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Chapter 9.5 Explosives and Propellant Safety

This could be you . . .

An employee received minor injuries when a NASA standard initiator without a Faraday cap installed ignited from being exposed to Radio Frequency radiation.

A small amount of propellant ignited when someone scraped it with a “non-sparking tool.” No one was hurt, but the employee was very surprised.

A T-38 ejection seat inadvertently fired while the plane was undergoing inspection. Flight operations were halted pending result of the mishap investigation.

9.5.1 Applicability of this chapter

You are required to follow this chapter if you use, test, handle, store, receive, transport, or dispose of explosives, solid propellants, or systems containing explosives or solid propellants, pyrotechnic devices, or electro explosive devices (EEDs) at JSC or a JSC field site.

9.5.2 Purpose of this chapter

This chapter establishes roles, responsibilities and procedures defining the Explosives, Propellants and Pyrotechnics (EP&P) Safety Program at JSC and JSC field sites.

9.5.3 General requirements

9.5.3.1 All EP&P operations at JSC and JSC Field Sites shall comply with NPR 8715.1, Ch. 6 and NASA-STD-8719.12, latest revisions.

9.5.3.2 This chapter does not address all sections and requirements in NASA-STD-8719.12. It is intended to address requirements that would benefit from using JSC terminology and clarity on planned compliance. In all instances, NASA-STD-8719.12 takes precedence and should be referred to for compliance.

9.5.4 Compliance audits

9.5.4.1 The following requirements apply to compliance audits:

- a. The Explosive Safety Officer (ESO) shall perform audits to verify compliance with the requirements of this chapter and NASA-STD-8719.12.
- b. Compliance Audits shall occur at least every two years or more often if the ESO deems it necessary.
- c. The JSC facilities below shall be audited using checklists developed for each facility:
 - (1) Energy Systems Test Area (ESTA)
 - (2) Ellington Field (EFD)
 - (3) Experimental Impact Laboratory (EIL), Building 31
 - (4) White Sands Test Facility (WSTF)

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- (5) Forward Operating Location, El Paso, TX (FOL)
- (6) Temporary facilities such as the CEV Parachute Assembly System (CPAS) hangar, Yuma, AZ
- d. The ESO shall produce a report of the audit findings that contains:
 - (1) Scope of the audit.
 - (2) A list of the participants.
 - (3) The date(s) audit was conducted.
 - (4) The location of the audit.
 - (5) A description of the findings.
- e. The ESO shall send the audit report to the Head of the Responsible Organization.
- f. Organizations being audited shall document that the deficiencies have been corrected.
- g. The ESO shall verify the corrective actions have been properly implemented and retain copies of the two most recent audit reports.

9.5.5 Operational Explosives Limits – Cardinal Explosives Rule

9.5.5.1 Organizations conducting EP&P operations shall:

- a. Conduct operations in a manner that exposes the minimum number of people to the minimum quantity of explosives for the minimum amount of time.
- b. Limit the quantity of explosives at an operating location to the minimum necessary to carry out an operation in a safe and efficient manner. The operating organization shall determine the operational explosives limits, which shall not exceed permitted quantities.
- c. Limit the number of personnel at the operating location to the minimum required (2 or more) consistent with a safe and efficient operation.
- d. Use the buddy system, with one person in the pair stationed nearby, not directly exposed to the hazard.
- e. Never perform unrelated tasks formed concurrently during explosives operations.
- f. Develop procedures to minimize the amount of time that personnel are exposed to the explosive hazards.

9.5.6 Hazardous Operations Requirements

9.5.6.1 All EP&P operations shall comply with Hazardous Operations requirements in Chapter 5.8, “Hazardous Operations: Safety Practices and Certification” and Chapter 6.8, “Space Systems and Test Safety”. The following shall be completed and fully concurred with before beginning EP&P operations:

- a. Test Readiness Reviews or User Readiness Reviews supported and concurred with by the ESO or a Test Safety Officer (TSO).
- b. Hazard Analysis reviewed and concurred with by the ESO or a TSO.

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- c. Procedures listing tasks in a logical order without introducing new hazards reviewed and concurred with by the ESO or a qualified TSO. Procedures shall comply with the provisions of NASA-STD-8719.12 Section 4.16, Preparing and Controlling Procedures for Explosives Operations, and Section 4.17, Explosives Operating Procedures.
- d. Technical Orders approved by the Department of Defense used at EFD and El Paso FOL.

9.5.7 Identifying Live and Inert Hardware

9.5.7.1 The following requirements apply to identifying live and inert hardware:

- a. Color coding pyrotechnic hardware at ESTA shall be per ESTA-OP-2-014, "Operating Procedure for Pyrotechnics Management Building 352".
- b. Color coding of pyrotechnic hardware at EFD and El Paso FOL shall be blue for inert and all others will be assumed to be live.
- c. Color coding of pyrotechnic hardware at off-site locations such as CPAS Yuma operations shall be per the respective programs color coding scheme and shall be documented in local work procedures.
- d. When components are transferred from one program to another, necessary changes in color coding shall be coordinated prior to transfer.

9.5.8 Licensing Explosive Facility Locations

9.5.8.1 To license an explosive facility location, an organization shall:

- a. Complete a NASA Form 1791 or equivalent for each licensed location, signed by the requesting organization and submitted for approval by protective services, and local fire authority before being approved by the ESO. When approved, the license is valid for one year.
- b. Prominently display a copy of signed NASA Form 1791 on the licensed magazine and retain the license for two years.

9.5.9 Safely storing explosives, propellants, or pyrotechnic systems

9.5.9.1 Approval from the ESO is required for facilities used to store explosives.

9.5.9.2 Organizations storing explosives, propellants, or pyrotechnic systems shall:

- a. Remove all loose packing materials, skids, dunnage, empty boxes, and other combustible materials from magazines.
- b. Mow and clean a 50-foot or larger fire break around magazines.
- c. Never use or store flammable materials in magazines.
- d. Never allow flame-, or spark-producing devices in magazines.
- e. Never smoke within 50 feet of a magazine.
- f. Never use magnesium flashlights, X-ray equipment, photographic flashbulbs, or strobe lights with 10 feet of a magazine without written permission from the ESO.
- g. Use only "non-sparking" tools around explosives, propellants, or pyrotechnics.

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- h. Keep magazine doors in good working condition.
- i. Keep magazine doors locked at all times, except when working in the magazine.
- j. Have a minimum of two fire extinguishers in good working condition, suitable for the hazards involved, outside the magazine.
- k. Use the compatibility group listing contained in NASA-STD-8719.12 section 5.29, Mixed Storage, to determine explosives compatibility.
- l. Post signs stating, "Explosives," "No Smoking," along with the appropriate fire symbol.
- m. Keep up-to-date inventories of all explosives, propellants, and devices stored in the magazine as required in 9.5.12.
- n. Post fire symbols as required by NASA-STD-8719.12, paragraph 5.3.
- o. Provide static grounding systems per NASA-STD-8719.12, paragraph 5.6
- p. Provide lighting protection per NASA-STD-8719.12, paragraph 5.7
- q. Verify all grounding and lighting systems by performing a visual inspection every six months and electrical testing annually. Retain records for at least three years.
- r. Maintain magazine entry logs in all storage magazines.

9.5.10 Handling Unserviceable Pyrotechnics

9.5.10.1 Organizations with unserviceable pyrotechnics shall:

- a. Store unserviceable pyrotechnics separately from serviceable stocks.
- b. Mark or tag all damaged pyrotechnic devices and put them in separate, properly marked containers and do not return to store in magazines with good product.
- c. Ship unserviceable devices back to the original supplier or to an authorized disposal facility, when the owning organization deems them unusable. The owning organization is responsible for verifying the disposal facility has the necessary permits required by local, state, and federal regulations.

9.5.10.2 When deemed safe to do so by the ESO:

- a. Damaged pyrotechnics devices may be "safed" by firing in place.
- b. Unserviceable propellants, or pyrotechnic devices may be initiated on-site for purposes such as engineering tests, autoignition tests, checkout test firings, extended age life testing, or training.

9.5.11 Transporting explosives, propellants, or pyrotechnics

9.5.11.1 The following requirements apply to transporting explosives, propellants, or pyrotechnics:

- a. All motor vehicle shipments shall comply with Department of Transportation (DOT), State, and municipal regulations.
- b. Propellants and pyrotechnic devices shall only be transported in vehicles approved for transporting explosives per NASA-STD-8719.12 Paragraph 5.33.4.

Verify correct version before use at [Center Directives Management System](#).

JSC Form JF2420B (Revised April 3, 2012) (MS Word August 28, 2006)

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- c. Placarding on vehicles transporting explosives shall follow DOT regulations.
- d. Before loading any motor vehicle designated for movement over public highways with explosives or ammunition (DOT Class 1, all Divisions), the vehicle operator shall inspect the vehicle using DD Form 626 or equivalent. The operator shall maintain the records for a minimum of one year.
- e. Personally owned vehicles shall not be used to transport explosives, pyrotechnic devices, or propellants.
- f. Do not transport explosives, pyrotechnic devices, or propellants in the cab of the vehicle.

9.5.12 Explosives, propellants, and pyrotechnic systems inventory

9.5.12.1 The explosives owner is ultimately responsible for the control and custody of explosives and shall maintain strict accountability.

9.5.12.2 Each facility shall maintain an ongoing accountability of all explosives, propellants, and pyrotechnic devices through the use of an inventory, tagging, and document management system. The information retained shall include, as a minimum:

- a. Name.
 - b. Part number.
 - c. Lot number (if applicable).
 - d. Serial number (if applicable).
 - e. Unit explosive weight.
 - f. Quantity.
 - g. Total explosive limit.
 - h. Hazardous classification.
 - i. Compatibility designation.
 - j. Manufacturer.
 - k. Manufacturing date.
 - l. Date explosives, propellants, or pyrotechnic materials or devices were placed in the facility.
 - m. Date explosives, propellants, or pyrotechnic materials or devices were removed from the facility.
 - n. Signature(s) of person(s) placing or removing materials or devices from the facility.
- 9.5.12.3 Facilities shall report their inventory of stored explosives material to the ESO at least annually. At a minimum the explosives inventory report will include description, quantity, location, net explosives weight, hazard division classification, lot number and or serial number.

9.5.13 Shipping and Receiving for EP&P

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9.5.13.1 All pickup, issuance, and transportation of EP&P onsite JSC shall be conducted by The Energy Systems Test Branch of the Propulsion and Power Division (EP6) per ESTA-OP-2-014, Section 3.1, Receiving Explosives and Section 3.2 Shipping Explosives.

9.5.13.2 Sealed inbound or outbound packages Class Division 1.4 may be stored temporarily in the building 420 Logistics Magazine waiting for shipment or ESTA EP6 pickup.

9.5.13.3 Class 1.1, 1.2 or 1.3 inbound or outbound packages must be delivered to or picked up directly from Building 352 via fire department or JSC security escort.

9.5.14 Safely handling explosives, propellants, or pyrotechnics

9.5.14.1 Personnel selected to handle explosives shall be thoroughly familiar with the items being handled and with the safety precautions to be observed. To safely handle EP&P, these personnell shall:

- a. Only handle explosives under the direct supervision of an experienced, trained and competent individual who understands the hazards and risks involved.
- b. Never throw explosives about or handle them in any manner which will damage them or cause their unintended activation.
- c. Never carry small explosives in pockets, toolboxes, lunch boxes, or similar unprotected places.
- d. Never subject explosives to open flame, prolonged direct sunlight, or heating and electrical equipment.
- e. Shield or short together wire leads for EEDs.
- f. Make sure wire leads are not twisted into loops, dipole antennas, or other types of antennas.
- g. Control electrostatic discharge (ESD) by complying with NASA-STD-8719.12, Ch. 5.9.
- h. Never use or allow radios, cellular telephones, or other transmitting equipment around EEDs.
- i. Use only continuity testers and firing units specifically designed for use with EEDs.
- j. Never rub or polish EEDs.
- k. Install explosive devices as late in the test schedule as possible, as determined by design and operational limitations.
- l. Never tap explosive devices or force them into place.
- m. Never allow smoking, welding, cutting, heating, or repair work that generates heat, sparks, or RF energy within 50 feet of explosives.
- n. Establish area access controll before installing explosive items to restrict unnecessary personnel from the work area while explosive components are being installed.
- o. Disconnect installed explosive items and install shorting devices before soldering is performed on electrical circuits.
- p. Use the "Personnel Limit – Operator" minimum two-person rule for all explosives operations.
- q. Never leave explosive items unattended during testing, installation, and connection operations.
- r. Keep EED's in their containers until immediately before they are to be installed.

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- s. If required by the operation, make a stray voltage check (meeting project voltage tolerance) of the circuit into which the device is to be connected, immediately before electrical connection of EED's.
- t. Upon notification of an approaching electrical storm within 10 miles, begin shutdown of explosives operations and evacuation of the explosives areas. Evacuate personnel to a suitable area that will provide protection.
- u. Use test chambers ("Closed Bombs") for electrical testing or lot-sample firings of EEDs. Chambers shall:
 - (1) Be adequately secured and of sufficient strength to prevent rupture due to gas expansion during testing or firing.
 - (2) Be designed, tested and safely operated per Attachment 9.5A, Appendix F.

9.5.15 Training and certification to work with explosives, propellants, or systems

9.5.15.1 JSC's explosive safety program has three categories of certifications: Explosives Handlers, Limited Pyrotechnic Certification and Pyrotechnics Officer.

9.5.15.2 Explosives Handlers shall be trained and certified per the requirements of this chapter and Chapter 5.8, "Hazardous Operations: Safe Practices and Certification." Explosives Handler certifications are good for three years. To be certified, Explosives Handlers shall:

- a. Successfully complete the instructor led NASA Basic Explosives Safety Course JSC-SLC-NBES-082. Following completion of the initial instructor led class, the online SATERN Course SMA-HQ-WBT-221, "Basic Explosives Safety Refresher" may be taken every other 3 year certification period.
- b. Complete a minimum of six months of documented on-the-job-training under the supervision of a certified Explosives Handler.
- c. Successfully complete additional training as specified by the individual's supervisor. Recommended training courses include:
 - (1) ESD, Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC) training.
 - (2) Chemistry of Explosives.
 - (3) Hands on Explosives and Lab Safety course.
- d. Successfully complete and pass the ordnance physical per NPR 1800.1, "NASA Occupational Health Program Procedures," Appendix C, "Physical Examination Matrix," Section 3, "Certification Examination," Item L, "Ordnance Handler," every two years.

9.5.15.3 The ESO has discretion to grant Limited Pyrotechnic Certification for pyrotechnic operations for a specific test or test sequence. Limited Pyrotechnic Certification is primarily used to grant certification for an off-site contractor to perform work on NASA owned or managed property or to extend an Explosives Handlers certification, necessary to complete a series of critical tests. To be certified, employees shall:

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- a. Successfully complete the Basic Explosives Handler's Course or equivalent training provided by the off-site contractor's organization and concurred with by the ESO.
- b. Successfully complete training for the specific operation.
- c. Be certified by letter signed by the immediate supervisor and stating the following:
 - (1) Name of the person being certified.
 - (2) Name of the hardware being handled by serial number.
 - (3) List of training that supports Limited Pyrotechnic Certification.
 - (4) Project being supported.
 - (5) The date on which the certification begins.
 - (6) The duration of the certification, not to exceed one year.

9.5.15.4 Mandatory training for a JSC Pyrotechnics Safety Officer includes the following:

- a. NASA Basic Explosives Safety Course.
- b. Familiarization with NASA-STD-8719.12 and this chapter.
- c. Review of project specific job hazard analysis.
- d. Review of project specific explosives handling procedures.
- e. Minimum 40 hours of continuing education every 2 years. Recommended courses include:
 - (1) ESD, EMI and EMC training.
 - (2) Chemistry of Explosives.
 - (3) Hands on Explosives and Lab Safety course.

9.5.16 For more information on working with explosives, propellants, and systems

- a. 49 CFR 177.848, "Segregation of hazardous materials"
- b. NPR 1800.1, "NASA Occupational Health Program Procedures"
- c. NPR 8715.1, "NASA Safety and Health Program"
- d. NASA-STD-8719.12, "Safety Standard for Explosives , Propellants and Pyrotechnics"
- e. JPD 4500.1, "Pyrotechnics – Logistic Management"

9.5.17 Roles and responsibilities for explosives safety:

- a. The *Center Director* shall appoint in writing, a qualified person as the ESO who is the Institutional Safety Discipline Lead for explosives, propellants, and pyrotechnic operations.
- b. The *JSC ESO* has jurisdiction for explosives safety at all JSC facilities and field sites and is responsible for:
 - (1) Fulfilling the responsibilities in paragraph 6.2 of NPR 8715.1 and paragraph 4.12 of NASA-STD-8719.12.

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- (2) Maintaining a current master list of all licensed explosive operating locations and explosive storage sites and their locations, fire symbols, and available empty storage sites(see paragraphs 9.5.17.j). This list shall be made available to the local (i.e. responsible) fire and security offices to ensure the information is dispatched to the first responders.
- (3) Approving Pyrotechnics Safety Officers.
- c. The *Manager, WSTF*, is responsible for designating, in writing, as required in WM-SAF-0002:
 - (1) WSTF ESO.
 - (2) WSTF Pyrotechnics Officer.
 - (3) Assistant WSTF Pyrotechnic Officer
- d. The *WSTF ESO* is responsible for the day-to-day explosives safety activities at WSTF as required in WM-SAF-0002.
- e. JSC Pyrotechnics Safety Officers are responsible for:
 - (1) Ensuring compliance with NASA-STD-8719.12, this chapter, and other applicable regulations at their respective remote locations.
 - (2) Coordinating closely with the ESO for all matters pertaining to Explosive Safety.
- f. The *Safety and Test Operations Division* is responsible for:
 - (1) Supporting ESO Compliance Audits, when requested.
 - (2) Reviewing readiness of new or modified energetic test facilities as required in Chapter 10.3.
 - (3) Reviewing readiness of energetic test operations as required in Chapter 6.8.
 - (4) Reviewing Facility Safety Management Process documentation of energetic test facilities as required in Chapter 10.4.
- g. The *supervisor* of an explosives handler has the authority to revoke an individual's explosives handler certification and is responsible for:
 - (1) Providing classroom and on-the-job training as required per paragraph 9.5.15.2.
 - (2) Verifying that the explosives handlers are qualified and able to safely perform the work and have met all the classroom and on-the-job training requirements.
 - (3) Ensuring the explosives handler meets the medical examination requirements of NPR 1800.1, "NASA Occupational Health Program Procedures," Appendix C, "Physical Examination Matrix," Section 3, "Certification Examinations," Item L, "Ordnance Handler."
 - (4) Maintaining the records for each explosives handler that includes:
 - Description and date training was received
 - Description and date certification was received
 - Date of medical examination completion
- h. Explosive Handlers are responsible for:
 - (1) Completing certified Explosives Handler Training.

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(2) Adhering to all standard safety practices to include bonding, grounding, and ESD precautions.

(3) Properly handling, securing and storing EP&P per all approved procedures.

- i. The Energy Systems Test Branch of the Propulsion and Power Division (EP6) shall be responsible for Pickup, issuance, transportation, controlled storage and end of life management of all EP&P on-site at JSC per the requirements of JPD 4500.1, "Pyrotechnics-Logistics Management".
- j. The *Security Office* is responsible for maintaining a current copy of JPD 4500.1 Pyrotechnics – Logistic Management (the master list of storage sites at JSC and Ellington Field).