

JSC Safety and Health Handbook	JPR No.	1700.1K
	Effective Date:	11/25/2013
	Expiration Date:	11/25/2018
	Page Number	Page 9.5-1 of 10

Chapter 9.5 Explosive and Propellant Safety

This could be you . . .

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

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 propellant production facility was heavily damaged when spilled propellant ignited. The cost of this accident was in excess of \$10 million.

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 at JSC or a JSC field site.

9.5.2 Definition of an explosive, solid-propellant, system that contains an explosive or solid propellant, or of an electro-explosive device

9.5.2.1 The following defines an explosive, solid propellant, system that contains an explosive or solid propellant, pyrotechnic device, or electro-explosive device (EED):

- a. An explosive is a material that undergoes rapid chemical change and generates large amounts of hot, high-pressure gases when exposed to heat, impact, friction, detonation, or other means of ignition.
- b. A solid propellant is an explosive mixture that propels rockets or missiles, or generates gases for powering auxiliary devices or systems. Solid propellant and propellant, as used in this chapter, mean the same thing.
- c. A system that contains explosives or propellants is any system, subsystem, component, or device that functions by igniting an explosive or a propellant inside the system, subsystem, or component. A device that functions by igniting an explosive or a propellant inside the system, subsystem, or component is also known as a pyrotechnic device. “System” is used instead of “system that contains an explosive or propellant” in this chapter.
- d. An EED is a system that contains explosives or propellants, and that is fired by passing an electrical current through a bridgewire embedded in the explosive or propellant.

9.5.3 General operating requirements

9.5.3.1 You shall follow the requirements below when working with explosives, propellants, or pyrotechnic devices or systems containing explosives at JSC:

- a. Follow NASA STD 8719.12, “Safety Standard for Explosives, Propellants, and Pyrotechnics” and paragraph 3.11 of NPR 8715.3.

JSC Safety and Health Handbook	JPR No.	1700.1K
	Effective Date:	11/25/2013
	Expiration Date:	11/25/2018
	Page Number	Page 9.5-2 of 10

- b. Don't handle explosives in a manner that could cause damage.
- c. Don't carry explosives in pockets, toolboxes, lunch boxes, or other unprotected places.
- d. Don't expose explosives to open flame, direct sunlight for long periods of time, or heating and electrical equipment.
- e. Don't use nails through packing materials or containers of explosives.
- f. Keep the safe distances required by subparagraph 9.5.7.1.c.
- g. Have a Hazardous Operations Permit as described in Chapter 5.8, "Hazardous Operations: Safety Practices and Certification," of this Handbook. Exceptions to the permit requirements are as follows:
 - (1) Test Readiness Reviews, Test Procedures, or Technical Orders reviewed and approved by the Explosive Safety Officer (ESO) or ESO designee (such as a qualified Test Safety Officer) at the locations listed in 9.5.5.c, where pyrotechnic operations are performed routinely.
 - (2) Test Readiness Reviews or User Readiness Reviews signed by the ESO or ESO designee for pyrotechnic operations performed at locations outside of those locations listed in 9.5.5.c. The ESO or ESO designee (such as a qualified Test Safety Officer) shall provide guidance for, review, and approve the safety measures put in place to mitigate the safety risks of the pyrotechnics operation.
- h. Prepare detailed operating procedures listing tasks in a logical order that doesn't introduce new hazards.
- i. Prepare a hazard analysis before working with explosives, propellants, or pyrotechnic systems.
- j. Have a Safety and Test Operations Division representative review and sign off on the detailed test procedures and hazard analysis.
- k. Prohibit smoking, open flames, or heat-producing operations around explosive, propellant, or pyrotechnic systems.
- l. Make sure that test chambers are designed and built to JPR 1710.13, "Design, Inspection, and Certification of Pressure Vessels and Pressurized Systems."
- m. Allow only authorized personnel, trained and certified per paragraph 9.5.9, to handle explosives, propellants, or systems.

9.5.4 Explosives, propellants, and pyrotechnic systems inventory

- a. The explosives owner is ultimately responsible for the control and custody of explosives and shall maintain strict accountability.
- b. Each facility shall maintain an ongoing accountability of all explosives, propellants, and pyrotechnic systems through the use of an inventory, tagging, and document management system. The information retained shall include, as a minimum:
 - (1) Name.
 - (2) Part number.

JSC Safety and Health Handbook	JPR No.	1700.1K
	Effective Date:	11/25/2013
	Expiration Date:	11/25/2018
	Page Number	Page 9.5-3 of 10

- (3) Lot number (if applicable).
- (4) Serial number (if applicable).
- (5) Unit explosive weight.
- (6) Quantity.
- (7) Total explosive limit.
- (8) Hazardous classification.
- (9) Compatibility designation.
- (10) Manufacturer.
- (11) Manufacturing date.
- (12) Date explosives, propellants, or pyrotechnic materials/devices were placed in the facility.
- (13) Date explosives, propellants, or pyrotechnic materials/devices were removed from the facility.
- (14) Signature(s) of person(s) placing or removing materials or devices from the facility.

9.5.5 Compliance audits

- a. The ESO or knowledgeable designee shall perform a compliance audit to verify compliance with the requirements of this chapter and NPR 8719.12 and to verify that the procedures and practices developed under this document are adequate and being followed.
- b. Compliance Audits shall occur at least every three years or more often if the ESO deems it appropriate.
- c. The JSC facilities below shall be audited using checklists developed for each facility:
 - (1) Energy Systems Test Area
 - (2) Ellington Field
 - (3) White Sands Test Facility
 - (4) Forward Operating Location, El Paso, TX
 - (5) CEV Parachute Assembly System hangar, Yuma, AZ
- d. The ESO or designee shall produce a report of the audit findings that contains:
 - (1) A list of the participants.
 - (2) The date(s) audit was conducted.
 - (3) The location of the audit.
 - (4) A description of the findings.
 - (5) The deadline for implementing corrective actions.
- e. The Audit report shall be sent to the Head of the Responsible Organization.

JSC Safety and Health Handbook	JPR No.	1700.1K
	Effective Date:	11/25/2013
	Expiration Date:	11/25/2018
	Page Number	Page 9.5-4 of 10

- f. Organizations being audited shall document that the deficiencies have been corrected and retain the two most recent audit reports.
- g. The ESO shall:
 - (1) Verify that the corrective actions have been properly implemented.
 - (2) Retain copies of the two most recent audit reports for each facility audited.

9.5.6 Requirements for safely handling explosives, propellants, or pyrotechnic systems

- a. Personal Protective Equipment (PPE). Before working with explosives, propellants, or pyrotechnic systems, you shall perform a hazard analysis to determine what PPE is required. It may include the following:
 - (1) Protective equipment and clothing as required by NASA-STD-8719.12, paragraphs 5.28 – 5.39.
 - (2) Wriststats or legstats to control electrostatic discharge as required by NASA-STD-8719.12, paragraph 5.13.2.
 - (3) Cotton clothing.
- b. To avoid problems with electrical energy you shall:
 - (1) Meet the National Fire Protection Association Standard 70, “National Electric Code,” for hazardous locations.
 - (2) Provide static grounding systems per NASA-STD-8719.12, “Explosives Safety,” Chapter 5.
 - (3) Provide lightning protection per NASA-STD-8719.12, Chapter 5.
 - (4) Verify all grounding systems annually and retain records for at least two years.
 - (5) Verify all lightning protection systems every six months and retain records for at least two years
- c. To work safely with Electro Explosive Devices, you shall:
 - (1) Follow all other requirements for working with explosives, propellants, or pyrotechnic systems in this chapter.
 - (2) Shield or short together wire leads.
 - (3) Make sure that wire leads are not twisted into loops, dipole antennas, or other types of antennas.
 - (4) Eliminate electrostatic charge buildup by using wriststats or legstats approved for use with EEDs.
 - (5) Never use or allow radios, cellular telephones, or other transmitting equipment around EEDs.
 - (6) Never rub or polish EEDs.
 - (7) Use only continuity testers and firing units specifically designed for use with EEDs.

JSC Safety and Health Handbook	JPR No.	1700.1K
	Effective Date:	11/25/2013
	Expiration Date:	11/25/2018
	Page Number	Page 9.5-5 of 10

d. The ESO shall verify that any training of off-site personnel coming on site to perform temporary explosives work meets the intent of the on-site explosives training program before the work is begun. For example, an off-site Prime Contractor working on a NASA Program that comes on site to install a pyrotechnic thruster assembly on a test article must first demonstrate to the ESO that he or she has met an appropriate level of training to safely handle and install the thruster assembly and cartridges. This could include a list of training classes and on the job training completed at the Prime Contractor's facility.

9.5.7 Safely storing explosives, propellants, or pyrotechnic systems

a. You shall follow these requirements in and around storage locations:

- (1) Remove all loose packing materials, skids, dunnage, empty boxes, and other combustible materials from magazines.
- (2) Mow and clean a 50-foot or larger fire break around your magazine.
- (3) Don't use or store flammable materials in magazines.
- (4) Don't allow flame-, or spark-producing devices in magazines without written permission from the Safety and Test Operations Division.
- (5) Don't smoke within 50 feet of a magazine.
- (6) Don't use magnesium flashlights, X-ray equipment, photographic flashbulbs, or strobe lights with 10 feet of a magazine without written permission from the Safety and Test Operations Division.
- (7) Use only "non-sparking" tools around explosives, propellants, or pyrotechnic systems.

b. You shall follow these requirements for all facilities storing explosives:

- (1) Have the Safety and Test Operations Division review and approve all facilities used to store explosives, propellants, or pyrotechnic systems.
- (2) Keep magazine doors in good working condition.
- (3) Keep magazine doors locked at all times, except when working in the magazine.
- (4) Have at least one 3A- or larger-rated fire extinguisher in good working condition outside the magazine.
- (5) Separate storage according to the class, division, and storage compatibility group (SCG). See paragraphs 9.5.7.c & d below.
- (6) Post signs stating, "Explosives," "No Smoking," along with the appropriate fire symbol. See paragraph 9.5.7.e below.
- (7) Keep up-to-date inventories of all explosives, propellants, and systems stored in the magazine as required in 9.5.4.b.

c. You shall observe the following safe distances:

JSC Safety and Health Handbook	JPR No.	1700.1K
	Effective Date:	11/25/2013
	Expiration Date:	11/25/2018
	Page Number	Page 9.5-6 of 10

<i>If the class and division is . . .</i>	<i>And if the exposure is to . . .</i>	<i>Use the safe distance tables listed in . . .</i>
1.1	Inhabited buildings or public transportation routes	NASA-STD-8719.12, Table XII
1.1	Operations on the same line	NASA-STD-8719.12, Table XIII
1.1	Other magazines	DOD 6055.9-STD, "Ammunition and Explosives Safety Standard," Tables 9.4 and 9.5
1.2	Anything	DOD 6055.9-STD, Tables 9.6 to 9.9
1.3	Anything	NASA-STD-8719.12, Table XXIII
1.4	Any exposure	DOD 6055.9-STD, Table 9.11
1.5	Same as 1.1	
1.6	Same as 1.1	

d. The class and division numbers and the SCGs were set up by the United Nations Organization for storage and shipment of hazardous materials worldwide. Explosives, propellants, and systems fall under Class 1. The divisions and SCGs indicate the relative hazard within Class 1:

(1) See NASA-STD-8719.12, paragraph 5.44, to find the class and division.

(2) See NASA-STD-8719.12, paragraph 5.46 table, to find the SCGs.

e. Post fire symbols as required by NASA-STD-8719.12, paragraphs 5.3 and 5.4, in the following ways:

<i>On . . .</i>	<i>Then display . . .</i>
Small buildings	A symbol on each side of a building
Buildings with long sides	As many symbols as required, but more than one
Buildings that are not visible from approaches	At least one symbol on each approach
Storage buildings	At least one symbol on a building
Vehicles transporting explosives on site at JSC	At least two symbols on the vehicle

f. You shall follow these requirements for unserviceable pyrotechnics:

(1) Store unserviceable pyrotechnics separately from serviceable stocks.

(2) Mark or tag all damaged pyrotechnic devices and put them in separate, properly marked containers.

JSC Safety and Health Handbook	JPR No.	1700.1K
	Effective Date:	11/25/2013
	Expiration Date:	11/25/2018
	Page Number	Page 9.5-7 of 10

- (3) When deemed safe to do so by the ESO, damaged pyrotechnics devices may be "safed" by firing in place.
- (4) When deemed safe to do so by the ESO, unserviceable propellants, pyrotechnic devices, or pyrotechnic systems may be initiated on-site for purposes such as engineering tests, autoignition tests, checkout test firings, extended age life testing, and training.
- (5) 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 that the disposal facility has the necessary permits required by local, state, and federal regulations.

9.5.8 Transporting explosives, propellants, or pyrotechnic systems

- 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 NPR 8719.12 Section 5J.
- c. Before any motor vehicle designated for movement over public highways may be loaded with explosives or ammunition (DOT Class 1, all Divisions), the vehicle shall be inspected and approved by a qualified explosives vehicle inspector.
- d. Personally owned vehicles (POV's) shall not be used to transport explosives, pyrotechnic devices, or propellants.
- e. Do not transport explosives in the cab of the vehicle.

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

9.5.9.1 Personnel handling explosives, propellants, or pyrotechnic systems shall be certified to handle explosives, propellants, or systems per the requirements of this chapter and Chapter 5.8, "Hazardous Operations: Safe Practices and Certification," of this Handbook. Training shall cover the following subjects, as a minimum, for each explosive, propellant, or pyrotechnic system involved:

- a. A safe attitude toward working with explosives
- b. Nature and properties of the explosive, propellant, or pyrotechnic system.
- c. Correct PPE to use in specific environments and where you can find it.
- d. Approved materials that are compatible with the explosive, propellant, or pyrotechnic system.
- e. Information on physical and health hazards.
- f. Proper handling methods for the explosive, propellant, or pyrotechnic system.
- g. Proper storage for the explosive, propellant, or pyrotechnic system.
- h. Proper transportation requirements for explosives, propellants, or pyrotechnic systems.
- i. Labeling systems and Safety Data Sheet terms.
- j. The correct skills and procedures for safe performance of pyrotechnic operations.

JSC Safety and Health Handbook	JPR No.	1700.1K
	Effective Date:	11/25/2013
	Expiration Date:	11/25/2018
	Page Number	Page 9.5-8 of 10

- k. The purpose and proper use of engineering controls, work practice controls, and PPE.
- l. Detection methods for the presence or release of a hazardous material in a work area.
- m. Procedures for responding to unexpected hazardous conditions and emergency situations.

9.5.9.2 Explosives Handler certifications are good for three years. To be certified as an Explosives Handler, you shall:

- a. Complete the training requirements in 9.5.7.1.
- b. Complete a minimum of six months of on the job training under the supervision of a certified Explosives Handler.
- c. Successfully complete training courses as designated by the individual's immediate supervisor and the ESO. Training shall include Basic Explosives Safety as a minimum. Recommended training courses include:
 - (1) ESD, EMI and EMC training.
 - (2) Chemistry of Explosives.
 - (3) Hands on Explosives and Lab Safety course.
- d. Pass an annual physical per NPR 1800.1, Appendix 3.
- e. Be certified by letter signed by your Immediate supervisor.

9.5.9.3 The ESO has discretion to grant Limited Pyrotechnic Certification for pyrotechnic operations involving a small number of pyrotechnic devices for a specific test. To be certified, you shall:

- a. Successfully complete training for that specific operation.
- b. Successfully complete the Basic Explosives Handler's Course.
- c. Be certified by letter signed by your immediate supervisor and the ESO and stating the following:
 - (1) Name of the person being certified.
 - (2) Name of the device(s) on which the person has successfully completed training.
 - (3) The date on which the certification begins.
 - (4) The duration of the certification, not to exceed one year.
 - (5) The name of the test or hardware on which the pyrotechnic device is being used or installed.

9.5.10 Emergency actions for explosives, propellants, or systems

- a. If an *explosion* happens, you shall:
 - (1) Evacuate the building according to your building's EAP.
 - (2) Call your emergency number and report the explosion.

JSC Safety and Health Handbook	JPR No.	1700.1K
	Effective Date:	11/25/2013
	Expiration Date:	11/25/2018
	Page Number	Page 9.5-9 of 10

b. If a *fire* happens, you shall call your emergency number and take action as described in this table for the fire symbol posted.

<i>If the fire symbol is . . .</i>	<i>Then . . .</i>
1	<ul style="list-style-type: none"> • Don't fight the fire unless you have planned a rescue attempt • Don't try to put out the fire unless other fire symbol 1 materials are far enough away and the fire chief approves • Take cover if your safety is in doubt
2	<ul style="list-style-type: none"> • Sound an alarm • Fight the fire only if it is in the beginning stages and you are trained to do so • Prevent the fire from spreading, if possible • Protect yourself from fragments
3	<ul style="list-style-type: none"> • Fight the fire only if explosives are not involved and you are trained to do so • Use lots of water if white phosphorus or tear-producing agents are involved • Use dry sand or dry powder in the early stages of a fire involving tear-producing agents • Don't use CO₂, water, or halon on fires involving magnesium, titanium, aluminum, or other light metals; use a 2-inch layer of dry sand or powder on the floor for light metal fires; rake the burning metals into the layer of sand or powder and put another layer of sand or powder on top of the burning metals
4	<ul style="list-style-type: none"> • Fight these fires if you are trained to do so • Protect yourself from minor explosions and hot fragments

Remember, your emergency numbers are: x33333 or (281) 483-3333 at JSC, Sonny Carter Training Facility, and Ellington Field, 911 at any off-site location, and x5911 at WSTF. You shall call your emergency number if you see an emergency.

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

- a. Department of Defense, DOD 6055.9-STD
- b. Air Force Manual, AFM 91-201, "Explosives Safety Standard"
- c. Army Materials Command Regulation, AMC-R 385-100, "Safety Manual"
- d. Army Technical Manual, TM5-1300, "Structures to Resist Accidental Explosions"
- e. NASA-STD-8719.12, "Safety Standard for Explosives , Propellants and Pyrotechnics"
- f. JPR 1710.13, "Design, Inspection, and Certification of Pressure Vessels and Pressurized Systems"

JSC Safety and Health Handbook	JPR No.	1700.1K
	Effective Date:	11/25/2013
	Expiration Date:	11/25/2018
	Page Number	Page 9.5-10 of 10

g. 49 CFR 172–183, “Department of Transportation Regulations for Transportation of Hazardous Materials”

9.5.12 Responsibilities for explosives safety:

- a. The *JSC Explosives Safety Officer* has jurisdiction for explosives safety at all JSC facilities and field sites and is responsible for:
 - (1) Fulfilling the responsibilities in paragraph 3.11.4 of NPR 8715.3.
 - (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. This list shall be available to emergency forces (such as, fire department, guard forces) at all times.
 - (3) Approving Pyrotechnics Safety Officers for all JSC facilities outside of WSTF.
- b. The Manager, WSTF, is responsible for designating, in writing, as required in WSP 25-0007:
 - (1) A WSTF Assistant Explosives Safety Officer.
 - (2) WSTF Pyrotechnics Safety Officers with acceptable explosives experience and training to perform duties as required to ensure compliance with applicable requirements.
- c. The WSTF Assistant Explosives Safety Officer is responsible for the day-to-day explosives safety activities at the WSTF as required in WSP 25-0007.
- d. Pyrotechnics Safety Officers are responsible for ensuring compliance with NASA-STD-8719.12, this chapter, and other applicable regulations in their areas.
- e. The *Safety and Test Operations Division* is responsible for:
 - (1) Supporting ESO assessments as required in paragraph 3.11.4 of NPR 8715.3..
 - (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 Chapters 6.9.
 - (4) Reviewing Facility Safety Management Process documentation of energetic test facilities as required in 10.4.
- f. 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) to make available to emergency forces (such as, fire department, guard forces) as needed.