutes, the ACO will contact the associated mission support personnel for the aircraft (SSO, DLWO-RECCE, MRU, etc) to see if they have had radio contact with the support aircraft in the last 15 minutes. If they have not had radio contact, the ACO will ask the mission support personnel to attempt to contact the aircraft. The mission support personnel may ask another mission support aircraft to attempt to contact the aircraft and relay any responses from the aircraft. If the mission support personnel have been unable to contact the aircraft by any means after an additional 15 minutes, the Surveillance crew will begin search activities to find the aircraft and the ACO will execute the Aircraft Emergency C/L 1-10. The SCO will be NO-GO and the Final Clear to Launch will be withheld.

The ACO ensures all support aircraft are at their MSPs by T-0. Each aircraft will have its own MSP that is outside the ACC. The MSPs for the Jolly aircraft are different for each mission. WX-1 has standard MSPs for all ELV missions. The primary WX-1 MSP is west of the Indian

River, between waypoints TICCO, INDIA, and MALET. The alternate WX-1 MSP is northwest of the Shuttle Landing Facility (SLF), between waypoints ASTRO and STARS.

As the countdown progresses on launch, certain events may require support aircraft to go to an alternate MSP. For example, if the countdown is held and the Jolly aircraft are re-deployed to re-scan the SCO Box or the WX-1 aircraft is in the airspace inspecting clouds when the User requests a new T-0, the aircraft may need to be given an alternate MSP in order to support the New T-0. This is typically done by vectoring the aircraft north or south of the ACC. The Surveillance crew can consult the SRA as needed to determine an alternate MSP. If support aircraft will not be clear of the ACC by T-0, the ACO will be NO-GO for support asset(s) in the ACC.

7.3.8.3 Sea Surveillance Procedures

Sea Surveillance procedures are utilized by the SSO to monitor and assess the movement of sea traffic within the LDZ. These procedures include fouled range procedures, support asset monitoring, and SCO Box Clear Time Management.

7.3.8.3.1 Fouled Range Procedures

Upon arrival of the support assets at L-2 hours, the SSOs begin receiving information on any target surface vessels in the LDZ. The SSOs assess whether the target will be a factor at T-0 and develop and initiate re-direct instructions to vector the target out of or away from the probability hit contours. If there is not enough time to divert the target prior to T-0 or all options are exhausted to divert the target, the SSOs will report NO-GO status and the details of the Fouled Range to the SCO. We will discuss the Fouled Range procedures in more detail.

Obtain Target Information

The SSOs can receive target vessel information in three ways:

- **Sea surveillance radar data displayed on the SCDS:** The SSOs can detect surface vessels from the sea surveillance radar returns, however, not all of these returns may be actual targets. Weather conditions and the sea state can create false targets on the displays. The SSOs may have to direct support assets to investigate the area to determine if the return is an actual target.
- **AIS data displayed on the SCDS:** The AIS receiver mounted on the SSR-South tower can only provide target vessel data for vessels equipped with an AIS transponder.
- **Verbal reports from support assets (Jollies/USCG):** The Jolly aircraft and the USCG vessels report information on vessels that they find within the LDZ to the SSO. The Jollies report target information to the SSO on the primary sea surveillance ops frequency, which is 143.725 VHF (referred to as 143.7 or “victor”) or the back-up sea surveillance ops frequency, which is 298.2 UHF (referred to as 298.2 or “uniform”). The SSO’s callsign during these calls is “Variety 1.” The USCG vessels report target information to the USCG liaisons in the SCC over marine band radio. The USCG liaisons then verbally relay the information to the SSOs.

Upon detection of a target in the LDZ, the SSOs obtain information about the target vessel to include:

- **Position:** This may be in the form of latitude and longitude coordinates or in the form of a bearing and range from another object.

- **Heading:** This may be in degrees or in the form of a cardinal direction (ex: north, south, east, west, etc)
- **Speed**
- **Vessel Type:** This information is obtained from either AIS, if available, or from the support assets.
- **Vessel Name:** This information is obtained from either AIS, if available, or from the support assets.
- **Souls on Board**: This information is obtained from the support assets.

At a minimum, the SSOs record target vessel information from support asset reports on the SSO Log. The SSOs may also choose to record radar and AIS tracks to help re-create the tracks in the case of an equipment failure. They also record which support asset made the report and the Zulu time of the report.

SSO LOG								
Op number:			Vehicle/Payload:			Date:		
SSO 1:			SSO 2:			SSO 3:		
Source	Time	Type	LAT/LON	COURSE/SPEED	NAME	Icon	Factor	Cleared

Figure 7-3-37: *SSO Log*

Determine if the Target is a Factor

The SSOs will plot or correlate the target data. For targets outside the range of the ER AIS and/or sea surveillance radars, the SSOs use the target data to create a Dead Reckoning (DR) or Parked (PRK) track on the SCDS for the target. For targets inside the range of the ER AIS and/or sea surveillance radars, the SSOs correlate the target data with an AIS or radar track that is already on the display. Note that the SSOs can label the radar tracks displayed on the SCDS with the vessel name, however, if the radar does not have a strong and steady track of the target, the target may drop off the display at times. When this occurs, the target will not keep the vessel name when it is re-acquired by the radar. In these cases, the SSOs should create a DR track for the target to help in tracking the target as it drops off and on the display. The SSOs then use the surface speed leaders to determine the target's position at T-0.

If the target's position has the potential to be a factor at T-0, the SSOs will obtain the target's intentions and/or capabilities as applicable. This may be required if 1) the target is parked or its predicted track will be within or near a probability hit contour, 2) it is a large vessel, such as a tanker or freighter, that could be heading into the port, or 3) the target's track has the potential to cross the contours on missions with long launch windows. The SSO will request the support assets to obtain the target's intentions for non-AIS equipped vessels. For AIS equipped vessels, the SSOs can typically obtain the target's intentions from the AIS data, which typically indicates its destination.

The SSOs will determine if the target is a factor based on its projected position at T-0, the target's intentions, the location of other vessels within the various probability hit contours, and the length of the launch window. The SSO will record whether or not the target is a factor on the SSO Log by indicating "Yes" or "No" in the "Factor" column. The SSOs will notify the support asset on whether or not the target is a factor (Ex: Target is not a factor at present course and speed).

Notify support asset(s) (as required)
The SSOs will notify the applicable support asset or assets that the target is or is not a factor. If the target is a factor, the SSOs will notify the SCO and direct the support asset to standby for re-direct instructions.

Notify the MFCO, RCO and ROC of the Fouled Range (as required)
If the target has fouled the range, the SCO will notify SRA who will in turn notify the RAC.

Initiate Re-direct of Target
Upon the direction of the SCO, the SSOs initiate procedures to re-direct the target. If the target was detected by the sea surveillance radars or the AIS receiver, the SSOs will notify a support asset of the target's location and direct it to intercept the target or attempt radio contact. The decision on which asset to use depends on the location of the target and the capabilities of the support asset. The SSOs will typically send the closest support asset to intercept the target. If the target is violating the security zone, the SSOs should have a USCG vessel intercept (if supporting), if possible, due to the closeness off the shore and the USCG has jurisdiction in the area. If the target is violating the USCG Safety Zone (activated at L-45 minutes), it may be necessary to have a Jolly intercept the target if it is several miles off shore, but the SSOs should provide the vessel information to the USCG liaisons to help them track repeat offenders and enforce any applicable fines.

If a Fouled Range is detected after the support assets have arrived at their MSPs, there are a couple of options for the surveillance team. The team may attempt to contact and divert the target through radio contact or they may direct a support asset to leave MSP in order to intercept the target. Depending on the situation, the latter action may require that the count be held due to the support asset entering the LDZ. The authority to direct the support assets to leave their MSPs lies with the SCO. If the SCO decides to have a support asset intercept the target, the SCO will direct the ACO and/or SSO to send the applicable support asset into the LDZ. If a Jolly will be sent back in, the ACO will coordinate with the MRU to direct the Jolly to re-enter the LDZ and contact Variety 1. If a USCG vessel will be sent back in, the SSOs will coordinate with the USCG liaisons to direct the USCG vessel to re-enter the LDZ. The SSOs will determine and provide re-direct instructions to the support asset to relay to the target. To develop the re-direct instructions, the SSOs can use the SCDS to plot out possible headings and speeds with a DR track. When developing re-direct instructions, the SSOs will need to tailor the instructions by consider the following:

- **Capabilities of the target:** For example, large vessels such as freighters and tankers cannot change speed or direction quickly. As a result, the SSOs may need to have the vessel change both its heading and speed. In addition, the SSOs will need to direct a larger heading change than is required since it takes a large vessel a long time to turn. Sailboats have relative slow speeds and are limited in their available course headings due to the wind direction and speed. In some cases, the SSOs may have to direct the sailboat to proceed to a certain location and hold short or anchor to avoid it from fouling the range. When developing re-direct instructions, the SSOs may have to obtain the capabilities of the vessel (Ex: What is its best speed?)
- **Intentions of the target:** The boating public has a right to the waterways outside the security and safety zones. If possible, the SSOs should tailor the re-direct instructions to try to help the vessel to accomplish its intentions while ensuring it is kept out of harm's way. For example, if a fishing vessel is trolling north or south of a certain location, the SSOs may need to direct the vessel to stay north (or south) or a certain latitude line.
- **Length of the launch window:** This is critical for missions with long launch windows. For example, if a freighter is approaching from the south and its location at T-0 will be short of the contours yet its course will take it across the contours, the vessel could become a factor if the T-0 is delayed. In this case, the SSOs could direct the vessel to turn and stay east of a meridian of longitude which is clear of the 1 ship contour until the end of the launch window, plus the nominal closure time as documented in the 45 SW/SE Hazardous Area Letter.
- Note: Redirect is dependent upon voluntary cooperation by the target.

Monitor Target Movement and Obtain/Provide Updates

The SSOs will continue to monitor the target vessel's movement on the SCDS and receive or obtain updates from the support assets on the efforts to divert it out of the area. The support assets should report back on whether or not the target received the re-direct instructions and if they are complying with the instructions. If not, the SSOs may have to ask the support assets to confirm this information. In addition, the SSOs should request position and course updates on the target vessels from the support assets to verify the progress of these vessels. This is especially critical in the event of a SCDS failure when the SSOs are operating off of the paper charts. The SSOs will record the updates on the SSO Log, plot or correlate the target data, and re-assess if the target is a factor as required.

Event termination for a target vessel which caused a NO-GO situation depends on the situation. If the vessel's course can be adequately tracked by radar or AIS, the SSO may be able to provide an expected clear time to be used as a basis for determination of a new T-0. If the vessel cannot be tracked by radar or AIS, the SSOs will have to wait for the vessel to actually clear the contour before declaring event termination or "GO" status. This can be verified by either a support asset or by having the operator of the vessel provide position updates over marine band radio. If the target vessel caused a NO-GO situation and fouled the range, the SSOs will provide any updates or changes in status to the SCO to keep the SCO apprised of the situation. The SCO will provide updates, as required, to the MFCO, RCO, and ROC using the General Status Change Checklist 1-1.

Notify of Event Termination (as required)
If the target vessel caused a NO-GO situation and its course is changed such that it's projected course will no longer violate a probability hit contour or it exits the violated probability hit contour, the SSO will notify the SCO of event termination. The SSO will then notify the applicable support assets that the target is no-longer a factor. The SCO will notify the MFCO, RCO, and ROC of the Fouled Range termination using the General Status Change Checklist 1-1.

Support Asset Monitoring
The SSOs monitor support asset tracks and verify status as required. If normal surveillance activities do not provide comm contact or sensor track for 15 minutes, the SSOs will perform or coordinate ops checks with the support assets. The SSOs will perform comm checks with the support aircraft, for example: "Jolly 1, Variety 1 on 143.7 with an ops check." The SSOs may ask another aircraft to act as a relay if required. The SSOs will ensure that the USCG liaisons perform ops checks with the USCG vessels. If no contact after 15 minutes, the surveillance crew will begin search activities to find the asset, the SCO will be NO-GO and the Final Clear to Launch will be withheld. If the support aircraft is an aircraft, the ACO will execute the Aircraft Emergency C/L 1-10. The SSOs ensure all support vessels are at their MSPs by T-0. The MSPs are typically one of the buoys that make up the security zone, usually CA and/or CD. The SSOs will verify with the USCG liaisons that the USCG vessels are at their MSPs. If a support vessel will be violating a probability contour at T-0, the SSOs will be NO-GO for a support asset in the LDZ.

7.3.9 AIRCRAFT EMERGENCY PROCEDURES
Aircraft Emergency Procedures are utilized when a support aircraft reports an emergency situation or a support aircraft is or is suspected to be lost at sea.

7.3.9.1 Overview
The pilot-in-command of an aircraft is directly responsible for and is the final authority as to the operation of that aircraft. The pilot-in-command determines whether the aircraft is in a distress situation or a state of urgency. A distress situation is one in which an aircraft is in grave and imminent danger and requires immediate assistance. Examples of "grave and imminent danger" include fire, mechanical failure, or structural damage. An urgency condition is a situation on the aircraft such as a mechanical breakdown or medical problem in which, for the time being at least, there is no immediate danger to anyone's life or to the aircraft itself. An aircraft is in at least an urgency condition the moment the pilot becomes doubtful about position, fuel endurance, weather, or any other condition that could adversely affect flight safety.

Whether performing normal flight operations or trying to safely recover a malfunctioning aircraft, pilots prioritize tasks and actions using the aviation priority triad of *"Aviate - Navigate - Communicate"*:

- **Aviate:** Maintain control of the aircraft
- **Navigate:** Know where you are and where you intend to go
- **Communicate:** Let someone know your plan and needs

When a distress or urgency condition is encountered on a support aircraft, the pilot will first endeavor to maintain control of the aircraft and establish stable flight. Then the pilot will navigate toward the closest or most suitable airfield in order to land as soon as possible or practical, depending on the situation. Finally the pilot will contact the MRU Controller (Cape Control) and provide as much of the following information as possible:

- The aircraft identification/callsign and type
- The nature of the distress or urgency situation
- Any weather conditions affecting flight
- The pilot's intentions and any required assistance
- Present position, and heading
- Altitude or flight level
- Fuel remaining on-board
- Number of people on board
- Any other useful information

If required due to comm problems, another aircraft may relay the information to Cape Control or the aircraft may begin squawking Mode A/3 code 7700 to indicate a General Emergency. The MRU Controller is responsible for immediately acknowledging the distress or urgency message, providing assistance as requested by the pilot, providing flight following (radar traffic information), and coordinating or directing the activities of assisting facilities. If the aircraft is heading to an airfield, the MRU Controller will contact the applicable control tower. If the affected airfield is Patrick AFB or the Skid Strip, the tower will initiate the Primary Crash Alerting System (PCAS), referred to as the “Crash Net”, to alert fire, security, and medical personnel. If the aircraft is heading to the SLF, NASA Tower will call the KSC Fire Department over the land line. If the Skid Strip or SLF Towers are closed, the MRU Controller may have to contact emergency services over the admin line.

The ACO will record the available aircraft and IFE information and pass an aircraft emergency voice report to the 45 SW Command Post (45 SW/CP). For aircraft lost at sea, the ACO will obtain the time the aircraft departed base and the last known location and pass an aircraft emergency voice report to the 45 SW Command Post. The ACO will also notify the SCO and the support aircraft of the IFE or aircraft lost at sea and ensure that the MRU Controller notifies Miami Missions and NASA Tower as required. If required, the SCO will consult with the SRA to determine if the aircraft will land within the ILL or affect the risk numbers for DFO, Toxics, and/or Debris for the launch. The SCO will notify the MFCO, RCO, and the ROC of the IFE and report any mission impact.

7.3.9.2 Aircraft Emergency Checklist 1-10

The ACO and SCO are responsible for implementing the Aircraft Emergency checklist (C/L 1-10) when an aircraft reports an emergency situation or is lost at sea. If the SSO detects an IFE situation, the SSO should immediately notify the SCO, ACO and the MRU.

Warning: In the event of an Aircraft Emergency, crew members shall not communicate with distressed aircraft unless directly contacted.

STEP 1: The ACO will obtain as much of the available information about the aircraft and the IFE/Lost at Sea situation as possible, per Checklist 1-10. The ACO will then use this information to pass a Voice Report to the 45 SW/CP IAW 45 SWI 13-203. This information can be compiled from the information provided by the aircraft upon arriving on station, from information provided by the pilot of the affected aircraft when the IFE was declared, and/or information relayed by another aircraft or other console personnel. This information includes:

- **Aircraft call sign**
- **Tail number:** This information will be obtained by the MRU Controller when the aircraft arrives on station.
- **Number of souls on board:** This information will be obtained by the MRU Controller when the aircraft arrives on station.
- **Aircraft type/unit of assignment:** This information is typically already known or briefed at the aircrew briefing.
- **Remaining fuel on board:** This information may be reported by the pilot at the time the IFE is declared or can be determined by subtracting the flight time from the fuel quantity reported in hours when the aircraft arrived on station.
- **Nature of emergency:** This information will be reported by the pilot at the time the IFE is declared.
- **Estimated Time of Arrival (ETA):** This information may be reported by the pilot at the time the IFE is declared or may be determined by comparing the aircraft's speed to its distance from its destination.
- **Armament/Cargo:** This information is usually not applicable because aircraft supporting ER operations do not typically carry armament or cargo.
- **Any amplifying information**

The ACO should keep in mind the aviation priority triad: *"Aviate - Navigate – Communicate"*. The pilot may not be able to pass all of the information listed in Step 1. The ACO ***will not*** contact the pilot to request any information from the checklist. If the aircraft is lost at sea, the ACO will also obtain and report the following:

- **Time Departed Base:** This information will be obtained by the MRU Controller when the aircraft arrives on station.
- **Last known location in Latitude and Longitude:** This information may be determined by noting the aircraft's last observed location on the SCDS or from information provided by another aircraft or other console personnel.

STEP 2: The ACO will notify the SCO of the situation and pass the information in Step 1. The ACO will then notify the Support Aircraft of the situation or relay the information to the Support Aircraft through other console personnel, such as the MRU Controller or the SSO. The ACO will also ensure that the MRU Controller notifies Miami Missions and NASA Tower (if manned) of the situation. The ACO will provide updates to the same personnel and agencies as required.

The SCO will consult the SRA, if required by the situation, to determine if the aircraft's planned or actual destination is within the ILL. The SCO will then use General Status Change Checklist 1-1 to notify the MFCO, RCO, and ROC of the situation on the Ops Support Net and report any mission impact. If this type of situation occurs, the Range Crew needs to be prepared for a possible fouled range situation. An in-flight emergency could result in a fouled range, or possibly could endanger the crew on the plane and any site in the flight path of the aircraft. After an emergency, search and/or rescue crews might also cause a fouled range situation. Other support assets may be required to assist in the IFE situation or to conduct search and rescue efforts. As a result, an IFE or Lost at Sea event could hinder or halt surveillance operations and result in a fouled range situation. The SCO will provide status and updates to the same personnel and agencies as required.

STEP 3: The crew will log all actions.

7-4 FLIGHT CONTROL OPERATIONS

7.4.1 OVERVIEW

A critical role of the Eastern Range (ER) is to ensure the safety of the public during launch operations. The Mission Flight Control Officers (MFCOs) and their Flight Control Team ensure the enforcement of the Launch Safety policy during the execution of the Flight Control Mission. The MFCOs are responsible for preventing a launch from occurring if Launch Safety criteria is violated during the countdown and for monitoring the vehicle in flight as well as sending destruct functions if the vehicle poses a threat to the public. MFCO console operations are conducted in accordance with EWR 127-1/AFSPCMAN 91-711 and the applicable MFCO Countdown Checklists.

7.4.2 FLIGHT CONTROL MISSION

According to AFSPCMAN 91-711, the Flight Control mission supports and enforces flight control policy and is executed by the MFCO. The Flight Control mission begins when the system or procedures used to exercise positive control of launch vehicle flight is activated during the launch countdown and is completed at end of range safety responsibility.

End of range safety responsibility is determined by Launch Safety analysis which is based on Range User data, mission objectives, and the risk to the public. Due to varying mission objectives, end of range safety responsibility is unique to the mission.

7.4.2.1 MFCO Responsibility

During the Flight Control mission, the MFCO’s Launch Safety responsibilities include: a safety assessment of the readiness of the operation to proceed; final Launch Safety Go/No-Go recommendation; monitoring launch vehicle performance in flight; and serving as the sole decision-making authority and initiator of the flight termination system (if required).

The MFCOs also receive critical support and status from other government positions which perform functions that support the Launch Safety mission. These positions assess and/or enforce aspects of the Launch Safety mission and report status and actions to the MFCO. These positions include:

- Launch Weather Officer (LWO)
- Surveillance Control Officer (SCO)
- Risk Assessment Center (RAC)
- Operations Safety Manager (OSM)
- Systems Safety (SEA)
- Range Control Officer (RCO)
- Range Engineer (RE)

The MFCOs also receive critical support from Eastern Range Technical Services (ERTS) positions during the countdown and in-flight. These positions include:

- Range Safety Displays (RSD) Coordinator
- Command Systems Controller (CSC)

Radar Supersystem Controller (RSC); callsign CAT-1

7.4.2.2 Flight Control Team

The MFCO leads the Flight Control Team in performing these duties. The Flight Control Team consists of:

- Telemetry Systems Officer (TSO)
- Command Systems Officer (CSO)
- Video Systems Officer (VSO)
- Forward Observer – Ground (FO-G)

7.4.2.2.1 TSO Console Operation Procedures

The Telemetry Systems Officer or TSO is responsible to the MFCO for reporting mission events, vehicle status, and any observed abnormalities. This includes relaying event discrete and anomalous events or conditions including roll, pitch, and yaw rates, combustion chamber pressures and Automatic Gain Control (AGC) values, in the minus count and during flight. The information reported by the TSO is used by the MFCO to assess vehicle performance and factors into the MFCOs' flight termination decision process. The TSO reports status based real-time on the information provided by the telemetry (TM) displays at the TSO consoles.

7.4.2.2.2 VSO Console Operation Procedures

The Video Systems Officer (VSO) provides critical inputs to the MFCO during both nominal and non-nominal flight. The VSO is responsible for monitoring vehicle flight on video (television) screen displays and auxiliary range safety displays, referencing mission specific documentation, and reporting status to the MFCO as required.

7.4.2.2.3 Wire Operation Procedures

The Forward Observer Ground also known as the wire or FOG's primary responsibility is to visually monitor launch vehicle performance from a close-in position and provide initial verbal input to the MFCO during the first critical seconds from ignition through early flight.

In addition, FOG duties include:

- Observe weather conditions at the wire site, including visibility to the launch pad and expected trajectory and reporting this information to the MFCO.
- Maintain visual surveillance of the area surrounding the wire site and report any traffic (land, sea, or air) believed to be unauthorized within the area encompassed by the impact limit lines (ILL).

7.4.3 COUNTDOWN ACTIONS

The Flight Control Mission on the ER nominally begins on ground based Flight Termination System missions at L-4 hours when the MFCOs arrive on console. The MFCOs begin by verifying the configuration and functionality of the equipment within the RSD area, performing communication checks with personnel, and obtaining initial status from personnel.

The MFCOs then begin enforcing the Launch Safety Launch Commit Criteria (LCC). The MFCOs receive event reports from various support personnel throughout the countdown. For each event, the MFCOs will assess the impact to Launch Safety LCC. The MFCOs will determine if the operation is safe to proceed to the next milestone. If it is not safe to proceed to the next milestone, the MFCOs perform countdown management actions as required. For example, if there are problems with the ground command destruct system during the countdown, the MFCOs may determine that the Final FTS Open Loop checks cannot be performed on time and direct that they be delayed until the ground command destruct system problem is resolved. If the event report involves the failure of a system or asset that is fulfilling a mandatory requirement, the MFCOs may have to declare additional equipment or assets as mandatory to ensure Launch Safety LCC are met. Also, depending on the event report, the MFCO may determine that equipment or assets must be reconfigured to meet Launch Safety LCC and direct personnel to take re-configuration actions. For example, if FOV1-A becomes non-operational, the MFCOs will declare FOV1-B and DRSD as mandatory for launch and direct the RSD coordinator to reconfigure FOV1-B to be the prime range safety system for distributing designate data to the instrumentation sites. If the event report involves the loss of mandatory equipment or assets and/or a violation of Launch Safety LCC low in the terminal count, the MFCOs are responsible for holding the countdown by activating the holdfire switch and/or calling the hold on the primary launch ops net.

7.4.3.1 Checkout of Range Safety Equipment

AFSPCMAN 91-711 and EWR 127-1 require the MFCOs to perform a final checkout of Launch Safety instrumentation to include the Range Safety Display Systems (RSD), the Command Destruct System (CDS), and the Telemetry Data Transmission System (TDTS) prior to launch. There are three main events in the countdown in which the MFCO performs a checkout of the Range Safety equipment.

7.4.3.1.1 Holdfire Checks

Holdfire checks verify the firing line interrupt capability. Atlas V launches conduct their holdfire checks after MFCOs arrive on-console. MFCOs support the holdfire checks from their consoles. The Delta IV launches perform their holdfire checks prior to the MFCOs arrival on-console. For these launches, an ERTS Timing Technician supports the holdfire checks from the MFCO consoles. For all launches that perform holdfire checks, the OSM supports and observes holdfire checks in the launch control center and reports the results of the checks to the MFCOs.

7.4.3.1.2 Range Safety Theoretical

For all launch vehicle programs, the ERTS contractor is required to provide a theoretical trajectory playback, called the Range Safety Theoretical, to the MFCOs and the Flight Control Team. The purpose of Range Safety Theoretical is twofold. It allows the MFCOs to perform a final functional verification of the Range Safety processing and display systems. This includes assessing how the tracking data is displayed on the system and how the system switches between the different displays and maps. It is also used by the MFCOs as a final familiarization activity of the expected mission performance. It gives the Flight Control Team a final opportunity to monitor the nominal trajectory data and to practice their nominal plus-count call-outs.

7.4.3.1.3 Flight Termination System Checkout and Monitoring

EWR 127-1 Chapter 4 and AFMAN 91-710 Vol 4 require that open loop tests be performed on the vehicle’s Flight Termination System (FTS) prior to launch to prove the integrity of the ground and airborne command transmitter system. For pad launches, this includes bringing up the command carrier at a launch head ground command transmitter site, turning on the vehicle’s Command Receiver Decoders (CRDS) and transmitting a specific command to the launch vehicle. The test data is monitored to ensure the ground command transmitter site properly sent the command, the launch vehicle CRDs received the command, and the CRDs properly processed the command. The MFCOs support this test by bringing up the command carrier, sending the required command and monitoring system data from the command site and the launch vehicle.

After the Command System Controllers (CSCs) complete the checkout of the ground command sites, they turn the Command Destruct System (CDS) over to the MFCO. They accomplish this by turning a key at the CSC console which remotes the system over to the MFCOs and limits the capabilities of the CSC console. When this occurs, only the MFCOs are able to send command functions and the CSO has control of which command site is radiating the command carrier. The CSC then delivers the console keys to the MFCOs.

The FTS Open Loop Checks are performed at a specific time in the countdown in accordance with the Safety approved procedures in the Range User's countdown document. The test is performed with close coordination between the MFCO, CSO, CSC, OSM and the Range User. The OSM verifies to the MFCO that the Blast Danger Area (BDA) is clear prior to the test and monitors the status of the airborne components of the FTS. In accordance with the Range User procedures, the MFCO will direct CDS configuration actions, such as bring up the carrier and switching command sites and transmitters, and sends commands. The CSO brings up the command carrier when directed by the MFCO and the CSO and the CSC provide CS status reports to the MFCO during the test to include verifying system configuration and that commands were sent.

After the test is complete, the Flight Control Team continues to monitor the status of the FTS through the remainder of the countdown and in-flight and report status to the MFCOs. The CSO monitors the status of CDS on the Range Safety Control and Display (RASCAD) while the TSO monitors the status of the airborne FTS on the TM displays to include the AGC values and receipt of Pilot Tone or Check Channel.

7.4.4 PLUS COUNT ACTIONS

The MFCOs are responsible for evaluating vehicle flight in the plus count and applying mission rules if required. For each mission, the MFCOs will determine a value for Time to Protect. Time to Protect is the time in the plus-count during which personnel must avoid making non-critical calls to the MFCOs. It is designed to prevent interference of Flight Control actions during flight.

7.4.4.1 Flight Assessment and Narration

During the plus count as the vehicle leaves the pad and ascends, the MFCO will verbalize the indications they are seeing on their displays, and verbalize their intentions. As part of the flight narration, the SMFCO will verbalize acknowledgement and concurrence of the MFCO narration. This is done to ensure that there is no ambiguity between the two MFCOs' interpretation of indications and intended actions. In addition, the MFCO will receive and acknowledge verbal inputs from the members of the Flight Control Team on the status of the launch vehicle or of the instrumentation systems.

Figure 7-4-1: *Flight Assessment and Narration*

The CSO is responsible for monitoring the status of CDS, reporting status to the MFCO and performing contingency procedures as directed. This includes monitoring command carrier switching, performing manual carrier switching as required, reporting command site elevation angles, verifying command functions if sent, and reporting any observed abnormalities.

The TSO monitors the vehicle telemetry and evaluates vehicle performance, assesses command receiver signal strength parameters, and reports nominal plus count events (staging events, engine shutdowns, etc.) or any anomalous behavior to the MFCO. The TSO makes periodic callouts during nominal flight: "TM is GREEN."

The VSO monitors mission events through optical video data sources displayed on Close-Circuit Television (CCTV) monitors and reports visible vehicle behavior to the MFCO.

The FO-G reports visual vehicle behavior to the MFCO from ignition through loss of visual contact.

7.4.4.2 Flight Termination Actions

The MFCO is responsible for making the decision concerning continued flight or flight termination based on interpretation of real-time events, mission rules, all available data sources, and sound judgment. Flight Analysis (45 SW/SELF) develops Mission Rules (destruct criteria) in coordination with the MFCOs and the Range User. These rules are unique to each mission; however there are three basic flight rules IAW EWR 127-1 and AFSPCMAN 91-711.

- Validated data confirms the launch vehicle has violated established flight safety criteria, in particular that the launch vehicle IIP has violated the destruct line limits.
- The launch vehicle exhibits gross deviation or obvious erratic flight where, in the judgment of the MFCO, continued flight may pose an unacceptable Launch Safety risk (to include loss of positive control) though the above destruct criteria are not violated.
- The performance of the launch vehicle is unknown and the capability exists to violate flight safety criteria.

7.4.4.2.1 Mission Rule #1

Validated data confirms the launch vehicle has violated established flight safety criteria.
This means that on the Range Safety Displays (FOV1-A, FOV1-B and DRSD) show that the vehicle has violated a destruct line. A destruct line is a line established to ensure that a launch vehicle's critical debris impact dispersion does not violate the Impact Limit Line (ILL). A Chevron Line is a dynamic destruct line that moves downrange based on changes to the vehicle's velocity. The Chevron Lines are designed to protect the ILLs from a vehicle pitching up with an IIP moving uprange or moving too slowly downrange.

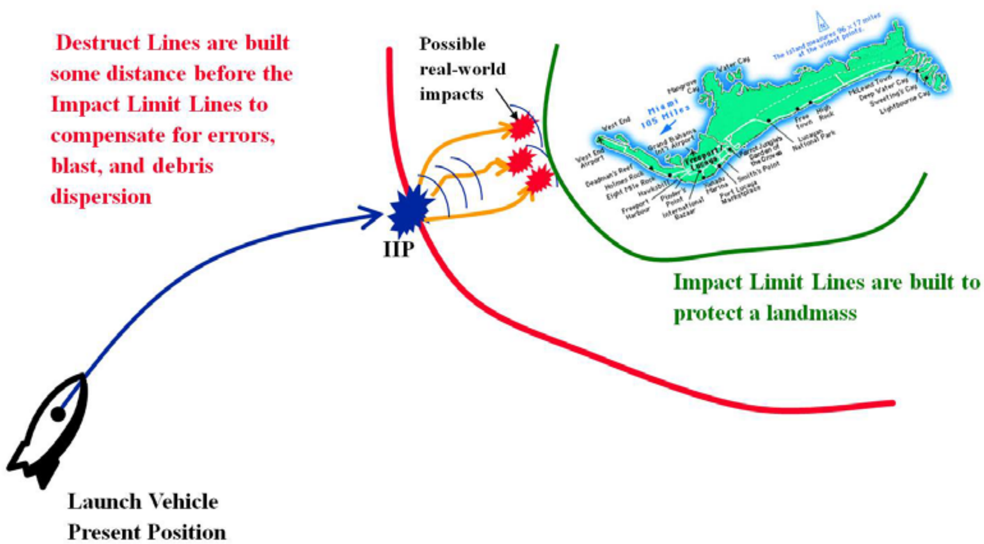


Figure 7-4-1: *Vehicle Violating Destruct Line*

For southeast trajectories, the destruct lines are designed to protect the North and South American landmass, the African landmass and multiple islands. For northeast trajectories, the destruct lines are designed to protect the North and South American landmass, the African landmass, the Greenland landmass, the European landmass and multiple islands.

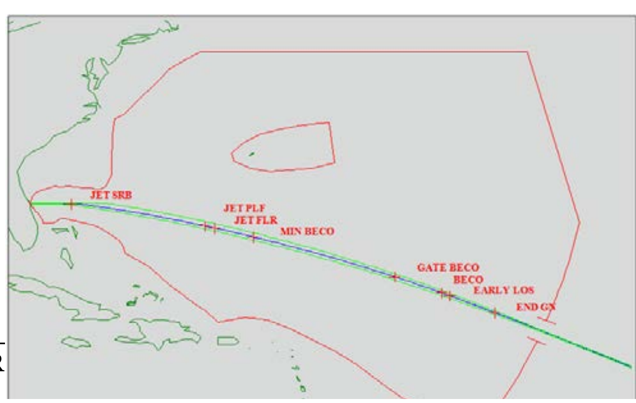


Figure 7-4-3: *Destruct Lines for Southeast Trajectories*

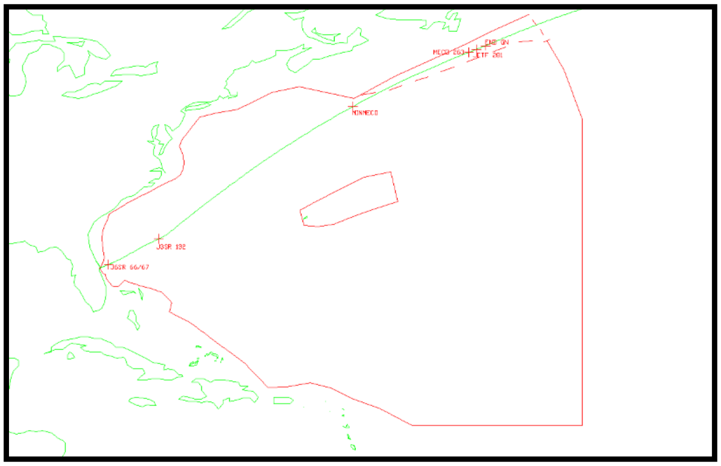


Figure 7-4-4: *Destruct Lines for Northeast Trajectories*

Destruct lines are displayed on the Range Safety Displays as red lines. For the IIP Display on the RSD system, a destruct line is violated when the vehicle's IIP crosses a static destruct line or a moving chevron line. For the Vertical Plane Display on the RSD systems, a destruct line is violated when the vehicle's present position trace exhibits parallelism to a destruct line. Examples include a straight-up mission (a vehicle which fails to program) or a vehicle which programs uprange (uprange missile).

Figure 7-4-5: *Destruct Lines Displayed on the IIP Display*

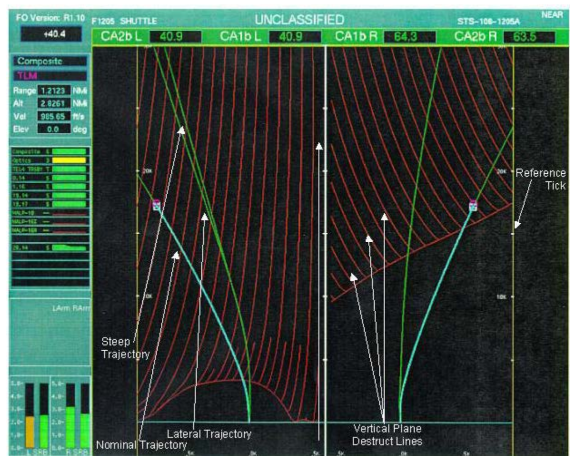


Figure 7-4-6: *Destruct Lines on Vertical Plane Display*

7.4.4.2.2 Mission Rule #2

The launch vehicle exhibits gross deviation or obvious erratic flight where, in the judgment of the MFCO, continued flight may pose an unacceptable Launch Safety risk (to include loss of positive control) even though destruct criteria have not been violated. This means an erratic vehicle is grossly deviating from the nominal, or exhibiting flight that is so abnormal that loss of flight termination control is likely to occur if flight is allowed to continue. As a result, functions are sent even though destruct lines have not been violated. Examples include short term rapid changes or instability in vehicle attitude, tumbling, pitching up, pitching down, and vehicle self-destruct.

Figure 7-4-7: *Navy SLBM Tumbling*

7.4.4.2.3 Mission Rule #3

The performance of the launch vehicle is unknown and the capability exists to violate flight safety criteria.

This occurs when track of the vehicle is lost and it cannot be determined what the vehicle is doing. Indications include a red diagonal line appears across the RSD displays and a loss of data on the TSO analog display pages. If this occurs and the vehicle flight was nominal up to that point, the MFCO will reference the Green numbers (Crit #) at the top of their display (not to be confused with critical angles).

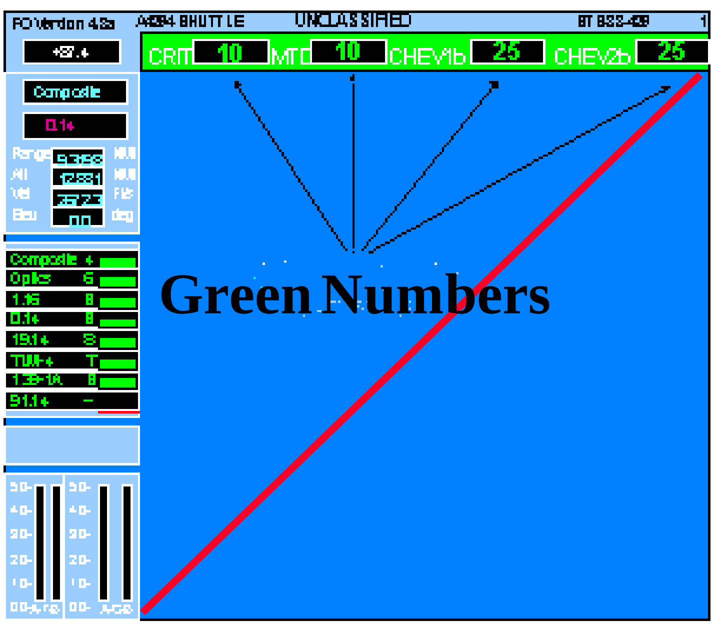


Figure 7-4-8: *Green Numbers*

7.4.4.2.4 Green Number

A Green Number is the minimum thrusting time during which a launch vehicle can move from a state or condition of nominal flight to a state or condition where the launch vehicle's inert and explosive debris endangers a protected area. The Green Numbers are calculated for a nominal trajectory from liftoff until a point shortly prior to the overflight or Head-on Gate. When track is lost on a launch vehicle, the Green Numbers on the RSD displays will begin counting down. If track is not re-acquired, the MFCOs will send functions when the Green Numbers countdown to zero. If the launch vehicle was non-nominal when track was lost (outside 3-sigma), the Green Numbers do not apply. As a result, the MFCOs will send functions after track is lost. The Minimum Time to Endanger (MTE) is the Green Number at liftoff. MTE is referenced if track is not acquired off the pad.

End Green Numbers (End GN) is the point in the flight of a launch vehicle where the time required for the impact point to travel along the nominal trajectory to the overflight gate is less than the time for the impact point to travel to all other points along the boundary lines. There are no Green Numbers after the launch vehicle has passed the END GN point on a nominal flight trajectory. If all track is lost after the End GN point and the vehicle was nominal, the MFCO will allow the flight to continue.

7.4.4.2.5 Extended Flight Rule

A related mission rule is called the Extended Flight Rule. The Extended Flight Rule states that if all track is lost prior to the End GN point and the vehicle had performed nominally up to that point, the MFCO may allow the flight to continue.

Beyond the three basic mission rules, there are additional special mission rules that apply to various launch vehicles.

7.4.4.2.6 Head-On Gate

The Head-On Gate is a valid destruct line through which a normally behaving space vehicle is permitted to fly. Normal behavior of the vehicle is based on the history of the flight and its expected trend as it passes through the gate; the IIP trace should be exhibiting parallelism to the nominal and 3-sigma dispersed trajectories or convergence to an expected nominal position. For an IIP trace that is, in the MFCO's judgment, clearly divergent from the nominal, and for all other errant or erratic behavior, the gate should be considered a destruct line.

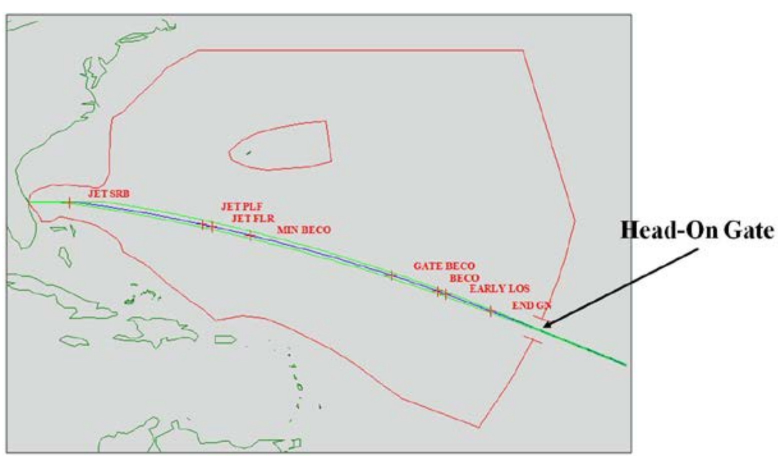


Figure 7-4-9: *Head-On-Gate*

7.4.4.2.7 Lateral Gate (North America or Caribbean/South America)

If the flight profile of the mission overflies or remains close to either the eastern seaboard of the United States or Canada for a northern mission or the Caribbean Islands and/or South America for a southern mission, a lateral gate will be constructed. Expectation of casualty will be assessed to ensure total mission debris risk is within acceptable levels for flight.

A Lateral Gate is a valid destruct line through which a normally performing space vehicle will be permitted to fly. Normal performance of the vehicle is based on the history of the flight and its expected trend as it passes through the gate. For an IIP trace that is, in the MFCO's judgment, clearly divergent from the nominal and for all other errant or erratic behavior, the gate shall be considered a destruct line.

A secondary destruct line, or back-up destruct line, protecting more populous regions will be constructed and if violated, functions will be sent according to flight termination criteria (Mission Rule #1) defined in EWR 127-1 and AFSPCMAN 91-710.

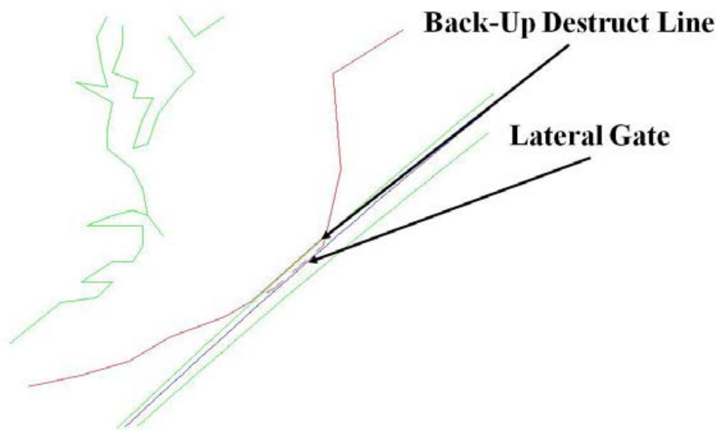


Figure 7-4-10: *Lateral Gate*

7.4.4.2.8 Stopped Impact Point (IP)

A Stopped IP occurs when the vehicle stops thrusting. If at any time other than staging events, the vehicle terminates thrust uprange of the Head-On Gate, functions ARM and DESTRUCT, will be sent prior to loss of command coverage. Command coverage is based on real time evaluation of signal strength, command elevation angles, and/or expected CRD shutdown times.

7.4.4.2.9 Minimum Engine Cutoff (Main Engine Cutoff [MECO] or Booster Engine Cutoff [BECO])

This is also referred to as the Min MECO or Min BECO Rule. Minimum MECO/BECO is the minimum energy state required for the upper stage of the vehicle to reach a minimum orbit of 70 nm perigee after an early shutdown of the booster stage.

In the event that MECO or BECO occurs prior to the "Minimum MECO" or "Minimum BECO" energy state tick mark on the IP display, functions ARM and DESTRUCT will be sent prior to loss of command coverage based on a real time evaluation of signal strength and command elevation angles.

7.4.4.2.10 BECO between MinBECO and Gate BECO

Gate BECO identifies the point at which the earliest BECO could occur while maintaining predicted acceptable command coverage of 3 degrees elevation at the Head-On Gate.

Early LOS identifies the earliest anticipated loss of command coverage based on the Min BECO trajectory. This icon is a visual cue for the MFCO; all decisions concerning command coverage shall be done based on real time evaluation of signal strength and elevation angle.

In the event BECO occurs between the Min BECO energy state tick mark and the Gate BECO tick mark on the IP display, command coverage may be lost prior to reaching the Head-On Gate (between Early LOS and the gate). Unless the vehicle is exhibiting erratic or errant behavior prior to loss of command coverage, no MFCO, actions should be taken. If the vehicle is exhibiting erratic or errant behavior, in addition to the early BECO, functions will be sent prior to loss of command coverage based on a real time evaluation of signal strength and command elevation angles.

7.4.4.2.11 Command Coverage Contingency Rule

If the vehicle is entering a region of single point command coverage and is considered erratic by the MFCO, functions ARM and DESTRUCT will be sent prior to loss of dual coverage. This rule mitigates the concern for single command coverage and does not affect a normally behaving vehicle.

7.4.4.2.12 Inadvertent Launch into a Manned COLA Closure

In the event of an inadvertent launch during a manned COLA closure period, functions ARM and DESTRUCT shall be sent prior to reaching the Head-On Gate (end of Range Safety responsibility).

The MFCOs may implement special mission requirements as requested by the Range User or as determined from pre-launch flight analysis.

7.4.5 FLIGHT ASSESSMENT NARRATION

The MFCOs conduct verbal real-time flight assessment and narration from ignition and throughout flight. The purpose of this flight assessment and narration is to:

- Perform a comparison and verification of the indications from the various displays and the Flight Control support positions
- Coordinate the crew's interpretation of vehicle status and their corresponding intentions

These verbal reports are conducted on FCO.LCL which is recorded in order to re-create events in the event of an anomaly.

7.4.5.1 Verbalizing Indications

The MFCO and SMFCO will assess the vehicle's performance in relation to the nominal trajectory, the nominal box, and/or the 3 sigma lines as well as compare the displayed vehicle performance on the available range safety display systems. The MFCO will report an assessment of vehicle performance (i.e. "Senior, I have two sources in agreement, on the nominal, in the box, moving downrange green.") The SMFCO will verbalize acknowledgement and concurrence with the MFCO narration and will usually provide an assessment of the agreement with the other display systems (i.e. “Senior concurs. DRSD agrees. MCD agrees.”) Either the MFCO or SMFCO may verbalize the assessment of the agreement with the other display systems; however, this is typically conducted by the SMFCO.

7.4.5.2 Acknowledging Verbal Inputs from Flight Control Support Positions

The MFCO will also acknowledge verbal inputs from the Flight Control launch support positions. The VSO, callsign “Video”, will monitor the video CCTV monitors and report visual indications of vehicle performance and behavior to the MFCO as required. This may include verifying separation events for which there are no telemetry discrete indications or reporting non-nominal behavior. The Forward Observer-Ground (FO-G), callsign “Wire”, will provide visual callouts and status updates to the MFCO. This includes nominal calls such as Ignition, Liftoff, and Programming Downrange. The CSO, call sign “Command”, will monitor Command Destruct System (CDS) status and provide reports as required. These reports may include reporting command carrier switching to another site, reporting command site elevation angles, or CDS failure indications. The TSO, call sign “TM”, will monitor the analog telemetry pages and provide reports to the MFCO. These reports include engine and motor ignition and burnout, separation events, AGC levels, and non-nominal vehicle behavior. The TSO will also provide a status report each time after the S/MFCO assess flight status. The nominal TSO report is “TM is Green.”

7.4.5.3 Nominal Vehicle Flight Narration

The initial report will be “Ignition” from Wire and TM. The MFCO will acknowledge this report (“Copy Wire. Copy TM.”). Next Wire will report “Liftoff.” The MFCO will acknowledge this report (“Copy Wire”) and will state which display he/she is monitoring. The MFCO will start off on the VP display and will state “I have VP track.” The SMFCO will respond with the display he/she is monitoring. The SMFCO starts off on the IP display and will respond “I have IP track.”

The MFCO then provides an initial assessment of the VP track (“I have two sources in agreement, climbing the VP on the nominal, in the box.”) The SMFCO verifies this assessment and provides an initial assessment of the IP track (“Senior concurs. IP over the pad.”)

Wire will report: “Programming Downrange.” The MFCO will acknowledge (“Copy Wire”). The SMFCO will verify programming on the IP display and will report when the IP begins moving out (“IP moving out”). Once this call is made, the MFCO will transition to the IP display and the SMFCO will transition to the VP display (MFCO: “Switching to VP”; SMFCO: “Switching to IP”).

The MFCO then provides an assessment of IP track (“I have two sources in agreement, on the nominal, in the box, moving downrange green”). The SMFCO verifies this assessment and provides an assessment of other displays (“Senior concurs. VP looks good. VT looks good. DRSD agrees. MCD agrees”). TM then provides the initial TM status update (“TM is Green”).

The MFCO will report when the chevron lines move out on the IP display and when they disappear from the screen (“Chevs moving out”; “Chevs away”). The SMFCO will report when VP track is complete and the screen transitions to the IP display (“Off the VP”).

TM will report mission events as they occur (i.e. TSO: “Fairing jettison”; MFCO: “Copy TM”). Command will report automatic or manual carrier switching (i.e. Command: “Command switch to 28”; MFCO: “Copy Command”).

The MFCO will provide flight assessments as flight progresses. The SMFCO will verify these assessments and provide an assessment of agreement with the other displays. TM will provide status reports after the MFCO and SMFCO perform their assessments.

The MFCO will assess flight performance prior to and after the various vehicle milestones such as separation events, engine cutoffs, and gates (“I have two sources in agreement, on the nominal, in the box, approaching Min BECO green”; “Through MIN BECO green”).

The MFCOs will initiate a timer for engine shutdown events. This is very critical for some vehicles, such as Atlas V and Falcon 9, to verify 2nd stage ignition or to detect a possible anomaly (TM: “BECO!’ MFCO: “Copy TM. Timers started.”).

The MFCO will confirm stage or solid motor ignition on the displays. The MFCO will use the Velocity/Time display to verify ignition for stages and solid motors (“Verified on Velocity/Time”) and will verify that the IP is moving out for stages (“IP moving out”).

For orbital missions, the MFCOs will perform certain actions or request certain reports after the vehicle passes through the Head-On Gate. As the vehicle approaches the end of command coverage, the MFCO will request elevation angle reports from the CSO and AGC reports from the TSO. The MFCOs will also monitor the Range Safety Displays to confirm orbital insertion (i.e. IIP vanish).

For suborbital missions, MFCOs will assess the location of the final IIP after burnout on the RSD Displays.

7.4.5.4 Non-Nominal Vehicle Flight Narration

The MFCO’s verbal assessment is critical if the vehicle’s performance is non-nominal. This assessment is essential for the coordination of actions between the MFCO and SMFCO. Time permitting, the verbal assessment should include:

- The assessment of the vehicle’s performance
- MFCO’s intentions IAW the applicable mission rule(s)

7.4.6 FLIGHT TERMINATION ACTIONS

7.4.6.1 Overview

The Mission Rules specify flight control and flight termination criteria to be applied during a launch mission and any special conditions for allowing the mission to continue. These rules are unique to each mission; however, there are three basic flight rules IAW EWR 127-1 and AFSPCMAN 91-711.

- Validated data confirms the launch vehicle has violated established flight safety criteria, in particular that the launch vehicle IIP has violated the destruct line limits.
- The launch vehicle exhibits gross deviation or obvious erratic flight where, in the judgment of the MFCO, continued flight may pose an unacceptable Launch Safety

risk (to include loss of positive control) though the above destruct criteria are not violated.

- The performance of the launch vehicle is unknown and the capability exists to violate flight safety criteria

Beyond the three basic mission rules, there are additional special mission rules that apply to the various launch vehicles.

The MFCO uses the guidance in the Mission Rules to assess situations in flight and execute flight termination actions. When the performance of the vehicle becomes non-nominal, the MFCO must assess the situation, identify and narrow down the applicable mission rule(s), and execute flight termination IAW the applicable mission rule. This requires a thorough understanding of the mission rules and vehicle flight characteristics as well as efficient coordination between the MFCOs.

7.4.6.2 Sending Functions

When the Command Destruct System (CDS) is in the Eastern Test Range (ETR) IRIG Mode for vehicles using standard command receivers, it does not require that the command sites confirm that the ARM Command has been sent prior to sending the DESTRUCT command. In addition, the priority in transmitting commands is from highest to lowest: DESTRUCT, ARM, SAFE (if used), and Check Channel. As a result, if DESTRUCT is requested prior to an ARM command, the system will not transmit the ARM command. Note that the vehicle's command receiver will not respond to a DESTRUCT command if it has not received an ARM command.

When ARM and DESTRUCT are required to be sent on a launch vehicle, regardless of the CDS operating mode, the MFCO will send the ARM command first, followed immediately by the DESTRUCT command. This will establish the proper habit pattern which can be used for both the ETR IRIG and Digital Range Safety (DRS) modes.

For some vehicles, the ARM command may be used to terminate flight by causing engine shutdown and allowing the vehicle to fall intact. This may be used to prevent a large debris field from being created near a populated land mass.

7.4.6.3 Straight-Up Missile

A straight-up missile is detected on the VP and IP displays as well as from verbal reports from the FO-G and VSO. The VP display will show the vehicle present position moving straight up the screen. The IP display will show the IP over the pad with the nominal box moving out along the nominal trajectory. The FO-G will report "Negative programming." The VSO will also be able to confirm negative programming from the CCTV displays.

The SMFCO will declare "Amber Zone" upon detection of the straight-up missile. The critical angles will appear on the VP display when the present position enters the red destruct line area. Functions are sent when the critical angles on the VP display reach 0 degrees or the IP violates the moving chevron line.

7.4.6.4 Uprange Missile

An uprange missile is detected on the VP and IP displays as well as from verbal reports from the FO-G and VSO. The VP display will show the vehicle present position moving upward and toward the center of the screen. The IP display will show the IP moving uprange toward the destruct lines. The FO-G will report “Programming uprange.” The VSO can confirm the vehicle is programming uprange from the CCTV displays.

The SMFCO will declare “Amber Zone” upon detection of the uprange missile. The critical angles will appear on the VP display when the present position enters the red destruct line area. Functions are sent when the critical angles on the VP display reach 0 degrees or the IP violates the moving chevron line or a static destruct line.

7.4.6.5 Pitchover

A pitchover is detected on the VP, PP and IP displays, the TM analog displays, and from verbal reports from the FO-G and VSO. Initially the VP display will show the vehicle on a depressed trajectory. Initially, the IP display will show the IP moving downrange ahead of the nominal box. The SMFCO will declare “Amber Zone’ upon detection of the impending pitchover.

When the vehicle begins to pitchover, the trajectory on the VP will level off and the vehicle will stop climbing. If allowed to continue, the vehicle will nose over and lose altitude. Then IP will begin to move uprange. The FO-G and VSO will report that the vehicle is pitching over and the TSO will see negative pitch rates on the TM analog displays. If allowed to continue, the vehicle will most likely break-up due to the aerodynamic loads on the vehicle.

Functions are sent when the trajectory on the VP levels off in order to initiate the destruct ordnance before the vehicle breaks-up. The concern is that a break-up of the vehicle could cause damage to the FTS and prevent initiation of the destruct ordnance.

7.4.6.6 Vehicle Break-up/Self Destruct

A vehicle break-up or self-destruct is detected on the VP and IP displays, the TM analog displays, and from verbal reports from the FO-G and VSO. The VP and IP may show multiple targets if radars are available for tracking. The TSO may report a loss of data if the TM system is too damaged to continuing transmitting data. The FO-G and VSO will report the vehicle break-up if it occurs within visible range. Functions are sent immediately to initiate the destruct ordnance before the FTS is damaged.

7.4.6.7 All Sources Off Track

An all sources off-track situation is detected on VP and IP displays as well as from verbal reports. The VP display will show a loss of data and a red bar across the screen. The IP display will show a loss of data and a red bar across the screen. The TSO will lose data on the TM analog display pages and will report “TM’s lost data.” IPC Net traffic will report a loss of track in both beacon and skin modes. The SMFCO will declare “Amber Zone” upon detection of all sources off track.

If the IP was within 3 Sigma, the MFCOs will monitor the green numbers. Note that the Minimum Time to Endanger (MTE) is the green number off the pad.

If all sources go off track during flight, functions are sent when the green numbers expire if the IP was within 3 Sigma or immediately if the IP was outside 3 Sigma. If all sources are off track off the pad, functions are sent when the manual timer initiated at liftoff reaches the MTE number. If track is reacquired prior to the expiration of green numbers, functions will not be sent.

7.4.6.8 Extended Flight Rule

Invoking the Extended Flight Rule states allows vehicle flight to continue after all track is lost prior to the End GN point. This decision is based on MFCO judgment; however, there are a couple of things for the MFCO to consider:

- Vehicle flight must have been nominal up to that point
- All major staging events prior to orbital insertion should have already occurred

7.4.6.9 Stopped IP

A stopped IP is detected on the IP, VT, and TM displays. The IP display will show the IP traveling uprange briefly prior to stopping. The VT will begin to plateau due to the loss of acceleration. The uprange movement of the IP is due to the Range Safety systems correcting the extrapolated data when they receive and process the actual data which indicates that the vehicle has stopped thrusting. The TM analog displays will show a drop in chamber pressures and the TSO will report cutoff of the applicable stage.

The MFCOs will initiate a timer and monitor for re-start or ignition of the next stage. Some vehicles have specified times in which a restart may still occur due to re-start or other sequencing actions such as the Atlas V and the Falcon 9. The SMFCO will declare “Amber Zone” upon detection of the Stopped IP. The MFCO will request the CSO to report command elevation angles at the time of the failure and updates as needed.

The vehicle will continue to climb until gravity eventually slows the vehicle enough to cause it to begin falling back to earth. Functions are sent at 3 degrees on command elevation angles. This allows the vehicle to fall close to the earth to create a smaller debris footprint. Sending functions immediately could cause a large debris field that may fall through airway routes. Command elevation angles of 3 degrees are used to ensure command coverage and attempt to avoid problems with multipath or antenna pointing uncertainties. Functions may be sent sooner if the vehicle begins tumbling, all sources go off track, or the vehicle has a CRD auto-safing time which will occur prior to 3 degrees command elevation angles.

7.4.6.10 Destruct Line Violation

A destruct line violation is detected on the IP display. The IP will deviate left or right of nominal, move outside 3 Sigma left or right, and approach a destruct line. The MFCO verbalizes when the vehicle diverges outside 3 Sigma left or right. At this time, the vehicle is non-nominal and the SMFCO will declare “Amber Zone.” Note that at this time, green numbers no longer apply.

Functions are sent no later than when the IP crosses the destruct line. The MFCO may send functions shortly prior to reaching the destruct line to allow time for C2 contingencies. This includes time for the MFCO to try the other FTU or to direct the CSC to switch transmitters. Functions may be sent sooner if all sources go off track or the vehicle becomes erratic which can be confirmed by the TSO observing high angular rates on the TM analog display pages.

7.4.6.11 Head-On Gate Violation

A Head-On Gate violation is detected on the IP display. The IP will deviate left or right of nominal and continue to diverge or exhibit erratic flight as it approaches the Head-On Gate. Functions are sent when the IP crosses the Head-On Gate. This includes an IP which crosses the solid line of the Gate or an IP that is diverging and crosses the dashed line of the Gate. The IP may or may not move outside 3 Sigma left or right. The IP must be clearly divergent. If the IP is exhibiting parallelism to the nominal and 3 sigma dispersed trajectories or converging back to nominal, functions are not to be sent. Unlike a regular destruct line violation, functions should not be sent early for C2 contingencies in order to ensure the IP violates the Gate.

7.4.6.12 Lateral Gate Violation

A Lateral Gate violation is detected on the IP display. The IP will deviate left or right of nominal and continue to diverge or exhibit erratic flight as it approaches the Lateral Gate. The IP must be clearly divergent. If the IP is exhibiting parallelism or converging back to nominal, functions are not to be sent. The IP may or may not move outside 3 Sigma left or right.

Functions are sent when the IP crosses the Lateral Gate. Unlike a regular destruct line violation, functions should not be sent early for C2 contingencies in order to ensure the IP violates the Gate. If the vehicle becomes erratic after entering the Lateral Gate, functions are to be sent immediately. Note that the IP should not be allowed to cross the back-up destruct line.

7.4.6.13 Minimum Engine Cutoff Rule

A violation of the Minimum Engine Cutoff Rule is detected on the IP, VT, and TM displays. Engine Cutoff will be indicated on the range safety and TM displays prior to the Minimum Engine Cutoff tick-mark on the IP display.

The MFCOs will initiate a timer and monitor for re-start or ignition of the next stage. The SMFCO will declare “Amber Zone” upon detection of the Minimum Engine Cutoff Rule violation. If a re-start occurs, functions will be sent based on whichever of the following occurs earliest:

- Prior to loss of command coverage (Based on real time evaluation of command signal strength and elevation angles)
- Prior to reaching the Head-On Gate

If re-start does not occur, the situation will be treated as a Stopped IP.

7.4.6.14 Gate Engine Cutoff Rule

This situation is detected when the engine cutoff occurs between the minimum engine cutoff tick mark and the gate engine cutoff tick mark on the IP display. The MFCOs will initiate a timer and monitor for re-start or ignition of the next stage. The MFCO will request command elevation angle updates from the CSO.

Unless the vehicle is exhibiting erratic or errant behavior prior to loss of command coverage, functions should not be sent. If the vehicle is exhibiting erratic or errant behavior, in addition to the early engine cutoff, functions will be sent prior to loss of command coverage based on a real time evaluation of signal strength and command elevation angles.

7.4.6.15 Command Coverage Contingency Rule

This rule is in effect when the vehicle is exhibiting erratic or non-nominal behavior when a command contingency occurs. The command contingency will be detected by the CSO or reported by the CSC. If the command site which experienced the failure is the next site after the current site transmitting the carrier:

- The MFCO will direct the CSO to switch to manual carrier switching mode and request elevation angle updates (Ex: MFCO may request that the CSO begin countdown in half-degree increments starting at 5 degrees).
- Functions are sent at 3 degrees on command elevation angles on the current dual command site.

If the command site which experienced the failure is the current site transmitting the carrier, functions will be sent immediately.

7.4.6.16 Inadvertent Launch into a Manned COLA Closure

If a hangfire or other problem occurs which results in a delay in the launch or liftoff of the vehicle, the crew will reference the Manned COLA closures. If launch occurred within a Manned COLA closure, the SMFCO will declare "Amber Zone" and functions will be sent to protect the manned object. Functions are sent prior to reaching the Head-On Gate or within a specified time if the trajectory could send debris toward the ISS or other manned objects. The time period designed to ensure that debris clears the launch head and does not endanger the ISS or other manned objects.

7.4.6.17 Range Safety Display Disagreements/Failures

Functions may need to be sent due to Range Safety Display system disagreements or failures which result in unknown performance of the launch vehicle.

7.4.6.17.1 Total Range Safety Display System Failure

If all of the Range Safety systems fail, the MFCOs will initiate manual timers and the SMFCO will declare "Amber Zone." The MFCOs will reference the Green Number Charts for the green number at the time of the failure last Range Safety display. Functions will be sent when the timers reach the applicable green number.

7.4.7 PERFORM C2 CONTINGENCIES

7.4.7.1 Overview

The MFCO is responsible for evaluating vehicle flight and making the decision concerning continued flight or flight termination based on interpretation of real-time events, mission rules, all available data sources, and sound judgment. The MFCO must also be ready to react if the flight termination actions fail to terminate the flight of an erratic vehicle.

7.4.7.2 C2 Contingencies

C2 Contingencies can occur due to a failure of the Ground Command Destruct System (CDS), a failure of the airborne Flight Termination System (FTS) or due to transmission path problems on the ground or in the air (i.e. aspect angles or multipath). The exact cause may be impossible to discern, however, the MFCO can take actions to detect the problem and execute the appropriate contingency procedures.

The first two steps in the MFCO Post-Destruct Checklists are designed to detect a C2 problem and there are corresponding contingency procedures used to react to the situation. Step 1 is to confirm that the DESTRUCT command was sent. If the command was not sent, it indicates that there is a problem within the CDS. In response, the MFCO can attempt to send functions from the other FTU. Step 2 is to confirm the destruction of the vehicle. If this is not confirmed, this could indicate a problem with the CDS, the FTS, or a transmission path problem. In response, the MFCO can switch command transmitters and resend functions. If that doesn't work, the MFCO can switch command sites and resend functions. The key is for the MFCO to quickly detect the problem and to execute all of the possible options as necessary in order to terminate flight.

7.4.7.2.1 Step 1: Confirm DESTRUCT was sent

After the MFCO or SMFCO has activated the FTU switches, they will confirm that DESTRUCT was sent. The S/MFCO will initially direct the Command Systems Officer (CSO) to confirm that the DESTRUCT command was sent by stating "Command confirm DESTRUCT sent" on FCO.LCL. The CSO will verify that the DESTRUCT indicators on the RASCADs are illuminated along with the plus time that the command was sent. These indicators are displayed when the Central CMEV receives the confirmation message from the command site that the command was sent. Note that in the plus count, these indicators will remain on the RASCAD even after the commands have been removed. As a result, the CSO will only be able to use the RASCADs to confirm when the functions have been initially sent. The MFCO can also verify that the command was sent by verifying that the FTU switch display for the DESTRUCT command has a Red background with the word "XMIT" which also indicates that the Central CMEV received the confirmation message from the command site.

If the DESTRUCT indicators on the RASCADs are illuminated, the CSO will report "DESTRUCT sent." If the DESTRUCT indicators are not present on the RASCADs, the CSO will report "DESTRUCT not sent." This indicates that the DESTRUCT was not sent due to a failure somewhere in the Ground CDS from the FTU to the command site itself.

When a command request is initiated at the FTU when the CCRS is in the Digital Range Safety (DRS) Mode, the flight code tone pairs are extracted from the MSUs by the Central CMEV and sent to the command site through the CMEV links. Once the command site has transmitted the command, the site CMEV sends a command confirmation message to the Central CMEVs through the CMEV links. The Central CMEV then relays the confirmation that the commands were sent by sending signals to activate the indicators on the FTUs and the RASCADs. When a command request is initiated at the FTU when the CCRS is in the Eastern Test Range (ETR) IRIG Mode, the command request is sent by the Central CMEV to the command site through the CMEV links. Once the command site has transmitted the command, the site CMEV sends a command confirmation message to the Central CMEVs through the CMEV links. The Central CMEV then relays the confirmation that the commands were sent by sending signals to activate the indicators on the FTUs and the RASCADs.

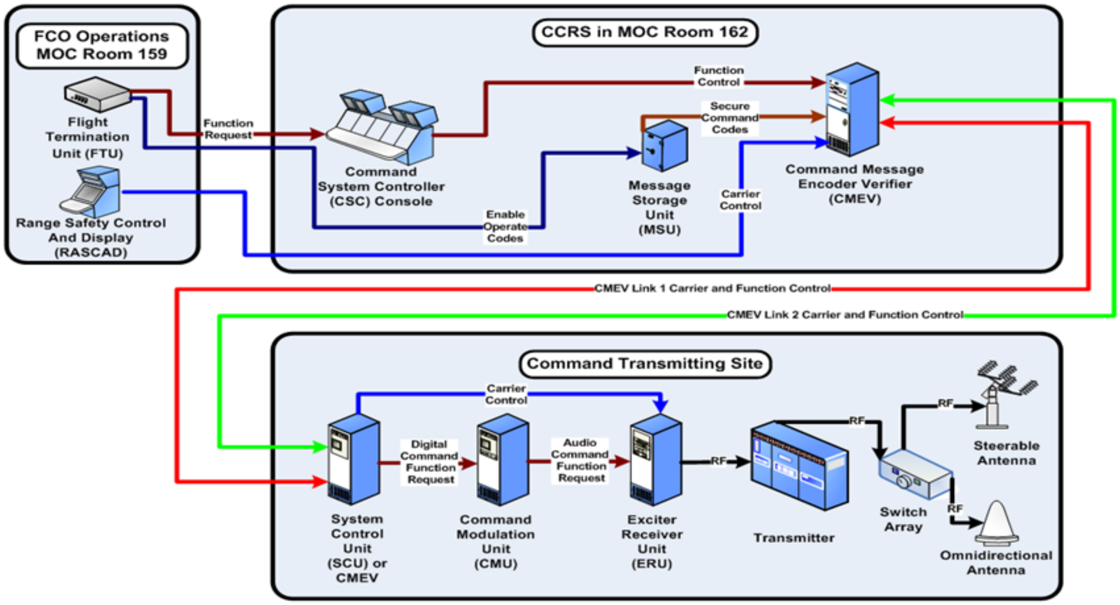


Figure 7-4-13: *Command Flow Chart*

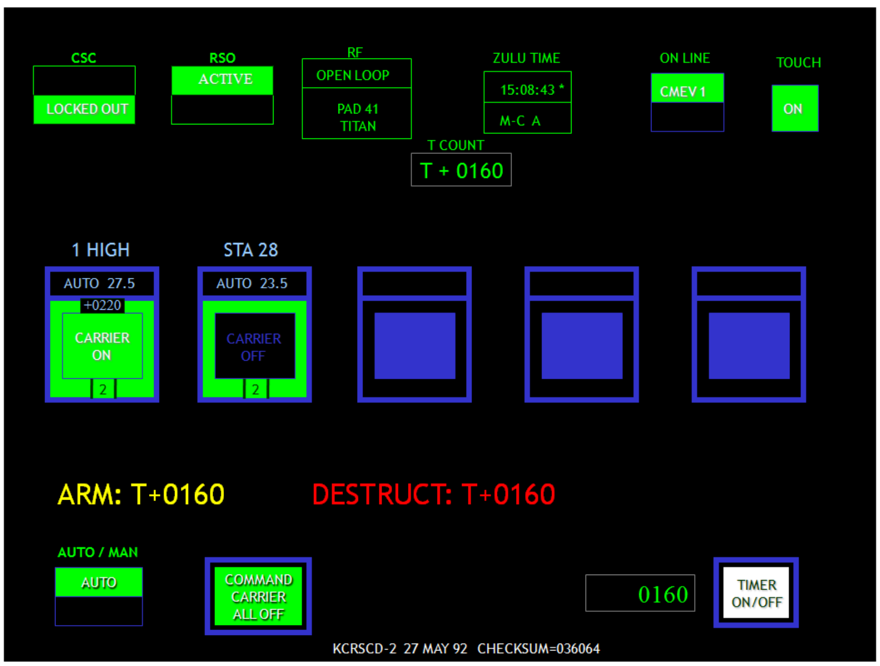


Figure 7-4-14: *RASCAD Display*

Figure 7-4-15: *FTU Switch Display*

If the CSO reports "DESTRUCT not sent", the MFCO or SMFCO will recycle their FTU switches (flip the switches back down) and have the other MFCO activate the switches on the other FTU in an attempt to send DESTRUCT. Each time the MFCO or SMFCO resend functions, they will confirm with the CSO and/or the FTUs that DESTRUCT was sent. When verifying that DESTRUCT was sent with the CSO, the MFCO will state "Command confirm DESTRUCT sent." Note that the CSO will only be able to confirm that a command function was sent the first time the command was successfully sent.

Once DESTRUCT has been successfully sent, the CSO will report "DESTRUCT sent", the SMFCO will declare "Missile Red, Missile Red, Missile Red" on FCO.LCL, and the MFCO will move on to Step 2 of the post-destruct checklists. If the CSO cannot verify that DESTRUCT was sent, even after both FTUs have been utilized, the MFCO will continue on to Step 2 of the post-destruct checklists. Note that if the site CMEV at the command site detects a fault in the online command string, it will cause a switchover to the other string and attempt to send the requested command function. If the CCRS is in the Auto-carrier mode and the online Central CMEV detects that the site radiating the command carrier fails to send a requested command after a specific time period, it will transfer the carrier to the next best available command site and request that command site to send the command.

7.4.7.2.2 Step 2: Confirm vehicle destruct

The SMFCO/MFCO will confirm the vehicle was destroyed. This can be confirmed in several ways. If the vehicle is within visual range, the FO-G or VSO will be able to determine if the vehicle was destroyed. Beyond visual range, the MFCOs rely on information from the SPARC Controller, callsign CAT-1, and from the TSO. If radar sites are tracking the vehicle and they detect a break-up of the vehicle, they will report "Break break, Code Blue" followed by their callsign (i.e. Gold XX; where "XX" equals the site's numeric identifier) on the Impact Prediction Correlation (IPC) Net. If another radar also detects the vehicle break-up, it will report its callsign and confirm Code Blue. The TSO may be able to confirm destruction by the loss of telemetry data. This will be indicated by a blue bar across the top of the TSO display and the TSO will report "TM has lost data."

If DESTRUCT was sent beyond visual range of the FO-G or the optics sites, the MFCO will be listening to the IPC net for confirmation of destruct from the radar sites. If the MFCO does not hear a break-up report on the IPC.NET, the MFCO will state on the IPC.NET "CAT-1, what are you tracking?" If the vehicle was not destroyed and the radars are still tracking the vehicle, CAT-1 will report that they are still tracking an intact vehicle. If the TSO is still receiving data from the vehicle, the TSO will report "TM still has data."

7.4.7.2.3 Switch to Back-up Transmitter

If vehicle destruct is not confirmed, the first contingency option that the MFCO will execute is to switch command transmitters and resend commands. The MFCO will recycle the FTU switches and state on FCO.LCL "CSC, switch to backup transmitter." The Command System Controller (CSC) will direct the command site radiating the carrier to switch to the back-up transmitter on the CSC.NET. When the site has switched to the back-up transmitter, the site will report to the CSC on the CSC.NET and the CSC will report on FCO.LCL that the transmitters have been switched. The MFCO or SMFCO will then send functions and reference the FTUs to confirm the DESTRUCT was sent. If the FTUs confirm that DESTRUCT was sent, the MFCO and

SMFCO will look to confirm vehicle destruct. If vehicle destruct is not confirmed, they will then try their next contingency procedure.

7.4.7.2.4 Switch to Another Command Site

If vehicle destruct is not confirmed after switching to the back-up transmitter at the current site, the MFCO will recycle the FTU switches and direct the CSO to switch to another command site on FCO.LCL. The MFCO may direct the CSO to switch to a particular site (i.e. “Command switch to 28”) or may state to switch to the “next best site.” Factors to consider for the next best site are a site with two online transmitters and elevation angles better than 3 degrees or whichever site has the highest elevation angles. Note that if the CCRS was configured for auto-carrier switching, the CSO will have to switch to manual carrier switching at this time. The CSO will select the requested or next best site and report to the MFCO on FCO.LCL when the carrier has switched (i.e. “Command switched to 28”).

The MFCO or SMFCO will then send functions and reference the FTUs to confirm the DESTRUCT was sent. If the FTUs confirm that DESTRUCT was sent, the MFCO and SMFCO will look to confirm vehicle destruct. If vehicle destruct is not confirmed, the MFCO and SMFCO will then repeat the process by using every available command site and transmitter until vehicle destruct has been confirmed or until all options have been exhausted. If all options have been exhausted, then the MFCO and SMFCO will transition to their errant vehicle procedures.

7-5 ANOMALY RESOLUTION PROCEDURES

7.5.1 PURPOSE

Anomaly resolution procedures are used during on-console operations to report instrumentation, communication, or console malfunctions for corrective action. They are also used to resolve any non-equipment related issues such as weather and area surveillance issues, in addition to problems that have been resolved following a failure, issue, or degradation.

In order to keep all key launch operations and Range personnel abreast of the current status we must follow anomaly resolution procedures to pass information in a timely and orderly fashion. This section will define terminology, describe processes, and illustrate procedures necessary to rapidly respond to problems that may occur on launch day.

7.5.2 DEFINITIONS

7.5.2.1 Fully Mission Capable (FMC)

An "FMC" asset is able to meet all mission requirements, and there is no loss or degradation of a capability required for the mission to include required redundancy within the system.

7.5.2.2 Partially Mission Capable (PMC)

A "PMC" asset is experiencing a loss or degradation of some capability or redundancy required for the mission. (PMC reports will have amplification information specifying capabilities lost and remaining).

7.5.2.3 Non-Mission Capable (NMC)

An "NMC" asset is inoperative and unable to meet any mission requirements.

7.5.2.4 PICARE (Job Aid 5)

The PICARE acronym is in place to help crewmembers quickly remember the important parts of an instrumentation anomaly report. PICARE stands for Problem, Impact, Cause, Action, Range Status, and ETRO. PICARE is tied to the Tier 1 and Tier 2 instrumentation reports below.

7.5.2.5 Tier 1 Report

A concise actionable report passed over Instrumentation Status Net or Operations Support Status Net regarding a change in system capability. It is a rapid response report (usually < 15 seconds) using structured phraseology, designed to put critical GO/NO-GO information into the hands of those with hold-fire authority. (PI from PICARE for instrumentation reports).

7.5.2.6 Tier 2 Report

A brief report (usually < 1 minute) providing amplifying details such as observed symptoms, cause, work arounds, recommended resolution plan, Estimated Time to Return to Operations (ETRO) and/or time of the next status update using a semi-structured phraseology passed over Instrumentation Status Net or Operations Support Status Net. (CARE from PICARE for instrumentation reports).

7.5.2.7 Tier 3 Report

An expansion of the Tier 2 report, (usually < 5 minutes) to include a more detailed tactical explanation of an anomaly's symptoms, underlying cause, and the associated resolution plan using non-structured phraseology (Q&A) over Instrumentation Status Net or Operations Support Status Net (Range Anomaly Net may be used if personnel who do not have one of the other two nets need to be included (i.e. AFLIO or System Controller).

Tier 3 reports are used when a crewmember needs a comprehensive explanation in order to make a GO/NO-GO or Range resource commitment decision.

7.5.2.8 Tier 4 Anomaly Resolution Process

Activation of the formal anomaly team to resolve complex or integrated strategic or policy level issues (no specific time constraints other than to meet a T-0). The Tier 4 Anomaly Resolution Process uses non-structured phraseology (discussion) over the Range Anomaly Net (for Range issues), or the Launch Agency's anomaly net (for integrated Range/User issues).

Some examples of situations which may require a Tier 4 discussion include: a highly complex technical discussion that requires multiple participants, the need to devise a unique strategy, workaround, or repair methodology, the need to engage in a joint resolution that includes both the Range and User (non-LV/SV specific issue), the existence of opposing opinions regarding corrective action or the way ahead, the anticipated need for a waiver, or the anticipated need for a senior leadership decision. LV/SV specific issues such as confirmed LV/SV hardware anomalies or LCC risk violations will be worked directly between the 45 SW responsible organizations (LCG and/or SE) and the launch operator to develop recommendations for LDA, i.e. not a Range Anomaly Team discussion.

7.5.3 OVERVIEW

There are three procedures we utilize when dealing with problem/failure resolution. Instrumentation Status Change procedures are used during on-console operations to report instrumentation malfunctions for corrective action. It is also used for instrumentation that has returned to operation following a failure or degradation. General Status Change procedures are used during on-console operations to report any change of status or items of interest that are not covered by another procedure. Communication/Console/SCDS Failure/Recovery procedures are used during on-console operations to report/resolve any issues with a crewmember's communications capabilities or console equipment.

7.5.4 CHECKLISTS

7.5.4.1 Instrumentation Status Change (C/L 9-1)

In order to keep all key launch operations and Range personnel abreast of Range instrumentation status we must follow reporting procedures to pass information in a timely and orderly fashion. Equipment outage and restoral notifications can come from multiple sources. Although most instrumentation outages and restorals will be reported to the Range Crew by the RE, all Range crewmembers must document and report outages and restorals to equipment under their control.

The Instrumentation Controllers keep the ISRO apprised of their efforts to bring NMC or PMC Range assets back on-line. The ISRO notifies the RE of corrective actions taken to restore instrumentation outages and recommends changing instrumentation status to the RE. Upon RE concurrence that instrumentation has been restored to FMC or PMC status, the RE notifies the ROC, RCO, and MFCO of the status change.

ENTERING ARGUMENTS: The Range crew should implement the Instrumentation Status Change checklist (C/L 9-1) as soon as they experience or are informed of an instrumentation outage or restoral.

The lead-in prior to Step 1 should be treated as a “floating lead-in.” If at any time during the processing of this checklist, the situation requires an Unscheduled Hold or an Extension of a Built-in Hold, go to Checklist 1-3 or 1-2 respectively to execute hold action immediately.

STEP 1: This checklist utilizes a “Tiered” reporting process with the ROC in a lead role for coordinating status and anomaly discussions. The objective is to have a standardized and consistent central reporting methodology to avoid varied, ad-hoc reporting procedures. Four distinct tiers are used to separate critical ops-related information from supporting technical and maintenance details as outlined in the Definitions section above. The RE, via the Tier 1 report will ensure the ROC, RCO and MFCO receive pertinent information via the Instrumentation Status Net. Pertinent information includes the system affected, its status (either FMC/PMC/NMC), and any capabilities lost or affected. The Tier 1 report covers the P and I from PICARE. If time allows, the MFCO, RCO, or ROC (in that order) can request Tier 2 information which includes any additional details, and expected clear time (or ETRO) or a time for a status update. The Tier 2 report covers the C, A, R, and E from PICARE. Tier 3, if requested, will be accomplished if a crew member needs a comprehensive explanation for decision making.

STEP 2: The ROC facilitates the forming of a Tier 4 Anomaly Resolution Team if required for complex or integrated, strategic or policy level issues that do not include LV/SV hardware anomalies or LCC risk violations. Tier 4 may be appropriate for situations that require a more thorough explanation than what is obtained via Tier 1, 2, and 3, or for situations where waivers need to be discussed to return to a GO status. Tier 4 discussions will occur on Range Anomaly 1 or 2 for Range issues, or on the Launch Agency anomaly net for integrated Range/User issues. The ROC will facilitate the forming of the team with the appropriate parties on the appropriate net. The RE can help guide this discussion in most cases. The ISRO or even supersystem controllers can also participate when requested. The AFLIO can also participate for issues regarding base support items such as commercial or generator power. The ROC will notify the LDA/OD at the beginning of a Tier 4 discussion to monitor if desired.

STEP 3: The MFCO and RCO will report their GO or NO-GO status to the ROC on the Instrumentation Status Net. The team will discuss any changes in mandatories and the ROC will determine Range Status.

STEP 4: Each crewmember will notify their respective launch team members of the appropriate Tier 1/2 information, Range Status, and any changes in mandatories. It is not necessary to pass all information to each launch team member. Crewmembers may tailor this notification to provide only the information needed/desired by the team. At a minimum, notify all team members of any changes to Range Status. Additionally, if Range Status does change, the RCO will make the appropriate announcement on the Range Countdown Net.

STEP 5: All crew members should log all information that would be necessary to recreate the event.

7.5.4.1.1 Instrumentation Status Net Reports:

Figure 7-5-1 shows the reporting process from the previous paragraphs. First, the system technicians at a specific site will report the problem to the Super System Controller. For example, the controller at Radar site 19.14 may report that Radar 19.14 is NMC to the Radar Super System Controller. The Super System Controller will then pass the report to the ISRO on Instrumentation Net 2. The ISRO will ensure the RE has all the necessary information and concurs with the FMC, PMC, or NMC determination. The RE will then call the MFCO, RCO, and ROC on the "Status Net" and pass Tier 1 information. If the crew requests, the RE will pass Tier 2 or 3 information. The STA plays a passive role monitoring the net. If Tier 4 is needed, the ROC will move the conversation to one of the Anomaly Nets.

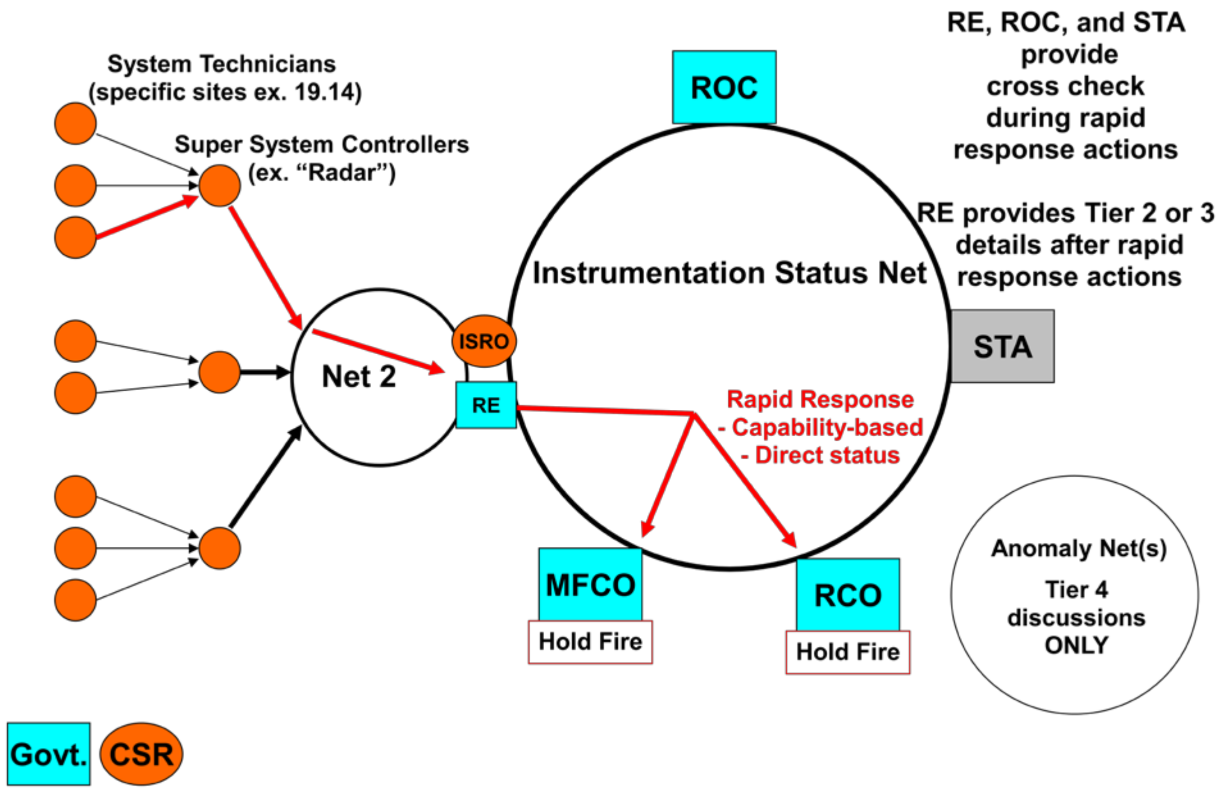


Figure 7-5-1: *Instrumentation Status Net Reports*

7.5.4.2 General Status Change (C/L 1-1)

The General Status Change checklist is used during on-console operations to report any change of status or items of interest that are not covered by another checklist.

ENTERING ARGUMENTS: If any agency reports a change in status (to include items of interest) not covered by another checklist, then the crewmember who initially receives the notification will initiate the General Status Change Checklist (C/L 1-1). This checklist is meant to be used for all launch agency and safety waiver situations, except those covered via the instrumentation status change checklist. Example situations that could cause the crew to implement this checklist include, but are not limited to, Blast/Toxics/Debris, Launch Agency status change, weather conditions (other than severe weather), Fouled Ranges, Range related vehicle problems such as Flight Termination System (FTS) or Beacon, and related waivers.

The lead-in prior to Step 1 should be treated as a "floating lead-in." If at any time during the processing of this checklist, the situation requires an Unscheduled Hold or an Extension of a Built-in Hold, go to Checklist 1-3 or 1-2 respectively to execute hold action immediately.

STEP 1: This checklist utilizes a "Tiered" reporting process with the ROC in a lead role for coordinating status and anomaly discussions. The objective is to have a standardized and consistent central reporting methodology to avoid varied, ad-hoc reporting procedures coupled with the numerous support entities and their associated criteria. Four distinct tiers are used to separate critical ops-related information from supporting technical details. Tier 1 is used for information relating to operations capability. It is initiated by the RAC, LWO, SCO, MFCO, or ROC for launch agency issues. The initiating agency will ensure the ROC, RCO and MFCO receive pertinent information via the Operations Support Status Net (Ops Support). Pertinent information includes the crew position affected, their status (GO/NO-GO), the condition/situation that resulted in the status change, and operational impact. If time allows, the MFCO, RCO, or ROC (in that order) can request Tier 2 information which includes any additional details, and expected clear time or a time for a status update. Tier 3, if requested, will be accomplished if a crew member needs a comprehensive explanation for decision making.

For certain safety criteria issues, such as Distant Focusing Overpressure (DFO), toxics, and debris, the RAC will initiate Step 1. The LWO will initiate Step 1 for any weather Launch Commit Criteria (LCC) issues. The ROC will initiate the conversation for Step 1 with the launch agency, stating the issues and requesting launch agency waivers. The MFCO will initiate for Range Safety non-instrumentation issues such as Vehicle FTS issues or safety waivers not covered in another checklist. The SCO will initiate Step 1 for surveillance issues such as fouled ranges for boats or aircraft. The process the SCO follows for this report is outlined below.

The ACO and SSO notify the SCO of a Fouled Range over SCO.NET, who in turn will notify the ROC/RCO/MFCO over OPS.SUPT using the Tier 1 Report (Position, status, and operational impact: "SCO is NO-GO – Fouled Range due to Intruder Aircraft"). If the Fouled Range event occurs during the terminal count, the RCO/MFCO will throw the holdfire switch. If there is time, the ROC/RCO/MFCO may request additional details and Expected Clear Time: "Aircraft approaching the aircraft corridor from the north – expected clear time is 5 minutes".

With the Surveillance Control Display System (SCDS), the ACO can determine if an aircraft has fouled the Range in real time by looking at the display. They can then notify the MRU and the SCO of the Fouled Range situation so that those individuals can perform their necessary steps. The ACO does not require a checklist for these steps.

STEP 2: The ROC facilitates the forming of a Tier 4 Anomaly Resolution Team if required for complex or integrated strategic or policy level issues that do not include LV/SV hardware anomalies or LCC risk violations. Tier 4 may be appropriate for situations that require a more thorough explanation than what is obtained via Tier 1, 2, and 3, or for situations where waivers need to be discussed to return to a GO status. Tier 4 discussions will occur on Range Anomaly 1 or 2 for Range issues, or on the Launch Agency anomaly net for integrated Range/User issues. The ROC will facilitate the forming of the team with the appropriate parties on the appropriate net. The ROC will notify the LDA/OD at the beginning of a Tier 4 discussion to monitor if desired.

STEP 3: When polled, the MFCO and RCO will report GO or NO-GO status to the ROC on the Operations Support Status Net. The team will discuss any changes in mandatories and the ROC will determine Range Status.

STEP 4: Each crewmember will notify their appropriate launch team members of the situation, Range Status, and any changes in mandatories. It is not necessary to pass all information to each launch team member. Crewmembers may tailor this notification to provide only the information needed/desired by the team. At a minimum, notify all team members of any changes to Range Status. Additionally, if Range Status does change, the RCO will make the appropriate announcement on the Range Countdown Net.

STEP 5: All crew members should log all information that would be necessary to recreate the event.

7.5.4.2.1 Operations Support Status Net Reports:
Figure 7-5-2 shows the reporting process from the previous paragraphs. The appropriate initiating agency will call the MFCO, RCO, and ROC on "Ops Support" and pass Tier 1 information. If the crew requests, Tier 2 or 3 information will be passed. Launch Agency status will primarily come through the ROC, but it will come through the LWO for Launch Agency related weather issues. The STA plays a passive role monitoring the net. If Tier 4 is needed, the ROC will move the conversation to one of the Anomaly Nets.

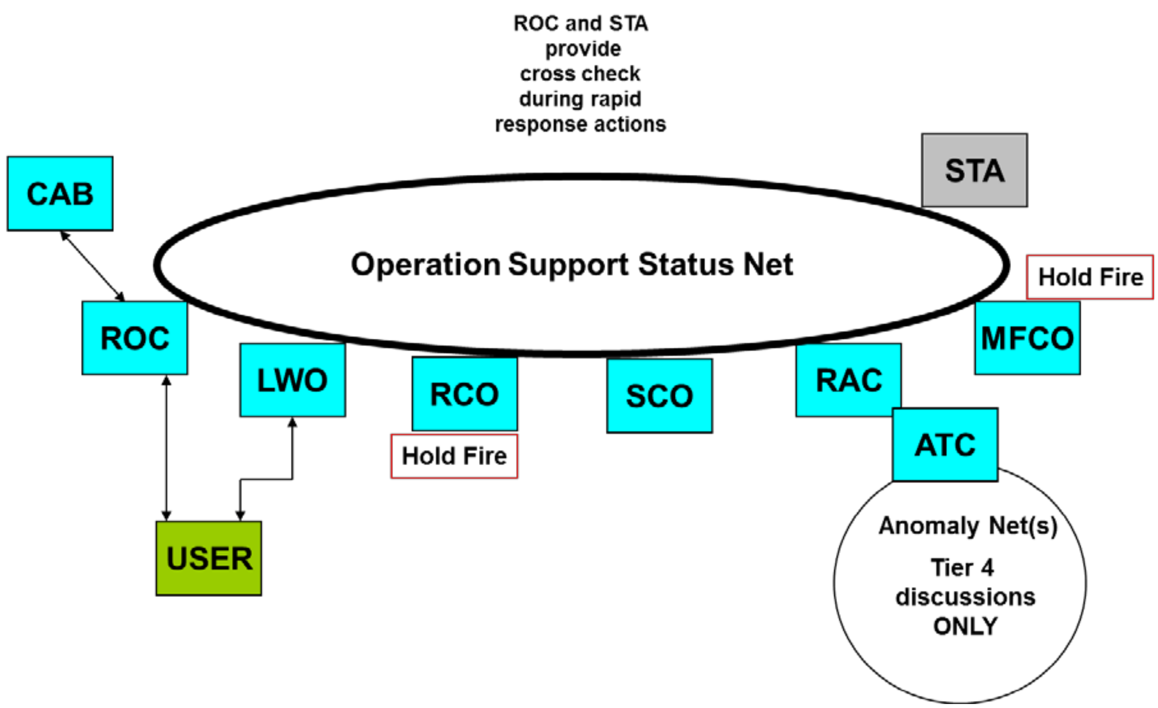


Figure 7-5-2: *Operations Support Status Net Reports*

7.5.4.3 Communication/Console/SCDS Failure/Restoral (C/L 10)
The Range crew is responsible for ensuring their communications are setup IAW the applicable OD and for properly operating, checking-out, and reporting problems for all communications equipment that will be used during an on-console operation. Checklist 10,

Communication/Console/SCDS Failure/Restoral, will be used to process failures and subsequent restoration of equipment during on-console operations.

The first lead-in prior to step 1 should be treated as a “floating lead in.” If at any time during the processing of this checklist, the situation requires an Unscheduled Hold or an Extension of a Built-in Hold, go to Checklist 1-3 or 1-2 respectively to execute hold action immediately.

The remaining lead-ins direct appropriate steps depending on whether the checklist is being accomplished for restoral or failure.

STEP 1: The SCO, ACO or SSO should verify the equipment is configured properly. Job Aid 4 provides details proper equipment configuration.

STEP 2: This step is only required if ALL surveillance capabilities are lost. The ACO will ensure the MRU Controller verifies NASA Tower status and requests airspace assistance if required, notifies support aircraft, and provides target aircraft data to the Analyst as required.

STEP 3: When an operator experiences a communication failure, he/she will determine and implement the use of backup resources. Once determined, the implementation portion includes notifying all positions affected by the outage of the backup plan. Use Attachment A: Common Backup Equipment/Channels/Frequencies/Primary Users as a guide for possible backup options. This guide is not mandatory, just a suggestion.

STEP 4: The operator who experiences the failure will notify their Center Supervisor (CS) and report the equipment/frequency affected, the degree of failure, the position or positions it affects, mission impact and backup plan.

STEP 5: The CS will notify the RCO of the communications problem. If the RCO is not supporting the operation, call COMM Control to report the problem. Report the equipment/channels/frequencies affected, the degree of failure, the position or positions it affects, mission impact and backup communication plan, and request an Estimated Time of Return to Operation (ETRO) or defer troubleshooting.

STEP 6: The RCO will notify the ISRO of the equipment/channels/frequencies affected, the degree of failure, the position or positions it affects, and request an ETRO. The ISRO will, in turn, notify the appropriate communications controller to repair the equipment. The RCO will also request FCA van assistance if the failure is caused by an unknown interference source.

At this point, if the situation could affect Range Status or Required/Mandatory communication systems, accomplish the Instrumentation Status Change Checklist 9-1 prior to continuing in order to make necessary decisions and notifications.

STEP 7: The RCO will pass the ETRO to the CS who reported the communication failure if this was a failure that was reported by a CS.

STEP 8: The CS will pass the ETRO to the individual who reported the communication failure if this was a failure that was reported by someone.

For communication/console failure, go to step 16, otherwise continue.

STEP 9: The RCO will notify the CS who reported the failure of restoral if this was a failure that was reported by a CS.

STEP 10: The CS will notify the individual who reported the failure of restoral if this was a failure that was reported by someone.

STEP 11: The individuals affected by the communication failure will perform checkouts on the affected equipment.

STEP 12: Upon completion of checkout, report to CS if required.

STEP 13: This step is only accomplished for restoral of surveillance capabilities. The ACO will Ensure the MRU notifies Miami Missions and NASA Tower. The ACO will notify Support Aircraft.

STEP 14: The CS will report results to the RCO. If the RCO is not supporting the operation, call COMM Control to report.

STEP 15: The RCO will notify the ISRO of communication restoral and checkout results.

STEP 16: The crew will log actions taken.

7-6 HOLD & RECYCLE PROCEDURES

7.6.1. PURPOSE

Hold and recycle procedures help minimize the time necessary to coordinate these holds and recycle events. It is essential to minimize coordination time for these events, due to the fact that these events can occur in a very short time span. These procedures also ensure that the appropriate agencies are kept appraised of the situation at all times. Holds are categorized into built-in hold extensions and unscheduled holds.

7.6.2. PROCEDURES/CHECKLISTS

7.6.2.1. Built-In Hold Extension (Vol 2 C/L 1-2)

ENTERING ARGUMENTS: The range crew is responsible for implementing the Built-in Hold Extension (Checklist (C/L) 1-2) when notified of any situation that will or could potentially cause an extension to any built-in hold during on-console operations.

STEP 1: The MFCO, RCO and ROC will conference (if required) to discuss what the requirements to extend the built-in hold. Any of the three listed crew positions can initiate this conference when it is determined that a built-in hold extension may be necessary. The conference is only required if the MFCO, RCO and ROC did not already discuss the requirements to extend the built-in hold during the processing of another checklist.

The requirement may come from the launch agency through the ROC. The crew may discuss the reason for the possible extension and what conditions would allow the team to not extend the built-in hold. At this point, each crewmember will notify their appropriate launch team members of the situation.

It is important for the crew and rest of the launch team to be completely cognizant of these facts to ensure quick coordination for picking up the count at the appropriate time.

If the BIH extension does not occur, then the crew will only accomplish Steps 3 & 5.

STEP 2: When the built-in hold extension starts, the RCO will announce on RCD.1 Net: "Your Attention Please: OPNR________ we remain at T-_____ minutes and holding. Range Status is Not Proceeding." The OPNR and T-Time are dependent on the launch and the time that the built-in hold extension starts.

The RCO makes this announcement to inform all personnel on the range that a built-in hold extension is occurring. The RCO is authorized to announce that Range Status is Not Proceeding, even if the ROC has not declared Range Status is Not Proceeding since a build-in hold extension meets the definition of Not Proceeding.

STEP 3: When Built-in hold extension starts, confirm the clock has stopped.

Since the MFCO and the RCO have a responsibility to ensure that the count stops when it is supposed to, they must confirm that the clock has stopped at the appropriate time.

STEP 4: This step is only accomplished ***IF*** hold extension actions were ***NOT*** taken. The MFCO, RCO, and ROC will conference (if required) to discuss that hold extension actions were not taken. Any of the three listed crew positions can initiate this conference when it is determined that a built-in hold extension have not occurred.

The conference is only required if the MFCO, RCO and ROC did not already discuss during the processing of another checklists. The notification may come from the launch agency through the ROC. At this point, each crewmember will notify their appropriate launch team members.

STEP 5: All crew members should log the Built-In Hold (BIH) extension actions taken.

7.6.2.2. Unscheduled Hold/Countdown Recycle (Vol 2 C/L 1-3)

ENTERING ARGUMENTS: The range crew is responsible for implementing the Unscheduled Hold/Countdown Recycle (C/L 1-3) when notified of any situation that causes an unscheduled hold during on-console operations.

The note, 'REFERENCE LAUNCH SUPPORT PLAN, RSOR OPERATIONS SUPPLEMENT, AND/OR USER COUNTDOWN FOR DETAILS CONCERNING HOW AND WHEN HOLDS WILL BE CALLED," reminds the crew to consult their on-console documentation first when encountering an unscheduled hold.

The Launch Support Plan (LSP) and user documentation will contain specific instructions on what channels to make hold announcements on, and any other requirements necessary. These requirements usually include throwing the hold-fire switch when appropriate.

STEP 1: When an unscheduled hold occurs, the RCO will announce on RCD.1 Net, "Your attention please: We have a hold on OPNR______: T-________ (min/sec) and holding, all areas standby." The OPNR and T-Time are dependent on the launch and the time that the unscheduled hold occurs. The RCO makes this announcement to inform all range personnel of the unscheduled hold.

STEP 2: The MFCO, RCO, and ROC will conference (if required) to discuss the reason for the unscheduled hold. Any of the three listed crew positions can initiate this conference when the reason is determined for the hold actions. The conference is only required if the MFCO, RCO and ROC did not already discuss the reason for the unscheduled hold during the processing of another checklists.

At this point, each crewmember will notify their appropriate launch team members of the situation. The RCO will also tell the ISRO to ensure range assets are held in current configuration until released. It is necessary to keep range assets in current configuration in the event that the launch team might need to accomplish a quick recycle and count pickup.

STEP 3: When the launch agency notifies the ROC of the recycle time, the ROC will pass the recycle time to the appropriate crewmembers who will then notify their appropriate launch team members.

STEP 4: When a countdown recycle occurs, the RCO will announce on RCD.1 Net, "Your attention please: We have recycled the count on OPNR______, T-________ (min/sec) and holding. Range Status is Not Proceeding." The OPNR and T-Time are dependent on the launch and the recycle time. The RCO makes this announcement to inform all range personnel of the countdown recycle. The RCO is authorized to announce that Range Status is Not Proceeding even if the ROC has not declared Range Status is Not Proceeding since a build-in hold extension meets the definition of Not Proceeding.

STEP 5: All crew members should log the unscheduled hold and the reason for it in addition to the recycle time.

7-7 NEW T-0 COORDINATION

7.7.1 PURPOSE

New T-0 coordination procedures occur following an unscheduled hold to ensure the entire launch team is ready to support the new T-0.

7.7.2 PROCEDURES/CHECKLISTS

7.7.2.1 New T-0 Coordination (Vol 2 C/L 1-4)

ENTERING ARGUMENTS: The range crew is responsible for implementing the New T-0 Coordination (Checklist (C/L) 1-4) when the launch agency or the range identifies any situation that necessitates setting a new T-0. Situations that would initiate a new T-0 coordination include any launch agency or range item that stops the team from attempting to launch at the current specified T-0.

The note, **"IF LDA WITHDRAWS RANGE CLEAR TO LAUNCH, THE ROC MUST ENSURE FCTL POLL IS REACCOMPLISHED BEFORE PICKING UP THE TERMINAL COUNT,"** reminds the crew to coordinate the Final Clear to Launch (FCTL) Poll with the LDA before the terminal count is initiated.

STEP 1: The ROC will obtain a new T-0 request and launch agency status from the launch agency. This can occur either by the launch agency coming to the ROC, or the ROC proactively asking the launch agency if they have a new T-0 time. The ROC also needs to request the countdown resumption time from the launch agency to ensure that all agencies understand what time the count will pick up.

STEP 2: At this point, the ROC will ensure the T-0 request is valid. In order to be valid, it cannot be during a Safety COLA. It must be within the approved, scheduled launch window. A current risk assessment must have been accomplished for the new T-0.

STEP 3: Once the ROC has verified that the T-0 requested is valid, the ROC will continue. This step is only required if entering the terminal count while Range Status is Proceeding with Exceptions, or the User is currently No-Go. A Hold Point and a Hold Initiator must be coordinated with the LDA/OD (LDA approval is required), Launch Agency (MD/LD approval required), RCO, and MFCO. The Launch Agency will not launch in a NO-GO condition; however, the Launch Agency/Range may proceed into the terminal count in a NO-GO condition should a situation warrant, contingent upon the approval of the MD/LDA. Should the launch agency/Range remain NO-GO at a pre-coordinated time (hold point), the Launch Agency/Range (hold initiator) will call a hold on the primary countdown channel.

STEP 4: The ROC will report approval or disapproval for the T-0 to the Launch Agency. If the T-0 is approved, the ROC will continue to Step 5. If it is disapproved, the ROC will return to Step 1 and obtain a new T-0 request from the Launch Agency.

STEP 5: The ROC will relay the approved times for T-0 and countdown resumption time to the appropriate crewmembers who will then notify their appropriate launch team members.

STEP 6: The RCO will announce, if time permits, on RCD.1 Net, "Your Attention Please: We will resume the count on OPNR ______ at ________Z where it will be T-______ (min/sec) and counting. Range Status is ______" This announcement informs all personnel on the range when the count will resume. If there is not enough time to make this announcement before the count is actually initiated, then this step is unnecessary.

STEP 7: When the count resumes, the RCO will announce on RCD.1 Net, "Your Attention Please: We have resumed the count on OPNR ________, T-________ (min/sec) and counting." This announcement informs all personnel on the range that the count has resumed.

STEP 8: All crew members should log the new T-0 coordination actions.

7-8 LAUNCH SCRUB

7.8.1 PURPOSE

Launch scrub procedures are contingency procedures used when a launch is canceled after the range has picked up the count on launch-day. These procedures ensure the vehicle is in a safe, non-launch configuration before releasing range safety support and facilitate the rescheduling of the launch operation.

7.8.2 Procedures/Checklist

7.8.2.1 Scrub (Vol 2 C/L 1-9)

Cancellation of launch operations after the range has picked up the count on launch-day. It is called a "reschedule" if it occurs prior to picking up the Range Count.

7.8.2.2 Voice Recordings

EWR 127-1 paragraph 7.11.2a and AFSPCMAN 91-711 paragraph 7.4.2.1.2 require that the MFCO communication nets be recorded for all launches and be filed for a minimum of 45 days. These recordings may be referenced to recreate events that occurred during the countdown or during flight, especially if a catastrophic event occurred or destruct actions were taken. The RGNext contractor uses four recorders in the MOC and four recorders in the XY building to record the various communication nets used during a launch operation. Each recorder utilizes 1-inch analog magnetic tape and can record up to 20 voice channels. These analog magnetic tapes are kept for a minimum of 45 days. In addition, the RGNext contractor records all of the comm channels on the MFCO panels in real time on Compact Disk (CD), starting at approximately L-3 hours through Range Safety release. Each CD can hold 80 minutes of data, so usually three CDs are created per mission. The voice recordings referenced in this chapter and the checklists refer to these CDs. At the end of each launch or mission scrub, the MFCO will determine the disposition of these CD recordings. If the MFCO chooses to keep the voice recordings, the RGNext contractor will deliver the CDs to the RCO or MFCO post-launch. If the MFCO chooses not to keep the recordings, the CDs will be kept and re-used for a later mission.

7.8.3 PARTICIPANTS/RESPONSIBILITIES

7.8.3.1 Operations Safety Manager (OSM)

IAW EWR 127-1 paragraph 6.17.3.1a and AFSPCMAN 91-711 paragraph 7.3.1.1.2, the pad safety representative (OSM for all ELVs except Trident II) will monitor launch vehicle and Flight Safety System (FSS) status during a scrub and report to the MFCO when the launch vehicle is in a safe, non-launch condition by verifying the following:

- Ignition firing circuit disabled
- Safe and Arm Devices (S&As) safed
- Automatic Destruct Systems (ADUs) on external power (if the vehicle uses ADUs)
- CRDs on external power

The OSM will also report to the MFCO when the CRDs have been turned off.

7.8.3.2 Launch Agency

The launch agency, also known as the "customer," declares a scrub when necessary. They are the only agency that may declare a scrub and request a reschedule from the range.

7.8.4 OVERVIEW

Launch Scrub procedures, from the range crew standpoint, are only used on launch-day after the range has picked up the count and a problem occurs preventing the launch within the approved launch window. Launch scrubs are a common occurrence, so these procedures are used often by the range crew. There are various issues or problems that could arise on either the launch agency or Range side of operations that could cause a scrub. These include either or any combination of the following issues:

- Range instrumentation problems
- Launch vehicle problems
- Spacecraft/payload problems
- Ground Support Equipment (GSE) problems
- Launch Agency or Range Weather Launch Commit Criteria (LCC) violations
- Distance Focusing Overpressure (DFO)/Toxics/Debris LCC violations
- Fouled Ranges
- Safety or Mission Assurance COLAs (Collision Avoidance)

When a problem arises, the launch agency will assess whether the launch can still occur within the launch window and will make the determination on whether or not to scrub the launch attempt. If the range is experiencing problems that could prevent a launch, the RCO/ROC will keep the launch agency informed in order to help them make their determination. If the launch agency determines that the launch will not occur by the end of the launch window, the launch agency will declare the scrub to the ROC.

Once the ROC is notified of a launch scrub, the ROC will implement the Scrub Checklist 1-9. Once notified of the scrub by the ROC, the MFCO will implement the MFCO Scrub Checklist 1-9A. These checklists provide the range crew with an orderly procedure for accomplishing the tasks necessary for the scrub. The major tasks are to:

- Distribute the scrub notification to the Range Team and support agencies
- Ensure the launch vehicle is in a safe, non-launch configuration prior to releasing range safety support
- Coordinate new launch date requests from the launch agency for approval through Range Scheduling
- Notify the range team of the new launch date and time, if available
- Release the range assets and the crew

Once notified of the scrub, the ROC will initiate the notification chain of the scrub. For all launch vehicles except Trident II, the MFCO will verify with the pad safety representative, OSM for all ELVs except Trident II that the launch vehicle is in a safe, non-launch condition. Then the MFCO will release the FO-G from mission support and authorize the SCO to release the airspace. Then the MFCO will coordinate with the RCO to cease C-Band interrogation, if required. The RCO will reference the launch agency's scrub procedures and coordinate with the user to cease C-Band interrogation, if required. Once the MFCO and the launch agency are ready, the RCO will direct the ISRO to cease C-band interrogation and will notify the launch agency when C-band beacon interrogation has ceased. The MFCO will verify with the OSM that the CRDs are turned off and will coordinate with the RCO to remove the command carrier, if required. The RCO will reference the launch agency's scrub procedures and coordinate with the user to remove the command carrier, if required, and notify the MFCO when the launch agency is ready. The MFCO will direct the CSO to remove the command carrier and will notify the RCO when the command carrier is removed. The RCO will also notify the launch agency when the command carrier has been removed. Then the MFCO will release range safety instrumentation and direct whether or not to keep the voice recordings. The RCO will then coordinate with the launch agency to release range instrumentation and notify the ISRO when instrumentation has been released and whether or not to keep the voice recordings. Meanwhile the ROC will coordinate the new launch date and time, if requested, with Range Scheduling for approval and initiate the notification chain of the approved launch date and time. The ROC will also complete the 45 SW/Command Post (CP) Scrub Report.

Normally, the launch agency is given two consecutive days of opportunity to attempt their launch. A scrub the first day is easily re-scheduled for the next day, but should be coordinated with Range Scheduling before notifying the launch agency. When a launch agency has used up both days of opportunity without launching, a greater level of coordination is required. The launch agency may request another day through the ROC, but must submit a formal, written request to the operations group. The ROC should not agree to a particular day until notified by Range Scheduling that it is formally approved. Formal approval comes from the LDA in coordination with the 45 SW/CC.

7.8.5 PROCEDURES/CHECKLISTS

The Scrub Checklists 1-9 and 1-9A are implemented by the range crew when a scrub is declared by the launch agency after the Range has picked up the count on launch day. When making notifications of a scrub, if the agency to be notified is not on-console at the time of the scrub, there is no need to notify them IAW the C/Ls. In this case, notification will be made by Range Scheduling (DOUS). As a courtesy to the range crew, the RCO/ROC should notify any crew member that is not on-console at the time of the scrub.

7.8.5.1 SCRUB CHECKLIST 1-9

The ROC will initiate this checklist when notified by the launch agency of the decision to scrub. The Warning prior to step 1 reminds the crew that, for all launch vehicles except the Trident II, the MFCO will verify with the OSM that the launch vehicle is in a safe configuration prior to authorizing the release of Range Safety support. Personnel are not to release range safety instrumentation, support assets, or airspace until directed by the MFCO.

The Note prior to Step 1 reminds the RCO to reference the launch agency's scrub procedures in order to coordinate actions between the launch agency's procedures and the actions conducted IAW the Scrub C/L 1-9.

Note: The scrub procedures used by some launch agency's may be their recycle procedures as they simply “recycle” or back out of the current configuration into a configuration in which they can secure the vehicle and prepare for another launch attempt on a different day.

STEP 1: The ROC gets official notice of a scrub from the launch agency. If the launch agency has already determined when they will be able to try their next launch attempt, they may provide the ROC with a request for another launch day at this time. Depending on how late in the countdown the launch agency declared the scrub, they may not be able to make a 24-hour turnaround attempt and may request a new launch date 48 hours, 72 hours or even 1 week later.

On the other hand, due to the nature of the problem that caused the scrub, the launch agency may not be able to determine when they will be able to make their next launch attempt. As a result, they may declare a scrub without requesting a new launch date.

STEP 2: The ROC will initiate the scrub notification by notifying the team of the scrub and reschedule request information, if available. The RCO will direct the ISRO to ensure range assets are held in current configuration until released. This is to ensure that personnel and equipment remain postured while the launch vehicle is secured. Note that the MFCO will notify the SCO of the scrub and direct them to maintain launch-ready status. This means the SCO will not release airspace or support assets until the MFCO has authorized the SCO to release them. The MFCO will not inform the SCO of the reschedule request unless it has already been formally approved. This will prevent confusion until an approved launch date and time is officially determined. The SCO will notify the ACO and SSO of the scrub. When notifying Wing Command Post, the ROC will make the notification verbally over the phone. The ROC should not inform Wing Command Post of the reschedule request unless it has been formally approved. The ROC will e-mail the official Scrub Report at step 10. The ROC informs the LDA & Range Scheduling of the request since they are the approval authority and action office for schedule requests. If the request is for the user's scheduled second day of opportunity, this should be a quick notification/approval. If the request is for an unscheduled date, Range Scheduling will work with the LDA for an approved date and provide this to the ROC.

STEP 3: The RCO will announce on the Range Countdown net (RCD.1), "YOUR ATTENTION PLEASE, OPNR _____ HAS BEEN SCRUBBED FOR THE DAY, NO RESCHEDULE INFORMATION IS AVAILABLE AT THIS TIME. ALL PERSONNEL REMAIN AT YOUR STATIONS AND MAINTAIN CURRENT CONFIGURATION UNTIL RELEASED." The purpose of this step is twofold: to provide the initial notification of the scrub to all other interested parties on the Cape and at the downrange sites and to instruct personnel to remain at their consoles and maintain their equipment at the current configuration. This announcement helps to ensure that personnel remain focused minimized while the launch vehicle is being secured. If the approved, rescheduled launch date and time is known at the time this announcement is made, it may be modified to include the reschedule information.

Steps 4 and 5 will not be accomplished until the MFCO has been able to confirm that the launch vehicle is in a safe, non-launch configuration. Step 6 will not be performed until the MFCO has been able to confirm that the launch vehicle CRDs have been turned off. Step 7 will not be performed until the MFCO is ready to release range safety instrumentation. It is important that the RCO reference the launch agency's scrub procedures before coordinating Steps 5 and 6 with the launch agency. The launch agency's procedures specify the tasks and sequence of events that must be accomplished to secure the vehicle. Typically, the launch agency will notify the RCO when they want C-band interrogation to cease and the command carrier removed. It is important that the RCO follow along in the procedure and understand when the launch agency will request that these actions be accomplished. For example, the launch agency may request to turn the CRDs off prior to requesting that C-band beacon interrogation be terminated.

STEP 4: Once the vehicle has been confirmed to be in a safe, non-launch configuration, the MFCO will authorize the SCO to release the Range Safety special use airspace and support assets. The SCO will then notify the ACO to release the airspace and support aircraft and will notify the SSO to release surface support assets (such as the US Coast Guard assets). The ACO will notify the support aircraft that they are released and will direct the MRU to notify Miami ATC and NASA Tower that the Range Safety special use airspace is released. The ACO will also notify Patrick Tower (if supporting) of the scrub and airspace release. This will allow Patrick Tower to resume normal operations. (Note that during some runway operations in the past, aircraft performing touch and go landings have interfered with radar operations at Patrick. Patrick Tower should not be notified of the scrub and allowed to resume normal operations until the vehicle has been safed). The SSO will notify the US Coast Guard representatives in the Surveillance Room that Range Safety surface assets are released and the port can be re-opened, if previously closed for the launch.

STEP 5: Depending on the time in the countdown when the launch agency decided to scrub the launch attempt, the launch head radars may already be interrogating the C-band beacon on the launch vehicle. Prior to releasing the range instrumentation from launch configuration, the MFCO will confirm with the OSM that the launch vehicle is in a safe, non-launch configuration. Once the launch vehicle has been confirmed to be safed, the MFCO will authorize the RCO to cease C-band interrogation. The RCO will coordinate this with the launch agency IAW the launch agency's scrub procedures. If the launch agency requests that the RCO cease C-band interrogations prior to the RCO receiving authorization from the MFCO, the RCO must verify clearance with the MFCO prior to ceasing C-band interrogation. Once the RCO has received authorization from the MFCO and the launch agency, the RCO will direct the ISRO to cease C-band interrogation. The ISRO will coordinate this with the Radar Supersystem controller and report back to the RCO when interrogation has ceased. Upon confirmation by the ISRO, the RCO will notify the launch agency that C-band interrogation has ceased. Note that this step is not required for Trident II missions because Trident II missiles do not have a C-band transponder.

STEP 6: Depending on the time in the countdown when the launch agency decided to scrub the launch attempt, the command carrier may already be active. Prior to removing the command carrier, the MFCO will confirm with the OSM that the launch vehicle CRDs have been turned off. Once the launch vehicle CRDs are confirmed to be off, the MFCO will initiate the coordination to remove the command carrier with the RCO. The RCO will coordinate these actions with the launch agency IAW the launch agency's scrub procedures. When the launch agency is ready, the RCO will coordinate with the MFCO to remove the carrier IAW the applicable Command procedures (P9-1, or launch agency procedures). When directed by the applicable Command procedures, the Command Systems Officer (CSO) will remove the command carrier using the RASCAD and report to the MFCO, who will then notify the RCO. The RCO will then notify the launch agency that the command carrier has been removed.

STEP 7: Once C-band beacon interrogation has ceased and the command carrier has been removed, the MFCO will release range safety instrumentation and direct the disposition of the voice recordings. The current 1 ROPS policy is to keep the voice recordings and to file them within the mission folder. If the MFCO was not on-duty (the MFCO usually reports for duty 4 hours prior to T-0), the RCO will release range safety instrumentation after Steps 5 and 6 are accomplished (if applicable) and the voice recordings are not required to be saved. The RCO will also coordinate with the launch agency to obtain the release of range instrumentation support. Note that there may be circumstances in which the MFCO or launch agency will not be able to grant the release of all support instrumentation but may grant a release with exceptions. The RCO should never release range assets until the MFCO and/or launch agency no longer require them. Once the RCO has been authorized to release range instrumentation by the MFCO and the launch agency, the RCO will direct the ISRO to release Range and network assets. If a release with exceptions was granted, the RCO will need to relay these exceptions to the ISRO. If the MFCO directed that the voice recordings be saved, the RCO will also provide this information to the ISRO. The ISRO will ensure the voice recordings are saved.

Steps 8 and 9 should be accomplished if a new launch date/time was requested and approved. If the user does not have a reschedule request while the crew is still on-console, the request will come through Range Scheduling. This may be days later if an anomaly occurs that cannot be quickly corrected. If a new launch date/time was not requested or approved, the crew should proceed to Step 10.

STEP 8: Once the reschedule request is approved, the ROC will notify the Launch Agency, RCO, MFCO, RAC, LWO, LDA and OD. The MFCO will notify the SCO who will then relay that information to the ACO and SSO. The RCO notifies the ISRO and LCU. The ACO will notify the support aircraft of the new launch date and time if they are still in the airspace. Note that if the support aircraft are no longer in the airspace, their agencies will be notified by Range Scheduling of the new launch date and time. The ACO will then notify his/her team of the new launch date and time. The SSO will notify the US Coast Guard representatives in the Surveillance Room of the new launch date and time.

STEP 9: The RCO will announce on RCD.1, "YOUR ATTENTION PLEASE, OPNR _____ HAS BEEN RESCHEDULED FOR DD/MMM, WITH A NEW T-0 OF _____ ZULU." This announcement may not need to be made if the rescheduled date and time was announced in STEP 3 or if the launch agency could not determine a new launch date.

STEP 10: The ROC will use the Scrub Launch Report (Job Aid 2) to notify the WCP. It can either be e-mailed to CPOST@patrick.af.mil, or faxed to 4-2844. Once sent, the ROC should call to verify receipt. This job aid contains the information required by the WCP for their reporting. The required information that must be entered on each of the nine lines is self-explanatory and listed in parentheticals below the lines.

STEP 11: The range crew should log all actions.

7.8.5.2 MFCO SCRUB CHECKLIST 1-9A

The MFCO will initiate this checklist when notified by the ROC of the launch agency's decision to scrub. The Warning prior to Step 1 reminds the MFCO to not release supporting surveillance assets, airspace, or instrumentation until the launch vehicle is confirmed to be in a safe configuration.

The first note prior to Step 1 informs the MFCO of the criteria that the OSM will use for all vehicles, except Trident II, to confirm that the launch vehicle is safed. This includes verifying the following:

- Ignition firing circuit disabled: This ensures a firing pulse cannot be sent to the launch vehicle.
- Safe and Arm Devices (S&As) safed: This safes the destruct ordnance to prevent inadvertent activation.
- CRDs/ADUs on external power

The second note prior to Step 1 reminds the MFCO to reference the launch agency's scrub procedures in order to understand when the criteria in the first note are met and to coordinate actions between the OSM and the actions conducted IAW the MFCO Scrub C/L 1-9A. As previously mentioned, the scrub procedures used by some launch agency's may be their recycle procedures as they simply "recycle" or back out of the current configuration into a configuration in which they can secure the vehicle and prepare for another launch attempt on a different day.

STEP 1: Once notified of the launch scrub by the ROC, the MFCO will notify the SCO and the FO-G (if supporting and on-station) of the scrub and direct them to maintain launch ready status until released by the MFCO or SMFCO. This is to ensure that personnel remain alert, that the support assets remain at a safe location, and that the airspace is not released until the vehicle is confirmed to be safed. The MFCO will not inform the SCO and FO-G of the reschedule request unless it has already been formally approved. This will prevent confusion until an approved launch date and time is officially determined. Note that there is not a FO-G for Trident II missions.

STEP 2: The MFCO will verify with the OSM that the launch vehicle is in a safe non-launch condition. The MFCO should reference the launch agency's scrub procedures prior to performing this step to determine when the safing actions are performed and when to call the OSM to verify that the launch vehicle has been safed. Note that for scrubs during Trident II missions, the MFCO does not need to verify that the missile is safed because the vehicle is not armed for launch until it leaves the launch tube of the SSBN.

STEP 3: If the FO-G has already traveled to the Wire site for pad launches, the MFCO will release the FO-G from mission support. Note that there is not a FO-G for Trident II missions.

STEP 4: The MFCO will authorize the SCO to release the Range Safety special use airspace and non-contingency support assets to include the support aircraft and surface vessels such as the US Coast Guard.

STEP 5: Depending on the time in the countdown when the launch agency decided to scrub the launch attempt, the launch head radars may already be interrogating the C-band beacon on the launch vehicle. If C-band beacon interrogation is active at the time the scrub is declared, the MFCO will authorize the RCO to cease C-band interrogation. Note that this step is not required for Trident II missions because Trident II missiles do not have a C-band transponder.

STEP 6: Depending on the time in the countdown when the launch agency decided to scrub the launch attempt, the command carrier may already be active and the launch vehicle CRDs turned on. If the command carrier is active at the time the scrub is declared, the MFCO will verify with the OSM that the launch vehicle CRDs have been turned off. The MFCO should reference the launch agency's scrub procedures and monitor the AGCs on the RSD and TSO displays prior to performing this step. This will help the MFCO determine when to call the OSM to verify that the launch vehicle CRDs have been turned off. Note that this step is not required for Trident II missions because the CRDs on the Trident II missiles are not captured until after broach.

STEP 7: If the command carrier is active at the time the scrub is declared and the OSM/RSR has confirmed the CRDs have been turned off, the MFCO will initiate the coordination to remove the command carrier with the RCO.

The Note prior to Step 8 reminds the MFCO to not bring down the command carrier until the OSM has verified the vehicle CRDs are off (if required, depending on the vehicle) and the RCO has coordinated removal with the launch agency. The RCO will coordinate this task with the launch agency IAW the launch agency's scrub procedures. The RCO will then notify the MFCO when the launch agency has given clearance to remove the command carrier.

STEP 8: When the RCO notifies the MFCO that the launch agency is ready for the command carrier to be removed, the MFCO will direct the CSO to remove the command carrier IAW the applicable Command procedures (P9-1 or launch agency procedures).

STEP 9: The MFCO will notify the RCO when the command carrier has been removed and will then release Range Safety instrumentation. Note the note to provide exceptions if required. The MFCO may not be able to release all of the instrumentation used as Range Safety support after the command carrier is brought down. Upon releasing Range Safety instrumentation, the MFCO will also direct the disposition of the Range Safety voice recordings. The current 1 ROPS policy is to keep the voice recordings and to file them within the mission folder.

STEP 10: The MFCO will release the Range Safety Display (RSD) coordinator and the Range Safety Systems from mission support.

STEP 11: The MFCO will return the Command System Controller (CSC) Console key to the CSC.

STEP 12: The MFCO will direct the CSO to verify on RASCAD when the CSC console is active and has control of the Central Command Remoting System (CCRS). This ensures that the Command System has been handed off and is under CSC control before the MFCO steps off console.

The note prior to Step 13 reminds the MFCO that the last step of the checklist should be accomplished when the MFCO receives the approved reschedule date and time.

STEP 13: If the ROC notifies the MFCO that the reschedule request has been approved, the MFCO will notify the SCO.

7-9 MISFIRE/HANGFIRE/MECO

7.9.1 PURPOSE

Misfire/Hangfire/MECO procedures are contingency procedures designed to quickly notify the range crew when a launch vehicle experiences a misfire, hangfire, or Main Engine Cut-Off (MECO) (after ignition) at T-0 and to ensure the range crew remains alert for a possible launch.

7.9.2 DEFINITIONS

7.9.2.1 Ignition Signal

The ignition signal is an electronic signal sent to activate the initiator in the propulsion system of a launch vehicle. It is also referred to as the firing pulse.

7.9.2.2 Initiator

The initiator ignites the propulsion system when it receives the ignition signal.

7.9.2.3 Misfire

A misfire is a condition that exists when it is known that the ignition signal has been sent but did not reach an initiator and ignition of the propulsion system was not achieved. If the condition is confirmed to be a misfire, the 30-minute waiting period does not apply.

7.9.2.4 Hangfire

A hangfire is a condition that exists when the ignition signal is known to have been sent and reached an initiator but ignition of the propulsion system is not achieved. A hangfire could launch at any time. Any failure to launch or ignite properly shall be treated as a hangfire until it can be definitely established that a misfire has occurred or until a 30-minute waiting period has elapsed. If the propulsion system does not function after the 30-minute waiting period, it is declared a misfire.

7.9.2.5 Main Engine Cut-Off (MECO)

MECO is a condition that exists when ignition of the main engine of the launch vehicle propulsion system was achieved but was prematurely shutdown for some unknown reason and the launch vehicle did not liftoff.

7.9.3 PARTICIPANTS/RESPONSIBILITIES

7.9.3.1 Operations Safety Manager (OSM)

In the event of a hangfire, the pad safety representative (OSM for all Expendable Launch Vehicles (ELVs) except Trident II) will ensure the Flight Safety System (FSS) remains configured in a manner that will enable the MFCOs to initiate destruct actions, if necessary, in the event of an unforeseen launch. Once the event has been confirmed to be a misfire or following expiration of the 30-minute wait period in the case of a hangfire with solid propellant stages or solid propellant starter devices, the OSM will monitor the user's actions to secure and safe the launch vehicle, authorize the launch agency to safe the FSS, and report status to the MFCO.

7.9.4 OVERVIEW

A misfire/hangfire only occurs at T-0 when an ignition signal was sent to launch the vehicle. A

MECO occurs after ignition when the main engine starts but then unexpectedly shuts down. It will be very obvious that a misfire/hangfire/MECO occurred when the count goes to zero and the vehicle does not liftoff. The MFCO/SMFCO will detect that the launch vehicle did not ignite and/or liftoff through reports from the TSO, the Video Systems Officer (VSO) and the FOG, a lack of data on the Range Safety Displays, as well as visual data presented on the CCTV displays. The rest of the Range crew can verify that liftoff did not occur by viewing the CCTV channel displaying the launch pad and/or the lack of receipt of a first motion signal

IAW EWR 127-1 paragraph 6.17.3 and AFSPCMAN 91-711 paragraph 7.3.1.1.1, any failure to launch or ignite properly shall be treated as a hangfire until it can be definitely established that a misfire has occurred or until the 30-minute waiting period has elapsed. In the event of a hangfire, Pad Safety, the Range Operations Squadron, and the Range User shall ensure the FSS remains configured in a manner that will enable the MFCOs to initiate destruct actions, if necessary, in the event of an unforeseen launch. Upon detection of the failed liftoff, the MFCOs will initiate the MFCO Misfire/Hangfire/ MECO checklist (C/L 1-5A). The MFCO will direct all personnel on FCO.LCL to remain alert for launch and will continue to monitor the vehicle configuration and reference the user procedures. The SMFCO will direct the RCO to remain alert for launch and to maintain range assets in launch ready status until released by the MFCO or the SMFCO. The SMFCO will notify Systems Safety (SEA) and Pad Safety (OSM) to remain alert for launch and to inform the MFCO when the vehicle is safed. The SMFCO will also direct the RSD Coordinator to remain alert for launch.

Once the RCO/ROC receives notification of the situation from the MFCO, they will implement the Misfire/Hangfire/MECO checklist (C/L 1-5). The RCO will notify all supporting instrumentation to remain on alert for a possible launch for at least the next 30 minutes on the Range Countdown Net. The RCO will also direct the ISRO to ensure range assets are held in current configuration until released. The ROC will notify the LDA, OD, RAC, and LWO of the situation. The SCO will be notified by the MFCO and will relay the information to the ACO and the SSO, who will ensure the airspace remains closed and the surveillance assets remain at their MSPs.

When the vehicle is in a safe, non-launch condition, the OSM will notify the MFCO. In the case of a hangfire, it may take the OSM several minutes after the required 30-minute wait period to assess the vehicle status. When the launch agency has analyzed the situation, they will inform the ROC of their decision to either recycle the count or scrub the launch. Since it is very unlikely that the launch agency will be able to find and correct the problem in time to launch within the scheduled launch window, most misfire/hangfire/MECO situations result in a scrub.

7.9.5 PROCEDURES/CHECKLISTS

The Misfire/Hangfire/MECO checklists 1-5 and 1-5A are implemented by the range crew upon detection of a possible misfire, hangfire, or MECO situation. These checklists provide a general guideline of the actions to be accomplished in the event of a misfire, hangfire or MECO. It is essential that the crew reference the applicable launch vehicle procedures, if any, to ensure the crew completes the specific tasks required for that launch vehicle.

7.9.5.1 Misfire/Hangfire/MECO (Vol 2 C/L 1-5)

The Misfire/Hangfire/MECO checklist (C/L 1-5) should be implemented by the range crew upon notification by the MFCO of a misfire/hangfire/MECO situation. The launch agency countdown manual may contain Misfire/Hangfire/MECO procedures. If available, the RCO must reference these procedures in addition to C/L 1-5 to ensure the range crew accomplishes the tasks necessary to support the user.

The Note prior to Step 1 provides the definitions for a hangfire, misfire, and MECO to the crew.

Step 1: Upon detection of the failed liftoff, the RCO will announce on RCD.1, "YOUR ATTENTION PLEASE, ALL STATIONS SUPPORTING OPNR _____, REMAIN ON ALERT FOR A POSSIBLE LAUNCH FOR AT LEAST THE NEXT 30 MINUTES." This announcement notifies instrumentation sites on the Cape and the downrange sites to be aware of an impending launch.

Step 2: Each crewmember will notify their appropriate launch team members of the situation. The ROC will notify the LDA/OD, RAC and LWO of the situation. The RCO will ensure the Instrumentation Superintendent of Range Operations (ISRO) maintains the range assets in current configuration until released and notifies the Launch Correlation Unit (LCU). This action will keep all instrumentation prepared to track the vehicle if it launches. The SCO will notify the ACO and SSO of the situation. The ACO will ensure all support aircraft remain at their MSPs and will ensure the MRU Controller coordinates with Miami Missions to extend the airspace activation if required. This will prevent aircraft from entering the flight hazard area as a result of a delayed T-0. The ACO will also notify Patrick Tower (if supporting) and ensure the MRU notifies NASA Tower. The SSO will notify the US Coast Guard representatives in the Surveillance Room and will ensure the US Coast Guard maintains the Range Safety surface assets at their MSPs and keeps the port closed (if required).

NOTE: The RCO should reference the user's Misfire/Hangfire/MECO procedures, if available, to maintain situational awareness and to support the tasks the user needs performed for the particular situation. These procedures may contain tasks for the MFCO to include verifying engine shutdown or sending the "ARM" command in order to shut down the vehicle propulsion system (if required).

Step 3: The Range Crew should log all actions.

7.9.5.2 MFCO Misfire/Hangfire/MECO Checklist 1-5A

The SMFCO implements the MFCO Misfire/Hangfire/MECO checklist (C/L 1-5A) upon detection of a hangfire, misfire, or MECO situation.

The warning prior to Step 1 reminds all stations to remain alert and ready to support a possible launch for at least the next 30 minutes. This keeps the crew postured for launch until it can be determined whether a hangfire situation exists.

The first note prior to Step 1 reminds the SMFCO that any failure to launch or ignite properly shall be treated as a hangfire until it can be definitely established that a misfire has occurred or until the 30-minute waiting period has elapsed. It also provides the MFCO crew with the definitions for a misfire, hangfire, and MECO.

The second note prior to Step 1 reminds the SMFCO that the FSS shall remain configured in a manner that will enable the SMFCO to take destruct action if necessary until the OSM has verified to the SMFCO that the launch vehicle is no longer in a launch configuration.

The third note prior to Step 1 reminds the SMFCO to refer to the user checklist for misfire/hangfire actions. Some Range Users may require the SMFCO to perform certain functions such as to confirm engine shutdown on the TSO displays or to send the "ARM" command in order to shut down the vehicle propulsion system. Referencing the User checklist will also help the SMFCO to maintain situational awareness on the configuration of the launch vehicle and be able to ensure the FSS remains configured for a possible launch. The step also states that the MFCO may direct the SMFCO to begin implementation of this checklist and that the MFCO and SMFCO will ensure this checklist and the user checklist are run concurrently. The step also reminds the MFCO that they may need to transition to the Scrub Checklist 1-9A if the Range User scrubs the attempt as a result of the misfire/hangfire/MECO.

The fourth note prior to Step 1 reminds the SMFCO that OSM will notify MFCO when vehicle has been safed and is no longer a risk for flight (The OSM will ensure the FSS remains configured in a manner that will enable the MFCOs to initiate destruct actions, if necessary, in the event of an unforeseen launch. Once the event has been confirmed to be a misfire or following expiration of the 30-minute wait period in the case of a hangfire with solid propellant stages or solid propellant starter devices, the OSM will monitor the launch agency's actions to secure and safe the launch vehicle, authorize the launch agency to safe the FSS, and report status to the MFCO).

Step 1: The SMFCO will direct all MFCO support positions (TSO, CSO, VSO, SCO, and FO-G) to remain alert for launch and will continue to monitor the vehicle while the SMFCO processes the C/L procedure.

Step 2: The SMFCO will direct the RCO to remain alert for launch and maintain range assets in launch ready status until released by the MFCO or SMFCO. The RCO will then notify the ISRO and direct him to maintain the range assets in current configuration until released. This action will keep all instrumentation prepared to track the vehicle if it launches.

Step 3: The SMFCO will direct RSD Coordinator to remain alert for launch. This will alert the RSD personnel to the situation and help to ensure the RSD systems remain postured to receive data should the vehicle suddenly liftoff.

7-10 NON-NOMINAL/DESTRUCT/ERRANT LAUNCH

7.10.1 PURPOSE

Non-nominal/Destruct/Errant launch procedures help minimize the time necessary to coordinate important events associated with a non-nominal vehicle, destruct actions, or an errant vehicle. It is essential to minimize coordination time for these events, due to the serious nature of the events, and the possibility of a launch vehicle endangering lives. These procedures also ensure that the appropriate agencies are kept aware of the situation at all times.

7.10.2 DEFINITIONS

7.10.2.1 Errant Vehicle

An errant vehicle is a launch vehicle which fails to achieve its planned parameters, cannot be confirmed destroyed, and its predicted impact point (IP) can reasonably be assumed to be outside range safety destruct lines.

In order to be declared errant, all options to destroy it must be exhausted with no success. All options to destroy a vehicle that cannot be confirmed destroyed include:

- Recycling and resending functions using the other Flight Termination Unit (FTU)
- Directing the Command System Controller (CSC) to switch to the backup transmitter at the command site and resending functions
- Directing the Command System Officer (CSO) to manually switch to another capable command station and resending functions

7.10.2.2 Non-Nominal Vehicle

A non-nominal vehicle is a launch vehicle which fails to achieve its planned parameters, but its predicted IP remains within range safety destruct lines.

7.10.2.3 Security Classification Guide

The security guide is published for each classified launch, containing information on how to handle classified data.

7.10.2.4 Skid Strip

Aircraft runway on CCAFS.

7.10.2.5 OD400: Eastern Range Instrumentation Launch Mishap Management

Operations Directive (OD) 400 is used to establish procedures to verify personnel safety, direct Range instrumentation actions, and control Range instrumentation data when mishaps occur during a Range Instrumentation Countdown for a launch operation.

A mishap is defined as any launch vehicle related failure, accident, or incident involving Eastern Launch and Test Range (ELTR) controlled flight or test hardware, support equipment, personnel, or facilities that jeopardize vehicle flight, prevents accomplishment of a major test objective, or terminates the flight of a vehicle prematurely.

7.10.2.5.1 Mishap Response Categories

ELTR instrumentation mishap response actions are divided into three categories depending on when the mishap event occurs:

- **Pre-Launch Mishap:** A mishap that occurs after the start of the Range Instrumentation Countdown but prior to first motion.
- **Launch Mishap Type I:** A mishap that occurs after first motion but before the end of Range Safety coverage.

Range Safety Coverage is defined as the intervals of usable data from instrumentation systems used to comply with Flight Control and Range Safety requirements. The end of Range Safety coverage is defined specifically for each launch by 45 SW/SE as the Head-On-Gate.

- **Launch Mishap Type II:** A mishap that occurs after end of Range Safety coverage, to the end of ELTR coverage, including payloads that do not obtain orbit, and Range Safety system failures.

In the event of a pre-launch mishap, instrumentation and communications systems will maintain configuration to the maximum extent possible. Time critical mode changes may be performed to enable data preservation, equipment protection, and to begin or continue recording if applicable. In the event of a Launch Mishap Type I or Type II, instrumentation and communications systems will maintain launch configuration and record data as long as possible or until released by the ISRO.

7.10.2.6 Code Words

The SMFCO will use the following set of code words to alert the ROC, RCO, and SCO of the launch vehicle's status during associated non-nominal and errant events. If time allows, the SMFCO will announce the words three times on FCO.LCL.

Amber Zone: Used to signify non-nominal flight (outside of 3 sigma and/or any plus count situation that would cause the MFCO to consider invoking a mission rule).
Missile Red: Used to signify that destruct functions have been sent.
Missile Black: Used to signify that destruct has been confirmed.
Missile Orange: Used to signify that the vehicle is errant (all destruct actions have failed)
Missile Green: Used to signify that the vehicle has returned to nominal flight.

7.10.3 PARTICIPANTS/RESPONSIBILITIES

7.10.3.1 Mission Flight Control Officer (MFCO)

IAW EWR 127-1 paragraphs 7.2.3a.3 and 7.2.3a.4 and AFSPCMAN 91-711 paragraph 7.1.1., the MFCO monitors launch vehicle performance in flight and serves as the sole decision-making authority and initiator of the flight termination system, if required. The MFCOs makes the decision concerning continued flight or flight termination based on interpretation of real-time events, mission rules, all available data sources, and sound judgment. The MFCO notifies the ROC, RCO, and SCO of anomalous vehicle flight by utilizing established code words and directs the actions of the range crew in the event that flight termination actions are taken. The SMFCO and MFCO will implement their vehicle specific Post-Destruct checklist (C/L 1-6A or 1-6B) and if necessary reference their errant vehicle checklist (C/L 1-7A). The MFCO will direct personnel to take cover, direct the RCO to initiate the aural warning announcement, if required, and pass vehicle destruct or errant vehicle data to personnel as required.

7.10.3.2 Launch Emergency Operations Center (LEOC)

The LEOC's primary mission is to deploy immediately to the disaster scene in the event of a launch catastrophe to provide initial C2, to save lives, and to suppress and control hazards. The 45 MSG Det 1/CC, CD, or 45 MSG/CC serves as the LEOC/CC and functions as the on-scene commander during safing operations, controlling the impact area until safing operations are complete. The group is comprised of the CCAFS commander, range safety, operations safety, Explosive Ordnance Disposal (EOD), fire department, ambulance crew, environmental health, security police, and disaster preparedness, launch controllers, etc. The LEOC may coordinate with the Range to receive air support from the Jollies.

7.10.3.3 Interim Safety Board President (ISBP)

An ISBP is appointed by the 45 SW/CC for each mission and is normally not involved in the operation. The ISBP ensures data control, impounds all data, logs, test procedures, maintenance and training records, and receives and reports updates to the LEOC.

7.10.3.4 Program Support Manager (PSM)

The PSM for the operation will assist the ISB in retrieving applicable AF range data for the safety investigation.

7.10.3.5 Recovery Action Team (RAT)

For Atlas and Delta launches, RAT members are selected from the LCG and approved by the 45 SW/CC. In the event the launch vehicle is destroyed and the impact occurs on land, the user will opt to activate the RAT. In this case, the RAT then becomes responsible for all search and salvage activities.

7.10.4 OVERVIEW

Although the 45 SW has been very successful in launching various vehicles, we must always be prepared for a non-nominal launch. If a non-nominal launch occurs, the range crew must be ready to implement procedures to handle the situation. The two checklists we use for this contingency are the Non-nominal/Destruct (C/L 1-6) and Errant Vehicle (C/L 1-7) checklists. The MFCO uses vehicle specific checklists for their post-destruct actions. They also have a MFCO errant vehicle checklist that directs specific MFCO actions.

When a launch vehicle's flight becomes non-nominal, the MFCO will monitor the vehicle and give it a chance to return to nominal flight. Upon hearing indications of non-nominal flight (Amber Zone) on FCO.LCL, the Range crew will implement the Non-nominal Destruct C/L. At this point the crew monitors the situation and prepares to take action if the vehicle is destroyed. When it is determined the vehicle needs to be destroyed, the MFCO will use the command destruct system to transmit a signal to the vehicle which will detonate its explosive charges. To confirm destruction, the MFCO can use a variety of systems such as the Range Safety Control and Display (RASCAD), Command Message Encoder Verifier (CMEV), radar, telemetry, and optics. Upon confirmation of destruct (Missile Black) on FCO.LCL the Range crew will implement the appropriate steps of the Non-nominal/Destruct C/L while the MFCO will implement the appropriate steps of their vehicle specific post destruct C/L. If the vehicle is destroyed at the launch head, the MFCO will contact Cape Support Operations and direct them to make an Aural Warning announcement. This announcement will be made over the Aural Warning System and broadcast Cape-wide. If unable to confirm the vehicle was destroyed, the

MFCO declares vehicle errant (Missile Orange) and notifies the range crew who, in turn, will implement the Errant Vehicle C/L while the MFCO will implement their errant vehicle C/L.

When a vehicle is destroyed, the LEOC will safe and secure the launch vehicle impact/debris area if debris impacts land near the launch site. In this case, the ACO will obtain clearance from the MFCO to direct the support helicopters to return to base, refuel, and remain on standby until the LEOC clears them back into the area. At that time, the helicopters may be directed to land at the Skid Strip and board LEOC members. Actual recovery actions cannot begin until the LEOC has given the “all clear” for ground traffic back into the debris area. A Recovery Director will be appointed and the user will activate the Recovery Action Team (RAT). In the event the RAT is activated, the Recovery Director will be the Recovery Team Commander.

7.10.5 PROCEDURES/CHECKLISTS

The Non-nominal/Destruct/Errant procedures are implemented when a launch vehicle deviates from or fails to achieve planned flight parameters or the vehicle is destroyed in flight. These procedures consist of two checklists: The Non-nominal/Destruct checklist and the Errant vehicle checklist.

7.10.5.1 Non-Nominal/Destruct Checklist 1-6.

If destruct actions were taken before this checklist was entered, then go directly to Step 2. The first step is used when notified that the vehicle has entered non-nominal flight.

STEP 1: When the RCO, ROC, and SCO hears notification on FCO.LCL from the SMFCO that the vehicle is non-nominal (Amber Zone), each crewmember will notify their appropriate launch team members of the non-nominal flight.

The range crew then monitors the vehicle’s flight on FCO.LCL and will standby ready to continue the C/L when notified by the SMFCO that the vehicle is errant or destruct actions have been taken. If the vehicle returns to nominal flight, the MFCO will inform the range crew (Missile Green). The crew will return to normal operations and notify the personnel listed in Step 1. If destruct actions were taken, the crew will continue the checklist.

STEP 2: When directed by the MFCO, The SCO will direct the ACO/MRU controller to provide break away instructions to the support aircraft and the SSO/USCG to broadcast warnings to ships and boats. For Navy missions, the SSCO will issue breakaway instructions to the NAVO onboard the NMIS.

Do not pass breakaway instructions to the controller unless specifically directed by the MFCO. Doing so could endanger the aircraft. If and when directed to pass breakaway instructions, the ACO will immediately announce “BREAKAWAY, BREAKAWAY, BREAKAWAY” to the MRU controller who will make the call to the support ACFT. This call will instruct the pilot to fly in a 45 SW/SELR approved breakaway direction as documented in the applicable MSP letter. The ACO will verify all aircraft are clear of the affected area until released by the MFCO. The MFCO will release applicable hazard areas (air/maritime) as specified in the Hazardous Area Closures letter.

If destruction of the vehicle cannot be confirmed, (Missile Orange declared by the SMFCO) the crew should exit this checklist and implement Errant Vehicle C/L 1-7. When destruction is

confirmed, (Missile Black declared by the SMFCO) the crew should continue with the Non-nominal/Destruct C/L.
Additionally, crews will not allow mobile resources into the hazardous area until cleared. The Surveillance crew will ensure that the air and sea space within the hazard areas remain clear until released by the MFCO. The MFCO will release the applicable hazard areas (air/maritime) as specified in the Hazardous Area Closures letter.

Range assets may have to break launch configuration if site personnel have to evacuate for safety reasons. The ISRO will notify the RCO and RE of any site evacuations for situational awareness. Also, in the event of a mishap, the L-Clock will be configured to indicate the time elapsed since the mishap occurred.

STEP 3: The SMFCO will notify the team of the situation on FCO.LCL when the vehicle is confirmed destroyed or if it will be allowed to fall intact. The ROC will then notify the Launch Agency and LDA/OD of situation. The ROC will recommend implementing OD 400. Once concurrence is given by the LDA/OD, the ROC will direct the RCO to implement OD 400. The ROC will continue to notify the situation with the LWO and 45 SW/CP by calling 494-7001 and passing Job Aid 1. The RCO will notify the ISRO to implement OD 400. The RCO will also notify the LCU of confirmed vehicle destruct. The SCO will notify both the SSO and ACO of the situation. The ACO will then direct the MRU controller to hold all aircraft clear of the affected area as required. The ACO will also ensure Miami Missions & NASA Tower are notified.

Unless another vehicle is currently in flight, the MFCO will remove the command carrier and release the supporting command sites to Local Mode in order to: 1) Prevent damage to the command antennas while radars search for and track falling debris and 2) Allow JDMTA Command to perform a memory dump prior to exceeding the memory limit (Approx. 15 mins max)

STEP 4: After being authorized by the S/MFCO, the RCO will direct ISRO to release all command sites to Local Mode.

"DO NOT PASS CLASSIFIED FLIGHT STATUS VIA NON-SECURE MEANS" reminds the crew to be careful when discussing the situation over non-secure means. Some information such as the success or failure of Navy launches is classified. When in doubt as to the classification of information, the crew should reference the Security Classification Guide.

STEP 5: The RCO and SCO will obtain the Non-nominal Errant Missile Sheet (called a "data page") containing destruct data from the MFCO. This information includes: confirmed destruct time, predicted impact points in latitude and longitude, range to destruct in nautical miles, and vehicle's present position.

STEP 6: The SCO/ACO/ SSO/RCO will pass that information to their appropriate team members. This data page will be available after the MFCO plays back the Range Safety Display (RSD) to the point destruct actions were taken and then prints out the information.

STEP 7: The ROC will contact Range Scheduling to notify them of the situation, and to get an OPNR for the OD 400. This OPNR will be used to schedule all contingency support.

STEP 8: Each crewmember will provide the OPNR for the OD 400 to their appropriate launch team members. This OPNR will be used for all support of the OD 400.

STEP 9: The ROC passes Job Aid 1 to 45 SW/CP. It can either be e-mailed to CPOST@patrick.af.mil, or faxed to 4-2844. The required information on each of the ten lines is self-explanatory and listed in parentheticals below the lines. The ROC will call the WCP (VDL or 494-7001) to ensure they have received he document.

The SCO will obtain the hazardous area closure data from the SRA. If the mishap occurred at the launch head, the SRA will determine if the areas and times listed in the Hazardous Area Closure Letter are still valid based on the vehicle's position when the mishap occurred. If the data in the Hazardous Area Closure Letter is not valid, then the SRA will re-evaluate the applicable hazard area(s) and closure time(s). If the mishap occurred downrange of the launch head, the data in the Hazardous Area Closure Letter may/may not be valid and the SRA will have to re-evaluate the new hazard area and closure time. The SCO will either confirm that the Hazardous Area Closure Letter is still valid or obtain and distribute the updated Hazardous Area Closure data.

STEP 10: SCO will obtain the hazardous closure data from the SRA by either confirming the applicability of the Hazardous Area Closure Letter (if applicable), or obtain 6 copies of the updated Hazardous Area Closure data (if required). If Hazardous Area Closure data is updated, then the SRA will print out 6 copies in the Alpha printer in MCR 2 and notify the SCO. The SCO or DSCO will either retrieve the 6 copies from the printer or direct another member of the Surveillance team to retrieve them.

STEP 11: The SCO will either report to the MFCO and the Surveillance Team that the data in the Hazardous Area Closure letter is valid or deliver the updated Hazardous Area Closure data to the personnel, as applicable.

STEP 12: If requested, the SCO will coordinate Jolly support for the LEOC with the ACO. The ACO will coordinate with the MRU to direct the Jollies to RTB, refuel, and remain on standby to support the LEOC/CC.

Note that the ISRO will notify the RCO when all sources are no longer tracking debris. Unless another vehicle is currently in flight, the RCO will notify the MFCO and request a Range Safety release of real-time data recordings in order to stop the recorders and to expedite data processing.

STEP 13: RCO will report completion of debris track to the MFCO and request Range Safety release of real-time data recordings. The RCO will then report Range Safety release of real-time data recordings to the ISRO.

DO NOT PERFORM Steps 14 and 15 until authorized by the MFCO. The MFCO will not authorize personnel to perform these steps until the hazardous area closure times have expired.

STEP 14: When authorized by the MFCO, SCO will direct the ACO/MRU to open restricted airspace and SSO/USCG to broadcast the all clear to ships/boats.

STEP 15: When authorized by the MFCO, RCO will direct the ISRO to release Range Safety instrumentation IAW OD 400.

STEP 16: The range crew should log all actions.

7.10.5.2 Expendable Launch Vehicle Post-Destruct Checklist 1-6A.
Keep in mind that the steps from this C/L may be tailored to the situation to safeguard human life and property.

STEP 1: The SMFCO/MFCO should confirm that Destruct was sent. This is done by verifying that the FTU switch display for the Destruct command has a Red background with the word “XMIT” and the Destruct indicators on the RASCADs are illuminated along with the plus time that the command was sent. If Destruct was sent, the SMFCO will declare “Missile Red” by announcing “Missile Red, Missile Red, Missile Red” on FCO.LCL. If Destruct was not sent, the MFCOs will initiate their command contingency procedures.

STEP 2: The SMFCO/MFCO will confirm the vehicle is destroyed. This can be confirmed in several ways. The FOG or VSO may be able to visually confirm that the vehicle was destroyed. The TSO may be able to confirm destruction by the loss of telemetry data. If radar sites are tracking the vehicle and they detect a break-up of the vehicle, they will report “Break, Break, Code Blue” followed by their callsign (i.e. Gold 28) on the Impact Prediction Correlation (IPC) net. If another radar also detects the vehicle break-up, it will report its callsign and confirm “Code Blue.” Once destruction of the launch vehicle is confirmed, the SMFCO will declare “Missile Black” by announcing “Missile Black, Missile Black, Missile Black” on FCO.LCL.

If the launch vehicle has violated destruct criteria and you have exhausted all options to destroy it with no success, accomplish the errant vehicle C/L.

The L-Clock will be configured to indicate the time elapsed since the mishap occurred.

STEP 3: The MFCO will direct the FOG to take cover, if applicable. This is applicable when destruct actions are taken at the launch head.

STEP 4: The SMFCO will direct the SCO to broadcast warnings to ship/boats, breakaway the aircraft and consult SELR as required, if applicable. This is applicable when destruct actions are taken at the launch head or in the vicinity of support assets.

The note prior to Step 5 states the situation will dictate the urgency for destruct data. It will be necessary to release one system or DRSD for playback to get the most accurate vehicle data.

STEP 5: The SMFCO will release one of the RSD string for playbacks and direct the RSD coordinator to display pieces/debris to impact with the remaining RSD string(s). Note that the RSD String that is prime for designate and the RSD String that is selected for playbacks need to be different strings. Since FOV1-A is usually prime for designate, FOV1-B should be the string that is released for playbacks.

It will be necessary to allow all supporting command sites to take local control of their respective antennas to prevent damage to the command antennas while radars search for and track falling debris, and allow JDMTA Command to perform a memory dump prior to exceeding the memory limit (approx. 15 mins).

STEP 6: The S/MFCO will remove command functions.

STEP 7: The MFCO will direct the CSO to bring down the command carrier.

STEP 8: The MFCO will direct the RCO to report carrier down and release all command sites to Local Mode.

STEP 9: When the applicable RSD string has been played back to the time at which the vehicle was destroyed, the SMFCO will call up the data page, press the "Hard Copy" key on the keyset of the applicable RSD system, and direct the RSD coordinator to print five hard copies. These hard copies will be used by the SMFCO, MFCO, RCO, SCO and SEA.

STEP 10: The MFCO or another member of the Flight Control team will deliver the data page to the RCO and the SCO. Providing a hard copy is the preferred method for passing data to the RCO and SCO. If problems are encountered while attempting to print out the data pages, the MFCO will pass the vehicle information to include the destruct time, predicted impact point, range to destruct and Present Position to the RCO and SCO.

STEP 11: The MFCO or another member of the Flight Control team will deliver the data page to the SEA representative on-console and notify them as to whether the vehicle **was** or **was not** destroyed on the nominal trajectory. This information will be used to advise the LEOC of the debris pattern.

The SCO will obtain the hazardous area closure data from the SRA. If the mishap occurred at the launch head, the SRA will determine if the areas and times listed in the Hazardous Area Closure Letter are still valid based on the vehicle's position when the mishap occurred. If the data in the Hazardous Area Closure Letter is not valid, then the SRA will re-evaluate the applicable hazard area(s) and closure time(s). If the mishap occurred downrange of the launch head, the data in the Hazardous Area Closure Letter may/may not be valid and the SRA will have to re-evaluate the new hazard area and closure time. The SCO will either confirm that the Hazardous Area Closure Letter is still valid or obtain and distribute the updated Hazardous Area Closure data.

STEP 12: The SCO will report to the MFCO that the data in the Hazardous Area Closure letter is valid or deliver the updated Hazardous Area Closure data, as applicable.

The RCO will notify the MFCO when all sources are no longer tracking debris and request a Range Safety release of real-time data recordings in order to stop the recorders and to expedite data processing. **DO NOT** release real-time data recordings until debris track is complete.

STEP 13: After confirmation from the ISRO, the RCO will notify the MFCO that debris track is complete.

STEP 14: The MFCO will notify the RCO that real-time data recordings may be released.

DO NOT CONTINUE CHECKLIST ACTIONS UNTIL THE HAZARDOUS AREA CLOSURE TIMES HAVE EXPIRED.

STEP 15: The MFCO will direct the SCO to open restricted airspace/broadcast all clear to ships/boats.

STEP 16: The MFCO will direct the RCO to release Range Safety instrumentation IAW OD 400.

STEP 17: The MFCO will notify the RSD coordinator that the RSD systems are released.

STEP 18: The MFCO will return keys to CSC.

STEP 19: The MFCO will verify with the CSO that CSC is active and RSO is locked out on RASCAD.

7.10.5.3 Navy Launch Vehicle Post-Destruct Checklist 1-6B.
Keep in mind that the steps from this C/L may be tailored to the situation to safeguard human life and property.

If functions are not sent and the missile is allowed to fall intact IAW mission rules, the crew should immediately proceed to step 3. Otherwise, continue.

STEP 1: If Destruct was sent, the SMFCO will declare “Missile Red” by announcing “Missile Red, Missile Red, Missile Red” on FCO.LCL. If Destruct was not sent, the MFCOs will initiate their command contingency procedures.

STEP 2: The SMFCO/MFCO will confirm the vehicle is destroyed. Since radars are not normally used to track Trident II missiles and a FO-G is not used on Navy missions, destruct will usually be confirmed by the VSO and/or the TSO. Once destruction of the launch vehicle is confirmed, the SMFCO will declare “Missile Black” by announcing “Missile Black, Missile Black, Missile Black” on FCO.LCL. If Destruct cannot be confirmed, the MFCOs will initiate their command contingency procedures.

If the launch vehicle has violated destruct criteria and you have exhausted all options to destroy it with no success accomplish the errant vehicle C/L.

The L-Clock will be configured to indicate the time elapsed since the mishap occurred.

STEP 3: The MFCO will notify the RCO of the situation. You will need to make sure you identify the vehicle if the mission is a Trident II “Ripple” mission in which a second missile is launched shortly after the first, resulting in two missiles in the air at the same time.

STEP 4: The MFCO will direct the SCO on the LASS to take cover, breakaway launch area aircraft, and to broadcast warnings to ships/boats, if applicable. This is applicable when destruct actions are taken in the launch area. For DASO missions, which use Jolly support, the MFCO will need to direct the LASS SCO to breakaway aircraft when destruct actions are taken in the launch area.

STEP 5: The SMFCO will direct the SCO to breakaway assets in the terminal area and consult SELR as required. This is applicable when non-nominal flight or destruct actions are taken in the terminal area may endanger the NMIS ship or any P-3 aircraft supporting the mission in the terminal area (if applicable).

The situation will dictate the urgency for destruct data. It will be necessary to release one system or DRSD for playback to get the most accurate data for the RCO/LCU.

STEP 6: The SMFCO will release one RSD string for playbacks and direct the RSD coordinator to display pieces/debris to impact with the remaining RSD string(s) if radar support is available. Typically you will only have telemetry and TGRS data to track the vehicle and will not be able track pieces/debris. The situation will dictate the urgency for destruct data. It will be necessary to release one system or DRSD for playback to get the most accurate data for the RCO/LCU.

It will be necessary to allow all supporting command sites to take local control of their respective antennas to prevent damage to the command antennas while radars search for and track falling debris, and allow JDMTA Command to perform a memory dump prior to exceeding the memory limit (approx. 15 mins).

STEP 7: The SMFCO/MFCO will remove all functions.

If another vehicle is currently in flight, the crew should proceed to step 10. Otherwise, continue.

STEP 8: The MFCO will direct the CSO to bring down the command carrier.

STEP 9: The MFCO will notify the RCO the command carrier has been removed, and direct the RCO to release all support command sites to Local Mode.

STEP 10: When the applicable RSD string has been played back to the time at which the vehicle was destroyed, the SMFCO will call up the data page, press the "Hard Copy" key on the keyset of the applicable RSD system, and direct the RSD coordinator to print four hard copies. These hard copies will be used by the SMFCO, MFCO, RCO and SCO.

STEP 11: The MFCO or another member of the Flight Control team will deliver the data page to the RCO and the SCO. Providing a hard copy is the preferred method for passing data to the RCO and SCO. If problems are encountered while attempting to print out the data pages, the MFCO will pass the vehicle information to include the vehicle nomenclature, the destruct time, predicted impact point, range to destruct, and Present Position to the RCO and SCO.

The SCO will obtain the hazardous area closure data from the SRA. If the mishap occurred at the launch head, the SRA will determine if the areas and times listed in the Hazardous Area Closure Letter are still valid based on the vehicle's position when the mishap occurred. If the data in the Hazardous Area Closure Letter is not valid, then the SRA will re-evaluate the applicable hazard area(s) and closure time(s). If the mishap occurred downrange of the launch head, the data in the Hazardous Area Closure Letter may/may not be valid and the SRA will have to re-evaluate the new hazard area and closure time. The SCO will either confirm that the Hazardous Area Closure Letter is still valid or obtain and distribute the updated Hazardous Area Closure data.

STEP 12: The SCO will report to the MFCO that the data in the Hazardous Area Closure letter is valid or deliver the updated Hazardous Area Closure data, as applicable.
Note that if another vehicle is still in flight, wait for Final Nominal and then go back and accomplish steps 8, 9, 13, and 14. Also, the RCO will notify the MFCO when all sources are no longer tracking debris and request a Range Safety release of real-time data recordings in order to stop the recorders and to expedite data processing. Do not release real-time data recordings until debris track is complete.

STEP 13: The RCO will notify the MFCO that debris track is complete after confirmation from the ISRO.

STEP 14: The MFCO will notify the RCO that real-time data recordings may be released.

STEP 15: The MFCO will direct the SCO to open restricted airspace/ broadcast all clear to boats. It should be noted that this step **should not** be accomplished until the time to clear the airspace has elapsed.

STEP 16: The MFCO will coordinate with the RCO to release Range Safety instrumentation IAW OD 400.

STEP 17: The MFCO will notify the RSD coordinator that the RSD systems are released.

STEP 18: The MFCO will return keys to CSC.

STEP 19: The MFCO will verify with the CSO that CSC is active and RSO is locked out on RASCAD.

7.10.5.4 Errant Vehicle Checklist 1-7.
The Errant Vehicle checklist (C/L 1-7) will be implemented when the SMFCO notifies the range crew that the launch vehicle is errant (Missile Orange).

"DO NOT PASS CLASSIFIED FLIGHT STATUS VIA NON-SECURE MEANS" reminds the crew to be careful when discussing the situation over non-secure means. Some information such as the success or failure of Navy launches is classified. When in doubt as to the classification of information, the crew should reference the Security Classification Guide.

"If at any time the vehicle can be confirmed destroyed or if the vehicle impacts, go to Non-Nominal/Destruct checklist (C/L 1-6), Step 4" reminds the crew to exit this checklist and return to the Non-Nominal/Destruct checklist when destruct is confirmed or if the vehicle impacts the ground.

STEP 1: When the RCO, SCO, or ROC receives notification from the S/MFCO that the vehicle is errant (Missile Orange), each crewmember will notify their appropriate launch team members of the errant vehicle. The RCO will also direct the ISRO to implement OD 400. The instrumentation should continue to track the vehicle as long as possible. This information can be valuable if a recovery effort is made and it may aid in determining what went wrong with the vehicle. The command carrier must remain active to allow the MFCO to send additional destruct commands if necessary. ROC notifies 45 SW/CP (Job Aid 1 will be passed at step 6)

STEP 2: The RCO/SCO will obtain data page information from the MFCO to include Errant vehicle time, predicted impact location in latitude and longitude, distance downrange, errant vehicle present position in latitude and longitude, and new azimuth.

STEP 3: The SCO, ACO, and RCO will pass the above date to their appropriate launch team members.

The crew should not continue checklist actions until all sources are no longer tracking the vehicle. The ISRO will notify the RCO when all sources are no longer tracking the vehicle. The RCO will then notify the MFCO and request a release of the supporting command sites to Local Mode and release of the real-time data recordings.

STEP 4: The RCO will report loss of vehicle track to the MFCO and then request the MFCO release the supporting command sites to Local Mode release the real-time data recordings with the MFCO. When the MFCO has removed the command functions and removed the command carrier, the MFCO will release the command sites to local mode and release the real-time data recordings. The RCO will then notify the ISRO.

STEP 5: The ROC will contact Range Scheduling (1 ROPS/DOUS) to notify them of the situation, and to get an OPNR for the OD 400. This OPNR will be used to schedule all contingency support.

STEP 6: Each crewmember will provide the OPNR for the OD 400 to their appropriate launch team members. This OPNR will be used for all support of the OD 400.

STEP 7: The ROC passes Job Aid 1 to 45 SW/CP. It can either be e-mailed to CPOST@patrick.af.mil, or faxed to 4-2844. Once sent, the ROC should call to verify receipt. This job aid contains the information required by the WCP in order to develop their OPREP report to higher headquarters. The required information that must be entered on each of the nine lines is self-explanatory and listed in parentheticals below the lines.

Note that for errant vehicles, the data in the Hazardous Area Closure Letter will not be valid and the SRA will have to re-evaluate the new hazard area and closure time. The SCO will determine the hazardous area closure data with the SRA. The SCO will obtain and distribute the updated Hazardous Area Closure data.

STEP 8: SCO will obtain 6 copies of the updated Hazardous Area Closure data. The SRA will print out 6 copies in the Alpha printer in MCR 2 and notify the SCO. The SCO or DSCO will either retrieve the 6 copies from the printer or direct another member of the Surveillance team to retrieve them.

STEP 9: SCO delivers Hazardous Area Closure data to the team members.

Note that the ISRO will notify the RCO when all sources are no longer tracking the vehicle. The RCO will notify the MFCO and request a Range Safety release of the supporting command sites to Local Mode and release of the real-time data recordings. The MFCO will remove the command carrier and release the supporting command sites to Local Mode in order to allow JDMTA Command to perform a memory dump prior to exceeding the memory limit (Approx. 15

minutes max). The MFCO will release real-time data recordings to allow the recorders to be stopped to expedite data processing.

DO NOT PERFORM STEPS 10 AND 11 UNTIL AUTHORIZED BY THE MFCO.

STEP 10: SCO will direct the ACO/MRU to open the restricted airspace

STEP 11: RCO will direct the ISRO to release Range Safety instrumentation IAW OD 400

STEP 12: All crew members will log all actions

7.10.5.5 MFCO/SMFCO Errant Vehicle Checklist 1-7A.

The Errant Vehicle checklist (C/L 1-7A) will be implemented after the MFCO/SMFCO verifies that the launch vehicle is errant (Missile Orange)

The NOTE states that if at any time the vehicle can be confirmed destroyed or if the vehicle impacts go to the appropriate post destruct C/L. If also defines the term "errant" as a vehicle that has violated destruct criteria and that has had all options to destroy it taken with no success.

All options to destroy a vehicle include: 1) Recycle and resend functions using other FTU's 2) Direct CSC to switch select command stations to the backup transmitter and repeat sending functions 3) Direct CSO to manually switch to another capable command station and repeat sending functions.

STEP 1: SMFCO/MFCO should confirm the errant vehicle and if it is errant declare "Missile Orange".

STEP 2: The SMFCO should direct the SCO to breakaway support aircraft if it's required. This step is required if support aircraft are in an area that would endanger them.

STEP 3: When the vehicle has been declared to be errant, the SMFCO will call up the data page, press the "Hard Copy" key on the keyset of the applicable RSD system, and direct the RSD coordinator to print four hard copies. These hard copies will be used by the SMFCO, MFCO, RCO, and SCO. Note that the although the hard copy of the data page will capture the snapshot in time when the vehicle was declared errant, the data on the data pages on the displays will be continually changing and updating as the vehicle continues to fly.

STEP 4: The MFCO or another member of the Flight Control team will deliver the data page to the RCO and the SCO. Providing a hard copy is the preferred method for passing data to the RCO and SCO. If problems are encountered while attempting to print out the data pages, the MFCO will pass the errant vehicle information to include errant vehicle time, the predicted impact point, the distance downrange, the errant vehicle present position and the new azimuth range to destruct and predicted to the SCO and the RCO. Note that the data on the data pages on the displays will be continually changing and updating as the vehicle continues to fly.

STEP 5: The SMFCO will direct RSD to continue to monitor vehicle track and sources.

Once the ER instrumentation loses track on the vehicle, the MFCOs will continue with the C/L. The RCO will notify the MFCO when all sources are no longer tracking the vehicle and will request a release of the supporting command sites to Local Mode and release of the real-time data recordings to expedite data processing.

It will be necessary to allow all supporting command sites to take local control of their respective antennas to allow JDMTA Command to perform a memory dump prior to exceeding the memory limit (Approx. 15 minutes).

STEP 6: The SMFCO/MFCO will remove all functions

STEP 7: The MFCO will direct the CSO to bring down the command carrier.

STEP 8: The MFCO will report to the RCO the carrier is down, all support command sites are released to Local Mode, and real-time data recordings are released.

Note that for errant vehicles, the data in the Hazardous Area Closure Letter is valid unless reported by exception by the SRA. The SCO will obtain and distribute the updated hazardous area closure data if applicable.

STEP 9: The SCO will deliver the Hazardous Area Closure data to the MFCO if applicable.

Do not continue checklist actions until the hazardous area closure times have expired.

STEP 10: The SMFCO/MFCO will direct the SCO to open restricted airspace/broadcast the all clear to ships/boats. This step **should not** be accomplished until the time to clear the airspace has elapsed.

STEP 11: The MFCO will direct the RCO to release Range Safety instrumentation IAW OD 400.

STEP 12: The MFCO will notify the RSD coordinator that the RSD systems are released.

STEP 13: The MFCO will return keys to CSC.

STEP 14: The MFCO will verify with the CSO that CSC is active and RSO is locked out on RASCAD.

7-11 WEATHER OPERATIONS

7.11.1 PURPOSE

Weather has a large scale effect on operations at Cape Canaveral AFS and the Kennedy Space Center. In the last 20 years, weather constraints have been the cause of 47% of all scrubbed launch attempts and 37% of all delays. Overall, weather has impacted, by either scrub or delay, 28% of all launch countdowns since 1 Jan 1988. The Launch Weather Officer (LWO) and other members of the 45th Weather Squadron monitor and evaluate weather conditions continuously and notify the users and/or the range as appropriate for any expected constraint violation to any ground or launch operation.

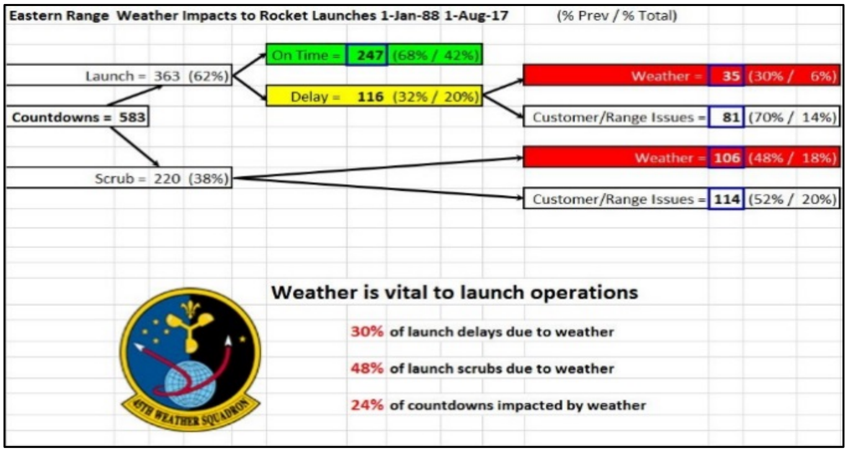


Figure 7-11-1: *Weather Scrubs*

7.11.2 DEFINITIONS

7.11.2.1 Routine Weather Operations

Routine weather operations are conducted 24 hours a day, 7 days a week for CCAFS, PAFB, KSC, and Port Canaveral. The weather team provides weather forecasts and issues weather watches, warnings, and advisories for these areas to ensure the safety of over 25,000 personnel and ensure resource protection for over $20 billion in facilities, not including flight hardware. This includes weather warnings for severe weather such as lightning, damaging winds, hail, and tornados. Lighting is a hazard of particular concern in Florida. Central Florida is referred to as the "Lightning Alley of the U.S." and there are over 1,200 lightning advisories issued in Central Florida per year.

Maximum for CCAFS/KSC = 16 flashes/km^2/Year

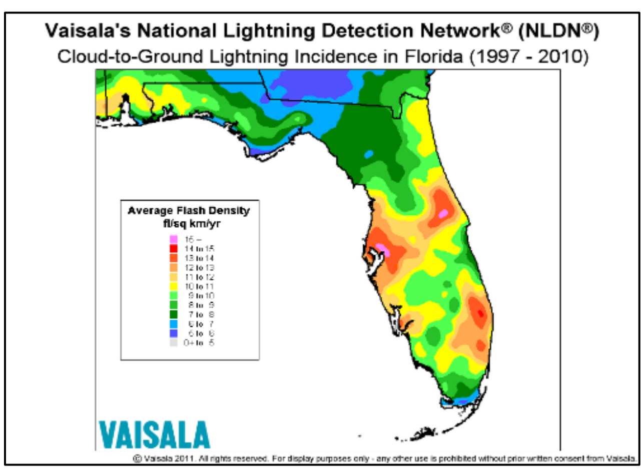


Figure 7-11-2: *Lightning Strikes*

7.11.3 WEATHER SUPPORT DURING EACH LAUNCH PHASE

7.11.3.1 Generation Phase Weather Support

During the generation phase, flight hardware, to include both launch vehicle components and spacecraft, are processed at facilities and launch pads at CCAFS and KSC for months prior to the launch. Over 5,000 ground processing operations are conducted per year. Weather can have a significant impact of these operations to include causing damage to the flight hardware or causing delays in ground processing operations, resulting in a slip of the launch date. The Weather Team provides support to ground processing operations in the form of weather briefings prior to the start of the operations and weather updates or advisories during the operations. These operations include:

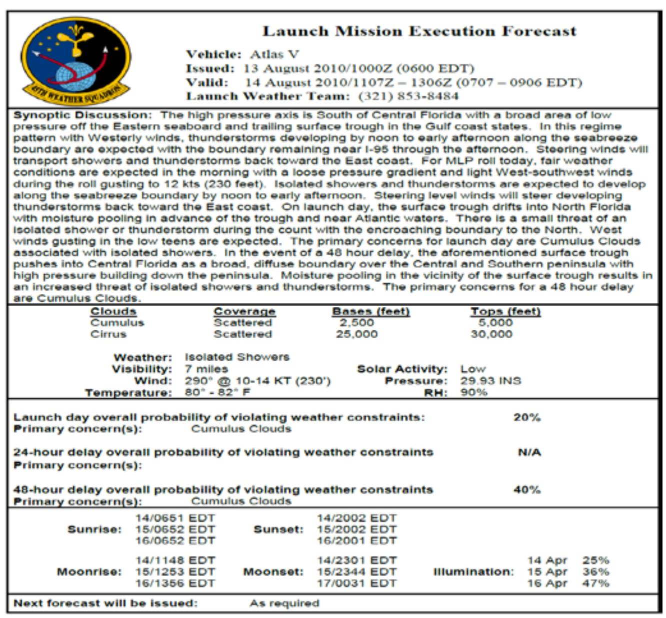
- Flight Hardware Receipt and Transport: Flight hardware (boosters, upper stages, payloads, fairings, and solid rocket motors), arrives at CCAFS via cargo aircraft, railcar, ocean-going barge, and truck. Offload and transport of various components have weather constraints associated with these operations.
- Launch Vehicle Stacking: Launch vehicle stacking involves lifting and mating several different parts of the rocket, including the booster, upper stage, payload, and payload fairing. Weather constraints vary for each stacking operation, but generally include limitations from lightning, ground winds, and precipitation.
- Mobile Service Tower (MST) Rollback/Mobile Launch Platform (MLP) Roll to Pad: This can occur during a scheduled launch complex operation. Weather constraints generally include limitations from lightning and ground winds.

Launch Vehicle tests at the launch pad: This can include tanking/de-tanking operations, avionics testing, integrated systems testing, etc. Weather constraints vary for each operation, but generally include limitations from lightning, ground winds, and precipitation.

7.11.3.2 Execution Phase Weather Support

7.11.3.2.1 Pre-Launch

During the Execution Phase, the Launch Weather Team (LWT) evaluates the Launch Safety weather Launch Commit Criteria (LCC) and the User WX LCC. At L-4 days or L-3 days, the LWT begins issuing daily Launch Mission Execution Forecasts or LMEFs to forecast the weather conditions for day of launch. The LMEFs provide a synoptic discussion which summarizes the expected weather conditions and patterns for launch day. It also provides the forecast probability of violating weather LCC on launch day. This is the overall probability of violating User and Range Safety LCC during the entire launch window. Also included are the probabilities for 24-hour and 48-hour turn-arounds (follow-on launch attempts after a launch



Launch Mission Execution Forecast

Vehicle: Atlas V
Issued: 13 August 2010/1000Z (0600 EDT)
Valid: 14 August 2010/1107Z – 1306Z (0707 – 0906 EDT)
Launch Weather Team: (321) 853-8484

Synoptic Discussion: The high pressure axis is South of Central Florida with a broad area of low pressure off the Eastern seaboard and trailing surface trough in the Gulf coast states. In this regime pattern with Westerly winds, thunderstorms developing by noon to early afternoon along the seabreeze boundary are expected with the boundary remaining near I-95 through the afternoon. Steering winds will transport showers and thunderstorms back toward the East coast. For MLP roll today, fair weather conditions are expected in the morning with a loose pressure gradient and light West-southwest winds during the roll gusting to 12 kts (230 feet). Isolated showers and thunderstorms are expected to develop along the seabreeze boundary by noon to early afternoon. Steering level winds will steer developing thunderstorms back toward the East coast. On launch day, the surface trough drifts into North Florida with moisture pooling in advance of the trough and near Atlantic waters. There is a small threat of an isolated shower or thunderstorm during the count with the encroaching boundary to the North. West winds gusting in the low teens are expected. The primary concerns for launch day are Cumulus Clouds associated with isolated showers. In the event of a 48 hour delay, the aforementioned surface trough pushes into Central Florida as a broad, diffuse boundary over the Central and Southern peninsula with high pressure building down the peninsula. Moisture pooling in the vicinity of the surface trough results in an increased threat of isolated showers and thunderstorms. The primary concerns for a 48 hour delay are Cumulus Clouds.

Clouds	Coverage	Bases (feet)	Tops (feet)
Cumulus	Scattered	2,500	5,000
Cirrus	Scattered	25,000	30,000

Weather: Isolated Showers
Visibility: 7 miles **Solar Activity:** Low
Wind: 290° @ 10-14 KT (230') **Pressure:** 29.93 INS
Temperature: 80° - 82° F **RH:** 90%

Launch day overall probability of violating weather constraints: 20%
Primary concern(s): Cumulus Clouds

24-hour delay overall probability of violating weather constraints N/A
Primary concern(s):

48-hour delay overall probability of violating weather constraints 40%
Primary concern(s): Cumulus Clouds

Sunrise: 14/0651 EDT, 15/0652 EDT, 16/0652 EDT
Sunset: 14/2002 EDT, 15/2002 EDT, 16/2001 EDT
Moonrise: 14/1148 EDT, 15/1253 EDT, 16/1356 EDT
Moonset: 14/2301 EDT, 15/2344 EDT, 17/0031 EDT
Illumination: 14 Apr 25%, 15 Apr 36%, 16 Apr 47%

Next forecast will be issued: As required

Figure 7-11-3: *Launch Mission Execution Forecast* scrub). Each probability includes the specific LCC rules of concern. The LWO will also brief the weather forecasts for these days during the Launch Readiness Review (LRR). The LWO will brief the community on the same information that is published in the LMEFs as well as explaining the weather factors that may affect the various events and areas in the launch day timeline such as tower roll/roll to the pad, propellant load, and the launch window. This information is used by the launch team to determine whether or not to proceed with the launch attempt.

7.11.3.2.2 Launch Weather Team

Figure 7-11-4: *Launch Weather Team*

The evaluation of weather Launch Commit Criteria (LCC) is a combined Launch Weather Team (LWT) effort. All LWT members play a crucial role in this process. Those members include the following:

- Launch Weather Commander (LWC). This is a mission support position that is usually fulfilled by the 45 WS/CC or DO. The LWC provides oversight to the LWT and high-level technical support to the LDA. The LWC has overall authority and responsibility for weather support provided, and decisions made, during a launch operation.
- Launch Weather Director (LWD). This position is filled by a certified LWO. The LWD orchestrates the LWT, including quality control and emergency procedures. The LWD assumes senior weather officer duties in the absence of the LWC.
- Launch Weather Officer (LWO). This is a mission support position. The LWO is the 45 WS individual who is assigned as the lead to provide all weather support for that launch. This includes activities during the generation, execution, and recovery phases of operations. Types of support include attending meetings, presenting operational briefings, coordinating meetings and support, and actions contained in applicable checklists when performing launch operations duties. The LWO monitors, evaluates, and reports violations/non-violations of weather constraint criteria during flight hardware processing, launch countdown, and post-launch operations

- Radar LWO. This position is filled by a certified LWO. The Radar LWO monitors weather radar and lightning equipment and immediately provides inputs to the LWO if or when any violations of weather criteria occur.
- Reconnaissance LWO (Recce). This position is filled by a certified LWO. The Recce coordinates support from a contract weather reconnaissance aircraft. This person also directs aircraft to areas of interest and uses aircraft reports, in combination with the Radar LWO, to validate weather conditions observed by radar equipment.
- The weather reconnaissance aircraft observer provides real-time weather observations to the Reconnaissance LWO. The reason the weather reconnaissance aircraft is used is because ground and space based weather instrumentation alone does not always enable the LWT to adequately assess Natural and Triggered Lightning Launch Commit Criteria (LCC). The observations can help the LWT to confirm that LCCs are, or are not, violated.

The primary weather reconnaissance aircraft used for Expendable Launch Vehicle (ELV) launch operations is the Learjet Model 31. The radio call sign used by this aircraft is "Weather One." WX-1 is on-standby for use in support of ELV launch operations at L-3 hours. When the aircraft is on the ground awaiting call-up for support, it is at Sanford International Airport in Sanford, Florida. If required, the Reconnaissance LWO will direct WX-1 to take-off. The take-off time will be determined based on the weather conditions, the length of the launch window, and the capability of WX-1 to support the entire launch window based on fuel constraints. Typically WX-1 arrives in the Launch Area by L-1 hour and 30 minutes and begins to perform weather observations. However, the DLWO-Recce will direct the aircraft to areas of interest for observation and reporting based on coordination with other members of the LWT.

Figure 7-11-5: *Weather One (WX-1)*

If WX-1 is unable to support the launch due to maintenance problems, the LWO will rely on the other tools and equipment available to assess the weather conditions. The loss of WX-1 may drive the LWO to be more conservative in their evaluation of the weather conditions.

Weather reconnaissance aircraft are not mandatory for launch support.

7.11.3.2.3 Day of Launch

On launch day, the LWT evaluates weather Launch Commit Criteria using satellite imagery, weather radars, lightning detection systems, wind towers, wind profilers, weather aircraft and weather balloons.

Weather balloons are used in support of launch operations to provide data for a variety of reasons. The Launch Agency uses the data for evaluation of the upper level wind constraints. The RAC uses the data for evaluation of Launch Safety LCC.

It takes time for the balloons to climb to the desired altitudes and for the data to be processed by the required agencies. In addition, the data is only valid for a certain period of time. As a result, the Balloon Release Schedule is defined to have the data available for specific weather briefings and critical milestones to ensure the data is available throughout the entire launch window in case of unexpected holds and to gather data for post-flight reconstruction.

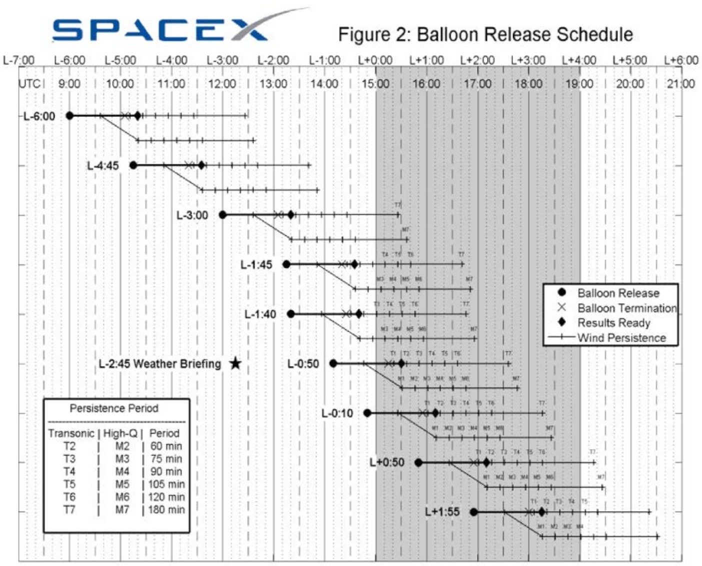


Figure 7-11-6: *Balloon Release Schedule*

In addition, the LWT provides data, support, and advice to other agencies. The Range User uses weather data to determine the impact of upper level winds on their flight profile. This may drive the User to be NO-GO for launch.

Throughout the countdown, the LWO will conduct weather briefings for the Range and the User via the appropriate Range and User voice net and Closed Circuit Television (CCTV), at various points in the countdown. There are two standard points in the Range Countdown in which the LWO briefs weather to the Range Team:

- Commander's Operations Briefing: The LWO briefs the weather conditions and forecast during the Commander's Operations Briefing. This briefing is conducted for the LDA at L-2 hours and 35 minutes.
- Range Weather Briefing: The LWO briefs the Range Team on the weather conditions and the forecast at L-1 hour.

The LWO also briefs the User at specific points in their countdown. These are typically conducted prior to critical milestones in their launch countdown and are used to help the User determine whether or not they should proceed with the next major milestone. This includes:

- MST Rollback or MLP Roll to the pad
- Cryogenic propellant loading
- Exiting the final Built-in Hold

The LWT must be absolutely clear and convinced that weather conditions are NOT violating constraints. If weather conditions occur that violate one or more of the established launch commit criteria, the LWO will notify the Range (MFCO, RCO, ROC) and the User. How the LWO makes these notifications depends on the LCC that is violated and the point in the countdown in which the violation occurs. If the violation occurs prior to exiting the Final Built-In Hold or prior to the Final Clear To Launch Poll (depending on the program), the LWO will notify the owner of the constraint first, then the LWO will notify the other agencies. For example, if the LCC that is violated is a Launch Safety LCC, the LWO will notify the MFCO, RCO, and ROC of the violation and then will notify the User. If a Launch Safety LCC violation occurs after the Final Built-In Hold, the LWO will call a hold until T-X which is the last time at which a hold may be called. If a User LCC violation occurs after the Final Built-In Hold, the LWO will report the violation in accordance with the User's specific procedures. This may be done by calling a hold until a certain specified point in the countdown or it may be conducted in the same manner as before the Final Built-In Hold or the Final Clear To Launch Poll.

After any GO/NO-GO weather condition is reported, the LWO updates the Launch Commit Criteria graphics and displays it over the Closed Circuit Television (CCTV) system.

7.11.3.3 Recovery Phase Weather Support

Following a launch, the LWT continues to monitor weather conditions to ensure safe recovery activities for the rest of the launch team. For example, support aircraft and vessels need current weather conditions and advanced notice of any significant weather as they return from their support positions. Additionally, weather support is provide during pad recovery operations. Following a Falcon 9 launch, the first stage and Dragon (if applicable) are recovered by ships and reused. Forecasts are issued at least daily for the recovery ships. The Dragon will also be recovered regardless of location (Pacific, Atlantic, or Gulf of Mexico). This mission will be 9-10 days. The forecast will include wave heights, winds, thunderstorms or bad landing weather which can scrub the planned recovery or even the landing attempt. After all recovery phase activities are complete, the Weather Squadron returns to their standard 24/7 operations.

7-12 EVACUATION

7.12.1 PURPOSE

Evacuation procedures are emergency procedures used during on-console operations to halt or secure operations, initiate system safing, and notify external agencies when a situation arises that warrants an evacuation of the MOC. These procedures streamline the tasks to be performed by the range crew.

7.12.2 PARTICIPANTS/RESPONSIBILITIES

The range crew is responsible for implementing evacuation procedures when the need for an evacuation arises. Each Center Supervisor (CS) is responsible for overseeing the actions of the crew members in their ops center. The ROC is responsible for the overall handling of the situation by the crew.

7.12.3 OVERVIEW

If the fire alarm sounds or a Public Address (PA) announcement is made directing personnel to evacuate, the range crew will implement evacuation procedures. Time is very critical when evacuating. Some situations may be very dangerous and could result in injury or loss of life if personnel do not evacuate quickly.

If an evacuation situation occurs during the minus count, actions will be taken to halt or secure operations and to initiate system safing. If the evacuation situation occurs during the terminal count, the MFCO and RCO will initiate hold actions. If an evacuation situation occurs prior to the terminal count for a pad launch, the MFCO and RCO will activate the holdfire switch to prevent the countdown from proceeding into the terminal count. For pad launches, the MFCO will then notify the OSM of the evacuation and direct the OSM to initiate system safing of the launch vehicle. The OSM will ensure the Launch Agency configures the vehicle into a safe, non-launch condition and powers down the Command Receiver Decoders (CRDs), as applicable.

Regardless of whether the evacuation situation occurs during the minus count or the plus count, the ROC will notify the Launch Agency of the MOC evacuation. In addition, the Surveillance Team will notify ATC agencies of the MOC evacuation and transition control of the aircraft to the appropriate ATC agency.

The Launch Agency will determine which actions they need to perform in order to secure operations, safe the launch vehicle, and/or manage the launch countdown. If the evacuation situation occurs during the minus count, the Launch Agency may continue the countdown until they reach the next critical milestone (ex: Cryo Loading, FTS Open Loop Checks, the next built-in hold, etc) in order to preserve the launch attempt. Once the applicable actions to halt or secure operations and initiate system safing have been completed, the Range crew will evacuate the MOC. The MRU will remain in the MOC to ensure the safe transfer of control of the aircraft unless his or her safety is in immediate jeopardy. During the plus count, the LDA, SMFCO, and MFCO will remain in the MOC to monitor vehicle flight, unless their safety is in immediate jeopardy (as determined by the LDA, SMFCO, or MFCO) or able to implement the “extended flight rule.” If their safety is in immediate jeopardy and they are unable to invoke the “extended flight rule”, the MFCOs will terminate flight and then evacuate the MOC.

Once at the evacuation point, each CS will account for their personnel and notify the ROC and the Facility Manager. Each crewmember will then notify the applicable external agencies of the MOC evacuation. They will also notify any personnel or assets that have not yet arrived on-station.

When the evacuation event is terminated, the Facility Manager will notify personnel when they can re-enter the MOC. When the event is terminated, each crew member will return to console, obtain status, and determine their ability to meet the next milestone or the requirement to recycle and/or scrub. The ROC will contact the Launch Agency to determine whether they want to scrub for the day or continue with the launch attempt. The ROC will poll each CS for status and report the Launch Agency's intention to scrub or to continue the launch attempt. If the Launch agency wants to continue the launch attempt, the ROC will assess the status reported by each CS, determine the ability of the Range to support the launch attempt, and determine Range Status. The range crew will notify the applicable personnel and agencies of their return to console and report status, as applicable. If required, the ROC will report Range Status to the Launch Agency and coordinate actions to continue the launch attempt.

7.12.4 PROCEDURES/CHECKLISTS

The Evacuation checklist (C/L 18) is implemented by the range crew during on-console operations when a situation arises that warrants an evacuation of the MOC.

EVACUATE ALL PERSONNEL IF THE FIRE ALARM SOUNDS OR A PA SOUNDS DIRECTING EVACUATION. Failure to comply may result in a serious injury or death.

DO NOT TOUCH OR MOVE A SUSPICIOUS OBJECT/BOMB. DO NOT TURN LIGHTS ON/OFF OR USE A RADIO WITHIN 300 FEET OF A SUSPICOUS OBJECT/BOMB. DO NOT EVACUATE INTO A MORE HAZARDOUS SITUATION. Failure to comply may result in serious injury or death.

If in the plus count, go to Step 4. Otherwise, continue.

STEP 1: The RCO and MFCO will perform hold actions **IF** in the terminal count. The RCO and MFCO will call a hold on the Launch Agency's primary launch operations net IAW the applicable launch vehicle hold procedures (ex: "Hold, hold, hold. This is the RCO with a hold for an evacuation of the MOC.") For pad launches, the RCO and MFCO will also activate the holdfire switch.

If evacuating during a pad launch, continue. Otherwise, go to Step 4.

STEP 2: If not previously accomplished, the RCO and MFCO will activate the holdfire switch. If an evacuation occurs prior to the terminal count of a pad launch, this step will be performed as part of system safing to prevent the countdown from entering into the terminal count.

STEP 3: The MFCO will notify the OSM of the MOC evacuation and will direct the OSM to perform system safing. The OSM will ensure the Launch Agency takes the appropriate actions to configure the vehicle into a safe, non-launch condition. If the command carrier is up, the OSM will coordinate with the Launch Agency to power down the CRDs.

STEP 4: The ROC will notify the Launch Agency of the MOC evacuation on the applicable Range coordination net or voice direct line. The Launch Agency will then determine which actions they need to perform in order to secure operations, safe the launch vehicle, and/or manage the launch countdown.

STEP 5: The SSO will notify the sea surveillance support aircraft of the MOC evacuation and direct the aircraft to contact the MRU (Cape Control) on the applicable Cape Control frequency. This step is performed in order to allow the MRU to transition control of the aircraft to the appropriate ATC agency.

STEP 6: The ACO will ensure the MRU performs ATC notifications and transfers control of the aircraft. The MRU will notify Miami Missions and Orlando Sector of the MOC evacuation. If the support aircraft are on-station, the MRU will also request the ATC agencies to assume control of the aircraft. Typically, Orlando Sector will assume control of the support aircraft flying at or below 16,000ft and Miami Missions will assume control of the support aircraft flying above 16,000ft. The ATC agencies will provide the MRU with the ATC contact frequencies for the applicable aircraft. The MRU will contact the support aircraft and direct them to contact the applicable ATC agency on the appropriate frequency.

The MRU will remain in the MOC to ensure the safe transfer of control of the aircraft unless his or her safety is in immediate jeopardy.

During the Plus Count, the LDA, SMFCO, and MFCO will remain in the MOC to monitor vehicle flight, unless their safety is in immediate jeopardy (as determined by the LDA, SMFCO, or MFCO) or able to implement the "extended flight rule."

STEP 7: Each crew member will secure classified, including the STE Cards, and evacuate with console documentation (checklists, logs, procedures, etc). Protection of classified material is important and every effort should be made to maintain control of it; however, personnel should not jeopardize personal safety to control the material. In addition, taking console documentation will help the crew to maintain a record of completed actions and to continue to process checklist actions; however, personnel should not jeopardize personal safety to gather console documentation.

When evacuating, all personnel will exit the building through the closest exit away from the dangerous condition and proceed to the Emergency Evacuation Assembly Point (EEAP) at the North end of the MOC parking lot. If there is a hazard at the MOC turnstiles, there is a break-out exit in the fence south of the MOC. Each CS should quickly scan their ops area on their way out to ensure all personnel have evacuated. **DO NOT GO OUT OF YOUR WAY TO SEARCH**. The range crew should not delay evacuation and endanger personnel to implement a search for missing personnel.

STEP 8: Once at the evacuation point, each CS will account for their personnel and report the results to the ROC and the Facility Manager. **DO NOT ATTEMPT TO GO BACK INTO THE FACILITY TO SEARCH FOR PERSONNEL,** you may endanger yourself or cause greater injury or loss of life. The rescue personnel are the ones trained in the proper techniques to search the building and locate anyone that is still inside. The ROC will track the accountability status of range operations personnel for situational awareness. The Facility Manager will track the accountability status of all personnel in the MOC and coordinate with emergency response agencies.

STEP 9: Personnel will report the situation to the applicable external agencies and to personnel or assets that have not yet arrived on-station.

If the LDA and OD have not yet arrived on station for the launch, the ROC will call them and notify them of the situation. The ROC will also notify the 45 SW/CP (494-7001) of the situation. If the ROC has been unable to contact the LDA or the OD, the ROC may request assistance from the 45 SW/CP in contacting the LDA or the OD.

If the MOC evacuation occurred after L-1 hour or personnel have not been allowed to return to console by 1 hour prior to the previously established T-0, the RCO will notify the LCU ((719) 474-4567) of the situation.

If the FO-G is proceeding to or is already on station in support of the launch, the MFCO will call and notify the FO-G of the situation.

If the MOC evacuation occurred after T-5 minutes or personnel have not been allowed to return to console by 5 minutes prior to the previously established T-0, the ACO will notify Patrick Tower (494-0038/494-2745) of the situation. This will allow Patrick Tower to continue to allow aircraft operations in the eastern half of Patrick AFB airspace. If the support aircraft from the 301st RS are not yet on station, the ACO will notify the 301st RS (494-8506) of the situation. This will allow the 301st RS to delay the take-off of the aircraft until the situation is resolved.
If USCG personnel and assets have not yet arrived on station for the launch, the SSO will notify the USCG Station (868-4200) of the situation. This will allow the USCG to delay the deployment of their assets until the situation is resolved.

When the actions listed above have been completed, the crew will continue to monitor the situation and await termination of the event. When the event is terminated, the Facility Manager will notify personnel when they can re-enter the MOC. When the event is terminated, continue with the following actions.

STEP 10: Each crew member will return to console, obtain status, and determine their ability to meet the next milestone or the requirement to recycle and/or scrub.

The ROC will contact the Launch Agency on the appropriate Range coordination net to report the termination of the MOC evacuation, to obtain the status of the Launch Agency's countdown, and to determine whether the Launch Agency wants to scrub or continue with the launch attempt. If the Launch Agency wants to continue with the launch attempt, the ROC will obtain from the Launch Agency their countdown status and coordinate the actions that need to be conducted to resume the countdown.

The RCO will contact the ISRO and determine the readiness of the range instrumentation/equipment and the status of the Range Instrumentation Countdown. In coordinating with the ISRO, the RCO will determine which instrumentation countdown tasks were completed prior to the evacuation, which tasks still need to be completed in order to catch-up in the countdown, and how long it will take to complete them. The RCO should take note of which instrumentation tasks can be conducted concurrently and which have to be conducted sequentially.

For pad launches, the MFCO will contact the OSM to report the termination of the MOC evacuation and to obtain the safing configuration of the launch vehicle. Note that if the CRDs have been powered down as part of safing the launch vehicle, the FTS Open Loop checks will have to be re-accomplished. If the FO-G is on station at the wire site, the MFCO will notify the FO-G of the termination of the evacuation.

The ACO will obtain status from the MRU to ensure that they have notified the ATC agencies of the termination of the MOC evacuation and have assumed control of any support aircraft in the area. The ACO will also notify the support aircraft of the termination of the evacuation and obtain their status and ability to support launch operations. If the 301st RS support aircraft are not on station, the ACO will notify the 301st RS (494-8506) of the termination of the evacuation and obtain the status of the support aircraft.

The SSO will coordinate with the USCG to determine the status of their assets and their ability to support launch operations. If USCG personnel and support assets are not on station, the SSO will call the USCG Station (868-4200) to notify them of the event termination and to obtain status.

The SCO will obtain status from the ACO and SSO and determine the ability of the Surveillance Team and support assets to support launch operations.

STEP 11: The ROC will poll each CS for completion of actions, assess mission impact, and determine Range Status. The execution of this step is dynamic and depends on the situation. The ROC may have to delay execution of this step until each CS has been able to execute their actions in Step 10. Prior to polling the CS team, the ROC should notify the CS team of the Launch Agency’s countdown status and the Launch Agency’s decision to scrub or to continue the launch attempt. The ROC will assess mission impact by polling each CS for status. When polled, each CS will report the completion of checklist actions, the status obtained in the Step 10, and the ability of their team to meet the next countdown milestone.

The RCO will report all actions complete (or exceptions), the readiness of the range instrumentation/equipment, the status of the Range Instrumentation Countdown, and the ability of Range instrumentation to meet the next countdown milestone, as applicable.

The MFCO will report all actions complete (or exceptions), the safing configuration of the launch vehicle, and the ability of the Flight Control Team to meet the next countdown milestone, as applicable.

The LWO will report all actions complete (or exceptions) and the ability of the Launch Weather Team to meet the next countdown milestone, as applicable.

The SCO will report all actions complete (or exceptions), the status of the surveillance assets, and the ability of the Surveillance Team to meet the next countdown milestone, as applicable.

If the Launch Agency has requested to continue with the countdown, the ROC will poll the RCO and MFCO for status and then determine Range Status (Proceeding, Not Proceeding, or Proceeding with exceptions).

STEP 12: Crew members will notify the applicable personnel and agencies of their return to console and report status, as applicable.

The ROC will notify the LDA and OD of the Launch Agency's countdown status to the team and whether the Launch Agency has decided to scrub or to continue the launch attempt. If the Launch Agency wants to continue the launch attempt, the ROC will notify the LDA and the OD of the Range's ability to support the launch attempt and Range Status (Proceeding, Not Proceeding, or Proceeding with exceptions). If the Launch Agency has requested to continue with the Launch Attempt, the ROC will notify the Launch Agency of Range Status and the ability of the Range to support the launch attempt. If the Range is able to support the launch attempt, the ROC will coordinate any necessary actions with the Launch Agency to continue the launch attempt. The ROC will notify the 45 SW/CC (494-7001) of the return to console and whether or not launch countdown operations will be resumed.

The LDA or OD will notify the MD or LD (as applicable) of the return to console. Depending on the status of the Launch Agency's countdown operations and the ability of the Range to support the launch attempt, the LDA or OD will coordinate any necessary information or status with the MD or LD.

If the MOC evacuation occurred after L-1 hour or personnel were not allowed to return to console by 1 hour prior to the previously established T-0, the RCO will notify the LCU ((719) 474-4567) of the return to console and will report the status of the countdown.

If the MOC evacuation occurred after T-5 minutes or personnel were not allowed to return to console by 5 minutes prior to the previously established T-0, the ACO will notify Patrick Tower (494-0038/494-2745) of the return to console and will report the status of the countdown.

STEP 13: All crewmembers will log actions.

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SECTION 8

POST MISSION

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8-1 POST MISSION

8.1.1 PURPOSE

Post-mission procedures, also called recovery phase procedures, establish a general outline and standardization for completing all post-mission actions. These procedures begin immediately after launch and include post-launch processing flow tasks such as launch pad safing, securing and turnaround, range asset reconfiguration, and mishap recovery operations as needed. Mishap recover operations are covered in another section.

8.1.2 INSTRUMENTATION/EQUIPMENT RELEASE

Prompt release of Range resources allows their maximum use, and minimizes costs to the Range User. There is no checklist for instrumentation release. The procedure steps are included in the Launch Support Plan (LSP) for release of instrumentation after an operation.

The RCO or ROC (vehicle dependent) is responsible for obtaining an instrumentation release from both Safety and the Launch Agency before releasing instrumentation. The RCO/ROC should request a release as soon as the instrumentation has completed its support for the operation. The RCO/ROC will wait for the MFCO (vehicle dependent) to initiate contact for coordination of release of the command carrier. Once the release is obtained, the RCO/ROC will record the time of release and inform the ISRO and ROC.

All personnel must record the times of instrumentation release. Recording this information is essential for proper payment of contracted off-Range support. Poor support documentation decreases the Air Force's ability to effectively oversee its contracts.

8.1.3 AIRSPACE/AIRCRAFT/VESSEL RELEASE

The SCO will release support assets and special use airspace IAW the 45 SW/SELF Hazardous Area Closure Letter. ACO coordinates release of support aircraft and Air Control Agency (ACA) assets and ensures the Military Radar Unit (MRU) releases airspace restriction (re-opens closed airspace). The SSO coordinates release of Coast Guard support vessels. All personnel must record the release times.

8.1.4 45 SW/CC HOTWASH

The Hotwash is a post-launch critique chaired by the LDA and facilitated by 1 ROPS/DOV. Its purpose is to identify problems, areas of concern, or trends and to assign action items. Rarely are solutions discussed, rather the intent is to assign issues for resolution. All Hotwash items are tracked by 1 ROPS/DOV in the Group Operations Review Panel (GORP). The ROC will forward Hotwash items for which 1 ROPS is the OPR to the 1 ROPS ORP Monitor.

8.1.5 ENHANCED HOTWASH

The Enhanced Hotwash is conducted approximately 7 to 10 days following a launch if required. This meeting, organized and chaired by the ROC and the appropriate 45 LCG Flight Commander (for missions with LCG participation) and facilitated by 45 OSS/OSK, provides a forum where each crewmember, including the range user, is free to discuss any items of interest or best practices. This meeting goes into more depth than the 45 SW/CC Hotwash since crewmembers have had some time to analyze their crew logs and the 2 and 7 day Anomaly Reports. The meeting utilizes the debrief process for operational issues which is accomplished IAW AFSPCI 10-415. The process uses event reconstruction, highlights the relevant issues (look for the "big rocks"), determines root cause, and develops a "fix" we can implement. Upon completion of the meeting, the ROC will draft the Enhance Hotwash minutes (EHW) in memorandum format. The EHW may not be required if after completing internal debriefs, it is noted that no issues dealing with multiple agencies occurred. If this is the case the EHW minutes will still be drafted up stating why a EHW did not need to take place. The minutes include a list of members and their crew positions, a discussion of each item of interest discussed, recommended actions, and best practices. The minutes are then reviewed by the 45 LCG/CC and 45 OG/CC and may be briefed to the 45 SW/CC during a weekly Ops Status briefing.

8.1.6 CONTRACTOR INSTRUMENTATION ANOMALY REPORTS

The ERTS contractor produces two anomaly reports following each launch.

- 2 Day Anomaly Report: Following a RGNext meeting consisting of the ISRO, TA, RGNext Mgmt, Supersystem Controllers, and technicians which occurs approximately two days following a launch, the 2 Day Anomaly Report is drafted as a snapshot document of all anomalies that were tracked in count and identifies if further investigation/root cause/analysis is needed.
- 7 Day Anomaly Report: A second meeting occurs approximately nine days following the launch resulting in a second report. This report is similar to the 2 Day but more in-depth. This report also includes a countdown summary. Every anomaly is discussed in length along with current status. The report gives each anomaly a tracking number, root cause, current system status, identifies a resolution agency, identifies how many subsystem anomalies the specific subsystem encountered, and identifies an expected completion date (ECD).

8.1.7 PROCEDURES

After a launch, the range crew will accomplish the following:

- The ROC, MFCO, SCO, PSM, and RCO (if available) will attend the 45 SW/CC Hotwash and debrief any Range Crew members who were unable to attend.
- Complete all logs.
- The RCO should support the contractor’s Post Mission Critique if requested.
- Support user post-mission meetings.
- Provide the RCO all logs and mission folders within two (2) duty days of the launch. The RCO will compile the mission folders and logs in one electronic folder located on the RANS drive in the “Mission Folders” section.
- The ROC will identify operational issues to the Operations Officer as soon as possible after the operation. The ROC will ensure all operational issues are presented to the ORP for action. The RCO will also ensure all non-operational issues are briefed to the appropriate section for action and closure.

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1 ROPS- 1st Range Operations Squadron	45 LCG- 45th Launch Group
45 LCSS- 45th Launch Support Squadron	45 MDG- 45th Medical Group
45 MSG- 45th Mission Support Group	45 OG- 45th Operations Group
45 OSS- 45th Operations Support Squadron	45 RMS- 45th Range Management Squadron
45 SCS- 45th Space Communications Squadron	45 SW- 45th Space Wing
45 SW/SE- 45th Space Wing Safety Office	45 WS- 45th Weather Squadron
5 SLS- 5th Space Launch Squadron	920 RQW- 920th Rescue Wing
ACME- Automated Command Message Evaluation	ACO- Aerospace Control Officer
ADP- Acquisition Data Processor	ADS- Automatic Destruct System
AF- Air Force	AFLD- Air Force Launch Director
AFSCN- Air Force Satellite Control Network	AFSPC- Air Force Space Command
AFSPCI- Air Force Space Command Instruction	AFSPCMAN- Air Force Space Command Manual
AFSS- Autonomous Flight Safety System	AGC- Automatic Gain Controllers
AIB- Accident Investigation Board	AMPS- Automated Meteorological Profiling System
AOC- Air and Space Operations Center	APC- Audio Plus Count
ASOC- Atlas Support Operations Center	ATC- Air Traffic Control
ATCALS- Air Traffic Control and Landing Systems	ATM- Asynchronous Transfer Mode
ATOTS- Advanced Transportable Optical Tracking System	BAPS- Broad Access Pesa Switch
BDA- Blast Danger Area	BECO- Booster Engine Cutoff
BIH- Built-In Hold	C/L- Checklist
CA- Conjunction Assessment	CA- Critical Angles
CAB- Commander’s Advisory Board	CCAFS- Cape Canaveral Air Force Station

CCDS- Combined Command Destruct System	CCRS- Central Command Remoting System
CCTV- Closed Circuit Television	CD- Compact Disk
CDS- Command Destruct System	CFM- Crew Force Management
CFR- Code of Federal Regulations	CHEV- Chevron
CLS- Current Launch Schedule	CLSRB- Current Launch Schedule Review Board
CMEV- Command Message Encoder Verifier	COLA- Collision Avoidance
CORs- Contract Officer Representatives	COTT- Compressed Theoretical Trajectory
CP- Command Post	CRD- Command Receiver Decoder
CRIT- Calculated Critical Time	CRU- Command Remoting Unit
CS- Center Supervisors	CS- Count Status
CSC- Command System Controller	CSCI- Computer Software Configuration Items
CSO- Command Systems Officer	CTPS- Centralized Telemetry Processing System
CTS- Command Terminate System	DAAR- Designate Angles and Auto Range
DBU- Data Buffer Units	Det- Detachment
DFO- Distant Focusing Overpressure	DFP- Debris Footprint
DIRLAUTH- Direct Liaison Authorized	DLWO-Radar- Deputy Launch Weather Officer Radar
DLWO-RECCE- Deputy Launch Weather Officer Reconnaissance	DNRO- Director of the NRO
DO- Director of Operations	DOAMS- Distant Object Attitude Measurement System
DoD- Department of Defense	DoL- Day of Launch
DOO- Operations Flight	DOUF- Program Management Flight
DOUS- Range Scheduling Flight	DOUX- Engineering and Technical Support Flight
DP- Display Processor	DRCS- Digital Range Communications Switches

DRFU- Destruct Radio Frequency Unit	DRS- Digital Range Safety
DRSD- Distributed Range Safety Displays	DSSS- Designate Source Select Switch
DV- Distinguished Visitor	ECP- Expected Coverage Plan
EELV- Evolved Expendable Launch Vehicle	EHW- Enhance Hotwash Minutes
ELB- Electronic Launch Book	ELS- Equivalent Level of Safety
ELSA- Emergency Life Support Apparatus	ELV- Expendable Launch Vehicle
EMOCC- Enhanced Maintenance Operations Center	EOD- Explosive Ordnance Disposal
ER- Eastern Range	ERD- Eastern Range Designators
ERDAS- Eastern Range Dispersion Assessment System	ERIAT- Eastern Range Instrumentation and Associated Targets
ERIH- Eastern Range Instrumentation Handbook	EROCH- Eastern Range Operational Configuration Handbook
ERTS- Eastern Range Technical Service	ETR- Eastern Test Range
ETRO- Estimated Time to Return to Operations	FAA- Federal Aviation Administration
FADSS- FOV1 Ascension Designate Software System	FCA- Flight Caution Area
FCA- Frequency Control and Analysis	FCTL- Final Clear to Launch
FDM- Frequency-Division Multiplexing	FDME- Firing Data Multiplexer Equipment
FEP- Front End Processor	FHA- Flight Hazard Area
FM- Frequency Modulated	FMC- Full Mission Capable
FO-FEP- Flight Operations-Front End Processor	FOG- Forward Observer Ground
FOUO- For Official Use Only	FOV1- Flight Operations Version 1
FRD- Formerly Restricted Data	FSS- Flight Safety Systems
FTS- Flight Termination System	FTU- Flight Termination Unit
GCM- Geodetic Coordinates Manual	GHz- Gigahertz

GLS- Ground Launch Sequencer	GOES- Geostationary Operational Environmental Satellite
GP-FEP- Guidance Processor-Front End Processors	GPS- Global Positioning System
GPS MT- Global Positioning System Metric Track	GSE- Ground Support Equipment
GTP- GPS Translator Processor	HCl- Hydrogen Chloride
HDD- High Density Data	HDD- High Density Designate
HDD- High Density Designate Data	HF- High Frequency
HFGCS- High Frequency Global Communications subsystem	HHQ- Higher Headquarters
HTU- Holdfire Transmission Unit	IAW- In Accordance With
ICE- Integrated Crew Exercise	IDP- Instrumentation Data Processing
IDS- Intelligent Data Switch	IF- Intermediate Frequency
IG- Inertial Guidance	IIP- Instantaneous Impact Point
ILL- Impact Limit Lines	INU- Inertial Navigation Unit
IP- Impact Point	IRIG-B- Instrumentation Group B
ISB- Interim Safety Board	ISBP- Interim Safety Board President
ISRO- Instrumentation Superintendent of Range Operations	ISS- International Space Station
JDMTA- Jonathan Dickinson Missile Tracking Annex	JSpOC- Joint Space Operations Center
KSC- Kennedy Space Center	LASS- Launch Area Support Ship
LC- Launch Conductor	LCC- Launch Commit Criteria
LCC- Launch Control Center	LCU- Launch Correlation Unit
LD- Launch Director	LDA- Launch Decision Authority
LDES- Launch Designate	LDZ- Launch Danger Zone
LED- Light Emitting Diode	LEOC- Launch Emergency Operations Center

LHC- Left-Hand Circular	LHCP- Left-Hand Circular Polarized
LISC- Launch Integrated Support Contract	LOS- Line-of-Sight
LRR- Launch Readiness Review	LSO- Launch Safety Officer
LSP- Launch Support Plan	LTRS- Launch and Test Range System
LV- Launch Vehicle	LVMA- Launch Vehicle Mission Assurance
LWC- Launch Weather Commander	LWD- Launch Weather Director
LWO- Launch Weather Officer	LWT- Launch Weather Team
MBS- Mircocomputer Buffer System	MCD- Mission Continuation Display
MCR- Mission Control Room	MD- Mission Director
MDP- Metric Data Processor	MDR- Mission Dress Rehearsal
MECO- Main Engine Cut-Off	MFCO- Mission Flight Control Officer
MHz- Megahertz	MK-51- Mark-51
MOC- Morrell Operation Center	MOCC- Maintenance and Operations Coordination Center
MOTR- Multiple Object Tracking Radar	MPA- Mission Planning Aid
MR- Mission Ready	MRTFB- Major Range and Test Facility
MRU- Military Radar Unit	MSC- Meteorological System Computer
MSP- Mission Support Point	MST- Mobile Service Tower
MSU- Message Storage Unit	MTD- MFCO Time to Destruct
MTE- Minimum Time to Endanger	MTIS- Missile Tracking Instrumentation Systems
MTU- Master Terminal Unit	N2O4- Dinitrogen Tetroxide
NAF- Numbered Air Forces	NASA- National Air and Space Administration
NGA- National Geospatial-Intelligence Agency	NLF- National Launch Forecast

NMC- Non-Mission Capable	NOAA- National Oceanic Atmospheric Administration
NOTAM- Notice to Airmen	NOTU- Naval Ordnance Test Unit
NRO- National Reconnaissance Office	NTSC- National Television Systems Committee
OCI- Operations Control Instruction	OCI- Operations Control Instruction
OD- Operations Directive	OD- Operations Director
OGV- Standardization and Evaluation	OPNR- Operation Number
OPR- Office of Primary Responsibility	OR- Operations Requirements
ORR- Operation Readiness Review	OSC- Orbital Sciences Corporation
OSCS- Optical Site Computer System	OSK- Weapons and Tactics Flight
OSL- Office of Space Launch	OSM- Operations Safety Manager
PA- Public Address	PAFB- Patrick Air Force Base
PAVE PAWS- Phased Array Weapon System	PCM- Pulse Code Modulated
PDTS- Post Detect Telemetry System	PDTS- Post Detection Telemetry Subsystem
PI- Program Introduction	PMC- Partial Mission Capable
PCMR- PC Monitor Recorder	POC- Point of Contact
POSIP- Portable Shipboard Instrumentation Package	PP- Present Position
PPE- Personal Protective Equipment	PRD- Program Requirement Document
PREX- Pre-Exercise	PSM- Program Support Manager
PSP- Program Support Plan	RAC- Risk Assessment Center
RADAR- Radio Detection And Ranging	RASCAD- Range Safety Control and Display
RAT- Recovery Action Team	RATS- Range Automated Tasking System
RC- Range Coordinator	RCO- Range Control Officer

RCS- Radar Cross-Section	RE- Range Engineer
RF- Radio Frequency	RFI- Radio Frequency Interference
RGNext- Range Generation Next	RHC- Right-Hand Circular
RHCP- Right-Hand Circular Polarized	RLV- Reusable Launch Vehicle
ROC- Range Operations Commander	ROSA- Radar Open Systems Architecture
RP-1- Rocket Propellant 1	RPV- Remotely Piloted Vehicle
RS- Range Safety	RSAS- Range Safety Advisory System
RSC- Radar Systems Controller	RSD- Range Safety Display
RSOR- Range Safety Operations Requirement	RTS- Range Tandem Switch
RTS- Range Tracking System	RTS- Remote Tracking Stations
RTU- Remote Terminal Unit	S&A- Safe and Arm
S/N- Signal-to-Noise	SATCOM- Satellite Communications
SC- Statement of Capability	SCDS- Surveillance Control Display System
SCO- Surveillance Control Officer	SCU- System Control Unit
SE- Chief of Safety	SEA- Safety Analysis
SEF- Flight Safety	SEG- Ground Safety
SEL- Launch Safety	SEL- System Engineering Laboratories
SELF- Launch Safety Flight Analysis	SELR- Launch Safety Risk Analysis
SEW- Weapons Safety	SIB- Safety Investigation Board
SLBM- Submarine Launched Ballistic Missile	SLC- Space Launch Complex
SLIPS- Space Launch Intrusion Prevention System	SMC- Space and Missile Center
SMFCO- Senior Mission Flight Control Officer	SpaceX- Space Exploration Technologies Corporation

SPARC- Single Point Acquisition and Radar Control	SPARC-RG- SPARC Radar Graphics
SPARC-SC- SPARC Switch Control	SPOF- Single Point of Failure
SRA- Surveillance Risk Analyst	SRB- Solid Rocket Booster
SRM- Solid Rocket Motor	SSN- Space Surveillance Network
SSO- Sea Surveillance Officer	STA- Safety Technical Advisors
STE- Secure Telephone Equipment	SV- Space Vehicle
SVMA- Space Vehicle Mission Assurance	SW- Space Wing
SWS- Space Warning Squadron	T&E- Test and Evaluation
TA- Technical Advisor	TAA- Telemetry Autotracking Antenna
TACAN – Tactical Air Navigation	TAE- Time, Azimuth, and Evaluation
TDM- Time Domain Multiplexing	TDRSS- Tracking and Data Relay Satellite System
TGRS- Translated Global Positioning System Range System	TMIG- Telemetry Inertial Guidance
TO- Training Officer	TRAC- Telemetry Radar Acquisition Computer
TRIO- Telemetry/Radar Input/Output	TRS- Telemetry Retransmission System
TRSB- Telemetry Range Safety Buffer	TS- Telemetry Stations
TSO- Telemetry Systems Officer	TSPI- Time Space and Position Information
TT&C- Tracking, Telemetry, and Command	UAV- Unmanned Aerial Vehicle
UCS- Universal Camera Site	UDS- Universal Documentation System
ULA- United Launch Alliance	UMHC- User Mandatory Hold Criteria
UMHL- User Mandatory Hold Letter	USCG- US Coast Guard
USG- United States Government	USSTRATCOM- US Strategic Command
V/T- Velocity vs. Time	VAFB- Vandenberg Air Force Base

VDL- Voice Direct Line	VP- Vertical Plane
VSO- Video Systems Officer	WANIU- Wide Area Network Interface Unit
WDR- Wet Dress Rehearsal	WFF- Wallops Flight Facility
WGS- World Geodetic System	WINDS- Weather Information Network Display System
WR- Western Range	

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GENERAL INFORMATION

A-1-1 SPACELIFT OPERATIONS

A.1.1.1 Major Range and Test Facility Base

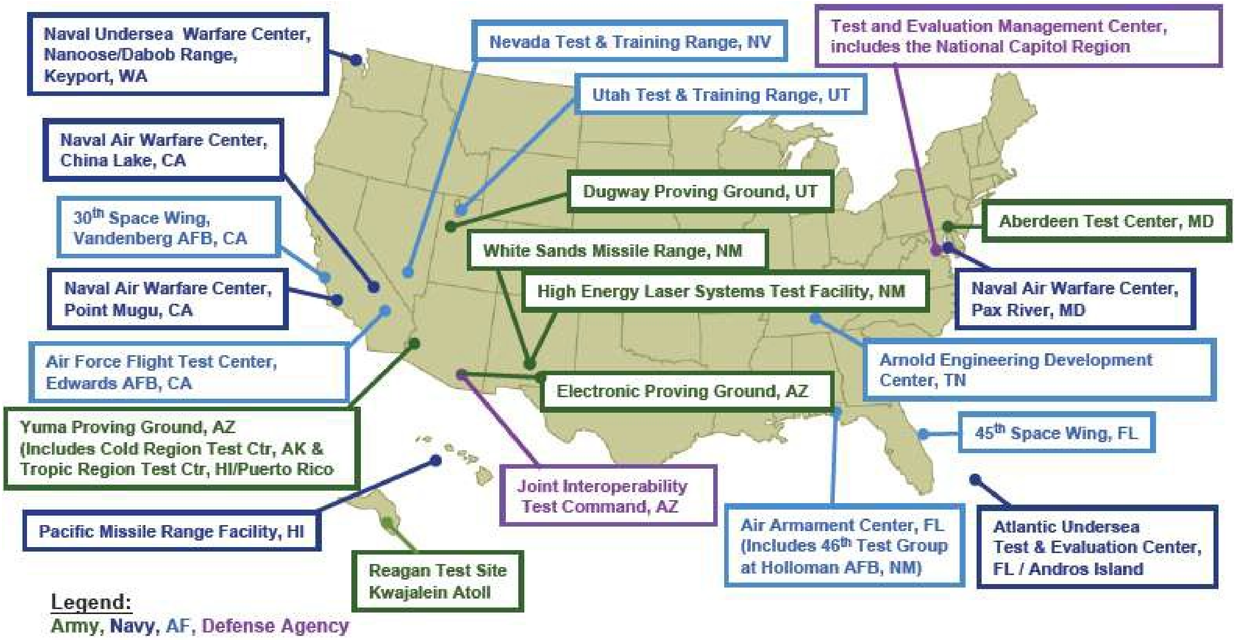


Figure A-1-1-1: *Major Ranges and Test Facility bases Map*

In addition, the LTRS provides Test and Evaluation support to DoD activities in accordance with DoDD 3200.11, ***Major Range and Test Facility Base.*** The Major Range and Test Facility Base (MRTFB) is a set of test installations, facilities, and ranges which are regarded as "national assets" and are required to support development and deployment of U.S. warfighting capabilities. Within the MRTFB, there are 21 test facilities whose management is performed by four service components and nine commands. The DoD established the MRTFB management concept to provide coordination among the major facilities, promote multi-Service use, reduce unnecessary duplication of assets and establish budgetary priorities at the Department level. Each of the MRTFB members were selected because of unique test and evaluation assets needed to ensure proper T&E support for U.S. military weapon systems developers. Oversight of the MRTFB is performed by the Under Secretary of Defense for Acquisition, Technology, and Logistics.

MRTFB policy and responsibilities are defined in DoDD 3200.11. It establishes the following:

- The MRTFB shall be sized, operated, and maintained primarily for DoD test and evaluation missions.
- The MRTFB shall provide a broad base of T&E capabilities sufficient to support the full spectrum of DoD T&E requirements.
- The MRTFB shall be managed and operated under uniform guidelines across the DoD Components.
- The MRTFB shall be financed through a combination of appropriated (institutional) funds and user charges.
- The MRTFB may be used by other DoD users (including DoD training users), and by users outside the Department such as U.S. government agencies, state and local governments, allied foreign governments, and commercial entities. Use of the MRTFB by non-DoD users shall not increase the institutional costs to the DoD to operate the MRTFB.

- Scheduling of the MRTFB shall be based upon a priority system that gives equitable consideration to all DoD components and accommodates DoD acquisition program priorities.

When a test requires the support of more than one MRTFB activity, a lead activity will serve as the principal point of contact with the user for planning, execution, and reimbursements, and will coordinate with other activities to obtain total support for the test.

A.1.1.2 Lead and Support Range

The Lead Range/Facility concept was established by DoDD 3200.11 when multiple MRTFB facilities to coordinate actions between facilities/ranges and to provide a single point-of-contact for Users. The words "range," "center," and "support agency" are used interchangeably. Also, the User or Requesting Agency is any U.S. or foreign government agency, industrial organization, or other institution with authority to use range or support agency resources.

Under this concept, the Lead Range or Lead Support Agency is the responsible range/support agency for coordinating total support planning and operations for a particular program, mission, or test. The lead range/lead support agency identifies the support required from other agencies and coordinates the total support effort.

The Support Range or Support Agency is an operational facility that provides support services to qualified users as determined by current directives.

A range or facility may be a Lead Range/Facility or a Support Range/Facility depending on the mission and the support required. For example, for a southeast trajectory launch from the ER, the ER will be the Lead Range with support typically being provided by the Air Force Satellite Control Network (AFSCN) and/or NASA’s Tracking and Data Relay Satellite System. For a northeast trajectory launch from the ER, the ER will be the Lead Range with support typically being provided by NASA’s Wallops Flight Facility and sometimes the AFSCN. Note that not all users will choose to utilize the Lead Range/Facility concept and may choose to coordinate with another support agency, such as the AFSCN directly.

The ER can also provide support as a Support Range. For example, the ER often acts as a support range for launches from the Wallops Flight Facility.

A.1.1.3 Range Commanders Council

Many of the Ranges/Facilities of the MRTFB are also members of the Range Commanders Council (RCC). The RCC was founded in August 1951 upon the recommendation of the Commander, Naval Air Missile Test Center, Point Mugu, California, to the Commanding General, White Sands Proving Ground, New Mexico, and the Commander, Patrick Air Force Base, Florida. The RCC was organized to preserve and enhance the efficiency and effectiveness of member ranges, thereby increasing their research and development, operational test and evaluation, and training and readiness capabilities. The RCC provides a framework wherein:

- Common needs are identified, and common solutions are sought.
- Technical standards are established and disseminated.
- Joint procurement opportunities are explored.
- Technical and equipment exchanges are facilitated.
- Advanced concepts and technical innovations are assessed, and potential applications are identified.

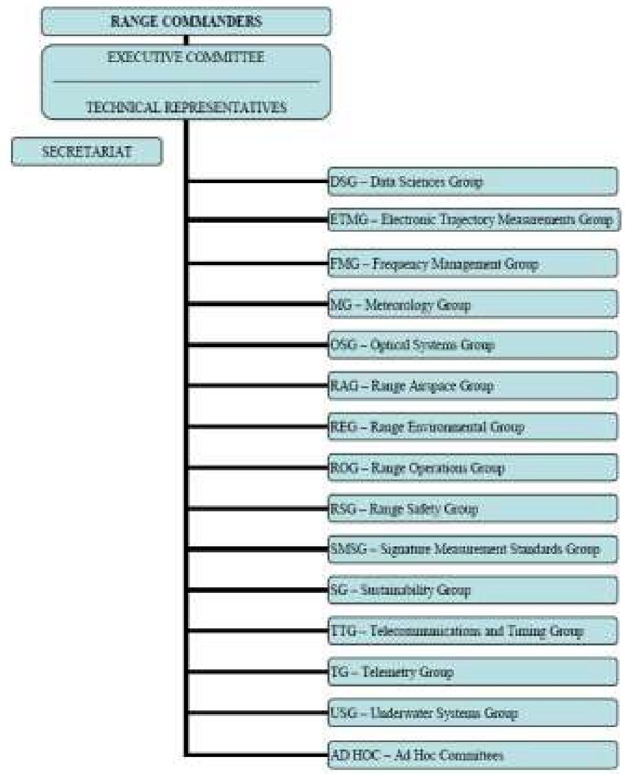


Figure A-1-1-2: *Organizational structure of the RC*

The RCC is comprised of the Range Commanders, an Executive Committee, Technical Representatives, standing and ad hoc groups, and the Secretariat. The organizational structure of the RCC is designed to permit maximum control by the Range Commanders, while providing for a flexible and efficient response to both long-range needs and quick-response situations. The RCC standing groups are established by the Range Commanders and are the backbone of the organization. The majority of the work carried out by the RCC is performed by the standing groups. These groups established the Universal Documentation System and the Inter-Range Instrumentation Group standards.

A-1-2 THE EASTERN RANGE

A.1.2.1 Launch Information Support Network (LISN)

To display these schedules, the Launch Information Support Network (LISN) is used. The LISN, managed and maintained by AFSPC, provides a collaborative, centralized, reporting tool to manage the space launch manifest, forecasting, launch history, constellation sustainment modelling and current operations information. Information reported in LISN includes scheduling status and major milestones of all major launch systems, range or pad maintenance, and other mission related significant events. LISN is routinely referenced to answer senior leader and HHQ questions and to support decisions affecting resource allocation through the Planning Programming Budgeting and Execution (PPB&E) process. This information is vital to ensuring leadership at all levels remains informed.

Figure A-1-2-1: *Launch Information Support Network*

A.1.2.2 Operation Categories

There are several difference categories of operations that can be scheduled on the ER.

A Launch Operation is a complete countdown including ignition firing and liftoff of a missile or other launch vehicle and plus count activities.

A Major Support Operation is an operation that requires technical planning for Range instrumentation to provide data; establishes Radio Frequency (RF) radiation restrictions that affect the ER and Range user, and requires significant involvement of major Range support. Examples include: Combined Systems Test (CST), Mission Dress Rehearsal (MDR), Terminal Countdown Demonstration Test (TCDT), Network Simulation (NETSIM), Dry Run at Sea (DRAS), Integrated Crew Exercises (ICE), or a major milestone pre-launch instrumentation activity.

A Minor Support Operation is any operation support required which is not defined in operations directives and does not require a major commitment of Range resources. Minor support operations are normally requested when time does not allow for proper documentation and should be restricted to user needs for which a minimum of prior planning is required.

An Associated Operation is any operation conducted to <u>support</u> the objective of a major milestone event or launch related activity as its basic source. For example: An RF collection system collecting spacecraft data for post-mission analysis by the spacecraft community. An External Operation is an <u>independent operation</u> that is not part of the objectives of the launch. The intent is to operate on a non-interference basis while using the launch to fulfill requirements stipulated by the External Operation's objectives. For example, a new instrumentation system shadowing a launch for the purpose of operational acceptance on the ER.

A-2-2 RADAR SYSTEMS

A.2.2.1 Purpose

In addition to providing metric launch data, ER radars perform a myriad of functions such as:

- Tracking weather balloons for the meteorological department to determine wind conditions during launch and landing operations.
- Performing system calibrations to maintain radar systems in the highest state for accurate and reliable metric data. System calibrations include satellite calibrations, loop gain checks and sphere tracks, F-1 launch checks, F-day launch checks, and maintenance procedures. Radar Boresite towers are used for angle calibration and alignment. Radar Range Targets are used for range calibration and alignment.
- Supporting Telemetry calibrations (outlined in Operations Directive [OD] 006) checkouts by providing acquisition data and correlating satellite track data for accuracy comparisons per OD 025.
- Phasing checks to prevent data loss caused by a break in track when two or more radars share the same beacon. This data loss results from the inability of a beacon to reply during a recovery period following a successful interrogation. If a beacon is interrogated in the recovery period, no reply is generated to the transmitting radar. Therefore, phasing slots are used to assign the separation of the integrated pulses and are specified by the applicable OD or Operations Control Instruction (OCI). Once in its assigned slot, radars use automatic beacon phasing or manual phasing procedures to verify beacon sequencer operations.
- Development and sustainment support to other ER contractors for systems development and upgrades.

A.2.2.2 Phased Array Radars

The array aperture contains 8,359 elements arranged in an equilateral triangular lattice. The center array element position is a foam support for the radome, with six adjacent array element modules used for logic distribution only. There are 8,352 element modules with radiating capabilities.

Each element contains a phase shifter and driver circuit, a phase shifter drive containing beam steering and collimation logic, and two dipole radiators. The Beam Steering Capability (BSC) provides computation logic to form individual phase shifter commands for each of the radiating elements and to monitor the status of the array. For beam steering, the lens array elements are grouped into six pie-shaped selectors. The array elements for each sector are physically organized and hard wired into one tangent line of 48 elements. The BSC commands are received by the first element in the radius line and then passed to others by a rippling action. The collimation data corrects for the unequal path between radiating elements and the feed horn and focuses the transmitter received RF energy into a narrow beam.

The beam can be steered both electronically and mechanically, allowing the beam to scan at thousands of degrees per second, fast enough to irradiate many individual targets, and still run a wide-ranging search periodically. By simply turning some of the antennas on or off, the beam can be spread for searching, narrowed for tracking, or even split into two or more virtual radars. This is important in debris tracking.

A.2.2.3 Designate Angles and Auto Range

The DAAR provides an Optical Q-bit. In DAAR mode, the radar is designated in angles, azimuth and elevation, and is tracking in range. DAAR mode is utilized for vehicles on the launch pad to provide a track bit and Q-bit for Flight Operations Version 1 (FOV1). It is also used when topography and RF path distortion between the radar line of site and the launch vehicle on the pad precludes complete AER three-coordinate closed loop automatic track. The range coordinate operates in either skin or beacon autotrack mode while the angle coordinates are designated off the launch pad by a selection of either the computer designate sources, the MK-51 site optical director, or the console joystick control. When the launch vehicle is visible within the radar console's boresight television (TV) reticle, the joystick operator presses a button that inserts a Q-bit indicator in the outgoing data stream, signifying a valid tracking source.

The radar's EFG output becomes a contender for the Range Safety solution. Shortly after launch, as the elevation angle increases sufficiently above the ground clutter, the angle coordinates are placed in full RF autotrack. To prevent loss of input to the Range Safety solution during the transition from DAAR to full RF track, the optical Q-bit remains activated (providing the vehicle remains visible) for a six second overlap period until the RF autotrack Q-bit satisfies the Range Safety software filter algorithm. ER Radar Cape1.16 is the only ER radar that is capable of utilizing DAAR.

A.2.2.4 Mark-51

The MK-51 designate mode is used to assist the radar. Because ER radar systems have such a narrow beam, it is advantageous to use a pointing device to assist with acquisition when the target characteristics are unknown. The MK-51 consists of a mount with a scope attached to it. It has a pair of synchros which can be slaved to the radar by pushbuttons on the adaptive mode switch (AMS) console in azimuth and elevation. The gun director requires an operator to function.

A.2.2.5 Antenna/Pedestal Subsystem

The Antenna/Pedestal subsystem is typically made up of an Antenna Pedestal, a Reflector, the components within the pedestal that accommodate the transmission and receiver lines, and the drive system needed to move it. Typical ER radar systems use a variety of pedestals from various sources.

Figure A-2-2-1: *Cape 1.16 Antenna/Pedestal*

The AN/FPQ-14 radar systems (KSC 19.14 and JDMTA 28.14) are a derivative of the older AN/TPQ-18 and AN/TPQ-6 radar systems. These systems are widely known as MIPIR class radars. They consist of a 29-foot reflector with 52 dB of antenna gain. The AN/FPS-134 radar (Patrick 0.134) is a derivative of the AN/FPQ-6 radar system using the same antenna and pedestal as the AN/FPQ-14 radar systems.

The AN/FPQ-15 radar (Ascension 12.15 or the NIKE Zeus) has a 40-foot reflector that has an antenna gain of 54 dB. The antenna is within a radome. The smaller radar (Cape 1.16) have AN/FPS-16 12-foot reflectors installed with 44 dB of antenna gain has a phased array antenna with an antenna gain of 46 dB, and within a radome. Each of these systems is tailored to their particular mission. All of the ER radar systems use amplitude-comparison monopulse principles for tracking. This principle, also known as simultaneous lobe comparison, is a technique for measuring the direction of arrival of RF, whether it is from an active transponder, or is re-radiated from a target which has been illuminated by a radar. Ascension 12.15 is used primarily for space track, and as such is equipped with the larger reflector. The mainland radars are used primarily for launch support.

A typical radar site antenna uses a parabolic reflector with an elevation over azimuth pedestal for moving the antenna. Typical systems use multiple motors to accomplish this. The antenna uses a slip ring assembly to allow for continuous rotation. The parabolic reflector focuses the incoming signal on a sub-reflector that further focuses the signal into a feed horn (called a cassegrain feed horn). A cassegrain system has several advantages: it has a short connection between the feed horn and the receivers to minimize line losses, it allows ease of access to the feed horn for maintenance since it is mounted behind the reflector, and the subreflector blocks less of the incoming signal than a feed horn. Some of the radars use a dial-guide type feed which allows better focusing attributes to further minimize the loss of received RF energy. These systems have the RF components mounted in a cone which protrudes from the front of the antenna reflector. Some of the radar antennas have linear vertical polarization only and others have the capability for either circular or linear vertical polarization. Ascension 12.15 has the ability to select either of the two circular modes (right-hand or left-hand transmit or receive).

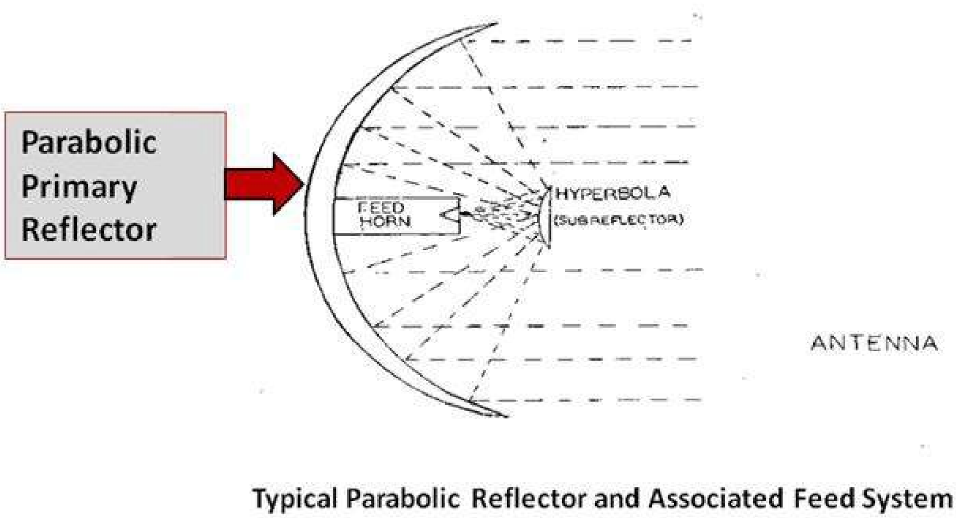


Figure A-2-2-2: *Typical Parabolic Reflector and Associated Feed System*

The KSC 19.39 radar antenna is a phased array antenna that has a feed horn that radiates linear vertical polarization. The energy is radiated in open air (space fed) to the array of elements. The lens contains 8359 elements. The elements are 3 bit phase shifters with receiving and transmitting dipoles. The pedestal uses slip rings for continuous rotation at a maximum rate of 800 milliseconds for azimuth and 300 milliseconds for elevation. The array cone beam width is 60 degrees. The RF beam width is 1 degree.

A.2.2.5.1 Antenna Polarization

The larger aperture radars have the ability to utilize either linear polarization or circular polarization. Although different launch vehicles use linear or circular polarization at the transmitting antennas, radar systems that have the capability can select whether to use circular or linear depending on the vehicle and mission. The smaller radars only have linear polarization available. The type of antenna used to transmit the signal determines the polarization of the signal. An electromagnetic wave, or signal, has an electric field vector component and a magnetic field vector component that are perpendicular to each other and to the direction of travel. The polarization of an electromagnetic wave is the property that describes the orientation (i.e., time-varying direction and amplitude) of the electric field vector perpendicular to the direction of propagation. The polarization of a signal is important because it determines how resistant the signal will be to signal degradation.

A.2.2.6 Computer/Data Handling Computer Subsystem

The radar site computer is used to process and record track and receive and transmit HDD. The radar computer subsystem consists of either a Gould/System Engineering Laboratories (SEL), COMPRO Telemetry Radar Acquisition Computer (TRAC), Silicon Graphics or Mentec LSI-11 emulator.

- **System Engineering Laboratories Computer -** The SEL computer is the central processing unit of the JDMTA 28.14 and runs the operational real-time program (RXRTOP). The SEL receives and processes data from the Telemetry/Radar Input/Output (TRIO) subsystem, including antenna position and system status, and transmits data to the TRIO subsystem for distribution to the rest of the Radar system.
- **COMPRO Gateway TRAC -** The TRAC has three major components: Gateway, main processor, and recorders. The Gateway is a rack-mounted server utilizing the SuSE Linux Enterprise Server operating system and provides the user interface to the main processor. The main processor runs the real-time operational program (RXRTOP) and is designed to host the functions provided by the legacy Gould/SEL Computer System. The main processor can only be accessed through the Gateway. Recorders include 9-track Magnetic Tape Units and Bernoulli disk drives (KSC 19.39 only). KSC 19.14 and Ascension 12.15 use the Gould emulator, known as the COMPRO TRAC, and KSC 19.39 uses a COMPRO emulator.

Figure A-2-2-3: *KSC 19.14 Console Site and Computer*

- **Silicon Graphics -** The SGI Origin 350 is the central computer system and data storage for the Patrick 0.134 (ROSA) radar system and is called the Real Time Processor (RTP). The operating system is Linux.
- **Mentec LSI-11 Emulator -** The LSI-11 emulator runs the Radar Control Standardized Operation Acquisition Program at Cape 1.16. The computer consists of three chassis: Processor 1, Processor 2, and the Q-Bus extender. Processor 1 runs the main program and interfaces with the data handling system. Processor 2 runs the peripherals (line printer and 9-track tape drive). The Q-Bus extender interfaces with the monitor controller which displays video and alphanumerics at the console.

Data Handling Subsystem

Data Handling Subsystem (DHS) interfaces between the computer and radar peripheral subsystems.

- The DHS at KSC 19.14, JDMTA 28.14, and Ascension 12.15 processes HDD, Inter-Range Instrumentation Group (IRIG) timing, and other computer interfaces.The DHS interfaces with the TRIO subsystem.
- The DHS at Cape 1.16 processes HDD, IRIG timing and other computer interfaces. The DHS processes and distributes encoder values, Range timing, and range target data to the various radar subsystems. The DHS also distributes radar track data via HDD.
- **Telemetry/Radar Input/Output Computer -** TRIO is a microprocessor-based system that interfaces between the Gould SEL Concept 32/27 and the radar peripheral subsystems. TRIO is the interfacing subsystem that receives and transmits HDD. The TRIO receives and distributes designate data between the SEL computer (COMPRO Gateway computer at KSC 19.39) and the range tracker, the servo subsystem, and the antenna subsystem.
- **Range Interface Unit (RIU) (Patrick 0.134 [ROSA]) -** This is the connecting point

for all HDD interfacing with the radar. The Range Interface Space Processor (RISP) interfaces the ROSA subsystem to the legacy radar antenna and other ER interfaces. The RISP is composed of two subsystems: RIU and Range Interface Box (RIB). The RIU interfaces with legacy communication data circuits including two HDD circuits, one NASA 46-character circuit, two Digital Message Network Element circuits, and one optional CS-5246 circuit. The RIU communicates with the RIB via the Utility net. The RIB encodes and decodes data to and from the RIU and communicates with the ROSA radar control subsystem via Sensors network, Display network, and Utility network. The RIU is a Dell 2850 Server. The RIB is composed of two Dell 1850 servers and one ThinkMate customized rack-mounted server.

- Multiple Object Tracking Radar **-** KSC 19.39 receives and transmits HDD to the MOC on two independent synchronous 56 kilobits per second communication channels. Data is routed to and from the MOTR computer, the COMPRO TRAC computer via a communications panel and an expansion chassis. The communications panel routes the cables to and from the expansion chassis. The expansion chassis is responsible for routing data to the applicable destination. HDD is routed directly to and from the radar computer.

A.2.2.7 Console Subsystem

The console is the means by which the operator can control the Radar system. Three types of consoles are used on ER radar systems:

Radar Adaptive Mode Switch Console

All of the radars (except KSC 19.39 and Patrick 0.134) use a console known as the AMS console

- The AMS console is a subsystem that collects control stimulus from all areas of the overall radar system, makes logical decisions, and generates necessary system control commands and status.
- The console serves as a peripheral device to the site computer/data system. As such a peripheral, it was serviced by means of an interrupt routine normally every 10 milliseconds or at what is called a 10 points per second rate. This simply means the computer would execute a routine every 10 milliseconds to examine the console for any new requests or status change. If a button had been pressed, the computer would execute this function and echo back to the console with a light to indicate that it had received the command/status request from the console.

KSC 19.39 Console

- The KSC 19.39 console consists of two identical workstations which share tracking responsibility for multiple object tracking. Functions can be shared or run independently depending on the mission. The radar console controls all of the functions needed to operate the radar.

Figure A-2-2-2: *KSC 19.39 Console*

ROSA Console

- The Patrick 0.134 console is a reconfigurable Graphical User Interface. The primary displays used are status display, A-scope display, monitor display, autotasker display, antenna display, and soft buttons display. These displays and others can be arranged in any order for operational requirements or operator needs.

Figure A-2-2-5: *Patrick 0.134 (ROSA) Console*

A.2.2.8 Receiver Subsystem

Receivers are used to collect the RF from the C-band received frequencies, down-convert to a useable frequency, and amplify the signal to make it available for processing. The C- band signal is received by the antenna in either vertical linear or circular so that signal strength and error can determine size and position of the target.

Outputs from the receiver are used in two ways:

- **Azimuth and Elevation Error Output -** This is derived from the comparator output in the feed assembly, down converted from C-band to an intermediate frequency (typically 30 megahertz) and converted to an equivalent voltage to drive the servo system back on track and record. These voltages are also calibrated by means of the angle error calibration to quantify that voltage into a distance (either mils or degrees) from the boresight tower. The computer system accepts these voltages for that purpose.
- **Peak Detected Voltage (PDV) Output -** The PDV is derived from the RF reference channel that corresponds to target size. The S/N is derived by means of a calibration done on a known signal source (located on the Boresight Tower). This calibration uses the PDV and correlates it to S/N. The computer also accepts this signal for that purpose.

The receivers also generate AGC, Logarithmic, and Acquisition signals which are voltage representations of the signal strengths at the input to the Range system. These signals are used for the A-scope display, and as input signals to the Range system and for recording purposes.

The receivers at Patrick 0.134 are digital and receive the C-band RF directly from the RF feed. The Patrick 0.134 (ROSA) system has two receivers that down convert the RF and digitizes the signal. This digital output is transmitted to the Digital Sampling System for processing and display.

A.2.2.9 Angle Tracker Subsystem

The drawing above illustrates, at the very fundamental level, the basic structure and signal flow in a conventional servo. The input circuitry is designed to provide the initial smoothing and conditioning of the input error. The input may also have the job of selecting the desired input signal source if multiple modes or sources are available.

The control element is the heart of the system. Here the conditioned error is integrated into an actual drive signal that generally will represent a velocity or acceleration in order to have the desired effect on the controlled element.

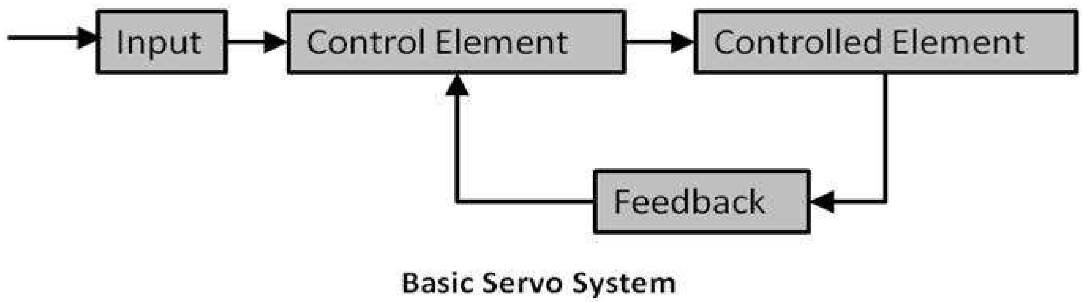


Figure A-2-2-6: *Basic Servo System*

The controlled element can be thought of as the antenna motors. In the case of the ER Radar systems, the motors are equipped with tachometers to output a voltage as a function of speed. This signal is output to a feedback network that will be used to provide a control stimulus to the control element so that the gain can be corrected as a function of the change in boresight error.

Servo systems have two types of classifications:

- Type I – are also called "constant velocity error" systems. This means the Type I servo will provide a fixed signal to the motors regardless of the misalignment.
- Type II – a more adaptable system whereby the drive signal amplitude is a function of the error amplitude.

Most ER radars have a selection option for either type.

A 2.2.10 Transmitter Subsystem

The transmitter subsystem can be split into two sections: the low power section and the high power section.

Low Power Section

The low power section is the part that contains the RF generation for the propagation of energy through the transmitter and the local oscillator outputs for use in the RF receiver. All radars with the exception of the KSC 19.39, Cape 1.16, and Patrick 0.134 use an exciter for this purpose. KSC 19.39 and Patrick 0.134 radars use a waveform generator, and Cape 1.16 uses a magnetron which requires no RF input.

- An intermediate power section takes the low power and amplifies it for use by the high powered section. All ER radar systems with the exception of Cape 1.16 use a traveling-wave tube for this purpose.

High Power Section

The high power section contains all of the high voltage circuits required to amplify the tube or tubes for the generation of high powered RF. The ER radars (except KSC 19.39) are non-coherent transmitters. That is, there is no stability from pulse to pulse and cannot be used for signature purposes. KSC 19.39 and Patrick 0.134 have a coherent transmitter which allows each output pulse to remain the same in both amplitude and phase. The high power RF tubes used on the ER radars consist of a Magnetron (Cape 1.16), Klystrons (Ascension 12.15, KSC 19.14, Patrick 0.134, and JDMTA 28.14) and CFA (KSC 19.39). These tubes amplify the RF for transmission. Each of the radars also use vacuum tubes and associated high voltage circuits to amplify the high voltage which is used to gate the RF through the RF tubes. All of our transmitters are of the hard tube modulator type.

A.2.2.11 Range Tracker Subsystem

The Range Tracker subsystem can be thought of as the master clock for a radar system. It is this subsystem that generates all of the clock signals needed to determine the range of the target and allows the radar to track it in range. All of the radars (except KSC 19.39 and Patrick 0.134) use a transistor-transistor logic (TTL) based range machine which has wire wrapped 2D modules. Although this concept was easy to modify for ongoing changes in the early days of the Range, it does not lend itself to a line replaceable unit concept to maintain. KSC 19.39 radar uses a signal processor for this function and Patrick 0.134 uses a combination of a Master Timing System (MTS) and the real-time processor.

Figure A-2-2-3: *KSC 19.14 Range Machine*

- **Standard TTL ER Range Machine** - The Range Tracker subsystem was fabricated in the late 1970’s and subsequently installed shortly after, in all of the ER Radars. The range machine consists of 36 blocks of Electronic Engineering Company 2D wire wrap boards installed in Cape 1.16. The KCS 19.14, JDMTA 28.14, and Ascension 12.15 uses 38 blocks of these same boards. Triggers needed for the transmitter and the receiver are generated for the pulse-repetition frequency (PRF) of the radar. For ER range machines, this is either 160 or 320/640.
- **KSC 19.39 –** KSC 19.39 interface is through the signal processor. This is the digital transfer of all data to and from the radar subsystem to the KSC 19.39 site computer. The range machine subsystem is a software calculation. This software resides on the KSC 19.39 site computer. The radar has a PRF rate of 20, 40, 80, 160, 320, 640, and 1280. The waveforms are 0.25 µsec, 0.5 µsec, 1.0 µsec, 3.125 µsec, 12.5 µsec, and 50 µsec. The receiver is a dual three channel monopulse RF/intermediate frequency (IF) receiver.
- **ROSA** - The Patrick 0.134 (ROSA) range data is generated in the MTS. This data is transferred to the RTP and is used throughout the system.

A.2.2.12 Power Distribution and Control Subsystem

All of the mainland radars use commercial power. None of the radar systems contain an uninterruptible power supply (UPS) system capable of powering the radars. The radar systems containing TRAC have an UPS to keep power on the computers in the event of a loss of power. All radar systems typically have the incoming power separated into two paths (Critical and

Industrial power).

- **Critical power** is provided for the instrumentation.
- **Industrial power** is provided for the facility to include the light, air conditioning, and heating systems.

In the event of a power failure, the facilities contractor can provide back-up generator power, though it may take as long as a day to provide. Most radar systems use a distribution center known as a Load Center. This series of racks provides multiple high power and low power circuit breakers for the instrumentation power. Input power may be 277 volts alternating current (VAC), 3 phase power which is regulated by a series of electro-mechanical regulators. There are also 3 phase regulators for the 3 phase 120 VAC power. However, on day of launch, JDMTA is powered solely by its generators to prevent any possible loss of operational capability due to a local area power outage.

Figure A-2-2-8: *KSC 19.14 Load Center*

A-2-3 TELEMETRY SYSTEMS

A.2.3.1 Telemetry Fundamentals

As seen below, a launch vehicle may have more than one set of S-Band antennas to transmit data on more than one telemetry link or frequency. For example, a vehicle may use one telemetry data link to transmit first and second stage data and a second telemetry data link to transmit third stage data. Also, the payload will use an additional telemetry data link to transmit its health and status information.

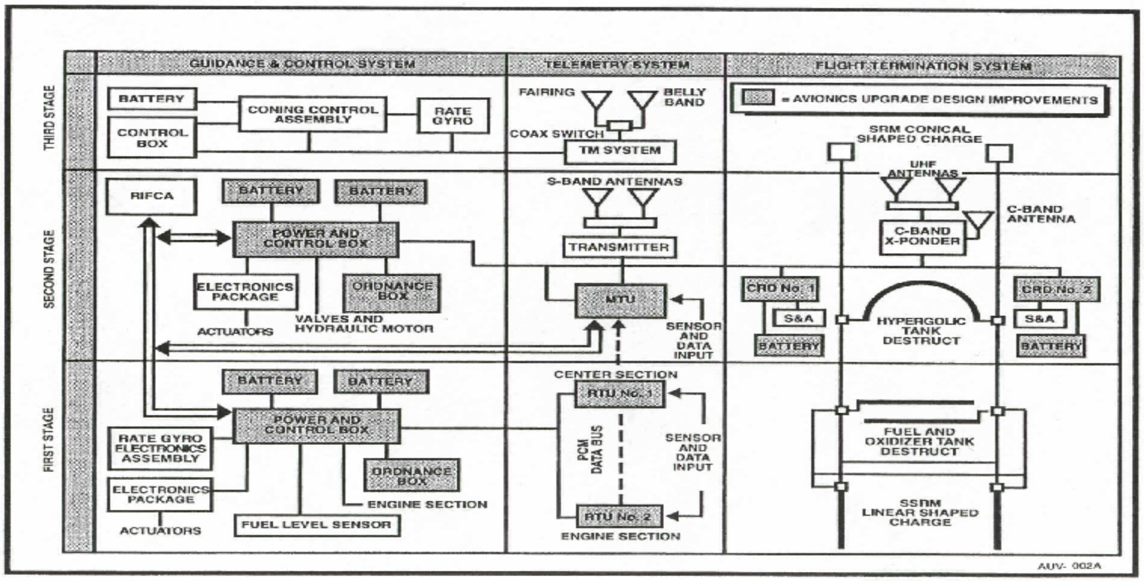


Figure A-2-3-1: *Launch Vehicle Avionics*

A.2.3.2 Frequency-Division Multiplexing

FDM allows for the simultaneous transmission of multiple separate sensor data channels through a shared medium (such as a wire, optical fiber, or air). FDM combines two or more sensor data channels by assigning a separate portion of the available frequency spectrum of a single data link to each of the individual channels. FDM is used for analog signals. For example, television transmitters use FDM to broadcast several channels at once. FDM was once the mainstay of the long distance telephone system.

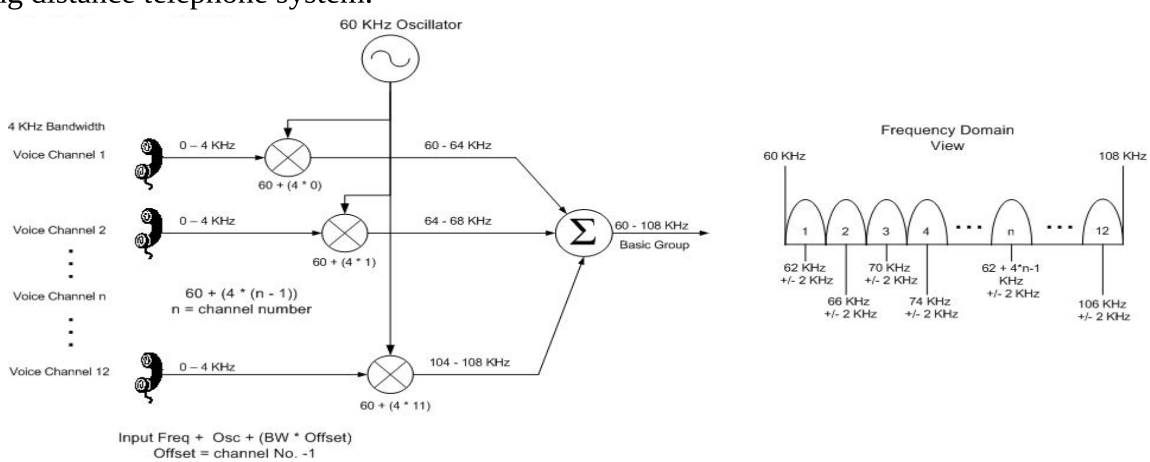


Figure A-2-3-2: *Frequency Division Multiplexing*

A.2.3.3 Time-Division Multiplexing

TDM is a type of multiplexing where two or more channels of information are transmitted over the same link by allocating a different time interval ("slot" or "slice") for the transmission of each channel. In other words, the channels take turns using the link. Currently, TDM is the most popular form of telemetry multiplexing. While TDM may be applied to either digital or analog signals, in practice it is applied almost always to digital signals. The resulting composite signal is thus also a digital signal.

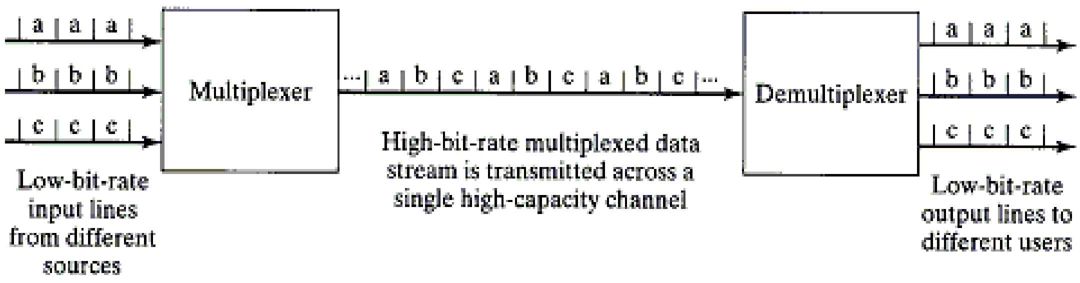


Figure A-2-3-3: *Time-Division Multiplexing*

A.2.3.4 Pulse Code Modulation

PCM is a popular application of TDM which creates a serial digital signal representation of the parameters. PCM is a sampling technique for digitizing analog signals. The signals in PCM are binary. To obtain PCM from an analog waveform, the analog signal amplitude is sampled (measured) at regular time intervals. The instantaneous amplitude of the analog signal at each sampling is rounded off to the nearest of several specific, predetermined levels. This process is called quantization. The number of levels is always a power of 2 (for example, 8, 16, 32, or 64). These numbers can be represented by three, four, five, or six binary digits (bits), respectively. The output of a pulse code modulator is thus a series of binary numbers, each represented by some power of 2 bits. Using PCM, it is possible to digitize all forms of analog data, including full-motion video, voices, and telemetry.

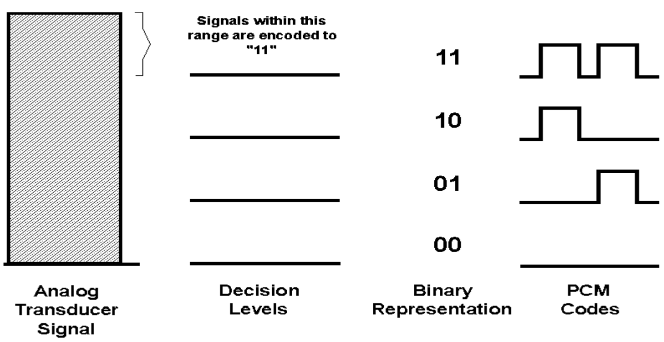


Figure A-2-3-4: *Converting an Analog Signal to a Digital Signal*

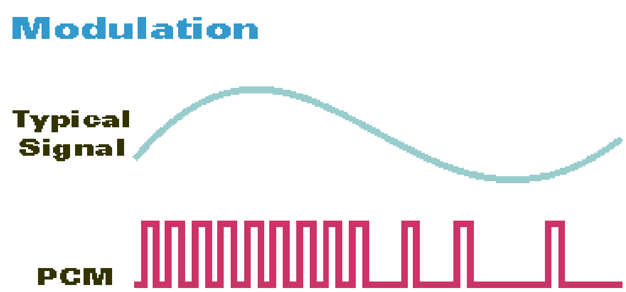


Figure A-2-3-5: *PCM Waveform of an Analog Data Signal*

A.2.3.5 Amplitude Modulation

AM is a form of modulation in which the amplitude of a carrier wave is varied in direct proportion to that of a modulating signal. AM is commonly used at radio frequencies and was the first method used to broadcast commercial radio. One of the advantages of this method is simplicity in design; however, AM signals are the most vulnerable to noise.

The Figure A-2-3-6 shows an example of amplitude modulation. The top diagram shows the modulating signal superimposed on the carrier wave. The bottom diagram shows the resulting amplitude-modulated signal. Notice how the peaks of the modulated output follow the contour of the original, modulating signal.

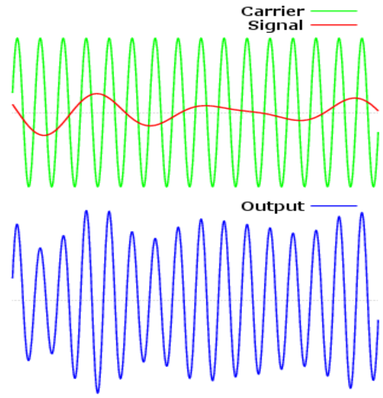


Figure A-2-3-6: *Amplitude Modulation*

A.2.3.6 Frequency Modulation

FM is a form of modulation which represents information as variations in the instantaneous frequency of a carrier wave. FM modulation is not as vulnerable to noise and is more popular than AM.

The Figure A-2-3-7 shows an example of frequency modulation. The top diagram shows the modulating signal superimposed on the carrier wave. The bottom diagram shows the resulting frequency-modulated signal.

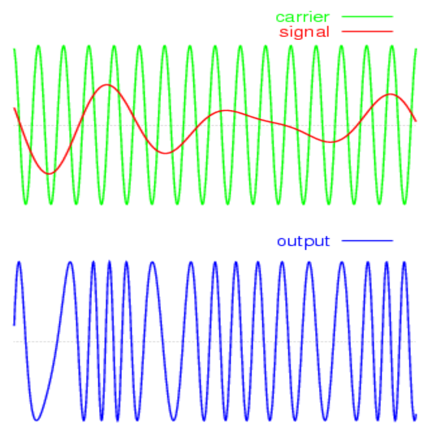


Figure A-2-3-7: *Frequency Modulation*

In analog applications, the carrier frequency is varied in direct proportion to changes in the amplitude of an input signal. Digital data can be represented by shifting the carrier frequency among a set of discrete values, a technique known as Frequency-Shift Keying (FSK). In other words, the binary 1s and 0s are represented by two different frequencies slightly offset from carrier frequency, shown in Figure A-2-3-8.

Even though a signal may be developed by TDM, it is normally transmitted by FM. For example, Delta IV uses a "PCM/FM" system. This means that the PCM output from the multiplexer is used to frequency modulate the transmitter directly. The terminology can even be carried a step farther. An example is a "PCM/FM/FM" system. This means that a PCM signal modulates an FM subcarrier. Typically, the FM channel is then combined with other similar channels by FDM, and the composite signal is used to frequency modulate the transmitter. The resulting system is a "hybrid" which combines TDM and FDM.

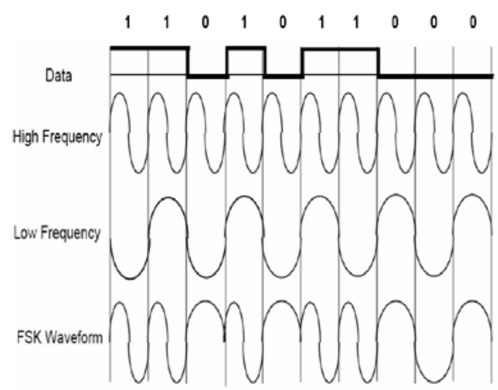


Figure A-2-3-8: *Frequency Shift Keying*

A.2.3.7 Phase Modulation - Binary Phase-shift Keying (BPSK)

PM is a form of modulation which represents information as variations in the instantaneous phase of a carrier wave. Unlike its more popular counterpart, FM, PM is not very widely used. This is because it tends to require more complex receiving hardware and there can be ambiguity problems, for example, the signal has 0 degrees phase or 180 degrees phase.
The Figure A-2-3-9 shows an example of PM. The top diagram shows the modulating signal superimposed on the carrier wave. The bottom diagram shows the resulting phase-modulated signal.

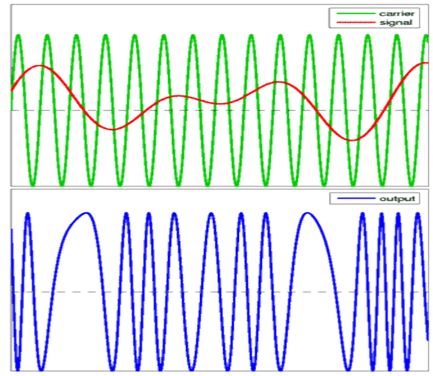


Figure A-2-3-9: *Phase Modulation*

In analog applications, the carrier phase is varied in direct proportion to changes in the amplitude of an input signal. In digital applications, a finite number of distinct phases are used to represent the digital data, a technique known as Phase-Shift Keying (PSK).

The simplest PSK technique is called BPSK shown in Figure A-2-3-10. It uses two opposite signal phases (0 and 180 degrees). The digital signal is broken up time-wise into individual bits (0 or 1). The state of each bit is determined according to the state of the preceding bit. If the phase of the wave does not change, then the signal state stays the same (0 or 1). If the phase of the wave changes by 180 degrees, that is, if the phase reverses, then the signal state changes (from 0 to 1, or from 1 to 0). Because there are two possible wave phases, BPSK is sometimes called bi-phase modulation. This scheme is simple to implement, but it is inefficient in terms of using the available bandwidth. BPSK is very robust, which is the reason that it is extensively used in satellite communication systems.

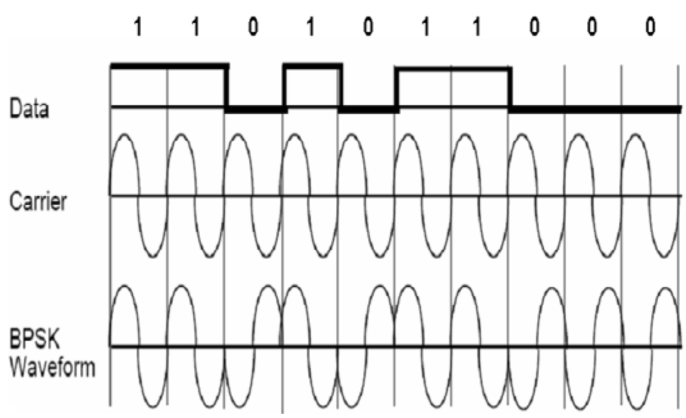


Figure A-2-3-50: *Binary Phase-Shift Keying*

A.2.3.8 Phase Modulation - Quadrature Phase-Shift Keying (QPSK)

Another technique, called QPSK, adds two more phases: 90 degrees and 270 degrees. Now two symbols per bit can be transmitted (00, 01, 10, or 11), twice the rate of BPSK. QPSK may be used to double the data rate compared to a BPSK system while maintaining the bandwidth of the signal or to maintain the data-rate of BPSK but halve the bandwidth needed. Each symbol's phase is compared relative to the previous symbol; therefore, if there is no phase shift (0 degrees), the bits "00" are represented. If there is a phase shift of 180 degrees, the bits "11" are represented.

Symbol	Phase Shift
00	0 degrees
01	90 degrees
11	180 degrees
10	270 degrees

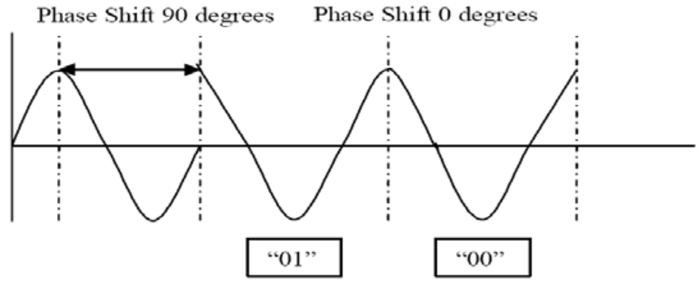


Figure A-2-3-11: *Quadrature Phase-Shift Keying*

For the Atlas V launch vehicle, TDRSS is used to relay telemetry data during portions of its flight when coverage by telemetry sites on the ground is not available. Since BPSK is extensively used in satellite communication systems, the Atlas V launch vehicle uses a "PCM/QPSK" to "PCM/BPSK" system for transmitting different amounts and rates of data on the same telemetry link. The Atlas vehicle transmits data on two "channels," the I and Q channels, on the 2211.0 megahertz (MHz) telemetry link. The I channel carries Atlas and Centaur vehicle PCM data, including Telemetry Inertial Guidance (TMIG) data, gathered by the vehicle's Master Data Unit (MDU). The Q channel carries research and development PCM data (data collected from microphones, vibration sensors, temperature sensors, etc.) gathered by a Digital Telepak mounted on the Centaur upperstage. Early in flight when the vehicle needs to transmit data from both the I and the Q channels, the vehicle's multiplexer uses QPSK to modulate both the I and Q channels onto the carrier signal for transmission to the ground sites or over the TDRSS data links. When the vehicle only needs to transmit the I channel data, the Centaur switches to the "PCM/BPSK" system, in which the multiplexer uses BPSK to modulate only the I channel data from the MDU onto the carrier signal for transmission over the TDRSS data links.

A.2.3.9 Linear Polarization

An antenna is vertically linear polarized when its electric field is perpendicular to the Earth's surface. An example of a vertical antenna is a broadcast tower for AM radio or the whip antenna on an automobile. Horizontally linear polarized antennas have their electric field parallel to the Earth's surface. For example, television (TV) transmissions in the United States use horizontal polarization. Thus, TV antennas are horizontally oriented.

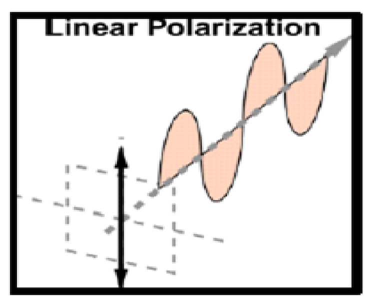


Figure A-2-3-12: *Linear Polarization*

A.2.3.10 Circular Polarization

In a circularly-polarized antenna, the plane of polarization rotates in a corkscrew pattern making one complete revolution during each wavelength. A circularly-polarized wave radiates energy in the horizontal and vertical planes as well as every plane in between. If the rotation is clockwise looking in the direction of propagation, the sense is called right-hand-circular (RHC). If the rotation is counterclockwise, the sense is called left-hand-circular (LHC). Since circular polarized antennas send and receive in all planes, they are more resistant to signal degradation due to surface reflectivity, atmospheric absorption, signal phasing, multi-path, and line of sight issues. Although different launch vehicles use

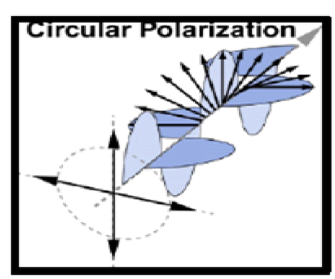


Figure A-2-3-13: *Circular Polarization* linear or circular polarization at the transmitting antennas, ground sites typically use circular polarized antennas in order to receive the transmitted signal in all planes.

A.2.3.11 Antenna

The parabolic reflector, shown in Figure A-2-3-14 either focuses the incoming signal on a feed horn (called a prime focus configuration) or on a subreflector that further focuses the signal into a feed horn (called a cassegrain feed horn). A cassegrain system, shown in Figure A-2-3-15 has several advantages: it has a short connection between the feed horn and the receivers to minimize line losses, it allows ease of access to the feed horn for maintenance since it is mounted behind the reflector, and the subreflector blocks less of the incoming signal than a feed horn. The antennas have the capability for simultaneous RHC polarization (RHCP) and LHC polarization (LHCP) in order to receive telemetry signals in any direction. For additional details, please refer to the ERIH.

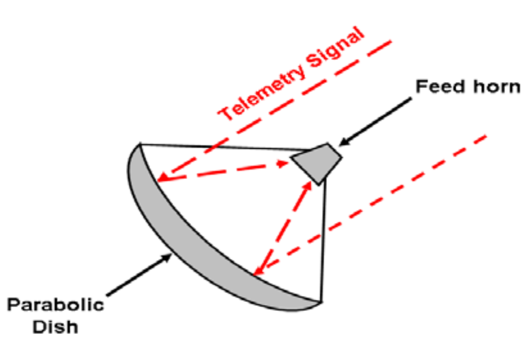


Figure A-2-3-14: *A Prime Focus Antenna*

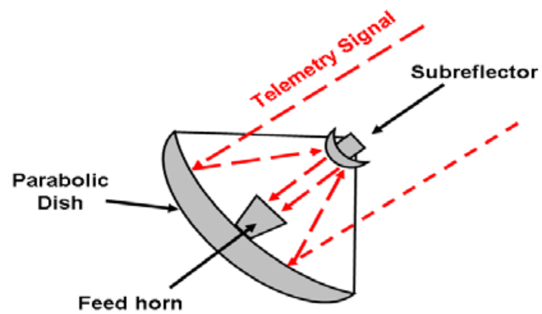


Figure A-2-3-15: A Cassegrain Antenna

A.2.3.12 Site Computer

- **System Engineering Laboratories computer:** The SEL computer is the central processing unit of the site computer and runs the site's operational real-time computer program. It accepts and processes data from the TRIO subsystem, including antenna pointing data, antennas systems status, and pointing and sends it to the TRIO subsystem for distribution to the rest of the antenna systems
- **Telemetry/Radar Input/Output computer:** The TRIO is a microprocessor-based control system providing an interface between the SEL computer and the tracking antennas. It sends tracking data and antenna status parameters from the antenna and High Density Designate (HDD) data received real-time from the Morrell Operations Center (MOC) HDD circuit to the SEL computer or COMPRO Gateway computer. The TRIO also accepts Computer Designate pointing data in and processed antenna data from the SEL computer or the COMPRO Gateway computer and distributes it to the rest of the antenna systems
- **Microcomputer Buffer System:** The MBS subsystem is a distributed control system which consists of an MBS Controller, an external bus, and a number of subcontrollers which reside in the antenna control consoles and provide operator interfaces to the Gould/SEL computer or the COMPRO Gateway computer

A.2.3.13 Receivers

The S-Band signal received by the antenna is a composite of both RHCP and LHCP components. Nominally, two receivers are set up for each telemetry link, one for the LHCP component of the signal and the other for the RHCP component, so that all of the received signal power can be recovered by the combiner.

Outputs from the receivers may be one of two types:

- **Pre-Detected (Pre-D) Output:** A Pre-D output is down-converted information possessing the carrier signal and all of the modulation characteristics of the transmitted S-Band signal. Pre-D outputs have been down-converted into an intermediate frequency (IF), a more manageable radio frequency, and digitized directly using an analog-to-digital converter
- **Post-Detected (Post-D) Output:** A Post-D output is a re-creation of the baseband data used to modulate the carrier. It is created when demodulator units are used to detect the baseband data and strip the raw data from the carrier signals for data quality monitoring and separation

The receivers also generate AGC signals, which are voltage representations of the signal strengths at the input to the receiver. AGCs are transferred to a multiplexer encoder to allow signal strength recording, distribution and display and to the diversity combiners for optimal combination of the LHCP and RHCP signals.

A.2.3.14 Recording Subsystem

- Analog Data Recorders: The Tel-4 Analog Data Recording System consists of ten Honeywell 97 analog recorders. The Honeywell 97 recorders are designed for use with 1 inch, 14-track magnetic tapes. Two of the ten Honeywell 97s in Recording may be switched between single density and double density record/reproduce heads as required to meet Range Customer tape requirements. All others are used only in double density mode. The purpose of the recorders is to record and reproduce telemetry signals for Range Customers and for internal configuration checks, data quality monitoring, and local testing. The analog data recorders support three types of recording. “Direct recording” implies that the output from a receiver or a combiner, whether a down converted Pre-Detect (Pre-D) Intermediate Frequency (IF) signal or a Post-Detect (Post-D) video signal, is recorded directly onto magnetic tape. For Pre-D signals, this requires the combiner Down Converter circuit to produce an IF frequency within acceptable range. For Post-D signals, the concern is that the raw baseband data must have a higher frequency than the lowest cutoff frequency of the acceptable range. “Frequency Modulation (FM) recording” is used when Post-D baseband data is composed of direct current (dc) levels (i.e., multiplexed bit streams) or very low frequency subcarriers; the data first modulates a subcarrier having an acceptable frequency, and this frequency is then applied to the record head. The drawbacks of FM recording rather than direct recording of a high-frequency signal are reduced data bandwidth and a lower signal-to-noise ratio. Lastly, “voice signal recording” is utilized to allow audio calibrations and annotations.

- Digital Data Recorders: The Tel-4 Digital Recording System has 10 digital recorders, two Universal Matrix switches with I/O adapters (also referred to as Telemetry Video Distribution System (TVDS)), two Ethernet switches and Personal Computer (PC) controllers. The 10 Telemetry Wideband Digital, Inc. Recorders are called the DIRs. The 10 Digital Data Recorders are divided into four Data Recorders and one Data Simulation/Playback on the A-side and a similar configuration for B-side. There are four PCs, each share resources and act as the Control Computers: 1) Two for the Digital Data Recording equipment, 2) One in Separation for the TVDS, and 3) One in Acquisition for the TVDS. The Wideband 3300E Recorders supports three data product media formats: 1) Serial Advance Technology Attachment (SATA) Hard Drive up to 400 gigabytes (GB) 2)

Digital Versatile Discs (DVDs) +R up to 8.5 GB per Disc (can span multiple discs) 3) AIT-3 digital tapes can archive up to 100 GB per cartridge (can span multiple cartridges and/or drives). The UW Small Computer System Interface (SCSI) interface has dual functions 1) Tape Archive Device 2) PC interfaces to provide data transfers. The UW SCSI card is installed on the PC. The data products are Compact Disc (CD)/DVDs and/or Advanced Intelligent Tape (AIT)-3 tapes and/or external universal serial bus (USB) hard drives and/or removable SATA hard drives. The WSI DRS3300E has nine Redundant Array of Inexpensive Disks (RAID) 10,000 revolutions per minute (RPM) hard disks. The recorders will continuously record/playback for 54, 108 or 216 minutes (m) at the maximum rate of 200 megabytes (MB) per second (Mbps). There are three DAS3000-AIT-3 external tape drives per Data Recorder System; each have 100 GB capacity per tape and have an approximate transfer rate of 12 Mbps per drive with a length of 230 m (approximate 32Mbps transfer rate using all three drives). The analog and digital (PCM) telemetry data is available on removable hard drives or CD/DVDs in the format of *.DAT or Inter-Range Instrumentation Group (IRIG) 106-07/106-09 Chapter 10 (*.CH10)

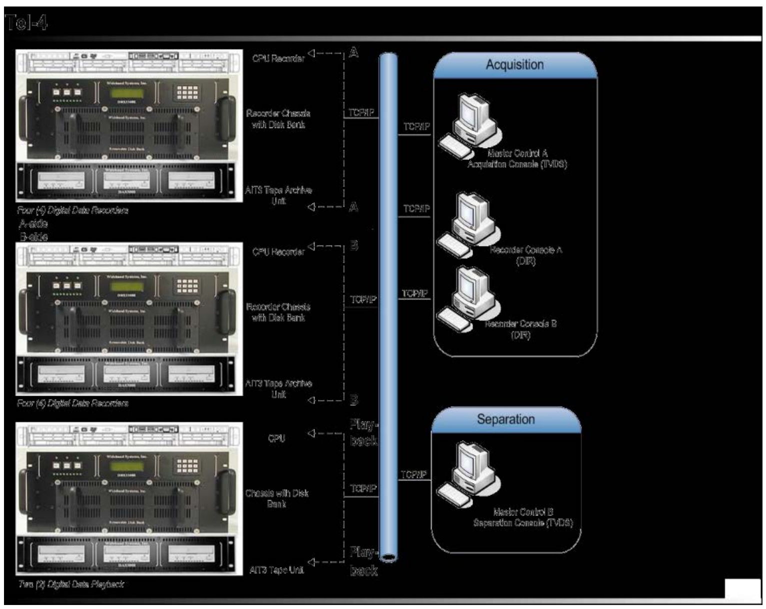


Figure A-2-3-16: *Digital Data Recorder System*

RECORDER SPEED (INCHES PER SECOND)	DIRECT RECORDING RANGE	FM RECORDING RANGE
120	800 Hz to 4 MHz	DC to 1 MHz
60	400 Hz to 2 MHz	DC to 500 kHz
30	400 Hz to 1 MHz	DC to 250 kHz
15	400 Hz to 500 kHz	DC to 125 kHz

Figure A-2-3-17: *Analog Data Recorder Characteristics (Double Density Recording)*

A.2.3.15 Separation Subsystem

On the ground, after being down-converted from S-Band to baseband by a receiver/demodulator, the video distribution system routes the signal to the input of a bit synchronizer.

- **PCM Bit synchronizer:** The Bit Sync converts baseband data into a serial digital bit stream of discrete ones and zeros and establishes a synchronous clock with the data
- **PCM Decommutator:** After bit synchronization, the PCM Decommutator frame synchronizes and decommutates the serial digital bit stream. This process involves changing the data from a serial format to a parallel format and separating the data into groups of bits, which represent the individual telemetry parameter value that was originally encoded on the flight vehicle for each parameter
- **Phase Modulation/Phase-Shift Keying Demodulator:** Some flight vehicles utilize PSK encoding in the telemetry downlink. The PSK demodulator is used to demodulate BPSK sub-carriers from the data receiver and convert that signal to conventional PCM format, which is identical in format to the Post-D output of the data receiver. After conversion to PCM, this signal is processed as any other PCM signal
- **Frequency Modulation Discriminator (FMD)**: In some cases, a specific analog vehicle parameter (vibration accelerometer, for example) may be used to frequency modulate the subcarrier frequency of the telemetry downlink. Several of these parameter signals may be FDM together on a single analog telemetry downlink. The FMD is used for the third stage telemetry link on the Delta II launch vehicle and on other launch vehicles when using special instrumentation sensors to gather data on new vehicle components. After these analog signals have been down converted from S-Band to baseband by the receiver, an FM Discriminator is used to demultiplex the signals to reconstruct the original data value of each telemetry parameter. After the signal is demultiplexed, it is usually converted from analog format to digital format via an analog-to-digital (A/D) converter so it may be placed on the parallel telemetry bus and finally be displayed to a Range and/or Launch Customer or retransmitted to the Centralized Telemetry Station (Tel-4)
- **Digital Multiplexer**: The parallel telemetry bus multiplexer (also known as the Digital MUX) is used to combine multiple parallel telemetry data streams (from multiple decommutators and/or an FM Discriminator), through TDM, into a single parallel telemetry bus which distributes real-time telemetry data to processing and/or display equipment throughout the local telemetry site. This data is typically output to the Telemetry Range Buffer System (TRSB) or sent to digital displays and/or digital to analog convertors
- **Post Detect Telemetry System (PDTS)**: PDTS provides the capability for the transport of real-time digital Post-D telemetry data from four instrumentation sites (Tel-4, Jonathan Dickinson Missile Tracking Annex [JDMTA] and Ascension) to the MOC. PDTS is responsible for the transport of Range Safety data and also provides the capability for the transport of limited Range Customer data, via user-digitized video or Launch Vehicle (LV) telemetry data links. At least 3.6 megabits per seconds (Mbps) of bandwidth is provided for Customer data. PDTS provides a transition of communications from analog to digital links and reduces the primary Satellite Communications (SATCOM) aggregate bandwidth from 18 MHz to 6.3 Mbps with a secondary link at 3.0 Mbps for transport of redundant Range Safety data

The PDTS system is comprised of three functional elements: Digital Telemetry, Control and Display, and Network Communication.

- **Digital Telemetry Element:** The Digital Telemetry Element converts demodulated, unconditioned PCM and FM baseband signals into synchronous bit streams for the Network Communication Function
- **Control and Display Element:** The Control and Display Element provides local and remote control and status of the telemetry processing equipment that make up the Post-Detect system
- **Network Communication Element:** The Network Communication Element receives processed telemetry data from the Digital Telemetry function and routes that data, along with Inter-Range Instrumentation Group B (IRIG-B) timing signals, to the Centralized Telemetry Processing System (CTPS) in the MOC for Range Safety Processing and to Tel-4 for Launch Customer Best Source selection. The transport of telemetry data is handled by the Wide Area Network Interface Units (WANIU). WANIUs are used at the telemetry sites to collect the multiple PCM digital telemetry data streams (such as the Delta II first and second stage data on 2241.5 MHz and third stage data on 2252.5 MHz), multiplex them into a single telemetry data stream or aggregate, and distribute the data at rates from 250 bps to 5.1 Mbps. Two WANIUs are located at each site except for JDMTA, which has four. Redundancy is accomplished by each site having at least two independent WANIUs, then transmitting its telemetry data to the MOC via independent communication paths. WANIUs at the end of the transmission link are used to demultiplex the data for distribution to the various Range and Launch Customers

A.2.3.16 Telemetry Data Flows

The outputs of the WANIUs at the telemetry receive sites are routed to MOC Communications (COMM) using the Network Core, inverse multiplexers, and satellite modems:

- TEL-4 telemetry data is transmitted from the Tel-4 WANIUs directly to the Network Core through redundant landlines called Asynchronous Transfer Mode (ATM) links, for processing by the MOC WANIU
- JDMTA PDTS data is transported from the JDMTA WANIUs through two different pathways. The primary pathway is through a microwave link, consisting of microwave towers at JDMTA and the XY Facility, with several repeater stations in between. The secondary path is through leased fiber optic commercial circuits. Both pathways send data through the XY Facility, on to the Core, for processing by the MOC WANIUs
- Ascension PDTS is transported over the SATCOM International Telecommunications Satellite (INTELSAT) systems for processing by the MOC WANIUs. Both sites use a primary satellite (SATCOM 1, INTELSAT satellite 907) and a backup satellite (SATCOM 2 INTELSAT satellite 901)

The MOC WANIUs output telemetry data into CTPS which strips out the Range Safety data and sends the data to the FOV1 and DRSD systems. The MOC WANIUs also output telemetry data to the Tel-4 WANIUs for processing and Best Source Selection output to the Launch Customers. Currently, the Atlas Space Operations Center (ASOC) and Delta Operations Center (DOC; Delta IV Launch Control Center) use WANIUs at their locations to receive telemetry data and IRIG-B timing signals through the Network Core that are generated by the Tel-4 Best Source Selection process. Other customers are still using legacy circuits from Tel-4 to receive the Best Source Selection output but are in the process of transitioning to WANIUs.

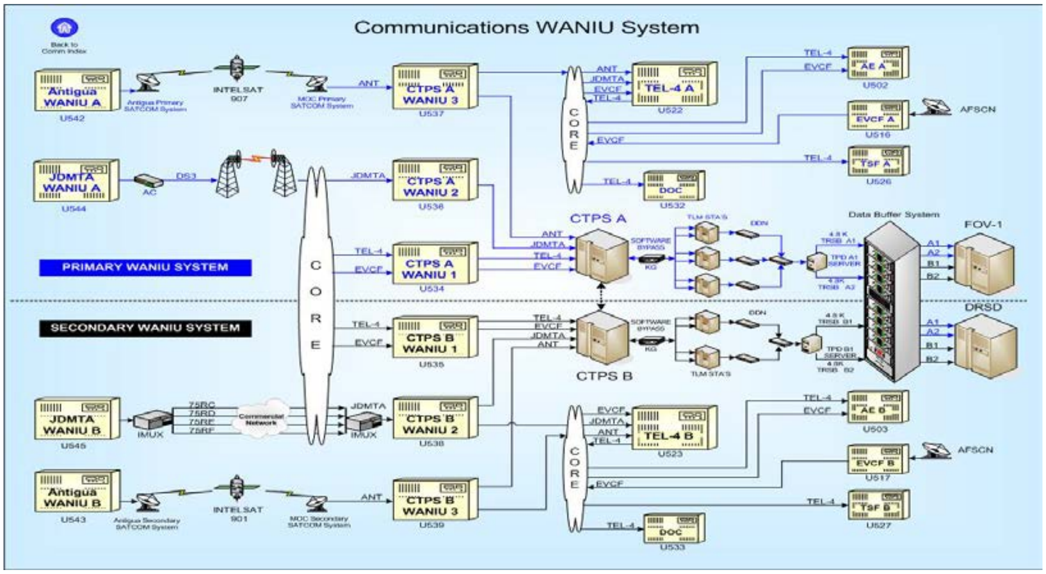


Figure A-2-3-18: *Communications WANIU System*

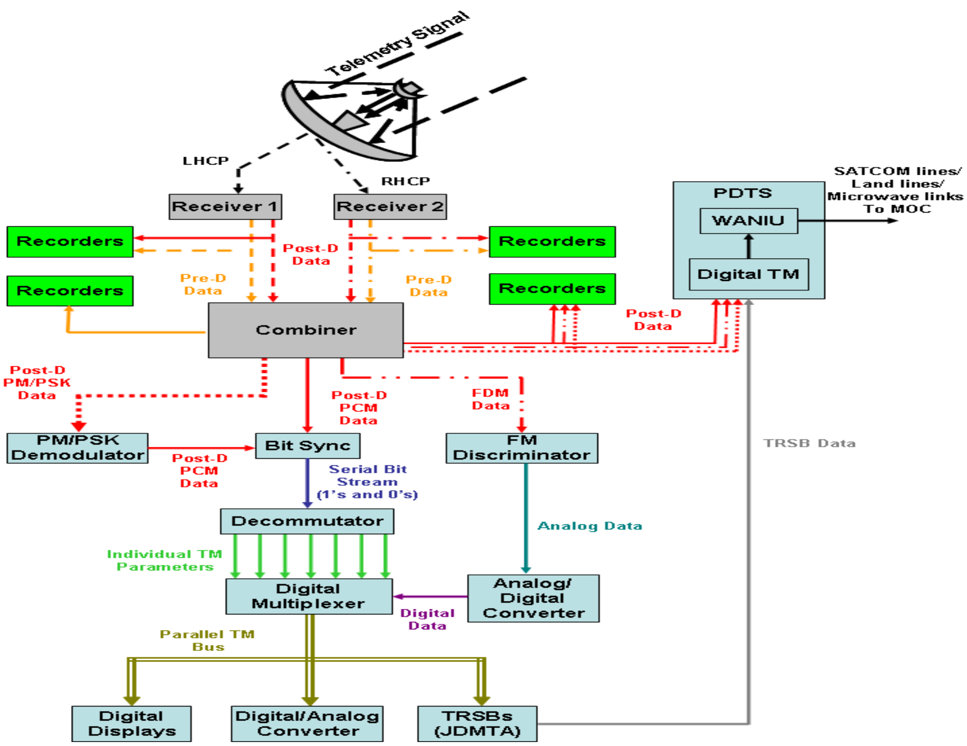


Figure A-2-3-19: *Telemetry Site Processing Flow*

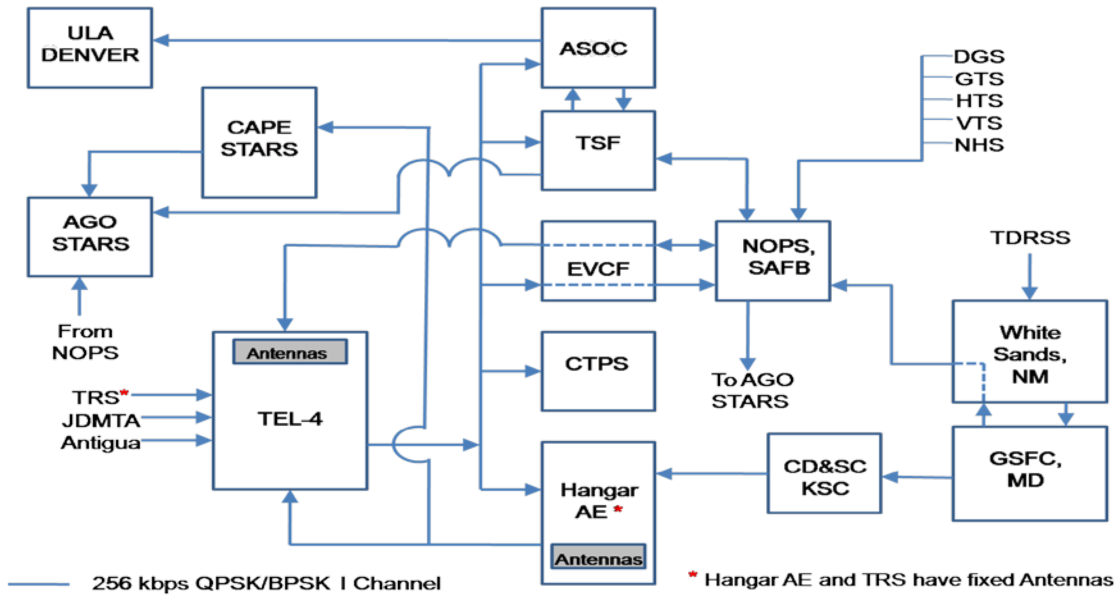


Figure A-2-3-20: *TDRSS Customer Data Flow*

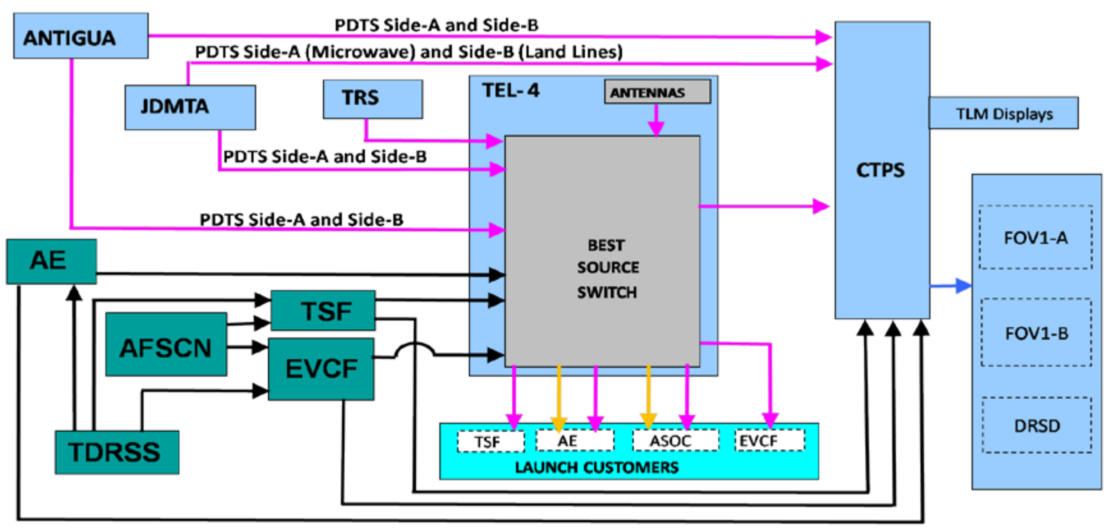


Figure A-2-3-21: *Atlas V Telemetry Data Flow*

2211.0 MHz - 256 kbps (I-channel) Range Safety and Launch Customer data

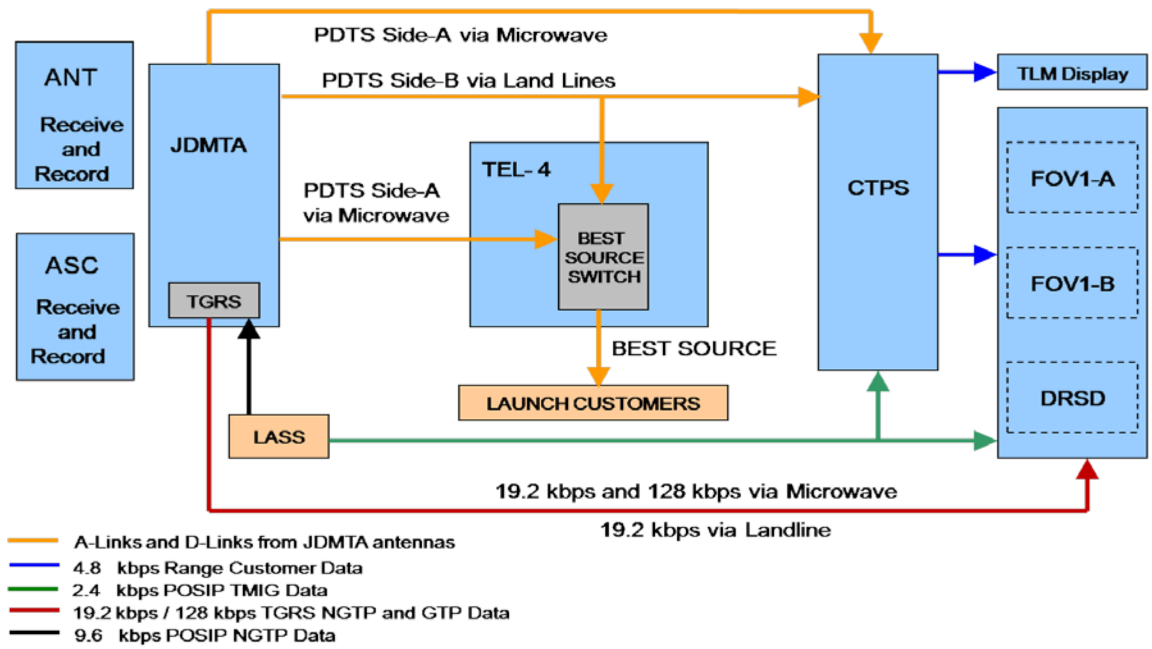


Figure A-2-3-22: *Delta IV Telemetry Data Flow*

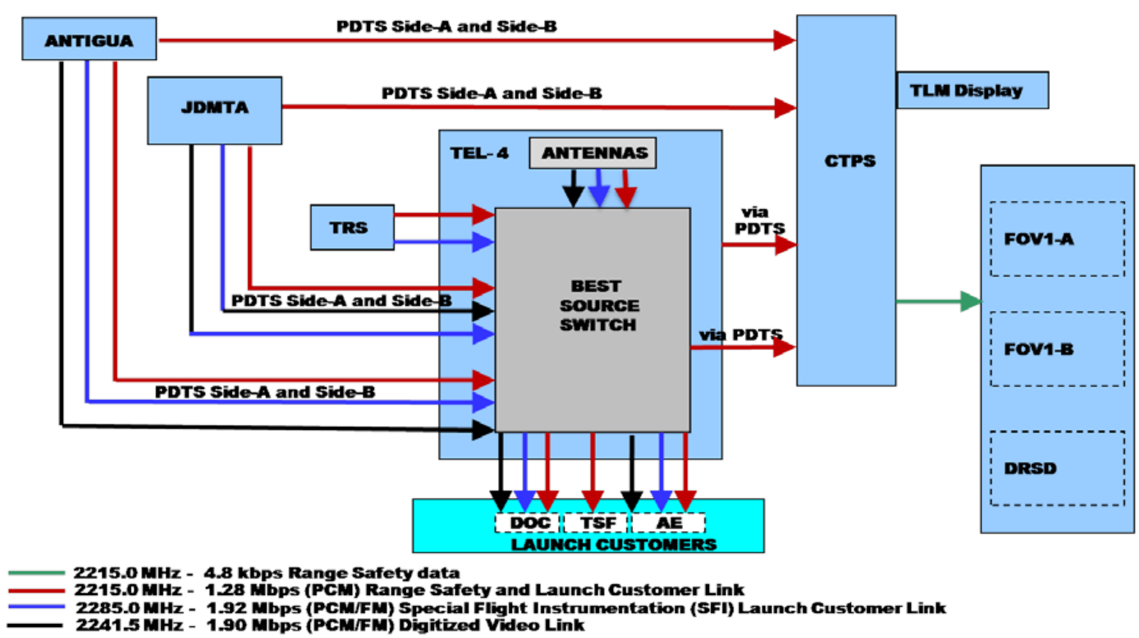


Figure A-2-3-23: *Trident II Telemetry Data Flow*

A.2.3.17 Non-Eastern Range Telemetry Sites and Antennas

Other non-ER telemetry assets are used to supplement ER sites.

A.2.3.17.1 Launch Area Support Ship (LASS)

The LASS routes telemetry data to the MOC during Trident II launches.

M465: The M465 is the Range Safety Communication System (RSCS) which provides redundant M345 (Navy System) telemetry data, state vector data, and secure voice communication between the LASS and the MOC at CCAFS. The M465 is a redundant system and consists of two independent paths, String 1 and String 2. Service coverage is provided by a commercial Ku-Band Satellite that provides a path for each string of 128 kilobits per second (kbps) between the LASS and the MOC.

- String 1 - provides a path for Secure voice nets 1 and 1A, Navy Global Positioning System Translator Processor (NGTP) data 1J and 1K, and Telemetry Processing Unit (TPU) data 1G
- String 2 - transports secure voice nets 2 and 2A, NGTP data 2J and 2K, and TPU data 2G

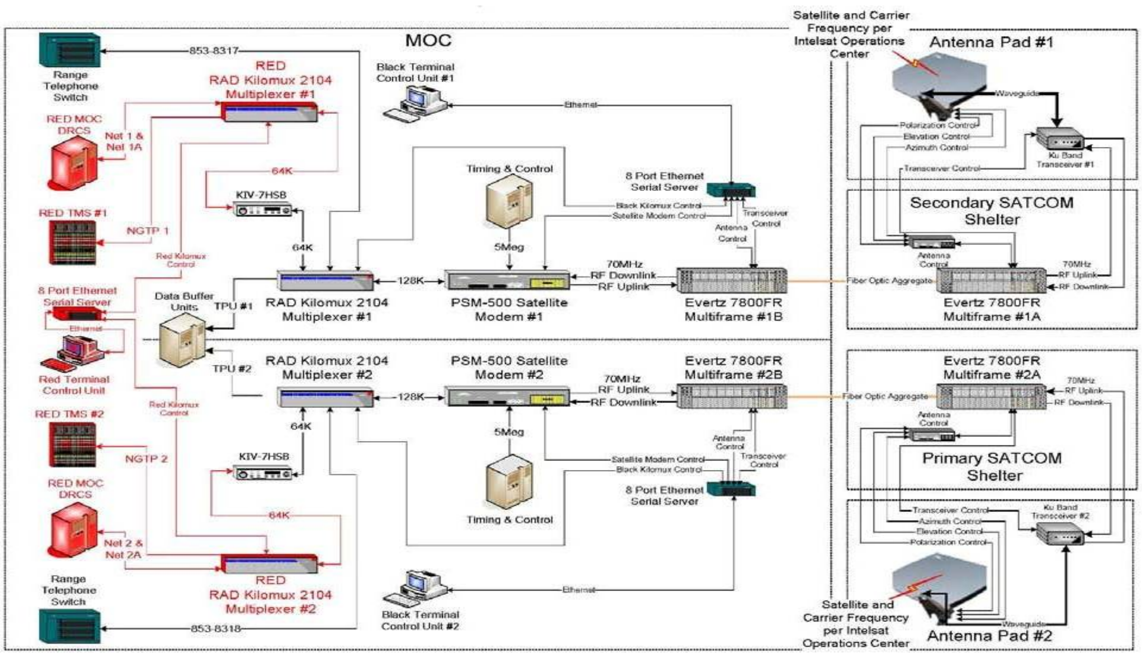


Figure A-2-3-24: *M465 Data Flow*

A.2.3.17.2 National Aeronautics and Space Administration (NASA) Telemetry Sites

Some National Aeronautics and Space Administration (NASA) telemetry can support other launch customers when required by the launch trajectory.

NASA Telemetry Sites Include:

- **Goddard Space Flight Center (GSFC):** Located in Maryland and Wallops Island (Station 86), Virginia

- **Wallops Flight Facility (WFF)**: Wallops Island in Virginia: Wallops Island has several Ground Networks (GN) stations, including Automated Wallops Orbital Tracking Station (AWOTS), Medium Gain Telemetry Antenna System (MGTAS), Satellite Automatic Tracking Antenna (SATAN), Small Command Antenna on a Medium Pedestal (SCAMP), Meteorological Satellite (METEOSAT), and 18-foot, 20-foot, 10-foot, 8-foot, and 23-foot Mobile Systems

Figure A-2-3-25: *Wallops Ground Station 11.3-meter Antenna*

- **Automated Wallops Orbital Tracking Station (AWOTS)**: The AWOTS Telemetry System is operated and maintained by NASA. Additionally, NASA controls the configuration of AWOTS. AWOTS is a NASA GN containing three automated subsystems:
- **Wallops Ground Station (WGS)**: One 11.3 meter (m) antenna for simultaneously transmitting at S-Band while receiving at S-Band and X-Band. Provides 1-way and 2-way Doppler, ranging, and antenna autotracking angle tracking services
- **Low Earth Orbiter Tracking Systems (LEO-T)**: One 5-meter antenna for simultaneously transmitting and receiving at S-Band. Provides no tracking services
- **Transportable Orbital Tracking System (TOTS)**: One 8-meter antenna for simultaneously transmitting and receiving at S-Band. Provides 1-and 2-way Doppler tracking services

All three provide baseband data interfaces with Internet Packet (IP), serial clock and data, and 4800 bit blocks encapsulated in IP packets. These subsystems have functions in addition to the S-band telemetry; however, those functions are not accepted interfaces to the Eastern Range.

Figure A-2-3-26: *LEO-T 5-meter Antenna*

Figure A-2-3-27: *TOTS-WFF 8-meter Antenna*

- **Ponce De Leon Station (PDL):** PDL is also part of the NASA GN, and is located on 1.4 acres of U.S. Coast Guard property, south of the PDL Inlet in New Smyrna Beach, Florida

Figure A-2-3-28: *PDL Ground Station*

A.2.3.17.3 Tracking and Data Relay Satellite System (TDRSS)

Ground Segment

The ground segment of TDRSS consists of two ground stations located at the White Sands Complex (WSC) and Network Control Center located at GSFC. These three stations are the heart of the network, providing command and control services

The WSC, located near Cloudcroft, New Mexico, in the Las Cruces area, consists of:

- White Sands Ground Terminal (WSGT) online in 1978
- Second TDRSS Ground Terminal (STGT) operational in 1994
- Extended TDRS Ground Terminal (ETGT)

The WSC remotely controls the Guam Remote Ground Terminal (GRGT), on Guam.

WSGT and STGT are geographically separated and completely independent of one another, while retaining a backup fiber-optic link to transfer data between sites in case of emergency. Each ground station has 19-meter dishes, known as Space-Ground Link Terminals (SGLT), to communicate with the satellites. Three SGLTs are located at STGT, two are located at WSGT and the remaining SGLT is in Guam. Together, the three SGLT provide full network support for the satellite covering the Zone of Exclusion (ZOE). Considered a remote part of the WSGT, the distance and location of the SGLT is transparent to network users. GRGT is an extension of the WSGT. The terminal contains SGLT 6, with the Communication Service Controller (CSC) located at WSGT's TDRS Operations Control Center (TOCC). Before the GRGT was operational, an auxiliary system was located at Diego Garcia.

Space and User Segments

The space segment of the TDRSS constellation is the most dynamic part of the system. Even with nine satellites on orbit, the system provides support with three primary satellites, while using the rest as on-orbit spares capable of immediate usage as primaries. The original TDRSS design had two primary satellites, designated TDE (for "east") and TDW (for "west"), and one on-orbit spare. The surge in user requirements allowed NASA to expand the network with the addition of more satellites, with some being co-located in a particularly busy orbital slot.

The user segment of TDRSS includes many of NASA's most prominent programs. Programs such as the Hubble Space Telescope and LANDSAT satellite relay their observations to their respective mission control centers through TDRSS. Since manned space flight was one of the primary reasons for building TDRSS, the space shuttle and International Space Station voice communications are routed through the system.

The TDRSS system has been used to provide data relay services to many orbiting observatories, and also to Antarctic facilities such as McMurdo Station by way of the TDRSS South Pole Relay. The US-built sections of the International Space Station (ISS) use TDRSS for data relay. TDRSS is also used to provide launch data relay for expendable boosters.

A-2-4 OPTICS

A.2.4.1 Metric Optics Controller's Console

The Metric Optics Controller console is manned by the Metric Optics Controllers during mission support. The Metric Optics Controller console uses two Acquisition Data Processor (ADP) workstations that provide the capability to monitor the status of individual Metric Optics sites and report information to the Instrumentation Superintendent of Range Operations (ISRO). The ADP workstations are part of the FOV1 system.

The Metric Optics Controller console has much the same functionality as the ADP (the MOC console is technically ADP-3), excluding the ability to control data output. This information can be used to direct the positioning of the optics at each site.
The console also includes eight 8" NTSC monitors (4 switchable and 4 hardwired) that allow the controllers to monitor live video provided from the Optical sites.

All Optical trackers have video cameras, video routers, and video transmitters which give them the ability to transmit their video images to the MOC. However, not all UCS sites have the infrastructure in place to transport the video. Metric Optics Planners must consider whether UCS sites have video transmission capabilities when planning the location of transportable Optical trackers.

A.2.4.1.1 Optical Site Computer System (OSCS)

The Optical Site Computer System (OSCS) is a specialized rack mount that has custom mission software for controlling Optical tracking systems on the ER. The functions of the OSCS include:

- Calibration
- Testing
- Translation
- Azimuth, elevation, and focus servo control and drive
- TAE recording
- Manual and computer drive operation
- Touch panel operator interfacing
- Interface with the Communications Supersystem for external HDD
- Interface with the Timing and Sequencing Supersystem for IRIG-B timing

A.2.4.1.2 Optics FOV1 and DRSD

Launch vehicle position is derived by the FOV1 and DRSD from TAE data collected in real-time from the trackers. The geometry of Optical tracker placement is vital to creating an accurate Optical Solution. Optics data is fed into FOV1 and DRSD through the Flight Operations Front End Processors (FO-FEP), undergoes a data format classification check, and is sent to each system's Estimation Processor (EP) where it is decoded, recorded, and checked for checksum errors. FOV1 and DRSD use similar filtering methods to calculate their independent Optical Solution representations.

FOV1 converts the azimuth and elevation measurements from each Optics site to Earth-Fixed Geocentric (EFG) by assuming the range to be one and the site location to be the Earth's center. This results in a set of unit vectors, in EFG coordinates, all pointing toward the target. A single Optics Kalman filter is used for all of the Optics sites and performs wild-point editing and velocity determination. The data is used to show the Present Position (PP) and Instantaneous Impact Point (IIP) of the vehicle, either as an individual source or as part of a Composite Solution.

The operators track launches in manual mode (joystick) and depress the On-Track footswitch if the vehicle is within the field of view. If the On-Track footswitch is released, the site's data will be rejected by FOV1.

A.2.4.2 Common Optical Site Subsystems

A.2.4.2.1 Power Distribution Subsystem

The Power Distribution subsystem routes either 3-phase or single-phase power to the appropriate components. No source of backup power is available.

A.2.4.2.2 Communication and Timing Equipment

As previously stated, communications and timing equipment is installed in the Optical sites. The equipment is actually part of the Communications Supersystem and Timing and Sequencing Supersystem. Although this equipment is not part of the Optical Supersystem, it is necessary for the proper operation of the Optical sites. Therefore, the communications and timing equipment and their functions are being included as follows.

A.2.4.2.2.1 Timing

The Timing and Optical interface includes a synchronous time code translator/generator and a distribution system that provides highly reliable timing signals to site instrumentation, even when the input signal is lost. See figure below.

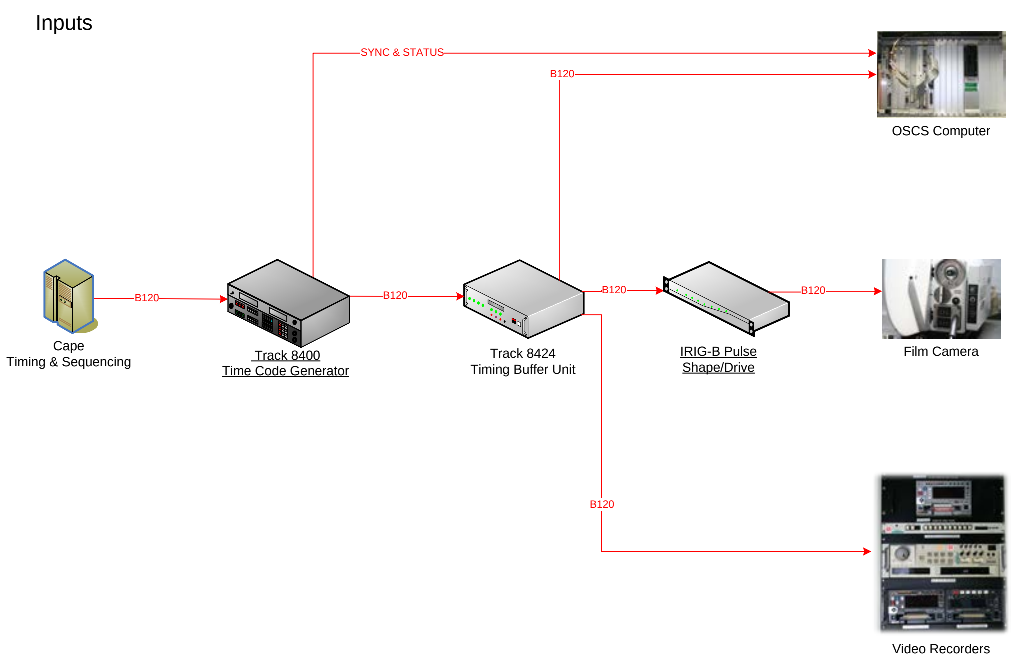


Figure A-2-4-1: *Example of Timing Data Flow*

A.2.4.2.3 Communication

The Optical site interfaces with Communication systems with both non-secure audio communications and secure data communications.

The audio (voice) communications for the Optical trackers is via the DRCS units. The Transistorized Operational Phone System (TOPS) end units are still installed in the mobile trackers because not all of the UCS sites are DRCS capable. The nets used by the Optical trackers to communicate with the Metric Optics controllers are the “Metric Engineering Net” and the “Telescope Tracking Net.”
The secure data communications consists of a 2400 bits per second (bps), full-duplex circuit which is used to provide acquisition information between FOV1 located in the MOC and the Optical tracker. This circuit is known as the HDD circuit. The communications security consists of a Universal Data Systems 201B modem and Key Generator-84 (KG-84) encryption/decryption device which mirrors equipment at the MOC.

The Range timing is used by the OSCS (Computer Subsystem) to time tag data. It is distributed to the video recorders and the film camera to time tag those products. It is also used to display the Range Count and Universal Time on the timing displays. Optical site synchronization with Range timing is critical. The FOV1 requires an HDD time delay of 0.2 seconds from each Optical tracker.

If the site’s incoming timing signal drops out, the time code translator switches to an internal generator and continues to provide valid timing signals to the instrumentation. In the event of a time code translator failure, the OSCS can also provide valid timing signals through a free-running clock in the Automatic IRIG-B Timebase Generator (AITG) plug-in card provided it was synchronized to Range IRIG at least once during the power-on cycle. The AITG card drift specification is + or -1 microsecond in 120 seconds of operation. The OSCS (AITG) timing will synchronize the HDD data with Range timing so the Range Safety data can be considered valid. However, the OSCS does not provide timing to the film camera or video recorders. So, the user data would have good imagery but no timing.

A-2-5 GPS TRACKING SYSTEMS

A.2.5.1 Translated GPS Range System (TGRS)

The TGRS system utilizes data from the GPS constellation and the launch vehicle to provide real-time Range Safety state vector (positional) data to the ER for up to four Trident missiles simultaneously. Note: TGRS falls under the Telemetry Supersystem and is carried under the TAA -50 Eastern Range Designators (ERDs). TGRS provides the capability for real-time line-of-sight tracking and recording of high quality pre-track GPS signals, which are a primary source of target and interceptor of position and velocity and real time flight safety track. The TGRS system operates in conjunction with the GPS constellation, the launch vehicle, and the ER to provide real-time Range Safety state vector data or Time Space and Position Information (TSPI) for D5 Low Cost Test Missile Kit (LCTMK) for the Department of Defense (DoD). TGRS is designed to process and record data for up to four Trident missiles simultaneously.

A.2.5.1.1 Microwave L1 and L2 Carrier Signals

A.2.5.1.1.1 Navigation Message

The 50 MHz Navigation Message consists of time-tagged data frames transmitted every 30 seconds that include the time of transmission, GPS satellite ephemeris/orbital data (position and velocity), and clock correction data parameters (satellite time vs. GPS time). It is modulated onto the L1 and L2 frequencies.

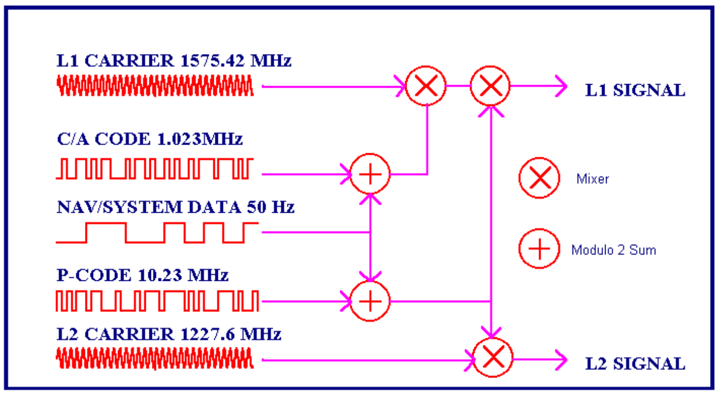


Figure A-2-5-1: *GPS Signals*

A.2.5.1.1.2 Coarse Acquisition (C/A) Code

The exact distance between a satellite and a GPS receiver is determined by calculating how long the signal takes to travel between the two. To measure the signal delay, an atomic clock aboard each satellite regulates the C/A code, which is a 1.023 MHz repeating Pseudo Random Noise (PRN) code that modulates the L1 carrier signal. The C/A code repeats every millisecond and there is a different C/A code PRN for each satellite, with defined PRN codes for 32 satellite identification numbers. The GPS receivers store a complete set of pre-computed C/A code chips in memory which they use to determine a correlation with a specific PRN code in a satellite's carrier signal. Each bit in the PRN pattern corresponds to an exact moment in the 30-second Navigation Message data frame transmission cycle. In order to calculate the time difference, a GPS receiver compares the phase shift between the bit pattern from the satellite and an identical pattern generated internally. Because the C/A code is repeated every millisecond, a GPS receiver can quickly lock onto the signal and begin matching the received codes with the replica codes. The C/A code is the basis for the GPS Standard Positioning Service (SPS), which is the level of service authorized for civilian users. C/A code signal processing is the P code signal from the P code signal processing section applied to a complex input port on the Digital Down-converter Field Programmable Gate Array (FPGA). The signal is translated to 70.026786 kilohertz (kHz) and then low pass filtered using decimate by 10 phase linear Finite Impulse Response (FIR) filter. The resulting signal of C/A code bandwidth is then applied to an Automatic Gain Control (AGC) function, which restores the duty cycle of the Least Significant Bit (LSB) to approximately 20 percent, the C/A code is then formatted into a serial data stream using an 8.024 MHz shift clock and an associated synchronization signal. Since the shift clock is not a multiple of 23.188 MHz (the signal sample rate), the data is re-clocked within the decimating FIR to minimize the amount of that is added to the signal.

A.2.5.1.1.3 Precision (P) Code

To get more precise measurements than those provided by the C/A code, the GPS satellites also transmit the P code at a chip rate 10 times the C/A code, or 10.23 million chips per second. The P code modulates both the L1 and L2 frequencies and is extremely long. The chip pattern repeats every 266 days. Each satellite is assigned a unique one-week segment of this code that is initialized at midnight on Saturday of each week. In the Anti-Spoofing (AS) mode of operation, the P code is encrypted into a Y code. The encrypted Y code requires a classified AS module for each receiver channel and is for use only by authorized users with cryptographic keys. The P (Y) code is the basis for the Precise Positioning Service (PPS), which provides access to both the C/A codes and P codes, and is designed primarily for military users. Even with the use of the P code, some margin of error results from the receiver's imperfect quartz clock. By taking measurements from a fourth satellite to factor out time errors, accuracy within 50 nanoseconds can be achieved. System accuracy is reported to be 16 meters (m); however, when performing such tasks as precision approaching and landing of commercial aircraft or maritime navigation of the seas, greater accuracy is needed. The sampled signal from the frequency conversion section is applied to a digital down-converter FPGA, which provides two down-conversion sections, one for P code signal processing and one for C/A code signal processing. The P code signal processing is the output of the frequency conversion translated by a factor of ¼ of the sample rate, converted, complex quadrature form, and low pass filtered using a phase linear decimate by two FIR filters. The resulting complex signal of P code bandwidth is provided as an output with an offset from baseband of 292.28571 kHz at a 23.188 MHz rate and the data format is offset binary.

A.2.5.1.2 PS Modernization

The first launch of the Block IIR-M GPS satellites in September of 2005 introduced the new military Code (M code) and a second civilian signal (L2C). The M code signal was added to both the L1 and L2 links and provides the war-fighter with a more robust, jam-resistant signal, enabling effective munitions targeting in stressed environments. The L2C, a redundant signal, is the first signal truly dedicated to the civilian community. Its pseudo-random civilian code features several performance-related enhancements when compared with the C/A code on L1. These improvements allow removal of ionosphere errors, which increases accuracy, and provides better resistance to jamming, and enhanced performance for current and future missions.

A.2.5.1.3 Differential GPS

One way of getting increased accuracy from GPS is called Differential GPS (DGPS). The DGPS combines GPS with signals from special land-based stations located around the world. Using its precise, known location, a DGPS station calculates the error present in each satellite's data and beams that correction out to any mobile GPS receiver within range. The receivers then use this information in their navigation solution to come up with a revised position that is accurate to about 1 meter.

A.2.5.2 TGRS Concept of Operation

A.2.5.2.1 Translated GPS Range System (TGRS)

The TGRS system utilizes data from the GPS constellation and the launch vehicle to provide real-time Range Safety state vector (positional) data to the ER for up to four Trident missiles simultaneously. TGRS falls under the Telemetry Supersystem and is carried under the TAA-50 Eastern Range Designators (ERDs). TGRS provides the capability for real-time line-of-sight tracking and recording of high quality pre-track GPS signals, which are a primary source of target and interceptor of position and velocity and real time flight safety track. The TGRS system operates in conjunction with the GPS constellation, the launch vehicle, and the ER to provide real-time Range Safety state vector data or Time Space and Position Information (TSPI) for D5 Low Cost Test Missile Kit (LCTMK) for the Department of Defense (DoD). TGRS is designed to process and record data for up to four Trident missiles simultaneously.

A.2.5.2.2 TGRS Process

TGRS processes S-Band translated GPS signals from the launch vehicle and L-Band reference GPS signals from one of four reference antennas to calculate a state vector describing the present position of the launch vehicle. TGRS determines the position of the vehicle indirectly through the calculations of the two-way travel time between each GPS satellite to the missile, and from the missile to JDMTA.

During the flight of a Trident D5 Missile, the missile receives GPS signals from a minimum of five GPS satellites. Translator equipment onboard the missile receives these L-Band signals (1-2 gigahertz [GHz]), frequency translates them to S-Band (2-4 GHz), impresses a continuous wave (CW) pilot carrier onto the signal, and transmits the link down to JDMTA where it is picked up by the site's telemetry antennas. At JDMTA, four GPS reference antennas receive L1, L2, and L3 signals directly from the GPS satellites. Real-time processing involves only the L1 component; the L2 and L3 components are recorded for post mission processing. This creates a GPS reference signal that is a composite of the GPS satellites in view of the station GPS antenna and is used to collect satellite almanac and ephemeris data, including the error corrections for each satellite. Prior to launch, the TGRS reference channel is required to track GPS satellites for 15 minutes to download status information of the GPS satellites before the TGRS translated channels will meet the acquisition/reacquisition specifications. Having this information prior to acquisition of the translated GPS signal speeds the time-to-first-fix to less than 5 seconds.

A.2.5.2.3 Range Sum Concept

Throughout the flight, TGRS determines the position of the vehicle indirectly through calculations of the two-way travel time between each GPS satellite to the missile, and from the missile to JDMTA. First TGRS uses the GPS reference and translated signals to find the resultant solution from each GPS satellite (range sums), which places the vehicle somewhere along an imaginary ellipse (Range Sum Concept figure) of which the GPS satellite and JDMTA are the foci. In the Range Sum Concept figure, the missile may be at points AB, CD, EF, GH, or any of an infinite set of points making up the ellipse.

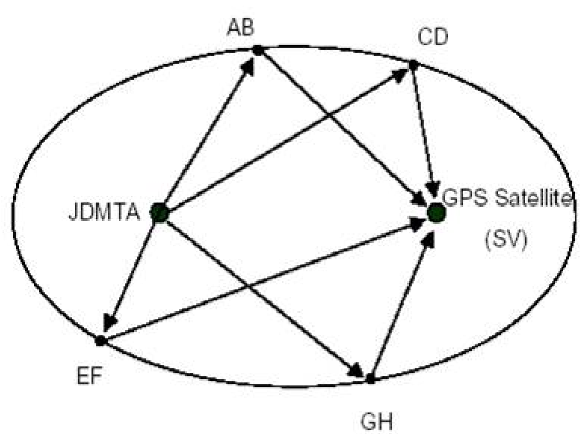


Figure A-2-5-2: *Range Sum Concept*

A.2.5.2.4 Pseudorange Sum

The intercept point of up to 12 ellipses (one for each of up to 12 Channel Trackers) is used to establish the approximate location of the vehicle. A minimum of five GPS satellites is required for valid state vector solutions (Determination of Pseudorange Sum figure). The distance from JDMTA to this intercept point is the pseudorange sum. It is called the pseudorange sum because it has not been corrected for receiver clock errors, atmospheric errors, or SA (if required). Having the pseudorange sums, TGRS then uses measurements of the pilot carrier frequency and measurements of the translated GPS carrier frequency to split the Doppler shift into two components: the shift associated with the relative motion between each GPS satellite and the launch vehicle, and the shift associated with the relative motion between the launch vehicle and the ground station. Then a Kalman filter uses the pseudorange sums and the two components of the Doppler shift to calculate the velocity vector. This velocity vector is the pseudorange rate sums. The Kalman filter then estimates the corrections for atmospheric errors, clock errors, and SA (if required) to compute the geometric range and range-rate measurements from the pseudo measurements. This data is then fed to the TGRS formatter every 100 milliseconds. The formatter interfaces to the redundant 19.2 kilobits per second (kbps) and 128 kbps data circuits that output data to the Morrell Operations Center (MOC).

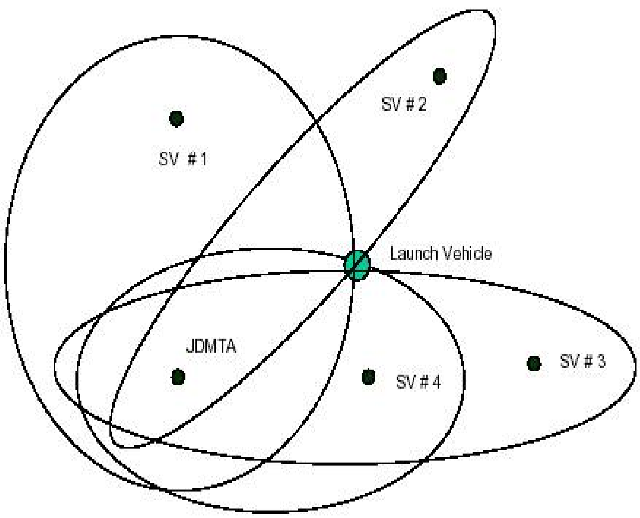


Figure A-2-5-3: *Pseudorange Sum*

A.2.5.3 TGRS Subsystems

There are five major subsystems in TGRS:

A.2.5.3.1 Reference Antenna System

There are four GPS reference antennas and preamplifiers mounted outside the JDMTA facility. These antennas receive L1/L2/L3 signals directly from the GPS satellites, amplify them, and supply them to the four GTPs for processing. The received satellite signals from one reference antenna/preamplifier can be power split to supply the signals to multiple GTP units.

A.2.5.3.2 GPS Translator Processor (GTP)

Each GTP processes the S-Band translated GPS signals received from the JDMTA telemetry antennas and the L-Band reference GPS signals from the Reference Antenna Subsystem to calculate a state vector describing the present position of the launch vehicle. There are four GTPs in the TGRS system. The following modules of the GTP accomplish this function:

A.2.5.3.2.1 RF Down Converter (RFDC)

The RFDC down converts and then digitizes the composite reference GPS signals from the Reference Antenna System. The digital representation of the signal is recorded by the PTS and is sent in parallel to the four GTP 12 Channel Tracker cards.

The RFDC consists of:

- A reference 10 MHz Oversized Crystal Oscillator (OVCXO).
- A reference receiver RFDC.
- A synthesizer function - producing various frequencies for use throughout the GTP unit.

The 10 MHz oscillator is used as the master frequency reference for the GTP, and capability is provided to switch between 5 MHz or 10 MHz signal for reference frequency. The RFDC receives a composite of the L1 or L2 GPS satellite signals and translates them to a 35.072 MHz Intermediate Frequency (IF) via two stages of down conversion without concentrating the signals. The AGC maintains the signal plus noise level constant over the full range of input signals. The output of the second down conversion stage, the Pseudo-Noise (PN) sequence, is applied to an Analog to Digital (A/D) converter that is sampled at a 46.376 MHz rate generating a quantized 2-bit data stream. Two local oscillator frequencies, coherent with the 10 MHz reference, are used to perform the frequency conversion. The first frequency conversion translates the L1 or L2 to an IF frequency of 184.14 MHz by mixing them with an Local Oscillator (LO) signal frequency of 1391.28 MHz for L1 or 1043.46 MHz for L2, and the difference frequency is filtered for further processing. The second conversion uses 149.06571 MHz as the LO. This LO is mixed with the output signals from the first conversion. The difference frequency is filtered to produce 35.07 MHz. The 35.07 MHz IF is sampled and quantized to 2 bits, at a 46.376 MHz rate.

A.2.5.3.2.2 Digital Baseband Converter (DBC)

The DBC utilizes the pilot carrier to separate the translated GPS signal's Doppler shift into two components. It then sends this data to the four GTP 12 Channel Tracker cards. The DBC supports the processing of GPS Translator signals received from LCTMK GPS Translators. The DBC accepts the sampled and quantized cross-polarized GPS Translator signals. The signals are quantized to 4 bits with a sample rate of 5 MHz to 25 MHz and accepts 1 PPS and 1 millisecond time marks. The DBC provides a Numerically Controlled Oscillator (NCO) with independent phase adders for each polarization, which is controlled by onboard Digital Signal Processor (DSP). The NCO is used to phase-lock to the Pilot Carrier (PC) and to phase rotate the translated GPS components, Translated L1 and Translated L2 of the composite signal, and provides in-phase and quadrature phase detectors for both polarizations of the PC signal.

A.2.5.3.2.3 12-Channel Tracker Cards

There are four 12 Channel Tracker cards for each GTP. Each tracker card is assigned three reference GPS satellites and three translated GPS satellites by the GTP Tracker Controller. The 12 Channel Tracker cards remove the GPS PRN code and detect the satellite ephemeris and almanac from the reference channels. The cards then use this data to quickly detect the individual GPS satellite Navigation Message from each of the translated satellites. This data is then passed on to the Tracker Controller. The 12 Channel Tracker provides code and carrier based measurement data from six independent GPS tracking channels (reference and/or translator based). The 12 Channel Tracker provides for six independent GPS tracking channels and provides the capability of selecting any GPS down converted or GPS translated baseband signal input to any one of the six tracking channels. The 12 Channel Tracker also demodulates the 50 bits per second (bps) GPS navigation message and provides the formatted navigation message as an output. Additionally, the 12 Channel Tracker accepts a different input of two bits in-phase (I) and two bits quadrature (Q) baseband data formatted in straight binary. The 12 Channel Tracker is a shared memory interface (Versa Module Eruopa [VME]) for input/output transfers. The 12 Channel Tracker supports six independent channels of P (Y) code, reduced bandwidth P (Y) code, C/A code, signal acquisition and tracking. The 12 Channel Tracker also supports the following modes of Fast Acquisition. Five channels of one bit C/A code fast acquisition with a five-point Fast Fourier Transform (FFT) and five channels of one bit C/A code fast acquisition with a five-point FFT with antenna switching commutation. The 12 Channel Tracker provides a means to download firmware, on-board processing control, a 1 millisecond output, and the ability to disable writes to non-volatile memory.

A.2.5.3.2.4 Tracker Controller (TC)

The TC is the functional element that controls and monitors the GTP and makes the major control decisions for the processors. It makes tracking assignments to the 12 Channel Trackers, receives the Navigation message from the trackers, and decodes the data. It provides the Kalman Filter function for velocity estimation and error corrections. It sends the position and velocity estimates to the TGRS formatters. Additionally, it receives commands from and sends status to the GCU.

- The TC makes the major decisions for the other processors and it receives the 50 bps data from the 12 Channel Tracker and decodes the data. It determines the 50 bps message from the 50 bps data and constructs the almanac and the ephemeris data for each satellite.
- The 12 Channel Tracker provides code and carrier based measurement data for six independent tracking channels and also demodulates the 50 bps GPS navigation message and provides that as an output.

A.2.5.3.2.5 S-Band Synthesizer (SBS)

The SBS RF module receives a 150 MHz LO signal, a 1 MHz reference signal and a frequency select word. The module employs two Voltage Controlled Oscillators (VCO) to generate an IF signal between 219 MHz - 409 MHz, frequency selectable in 1 MHz steps and phase-locked to the 1 MHz reference input, the module multiplies the 150 MHz LO by 12 to provide an 1800 MHz signal. The 1800 MHz signal is mixed with the 219 MHz - 409 MHz IF to produce the desired output LO frequency between 2019 MHz and 2209 MHz.

A.2.5.3.2.6 S-Band Converter (SBC)

The SBC converts the S-Band RF input signal to an 80 kHz complex signal, utilizing the local oscillator signals provided as inputs. The complex baseband signals are sampled at 80 MHz and quantized to at least 6 bits. The SBC down-converts an input S-Band signal into baseband I and Q components, samples and converts the analog I and Q baseband signals to at least 6-bit digital signals, accepts an S-Band local oscillator signal for down conversion and allows input from either a receiving antenna/preamplifier or a test signal source. The SBC uses input band pass filtering to reject preamplifier noise in the image band.

A.2.5.3.2.7 Analog Translator Processor (ATP)

The ATP provides the functional elements required to control the hardware when receiving, processing, and monitoring analog translator (D5 LCMTK) signals in the normal or test mode. The ATP Computer Software Component (CSC) is loaded into the Digital Baseband Circuit card and controls the hardware necessary for processing translated GPS signals from an analog translator. The ATP uses a 1024-point Fast Fourier Transform (FFT) to estimate the frequency of the PC which allows a third order phase-locked loop (PLL) to be prepositioned to achieve rapid and reliable acquisition. The PLL is updated every 50 microseconds; the output of the loop is used to control the PC Doppler NCO. The oscillator controls are accumulated over 50 millisecond periods and the result is the PC frequency measurement.

A.2.5.3.2.8 Recorder Input/Output (RIO)

The RIO provides Time of Day (TOD) on the PTS recording at a rate of at least once per second to a minimum resolution of 1 millisecond. The RIO also measures and outputs the following to the PTS; the time delta between the one millisecond mark received from the 12 Channel Trackers, and the following signals to an approximate resolution of 100 nanoseconds, Telemetry Main Frame Sync, External 1 PPS, and Antenna Switch Signal State (2 bits). The RIO provides the serial input/output (I/O) bus interface so the Tracker Controller Central Processing Unit (CPU) can send controls to and receive status from the RF modules (via the RIO serial I/O bus). The RIO is bus master for the serial I/O bus interface and this interface provides for six separate serial I/O bus ports. Each port consists of one serial input data line and one serial status line. The control and status registers are accessible via the VME interface on the RIO; the serial I/O bus uses Fast Cmos Technology (FCT) logic levels. The serial I/O bus clock frequency is software settable. “Cmos” is the shortened term for “complementary metal-oxide-semiconductor,” which is known as the technology for constructing integrated circuits.

A.2.5.3.2.9 DGT Demodulator

The Digital GPS Translator (DGT) Demodulator receives complex, digitized, narrow band Quadrature Phase Shift Keying (QPSK) (Feher QPSK [FQPSK]) modulated data from Right Hand Circular Polarization (RHCP) and Left Hand Circular Polarization (LHCP) signal paths and processes this data to produce a demodulated, decoded, and descrambled serial data output. The DGT Demodulator is required only for the processing of signals received from the DGT. The DGT Demodulator receives asynchronous sampled RHCP and LHCP data for demodulation, provides carrier tracking and baseband conversion for each polarization, provides data re-sampling at the recovered symbol timing rate, and provides phase alignment between polarizations and provide frequency measurement via FFT to aid in the acquisition process.

A.2.5.3.2.10 DGT Deformatter

The DGT Deformatter (DFM) is used to deformat a serial data stream configured of both Telemetry and GPS data. The deformatter first optionally decrypts the combined data stream and then separates the Telemetry data from the GPS data in the data stream by detection of a 28-bit sync word. The sync word is part of a 32-bit segment which replaces a 32-bit GPS data segment every 4096 GPS data clocks. The remaining four bits are made up of a 2-bit antenna switch state and 2 bits of status data. The Telemetry and GPS data is re-clocked to their original pre-formatted rates by the deformatter.

A.2.5.3.2.11 Fiber Channel Data Acquisition Card (FCDAC)

The FCDAC is a VME host adapter board used to transfer data between a Fiber Channel Interface and a proprietary Differential Fast Bus (DFB) or Expanded Differential Super-Fast Bus (EDSFB). The FCDAC provides a simple interface bridge to the Fiber channel disk arrays without the need to develop Fiber channel expertise and/or a host adapter. Commands, status, and power will be passed across the VME bus while all data is passed between the Fiber channel and the EDSFB. Continuous data transfer is 100 megabytes (MB) maximum. All data transfers will be initiated by the host sending a transfer Computer Data Bus (CDB) to the FCDAC, across the VME, and will conclude with the FCDAC sending status to the host across the VME.

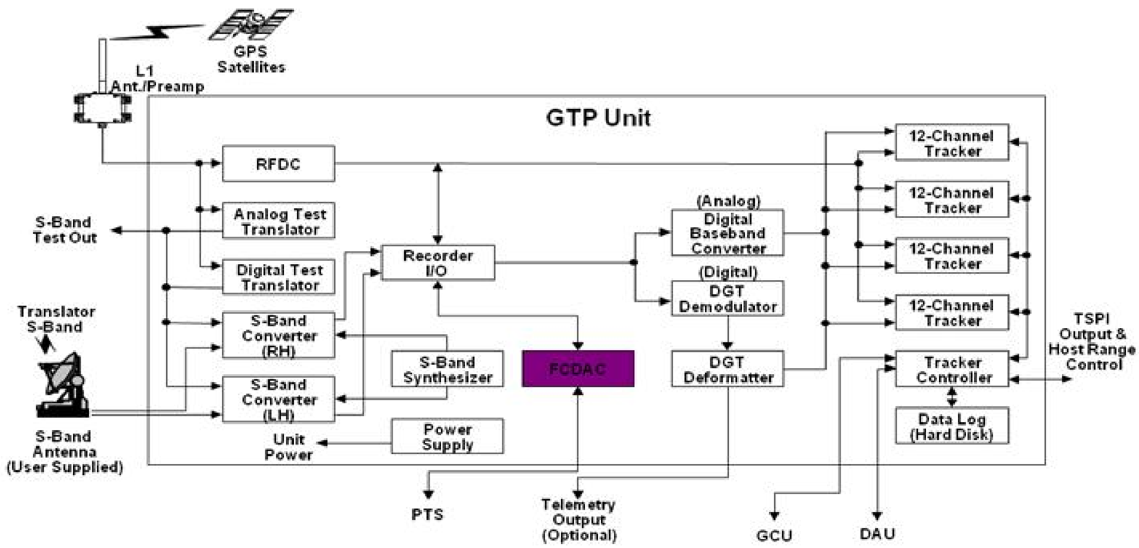


Figure A-2-5-4: *FCDAC*

A.2.5.3.3 GTP Control Unit (GCU)

The GCU provides the means to control and display the status of the each GTP as well as its associated PTS, as necessary for maintenance, unit control, mission set-up, and system performance analysis. The GCU allows the operator to manually reject one or more satellites from being used in the state vector estimate. There are two independent GCUs, each of which is capable of concurrently controlling the operation of up to four GTP units with associated PTS recorders. The GCU provides the means to generate summaries and plots from the data log recorder. The GCU has the capability to extract the target vehicle's trajectory information and convert it to a form acceptable to the Satellite Constellation Simulator (SCS). The GCU provides a printer interface to print all quick-look and post-mission data analysis operator displays, summaries, and plots.

A.2.5.3.4 Pre-Track Signal (PTS) Recorder

The PTS interface with the GTP provides for both record and playback capability. The signals recorded by the PTS include reference GPS signals and both RHCP and LHCP translator signals. Time of day is also provided on the PTS recording at a rate of at least once per second to a minimum resolution of 1 millisecond.

A.2.5.3.5 Data Archive Unit (DAU)

The DAU is a data archiving unit that has the ability to transfer and transport off-site the PTS and the GTP data log files for archiving and post-flight processing needs. The DAU provides the means to transfer previously archived PTS data back to the PTS for replay and evaluation purposes. The DAU provides the means to transfer the PTS recordings and the GTP unit data log records to a removable and transportable media. The DAU is connected to the GCU computer for data log archiving, data log restoring, and TGRS software maintenance, and is connected to the GTP unit when archiving the PTS recorder. The purpose of the L1/L2 Antenna/Preamplifier is to recover the direct reference GPS satellite signals, L1 and L2, in the P (Y) code bandwidth, and then amplify and supply them to the GTP for processing. The supplied signals from the L1/L2 antenna preamplifier are required by each GTP.

A.2.5.3.6 TGRS Functions

The GTP provides the capability for both real-time output of TSPI, translator and reference, and recording of raw data. The GTP translator unit provides an interface to a PTS recorder unit for recording of the S-Band translator signals. The GTP processes the S-Band transmission from one analog translator through a user supplied S-Band antenna/preamplifier. The PTS recorder provides the means to record and playback Telemetry and pre-track GPS signals from the tracked translators and direct GPS Reference Signals through the GTP unit. The PTS supports both record and playback capabilities. The recorded data contains the raw Telemetry data stream, the pre-tracked translated GPS sampled signal stream, the pre-track direct reference, L1 C/A code only sampled signal stream, and the current antenna commutation state. For the D5 LCTMK translator applications, the recorded data includes the timing of the Telemetry Main Frame Synch Pulse (MFSP).

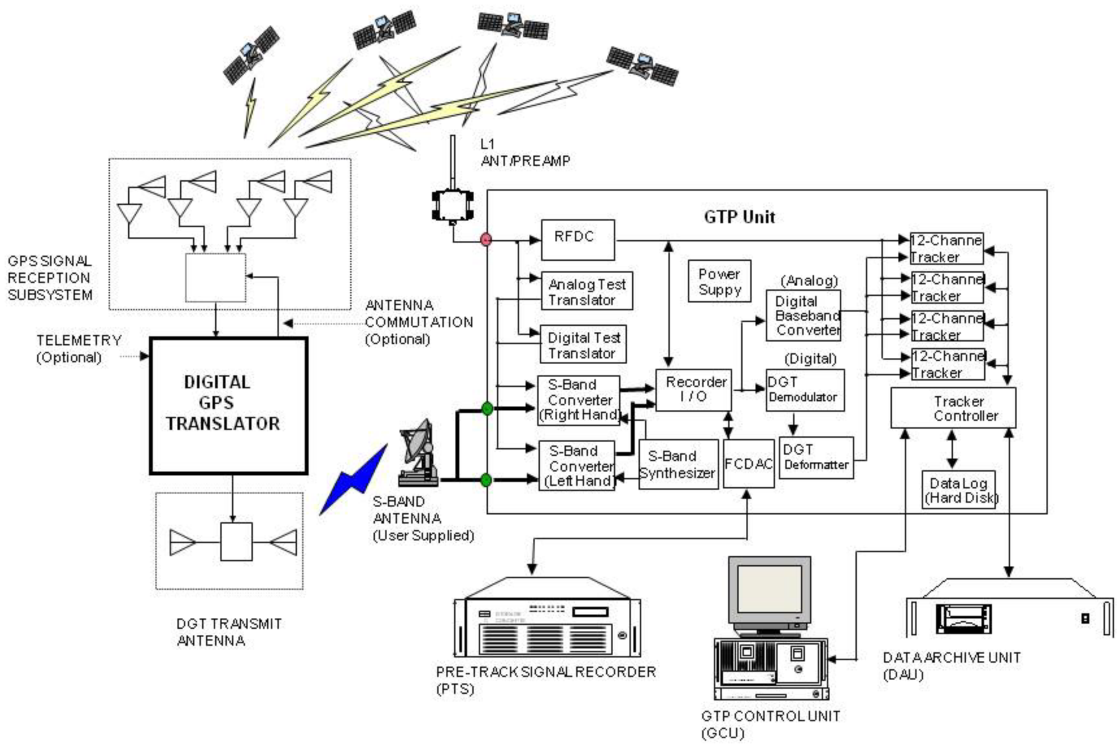


Figure A-2-5-5: *TGRS Block Diagram*

The GTP unit accepts the recorded signals from the PTS in place of the corresponding real-time signals for mission playback. The PTS recording is also used for enhanced post- flight trajectory analysis. The PTS provides the means for transferring the recorded data to a transportable media DAU for off-site processing and archiving. The GTPs and PTSs are controlled and status monitored by the GCU, including mission set-up and performance analysis. One GCU is capable of controlling the operation of up to four GTP units and PTS recorders. The GCU is capable of Post Mission Processing, generating summaries of Data Log Data items, and viewing/printing plots from the Data Log Recorder for Quick Look and post-mission data analysis.

A.2.5.4 TGRS Data

A.2.5.4.1 Processing

A.2.5.4.1.1 Flight Operations Version 1 (FOV1)

Unlike radar and optics data, TGRS data processing is limited to decoding, low-level checks, line selection, and covariance estimate generation. TGRS data is treated as classified and is not filtered by FOV1. TGRS data is processed by an FOV1 system, which is a Range Safety Supersystem system. The TGRS formatters send the data to the MOC where the FOV1 Flight Operations – Front End Processors (FO-FEP) ensure the FOV1 system is configured for a classified operation before passing the information on to the Front End Processor (FEP). The FEP decodes and records the data and checks for checksum errors. FOV1 then edits TGRS data in the same way it edits Telemetry Inertial Guidance (TMIG) data, using a fixed covariance matrix and using a state vector editing package to ensure the data meets four data limit values:

- The maximum allowable difference between measurement position and the position extrapolated from recent history
- The maximum allowable difference between measurement velocity and the velocity extrapolated from recent history
- The maximum allowable implied acceleration between the current measurement and the most recent historical state vector
- The maximum number of consecutive edits that may be replaced by extrapolated values

FOV1 then adjusts the output time of the TGRS processing so that all data displayed is extrapolated to the current wall clock time. The data is then used to show the Present Position (PP) and Instantaneous Impact Point (IIP) of the vehicle as an individual source. There is not a composite solution for Navy missions.

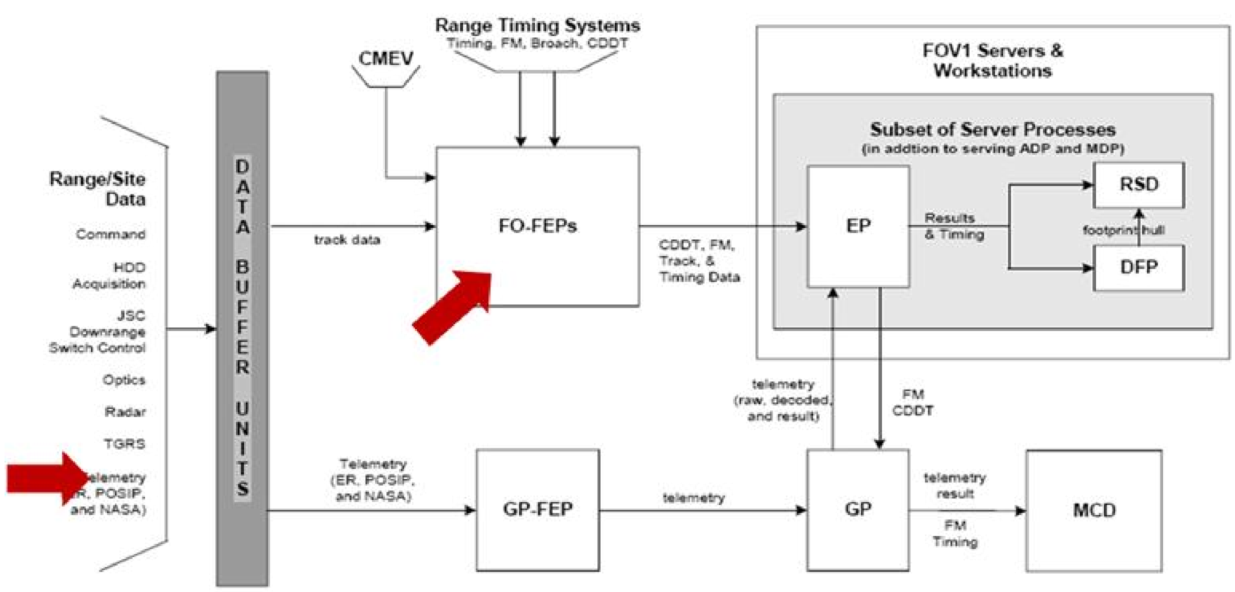


Figure A-2-5-6: *FOV1 Data Flow Overview*

A.2.5.4.1.2 Distributed Range Safety Displays (DRSD)

In addition to FOV1, the TGRS data is reformatted and delivered to the DRSD. Data formatters receive streams of data from GTPs. This data is reformatted and delivered to the FOV1 and DRSD. The data is processed through the Data Buffer System (DBS) to the DRSD FEPs then on to the DRSD estimation processor (EP) and then to the display processors (DP) used by the MFCO and designate customer (if selected as the prime Range Safety system).

A.2.5.4.2 Products

Three products are required from the TGRS data processing:

- Quick Look Plots.
- Comma Separated Variable (CSV) Files.
- State Vector Quality Dropout Reports.

Quick Look Plots and State Vector Quality Dropout Reports are required prior to operations that follow the launch.

A-2-6 SPARC SYSTEMS

A.2.6.1 Switch Control Display

A.2.6.1.1 System Status

The system status area displays Range time, countdown time, operating mode, logging status, local switch status, downrange switch status, OPNR, and auto-switching. Operator input commands are available on the right side of the display. The SC can be operated in real-time mode, simulation mode, and playback mode. Simulation mode replays data and FEP status from a saved file and permits user input from the keyboard. Playback mode displays data and FEP status from a saved file. Operator inputs are not accepted other than start and stop playback commands.

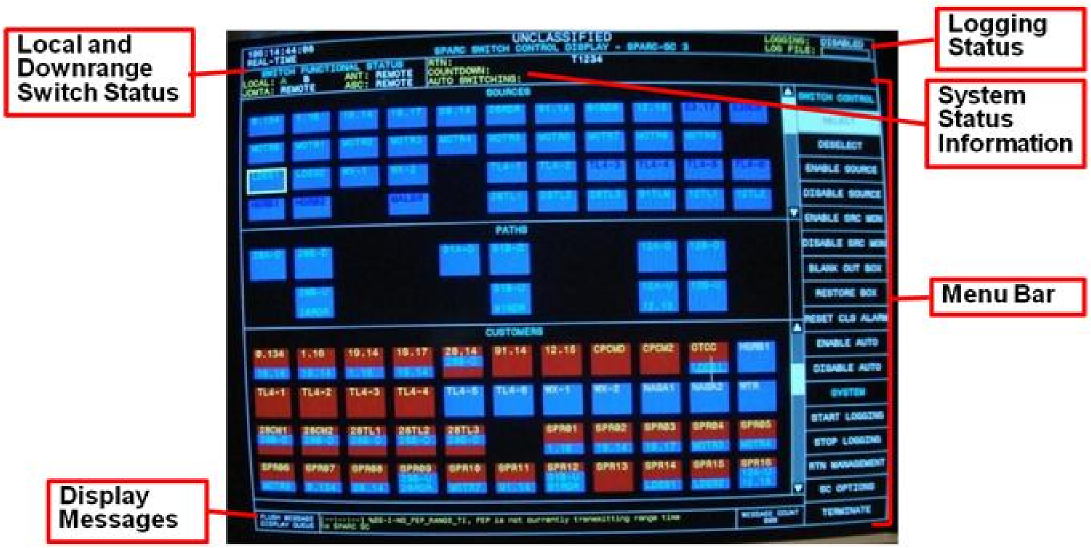


Figure A-2-6-1: *SPARC-SC System Status*

The local switch is located on the FOV1 FO-FEP. The primary FOV1 system and the associated local switch status are displayed in the upper left corner of the display. The current configuration of the downrange switches is also indicated (local or remote). Local indicates that the station has control of the switches and data routing. Remote indicates that data routing commands are controlled from the SPARC-SC console. Auto-switching allows the operator to create or edit a file which will automatically connect or disconnect data paths at a specific countdown time without operator participation. Status and error messages are displayed at the bottom of the screen. The Menu Bar, located on the right side of the display, shows user-selectable options in real-time and simulation modes.

A.2.6.1.2 Common Optical Subsystems

A.2.6.1.3 Menu Bar

Menu Bar options:

- Select/Deselect a data routing path from a source to customer.
- Downgrade a normally classified source on the local switch to transmit unclassified data to an unclassified customer.
- Reclassify previously downgraded sources.
- Monitor the sync status of a source and report changes to the sync status.
- Temporarily remove a source, path, or customer box from the switch status display.

- Restore a previously removed source, path, or customer box.
- Log data, operator inputs, and auto-switch commands.
- Manage up to 15 RTNs at one time.
- Configure the local and downrange switches to the current switch configuration.

A.2.6.1.4 Sources and Customers

A source is an instrumentation site that is capable of producing the following data types: tracking, designate, JSC designate, or Compressed Theoretical Trajectory (COTT). A customer is a site that is capable of accepting source data. As indicated, sources are located on the top portion of the display and customers are located in the bottom. Site mnemonics are indicated on the top line of the source or customer boxes. Source mnemonic texts are green when the circuits are operational, white when the circuit is receiving dropouts, and black when the circuit is out of synchronization. Customer mnemonics texts reflecting site ID are in yellow text. The text for the source in the customer box reflects the connection path status, green for good connection, white for marginal (receiving dropouts) and black for out of sync. Source boxes are blue when the data lines are configured for unclassified data; they are red for classified data. Customer boxes are red if the customer is capable of receiving classified data and are blue for customers who can only receive unclassified data.

A.2.6.1.5 Data Paths

A path is a circuit connection from a source to a customer. The RSC establishes paths by using a mouse to select the source and the corresponding customer(s).

A.2.6.1.6 Switches

The SC receives switch status via FOV1 FEPs. The data switches for all sources, excluding JDMTA, Antigua, and Ascension, are located at the FO-FEPs.

Data routed to and from JDMTA, Antigua, and Ascension must be routed through IDS switches located at the applicable sites. The data paths for these sites are labeled with the following information:

- Station identification (ID) numbers (28 for JDMTA, and 12 for Ascension).
- The primary (A) or secondary (B) circuit indicator.
- The data flow direction (D-down to the site, U-up from the site).
- The source on the line (e.g., 28 Radar or 12.15); if no designate source is being routed on the line, no site ID is displayed.

As shown on the display, JDMTA does not have an indicated primary high density designate (HDD) circuit from the station. Radar data from these stations has been hard-wired to the primary HDD uprange switches. The secondary line can be configured to receive Telemetry or Command data. The Switch Control display configuration is specified in the pertinent Operations Directive (OD).

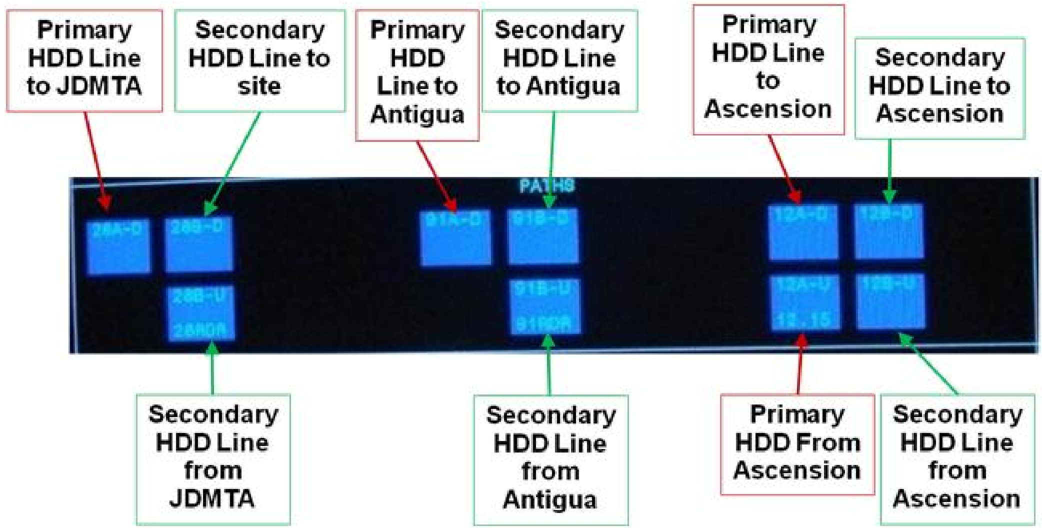


Figure A-2-6-2: *SPARC-SC IDS Downrange Switches*

A.2.6.2 Radar Graphics Displays

Primary Radar Graphics functions are:

- File processing consisting of archiving, restoring, displaying, and printing files from the data disk.
- Loading background maps, Impact Position (IP) and Present Position (PP) maps, for specific objects from the Range Safety Supersystem to the data disk.
- Adding and deleting RTNs for launch support.
- Associating the map background files to the particular object to be tracked.
- Selecting the operating modes: real-time, simulation, and playback.

A.2.6.2.1 System Status

The system status area displays the title, Range time, countdown time, operating mode, display mode, logging status, classification, software version number, Spacecraft Limits Bypass (SLB) status, and the RTN.

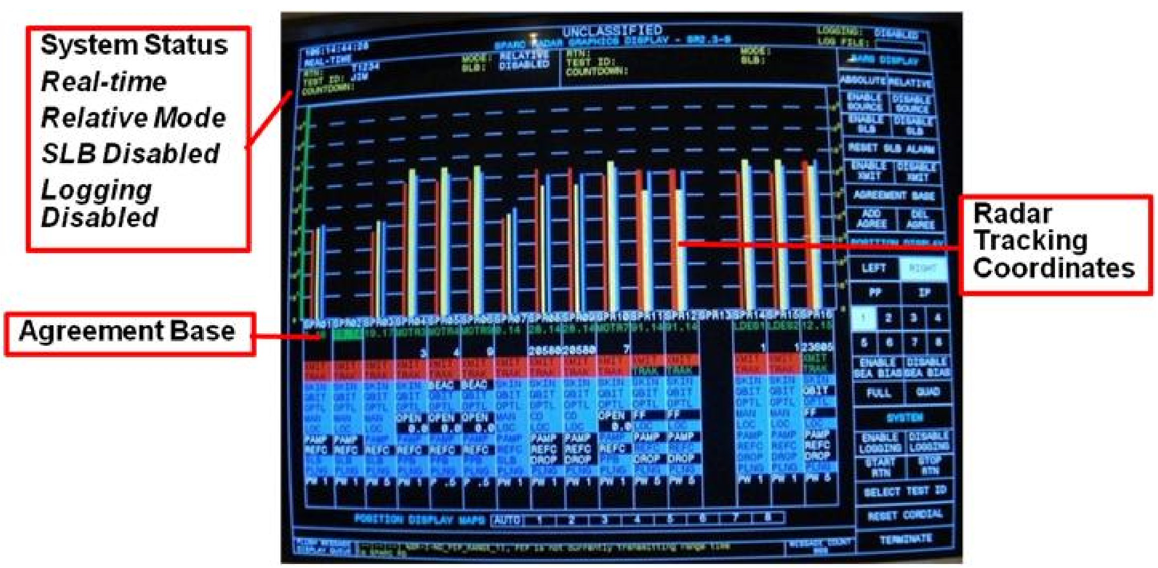


Figure A-2-6-3: *Bars Display*

The operating modes are real-time, simulation, and playback. The display mode, absolute or relative, defines the method used to display the tracking coordinates for each source. Absolute displays the tracking coordinates of the radar target in Earth-fixed Geocentric (EFG) coordinates. Relative mode uses an operator-specified source as the point of reference, the agreement base. Tracking coordinates are relative to the agreement base.
The SLB indicator prints the tracking sites' SLB status. When the status changes at any of the sites, the SLB status indicator audibly alarms until the operator resets the alarm.

A.2.6.2.2 Radar Tracking Coordinates
The Bars display can concurrently display radar tracking coordinates and site configurations for up to 16 sources. The user selects one of the possible 16 sources as the agreement base (the point of reference), and a desired threshold. The site ID field for the agreement base has a green background with black text. The threshold is indicated by a green line at the left side of the Radar Tracking Coordinates display area.
When in absolute mode, the EFG coordinates for each source are displayed in vertical bar graph form. The height of the vertical lines indicates the magnitude of the coordinate; the width of the line indicates the sense of the coordinate (agreement with respect to direction). Positive readings are denoted by wide lines; negative coordinates have narrow lines. In relative mode, the displayed coordinates are relative to the agreement base's target EFG coordinates.

A.2.6.2.3 Radar Tracking Status
The radar tracking status area displays the following configuration data:

- Source and Site ID.
- Object Number.
- Radiation Status (on or off).
- On-track Status (on or off).
- Skin or Beacon Tracking selection.
- Quality-bit (Q-bit) Status (on or off).
- Optical Track Status.
- Antenna Tracking Mode Status (e.g., manual, computer drive, open, freefall).
- Signal-to-noise ratio for the MOTR or the local oscillator mode status for non-MOTR radars.
- Paramp Status (on or off).
- Refraction Status (in or out).
- SLB Status for Radars 1.16, 19.14 and 0.134, Payload Protection Bypass (PPB) Status for MOTR radar, and Droop (a measurement of the decrease of mean pulse amplitude) Status for all other radars.
- Plunge mode status (on or off).
- Pulse Width Selection.
- Format Type.
- Liftoff Status.

A.2.6.2.4 SPARC-RG Message
The SPARC-RG message area displays informational messages, software processing error messages, and user input error messages. Informational and software processing error messages are queued for display and require user acknowledgement to be cleared. A maximum of 999 messages can be queued.

A.2.6.2.5 Menu Bar

The menu bar controls the Bars, PP, and IP display selections and configuration. The menu bar allows the operator to perform the following functions:

- Selection of absolute or relative mode.
- Enabling or disabling sources.
- Enabling or disabling SLB.
- Resetting the SLB alarm.
- Enabling and disabling transmit.
- Selecting the agreement base.
- Selecting or deselecting sources for comparison with the agreement base.
- Selecting IP and/or PP displays for the Graphics displays.
- Selecting the Graphics displays formats.
- Enabling or disabling logging.
- Starting and stopping RTN operation.
- Selecting Test ID.

A.2.6.2.6 IP and PP Displays

The IP and PP displays are map backgrounds containing, respectively, calculated impact trajectory or nominal trajectory for the launch vehicle. The IP displays a computed IP and compares the IP of a radar target with a nominal IP. The PP displays the current radar target and compares the actual trajectory of the launch vehicle with a nominal trajectory for up to two concurrent tests. The PP map backgrounds are available in two formats: a trajectory background or a geographic map background.

Figure A-2-6-4: *Present Position Display*

Two monitors are dedicated to IP and PP displays. The background maps for either display may be divided on a single monitor into one or four displays concurrently. For multi-missile tests, a composite IP display is also available. Selection of the IP map, PP map, or both maps is at the user’s discretion. The display contains the title, program version, Range time, countdown time, display classification, map classification, sub-map identification, test ID, mode status, site ID, and on-track status. The map display area contains the plots and the map background. A maximum of two sites may be displayed on a single map.

A.2.6.3 Radio Frequency (RF) Monitoring

The SPARC Controller is also responsible for communicating RF restrictions to launch head radars to ensure vehicle payload protection from excessive transmit power. Using the Bars display, the RSC can monitor SLB or MOTR's PPB configuration. Sites granted SLB or, for MOTR, PPB, attenuate their output power as specified in the OD or Operations Control Instruction (OCI).

A-2-7 RANGE SAFETY SYSTEMS

A.2.7.1 Data Buffer Units

Each Data Buffer Unit (DBU) has two buffers. Each buffer has the capability to transmit and receive data to and from a single instrumentation site, so that each DBU has the ability to communicate with two individual instrumentation sites (Figure A-2-7-1). The DBU Rear Panel Schematic (pictured) shows a rear panel diagram of a Model 831914 DBU which contains two data buffers housed in one assembly. Each DBU has one Clock Port and one Control Port. The Clock Port is used to provide timing information to the DBU. Through selective use of port pins, each buffer can be provided with different timing information. The Control Port connects each DBU to the Data Output Remote Control (DORC). Additionally, a DBU has two Site Ports, one for each buffer to connect to a radar site, an optical site, a telemetry site, or to the Translated GPS Range System (TGRS) system.

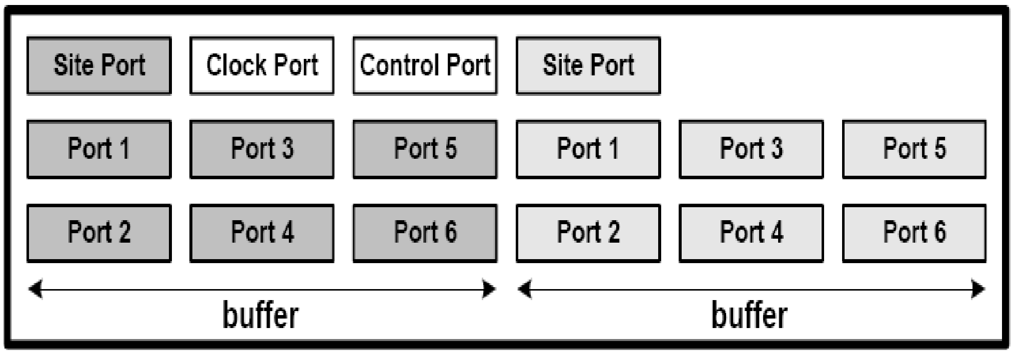


Figure A-2-7-1: *DBU Rear Panel Schematic*

Each buffer also has six ports to interface with Range Safety systems:

- Port 1 - connected to FOV1-A
- Port 2 - connected to FOV1-B
- Port 3 - connected to DRSD
- Port 4 reserved for the input/output pre-processor (IOPP) - a carry-over from a legacy system no longer used
- Port 5 - blank (unused)
- Port 6 - connected to the Range Instrumentation Simulator (RIS)

A.2.7.2 Input

DBUs receive raw site data (radar, optical, telemetry, and TGRS) from the ER instrumentation sites and distribute the data to the FOV1 and DRSD systems. The DBUs are also used to output data, such as designate data for track acquisition, to the external instrumentation sites. Although FOV1-A, FOV1-B, and DRSD receive data simultaneously from the DBUs, only the prime system can output designate data to the external sites.

Data Buffering Units:

- 2 Units for Classified (Red – DBU Cabinets 4577 and 4578)
- 1 Unit for Unclassified (Black – DBU Cabinet 4581)
- 1 Unit is dedicated to Centralized Telemetry Processing System (CTPS) Telemetry Range Safety Buffer (TRSB) (DBU Cabinet 4719)

A.2.7.3 Output

The red and black DBU cabinets each have 16 DBUs, which contain two data buffers, and a DORC. The CTPS TRSB DBU cabinet has eight DBUs but no DORC. The seven DRSD-2 buffer units are housed in two cabinets, one with two buffer units (DBU Cabinet 4716) and a second with five buffer units (DBU Cabinet 4579).

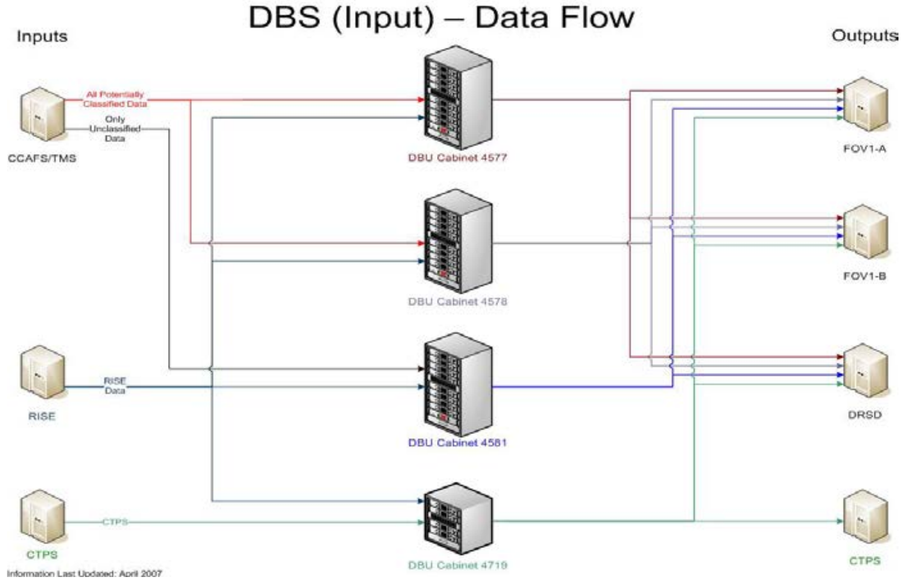


Figure A-2-7-2: *DPS (Input) Data Flow*

A.2.7.4 DSSS

The DSSS has four port receptacles, one corresponding to each DBU cabinet. However, the DSSS is not currently connected to the CTPS TRSB DBU cabinet. The DORC is connected between the DSSS and the DBUs. A signal from the DSSS is routed to each DBU Cabinet where the DORC enables the DBUs to output the appropriate designate data to the external systems, as well as to the Command Destruct Supersystem. There are 17 DB-25 port receptacles on the DORC; one port receptacle connecting to the DSSS and one port receptacle for each of the 16 DBUs in the DBU cabinet.

A.2.7.5 DRSD-2

The cabinet containing two DRSD-2 buffer units, in Cabinet 4716, fan-out Portable Shipboard Instrumentation Package (POSIP) data (POSIP 1 and POSIP 2) from the black data DBU (DBU Cabinet 4581) and route the data to CTPS, Tel-4, TMS, and Timing Systems. Four of the five DRSD-2 buffer units in Cabinet 4579 fan-out Command Message Encoder Verifier (CMEV) data from the FOV1-A and FOV1-B systems and routes the data to the red DBU cabinets (DBU Cabinets 4577 and 4578). Each CMEV data stream is fanned-out to all three Range Safety system ports on the data buffer (Ports 1 through 3) so that the CMEV data gets routed to the Command Destruct System regardless of which Range Safety system is selected as prime. The one remaining DRSD-2 buffer unit in Cabinet 4579, fans-out the Command data from DBU Cabinet 4577 to both the Cape 1A and Cape 1B Command Destruct systems.

A.2.7.6 Metric Track Data Flow Diagram

Radar or optical site data (Metric Track Data), TGRS data, and timing data enters the FOV1 system in a serial line data format from the DBUs into the serial ports of the FOV1 FO-FEP. The FO-

FEPs perform a data classification check to determine if the data is classified (such as for Navy launches) or if it is unclassified, converts into a LAN message format, and broadcasts it continuously on the FOV1 Ethernet LAN. Concentrators on the FOV1 LAN patch the data on the Ethernet LAN into the FOV1 LAN where it can be obtained and utilized by the Metric Server/Estimation Processor, Metric Data Processor (MDP), Debris Footprint Processor (DFP), ADP, and the Range Safety Display Server (RSDS).

A.2.7.7 FO-FEPs

The FO-FEPs are rack mounted Personal Computers (PC) which are used to ingest and distribute radar, optical, TGRS, and timing data into the FOV1 systems. The FO-FEPS are also used to output designate data from ADP, through the FOV1 LAN, through the FO-FEPs to the DBUs and out to the external instrumentation sites.

A.2.7.7.1 Red FO-FEPs

Each FOV1 system also has three Red FO-FEPs (FO-FEPs 1 - 3) that connect to circuits capable of transmitting and receiving classified data. The RedFO-FEPs also have five Emulex cards each with the exception of Red FO-FEP 3 on each system, which has only two Emulex cards. The Red FO-FEPs provide for a maximum of 48 classified serial data interfaces.

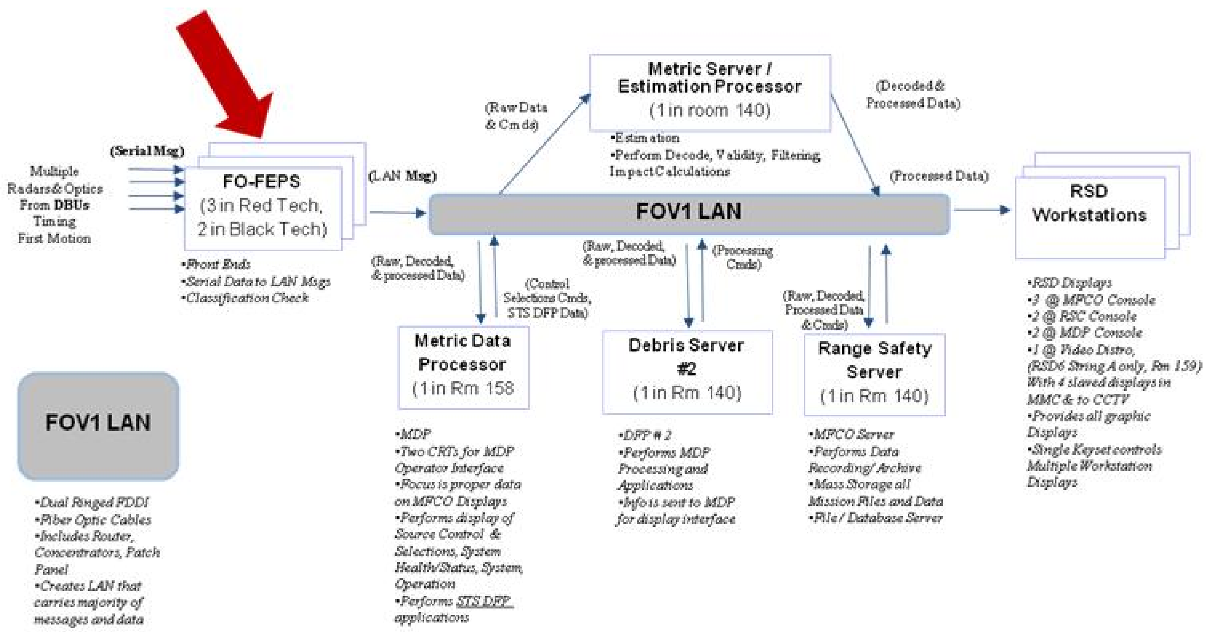


Figure A-2-7-3: *Metric Track Data Flow Diagram*

A.2.7.7.2 Black FO-FEPs

Each FOV1 system has two black FO-FEPs (FO-FEPs 4 - 5) that transmit and receive unclassified data. Each black FO-FEP contains five Emulex cards with four serial ports, for a total of 20 serial ports providing up to 40 unclassified interfaces to the external instrumentation sites via the DBUs. Black FO-FEP 4 is connected to the Countdown Demonstration Test (CDDT) RS-530 circuit, which provides data for up to four countdowns for use in Navy Trident operations. Additionally, Black FO-FEP 4 contains an Inter-Range Instrumentation Group (IRIG)-B card. This card is used to provide Universal Coordinated Time (UTC) to the FOV1 systems. If the IRIG-B card fails, the

FO-FEP uses the PC's internal clock time. The FO-FEPs receive four discrete First Motion/Broach inputs from timing.

The FO-FEP Emulex Card Configuration (pictured) lists the data sources on each card in each FO-FEP for a string of FOV1. The sources are listed sequentially according to the card on which they reside. These ports and data lines serve various functions including transmitting data from FOV1 to the sites, as well as receiving data from the sites or both. Some of these sites are providing tracking data while others are providing a status message.

A.2.7.8 Telemetry Data Flow

Telemetry data from the CTPS, Jonathan Dickinson Missile Tracking Annex (JDMTA) TRSBs, the POSIP, and/or NASA telemetry source data (Merritt Island Launch Annex [MILA]) enters the FOV1 system in a serial data format from the DBUs into the serial ports of the FOV1 GP-FEP. The GP-FEP converts the data into a LAN message format and sends it to the GP through an Ethernet Hub. The GP receives and decodes the telemetry data. It broadcasts Telemetry Inertial Guidance (TMIG), Automatic Gain Control (AGC), and raw and decoded telemetry data over the FOV1 LAN where it is accessed and utilized by the Metric Server/Estimation Processor, MDP, DFP, ADP, and the RSDS. On FOV1-A, the GP also broadcasts the newest TMIG data over the MCD LAN to the MCD for display to the MFCOs.

A.2.7.9 GP – FEP

From the DBUs, telemetry data enters the FOV1 systems through the GP-FEP. There is one GP-FEP per FOV1 system, which is connected to the GP via an Ethernet Hub. The GP-FEP is a Real-Time Integration (RTI) Net Acquire Serial input/output unit which has 16 serial ports that are connected to the DBUs to receive telemetry data from the sites. The GP-FEP converts serial line data from these ports into LAN data to transfer the data to the GP through an Ethernet Hub.

A.2.7.10 FOV1 LAN

The FOV1 LAN for each system of FOV1 is a fiber-distributed data interface which includes computer network equipment, such as routers, concentrators, and Gateway workstations that are necessary to distribute data in the FOV1 systems.

A.2.7.11 Router

There is one router on each system of FOV1 that act as "traffic cop" for the FOV1 system messages. The router monitors the message traffic between the different FOV1 system processors, detects those that communicate a lot with each other, and forms a virtual network between the processors to help speed up the information flow between them.

A.2.7.12 Concentrators

There are two concentrators on each system of FOV1 that act as hubs to patch together different types of networks within the FOV1 system and reformat the headers of the data to cross from one network to another. Examples of this are data coming in from the FO-FEP Ethernet as a LAN message being patched into the FOV1 LAN and data being exchanged between the FOV1 LAN and other range systems through the FOV1 Gateway workstations.

A.2.7.13 Gateway Workstations

There is a Gateway for each FOV1 system, which allows data exchange between various processors such as SPARC, FVTAM, and ADP.

A.2.7.14 Data Processing

A combination of processors, servers, and software are utilized to process and display the PP, IP, and debris footprint of a launch vehicle in real time.

A.2.7.15 Guidance Processor

After receiving telemetry data from the GP-FEP, the GP decodes the data, separating the data into its components according to the vehicle specific telemetry decoding formats. The GP then checks for checksum errors, which is a quality check to determine if data has been lost or altered during transmission. The GP then uses the data to compute TMIG state vectors and AGC values. The GP also selects the telemetry source with the newest data and sends it to the MCD for display. It creates a plus time for the MCD display by using the received first motion time from the EP.

The real-time data processing performed by the Range Safety systems should not be confused with the data process accomplished by the Data Handling Supersystem. FOV1 and DRSD perform real time data processing while the Data Handling Supersystem provides near-real time, pre-flight and post-flight data processing support.

A.2.7.16 Metric Server/Estimation Processor

The Metric Server, or EP as it is commonly referred to, is the primary data processor of the FOV1 systems. It is used to process ER site data to generate a PP and IP of the launch vehicle for display for the MFCOs.

FOV1 processes all measurements to form a *state estimate*, which are associated with one or more sensors and referred to as an *independent source*. Each state estimate consists of:

- Three dimensional position information in Earth Fixed Geocentric (EFG) coordinates
- Three dimensional velocity information in EFG coordinates
- The time the vehicle was at that position and velocity
- A *covariance estimate*, which models and corrects for some known source errors, such as noise, low elevation, and track mode.

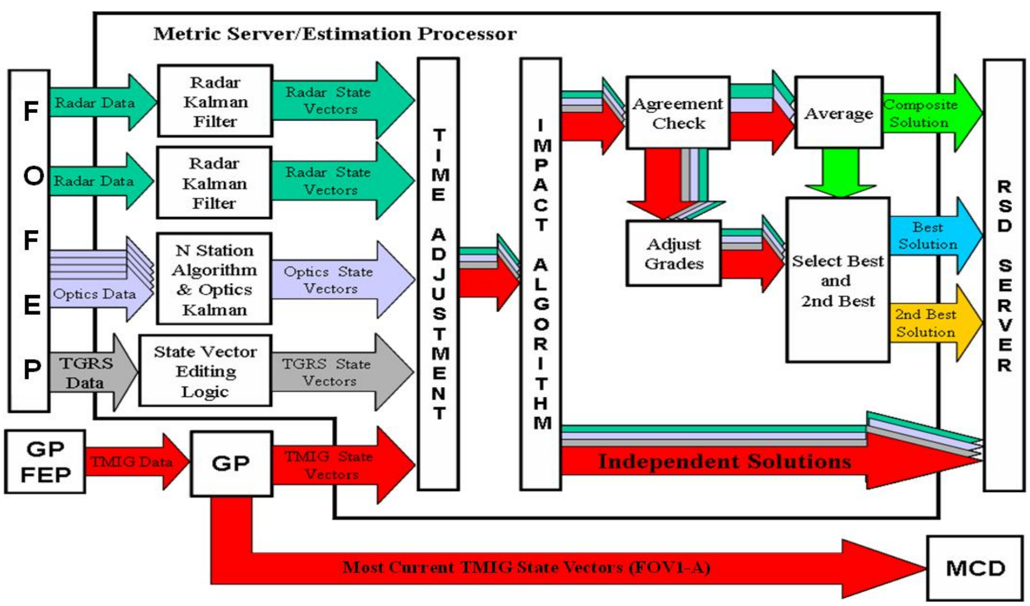


Figure A-2-7-4: Metric Server/Estimation Processor

Due to the nature of the different types of data, FOV1 has to process the different types of data differently to produce the required state estimates. All site data needs range checking, *wild-point editing* (to correct erroneous data measurements), and time shifting (so that all data displayed is extrapolated to the current wall clock time). Refraction correction is performed on the radar data from sites that require this correction. Additionally, the FOV1 systems use a Kalman Filter for radar and optical wild-point editing and velocity determination. There is one Kalman Filter for each tracker and another for combining optical measurements.

The *Kalman Filter* is an efficient recursive filter which estimates the state of a dynamic system from a series of incomplete and noisy measurements. In this application, the Kalman Filter is used to provide accurate continuously-updated information about the position and velocity of an object given only a sequence of observations about its position, each of which includes some error due to corruption by noise. The Kalman Filter is able to remove or "filter" the effects of the noise and get a good estimate of the location of the target at the present time.

A.2.7.17 Radar

Radar data enters FOV1 at a high data rate (10 Hz) in the form of EFG coordinates derived from ranging the vehicle with a radio frequency (RF) pulse and extracting azimuth and elevation data from the antenna position. Once the EP has received the radar data, it processes the data through the following process:

- The EP decodes and records the data and checks for checksum errors (data bits lost during transmission)The EP then performs an atmospheric refraction correction on the radar data that indicates it was not refracted correctly at the site (currently only radar data from the Wallops Radars require the EP to make this correction)
- The EP then filters all radar data using an independent Kalman Filter for each radar site after it receives four on-track measurements

The Kalman Filter is used to:

- Perform wild-point editing: The Kalman Filter compares new measurements to predicted measurements based off of previous data. If it does not match, the data point is considered to be "wild" or erroneous and the EP "edits" the data, replacing it with the predicted measurement. If the EP edits more than 5 measurements in a row, the Kalman reinitializes and starts gathering data all over again. This helps it to "coast" through wild measurements and yet detect non-nominal flight conditions
- Perform velocity determination: The EP determines the velocity of the launch vehicle by comparing the changes in its position over time
- Generate a Covariance Estimate: The EP generates a covariance estimate for each radar based upon data from quarterly performance reports and the track mode (beacon/skin) of the radar

A.2.7.18 Optical

Optical data enters FOV1 at 10 pulses per second (pps) in the form of azimuth and elevation data from the different optical sites. Once the EP has received the optical data, it processes the data through the following process:

- The EP decodes and records the data and checks for checksum errors
- The EP then filters the optical data using a base optical measurement uncertainty (error factor correction) that is used for all of the optical sites
- The optics Kalman is initialized by results from a simple N-station solution. The N-station solution is a mathematical method for verifying that N stations are tracking the same object,

i.e., a validity check. The N-station solution is a least squares position average of at least two optics sites. FOV1 uses up to 12 optics sites in the N-station solution. FOV1 converts the Azimuth Elevation (AE) measurements from each optics site to EFG by assuming the range to be one and the site location to be the Earth center. This results in a set of unit vectors, in EFG coordinates, all pointing toward the target. The N-station solution is the best estimate of the position in EFG coordinates. The EP continually computes the N-station solution even after Kalman filter initialization to validate the optical sources
- The Kalman filter initializes after receiving four on-track measurements. The Kalman filter will continue to run with less than four optical sources, but four are required to initialize

The Kalman Filter is used to:
- Perform wild-point editing: Wild-point editing of the optical data is performed slightly different than for radar data. Each measurement or data point from the optical solution is actually composed of data from several different optical sites that was received during the same cycle of data gathering. Because of this, the EP only edits a data point in the optical solution if it does not receive any good data from any of the optical sites during a cycle
- Perform velocity determination: Accomplished the same way as with Radar data
- Generate a Covariance Estimate: The EP generates a covariance estimate for the optical solution based upon the initial assumptions made to determine the initial velocity values. Since a single optical Kalman Filter is used to process all optical data, once processed by the Kalman Filter, all optical data are treated as a single source. This can result in bad optical data from a single site impacting the range safety solution.

This is mitigated in two ways:
- Individual optical sites can be rejected from being processed, removing a bad site from the optical solution.
- The optical composite, as an individual source, can be rejected from the range safety solution

A.2.7.19 Telemetry - TMIG

Unlike radar and optical data, FOV1 does not Filter TMIG data since the TMIG data provides position *and* velocity information. The FOV1 systems' processing is limited to decoding, low-level checks, line selection, and generation of a covariance estimate. Most of the TMIG decoding and processing takes place in the GP, while time adjustments, source evaluation, and selection take place in the EP.

The GP decodes and records the data and checks for checksum errors.

The GP generates a TMIG covariance estimate: Launch vehicle inertial guidance computer systems collect data on vehicle acceleration (detected by accelerometers) and vehicle attitude motion (pitch, roll and yaw motion detected by gyroscopes) and integrate that data to determine changes in the vehicles position and velocity from liftoff. Due to this integration process, the telemetry state vectors are very smooth. However, the position and velocity values are biased and tend to drift over the length of the operation. This is due to induced errors from the friction of moving parts in the accelerometers and gyroscopes. Bias errors of 150 meters (m) and drifts of 3.7 meters per second (mps) are typical. The GP generates a covariance estimate to account for the errors due to this drift.

The GP performs wild-point editing: The GP utilizes a state vector edit package which maintains a history of the three most recent state vectors from the TMIG source. The GP also processes new TMIG measurements to verify the data passes four limit values:

- The maximum allowable difference between measurement position and the position extrapolated from recent history
- The maximum allowable difference between measurement velocity and the velocity extrapolated from recent history
- The maximum allowable implied acceleration between the current measurement and the most recent historical state vector
- The maximum number of consecutive edits that may be replaced by extrapolated values

Data that violates these limit values are "edited" by replacing it with a state vector extrapolated from the state vector history. If the GP edits more than 5 measurements in a row, the algorithm reinitializes and starts gathering data all over again. This helps it to "coast" through wild measurements and yet detect non-nominal flight conditions.

A.2.7.20 Telemetry - TGRS

Like TMIG data, TGRS data processing is limited to decoding, low-level checks, line selection, and covariance estimate generation. TGRS data is treated as classified and is not filtered by FOV1. In most cases, TGRS data arrives on multiple lines; the EP selects the newest TGRS data for further processing.

The EP decodes and records the data and checks for checksum errors.

The EP generates a TGRS covariance estimate using a fixed, base uncertainty.

The EP performs wild-point editing of the TGRS data in the same way the GP edits TMIG data, using a history of the three most recent state vectors. As new state vectors are received, they are processed and checked to ensure they pass all enabled edit limits. Once the state vector is validated, it is placed in the state vector history, and the oldest prior state vector is dropped. In the event of an edit, the previous TGRS vector will continue to be used. If the number of consecutive edits exceeds a configurable limit, the default is five, the edit routine reinitializes and the state vector history is cleared.

A.2.7.21 Timing Adjustment

The EP then performs a time adjustment on all of the different types of data (radar, optical, TMIG, and TGRS) so that all data displayed is extrapolated to the current wall clock time.
In addition to extrapolation, the TMIG measurements are interpolated so that the update rate of the displays and the output acquisition data matches the higher output rate of radar data (radar data is provided at a rate of 10 points per second [pps], versus 1 pps for TMIG). For each source of data, the measurement latency, which is the latency of the newest measurement used in building the state vector estimate, determines exactly how much FOV1 extrapolates the output. The amount that this extrapolation increases the uncertainty or possible error in the measurement is accounted for in the output state covariance estimate. An IIP uncertainty ellipse (an ellipse that appears around the IIP for each source) gives a visual representation of this covariance estimate.

A.2.7.21.1 IP Calculation

The EP then uses an impact algorithm to propagate the PP data into instantaneous impact coordinates, utilizing a worst case scenario by assuming there is no drag induced on the vehicle due to wind.

A.2.7.21.2 Agreement Check

Next an agreement check is performed to ensure that only sources that are actually tracking the same target are included in the composite output. The use of multiple single source Kalman Filters provides a grade for each source in the form of the covariance matrix. The results of the agreement check are used to adjust the grades of the independent sources. Sources that are not in agreement are less likely to be selected as the best or second best source.

A.2.7.21.3 Forming a Composite Solution

During all non-Navy launches, a covariance-weighted average is used to form a composite solution from the independent sources that agree with each other. The composite solution is used as another independent source by the FOV1 system. Because the composite solution is developed from the independent sources that agree with each other, the displayed composite IP will always be within the group of independent source IPs. The amount of influence that an individual source (for example Radar 1.16) has in forming the composite solution is based upon the amount of error in the measurements of the source, which is modeled in its covariance estimate. In other words, a source that has smaller measurement errors than the other sources will have more influence or "weight" in forming the composite solution. As a result of this process, the composite solution will always have a smaller associated error and will usually be utilized as the best source over the independent sources.

A.2.7.22 Estimation Processor

Similar to the FOV1 system, the EP converts the decoded tracking data, received from the FEPs, into independent and composite estimates of the tracked vehicle's state (i.e., position and velocity). Various filtering algorithms are used to compute both individual source and composite solution sets of independent IIPs. For non-Navy vehicles, the EP uses position data from metric radars, pointing data from optical mounts, and TMIG position and velocity. The alpha beta (αβ) filters are used to pre-qualify site measurements for use in subsequent computations, and only accepts radar data with valid Q-bit. The alpha beta gamma (αβγ) filters process radar position data to produce smoothed position and velocity estimates for each eligible radar. An optical Kalman Filter receives data from many optical sites and produces a single optical output. Another Kalman Filter processes all available and qualified measurements to produce a composite state vector estimate. For DRSD, this composite output is the default source and is the only source displayed on the DRSD. For Navy vehicles, TGRS and TMIG data are used as the Best and Next-best solutions, respectively, and no composite solution is formed.

A.2.7.23 Range Safety Advisory System

In addition to FOV1-A, FOV1-B, and DRSD, RSAS is a Range Safety system utilized by the MFCOs to detect abnormal vehicle performance early in flight.

A.2.7.23.1 RSAS

- Is an independent range safety system that is used for:

- All missions containing a nuclear payload due to the extremely dangerous consequences if the vehicle, containing a combination of a solid fuel system and radioactive components, were to crash into solid ground
- Pegasus operations
- Provides early warning of abnormal vehicle performance, allowing the MFCO to take action for the safety of people and property
- Consists of two independent hardware strings (A and B) which are both mandatory for launch when used
- Is an Eastern Range (ER) developed and integrated telemetry processing and analysis system built by VEDA Systems Inc., with local enhancements and integration provided by the ERTS and Spacelift Range System Contractor (SLRSC)

RSAS provides the MFCOs with a graphical display of mission-specific spacecraft telemetry data (including vehicle rotation angles, attitude, engine gimbals, chamber pressure, axial acceleration, and height) which are viewed on the Vehicle Attitude Display (VAD). It also provides audible alarms and a warning light to alert the MFCO when certain mission-specific telemetry parameters are exceeded in the event of a vehicle pitch-over shortly after lift-off. Receipt and display of the telemetry-based information is most crucial in the first 10 seconds of vehicle lift-off, when the vehicle is obscured by flame trench steam and vehicle exhaust, and optical data are not available due to the smoke plume. During this time, failure modes exist that could lead to the rupture and release of vaporizing nuclear material. Early detection of vehicle anomalies and early MFCO response to initiate the Command Destruct functions minimizes material exposure by assuring vehicle stage breakup system activation.

RSAS is capable of processing two full-rate telemetry data streams from Tel-4 and central timing information as well as Pulse-Code Modulation (PCM) data, but only receives data from Tel-4. RSAS receives telemetry data and converts it into an on-axis radar format - Medium Delay Data Format (MDDF). This data is sent to FOV1 and DRSD (via the DBUs), processed as a radar source, and used in the Composite Solution computation. The RSAS software is then used to compute and graphically output the vehicle specific telemetry information which is then displayed on the RSAS graphics display monitors.

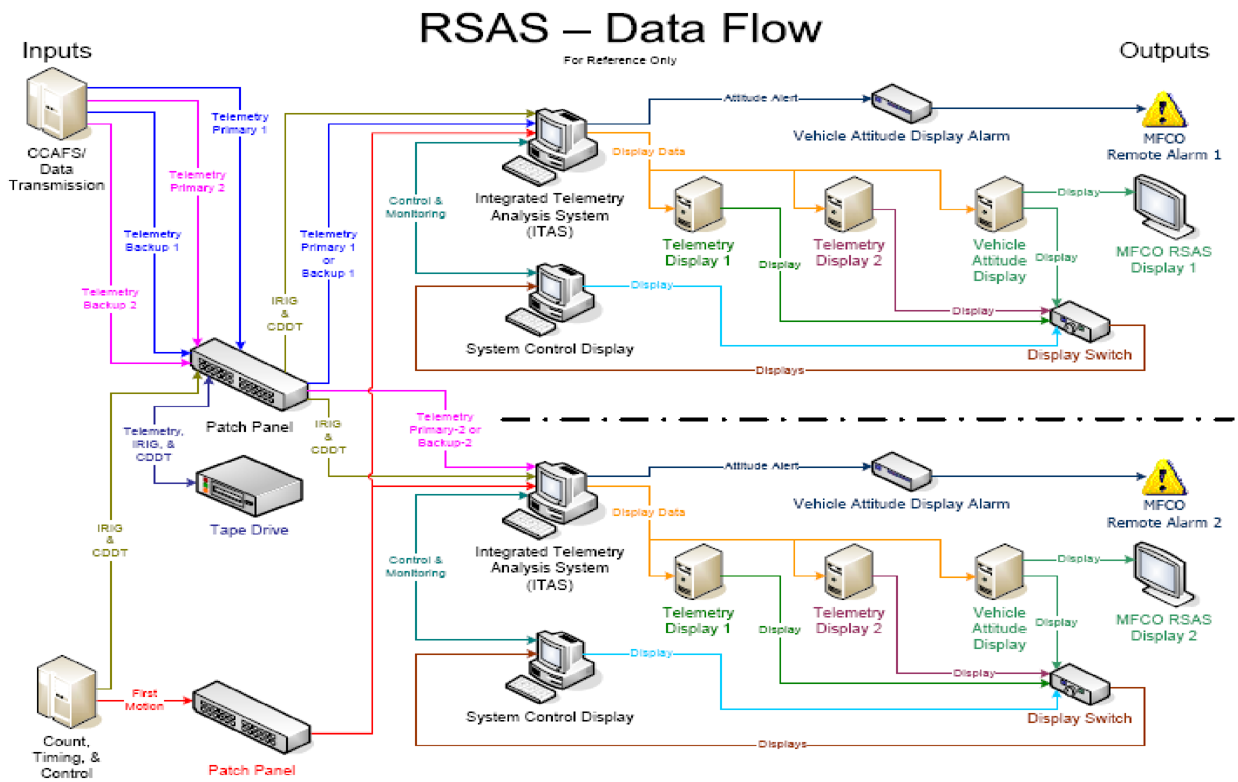


Figure A-2-7-5: *RSAS Data Flow*

For each mission requiring RSAS use, a new mission-and vehicle-specific VAD must be developed to accommodate the differences in telemetry parameters between vehicles. This requires software changes and new algorithms to be developed for each RSAS version.

There are currently four software versions:

- RSAS1 supported the Titan IV/Centaur Cassini mission in October of 1997
- RSAS2 supports Pegasus missions by receiving full rate telemetry from Tel-4 for analogs and providing telemetry data to DRSD. This data is converted to the on-axis radar format prior to being passed to DRSD
- RSAS3 supported the Delta II Mars Exploration Rover (MER)-A and MER-B missions in June 2003 and July 2003
- RSAS4 supported the Atlas V New Horizons mission to Pluto in January of 2006

A-2-8 COMMAND DESTRUCT

A.2.8.1 Fail-Safe/Monitor Tone

The Fail-Safe or Monitor tone (typically RCC standard tone 5) is used for missions that utilize a fail-safe system to terminate vehicle flight due to a loss of command capability. Some missions use a fail-safe circuit within the CRD to initiate flight termination upon the absence of incoming signals. This is typically used for unmanned aerial vehicles or drones. In these applications, the fail-safe or monitor tone is used to demonstrate constant link closure between the ground transmitter and the launch vehicle. The CRD detects this signal and provides an indication of link closure via the telemetry stream to a ground station which is then processed and displayed for range safety. If the signal is lost for more than a pre-determined time period (based on vehicle performance characteristics), the CRD recognizes that the fail-safe/monitor tone is no longer being received and initiates the flight termination method.

A.2.8.2 Command Receiver Decoder (CRD)

There are several components within the CRD:

- **Receiver:** The receiver section is receives the FM signals from the UHF antennas. The receiver is factory tuned to 416.5 MHz or 421.0 MHz, the frequency of the command carrier, by use of a fixed tuning element
- **Tone Detection:** “High-Alphabet” or IRIG tone frequency detection is accomplished by a microprocessor and associated circuitry. The audio signal as recovered by the receiver section is digitized and processed using a filter algorithm. The tone detection threshold self-adjusts to the signal and noise characteristics of the audio signal
- **Decoder:** The decoder section distinguishes between the different RCC tones present in a discriminated composite audio signal and is capable of performing logic analysis based on the combination or lack of tones present. The message decoding is accomplished by a microprocessor and associated circuitry. For standard receivers, the sequence of detected tones is compared with the pre-stored sequences. For secure receivers, the sequence of detected characters (a character consists of two simultaneously transmitted audio tones) is compared with the pre-stored code-of-the-mission. If the comparison is favorable, an output command signal is generated
- **Secure Code Storage:** For secure receivers, volatile memory is used to store the high-alphabet codes. The decoder section references the high-alphabet codes stored in the memory for comparison with the received tone sequence
- **Command Outputs:** The command outputs route the analog command signals to the applicable equipment (engine or propellant system control equipment, Electro-Explosive Devices (EEDs), etc) to perform the associated command function (engine shutdown, destruct ordnance initiation, etc)
- **Telemetry:** Telemetry signals on various CRD data to include AGC voltage levels, Battery Voltage, Input Current, Check Channel/Pilot Tone, command functions (SELF TEST, SAFE, ARM, DESTRUCT), EED Activation, EED Monitor, and Internal Power On are sent to the telemetry system for transmission to the ground stations

A.2.8.3 Destruct Ordnance Train

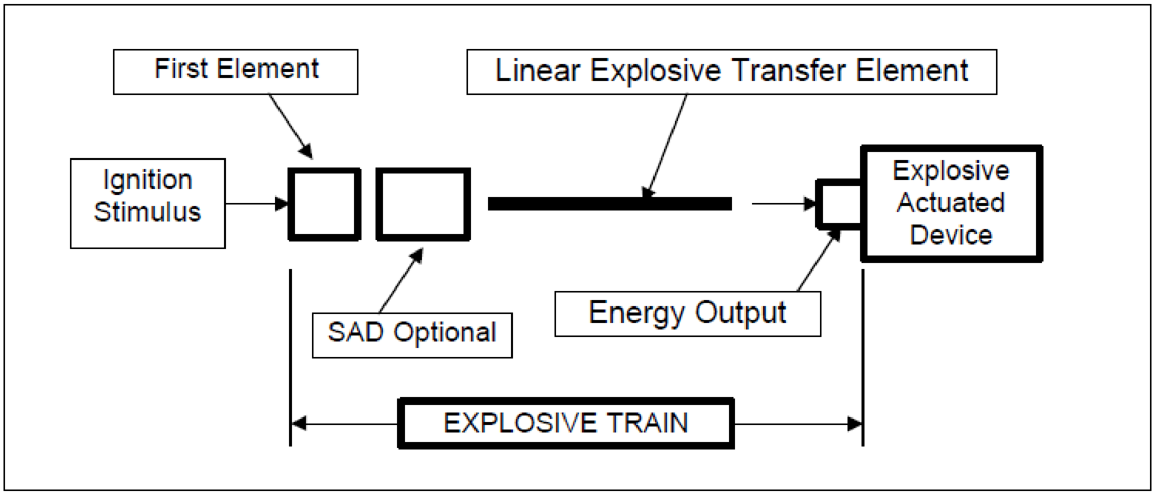


Figure A-2-8-1: *Destruct Ordnance Train*

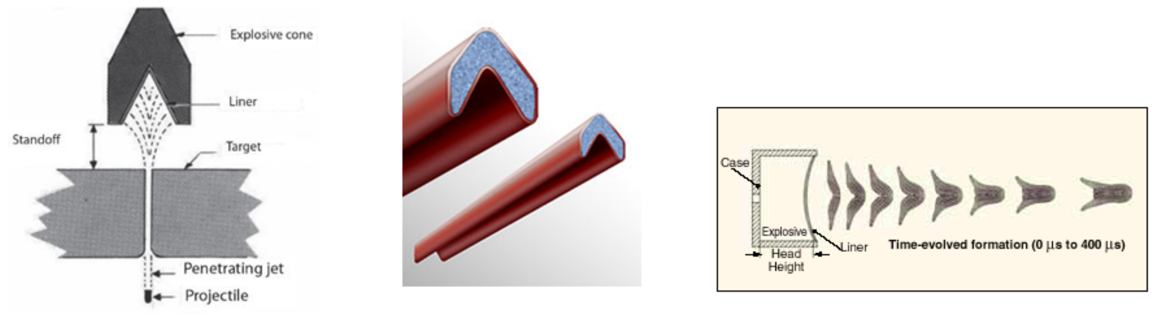
A.2.8.3.1 Initiator
The initiator is the first explosive element in an explosive chain that, upon receipt of the proper mechanical, optical or electrical impulse, produces a deflagration or detonating action. Initiators can be electrically actuated, optically actuated, or mechanically actuated. The deflagration or detonation action is transmitted to other elements in the train. An initiator may be a shock actuated percussion primer, electrically actuated electro-explosive device (EED) or optically initiated Laser Initiated Device (LID). For FTS applications, an EED is typically used.

A.2.8.3.2 Booster Charge
A booster charge is an explosive charge downstream of the first element of an explosive train that acts as a bridge between a low energy explosive and a low sensitivity (but typically high energy) explosive. It increases the energy of an initiating explosive to the degree sufficient to trigger the secondary charge or to increase the energy output to the end item. In FTS applications, a booster charge, if needed, forms a part of the EED assembly and is used to increase the energy going into the ETA.

A.2.8.3.3 Explosive Transfer Assembly (ETA)
An ETA is an explosive train consisting of an assembly of linear charges used to transfer a detonation from an initiator to an end function. The purpose of the ETA is to allow the initiator to be located away from the end function for accessibility. The ETA may also be referred to as an explosive transfer system (ETS) or as a linear explosive assembly (LEA). In FTS applications, an ETA is generally used to transfer the initiation signal from a S&A device to another ordnance component, such as a destruct charge. Typical linear explosive elements used in an ETA have a variety of names and configurations. These include: Confined Detonating Cord (CDC); Mild Detonating Fuse (MDF); Shielded Mild Detonating Cord (SMDC); Flexible Confined Detonating Cord (FCDC); Rigid Explosive Transfer Assembly (RETA); Flexible Explosive Transfer Assembly (FETA); Thin Layer Explosive (TLX); and others. Some of these are trade names or variations thereof. All accept detonation inputs and deliver detonation outputs. Only the TLX type transitions from detonation to deflagration and then back to detonation as its output.

A.2.8.3.4 Destruct Charges

A destruct charge is an explosive assembly used to sever or penetrate through elements of a space vehicle to cause structural break-up or to disable propulsive systems. Typically shaped charges are used. A shaped charge is a severing or penetrating explosive actuated device whose physical shape is used to focus explosive energy in a desired direction. Shape charges include Conical Shaped Charge (CSC), Linear Shaped Charge (LSC), and Explosively Formed Projectile (EFP) designs.



Conical Shaped Charge (CSC) Linear Shaped Charge (LSC) Explosively Formed Projectile (EFP)

Figure A-2-8-2: *Destruct Ordnance*

A.2.8.3.4.1 Conical Shaped Charge (CSC)

A CSC is a shaped charged with a conical liner backed by a high explosive, all in a steel or aluminum casing. When the high explosive is detonated, the metal liner is compressed and squeezed forward, forming a high velocity metallic jet that can be used to penetrate space vehicle structures.

A.2.8.3.4.2 Linear Shaped Charge (LSC)

A LSC is a linear explosive charge in a metal sheath whose cross section is formed into a chevron shape. The chevron shape results in concentrated directionality of a jet of molten sheath material expelled perpendicular to the linear propagation of detonation waves. Properly positioned the LSC can be used to sever or penetrate a space vehicle structure.

A.2.8.3.4.3 Explosively Formed Projectile (EFP)

An EFP is an explosive device that when activated causes detonation products to act on an integral concave metallic liner that is projected at high velocity toward a predetermined target. The concave liner is reshaped during this process into a slug of metal simulating a finned projectile that can be used to penetrate space vehicle structures.

A.2.8.4 DRS - Manned Secure (STS) (Currently not used)

The DRS-STS mode was used during Space Shuttle missions. In the DRS-STS mode, there is an additional layer of protection when sending command functions. The Central CMEV transmits the message to the command site that is radiating the carrier. Upon receipt of one the message, the command site echoes back to the CMEV the command request that it received. The CMEV verifies that the echoed request is the same as the original request. If so, the request is repeated to the command site in a different format, referred to as a STS Dump Request. The command site must receive and verify both requests before it transmits the requested command. After it has received the STS Dump request, the command site will generate the secure tones to build the message and transmit the requested function to the in-flight vehicle. When the command site has transmitted the command function, the site will send a confirmation message back to the CMEVs for display on the RASCADs and the FTUs. In the DRS-STS mode, commands are continuously transmitted when they are requested until they are removed or a higher priority command is requested. The command site will send a command transmission confirmation message every time the command is sent. The priority in transmitting commands is from highest to lowest: DESTRUCT, ARM, SAFE, Spare 1 and Spare 2. Spare 1 and Spare 2 are not currently used but are supported by the software. SAFE is currently only supported in the test mode and is not used during launch operations. The Cape 1A, Cape 1B, and JDMTA command sites can support the DRS-STS mode.

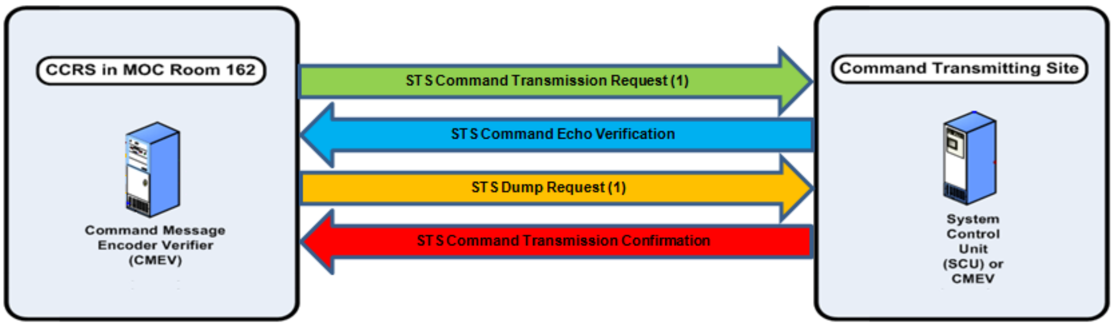


Figure A-2-8-3: *DRS-STS Command Request/Confirmation Data Flow*

A.2.8.5 CCRS Command Functions

There are sixteen commands functions that can be utilized in the CCRS. The first function in each group of four is used to send the combined ARM/DESTRUCT command message for that particular missile ID (W, X, Y or Z) when in the system is in the ETR-IRIG OT mode. Functions W1 through W3 are used in the ETR-IRIG Normal mode, functions W1 through W4 are used in the DRS-STS mode, and functions W1 through X1 are used in the DRS-UMS mode.

COMMAND FUNCTION	COMMAND NAME
W1	DESTRUCT W
W2	ARM
W3	SAFE (TEST for the DRS-UMS mode)
W4	SPARE 1 (RESET for the DRS-UMS mode)
X1	DESTRUCT X (SAFE for the DRS-UMS mode)
X2	Undefined
X3	Undefined
X4	Undefined
Y1	DESTRUCT Y
Y2	Undefined
Y3	Undefined
Y4	Undefined
Z1	DESTRUCT Z
Z2	Undefined
Z3	Undefined
Z4	Undefined

Table A-2-8-1: *CCRS Command Functions*

A.2.8.6 Automatic (Auto) Carrier Switching Algorithm

In Auto Carrier Mode or Auto Mode, carrier selection by manual control is inhibited, and the CMEV utilizes an algorithm utilizing a 16 bit word to perform a real-time analysis of several criteria to determine which command site has the best coverage. The station with the highest selection value is the best choice to transmit the command carrier. Each factor in the selection process is represented by a single bit or group of bits, with the most important factors having the highest weights; i.e., the most significant bits:

- **Bit 1 - Supporting Site:** The most important factor is whether or not the site is supporting the mission. If the site is configured on the console, the first bit is set. If it is not configured, the selection value is set to zero, since the site may not be used under any circumstances.
- **Bit 2 – Site Health:** The second bit represents health. Among those sites supporting the mission, the next most important factor is site health. Health for ETR sites equals one good CMEV link in both directions, one good transmitter, one good site CMEV, and system ready.
- **Bit 3 - Validity:** The third bit represents validity. Validity is defined in a negative manner: a site is invalid if it does not respond properly to carrier or function requests within 3 seconds, or if a requested function or carrier drops out and does not return within 3 seconds. A site is considered invalid for a period of 15 seconds following the error, after which it is again considered valid.
- **Bits 4 and 5 - Coverage:** The fourth and fifth bits represent coverage. Using two bits allows four levels of coverage. Level 0 is the lowest level of coverage. It indicates an elevation angle of less than 3 degrees. Level 1 is a special level that applies only to the Cape sites (1A and 1B) when plus time is less than 60 seconds, and elevation is less than 3 degrees. This is to give the edge to the Cape sites in the first few seconds of flight. In particular, if Cape 1A fails in the minus count or very early in the plus count, this feature will cause Cape 1B to be selected even if its elevation is less than 3 degrees. Skipping over Level 2 for a moment, Level 3 is the highest level of coverage, indicating an elevation angle of at least 3 degrees. Level 3 may be modified by use of the Carrier Transfer Time switches at the CSC console. A set of these thumbwheel switches exists for the Cape and JDMTA with the Cape switch applying to both Cape 1A and Cape 1B. Setting a switch for a particular plus time allows suppression of that site's coverage such that if the plus time is greater than or equal to the set value of the elevation is at least 3 degrees, the site's coverage is set to Level 2. This causes the system to look for a site with Level 3 coverage to switch to, or to remain with the Level 2 site if no better site is available. If the switch is set to zero, the site remains in Level 3 as long as the elevation is at least 3 degrees. This feature may be used to cause carrier transfers desired because of flame attention or other, as yet unknown, reasons. Elevation angles are ignored before liftoff to prevent spurious data from the FOV1 FOFEP causing a carrier switch in the minus count.
- **Bits 6, 7, 8, 9, and 10 – Not used**: At present, they are set to zero.
- **Bits 11, 12, 13, and 14 – Site Elevation Angles:** Bits 11, 12, 13, and 14 represent the actual elevation angle at the site. These bits represent 4 degrees, 2 degrees, 1 degree, and 0.5 degrees, respectively. The largest elevation that can be represented in this manner is 7.5 degrees; if the elevation is higher than 7.5 degrees, all four bits are set.
- **Bit 15 – Increasing Elevation Angles:** Bit 15 is set if the elevation is increasing.
- **Bit 16 – Current Site:** Bit 16 is set only for the currently selected site. This is used as a tiebreaker to prevent a switch if another site ties with the currently selected site. It is possible, although extremely unlikely, that two or more sites could tie when the auto-carrier is first requested, or when a switch <u>must</u> be made, as in the case of a link failure. In this case, the table of structure causes a prejudice in the order Cape 1A, Cape 1B, and JDMTA.

The mechanism of the auto-carrier is straightforward; when auto is first selected, the program will select the site with the highest selection value and turn its carrier on unless a site has a carrier on already and it is a valid selection. At one-second intervals the program re-computes each site's selection value, and if the currently selected site has a selection value of at least 176000 octal (i.e. supporting, healthy, valid, Level 3 coverage, increasing elevation) no action is taken. Otherwise, the site with the highest value is chosen, and if it is not the currently selected site, the program will affect a carrier transfer to the new site.

Normally, it is preferred to launch in the Auto Mode for two reasons:

- In order for carrier switching to be performed at the optimum times
- In order for the carrier to be quickly transferred to another command site upon CMEV detection of a CDS failure that will result in a loss of the carrier or prevent a command function from being transmitted.

A.2.8.7 Command Site Recording Subsystem

The command sites's key output products are reproduced by the Recording subsystem. System status, antenna position data, carrier frequency, incident power, reflected power, Universal Time Coordinated (UTC), and various event and tone information are recorded on various media (magnetic tape, zip drive, floppies, cassette, etc) among the different command sites. The data is used by the ERTS contractor to analyze the performance of the command site.

A-2-9 COMMUNICATIONS SYSTEMS

A.2.9.1 UHF/VHF Subsystem

The receiver site transceivers are tuned to the following frequencies and in some cases have a daily user and a different user during mission support. The following are used during missions for:

- 118.625 VHF –the tower and the Skid Strip
- 239.05 UHF – the tower and the Skid Strip
- 123.225 VHF – communication with the Weather (WX) aircraft
- 225.05 UHF – Day-to-day weather service information to aircraft in local area
- 128.15 VHF – communication with the NASA aircraft
- 349.60 UHF – communication frequency for the Range Clearing mission
- 133.80 VHF – the MRU (call sign Cape Control) at the MOC
- 264.80 UHF – the MRU (call sign Cape Control) at the MOC
- 149.50 VHF – NASA aircraft for rescue operations
- 381.80 UHF – United States (U.S.) Coast Guard
- 138.15 VHF – spare

In addition to the transceivers listed above, there are two tunable transceivers at the receiver site, which can be tuned and patched in the event of an equipment failure.

A.2.9.2 LMR Subsystem

The LMR subsystem is completely digital. Voice traffic is first converted from analog to digital using a voice encoder. Digitizing reduces the required bandwidth from 30 kHz to 12.5 kHz. The other advantage, although the traffic is unencrypted, is that digital transmissions are more secure than analog transmissions.

A.2.9.3 AN/WSC-3 Satellite Radio Subsystem

The AN/WSC-3, more commonly referred to as the “Whiskey 3”, is a UHF transceiver. The AN/WSC-3 is most commonly used by the U.S. Navy for ship-to-shore communication. The AN/WSC-3 transmits and receives to/from the U.S. Navy’s Fleet Communications Satellite, also known as FLTSATCOM. FLTSATCOM is a group of satellites in geosynchronous orbits, which are used by both the Navy and the Air Force.

The only AN/WSC-3s on CCAFS are located at Building 1663 (Television Operation Center [TVOC]). There are four transceivers, two hardwired for use and two spares. The AN/WSC-3s are supported by an antenna mounted on an elevated platform just to the east of TVOC. The antenna is single helix and manually steerable.

A.2.9.4 TMS

The four Cape Transport Management System (TMS) is an intelligent communications platform designed for provisioning digital circuits and frame-based services, and for the internet-working of communications resources. This system is primarily used for the point-to-point multiplexing of Eastern Range (ER) circuits. The TMS is used throughout the ER to provide a network management system. The TMS-3000 configuration is a group of nodes that are connected together with aggregate trunks. An aggregate is a connection between two TMS nodes where the entire trunk carries a single bundle carrying the data originating from the TMS channels. It provides performance based circuit routing, automatic re-routing, adaptive down speeding, and acts as both a digital switch and a multiplexer. The TMS configuration is a group of nodes that are connected together with aggregate trunks. A node is an addressable location within a network capable of carrying a TMS circuit. At a node, data is transferred between: aggregates and other aggregates, channels and aggregates, or channels and other channels. An aggregate is a connection between two TMS nodes that is full duplex (data is transmitted in both directions) where the entire trunk carries a single bundle carrying the data originating from the TMS channels.

The Cape TMS System is comprised of two strings of equipment; String #1 and String #2 (Fig. 1-1 and Fig. 1-2) provide general connectivity throughout the ER. Each subsystem or string is further segmented into components identified as Black TMS String 1, Black TMS String 2, Red TMS String 1, and Red TMS String 2. Each TMS nodes are considered a slave node of the Cape TMS. The dual string configuration provides redundancy in that a failure of one string does not preclude the ER from accomplishing the Range Safety Mission. The master node of the Cape TMS is located in the Morrell Operations Center (MOC) with the Black TMS String controllers located in MOC Communications and the Red TMS String controllers located in Red Technical Control at the MOC. Each slave node configurations for circuit configuration is controlled from the master controllers located in the MOC. Please reference the ERIH for the Cape TMS data flow and additional information.

A.2.9.5 M465

During Trident operations the ER uses the M465 Range Safety Communication System (RSCS) to provide redundant telemetry data, state vector data, and secure voice communication between the LASS and the MOC.

The M465 is a redundant system and consists of two independent paths, System One and System Two. Both systems uplink and downlink to the same commercial Ku-Band satellite and same transponder, but on separate carriers. System One provides a path for Secure voice nets 1 and 1A, Navy Global Positioning System Translator Processor (NGTP) 1 data, and Portable Shipboard Instrumentation Package (POSIP) 1 data. System Two transports secure voice nets 2 and 2A, NGTP 2 data, and POSIP 2 data.

The interface equipment between the MOC and the antennas are collocated with the primary and secondary SATCOM shelters.

Figure A-2-9-1 shows the M465 System data flow block diagram.

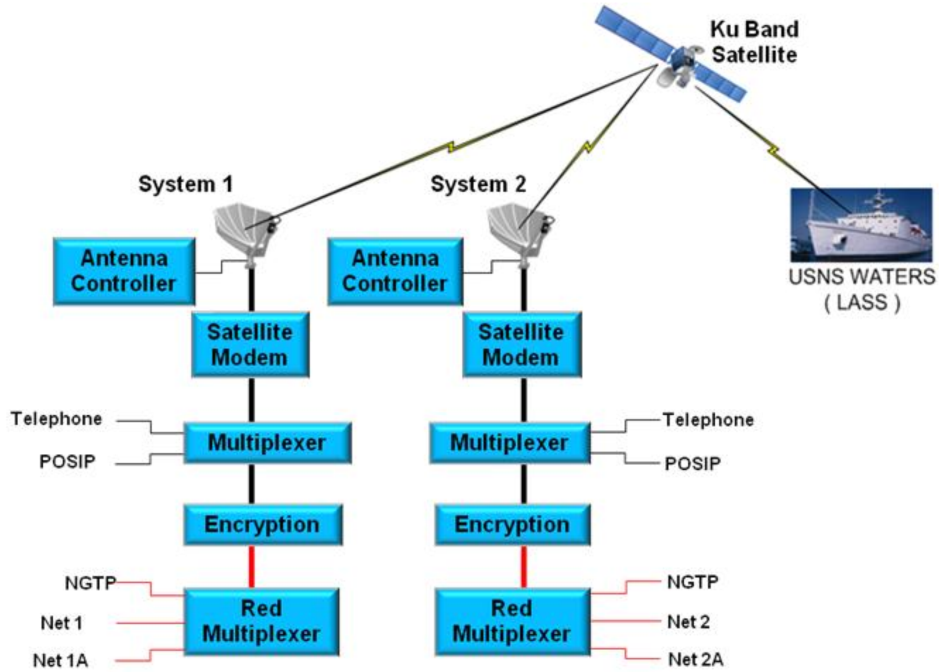


Figure A-2-9-1: *M465 System Data Flow Block Diagram*

Note that while satellite systems normally exhibit near 99% reliability, they are subject to transmission delay, precipitation attenuation, solar outages, and high winds

A.2.9.6 Ascension

There are several different data paths to and from Ascension. The Commercial Satellite Communications (SATCOM) system provides the Eastern Range (ER) with a satellite communications network between Cape Canaveral Air Force Station (CCAFS) and the downrange stations at Ascension. It provides a full-duplex digital narrowband for the transfer of voice and data, as well as a simplex digital wideband channel for the transmission of high-rate telemetry and video.

A DISA circuit through the DSCS system is also available to Ascension. It utilizes a satellite link between Ascension and Northwest, Virginia, then the Integrated Digital Network Exchange (IDNX) network to route circuits between Northwest, Virginia and CCAFS. It is used for several reasons to include alternate routing and additional bandwidth. In the event of a failure of the primary SATCOM link, the Red TMS String 2 can be routed through the DSCS satellite.

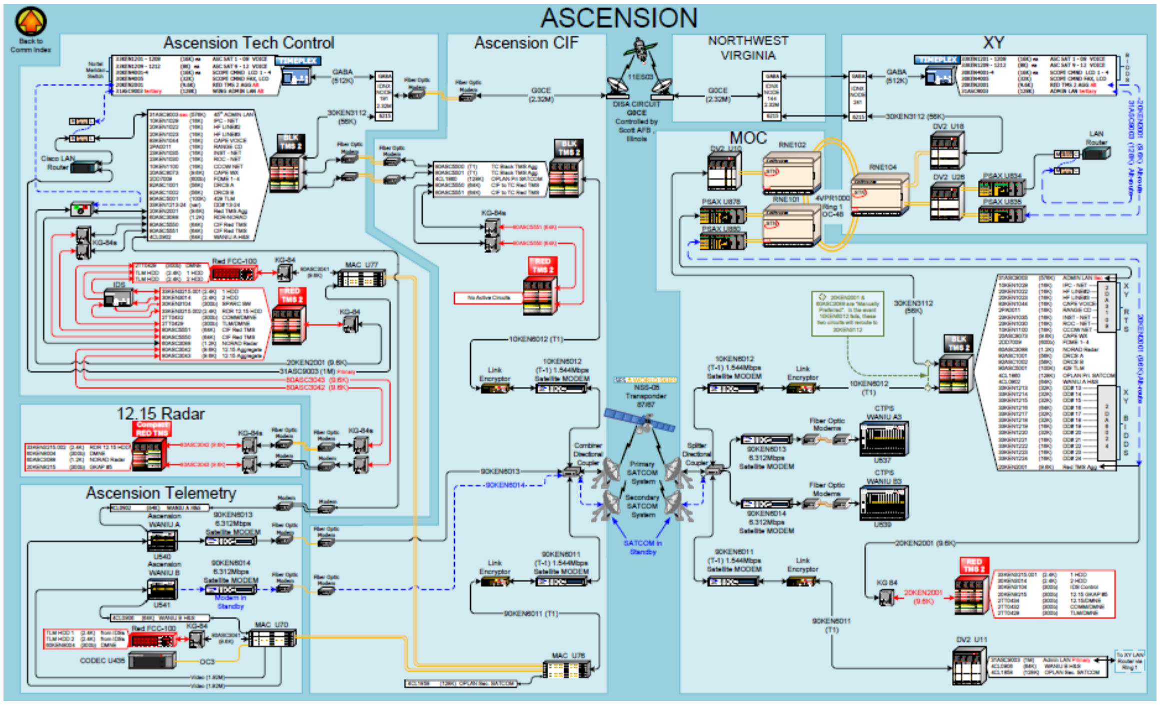


Figure A-2-9-2: *Ascension*

Ascension Radar 12.15 also supports North American Aerospace Defense Command (NORAD) with global monitoring via a dedicated 24/7 circuit to Cheyenne Mountain, which is routed over the DSCS satellite.

There are 14 Global HF sites throughout the globe and Ascension is one of those 14 sites. Ascension HF transmitters and receivers are controlled and can be accessed via command from Andrews Air Force Base in Virginia.

Ascension also has an IDS. All HDD data is routed through the Ascension IDS. The Ascension IDS allows a switch between HDD 1, HDD 2, or Radar 12.15 track data (if the radar is tracking). The IDS is controlled by the Single Point Acquisition and Radar Control (SPARC) in the MOC through the Red TMS 2 circuit.

A-2-10 TIMING AND SEQUENCING SYSTEMS

A.2.10.1 Back-up/Forced First Motion

This provides a +28 vdc signal to MOC Central Timing which is selected to a legacy first motion distribution panel for relay to ER instrumentation as either a +28 vdc or -48 vdc signal via legacy data transport systems.

There is no connectivity between the legacy first motion distribution components and the components that process and distribute TVFM in the CS-5246 data stream. Therefore backup first motion will not be received by customers using the CS-5246 TVFM. The reason is that first motion is used by Command and tracking (Radar, Telemetry) systems to initiate stored nominal trajectory data to facilitate acquisition during launch operations. First motion is also used to start data recorders and provide a time reference for vehicle liftoff in data products used during post launch analysis and delivered to launch customers. The inability to insert a backup first motion in the CS-5246 count status data stream could result in a degraded vehicle acquisition capability for systems relying in CS-5246 for TVFM to start stored nominal trajectory data, as well as a potential loss of data recordings and degraded data products.

Initiation:

- FOV-1 MDP controller initiates from the Acquisition Data Processor (ADP #1 Console- sent out through launch designate
- Real Time Computers System Controller initiates from the ADP #2 console- sends First Motion to central timing for distribution through the timing data circuits

A.2.10.2 Holdfire

The EELV holdfire subsystem transports holdfire commands as multiplexed triple redundant Frequency Shift Key (FSK) signals between Holdfire Timing Unit (HTU) at MOC Central Timing and the Launch Control Centers. EELV holdfire is utilized for the Atlas V and Delta IV launch programs.

A.2.10.3 American Standard Code for Information Interchange (ASCII)

Computers can only understand numbers, so an ASCII code is the numerical representation of a character such as 'a' or '@' or an action of some sort. ASCII was developed a long time ago and now the non-printing characters are rarely used for their original purpose. In regards to First Motion Time, it is distributed as legacy discrete DC voltage (hard-line) signals or as ASCII Time of Vehicle First Motion (TVFM) contained in the CS-5246(x4) data stream.

A.2.10.4 Back-up/Forced First Motion

If the primary first motion is not received by the liftoff time and is observed by the controller, a manual first motion button is depressed. This provides a +28 vdc signal to MOC Central Timing which is selected to a legacy first motion distribution panel for relay to ER instrumentation as either a +28 vdc or -48 vdc signal via legacy data transport systems.

There is no connectivity between the legacy first motion distribution components and the components that process and distribute TVFM in the CS-5246 data stream. Therefore backup first motion will not be received by customers using the CS-5246 TVFM. The reason is that first motion is used by Command and tracking (Radar, Telemetry) systems to initiate stored nominal trajectory data to facilitate acquisition during launch operations. First motion is also used to start data recorders and provide a time reference for vehicle liftoff in data products used during post launch analysis and delivered to launch customers. The inability to insert a backup first motion in the CS-5246 count status data stream could result in a degraded vehicle acquisition capability for systems relying in CS-5246 for TVFM to start stored nominal trajectory data, as well as a potential loss of data recordings and degraded data products.

Initiation:

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A.2.10.5 Holdfire

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A.2.10.6 Atlas V Count Distribution and Identifier

CS-5246 count are distributed via the Core, while the ERCN transporting FDME count are distributed via legacy count distribution and data transport systems. During launch operations, ERCN-3 is utilized for T-Count, while ERCN-1 is utilized for L-Count.

Select customers also receive the CS-5246 count in a multiplexed format (CS-5246x4). The multiplexed data stream carries up to four counts, each having a unique identifier. Atlas V uses Count ID “A” for the T-Count and “L” for the L-Count.

A.2.10.7 Atlas V PCG Operation

The PCG generates count in CS-5246 format, which are transmitted over the Core (a fiber optic communications transport system) on redundant circuits from the ASOC to two Range Count Signal Generators in MOC Central Timing. The output from the primary RCSG is selected for distribution on the ER.

During the minus count, the RCSG operate in a slaved mode. That is, signal outputs are synchronized to the CS-5246 count input from the ASOC PCG. Upon receipt of TVFM, the RCSG switch to internal mode and generate an independent plus count which is referenced to the TVFM time stamp received in the CS-5246 data stream.

A.2.10.8 Atlas V Primary First Motion

The signal is time-tagged upon receipt by both units and transmitted over the Core on redundant circuits as TVFM to two RCSG in MOC Central Timing. The CS-5246 count output (containing TVFM) from the primary RCSG gets distributed on the ER via the Core. A +28 vdc discrete first motion signal will also be output from the primary RCSG which gets distributed via legacy distribution equipment and data transport systems.

A.2.10.9 Delta IV PCG Operation

The PCG generates count in CS-5246 format, which gets transmitted over the Core on redundant circuits from the DOC to two RCSG in MOC Central Timing. The output from the primary RCSG is selected for distribution on the ER.

During the minus count, the RCSG operates in slaved mode. That is, signal outputs are synchronized to the CS-5246 count input from the DOC PCG. Upon receipt of TVFM, the RCSG switch to internal mode and generate an independent plus count which is referenced to the TVFM time stamp received in the CS-5246 data stream.

A.2.10.10 Delta IV Count Distribution

The ERCN transporting CS-5246 count is distributed via the Core, while the ERCN transporting FDME count get distributed via legacy count distribution and data transport systems. During launch operations, ERCN-3 is utilized for T-Count, while ERCN-1 is utilized for L-Count.

Select customers also receive the CS-5246 count in a multiplexed format (CS-5246x4). The multiplexed data stream carries up to four counts, each having a unique identifier. Delta IV uses count ID “D” for the T-Count, while Count ID “L” is used for the L-Count.

The CS-5246 count output (containing TVFM) from the primary RCSG gets distributed on the ER via the Core. A +28 vdc discrete first motion signal will also be output from the primary RCSG which gets distributed via legacy distribution equipment and data transport systems.

A.2.10.11 Delta IV Backup First Motion

This provides a +28 vdc signal to MOC Central Timing which is selected to a legacy first motion distribution panel for relay to ER instrumentation as either a +28 vdc or -48 vdc signal via legacy data transport systems.

There is no connectivity between the legacy first motion distribution components and the components that process and distribute TVFM in the CS-5246 data stream. Therefore backup first motion will not be received by customers that use the CS-5246 TVFM.

A-2-11 METEOROLOGICAL SYSTEMS

The radar antenna, transmitter, receiver and signal processor are located at the Deseret Orange radar site in Brevard County, 23 miles northwest (NW) of PAFB, while the processing and display equipment are located at the MOC on Cape Canaveral Air Force Station (CCAFS).

The WSR antenna, transmitter, and receiver were manufactured by Radtec Engineering in Broomfield, Colorado. It is a 250 kilowatt (kW) C-band, klystron-based Doppler Weather Radar (DWR).

The WSR scan strategy is user-programmable and the number and elevation of each volume scan can be changed as operational needs dictate. The implemented scan strategy provides an accurate characterization of both the horizontal and vertical development of precipitation in the launch area with update rates and data latencies short enough to capture the sometimes very rapidly developing convective clouds common to the Cape Canaveral area.
The WSR can transmit in one of three modes of operation:

- Doppler and Dual-Polarity Mode: This default mode of operation provides the advantages of a C-band DWR transmitting in both horizontal polarization and vertical polarization. The additional information can also be used to improve the accuracy of radar-based rainfall estimates, improve the reliability of hail detection, and help to identify the state of the target. In this mode, the WSR TDR 43-250 has a range of about 40 nautical miles (nmi). The WSR can measure unambiguous radial wind velocities up to about 50 knots (kt)
- Doppler Only Mode: In this mode, the WSR can measure unambiguous radial wind velocities up to about 30 kt. Automated unfolding Doppler velocity can be used to extend detection of radial velocities up to about 60 kt. This is useful because it extends well above the 50 kt threshold for severe weather. However, this feature can only be used with single polarization. Single polarization lacks the ability to classify particles and has limited ability to estimate rainfall. The WSR TDR 43-250 has a range of 40 nmi using Doppler Only Mode
- Dual-Polarity Only Mode: In this mode, the WSR TDR 43-250 has a range of 80 nmi, but it cannot measure wind velocity. However, it can classify particles and employ five methods of estimating rainfall

A-2-12 AREA SURVEILLANCE SYSTEMS

A.2.12.1 ASR-11/GPN-30 AIR SURVEILLANCE RADAR

To synchronize the range data from both systems, the MSSR system transmits at the same time as the PSR system. To synchronize the azimuth data from both systems, the MSSR antenna is mounted on top of the PSR antenna with both antennas always pointing in the same direction.

A.2.12.2 SEA SURVEILLANCE RADAR (SSR) NORTH/SOUTH

The SSR South media converter transmits the data by fiber optic cable to the Fiber Optic (FO) Distribution Unit Assembly in the MOC. The SSR North media converter transmits the data by fiber optic cable to the Fiber Optic (FO) Distribution Unit Assembly in the XY Building which routes the data through the media converter to the same Data Converter Chassis Assembly used for the air surveillance data. The sea surveillance data is then routed back through the media converter and the Fiber Optic Distribution Unit Assembly for distribution to the MOC.

A.2.12.3 SURVEILLANCE CONTROL DISPLAY SYSTEM (SCDS)

Within the SCC, there is an SCDS equipment rack which contains the equipment used to receive and process data from the surveillance sensors. The SCDS Equipment Rack consists of:

- **A Fiber Optic (FO) Distribution Unit Assembly:** This assembly receives air and sea surveillance sensor data and distributes it to the Media Converter Assembly
- **A Media Converter Assembly:** This assembly receives air and sea surveillance sensor data from the FO Distribution Unit Assembly, converts the data to Transmission Control Protocol/Internet Protocol (TCP/IP) format, and distributes the data to the 24-port Ethernet Switch VLAN Assemblies
- **A Network Time Server:** The Network Time Server receives IRIG-B Time from Timing and distributes the timing data to the 24-port Ethernet Switch VLAN Assemblies
- **Two 24-port Ethernet Switch Virtual Local Area Network (VLAN) Assemblies:** These assemblies transmit the air and sea surveillance sensor data in the TCP/IP format from the Media Converter Assembly and the timing data from the Network Time Server and distribute the data to the two Suretrak Server Assemblies. They also distribute the processed data from the Server assemblies to all of the SureTrak Workstations. These VLAN Assemblies are redundant and are able to process all of the data for distribution to both of the Suretrack Servers

Figure A-2-12-1: *SCDS Equipment Rack*

- **Two Suretrack Servers:** These servers house the Suretrack Software Version 5.7.2, process data from the 24-port Ethernet Switch VLAN Assemblies and then sends the process data back to the 24-port Ethernet Switch VLAN Assemblies for distribution to all of the SureTrak Workstations, including the workstation at the SLF. These servers are redundant and able to process all of the SCDS data. One acts as the primary server and the other acts as a secondary or hot back-up server. If there is a failure of the primary server, the system can be configured to use the secondary server. This action be executed by ERTS personnel.
- **A Video Distribution Amplifier:** This amplifier is used to distribute data from the SCO SCDS workstation to the display monitors in the SCC, the CAB, and at the ROC console.

A-2-13 DATA HANDLING SYSTEMS

A.2.13.1 Digital Acquisition System (DAS)
The DAS system is used to digitally record data that has been pre-recorded onto standard Video Home System (VHS) VCR tapes.

The DAS functions as a continuous radar data recording and storage system. The DAS inputs the signals from the VCR of an entire mission videotape, conditions them as necessary, digitizes the analog radar data, time-tags the data, and then stores the digital data on a RAID. The RAID can store over 200 GB of data, which is enough room to accommodate a minimum of five missions with a typical duration of 500 to 600 seconds. This is based on digitizing at a maximum sampling rate of 20 MHz resulting in a storage requirement of 24 GB maximum per mission. The DAS also displays the data as it is being digitized in both a RTI plot and an A-Scope display.

A.2.13.2 Signal Analysis Subsystem (SAS)
The SAS is used to analyze signals that are recorded by the DAS system. The SAS facilitates radar calibration and head switch anomaly characterization, performs detailed target analysis and variable-speed target viewing, prints "quick-look" plots, displays waterfall plots, and permits raw data editing and extraction of data subsets.
The SAS inputs the digitized, time-tagged data stored on the DAS by either using a gigabit Ethernet connection or by transferring the data manually on DVD-Random Access Memory (RAM) media. If further analysis is deemed necessary, the same data, combined with calibration data located on the end of each videotape, is used to determine SNR and Radar Cross Section (RCS) information. The SAS provides the environment for display, analysis, and production of data products based on the digitized radar data to include analyses on vehicle performance, radar instrumentation performance, flight events, debris objects, and tracked targets.

A.2.13.3 FOV1 Ascension Designate Software System (FADSS)
The FADSS processes Trident II D5 Telemetry Inertial Guidance (TMIG) data, analog discrete data and Translated Global Positioning System (GPS) Range System (TGRS) data to calculate an IRV to be sent to Down Range sites for missile acquisition.

During Trident launch operations, data is generated from FOV1 and sent to FADSS for processing. FADSS processes the data, generates an IRV and then sends it to DMNE for distribution to down range sites.

2.13.5.1 Pre-Mission
Before each operation, mission parameters are generated on LAPS. Once the mission parameters are generated, it is sent to FOV1-A and, in turn, FOV1-A sends it to FADSS. The mission parameter file is an ASCII text file containing global mission information, at least one missile record, and at least one Return Entry Body (REB) record per missile. The mission parameters provide initial data for FADSS which include the test number, number of missiles scheduled to be launched, classification of the launch, operational mode, launch area and missile information. The missile information includes the number of REBs scheduled, deployment plus count, position, velocity, delta position, delta velocity, and up-rise plus time.

2.13.5.2 During Launch Operations

CRADIS receives TMIG data from the FOV1 Guidance Processor (GP) and TGRS data from the Flight Operations – Front End Processor (FO-FEP). CRADIS detects certain scheduled vehicle events, such as REB releases, 3rd Stage Separation (3 STG), and Equipment Section (ES) burnout, in the incoming data.

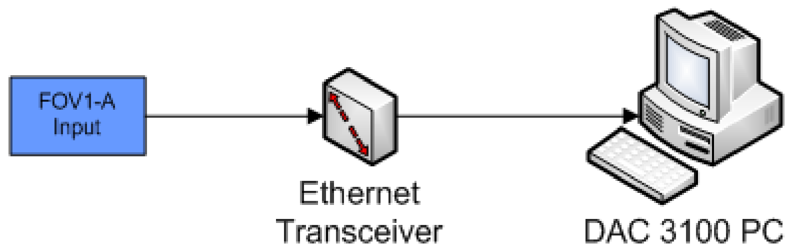

Figure A-2-13-1: *TMIG data flow*

2.13.5.3 FADSS Operational Limitations

- The FADSS performs no error detection and/or correction and is vulnerable to unexpected input anomalies
- The FADSS is also unable to properly process and log incoming messages from DMNE. An incoming DMNE message will cause FADSS to stop processing data. Therefore, the incoming DMNE line must be disabled before any operation. The FADSS also has no pre-test simulation capabilities
- The FADSS has an additional limitation regarding the REB weights. The Navy's new vehicle packages require multiple weight REBs. Presently, CGACTR is limited to a single weight for each REB. A workaround for multiple REB weights is available, but requires additional testing. In the workaround, multiple runs are performed and individual mission parameter files are merged to create a mission parameter file that FADSS can process

A-3-1 ATLAS V

A.3.1.1 Launch Facilities

The Vertical Integration Facility is a weather-enclosed steel structure, approximately 22.9 m (75 ft) square and 87.2 m (286 ft) tall, with a fabric roll-up door, a hammerhead bridge crane, platforms, and servicing provisions required for launch vehicle integration and checkout.
The Pvan, consists of a rail car undercarriage and support container that houses the spacecraft ground support equipment. The PVan provides 23.2 m^2 (250 ft2) of floor space for spacecraft mechanical, electrical, and support equipment. The PVan also provides power, air conditioning, lighting, and environmental protection.

The Mobile Launch Platform consists of a structural steel frame capable of supporting the various Atlas V 400 and 500 series launch vehicle configurations. Supported operations include integration of the booster(s), mating of the Centaur and spacecraft in the VIF, transport to the launch pad, launch vehicle fueling, final preparation for launch, thrust hold-down, and release of the launch vehicle at launch. This frame is supported underneath by piers at the VIF and at the launch pad. The frame is rolled to these locations using four 227,000-kg (250-ton) rail cars equipped with a hydraulic jacking system for raising the MLP for movement and lowering onto the piers for stability.
The MLP is moved between the VIF and launch pad by two tugs that ride on a rail system. The MLP frame also supports the umbilical mast.

All spacecraft umbilicals needed at the launch pad are flyaway disconnects. Rollback from the launch pad to the VIF can be accomplished in six hours if launch vehicle propellants have not been loaded, or within 18 hours if launch vehicle propellants must be detanked.

A.3.1.2 Launch Vehicle Description

The Atlas V uses a standard Common Core Booster (CCB) with the Russian RD-180 dual-thrust chamber engine with throttling capability, a stretched version of the restartable Centaur cryogenic upper stage using one or two Pratt & Whitney RL10A-4-2 turbopump-fed engines in either the Single-Engine Centaur (SEC) or the Dual-Engine Centaur (DEC) configuration, and one of several Payload Fairings (PLF). For typical, high-energy, high altitude Medium Earth Orbit (MEO) and Geo Transfer Orbit (GTO) mission applications, the SEC configuration will be used. For heavy payload, low earth orbit (LEO) missions, the DEC configuration will be used to maximize boost phase mission performance. There are also options to add up to five strap-on solid rocket boosters (SRBs) or two additional CCBs to increase the payload performance.

Digit	Indicates	Examples	
1st	Fairing diameter	4 5	4 meter fairing 5 meter fairing
2nd	Number of solid rocket motors	0 1 2 3 4 5	None One solid rocket motor Two solid rocket motors Three solid rocket motors Four solid rocket motors Five solid rocket motors
3rd	Number of second stage RL-10 engines	1 2	Single-Engine Centaur (SEC) Dual-Engine Centaur (DEC)
Example: Atlas V 532			
Digit	**Indicates**		
5	5 meter fairing		
3	Three solid rocket motors		
2	Dual-Engine Centaur (DEC)		

Table A-3-1-1: *Atlas V Three-Digit Designation*

A.3.1.3 Telemetry System

S-Band Antennas:

Binary Phase-Shift Keying/Quadrature Phase-Shift Keying (BPSK/QPSK) transmitterTracking and Data Relay Satellite System (TDRSS), associated S-Band antennas, and interconnecting wire and cabling.

Additionally, all Atlas Vs will have a Data Acquisition System (DAS) consisting of one Master Data Unit (MDU), up to four Remote Data Units (RDU), associated transducers (temperature, pressure, acceleration and strain) and interconnecting wire and cabling. Options to increase the bit rate of the DAS from 512 to 1024 kbps must also be considered.

An R&D instrumentation kit consisting of up to three Digital Telepaks (DTP), utilizing data rates of up to 3.2 Mbps, and an Atlas low power RF DTP's transmitter transmitting at 2232.5, 2255.5, or 2272.5 MHz will be used to acquire special high frequency analog data.

A.3.1.4 Flight Termination System

The CRDs also provide a Centaur auto-destruct System (CADS) that sense break-wires to be "open" or "shorted" to vehicle structure due to vehicle inadvertent stage separation or vehicle break-up. Upon sensing an "open" or "short" the CRD(s) will respond similarly as if the CRD(s) received an RF Destruct command as described above. The CADS break-wire sensing loops, when required, typically run down to the Atlas from the Centaur as a redundant set to that of the Booster Auto-Destruct System (BADS). The break-wires may also be run up to the payload to sense an inadvertent payload separation. The CADS is employed on a mission peculiar basis. The CADS break-wires must be "safed" prior to stage separation. The airborne break-wire safing logic requires at least one safing command from either Channel 1 or Channel 2 sides of the URCU and at least one command from ORCA 1 or 2 in order for the break-wires to be safed.

The CRDs are automatically "safed" in flight from the FTINU via the Upper Remote Control Unit (URCU) and Ordinance Remote Control Assembly (ORCA) in that one high output from the

URCU and one high output from the ORCA is present at the CRD safing inputs, four inputs on each CRD.

The Atlas contains two Automatic Destruct Units (ADU(s)) that sense break-wires to be “open” or “shorted” to vehicle structure due to vehicle inadvertent stage separation or vehicle break-up. Upon sensing an “open” or “short”, the ADU(s) will respond by providing a high current pulse to the EEDs that initiate ordnance to destroy the Atlas, and SRBs (if flown). The ADUs are “safed” in flight by the URCU and the Booster Remote Control Unit (BRCU) where at least one output must be received by the ADU from the URCU (one of two outputs) and the BRCU (one of two outputs).

The Atlas SRBs have lanyard pull initiators that ignite the ordnance in the event that the one or more SRBs separate inadvertently from the Atlas. In nominal operation each SRB is “safed” via the ordnance train safing interrupter.

The Pulse Code Modulation (PCM) format for all FTS telemetry will remain constant for all Atlas V missions.

A-4-16 RANGE STATUS, CONSTRAINTS, AND WAIVERS

A.4.16.1 Launch Vehicle/Space Vehicle Redline Limits

Sensors onboard launch vehicles and spacecraft are used to measure parameters in the various subsystems. Operational and redline limits for these sensor measurements are established and monitored on launch day to ensure the subsystems are functioning properly. Values approaching or exceeding redline limits indicate a system problem or failure. Some redline limits include:

- **Pressure:** Pressure redline limits are used to indicate problems with such things as propellant tanks, pneumatic systems, and the pressurization bottles for the propellant tanks.
- **Voltage/Current:** Voltage and current redline limits are used to indicate problems with such things as avionics, power and spacecraft systems.
- **Temperature:** Temperature redline limits are used to indicate problems with such things as propellant tanks, avionics, power, and spacecraft systems.
- **Humidity:** Humidity redline limits are used to protect avionics and spacecraft systems. If not properly maintain, it can lead to an electrostatic discharge that could cause damage to these systems.

Often some sensors will provide redundancy in collecting data. A failure of one sensor may make another mandatory. A failure of a mandatory sensor may cause a launch hold or scrub.

In addition, launch agencies also establish Radio Frequency (RF) limitations to protect avionics and spacecraft systems from high-powered range or other transmitting systems. Range transmitting systems use signal attenuation until the launch vehicle is sufficiently downrange to prevent damage to these systems. RF levels are monitored by ground support equipment. Violations of these levels may require a launch scrub until these systems can be re-tested or replaced.

A.4.16.2 Support Facility Constraints

Support Facility constraints include facilities such as Launch Control Centers (LCCs), Satellite Operations Centers (SOCs), and other facilities used for telemetry monitoring and vehicle commanding. Failures of processing and control systems at these facilities may result in a launch hold or scrub.

For DoD and NRO missions, the anomaly and waiver processes are developed during the launch campaign and are refined and validated through rehearsals such as Integrated Crew Exercises (ICEs) and the Mission Dress Rehearsal (MDR). Typically when an issue arises, an anomaly team is formed by an anomaly team lead who brings together the applicable system engineers and facilitates a discussion on how to resolve the issue or to determine the feasibility of a waiver. Once a course of action or a set of options has been developed, the anomaly team lead briefs the MD and the launch management team on the anomaly teams' recommendations. Usually there is an anomaly team lead for the launch vehicle and an anomaly team lead for the spacecraft to deal with issues affecting their applicable systems. For integrated issues affecting both the launch vehicle and the spacecraft, the anomaly team leads will coordinate with each other and jointly brief the MD as required.

The MD is responsible for launch vehicle and space vehicle mission assurance and is the waiver authority for launch agency mandatory assets. The MD will assess the risk to the mission and select a course of action or approve/disapprove the waiver.

Range instrumentation or network failures can impact launch vehicle and/or spacecraft constraints. Upon notification by the RCO of the outage, the user's Range interface, such as the Range Coordinator, will notify the launch team management.

A.4.16.3 Acquisition Organization Risk Responsibility

The acquisition organization (such as SMC) is responsible from orbital insertion through early orbit testing and until the operational organization assumes tactical control (TACON). The acquisition organization also has responsibility for follow-on support and any post-End of Life (EOL) activities (such as reentry recovery).

A.4.16.4 Operational Organization Risk Responsibility

Consistent with other agreements, the operational organization (such as a Space Operations Squadron or SOPS) is responsible for all operational risks after the successful completion of early orbit testing through EOL activities.

A.4.16.5 Mishap Prevention and Reporting

The goal of Space Safety is to enhance mission effectiveness and success by proactively preventing mishaps and close calls. The cornerstone of mishap prevention is understanding failures and close calls, and taking action to prevent future occurrences. AFI 91-217 requires units to document and report lessons learned from failures and close calls in order to share with other organizations to help prevent future mishaps.

A.4.16.6 Space Safety Training

AFI 91-217 requires that safety and operations personnel receive Space Safety training that is tailored for their assigned tasks and positions to ensure mission effectiveness appropriate for the duties and missions of their assigned organization.

A.4.16.7 Eastern and Western Test Range Manuals

In 1956, Public Law 10 was passed to define similar safety requirements for ordnance storage and operations. With the passage of these laws, the Air Force Military Test Center and the Department of Defense issued memoranda defining the responsibility of the Commander and the Deputy Commander and holding them personally liable for safety on the proving grounds. To implement the safety policy of the Commander, the Directorate of Center Safety was established. The first document written to address those safety requirements was the *Air Force Western Test Range Manual 127-1*, published in August 1969. Public Law 29, the Occupational Health and Safety Act, passed in 1971 defined the requirements for protecting the civilian work force; and the Air Force Occupational Safety and Health Manual, published in 1972 further refined these requirements. Shortly afterwards, the *Air Force Eastern Test Range Manual, AFETRM 127-1* was published.

A.4.16.7.1 Eastern and Western Space and Missile Center Regulations

In 1983 and 1984, revised editions of the Eastern and Western Test Range Manuals were issued and the names changed to reflect the change in names of the test centers. The manuals were changed to regulations that were considered more directive and binding. The AFETRM 127-1 was renamed the Eastern Space and Missile Center Regulation (ESMCR) 127-1 and the AFWTRM 127-1 was renamed the Western Space and Missile Center Regulation (WSMCR) 127-1. The responsibilities of the Center Commander were further clarified in these regulations by incorporating guidance from Department of Defense Directive (DODD) 3200.11.

A.4.16.7.2 Eastern and Western Range Regulation (EWR) 127-1

Shortly after the Eastern and Western Space and Missile Center Regulations were published, Congress passed the Commercial Space Launch Act to accommodate private sector aerospace companies that wanted to use military facilities to launch satellites for commercial purposes. In response to this law, the Department of Defense issued Directive 3230.3 in 1986, further clarifying the Department's safety responsibilities and support requirements for commercial launch activities. Again in 1988, Congress addressed commercial launches with an update to the Commercial Space Launch Act, assigning the Department of Transportation the responsibility for licensing commercial launches. During the same period, safety, policy, and criteria for the launch of any launch vehicle from the Range were established in the 80 series of the Air Force regulations; and the goals and responsibilities of the Commander and other personnel for the prevention of mishaps were described in the 127 series. The 1993 editions of the regulations incorporated the requirements of the public laws, the Department of Defense Directives, and the Air Force regulations. Because private sector aerospace companies are not directly bound by military regulations, standards, and specifications in the launch of launch vehicles and payloads from the Ranges, the 1993 editions were much more comprehensive, providing the minimum standards for the safe conduct of operations on the Ranges.

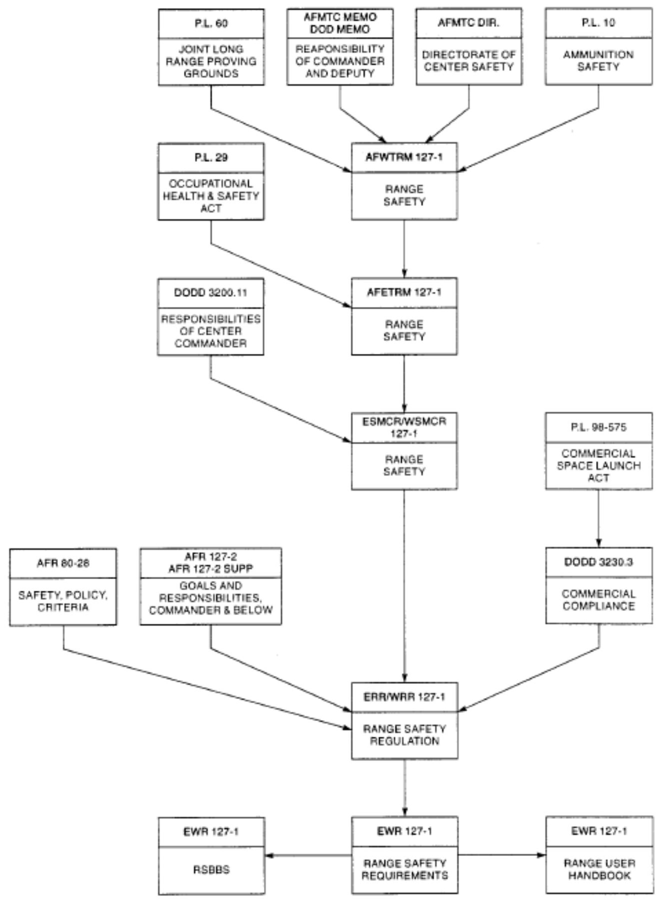

Figure A-4-16-1: *Evolution of EWR 127-1*

Throughout the life of these two Range documents, attempts were undertaken to make the requirements common to both Ranges; however, it was not until 1994 that a concerted effort was made to have a document common to both Ranges. In March 1995, *Eastern and Western Range 127-1*, *Range Safety Requirements* was signed by the Wing Commanders and published. Figure A-4-16-1 shows the evolution of EWR 127-1.

A.4.16.8 Assessing Risk

Risk is viewed as a product of the probability of an event occurring (rocket exploding) and the potential consequence (such as HCl gas from solid motors affecting the public).

Risk = *Probability* **x** *Consequence*

The "consequence" in the calculation is also referred to as a "casualty." A casualty is a serious injury or worse, including death, for a human. For the purposes of implementation on an AFSPC Range, serious injury is defined as Abbreviated Injury Scale (AIS) Level 3 or greater except where prior general practice at the range has been to protect to a lesser level of injury than AIS level 3, such as eardrum protection.

The risk to people due to the hazards from launches is measured in casualties and is expressed as individual risk or collective risk, both of which are expressed with the following notation: 1E-7 = 10-7 = 1 in ten million.

A.4.16.8.1 Individual Risk/Probability of Casualty (P_c)

Individual risk is the risk that a person will suffer a consequence. Unless otherwise noted, individual risk is expressed as the Probability of Casualty (P_c**)** or the probability that an individual will become a casualty due to all hazards from an operation at a specific location. RCC 321-07 guidance information is as follows: if each person in a group is subject to the same individual risk, then the collective risk may be computed as the individual risk multiplied by the number of people in the group. In the context of this standard, individual risk refers to the probability that the exposed individual will become a casualty as a result of all hazards from a mission.

A.4.16.8.2 Collective Risk/Expectation of Casualty (E_c)

Collective risk is the total combined risk to all individuals within a category (Launch Essential Personnel (LEP), general public) exposed to any hazard from an operation. Unless otherwise noted, collective risk is expressed as the Expectation of Casualty (E_c**)** or the mean number of casualties predicted to result from all hazards associated with an operation. Note that the expectation of casualties is the mean number of casualties predicted to occur as a result of an operation if the operation were to be repeated many times. Collective risk is specified as either for a mission or per year. The collective risk should include the aggregate and accumulated risk.

$$E_C = P_C \times Population$$

A.4.16.8.3 Population Center Categories

To fully quantify the individual and collective risks, the susceptibility of the public to the hazard is assessed based upon time of day, whether the population will be inside or out, the types of structures they will occupy, the general physical health of the population, and an analysis of the launch vehicle. All of these factors affect how an individual could be affected by hazards from a launch. In addition, personnel are categorized into types of population centers based on the level of acceptable risk for that population. There are three categories of population centers utilized on the ER: General Public, Launch Essential Personnel (LEP), and Neighboring Operations Personnel (NOP).

A.4.16.8.4 General Public

The general public includes all persons who are not in the launch-essential or neighboring operations personnel categories; for a specific launch, the general public includes visitors, media, and other non-operations personnel at the launch site as well as persons located outside the boundaries of the launch site who are not associated with the specified launch.

A.4.16.8.5 Launch Essential Personnel (LEP)

Launch Essential Personnel or LEP are the minimum number of persons necessary to successfully and safely complete a launch operation and whose absence would jeopardize the completion of the operation. This includes persons required to perform emergency actions according to authorized directives, persons specifically authorized by the SW/CC to perform scheduled activities, and persons in training. The number of LEP allowed within Safety Clearance Zones or Hazardous Launch Areas is determined by the SW/CC and the Range User with 45 SW/SE concurrence.

A.4.16.8.6 Neighboring Operations Personnel (NOP)

Neighboring Operations Personnel or NOP (also referred to as Critical Operations Personnel or COP) are individuals who are required to perform safety, security, or operationally critical tasks but are not associated with the specific/current operation or launch under consideration. The critical operations Range User (or manager) provides the number and justification of personnel required to conduct the critical operations. 45 SW/SE will approve or determine the number and location of NOP individuals with the concurrence of the SW/CC. The NOP individuals are included in the same risk category as LEP. These individuals are aware of the launch mission risks and trained in mitigation tasks or accompanied by properly trained escorts.

A.4.16.9 Risk Calculations

There are two types of risk calculations which are used to determine the individual and collective risks: Accumulated Risk and Aggregate Risk.

A.4.16.9.1 Accumulated Risk

Accumulated risk is the combined collective risk to all individuals exposed to a particular hazard (such as debris, toxics, *or* distant focusing overpressure) through all phases of an operation. RCC 321-07 guidance information is as follows: for the flight of an expendable orbital launch vehicle, risk should be accumulated from liftoff through orbital insertion. For the flight of a suborbital launch vehicle, risk should be accumulated from liftoff through the impact of all pieces of the launch vehicle, including the payload.

A.4.16.9.2 Aggregate Risk

Aggregate risk is the accumulated risk due to all hazards (such as debris, toxics, *and* distant focusing overpressure) associated with a flight. Guidance information is as follows: for a specified launch, aggregate risk includes, but is not limited to, the risk due to debris impact, toxic release, and distant focusing of blast overpressure.

A.4.16.9.3 Risk Criteria

AFSPCI 91-701 and EWR 127-1 require all range operations shall be accomplished in such a manner as to ensure that the aggregate risk to the public, range/third party launch area and launch complex personnel, and range/third party owned resources are provided an acceptable level of safety consistent with mission needs and national priorities. Aggregate risk criteria, as developed in RCC 321-10, and adopted by AFI 91-217 Chapter 4, has been established to increase launch availability while maintaining an equivalent level of safety. The AFSPC 91-700 series of documents are currently being revised to incorporate AFI 91-217 aggregate risk criteria. Commercial launches are licensed by the FAA, therefore risk to the general public for these missions shall be assessed against FAA risk criteria as established per 14 CFR 417. Table 14-16-2 captures current aggregate risk criteria for DoD/civil launches, and risk criteria for FAA-licensed launches.

Population Center	**Launch Type**	**Normal Limit (no waiver required)**		**LDA Waiver Authority w/o 14 AF Notification**	
		Individual	**Collective**	**Individual**	**Collective**
Public	DoD/Civil	1x10^{-6}	100x10^{-6} *	< 10x10^{-6}	< 1000x10^{-6}
	FAA-Licensed	1x10^{-6} **	30x10^{-6} **	N/A	N/A
Launch Essential		10x10^{-6}	300x10^{-6}	< 100x10^{-6}	< 3000x10^{-6}

Table A-4-16-1: *Aggregate Risk Criteria*

* 30x10^{-6} limit for toxic dispersion exposure
** For each hazard (debris/toxic dispersion/blast overpressure)

For non-FAA-licensed launches the general public will not be exposed to an aggregate collective Expectation of Casualty (E_c) greater than 100 x 10^{-6} (one-hundred in one million) for all hazards associated with a mission or an individual P_c greater than 1 x 10^{-6} for the mission. Launch essential personnel will not be exposed to an aggregate collective E_c greater than 300 x 10^{-6} (three-hundred in one million) for all hazards associated with a mission or an individual P_c greater than 10 x 10^{-6} for the mission. Note that the Range is required to separately ensure the allowable level of risk from toxics does not exceed other range safety standards for toxic exposure limits for the general public or launch personnel, when appropriate mitigations are in place.

If the risk is too high, actions must be taken to lower the risk or the SW/CC can waive the risk criteria.

For many years on the ER, a containment approach was used to define Range Safety Responsibility, which extended from liftoff through orbital insertion or until final impact of suborbital vehicles or jettisoned components. In 2008, AFSPC embarked on an initiative known as Launch Enterprise Transformation (LET). One of the three major objectives of this initiative was to significantly reduce Test Range Operations and Maintenance (O&M) costs by transforming the ER and WR into an architecture which utilizes telemetry and GPS as the primary sources of metric tracking and Automated Flight Termination Systems (AFTS) for command destruct capability. The goal was to allow the ranges to reduce costs through the divestiture of redundant instrumentation and the decommissioning of ground assets and facilities. To support this effort, AFSPC transitioned to a risk management approach to define Range Safety Responsibility. As a result, a 3 Jun 2009 AFSPC/CC memorandum titled "Guidance Clarification - Duration of Command and Tracking Capability for Purposes of Public Safety" stated that "Fully Redundant command and tracking capability is necessary only from liftoff to over-the-horizon loss of signal, as viewed from the launch head, provided public risk criteria is not exceeded."

A-6-3 BEACON CHECKS

A.6.3.1 MEASUREMENTS AND DEFINITIONS

A.6.3.1.1 Beacon Responsibility

Definition - Beacon sensitivity is the power in dBm at the beacon receiver antenna connector which will produce three percent countdown.

Measurement - Increase the transmitter attenuation until countdown is noticed, then adjust the transmitter frequency for minimum countdown. Repeat until three percent countdown is reached and any change in frequency will increase the countdown. Read the beacon sensitivity from the visual display.

A.6.3.1.2 Beacon Interrogate Frequency

Definition - The beacon interrogate frequency is the frequency of the van transmitter when adjusted to the frequency to which the beacon receiver is tuned.

Measurement - After the interrogate frequency has been adjusted, measure the frequency using transfer oscillator and counter to the nearest tenth of a MHz.

A.6.3.1.3 Beacon Power

Definition - The beacon power is the peak power of the beacon reply at the beacon output antenna connector measured in dBm.

Measurement - Adjust the van receiver frequency for maximum beacon received power of two volts as indicated on the oscilloscope. The receiver attenuator is servo-driven to maintain the receiver input at a constant -60 dBm level. Transfer the attenuator indication on the receiver input to the computer and read the beacon power from the visual display and the print out.

A.6.3.1.4 Beacon Reply Frequency

Definition - The beacon reply frequency is the frequency of the center of the main lobe of the beacon transmitter frequency spectrum.

Measurement - The reply frequency is measured by using the spectrum analyzer and computer readout.

A.6.3.1.5 Countdown

Definition - Countdown is the ratio, expressed as a percentage, of the number of times the beacon fails to reply to an interrogating pulse to the number of interrogating pulses over an interval of time.

Measurement - Set the interrogate PRF to 1000 and the transmitter on-time for 10,000 pulses. Add attenuation to transmitter until countdown occurs, then remove 10 dB of attenuation and make readout.

A.6.3.1.6 Pulse Width

Definition - The beacon reply pulsewidth is the time in microseconds between half-power points of the leading edge to the trailing edge of the beacon reply pulse.

Measurement - The pulsewidth is read directly from the counter.

A.6.3.1.7 Beacon Delay
Definition - The beacon delay is the time in microseconds between the center of a one microsecond interrogate pulse and the center of the reply pulse measured at the beacon terminals. In the case of a coded beacon, the interrogate pulse is considered the last pulse in the group.

Measurement - The interrogate PRF is set for 1000 and the delay is read directly from the counter.

A.6.3.1.8 Recovery Time
Definition - The recovery time is the minimum time in microseconds between the center of the interrogating pulse and the center of the next interrogating pulse to which the beacon can reply.

Measurement - Adjust the time base on the scope so that reply of the second interrogate pulse can be viewed. Reduce the time of the second interrogate pulse until the second beacon reply starts to count down and read the recovery time from the counter.

A.6.3.1.9 Jitter
Definition - Jitter is the maximum difference in microseconds between an early reply and a late reply with reference to the interrogating pulse.

Measurement - Manually subtract the indications in microseconds between the maximum delay counter and the minimum delay counter. This gives the jitter in microseconds. Computer output is also available.

A.6.3.1.10 PRF Compatibility
Definition - The ability of a beacon to reply to multiple radar interrogations, correctly phased, without any changes in the reply pulse characteristics.

Measurement - Increase the PRF to 2000 and check the beacon replies for any change in countdown, delay, power, and sensitivity. For measuring countdown, use a sample interval of 10 seconds (20,000 pulses).

A.6.3.1.11 Code Spacing
Definition - The code spacing is the assigned beacon code plus or minus any deviation (in microseconds) as determined from the measurements.

Measurement - While interrogating the beacon, reduce the code spacing until countdown just starts and log this minimum spacing from the dial readings. Increase the code spacing until countdown just starts and log the maximum code spacing from the dial readings. Average the minimum and maximum code spacing and compare it with the beacon assigned code spacing. Computer printout is also available.

RGNext
Range Generation Next

C-BAND BEACON READOUT LOG

Pad Number							
OPNR							
Date							
Van/Radar Used							
Van Location							
Power Output (+) XX.X							
Sensitivity (-) XX.X							
Ant. Pol.							
Pulse Upper X.XXX							
Pulse Lower X.XXX							
Pulse Code ± .15 usec of latest van reading							
Delay – 2.5 – 4.3 usec; 2.8 ± .2 usec is preferred							
Jitter (.05 or more) -- .1 usec Max							
Countdown (Actual) –PRF>160=10% Max; PRF = 160 = 5% Max							
Recovery Time – 200 usec; No More Than 244 usec							
Pulse Width -- .25 – 1.0 usec; .5 – 1.0 usec is preferred							
High 1000 PRF	Interr. Freq 5,690 ± 25 MHz						
	Reply Freq 5,765 ± 7.5 MHz						
	Drift (±) X.X (VAN)						
Low 160 PRF	Interr. Freq 5,690 ± 25 MHz						
	Reply Freq 5,765 ± 7.5 MHz						
	Drift (±) X.X (VAN)						
Time							
Gantry Retired							
Compatibility							
Passed To	ISRO						
	RSC						
Initial							

XX. -Nearest whole number .X-One decimal place .XX-Two decimal places .XXX-Three decimal places

Figure A-6-3-1: *C-Band Beacon Readout Log*

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A-6-5 TELEMETRY CHECKS

A.6.5.1 Definitions

A.6.5.1.1 Telemetry

Telemetry is the process of taking measurements from a distance. Webster's dictionary defines telemetry as: "The science and technology of automatic data measurement and transmission, as by wire or radio, from remote sources, such as space vehicles, to a receiving station for recording and analysis." In spacelift, telemetry is the process of measuring events and values of launch vehicle on-board flight hardware, and transmitting that information to ground stations for integration, display, and analysis. See section 2.10 for more detailed Telemetry information.

A.6.5.1.2 Telemetry Checks

Telemetry Checks are the process of measuring the RF characteristics of a launch vehicle's telemetry transmitter to verify established criteria IAW the Operations Directive (OD) and/or user requirements.

A.6.5.1.3 TEL-4

TEL-4, the Eastern Range's central telemetry ground station, has telemetry antennas to capture open-loop telemetry transmissions during ground tests and during powered flight while the vehicle is in view. TEL-4 records and decommutates telemetry using data from other antennas and stations, Tracking and Data Relay Satellite System (TDRSS), and the Air Force Satellite Control Network (AFSCN).

A.6.5.1.4 Center Frequency

The center frequency is the frequency of the carrier wave actually received at Tel-4.

A.6.5.1.5 Deviation

The peak difference between the frequency of the modulated wave at any given instant and the carrier center frequency. The amount of deviation is proportional to the amplitude of the modulating signal; the rate of deviation is proportional to the frequency of the modulating signal.

A.6.5.1.6 Signal Strength

The signal strength's received signal power, measured in decibels (dB) with respect to milliwatts (dBm).

A-6-6 RANGE COUNTDOWN INSTRUMENTATION CHECKS

A.6.6.1 TRSB Pattern Checks

Verification of connectivity of TRSB lines from Centralized Telemetry Processing System (CTPS) to the Range Safety Display systems. Verification that data is not static and updates with changes to the input.

Range Safety: Configure the Range Safety Display systems to monitor each of the four incoming TRSB lines from CTPS. Direct CTPS to output the predetermined bit pattern on the TRSB lines. Direct CTPS to select the second pattern in which the bits are reversed.

Telemetry: CTPS output pattern data on prime and back-up lines from both CTPS-A and CTPS-B. Select the alternate pattern when directed by the Computer Controller.

A.6.6.2 Initial Ground Command Open Loop Checks

These checks are accomplished by the utilization of maintenance codes at CCRS to request that each required function be radiated by the selected combination of equipment. As the requested functions are transmitted through each combination of equipment, proper operation is verified by receipt of a confirm message for each function, and the ACME system is used to verify that the transmitted Command message is in compliance with the performance requirements of EWR 127-1 and 91-7XX series regulations. The initial check is done early in the countdown to allow time for troubleshooting and correction of any identified deficiencies.

A.6.6.3 Initial NRT QBF Checks

Verify the interface between the Flight Operations Version 1 (FOV1) VAX/Trajectory Estimation and Acquisition Messages (TEAM)-based Acquisition Message (FVTAM) system and the Digital Message Network Element (DMNE) subsystem (part of the Cape Data Transmission system) for the routing and distribution of message traffic meets NRT operational requirements. The initial check is done early in the countdown to allow time for troubleshooting and correction of any deficiencies identified.

Data Handling: The FVTAM operator selects the standard QBF test message, which includes all 36 alphanumeric characters, addressed to the systems and organizations supporting the operation. The test message is then transmitted via the DMNE to the addressees.

Telemetry: Confirm that supporting telemetry sites have opened their circuits for traffic from DMNE prior to the transmission of the test message.

Radar: Confirm that supporting radar sites have opened their circuits for traffic from DMNE prior to the transmission of the test message.

A.6.6.4 Final NRT QBF Checks

Verify the interface between the FOV1 VAX/TEAM FVTAM system and the DMNE sub-system (part of the Cape Data Transmission system) for the routing and distribution of message traffic meets NRT operational requirements. The final check is done late in the countdown to confirm that nothing has failed since the initial check and minimize the time between the final check and operational use.

Data Handling: The FVTAM operator selects the standard QBF test message, which includes all 36 alphanumeric characters, addressed to the systems and organizations supporting the operation. The test message is then transmitted via the DMNE to the addressees.

Telemetry: Confirm that supporting telemetry sites have opened their circuits for traffic from DMNE prior to the transmission of the test message.

Radar**:** Confirm that supporting radar sites have opened their circuits for traffic from DMNE prior to the transmission of the test message.

A.6.6.5 Pad/Skin/Beacon/On-Track BIT Checks

Verify that data from each tracker matches a known fixed location. Verify radar status bits properly indicate the radar operating mode and status.

Range Safety: Using a table such as the one below tailored to the specific mission requirements, monitor the incoming data from the launch area trackers and compare with the known location of the launch pad. Coordinate with each tracker and monitor the incoming data as they manually change modes and track status.

Optical: Direct Optical trackers to acquire the launch vehicle sitting on the pad. With the vehicle in sight, set each site’s on-track bit to on.

Radar: In coordination with the Computer Controller, each radar in the launch area will output a location corresponding to the launch pad. While outputting the pad location the radar will set the site’s on-track bit to on and switch between beacon and skin tracking modes. On missions requiring use of the “Designate Angles/Auto Range” (DAAR), those radars which will use DAAR will also check the Optical bit.

A-7-3 SURVEILLANCE CONTROL OPERATIONS

A.7.3.1 Flight Rules

There are two basic categories of Flight Rules under which pilots operate: Visual Flight Rules and Instrument Flight Rules.

A.7.3.2 Radio-Navigation

The primary means of navigation under IFR are via ground-based radio beacons or GPS signals. Ground-based radio beacons transmit signals which allow the pilot of a properly equipped aircraft to determine bearing and/or range from a particular station. There several different types of ground-based radio navigation systems. but the Tthree systems that provide the basic guidance for en route air and terminal navigation along withand non-precision approach in the United States are the Very High Frequency (VHF) Omni-directional Range (VOR), Distance Measuring Equipment (DME), and Tactical Air Navigation (TACAN) systems.

Radio-Navigation: Very High Frequency (VHF) Omni-directional Range (VOR)

The VOR system is a civilian radio navigation system that transmits a signal which allows the airborne receiving equipment to determine a magnetic bearing from the station to the aircraft. A VOR ground station broadcasts a VHF radio composite signal including the station's identifier, a voice signal (if equipped), and a navigation signal. The identifier is Morse code. The voice signal is usually station name, in-flight recorded advisories, or live flight service broadcasts. The navigation signal consists of two signals, a constant omni-directional signal called the reference phase and a directional signal which rotates through 360° and consistently varies in phase through each rotation. The VOR receiver onboard the aircraft senses the phase difference between the two frequencies and the difference identifies 360 different directions or "radials" from the VOR.

Figure A-7-3-1: *VOR/DME System*

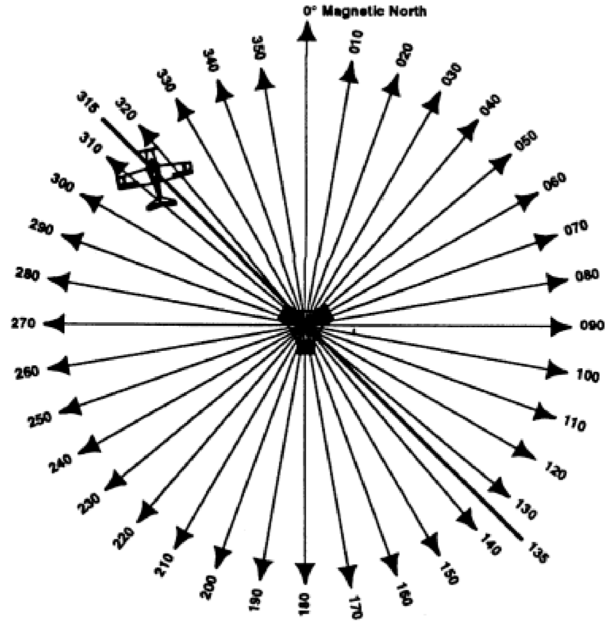

Figure A-7-3-2: *Magnetic Bearing from VOR Beacon*

Imagine a wheel with 360 spokes at one degree azimuth spacing with the VOR beacon being the hub. The spokes are numbered clockwise from one to 360 and each spoke or radial represents a magnetic bearing from the VOR beacon, which is just the reciprocal of the bearing to the station from the aircraft. When the appropriate VOR frequency for a station is entered into a navigation radio, the airborne navigation circuitry measures the phase angle difference between the directional signal phase received and the reference signal phase and the VOR indicator connected to that radio indicates the radial on which the aircraft lies from that station. The radials are identified by magnetic bearing. On this slide, the aircraft is positioned directly on the 315° radial from the VOR. Note: We do not know on what course the aircraft is flying, although its heading appears to be about 350°. A VOR does not provide distance information, however, the accuracy of course alignment of the VOR is excellent, being generally plus or minus 1 degree.

Radio-Navigation: Distance Measuring Equipment (DME)

The Distance Measuring Equipment (DME) is a civilian radio navigation system that measures distance by timing the propagation delay of VHF or UHF radio signals. The DME measures "slant range" from the DME station. Slant range is a measure of an aircraft's position relative to the DME station that incorporates the height of the aircraft, its angle from the ground station and its unknown ground range based upon a 90° angle. The farther the aircraft is from the station and the lower the aircraft's altitude, the more accurate the distance reading. An aircraft could be directly over the DME station at an altitude of 10,500 feet above ground level (AGL) and the DME would correctly indicate the aircraft is two miles from the station. In most cases, a DME system is collocated with a VOR, referred to as a VOR/DME facility, to provide both range and bearing. Melbourne International Airport has a VOR/DME.

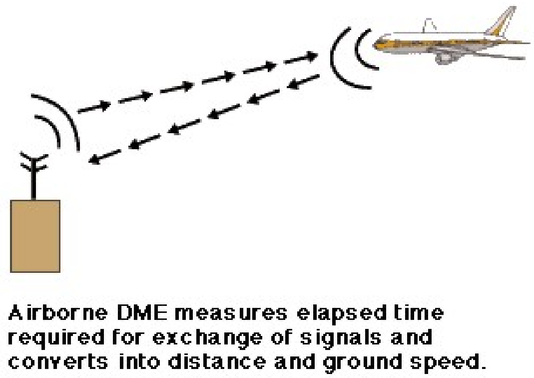

Figure A-7-3-3: *Distance Measuring Equipment*

Figure A-7-3-4: *DME System*

Radio-Navigation: Tactical Air Navigation (TACAN)

The Tactical Air Navigation (TACAN) system is a military radio navigation system. It provides the user with bearing and distance (slant-range) to a ground or ship-borne station. TACAN in general can be described as a more accurate military version of the VOR/DME system. There is a TACAN at Patrick AFB. The DME and the distance measuring function of TACAN are functionally the same. As a result, TACAN stations are frequently co-located with VOR facilities and referred to as VORTACs. This is a station composed of a VOR for civil bearing information and a TACAN for military bearing information and military/civil distance measuring information.

Figure A-7-3-5: *TACAN System*

Figure A-7-3-6: *VORTAC System*

A.7.3.2.1. Navigation Waypoints

Navigation waypoints are predetermined geographical positions that are defined in terms of latitude/longitude coordinates and are used to help define invisible routing paths or airways for air navigation. These airways are designed to facilitate air traffic control and routing of traffic between heavily traveled locations. Area navigation, a method of navigation that permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of these, relies heavily upon waypoints. Waypoints may be a simple named point in space or may be associated with existing navigational aids, intersections, or fixes. Waypoints are given five-letter names so that they may easily be conveyed by voice and are annotated on aeronautical charts and are also available for display on the SCDS. On the ER, waypoints are sometimes used to define Mission Support Positions (MSPs) for aircraft.

A.7.3.2.2 Aircraft Transponders

In aviation, aircraft have transponders to assist in identifying them on radar and on other aircraft's collision avoidance systems. When the transponder receives a radar signal it sends back a transponder's squawk code, referred to as “Squawk” code or Mode 3/A code, which is displayed on the radar display.

Figure A-7-3-7: *Aircraft Transponder*

Mode 3/A codes are four digit numbers. The dials on a transponder read from zero to seven inclusive. Thus the lowest possible squawk is 0000 and the highest is 7777. There are 4096 permutations of these four digit codes. Mode 3/A codes can be assigned to an aircraft by ground controllers to uniquely identify the aircraft on radar. Mode 3/A codes 5030 through 5057 are utilized by the ER to identify mission support aircraft. Mode 3/A code 1200 is used when an aircraft is operating under VFR and no other Mode 3/A code has been assigned. Mode 3/A codes can also be used to indicate an emergency situation. The emergency mode codes include:

- 7500: Unlawful Interference (i.e. Aircraft hijacking)
- 7600: Lost Communications
- 7700: General Emergency

All mode A, C, and S transponders include an "ident" button, which activates a special "thirteenth" bit on the Mode 3/A reply known as Ident, short for Identify. When radar equipment receives the Ident bit, it results in the aircraft's blip "blossoming" on the radar scope. This is often used by the controller to locate the aircraft amongst others by requesting the ident function from the pilot (e.g., "Cessna 123AB, squawk 0363 and ident"). Ident can also be used in case of a reported or suspected radio failure to determine if the failure is only one way and whether the pilot can still transmit or receive but not both (e.g., "Cessna 123AB, if you read, squawk ident").

A.7.3.2.3 Automatic Identification System (AIS) Transponders

The International Maritime Organization's (IMO) International Convention for the Safety of Life at Sea (SOLAS) requires AIS to be fitted aboard all ships of 300 gross tonnages and upwards engaged on international voyages, cargo ships of 500 gross tonnages and upwards not engaged on international voyages and all passenger ships irrespective of size. In addition, Title 33 of the Code of Federal Regulations (CFR) requires AIS on self-propelled vessels of 65 feet or more in length, other than passenger and fishing vessels, in commercial service and on an international voyage.

Shipboard AIS transponders autonomously broadcast two different AIS messages: a “Position Report” which includes the vessels dynamic data (e.g. latitude, longitude, position accuracy, time, course, speed, navigation status) and a “Static and Voyage Related Report” which includes data particular to the vessel (e.g. name, dimensions, type) and regarding its voyage (e.g. static draft, destination, and ETA). Position reports are broadcasted very frequently (between 2-10 seconds-depending on the vessels speed-or every 3 minutes if at anchor), while static and voyage related reports are sent every six minutes.

Specifically, the Position Report includes:

- The vessel's Maritime Mobile Service Identity (MMSI) – a unique nine digit identification number.
- Navigation status – "at anchor", "under way using engine(s)", "not under command", etc.
- Rate of turn – right or left, from 0 to 720 degrees per minute
- Speed over ground – 0.1-knot (0.19 km/h) resolution from 0 to 102 knots (189 km/h)
- Positional accuracy:
- Longitude – to 0.0001 minutes
- Latitude – to 0.0001 minutes
- Course over ground – relative to true north to 0.1°
- True heading – 0 to 359 degrees (for example from a gyro compass)
- Time stamp – UTC time accurate to the nearest second when these data were generated

Specifically, the Static and Voyage Related Report includes:

- IMO ship identification number – a seven digit number that remains unchanged upon transfer of the ship's registration to another country
- Radio call sign – international radio call sign, up to seven characters, assigned to the vessel by its country of registry
- Vessel Name – 20 characters to represent the name of the vessel
- Type of ship/cargo
- Dimensions of ship – to nearest meter
- Location of positioning system's (e.g., GPS) antenna onboard the vessel - in meters aft of bow and meters port of starboard
- Type of positioning system – such as GPS, DGPS or LORAN-C.
- Draught of ship – 0.1 meter to 25.5 meters
- Destination – max. 20 characters

- ETA (estimated time of arrival) at destination – UTC month/date hour: minute

There are two types of AIS Transponders. Class A Transponders are designed for vessels meeting the requirements of the IMO AIS SOLAS requirements. These transponders transmit the signals at a power level of 12 W, providing a nominal range at sea of approximately 20 nm. Class B Transponders are cheaper, less capable units for vessels that are not required to carry AIS by the IMO or the CFR. These transponders transmit the signals at a power level of 2 W, providing a nominal range at sea of approximately 5-10 nm. Class B transponders are nearly identical to Class A transponders, except that they have a reporting rate less than a Class A (e.g. every 30 sec. when under 14 knots, as opposed to every 10 sec. for Class A) and they do not transmit:

- Vessel IMO number
- ETA or Destination
- Navigational status
- Rate of turn information
- Draught of Ship

A.7.3.2.4 International Civil Aviation Organization (ICAO)/FAA Identifiers

The International Civil Aviation Organization (ICAO) assigns a four-letter or four-letter alphanumeric location code to airports, navigation aids, and weather stations. These location codes are used as symbolic representations of these locations in various documentation and computer systems to include aeronautical charts and the SCDS. US locations are assigned a “K” prefix. Within the CONUS the FAA identifiers uses as a symbolic representation for the name and the location of an airport, navigation aid, or weather station in various documentation and computer systems to include aeronautical charts and the SCDS. Within the CONUS, the FAA often uses the last three letters of the ICAO code as FAA identifiers for airports and airfields.

The FAA identifiers for the airports in the local area include:

CCAFS Skid Strip: XMR
KSC SLF: TTS
Patrick AFB: COF
Space Coast Regional: TIX
Merritt Island: COI
Daytona Beach International: DAB
Ormond Beach: OMN
New Smyrna Beach: EVB
Spruce Creek: 7FL6
Kissimmee Gateway: ISM

Orlando International: MCO
Orlando Sanford International: SFB
Orlando Executive: ORL
Melbourne International: MLB
Arthur Dunn: X21
Massey Ranch: X50
Valkaria: X59
Sebastian: X26
Vero Beach: VRB

These FAA identifiers are available for display on the SCDS.

A.7.3.2.5 Support Airfields

Although there are many airfields located near the ER, there are three key airfields which support ER surveillance ops: Patrick AFB (COF), the CCAFS Skid Strip (XMR), and the KSC Shuttle Landing Facility (SLF) (TTS). We will discuss each of these airfields in detail.

Note that runways are named by a number between 01 and 36, which is generally one tenth of the magnetic azimuth of the runway's heading: a runway numbered 09 points east (90°), runway 18 is south (180°), runway 27 points west (270°) and runway 36 points to the north (360° rather than 0°). A runway can normally be used in both directions, and is named for each direction separately: e.g., “Runway 33" in one direction is “Runway 15" when used in the other. The two numbers always differ by 18 (180°).

Patrick AFB (COF)

Patrick AFB (COF) provides support to 920 Rescue Wing (RW) aircraft operations and the National Airborne Operations Center (NAOC) aircraft as well as services for transient aircraft. It has two runways: Runway 2/20 and Runway 11/29. Runway 2/20 is 9,023 x 200 ft and Runway 11/29 is 4,000 x 200 ft.

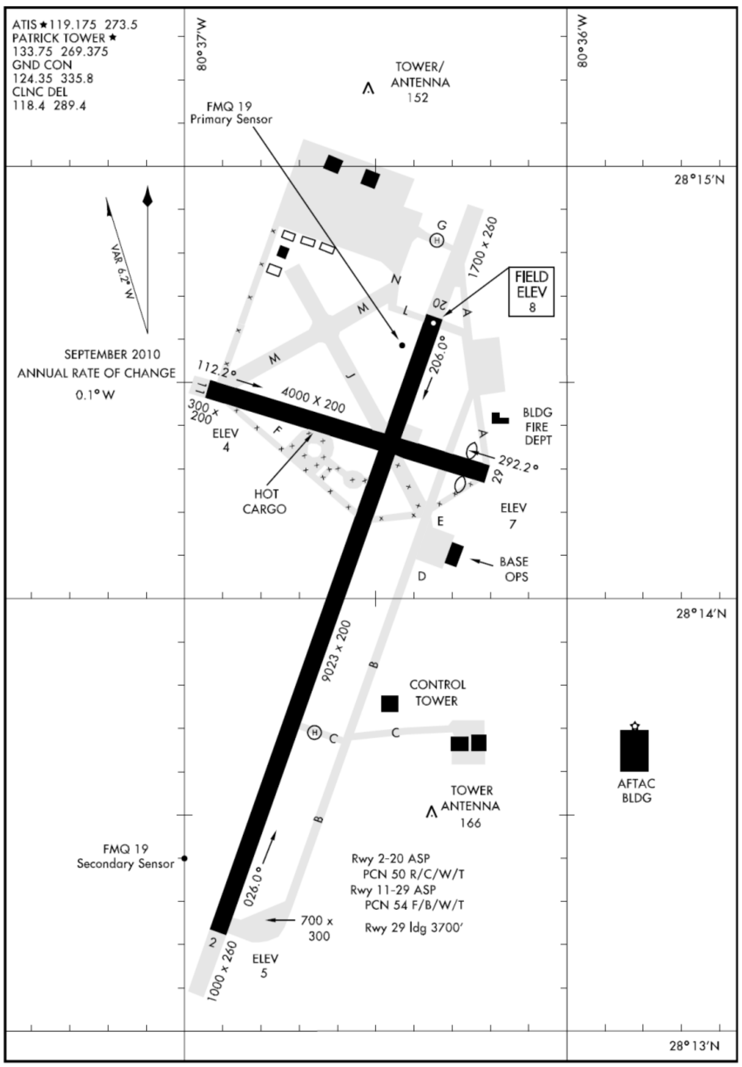

Figure A-7-3-8: *Patrick AFB (COF) Layout*

The radio frequencies for Patrick Tower are 133.75 VHF and 269.375 UHF. There is a TACAN located at Patrick AFB, referred to as the Patrick TACAN. Patrick Tower’s typical hours of operation are 0800L – 0000L, 7 days a week, however, the tower will be manned as required to support ops.

Aircraft operating in the eastern half of Patrick AFB airspace have the potential to interfere with tracking operations during flight. Due to their proximity to the airfield, aircraft operating in this airspace may block the line of sight between Radar 0.134 and/or the Patrick DOAMS optics site and a vehicle in flight. As a result, Patrick Tower restricts aircraft operations to the western half of the Patrick AFB airspace from T-2 minutes to T+10 minutes. The ACO notifies Patrick Tower of the impending launch at T-5 minutes and that the launch is complete at T+10 minutes. The ACO notifies Patrick Tower if the launch is delayed or scrubbed, as required.

CCAFS Skid Strip (XMR)

The CCAFS Skid Strip (XMR) is used by U.S. Customs and Border Protection (CBP) Unmanned Aerial Vehicle (UAV) ops, aircraft delivering flight hardware and mission support aircraft. It has one runway, Runway 13/31, which is 10,000 x 200 ft. The primary radio frequencies for Cape Tower are 118.625 VHF and 239.5 UHF with back-up frequencies of 143.15 VHF and 270.0 UHF. There are no navigational aids located at the Skid Strip. Cape Tower's typical hours of operation are 0800L – 1700L, Monday through Friday, however, the tower may be scheduled up after hours to support launches if support aircraft need to operate from the Skid Strip.

Figure A-7-3-9*: CCAFS Skid Strip (XMR)*

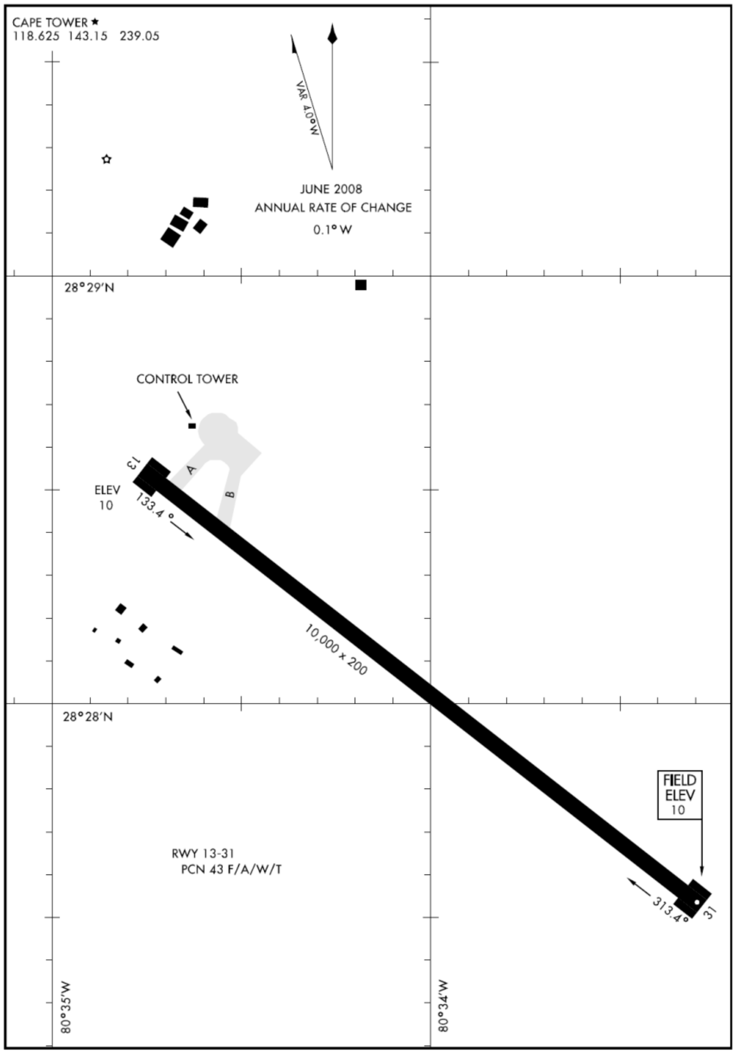

Figure A-7-3-10: *CCAFS Skid Strip (XMR) Layout*

There are times when aircraft may be scheduled to land at the Skid Strip during launch operations, such as when VIPs are flying in to observe the launch. If not properly scheduled and de-conflicted, these arriving aircraft could interfere with support aircraft operations during critical times of the countdown. As a result, procedures have been developed to mitigate the disruption of ER surveillance ops with the demarcation line being 60 minutes prior to the planned T-0.

1 ROPS/DOUS will advise aircraft operators and scheduling agencies that aircraft can land no later than 1 hour prior to the launch operation's planned T-0. If a pre-approved inbound aircraft is delayed, the Cape Tower may authorize the aircraft to land after L-1 hour, but no later than L-40 minutes if approved by the SCO. Aircraft experiencing emergency conditions may land after L-1 hour if they cannot be safely diverted to an alternate airport based on the Pilot-in-Command's assessment of the situation. Cape Tower will notify the SCO of any emergency inbounds as soon as possible. Mission support aircraft operating in conjunction with launch operations may land or depart as required. The CCAFS Airfield Manager will direct arriving aircraft crews to call the Risk Assessment Center (RAC) to ensure all aircrew and passengers remain clear of hazard areas. The aircrew and passengers are required to follow the instructions provided by the RAC.

KSC Shuttle Landing Facility (SLF) (TTS)

The SLF (TTS) supports NASA aircraft operations. It has one runway, Runway 15/33, which is 15,000 x 300 ft. The radio frequencies for NASA Tower are 128.55 VHF and 284.0 UHF. NASA Tower's typical hours of operation are 0700L – 2200L, 7 days a week. The tower may be scheduled up after hours to support launches. In addition, the MRU operates from 0600 – 2200L, 7 days a week, from the SLF when the MRUs are not working in the MOC in support of launch operations.

Figure A-7-3-11: *SLF (TTS)*

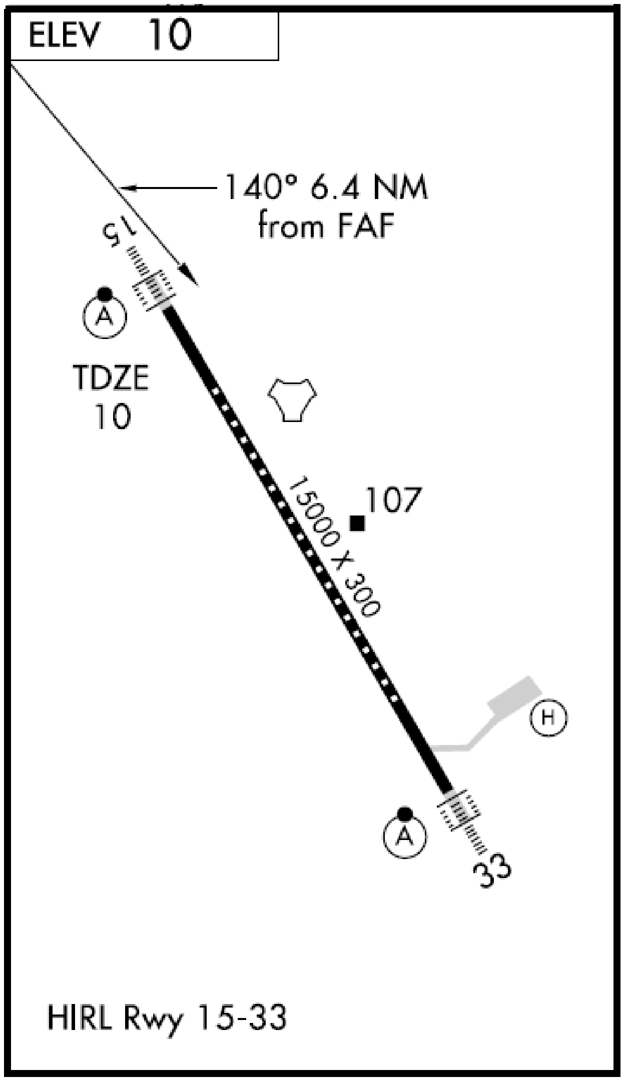

Figure A-7-3-12: *KSC Shuttle Landing Facility (SLF) (TTS) Layout*

A-7-4 FLIGHT CONTROL OPERATIONS

7.4.5.3 Nominal Vehicle Flight Narration

Atlas V Nominal Flight Example:

- **T-0s:** FOG - “Ignition.”
  TSO - “Ignition.”
  MFCO - “Copy Wire....Copy TM.”
- **T+3s** FOG - “Liftoff”
  MFCO - “Copy Wire. I have VP track.”
  SMFCO – “I have IP track.”
- **T+5s MFCO - “I have two sources in agreement, climbing the VP on the nominal, in the box.”**

  SMFCO - “Senior concurs. IP over the pad.”
- **T+15s** FOG - “Programming Downrange!”
  MFCO - “Copy Wire.”
  SMFCO – “You have an IP moving out.”
  MFCO – “Copy, switching to IP.”
  SMFCO – “Switching to VP.”
  MFCO - “Senior, I have two sources in agreement, on the nominal, in the box, moving downrange green.”
  SMFCO – “Senior concurs. VP looks good. VT looks good. DRSD agrees. MCD agrees.”
  TSO - “TM is green.”
  MFCO - “Copy Wire.

A.7.4.5.4 Non-Nominal Vehicle Flight Narration

"I have two sources in agreement, on the nominal, *slightly behind the box*"
"I have two sources in agreement, on the nominal, *ahead of the box*"
"I have two sources in agreement, deviating to the right (or left) of the nominal, *right (or left) of the box*"
"I have two sources in agreement, on the ADDJUST, *slightly to the right (or left) of the box*"
"I have two sources in agreement, *converging on the nominal, converging on the box*"
"I have two sources in agreement, *diverging from the nominal, outside of three sigma, green numbers no longer apply.*
"I have one source, on the nominal, in the box"
"I have two sources in agreement climbing the VP, slightly depressed"
"I have a straight up missile, my intentions are to send functions upon violation of critical angles or when the IP crosses the destruct line"
"The IP is moving up range, my intentions are to send functions upon violation of critical angles or when the IP crosses the destruct line"
"I have ALL SOURCES OFF TRACK, nominal flight up until this point, my intentions are to send functions upon expiration of green numbers"
"I have two sources in agreement, diverging from the nominal, outside of three sigma, I have ALL SOURCES OFF TRACK, sending functions now"
"I have two sources in agreement climbing the VP, severely depressed, my intentions are to send functions when the vehicle pitches downward"
"I have a stopped IP, Command give me angle updates every degree, my intentions are to send functions at 3 - 5 degrees of command coverage"
"Copy SECO prior to Min SECO, my intention is to send functions prior to the Gate"
"I have two sources in agreement outside of three sigma converging towards the nominal, my intentions are to allow the vehicle to pass through the gate"
"I have two sources in agreement, ALL SOURCES OFF TRACK, nominal flight up to this point, my intentions are to allow the vehicle to fly based on the extended flight rule"
"I have two sources in agreement, taking a sharp right hand turn, the IP is now moving uprange, I have obviously erratic flight, I am sending functions at this time"
"I have two sources in agreement deviating from nominal heading towards the destruct line. I'll let it fly for data collection purposes and intend to send functions at the destruct line"

A.7.4.6.9 Stopped IP

For example, the MFCO may request that the CSO begin countdown in half-degree increments starting at 5 degrees. The MFCO may request status updates from the TSO for indications of a re-start or for angular rates to determine if the vehicle is tumbling.

A7.4.6.14 Gate Engine Cutoff Rule

For example, the MFCO may request that the CSO begin countdown in half-degree increments starting at 5 degrees. The MFCO will also request AGC status updates from the TSO.