Chapter 9.5
Explosives and solid 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.

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.

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

The following defines an explosive, solid propellant, system that contains an explosive or solid propellant, 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, propellants in any system, subsystem, component, or device that functions by igniting an explosive or a propellant inside the system, subsystem, or component. "System" is used instead of "system that contains 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 the explosive or propellant.

3. Precautions when working with explosives, propellant, or systems

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

a. Follow NASA Safety Standard 1740.12, "Explosives Safety."

b. Don't handle explosives, propellants, or systems in a manner that could cause damage.

c. Don't carry explosives, propellants, or systems in pockets, toolboxes, lunch boxes, or other unprotected places.

d. Don't expose explosives, propellants, or systems to open flame, direct sunlight for long periods of time, or heating and electrical equipment.

e. Don't use bale hooks to handle explosives, propellants, or systems.

f. Don't use nails through packing materials or containers of explosives, propellants, or systems.

g. Keep the safe distances required by paragraph 6.d.

h. Have a Hazardous Operations Permit as described in Chapter 5.8, "Hazardous operations: safety practices and certification," of this handbook.

4. Special precautions when working with explosives, propellants, or systems

You shall do the following:

a. Prepare detailed operating procedures listing tasks in a logical order that doesn't introduce new hazards.

b. Prepare a hazard analysis before you work with explosives, propellants, or systems.

c. Have a Safety and Test Operations Division representative review and sign off on the detailed test procedures and hazard analysis.

d. Prohibit smoking, open flames, or heat-producing operations around explosive or propellant systems.

e. Make sure that test chambers are designed and built to JPR 1710.13, "Design, Inspection, and Certification of Pressure Vessels and Pressurized Systems."

f. Allow only authorized personnel, trained in accordance with paragraph 9, to handle explosives, propellants, or systems.

5. Working safely with EEDs

You shall:

a. Follow all other requirements for working with explosives, propellants, or systems in this chapter.

b. Twist wire leads together or shield them and attach the leads to a good ground.

c. Make sure that wire leads are not twisted into loops, dipole antennas, or other types of antennas.

d. Provide electromagnetic protection with Faraday plugs or caps on EEDs with connectors instead of wire leads. If they are not available, use other means of protection, such as shorting springs or aluminum foil between the connectors.

e. Eliminate electrostatic charge buildup by using wriststats or legstats.

f. Never use or allow radios, cellular telephones, or other transmitting equipment around EEDs.

g. Never rub or polish EEDs.

h. Use only continuity testers and firing units specifically designed for use with EEDs.

6. Safely store explosives, propellants, or systems

There are several things that you shall do when storing explosives, propellants, or 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-, spark-, or other-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" or reduced-sparking tools around explosives, propellants, or 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 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 6 and 7 of this chapter.

6. Post signs stating, "Explosives," "No Smoking," along with the appropriate fire symbol. See paragraph 10 of this chapter.

7. Keep up-to-date inventories of all explosives, propellants, and systems stored in the magazine.

c. You shall follow these requirements to avoid problems with electrical energy:

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. Check all grounding systems at least every 6 months.

d. You shall observe the following safe distances:

If the class and division is . . .	***And if the exposure is to . . .***	***Use the safe distance tables listed in . . .***
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	

7. What the class and division numbers and SCGs mean

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:

a. Use the following table to find the class and division:

If the hazard from the explosive, propellant, or system is . . .	***The class and division is . . .***
Mass detonation of almost all the material	1.1
Fragments or firebrands	1.2

If the hazard from the explosive, propellant, or system is . . .	*The class and division is . . .*
Mass burning of almost all the material, but not detonation	1.3
Minor fire or blast damage limited to the package	1.4
Mass detonation of the material, but there is very little chance of detonation or mass burning causing detonation	1.5
Mass detonation of the system, but very little chance of accidentally initiating the system	1.6

b. Use this table to find the SCGs:

If the explosive, propellant, or system is . . .	*The SCG is . . .*
An initiating explosive that is sensitive to heat, friction, or percussion	A
A detonator or other device that contains explosives designed to initiate an explosives train	B
A bulk propellant, propelling charge, or system with or without its own way of initiating	C
A bulk explosive or system that contains explosive with its own means of ignition and two or more independent safety features	D
A system that contains explosives and propelling charges, without its own means of ignition; doesn't include systems that contain flammable or hypergolic liquids	E
A system that contains explosives and propelling charges with its own means of ignition; doesn't include systems that contain flammable or hypergolic liquids	F
Fireworks, an illuminating, incendiary, smoke-, tear-, or noise-producing system; doesn't include water activated or white phosphorus	G
A system that contains explosives and white phosphorus or pyrophoric materials	H
A system that contains explosive and flammable liquids or gels	J
A system that contains explosives and toxic chemical agents	K
A system or bulk explosive or propellant not in other SCGs; not having characteristics allowing storage with other types of systems; waste, damaged, or contaminated explosives, propellants, or systems; or a new explosive, propellant, or system	L
A system that is extremely insensitive	N
A system that presents minor blast or fire hazard that is designed to confine the effects within the system or the packaging and doesn't hamper firefighting activities around the system	S

8. Protective clothing and equipment to use when working with explosives, propellants, or systems

When you work with explosives, propellants, or systems, you shall first perform a hazard analysis to determine what PPE is required. It may include the following types of PPE:

a. Eye protection

b. Face shields

c. Wriststats or legstats

d. Conductive safety shoes

e. Non-static-producing clothing such as cotton or specially treated anti-static garments

9. Training to work with explosives, propellants, or systems

You need to be certified to handle explosives, propellants, or systems under Chapter 5.8, "Hazardous operations: safe practices and certification," of this handbook. Your training shall cover the following subjects for each explosive, propellant, or system that you work with:

a. Nature and properties of the explosive, propellant, or system

b. Correct PPE to use in specific environments and where you can find it

c. Approved materials that are compatible with the explosive, propellant, or system

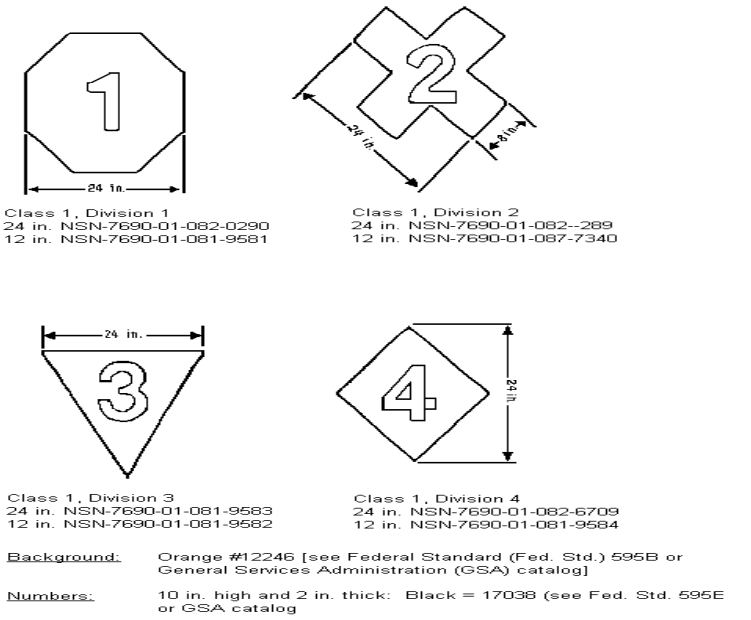
d. Proper handling methods for the explosive, propellant, or system

e. Proper storage for the explosive, propellant, or system

f. Proper transportation requirements for the explosive, propellant, or system

10. Fire symbols for working with explosives, propellants, or systems

Post the following fire symbols as described in the tables below.



Post fire symbols in the following ways:

If the explosive, propellant, or system hazard is . . .	***The fire symbol is . . .***
Mass detonating	1
Fragment or blast damage	2
Mass fire	3
Moderate fire, minor explosive	4

Post fire symbols in the following ways:

On . . .	***Then display . . .***
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

11. Emergency actions for explosives, propellants, or systems

You shall take the following actions for these emergencies:

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.

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

If the fire symbol is . . .	***Then . . .***
1	• 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	• 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	• 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 CO_2, 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	• Fight these fires • Protect yourself from minor explosions and hot fragments

Remember, your emergency numbers are: x33333 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.

12. For more information on working with explosives, propellants, and systems

You can find more information on working with explosives, propellants, and systems in these documents:

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, "Explosives Safety."

f. JPR 1710.13, "Design, Inspection, and Certification of Pressure Vessels and Pressurized Systems"

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

13. Responsibilities for explosive Safety:

The following individuals and organizations have responsibilities for explosive safety:

a. The ***JSC Authority Having Jurisdiction for Explosives Safety*** is responsible for maintaining a current master list of explosive storage sites and their locations, fire symbols, chemical storage sites, and available empty storage sites. This list shall be available to emergency forces (e.g., fire department, guard forces) at all times.

b. The ***Safety and Test Operations Division*** is responsible for keeping a current copy of the master list of storage sites to make available to emergency forces (e.g., fire department, guard forces) as needed.

c. The ***Security Office*** is responsible for keeping a current copy of the master list of storage sites to make available to emergency forces (e.g., fire department, guard forces) as needed.