

Recommended Practices for Oilfield Explosives Safety

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**RECOMMENDED PRACTICES FOR
OILFIELD EXPLOSIVES SAFETY**

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**RECOMMENDED PRACTICES FOR
OILFIELD EXPLOSIVES SAFETY****FOREWORD**

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SECTION 1 GENERAL

1.1 Scope. This publication is applicable to explosives used in oil and gas producing operations, more specifically, explosives used inside a wellbore. The purpose of this standard is to prevent inadvertent detonation of explosives.

1.2 Introduction. Operating companies and/or service companies may establish more stringent and additional policies/procedures that they deem appropriate for their particular situation(s).

1.3 Human Factors. It is recognized that the principle cause of explosives accidents/incidents is human error.

Persons who use explosives on a regular basis over a long period of time must guard against becoming complacent and taking "short-cuts" in the required operations and procedures. Prevention of explosives accidents requires the faithful observance of established procedures.

1.4 Attitude. The total commitment of all individuals and their respective companies is necessary to achieve safe use of oilfield explosives.

SECTION 2

FIELD SAFETY PROCEDURES

2.1 Introduction. The purpose of this section is to describe recommended procedures for handling and operation of explosive devices at the well site. Included are general practices and electric line conveyed, tubing conveyed, and special operations.

2.2 Transportation. Conveyance of explosives to and from the well site — whether by roadway, air, or water — shall be in compliance with *Title 49 Code of Federal Regulations** (U.S. Department of Transportation), or applicable equivalent for operations outside the United States.

GENERAL PRACTICES

2.3 Arrival at the Well Site.

2.3.1 Existing Well Site Hazards. Identify and correct, where necessary, any specific well site conditions that might contribute to safety hazards in handling and operation of the explosive devices to be deployed. This should include consultation between the onsite operator, contractor, and service company representatives.

2.3.2 Smoking Areas/Open Flames. Identify and enforce designated smoking areas and repositories for smoking materials. Smoking shall not be permitted except within these areas; smoking materials shall be confined to said areas at all times. No open flames nor flame-producing devices shall be permitted within 50 feet (15 meters) of operations involving explosives, unless an appropriate radiant heat barrier has been installed. Local regulations shall be checked to determine requirements for space between open flames and explosives operations, as they may require separation by more than 50 feet (15 meters).

2.3.3 Explosives Temporary Storage Facilities. Establish and observe designated location(s)/facilities for temporary storage of explosive materials, if such storage is required. Such areas should be removed from sources of heat, impact/shock hazards, and living accommodations by a distance as specified by applicable local regulations or by the explosives manufacturing/service company, whichever is greater.

2.3.4 Explosives Packaging/Identification. Explosive materials arriving at the well site shall be properly packed and clearly labelled in accordance with applicable regulations (refer to Par. 2.2).

2.3.5 Designated Gun Loading/Make-up Site. Define the gun loading site (where applicable) and the location at which guns will be made up (not necessarily where they are armed).

2.3.6 Storage at the Well Site. Charged well casing perforating guns and sidewall sampling guns not in use shall be stored on location in accordance with applicable local, state, or federal regulations.

NOTE: *Propellant activated sidewall sample takers, bullet perforating guns, and select fire guns that are ballistically armed shall not be placed on the catwalk or any other area(s) where logging tools may be powered up.*

2.4 Well Site Loading/Unloading of Explosive Devices.

2.4.1 Designated Site. Loading operations shall be conducted only within the designated site, located at least 50 feet (15 meters) removed from sources of heat, such as open flame, welding operations, etc., unless an appropriate radiant heat barrier has been installed. Local regulations shall be checked to determine requirements as they may require separation by more than 50 feet (15 meters).

2.4.2 Warning Signs. Signs reading "DANGER EXPLOSIVES", or equivalent, shall be displayed at the immediate loading/unloading site.

2.4.3 Personnel. Only personnel authorized by the Explosive User in Charge may be present in the loading/unloading area at any time during these operations (refer to Pars. 5.1 and 5.2).

2.4.4 Explosives Handling.

2.4.4.1 No detonators or initiating devices are permitted within the loading area during the loading process, except as approved by the Explosive User in Charge (refer to Pars. 5.1 and 5.2).

2.4.4.2 Explosives are to be removed from packaging within the loading area, utilizing tools recommended by the manufacturer.

2.4.4.3 Explosives are to be removed from packaging only in quantities required for loading. Do not permit unpackaged explosives to accumulate.

2.4.4.4 Use only approved loading tools and detonating cord severing devices and techniques recommended by the explosive manufacturer or authorized by the service company.

2.4.4.5 In the handling and assembly of explosive devices, be alert to proper fit. Do not force parts. Avoid impacts, pinching, crushing, and sparks from all sources.

2.4.4.6 Following loading operations, immediately collect loose, remnant, or unused explosives and repackage in compliance with Par. 2.2 for shipment off the well site.

2.4.4.7 Store loaded guns in a designated storage area (refer to Par. 2.3.3).

2.4.4.8 A handling cap, plug, or other closure device shall be installed in the ends of hollow carrier type loaded guns at all times during handling or storage. The closure device must have a feature that will relieve pressure inside the gun in case of excess heat or fire. Guns or devices with exposed detonating components (such as expendable or strip types) must be protected from damage.

*Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

2.4.5 Housekeeping. Clean up immediately following loading operations. Utilize separate containers for ordinary trash and explosive remnants. Remove all explosive materials from the well site, including empty explosive packaging materials. These materials should be properly disposed of. *Do not mix with ordinary trash!* Refer to Pars. 2.5.1 and 2.5.2 regarding packaging, transporting, and disposal of residual explosives, trash, and debris associated with wellsite operations.

2.5 Post-job Operations.

2.5.1 Handling Remnant Explosives. Locate all residual explosives such as pieces of detonating cord, defective charges, and misfired detonators and package into proper shipping containers for transportation off the well site (refer to Par. 2.2)

2.5.2 Disposition of Trash. Collect all trash and debris associated with the operation, including empty explosive containers or packaging, spent gun tubes, etc. Organize and appropriately package these materials for transport off the well site and proper disposal. Appropriate local, state, and federal regulations should be checked to determine requirements for disposal of explosives materials, explosives packaging materials, and associated debris.

ELECTRIC LINE CONVEYED OPERATIONS

2.6 Well Site Preparation.

2.6.1 Warning Signs. Signs such as "DANGER EXPLOSIVES — TURN OFF RADIO TRANSMITTERS", or equivalent, shall be prominently displayed at the site and at all entrances. When using initiating devices established to be insensitive to currents from electromagnetic fields created by RF transmitters (such as devices identified in Pars. 4.3.1, Items 2, 3, and 4), the signs need only read "DANGER EXPLOSIVES", or equivalent (refer to Par. 3.10).

Warning procedures similar to those specified in *HSAC-RP 92-2: Performing Operations — Helideck/Heliport Operational Hazard Warnings/Procedures**, should be prominently displayed in any restricted area where helicopter operations are anticipated.

2.6.2 Eliminate Sources of Stray Electrical Energy.

2.6.2.1 Cathodic Systems. Turn off electrical cathodic protection systems.

2.6.2.2 Electric Welding. Discontinue all electric welding operations.

2.6.2.3 Radio Frequency Energy. Precautions shall be exercised in explosive operations to prevent radio frequency radiation hazards. Warning signs shall be posted or other appropriate measures taken so that radio and radar frequency units will be shut off when within hazardous distances of explosive operations. Refer to *IME Safety Publication No. 20: Safety Guide for the Prevention of Radio Frequency Radiation Hazards in the Use of Commercial Electric Detonators (Blasting Caps)***, check latest edi-

tion, and *Recommended Practices for Radio Silence When Conducting Wireline Services Involving the Use of Explosives****, check latest edition, for recommended distances for posting signs and shutting off radio, radar, cellular telephone, and pager frequency transmitting units.

2.6.2.4 Stray Voltages. Any voltage (AC or DC) in excess of 0.25 volt between the wellhead, rig, perforating unit, generator skid, rig auxiliary power source, and barge (if applicable) shall be eliminated prior to and during explosive device arming or disarming. After the voltage level has been reduced to 0.25 volt or less, the perforating unit, rig, and wellhead shall be connected together electrically with grounding/bonding cables. Refer to Par. 3.7.

2.6.2.5 Rig Wiring. Remove or de-energize any rig electrical wiring that might contact the unit, cable, or explosive device during rig-up and for the duration of the operation. Top drive systems should be electrically isolated in accordance with the manufacturer's procedures.

2.6.2.6 Exception. Compliance with Pars. 2.6.2.1, 2.6.2.2, 2.6.2.3, and 2.6.2.4 is not necessary when using devices as defined in Pars. 4.3.1, items 2, 3, and 4.

2.7 Pre-checks, Unit System.

2.7.1 Cable Conductor Continuity. Proper insulation and continuity of cable conductors shall be verified prior to arming.

2.7.2 Checking Gun Circuits. Only a circuit testing instrument, as specified in Par. 3.9, shall be used in checking continuity or insulation of a gun circuit.

2.7.3 Checking Detonators. Blasting caps/detonators or other initiation devices shall be contained within a safety loading tube during checking operations (refer to Par. 3.8.1).

2.7.4 Using Unit Power (Check Fire or Hot Check). When unit power is to be used to check the cable head/accessory equipment, the latter shall be in clear view of the person applying the power. No power is to be applied while any gun is armed, nor applied through a gun or explosive tool assembly at any time while the gun is on the surface.

2.8 Unit Preparation for Explosive Tool Attachment.

2.8.1 Isolate the Cable Circuit. Disconnect the cable circuit from unit instrumentation with a positive disconnect.

2.8.2 Isolate the Control Panel Power. Turn off all instrument power switches.

2.8.3 Isolate the Power Source. Turn off the main circuit breaker(s) in the unit.

2.8.4 Activate the Current/Voltage Limiting Circuits. Ground all electrical cable conductors to the unit ground through a nominal resistance of 5,000 ohms (refer to Par. 3.3.1).

*Available from Helicopter Safety Advisory Conference (HSAC), P. O. Box 60220, Houston, Texas 77205.

**Available from Institute of Makers of Explosives, 1120 19th Street, N. W., Suite 310 Washington, DC 20036-3605.

***Available from the Institute of Petroleum, 61 New Cavendish Street, London W1M, 8AR. Published by John Wiley and Sons, Great Britain.

2.8.5 Lock Circuits in the Safe Mode. Place the cable circuit in the safe mode (refer to Pars. 2.8.1 and 2.8.4), remove the key to the lockout device, and ensure that the key to the lockout device remains outside the electric wireline unit until the explosive device is introduced into the well to a minimum depth of 200 feet (70 meters) below ground level or the sea floor.

2.9 Gun/Explosive Device Arming Sequence.

NOTE: Arming should not be attempted during a thunder storm (either rain or snow), dust storm, sand storm, or during arrival of helicopters or boats at an offshore site. Arming procedures should not be commenced if such weather is expected to arrive before the arming operation can be completed and the gun introduced into the well to a minimum depth of 200 feet (70 meters) below ground level or the sea floor.

2.9.1 Stray Voltage Check. Verify that the voltage between the wellhead, rig, and unit (including generator skid and barge, when applicable) does not exceed 0.25 volt.

2.9.2 Personnel. All personnel unnecessary to the operation should be relocated to a safe site. Clear the line of fire of all personnel.

2.9.3 Connect the cable head/accessory equipment to the *unarmed* explosive device.

2.9.4 Ensure that sources of stray electrical energy are eliminated (refer to Par. 2.6.2). The key to the lockout device should remain outside the electric wireline unit until the explosive device is introduced into the well to a minimum depth of 200 feet (70 meters) below ground level or the sea floor.

2.9.5 Verify that no voltage exists between the points where the blasting cap wires are to be attached.

2.9.6 Remove detonator from the container (assuring that leg wires are shunted), insert into the detonator safety tube, and convey to the arming area.

2.9.7 Connect the detonator lead wires (ground connector should be connected first) to those of the explosive device (with the detonator still in the safety tube).

2.9.8 Remove the detonator from the safety tube and connect to the detonating cord (or device to be fired).

2.9.9 Complete the assembly, taking care not to pinch, crush, or impact the explosive components.

2.10 Running the Gun/Explosive Device Into the Well.

2.10.1 Restoring Power. When the gun/explosive device has reached a level of 200 feet (70 meters) or more below ground level or the sea floor, the cable safety circuit may be taken out of the safe mode position.

2.10.2 Descent. The explosive device should be run to depth; tie-in for depth control; position the device; activate the firing control panel; and fire the device.

2.11 Recovery of Gun/Explosive Device From the Well.

NOTE: Disarming should not be attempted during a thunder storm (either rain or snow), dust storm, or sand storm. Disarming procedures should not be commenced

if such weather is expected to arrive before the disarming operation can be completed. The gun should be kept in the well at a minimum of 200 feet (70 meters) below ground level or the sea floor until such storm conditions cease.

2.11.1 Powering Down. At 200 feet (70 meters) or greater below ground level or the sea floor, safety circuits should be placed back in the safe mode position.

2.11.1.1 Isolate the Control Panel Power. Turn off all instrument power switches.

2.11.1.2 Isolate the Power Source. Turn off the main circuit breaker(s) in the unit.

2.11.1.3 Lock Circuits in the Safe Mode. Place the cable circuit in the safe mode (refer to Pars. 2.8.1 and 2.8.4), remove the key to the lockout device, and ensure that the key to the lockout device remains outside the electric wireline unit until the explosive device is disarmed.

2.11.2 Personnel. All personnel unnecessary to the operation should be relocated to a safe site. Clear the line of fire of all personnel.

2.11.3 Internal Pressure. Check both fired and misfired tools for evidence of internal pressure (where applicable, as with hollow carrier guns). If internal pressure is encountered, relocate all nonessential personnel to a safe site and bleed off the pressure following service company recommended procedures.

2.11.4 Disarming Misfired Devices. Immediately disarm all misfired devices as follows:

2.11.4.1 Remove the detonator from the detonating cord (or device).

2.11.4.2 Put the detonator in the safety tube (refer to Par. 3.8.1).

2.11.4.3 Disconnect the detonator wires from the circuit.

2.11.4.4 Shunt the detonator lead wires together, remove from the safety tube, and place into appropriate containers for transportation off the well site (refer to Par. 2.2).

TUBING CONVEYED OPERATIONS

2.12 Well Site Preparation.

2.12.1 Electrical Firing. Observe the provisions of Par. 2.6.

2.12.2 Mechanical/Percussion Firing. Warning signs such as "DANGER EXPLOSIVES", or equivalent, shall be prominently displayed at the site and at all entrances.

2.13 Gun Make-up.

2.13.1 Supervision. Gun make-up operations should be supervised by the designated Explosive User in Charge (refer to Pars. 5.1 and 5.2).

2.13.2 Avoiding Explosive Component Impacts/Mechanical Interference. When making a vertical gun connection, first remove the handling cap from the suspended gun, then remove the handling cap from the lower section. Ascertain that no extraneous

material or objects are present within the gun end cavities just prior to connection.

2.13.3 Safety Sub(s). A safety spacer or blank gun section shall be installed between each gun assembly and firing head to place the loaded portion a safe distance below the rig floor during arming and disarming operations. Spacer minimum length should be 10 feet (3 meters). In some cases, a longer safety spacer will be required to place the loaded gun assembly safely below the living quarters or other occupied areas. A safety spacer may not be required in a bottom-up firing system (refer to Par. 2.16).

2.14 Gun Arming — Electrical Firing.

NOTE: Observe the inclement weather precautions and procedures as shown in Par. 2.9.

2.14.1 Eliminate Sources of Stray Electrical Energy. Refer to Par. 2.6.2.

2.14.2 Arming Sequence — Firing Head.

2.14.2.1 Suspend all work on the rig floor.

2.14.2.2 Relocate all nonessential personnel to a safe site until the gun assembly has been armed and run into the well to a depth of 200 feet (70 meters) or more below ground level or the sea floor. No personnel should be present below the rig floor during arming or lowering operations. Clear the line of fire of all personnel.

2.14.2.3 Remove detonator from the container (assuring that leg wires are shunted), insert into the detonator safety tube, and convey to the arming area.

2.14.2.4 Secure the detonator into the firing mechanism housing, install protective devices, and convey to the gun assembly.

2.14.2.5 Install the firing mechanism(s) at the top of the safety spacer.

2.14.3 Running the Gun/Explosive Device Into the Well.

2.14.3.1 Run the gun assembly into the well without unnecessary delay.

2.15 Gun Arming — Mechanical Firing.

2.15.1 Arming Sequence. Procedures will be same as Par. 2.14 excepting those electrical aspects covered in Pars. 2.14.1 and 2.14.2.3.

2.16 Gun Arming — Firing Bottom-Up. No firing head should be installed at the bottom of a loaded gun assembly unless there is a demonstrated safe design to prevent accidental firing of the upper gun string at or near the surface during arming or disarming (following exposure to well downhole conditions). Operation of such configuration will require prior review of and agreement between service company and operator.

2.17 Recovery of Tubing Conveyed Guns From the Well.

2.17.1 Drop Bar. Do not recover guns to the surface without making all reasonable attempts to retrieve or disable the drop bar, unless there is a positive indication that the gun has fired.

2.17.2 Personnel Safety. Relocate all nonessential personnel to a safe site while the gun is being re-

trieved from a depth of 200 feet (70 meters) below ground level or the sea floor. No personnel should be present below the rig floor while the gun is being retrieved from 200 feet (70 meters) below ground level or the sea floor. Clear the line of fire of all personnel.

2.17.3 Pre-Disassembly. Prior to commencing disassembly operations, confirm that the gun has fired and whether internal pressure exists within the gun system.

2.17.4 Internal Pressure. If internal pressure is encountered, relocate all nonessential personnel to a safe site and bleed off the pressure following service company recommended procedures.

2.17.5 Disassembly. Immediately remove the firing mechanism. Proceed to break down the guns in a reverse manner to the procedure described in Par. 2.13.2.

2.17.6 Misfires. Misfired detonating components should be immediately removed to an approved shipping container (refer to Par. 2.2).

SPECIAL PROVISIONS

2.18 Downhole, Self-Contained Activating Tools. (Explosive activating tools that are conveyed into the wellbore by means other than electric line and with self-contained power sources.)

2.18.1 Gun/Explosive Device Arming.

NOTE: Observe the inclement weather precautions and procedures as shown in Par. 2.9.

2.18.2 Well Site Preparation. Observe the provisions of Par. 2.6.

2.18.3 Pre-Checks.

2.18.3.1 Tool Check. Check all activation devices, safety devices, and the tool operation.

2.18.3.2 Checking System Circuits. Only a circuit testing instrument, as specified in Par. 3.9, should be employed in checking continuity or insulation of a gun system.

2.18.3.3 Checking Detonators. Blasting caps/detonators or other initiation devices must be contained within a safety loading tube during checking operations (refer to Par. 3.8.1).

2.18.4 Gun/Explosive Device Arming Sequence.

NOTE: Arming should not be attempted during a thunder storm (either rain or snow), dust storm, sand storm, or during arrival of helicopters or boats at an offshore site. Arming procedures should not be commenced if such weather is expected to arrive before the arming operation can be completed and the gun introduced into the well to a minimum depth of 200 feet (70 meters) below ground level or the sea floor.

2.18.4.1 Stray Voltage Check. Verify that the voltage between the wellhead, rig, and unit (including generator skid and barge, when applicable) does not exceed 0.25 volt.

2.18.4.2 Personnel. All personnel unnecessary to the operation should be relocated to a safe site. Clear the line of fire of all personnel.

2.18.4.3 The Explosive User (refer to Par. 5.2.1) shall connect the cable head to the tool (explosive device).

2.18.4.4 Confirm that sources of stray electrical energy are eliminated (refer to Par. 2.6.2).

2.18.4.5 Verify that no voltage exists between the points where the blasting cap wires are to be attached.

2.18.4.6 Remove detonator from the container (assuring that leg wires are shunted), insert into the detonator safety tube, and convey to the arming area.

2.18.4.7 Connect the detonator lead wires (ground connector should be connected first) to those of the explosive device (with the detonator still in the safety tube).

2.18.4.8 Remove the detonator from the safety tube and connect to the detonating cord (or device to be fired).

2.18.4.9 Complete the assembly, taking care not to pinch, crush, or impact the explosive components.

2.18.5 Running the Gun Assembly Into the Well. Run the gun assembly into the well without unnecessary delay.

2.18.6 Recovery of Gun/Explosive Device From the Well.

NOTE: *Disarming should not be attempted during a thunder storm (either rain or snow), dust storm, or sand storm. Disarming procedures should not be commenced if such weather is expected to arrive before the disarming operation can be completed. The gun should be kept in the well at a minimum of 200 feet (70 meters) below ground level or the sea floor until such storm conditions cease.*

2.18.6.1 Deactivate Tool. Follow service company recommendations required to allow deactivation of the tool prior to starting out of the hole.

2.18.6.2 Personnel. All personnel unnecessary to the operation should be relocated to a safe site. Clear the line of fire of all personnel.

2.18.6.3 Internal Pressure. Check both fired and misfired tools for evidence of internal pressure (where applicable, as with hollow carrier guns). If internal pressure is encountered, relocate all nonessential personnel to a safe site and bleed off the pressure following service company recommended procedures.

2.18.6.4 Disarming Misfired Devices. Immediately disarm all misfired devices as follows:

1. Remove the detonator from the detonating cord (or device).
2. Put the detonator in the safety tube (refer to Par. 3.8.1).
3. Disconnect the detonator wires from the circuit.
4. Shunt the detonator lead wires together, remove from the safety tube, and place into appropriate containers for transportation off the well site (refer to Par. 2.2).

2.19 Setting Tools.

2.19.1 Setting tools containing gas generating charges shall be treated as wireline or tubing conveyed explosive devices, except that they may be ballistically armed prior to electrical arming. Setting tools that do not contain any gas generating components are exempt from this Recommended Practice.

2.20 Cased Hole Formation Testers.

2.20.1 Cased hole formation testers shall be treated the same as wireline perforating device(s), refer to Pars. 2.1 through 2.11.

2.21 Propellant Activated Sidewall Sample Takers.

2.21.1 Propellant activated sidewall sample takers should be treated as any other wireline explosive device, with the exception of Par. 2.9.3 and Pars. 2.9.5 through 2.9.8. These tools are ballistically armed during assembly, hence the arming sequence in Par. 2.9.3 and Pars. 2.9.5 through 2.9.8 is not appropriate. Provisions in Par. 4.6.1 are applicable to these tools.

NOTE: *Sidewall sample takers shall not be placed on the catwalk or any other area(s) where logging tools may be powered up.*

2.22 Select Fire and Bullet Perforating Guns.

2.22.1 Select fire and bullet perforating guns should be treated as any other wireline explosive device (refer to Pars. 2.1 through 2.11.2, with the exception of Par. 2.9.3 and Pars. 2.9.5 through 2.9.8). Some of these select fire tools are ballistically armed during assembly so the arming sequence in Par. 2.9.3 and Pars. 2.9.5 through 2.9.8 is not appropriate. Provisions in Par. 4.6.1 are applicable to these tools.

SECTION 3 SURFACE EQUIPMENT

3.1 Introduction. The purpose of this Section is to describe recommended surface equipment to be used at the well site during operations involving explosive devices.

3.2 Electrical Power for the Electric Wireline Unit. There shall be a main power switch in the electric wireline unit to control all power to the shooting system.

3.3 Cable Safety System.

3.3.1 When in safe mode, the cable circuit shall open all cable connectors from the electric wireline unit circuits and all conductors shall be shunted to armor through a nominal 5,000 ohms. The 5,000 ohms shall consist of a minimum of two (2) similar resistors in parallel with the net resistance being 5,000 ohms.

3.3.2 The safe mode shall be assured with a lock-out feature.

3.3.3 The cable safety circuit should be inside the electric wireline unit.

3.3.4 Electrical continuity from the cable safety circuit to the cable conductor shall exist and wiring shall have mechanical protection.

3.4 Firing System.

3.4.1 There shall be at least three deliberate actions required to fire the explosive device.

3.4.2 There shall be at least one action that requires the use of two hands.

3.4.3 There shall be at least one action that involves a spring loaded switch.

3.5 Communication System.

3.5.1 There shall be *effective* communications between the electric wireline unit and those areas where explosive devices are armed or disarmed.

3.5.2 The communications system shall be designed and maintained to ensure that no current greater than 10% of the no-fire limit of the detonating device can enter the cable/blasting cap circuit.

3.6 Inspection/Maintenance. Equipment shall be maintained by qualified personnel in accordance with the manufacturer's recommendations and specifications.

3.7 Electrical Grounding/Bonding System.

3.7.1 The grounding system shall positively electrically bond the electric wireline unit to the casing/wellhead/blowout preventer and the rig (sheave support system).

3.7.2 Attachment of the bonding cables to the rig and wellhead/casing shall be via a "C" clamp firmly secured by a pin type screw fitting with a sharpened point.

3.7.3 The bonding cables shall be of stranded copper conductor, insulated with a wire size of at least No. 10.

3.7.4 A positive electrical bond from the electric wireline unit to the armor of the cable shall be provided.

3.7.5 Electrical grounding/bonding shall be attached only after the system voltage is below 0.25 volt, AC and DC. **EXCEPTION:** Compliance with Par. 3.7.5 is not necessary when using initiating devices as defined in Pars. 4.3.1, Items 2, 3, and 4.

3.8 Electrical Detonator Safety Tube. The electrical detonator safety tube shall be a heavy-walled tube with one end closed and a cover at the other end. The tube shall be prototype tested by the service company to contain the blast of a No. 8 detonator.

3.9 Electrical Detonator Circuit Testing Instruments. The instruments recommended for use in testing electrical detonators and detonator circuits are Blasting Multimeters, Blasting Ohmmeters, and Blasting Galvanometers*. These instruments are specifically designed and manufactured for checking explosives and explosives circuits. The test current from the meter used to perform resistance checks shall not exceed 25 milliamperes or 10% of the no-fire rating of the detonator in the circuit, whichever is less.

3.10 Explosive Warning Signs (Land Operations).

3.10.1 Explosives warning signs shall include the words "DANGER EXPLOSIVES", or equivalent. In operations involving electric detonators, signs should include the additional words, "TURN OFF RADIO TRANSMITTERS", or equivalent.

3.10.2 The explosives warning signs should be durable.

3.10.3 The explosives warning signs should be visible and legible from 50 feet (15 meters).

3.11 Chemical Cutter Protective Sleeve. The chemical cutter sleeve (also known as a protective sleeve) shall:

1. cover the severing head,
2. be made of aluminum,
3. be of sufficient thickness to provide effective deflection,
4. be open on both ends,
5. have an inside diameter adequate to pass over the severing head, and
6. have a positive means for securing to the severing head.

NOTE: Field modifications to equipment shall be allowed only with written approval of the equipment manufacturer.

*Refer to Institute of Makers of Explosives, 1120 19th Street, NW, Suite 310; Washington, D.C. 20036-3605.

SECTION 4 DOWNHOLE EQUIPMENT

4.1 Introduction. The purpose of this Section is to describe recommended features and minimum requirements of downhole equipment, as they pertain to personnel safety.

4.2 Primary High Explosives. Primary high explosives are permitted only in electric and percussion detonators.

4.3 Detonators and Initiating Devices.

4.3.1 Detonators and initiators must incorporate at least one of the following features:

1. Minimum DC resistance of 50 ohms, and minimum "no-fire" current of 200 milliamperes.
2. High voltage exploding bridgewire (EBW) designs.
3. High voltage exploding foil initiator (EFI) designs.
4. Features offering protection essentially equivalent to those afforded by features of Pars. 4.3.1, Items 2 or 3, as validated by an independent, recognized testing agency.

4.3.2 Electric detonators/initiators shall be designed and manufactured to withstand at least 7 pounds pull applied between the detonator body and the lead wires. *CAUTION: Do not field test this capability, as pulling wires from the detonator/initiator body could cause detonation.*

4.3.3 Percussion style detonators/initiators that are not exposed to well fluids/pressure shall be designed to withstand an impact of at least 2 foot-pounds without functioning. Percussion style detonators/initiators that are exposed to well fluids/pressure shall be designed to withstand an impact of at least 5 foot-pounds without functioning.

4.3.4 Detonators/initiators must not contain any exposed primary explosive (lead azide, etc.).

4.3.5 Specifications for the temperature and pressure rating of detonators that are exposed to the wellbore must be based on tests that simultaneously apply temperature and pressure.

4.4 Downhole Firing Systems.

4.4.1 Capacitive discharge systems must incorporate a permanent bleed off resistor that should discharge the capacitor to below 50% of the minimum required firing voltage within 60 seconds.

4.4.2 Non-electric downhole firing systems must require at least two independent actions to function the

detonator/initiator on or near the surface, incorporate at least two independent safety features that prevent inadvertent functioning, or have a combination of such actions and safety features. Categories of acceptable actions and features are:

1. Mechanical designs that physically restrict or limit actions required to cause functioning.
2. Mechanical designs that cause the detonation train to cease.
3. Pressure activation.

4.4.3 Downhole firing systems must not function when dropped in a manner simulating accidental dropping of the explosive tool a distance of 30 feet (9.1 meters) or more in air onto a steel plate supported by concrete.

4.4.4 Systems that require electrical hook-up to the detonator while on or near the surface must be such that the detonator can be armed electrically before ballistically.

4.5 Other Downhole Equipment.

4.5.1 Any downhole power source must incorporate at least two independent safety features that prevent inadvertent functioning when used in combination with a detonator/initiator.

4.5.2 Tool designs must be such that upon retrieval from the wellbore, internal trapped pressure can be safely bled down. Threaded connections must incorporate a feature that vents trapped pressure.

4.6 Special Provisions.

4.6.1 Propellant activated sidewall sample takers, select fire, and bullet perforating gun designs do not lend themselves to incorporation of initiators meeting the requirements of Par. 4.3. These tools should have a minimum of 50 ohms resistance in the downhole firing circuit and either; 1) a provision that prevents electrical connection to the initiating devices prior to running in the hole, or 2) a ballistic interrupter device that can be deactivated after the cable head is connected to the tool, or 3) another equivalent safety contingency. Interim operations of these devices should be determined to be safe by prior review and agreement between the service company and operator.

NOTE: *Field modification to equipment shall be allowed only with written approval of the equipment manufacturer.*

SECTION 5

PERSONNEL TRAINING

5.1 Introduction. The purpose of this Section is to establish recommended minimum qualifications for personnel who participate in the storage, handling, and use of explosives at the well site.

5.1.1 Explosive User. An Explosive User is a person that has completed training identified in Par. 5.2.1.

5.1.2 Explosive User in Charge. An Explosive User in Charge is the Explosive User responsible for safe explosive operations at the wellsite. This is the person responsible for connecting detonators to the explosive devices.

5.1.3 Explosive Trainee. An Explosive Trainee (any other person involved in explosives operations) has completed training identified in Par 5.2.2 and works under direct supervision of an Explosive User.

5.2 Qualifications. Personnel shall meet minimum age requirements as prescribed by federal, state, and local laws, rules, regulations, or statutes governing transportation and use of explosives. Personnel shall be determined to be physically and mentally competent as a condition of employment.

5.2.1 The *Explosive User* shall have a minimum of six (6) months training as an Explosive Trainee and have available on site a current document certifying training in the following areas:

1. Classification of explosives used in oilfield service operations.
2. Characteristics and behavior of each class of explosive.
3. Procedure for the safe handling of explosives, including detonators.
4. Procedure for safe well site operations involving use of explosive devices.
5. Applicable federal, state, and local laws, or applicable equivalent for operations outside the U. S.,

regarding the storage, handling, and disposal of each class of explosive.

6. Applicable federal, state, and local laws, or applicable equivalent for operations outside the U. S., regarding transportation of each class of explosive.

7. Annual refresher of Items 1 through 6 of Par. 5.2.1, including new tools and technology, with a comprehensive exam.

5.2.2 An *Explosive Trainee* shall have completed an orientation course prior to involvement in field operations involving explosives that includes the following:

1. Classifications of explosives used in oilfield service operations.
2. Characteristics and behavior of each class of explosive.
3. Procedures for safe handling of explosives, including detonators.
4. Procedures for safe well site operations involving use of explosive devices.

5.3 Training.

5.3.1 Formal training courses offering Items 1 through 7 of Par. 5.2.1 and Items 1 through 4 of Par. 5.2.2 can be provided by:

1. Service company/employer certification of employees based on successful completion of course work and exams.
2. Industry cooperative courses.
3. University courses.

5.3.2 Personnel training records should be verifiable through credentials issued by the service company/employer to qualified personnel. These credentials or appropriate individual training records should be made available, on request, to the operating company.

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