COPY #1

WESTERN RANGE

RANGE SAFETY REQUIREMENTS

WRR 127-1

30th SPACE WING

30 JUNE 1993

DEPARTMENT OF THE AIR FORCE
Headquarters 30th Space Wing (AFSPACECOM)
Vandenberg Air Force Base, California 93437-5000

WESTERN RANGE REGULATION 127-1
30 June 1993

Safety

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Chapter 2: Major portions have been rewritten and reorganized (see expanded Table of Contents). Flight safety approval process has been modified (paragraph 2.2). Probability study requirements have been identified

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FOREWORD

Safety, in the context of this regulation, implies a concerted effort by the users of the Western Range (WR) to operate in a manner that will minimize in every way possible the inherent danger in missile operations. This document brings to the Range User the safety requirements and procedures established by this Range.

It is our desire and purpose to assist you in any way so that you can best meet both your program objectives and the Range safety requirements. Because of the great complexity of present space and ballistics programs, and the inevitable cost of changes in hardware and time schedules, I cannot emphasize strongly enough the importance of meeting with the 30 SPW Chief of Safety early in the planning stages. This will ensure the earliest launch approval and the optimum in planning from a safety standpoint.

Sebastian F. Coglitore

SEBASTIAN F. COGLITORE
Brig Gen, USAF
Commander

Chapter 1

WESTERN RANGE SAFETY POLICY

1.1 Introduction. The National Range System, established by Public Law 60 (PL60), was originally sited based on two primary concerns, one was location, the other, to ensure public safety. Thus, Range Safety, in the context of national range activities, is also rooted in PL60. The implementation of PL60 is carried forward in Presidential Directive 25, and Department of Defense Directives (DODD) 3200.11, which designates the facility commander as the final authority for safety and 3230.3, which levies compliance requirements on commercial programs. To fulfill the safety responsibility for public safety IAW PL60 the ranges, through Range Safety, must ensure that the facility users conduct launch and flight of missiles and space vehicles in a manner that presents no greater risk to the general public than that imposed by the overflight of conventional aircraft. In addition to public safety, safety on a national range includes launch site safety and resource protection. This regulation establishes and defines the Western Range safety program. It sets forth the minimum safety requirements and procedures that must be met by all range users, supporting agencies, and range organizations conducting operations on the Western Range. Each of these functions is described in this chapter as well as the safety program, process, scope, responsibility, authority, and policy.

1.2 Safety Objective. Range Safety is intrinsic to the range mission of providing range users the facilities, instrumentation, and infrastructure to support launch vehicles and payloads during prelaunch and launch operations. Inherent to ballistic missile and cruise missile tests, remotely piloted vehicles (RPV), and space launch operations are significant hazards and risks; therefore, it is the objective of Range Safety to insure that all users of the Western Range operate within acceptable risk limits with respect to life, health, and property consistent with mission requirements and national needs. Because of the complexity of new launch systems being introduced and the inevitable cost and impact to schedules resulting from changes, it is important that an efficient and effective safety program be an integral part of the total system. Government launch program equipment safety compliance will be assessed both for asset and personnel protection. Commercial launch program equipment will be assessed for failure propagation to government/civil property and for personnel protection.

1.2.1 This regulation provides specific requirements, criteria, and guidance for developing a sound/safe system. To avoid costly changes and delays, it is critical that range users seek Range Safety participation and involvement in the overall system acquisition process as early as possible preferably during the conceptual phases. Range Safety encompasses all activities from design concept through test, checkout, assembly, and launch of vehicles at the Western Range; therefore, notification of and involvement in preliminary and critical design reviews, system design reviews, data submittals, test procedures review, risk analyses, flight/mission planning, monitoring of hazardous operations, development and implementation of vehicle controls and mission rules is very important.

1.2.1.1 The above can be accomplished by scheduling a session with the formulated Western Range Safety Requirements Working Group (WRSRWG). The WRSRWG consists of personnel representing all aspects of range safety including Flight Analysis, Flight Termination Systems, and System Safety who will assist the user in understanding/interpreting and complying with this regulation. To schedule a working group session, contact 30 SPW/SE at (805)-734-8232 ext 5-7251. The Safety Office or "Safety" in the context of this document refers to 30 SPW/SE.

1.3 Scope. The policies, requirements, criteria, and procedures outlined in this regulation apply to all agencies, organizations, companies, and programs conducting or supporting operations on the Western Range. The Western Range is defined as the launchhead at Vandenberg AFB and extends from along the west coast of the continental United States westward throughout the Pacific and Indian Oceans. Range management activities as well as launch and prelaunch processing activities are concentrated at Vandenberg AFB, CA.

1.3.1 Range users include the Department of Defense (DOD), non-DOD U.S. government agencies, civilian commercial companies, and foreign government agencies that require use of Western Range facilities, test equipment, prelaunch and launch and on-orbit support.

1.3.2 Commercial users of the range must be sponsored by a DOD or US government agency, have a license from the Department of Transportation (DOT), and be accepted by the DOD for use of the Western Range. Foreign government organizations must be sponsored by an appropriate US government organization and provide proper authentication for use of the range.

1.4 Responsibilities and Authorities. Public Law 60 and Presidential Directive 25, as implemented by DODD 3200.11, establishes the responsibility for range safety as being delegated to the Missile Range Test Facility Base (MRTFB) commander. Therefore final authority and responsibility for range safety at the Western Range rests with the Commander, 30th Space Wing/Western Range Director. The commander and or his designated representative, the Chief of Safety for the 30th Space Wing, is responsible for carrying out the range safety program as described in this regulation. The Chief of Safety is responsible for developing, implementing, and enforcing the range safety program. All range users are responsible for complying with and implementing those portions of the safety program that are applicable to their activities, facilities, ground operations, flight hardware, launch operations, and on-orbit activities.

1.4.1 The Chief of Safety utilizes the following functional disciplines to accomplish the range safety responsibilities:

1.4.1.1 Flight Safety Analysis. This functional area provides for control of errant vehicles flight to provide public safety through the processes of reviewing and approving flight plans, determining the need for flight termination systems (FTS), determining criteria for flight termination action, establishing mission rules, performing risk assessments, developing analysis tools/math models, requirements and specifications for safety display systems and tracking requirements, and actual control/go-no-go decision of vehicle flight.

1.4.1.2 System Safety Engineering. This functional area ensures that public and launch site safety and resource protection are adequately provided for on all programs. This includes developing all support and launch facility siting plans for approval, ensuring conformance with safety standards in facility and launch vehicle and design, that hazardous operations are properly identified and hazards mitigated, reviewing and approving prelaunch hazardous procedures. This function also includes developing flight termination system design criteria and requirements, qualification and acceptance tests and approval of all airborne FTS and range tracking systems (RTS).

1.4.1.3 Ground Safety: This functional area provides the review, implementation of procedures for prelaunch processing, and monitoring of all hazardous activities at the launchhead. It also provides prelaunch and countdown Launch Support Team (LST) support including control of access to hazardous areas, emergency response in the event of failures/accidents, and advises the on-site commander on disaster preparedness/responsiveness.

1.4.3 Commander, 30th Operations Group (30 OPG) is responsible for providing range safety with the tracking and command instrumentation systems; data transmission, processing and displays; communications; and system status IAW defined and documented range support requirements.

1.4.4 Commander, 30th Logistics Group (30 LG) will ensure that all defined requirements for development or enhancements of range hardware and software necessary for range safety to carry out its functions are designed and produced to perform to the prescribed level of reliability and in accordance with range safety specifications.

1.5 **Policy.** The Western Range is delegated with the responsibility to ensure that the risk to the general public and foreign countries from range operations does not exceed the risk exposure from natural causes. To accomplish this safety will:

1.5.1 Control all prelaunch and launch operations conducted on the Western Range to ensure that hazards associated with propellants, ordnance, debris, and radioactive material do not expose the general public to risks greater than those considered acceptable by Public Law and State regulations, such as SARA Title 3, NIOSH, and OSHA. Ensure that vehicle launch and flight operations do not exceed acceptable risks consistent with mission and national needs.

1.5.1.1 Verify that all space vehicles and missiles launched from or onto the Western Range have a positive, range approved method of controlling errant vehicles. These controls must meet the objectives of minimizing risks to the public and foreign countries. Normally, control systems used on vehicles launched at the Western Range consist of a flight termination system that must meet all the requirements and specifications identified in Chapters 2, 4, and 6 of this regulation.

1.5.1.2 Develop the safety criteria for flight to ensure adequate response time is available for positive control and containment of hazardous materials throughout powered flight or orbit insertion. Develop safety clearance zones and procedures to protect the public on land, sea, and air.

1.5.2 Launch Site Safety. The 30 SPW will ensure that all personnel located on Vandenberg AFB launch sites or supporting locations within the Western Range are provided protection from the hazards associated with range operations. 30 SPW Safety will conduct risk studies and analyses to determine and define acceptable risk levels, develop exposure criteria, establish controls, procedures, and processes to minimize personnel risk.

1.5.3 Resource Protection. The 30 SPW will ensure that physical resources are provided an acceptable degree of protection from hazardous conditions and operations. The level of protection is based on national standards, DOD, Air Force, or other government agencies' requirements.

1.5.3.1 Procedures and policies that are applied for public and launch site safety will also be utilized to reduce/minimize risks to physical resources. Resource protection issues will be coordinated with affected range users.

1.5.4 Radionuclide Material Launch. All range users must comply with Presidential Directive 25 and notify Range Safety and or the 30 SPW Radiation Safety Committee of any intent to launch radioactive materials. Approval and operating licenses for use of and handling of radioactive materials must be current and presented to the 30 SPW.

1.6 Safety Approvals. The Users have the basic responsibility for compliance with Western Range safety directive and demonstrate compliance with safety requirements prior to requesting approval. The standard approvals are:

1.6.1 Statement of Program Acceptance (SPA). Used for flight and ground safety conceptual concurrence. Proposed plans and supporting documentation are submitted as outlined in Chapter 2.

1.6.2 Flight Plan Approval (FPA). A Flight Plan Approval must be obtained prior to Range acceptance of a launch commitment. Proposed plans and supporting data are submitted as outlined in Chapter 2.

1.6.3 Missile Systems Ground Safety Approval (MSGSA). The Range Safety Office (30 SPW/SE) approves all airborne systems and their associated ground facilities, support equipment, and all subsequent modifications used on the Western Range as defined in Chapter 3.

1.6.4 Flight Termination System Approval (FTSA). The requirements and process for obtaining a FTSA are outlined in Chapter 4 and must be requested in conjunction with the submittal of the Flight Termination System Report.

1.6.5 Operation Approval Letter (OAL). The OAL acknowledges approval for an operation involving a particular vehicle within specific constraints and is issued only after all requirements have been satisfied and all other approvals identified above have been issued.

1.7 Safety Waivers/Deviations. The policy of the 30 SPW/SE is to avoid issuing waivers except in extreme rare situations. A waiver may be requested and granted when mission objectives are of a sufficient importance and cannot be otherwise achieved. All waivers are considered on a case by case bases and only after the user submits justification and substantiation along with analysis identifying the added risks and the compelling circumstances associated with the impact for a redesign or delay in schedule. Costs alone are not sufficient justification for requesting and granting waivers but must be provided as supporting information. Variances to AFOSH standards can only be granted I.A.W. AFR 127-12.

1.7.1 All waivers and deviation requests must be submitted formally in writing by the range user to the Chief of Safety, 30 SPW/SE, and in a reasonable time to allow for evaluation and consideration.

1.7.2 Waiver and Deviation Categories. Waivers and deviations issued by Range Safety at Vandenberg AFB are categorized as follows:

1.7.2.1 Public Safety Waivers. These waivers involve risk to the general public or foreign countries and shall require approval by the 30 Space Wing commander or his designated representative, the Chief of Safety. Under some situations, the Secretary of Defense or the State Department must concur. It should be noted that public safety waivers require extensive risk analysis and assessment that typically take 1 to 2 years to perform and coordinate an approval; therefore, users contemplating these requests should contact Range Safety far in advance of planned launch dates.

1.7.2.2 Launch Site Safety Waivers. These waivers typically involve flight hardware, ground support equipment, or hazardous support systems. To obtain a waiver of this type requires positive and continuing mitigation controls that will ensure the risks to personnel and resources can be kept to acceptable limits in accordance with policies and criteria established by the 30 SPW commander. As for launch site safety waivers, strong justification and supporting technical data must be provided. These requests normally take several months to process; therefore, users contemplating requesting such waivers must inform Range Safety with sufficient lead time for proper consideration and response. Life of the program waivers are not normally granted, however consideration will be given for unique and rare circumstances.

1.7.2.3 Limited Waivers. These waivers will have a time constraint based on the time required to modify system design, obtain new hardware, change or modify procedures/operations, or obtain different equipment that meet the requirements being waived. Technical data and justification must be provided with supporting risk analyses. These waivers vary in time to process from a few weeks to several months and users must allow sufficient time for proper processing.

1.7.2.4 Deviations. Deviations are considered and granted where the risk to personnel and/or resources is sufficiently low, or the probability of occurrence is small enough that the overall level of risk is acceptable without a waiver. Deviations can be granted for the life of a program or be time constrained.

1.7.2.5 Safety Equivalency. (Meets the intent). In many situations, designs, hardware, operations, procedures, and/or controls do not meet specific requirements of this regulation, but meet the intent by providing the same degree of safety. Once identified and agreed to by Range Safety, these items can be accepted for the life of a program.

1.7.3 Grandfather Approvals. Program approvals and compliances, flight hardware designs, subsystems, ground support equipment, facilities, procedures, and operations including waivers approved by Range Safety prior to the date of this regulation will be honored/grandfathered with the following conditions:

1.7.3.1 If it is economically and technically feasible to satisfy the new requirement into the new system, Range Safety my require conformance.

1.7.3.2 If the system/program has been or will be modified to the extent that it is considered a new program or that existing safety approvals no longer apply, compliance with this regulation is required.

1.7.3.3 Compliance with this regulation is required if a previously unforeseen or newly defined safety hazard/increased risk exists.

1.7.3.4 When a previously overlooked non-compliance is found in an approved system, the non-compliant part/system will be brought up to the standard of this document.

1.7.3.5 This regulation will apply if a system or procedure is modified and a new requirement affects that modification.

1.7.3.6 Accident/incident investigations and reports may dictate compliance with this regulation.

1.8 **Flight Termination System.** All missiles and space vehicles flown on the Western Range must be equipped with a flight termination system according to the requirements of Chapter 4 of this regulation. The system must be designed to survive and operate under all flight environments until a safe, final impact point is established, or orbital injection occurs. Depending on the mission and conditions small rockets maybe excluded from the requirement for a flight termination system. (See Chapter 2).

1.9 **Tracking Aids and Missile Performance Data.** All missiles and space vehicles launched on the Western Range must be equipped with at least two systems that provide tracking information that are completely independent of each other and the vehicle guidance system and meets the accuracy requirements established by Range Safety. The systems will be designed according to the requirements of Chapter 4 of this regulation and are applicable to tracking transponders and GPS if used. (See paragraph 2.4.2.3).

1.9.1 Telemetry Data. All missiles and space vehicles launched on the Western Range must provide telemetry inertial guidance (TMIG) data for all inertially guided vehicles as defined in chapter 2 and missile performance and flight termination system status data identified in chapter 4.

1.10 Impact Restrictions. Missile, space vehicle, payload, reentry vehicle, or jettisoned component impact dispersion areas are not to intentionally encompass land, unless designated as a target. The range user is responsible for ensuring that all impacting hardware will either sink or be recovered. For stages that contain engines having multiple burn capability, the impact dispersion areas (corresponding to any planned cutoff prior to orbital injection) must be entirely over water. Trajectories must also be shaped so impact dispersion areas are entirely over water at times of other critical discrete events.

1.11 Safety Holds. A safety hold is a directive to either prevent an operation from starting or stopping an operation already underway. Safety holds may be called if safety criteria cannot be assured or maintained, safety criteria is violated, personnel and equipment are or will be unduly jeopardized, or an imminently dangerous situation exists. Safety holds may be called by Range Safety representatives or by responsible supervisors in charge of an operation. Each launch system must have a "hold-fire" capability that will stop the launch sequencer in the event of unsafe range conditions or loss of critical range safety systems.

1.12 Range Users and supporting agencies are responsible for full funding of activities associated with safety support early in the program IAW reimbursable funding requirements of DODD 3200.11 and AFR 80-28 with follow on funding for each FY received at the start of the new FY.

1.13 Revision/Update Process. This regulation is applicable upon the effective date of issuance, 30 June 1993. The regulation will be revised or updated periodically as required but no later than once every two years. The process for revisions and updates are follow:

1.13.1 Organizations and or agencies effected by this regulations may submit review comments and suggestions/recommendations to the 30 SPW/SE at any time. Comments and recommendations of a constructive nature are encouraged. The Range Safety office will review and evaluate all submittals to determine enhancement potential and value to the safety mission.

1.13.2 Revisions will be incorporated into the original regulation on a chapter by chapter basis. When a chapter is revised the original regulation dated 30 June 93 will be given a revision number, i.e., WRR 127-1 Rev I with a date of the revision.

1.13.3 If a revision operation involves all the chapters, the revision will be considered as major and the regulation will be issued as a new WRR 127-1 with a new date if issuance.

1.14 It is the intent of the Safety Office of the 30 Space Wing to work with any and all range users to create a tailored version of this regulation applicable to the users program. This process requires a dedicated effort on the part of the user and the 30 Space Wing Safety personnel which we will commit to. Such a task and end product will ensure compliance with safety requirements, ensure user objectives are accomplished and reduce cost to a given program.

SPECIAL NOTE: Chapter 4 of this regulation (WRR 127-1) is identical to Chapter 4 of the Eastern Range Regulation (ERR 127-1). Compliances with this chapter will be applicable with both ranges provided proper coordination is obtained at both ranges and non-compliances are identified and submitted to each range regardless of plans as to whether launches will occur at both or just at one launch head.

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paragraph (2.2.6.2). Spacecraft data requirements have been identified (paragraph 2.2.3.2.9). Turn, fragment, and trajectory data requirements have been modified. Requirements for GPS data have been identified (paragraph 2.4.2.3). Directed energy systems data requirements have been expanded (paragraph 2.10).

Chapter 3: System Safety Program has been rewritten to use the MIL-STD 882C format (paragraph 3.2). The Safety Assessment Report (SAR) replaces the Accident Risk Assessment Report (ARAR) requirements (paragraph 3.2.7). Inhibit/exposure criteria has been put into table format (Table 3-1). The phase safety review process has been added (paragraph 3.3). Seismic design criteria has been expanded (paragraph 3.5.9.4) Cranes, lifting devices and materials handling equipment has been removed from Chapter 5 and expanded (paragraph 3.6.5). "Hazardous materials" replaces "Toxic materials" and has been expanded to include latest AF requirements and protective equipment (paragraph 3.10). Toxic Hazard Corridors (THCs) have been added and appear as Attachment 6. The ordnance section has been expanded to include laser initiated ordnance systems (LIOS) (paragraph 3.13.10).

Chapter 4: Has been completely rewritten/reorganized so as to be the same in both the WRR and ERR 127-1s. We are, however, providing a more detailed table of contents to guide the User thru the new Chapter 4. No attempt has been made to identify changes but the expanded table of contents will help.

Chapter 5: Crane and lifting equipment requirements have been removed and placed in Chapter (3 paragraph 3.6.5). Launch and launch support team (LST) support/requirements have been added from 1 STRADR 127-200 (paragraph 5.15).

Chapter 6: The requirement for redundancy for systems specified as mandatory in the Missile Flight Control Operations Requirements (MFCOR) has been added (paragraph 6.2.6). Mission Flight Control Officers' (MFCOs) freedom to deviate from written plan during launch vehicle powered flight has been added (paragraph 6.5).

Chapter 7: Is a new chapter utilizing requirements from the 1 STRADR 127-200 showing host-tenant relationship and responsibilities.

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Chapter 2

FLIGHT ANALYSIS

2.1 Introduction. This chapter sets forth requirements designed to provide the Wing with the basic data needed to determine the acceptability of operations from a flight safety standpoint, to determine launch constraints, to determine the requirement for a flight termination system, and to establish the real-time criteria used for flight termination.

2.1.1 Applicability of Requirements. Detailed data requirements pertaining to the trajectory and flight characteristics of the following types of programs are required:

2.1.1.1 Surface or air launched ballistic missiles and spacelift vehicles.

2.1.1.2 Cruise missiles.

2.1.1.3 Surface or air launched small rockets.

2.1.1.4 Nonpropulsive objects dropped from aircraft.

2.1.1.5 Aircraft and ship sensor support.

2.1.1.6 Aircraft and aeronautical systems.

2.1.1.7 Aerostat/Balloon Systems.

2.1.1.8 Directed energy systems.

2.1.1.9 Large nuclear systems.

2.1.2 Data Submission Format. The data package provided by the Range User to meet the approval process requirements of this chapter may be submitted in any convenient format. The following general format is suggested (if the format is adopted and the information submitted in response to a requirement cannot easily be placed in the data package document, it should be made an appendix to the specific part, e.g., the trajectory tapes and listings):

Part 1: Introduction

Part 2: General Vehicle Data

Part 3: Trajectory Data

Part 4: Additional Data

2.1.3 Other Instructions.

2.1.3.1 In meeting the requirements of this chapter, much of the information submitted by the Range User may not change from vehicle to vehicle. In such cases, the information only needs to be supplied once. However, for each flight, the Range User must state in writing which trajectory tapes or printouts are applicable, and specify the document, paragraph, and page number where each required item can be found. This statement must be submitted to SEY according to the lead times established in paragraph 2.2.1.

2.1.3.2 Although the requirements in this chapter are intended to be complete, special types of launches or special circumstances may make it necessary to request additional information. Such requests will be made in writing to the Range User.

2.1.3.3 In the remainder of chapter 2 certain required data items are marked with an asterisk (*), for example, the time interval when turn angle graphs are required. The asterisk means that the interval, duration, or magnitude for which the particular item is to be provided varies from program to program, and that the value listed is simply a typical value. For each vehicle program, SEY states the particular value to use for each parameter marked with an asterisk.

2.1.3.4 The X, Y, Z coordinates referred to in this chapter must be expressed in an orthogonal, earth-fixed, left-handed system with origin at the launch point. The X, Y plane should be tangent to the ellipsoidal earth at the origin, the positive X axis should coincide with the initial flight azimuth, the positive Z axis should be directed away from the earth, and the Y axis should be positive to the right looking downrange. AFSPACECOMM 80-12 (formerly AFSCM 80-12) AFSPACECOM Standard Theoretical Trajectory Magnetic Media Format Manual, provides detailed instructions on how to compute trajectories and on how they should be formatted for submittal to SEY.

2.1.3.5 The Range User must provide a security classification level cross correlation matrix table for trajectory information. This matrix table must indicate word classification levels for each word in the Binary Coded Decimal (BCD) and binary data files when associated with other words in the files in addition to the classification level of each singular word. If classification changes with stages or other events, a classification matrix must be included for each change.

2.2 Flight Safety Approvals:

2.2.1 Overview of Flight Safety Approval Process. The flight approval process begins with the submittal of data for Statement of Program Acceptance (SPA, para 2.2.2). Data regarding anticipated flight trajectories, booster configuration, flight termination system design, and more, is included. After this data is reviewed, a determination whether the program is feasible from a flight safety standpoint will be made. Next, the submittal for a Preliminary Flight Plan Approval (PFPA, para 2.2.3) is accomplished. The PFPA is for new programs only. It supplies more detailed program related data so that SE can determine acceptability of launch azimuths and flight termination system requirements. The Flight Plan Approval (FPA) follows with the submittal of a basic flight analysis data package (para 2.2.4). This includes specific trajectory information, break up data, jettisoned item impact areas, etc. The FPA must be accomplished for all missions. Past data submittals may be referenced if that data has not changed from previous operations. The final approval, the Operation Approval Letter (OAL), is issued only after all other safety approvals have been issued. Data submittals for SPA, PFPA, FPA, MSGSA (see chapter 3), and FTSA (see chapter 4), are sufficient for issuance of the OAL. The following table lists the timelines for delivery of data:

Approval	Data Due
Statement of Program Acceptance	L - 2 Years
Preliminary Flight Plan Approval	L - 1 Year
Flight Plan Approval	
New Programs	L - 100 Working Days (20 weeks)
Recurring Programs	L - 30 Working Days (6 weeks)

2.2.2 Statement of Program Acceptance (SPA).

2.2.2.1 SPA Description. An SPA is required for programs new to the Range. The purpose of the SPA is to ensure safety requirements and design constraints are included in the overall system design and determine if the specific program is conceptually acceptable from a flight safety standpoint. The request for a SPA should be made very early in the conceptual phase of a new program. This is accomplished during interchange meetings with Safety representatives.

2.2.2.2 SPA Data Requirements. The request for SPA shall contain, as a minimum, the following information: (SPA data requirements may be tailored by SEY per request from the Range User).

2.2.2.2.1 Basic program objectives.

2.2.2.2.2 Booster and vehicle description.

2.2.2.2.3 General description of the airborne flight safety system (made up of the destruct system, inadvertent separation destruct devices and tracking aids). NOTE - SE must be involved prior to the Preliminary Design Review time frame if a new design is to be considered.

2.2.2.2.4 Vehicle and spacecraft propellant characteristics (type, quantities, TNT equivalency, etc.).

2.2.2.2.5 Siting of launch facilities, support buildings, and the structural integrity information for each of these.

2.2.2.2.6 General program mission scenarios and proposed target areas.

2.2.2.2.7 Preliminary trajectory data on magnetic media, and listings, in the AFSPACECOMM 80-12, AFSPACECOM Standard Theoretical Trajectory Magnetic Media Format.

2.2.2.2.8 Vehicle maximum turn capabilities.

2.2.2.2.9 Preliminary estimate of fragment characteristics (e.g., number, composition, size, weight, etc.) due to all potential modes of vehicle breakup (e.g., destruct action, self destruct, aerodynamic loading, etc.).

2.2.2.2.10 The nominal impact and dispersion areas for all planned jettisons of discarded stages, strap-ons, thrust termination ports, payload fairings, etc and for ballistic programs, the nominal target area.

2.2.2.2.11 Map and listing of downrange and crossrange vacuum instantaneous impact points for each second of powered flight time.

2.2.2.3 **SPA Data Submission Timeline.** Data should be submitted two years prior to launch. Preferably, as early in the program as possible and no later than submittal of the Program Introduction.

2.2.3 **Preliminary Flight Plan Approval (PFPA).**

2.2.3.1 **PFPA Description.** For programs not already active on the range, a PFPA is required. PFPA can be requested for single or multiple mission profiles. Discussions on PFPA requirements will begin during the Safety Requirements Working Group meetings.

2.2.3.2 **PFPA Data Requirements.** When requesting a PFPA, the Range User provides the following information in writing to SEY: NOTE: Reference may be made to documentation previously submitted, where applicable. If specific data are not available, the best engineering estimate should be given. PFPA data requirements may be tailored by SEY per request from the Range User.

2.2.3.2.1 Number and designation of launches to which the proposed flight plan applies.

2.2.3.2.2 A statement indicating whether the proposed flight plan is similar to some prior mission.

2.2.3.2.3 Intended launch date(s).

2.2.3.2.4 Description of vehicle configuration, including the guidance and control system.

2.2.3.2.5 Description and location of destruct systems and inadvertent separation destruct devices, or statement that the proposed system is similar to one already in use.

2.2.3.2.6 Tracking aids (for example, C-Band transponder) installed in the vehicle that can be used for missile flight safety purposes and their locations in the stages or sections.

2.2.3.2.7 **Propellant Description.** If a vehicle has the capability of exploding as a result of self-initiation, destruct system activation, or ground or water impact, data for blast damage assessment is required. If a vehicle uses propellants that are toxic in gaseous or vapor states due to combustion or release to the atmosphere, data for toxic risk assessment is required. The following data must be submitted:

2.2.3.2.7.1 TNT equivalency vs flight time and explosion scenario for each separate stage and each possible combination of stages that could result from malfunction conditions.

2.2.3.2.7.2 The probability of explosion vs flight time for each of the following: self-initiation, destruct system activation, and ground or water impact.

2.2.3.2.7.3 Description of methods used to minimize the possibility of explosion.

2.2.3.2.7.4 Time of day when launches will be scheduled and the number of launches.

2.2.3.2.7.5 Maximum total quantities of liquid and solid propellants.

2.2.3.2.7.6 Nominal vehicle altitude (meters AGL) versus time through 3,000 m in the following format: $t = a*z^b+c$, where t = time (sec) after initial ignition, z = height (m) of the vehicle above the launch pad, and a, b, c are coefficients found by a least squares fit to an estimated time-height profile for this booster.

2.2.3.2.7.7 Heat released (cal) by the solid fuel when combusted to an equilibrium state of the exhaust products. Also provide the time required for the exhaust products to reach chemical equilibrium.

2.2.3.2.7.8 Burn time and expenditure rate of solid propellant for nominal launch and a catastrophic abort occurring at lift-off. Include fuel fragmentation and expenditure rate assumptions used to generate the atmospheric abort parameters.

2.2.3.2.7.9 Liquid propellant expenditure rate (grams per sec) for nominal launch.

2.2.3.2.7.10 Fractions of following species released from liquid and solid propellant combustion during nominal and catastrophic scenarios: hydrogen chloride, carbon dioxide, carbon monoxide, aluminum oxide, hydrazine, unsymmetrical dimethylhydrazine, monomethylhydrazine, nitrogen tetroxide, nitrogen dioxide, nitrosodimethylamine, and formaldehyde dimethylhydrazine.

2.2.3.2.7.11 **Initial Exhaust Cloud Data.** The following information is needed to specify the initial exhaust cloud parameters. These values describe the exhaust ground cloud when the horizontal momentum produced by the ducting in the launch mount becomes negligible compared to the buoyant forces within the cloud for the nominal launch scenario.

2.2.3.2.7.11.1 Initial exhaust ground cloud central radius (meters) for nominal launches and radius of area over which solid fuel fragments are dispersed for catastrophic abort cases.

2.2.3.2.7.11.2 Vertical velocity of cloud centroid (meters per sec) for nominal and catastrophic cases.

2.2.3.2.7.11.3 Initial ground cloud centroid height (meters AGL).

2.2.3.2.8 Trajectory data. The trajectory data described below is required on magnetic media with listings, in the AFSPACECOMM 80-12, AFSPACECOM Standard Theoretical Trajectory Magnetic Media Format.

2.2.3.2.8.1 Initial flight azimuth for single azimuth launches or desired azimuth sector for variable azimuth launches.

2.2.3.2.8.2 $X, Y, Z, \dot{X}, \dot{Y}, \dot{Z},$ as functions of time throughout powered flight. The data should be provided in time intervals of one second. If position and velocity components cannot be provided then, with the approval of SEY, ground range and altitude values may be substituted for X, Y, Z and the total earth-fixed velocity relative to the pad with flight path angle may be substituted for $\dot{X}, \dot{Y}, \dot{Z}$.

2.2.3.2.8.3 Geodetic coordinates of launch site or location on the earth's surface for launches that occur above or below the earth's surface.

2.2.3.2.8.4 Map showing the planned locus of vacuum instantaneous impact points for the intended flight azimuth or azimuth sector. This map should also show the mean impact points and the three sigma, drag-corrected impact dispersion areas for all jettisoned bodies (e.g., stages, reentry vehicles, etc.).

2.2.3.2.8.5 Ballistic coefficient or drag data (weight, reference area and C_D vs Mach number) of all nominally jettisoned hardware, time of jettison, and free fall trajectory for all major spent stages.

2.2.3.2.8.6 Range from the launch pad to the vacuum impact point at times of discrete events; such as arming of engine cutoff circuits, ignition of upper stages, firing of retrorockets, and the end of burns that occur prior to orbital injection. The trajectory must be shaped for vehicles within the plus or minus three sigma limits so these events occur while the impact dispersion area is over water.

2.2.3.2.9 Spacecraft Data Requirements. All spacecraft (payloads and upper stages) must be analyzed to determine the risk potential associated with a malfunctioning launch vehicle or a spacecraft that may separate prematurely from the launch vehicle. The following information is required to determine if the spacecraft poses enough of a threat to warrant an FTS:

2.2.3.2.9.1 The types, weights and containment of propellants, ordnance items, toxic and radioactive materials.

2.2.3.2.9.2 Functional description of structural, mechanical, and electrical inhibits or safe-guards for preventing premature separation and ignition of upper-stage and payload propulsion systems. Extent to which such inhibits are independent. Simplified schematics and operational description of propulsion system ignition circuits. Extent to which circuits and systems are shielded.

2.2.3.2.9.3 Description of failure modes which can lead to premature separation and/or ignition of upper stage and payload propulsion systems. Probability of occurrence for each mode including method of derivation and a fault tree analysis if multiple components or subsystems are involved.

2.2.3.2.9.4 Probability of stable flight of prematurely separated and thrusting upper stage and/or payload. Include description of stability characteristics, both within and outside the sensible atmosphere. Include the effects of structural confinement (e.g., payload fairing) on prematurely separated upper stage/payload.

2.2.3.2.9.5 Impact dispersion analysis showing the extent to which the impact point(s) of the upper stage and/or payload can deviate from nominal if either separates prematurely and the propulsion system ignites. Computations are required from liftoff until upper stage fuel depletion or orbit insertion.

2.2.3.2.9.6 The trajectory data from paragraph 2.2.3.2.9.

2.2.3.2.10 Supporting Data and Justification. The Range User may be asked to provide some or all of the following additional supporting data and justification before a decision on PFPA can be made. NOTE: The need for this information is established in the SE response to each PFPA request or in the initial PFPA discussions.

2.2.3.2.10.1 A statement of objectives for powered flight.

2.2.3.2.10.2 Effect on the program (cost, schedule, data requirements, reli-ability) if the plan is not approved.

2.2.3.2.10.3 Statement of the objectives that will not be met if the plan is not approved as proposed.

2.2.3.2.10.4 Any alternate flight plans that will accomplish the program objectives.

2.2.3.2.10.5 The effect on the program of modifying the proposed trajectory.

2.2.3.2.10.6 Any other data the Range User may wish to submit.

2.2.3.2.11 Buoyancy analysis. The Range User performs a buoyancy analysis of all impacting hardware. If the hardware will float, a means of sinking or aids to recovering floating items must be provided. If recovery is desired, a recovery procedure must be provided.

2.2.3.3 PFPA Data Submittal Timelines. All data required for PFPA should be submitted at least one year prior to launch. Our analysis of this data may result in changes to the flight profile, therefore timely submittal is critical.

2.2.4 Flight Plan Approval (FPA).

2.2.4.1 FPA Description. FPA is required for every operation. In response to the WR User request, the FPA is issued when SE is satisfied that a specific operation(s) can be supported within the limits of flight safety control capabilities to provide positive protection to life and property. The FPA is based on detailed analysis of program objectives, vehicle performance, and other data items required by this regulation. Any constraints or conditions identified in the SPA or PFPA may be superseded by those stated in the FPA. The FPA applies to a specific operation, and does not guarantee that similar missions will receive an FPA. If a program consists of numerous, identical missions that will occur within a relatively short time span (less than two years), a blanket FPA may be granted that would remain in effect throughout the life of the program as long as the missions remain within the specified safety constraints.

2.2.4.2 FPA Data Requirements. Data package requirements are defined later in this chapter. If required FPA data are equivalent to already submitted SPA or PFPA data, it need not be resubmitted. FPA data requirements may be tailored by SEY per request from the Range User. To determine which requirements apply to a specific program, use the following table:

Vehicle	Type	Paragraph
Ballistic	Single or Multiple Flight Azimuths	2.4
Spacelift	Single or Multiple Flight Azimuths	2.4
Cruise Missile	Ground or Air Launched	2.5
Small Rocket	Without Destruct System	2.6
Aircraft & Aeronautical Systems	All	2.7
Projectiles and Torpedoes	Air Dropped	2.8
Aerostat/Balloon Systems	Tethered or Untethered	2.9
Directed Energy Systems	Ground, Air, Space tests	2.10
Large Nuclear Systems	All	2.11

2.2.4.3 FPA Data Submission Timelines. For programs already active at the WR, such as ballistic missile operational testing and satellite replacement, updated FPA data must be submitted or previously submitted data recertified no later than thirty working days (six weeks) prior to launch. All new programs must submit FPA required data no later than 100 working days (20 weeks) prior to the operation. Timelines may be shortened depending upon the complexity of the program. If the FPA requirements are not provided within the time lines specified, then SEY may not be able to prepare all necessary safety criteria in time to support a proposed mission. In this event, the mission will not be conducted until adequate safety preparations can be made.

2.2.5 Operation Approval Letter (OAL). An OAL is issued by SE for each mission. Ideally, the OAL will be issued seven days before the mission. All safety approvals (SPA, PFPA, FPA, MSGSA, and FTSA) must have been issued before the OAL will be released. Issuance of the OAL requires no additional data beyond that already submitted for the above stated approvals.

2.2.6 Probability Study. A probability study (or hazards analysis) quantifies the hazards associated with the proposed mission in terms of probability of impact and expectation of casualty to downrange populated areas (more than 100 nautical miles from the launch point) along the flight path. Be forewarned, in order to complete the study most of the data required for FPA must have already been computed (i.e., debris data, failure rates, trajectory, turn data).

2.2.6.1 Requirement for Probability Study. A probability study is required for FPA if the flight plan involves any of the following:

2.2.6.1.1 Mission objectives are met by direct overflight or the possibility of direct overflight (three-sigma of instantaneous impact position or present position) of land prior to thrust termination or orbital injection.

2.2.6.1.2 Flight so close to land that destruct criteria are violated by a normal vehicle or debris could impact land if a destruct event were to occur.

2.2.6.1.3 Launch phase trajectory so steep that critical coastal areas cannot be protected by standard safety destruct criteria.

2.2.6.1.4 A period during flight when land areas cannot be protected from a malfunctioning vehicle because either the vehicle has no flight termination system or the flight safety system capability is surpassed by the vehicle's performance.

2.2.6.2 Probability Study Data Requirements. The probability study will present the following:

2.2.6.2.1 A list of all population centers along the flight path that could have debris impacting upon them after a destruct event. The list should include the name, area, location of centroid in geodetic latitude and longitude, and number of persons.

2.2.6.2.2 Probability of Impact Density functions for each failure or malfunction mode in terms of downrange and crossrange components. A description of how these functions were computed and the failure modes considered should be provided.

2.2.6.2.3 Probability of Impact (P_i) for each population center computed by summing the individual failure mode probabilities of impact over all fragment groups. Consider the failure rates for each of the failure modes and the flight dwell time over each population center.

2.2.6.2.4 Casualty Expectation (E_c) for each population center. Total population center E_c is computed by summing the E_c values over all fragments affecting each population center. In simplified terms, not accounting for possible sheltering of persons, Ec= P_i * (1/population center area) * number of persons in population center.

2.2.7 Reliability and Malfunction Analysis Data. This paragraph is added to conform with ERR 127-1. 30 SPW/SE has no additional requirements for reliability and malfunction analysis data at this time.

2.3 Approval Procedures for Ship/Aircraft Intended Support Plans (ISPs).

2.3.1 Introduction. During missile and spacelift vehicle launch operations, final authority and responsibility for the safety of support ships and aircraft rests with the Wing Commander. Hazards to ships and aircraft exist primarily in the launch area, along the flight line where jettisoned stages and components reenter, and in the target area where reentry vehicles and final stages impact. For the most part, support ships and aircraft must be located in these relatively hazardous areas to collect the data needed to meet mission objectives on a non-interference basis. As the Commander's representative, the Flight Analysis Branch establishes procedures for providing maximum safety consistent with mission objectives.

2.3.2 Procedures. Intended Support Plans (ISPs) for ships and aircraft shall be developed either by the Range User or by support organizations that are responding to requirements contained in the Program Requirements Document (PRD) or the Operations Requirements (OR) Document. In either case the developing organization must furnish the Flight Analysis Branch (SEY), either directly or through the Range Squadron, with an ISP for review and approval at least twenty calendar days before launch.

2.3.3 Aircraft and Ship Support Plan Data Requirements. For missile launch or reentry operations requiring support aircraft or ships, the following additional information is required twenty calendar days prior to the mission:

2.3.3.1 Aircraft Flight Profile Information:

2.3.3.1.1 Type of aircraft.

2.3.3.1.2 Call sign ("N" number, tail number, etc.).

2.3.3.1.3 Final staging and recovery base.

2.3.3.1.4 Warning area and mission area penetration (entry and exit) point(s).

2.3.3.1.5 Holding fix(es) and altitude(s).

2.3.3.1.6 Course, speed and altitude(s) to the mission support position (MSP), that is, terminal end of the data run.

2.3.3.1.7 Maneuvering after MSP for departure to recovery base.

2.3.3.1.8 A copy of information supplied in Federal Aviation Administration (FAA) and other required flight plans for controller background information.

2.3.3.1.9 A copy of information, both written and graphic, describing the data gathering maneuvers to be conducted while operating in an area controlled by the supporting center.

2.3.3.1.10 Prior to the start of the operation, each aircraft commander receives an operation identifier, for example, operation number, that must be included in the FAA flight plan remarks section at the time of filing.

2.3.3.2 Ship Cruise Profile Information:

2.3.3.2.1 Class of ship.

2.3.3.2.2 Call sign (registration number, name, etc.).

2.3.3.2.3 Final staging and recovery point.

2.3.3.2.4 Warning area and mission area penetration (entry and exit) point(s).

2.3.3.2.5 Holding fix(es).

2.3.3.2.6 Course and speed to the mission support position (MSP), that is, terminal end of the data run.

2.3.3.2.7 Maneuvering after MSP for departure to recovery point.

2.3.3.2.8 A copy of information supplied in sailing orders for controller background information.

2.3.3.2.9 A copy of information, both written and graphic, describing the data gathering maneuvers to be conducted while operating in an area controlled by the Range.

2.4 Ballistic Missile and Spacelift Vehicle FPA Data Requirements. The general vehicle and trajectory data requirements in this paragraph apply to all ballistic missile and spacelift vehicles. Lead time requirements are listed in paragraph 2.2.4.3

2.4.1 General Vehicle Data Requirements. The following items are required for each missile/spacelift vehicle flight or group of similar flights and should be updated as changes of vehicle configuration occur or revised information becomes available.

2.4.1.1 General information concerning the nature and purpose of the flight.

2.4.1.2 Trajectory deviations (or any other conditions) beyond which the launch agency is no longer interested in the vehicle flight, and is willing to accept premature flight termination even though the missile may not have reached a dangerous position or altitude.

2.4.1.3 Time schedule of events such as ignition, cutoff and separation of each stage, firing of separation rockets, jettisoning of heat shields and nose fairings, initiation and termination of various control and guidance modes, coast periods, arming of engine cutoff circuits, and timer settings for backup engine cutoff signals.

2.4.1.4 Burning rate of any solid propellants (inches per sec) versus pressure at the burning surface.

2.4.1.5 Percent propellant TNT equivalency for each stage as a function of relevant impact parameters such as weight of propellant, impact velocity, surface composition and impact geometry.

2.4.1.6 Stage ignition and burntime, total weight of propellant, and propellant density.

2.4.1.7 Approximate time interval from receipt of a destruct signal at the command antenna until destruct charges explode.

2.4.1.8 Acoustic intensity contours above 85 dB (at 10 dB intervals) that are generated during launch of the vehicle. Also the predominant acoustical bands above 85 dB at distances of .5, 1, 2, and 3 nm surrounding the launch pad.

2.4.1.9 A statement indicating the flight time interval when the vehicle is experiencing the "high q" flight region. This region is defined as the time during flight when the dynamic pressure causes vehicle aerodynamic breakup during a malfunction turn with the result of creating little or no crossrange displacement.

2.4.2 **Airborne Data Sources.** Vehicle telemetry, TMIG, and GPS data may be required (certain detailed information contained in chapter 4).

2.4.2.1 **TMIG Data.** TMIG data is a mandatory requirement as a tracking source for programs using a launch vehicle inertial guidance system. The TMIG data is to be made available in the standard Inter-Range Instrumentation Group (IRIG) format at a 20 samples per second (sps) rate.

2.4.2.1.1 Position (X, Y, Z) and Velocity ($\dot{X}, \dot{Y}, \dot{Z}$)

2.4.2.1.2 Identification of available malfunction detection indicators with data word definition. These indicators are used by the Mission Flight Control Officer (MFCO) in verifying the validity of the TMIG data and as a check on the health of the guidance system.

2.4.2.1.3 The TMIG data is required at an accuracy that provides an Instantaneous Impact Point (IIP) uncertainty (at the three-sigma level) no greater than $\pm$ one nautical mile (nm) crossrange and no greater than $\pm$ three nm in the uprange-downrange direction.

2.4.2.1.4 The TMIG data is required during all phases of powered flight.

2.4.2.2 Telemetry Data. Telemetered performance, guidance, and flight termination system data shall be made available to the Range at a 20 sps rate. The definition of the items required in real time will be defined by SE through the Safety Requirements Working Group described in Chapter 1. Data shall typically include, but not necessarily be limited to:

2.4.2.2.1 Performance data: chamber pressure, fuel pressure, accelerometer outputs, steering information, discreet events such as staging and payload or RV release, and status of key subsystems such as battery voltages and current drains.

2.4.2.2.2 Guidance data: (in addition to the current vehicle state vector) guidance phase and internal cycle status (e.g., major and minor cycles), steering commands, accelerometer inputs and sums (e.g., PIGA, and SFIR) and discreet initiations.

2.4.2.2.3 Flight termination system data: system status, S/A switch positions, received signal strength, decoded outputs or commands, and other health data on support systems.

2.4.2.3 GPS Data. The following paragraphs for GPS to be used by SE as tracking systems are preliminary and will be developed in more detail as the new technology matures at the Range. GPS requirements for safety usage at Range can fall into either of two categories; one, where the GPS is used to provide real-time updates to the vehicle's guidance system (see para 2.4.2.3.1); and two, where the GPS is used as a principal source of safety tracking data (see para 2.4.2.3.2).

2.4.2.3.1 Any vehicle flying from Range facilities using GPS data as a real-time input to its guidance system must: (1) identify to SE the location, format, and reference system used in the GPS data downlink and; (2) demonstrate to SE that the addition of GPS vehicle equipment does not detrimentally affect the reliability and performance of any other safety system (i.e., the TMIG, radar, transponder, flight termination and telemetry systems). NOTE: In this case, SE will not use GPS data as a real-time tracking source. The GPS will be used to become familiar with, characterize, and assess it for potential safety applications.

2.4.2.3.2 Any vehicle flying from Range facilities using GPS as a replacement for the C-Band transponder system must carry a GPS system which meets all the design requirements such as reliability, testing and system independence as currently required for the C-Band transponder system (see Chapter 4). The GPS safety tracking system must fulfill the following (preliminary) requirements:

<u>Accuracy</u>. Same as TMIG data, para 2.4.2.1.3 above, or as approved by SE.

<u>Data Format and Rate</u>. Identify data format (i.e., TMIG) compatible with the Wing systems at a 20 sample per second (update) rate (para 2.4.2.1).

<u>Data Validity</u>. The GPS safety tracking system shall provide real-time error covariance matrix information which represents the mathematical uncertainty in the IIP location.

Data Downlink. The GPS safety tracking system data must be downlinked independent of the vehicle's telemetry downlink.

Power. The GPS on-board equipment shall be powered independent of the FTS and telemetry power systems.

Time Delay. The time delay between vehicle acquisition of the GPS signals and readiness for use in the realtime metric processing computers, due to preprocessing and transmission, shall be no greater than 125 milliseconds.

2.4.2.3.3 Special Remarks: (1) A GPS that is used to update vehicle guidance will not be used as a safety tracking source (para 2.4.2.3.1 above). (2) Mission completion upon loss of GPS data and prior to TMIG validation, or in the absence of TMIG data, cannot be guaranteed by SE. (3) Radar skin tracking data will be mandatory for vehicles using GPS as a replacement for the C-Band transponder.

2.4.3 Sonic Boom Analysis Data. The following information may be required for a sonic boom hazard analysis:

2.4.3.1 Control Information:

2.4.3.1.1 R - distance from vehicle where the Near Field Signature (NFS) is determined, in feet (ft).

2.4.3.1.2 LM - length of model of vehicle in feet.

2.4.3.1.3 LR - vehicle length in feet.

2.4.3.2 NFS Data with Exhaust Plume:

2.4.3.2.1 θ - roll angle, in degrees.

2.4.3.2.2 M - mach number.

2.4.3.2.3 N - number of points in NFS.

2.4.3.2.4 X - vehicle station on model where pressure perturbation was measured in feet.

2.4.3.2.5 $\Delta P/P$ - pressure perturbation divided by ambient pressure.

2.4.4 Velocity Turn Data. Velocity turn information is required from launch up to a point in flight where effective thrust of the final stage has terminated or to thrust termination of that stage or burn that places the vehicle in orbit. The turn data define the turning capability of the vehicle velocity vector as a function of thrust vector offset (or other parameter characterizing the turns).

2.4.4.1 The turn data must be defined for a series of parameter (e.g., thrust vector offset) values covering the credible range of values that the parameter could have and must include enough values to demonstrate the variation of the turn characteristics with parameter value. If the turns can occur as a function of more than one parameter (e.g., SRM thrust vector offset angle for thrust vector control failures and thrust dissipation time for SRM nozzle burn throughs), turn data must be provided for each parameter. Where possible, the same set of parameter values should be used for each turn initiation time.

2.4.4.2 In beginning the various turning angle computations, it should be assumed that the vehicle has behaved normally up to the point of the malfunction that produces the turn. Computations need not be made for the three-sigma maximum and the three-sigma minimum trajectories, but a method for applying the turning angles to these trajectories must be provided. If the trajectory used is not one of those provided in response to 2.4.10.2 below, then this trajectory must also be submitted (format described in 2.4.10.3). In addition, a complete discussion is required of assumptions made, method of calculations, and equations used in deriving the turn data.

2.4.4.3 Turn data, for both pitch and yaw turns, are to be generated without the effect of gravity.

2.4.4.4 **Types of Turns.** In determining the turning capabilities of a vehicle, the Range User must consider both trimmed turns and tumbling turns in both the pitch and yaw planes. Trimmed turn refers to a turn where the angle of attack is such that the aerodynamic moment is just balanced by the thrust moment, such as a guidance and/or control malfunction which directs the vehicle to achieve a constant attitude rotation rate. A maximum-rate trimmed turn is a turn made at, or near, the greatest angle of attack that can be maintained throughout the turn. Tumbling turn means the family of turns that result if the airframe rotates in an uncontrolled fashion at varying angular rates, each angular rate history being brought about by a different constant value of the thrust vector offset angle, or constant value of another parameter which defines the tumbling turn. Yaw turn means the angle turned in the yaw plane by the total velocity vector, not the angle turned in the horizontal plane by the horizontal component. The procedure outlined in paragraphs 2.4.4.4.1 through 2.4.4.4.3 should be followed in determining the type of turn information provided at each failure time.

2.4.4.4.1 For vehicles that are aerodynamically unstable at all angles of attack, the following will apply: If the Range User can show that the probability of flying a trimmed turn (even for a period of only a few seconds) is virtually zero, only tumbling turn data is required. If the Range User cannot so state, both trimmed turns and tumbling turns must be considered and data provided.

2.4.4.4.2 For vehicles that are stable at all angles of attack, or unstable at low angles of attack but stable at higher angles of attack, such that the maximum thrust moment cannot produce tumbling, then only trim turn data is required.

2.4.4.4.3 During the first 100* seconds of flight, both pitch turns and yaw turns must be investigated and data for both provided if, when neglecting gravity, the pitch data are different from the yaw data. However, after 100* seconds, turns need be computed only for the yaw plane.

2.4.4.5 Turn Initiation Times and Durations. Velocity turn information is required for failures initiated at even 4* second intervals, beginning 4* seconds after first motion and continuing for the first 100* seconds of flight, and at even 8* second intervals thereafter. The velocity turn curves (turn angle and velocity magnitude) are to be carried out for a sufficient time into the turn such that one of the following two conditions are met: (1) the vehicle reaches a critical loading condition that will cause breakup, or (2) the vehicle is tumbling so rapidly that the effective thrust acceleration is negligible (i.e., the projected vacuum impact point is no longer moving significantly). The information which describes the turn (see 2.4.4.7 below) is required at intervals of one second or less.

2.4.4.6 Turn Data Formats. Velocity turn data is to be delivered in the form of graphs. In addition, tabular listings of the data used to generate the graphs must be provided in ASCII format files on floppy disks and corresponding hardcopies. For the velocity turn angle graphs (see paragraph 2.4.4.7.1 below), the ordinate of the graphs should represent the total angle turned by the velocity vector in degrees and the abscissa the time duration of the turn in seconds. For the velocity magnitude graphs (see paragraph 2.4.4.7.2 below) the ordinate of the graphs should represent the magnitude of the velocity vector in feet per second and the abscissa the time duration of the turn in seconds.

2.4.4.7 **Turn Data Items.** The following data items are required for each turn initiation time:

2.4.4.7.1 Velocity Turn Angle. This data item defines the angular rate of change in the direction of the vehicle velocity vector. A family of curves for representative constant values of thrust vector offset (or other parameter) and an envelope which represents the outer contour of all such curves is required.

2.4.4.7.2 Velocity Magnitude. This data item defines the variation in the magnitude of the vehicle velocity throughout the turn. Velocity magnitudes must be provided for each thrust vector offset (or other parameter) used to define the turn envelope. Either total velocity magnitude or incremental change in velocity magnitude from time of malfunction can be provided, although the total velocity magnitude is desired. For each thrust vector offset angle (or other parameter), the point on the velocity graph corresponding to the point of tangency of the corresponding turn angle curve with the turn angle envelope must be indicated.

2.4.4.7.3 Vehicle Orientation. If the vehicle has thrust augmenting rocket motors, then the vehicle attitude (in the form of the angular orientation of the vehicle longitudinal axis) as a function of time into the turn must be provided for each turn initiation time.

2.4.4.7.4 Onset Conditions. This data item defines the state of the vehicle at the beginning of the turn. Information required for each set of turn curves includes the thrust, weight, and state vector (including velocity magnitude) of the vehicle.

2.4.4.7.5 Breakup Information. The Range User must specify if the vehicle will remain intact throughout the turn. If the vehicle will breakup during a turn, then the point (time) for which vehicle breakup is expected to occur must be indicated. The time into the turn at which vehicle breakup would occur can be a specific value or a probability distribution for time to breakup.

2.4.4.7.6 Probability of Occurrence. The distribution for the probability of occurrence for the value of the parameter defining the turns (thrust vector offset, etc.) must be defined for each parameter (as a function of turn initiation time if the distribution varies with time). Also, information defining how the probability distribution was determined must be provided.

2.4.5 Fragment Data. Fragment listings and characteristics for all potential modes of vehicle breakup must be provided. At a minimum, the following modes of vehicle breakup must be considered: (1) breakup due to activation of the flight termination system, (2) breakup due to an explosion, and (3) breakup due to aerodynamic and/or inertial loads (including breakup during reentry for failures occurring out of the atmosphere, with specification of the expected breakup altitude). This information is required up to thrust termination of the last stage that carries a destruct system. All fragments must be included; however, similar fragments can be accounted for in fragment groups. A fragment group is one or more fragments whose characteristics are similar enough to allow all the fragments to be described by a single "average" set of characteristics. The data items below should be included for each mode of vehicle breakup. The variation of the fragment characteristics with flight time must be defined. Normally this is accomplished by specifying multiple fragment lists, each of which is applicable over a specified period of flight.

2.4.5.1 Describing Fragment Groups. The following information is provided to aid in determining fragment groups:

2.4.5.1.1 Fragment type: All fragments must be of the same type (propellant, inert), including whether or not fragments involving propellant are burning following breakup.

2.4.5.1.2 Ballistic coefficient (beta): The maximum beta in the group should be no more than about a factor of three times the minimum (except for very low beta fragments where betas ranging from near zero to about 5 lbs/ft^2 can be grouped together).

2.4.5.1.3 Weight: If the fragments contain propellant which is burning during free fall the maximum weight of propellant in a fragment group should be no more than a factor of 1.2 times the minimum weight of propellant. The fragments included in a group should be such that the kinetic energies (*KE*) based on terminal velocity (*KE = 13*W*beta*, ft-lbf) are within the following guidelines:

- Fragments having *KE* < 35 are grouped.
- Fragments having 35 < *KE* < 100 are grouped.
- Fragments having 100 < *KE* < 6,200 should be grouped such that the maximum fragment *KE* is no more than about three times the minimum.
- Fragments having 6,200 < *KE* < 33,670 should be grouped such that the maximum fragment *KE* is no more than about three times the minimum.
- Fragments having 33,670 < *KE* < 74,000 should be grouped such that the maximum fragment *KE* is no more than about three times the minimum.
- Fragments having 74,000 < *KE* < 1,616,000 should be grouped such that the maximum fragment *KE* is no more than about three times the minimum.
- Fragment having *KE* > 1,616,000 are grouped.

2.4.5.1.4 Velocity perturbation: The maximum expected destruct induced velocity in the group should be no more than a factor of 1.2 times the minimum destruct induced velocity.

2.4.5.1.5 Projected area: For explosive fragments, the range of projected areas should be controlled by requiring that the maximum value of the weight of propellant at impact is no more than a factor of two times the minimum (however, if the propellant is burning during free fall the factor is 1.2). There is no limit on the range of projected areas for inert fragments.

2.4.5.2 Fragment Data Items. This paragraph provides a description of the data items required for each fragment or fragment group for each potential mode of vehicle breakup.

2.4.5.2.1 Fragment group name.

2.4.5.2.2 Number of fragments.

2.4.5.2.3 General description(s) of fragments (e.g., part/component, shape, dimensions, figure, etc.).

2.4.5.2.4 Nominal, plus three-sigma and minus three-sigma ballistic coefficient values (lbs per square ft) for each fragment or group. Include, if possible, graphs of the coefficient of drag (C_D) versus Mach number with three sigma tolerance limits for each fragment or group.

2.4.5.2.5 Weight per fragment (lbs). Include the possible weight variation for the fragment or group. NOTE: The fragment data must approximately add up to the total weight of inert material in the vehicle plus the weight of contained liquid propellants and solid propellant that is not consumed in the initial breakup/conflagration.

2.4.5.2.6 Projected area per fragment (ft^2). Include the possible variation in area for the fragment or group. This information is not required for those fragment groups classed as uncontained propellant fragments, see 2.4.5.2.8 below.

2.4.5.2.7 Estimates of the maximum incremental velocities (ft per sec) imparted to the vehicle pieces due to explosive and/or overpressure loads at breakup. The velocity is normally assumed to be Maxwellian distributed with the specified maximum value equal to the 97th percentile. If the distribution is known to be significantly different than the Maxwellian, the correct distribution should be specified (including if the specified value should be interpreted as a fixed value with no uncertainty).

2.4.5.2.8 Fragment group type, where inert fragments contain no volatile type material that could be burning or could explode, uncontained propellant is solid propellant exposed directly to the atmosphere, contained propellant is propellant that is enclosed in a container (such as a motor case) but will not explode upon impact and explosive fragments are either uncontained or contained propellant fragments that will explode upon impact:

1 = inert fragment.
2 = uncontained propellant fragment.
3 = contained propellant fragment.
4 = contained propellant fragment, explosive.
5 = uncontained propellant fragment, explosive.

2.4.5.2.9 Casualty area per fragment (ft^2). The casualty area per fragment should be based on a fragment falling vertically at impact, and should reflect the credible fragment orientation giving the maximum projected area.

2.4.5.2.10 Vehicle stage where fragment group originated.

2.4.5.2.11 For those fragment groups defined as uncontained propellant fragments, contained propellant fragments, and explosive fragments, an indication is required as to whether or not the propellant fragments are burning during free fall.

2.4.5.2.12 For those fragment groups defined as contained propellant fragments, explosive or non-explosive, the initial weight of contained propellant (lbs) and the consumption rate during free fall (lbs per sec) is required. The initial weight of the propellant in a contained propellant fragment is the weight of the propellant before any of the propellant is consumed by normal vehicle operation.

2.4.5.2.13 Diffusion and dispersion of any fragments containing toxic or radioactive materials and the radiation and exposure characteristics.

2.4.5.2.14 For pieces that may stabilize during free flight, C_D curves should be provided for this stabilization angle of attack. If the angle of attack where the piece stabilizes is other than zero degrees, both the coefficient of lift (C_L) versus Mach number and the C_D versus Mach number curves should be provided. For pieces that will tumble during free flight, the tumbling drag coefficient curves should be provided.

2.4.5.2.15 The explosion effect on the remaining fuel and stages are also required, particularly with respect to ignition or detonation of upper stages if destruct action is taken during the burning period of a previous stage. If one of the upper stages can be ignited as a result of destruct action taken on a previous stage, sufficient information is required to evaluate the effects and duration of thrust, and the maximum deviation of the impact point that can be brought about by this thrust.

2.4.6 Failure Rate Data. Failure rate data must be provided for each stage. An analysis of all subsystems should be made to determine those failure modes that would result in a catastrophic event (such as failure of the hydraulic system, failure of the guidance or control system, failures that lead to premature thrust termination, etc.).

2.4.6.1 Define all credible failed vehicle response modes. A response mode is a category of vehicle dynamic response, including vehicle breakup, that results from one or more failure modes. At a minimum, the response modes should include on-trajectory failures (thrust termination, explosion, etc.) and malfunction turn (loss of thrust vector control, tumble turn, nozzle burn through) failures. On-trajectory failures should be subdivided according to the type of breakup (aerodynamic, explosive, etc.) that will result. Malfunction turns should be sub-divided into tumble turns and trimmed turns if trimmed turns are a credible response mode.

2.4.6.2 An estimate of the probability of occurrence or failure rate (versus time) is required for each failure mode. Also state any other information considered pertinent with respect to critical portions of flight, such as vehicle stability characteristics and structural limits.

2.4.7 Jettisoned Body Data. Data indicating expected impact point or aiming point, associated drag data and impact dispersion data for each jettisoned body (e.g., stages, panels, shrouds, etc.) is required. Include maximum possible impact range of each impacting stage or reentry vehicle for a missile burning to fuel exhaustion.

2.4.7.1 The expected impact point for each jettisoned body should be given in terms of geodetic latitude and longitude in decimal degrees, and range (nm) from the pad. Computations should be made for an ellipsoidal rotating earth taking into account drag and, if applicable, lift.

2.4.7.2 The number of fragments resulting from a specific scheduled jettison. If the jettisoned body is expected to break up during reentry, an estimate of the number of pieces, their approximate weights, cross sectional areas, and their impact ranges must also be provided.

2.4.7.3 Jettison flight time (sec), total weight jettisoned and weight per fragment (lbs), reference area per fragment (ft^2), and the best estimate of C_D vs Mach number (preferred) or subsonic and supersonic W/C_DA for each stage or piece. The C_D vs Mach number data should be provided in a tabular format for the nominal, minus three sigma and plus three sigma drag coefficients and must cover the range of possible Mach numbers that could be encountered for the scheduled fragment(s) during free fall.

2.4.7.4 The three sigma uprange-downrange (nm) and crossrange (nm) impact distribution uncertainty and the azimuth orientation of the major axis (degrees clockwise from true north), assuming a normally functioning vehicle. Three sigma wind effects acting upon the descending body or pieces must be included in the dispersion area. A brief discussion of the method used to determine dispersion should also be provided.

2.4.7.5 Impact ballistic coefficient (lbs per ft^2).

2.4.8 **Reentry Vehicle Data.** Information for reentry vehicle description drag data and for weapons systems or reentry vehicle development tests is required (if applicable). The items in 2.4.8.1 through 2.4.8.4 below should be provided in records 23, 24, and 25 of the trajectory or submitted with general vehicle data.

2.4.8.1 Type of reentry vehicle (ablation or heat sink) and ablation tables when applicable. The ablation table should consist of a table of Mach number or altitude vs the ratio (W/W_o), where W equals the instantaneous reentry vehicle weight during reentry and W_o equals the vehicle weight before ablation.

2.4.8.2 The reentry vehicle weight before ablation.

2.4.8.3 A table of reentry vehicle drag coefficient versus Mach number of altitude.

2.4.8.4 Reentry vehicle aerodynamic reference area associated with the drag coefficients.

2.4.8.5 **Detonation Data.** A description of the effects of explosives on reentry vehicles, if applicable. This description includes, but is not limited to, the:

2.4.8.5.1 Location and altitude of the point where the device is intended to be detonated.

2.4.8.5.2 Effects of detonation on the vehicle and reentry vehicle containing the device.

2.4.8.5.3 Dispersion of the resulting fragments. The description should also include diffusion and dispersion of any toxic or radioactive clouds or fragments and the radiation exposure characteristics.

2.4.9 **Land Overflight Data.** For land overflight data, information is required to establish guidelines for safety action decisions. The ultimate use of this information depends on land overflight hazards and mission objectives. The derivation of the following items may be lengthy. Therefore, when necessary, SE will accept information based on the Range User's best estimate.

2.4.9.1 **Flight Azimuth Limits.** The flight azimuth limits where the primary mission objectives and a useful orbit can be accomplished. These azimuth limits are used to establish bounds for safety action decisions. For both, a complete explanation is required of:

2.4.9.1.1 The mission objectives that are met by the azimuth selections.

2.4.9.1.2 The circumstances or type of malfunction that can cause the vehicle to fly outside the three sigma limits of normality but still accomplish use objectives.

2.4.9.1.3 The probability of such a malfunction occurring.

2.4.9.1.4 An explanation of the effect of this malfunction on the success of succeeding burns or stages.

2.4.9.2 The most lofted and depressed trajectories where the primary mission objectives and a useful orbit can be accomplished. These trajectories should consider only perturbations that result in deviations in the pitch plane. Position and velocity data in the AFSPACECOMM 80-12 format are required for these trajectories and the information requested in 2.4.9.1.1 through 2.4.9.1.4 above, is also required.

2.4.9.3 The minimum (and maximum if it exists) impact range from the pad as a function of time required for a useful orbit. These ranges should be such that orbit cannot be accomplished if the impact range, as a function of time, is less or greater than the limits specified for orbit. This information should be supplied at staging times and at sufficient other times to confirm the orbit capability.

2.4.9.4 A probability study (para 2.2.6) must be submitted.

2.4.10 Trajectory Data. The trajectory data must be calculated using both vehicle state and attitude data. All trajectories must be provided from launch up to a point in flight where effective thrust of the final stage has terminated or to thrust termination of that stage or burn that places the vehicle in orbit. The trajectory files must be provided in accordance with media and formats described in AFSPACECOMM 80-12. The media containing the files, two copies of printouts of the files, and a letter of transmittal are to be provided according to the lead times established in paragraph 2.2.4.3. NOTE: The WR does not require three-sigma steepest launch area trajectories as per ERR 127-1.

2.4.10.1 Description. A brief discussion of the parameters considered, their standard deviations, and all assumptions and procedures used in deriving the trajectories is provided below. A graph and tabulation of the wind profiles used must also be included.

2.4.10.1.1 The nominal or reference trajectory is the trajectory that the vehicle would fly if all vehicle parameters were exactly as expected, if all vehicle systems performed exactly as planned, and there were no external perturbing influences.

2.4.10.1.2 **Dispersed Trajectories.** To generate three sigma maximum, minimum and lateral trajectories, the following procedure is suggested: NOTE: If the following procedure is not used, then a description of the method used to generate the three sigma trajectories is required.

2.4.10.1.2.1 Identify individual parameters (for example, thrust, weight, specific impulse, etc.) which significantly affect the IIP performance of the vehicle. Estimate three sigma dispersions for these parameters.

2.4.10.1.2.2 Run a series of trajectory computations, or simulations, where three sigma values of significant perturbing parameters are introduced singly. For a suitable number of time points, tabulate the IIP deviations from nominal, in the uprange, downrange, and crossrange directions, that have been caused by each parameter.

2.4.10.1.2.3 For each time point and direction, calculate the square root of the sum of the squares of all deviations to arrive at the three sigma IIP deviations.

2.4.10.1.2.4 By further trajectory computations or simulations, generate three powered flight trajectories (a three sigma no-wind trajectory) that match as closely as possible the three sigma deviations calculated in 2.4.10.1.2.3 above. This may be done by perturbing only a few key parameters at varying magnitudes throughout the run.

2.4.10.1.2.5 Compute the required three sigma trajectory using "worst winds" and the parameter magnitudes used to calculate the three sigma no-wind trajectory. The wind dispersed trajectories indicate vehicle performance deviations due to the effects of severe winds. This data should be supplied until the missile attains an altitude where there is essentially no wind effect. It is usually sufficient to use 100,000 feet as this altitude limit. Computations should not be limited to wind drift but include all wind effects.

2.4.10.1.3 The three sigma maximum- and three sigma minimum-performance trajectories define, at any time after launch, the limits of normality as far as impact range is concerned. The three sigma maximum-performance trajectory provides the maximum downrange distance of the IIP for any given point in time and the three sigma minimum-performance trajectory provides the minimum downrange distance of the IIP for any time. In calculating these trajectories, head and tail wind profiles should be used that represent the worst wind conditions when a launch would be attempted.

2.4.10.1.4 The three sigma lateral trajectory defines the lateral limits of normality for the IIP. This trajectory is calculated using the worst lateral wind condition when a launch would be attempted. Since only one, three sigma lateral trajectory is requested for single azimuth launches, the assumption is made that the three sigma left and the three sigma right trajectories are symmetric about the nominal trajectory. If this assumption is not reasonable, then both three sigma left and three sigma right trajectories must be provided. For multiple azimuth launches a similar assumption is made with respect to symmetry of the three sigma trajectories about each nominal trajectory. However, the further assumption is made that the three sigma lateral trajectory computed for the centrally located azimuth can be used to produce a three sigma trajectory for any other nominal azimuth simply by reorienting the X and Y axes of the data. If this assumption is not reasonable, additional trajectories can be defined for any flight azimuth.

2.4.10.1.5 Ballistic mission fuel exhaustion trajectories should be provided for the last stage only. For orbital flights, the fuel exhaustion trajectory should be provided for the stage preceding the stage that achieves orbit. The requirement is met by extending either the nominal or three sigma maximum trajectory through fuel exhaustion, depending on which produces a greater impact range.

2.4.10.1.6 The three sigma trajectories should be computed using annual wind profiles unless the launch is to be conducted at a particular time of the year and only at that time. Care should be exercised in the selection of the cumulative percentage frequency of the wind profile used for the computation of these trajectories. Selecting a wind profile as severe as the worst wind conditions when a launch would be attempted is usually recommended. This has the advantage of relieving the Range User or their representative of reevaluating the three sigma trajectories using launch day winds so Safety can make sure the vehicle will not violate established flight safety destruct criteria. In critical instances, this has the disadvantage of limiting the allowable launch azimuth or reducing the allowable launch day winds in the flight safety restrictions for wind drift of vehicle fragments resulting from destruct. The wind profiles used in the computations should be identified. If the Inter-Range Instrumentation Group (IRIG) wind profiles are not used, a tabulation of wind magnitude and direction vs altitude is required for the profile actually used. SE, in the destruct criteria, allows for as much vehicle deviation due to wind as shown in these trajectories, but does not assume responsibility for the safety of a vehicle launched under wind conditions that exceed those used in these computations.

2.4.10.2 Trajectory Requirements.

2.4.10.2.1 Single Azimuth Programs. For single azimuth programs, the trajectory data items of 2.4.10.3 below are required for the following trajectories. These trajectories are computed for a normally performing missile.

2.4.10.2.1.1 Nominal or reference trajectory.

2.4.10.2.1.2 Three sigma maximum-performance trajectory.

2.4.10.2.1.3 Three sigma minimum-performance trajectory.

2.4.10.2.1.4 Three sigma lateral trajectory.

2.4.10.2.1.5 Fuel exhaustion trajectory.

2.4.10.2.2 Variable Azimuth Programs. For programs involving variable flight azimuths or profiles, the trajectory data items of 2.4.10.3 below are required for the following trajectories. These are to be computed for a normally performing missile.

2.4.10.2.2.1 Extreme right-hand or steepest nominal trajectory.

2.4.10.2.2.2 Extreme left-hand or shallowest nominal trajectory.

2.4.10.2.2.3 Centrally located nominal trajectory.

2.4.10.2.2.4 Three sigma maximum-performance trajectory for the centrally located flight azimuth.

2.4.10.2.2.5 Three sigma minimum-performance trajectory for the centrally located flight azimuth.

2.4.10.2.2.6 Three sigma lateral trajectory for the centrally located flight azimuth.

2.4.10.2.2.7 Fuel exhaustion trajectory.

2.4.10.3 **Trajectory Data Items.** This paragraph lists the trajectory data items required by 2.4.10.2 above. These items must be provided according to the coordinate system, accuracy, and definitions specified in AFSPACECOMM 80-12. The coordinate system for the AFSPACECOMM 80-12 format is also defined in paragraph 2.1.3.4. All data is submitted either in English or metric units.

2.4.10.3.1 X, Y, Z (ft) vs time (sec).

2.4.10.3.2 $\dot{X}, \dot{Y}, \dot{Z}$ (ft per sec) vs time (sec).

2.4.10.3.3 Speed = $\sqrt{(\dot{X}^2+\dot{Y}^2+\dot{Z}^2)}$ (ft per sec) vs time (sec).

2.4.10.3.4 Path angle of velocity vector relative to local horizontal (deg) vs time (sec).

2.4.10.3.5 Altitude (ft) above the subvehicle point on the reference spheroid vs time (sec).

2.4.10.3.6 Total weight (lbs) vs time (sec).

2.4.10.3.7 Ground range (nm) along surface of earth from the origin (pad) to a point directly beneath missile vs time (sec).

2.4.10.3.8 Thrust (lbs) vs time (sec).

2.4.10.3.9 Instantaneous impact point data [geodetic latitude (deg), longitude (deg), impact range (nm) and remaining flight time (sec)] vs time (sec).

2.4.10.3.10 The name, coordinates, and mean sea level elevation of the coordinate system origin (launch pad).

2.4.10.3.11 Initial flight azimuth in degrees measured clockwise from true north.

2.4.10.3.12 Name of reference spheroid used in trajectory calculations.

2.4.11 Air Launched Vehicle Data Requirements. For air launched ballistic and spacelift vehicles, the data requested below, along with the data required in paragraph 2.7, FPA Data Requirements for Aircraft Operations, is required.

2.4.11.1 Type of aircraft and performance capability of aircraft, that is, turn rate, climb rate, velocity, etc.

2.4.11.2 Description of drop aircraft flight plan, such as aircraft flight azimuth (degrees true), speed (kts), altitude (ft), flight path angle (deg) of velocity vector relative to local horizontal at vehicle drop point.

2.4.11.3 For other than level flight launches, add a statement on how the aircraft path angle and launch azimuth are determined for vehicle release.

2.4.11.4 The expected maximum region around the drop point, that is, a drop point envelope where the mission is conducted. This is provided as distances downrange, uprange, and crossrange relative to the expected drop point and perpendicular to the launch azimuth or by providing the geodetic latitude and longitude of the corners of the drop box.

2.4.11.5 The rate of drop of launched vehicle and description of stabilizing system used.

2.4.11.6 Method of ignition and position of the vehicle relative to the earth at ignition.

2.4.11.7 A definition and description of events occurring prior to vehicle release and to time of engine ignition.

2.4.11.8 Description of guidance system used and how ignition time and altitude are determined.

2.4.11.9 Predicted impacts of jettison hardware and their dispersion associated with the vehicle drop system.

2.4.11.10 Predicted impact point of jettison hardware and vehicle, and the associated dispersions resulting from ignition failure. The dispersions should include wind effects to all impacting debris.

2.4.12 Statement of Vehicle Performance. Statement of Vehicle Performance is required within one to three months after a failure occurs during a mission. This information is provided by written letter or by lending SE the performance evaluation documents prepared for other purposes. Information desired includes:

2.4.12.1 Qualitative statement about the performance of each stage and the various subsystems.

2.4.12.2 Failures that occurred and resulting flight conditions produced.

2.4.12.3 Probable cause of failure and corrective action taken.

2.4.12.4 Impact points for stages.

2.4.12.5 Miss distances for weapons systems tests.

2.4.12.6 Comparison for planned and achieved cutoff for each stage.

2.4.12.7 Performance of on-board safety instrumentation systems.

2.5 **Cruise Missile FPA Data Requirements.** The trajectory and performance data requirements set forth under this heading apply to cruise missiles. Lead time requirements are listed in paragraph 2.2.4.3.

2.5.1 **General Vehicle Data Requirements.** The following missile related items are required for each missile flight or group of similar flights.

2.5.1.1 General information concerning the nature and purpose of the flight.

2.5.1.2 A scaled diagram of the general arrangement and dimensions of the missile.

2.5.1.3 Location of tracking equipment on board the missile used for missile flight safety tracking, such as S or C band transponder and telemetry transmitter.

2.5.1.4 Description of typical failures which may occur during flight. To meet the requirements of this paragraph, the information requested in paragraph 2.4.6 for ballistic missiles/spacelift vehicles should be provided.

2.5.1.5 **Turn Data.** Maximum turning capability of velocity vector (deg per sec) vs time of flight.

2.5.1.5.1 Maximum turning capability details from launch or drop until cruise altitude is reached are required. This information provides a means of determining the maximum angle that the missile velocity vector can turn in the event of missile malfunction. The maximum angles turned for time intervals up to about 30* seconds duration are of interest. Both pitch and lateral turns should be investigated and the larger presented. It should be assumed the missile has behaved normally up to the point of malfunction that produces the maximum rate turn, the missile is trimmed to the maximum air load the structure can stand, or the missile is flying out of control in an attitude that produces the maximum lateral acceleration (for example, a near 90 degree bank with a maximum pitch turn). During the launch phase, the missile may not be able to fly for 30* seconds under these extreme conditions. In this event, it is assumed the missile is turned at the maximum possible rate where flight can be maintained. A complete discussion of the methods used in calculating must be provided. This discussion includes all assumptions made, types of malfunctions considered, forces producing turns, and equations used.

2.5.1.5.2 During the cruising phase, the maximum turning rate of the velocity vector, as a function of altitude, is required. Rates are based on normal missile weight and expected cruising speed at each altitude. For this phase of flight, the data may be expressed in the form of maximum lateral accelerations, if desired. A complete discussion, similar to that requested for 2.5.1.5.1 above, is required. The maximum turning rates that the guidance system and the autopilot can command during the cruise phase are also required.

2.5.1.6 A description of the effects of destruct action and other potential modes of structural failure (e.g., aerodynamic breakup, self destruct, etc.) on the missile and drag data for resulting pieces. To meet the requirements of this paragraph, the information requested in paragraphs 2.4.5, Fragment Data, for ballistic missiles/spacelift vehicles should be provided.

2.5.1.7 Expected impact point or aiming point for missile and each jettisoned body. The expected impact point for each jettisoned body should be given in terms of geodetic latitude and longitude in decimal degrees, and range (nm) from the pad. Computations should be made for an ellipsoidal rotating earth taking into account drag and, if applicable, lift. Jettison flight time (sec), total weight jettisoned and weight per fragment (lbs), reference area per fragment (ft^2), and the best estimate of C_D vs Mach number (preferred) or subsonic and supersonic W/C_DA for each piece.

2.5.1.8 The three sigma uprange-downrange (nm) and crossrange (nm) impact distribution uncertainty and the azimuth orientation of the major axis (degrees clockwise from true north), for each jettisoned body. Three sigma wind effects acting upon the descending body or pieces must be included in the dispersion area. A brief discussion of the method used to determine dispersion should also be provided.

2.5.1.9 Maximum possible impact range for missile burning to fuel exhaustion.

2.5.1.10 Trajectory deviations (or any other conditions) beyond which the Range User is no longer interested in the vehicle flight and thus is willing to accept a premature flight termination even though the vehicle may not have reached a dangerous position or altitude.

2.5.1.11 Graphs of fuel weight (pounds) vs time (sec or min) and gross weight (pounds) vs time (sec or min).

2.5.1.12 Explosive warhead information. To meet the requirements of this paragraph, the information requested in paragraphs 2.4.8.5 for ballistic missiles/spacelift vehicles should be provided.

2.5.1.13 Graph of maximum cruising speed (ft or sec) vs altitude (ft).

2.5.2 Trajectory Data.

2.5.2.1 Description.

2.5.2.1.1 The three sigma maximum and minimum altitude trajectories define for any ground range the limits of normality as far as altitude is concerned. In other words, for any particular ground range, approximately 99.7 percent of all normal missiles (assuming a normal distribution) have altitudes between the extremes achieved at that point by three sigma maximum-altitude and three sigma minimum-altitude missiles. Any deviation outside these limits indicate the missile is behaving in an abnormal, though not necessarily dangerous, manner. However, the mission flight control officer may destroy such a missile if it is approaching a land mass or threatening to get outside or below the command destruct coverage area.

2.5.2.1.2 In computing the three sigma trajectories, those parameters having a significant effect upon vehicle dispersion (such as thrust, specific impulse, wind weight, and atmospheric density) should be combined in the way best to produce the required trajectories. A brief discussion of the assumptions and calculations made in deriving these trajectories must be provided.

2.5.2.2 Trajectory Requirements. For each cruise missile flight or group of similar flights, five separate and distinct trajectories must be provided as indicated below:

2.5.2.2.1 For nominal or expected trajectory, provide all data items in 2.5.2.3 below. The nominal or reference trajectory is the trajectory the missile would fly if all vehicle parameters were exactly as expected, all vehicle systems performed exactly as planned, and there were no external perturbing influences.

2.5.2.2.2 For three sigma maximum-altitude trajectory, provide either the data items in 2.5.2.3.1 below, or the maximum-altitude high deviations (in feet) from nominal as a function of ground range from the launch or drop point.

2.5.2.2.3 For three sigma minimum-altitude trajectory, provide either the data items in 2.5.2.3.1 below, or the maximum-altitude low deviations (in feet) from nominal as a function of ground range from the launch or drop point.

2.5.2.2.4 For three sigma lateral trajectory, provide either the data items in 2.5.2.3.1 below or the maximum lateral deviations (feet or miles) from the intended flight path as a function of ground range from the launch or drop point. The three sigma lateral trajectory defines the lateral limits within which 99.7 percent of all normal missiles are expected to remain. A missile that deviates outside these limits is subject to possible destruction as discussed for the maximum and minimum altitude trajectories.

2.5.2.2.5 For three sigma high-performance trajectory, provide all data items in 2.5.2.3.1 and 2.5.2.3.2 below from launch or drop until the vehicle reaches a steady state cruise condition. The three sigma high-performance trajectory should define the vehicle capability limits in climbing to maximum altitude at the maximum possible rate.

2.5.2.3 Trajectory Data Items. The following data items are required according to the requirements set forth in 2.5.2.2 above. The information must be provided in tabular form in one second intervals for the first two* minutes of flight, in 15 second intervals from this point until the missile reaches cruise altitude, in one minute intervals throughout the cruise phase until the terminal phase of flight is reached, and at 15 second intervals thereafter until mission termination or impact. The time 0.0 seconds must correspond to first motion for pad launched vehicles and to the instant of drop for air launchings.

2.5.2.3.1 X, Y, Z (to the nearest foot) vs time (sec). After the first two minutes of flight, with SE approval, X, Y, Z vs time may be replaced by ground range along earth's surface from launch point to submissile point (ft or nm) vs time (sec or min), altitude above the earth's surface (ft) vs time (sec or min), and crossrange displacement (ft or nm) vs time (sec or min).

2.5.2.3.2 $\dot{X}, \dot{Y}, \dot{Z}$ (to the nearest one-tenth foot per second) vs time (sec or min). After the first two minutes of flight, with SE approval, $\dot{X}, \dot{Y}, \dot{Z}$ vs time may be replaced by speed (ft per sec) vs time (sec or min) and path angle of velocity vector relative to local horizontal (deg) vs time (sec or min).

2.5.2.3.3 Geodetic latitude and longitude of launch pad or drop point.

2.5.2.3.4 Initial flight azimuth in degrees measured clockwise from true north.

2.5.2.3.5 A map showing the expected flight path over the surface of the earth, and an altitude profile correlated with the flight path. Times should be indicated at regular intervals along the path.

2.5.3 Air-Launched Data Requirements. For air-launched cruise missiles, the information requested in paragraph 2.7, FPA Data Requirements for Aircraft Operations, is required in addition to the following:

2.5.3.1 Type of launch aircraft.

2.5.3.2 Description of drop aircraft flight plan.

2.5.3.3 Aircraft flight azimuth (degrees true), speed (ft per sec), altitude (ft) at launch and path angle of velocity vector relative to local horizontal (deg) at launch.

2.5.3.4 For other than level flight launches, a statement on how the aircraft path angle and the launch azimuth are determined for vehicle release.

2.5.3.5 The maximum region around the drop point where drop can occur. This is provided as distances downrange, uprange, and crossrange relative to the expected drop point, along and perpendicular to the launch azimuth, or by providing the geodetic latitude and longitude of the corners of the drop box.

2.5.4 Statement of Vehicle Performance. A statement of vehicle performance is required within one to three months after a failure has occurred during a mission. This information is provided by written letter or by sending SE the performance evaluation documents prepared for other purposes. To meet the requirements of this paragraph, the information requested in paragraph 2.4.12 for ballistic missiles/spacelift vehicles should be provided.

2.6 Small Rocket FPA Data Requirements. The trajectory and performance data requirements set forth in this part apply to all small rockets. Small rockets are not required to carry destruct systems when dispersion analysis and control of launch conditions indicate that the vehicle and debris can be contained within predetermined safe areas. Lead time requirements are listed in paragraph 2.2.4.3.

2.6.1 General Vehicle Data Requirements. General information concerning the purpose of the mission, number of launches in the program, a brief description of payload including weight, and the nature of data to be obtained.

2.6.1.2 Scaled diagram of vehicle.

2.6.1.3 Latitude and longitude of launcher.

2.6.1.4 Desired launch azimuth and launch elevation angle including the variation in azimuth and elevation angle that is acceptable from the standpoint of mission accomplishment. Indicate which mission objectives actually determine the acceptable limits for azimuth and elevation angle.

2.6.1.5 A brief description of the type of launcher is required and should include whether it is a zero length or short rail type, the amount of effective guidance, adjustments available in quadrant elevation (QE), azimuth, and the smallest measurement for these adjustments.

2.6.1.6 Total vehicle weight and propellant weight of stages at lift-off.

2.6.1.7 Coefficient of drag (C_D) vs Mach number, giving reference area (A) and weight (W) for expended stage or stages and for payload. Curves must cover Mach number range from zero up through maximum values expected. Also indicate whether bodies are stable and, if so, at what angle of attack, and state briefly how drag curves were determined.

2.6.1.8 Required dispersion data: Three sigma in-range and cross-range dispersions are required for each stage, separable fragment or component, and payload. Since the magnitude of these dispersions may determine whether a destruct system waiver will be granted or the extent to which shipping must be clear of impact areas, a careful analysis is essential. The following factors should be considered in determining three-sigma impact dispersions about predicted impact points: variation in thrust, error in drag estimates, thrust misalignment, fin and body misalignment, variation in weight, variation in ignition times of stages, impulse errors, tip-off and separation perturbations, errors in wind velocity measurements, error in launcher setting, and other significant perturbing influences.

2.6.1.9 Required Impact Prediction Data: In most cases, wind is the largest independent factor causing displacement of unguided vehicle impact points. Accompanied by tabulations, charts and a comprehensive discussion of their formulation, the following data are required to predict the magnitude and direction of this effect:

2.6.1.9.1 Wind Affects Data. Ballistic wind weighing factors vs altitude in feet. The wind weighing factors should be presented in percent of wind effect for specific wind altitude intervals. The ballistic wind weighing factors should include both the effects of drift and weather cocking. Booster or first-stage wind drift effects are of prime importance since the booster and first stage motor impact point is usually near the launch site.

2.6.1.9.1.2 Change of the nominal impact point due to missile weather cocking and drift as a result of ballistic winds (head, tail, side, or resultant wind effect) in feet, nm or ft per sec of wind. This data varies significantly with a change in launcher QE and, therefore, must be supplied in a table of launcher QE vs unit wind effect. The table must have a minimum interval of 2 degrees and include plus and minus 12 degrees from the desired resultant QE up to a maximum launcher setting of 88 degrees.

2.6.1.9.1.3 Launcher adjustment curves to correct the launcher in azimuth and elevation for wind effects. This data is required only if the Range User desires to adjust the launcher azimuth and elevation to correct for wind effects, and must be supplied for all desired resultant QEs. Wind compensation minimizes the area clearance problem by maintaining a constant impact point. A thorough description of the correction method and the expected accuracies to be achieved are required in addition to the proper curves and tabulation of data.

2.6.1.9.1.4 A graphical and tabular presentation of the impact point displacement due to earth rotation vs QE. Calculations for this information are based upon the latitude of the launcher and the desired launch azimuth. The table must have a minimum interval of 2 degrees and include plus and minus 12 degrees from the desired resultant QE up to a maximum of 88 degrees.

2.6.1.9.2 When a computer program is used to perform the calculation required for adjustment of the launcher in QE and azimuth, the Range User must include a discussion of the intended use of the program. If the Range User wishes to use one of the computer programs available at the range, consultation should be made with the Range to make sure that 2.6.1.9.1.1 through 2.6.1.9.1.4 above, are presented in a form compatible with the necessary computer input.

2.6.1.10 If any fragments, such as spin motors or hatch covers, etc., are ejected from the vehicle during any portion of the flight, there must be a complete description of the ejection conditions and associated impact dispersion area.

2.6.1.11 All analyses for long-range probes (500 nm plus) must be calculated using a rotating spherical or ellipsoidal gravity field. Long-range probes, in contrast to the majority of probe vehicles, normally require a destruct system that is incorporated in an unguided vehicle. The data requirements are the same as those specified for guided ballistic missiles. If it can be shown that a destruct system is unnecessary for some long-range probes when launched from a definite geographical position with specific launch parameters, an impact probability study shall be submitted according to paragraph 2.2.6.

2.6.1.12 Air-Launch Data Requirements. If an air-launch of a small rocket is desired, the following specific data are also required:

2.6.1.12.1 Type of launch aircraft.

2.6.1.12.2 Launch QE.

2.6.1.12.3 Launch velocity in ft per sec or Mach number.

2.6.1.12.4 Launch altitude in feet.

2.6.1.12.5 Flight azimuth.

2.6.1.12.6 Geodetic latitude and longitude of the expected drop point. In addition to the expected drop point, the maximum region around this point where drop could occur should be defined. This is provided in distances downrange, uprange, and crossrange relative to the expected drop point or by providing the geodetic latitude and longitude of the corners of the drop box.

2.6.1.12.7 For launchers other than level flight, a description of the method of determining the launch QE and launch azimuth for vehicle release.

2.6.1.12.8 Nominal flight profile for each stage from launch to impact, showing altitude in feet vs downrange in feet, with timing marks in seconds indicated on the profile. Profiles must be included for all unignited or nonseparation conditions of the vehicle.

2.6.1.13 Summary of past vehicle performance giving number launched, launch location, number that performed normally, behavior and impact for any that malfunctioned, and nature of malfunction and corrective action.

2.6.2 Trajectory Data Requirements. The following trajectory data are required for the nominal trajectory for each desired nominal QE angle and payload weight, from launch until burnout of the final stage. These data must be provided in a tabular form with the independent variable, time in seconds, appearing on each sheet and with each column of the table containing only a single parameter. This table is a direct printout from the computer used to calculate the trajectory; however, it must conform with the table format specified. A definition of symbols must accompany each set of data. Time must be given at even intervals, not to exceed one second increments during thrusted flight, and for times corresponding to ignition and thrust termination or burnout of each stage.

2.6.2.1 Velocity (ft per sec) vs time of flight (sec).

2.6.2.2 Altitude (ft) vs time of flight (sec).

2.6.2.3 Ground range (ft) vs time of flight (sec).

2.6.2.4 Flight path angle of the total velocity vector (deg) vs time of flight (sec).

2.6.2.5 Coriolis displacement of the impact point should be presented, if it has been omitted in the trajectory data calculations.

2.6.2.6 **Graphical Data.** In addition to the tabular nominal trajectory information, the following characteristic vehicle data are required in graphical format:

2.6.2.6.1 Impact range vs launch elevation angle for each stage and payload (nm vs deg).

2.6.2.6.2 Apogee altitude vs launch elevation angle for each stage and payload (ft vs deg).

2.6.2.6.3 Ground range vs altitude for each stage and payload (nm or ft vs ft).

2.6.3 **Statement of Vehicle Performance.** A statement of vehicle performance is required within one to three months after a mission has been conducted. This information may be provided by writing a letter or by loaning SE the performance evaluation documents prepared for other purposes.

2.6.3.1 Qualitative statements about the performance of each stage and the various subsystems.

2.6.3.2 Failures that occurred and resulting flight conditions produced.

2.6.3.3 Probable cause of failures and corrective action taken.

2.6.3.4 Vehicle type and number, launch date, launch location, operation number, payload type and weight.

2.6.3.5 Actual launcher azimuth and elevation setting (degrees).

2.6.3.6 Predicted range (nm) and azimuth (deg) from the launcher to the impact point for each stage and payload. The predicted range and azimuth is based upon the predicted winds at time of launch.

2.6.3.7 Actual range (nm) and azimuth (deg) from the launcher to the impact point for each stage and payload.

2.6.3.8 Actual impact range components (nm) for each stage and payload measured along and perpendicular to the predicted impact azimuth. Where a stage is not tracked to impact, the impact point is computed using the best estimates of the drag characteristics and of the winds at launch.

2.6.3.9 Predicted effective QE (deg) of trajectory for each stage.

2.6.3.10 Actual effective QE (deg) of trajectory for each stage.

2.6.3.11 Predicted range (nm) and altitude (ft) of apogee for each stage.

2.6.3.12 Actual range (nm) and altitude (ft) of apogee for each stage.

2.6.3.13 A tabulation of the reduced wind data used to make the launcher setting calculations giving speed (ft per sec) and direction (deg) as a function of altitude (ft).

2.6.3.14 A reference list of all documents, graphs, and tabulations used to make the launcher setting calculations, that is, wind weighing curves, ballistic wind weighing factors, unit wind effect, tower tilt factor, etc.

2.6.3.15 Source of tracking data.

2.7 FPA Data For Aircraft Operations.

2.7.1 General Data Requirements. General information concerning the nature and purpose of the flight. In addition to the items required in paragraph 2.8, the following items are required for aircraft flight:

2.7.1.1 List associated aircraft (chase, tanker, etc.) by type(s) and "N" or tail numbers.

2.7.1.2 Specify minimum weather requirements for the operation.

2.7.1.3 Emergency Requirements. Specify special emergency requirements.

2.7.1.3.1 Search and Rescue (SAR) support requirements.

2.7.1.3.2 Emergency Recovery Plan. Include minimum field length(s).

2.7.1.3.3 Describe ditching characteristics, if known.

2.7.1.3.4 Describe secondary communication procedures to be used in the event of primary communications failure.

2.7.1.3.5 If structural flight and systems tests are to be conducted, specify any weather minimums and special requirements.

2.7.1.3.6 A sonic boom report is required if sonic boom testing is to be conducted in compliance with AFR 55-34, Reducing Flight Disturbances, and file AF Form 121, Sonic Boom Report.

2.7.1.3.7 For environmental assessment, comply with AFR 55-34 and AFR 19-2, Environmental Impact Analysis Process (EIAP).

2.7.1.3.8 Range Users should comply with WRR 55-7, Aircraft and Aeronautical Systems Testing on the WCOOA.

2.7.2 **Sonic Boom Data Requirements.** The following information is required for a sonic boom hazard analysis.

2.7.2.1 **Control Information:**

2.7.2.1.1 R - distance from aircraft where NFS is determined, in feet.

2.7.2.1.2 LM - length of model of vehicle in feet.

2.7.2.1.3 LR - vehicle length in feet.

2.7.2.2 **NFS Data:**

2.7.2.2.1 θ - roll angle, in degrees.

2.7.2.2.2 M - Mach No.

2.7.2.2.3 N - number of points in NFS.

2.7.2.2.4 X - Aircraft station on model where pressure perturbation was measured in feet.

2.7.2.2.5 $\Delta P/P$ - pressure perturbation divided by ambient pressure.

2.7.2.3 **Flight Profile Data:**

2.7.2.3.1 Time (seconds).

2.7.2.3.2 Vehicle altitude (feet) above reference spheroid.

2.7.2.3.3 Geodetic latitude (degrees) of vehicle.

2.7.2.3.4 Longitude (degrees) of vehicle.

2.7.2.3.5 Vehicle freestream Mach number.

2.7.2.3.6 Vehicle flight path angle (degrees) measured up from horizontal.

2.7.2.3.7 Vehicle heading (degrees) from true north.

2.7.2.3.8 $\dot{M}$ - The time rate of change of Mach number (per second).

2.7.2.3.9 Time rate of change of flight path angle (degrees per second).

2.7.2.3.10 Time rate of change of heading (degrees per second).

2.7.2.3.11 Roll angle (degrees) from horizontal up to right wing. Wing as viewed from behind the vehicle.

2.8 FPA Data Requirements for Air-Dropped Objects/Projectiles and Torpedoes. The data requirements set forth under this heading apply to all nonpropulsive objects dropped ballistically or by parachute from an aircraft. Lead time requirements are listed in paragraph 2.2.4.3. The requirements levied in paragraph 2.7, FPA Data Requirements for Aircraft Operations, also applies. The following data are required for each mission or group of missions:

2.8.1 General information concerning the purpose of the mission, description of the object, and the type of data to be obtained.

2.8.2 Geodetic latitude and longitude of the desired drop point and impact point. In addition, the maximum region around these points where drop or impact could occur should be defined. This is provided in distances downrange, uprange, and crossrange relative to the expected drop point or by providing the geodetic latitude and longitude of the corners of the area.

2.8.3 C_D vs Mach number, reference area, and weight of object being dropped. The distance traveled in the horizontal direction from the point of release to impact can be supplied instead of the drag information.

2.8.4 The effect on the location of the impact point due to winds blowing in the direction of drop and perpendicular to the direction of drop is specified as distance per knot of headwind or crosswind.

2.8.5 Three sigma dispersion or circular error probability (CEP) of impact point. If pilot error is not included in this dispersion, provide as a separate dispersion.

2.8.6 Flight plan of the drop aircraft. This includes the altitude of the aircraft, true air speed, and dive angle beginning 60 seconds prior to drop and continuing through drop. The required profile trajectory of the drop is in altitude in feet vs downrange distance in feet. Trajectories are included with parachute opening and with parachute not opening. Timing marks in seconds are indicated on the trajectory, as well as total time of flight for each object dropped.

2.9 Aerostat or Balloon FPA Data Requirements.

This paragraph is added to conform with ERR 127-1. 30 SPW/SE has no requirements for aerostat or balloon data at this time.

2.10 Directed Energy Systems. The data requirements set forth under this heading apply to the testing of all forms of directed energy systems. These systems include, but are not limited to, lasers, and neutral and ion beams, with any combination of surface, air or space locations for the energy source and target. Lead-time requirements are listed in paragraph 2.2.1. These timelines may vary depending on the complexity of the system and proposed operating scenario. Requirements will be tailored to the specific characteristics of the system and test scenario.

2.10.1 General Data Requirements. The following data are required for each test or group of tests. Additional data may be required depending on the system to be tested.

2.10.1.1 System and Test Data. General information on the purpose of the test, the system, and the planned test operations.

2.10.1.1.1 Basic program objectives.

2.10.1.1.2 Description of the laser or other directed energy system and its operation.

2.10.1.1.3 Laser classification in accordance with ANSI Z136.1.

2.10.1.1.4 Test program mission scenarios and proposed target areas, if known.

2.10.1.1.5 Copies of safety analyses conducted on the system and proposed test scenarios.

2.10.1.1.6 Laser Emission Characteristics:

2.10.1.1.6.1 Mode of operation (continuous wave or pulsed).

2.10.1.1.6.2 Wavelength (meters).

2.10.1.1.6.3 Energy per pulse in Joules for pulsed lasers, or power in Watts for continuous wave lasers.

2.10.1.1.6.4 Pulse repetition frequency (Hertz).

2.10.1.1.6.5 Pulse width and pulse separation (seconds).

2.10.1.1.6.6 Beam diameter between 1/e points at the exit aperture, or at the waist if convergent beam (centimeters).

2.10.1.1.6.7 Beam divergence angle at the aperture or waist (radians).

2.10.1.1.7 Number and designation of laser operations to which the proposed test plan applies.

2.10.1.1.8 A statement indicating whether the proposed test plan is similar in its safety aspects to that of some prior mission for which documentation is available.

2.10.1.1.9 Intended test dates.

2.10.1.1.10 Functional description of the target acquisition and laser firing process, and of any error/failure detection and correction or termination capability, including its reliability and response time.

2.10.1.2 Nominal Mission Data.

2.10.1.2.1 **Scenario Type** (can be any combination of the following):

2.10.1.2.1.1 Fixed laser and/or target.

2.10.1.2.1.2 Moving laser and/or target.

2.10.1.2.2 **Laser and Target(s) Position Data.**

2.10.1.2.2.1 Fixed - latitude, longitude and altitude of each object.

2.10.1.2.2.2 Moving - position and velocity vector versus time of each object in an Earth Centered Rotating (ECR) coordinate system.

2.10.1.2.3 **Nominal Test Scenario Data.**

2.10.1.2.3.1 Event times (e.g., acquisition, arming and firing on/off times).

2.10.1.2.3.2 Duration of each laser firing (seconds).

2.10.1.2.3.3 Slew rate (radians/seconds).

2.10.1.2.3.4 Hardware and software stops (angles from forward direction, radians).

2.10.1.2.3.5 Pointing accuracy (radians).

2.10.1.2.3.6 Laser platform/vehicle attitude control accuracy (static, radians; dynamic, radians/second).

2.10.1.2.4 **Target(s) Data.**

2.10.1.2.4.1 Target size - radius, or height, width and length.

2.10.1.2.4.2 Orientation - angle of each target surface with respect to the incident beam.

2.10.1.2.4.3 Type of reflection possible (i.e., specular or diffuse).

2.10.1.2.4.4 Reflection coefficients.

2.10.1.2.5 **Exposure Controls.** Maximum Permissible Exposure level, Nominal Optical Hazard Distance and other applicable hazard ranges, for each laser.

2.10.1.2.5.1 Description of the maximum region around each target that can be hazarded during a nominal test.

2.10.1.2.5.2 Reflection characteristics of other significant objects in the hazarded region around each target. The hazard region is the zone where the laser radiation levels may exceed the maximum permissible exposure level.

2.10.1.3 **Non-Nominal Mission Data.**

2.10.1.3.1 Probability of Occurrence Data. The probability of occurrence versus time of operation for each of the following generic hazard modes (i.e., modes of beam control error or failure): Pointing Error, Inadvertent Slewing, Premature Firing, Delayed Firing, Beam Focusing Error, Loss of Focus, and other modes (e.g., Wrong Target Acquisition) applicable to the system. If the probability of occurrence is non-zero for any of these hazard modes, then probability distributions for the random hazard mode parameters, which describe how each mode can occur over time, shall be provided. The following parameters describe each of the stated failure modes.

2.10.1.3.1.1 Pointing Error Hazard Mode: offset angle (radians) between the correct laser to target pointing direction and the incorrect pointing direction (angle assumed constant during a firing).

2.10.1.3.1.2 Inadvertent Slewing Hazard Mode:

2.10.1.3.1.2.1 Time (seconds) during firing at which the inadvertent slewing starts.

2.10.1.3.1.2.2 Azimuth angle (radians, measured from north) of the slew plane. It is assumed that, over time, the laser to target line remains contained in a plane.

2.10.1.3.1.2.3 The angular rate (radians/second) of slewing in the plane (rate assumed constant).

2.10.1.3.1.2.4 Duration of the slewing (seconds), if other than that of the nominal firing time remaining after the start of the slewing.

2.10.1.3.1.3 Premature Firing Mode: number of seconds prior to the nominal start time that laser firing occurs.

2.10.1.3.1.4 Delayed Firing Termination Mode: number of seconds after the nominal termination time that laser cutoff occurs.

2.10.1.3.1.5 Beam Focusing Error Mode: range (meters) along the laser-to-target vector at which the (convergent) beam is misfocused. The incorrect range can either be too long or too short relative to the nominal focus range.

2.10.1.3.1.6 Loss of Focus Mode:

2.10.1.3.1.6.1 Time (seconds) during firing at which the loss of focus occurs.

2.10.1.3.1.6.2 Beam divergence angle (radians) which measures the spreading of the beam (assumed to remain centered on the laser-to-target vector).

2.10.1.3.2 Applicable hazard modes shall be defined and documented by failure modes, effects, and criticality analyses or the equivalent. Their probabilities of occurrence and the probability distributions of their descriptive parameters shall be quantified with fault tree analyses or the equivalent.

The level of analysis conducted in each case shall be the level at which appropriate component error/failure data are available. If necessary for confidence in the results, analyses of the effects of the uncertainties in the component data shall be carried out.

2.10.1.3.3 Alternative Data Submission. The Range User may arrange with SEY to provide the following data so as to enable the analysis by SEY of the hazard modes and their probabilities.

2.10.1.3.3.1 System design description and performance data, and functional and reliability block diagrams, for portions of the system affecting beam control (including platform attitude control).

2.10.1.3.3.2 Associated component (including hardware, software, and human) reliabilities or, as a minimum, component and component environment descriptions allowing the estimation of these reliabilities.

2.10.2 Coordination Requirements. Coordination with the Space Defense Operations Center (SPADOC) is required for all class 3 and 4 lasers operated outside of a confined laboratory environment. For these systems, test day coordination with SPADOC shall be required to verify a clear range. A test plan shall be developed by the Range User and exercised prior to test day to verify timely operational control. In addition, coordination with the FAA is required for laser radiation above the MPE outside restricted airspace.

2.11 FPA Data Requirements for Launch of Large Nuclear System Into Space.

This paragraph is added to conform with ERR 127-1. 30 SPW/SE has no requirements for the launch of large nuclear systems at this time.

Chapter 3

SYSTEM GROUND SAFETY

* 3.1 System Ground Safety Introduction:

3.1.1 This chapter establishes the policies, responsibilities, technical requirements, and data deliveries required for prelaunch processing, launch, recovery, and the post-launch facility refurbishment of space and missile systems. Compliance provides the level of safety required by WR for the User to obtain incremental safety approvals which lead to Missile System Ground Safety Approval (MSGSA).

3.1.2 30 SPW/SE must be assured that User operations do not present unacceptable hazards. Therefore, the use of MIL-STD-882C to conduct safety assessments and document risk to property and personnel is mandatory. The User has the responsibility for accepting the overall system risk. The 30 SPW Commander has the final responsibility for accepting risk which may endanger contractor personnel, government personnel, the general public, WR resources, or more than one User's property. This is accomplished through the Phase Safety Review process, incremental approvals, and MSGSA.

3.1.3 It is the responsibility of all Users to provide for the safety of their systems and verify compliance with WRR 127-1. The use of contractor support does not relieve the User of the primary responsibility to demonstrate the compliance. The User must provide adequate contractual direction and monitor contractor performance. Failure of a contractor to produce a verifiably safe system must be corrected by the User or permission to operate at the WR will be denied.

3.1.4 The User shall inform 30 SPW/SE of all new systems, hardware or software changes, and modifications, which have a safety implication. The notification and coordination should be made during early planning, before contract statements of work containing safety tasks are developed, normally prior to the Phase 0 Safety Review.

3.1.5 Mishap risks can be independently accepted by the User, with 30 SPW/SE concurrence, only when the effects of the potential mishap are contained totally within User controlled resources and do not constitute a personnel hazard. If the effects of a mishap can generate damage across an interface to resources under the control of another agency, then mishap risks will only be accepted with the concurrence of the affected agencies and the highest management authority participating in the operation.

3.1.6 Fault tolerance as described in paragraph 3.2.8 and high reliability parts (such as parent metal valves) will be used to prevent mishaps. Systems in a storage or non-operating mode must be designed to present minimum hazards.

3.1.7 Systems which generate hazards during dynamic operations must have the capability of being safed. This safing capability must be available for response to hazardous conditions generated either within or from without the system. The severity of the hazard will dictate whether the safing must be accomplished locally or remotely (see paragraph 3.2.8.2 and Table 3-1). It is not the intent of this document to dictate what action is required to safe a particular system as that is dependent on the design of the system. It is, however; mandatory that personnel safety can be assured at all times.

3.1.8 The processing of vehicle or payload simulators, facility checkout vehicles (pathfinders) or special test activities shall not be exempted from the requirements of this document. Compliance shall be documented in a Safety Assessment Report (SAR).

3.1.9 The safety requirements established in this regulation provide many design suggestions to prevent hazardous conditions. They apply generally to all systems operated at the WR. Safety analyses may show alternative methods of hazard control more appropriate to a specific system design. Such alternate methods which meet the intent can be coordinated for approval by 30 SPW/SE during design or phase safety reviews.

3.1.10 Attachment 2 is a listing of reference documents for safe design considerations. They are mandatory for compliance to the extent that they are referenced in other paragraphs of this regulation (all documents are to be latest version or as agreed to by contract). When not specifically referenced, they are sources of information to be used in system design and in the preparation of safety analyses and in conjunction with other recognized codes and standards. The requirements of this document are in addition to those of Federal, State, or local jurisdictions. This document does not relieve the User from meeting existing Federal, State, or local requirements/codes. The User must review Attachment 2 and determine which documents or portions thereof are applicable to the system. The User may submit requests for clarification of conflicting requirements or questions of tailoring to 30 SPW/SE for interpretation and final resolution.

*** 3.2 System Safety Program:**

3.2.1 All systems operated at the WR shall meet OSHA and AFOSH Safety requirements and a MIL-STD-882C compliant system safety program must be conducted for each system operated at the WR. The User should refer to the standard's Appendix A, Guidance for Implementation of System Safety Program requirements, for the application of safety tasking on specific programs. The considerations for selecting and tailoring each task to achieve an effective safety program at reasonable cost are dependent on hazard severity, system complexity, and mission. Therefore, the selection of tasks and modification of their contents will be unique for each program.

3.2.2 The safety sections of the contract statement of work, data requirements, and applicable documents must be coordinated with 30 SPW/SE in writing. A System Safety Program Plan and Safety Assessment Report are required; the use of Data Item Description DI-SAFT-80100 (System Safety Program Plan) and DI-SAFT-80102 (Safety Assessment Report), as tailored by paragraph 3.2.7, are mandatory and minimum requirements. The Accident Risk Assessment Report (DI-S-30565), mentioned in previous editions of WRR 127-1, is equivalent to the tailored Safety Assessment Report.

3.2.3 The System Safety Program Plan (SSPP) will describe the safety program planned for system installation and operation at WR. It will describe how the aspects of MIL-STD-882C and data items pertinent to the program will be implemented. The draft SSPP will be coordinated with 30 SPW/SE prior to program office approval. 30 SPW/SE will be provided final copies of the SSPP prior to the Phase 0 safety review. Incremental deliveries of the Safety Assessment Report (SAR) will support the Phase Safety Review process and the first conduct of hazardous operations.

3.2.4 Coordination will be made with 30 SPW/SE to determine the data items and number of copies required by the Safety Office. The technical data required to support design and safety reviews will not be limited to safety CDRLs.

3.2.5 The User must have an operations safety program for the identification and timely action to eliminate or control hazardous conditions caused by design deficiencies, unsafe acts, or procedural errors. Procedures must be established to assure identification, review, and supervision of high risk tests, including tests performed specifically to obtain safety data. The User must:

3.2.5.1 Assess all ground support equipment (GSE), facilities, missile and space systems, critical software modules, computer controlled test equipment, maintenance schedules, and modifications to systems to identify hazardous configurations and operations as described in paragraph 3.2.7. Special attention must be given to the planning, design, and refurbishment of reusable support equipment to make sure safety is not degraded by continued usage. Identified requirements for support equipment must be equal to, or better than, those specified by Federal and Air Force Occupational Safety and Health (AFOSH) Regulations or national consensus standards. This assessment is normally a continuation of assessments conducted during the Phase Safety Review process.

3.2.5.2 Review and approve test plans, procedures, and changes to verify that safety requirements identified by safety analyses are incorporated.

3.2.5.3 Provide procedures to 30 SPW/SE for approval 60 days before establishing hazardous configurations or conducting hazardous operations so that any necessary changes can be incorporated prior to use. All hazardous procedures will require a signature block for 30 SPW/SE approval. The information contained in these procedures will be as specified in paragraph 5.6 through 5.6.11.

3.2.5.4 Include an assessment of accident risk in all readiness reviews.

3.2.5.5 Provide a Launch Complex Safety Plan (LCSP) according to Chapter 5. Payload organizations normally supplement existing booster launch complex safety plans.

3.2.6 30 SPW/SE must be a participant in the system acquisition safety program. Representation will be given in the System Safety Groups formed by design agencies. Notice and data packages for design reviews and program reviews will be provided to 30 SPW/SE 30 days in advance. Major system milestones such as system level SDR, PDR, and CDR will have phase safety reviews (paragraph 3.3) associated with them. 30 SPW/SE representatives will attend meetings.

3.2.7 The Safety Assessment Report must include the following to demonstrate compliance with WRR 127-1:

3.2.7.1 Descriptions of the booster system, payload system, ground support equipment, software control system, and any other systems having safety implications. A description of the processing conducted at WR must be included with a detailed assessment of hazardous or dangerous operations. Details of the hazardous subsystems and the results of hazard analyses must be provided as Safety Assessment Report sections, described in paragraph 3.2.7.2 below. Safety requirements for support equipment must be identified and safety design criteria must be incorporated in the design specifications.

3.2.7.2 Descriptions of Safety Assessment Report sections are as follows. If not used, a negative response is required in the Safety Assessment Report.

Ground Support Equipment and Facilities - Section 3.5
Handling Equipment - Section 3.6
Noise Protection - Section 3.7
Non-Ionizing Radiation - Section 3.8
Ionizing Radiation - Section 3.9
Hazardous Materials - Section 3.10
Propellants and Propulsion Systems - Section 3.11
Pressurized Systems - Section 3.12
Ordnance Systems - Section 3.13
Electrical and Electronic Systems - Section 3.14
Computing Systems and Software - Section 3.15

3.2.7.3 Other data such as special analyses, certifications, and approvals required by reference in this chapter must be included in the Safety Analysis Report.

3.2.8 The User's system must be designed to tolerate a number of credible failures or operator errors as determined by the degree of hazard involved in the operation. All sequences, procedures, or functions which operate under computer control shall be designed in such a manner that a critical failure mode or error condition will result in the system reverting to a known safe state.

3.2.8.1 Ordinary operations are those operations having mishap potential, but normal industrial safety practices are sufficient to prevent mishap occurrence. (Design safety factors for slings, hoists, cranes, etc., are considered sufficient protection.) During ordinary operations, all system must remain at least two failures from a serious mishap (single-fault tolerant) and three failures from a major mishap (two-fault tolerant).

3.2.8.2 The degree of fault tolerance needed to maintain a safe operating environment is defined in Table 3-1. This table establishes the fault tolerance required based on mishap consequences and exposure. A major mishap would potentially result in a fatality or major damage (such as the loss of launch capability for more than 30 days, the loss of flight systems, or the loss of a major launch processing facility). A serious mishap would potentially result in high value property damage, injury to personnel, or require the use of contingency or emergency procedures.

TABLE 3-1
Inhibit/Exposure Criteria

EXPOSURE	CONSEQUENCES (See Paragraph 3.2.8.2) Major Mishap	Serious Mishap
Unrestricted Access (Green Light)	3 Inhibits (Two Fault Tolerant)	2 Inhibits (Single Fault Tolerant)
Essential Personnel Only (Amber Light)	2 Inhibits (Single Fault Tolerant)	1 Inhibit (No Fault Tolerant)
No Personnel Allowed (Red Light)	1 Inhibit (No Fault Tolerant)	

3.2.8.2.1 Hazardous or dangerous operations must be approved by 30 SPW/SE. Inhibits must be highly reliable, independent and verifiable. An assessment of the inhibits to this criteria must be submitted to demonstrate that the exposure of personnel is reasonable and prudent. The requirements for hazardous and dangerous operations are further defined in paragraph 5.6.

3.2.9 Users will apply the hazard severity categories and probability levels defined in MIL-STD-882C. Recommendations for other definitions shall be coordinated with 30 SPW/SE at the start of a program.

3.2.10 Residual hazards are conditions that retain the potential of causing injury to personnel, or damage to equipment, after intended design or other control actions have been implemented.

3.2.10.1 Hazardous Operations are those that contain Category II (critical) residual hazards. Such hazards could result in serious mishaps.

3.2.10.2 Dangerous operations are those that contain Category I (catastrophic) residual hazards. Such hazards could result in major mishaps.

*** 3.3 Phase Safety Reviews:**

3.3.1 New programs and major modifications to systems scheduled to operate at the WR must participate in a Phase Safety Review and approval process leading to MSGSA. Subsystems such as the booster, flight termination system, payload, ground support equipment, and software will be evaluated. The User must verify and present evidence that safety requirements are met. Acceptable verification documentation includes design specifications, engineering drawings, hazard control procedures, documented inspections, and test results. This process requires the incremental delivery of the Safety Assessment Report and User/program office/contractor support for up to four Phase Safety Review meetings. The extent of the safety review will be made program specific through mutual agreement between the User and 30 SPW/SE. Formal meetings at all or some of the phases may not be required and document submittals may vary depending on program content.

3.3.2 Generally, Phase Safety Reviews will be held near or during major program milestones. Data packages should be received by WR 30 days prior to the review. At each review, the User will brief the system overview to include safety critical items, the results of safety assessments, and submit deviation/waiver requests. Agreement between the User and the WR that either the safety effort is progressing satisfactorily or that specific corrective measures have been identified and will be implemented constitutes a successful completion of each review.

3.3.2.1 Incremental submittals of the Safety Assessment Report must be submitted to support the schedule of phase safety reviews and the conduct of hazardous or dangerous operations. These submittals are due 30 days prior to each phase safety review. The final submittal of the Safety Assessment Report is required 60 days prior to conducting hazardous or dangerous operations at the launch base; 120 days if radioactive sources are to be used. A minimum of three copies of the Safety Assessment Report must be provided. More may be required if review is required by several safety offices.

3.3.3 The Phase 0 Safety Review is a Conceptional Planning Review and will document the scope of the safety program and define the extent of the Phased Safety Review process. It should be scheduled to occur during the System Design Review (SDR). 30 SPW/SE and the User will reach a mutual understanding of safety requirements needed to provide an integrated safety approach to safety assessment for facilities, booster, upper stages, and spacecraft. One of the User elements will be required to provide an Integrated Safety Assessment Report. Results of the Preliminary Hazard Analysis (PHA) must be presented at the Phase 0 Safety Review. The final System Safety Program Plan (SSPP) must be submitted at least 30 days prior to the review.

3.3.4 Phases 1&2 Safety Reviews are the PDR and CDR Safety Reviews and are required to evaluate the implementation of WR safety requirements in system design and operations development at these major milestones. Results of other hazard analyses performed must be presented at these reviews based on program maturity.

3.3.5 The Phase 3 Safety Review is a Final Safety Review and is held 120 days prior to shipping a system to the WR. This review is mandatory for all programs. Safety design requirements should be verified as implemented, all contractually applied safety analyses shall be complete, approved deviations/waivers and completed statements of product safety certification must be submitted. The inclusion of safety requirements in procedures need not be completed until 60 days prior to their use and will be approved by the 30 SPW/SE separately.

3.3.6 Program managers will be notified of failure to pass a Phase Safety Review and the associated program milestone will remain open until issues are resolved.

*** 3.4 Missile System Ground Safety Approval (MSGSA):**

3.4.1 MSGSA is used to provide approval for the operation of space and missile systems. MSGSA is normally granted 2 to 4 weeks before launch. Successful completion of the Phase Safety Review process and approval of the final Safety Assessment Report are required for the MSGSA. 30 SPW/SE approval of the incremental submittals of the SAR and of final hazardous procedures constitutes 30 SPW/SE concurrence to establish hazardous configurations or start hazardous operations.

3.4.2 When proposed missile and space systems are approved for operation, the User is given a MSGSA specifying the applicable vehicle and conditions of approval. The approval is effective as long as the designated system remains within the approved configuration, use, and conditions of approval. 30 SPW/SE must be informed of design changes, operational changes or mishaps which affect the safety of the system or the MSGSA may be automatically invalidated. MSGSAs are not repetitive. A MSGSA must be requested and obtained by the User prior to each launch of a continuing program. Requests must certify that the system configuration has not changed or the User must include a safety assessment of the changes. If the program is continuing, updates for subsequent launches may refer to the original Safety Assessment Report and detail only those items or systems that are new or changed. However, a complete new Safety Assessment Report will be required on major continuing missile and space systems at least every 10 years. (Provisions should be made for this by the User.)

*** 3.5 Ground Support Equipment and Facilities:**

3.5.1 Safety approval of facilities, GSE missile systems, explosive siting, design and modifications consist of:

3.5.1.1 Construction engineering packages involving design, construction, modifications installation and testing must be approved by 30 SPW/SE prior to start. Review, coordination, and approval of support facilities, and modifications to them normally require a minimum of 30 days (excluding siting).

3.5.1.2 AFR 127-100, Explosives Safety Standards, will be used for planning, siting, constructing, operating, modifying, or relocating any ordnance or/and propellant storage and processing facilities, or launch complex facilities at WR. 30 SPW/SE must approve all quantity-distance (QD) site plans or proposed facilities that fall within proposed or existing explosive safety clear zones. Facility explosive quantity distance siting requires a minimum of 120 days for the review and approval processing cycle. Approvals must be obtained from higher headquarters prior to the start of construction. Changes to approved facilities, processing operations, temporary siting of propellants, or temporary buildings and trailers within an approved explosive area requires request for approval through 30 SPW/SE."

3.5.1.3 30 SPW/SE may elect to participate in government buy-off of facilities. Safety shall participate on beneficial occupancy date and joint occupancy date (BOD/JOD) inspection teams and other such acceptance processes.

3.5.1.4 Existing GSE. The contractor shall identify existing GSE, or GSE already designed and under construction (e.g., GSE already used at ER and being brought over to WR), whose design does not meet the requirements in this document and shall submit a risk analysis to the Government for evaluation.

The analysis shall contain all information necessary to evaluate the GSE performance under all operational conditions (including seismic event) and the risk to personnel and GSE. 30 SPW/SE shall evaluate the risk analysis and determine if GSE redesign is necessary.

3.5.1.5 Fire-protection systems will be provided according to sound economical and engineering practices to make sure the proper degree of fire protection is provided. Fire protection systems will be designed with failure tolerance provisions to prevent inadvertent discharge of suppressant onto high value equipment or equipment that controls critical safety functions. Fire protection for Air Force facilities must meet the requirements of AFR 88-15. Deviations to these requirements must have an approved waiver. A copy of the waiver will be included in the facilities section of the SAR. NFPA 101 Life Safety Code requirements are not waiverable. For facilities or equipment designated critical in accordance with NFPA 220, fire suppressant systems shall be designed with consideration given to repeat application capability, system redundancy and suppressant replenishment time.

3.5.1.6 AFR 88-15 and AFM 88 series documents are the prime source for facility design direction; other Government and national consensus standards and specifications are secondary sources for facilities used in the storage, assembly, checkout, prelaunch, and launch of missile space vehicles and payloads. (See also Attachment 2.) GSE trailers such as those used for offices, instrumentation, shop or storage, remaining in position for longer than 24 hours shall be anchored and stabilized. They shall be secured against wind loads per the design criteria of AFM 88-3, Chapter 1, and ASCE #7, Section 6. A maximum design wind pressure resulting from a velocity of 80 MPH, including gusts, will be used.

3.5.2 Fencing encompassing facilities where hazardous operations are performed must have emergency egress gates. Gates must be located to preclude the necessity for personnel to egress toward or past any potential hazard. Where there is a potential for metal fencing becoming electrically charged at User facilities as a result of lightning strikes, falling electrical power lines, or component or system failure of adjacent electrical equipment such as substation transformers or switch gear, fences will be grounded and gates bonded. Design shall be in accordance with MIL-STD-188-124A, MIL-HDBK-419A, and MIL-STD-1542A. Test data and dates (at least annually) shall be maintained within the facility.

3.5.3 Hazardous Systems:

3.5.3.1 Once hazardous systems are approved, their components and interfaces with other systems must not be modified without prior 30 SPW/SE approval. If modifications are made without prior coordination, SE approval is automatically revoked. The procedure for obtaining approval for modification is the same as for a new system. Changes must conform to current safety requirements at the time of the change and not necessarily to the requirements of the original design.

3.5.3.2 When an operation could cause damage to equipment, injury to personnel, or degradation of system functions, particular attention must be given to controls.

3.5.3.3 Operation of controls that initiate hazardous operations shall require operation of an associated or locking control (single fault tolerant). When practical, the critical position of such a control shall activate a visual and auditory warning device in the affected work area. Public address (PA) announcements are mandatory for the start of hazardous or dangerous operations and should be used to terminate safety control areas when operations are complete.

3.5.3.4 Deadman controls must be utilized when operator incapacity can cause an immediate safety-critical system condition.

3.5.3.5 Systems must have sufficient assistant operators or spotters to make sure that all sides of the system are clear for operation. All operators or spotters must have aural communications for coordination between themselves when power is on the system.

3.5.3.6 If system movement could be critically hazardous from the view of a spotter or assistant operator, an emergency stop capability must be available at each such viewpoint.

3.5.3.7 For systems where concurrent commands can be made, priority is provided for the superior command, or the control station must be provided with a disconnect or key lock-out feature. The lock-out feature must not preclude the emergency stop capability.

3.5.4 Lifeline or lanyard anchor points:

3.5.4.1 During design, consideration shall be given to the use of fixed platforms with guard rails for maintenance/accessibility in lieu of extensive use of personnel tie-offs (see paragraph 3.5.6).

3.5.4.2 The following is provided for determining the adequacy of anchorage points for lifelines, lanyards, or droplines and is based on criteria established in ANSI A10.14.

3.5.4.2.1 The anchor points shall be designed to withstand a deadload of 5400 lbs to yield for each User of the anchor point.

3.5.4.2.2 The integrity of anchor points shall be determined by design analysis or by acceptance of vendor design specifications. If these methods are not possible, or the quality of fabrication is in question, the anchor points shall be proofload tested to 2160 lbs for each User of the anchor point.

3.5.4.2.3 Design analysis and proofload shall consider all possible vectors of the forces induced by fall. The design analysis or proofload shall be repeated if the anchor point becomes damaged, modified, repaired, exposed to launch heating effects, or is over loaded.

3.5.4.2.4 The anchor points shall be stenciled or tagged with the maximum number of persons and total weight allowed to be attached to the anchor point at a given time using 5400 lbs per person static design load value.

3.5.4.2.5 The anchor points will be located as high as practical to limit the distance of potential fall.

3.5.4.2.6 Fixed anchor points shall be located so that they do not endanger fluid or gas lines, electrical cabling, critical hardware, or flight components when the lifeline or lanyard is attached, in use, or under load. To preclude the above conditions, shielding or guarding of the components or systems in question may be required.

3.5.4.2.7 Anchor points other than those existing and designated may be approved if they are verified to comply with the above criteria. Additional fixed anchor points may use existing structures which comply with the requirements stated here when approved by 30 SPW/SE.

3.5.4.2.8 Dog-runs for lanyard tie-offs shall be approved by 30 SPW/SE on a case-by-case basis.

3.5.5 Seismic Design Criteria:

3.5.5.1 Seismic design of all new facilities, systems and equipment, and modifications thereto, shall be IAW AFR 88-15, AFM 88-3, Chap 13 and Sections A and B. Where specific design guidance is not provided in the design manuals, design guidance shall be obtained from industry standards (e.g., SEAOC "Block Book," UBC, FEMA-95, ATC 3-06, etc.). Seismic design of facilities and equipment shall consider both the vertical and horizontal component of seismic loading. The seismic design of all facilities shall consider the equipment or other items installed or stored in said facility. All equipment, GSE, AGE, RPIE, Systems, etc., that has potential, directly or by propagation, for causing (1) severe personnel injury, (2) significant impact on SLV processing and launch capability, (3) a catastrophic event or (4) damage to flight hardware, shall be restrained to restrict movement. Essential equipment needed for post-earthquake recovery shall be designed to withstand a seismic event and remain operational. Equipment which failure could endanger personnel or could propagate to a catastrophic event (Reference items (1) through (4) herein) shall be designed to withstand earthquake loading, but need not remain operational following an earthquake. High-cost computer or electronic equipment should be mounted on seismic isolation bearings (SIB), where cost-effective, to mitigate damage during an earthquake. FEMA 74 shall be used as a guide to reduce the risk of earthquake nonstructural damage.

3.5.5.2 AFM 88-3, Chapter 13 places Vandenberg in a seismic zone 4. This designation means that VAFB is located in the most severe seismic region. Its probability of being exposed to a great earthquake is large enough to require taking specified mitigating measures in design. Local geologic structure determines zone designations 1 - 4 considering the potential severity, frequency, and damage from a seismic event.

3.5.5.3 Facilities and equipment at the WR shall be designed to the "Zone 4" criteria. Facilities and equipment which must remain operational after a seismic event shall be designed in accordance with AFM 88-3, Chapter 13, with an importance factor "I" of 1.5.

3.5.5.4 Seismic Design Criteria for Equipment:

3.5.5.4.1 The Range User shall perform a safety assessment to determine which pieces of equipment may cause injury, damage or catastrophic events under a seismic condition. The Range User shall submit this data at the appropriate design reviews or technical interchange meetings.

3.5.5.4.2 The Range User will submit as part of the safety assessment a risk assessment to include expected "G" forces, the level of "G" forces the element can withstand, and the magnitude of potential damage.

3.5.5.4.3 Equipment shall be designed such that movement or failure during a seismic event shall not cause severe injury, death, or a catastrophic event. Equipment interfacing flight hardware, where the failure of the flight hardware may cause severe injury, death, or a catastrophic event, shall be designed to mitigate the seismic forces being transmitted to the flight hardware to the point that the flight hardware will not cause severe injury, death, or a catastrophic event.

3.5.5.4.4 It shall be the WR User's responsibility to assure Seismic Design Criteria is applied as appropriate.

3.5.5.4.5 The 6595 ATG/TEG and 30 SPW/SE will review the WR User's assessment of equipment design and ground operations planning and provide concurrence/nonconcurrence on a case-by-case basis as to compliance with the Seismic Design Criteria.

3.5.5.4.6 For those items identified as needing restraints, the equipment and restraints shall be designed to withstand loads as described in the following paragraphs. Materials and techniques for implementing the following should be accomplished under the guidelines established by AFM 88-3, Chapter 13, "Seismic Design for Buildings."

3.5.5.4.6.1 Equipment support or restraints shall be designed to react to accelerations equivalent to a horizontal force of two times the equipment weight, applied through its center of gravity in the direction in which movement is to be restricted. As an option, instead of using a force of two times the equipment weight, calculations of force may be made in accordance with AFM 88-3, Chapter 13. Vertical accelerations shall be considered whenever appropriate.

3.5.5.4.6.2 The equipment identified as capable of causing severe injury, death, or a catastrophic event will be restrained. Restraint will prevent tip over, collapse, excessive deflection, or sliding. Restraint is not intended to ensure equipment function after a seismic event. Acceptability of restraint techniques shall be coordinated with and approved by 6595 ATG/TEG and 30 SPW/SE. Equipment shall be located so as not to exceed facility design limits.

3.5.5.4.6.3 Equipment that is mounted on casters or wheels shall have provisions for locking these casters or wheels and shall also comply with applicable parts of this section.

3.5.5.4.6.4 Utilization of friction to resist seismic loads is permitted only when accompanied by proper load and risk analysis.

3.5.5.4.6.5 Items of equipment which present seismic hazards for a cumulative total of 24 hours or less during any 365 consecutive day cycle are exempt from these requirements. Seismic hazards are defined as when the equipment could fail from induced seismic loads and cause severe injury, death or catastrophic events.

3.5.5.4.6.6 Equipment construction that is not part of a launch facility or direct support equipment (that may not require a safety buy off) that meets the failure criteria in paragraph 3.5.5.4.6.2 must be approved by the procuring/using agency under the guidelines established by AFM 88-3, Chapter 13.

3.5.6 Platform/Guardrail Design and Load Testing: (See Also 5.5.12)

3.5.6.1 For purposes of this section, work platforms are defined as walking/working surfaces supported by a fixed structure other than those described in ANSI/OSHA standards, such as manlifts, mobile platforms, scaffolding, or suspended workmen's platforms. Platforms are of two basic types, fixed and reconfigurable. fixed platforms are rigidly attached to a fixed structure. Reconfigurable platforms include folding, telescoping, horizontal pivoting, bolted extensions, and drop-in types.

3.5.6.2 Platform design shall consider the intended operational use, i.e., weight of equipment and manloading, but in no case shall design load be less than 50 pounds per square foot uniformly distributed live load.

3.5.6.3 Basis for Design, Design Criteria, Specifications and mechanical drawings shall contain calculations to support the requirements of this section, including safety factors and load test data.

3.5.6.4 Materials shall be selected in accordance with the physical properties and applicable stress tables contained in government publications and nationally recognized standards such as MIL-HDBK-5, ASTM, AISC, ASE, etc.

* 3.5.6.5 Safety factors for the design of platforms will be consistent with that of the overall structure in which they are permanently mounted. In no case shall the factors of safety be less than that of the overall structure or the applicable national consensus standard (AISC, the Aluminum Association, etc.), whichever is greater. Hinges, attaching points, and other high stress or abuse prone components and their interface hardware shall be designed with a safety factor of at least 4:1 against ultimate <u>and</u> 3:1 against yield.

3.5.6.6 Prior to first use, reconfigurable platforms shall be load tested to 125 percent of their rated load unless specifically exempted by 30 SPW/SE. An annual inspection of platform hinges, pivot points, roller, slides, and attachments, shall be determined on a case-by-case basis.

3.5.6.7 Platform design and intended use shall be approved by 30 SPW/SE.

3.5.6.8 Platforms shall be physically identified a to their rated load, in terms of both uniformly distributed live load (personnel) and concentrated live load (equipment).

3.5.6.9 Guard rails must conform to the requirements of CFR Title 29, Section 1910.23. Guarding Floor and Wall Openings and Holes. Validation of the completed design will be accomplished by either load testing or analysis.

* 3.5.7 This paragraph establishes the policies for the User to accomplish the selection, and identify the usage, of plastic film materials in conjunction with payloads and missile systems at WR. NASA KSC/ERR has a wealth of information already available on plastics that could help the User in preparing the data submittal package. Test data and the test methods prescribed in NASA Report MTB-402-85 or the equivalent will be used for assessment of static generation qualities, flammability, and compatibility with propellants. Additional information concerning testing may be obtained by contacting 30 SPW/SE.

3.5.7.1 A written safety analysis shall be prepared by the User and submitted to 30 SPW/SE in the SAR for approval and shall include:

3.5.7.1.1 Identification and characteristics of the plastic film to be utilized.

3.5.7.1.2 The method or conditions under which the materials are to be utilized.

3.5.7.1.3 An assessment of the hazards involved and the method or action to be taken to minimize any related risk.

3.5.7.2 Hazard control measures will include:

3.5.7.2.1 Identification of the ESD bleed-off capability of the "as-used" configuration.

3.5.7.2.2 Identification of the method to be utilized to assure continuing anti-static properties of the selected material.

3.5.7.2.3 Identification of the cleaning methods to be used to maintain surface cleanliness and conductivity. Ensure there will be no undesired changes in flammability or compatibility properties of the material from cleaning.

3.5.7.2.4 Establishment of minimum acceptable voltage accumulation levels for the materials or operations.

3.5.7.2.5 Establishment of a method for assuring conductivity between adjoining pieces of the plastic film materials.

3.5.7.2.6 Identification of flammable or explosive materials in the area where plastics are to be used and methods for monitoring for the presence or status of these materials.

3.5.7.2.7 Identification of the minimum energy required to cause ignition of flammable or explosive mixtures and the methods to preclude this ignition.

3.5.7.2.8 Identification of clothing or equipment restrictions for personnel performing the identified operations.

3.5.7.2.9 Assessment of the environmental effects on the selected material; such as humidity, ultraviolet light, temperature, etc., that could cause degradation of conductivity, flammability or electrostatic properties.

3.5.7.3 The User shall provide the above assessment to 30 SPW/SE for review and approval at least 120 days prior to the first planned use of the selected materials or operations at WR. (See also paragraph 3.11.18.)

3.5.7.4 The User shall notify 30 SPW/SE of all proposed changes to the above information prior to performing operations utilizing those changes.

3.5.7.5 Prior to proceeding with usage of the materials at WR, approval must be received from 30 SPW/SE.

3.5.7.6 Additional information concerning guidance for selection of plastic film at WR may be obtained by contacting 30 SPW/SE.

*** 3.6 Handling Equipment:**

3.6.1 Forklifts/lift trucks:

3.6.1.1 Forklift/lift truck handling critical loads shall be designed in accordance with ANSI B56 Series Standards (Lowlift and Highlift Trucks), 29 CFR 1910.178 (Powered Industrial Trucks), and other applicable standards. The design must provide for initial proofload testing to 125 percent of the rated load where the manufacture and/or equipment protection devices do not allow such, the equipment shall be downrated to 80 percent of the allowed test load.

3.6.1.2 Forklifts used for critical loads shall be specifically approved for the critical loads to be lifted and shall have an approved maintenance program and checklists before the forklift may be used for critical loads.

3.6.2 Elevators:

3.6.2.1 Validation tests will be accomplished on all elevators in accordance with the requirements of the American National Standards Institute (ANSI) A17.1 and ANSI A17.2, as amended or updated.

3.6.2.2 Elevators at missile facilities must be equipped with emergency lights or lights tied into a backup emergency electrical system, a telephone, and a public address (PA) speaker where a PA system is available and in use.

3.6.2.3 Passenger elevators must not be used for freight, ordnance, propellant or other hazardous commodity without express approval of 30 SPW/SE.

3.6.2.4 Freight elevators used for the movement of ordnance that has been removed from original shipping containers, toxic propellants, or other hazardous commodity are controlled remotely. Personnel must not ride in the elevator during movement of the above commodities. Exceptions to the above must be approved by 30 SPW/SE on a case-by-case basis.

* 3.6.3 Cranes, Lifting Devices and Materials Handling Equipment:

3.6.3.1 This section applies to overhead cranes (including fixed auxiliary hoists), mobile cranes, derricks, base mounted drum hoists, job and monorail cranes, and gantry cranes. It also applies to below the hook lifting devices including slings, riggers' hardware (shackles, turnbuckles, pins, etc.), and special lifting/rotating fixtures. It does not include forklifts, aerial buckets, elevators, K-loaders, personnel lifting devices, jacks, or hoists used for raising hinged platforms. The 30 SPW/SE chairs the VAFB Blue Ribbon Crane Committee (BRCC) to oversee safety improvement in the design, operational use and maintenance of VAFB cranes. A copy of the BRCC charter and its membership can be obtained from 30 SPW/SES. The BRCC is the approval authority for all new, modified or renovated cranes on VAFB.

3.6.3.2 All cranes, hoists, and other handling equipment used or operated at WR for permanent or short-term use shall be properly inspected, tested, functionally validated and maintained according to AFTO 36-1-58 and applicable ANSI B30 series codes, as supplemented by this regulation. This applies whether equipment is DOD or contractor owned, rented or leased. Cranes not on Vandenberg Exclusive Federal Jurisdiction property require inspections, testing and certifications in accordance with California Occupational Safety and Health (CAL-OSHA) requirements. These requirements can be found in Title 8 of the Administrative Code, Chapter 4, General Industry Safety Orders. As a minimum, they require initial and quadrennial 125 percent proofload testing and annual examination and certification by a state authorized agency. CAL/OSHA proofload testing certification meets the WRR 127-1 load test requirements.

3.6.3.2.1 Recognized standards such as CMAA, MHI (Material Handling Institute), ANSI, SAE, and AFSC Design Handbook 1-6, must be utilized to the maximum extent in design or modification of lifting and handling equipment. Design or modification specifications shall be submitted to 30 SPW/SE for review and approval. Specification submittals must include statements requiring manufacturers to provide certificates of acceptable conformance to the above standards. Specifications for critical cranes must include the following for the design of new cranes or the modifications to existing cranes:

3.6.3.2.1.1 * An emergency brake located on the drum.

3.6.3.2.1.2 * Dual upper limit switches.

3.6.3.2.1.3 * Emergency manual lowering capability.

3.6.3.2.1.4 Use of mechanical/electrical overload sensors.

3.6.3.2.1.5 * Wire rope mis-reeving slack detection devices.

3.6.3.2.1.6 Restriction of open rail power collectors/contactors.

3.6.3.2.2 Crane and hoist controls such as pendants, push-button stations, and operator stations, shall be configured and identified according to the appropriate ANSI and CMAA standard. For trolly and bridge movement, compass points (north, south, east, west) are preferred identification for the controls.

3.6.3.2.3 All inspections, tests, and functional validations at WR shall be performed using written procedures which describe safety control areas, emergency procedures, and supervisor and operator responsibilities.

Procedures shall be submitted to 30 SPW/SES for approval at least 30 days prior to date needed. Inspections and tests shall be performed by appointed or authorized persons. Inspection and test records (or copies) are to be maintained at the facility where the AGE device is installed or maintained. CES/DE will maintain tests and records for all RPIE cranes. Certifying agents for VAFB cranes must provide the following data for the contracting officer:

3.6.3.2.3.1 Federal or state office issuing certification authority.

3.6.3.2.3.2 Expiration date of certification authority.

3.6.3.2.4 Crane block, hook, fixture, and the component being lifted shall be of equal potential using grounding and bonding techniques when handling explosive stages, solid rocket motor segments or other ordnance devices. The WR recognizes that ordnance cannot be kept grounded at all times, for example, during transportation. The ground may be disconnected after the load is lifted clear of the cradle, fixture, container, pallet, or supporting structure to facilitate dolly or vehicle transportation. The ground shall be reconnected at the earliest convenient time before the load is placed on or into the above mentioned support equipment. The WR User shall describe his grounding methods and exceptions, with analysis, in the ordnance section of the SAR. Acquisition of new cranes should consider an isolated hook concept when cranes will handle fueled payloads or ordnance.

3.6.3.2.5 A design hazard analysis shall be performed on all critical cranes and hoists to identify failure conditions which could result in personnel injury, loss of load, or damage to critical hardware. The analysis must encompass the complete power and control circuitry as well as the load path from hook to structure, and critical failure points and modes must be documented for tracking to elimination or acceptance. This analysis will become a part of the SAR for system operation. A FMEA is required for all cranes handling critical loads. MIL-STD 1543B may be tailored as approved by 30 SPW/SES.

3.6.3.3 Two types of load tests are used for crane and hoist certification at WR, the rated load test and capability verification tests.

3.6.3.3.1 A rated load test is used to establish the maximum allowable, (i.e., rated), load for the device. This test is performed on new, modified, or extensively repaired equipment, using a test load of 125% (110% for mobile cranes and base mounted drum hoists) of the rated load to be assigned to the lifting device. The rated load shall be 80% of the test load and shall be clearly marked on the lifting equipment.

3.6.3.3.2 The capability verification test is used to periodically verify that a lifting device is still capable of handling its rated load after a period of non-use, (see p/u (1), Atch 4) or use at less than maximum capability. This verification is made using 100% of the rated load.

3.6.3.3.3 For both the rated load test and the capability verification tests, test weights shall be accurately identified and tagged with total weight (lbs), and owner or agency identification number. Reenforcing steel (rebar) shall not be used for lift points. Static load testing of cranes is not an acceptable alternate for load tests with approved weights.

3.6.3.3.4 Both the rated load test and the capability verification tests are conducted by lifting the load, holding the load for a predetermined time, raising the load again, exercising the loaded hoist through its operational envelope lowering the load, holding, then lowering to the floor. If for any reason this verification is accomplished using a load less than the rated load, the lifting device may only be qualified to 80 percent of the test load used. Rerating or derating shall not be done without adequate written justification and specific approval of 30 SPW/SE.

3.6.3.3.5 After the load test, a functional test of mechanical and electrical controls, limit switches, and safety devices shall be performed through the complete operational range without a load.

3.6.3.3.6 Test and inspection frequency requirements are shown in Attachment 4. Note that lifting equipment used to handle critical loads receive annual capability verification, while those not used to handle critical loads are tested every four years. Critical loads include, but are not limited to, ordnance or propellant items, missile components, spacecraft or other space hardware, and unique or high value items identified by program managers.

3.6.3.4 Slings, Riggers Hardware, and Special Handling Fixtures:

3.6.3.4.1 Handling fixtures and devices (slings, strongbacks, cradles, spreader bars and beams, etc.), shall be designed and tested in accordance with this section. Only materials handling equipment which meets the requirements of this section shall be used at the WR.

3.6.3.4.2 Ground handling rigid/fixed support stands, work stands, structural members, and transporters shall be designed to a safety factor of 4:1 against ultimate and 3:1 against yield.

3.6.3.4.3 All handling equipment to be used for hazardous operations or operations involving critical hardware as described in paragraph 3.6.3.3.6 shall be identified to 30 SPW/SE. Exceptions will be evaluated on a case-by-case basis.

3.6.3.4.4 All slings, riggers hardware and special lifting fixtures shall be proof tested to 200% of the rated load prior to initial use at the WR or after any modification or alteration. Synthetic slings shall have a design margin so the proofload will not stress the fibers beyond their rated working strength.

3.6.3.4.4.1 Other than those items contained in 3.6.3.4.4.7, slings, riggers hardware and special lifting fixtures used to handle critical equipment as identified in paragraph 3.6.3.3.6 shall be retested to 200% of their rated load annually or within 12 months prior to use.

3.6.3.4.4.2 Special handling fixtures such as strongbacks, cradles, spreader bars and beams, etc., which cannot be proofload tested at the user location due to the potential for overloading the lifting device, physical size, or overstressing structural members, shall be brought to the attention of 30 SPW/SE for resolution.

3.6.3.4.4.3 Critical hardware slings which have components that are normally disassembled shall be marked, coded, or tethered to insure proper reassembly. Those items described in 3.6.5.4.4.2, shall not be used for any purpose other than what was intended. Disassembly or removal of any part for the purpose of lifting other items is prohibited. Components not properly identified shall invalidate certification of the entire assembly.

3.6.3.4.4.4 Slings, riggers hardware and special lifting fixtures not requiring annual retest in accordance with paragraph 3.6.3.4.4.1 above may be periodically tested at the discretion of the user, not to exceed an interval of four years before use. This load test shall not be used as a substitute for inspections and shall not exceed 200% of the rated load.

3.6.3.4.4.5 The proofload for single leg slings and endless slings shall be two times the vertical-orientation rated capacity.

3.6.3.4.4.6 The proofload for multiple leg bridle slings will be applied to the individual legs and shall be two times the vertical orientation rated capacity of a single leg sling of the same size, grade, and construction of rope.

3.6.3.4.4.7 Hooks, shackles, links, eyebolts, and single failure point welds used for handling critical hardware as identified in paragraph 3.6.5.3.6 shall receive a nondestructive test (NDI) annually. This type of equipment used for handling other than critical hardware do not require NDI testing but shall comply with the testing, maintenance, and inspection requirements of OSHA 1910.184, and applicable ANSI standards.

3.6.3.4.5 Slings shall be visually inspected each day prior to use. A periodic inspection schedule must be established based on frequency of use, severity of service conditions, nature of lifts being made, and previous experience with slings in similar circumstances. Identification and record keeping requirements of ANSI B30.9 and OSHA 1910.184 shall be met; identification tags must indicate, as a minimum, inspection dates, proof test date, and maximum load rating. Records shall be maintained by the User.

3.6.3.4.6 Repaired or refurbished slings shall be proofloaded prior to being returned to service.

3.6.3.4.7 Hydrasets used for critical loads shall be initially load tested to 200% of the rated load and annually thereafter to 125% of the rated load. A 125% proofload is required after seal replacement. A manufacturer's or approved testing lab's certification is acceptable for new or reworked hydrasets.

3.6.3.4.8 Chainfalls used for critical loads shall be load tested initially at 125% and annually thereafter to 100% of their rated load.

3.6.3.4.9 Hydracranes used for critical loads shall be load tested initially and annually thereafter at 110% of their rated load.

3.6.3.4.10 Tag lines shall be used when there is potential for load sway which could damage the article lifted, high value equipment or flight hardware. Tag line personnel shall not impart undesirable motion to the load.

3.6.3.5 Cranes utilized for lifting/hoisting personnel require specific safety approval for the operation being conducted. In addition to OSHA requirements, the crane must have the following:

3.6.3.5.1 Upper limit switch which interrupts/stops the up power and activates a warning signal.

3.6.3.5.2 Power control lowering only, free fall features must be deactivated.

3.6.3.5.3 Current load test and inspection for the configuration in use.

3.6.3.5.4 Safety approved work cage/basket.

3.6.3.5.5 An Operation Log Book shall be maintained for all cranes lifting critical loads.

3.7 Noise Protection:

3.7.1 Noise protection design for personnel is implemented in accordance with criteria outlined in AFSC DH 1-3, MIL-STD-1472C, and AFR 161-35, Hazardous Noise Exposure. Objectives of hearing protection in facility designs are to minimize short and long term hearing loss, increase task efficiency, improve communications, and reduce operator fatigue.

3.7.2 The User must include, as part of the SAR, the location of all noise source fields that may result in hazardous noise exposure for personnel. The User must include data on the operating acoustic level and characteristics of systems or subsystems such as hydraulics, power units, and similar high energy noise producing systems when they exceed 84 decibels/A scale (dBA).

3.7.3 A method of protection must be provided for personnel who are exposed to sound pressure levels above 84 dBA in any octave band for continuous daily exposure of 8 hours per day, 40 hours per week. AFR 161-35 serves as the guide for determining the effectiveness of protection equipment and methods. Unprotected noise exposure shall never exceed 115 dBA for any exposure period. No one shall be exposed to noise levels that exceed 150 dBA no matter how much the noise level in the ear canal has been reduced.

3.8 Non-Ionizing Radiation:

3.8.1 Radio Frequency (RF) Systems producing RF radiation, must be designed so the hazards presented to personnel are at the lowest practical level. Personnel exposure to radiation must not exceed the permissible exposure levels as defined in AFOSH STD 161-9.

3.8.1.1 Interlocks should be utilized to prevent unnecessary exposure of personnel to hazardous areas. Interlocks must be utilized in areas where electrical radiation hazards would be present if protective coverings were removed.

3.8.1.2 Appropriate "fail-safe systems" will be incorporated so that accidental operation of RF emitting systems is prevented.

3.8.2 A list of all radiating sources within launch complexes and ground processing locations will be provided in the SAR with the information required by AFOSH STD 161-9.

* 3.8.2.1 When permanent RF radiating equipment is to be introduced into WR environments, a facility siting hazard analysis must be accomplished in accordance with AFOSH STD 161-9, and AF TO 31Z-10-4. This analysis must be submitted to 30 SPW/SE for review. Test acceptance approvals may include a field survey of the RF power density. A copy must be posted at each facility and two copies will be forwarded to 30 SPW/SE for file and distribution.

* 3.8.2.2 Hand held and mobile radio transmitters shall not be operated in close proximity to ordnance or fueling operations without 30 SPW/SE approval. Safe operating distance requirements shall be established on a case-by-case basis. The minimum information that is required to make the safe distance determination is: NAME, Model No, transmitter power, frequency and antenna gain.

* 3.8.3 Laser system designs must incorporate requirements of AFSC DH 1-6, AFOSH STD 161-10 and paragraph 2.10 of this regulation.

3.8.3.1 For areas where electrical or laser hazards would be present if protective coverings or proper protection were removed, interlocks must be utilized to prevent unnecessary exposure of personnel to laser hazards.

3.8.3.2 Appropriate protection must be incorporated to prevent inadvertent or accidental operation.

3.8.3.3 When toxic chemicals or cryogenic materials are utilized with laser systems, shutoff valves must be provided in locations to minimize leakage in the event of a line rupture.

3.8.3.4 Laser systems must be designed so hazards to personnel and equipment are at the lowest practical level. All laser systems must conform to the laser health hazards control specified by AFOSH STD 161-10.

3.8.4 The User must submit copies of the following information for laser systems as an appendix to the SAR:

* 3.8.4.1 A complete safety system description. Include drawings of the system which identify, show the location, and describe the operation of all safety-critical components, interfaces, and safety interlocks. Provide reliability estimates for the components and, where appropriate, interlocks.

3.8.4.2 Laser specifications data sheet (including nomenclature), maximum and minimum power output, pulse durations, power measurements before and after optics, beam diameter with variations due to optics such as converging lenses, beam divergence angle, warnings and fail-safe provisions.

* 3.8.4.3 A hazard analysis addressing chemical, electrical, X-ray, optical and other related hazards. It must include the calculated nominal ocular hazard distance (NOHD) data showing that maximum permissible exposure level (MPE) is controlled and not exceeded, and the aspects and effects of weather, reflectivity, "hot spots," and ordnance considerations.

3.8.4.4 Standard Operating Procedures (SOP) detailing operations, personnel and eye protection, and personnel access controls.

3.8.4.5 Certification for laser systems installation and operation at WR must be implemented through the 30 Medical Group/SGB.

3.9 Ionizing Radiation:

3.9.1 Radioactive system or subsystems must conform to requirements of Nuclear Power Systems Safety Reviews and Surveys, AFR 122-16, Nuclear Safety Review Procedures for Space or Missile Use of Minor Radioactive Sources; AFR 160-132, Control of Radiological Health Hazards; CFR Title 10; CFR Title 49; TO 00-110N-2 and 3. This evaluation is the basis for WR approval. The request for TNSE must be submitted in accordance with AFR 122-16.

3.9.1.1 Nuclear radioactive sources carried aboard missile or space vehicles must be compatible with, and have no adverse effects on, ordnance items or flight termination systems.

3.9.1.2 Nuclear radioactive sources aboard missile or space vehicles must be designed so they may be installed as late as possible in the countdown, particularly if personnel are required to work within controlled radiation areas (2mR/hr) while performing any tasks.

3.9.1.3 Design and task sequencing will be so that personnel exposure is as low as reasonably achievable (ALARA) and according to AFR 161-8, Control and Recording Procedures Occupational Exposure to Ionizing Radiation, CFR Title 10, and AFR 160-132.

3.9.1.4 The system must be designed to minimize the radiological accident risk potential in the event of a launch facility accident involving the launch vehicle. The SAS must contain location estimates of the source and its physical characteristics (vaporizes, melts, etc.).

3.9.2 Two final copies of a SAS and Radiation Protection Plan (RPP), prepared according to AFR 122-16, Nuclear Safety Review Procedures for Space or Missile Use of Radioactive Sources, and AFR 122-16/30 SPW Sup 1 must be submitted to 30 SPW/SE 120 days prior to arrival of the radioactive material at WR. A SAS is required regardless of security classification. If there are no radioactive sources associated with a program, a negative response is required. Non-Air Force Users are required to certify that their flight approval requirements have been met. Copies of their approval correspondence must be provided to the WR Radiation Safety Committee.

3.9.2.1 Radioactive material or assemblies must be handled under the supervision of a designated User or the Radiation Protection Officer named on the US Nuclear Regulatory Commission (NRC) license, State license, or USAF permit. Licensing/ permitting requirements and procedures are specified in AFR 161-16 and VAFBR 161-1. Applications for USAF permits must be submitted to the 30 Medical Group/SGB and must include a copy of the User's NRC license. The NRC licensee or contractor must submit three copies of the NRC license with the USAF permit to 30 SPW/SE at least 30 days prior to planned entry to WR.

3.9.2.2 In addition to submission of procedures and SAR approval action, field processing must be approved in writing by the 30 SPW Radiation Safety Committee for all flight materials. As a necessary step to obtain approval, the facility user will brief the WR Radiation Safety Committee on all hazards and procedures concerning the handling of their radioactive material at WR. A MSGSA can only be issued after receipt of written approval from the 30 SPW Radiation Safety Committee. An approved environmental impact statement is a prerequisite for approval of the Radiation Safety Committee.

3.9.2.3 The 30 Medical Group/SGB must have access to the source to maintain appropriate records, perform routine surveys on handling procedures associated with each source, and, where necessary, perform radiation surveys on the operational use of the material. These actions will be accomplished under the surveillance of the 30 Medical Group Radiation Protection Officer in coordination with 30 SPW/SE.

3.9.2.4 Notification procedures for entry and transportation of radioactive materials on Vandenberg AFB are found in VAFBR 161-1, Control of Ionizing Radiation. Radioactive sources must be shipped and transported IAW 10 CFR Part 71 and 49 CFR Parts 172-173. Radioactive source material must be received IAW 10 CFR Part 20.205.

*** 3.10 Hazardous Materials:**

3.10.1 The design of systems which contain hazardous materials shall be carefully assessed to eliminate releases of these materials to atmosphere. Strong consideration should be given to the use of scrubbers, aspirators, fuel/oxidizer burner systems, and other methods to reduce the hazard of personnel and public exposure.

3.10.2 A statement is required in the SAR that personnel must not be subjected to concentrations greater than the Threshold Limit Value (TLV) or other appropriate level, under normal circumstances. Exposure at the TLV or below should be kept as low as reasonably achievable.

3.10.3 SCAPE/PPE Policy:

3.10.3.1 PPE shall provide full respiratory protection and body coverage. (SCAPE Cat I and Cat IV), shall be worn during any dynamic payload, booster and/or GSE toxic propellant operations, or whenever the toxic propellants are not in a closed system. At all other times that toxic propellants are present, emergency escape breathing devices shall be available for all personnel. The following are conditions when full respiratory protection and body coverage is mandatory:

3.10.3.1.1 Any connection/disconnection of a propellant system that contains toxic propellants.

3.10.3.1.2 Any connection/disconnection of a propellant system that contains toxic propellants and concentration levels have not been verified to be below safe allowable levels.

3.10.3.1.3 All toxic propellant sampling operations in confined areas, clean enclosures and spacecraft processing rooms.

3.10.3.1.4 Any servicing/deservicing/internal circulation (dynamic flow) of toxic propellants until system integrity has been verified, i.e., no leakage is present.

3.10.3.1.5 Any application of pressure to the toxic propellant transfer system or tankage until a stabilization period of 15 minutes minimum has been achieved and system integrity has been verified. Remote pressurization operations when personnel are clear of the safety control area are exempt.

3.10.3.2 Downgrading from Cat I or Cat IV coverage above requires 30 SPW/SE concurrence. Use of splash suits with airline respirator must be approved for each specific operation.

3.10.3.3 All personal protective equipment shall be compatible with the toxic materials involved, and their use shall be approved by 30 SPW/SE and 30 Medical Group/SGB.

3.10.3.4 The M26A1 Rocket Propellant Canister Mask does not provide respiratory protection in oxygen deficient atmospheres. Positive pressure respirators will be used where scenarios may require escape through oxygen deficient atmospheres. See also paragraph 5.12.3.

3.10.3.5 Respirators used to protect personnel will be in accordance with AFOSH Std 161-1, NIOSH recommendations for the material involved, 29 CFR 1910.134 and ANSI Z88.2. AFM 161-30, Volume II, Appendix C, provides guidance for protective equipment acceptable for use for certain types of exposure.

3.10.4 A general description of the commodity in use and the hazardous qualities of the material shall be included in the SAR. Material Safety Data Sheets are mandatory, if available.

3.10.5 An analysis of the handling and storage of hazardous materials and personnel protection from known and inadvertent exposure shall be included in the SAR. This analysis shall include PPE required for specific operations, and PPE required for emergency egress. The PPE description must include type, make and location of breathing apparatus, type of protective clothing ensemble required, and any special handling equipment required, with instruction for use. The analysis shall also include a description of any detection equipment used, its location, and a description of how it will be used. Clean-up operations, decontamination equipment and neutralizers shall be identified in the SAR. If hazardous waste is generated, labeling and disposal procedure will be stated or the applicable document referred to.

3.10.6 The information required by paragraph 3.10.5 shall also be included in procedures and Launch Complex or Facility Safety Plan, as appropriate. The type and category of PPE shall be specified in applicable procedures. No substitution or configuration alteration of PPE specified in procedures will be allowed without 30 SPW/SE approval.

3.10.7 The type, frequency, and extent of medical examinations for Air Force and Air Force Civilian Personnel shall be in accordance with the guidance of AFR 161-33 or substance-specific AFOSH Standards. The base supporting medical facility is responsible for medical examinations of government personnel occupationally exposed to those chemical substances listed in AFOSH Std 161-8, Attachment 1. Medical examinations for contractors shall be in accordance with CFR 29, part 1910.

3.10.8 On-the-job indoctrination covering hazards, safe practices, hazard reporting, personal cleanliness, and the use and care of protective items will be accomplished by the supervisor. This training must be accomplished in accordance with AFR 127-12, Air Force Occupational Safety and Health Program, and records maintained by the supervisor.

3.10.9 All operations involving the transfer or handling of any hazardous material must be performed by groups of two or more persons with a thorough knowledge of the nature and properties of the materials. Practice operations with inert materials should be run.

3.10.10 Procedures must contain emergency backout instructions for hazardous conditions resulting in spill or other mishaps. The Launch Complex or Facility Safety Plan will contain contingency operations. If an unplanned release of propellant or vapors occur, all unprotected personnel must be evacuated.

3.10.11 An adequate water supply must be available for diluting, flushing, decontaminating, and fire fighting when handling hazardous materials.

3.10.12 Rags, cotton waste, sawdust, excelsior, or other materials of a large surface area that have absorbed hydrazine or hydrazine-based propellants may eventually cause spontaneous ignition. Such materials should not be stored under conditions that prevent dissipation of the heat that can accumulate by gradual process of air oxidation.

3.10.13 Nitrogen tetroxide (N204) and mixed oxides of nitrogen are oxidizers, but they are not hypergolic with all combustible materials. Such non-hypergolic mixtures present an explosion hazard, particularly when subjected to elevated temperatures, pressures, or impact.

3.10.14 Toxic Hazard Corridors (THCs) are established to protect personnel and public during planned and inadvertent releases of propellant vapors. THC predictions are based on analysis of source strength and prevailing meteorological conditions. Input to the THC forecast by the User must consider the worst-case credible spill scenario (spill quantity, spill rate, expected wetted surface area, etc.). THCs shall be prepared in accordance with Attachment 6.

3.11 Propellants and Propulsion Systems:

3.11.1 The design considerations contained in MIL-STD-1522, AFM 161-30, National Fire Prevention Association (NFPA) 70, National Electrical Code Article 500, AFR 127-100, ANSI B 31.3 and AFOSH Standards shall be used in designing launch vehicle and spacecraft liquid propellant propulsion systems. AFSC Design Handbook DH 1-6 and T.O. 00-25-223 shall be used as guidance in this design. All agencies using WR facilities must meet the following requirements:

3.11.1.1 Missile support systems piping and storage areas at launch pads or missile facilities must be identified in accordance with MIL-STD-1247.

3.11.1.2 Propellant lines and electrical lines must be located or designed to make sure that a single failure, such as leakage or electrical arcing, cannot cause ignition of the propellant.

3.11.1.3 Materials will be selected based on their compatibility with the service fluid. (See also paragraph 3.11.17.)

3.11.1.4 Ensure that GSE for loading DUAL propellant systems can be used independently and can be individually leak-checked.

3.11.1.5 Ensure that the flight vehicle is protected from the explosive effects of vapor phase explosions in the fuel holding or transfer areas.

3.11.2 During facility conceptual phase design reviews all tanks, containers, and areas where propellants are handled shall be identified. This data shall be made available to 30 SPW/SE at the earliest possible time for evaluation of quantity separation distances, TNT equivalency, and storage compatibility for compliance to DOD regulations. Siting Plan Packages are approved based on the data provided.

3.11.3 Storage, transfer sites, and areas where toxics are tested must be kept clean, free from combustibles, and frequently inspected.

* 3.11.4 There should be at least two access roads to transfer and storage sites of hazardous materials. Emergency egress personnel gates shall be installed and located on perimeter fencing to permit rapid evacuation of areas whenever toxic propellants are handled, transferred, or stored.

3.11.5 The US Coast Guard is responsible for enforcing regulations concerning shipment of explosives and other dangerous materials via water, either all or part of the way. The regulations are contained in Coast Guard (USCG)-108.

3.11.6 Hazardous materials must be marked according to DOT classifications during shipment (for example, monomethylhydrazine is required to have a red label with a placard displaying "FLAMMABLE"). (See AFR 74-1 for specific detail.)

3.11.7 Ensure fuel and oxidizer offload stations are equipped with different size connectors to prevent cross connecting.

3.11.8 Provisions for draining propellants from transfer lines and a method for decontaminating those lines shall be provided.

3.11.9 Entrances to propellant areas shall be properly placarded.

3.11.10 Simultaneous transfer of fuel and oxidizer is prohibited unless prior written approval is received from 30 SPW/SE.

3.11.11 The pressurant used to pressurize a propellant system may become contaminated by the propellant. A positive means shall be provided to ensure that any gas so contaminated cannot then come in contact with an incompatible propellant. Separate (non-interchangeable) lines shall be used.

* 3.11.12 Propellant delivery systems will be designed with final filters when the transferred fluid will enter a safety critical system (any system or subsystem which if a mishap should occur personnel injury and/or facility and/or equipment damage is imminent).

3.11.13 Propellant systems shall be designed to prevent liquid flow from system vents.

* **3.11.14** Propellant systems shall be designed to prevent toxic effluents from entering the atmosphere. Where piping disconnects are utilized for hazardous propellants, design will ensure disconnect poppets are closed and seal is variable before disconnect is initiated.

3.11.15 All propellant systems shall be designed so that launch vehicles, spacecraft, and propellant loading systems can be commonly grounded and bonded during propellant transfer operations. All flanges shall be bonded and grounded.

* **3.11.16** All AVE propellant systems must have the capability for emergency safing and must have the procedures to accomplish it, e.g., contingency off load. This capability must exist no matter where fueling is done and will include during transporting a fueled system if loading is done off site. See also 3.1.7. This document does not mandate how a system is made safe.

* **3.11.17** Test Requirements:

* **3.11.17.1** New, modified, relocated, or repaired propellant storage or transfer systems must be validated by a functional cold flow and proof pressure test prior to certification for operational use. It is also recommended that a hot flow follow the cold flow.

* **3.11.17.2** The User must certify in writing in the SAR that system or subsystems have satisfactorily passed the required tests. The test data must be available for review.

* **3.11.18** Special materials brought into propellant areas such as for clean room enclosures, curtains, etc., must be assessed for static generation qualities, flammability, and compatibility with propellants. This hazards assessment will be provided in the SAR. Test data and the test methods prescribed in NASA Report MTB-402-85 or the equivalent will be used for compatibility assessment. (See also paragraph 3.5.7).

3.12 Pressurized Systems:

* **3.12.1** Pressure system design compliance criteria to be followed by the User are contained in American Standard of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section VIII, Divisions 1 and 2, and MIL-STD-1522A. Technical Order 00-25-223, ANSI B31.1 and AFSC Design Handbook DH 1-6A are for guidance. MIL-STD-1247C is used to identify aerospace ground support equipment systems that are on site and used in direct support of a missile or space system. Pressure vessels must be marked, using six inch high black lettering, one inch wide indicating as a minimum the following information: contents, maximum allowable working pressure, and classification of hazard. The markings should be on the side of the vessel facing the roadway approach.

3.12.2 A detailed system operating hazard analysis must be performed to determine the operation, interaction, or sequencing of components will not lead to unsafe conditions, personnel injury, major damage to the spacecraft or RV, its booster, or associated ground support equipment.

3.12.3 Analysis data must show that the system provides the capability of maintaining all pressure levels in a safe condition in the event of interruption of any process, or control sequence, at any time during test or countdown.

3.12.4 A complete structural analysis must be accomplished for all pressure systems. The results of the structural analysis must indicate safe stress levels for components and the structures required to support them. Relief devices shall be set at no higher than 110% of system MAWP/MEOP. Structural analysis in accordance with AFM-88-3, Chapter 13 seismic zone 4, for the full range of operational conditions, e.g., Vessels from partial full to full, should be provided to identify the worst case condition.

3.12.5 During prelaunch pressurization, pressure monitoring must be provided by means of a hardline umbilical cable or telemetry.

3.12.6 Pressure vessels for ground support service up to 3000 psi shall be designed to a safety factor of no less than 4:1, based on ultimate, in accordance with ASME Boiler Code Division 1 criteria. Ground support pressure vessels may have a safety factor of 3:1 based on ultimate, providing the requirements of ASME Division 2 are satisfied. Design via fracture mechanics is acceptable in lieu of conventional safety factors, but full records and analyses are required for review and approval by 30 SPW/SE on a case-by-case basis. Pressure vessel proof test and relief valve requirements shall be according to the ASME Boiler Code. Proof test and relief valve criteria can be different when comparing pressure vessels and piping systems.

3.12.7 All ground installed pressure vessels as defined by ASME Code Section VIII shall be approved by a WR certification authority and subject to an ongoing in-service maintenance and recertification program.

3.12.8 New or modified pressure systems shall undergo hydrostatic or pneumatic pressure testing. Hydrostatic testing is preferred and shall be 1.5 times the maximum allowable working pressure. Pneumatic testing shall be to 1.25 times the maximum allowable working pressure.

3.12.9 A system description and supporting data are required for pressure systems design and will be provided in a separate section of the SAR as outlined in the Data Item Description DI-SAFT-80102. Supporting calculations, as required by MIL-STD-1522A, shall be included in this section of the SAR.

3.12.9.1 Ground support equipment must provide for two sources of pressure relief; however, use of two burst discs is prohibited.

* 3.12.9.2 Two independent automatic relief devices are required if unregulated upstream pressure exceeds burst pressure of any component downstream. At least one relief device is required if upstream pressure exceeds MAWP of any component downstream of the regulator.

3.12.10 Aerospace Vehicle Equipment (AVE) pressure systems shall be designed in accordance with MIL-STD-1522A. In addition, they shall be designed so that initial pressurization of the systems at the center can be accomplished remotely (e.g., locate control behind blast shields) unless the user can provide certification that the following has been accomplished.

3.12.10.1 The assembled system has been proof tested at a pressure equal to 1.5 times the system maximum expected operating pressure (MAWP).

3.12.10.2 System configuration has not been modified or repaired subsequent to above testing. Unwelded relief or sensing devices may be replaced after system proof testing.

3.12.10.3 Inspection of the pressure system at the launch site verifying damage has not been sustained during transportation or handling subsequent to above testing.

3.12.11 The 2:1 safety factor must not be violated in the pressure vessel by any combination of pressure and dynamically induced strain during on-base transport and handling of pressurized AVE (see 3.12.14).

* 3.12.12 Unmanned launch vehicle pressure vessels which have a safety factor of less than 2:1 must be pressurized remotely. All personnel must be

evacuated during pressurization and must stay evacuated as long as the vessel is pressurized. The only exception to this requirement is if a fracture mechanics analysis is accomplished IAW MIL-STD-1522A and classified leak before burst. The analysis must be approved by WR Safety.

* 3.12.13 Relief devices shall be provided on flight hardware or GSE to protect flight hardware against overpressurization. Launch vehicles using GSE relief devices when pressure systems are active shall have these relief devices connected as long as possible prior to launch. After disconnection access to the potential hazard area will be restricted.

3.12.14 Transportation of Pressurized Vessels (AVE):

3.12.14.1 Noncomposite metallic pressure vessels, which are designed to MIL-STD-1522A requirements using approach A (paragraph 4.1), may be pressurized to one of the following criteria.

3.12.14.1.1 Pressure vessels that exhibit a brittle fracture, i.e., burst before leak (BBL) or hazardous leak-before-burst (LBB) failure mode, shall maintain a minimum safety factor of 2:1 (design burst to transport pressure) during transport or ground handling operations.

3.12.14.1.2 Pressure vessels that have a nonhazardous LBB failure mode shall maintain a minimum safety factor of 1.5:1 during transport or ground handling operations.

3.12.14.2 Composite vessels, with a load-carrying metallic liner designed to MIL-STD-1522A requirements using approach A, may be pressurized to one of the following criteria:

3.12.14.2.1 Pressure vessels that exhibit a BBL or hazardous LBB failure mode may be transported or handled according to requirements of Table 3.2. A safe-life demonstration test and analysis are required. The overwrap must also be compatible with the fluid in the vessel.

3.12.14.2.2 Pressure vessels that have a nonhazardous LBB failure mode may be transported or handled according to requirements of Table 3-2. Failure mode shall be based on the characteristics of the liner and overwrap. LBB demonstration test is required using an inert fluid. Pneumatic pressure vessels shall demonstrate LBB of the liner and overwrap using a gas.

Table 3.2

Allowable Transportation Safety Factors

	OVERWRAP LOAD CARRYING (%)		
	BELOW 35%	35%-85%	ABOVE 85%
NONHAZARDOUS LBB	1.5	3.0	4.0
BBL; HAZARDOUS LBB	2.0	4.0	5.0

3.12.14.3 Noncomposite or composite pressure vessels, which are designed to MIL-STD 1522A requirements using approach C, may be pressurized to their maximum allowable working pressure, as defined by American Society of Mechanical Engineers (ASME) or DOT standards.

3.12.14.4 Deviations from the above safety factors will only be considered if a complete and detailed justification analysis shall clearly identify safety issues regarding personnel/environment/facilities and flight hardware, schedule, and cost impacts. In addition, the deviation will only be approved if the following transport procedural controls are implemented.

3.12.14.4.1 The transport route shall use the least populated roads leading to the launch complex or processing facility (i.e., perform route risk assessment).

3.12.14.4.2 All traffic shall be detoured from the route for the duration of the transport. Security will enforce.

3.12.14.4.3 All personnel shall be cleared a minimum of 1,250 feet from the transport convoy route or instructed to enter and remain inside a building for the duration of transport. Security will monitor/enforce.

3.12.14.4.4 The transport shall take place during off-duty hours.

3.12.14.4.5 Emergency response plans shall be approved by the regulatory safety office.

3.12.14.4.6 Immediate emergency response capability is required.

3.13 Ordnance Systems:

* 3.13.1 This section establishes the policies and procedures to be met in design and operations such as handling, storing, installing, testing, and connecting WR Category A ordnance during prelaunch operations at WR. Ordnance is defined as all electro-explosive devices (EED), detonators, squibs, primers, exploding bridge wire (ebw), pyrotechnic devices, initiators, ignitors, laser initiated detonators, solid propellants, explosives, warheads, ammunition, fuses, and energy transfer systems including, but not limited to, primacord, superzip, mild detonating fuse (MDF), and confined detonating fuse (CDF). Liquid propellants are also defined as ordnance by DOD for siting, storage, and handling purposes. In this document, liquid propellants are covered in section 3.11. Prior to first use of a procedure involving operations with live ordnance or pressure systems, practice operations should be conducted at Vandenberg AFB using inert or dummy ordnance or nonpressurized systems. Documentation requirements are as specified in para 3.1.8. (For explosive transportation routes see AFR 127-100, VAFB Supplement 1.).

3.13.2 Ordnance items must be assigned the appropriate DOD hazard classification in accordance with DODS 6055.9 and cannot be classified by similarity. Items not previously classified and cannot be classified by similarity must be tested in accordance with TO 11A-1-47 (NAVORD Inst 8020.3) and classified accordingly. The User is responsible for classification tests and for submitting the results to 30 SPW/SE for concurrence. Preliminary DOD ordnance hazard classification data must be provided to 30 SPW/SE prior to arrival of the ordnance at the WR. All ordnance initiating items will be classified as a WR category A or B device for both the preinstallation and postinstallation situations. Category A EEDs are those that, by the expenditure of their own energy or because they initiate a chain of events, may cause injury (or death) to people or damage to property. Category B devices are those that will not, in themselves (hand-safe) or by initiating a chain of events, cause injury to people or damage to property (see 3.13.4 for test requirements).

* 3.13.3 Ordnance subsystems and their components shall be designed according to MIL-STD-1576 and DOD-E-83578A. Ordnance devices such as solid propellant rocket motors, destruct charges, and other ordnance systems will be designed so the sensitive or initiating elements can be installed in the system just prior to electrical hookup and as late in the countdown as possible or practical.

3.13.3.1 For fault tolerance general requirements, the design of an electro-explosive subsystem performing a safety critical function shall tolerate a minimum number of credible failures or operator errors according to the following criteria contained in MIL-STD-1576.

3.13.3.1.1 If loss of ordnance function is safety critical, the design of the electro-explosive subsystem shall preclude single point failures and shall include at least two EEDs.

3.13.3.1.2 If inadvertent firing is safety critical, the design of the electro-explosive subsystem shall provide a condition such that no single failure or operator error can cause a serious hazard and no combination of two failures or operator errors can cause a major hazard. (See paragraph 3.2.8 for inhibit requirements.)

* **3.13.3.2** Category A EEDs must meet the requirements of the following paragraphs to minimize the hazards of electromagnetic radiation to EEDs. Special considerations are given by 30 SPW/SE to any new EED concept or design that demonstrates adequate selectivity in response between direct current and radio frequency energy in the WR RF environment.

3.13.3.2.1 Category A ordnance devices must have one-amp and one-watt no-fire survivability (MIL-STD-1576).

3.13.3.2.1.1 The no-fire current must not be less than one ampere as the result of the application of a direct current (DC) voltage for five minutes, without the use of external shunts.

3.13.3.2.1.2 The no-fire power must not be less than one watt as the result of the application of a DC voltage for five minutes, without the use of external shunts.

3.13.3.2.2 The survivability levels of each EED, in its most sensitive mode, must be determined in terms of the RF power density that could produce the maximum-no-fire power in its bridgewire. In addition to the one amp, one watt requirement, the WR User shall validate the survivability of each electro-explosive device before, during, and after installation in accordance with paragraph 3.13.3.2.3.5.

3.13.3.2.3 All WR category A firing circuits must be interrupted between the ordnance item and the power source by using an S&A device, arm/disarm device, barometric switch, arm or safe plug, relay or equivalent device that provides positive interruption of the circuit. The devices should be as close to the ordnance end of the circuit as possible. The devices must be capable of performing the inhibiting function when power is applied to the firing circuit. An inhibit in an ordnance firing circuit is a device which provides a positive interruption of the circuit. A control is a device or command which causes an inhibit to function. There is no mandatory WR requirement for an ordnance system to contain specific types of ordnance safing devices in the ordnance circuit. The WR requirement is for the following inhibit criteria to be met for WR Category A ordnance under all conditions. Three independent verifiable circuit inhibits are required for unlimited exposure of personnel during test. Two independent circuit inhibits will reduce exposure to essential personnel only and must be approved by 30 SPW/SE. No exposure of personnel will be permitted if a circuit has only one inhibit. A WR approved ordnance safing device that is manually pinned and safed can normally be counted as two (2) inhibits with pin in place. (The device shall be designed so that the pin can not be removed with the arming power present. In no case will inhibits and controls be allowed that share the same common failure modes (see paragraph 3.2.8.2).

3.13.3.2.3.1 EED firing circuits, including EED leads, must be isolated from other electrical circuits and each other by means of individual shields at all times. Insulation resistance between all insulated parts, at a potential of

500 VDC minimum, must be greater than 2 megohms. Electromagnetic Interference (EMI) shielding between conductors must be 20 dBA minimum. Shielded EED circuits may be routed together in a common secondary shield.

3.13.3.2.3.2 Firing circuit shields must be continuous from the power source to the EED case. If the EED is enclosed in a metal container providing attenuation at least equal to that of the shield, the shield may be terminated at the container. Shields need not be carried through a connector if the connector can provide RF attenuation and electrical conductivity at least equal to that of the shield. Shields terminated at a connector must be electrically joined with no gaps around the full 360 degree circumference of the shield.

3.13.3.2.3.3 Firing circuit conductors, including EED leads, must be twisted and shielded to reduce induction from external alternating current (AC) and RF sources and maintain electrical balance in AC circuits. Splicing is prohibited.

* 3.13.3.2.3.4 Sections of the firing circuit that are electrically isolated by inhibits until after lift-off may be shielded to the positive interruption (inhibit) rather than to the power source. Approval is dependent upon the RF characteristics of the inhibit.

* 3.13.3.2.3.5 In all cases, demonstration of survival in the WR ground and aerospace vehicle environment must show that the EED and inhibit control circuitry cannot receive more than 20 dBA and 10 dBA respectively below the maximum no-fire power/activation power in all modes of use and exposure. Computed RF power density levels for WR facilities are available from 30 SPW/SE.

3.13.3.3 A S&A device is a WR approved, highly desirable, inhibit for category A firing circuits. S&A devices must satisfy the requirements of MIL-STD-1576.

3.13.3.4 Shielding caps must be provided and placed on the EED during shipment, storage, handling, and installation up to the point of electrical connection in the missile. The shielding cap must have an outer shell made of conductive material that provides an RF shield and makes electrical contact with the EED case. There will not be RF gaps around the full 360 degree mating surface between the shielding cap and the EED case.

3.13.3.4.1 The shielding cap must be designed to accommodate the torquing tool during installation or torquing without the removal of the shielding cap. EBW system initiators, by their nature, require high current for firing and are considered to meet the requirements of 3.13.3.2.1 above. However, EBW systems must:

3.13.3.5.1 Include a dual bleed system with either system capable of bleeding the capacitor charge.

3.13.3.5.2 Have remote monitoring of the capacitor charge status.

* 3.13.3.5.3 Have established no-fire current.

3.13.3.5.4 Contain explosive materials of an insensitive mixture such as pentaerythritol tetranitrate (PETN) and research department explosive (RDX).

* 3.13.3.5.5 Maintain auto-ignition temperature of the device above 300F.

3.13.3.5.6 Meet the requirements of paragraph 3.13.3.2.3.

3.13.3.6 WR Category B EEDs are not required to comply with the RF and stray voltage or no voltage requirements of this chapter. RF protection for category B EEDs is the sole responsibility of the WR User.

* 3.13.3.7 Ordnance circuits must be capable of being safed during any phase of ground operation. (See 3.1.7.)

3.13.3.8 Special materials brought into ordnance areas must be assessed for static generation qualities, flammability, and compatibility with propellants. This hazards assessment will be provided in the SAR. Test data and the test methods prescribed in NASA Report MTB-402-85 or the equivalent will be used for compatibility assessment (see also paragraph 3.5.7).

3.13.4 Test Requirements are:

3.13.4.1 Operations having an energy potential (electrical, light, etc.) applied to an ordnance circuit with ordnance connected will be considered as testing of ordnance. All testing of category A ordnance circuits or devices will be considered as dangerous until the User submits an analysis to 30 SPW/SE which proves otherwise. Testing of any ordnance circuit or device that could result in personnel injury or death (if the ordnance should fire) must be conducted with no personnel exposed (i.e., remotely or in a test cell or behind a barricade or shield).

3.13.4.2 For ordnance tests in nonapproved test locations, a justification of why the test has to be performed in location described and time sequence must be provided. It must include the data below, plus a description of what alternatives were considered and rationale for the decision:

3.13.4.2.1 All procedures and ordnance circuit schematics relating to electrical testing of ordnance.

3.13.4.2.2 Precautions to prevent injury to personnel or damage to equipment assuming device is initiated during test.

3.13.4.2.3 A description of the location and configuration of the test.

3.13.4.2.4 A description of worst case event as a result of initiation of each device being tested.

3.13.4.3 All test equipment used to check out and test ordnance items and ordnance circuits (category A) must be approved by 30 SPW/SE prior to use on the WR. The SAR must clearly identify such equipment and also contain evidence of the 30 SPW/SE approval. Normally, ordnance test equipment is approved for a specific use on a specific system. Approval on one system does not constitute automatic approval on another system.

* 3.13.4.4 Hazardous energy is defined as that greater than one-tenth of the no-fire energy for the specific ordnance item being tested. Energy shall not be applied to Category A ordnance devices without prior approval by 30 SPW/SES. This requirement applies specifically to ordnance test equipment, AGE, and AVE as potential sources of hazardous energy. (See 3.13.10 for Laser Systems.)

3.13.4.5 All instruments intended for resistance measurement of electro-explosive devices (EEDs) shall be designed such that they will not pass a hazardous current across an EED bridgewire. (3.13.4.4)

3.13.4.6 Clear cases of unacceptable energy or current for a particular resistance range or ranges shall be excluded from use by disablement by the manufacturer or local authority before certification.

3.13.4.7 Proposed meters shall be analyzed to verify that rough handling, dropping or single component failure will not result in negating the current limiting feature.

3.13.4.8 Certification of each meter shall include a tabular listing, to be kept with or marked on each meter, of the energy level and current levels available at each of the selectable ranges for the meter.

3.13.4.9 Procedures shall ensure only designated meters with appropriate approvals are used.

3.13.4.10 The following information shall be provided to 30 SPW/SES in the SAR and at least 60 days prior to use by the requesting user in order for 30 SPW/SES to evaluate requests for approval of use of the test equipment.

3.13.4.10.1 A statement of intended use including configuration (illustrative) information and the max safe no-fire amperage of the ordnance being tested shall be provided.

3.13.4.10.2 A declaration of any certifications currently in effect for the instrument along with the manufacturer's specifications including:
(a) range, (b) accuracy, (c) power supply and recharge capability,
(d) self-test features, and (e) schematics.

3.13.4.10.3 The written results of failure analysis including the outcome of energy analysis (open circuit or maximum terminal voltage) and current-limit analysis (short-circuit or maximum output current).

3.13.4.10.4 The instrument description including any modifications required for operational use and details of safety design features (e.g., interlocks) shall be provided.

3.13.4.10.5 A copy of the User's safety assessment certifying the meter can be used safely for its intended purpose including a statement as to where the safety certification appears in the program safety documentation.

3.13.4.10.6 The proposed procedures for use at the intended location.

* 3.13.5 The User will submit complete ordnance data in the SAR to include part number, manufacturer, type of device and use, DOD hazard classification, net explosive weight, WR Category (A or B), bridgewire resistance, minimum and no-fire current, temperature and humidity requirements, and other special data.

3.13.6 EMI testing will not be conducted with WR Category A EEDs installed on the vehicle or payload without written approval by 30 SPW/SE.

3.13.7 The WR User is responsible for making no-voltage or stray voltage checks on circuitry connecting to category A ordnance prior to the connection or prior to test equipment and support equipment connections to such circuits. A no-voltage check, for example, would be made when mating two missile stages and one of the stages contains an AVE battery or other voltage source. The test would be made looking for no voltage toward the voltage source prior to making the final connection. A stray voltage check, for example, would be made prior to connecting ground test equipment to a single stage for electrical testing. Stray voltage tests should be made with equipment in a POWER ON condition and then in a POWER OFF condition. This sequence is to assure there are no sneak circuits or induced RF/EMI in the cable or equipment which may allow leakage voltage to exist on the ordnance circuits. In instances where some voltage is permitted, it must be specified in the test procedure and approved by 30 SPW/SE. These tests are not necessary in category B ordnance circuits and may not be required on category A circuits depending upon the number of verifiable inhibits in place and the lack of credible voltage source at the time of final cable connection. It is the responsibility of the User to obtain a deviation from 30 SPW/SE when such tests are not accomplished on category A circuits.

3.13.8 The range User is responsible for ensuring that the render safe procedures and normal safing procedures are available for their systems. (See paragraph 3.1.7.)

3.13.8.1 Render safe procedures must be available prior to arrival of the range user's first live ordnance at WR. Normal safing procedures must be available to support launch countdown operations (i.e. hangfire, misfire, no fire).

3.13.8.2 Normal safing, as used in this regulation, applies to the act of returning ordnance systems to a safe configuration. It differs from render safe functions in that ordnance system status or control is not lost. For example: A missile hangfire, misfire or no fire where ordnance systems can remotely be returned to a safe condition and system status is not lost, will be accomplished with a normal safing procedure. A hangfire, misfire or no fire with loss of ordnance status or loss of ordnance system control where safety of the safing crew cannot be guaranteed, will normally be considered a render safe function for returning the system to a safe condition. Render safe procedures performed by EOD or contractor support personnel would be used for that situation. The User must clearly identify in the SAR submittal, specific tasks his support contractors will or will not perform during render safe operations. 30 SPW/SE recognizes that written procedures cannot be prepared in advance to address all possible variations of render safe tasks. However, the User must consider as many render safing tasks as feasible and must have a normal safing procedure to recover from a missile hangfire, misfire or no fire situation.

3.13.8.3 All render safe and normal safing tasks will be considered hazardous until ordnance systems are returned to a known safe condition. 30 SPW/SES will approve all render safe and normal safing procedures prior to use.

3.13.8.4 Render safe procedures and adequate EOD or contractor support personnel training with those procedures are mandatory prior to issuing MSGSA by 30 SPW/SES. The range user must plan, program and fund for render safe procedure preparation as well as EOD or contractor support personnel training for render safe operations as may be required by EOD.

3.13.9 Operations involving Category A ordnance will not be conducted in relative humidities below 35% without specific approval from 30 SPW/SE. If the User requires an ordnance task be conducted in a lower humidity, he will perform a safety assessment (with justification) in support of a request for approval. The assessment must consider static generation, static dissipation, system/item susceptibility and worst case event (see also paragraph 3.13.3.8).

* 3.13.10 Laser Initiated Ordnance (LIO) Firing Systems

3.13.10.1 Laser initiated ordnance and ordnance circuitry shall be tested to determine the susceptibility to all energy sources present during prelaunch processing and the flight environment. The no-fire/all-fire sensitivity characteristics of the Laser Initiated Device (LID) to these energy sources will be established by test in terms of energy density and frequency. The no-fire and all fire tests must function a minimum number of laser initiators in a Bruceton type test in accordance with MIL-STD-1576. Firing probability for laser initiated ordnance when subjected to the no-fire energy shall be less than .001 at 95% confidence level. The test results shall be provided to 30 SPW Safety in the SAR.

3.13.10.2 Prelaunch processing; which includes installation, power on, and test; shall not expose laser initiated ordnance and control circuits to energy density levels greater than four orders of magnitude below no-fire of the ordnance initiator and 20 dB below the activation level of control circuits. This energy constraint is to be applied at the end of the fiber optic cable just prior to entering the laser ordnance initiator/reflective coating and to the input of the control circuit. To eliminate the time element as a failure mode consideration, all laser ordnance initiator/detonators must dissipate heat faster than failure conditions can input into the device. This does not include full laser firing energy output. LIDs shall not use primary explosives. If modified secondary (composition) explosives are used, their sensitivity characteristics must be established by test (e.g., MIL-STD-1751, ADA 086259, etc.). The test requirements and test report must be reviewed and approved by Safety.

3.13.10.3 Power on (either ground or airborne) operations for laser initiated ordnance systems will be conducted with either the firing circuit verified disconnected or will have an appropriate number of inhibits in place depending upon personnel/property exposure. Disconnection can include an electrical cable separation of the circuit on the laser input side, a physical separation of the fiber optic cable, or a removal of the live ordnance from the firing circuit. Examples are; removal of the power input cable to the laser, removal of the fiber optic cable from the laser output, or disconnection of the fiber optic cable from the laser initiator/detonator.

3.13.10.4 If a full laser firing test is to be performed with the firing circuit connected, the personnel exposure inhibit criteria of paragraph 3.13.3.2.3 must be met. System design must encompass safeguards to insure the test cannot be performed unless the correct number of inhibits are in place. (Paragraph 3.13.10.7.) Positive verification is required utilizing an active monitor system that will disallow the test to start without the inhibits in place.

3.13.10.5 If a low energy level continuity test is to be performed with the firing circuit connected, inadvertent firing of the ordnance must be shown to be a non-credible hazard. Meeting the four orders of magnitude requirement alone is not sufficient. Additional safety features such as limiting the low power level laser output, diachroic (reflective) coatings, output frequency management, and other type items could lead to the non-credible hazard conclusion. Normal inhibit requirements apply to the high energy laser during this test.

3.13.10.6 The range user must identify inhibits which will be used during specific prelaunch power on/test conditions to meet the personnel exposure requirements of paragraph 3.13.3.2.3.

3.13.10.7 WR Safety will review and consider for approval those inhibits identified above. There is no range safety requirement for using a particular type of an inhibit in a laser ordnance firing system. Examples of possible inhibits are shutters, sequencing devices, arm/disarm switches, optical switches, field effect transistors, relays, and other similar devices. Some inhibits are considered by WR Safety to be better than others. For example, electro-mechanical shutters and/or relays, and arm/disarm switches are considered to be more positive than the other mentioned inhibits. The method of prelaunch testing, personnel exposure and the overall laser firing system design will greatly influence the type of inhibits approved for use. In no case will a system utilizing all solid state devices for inhibits be approved for use at WR.

3.13.10.8 All test equipment which has the capability to apply energy to the laser ordnance firing circuit must be assessed in the SAR and approved by WR safety.

3.13.10.9 Proper laser ordnance system design may negate the need for an ordnance simulator and allow the user to conduct all prelaunch testing with ordnance connected in a green light (personnel present) condition. This statement is made from a personnel safety view point. Laser ordnance firing systems designed for flight termination system use must also meet the requirements of Chapter Four of WRR 127-1.

3.14 Electrical and Electronic Systems:

3.14.1 Electrical and electronic systems should meet design requirements of AFSC DH 1-6, section 4E.

3.14.1.1 Elements of safety-critical redundant systems may not pass through the same connector used by elements of the primary system.

3.14.1.2 System design should limit the use of connectors to applications that require frequent disconnection, such as for rapid component replacement. Hardline wiring is the preferred means of connection.

3.14.1.3 Aerospace Vehicle Equipment (AVE) shall be designed to preclude accidental ignition of exposed solid propellants and potential hazardous atmospheres from liquid fueled missiles.

3.14.2 Electrical, electronic equipment and wiring located in hazardous classified locations shall be certified to 30 SPW/SE showing compliance with the requirements of the NEC, Article 500 and NFPA 70 and be "explosion or hazard proofed." Consideration shall be given to the hazard location Class and Division, and determine which of the following methods best suits safety and design requirements.

3.14.2.1 Explosion proof equipment is designed of sufficient strength to withstand the maximum pressure that can be generated by an internal explosion in order to prevent rupture and the release of burning or hot gasses.

3.14.2.2 NFPA 496 provides information for the design of purged and pressurized enclosures to eliminate or reduce a Class I hazardous location classification within the enclosure.

3.14.2.3 Purged and pressurized Control Rooms, Power Equipment Enclosures and similar rooms or buildings each have specific hazard proofing requirements and can be tailored to specific needs provided the requirements of NFPA 496 are met.

3.14.2.4 The use of manual kill switches, interlocks or automatic shutdown devices in lieu of hazard proofing shall be in accordance with NFPA 496 and coordinated with 30 SPW/SE.

3.14.2.5 Intrinsically safe equipment and associated wiring which have been approved shall be permitted in any hazardous location for which it has been approved. The provisions of Article 500 through 517 need not be considered applicable to such installations. Locations where intrinsically safe equipment are to be installed shall be identified and documented in the SAR. Intrinsically safe equipment which is not "labeled, identified, or listed" requires a national testing laboratory approval statement and shall accompany all requests for intrinsically safe equipment use. Testing shall be in accordance with NFC 493.

3.14.2.6 The hazardous area for liquid fueled missiles is considered to be within 100 feet of the missile.

3.14.2.7 The hazardous area for exposed solid propellant is considered to be within 10 feed of the propellant and shall meet the hazardous atmosphere requirements of the NEC for Class 1, Division 2, Group D, as a minimum.

3.14.3 Electrical connectors in potentially hazardous systems must be keyed, sized, or configured so it is physically impossible to interconnect incompatible systems. Where cross-connection has no impact on system operation or performance, connectors may be identical. However, a statement to this effect is required as part of the SAR data submittal.

3.14.4 Electronic design of all GSE will incorporate a main power switch located on the equipment. If fault isolation switches are incorporated in the design, they must not bypass the main power switch.

3.14.4.1 The equipment must be constructed and designed so external parts, surfaces, and shield are at GSE ground potential at all times.

3.14.4.2 Power switches must be located and guarded so accidental contact by personnel does not place equipment in operation. Critical switches that can produce or induce hazardous conditions if inadvertently activated must have a protective cover over them.

3.14.4.3 Electrical fuse and switch boxes must be stenciled on the outside to show the voltage present and the functions controlled by the circuits.

3.14.5 Batteries must be capable of easy disconnection and removal.

3.14.5.1 Polarity of terminals must be marked.

3.14.5.2 Connections must be designed to prevent reverse polarity.

3.14.5.3 Sufficient ventilation must be provided whenever out gassing could create a hazard.

3.14.5.4 Battery charging current must be limited by design. It must be impossible to initiate or sustain a runaway failure of a battery because of the charging current.

* 3.14.5.5 Batteries will be sealed and must have pressure relief valves or blowout plugs unless the battery is designed to a safety factor of at least 2:1 based on worst case internal pressure.

3.14.5.6 Cell and case retention must be provided to the maximum extent possible to minimize the hazard of battery rupture. Proper ventilation as described in 3.14.5.5 above must still be maintained.

3.14.5.7 Lithium batteries must be stored in a cool, well-vented area remote from all other batteries.

3.14.5.8 Lithium batteries require special safe handling procedures for all operations to include storage through disposal.

3.14.6 Mechanical or electromechanical devices used for structure deployment or actuating release mechanisms are evaluated to establish if damage to equipment or injury to personnel could occur in the event of inadvertent initiation. If it is determined that damage to equipment or personnel injury could result, the device, or devices, must be controlled in a manner similar to category A ordnance devices. At least two independent actions must be taken in a serial sequence prior to activation of the device.

3.14.7 Grounding, bonding, and shielding requirements are:

3.14.7.1 Missile ordnance items and related handling equipment must remain grounded during receipt to launch processing tasks. This is particularly true of missile stages with EEDs installed and especially true during stage lifting operations with cranes. Many different methods of grounding exist and the particular method chosen is left to the discretion of the User. The main guideline to be followed is that the ordnance item and anything conductive which interfaces with it must be kept at the same voltage potential. The WR recognizes that ordnance cannot be kept grounded at all times, for example, during transportation, but the User must describe his grounding methods and exceptions, with analysis, in the ordnance section of the SAR.

3.14.7.2 Users who design, build, or modify intrinsically safe apparatus for use in class I, II, and III, division I hazardous locations must submit all test results required by Article 504 of NFPA of 70 to 30 SPW/SE.

3.14.7.3 The discharge time for high voltage circuits and capacitors accessible to personnel must comply with MIL-STD-454.

*** 3.15 Computing Systems and Software:**

3.15.1 All computing systems and software used to control or monitor safety critical ground or flight sequences, functions, or processes shall be designed according to Attachment 5, Safety Design Requirements and Guidelines for Safety Critical Computing Systems. These requirements can and will be tailored by 30 SPW/SE in conjunction with the managing agency (MA). Approved software safety requirements and guidelines are not intended to be used solely as a checklist, but as an augmentation to tasks performed in accordance with contractual documents such as MIL-STD-882C, MIL-STD-1472 and DOD-STD-2167 as tailored by the MA.

3.15.2 The User shall provide the following information to 30 SPW/SE:

3.15.2.1 Hardware description including layout of operator console and displays.

3.15.2.2 Flow charts or diagrams showing hardware, data busses, hardware or software interfaces, data flow, power systems, and any redundancy.

3.15.2.3 Logic flow charts.

3.15.2.4 Operator user manuals and documentation.

3.15.2.5 List and description of all Safety Critical Computing System Functions (SCCSFs) including interfaces.

3.15.2.6 Software hazard analyses.

3.15.2.7 Configuration management plan and procedures.

3.15.2.8 Software test plan, test procedures, and test results.