Chapter 15

THE FLIGHT SURGEON'S ROLE IN FLIGHT SAFETY

The Flight Surgeon's role in flight safety is of paramount importance. Indeed, the Flight Surgeon's rating and flying status are justified, to a great degree, by his contribution to flight safety, the end product of many of his endeavors.

The following facts illustrate the importance of promoting aerospace safety in the Air Force. A review of mortality rates during 1964 and 1965 reveals that 73% of all deaths occurring in Air Force flying officers during that period were attributed to aircraft accidents. Other statistics indicate that, from January 1960 to 1 January 1966, 1,974 persons died in Air Force aircraft flight accidents. This also entailed the loss of 1,677 aircraft at an average annual cost of $376,474,000.

The Deputy Inspector General for Inspection and Safety defines "aerospace safety" as the conservation of our resources, whether men, money, or materiel, from the standpoint of increasing the over-all effectiveness and combat readiness of the Air Force. The Aerospace Safety Directorate of the Deputy Inspector General for Inspection and Safety is divided into three divisions: Flight Safety, Ground Safety, and Missile and Space Safety. This chapter will deal only with Flight Safety.

The Flight Surgeon's daily activities involve all phases of Flight Safety. For purposes of clarity, these phases are presented in this chapter under three major categories: *The Flying Safety Program, Standard Procedures in Aircraft Accidents,* and *Accident Investigation.* The last two are closely related to accident prevention which is the primary goal of flight safety. In the investigation of an aircraft accident, the factors that produced the accident are identified and evaluated, and recommendations as to ways and means for preventing recurrences are established. The Flight Surgeon evaluates the patterns of human injury to determine the effectiveness of personal protective, life support and emergency egress equipment. From this evaluation he makes recommendations for improvements and modifications of this equipment.

THE FLYING SAFETY PROGRAM

The role of the Flight Surgeon in flying safety has several aspects. His practice of flight medicine, his participation in flying activities, his support of the flying safety education program, and his contribution to research and development activities form the firm foundation of this role.

Flight Medicine

Medical Selection. Medical selection of applicants for aircrew training is one of the most effective flying safety measures available to the Flight Surgeon. When performing Class I physical examinations, he should realize the importance of a thorough and complete evaluation of each applicant and the implications of his decision that the man is physically qualified. Errors of selection on his part could result in an accident during training or a costly elimination from a training program. The conscientious application of the exacting physical and psychological standards in AFM 160-1 has helped to keep human factor accidents and hazards to a minimum.

Annual Physical Examination. Physical qualifications for flying are monitored by the annual Class II physical examination and during individual medical attention provided by sick call visits. The high standards of medical selection and qualification have produced a very healthy population. This is reflected in the very low incidence of medical incapacitation as a cause of aircraft accidents.

Routine Medical Care. Providing prompt, personalized medical attention and care to the flier is an important responsibility of the Flight Surgeon. Maintaining the health and physical fitness of flying personnel has a direct relationship to flying safety and combat effectiveness. The Flight Surgeon must evaluate each disease and injury in terms of the impact that such conditions may impose on each flier's ability to perform safely and effectively. Aircrew confidence and respect for the Flight Surgeon are gained from the application of high professional medical standards. This confidence and respect pay off by the earlier reporting of disease and injury, with resultant early treatment and lower morbidity. Delays in seeking medical advice and/or a practice of self-treatment by fliers might otherwise result in situations fraught with hazard, particularly in the flying environment.

An early return to flying status is essential to maintain crew integrity and a low level of noneffectiveness. While such a practice fully supports commanders in meeting their operational commitments, it is imperative that full professional consideration be given to insure complete recovery from the disease or injury and the effect of medications. The stresses of flight can be unforgiving, especially when a person's physiology and ability to respond are compromised.

Medical Education and Training. Another important aspect of the Flying Safety Program is medical education and training. This role of the Flight Surgeon is assumed during formal and informal contacts with aircrew members. A contribution to expanding their knowledge of medical facts, health hints, and first aid may occur, *for example,* as a result of a presentation at a flying safety meeting, while conversing at lunch in the alert facility, while conducting the physical examinations, or in the course of performing flying activities. The following topics, which, generally, have been well received by the aircrews, are recommended for frequent presentation:

Basic concepts of hygiene and nutrition.

Types and effects of fatigue.

Effect of medication and dangers of self-medication.

Health aspects of smoking, obesity, and physical fitness.

Pharmacology of ethyl alcohol.

Personal preventive medicine measures.

Use of protective equipment. (The Flight Surgeon should illustrate this topic with actual case histories; *for example,* the protection boots and gloves afforded a flier who exited an aircraft on fire. Pictures can add emphasis.)

Flying Activities

The Flight Surgeon's flying and flightline activities represent one of his most productive areas of endeavor. By active participation in his unit's flying mission, the Flight Surgeon experiences the psychophysiologic stresses of the flying environment. This experience provides him with a valuable background for evaluating the reactions of aircrewmembers to the stresses of flying. In addition, it provides an opportunity to evaluate firsthand the crew discipline, use of personal and survival equipment, and hazardous conditions related to aviation.

Perhaps the most important and difficult task a Flight Surgeon faces is the establishment of rapport with the aircrews. "Professionalism" is a way of life to our aircrews, and a Flight Surgeon must demonstrate a professional approach to his aircrew duties to be accepted by the flight crews. By demonstrating medical proficiency in the flying environment, the Flight Surgeon strengthens the confidence of fliers in his medical ability and establishes the rapport that will bring them to his office when they have symptoms that may threaten their flying careers. This probably will be the Flight Surgeon's most important contribution to flying safety.

Flying Safety Participation

In the performance of flying safety activities, the Flight Surgeon should establish a close working relationship with the unit Flying Safety Officer. The Flying Safety Officer is a source of information on the technical aspects of flying safety and can pinpoint problem areas in which a medical input is required. The Flight Surgeon, on the other hand, should offer consultation and advice on matters pertaining to the physiology of flight, medical problems, and personal and survival equipment. Thus, the Flight Surgeon/Flying Safety Officer Team brings medical activities into direct alignment with the Flying Safety Program.

The Flight Surgeon should participate actively in unit flying safety meetings and have a role in planning them. Presentations and discussions need not be long and highly technical; ideally, Flight Surgeon participation should be brief, to the point, and presented in understandable terminology.

Topics for the meetings should be timely and pertinent to the flying mission. A suspense file should be kept, to insure the discussion of seasonal hazards before the fact. For instance, winter flying and survival hazards should be covered in the early fall. The unit flying mission should be closely monitored because special missions often dictate unscheduled coverage of unique medical hazards. Topics should be covered repeatedly, and, here again, a suspense file of topics is helpful. It requires an imaginative approach to present the same material again and again without boring the audience. Repetition is essential, however, because of the rotation of personnel and the necessity to assure that medical hazards are recognized and avoided.

Personal experience with the aircrew members is a prime source for interesting and timely topics. Background medical, flying, and accident experiences often dictate pertinent topics concerning the health and welfare of aircrews.

The Flying Safety Officer also should be a source of topics as he receives from the Directorate of Aerospace Safety, DIG/IS, Norton AFB, the bimonthly Kit for Flight, Ground, and Missile Safety Officers, containing information extracted from the entire Air Force accident/incident experience. "Notes to the Flight Surgeon," prepared by the Life Sciences Division, is also a part of this kit and is an important source of current aeromedical problems.

The publications, "Aerospace Safety" and "Aerospace Maintenance Safety" are also good references.

Research and Development Activities

A few flight surgeons will be assigned to primary Research and Development centers. Their primary duty in such assignments is related to the multiple facets of life sciences and life support. They endeavor to "fit the machine to the man." This requires the thorough application of medical knowledge to the design and engineering of the entire weapon system and covers every parameter of operation.

Research and Development (R&D) activities attempt to insure maximum efficiency and effectiveness of weapon systems and, in the case of mishap, to provide procedures and equipment that will permit emergency escape and survival of our most important resource, the trained aircrew member.

The role of the Flight Surgeon in aerospace R&D may be important when he generates requirements for R&D. He does this by recognizing and reporting materiel deficiencies. He may support the flying safety officer, the life support officer, or the aircrew member in submitting reports, such as AFTO Forms 29, "Unsatisfactory Report" (URs), Emergency Unsatisfactory Reports (EURs), reported on DD Forms 173, "Joint Messageform," and AFTO Forms 109, "Quality Control Deficiency Report" (QCDRs). R&D activity in response to these reports often results in design and quality deficiency corrections, new and modified equipment, or improved operational procedures. The Flight Surgeon, then, has the opportunity to evaluate the effectiveness and the crew acceptance of these results. This evaluation is important because equipment and procedures which are poorly accepted and applied may have adverse effects on flight safety and crew morale.

Operational Hazard Reports

The reporting of operational hazards is an effective tool in aircraft accident prevention. The Flight Surgeon may have opportunities to initiate or to support AF Forms 457, "Operational Hazard Report" (OHRs). These reports enable commanders to be immediately aware of, and to correct, dangerous conditions that could cause death or injury to personnel and loss of or damage to aircraft and property.

Aircraft Accident Investigation

Finally, the Flight Surgeon must investigate thoroughly each aircraft accident. This involves a retrospective investigation of all human and environmental factors that may cause an accident, and a determination of the effectiveness of egress systems and survival equipment. To support the investigation and findings, every scrap of evidence must be salvaged and all available information made a matter of record. Knowledge gained from such investigations plays an important role in accident prevention.

STANDARD PROCEDURES IN AIRCRAFT ACCIDENTS

Responsibility for Disaster Plans

It is the responsibility of the commander of each installation to publish a detailed Base Disaster Preparedness Operations Plan and to insure that the base is prepared to act promptly with appropriate measures to cope with potential or actual disaster situations. The Director of Base Medical Services (DBMS) is responsible for the Medical Annex to this Plan. Detailed information on planning and operations for disaster preparedness is in AFMs 160-37 and 355-1. The Flight Surgeon should be thoroughly familiar with the provisions of these manuals since he will exercise an early medical response to aircraft accidents and other disaster situations. The responses presented in this chapter are limited to those related to aircraft accidents.

Disaster Control Personnel

Personnel authorized to attend aircraft accident emergencies should be limited to the following three general groups:

Personnel required to participate in immediate aircraft accident operations (active participation);

Personnel required to perform related supporting services as circumstances may exist or develop (supporting participation); and

Personnel required to perform official duties in connection with such operations (administrative personnel).

Active participation is required by the following personnel:

Officer in charge of crash, firefighting, and rescue.

Crash, firefighting, and rescue crews.

Crash ambulance crews.

Designated medical personnel.

Special rescue crews (*e.g.*, rescue boat crews).

Supporting participation is provided by the following personnel as required:

Installation fire, maintenance and wrecker crews.

Provost Marshal, security, and law enforcement personnel.

Photographic personnel.

The entire base is alerted to provide administrative support. Examples of participants are: Public Relations or Information Officer; Chaplain; Base Legal Officer; and Explosive Ordnance Disposal Officer. The role of all of these personnel is usually detailed in the Base Disaster Preparedness Operations Plan (Base Oplan 355-).

Crash Alert and Notification Systems

Two crash alert and notification systems are generally used. These are the *primary* and *secondary crash alert nets*. The *primary* crash net is a direct wire, "hot line," intercommunication system normally installed between the control tower, the operations dispatcher desk, the crash fire station, and the crash ambulance station. The *secondary* crash alarm intercommunication net usually operates through the regular telephone exchange. It notifies, by established priority, all the necessary support organizations which, in turn, have their own disaster alert response plans.

The *Medical Crash Alert System* (MCAS) is generally a pyramidal one. This can vary according to the units' needs and capabilities. However, it should provide the following: *priority of notification; redundancy,* so that the absence of one person will not cause a break in alerting personnel; *flexibility,* to insure operational capability at all times and under all manning conditions, and *simplicity,* to avoid reference to complicated charts, etc. Practice is of paramount importance. Medical personnel should respond reflexively to emergencies. This can only be achieved by thorough initial training and repeated exercise of the Medical Crash Alert System.

A *crash message* is prepared at the earliest possible time by the operations and tower personnel. It is disseminated over the primary crash net to all members of the crash control team. Its purpose is to coordinate the crash control team efforts and to give advance warning of special conditions and/or hazards presented by the emergency or crash. The following information is included in the message: (1) Type of aircraft; (2) nature of emergency (*e.g.,* emergency landing or actual crash); (3) location of crash or landing runway in the case of emergency landing; (4) expected time of arrival; (5) number of occupants; (6) type of cargo (explosives, etc.); (7) the time before a "weapon" engulfed in flames will explode; and (8) such other information as is pertinent to the anticipated emergency operation.

Medical Support for Aircraft Disaster

The Director of Base Medical Services is responsible for all medical support in emergency and disaster situations. The medical facility must be prepared to organize disaster casualty control teams to insure maximum efficiency in the triage and treatment of casualties. The Chief of Aerospace Medicine must provide crash ambulances and trained crash ambulance teams on 24-hour standby alert. Provisions must be made for detection and decontamination of radiation and biologic hazards. The Flight Surgeon serves as the Crash Ambulance Team Chief and, as such, is the most important member of the Medical Crash Control Team.

The following are typical sequential procedures to be employed when the medical service implements a crash control exercise:

Initiate recall of medical personnel upon receipt of crash notification.

Dispatch crash ambulance teams to the scene.

Establish the Medical Command Post.

Prepare the hospital for emergency action.

Transport staff and supplies to the scene as requested by the Crash Ambulance Team Chief.

Initiate triage and the treatment of casualties as required.

Make a survey to determine radiation hazards.

Recommend exposure control and sampling procedures in the event a radiation hazard exists.

Identify and provide for the dead.

Investigate medical aspects of the crash.

Provide hospital medical care and evacuation of patients as necessary.

Procedures at a crash scene are fairly standard; however, because of the time, distance, navigation, and legal problems involved, it is mandatory to classify an accident under one of two categories: *on base* or *off base.*

On Base Accident Procedures:

Crash ambulance team departs immediately upon notification of emergency.

Crash ambulance proceeds directly to the scene (following all traffic and speed restrictions).

Crash ambulance obtains clearance from tower before crossing any runway. (This is done by radio or light signals from the tower. In the latter case, the ambulance should remain clear of the runway on "red" and proceed across on "green.")

Medical personnel will remain clear of the crash site until directed into the area by the Crash Firefighting and Rescue Chief.

(Two thousand feet is a minimum distance. They should avoid being downwind or downhill from the aircraft because of the fire hazard.) The medical team *will not enter:* the danger zone if explosives are a hazard; a burning wreck, until the fire is extinguished; a wreck where fire or explosion is likely, *unless cleared by the Fire Chief* and a lifesaving procedure requires their presence. In the latter case, rapid entry and exit are advisable. The reasons for this are twofold: (1) Inexperienced personnel may ignite a fire or trigger an explosion and (2) assuming a recovery role for which medical teams are untrained could result in unnecessary injury and death. (There have been cases where an entire medical team has been incapacitated by an explosion and fire at a crash scene.)

Off Base Accident Procedures: In general, bases have the responsibility for military aircraft disaster functions for half the distance between adjacent bases. (*Note: To Avoid Tragic Confusion, Know Your Area of Responsibility.*)

Standard maps are maintained at the control tower, base operations, fire and crash stations, security office, medical command post, and in crash ambulances. These maps cover a radius of 15 miles. They have numbered grids and superimposed compass-bearing lines to insure coordinated directions to the crash scene. The crash crews should be familiar with roads, bridges, paths, and other terrain features in the 15-mile area around the base. Map drills are an effective way to attain this proficiency.

Normally, when alerted for an off base crash, the crash ambulance will proceed to a designated convoy assembly point. A convoy is formed and led by the Crash Chief. Procedures are usually established for marking turns, etc., for follow-on vehicles. Occasionally, a crash ambulance will be dispatched to the off base scene, independent of the Crash Convoy. In this situation, the medical unit should know the location of the crash, route of travel, time of departure, and estimated time of return. This is especially important in foreign countries where ambulances are easily "lost."

Once off Government property, military personnel are subject to civil law. This also applies to the operation of emergency vehicles. Emergency vehicles are not to exceed legal speed or violate traffic rules. A clear understanding of the local laws should be established at each base.

In the event of aircraft fatalities, the remains come under the jurisdiction of the local coroner. It is extremely important to establish liaison with civil authorities and agree on procedures for handling this problem before a crash occurs. It is advisable to have a military legal representative advise medical personnel on any agreement discussed with civil authorities. AFR 160-109 emphasizes the importance of autopsies and establishes the responsibilities for performing autopsies on crew fatalities. Most civil authorities will welcome any assistance and cooperate fully if they understand the importance of such autopsies. *To repeat,* prior liaison is advised to assure cooperation and to avoid delays and confusion. If at all possible, military personnel should clear with the local coroner before removing a body to the military base. Undue delay is to be avoided.

Crash Site Procedures:

Obtain clearance from the Fire Chief to enter area.

Estimate the number and type of casualties. At the earliest opportunity, the Flight Surgeon must develop estimates and request additional medical help as required. Casualty estimates received in advance of the arrival of patients will better enable the medical staff to make necessary preparations. When all casualties in an accident are fatalities, the medical command post should be notified so that the entire medical unit is not held in an alert status unnecessarily.

Casualty Classification. Triage is the art of classification of multiple casualties by prognosis and by type and severity of injury. Triage, skillfully applied, is the best way to overcome and control confusion when large numbers of casualties are involved. Fundamentally, triage categories are based upon the physiologic threat posed by the injuries. The following classifications are used:

Class I. Minimal. No physiological threat exists and there is either no or scant loss of function. *Examples:* contusions, abrasions, lacerations; simple fractures of smaller bones; second degree burns of less than 10%; moderate anxiety states.

Class II. Immediate. Properly accomplished and brief lifesaving procedures are essential. *Examples:* mechanical respiratory hazards; hemorrhage at a quickly accessible site; severe extremity wounds; incomplete amputations; open fractures; crush wounds.

Class III. Delayed. A delay in management does not hazard life. *Examples:* moderate lacerations without extensive bleeding; second degree burns involving less than 30% and third degree burns less than 20%; closed fractures of principal bones; noncritical central nervous system injury.

Class IV. Expectant. Medical management requirements are complicated and time-consuming. *Examples:* second or third degree burns over 40%; abdominal injury with possible viscus damage; critical central nervous system injury; multiple severe injuries.

Medical Treatment at Crash Site. There are six immediate requirements in casualty care:

Maintain respiration.

Stop hemorrhage.

Immobilize all fractures (often this is extended to include soft tissue which has sustained massive trauma).

Prevent further infection—dress the wounds.

Never interfere with natural defenses.

Transport properly.

The Flight Surgeon should be able to accomplish quickly and effectively the procedures necessary to manage these requirements. His primary responsibilities are accurate diagnosis, rapid triage, and the efficient supervision of medical and paramedical personnel.

Initial treatment is performed "on the spot" if conditions permit; *i.e.,* splints, tourniquets, etc., are usually applied where the casualty lies, unless a fire hazard makes rapid evacuation of casualties necessary.

DD Form 1380, "U. S. Field Medical Card" (see AFM 168-4), is filled out at the time of triage. The diagnosis and type and time of treatment are necessary entries. Completion of this form will readily identify the person who has received initial treatment and thus, prevent overtreatment.

Casualty Holding Area (CHA). With large numbers of patients a considerable delay in evacuation can be expected, and many casualties will have to be held at the site. The Medical Team Chief should select a Casualty Holding Area to which casualties can be moved after initial treatment, and have metal standards and flags erected as markers for placing the casualties by type of injury. When casualties have been grouped according to the casualty classification, the medical personnel will direct stretcher-bearers to the specified area in the Casualty Holding Area. This orderly movement will permit more effective use of supplies and skills of medical personnel as well as simplify casualty surveillance.

The Casualty Holding Area should be located far enough from the crash to insure safety in case of fire or other potential hazards, but close enough to minimize litter portage. It should be located close to the access road, but out of direct line of traffic. (See figure 15-1 (A).)

On selecting the site, the Medical Team Chief should insure that the ambulance driver unloads the medical supplies and erects the casualty classification standards. It frequently happens that, during Operational Readiness Inspections (ORIs), an ambulance driver will evacuate a load of patients and take all the available medical supplies with him. Therefore, the unloading of medical supplies at the holding point should be a checklist item. If a Disaster/Casualty Control Team is called in by the Medical Crash Team Chief, its members can concentrate their efforts in definitive care in the holding area. Also, as the workload shifts, the Medical Chief can better control the shift of medical personnel back to the hospital.

The Casualty Holding Area concept is very flexible and can be either omitted entirely or expanded, depending on the change in number of casualties, terrain, weather conditions, etc. *For instance,* with a crash on a small base, the Dispensary might become the Casualty Holding Area, while in a remote area, the Casualty Holding Area at the scene might have to provide definitive care for hours.

A crash ambulance should remain at the crash scene until the area is declared safe by the Firefighting/Rescue Chief and all firefighting/rescue personnel have left the area.

All uninjured personnel involved in the crash must be taken to the medical facility for observation. Further, they must receive an aeromedical evaluation and clearance by the Flight Surgeon prior to return to flying.

Crash Ambulance Team and Equipment:

Personnel. The Crash Ambulance Team Chief should be a Flight Surgeon. If it is after duty hours, the Medical Officer of the Day will be the team chief until the Flight Surgeon reaches the scene and takes charge. At least one first aid man, preferably an aeromedical technician who can also act as a driver, is required; also, a licensed ambulance driver who has some skill in first aid, is desirable.

Litter Bearer Requirements. For short carries over good terrain, one litter requires only two bearers. Up to a mile of unimproved terrain requires four bearers per litter. For anything over a mile or in difficult terrain, six bearers per litter will be required for sustained travel.

Litter Bearer Pool. Trained medical corpsmen should not be used as litter bearers in mass casualty situations. A manpower pool should be established at the perimeter of triage/initial care area. When initial treatment has been accomplished, the Crash Ambulance Team Chief should call in litter bearers who will move patients to the Casualty Holding Area. This prevents a waste of trained personnel and further injury to casualties by untrained persons. The use of a bullhorn is a valuable aid in directing this operation.

Crash Ambulance Equipment. Equipment for crash ambulances should consist of the following:

Standard maps with suitable grid or coordinate systems. Additional local or county maps that indicate trails and small roadways can be helpful, if available.

Basic equipment (litters, straps, splints) to care for at least four casualties. Blankets and extra material to construct more litters and cover at least 12 casualties.

A Crash Ambulance Kit and a Flight Surgeon's Kit. These are not standardized because of differences in physician preferences or the unique requirements of the area. However, they should contain medical equipment for emergency lifesaving procedures for 20 casualties and for the definitive care of 12 casualties.

Approved Resuscitator.

Supply of DD Forms 1380.

Human Remains Pouches.

Communication Equipment:

A two-way radio, capable of maintaining communication with the Medical Command Post, the Control Tower, and the Firefighting/Rescue Chief, is required.

A battery-powered bullhorn is desirable to enable the Crash Ambulance Team Chief to direct the Casualty Control operation over the noise and confusion at the crash scene.

Personal Equipment:

Hard Hats, color-coded to identify the Team Chief and the medical team, are an aid in establishing order at the crash scene.

Lanterns or Head Lamps that attach to the Hard Hats are essential for night operations.

Personal equipment for inhalation and ingestion protection against radiation should be provided. Boots, gloves, and coveralls, secured with masking tape, will provide adequate protection against gross external contamination.

Ample environmental protection

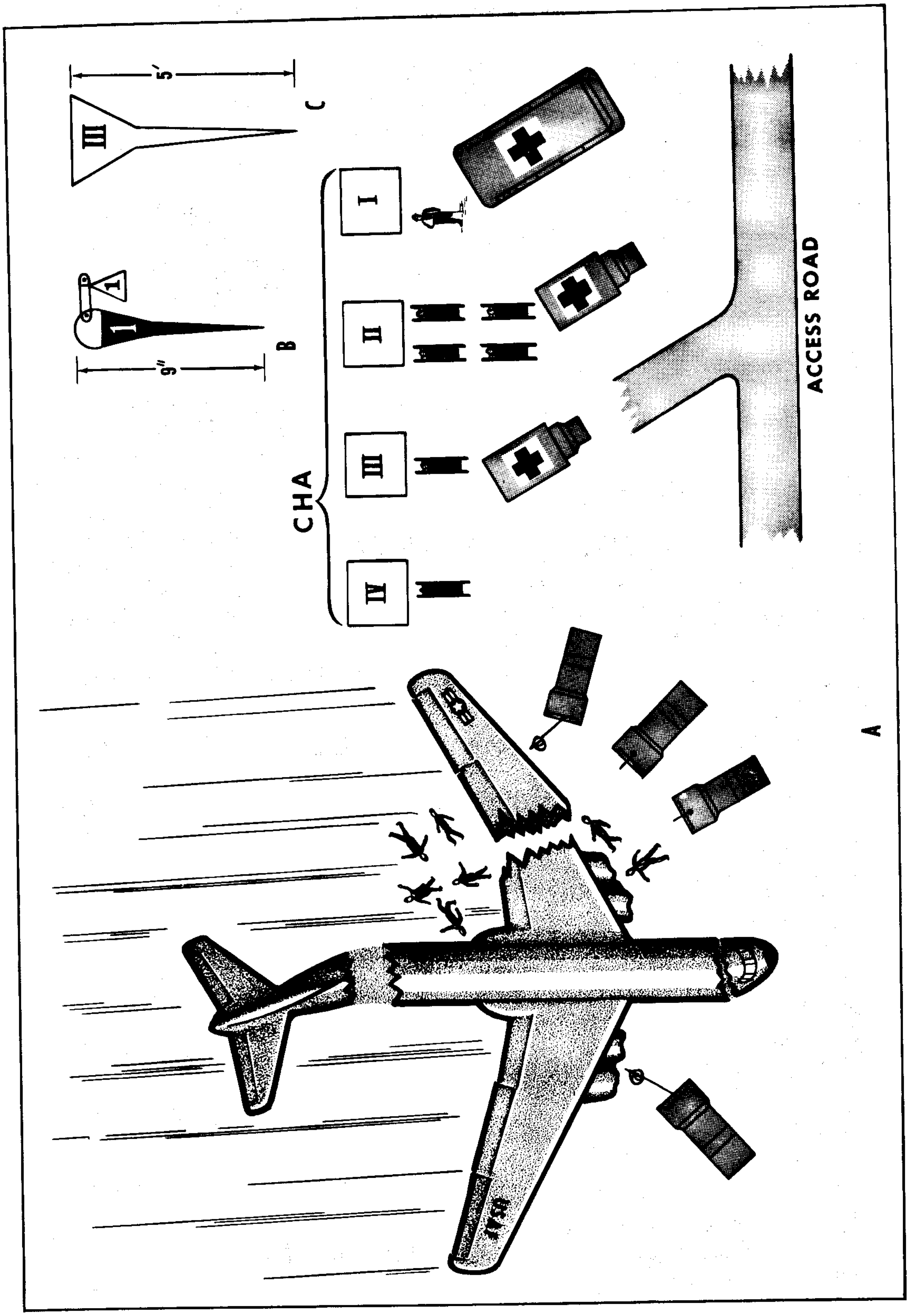

Figure 15-1. Accident Scene Schematic Showing the Casualty Holding Area Concept.

designed to meet the hazards of the local climate and terrain should be provided. (*To cite one case,* a crash ambulance team responding to a crash at one of our northern bases, was incapacitated by the unexpected nighttime cold.)

Miscellaneous Items. Many flight surgeons have devised miscellaneous items of equipment to meet local needs. These are fabricated at base shops at little cost. The following are recommended items of equipment:

Body Position and Identification Pins and Tags. (See figure 15-1(B).) These (steel) pins have safety-pinned tags with the same number *stamped* on both. The pin is easily inserted into hard ground to mark a position. The tag is pinned to the body, an object, or placed in a container. The numbers are stamped on to prevent loss of number by fire or smudging by water, mud, etc.

Casualty Classification Standards. (See figure 15-1(C).) These standards are color-coded by casualty type and placed in the Casualty Holding Area in a way that will insure correct grouping of casualties. This procedure avoids confusion and enables the Crash Ambulance Team Chief to merely direct litter bearers to a designated "standard" instead of having to give detailed directions.

Other miscellaneous items that have served a useful purpose include a crowbar, chain cutter, shovel, pickax, and hammer.

Accident Investigation Aspects of Crash Control Operations. The primary interest of the rescue team is, of course, preservation of life; however, the importance of the subsequent investigation must not be forgotten. The Flight Surgeon must carry out the following procedures when conducting crash control operations:

Maintain the accident scene as near to its original state as possible. This can be accomplished best by the use of body position identification pins (stakes) before moving casualties and bodies.

Photograph all bodies prior to movement, if feasible.

Make critical observations (photographs, if possible) of egress, personal, and survival equipment before anything is disturbed.

Identify body before removal, if possible—*i.e.,* look for all personal effects, dog tags, and papers in the immediate vicinity before moving a body. Examine the area covered by an incinerated body after its removal. Place remains and any possible identifying objects in Remains Pouch; also put DD Form 1380 inside the Pouch.

Methods of Remains Identification:

Position in aircraft—*i.e.,* pilot's or copilot's seat, etc.

Laundry marks—usually consist of initials and last four digits of serial number. (Look on underclothes, under belt, on a burned body.)

Personal effects.

Parachute number (not reliable on large aircraft). (Check at base personal equipment shop for issue record.)

Insignia, especially grade and rating.

Body marks, deformities, and tattoos (cross-check SF 88).

Fingerprints.

Footprints.

Body size.

Blood type and subtype.

Shoe and clothing sizes.

Dental identification. (This is a reliable method when performed by a qualified dental officer.)

Responsibility for Identification. The Mortuary Affairs Officer is responsible for the identification of human remains. He, however, will rely on the Flight Surgeon in many cases. In the event that all local resources have been exhausted and identity cannot be made, HQ AFLC, Wright-Patterson AFB, Ohio, will provide the services of Mortuary Affairs Identification Specialists on a 24-hour basis.

Autopsy

AFR 160-109 states the purpose, scope, responsibility, and procedures for autopsy. In general, autopsies will be performed on all crew member fatalities. In addition, autopsies will be performed on passenger fatalities when, in the opinion of the medical officer, such autopsies will yield information having a bearing on the cause of accident, mechanism of injury, or design of protective measures.

Military personnel will cooperate with the local coroner, to the extent possible, without jeopardizing national security or the performance of the military mission. This relationship should be preplanned with the assistance of the base legal officer.

ACCIDENT INVESTIGATION

Role of the Flight Surgeon

Under the provisions of AFR 127-4, an Aircraft Accident/Incident Investigating Board is established at each base, wing, or higher command to investigate and properly report Air Force accidents and incidents. A Flight Surgeon or Flight Medical Officer is designated as one of the primary voting members of each Board, and is responsible for the Life Sciences portion of the investigation (see AFM 127-2). He is uniquely suited to this investigative role because of his background in science and medicine which has developed his ability as a critical observer.

Investigation entails primarily the observation of facts and the reduction of these facts to a logical pattern, thus forming the basis for a scientific judgment. The Accident Investigating Board must rely on the Flight Surgeon for qualified opinions on psychophysiologic factors and their effect on the judgment of the pilot.

The Flight Surgeon, confronted with an aircraft accident investigation, faces a difficult and challenging diagnostic task. He must determine the human or environmental factors that contributed to the accident. The talents and assistance of bioenvironmental engineers and aerospace physiologists may be invaluable in evaluating these factors. Further, he must correlate injury patterns with sequential crash events so that system failures, design deficiencies, or the lack of protective equipment can be determined and corrected. Many of the signs and symptoms on which the Flight Surgeon must base his diagnosis, are very transitory. For example, the key to the cause of a fatality can be destroyed by the simple act of moving a body during the crash control phase. For this reason, the Flight Surgeon must have his approach to accident investigation firmly in mind before an accident occurs. Triage and treatment of casualties are of utmost concern, but the Crash Ambulance Team must be prepared to preserve vital and fragile clues.

Phases of Medical Investigation

The medical investigation of an aircraft accident has three main phases: (1) Determination of the cause of death or injury; (2) human factors involved; and (3) evaluation of egress systems, personal and survival equipment, and rescue procedures and equipment.

Cause of Injury. The Flight Surgeon's approach to the analysis of injuries sustained in an aircraft accident should be *not* to accept the obvious as the whole truth. It is essential to identify the sequential injury patterns formed in the accident, egress, or survival phases of a mishap. The Flight Surgeon must evaluate the following factors in determining the cause of injury and correlate this evaluation with the entire accident picture in order to recommend remedial action:

Nature of the Injury. Injuries range from abrasions and contusions to complete fragmentation of the body. Even in badly fragmented bodies, a critical analysis of the injury pattern is necessary. The following examples illustrate the fact that critical analysis of wound patterns is vital in diagnosing the cause of accidents and detecting deficiencies in egress and survival equipment and safety design deficiencies of the aircraft:

a. A pilot and his seat were found at the site of wreckage of one of our fighter aircraft. At first glance, it appeared that ejection was initiated too late. An alert Flight Surgeon noted laceration-type wounds of the head, and upon examination of the aircraft control surfaces, found microscopically identifiable brain tissue. This indicated an ejection seat failure and led to design correction.

b. Analysis of the pattern of injuries sustained by victims of a commercial airliner that disappeared at sea, revealed the classic picture of free fall from great heights. Bodies were nude (wind blast will strip a normally clothed, free-falling body) and had little external injury; there was massive laceration of the great vessels and viscera, and little or no evidence of burns or explosive forces. This picture pinpointed the tragic design deficiency which caused the fuselage to split open at altitude, spilling the occupants out to free fall to the ocean.

c. A severe laceration of the groin in a person obviously dead from impact with the ground after his chute burned, revealed poor crew discipline, as the chute had been incorrectly donned in haste after the onset of the emergency. Opening shock plus a loose leg strap produced the laceration.

Escape and Survival. After determining the nature of injuries, the next question is, "Were the injuries caused or compounded by inadequate provisions for escape and survival?" *For example,* seat-man-chute interference has occurred in 10% of Air Force ejections, resulting in serious major injuries; burn injuries almost invariably have been associated with inadequate escape hatches and devices.

Decelerative Forces. Decelerative forces in accidents range from very mild to explosive impacts in which total disintegration occurs. Ironically, many fatalities occur in the very mild decelerative force range. The Flight Surgeon must correlate the injury pattern with analysis of the direction, magnitude, and the rate of onset of G forces to which an individual is exposed during the accident egress sequence. (A soft seat cushion, for example, negated body position restraints and also allowed the seat pan to accelerate while the cushion compressed. As a result, a number of vertebral fractures occurred in crash landings and ejections. A firmer cushion was the definitive fix.)

Personal Restraint Equipment. To analyze correctly the role of restraint equipment in the production of injuries, the following questions should be asked: "Was the injury due to failure of restraints, allowing the person to become a "far flung" object?" "Did the restraints themselves cause the injury, either by improper alignment with the G force (submarining effect of loose lap belt during ejection) or lacerations produced by high deceleration against loose restraints?" "Did the restraints prevent flailing injuries of the extremities?"

Shrapnel. Even a grossly disintegrated body should be closely examined for shrapnel wounds. X-ray of the remains is the best way to detect this. Two distinct classes of shrapnel should be considered:

a. Loose or poorly secured objects in the cabin which become missiles on deceleration. Even in an unsurvivable wreck, evidence of this type of shrapnel might prevent injuries in a subsequent survivable accident.

b. The explosive nature of a wound plus the presence of rigid and nonrigid shrapnel particles might be the first clue to an act of sabotage or combat injury.

Injury by Fixed Objects. Not only are anterior-posterior G forces experienced in the accident phase, but any and all axes may be involved. Thus, it happens that injury may result from a mild accident force when a properly restrained navigator strikes his head on a piece of navigational equipment. The Flight Surgeon should identify fixed objects that are hazards and recommend appropriate remedial action. If a person becomes a missile-like object, the chance of injury is greatly increased. However, design of the fixed interiors of aircraft can minimize injury. Such wounds and their mechanism of infliction should be identified so that remedial action can be effected.

Miscellaneous Causes of Injury. No cause of injury is too trivial to be thoroughly investigated and reported. A high index of suspicion is characteristic of a diagnostic mind, and it is this approach that detects previously unrecognized hazards.

Human Factors:

Accidents rarely happen because of a single act or omission on the part of the crew or because of a single mechanical failure. In reviewing Air Force accidents, it becomes clear that accidents occur as a mosaic of factors that blend together to form the tragic picture. In the performance of any complicated task, omissions, hesitations, or mistakes are to be expected. If you add to these bad weather, a fuel low level light, a background of worry over a sick child, and a body fatigued by a sleepless night, what is the result? Luckily, in the vast majority of cases, a safe penetration and landing result. However, when the end result is smoldering destruction, the Flight Surgeon must correctly evaluate the role and interplay of these factors in producing the complete crash "mosaic."

Before attempting to determine the human factors in aircraft accidents, the Flight Surgeon should have the accident picture clearly in mind. Human factors often can be correlated with a particular type of accident. For example, a power dive from FL 390, without radio transmission or attempted recovery, would certainly raise the question of pilot incapacitation. Therefore, an understanding of the types of accidents will aid in the human factor diagnosis.

Vertical Accidents. These accidents occur with an acute angle of impact. There is usually little or no wreckage, either human or mechanical, to provide clues to the cause. The accident investigator must rely on indirect evidence to make the proper decision. The presumptive diagnosis is usually made by "exclusion" in these cases. Figure 15-2 correlates vertical type accidents with environmental and human factors.

Horizontal Accidents. A thorough study of figure 15-3 makes it clear that pilot incapacitation is very unlikely in horizontal accidents. The more likely cause would be a deficiency in flight planning or discipline; also, distraction, inexperience, or preoccupation could be factors. (A commercial airliner was nearing minimums on an ILS approach when the copilot noted a minor deviation from course. He pointed this out to the pilot over the intercom and a correction back to course ensued. However, this correction continued past centerline and the jet transport was in a steep bank when the copilot took the controls and made an emergency go-around. The 48-year-old pilot was pronounced dead when the aircraft landed.) The above incident emphasizes the importance of keeping an open mind and investigating all possibilities in an accident. The odds against pilot incapacitation causing a horizontal type accident are great, but this one almost happened.

Psychophysiologic Factors. "Pilot error" is listed as a factor in the majority of aircraft accidents. This does not usually imply neglect or lack of skill on the pilot's part; rather, that the stresses to which he was subjected exceeded his psychophysiologic capability. In determining human factors or pilot error, three parameters of human performance must be evaluated: physiologic tolerances, behavioral responses, and physical condition.

Physiologic Tolerances. With the advent of high altitude flying, our aircrewmembers are exposed to the hazardous environment of reduced barometric pressure and reduced partial pressure of oxygen. *Hypoxia* and *decompression sickness,* insidious in their onsets, may incapacitate a flier before he is aware of his predicament. When he is engrossed in the complicated tasks of flying, he may be most susceptible to these conditions. In unexplained, high altitude vertical accidents, these factors should be thoroughly investigated. AFP 161-16 is recommended reading for the Flight Surgeon, especially if he is faced with this type of accident.

Vertigo or *spatial disorientation* is another condition which strikes with little or no warning. Vertical accidents from low altitude are typical of those caused by spatial disorientation. Intermittent weather/visual flight, transition from visual to instrument flying, bright, hazy days, and very black nights where ground lights are indistinguish-

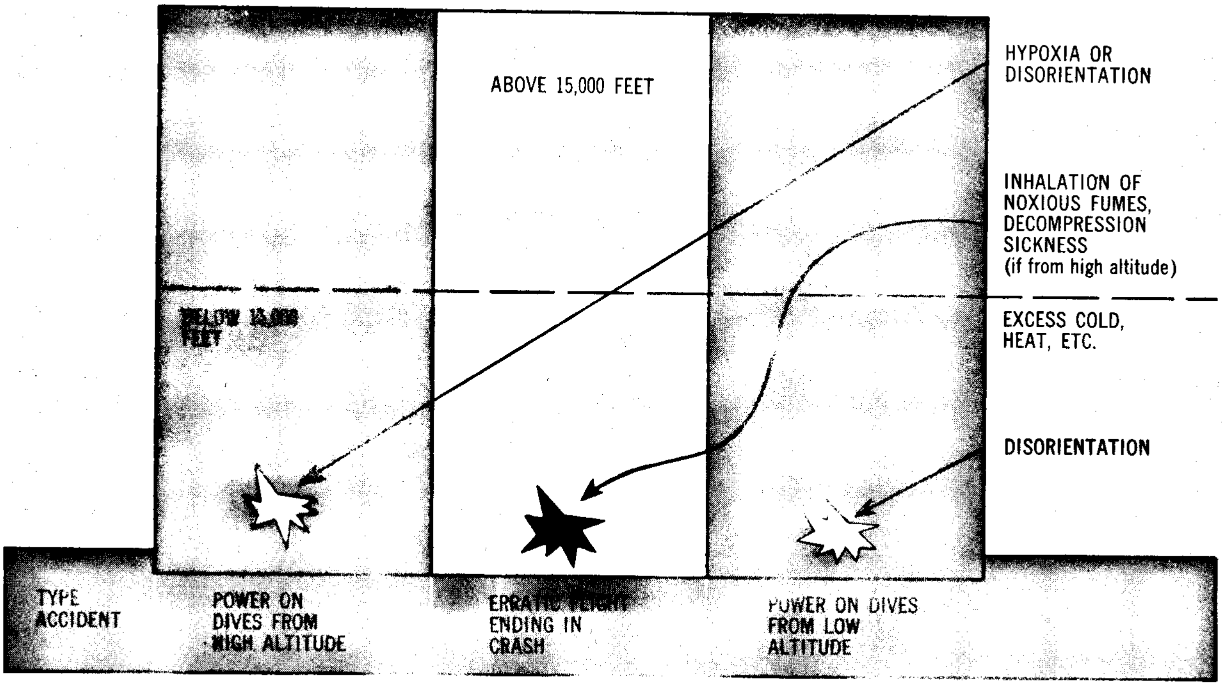

Figure 15–2. Vertical Type Accidents.

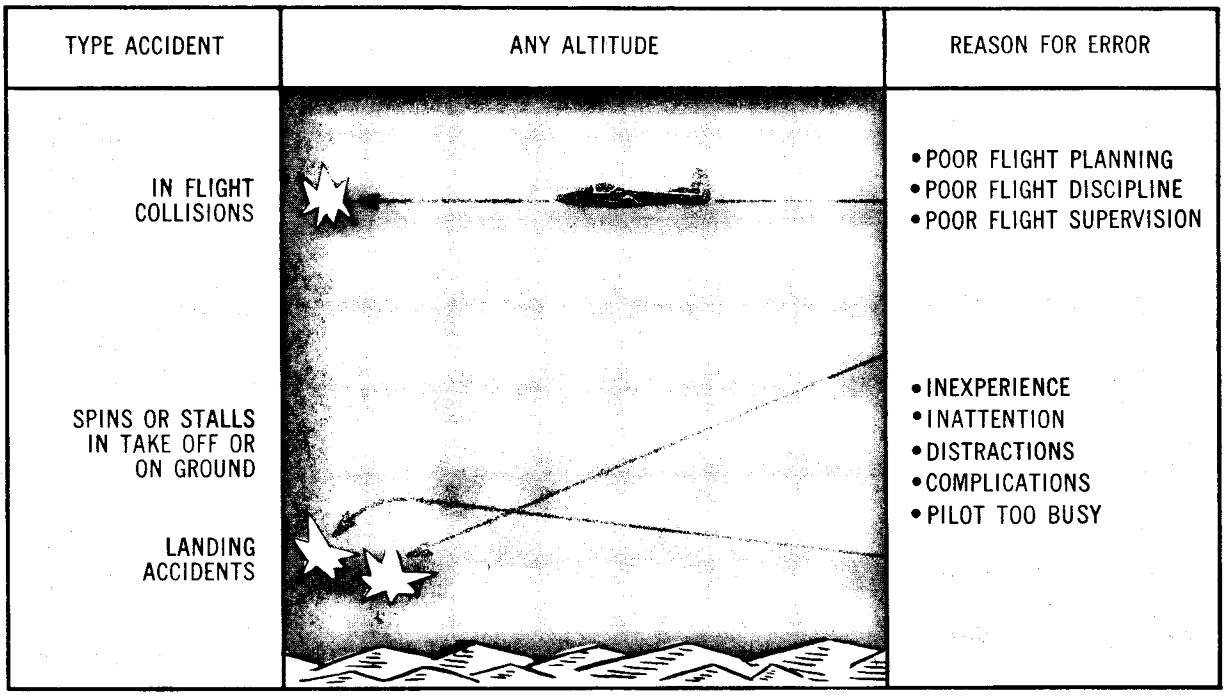

Figure 15–3. Horizontal Type Accidents.

able from stars, are conditions especially prone to cause spatial disorientation.

Behavioral Responses. The investigation of an aircraft accident should always include a detailed search for psychophysiologic and environmental factors. The investigating Flight Surgeon should evaluate all factors which could affect a pilot's ability to cope with the accident phase of a mishap. The behavioral responses of humans are unlimited and vary from person to person and from situation to situation. These variations in human behavior often provide the missing pieces in the aircraft accident mosaic.

The Flight Surgeon must not restrict himself to the accident phase, but must actively follow this line of investigation through the escape, survival and rescue phases also. This is the best guideline we have for developing our egress, survival, and rescue training.

The following factors must be considered:

Supervisory. An inadequate briefing or poor crew coordination, etc.

Preflight. A faulty flight plan or careless preflight of the aircraft might indicate an overconfident or unprofessional pilot.

Experience and Training. A pilot's total flying experience and training, and current experience with the type of aircraft are primary factors affecting his ability to cope with in-flight emergencies.

Design. Design—*i.e.,* location, lighting of controls and instruments, runway lighting, etc., should be carefully evaluated.

Communication. Problems of communication are definite factors causing accidents. Noise interference, misinterpreted or disrupted transmission, etc., must be determined.

Psychophysiological. Some of the most important are fatigue, self-medication, alcohol, hypoxia, distraction, overconfidence or lack of confidence, boredom, worry, and panic. Other factors, such as habit interference and task oversaturation are also important. The Medical Officer's Report form lists other possible psychophysiologic factors not mentioned here.

Environmental. These should be considered as they affect human behavior and performance. For instance, glare decreases visual capability, and excessive heat or cold is associated with performance decrement.

Source of Psychophysiological Data. The source of most of this data is obvious. Much of it can be obtained from the other Accident Investigating Board members. A careful analysis of medical records, unit duty rosters, and individual flight records will reveal possible medical or fatigue factors. The Flight Surgeon should attempt to get a picture of the pilot's personality if he doesn't know him. Interviews with fellow fliers, friends, and associates are useful. Finally, the Flight Surgeon must interview the family of a deceased crew member to determine specifically his activities immediately prior to the accident, and any possible emotional or family trouble. This is an extremely sensitive endeavor and must be left to the Flight Surgeon's judgment and experience as to how it should be handled. Excessive delay is to be avoided where possible.

Physical Condition. Physical incapacitation as the cause of an aircraft accident is uncommon. The physical condition of the aircrewmembers and the medical care and supervision which they receive contribute to this healthy state. The possibility of sudden incapacitation, such as an acute myocardial infarction, an acute loss of consciousness, or an epileptic seizure, should be suspected in any accident of unexplained cause. Further, self-medication with drugs which have undesirable effects may occur in spite of the efforts of the Flight Surgeon to educate his fliers. Review of medical records, questioning of associates and family members, complete post mortem examination with biochemical tests, and personal knowledge of the accident victim are all valuable means of establishing or disproving physical incapacitation as an accident cause.

Life Sciences Analyses of the Escape, Survival, and Rescue Phases:

Egress Systems. Ejections may be successes or failures. It is very important to investigate a successful ejection as it provides a base line against which ejection failures may be evaluated.

Successful Ejection. In order to completely investigate the circumstances surrounding an ejection, it is necessary to start with the emergency that prompted the ejection and investigate all the facets of escape to the point where the crewmember was recovered. The following checklist will serve as a guide for the investigation of a successful ejection:

Decision to Eject. The medical member of an Accident Investigating Board should determine why the ejectee decided that it was necessary to eject. Such a determination should be the result of objective consideration of all the factors, real or imagined, that caused this decision. If inability to cope with a malfunction caused an inexperienced pilot to eject from an aircraft that might have been saved, or if overconfidence caused a pilot to delay the ejection too long, this should be noted. It should be determined whether the pilot delayed ejection because he tried to avoid populated areas or unfavorable terrain, or tried to zoom to higher altitude.

Difficulties in Initiating Ejection. Ejection may have been delayed or made more difficult due to failure to remove safety pins, difficulty in locating actuating devices, excessive G forces, difficulty in removing canopies or hatches, inability to assume an optimal body position, or other problems. It is important that the investigator document these problems, even though the particular pilot survived. (The next man might not have as much time to overcome these difficulties.)

Aircraft Altitude, Attitude, and Airspeed. These factors should be determined as accurately as possible. Aircraft altitude should be determined for mean sea level and for terrain clearance.

Body Position. The position of the body at the time ejection was begun should be determined as accurately as possible and a description given of any tumbling, flailing, or other movements that occurred later.

Methods of Initiating Escape. The great variety of actuating mechanisms makes it necessary to determine which methods have been used most frequently and with the greatest success. It is important to note not only which actuating controls have been used, but also which hand has been involved in initiating the action.

Difficulties During Ejection. Once ejection is initiated, a multitude of hazards are encountered. Careful inquiry into the force and effect of ballistic and rocket catapults, wind blast, seat separators, and opening shock is in order. The failure or success of automatic devices for lap belts, seat separators, and parachute deployment should be determined. Collision of the seat with the parachute or the ejectee is common, and trace evidence of this should be diligently sought. Losses of equipment, flailing, tumbling, panic, disorientation, failure to release seat handles, and numerous other problems can occur.

Methods of Parachute Deployment. A number of devices, designed to provide quicker parachute deployment, are in use. The zero lanyard, the ballistically deployed chute, and a number of devices unique to a particular system may be used. A report should be made on the devices actually used and whether any attempt was made to beat the system with the D-ring.

Problems During Descent and Parachute Landing. The altitude above terrain at parachute opening should be determined as accurately as possible. The degree and persistence of oscillations should be noted, as well as any actions taken to stop oscillations. Technical Order 14D1-2-1, Mid-Air Modification for Steerability, deals with the "four line cut." Positive mention of the use or nonuse of this procedure should be made. Any other maneuvers or alterations used to control descent should be described. Deployment of survival kits or life rafts and inflation of underarm life preservers during descent should be reported. The direction the parachutist is facing in relation to his direction of travel along the ground is important. His travel may be due to wind, oscillation, or both. His body position at ground contact and any maneuvers performed to lessen impact should be noted. Any problems, such as dragging over the ground or in the water, or difficulty in releasing risers, should be investigated carefully.

Parachute Landing Conditions. The terrain and surface winds should be described accurately. The total weight suspended under the parachute should be given, noting how much represents equipment, seat, and man, respectively. Often, the seat will pass through or hang up in the parachute, and this should always be reported.

Unsuccessful Ejection. An unsuccessful ejection may occur at any point from the initiation of the ejection sequence to the safe rescue of the ejectee. In the investigation of an unsuccessful ejection, the relative positions of the aircraft canopy, the seat/man mass, and the crash are extremely important.

If body/seat and wreckage are found together, but canopy has been jettisoned:

Estimate time between jettisoning of canopy and crash. A long time could indicate system failure, or inability to initiate ejection due to incapacitation or high G forces.

Note method of canopy removal —*i.e.*, leg brace, T-handle, etc.

Check position of seat triggers to determine whether they have been activated.

Check seat pins in leg brace initiator. Seat pins left in can delay or negate an ejection.

Check pilot helmet for evidence of possible damage by contact with canopy.

Check chute straps, lap belt, zero lanyard, and chute arming lanyard (Gold Key) for proper attachment. The pilot might delay ejection too long, attempting to fasten or attach one of these items.

If canopy has not been jettisoned, check position of leg brace or other canopy jettisoning system—*i.e.*, "T-handle." Even with canopy jettison failure, through-the-canopy ejection is possible. The delay might be fatal, however.

If both canopy and seat have exited the aircraft:

Estimate altitude, indicated air speed (IAS), and attitude of escape by plotting wreckage fallout. Overconfidence in an egress system may cause delayed ejection.

Determine whether man-seat separation occurred before or after impact.

Determine whether seat separator functioned. Check tautness of straps.

Check degree of chute deployment.

Check method of deployment—*i.e.*, zero delay lanyard, F-1B automatic timer, or D-ring.

Check the seat and the chute for location of "Gold Key." This could indicate the nonuse, misuse, or "inadvertent" opening of the lap belt.

Check to see if the manual lap belt latch is open, and if so, why.

Look for evidence of seat/chute involvement. If chute is damaged, check carefully for paint from seat. Severed suspension lines usually indicate damage by seat.

Look for evidence of seat/man involvement. Here, the type of injury can point to seat/man involvement. (One Investigating Board had concluded that ejection had been initiated too low. However, the Flight Surgeon matched a linear crushing chest wound with the top edge of the seat and proved seat/man involvement.)

Personal and Survival Equipment. Personal and survival equipment of accident victims often contains many important clues to accident mishaps. The personnel who arrive first on the scene often destroy these clues in their eagerness to help a casualty. The following approach will minimize this loss: *First,* photograph the equipment before moving the casualty/remains, if possible; *second,* preserve all items of equipment/clothing for subsequent analysis; and *third,* if treatment dictates removal of clothing, preserve the ventral surface. The front of a flying suit, etc., will usually have more clues. Powder burns on the lap area, *for example,* can prove that the lap belt separator fired.

A complete listing of all equipment used by persons involved in an accident must be made. Personal equipment specialists can provide assistance in obtaining correct model designation and nomenclature. (*For example:* "Helmet, HGU-2/P.") The following categories of equipment will be involved in most accidents:

Clothing. Helmets, gloves, boots, and thermal or fire-retardant clothes.

Oxygen. Masks and regulators used by crews. Special attention should be given to emergency oxygen equipment for passengers subjected to rapid or explosive decompression. Decompression sickness is rarely encountered as a cause factor in aircraft accidents. However, careful analysis of each case is mandatory to establish the adequacy of present procedures, equipment, and operational restrictions where passengers are involved.

Flotation Devices. Their availability and number, and problems of launch are factors to be investigated.

Seats and Restraints. In addition to crew restraints, a careful analysis of passenger restraint systems must be made. Analyzing the restraint/seat failure pattern and the injury pattern resulting from failure will establish guidelines for future R&D.

Parachutes. The type of chute, opening/deployment devices, and canopy release should be recorded.

Survival Gear. Survival kits, radios, and other signaling devices.

Method of Life Sciences Analysis:

Determine whether the requirement for the item of equipment was established by Air Force directive or was a personal or base development.

Determine availability of the item of equipment in the aircraft at the time of the accident.

Determine phase of mishap in which the item of equipment was used, needed, discarded, lost, or failed. (Phases of mishap are (A) Accident, (E) Escape, (S) Survival, and (R) Rescue.)

Document any problems experienced that involved equipment, to include supply problems as well as malfunctions.

Survival and Rescue Experience:

The Korean and Vietnam conflicts dictated the need for an improved survival and rescue capability. The Air Force expended all its technologic resources in producing training facilities, equipment, and techniques currently used. They are the best the "state of the art" has produced. However, a look at the statistics reveals that a number of crew members survive the accident and escape phases, only to be lost during the rescue phase.

The avoidable loss of even one flier is a justification for systems improvement. Systems improvement must be based on a valid analysis of all survival/rescue parameters. AF Form 711gA, "Life Sciences Report of an Individual Involved in an AF Accident/Incident—Section A, Aircraft Accident/Incident" is devoted to a comprehensive analysis of this problem. The following are some of the parameters which may play a role in rescue:

Background training.

Environmental conditions.

Time sequence of rescue events.

Personnel/vehicles available and utilized in rescue.

Rescue equipment available and utilized.

Alert/communication methods and problem areas.

Search procedures.

The Flight Surgeon conducting the analysis should use AF Form 711gA to guide his investigation. It should not, however, be taken as a limit to his investigative efforts. Any new factor should be carefully evaluated and recorded.

Photography

Reference has been made repeatedly to the importance of photography in accident investigation. The following procedures are important in this phase of the investigation:

Photograph bodies to show relation to crash site, ejection seat, or any orientation point.

Take a closeup photograph to demonstrate equipment position or a possible mechanism of injury, before body is moved.

Photograph bodies, front and back, with

all equipment in place; also, front and back, nude. This combination of dressed and nude photographs will correlate injuries related to personal equipment. (This will also apply to casualties wherever possible.)

Take photographs in color and in black and white.

Equipment. Large hospitals with medical illustration departments are authorized the necessary camera equipment. These same facilities usually supply pathology support for aircraft accident investigation, and the medical photographer is part of the team. Smaller facilities must rely on the base photographic personnel. The Flight Surgeon should consult these individuals to work out procedures that will insure good photographic support for Life Sciences investigation prior to the occurrence of an accident.

Reports

AFR 127-4 establishes the requirement for formal reports of Air Force mishaps. The formal report of an Air Force aircraft accident is prepared on AF Forms 711 series. AFM 127-2 provides the format and guidance for proper completion of this report. The medical officer on the Investigating Board is responsible for the completion of AF Form 711gA.

The evaluation of Life Sciences factors in aircraft mishaps has been a laborious process involving much manual processing of accident reports. The conflict in Vietnam generated the requirement for faster detection and analysis of trends, especially in the areas of egress, escape, survival, and rescue. To meet this requirement, an automatic data processing capability is being established within the Office of the Deputy Inspector General for Inspection and Safety. Further, AF Form 711gA has been revised and expanded to make it adaptable to this automatic data processing system.

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