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Performance Specification for the Forward Looking Infrared



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PATUXENT RIVER, MD 20670-1161

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# Scope

This performance specification documents the performance, design, test, quality for the CH-53K Forward Looking Infrared (FLIR) to be installed on the CH-53K. The capabilities provide imagery, command and control data, and awareness data. The FLIR system will provide sensing to aid in completing mission conducted in low and high dust environments.

# Applicable Documents

## Government Documents

The documents listed in Section 2, below, are a part of this specification. If a document is referenced without indicating any specific paragraphs a being applicable, the specification is applicable in its entirety. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification is the superseding capability.

### Government Standards, Specifications and Handbooks

|  |  |  |
| --- | --- | --- |
| Document Number | Date | Document Title |
| MIL-L-85762A | 28 JUN 2019 | Lighting, Aircraft, Interior, Night Vision Imaging System (NVIS) Compatible |
| MIL-N-18307G Amendment 2 | 15 SEP 1986 | Nomenclature and Identification for Aeronautical Electronic Equipment |
| MIL-STD-130N | 26 AUG 2019 | Identification Marking of U.S. Military Property |
| MIL-STD-461G | 11 DEC 2015 | Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment |
| MIL-STD-464D | 20 DEC 2020 | Department Of Defense Interface Standard: Electromagnetic Environmental Effects, Requirements For Systems |
| MIL-STD-810H Change 1 | 18 MAY 2022 | Environmental Engineering Considerations and Laboratory Tests |
| MIL-STD-882E | 10 FEB 2022 | System Safety Program for System and Associated Subsystems and Equipment, Requirements for |
| MIL-STD-1425A | 29 MAR 2010 | Safety Design Requirements for Military Lasers and Associated Support Equipment |
| MIL-STD-1553B | 12 FEB 1980 | Digital Time Division Command/Response Multiplex Data Bus (USAF) |
| MIL-STD-1472H | 15 SEP 2020 | Human Engineering |
| MIL-STD-704F | 12 MAR 2004 | Department of Defense Interface Standard: Aircraft Electric Power Characteristics |
| MIL-HDBK-217F | 02 JUN 2022 | Reliability Prediction of Electronic |
| MIL-HDBK-235D | 03 APR 2018 | Military Operational Electromagnetic Environment Profiles Part 1D General Guidance |
| MIL-HDBK-5400 | 11 FEB 2019 | Electronic Equipment, Airborne, General Guidelines |
| NAVAIR 01-1A-505-1 | 31 MAR 2015 | Installation Practices For Aircraft Electric and Electronic Wiring |
| NAVAIR 01-1A-505-2 | 15 AUG 2011 | Installation and Repair Practices Volume 3 Aircraft Circular Electrical Connectors and accessories |
| NAVAIR 01-1A-505-3 | 01 SEP 2011 | Installation and Repair Practices Volume 3 Aircraft Rectangular Electrical Connectors and accessories |
| NAVAIR 01-1A-505-4 | 12 AUG 2012 | Installation and Repair Practices Aircraft Fiber Optic Cabling |
| OPNAVINST 5100.27/MCO 5104.1 Enclosure 4 |  | Data Requirements for LSRB Approval |
| NGA Motion Imagery Standards Profile, v2022.1 | OCT 2021 | MISB developed supporting documentation in the form of MISB Standards (STs) and MISB Recommended Practices (RPs) |
| ANSI Z136.1 |  | Safe Use of Lasers |
| SAE-AMS-STD-595 |  | Colors Used and Government Procurement |
| SMPTE ST170M |  | Television – Composite Analog Video Signal |
| SMPTE ST 292-1 |  | 1.5Gb/s Signal/Data Serial Interface |
| ISO 9211-1 | 09/2018 | Optics and Photonics Optical Coatings Part 1: Vocabulary |
| ISO 9211-2 | 3/2010 | Optics and Photonics Optical Coatings Part 2: Optical Properties |
| ISO 9211-3 | 03/2023 | Optics and Photonics Optical Coatings Part 3: Environmental Durability |
| ISO 9211-3 | 04/2012 | Optics and Photonics Optical Coatings Part 4: Specific Test Methods |
| RTCA/DO-160C |  | Radio Technical Commission for Aeronautics |
| EIA RS-170 |  | Electrical Performance Standard, Monochrome Television Studio Facilities |
| 06524M1300 | 20 AUG 2024 | Turret Envelope without Adaptor CH-53K |
| 06524M1302 | 20 AUG 2024 | Turret Aircraft Interface CH-53K |
| 06524M1301 | 20 AUG 2024 | Turret Envelope with Adaptor CH-53K |

# FLIR System Requirements

The CH-53K Forward Looking Infrared (FLIR)shall be designed, integrated, tested and manufactured in accordance with this specification.

The FLIR shall operate in day and night, in sand and dust environments, and adverse weather conditions. The FLIR shall have a minimum of four field of view selections for each imaging sensor. The FLIR shall have a high-definition mid-wave infrared (MWIR) detector and a high-definition color television (TV) camera. The FLIR may have additional sensors such as a short-wave infrared detector or a long-wave infrared detector. The FLIR shall have a Laser Range Finder (LRF) as a threshold requirement and Laser Target Marker (LTM) as an objective requirement. The FLIR shall have the following capabilities:

· Target Detection

· Target Tracking

· Digital Image / Data Processing

Components and assemblies used in the FLIR system shall be a TRL Level 7 or higher. The FLIR system shall not impose any modifications to airframe.

## FLIR Description

The CH-53K Forward Looking Infrared shall have multiple Fields of View (FOV), Medium Wave Infrared (MWIR), black and white or color imagery, visible color camera, Laser Range Finder (LRF), and Adversary Laser Protection. The LRF will enable crew to aid in determine the distance of an object while the LTM will aide in highlighting a target for other aircrew and other blue forces. The adversarial laser protection is a Counter Counter Measure (CCM) to laser systems that try to damage or bloom the detector while in use. The aircraft interface is a 1553 Multiplex bus and/or ethernet which is denoted in system block diagram below. The FLIR system configuration could have a separate or self-contained electronics, as denoted in figure 1 and figure 2.

A FLIR consisting of a Turret Unit and separate Electronics Unit is denoted in the bock diagram in Figure 1



Figure 1: FLIR System Block Diagram with Separate Electronics



Figure 2: FLIR System Block Diagram Self Contained Electronics

The FLIR could have the Electronics Unit self-contained in the Turret Unit, as denoted in the block diagram in Figure 2.

Note: For purposes of this specification, turret positioning shall be defined as 0 degrees elevation and azimuth is defined as straight off the nose of the aircraft. 90 degrees elevation is defined as straight up, -90 degrees as straight down. 90 degrees azimuth is defined as directly to starboard, -90 degrees as directly port.

### FLIR Characteristics

The Turret Electronics provides the interface between the CH-53K and the Turret for signals and power. The Turret Electronics shall be mechanically separate from the Turret, or the Turret Electronic functions shall be integrated into the Turret.

1. The dimensions of the FLIR shall not exceed:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Height [inch] | Width [inch] | Diameter  [inch] | Depth [inch] |
| Turret, including adaptor plate \* | 15.500 | N/A | 14.625 | N/A |
| Turret Center of Gravity | 60% of overall height when measured to the mounting surface | N/A | N/A | N/A |
| Turret Electronics | 8.000 | 10.500 | N/A | 16.500 |

2. The maximum weight of the FLIR shall not exceed:

|  |  |
| --- | --- |
|  | Max Weight [pounds] |
| Turret, including adaptor plate \* | 55.0 |
| Turret Electronics | 46.0 |

2. \* If the Turret Electronic functions are integrated into the Turret, the Turret shall maintain the same maximum dimensions and maximum weight.

#### Turret Unit Alignment

The TU shall provide alignment pin engagement to allow an index to mount for pins and pads of less than or equal to 2 milliradians.

#### Operational Modes

##### Standby Mode

When the turret is commanded to standby mode it shall be positioned to an azimuth of 0° and elevation of 120°.

##### Test Mode

The turret system shall have a test mode in which pertinent information is displayed over the video feed. The intent is to isolate and troubleshoot during ground or flight checks.

##### Geo Point Mode

The FLIR system shall receive commands over the 1553 or Ethernet to point and fix on a latitude and longitude coordinate.

##### Inertial Point Mode

In Inertial Point mode, the FLIR shall be stabilized with respect to an inertial frame of reference.

##### Position Mode

The turret shall have a position mode to stabilize the LOS with a command over 1553 or Ethernet to automatically maintain the relative angle position.

##### On/Off Mode

The operator shall have the ability to turn the FLIR system on and off. While in Off mode, the FLIR shall have no power. If in STOW position prior to power-down the FLIR shall remain in STOW mode.

#### Operator Controls

The FLIR system shall support the following Operator Control Functions:

1. LOS Slew Control
2. Focus Control
3. Inertial Point Mode Select
4. Heading Hold Mode Select
5. Polarity Select
6. Tracker Control
7. Menu Select and Control
8. Freeze Frame Select
9. System Power On/Off
10. Stow Select
11. Manual Gain/Level Control
12. Auto Gain/Level Select
13. FOV Select
14. Laser Rangefinder Firing Control
15. Moving Target
16. Location Accuracy

#### Discrete Control

The contractor shall adhere to current wiring specification in accordance XXX document to interface with the EGI/FLIR control panel. The contractor’s FLIR system shall interface with the current EGI/FLIR panel to power ON, OFF, and Cool Down.

### Electrical Power Interface

The FLIR System shall perform in accordance with this specification without any malfunction or degradation of performance when supplied with power in accordance with MIL-STD-704F.

### Interfaces

#### Maintenance /Safety Interface

The FLIR system shall provide a signal that implements a maintenance and safety condition for the laser system.

#### Mechanical Interface

The FLIR turret shall adhere to the CH-53K utilizing legacy mounting space and provisions. The Contractor shall design and deliver a modified adapter plate, as shown in APSD documents 06524MI300,06524MI301, 06524MI3002. The modified adapter plate shall mount to existing aircraft side mounting provisions and shall not change the aircraft airframe.

Additional components, if required, will be mounted within the aircraft’s legacy avionics bays.

#### Video Interface

The FLIR shall have a minimum of two Digital video outputs meeting SMPTE 292M. Additional unused video outputs shall be properly terminated per NAVAIR 01-1A-505.

#### Signal and Cabling Interface

The signal and cabling external to the turret and any other components shall be in accordance with NAVAIR 01-1A-505 series publication cited herein. Connecters external to any component shall comply with NAVAIR 01-1A-505.

#### Turret Slewing Interface

The FLIR system shall accept a +/- 10 volt 3 wire analog data concentrator unit interface for slewing the turret. The DCU accepts a +/- 8 volt inputs from one of the two Multi-Function Control Unit (MFCU)s (part number 799-7715 and 799-7716) and upconverts it to the +/- 10 volt output to the FLIR unit.

Remaining turret commands and functions shall be commanded via 1553 or Ethernet from the Avionics Management System (AMS) software.

#### Navigational Data Interface

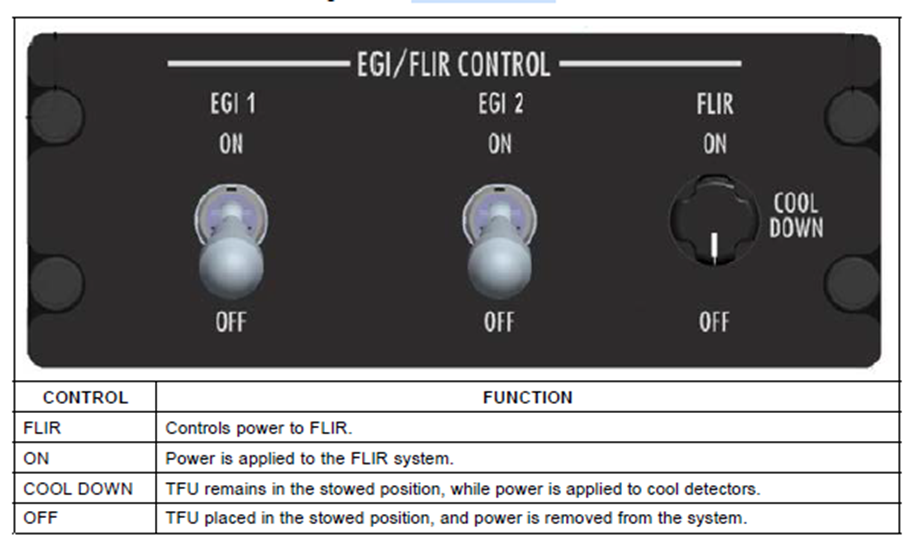
The FLIR system shall be capable of receiving navigational data by either 1553 or Ethernet interface per IEEE 802-3.

#### Command and Control Interface

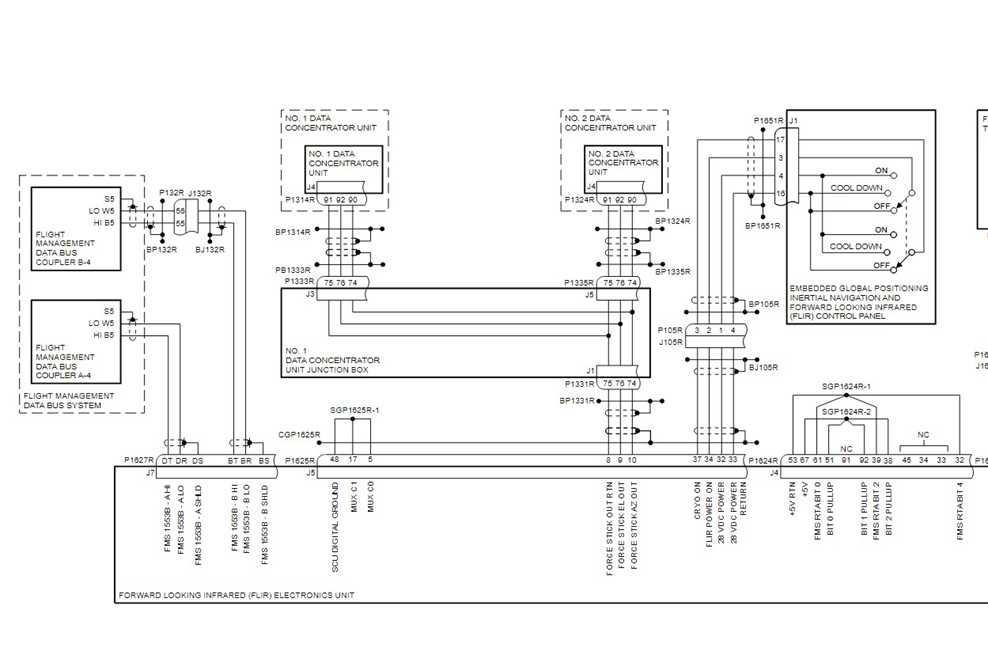
The FLIR system shall be capable of receiving and sending command and control data by either 1553 or Ethernet interface per IEEE 802-3.

#### FLIR Control Panel Interface

The EGI/FLIR Control Panel, as shown in Figure 3: EGI/FLIR Discrete Function, has a three-function rotary switch with analog output. The FLIR system shall utilize the on-off function of the EGI/FLIR control panel. The contractor may utilize the cool down function if required. The Contractor shall maintain current wiring in accordance with Figure 4: FLIR panel wiring schematic in regards to EGI FLIR control panel.



**Figure 3: EGI/FLIR Discrete Function**



**Figure 4: FLIR Panel Wiring Schematic**

### FLIR Data Display

#### Sensor Video Symbology

The data required to generate the FLIR Symbology data shall be generated by the FLIR system on the 1553 or Ethernet data bus to display the FLIR Symbology data by external devices. The FLIR symbology data at minimum shall be:

1. Line-of-Sight
2. Field-of-View Indicator
3. Field-of-View Size Reticle
4. Gimbal Angle Indicator (Azimuth and Elevation)
5. Target Data

* Range
* Longitude
* Latitude

1. Navigational Data

* Longitude
* Latitude

1. Time and Date (Local or Zulu)
2. BIT/FIT Status
3. Autotrack/Tracker
4. Gain/Level Indicator
5. Manual Gain/Level Indicator
6. Focus Indicator
7. Aircraft Position
8. Aircraft Heading
9. Laser Operational Indicators

* Laser Arm Status
* Laser Firing Status
* LDR Boresight Status
* Selected Laser Codes

#### Aircraft Position

The aircraft position shall be supplied by the FLIR System. When the FLIR System is powered down the FLIR will not supply aircraft position. When the FLIR System is in built-in-test mode the FLIR System will not supply aircraft position. When the navigation solution is off-line the FLIR System will supply not supply aircraft position. When the communication interface that supplies the navigation solution is offline, the FLIR System shall display zeros for aircraft position.

#### Video Grayscale Generator

The FLIR system shall have an embedded grayscale generator which has a minimum of 256 shades of gray from black to white. This grey scale pattern shall be selectable by the operator. The grayscale is used to adjust used to adjust the display intensity and contrast for varying lighting conditions.

#### Maintenance Symbology

The FLIR system shall provide the minimum symbology set during maintenance:

1. Time of Day in ZULU time.
2. Calculated Position of Target within the center of the FOV
3. Calculated Target Range
4. White Hot/Black Hot
5. FOV Setting
6. Laser Arm Status
7. Laser Firing Status
8. Laser Selection
9. Tracker Selection
10. Tracker Gate Box
11. Next Narrow FOV Box
12. Moving Target indicator (If applicable)

Note: Symbology may be burned into the video for maintenance actions.

#### System Fault and Error Message Processing

The FLIR system shall provide current status over 1553 or Ethernet. This includes, but not limited to performing Non-Uniformity Correction (NUC), cooling down, operational modes, Built-In test results, laser calibration data.

The FLIR system shall indicate a fault message to indicate 1553 or Ethernet communication issues to the operator.

#### Loss of Communication with Avionics

The FLIR system shall remain in the last commanded state and provide a message to the operator of the loss link.

## Performance Characteristics

The FLIR performance characteristics shall adhere to the sections denoted below. All requirements specified in this document are minimum threshold unless specified.

### FLIR Readiness

Upon power on, the FLIR system shall perform start-up and run-time BIT. The BIT shall not cause the LASER to fire. The FLIR shall indicate a Not Ready message over the 1553 or Ethernet data bus. This message shall be updated to a READY when system become fully functional with exception of the IR imager cool down. The FLIR system shall be operational after 10 minutes of power on. Fully operational includes system cooldown, BIT, and FLIR to laser boresight.

### Maintenance System Defaults

During maintenance functions, the FLIR shall have set configurations for:

Field-of-View; Laser Polarity; Gain/Level/White Hot Mode/Automatic

### Power Up

With the exception of the IR imaging function, the FLIR system shall be operational and capable of responding to operator commands within 60 seconds after power is applied.

### Infrared Optics

#### Field of View

A minimum of four optical Field of Views (FOV) shall be provided.

##### Narrow FOV

The Narrow Field of View (NFOV) azimuth angle shall be a maximum of 1.8 degrees.

##### Wide FOV

The Wide FOV (WFOV) azimuth angle shall be between 50 degrees and 70 degrees.

##### Medium FOV

The Medium FOV shall have multiple FOV between the WFOV and NFOV. No incremental step in FOV shall be less than 1/3 of the FOV of the previous wider FOV.

#### FOV Transition Time

The FLIR shall have transition times between FOVs such that it does not exceed 0.5 seconds.

#### FOV Boresight

Each FOV step shall maintain the center of the image to within 15 pixels for next narrowest FOV for each detector over the environmental operational specifications.

#### Coincidence of Multiband Sensors

Each band shall maintain the center of the FOV of each sensor to within 20 pixels of the MWIR sensor over the environmental operational specifications.

#### Optical Focus

Optical Focus shall be automatically maintained without operator adjustment.

#### Horizontal Rotation Limit

Gimbal shall have a minimum horizontal rotation range, azimuth rotation, of +/- 180 degrees from nose of aircraft.

#### Vertical Rotation Limit

Gimbal shall have a minimum vertical rotation range, elevation rotation, of +120 degrees to –170 degrees (Up Positive).

#### Electronic Zoom

The FLIR shall have an electronic zoom

#### Infrared (IR) Range Performance

The FLIR system shall be capable of achieving the detection, recognition and identification ranges as defined in the section below.

##### Detection

The FLIR IR system shall produce optical imagery to enable an operator to detect, with a 50% probability (N50), of a standing man-sized target at 4.0 km while operating at 5k ft in mid Atlantic summer atmospheric environment with a Navy maritime aerosols, Navy maritime visibility override 15.0 km, wind speed 0m/s, and Navy Maritime Air Mass 5. Target shall have a 3 Kelvin temperature difference to background.

##### Identification

The FLIR IR system shall produce optical imagery to enable an operator to identify, with a 50% probability (N50), a standing man-sized target at 2.0 km while operating at 5 kft in mid Atlantic summer atmospheric environment with a Navy maritime aerosols, Navy maritime visibility override 15.0 km, wind speed 0m/s, and Navy Maritime Air Mass 5. Target shall have a 3 Kelvin temperature difference to background.

##### Noise Equivalent Temperature Difference (NETD)

The average temporal NETD shall be less than 35 mK as a threshold requirement and less than 25mK as an objective when measured in ambient conditions and utilizing a blackbody with background temperature of 22.5° +/- 2.5° C.

#### Visible Range Performance

##### Detection

The FLIR systems color visible detector shall produce imagery to enable an operator to detect (N50) a standing man-sized target at 6.0 km while operating at 5k ft in mid Atlantic summer atmospheric environment with a Navy maritime aerosols, Navy maritime visibility override 15.0 km, wind speed 0m/s, and Navy Maritime Air Mass 5, during daytime conditions. Target to background contrast of 36%.

##### Identification

The FLIR systems color visible detector shall produce imagery to enable an operator to detect (N50) a standing man-sized target at 4.5 km while operating at 5k ft in mid Atlantic summer atmospheric environment with a Navy maritime aerosols, Navy maritime visibility override 15.0 km, wind speed 0m/s, and Navy Maritime Air Mass 5, during daytime conditions. Target to background contrast of 36%.

#### Night Vision Imaging System (NVIS) Lighting Compatibility

The NVIS lighting shall be capable of the following:

1. Indicators shall meet NVIS radiance criteria as specified in MIL-L-85762A, Table IX.

Advisory: ≤ 1.70E-10 NRa

1. Indicators shall meet chromaticity criteria as specified in MIL-L-85762A, Table VIII.

Advisory:

NVIS Green B: u’= 0.131, v’= 0.623, r = 0.057

1. Indicators shall meet night luminance criteria specified in MIL-STD-411F. Section 5.1.5 for Advisories: Night: 0.1 fL

#### Noncorrected Detector Uniformity

When viewing a uniform temperature blackbody source of 290 ± 5 Kelvin the output video signal shall contain no non-uniformities in excess of: 10 percent of the total video dynamic range at maximum in any local area (rectangular area with sides ¼ of the total vertical and horizontal FOV), 20 percent of the total video dynamic range across the entire FOV. Where the total dynamic range is defined as a manual gain setting for which the output dynamic range is 2.0° ± 0.2 C.

#### MWIR Detector Operability

The detector shall have an operability of 99% . The MWIR detector shall have no more than 10 adjacent pixels which are defective. In addition, no more than 5% of the total Defective pixels shall be within one column or row.

#### Detector Cool Down

The detector shall reach its operational temperature within 10 minutes after the application of power when the ambient temperature is 60° Celsius.

#### Image Processing

The FLIR system shall provide manual and automatic Gain and Level adjustments. The FLIR system shall provide this contrast enhancement over the entire image.

#### Multiband Imagery Composite

The operator shall be able to select blended imagery from the visible and thermal sensor (threshold)Blending is applying a weighting factor to a sensor image and adding the image to the other sensor images with the corresponding weight factor i.e 30%+70%,.

An objective requirement is the operator shall have a fused image. The fused image shall be composed of at least two separate imaging bands and is the result of using the prevailing imagery components from each sensor.

#### Polarity

The FLIR system shall be able to display thermal imagery as either white equals hot or black equals hot.

### LASERS

The FLIR system shall have LASER capability to perform range finding, and target illumination (Objective) for users utilizing Gen III night vision goggles (NVGS).

The FLIR system shall allow configuration of the lasers and their modes through the 1553 or Ethernet.

#### Auto Tracker Control

The operator shall be able to activate, deactivate and setup the tracker modes from 1553 or Ethernet interface.

#### Tracker

The FLIR system shall be capable of varying turret orientation automatically and continuously to track stationary and moving targets. When the Track mode is engaged, the auto-tracker shall lock onto and follow a target that satisfies the tracker target detection criteria in the center of the image. If a target cannot be seen at the image center, the auto-tracker shall lock onto the target closest to the image center. Tracker mode shall be operator-selectable.

Additionally, the tracker shall be capable of maintaining track through target size, target aspect, FOV and Polarity changes. The tracker shall accept manual offset adjustment. The tracker shall maintain track in the presence of clutter, glint, and video polarity reversals. The tracker shall track any discernible, significant, displayed object as small as 1 pixel and as large as 75 percent of the selected FOV dimensions.

#### Moving Target Indicator (MTI)

The MTI is an objective requirement. If included, the MTI shall be selectable on/off through the 1553 or Ethernet.

#### Target/Range Accuracy

The accuracy of target location shall be less than 20 meters at 10 kilometers slant range with use of laser range finder.

#### Laser Range Finder (LRF)

The FLIR system shall have an eye safe laser range finder capable of measuring range at 8 meter accuracy at a slant range of 10km and an altitude of 5000 ft during mid Atlantic mid-summer conditions.

#### Laser Target Marker (LTM)

The LTM is an objective requirement. The FLIR system shall have a target marker that is not seen by the naked eye but to be seen by Generation III night vision googles. LTM shall be able to illuminate a target at 3km during a full moon night such that it will be clearly visible to NVGs.

#### Boresight

LRF and LTM shall not require special calibration equipment to calibrate boresight at the operational level.

## FLIR Settings

All selectable settings shall be configured through the 1553 or Ethernet to include but not limited to:

* Image Processing Mode
* Multiband Imagery
* Image Polarity
* Laser Settings
* Field of View
* Black Hot/White Hot
* Tracker Modes

## Laser Counter Counter Measures (CCM)

The FLIR system shall employ laser CCM as defined in specification AC1424059-1S.

## Software

The FLIR system shall be capable of being field loadable via the Program Loader Set (PLS) and capable of being stored on Naval Data Distribution System (NDDS). The contractor shall use the Program Loader Set (PLS, AN/USQ-203, part number- 4032AS100-1) Common Support Equipment or be loadable through 1553/Ethernet via CH-53K Advanced Data transfer System (ADTS).

## Design and Construction

### Inverted Mounting Configuration

The Turret Unit shall meet its operational performance requirements when mounted in the ball down configuration.

### AC Power

The FLIR system shall meet the requirements from MIL-STD-704F.

#### Load Measurements

The maximum steady state power required for the AC-powered portion of the FLIR system shall not exceed 731VA.

#### Normal Steady State Limits for Voltage and Frequency

The FLIR system shall provide full undegraded performance when subjected to any combination of normal steady state voltages between 108 Vrms and 118 Vrms, and steady state frequencies between 393 Hz and 407 Hz per MIL-STD-704F.

#### Voltage Modulation

The FLIR system shall provide full undegraded performance when subjected to voltage modulation amplitudes less than or equal to 2.5 Vrms per MIL-STD-704F.

#### Frequency Modulation

The FLIR system shall provide full undegraded performance when subjected to frequency modulation amplitudes of 4 Hz per MIL-STD-704F.

#### Voltage Distortion Spectrum

The FLIR system shall provide full undegraded performance when subjected to the voltage distortion spectrum of Figure 7 per MIL-STD-704F.

#### Total Voltage Distortion

The FLIR system shall provide full undegraded performance when subjected to a maximum total voltage distortion of 5% per MIL-STD-704F.

#### DC Voltage Component

The FLIR system shall provide full undegraded performance when subjected to DC offset of ±0.10 V per MIL-STD-704F.

#### Normal Voltage Transients

The FLIR system shall provide full undegraded performance when subjected to normal voltage transients as specified in Figure 3 per MIL-STD-704F.

#### Normal Frequency Transients

The FLIR system shall provide full undegraded performance when subjected to normal frequency transients as specified in Figure 5 per MIL-STD-704F.

#### Power Interrupts

The FLIR system shall be permitted a degradation or loss of function without damage or creating an unsafe condition when subjected to power interruptions of less than 50 milliseconds per MIL-STD-704F. The FLIR shall automatically recover to full performance when the electrical power characteristics are restored to the normal operation limits specified in paragraph 3.1.3.8 of this specification.

#### Abnormal Steady State Limits For Voltage and Frequency

The FLIR system shall be permitted a degradation or loss of function without damage or creating an unsafe condition when subjected to any combination of abnormal steady state voltages between 100 Vrms and 125 Vrms, and steady state frequencies between 380 Hz and 420 Hz per MIL-STD-704F. The FLIR shall automatically recover to full performance when the electrical power characteristics are restored to the normal operation limits specified in paragraph 3.1.3.8 of this specification.

#### Abnormal Voltage Transients

The FLIR system shall be permitted a degradation or loss of function without damage or creating an unsafe condition when subjected to abnormal voltage transients as specified in Figure 4 per MIL-STD-704F. The FLIR shall automatically recover to full performance when the electrical power characteristics are restored to the normal operation limits specified in paragraph 3.6.2.8 of this specification.

#### Abnormal Frequency Transients

The FLIR system shall be permitted a degradation or loss of function without damage or creating an unsafe condition when subjected to abnormal frequency transients as specified in Figure 6 per MIL-STD-704F. The FLIR shall automatically recover to full performance when the electrical power characteristics are restored to the normal operation limits specified in paragraph 3.6.2.8 of this specification.

#### Emergency Steady State Limits For Voltage and Frequency

The FLIR system shall be permitted a degradation or loss of function without damage or creating an unsafe condition when subjected to any combination of emergency steady state voltages between 108 Vrms and 118 Vrms, and steady state frequencies between 393 Hz and 407 Hz per MIL-STD-704F. The FLIR shall automatically recover to full performance when the electrical power characteristics are restored to the normal operation limits specified in paragraph 3.6.2.8 of this specification.

#### Power Failure

The FLIR system shall be permitted a degradation or loss of function without damage or creating an unsafe condition when subjected to power failures less than or equal to 7 seconds as specified in MIL-STD-704F The FLIR shall automatically recover to full performance when the electrical power characteristics are restored to the normal operation limits specified in paragraph 3.6.2.8 of this specification.

#### Phase Reversal

The FLIR system shall be permitted a degradation or loss of function without damage or creating an unsafe condition when subjected to reversed phase power per MIL-STD-704F. The FLIR shall automatically recover to full performance when the electrical power characteristics are restored to the normal operation limits specified in paragraph 3.6.2.8 of this specification. A positive means to prevent phase reversal may be used to fulfill this requirement.

#### In-rush Current

Startup and transient in-rush currents for FLIR system operating under time constraints shall not exceed 75% of the minimum available percent rated load current of the 7.5A circuit breaker and maximum current is no more than 3.75 times rated load current.

#### Circuit Breaker Compatibility

The FLIR system shall not cause tripping of an 7.5A circuit breaker during normal and abnormal electrical system operation.

#### Power Return Isolation

The FLIR system shall not utilize chassis as a power return.

#### Self-Discharge

Internal circuits within the FLIR system shall self-discharge to a voltage less than 30 Vrms within two seconds of power removal.

### DC Power

The FLIR system shall meet the requirements from MIL-STD-704F.

#### Electrical Load

The maximum steady state power required for the DC-powered portion of the FLIR system shall be less than less than 24Amps.

#### Steady State Voltage

The FLIR system shall provide full undegraded performance when subjected to minimum steady state voltages greater than or equal to 22.0VDC and less than or equal to 29.0VDC per MIL-STD-704F.

#### Voltage Distortion

The FLIR system shall provide full undegraded performance when subjected to voltage distortion amplitudes greater than or equal to 0.1Vrms and less than or equal to 1.0Vrms per MIL-STD-704F.

#### Voltage Ripple

The FLIR system shall provide full undegraded performance when subjected to voltage ripple amplitudes less than or equal to 1.5Vp-ave per MIL-STD-704F.

#### Normal Voltage Transients

The FLIR system shall provide full undegraded performance when subjected to normal voltage transients as specified in MIL-STD-704F, Figure 13.

#### Electrical Power interrupts

The FLIR system shall provide full undegraded performance when subjected to power interruptions of less than 50 milliseconds per MIL-STD-704F.

#### Abnormal Steady State Voltage

The FLIR system shall be permitted a degradation or loss of function without damage or creating an unsafe condition. The FLIR shall automatically recover to full performance when the electrical power characteristics are restored to the normal operation limits specified in paragraph 3.1.2.1.2 of this specification when subjected to abnormal steady state voltages greater than or equal to 20.0VDC and less than or equal to 31.5VDC per MIL-STD-704F.

#### Abnormal Voltage Transients

The FLIR system shall be permitted a degradation or loss of function without damage or creating an unsafe condition. The FLIR shall automatically recover to full performance when the electrical power characteristics are restored to the normal operation limits specified in paragraph 3.1.2.1.2 of this specification when subjected to abnormal voltage transients as specified in MIL-STD-704F, Figure 14.

#### Emergency Steady State Voltage

The FLIR system shall be permitted a degradation or loss of function without damage or creating an unsafe condition. The FLIR shall automatically recover to full performance when the electrical power characteristics are restored to the normal operation limits specified in paragraph 3.1.2.1.2 of this specification when subjected to emergency steady state voltages greater than or equal to 18.0VDC and less than or equal to 29.0VDC per MIL-STD-704F.

#### Starting Voltage

The FLIR system shall be permitted a degradation or loss of function without damage or creating an unsafe condition. The FLIR shall automatically recover to full performance when the electrical power characteristics are restored to the normal operation limits specified in paragraph 3.1.2.1.2 of this specification when subjected to starting voltage transients that are greater than or equal to 12.0VDC and less than or equal to 29.0VDC per MIL-STD-704F.

#### Electrical Power Failure

The FLIR system shall be permitted a degradation or loss of function without damage or creating an unsafe condition. The FLIR shall automatically recover to full performance when the electrical power characteristics are restored to the normal operation limits specified in paragraph 3.1.2.1.2 of this specification when subjected to power failures less than or equal to 7 seconds as specified in MIL-STD-704F, Figure 14.

#### In-rush Current

Startup and transient in-rush currents for FLIR system operating under time constraints shall not exceed 75% of the minimum available percent rated load current of the 30A circuit breaker and maximum current is no more than 3.75 times rated load current.

#### Circuit Breaker Compatibility

The FLIR system shall not cause tripping of a 30A circuit breaker during normal and abnormal electrical system operation.

#### Power Return Isolation

The FLIR system shall not utilize chassis as a power return.

### Electromagnetic Environment

The FLIR system shall be designed in accordance with EMI design requirements of MIL-STD-461G. The FLIR system shall perform in accordance with this specification without any malfunction or degradation of performance when subjected to the electromagnetic environment defined in MIL-STD-461G.

The FLIR shall not cause interference or damage or be susceptible to interference or damage from conducted interference.

### Lightning Protection

The FLIR shall provide protection from direct and indirect lightning effects. Any direct lightning effects shall not compromise the integrity or safety of the host platform. The FLIR shall meet its operational performance requirements for indirect lightning effects IAW MIL-STD-461G Section 5.15, CS117. THE FLIR shall be also adhere to Section 5.15, utilizing table VII, which defines the waveform parameters, with current components A, D and H being applicable for indirect lightning.

### Bonding

The FLIR shall meet the bonding requirements of MIL-STD-464D.

#### Turret Unit Bonding

The Turret Unit shall provide conductive mounting surfaces to allow a 2.5 milli-ohm between the Turret Unit and Turret Adapter Plate.

#### Turret Adapter Plate Bonding

The Turret Adapter Plate shall provide a provide conductive mounting surfaces to allow a 2.5 milli-ohm between the Turret Adapter Plate and CH-53k

#### Electronic Unit Bonding

If an Electronic Unit is part of the FLIR, then the Electronic Unit shall provide conductive mounting surfaces to allow a 2.5 milli-ohm between the Electronic Unit and CH-53K.

#### Electro-Static Discharge (ESD)

The FLIR, when integrated on the CH-53K, shall safely control and dissipate the build-up of electrostatic charges caused by precipitation static (p-static) effects, personnel charging, and other charge generating mechanisms to avoid fuel ignition, inadvertent detonation or dudding of ordnance hazards, to protect personnel from shock hazards, and to prevent performance degradation or damage to electronics, IAW MIL-STD-464D.

The FLIR, when integrated on the CH-53K, shall be electromagnetically compatible within itself such that system operational performance requirements are met, IAW MIL-STD-464D, Intra-System Electromagnetic Compatibility (EMC).

The FLIR system, when integrated on the CH-53K, shall be electromagnetically compatible with its defined external RF EME such that its system operational performance requirements are met, IAW MIL-STD-464D, External RF EME.

### Interchangeability

The FLIR system WRAs and SRAs that have the same part number shall be interchangeable with each other with respect to installation and performance.

## Structural Design

### Strength

The FLIR system shall be designed and analyzed to withstand the worst-case static load profile, which will be identified in following section.

### Loads

For structural design and analysis, the worst-case mass property values (including nominal and worst-case allowed tolerances in weight and center of gravity) shall be used to generate maximum component attachment loads.

Structural Design Loads Requirement: Provide design loads used to design the structural attachments of new or modified components to the aircraft, including the structure between the ball support trunnion and the aircraft structure. Include detailed explanations of the methodology and assumptions used to generate the design loads – accompanied as necessary by illustrations, tables, figures, graphs, free-body diagrams, shear load diagrams, moment and torsion diagrams, etc.

### Flight Loads

FLIR System shall withstand the worst-case combination of flight aerodynamic and maneuver inertial loads; each generated using the criteria of the following paragraphs. Ultimate loads correspond to limit loads multiplied by a 1.50 ultimate load factor.

(1) Maneuvering inertia limit loads are the maximum installation weight for all configurations multiplied by local load factors applied at the installation center of gravity. For the FLIR system, the inertial load limits are 1.7G Forward, 3.9G Aft, 7.2G Up, 2.6G Down, and 3.3G Inboard/Outboard.

(2) Aerodynamic limit loads are based on worst case combined forward and sideward dynamic pressures generated within the speed (maximum of 196 KEAS for CH-53K), and sideslip envelope, as shown in Figure 5, with an assumed drag coefficient of 2.0, and the projected frontal and side areas of the equipment exposed to freestream flow.

Chart

Description automatically generated

Figure 5: CH-53K Airspeed vs Sideslip Envelope

### Handling Loads

Each installation shall be capable of withstanding abuse loads that may result from the "rough handling" of the equipment, including unintended use as handles or steps. Specifically, the FLIR Turret shall be designed to withstand abuse ultimate loads of 150 lbs applied at the tip of the turret in the most critical direction. This requirement ensures that the FLIR Turret is robust enough to endure potential misuse and rough treatment during its operation.

### Crash Loads

The component support structure and means of attachment shall be designed for worst case mass properties with the following ultimate inertia-load factors referenced to the aircraft axis, all acting separately: Fore/Aft +/- 10G, Up/Down +/- 10G, Inboard/Outboard +/-5G.

### Vibration Design Requirements

The FLIR system shall maintain structural integrity, without failure or permanent deformation, and meet it operational performance requirements during and after exposure to the operational vibration environment for the entire operational service life. The FLIR operational vibration environment is characterized by the random vibrations and peak value of sinusoidal vibration excitations in flight. The frequencies and amplitudes of the vibration environment are defined based on the Vibration Zone of the component location in aircraft.

The (aircraft-induced) vibratory operational environment for the FLIR Turret and separate electronics components is described by the following random performance spectrum and performance peak sine amplitudes.

Random Performance Spectrum

|  |  |
| --- | --- |
| Random Spectrum Location | Random Spectrum Parameters  (ref. MIL-STD-810H Change 1,Fig. 514.8D-4,  Table 514.8D-IIIb, w/ 0.2 scale factor) |
| External Stores (scaled by 0.2) | W0 = 0.00040 g^2/Hz  W1 = 0.0040 g^2/Hz  ft = 500 Hz |
| Internal Stores (scaled by 0.2) | W0 = 0.00020 g^2/Hz  W1 = 0.0020 g^2/Hz  ft = 500 Hz |

Performance Peak Sinusoidal Spectrum

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Source | Frequency, Hz | Sinusoidal Amplitudes,  Performance Amplitude, g | | | |
| Long. | Lat. | Vert. | Max\* |
| 1/ TR | 12 | 0.54 | 0.36 | 0.89 | 0.89 |
| 7/ MR | 21.5 | 0.74 | 1.38 | 2.69 | 2.69 |
| 4/ TR | 48 | 0.39 | 0.23 | 0.41 | 0.44 |
| 8/ TR | 96 | 0.25 | 0.10 | 0.44 | 0.44 |

\*May use max on all three axes to simplify test and maximize installation flexibility, if desired.

## Hazardous Materials

The FLIR system shall not use of hazardous materials in the system lifecycle as listed below. Additionally, the FLIR system shall not use radioactive material, ozone depleting substances, and dissimilar metal.

* Polyvinyl Chloride (PVC)
* Polychlorinated Biphenols (PCB)
* Asbestos
* Thorium or other radioactive Optical Materials
* MIL-W-81381/MIL-DTL-81381(Polyimide/Kapton)

## Human Factors

The FLIR system shall be designed and developed in accordance with MIL-STD-1472H human engineering design criteria.

## Nomenclature Identification and Marking

Nomenclature, serial number assignments, nameplates approval and equipment identification shall adhere to MIL-N-18307. Marking of hardware and software shall adhere to MIL-STD-130.

## Safety

The FLIR system shall be designed and developed in accordance with MIL-STD-882B, paragraph 4.3.

### Laser Safety

The FLIR laser system shall be designed in accordance with MIL-STD-1425A.

The Laser shall meet the Eye Safety standard of ANSI Z 136.1-2000; Procedures to ensure personnel and eye safety shall be in accordance with ANSI Z136.1-1993.

#### Double Activation Integrity

At least two separate operator commands (Arm and Fire) shall be required to cause the LTM or LRF to emit energy.

#### Laser Interlock

The FLIR laser systems shall be designed to accept a mechanically wired interlock which prevents laser from firing while on the ground. This is accomplished through a discrete which provides a ground when weight is applied to the wheels.

#### Laser Fire Masking

The FLIR system shall have a programed laser masking that prevents the lasers from lasing the aircraft while in flight. This masking area shall be automatically set upon installation into the aircraft. The masking area shall provide a 2 degree +/- 1 degree buffer from the aircraft. Rotor and Flexible areas of the aircraft shall be allowed a 10-degree buffer.

## Reliability

The FLIR system shall have a Mean Time Between Failure (MTBF) no less than 500 operating hours.

### Operational Life

The FLIR system shall have a minimum useful life of 10,000 hours.

### Storage

The equipment shall withstand, without performance degradation, a non-operating period of up to six months on the ground or installed on aircraft.

## Maintainability

### O-Level Maintenance

#### Mean Time to Repair

O-level repair of the FLIR system shall be capable of being performed in less than 120 minutes after removed from the aircraft. The objective for O-Level maintenance of the FLIR system is less than 90 Minutes.

#### Mean Time to Remove and Replace

The maximum time to remove and replace the FLIR shall be less 120 minutes and the objective for removal and replacement is less than 90 minutes.

### Off Aircraft Maintenance

The FLIR system shall accept commands from a hand controller for maintenance. The FLIR system shall accept commands from a hand controller to display symbology burned into the imagery for off aircraft maintenance. The FLIR system shall accept commands from a hand controller to turn off symbology burned into the imagery.

### Built In Test (BIT) Implementation

The FLIR shall provide for the FLIR (TU and EU) self-test BIT, status BIT, SRA BIT/Initiated BIT, and fault isolate when commanded by 1553 or Ethernet.

### Status BIT

The FLIR shall provide BIT status over 1553 or Ethernet. The BIT shall run in the background tasks without inhibiting, interfere, or degrade the performance of the equipment.

### Fault Isolation

The FLIR shall provide the operator notification the full name of the failure and the cause of the BIT Failure. Self-test BIT, status BIT, and fault isolate shall provide 97% of the detected failures for the WRA down to the SRA level.

### False Alarm

BIT false Alarm shall not be permitted.

## Vibration and Shock

### Aircraft Induced Vibration

The FLIR system shall withstand Aircraft Induced vibration in accordance with MIL-STD-810H Change 1, Method 514.8, Procedure I using the sine-on-random vibration test spectrum defined by the random spectrum and sinusoid frequencies, based on frequencies and amplitudes for endurance testing associated with the Vibration Zone of the component location.

The (aircraft-induced) vibratory environment for all components located in the Electronics Bay is consistent with levels defined for Sine-on-Random Vibration Testing IAW MIL-STD-810H Change 1, Method 514.8, Procedure I, Category 14, and Fig. 514.8D-4 to the following random spectrum and the sine amplitudes corresponding to 4Hr/axis vibration qualification levels.

Random Spectrum

|  |  |
| --- | --- |
| Random Spectrum Location | Random Spectrum Parameters  (ref. MIL-STD-810H Change 1, Fig. 514.8D-4, Table 514.8D-IIIb) |
| External Stores | W0 = 0.0020 g^2/Hz  W1 = 0.020 g^2/Hz  ft = 500 Hz |
| Internal Stores | W0 = 0.0010 g^2/Hz  W1 = 0.010 g^2/Hz  ft = 500 Hz |

Qualification Sinusoidal Spectrum

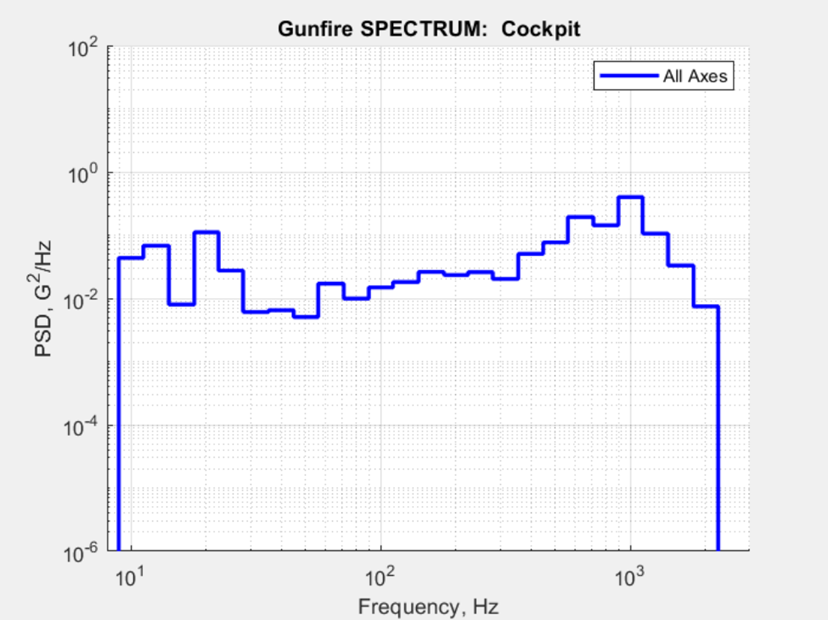
|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Source | Frequency, Hz | Sinusoidal Amplitudes,  16-Hour Vibration Qual. Level, g | | | |
| Long. | Lat. | Vert. | Max\* |
| 1/ TR | 12 | 1.02 | 0.68 | 1.67 | 1.67 |
| 7/ MR | 21.5 | 1.38 | 2.57 | 5.03 | 5.03 |
| 4/ TR | 48 | 0.75 | 0.44 | 0.78 | 0.78 |
| 8/ TR | 96 | 0.47 | 0.18 | 0.83 | 0.83 |

\*May use max on all three axes to simplify test and maximize installation flexibility, if desired.

### Gun-Fire Vibration

The FLIR system shall withstand gunfire vibration requirements in accordance with MIL-STD-810H Change 1, Method 519.8 Procedure III using the following 1/3 octave-band random profile (without inclusion of sine tones) for 1 hour per axis using the gunfire vibration test spectrum defined in Table 1 and shown in Figure 10.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Frequency Band, Hz | | |  | PSD, G^2/Hz | | |
| Start | Center | Stop |  | X | Y | Z |
| 8.91 | 10.00 | 11.18 | 4.36E-02 | 4.36E-02 | 4.36E-02 |
| 11.18 | 12.55 | 14.14 | 6.80E-02 | 6.80E-02 | 6.80E-02 |
| 14.14 | 15.87 | 17.89 | 8.01E-03 | 8.01E-03 | 8.01E-03 |
| 17.89 | 20.08 | 22.36 | 1.11E-01 | 1.11E-01 | 1.11E-01 |
| 22.36 | 25.10 | 28.06 | 2.75E-02 | 2.75E-02 | 2.75E-02 |
| 28.06 | 31.50 | 35.5 | 6.09E-03 | 6.09E-03 | 6.09E-03 |
| 35.5 | 39.85 | 44.72 | 6.48E-03 | 6.48E-03 | 6.48E-03 |
| 44.72 | 50.20 | 56.12 | 5.06E-03 | 5.06E-03 | 5.06E-03 |
| 56.12 | 62.99 | 70.99 | 1.71E-02 | 1.71E-02 | 1.71E-02 |
| 70.99 | 79.68 | 89.44 | 9.91E-03 | 9.91E-03 | 9.91E-03 |
| 89.44 | 100.39 | 111.8 | 1.49E-02 | 1.49E-02 | 1.49E-02 |
| 111.8 | 125.49 | 141.43 | 1.81E-02 | 1.81E-02 | 1.81E-02 |
| 141.43 | 158.75 | 178.89 | 2.62E-02 | 2.62E-02 | 2.62E-02 |
| 178.89 | 200.80 | 223.61 | 2.34E-02 | 2.34E-02 | 2.34E-02 |
| 223.61 | 250.99 | 280.62 | 2.60E-02 | 2.60E-02 | 2.60E-02 |
| 280.62 | 314.99 | 354.97 | 2.03E-02 | 2.03E-02 | 2.03E-02 |
| 354.97 | 398.44 | 447.22 | 5.07E-02 | 5.07E-02 | 5.07E-02 |
| 447.22 | 501.99 | 561.25 | 7.69E-02 | 7.69E-02 | 7.69E-02 |
| 561.25 | 629.98 | 709.94 | 1.93E-01 | 1.93E-01 | 1.93E-01 |
| 709.94 | 796.88 | 894.43 | 1.43E-01 | 1.43E-01 | 1.43E-01 |
| 894.43 | 1003.96 | 1118.04 | 3.99E-01 | 3.99E-01 | 3.99E-01 |
| 1118.04 | 1254.96 | 1414.26 | 1.06E-01 | 1.06E-01 | 1.06E-01 |
| 1414.26 | 1587.45 | 1788.87 | 3.31E-02 | 3.31E-02 | 3.31E-02 |
| 1788.87 | 2007.94 | 2244.92 | 7.45E-03 | 7.45E-03 | 7.45E-03 |



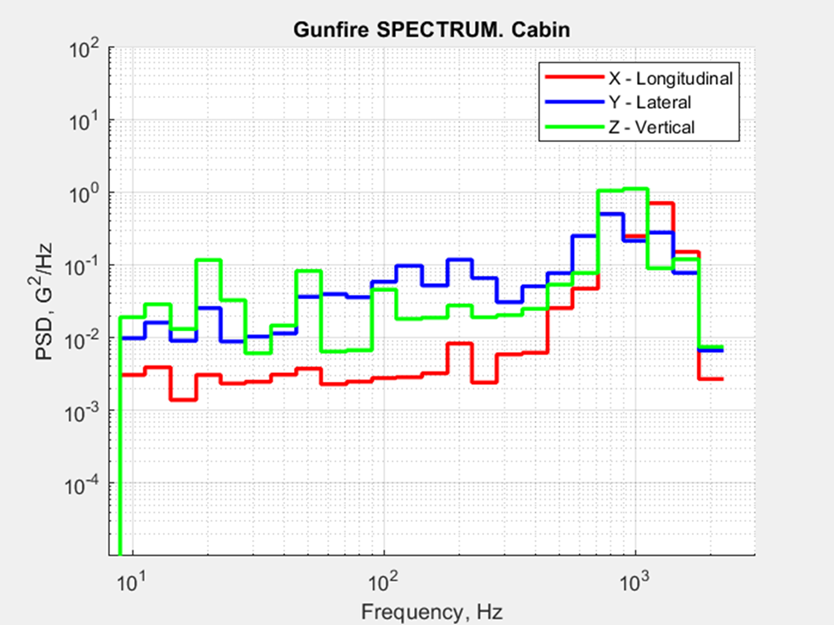


Figure XX: Gunfire Spectrum

### Functional Shock

The FLIR shall meet performance requirements and shall not be damaged after exposure to 18 impact shocks of 20g, consisting of 3 shocks in opposite directions along each of 3 mutually perpendicular axes, using MIL-STD-810H Change 1, Method 516.8, Procedure I and Figure 516.8-3 (sawtooth). Each shock pulse shall have a time duration of 11 milliseconds. The ‘g’ value should be within ±10 percent when measured with a 0.2 to 250 Hz filter.

## Environmental Conditions

### Operational Temperature

The FLIR System shall operate between -40 degrees C and +55 degrees C.

### Non-Operating Temperature

The FLIR System shall be designed to withstand the non-operating temperature of -54 degrees C to +71 degrees C.

### Altitude

The FLIR System shall be operational up to 17, 000 feet above sea level and withstand air transport (Non-Operational) up to 50,000 feet above sea level.

### Rain

The FLIR turret shall remain operational during rainfall of 3.4 mm/min (8 in/hr) with a forward airspeed of 100 kts for a duration of 30 mins.

### Icing and Freezing Rain

The FLIR system shall comply with MIL-STD-810H Change 1, Method 521.4, specifically Procedure I for Glaze Ice with a thickness of 75 mm (heavy loading, marine environment), spray at –10 °C, de-ice by external means, non-operational.

### Humidity

The FLIR system shall withstand 0-100% relative humidity, including conditions where moisture condenses on the component.

### Sand and Dust

The FLIR system, excluding the optics, shall be able to remain operational after exposure to blowing sand and dust in both operational and non-operational conditions.

### Optics Coating Durability

#### Abrasion

The exterior optical component’s coatings shall withstand being delaminated under ISO -9211-4 section 5, Abrasion resistance tests, for a 04 Degree of severity.

#### Adhesion

The exterior optical component’s coatings shall withstand being delaminated under ISO -9211-4 section 6, Adhesion tests, for a 02 degree of severity.

#### Crosshatch

The exterior optical component’s coatings shall withstand being delaminated under ISO -9211-4 section 7, Crosshatch tests.

### Explosive Atmosphere

The FLIR system shall not cause ignition of an ambient-explosive-gaseous mixture with air when operating in such an atmosphere.

### Salt Fog

The FLIR system shall operate without degradation exposure to a 5 percent salt fog environment alternating 24-hour periods of salt fog exposure and drying conditions for a minimum of four 24-hour periods (two wet and two dry) in accordance with MIL-STD-810H Change 1, Method 509.8, Procedure I.

# Verification and Qualification

It shall be the responsibility of the equipment provider to verify the product meets all the requirements of this specification and to perform any tests or other verifications required herein prior to equipment delivery.

The requirements of this document shall be verified by means of inspection, analysis, demonstration or test. If the FLIR components have been through successful acceptance test, the contractor may submit previous test results for Government consideration in lieu of performing additional testing.

Verification Methods are as Follows:

1. Inspection is defined as the physical examination of the product in order to determine conformance to the specification.
2. Analysis is defined as the use of equations, models, charts, predictions, etc. to derive evidence of conformance to the specification.
3. Demonstration is defined as the operation of the product in its intended environment to determine conformance to the specification. Typically, quantitative measurements are not made as part of a demonstration.
4. Test is defined as the operation of the equipment where performance is measured quantitatively to determine conformance to the specification.

## FLIR Description

There are no verification requirements for this paragraph.

### Turret Unit

The requirements of paragraph 3.1.1 shall be verified by inspection.

#### Turret Unit Alignment

The requirements of paragraph 3.1.1.1 shall be verified by analysis.

#### Operational Modes

The requirements of paragraph 3.1.1.2 shall be verified by demonstration.

##### Standby Modes

The requirements of paragraph 3.1.1.2.1 shall be verified by demonstration.

##### Test Modes

The requirements of paragraph 3.1.1.2.2 shall be verified by demonstration.

##### Geo Point Mode

The requirements of paragraph 3.1.1.2.3 shall be verified by demonstration.

##### Inertial Point Mode

The requirements of paragraph 3.1.1.2.4 shall be verified by demonstration.

##### Position Mode

The requirements of paragraph 3.1.1.2.5 shall be verified by demonstration.

##### On/Off Mode

The requirements of paragraph 3.1.1.2.6 shall be verified by demonstration.

#### Operator Controls

The requirements of paragraph 3.1.1.3 shall be verified by demonstration.

#### Discrete Controls

The requirements of paragraph 3.1.1.4 shall be verified by demonstration.

### Electronic Power Interface

The requirements of paragraph 3.1.2 shall be verified by test in accordance with MIL-STD-704F.

### Interfaces

The requirements of paragraph 3.1.3 shall be verified by demonstration.

#### Maintenance/Safety Interface

The requirements of paragraph 3.1.3.1 shall be verified by demonstration.

#### Mechanical Interface

The requirements of paragraph 3.1.3.2 shall be verified by inspection.

#### Video Interface

The requirements of paragraph 3.1.3.3 shall be verified by demonstration.

#### Signal and Cabling Interface

The requirements of paragraph 3.1.3.4 shall be verified by analysis.

#### Turret Slewing Interface

The requirements of paragraph 3.1.3.5 shall be verified by demonstration if applicable.

#### Navigational Data Interface

The requirements of paragraph 3.1.3.6 shall be verified by demonstration.

#### Command and Control Interface

The requirements of paragraph 3.1.3.7 shall be verified by demonstration.

#### FLIR Control Panel Interface

The requirements of paragraph 3.1.3.8 shall be verified by demonstration.

### FLIR Data Display

There are no verification requirements for this paragraph.

#### Sensor Video Symbology

The requirements of paragraph 3.1.4.1 shall be verified by inspection or demonstration.

#### Aircraft Position

The requirements of paragraph 3.1.4.2 shall be verified by demonstration.

#### Video Grayscale Generator

The requirements of paragraph 3.1.4.3 shall be verified by demonstration.

#### Data Symbology for Maintenance

The requirements of paragraph 3.1.4.4 shall be verified by demonstration.

#### Moving target Indicator

The requirements of paragraph 3.1.4.5 shall be verified by demonstration.

#### Loss of Communication with Avionics

The requirements of paragraph 3.1.4.6 shall be verified by demonstration.

## Performance Characteristics

There are no verification requirements for this paragraph.

### FLIR Readiness

The requirements of paragraph 3.2.1 shall be verified by demonstration.

### Maintenance System Defaults

The requirements of paragraph 3.2.2 shall be verified by demonstration.

### Power Up

The requirements of paragraph 3.2.3 shall be verified by demonstration.

### Infrared Optics

There are no verification requirements for this paragraph.

#### Field of View

The requirements of paragraph 3.2.4.1 shall be verified by analysis.

##### Narrow FOV

The requirements of paragraph 3.2.4.1.1 shall be verified by analysis.

##### Wide FOV

The requirements of paragraph 3.2.4.1.2 shall be verified by analysis.

##### Medium FOV

The requirements of paragraph 3.2.4.1.3 shall be verified by analysis.

#### FOV Transition Time

The requirements of paragraph 3.2.4.2 shall be verified by analysis.

#### FOV Boresight

The requirements of paragraph 3.2.4.3 shall be verified by demonstration.

#### Coincidence of Multiband Sensors

The requirements of paragraph 3.2.4.4 shall be verified by demonstration.

#### Optical Focus

The requirements of paragraph 3.2.4.5 shall be verified by demonstration.

#### Horizontal Rotation Limit

The requirements of paragraph 3.2.4.6 shall be verified by inspection.

#### Vertical Rotation Limit

The requirements of paragraph 3.2.4.7 shall be verified by inspection.

#### Electronic Zoom

The requirements of paragraph 3.1.12 shall be verified by demonstration.

#### FLIR Range Performance

The requirements of paragraph 3.2.4.9 shall be verified by analysis.

##### Detection

The requirements of paragraph 3.2.4.9.1 shall be verified by analysis.

##### Identification

The requirements of paragraph 3.2.4.9.2 shall be verified by analysis.

##### Noise Equivalent Temperature Difference

The requirements of paragraph 3.2.4.9.3 shall be verified by test in accordance with ASTM E 1543-00.

#### Visible Range Performance

##### Detection

The requirements of paragraph 3.2.4.10.1 shall be verified by analysis.

##### Identification

The requirements of paragraph 3.2.4.10.2 shall be verified by analysis.

#### Night Vision Imaging System

The requirements of paragraph 3.2.4.11 shall be verified by test in accordance with MIL-L-85762.

#### Noncorrected Detector Operability

The requirements of paragraph 3.2.4.12 shall be verified by demonstration.

#### MWIR Detector Operability

The requirements of paragraph 3.2.4.13 shall be verified by demonstration.

#### Detector Cool Down

The requirements of paragraph 3.2.4.14 shall be verified by test.

#### Image Processing

The requirements of paragraph 3.2.4.15 shall be verified by demonstration.

#### Multiband Imagery Composite

The requirements of paragraph 3.2.4.16 shall be verified by demonstration.

#### Polarity

The requirements of paragraph 3.2.4.17 shall be verified by demonstration.

### Lasers

The requirements of paragraph 3.2.5 shall be verified by demonstration.

#### Auto Tracker Control

The requirements of paragraph 3.2.5.1 shall be verified by demonstration.

#### Tracker

The requirements of paragraph 3.2.5.2 shall be verified by test.

#### Moving Target Indicator

The requirements of paragraph 3.2.5.3 shall be verified by demonstration.

#### Target/Range Accuracy

The requirements of paragraph 3.2.5.4 shall be verified by analysis.

#### Laser Range Finder

The requirements of paragraph 3.2.5.5 shall be verified by analysis.

#### Laser Target Marker

The requirements of paragraph 3.2.5.6 shall be verified by demonstration.

#### Boresight

The requirements of paragraph 3.2.5.7 shall be verified by analysis.

## FLIR Settings

The requirements of paragraph 3.3 shall be verified by demonstration.

## Laser Counter Counter Measures

The requirements of paragraph 3.4 shall be verified by analysis.

## Software

The requirements of paragraph 3.5 shall be verified by demonstration.

## Design and Construction

### Inverted Mounting Configuration

The requirements of paragraph 3.6.1 shall be verified by test.

### AC Power

The requirements of paragraph 3.6.2 shall be verified by analysis.

#### Load Measurements

The FLIR system requirements of paragraph 3.6.2.1 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Normal Steady State Limits for Voltage and Frequency

The FLIR system requirements of paragraph 3.6.2.2 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Voltage Modulation

The FLIR system requirements of paragraph 3.6.2.3 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Frequency Modulation

The FLIR system requirements of paragraph 3.6.2.4 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Voltage Distortion Spectrum

The FLIR system requirements of paragraph 3.6.2.5 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Total Voltage Distortion

The FLIR system requirements of paragraph 3.6.2.6 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### DC Voltage Component

The FLIR system requirements of paragraph 3.6.2.7 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Normal Voltage Transients

The FLIR system requirements of paragraph 3.6.2.8 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Normal Frequency Transients

The FLIR system requirements of paragraph 3.6.2.9 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Power Interrupts

The FLIR system requirements of paragraph 3.6.2.10 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Abnormal Steady State Limits For Voltage and Frequency

The FLIR system requirements of paragraph 3.6.2.11 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Abnormal Voltage Transients

The FLIR system requirements of paragraph 3.6.2.12 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Abnormal Frequency Transients

The FLIR system requirements of paragraph 3.6.2.13 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Emergency Steady State Limits For Voltage and Frequency

The FLIR system requirements of paragraph 3.6.2.14 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Power Failure

The FLIR system requirements of paragraph 3.6.2.15 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Phase Reversal

The FLIR system requirements of paragraph 3.6.2.16 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### In-rush Current

The FLIR system requirements of paragraph 3.6.2.17 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Circuit Breaker Compatibility

The FLIR system requirements of paragraph 3.6.2.18 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Power Return Isolation

The FLIR system requirements of paragraph 3.6.2.19 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Self-Discharge

The FLIR system requirements of paragraph 3.6.2.20 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

### DC Power

The requirements of paragraph 3.6.3 shall be verified by demonstration.

#### Electrical Load

The FLIR system requirements of paragraph 3.6.3.1 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Steady State Voltage

The FLIR system requirements of paragraph 3.6.3.2 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Voltage Distortion

The FLIR system requirements of paragraph 3.6.3.3 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Voltage Ripple

The FLIR system requirements of paragraph 3.6.3.4 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Normal Voltage Transients

The FLIR system requirements of paragraph 3.6.3.5 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Electrical Power interrupts

The FLIR system requirements of paragraph 3.6.3.6 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Abnormal Steady State Voltage

The FLIR system requirements of paragraph 3.6.3.7 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Abnormal Voltage Transients

The FLIR system requirements of paragraph 3.6.3.8 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Emergency Steady State Voltage

The FLIR system requirements of paragraph 3.6.3.9 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Starting Voltage

The FLIR system requirements of paragraph 3.6.3.10 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Electrical Power Failure

The FLIR system requirements of paragraph 3.6.3.11 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### In-rush Current

The FLIR system requirements of paragraph 3.6.3.12 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Circuit Breaker Compatibility

The FLIR system requirements of paragraph 3.6.3.13 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

#### Power Return Isolation

The FLIR system requirements of paragraph 3.6.3.14 shall be tested in accordance with MIL-STD-704F. Electrical qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

### Electromagnetic Environment

The requirements of paragraph 3.6.4 shall be verified by test in accordance with MIL-STD-461G.

The FLIR system shall be verified using test methods CE102, CS101, CS114, CS115, CS116, CS117 & CS118 of MIL-STD-461G. The FLIR shall not incur permanent damage or be susceptible while operating on the aircraft in the electromagnetic environment specified in MIL-STD-461G. This shall be verified using the following test methods of MIL-STD-461G:

i. RE102 (Radiated Emissions, Electric Field); 10 kHz to 18 GHz (FIGURE RE102-3, 10 kHz to 18 GHz).

ii. RS103 (Radiated Susceptibility, Electric Field); 2 MHz to 40 GHz (2 MHz to 18 GHz @ 200 V/m).

### Lightening Protection

The requirements of paragraph 3.6.5 shall be verified by analysis.

### Bonding

The requirements of paragraph 3.6.6 shall be verified by test in accordance with MIL-STD-464D.

#### Turret Unit Bonding

The requirements of paragraph 3.6.6.1 shall be verified by test in accordance with MIL-STD-464D.

#### Turret Adapter Plate Bonding

The requirements of paragraph 3.6.6.2 shall be verified by test in accordance with MIL-STD-464D.

#### Electronic Unit Bonding

The requirements of paragraph 3.6.6.3 shall be verified by test in accordance with MIL-STD-464D.

#### Electro-Static Discharge

The requirements of paragraph 3.6.6.4 shall be verified by test in accordance with MIL-STD-461G.

### Interchangeability

The requirements of paragraph 3.6.7 shall be verified by demonstration.

## Structural Design

### Strength

The requirements of paragraph 3.7.1 shall be verified by analysis.

### Loads

The requirements of paragraph 3.7.2 shall be verified by analysis.

### Flight Loads

The requirements of paragraph 3.7.3 shall be verified by analysis.

### Handling Loads

The requirements of paragraph 3.7.4 shall be verified by analysis.

### Crash Loads

The requirements of paragraph 3.7.5 shall be verified by analysis.

### Vibration Design Requirements

The requirements of paragraph 3.7.6 shall be verified by test.

## Hazardous Materials

The requirements of paragraph 3.8 shall be verified by analysis.

## Human Factors

The requirements of paragraph 3.9 shall be verified by analysis.

## Nomenclature Identification and Marking

The requirements of paragraph 3.10 shall be verified by inspection.

## Safety

### Laser Safety

#### Except for demonstrations and tests cited herein, the requirements of paragraph 3.11.1 shall be verified by analysis. The Navy Laser Safety Review Board (LSRB) will test the lasers at the contractor facility to determine stay light hazards and laser beam energy profiles. Double Activation Integrity

The requirements of paragraph 3.11.1.1 shall be verified by demonstration.

#### Laser Interlock

The requirements of paragraph 3.11.1.2 shall be verified by demonstration.

#### Laser Fire Masking

The requirements of paragraph 3.11.1.3 shall be verified by demonstration.

## Reliability

The requirements of paragraph 3.12 shall be verified by analysis.

### Operational Life

The requirements of paragraph 3.12.1 shall be verified by analysis.

### Storage

The requirements of paragraph 3.12.2 shall be verified by analysis.

## Maintainability

### Mean Time to Repair

The requirements of paragraph 3.13.1 shall be verified by analysis.

### Off Aircraft Maintenance

The requirements of paragraph 3.13.2 shall be verified by demonstration.

### Built in Test (BIT) Implementation

The requirements of paragraph 3.13.3 shall be verified by demonstration.

### Status BIT

The requirements of paragraph 3.13.4 shall be verified by demonstration.

### Fault Isolation

The requirements of paragraph 3.13.5 shall be verified by demonstration.

### False Alarm

The requirements of paragraph 3.13.6 shall be verified by analysis.

## Vibration and Shock

### Aircraft Induced Vibrations

The requirements of paragraph 3.14.1 shall be verified by test in accordance with MIL-STD-810H Change 1, Method 514.8, Procedure I.

A resonance search test (i.e., sinusoidal scan) shall be performed in accordance with RTCA/DO-160G subparagraph 8.8.1.3.a before and after each vibration qualification test segment. The results from the initial resonance search test shall be reviewed prior to commencement of vibration qualification testing to finalize selection of the sinusoidal test frequencies. For any resonances that are within 5% of the aircraft forcing frequencies (1 per MR 3.1 Hz, 1 per TR 12 Hz, 7 per MR 21.5 Hz, 14 per MR 43 Hz, 4 per TR 48 Hz, and 8 per TR 96 Hz), the corresponding sinusoidal test frequencies will be reviewed and may be adjusted to coincide with these resonance frequencies during the sine-on-random vibration test.

### Gun-Fire Vibration

The requirements of paragraph 3.14.2 shall be verified by test in accordance with MIL-STD-810H Change 1, Method 519.8 Procedure III.

### Functional Shock

The requirements of paragraph 3.14.3 shall be verified by test in accordance with MIL-STD-810H Change 1, Method 516.8, Procedure I and Figure 516.8-3 (sawtooth).

## Environmental Conditions

### Operational Temperature

The requirements of paragraph 3.15.1 shall be verified by test.

The FLIR system shall be tested to MIL-STD-810H Change I Method 501.7, Procedure II for the +55 C operational temperature limit. Environmental qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

The FLIR system shall be tested to MIL-STD-810H Change I Method 502.7, Procedure II for the -40 C operational temperature limit. Environmental qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

### Non-Operating Temperature

The requirements of paragraph 3.15.2 shall be verified by test.

The FLIR system shall be tested to MIL-STD-810H Change I Method 501.7, Procedure I for the +71 C operational temperature limit. Environmental qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

The FLIR system shall be tested to MIL-STD-810H Change I Method 502.7, Procedure I for the -54 C operational temperature limit. Environmental qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

### Altitude

The requirements of paragraph 3.15.3 shall be verified by analysis of environmental test data provided by the vendor for each electrical / avionics unit. Results of the analysis shall verify that the electrical / avionics units will function at specified performance in the CH-53K operational environment. Environmental qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

### Rain

The requirements of paragraph 3.15.4 shall be verified by test. The FLIR turret shall be tested to MIL-STD-810H Change 1 Method 506.6, Procedure I. Environmental qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

### Icing and Freezing Rain

The requirements of paragraph 3.15.5 shall be verified by test.

The FLIR system shall comply with MIL-STD-810H Change 1, Method 521.4, specifically Procedure I for Glaze Ice with a thickness of 75 mm (heavy loading, marine environment). The test will involve spraying the system at a temperature of -10°C and de-icing it using external means. The system will not be operational during the testing. Once the system has thawed, it must be fully operational again.

### Humidity

The requirements of paragraph 3.15.5 shall be verified by test. The FLIR turret shall be tested to MIL-STD-810H Change 1 Method 507.6, Procedure I. Environmental qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

### Sand and Dust

The requirements of paragraph 3.15.6 shall be verified by test. The FLIR system shall be tested in accordance with MIL-STD-810H Change 1, Method 510.7, Procedure I. Environmental qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

### Optics Coating Durability

#### Abrasion

The requirements of paragraph 3.15.8.1 shall be verified by test in accordance with ISO -9211-4 section 5, Abrasion resistance tests, for a 04 Degree of severity.

#### Adhesion

The requirements of paragraph 3.15.8.2 shall be verified by test in accordance with ISO -9211-4 section 6, Adhesion tests, for a 02 degree of severity.

#### Crosshatch

The requirements of paragraph 3.15.8.3 shall be verified by test in accordance with ISO -9211-4 section 7, Crosshatch tests.

### Explosive Atmosphere

The requirements of paragraph 3.15.9 shall be verified by test.

The FLIR system shall be tested in accordance with MIL-STD-810H Change 1, Method 511.7, Procedure I. Environmental qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.

### Salt Fog

The requirements of paragraph 3.15.10 shall be verified by test.

The FLIR system shall be tested in accordance with MIL-STD-810H Change 1, Method 509.8, Procedure I. Environmental qualification tests shall not be required for previously qualified electrical / avionics units that are acceptable for use in the CH-53K operational environment.