



Sanford

Underground Research Facility

South Dakota Science and Technology Authority

Explosive Materials Management Standard

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Revision History

Rev	Date	Section	Paragraph	Summary of Change	Authorized by
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1.0 Purpose

The Explosive Materials Management Standard shall provide the framework to ensure that management strategies are in place to:

- Minimize the risk of injury to all personnel and mitigate environmental impacts from explosive materials during storage, transport and use.
- Control the use of explosive materials to meet federal, state and local regulatory guidelines and incorporate best practices.
- Provide employees who are responsible for handling and using explosive materials onsite with the requirements needed to do so.
- Provide formalized inspection and inventory processes.
- Minimize disruptions and eliminate damage to science experiments.

2.0 Scope

This standard is applicable to Sanford Underground Research Facility (SURF) and applies to all South Dakota Science and Technology Authority (SDSTA) employees, science users and contractors/subcontractors exposed to explosive material handling, storage and transportation.

3.0 Definitions

Actual Possession – When a person is in immediate possession or control of explosive materials.

All-clear – An announcement made following a blast after ventilation controls have been restored to normal configuration and permissible air quality has been verified.

Ammonium Nitrate/Fuel Oil (ANFO) – An explosive material consisting of ammonium nitrate and fuel oil.

Attendant – A person assigned to a specific task or duty.

Attended – The physical presence by a person.

Authorized Escort – A person assigned to guide incoming explosive material deliveries from access gates to predetermined off-loading location.

Auxiliary Facilities – An underground storage structure that meets the requirements of 30 CFR Part 57, Subpart E – Explosives, and holds less than one week's supply of explosive materials.

Barricade – A physical barrier that separates the blasting area from personnel, equipment, flying materials, etc.

Blast(ed/ing) – The ignition of an explosive charge for the breaking and displacing of rock.

Blast Area – The area of blast within the influence of flying rock, gasses and concussion.

Blast Door – A door and frame that is engineered to resist the pressure and concussive forces of a nearby detonation; may serve as a ventilation control.

Blast Firing Location – A designated location outside of the blast area used for blast firing purposes and provided with a battery powered phone (e.g. FEMCO™) and radio capabilities for announcement of pre-blast warnings.

Blast Location – The actual area for excavation activities as specified in the blast plan.

Blast Monitoring – The measuring of air overpressure and ground vibration (concussive force) that occurs during the initiation of explosive materials.

Blast Patterns – A designed array of drilled holes to be loaded and detonated in a specified sequence.

Blast Plan – An engineered work document designed to manage explosive materials and optimize their efficiency while minimizing the negative impacts to underground personnel and ongoing research.

Blast Site – The area where explosive material is handled during the loading and detonation of blast holes; it includes at least 15 feet (4.6 meters) of the surrounding solid or broken rock.

Blast Time – The exact time the blast is initiated.

Blast Warning – Three sequential announcements providing blast initiation information; 15 minutes, 5 minutes and immediately prior to the blast.

Blast Window – A preestablished timeframe, not to exceed 60 minutes, for the scheduling of a blast, e.g. 9:00 - 10:00 am. At no time shall a blast occur prior to the scheduled blast window, e.g. 8:55 am would be unacceptable in the listed example.

Blast Zone – A predetermined area that accounts for dispersal of toxic and asphyxiating gasses associated with blasting.

Blaster – An individual designated by the responsible person (licensee/permittee) who is qualified in the use, transportation, storage and supervision of explosive materials and is responsible for the initiation of blasts.

Blasting Agents – Explosive materials have been tested and found to be so insensitive that it is unlikely that they will initiate or detonate in a fire during normal transportation conditions (cannot be detonated by a number 8 test detonator cap).

Blasting Cap – A metallic tube closed at one end containing a charge of one or more detonating compounds and designed for and capable of detonation.

Blasting Circuit – The distribution network utilized to initiate a blast; components may be comprised of detonator leads, trunkline, shot line, lead line and initiating device.

Blasting Permit – A form utilized to capture blast related information and used to inform personnel of associated hazards and requisite controls.

Cage Attendant – An Infrastructure Technician designated as a person responsible for communication of cage movements to the Hoist Operator.

Cargo Space – An area solely dedicated to storage and transport of explosive materials.

Competent – A person who is capable of identifying existing and predictable hazards in the surroundings or working conditions that are unsanitary, hazardous or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Constructive Possession – When a person lacks direct physical control over explosive materials but knowingly has the power and intention to exercise dominion and control over the explosive materials, either directly or indirectly through others (e.g., an employee at a construction site who keeps keys for magazines in which explosive materials are stored, or who directs the use of explosive materials by others).

Conveyance – Any nonself-powered unit used for transporting personnel or materials, including, but not limited to, trailers, railcars, cages and skips.

Detonate(ed/ing) – To cause to explode by the application of sudden force.

Detonating Cord – A flexible cord containing a center core of high explosives which may be used to initiate other explosives.

Detonator – Any device containing a detonating charge used to initiate an explosive. These devices include electric or nonelectric instantaneous or delay blasting caps, and delay connectors.

Detonator Leads – The wires or shock tube attached to the detonator.

Electric Blasting – The firing of one or more charges using electric igniting or exploding devices.

Employee Possessor – An individual who has actual or constructive possession of explosive materials.

Explosive – Any chemical compound, mixture or device that can undergo a rapid chemical reaction and produces an explosion.

Explosives Manifest – Documentation that accompanies the initial onsite delivery of explosive material.

Explosive Material – Explosives, blasting agents and detonators.

Extraneous Electricity – Electrical energy, other than actual firing current or the test current from a galvanometer, that is present at a blast site and that could enter an electric blasting circuit. Such

electricity can include lightning, current from high tensioned powerlines and static charge carried on a person.

Fly Rock – Rock that is propelled from the blast by the force of an explosion.

Grizzly – A device designed for the sizing or sorting of blasted rock.

Initiating Device – A device independent of facility electrical systems that provides electrical current or concussive force to the lead line to propagate the initiation of the explosive materials.

Intrinsically Safe – A protection technique for safe operation of electrical equipment in a hazardous area by eliminating the electrical or thermal energy available for ignition.

Inventory – (n) A listing of all explosive materials stored in a magazine. (v) The process of accounting for the listing of all explosive materials.

Lead Line – A primary line intended for repeat use that connects the initiating device to the shot line.

Loading – Placement of explosive materials into blast holes in preparation for a blast.

Magazine – A structure specifically constructed and located for the safe storage of explosive materials. Magazines include the following three types which are categorized based on amount of storage capability:

- Primary: may hold more than a one-week supply of explosive materials
- Auxiliary: limited to less than a one-week supply of explosive materials
- Day Box: limited to a one-day supply of explosive materials

Misfire – (v) The complete or partial failure of explosive material to detonate as planned. (n) The explosive material itself that has failed to detonate.

Nonelectric – A system for the firing of one or more charges dependent on nonelectric materials to initiate a blasting cap, e.g. safety fuse, ignitor cord, detonating cord, shock or gas tubing.

Personnel-trip – A trip in which persons are transported to and from a work place. This is not inclusive of cage attendants or equipment operators tasked with the responsibility of transport operations.

Primer – A unit, package or cartridge of explosives that contains a detonator and is used to initiate other explosive materials.

Purchaser's Representative – An individual appointed by the buyer of explosive materials who is responsible for receipt and inventory of delivered explosive materials.

Qualified – A person who, by possession of a recognized degree or certificate of professional standing, or who, by extensive knowledge, training and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work.

Responsible Person – An individual who has the power to direct the management and policies of the applicant pertaining to explosive materials.

Safety Fuse – A flexible cord containing an internal burning medium by which fire is conveyed at a continuous and uniform rate for the purpose of firing blasting caps.

Secondary Blasting – The use of explosive materials to reduce oversized rock to the dimension required for handling, or the blasting of misfires.

Semi-conductive Delivery Hose – A hose with an electrical resistance high enough to limit flow of stray electric currents to safe levels, yet not so high as to prevent drainage of static electric charges to ground; hose of not more than two megohms resistance over its entire length and of not less than 5,000 ohms per foot meets the requirement (e.g. ANFO hose).

Shot Line – A single-use line located within the blasting circuit that connects the trunkline to the lead line (see Figure 1: The Blasting Circuit Tie-in Sequence).

Shunted – Joining two points of a circuit to impede the flow of electrical current.

Signage – An administrative control that communicates workplace information or potential hazards and follows American National Standards Institute (ANSI) formatting.

Tamping – The process of using a non-sparking device to compress the explosive material within a blast hole.

Trigger Action Response Plan (TARP) – A predetermined list of controls aligned with escalating levels of risk.

Trunkline – The portion of the blasting circuit located at the blast site used for the tying-in of all loaded holes within a blast pattern.

Tying-in – The process of connecting loaded holes to an initiation device.

Unattended – A vehicle with no personnel at the controls.

Vehicle – A self-propelled means of transport that is mechanically or electrically powered, e.g. truck, van, locomotive, bus, etc.

Ventilation Controls – Engineered mechanisms designed and used to control the amount and direction of air flow, e.g. regulators, air locks, personnel doors, curtains, blast doors.

Without Undue Delay – When unrelated activities do not impede or take precedence of the specified task.

Workplace – Anyplace where work is being performed.

4.0 Responsibilities

4.1. SDSTA Executive Director

- 4.1.1. Ensures that necessary processes, tools and training regimes align with the risk profile.
- 4.1.2. Ensures accountability of the requirements of this document with direct reports.
- 4.1.3. Maintains responsible person status.
- 4.1.4. Define the responsibilities of the position.

4.2. Director of Facility Infrastructure

- 4.2.1. Reviews SDSTA self-performing blast plans and blasting permits.
- 4.2.2. Reviews/comments on non-SDSTA managed blast plans.
- 4.2.3. Receives blasting permit notifications and reviews for scheduled work activity conflicts.
- 4.2.4. Ensures that direct reports follow all requirements as specified in this standard.
- 4.2.5. Ensures SDSTA equipment, conveyances and vehicles used for explosive materials are properly maintained.

4.3. Director of Underground Access

- 4.3.1. Approves SDSTA self-performing blast plans and blasting permits.
- 4.3.2. Reviews/comments on non-SDSTA managed blast plans.
- 4.3.3. Receives blasting permit notifications and reviews for scheduled work activity conflicts.
- 4.3.4. Ensures that direct reports follow all requirements as specified in this standard.
- 4.3.5. Ensures personnel conduct the proper inspections, inventories and housekeeping of SDSTA controlled explosive magazines.
- 4.3.6. Ensures personnel conduct the proper inspections of explosive magazines.
- 4.3.7. Maintains the inventories for the explosive materials.
- 4.3.8. Ensures protocols and procedures are followed per blasting permits.
- 4.3.9. Takes initial receipt of incoming explosive materials deliveries. (The Underground Access Director shall be notified 24 hours in advance of all deliveries of explosive materials).

4.4. Director of Environment Safety & Health (ESH)

- 4.4.1. Approves SDSTA self-performing blast plans.
- 4.4.2. Reviews/comments on non-SDSTA managed blast plans.
- 4.4.3. Receives blasting permit notifications and reviews for scheduled work activity conflicts.
- 4.4.4. Ensures that direct reports follow all requirements as specified in this standard.
- 4.4.5. Coordinates training resources and maintains associated records.
- 4.4.6. Manages the permit and licensing process.
- 4.4.7. Audits the inventory process.

4.5. Director of Science

- 4.5.1. Reviews SDSTA self-performing blast plans and blasting permits.
- 4.5.2. Reviews/comments on non-SDSTA managed blast plans.
- 4.5.3. Receives blasting permit notifications and reviews for scheduled work activity conflicts.
- 4.5.4. Ensures that direct reports and users follow all requirements as specified in this standard.
- 4.5.5. Notifies principal investigators and lab coordinators of blasting schedules.

4.6. Responsible Person

- 4.6.1. Directs the management and policies of the applicant pertaining to explosive materials.

4.7. Employee Possessor

- 4.7.1. Follows all requirements within this standard.

4.8. Project Manager

4.8.1. Ensures that project personnel follow all requirements as specified in this standard.

4.9. Supervisor

4.9.1. Ensures that direct reports follow all requirements as specified in this standard.

4.10. On-Site Personnel

4.10.1. Follows all requirements as specified in this standard.

4.11. Duty Officer/Security

4.11.1. Supports communication efforts as identified in the blast permit procedure.

5.0 Instructions

This section provides guidance and directives covering the use of explosive materials and has been developed in a sequential manner reflective of the lifecycle usage of explosive materials.

5.1. Regulatory licensing and permitting

- There are federal, state and local licenses and permits that must be obtained prior to receiving and using explosive materials (see Table 1: Permit and License Requirements).

Government Agency	Application Form	Permit/License
Federal (Alcohol Tobacco Firearms and Explosives (ATF))	ATF Form 5400.13/5400.16	Federal Explosives License/Permit-User of Explosives (ATF Form 5400.14/5400.15 Part I)
Federal (ATF)	Employer Possessor Questionnaire – 5400.28	Notice of Clearance for Responsible Person and Employer Possessor
State (South Dakota)	Application for Permit to Purchase, Use, Transport, Sell, or Manufacture Explosives	South Dakota Explosives Permit
Local (City of Lead)	Magazine Inspection	Approval of City Building Inspector

Table 1: Permit and License Requirements

5.2. Qualifications for authorized personnel

- SDSTA recognizes three qualification levels associated with corresponding explosive materials management responsibilities (see Table 2: Qualification Levels for Explosive Materials Related Activities).

	Responsible Person	Employee Possessor *	Blaster **
Licensee/Permittee	✓		
Qualified to Supervise Use of Explosives			✓
Responsible for Blasting Activities			✓
Authority to Direct Management and Policies	✓		
Qualified to have Constructive Possession		✓	
Qualified to have Actual Possession		✓	

Table 2: Qualification Levels for Explosive Materials Related Activities

* Employee possessors may not necessarily be blasters.

** All blasters must be employee possessors.

- Blaster requirements
 - The blaster has direct responsibility for the safe initiation of all explosive materials and ensures compliance with the blast permit. The blaster shall:
 - ◆ Ensure that anyone handling explosive materials is an employee possessor.
 - ◆ Be able to understand and give written and oral orders.
 - ◆ Be in good physical condition and not be addicted or under the influence of narcotics, intoxicants or similar types of drugs.
 - ◆ Be required to furnish satisfactory evidence of competency in handling explosive materials and performing in a safe manner for the type of blasting that will be required.
 - ◆ Be knowledgeable and competent in the use of each type of blasting method used.
 - ◆ Ensure that untrained, inexperienced personnel are always under the immediate and direct supervision of a person trained and experienced in the handling and use of explosive materials.
 - ◆ Be familiar with and understand the requirements of the blast plan.

5.3. Blast Plan

- The blast plan is foundational to all blasting activities and specific to each blast scenario, e.g. borehole access drift, enlargement of travelway, Ross Shaft/4850L transition, intersection development, chamber bench round, etc.
- The design and development of the blast plan shall be performed by an individual who is qualified in all aspects of explosive management and authorized by the responsible person of the company engaged in the use of explosives. The submission of the blast plan must take place at least two weeks prior to planned blasting activities. In the event of an unplanned blast scenario, SDSTA will expedite the review process.
- The blast plan for self-performing blast activities must be approved by the SDSTA Environment Safety & Health Director and Underground Access Director. The blast plan shall be provided to the Science Director for review and comment.
- The blast plan for non-SDSTA managed contractor blast activities must be submitted to the SDSTA Environment Safety & Health Director, the Underground Access Director and Science Director for review and comment prior to engaging in any blasting activities under the proposed plan.
- At a minimum, the blast plan shall include:
 - Projected date of blast scenario, e.g. July 1, 2020 – December 31, 2020
 - Restrictions to primary and secondary access/egress and refuge chamber travelways, including time lost to:
 - ◆ Blast.
 - ◆ Wetting down.
 - ◆ Scaling.
 - ◆ Removal of blasted rock, and.
 - ◆ Installation of ground support.
 - Configuration of blast/ventilation controls.
 - Placement of personnel (guard) for access control during a blast and subsequent ventilation activities.
 - Potential fly rock.
 - Gasses and dust produced by a blast and associated ventilation dispersal times that shall be established by a qualified ventilation engineer.
 - Effects of noise on personnel.
 - Impacts to normal traffic patterns prior to, during and after blasting activities.
 - Considerations for potential to adversely impact travel in the shafts.
 - Detailed diagram of intended blasting circuit e.g. all electric, all nonelectric, combination electric and nonelectric.
 - Types and amounts of explosive materials to be used in a standard round to control fragmentation and overbreak.

- o Types of explosive materials to be used.
- o Location and type of magazines and types of contents (e.g., 4850L primary explosive/powder magazine - detonator cord, Trim-Tex™, ANFO, Tovex™).
- o Copies of all supporting licenses and permits.
- o Identification of regularly scheduled time-frames greater than four hours without blasting activities taking place.
- o Signatures:
 - ◆ Responsible person.
 - ◆ Blast plan author.
 - ◆ Fermi Research Alliance (FRA) authorization and SDSTA reviewer.
- o Methods of blast monitoring to evaluate the following effects:
 - ◆ The blast energy transmitted through the air overpressure.
 - ◆ The blast energy transmitted through the rock (shock wave) to include the frequency and amplitude of blast vibrations on the surface and underground.
 - ◆ Blast monitoring data to be made available to SDSTA upon request.
- o Any change to an approved blast plan requires that an updated blast plan be submitted for review and approval.

5.4. Work planning & control requirements

- A Job Hazard Analysis (JHA) and Standard Operating Procedure (SOP) shall be developed and implemented for each operational task and blast-related activity. Personnel shall be trained in all JHAs and/or SOPs prior to participating in associated work activities.
- Blasting Permits
 - o SDSTA has stakeholders representing activities not directly associated with blasting. The underground areas are reliant upon consistent ventilation flows and accessible travelways. During blasting operations, ventilation and some travelways may be impeded for brief periods of time during pre/post blasting activities. To ensure the safety and health of personnel, environment and property, communication of blasting activities is necessary. An ESH-(5000-F)-128500 Blast Permit shall be utilized to serve as a proactive means of communicating blasting details. This permit shall be provided to SDSTA, as per the blast permit procedure, at least three hours prior to a planned blast. At a minimum, the permit shall include:
 - ◆ Date issued.
 - ◆ Shift.
 - ◆ Permit owner.
 - ◆ Name of blaster.
 - ◆ Blast phase.
 - ◆ Blast window.
 - ◆ Specific blast location.

- ◆ Blast door/vent/curtains/controls (configuration pre/post blast).
- ◆ Amount of explosive materials in pounds.
- ◆ Blast zone.
- ◆ Minimum ventilation times (time to reduce blast gasses to allowable threshold limit values (TLV) levels).
- ◆ Signatures.
- ◆ Blast phase map (e.g. 1-A, 1-B).
- If a blast does not occur during the scheduled blast window, that blast shall not occur until the next scheduled blast window and must be aligned with the blast permit process.
- The completion and submission of the blast permit shall be performed by an individual(s) who is/are competent in all aspects of blast-related activities and the associated ventilation and blasting controls. This person shall be authorized by the responsible person of the company engaged in the use of explosives.
- Underground evacuation
 - In the event of an emergency requiring the underground workings to be evacuated, the following processes shall be adhered to:
 - ◆ Blasting activities shall cease.
 - ◆ Blasting circuit shall be isolated, if applicable.
 - ◆ Blast area shall be made secure with signage and barricades.
 - ◆ Personnel shall exit the underground workings in the prescribed manner.
- Trigger Action Response Plan (TARP)
 - In some instances, a TARP may be proactively developed to address escalating levels of risk, e.g. lightning/explosives – TARP (see Table 3).
 - At least one handheld personal lightning detector/monitor shall be utilized during the handling of any explosive material on the surface.

BLUE ALERT 40 – 20 miles (64 – 32 km)	YELLOW ALERT 20 – 10 miles (32 – 16 km)	RED ALERT 10 – 0 miles (16 – 0 km)
SURFACE		
<ul style="list-style-type: none"> Off-loading explosive materials shall not be started. When in the process of off-loading explosive materials for transport underground or into magazines, those activities may continue without undue delay. Surface loading and blasting activities are prohibited. 	<ul style="list-style-type: none"> All handling of explosive materials on surface to cease and personnel to be withdrawn from magazines. Explosive materials laden shaft conveyances shall proceed underground and immediately be off-loaded. 	<ul style="list-style-type: none"> All personnel to seek shelter indoors. All handling of explosive materials on surface to cease and personnel shall be withdrawn from magazines. All hoisting activities relating to the movement of explosives shall cease. Personnel are prohibited from entering onto a shaft conveyance from any level, including the surface.
UNDERGROUND ACCESS		
<ul style="list-style-type: none"> Use of explosive materials is permitted when initiation systems are independent and isolated from surface power source. Connection of electrical initiation systems is not permitted when initiation systems are dependent on and not isolated from surface power source. 	<ul style="list-style-type: none"> Explosive materials laden shaft conveyances shall proceed underground and immediately be off-loaded. Connection of electrical initiation systems is permitted when initiation systems are isolated from the facility electrical systems. 	<ul style="list-style-type: none"> Personnel handling explosives are prohibited from entering onto a shaft conveyance from any level, including the surface. Connection of electrical initiation systems is permitted when initiation systems are isolated from the facility electrical systems.
BE AWARE	BE PREPARED	TAKE ACTION

Table 3: TARP Lightning/Explosives

5.5. Explosive material storage – general

- There are general requirements that apply to all magazines without regard to their type or location.
- All explosive materials shall be stored in approved locations in a manner that protects personnel, the public, property, environment and the explosive materials. The storage of explosive materials shall be confined to approved magazines. At a minimum, all magazines shall be:
 - Located out of the line of blasts so they will not be subjected to concussive forces or fly rock.
 - Separated by at least 25 feet (7.62 meters) from other facilities used to store detonators.

- Used exclusively for the storage of explosive material.
- Free of all sparking materials in the interior.
- Kept in good repair.
- Emptied of all explosive materials prior to making repairs to the inside or outside.
- Maintained to prevent the accumulation and storage of combustibles within 50 feet (15.24 meters) of explosive materials.
- Located in an area that is graded and/or bermed in a manner to allow for drainage away from the area and to prevent the introduction of fluids.
- Provided with signage that is visible from all angles of approach and communicates the nature of the hazard, e.g., “Danger,” “Explosives,” “Keep Out”.
- Located at least 50 feet (15.24 meters) from electric substations.
- Located at least 25 feet (7.62 meters) from detonator storage facilities..
- Located out of the line of blasts and protected from uncontrolled vehicular traffic.
- Free of electrical switches and outlets inside the facility and if internal lighting is provided, must be intrinsically safe, kept clean, dry, orderly and well ventilated.
- Organized so that explosive materials are:
 - ◆ Stacked in a stable manner less than 8 feet (2.44 meters) high.
 - ◆ Stored according to brand and type to facilitate identification.
 - ◆ Placed in such a fashion to utilize oldest materials first.
- The ATF requirements of 27 CFR Part 555, Subpart K– storage requirements, shall be adhered to when designing, placing and implementing an approved storage facility.
- Inventory and inspection of magazines – general
 - There are general requirements that apply to the inventory and inspection of all magazines without regard to their type or location.
 - A running inventory of explosive materials shall be maintained any time the product is removed from or placed into the magazine.
 - At least every 7 days, the magazine shall be:
 - ◆ Inspected for housekeeping.
 - ◆ Inventoried for contents.
 - ◆ Inspected for unauthorized or attempted entry.
 - ◆ Inventoried and reconciled to reflect the actual number of explosive materials in the magazine.
 - If reconciliation is necessary, an immediate investigation is required to determine cause of discrepancy. In the event of suspected theft, ATF shall be notified.
 - Explosive materials shall be stored in locked magazines unless they are being:
 - ◆ Physically attended.

- ◆ Used.
- ◆ Transported.
- ◆ Loaded or unloaded into or from transportation vehicles or conveyances.

5.6. Explosive material storage – specific types

- For all specific types of explosive materials storage facilities, the general storage requirements as listed above apply and must be adhered to.
- Surface magazine – specific types.
 - Storage of explosive materials on the surface can pose a risk to employees, the general public, property and the environment. In all cases, the following surface magazine requirements apply:
 - ◆ The areas surrounding storage facilities for explosive materials shall be clear of rubbish, brush, dry grass and trees for 25 feet (7.62 meters) in all directions; live trees 10 feet (3.05 meters) or taller need not be removed.
 - ◆ The magazine must be bullet resistant.
 - ◆ Metal magazines shall be equipped with electrical bonding connections between all conductive portions, so the entire structure is at the same electrical potential.
 - ◇ Suitable electrical bonding methods include welding, riveting or the use of securely tightened bolts where individual metal portions are joined.
 - ◇ Conductive portions of nonmetal magazines shall be grounded.
 - ◆ Metal magazines must be provided with assured grounding.
 - ◆ Signage must be placed in such a manner that if a bullet passed through any of the signs it would not strike the magazine.
 - Primary underground magazine – specific types
 - Main facilities used to store explosive materials underground shall be located:
 - ◆ In stable or supported ground.
 - ◆ In such a way that loss of control of any vehicle does not result in an impact to the magazine.
 - ◆ So that a fire or explosion in the storage facilities will not impede the access along emergency egress routes or cause detonation of the contents of another storage facility.
 - ◆ At least 200 feet (60.96 meters) from any shaft or active underground workplace.
 - Auxiliary underground magazine – specific types
 - Auxiliary facilities used to store explosive materials near work places shall be wooden, box-type containers equipped with covers or doors, or facilities constructed or excavated in a manner to provide equivalent impact resistance and confinement.
 - The auxiliary facilities shall be:
 - ◆ Located at least 15 feet (4.57 meters) from all travelways and electrical equipment or placed entirely within a mined-out recess used exclusively for explosive materials.

- ◆ Kept securely locked unless all access to the facility is either locked or attended.
- ◆ Filled with no more than a one-week supply of explosive materials.

5.7. Delivery, acquisition and inventory

- The receipt and management of explosive materials is closely monitored, documented and supervised during all phases of the delivery, acquisition and Inventory process.
- Delivery:
 - The Underground Access Director or designee shall be notified 24 hours in advance of all deliveries of explosive materials to SURF.
 - All incoming deliveries shall remain outside of the gate until an authorized escort is provided. Prior to entry, the explosives manifest must be provided to the authorized escort.
 - Upon entry to the site, the delivery vehicle is to be escorted immediately to a pre-determined off-loading location that shall include:
 - ◆ Signage visible from all angles of approach that indicates:
 - ◇ Explosive materials handling zone.
 - ◇ Restricted access.
 - ◇ No smoking/open flames.
 - ◆ Sufficient space that is:
 - ◇ Clean, neat and orderly.
 - ◇ Free of slips, trips and fall hazards.
 - ◇ Free of combustibles.
 - ◇ Properly illuminated.
 - ◇ Dedicated for the sole purpose of receiving the explosive materials.
 - ◇ Provided with a minimum of two 10-pound ABC fire extinguishers.
 - ◇ Free of extraneous electricity.
 - ◆ Appropriate configuration of primary delivery vehicle:
 - ◇ explosive materials laden vehicle shall have its emergency brakes set and wheels chocked to prevent inadvertent vehicle movement.
 - ◇ Engine must be shut off unless necessary for loading or unloading operations and is equipped with an exhaust spark arrestor.
 - When explosive materials are transported on public roadways all Department of Transportation regulations must be adhered to.
- Acquisition and inventory:
 - A physical inventory shall occur in the presence of the purchaser's representative and be reconciled against the explosives manifest. The inventory shall be conducted:
 - ◆ Immediately following or during off-loading of contents from delivery vehicle into a surface magazine, or in the case of shaft delivery, prior to product being placed on conveyance.

- o The explosives manifest shall be signed off by the appointed purchaser's representative and the delivery driver of the explosive materials.
- o Upon verification of the explosives manifest, the delivery vehicle shall be escorted off-site.
- o Inventory and explosives manifest documents shall:
 - ◆ Accurately reflect quantities received.
 - ◆ Be noted and communicated to the purchaser's representative and the vendor supplying the product of any variances in documents.
 - ◆ Be retained for the life of project or five years, whichever is greater.
 - ◆ Be retained in a location that provides for immediate access upon request:
 - ◇ Contractors are responsible for their own record keeping and copies shall be provided to SDSTA within one business day.

5.8. Transportation of explosive materials – general

- There are general requirements that apply to the transportation of explosive materials without regard to mode of transport.
- Explosive materials shall be transported without undue delay to the storage area or blast site. Unrelated activities shall not impede this task, e.g. other use of the hoist, transporting equipment, etc.
- Vehicles or conveyances utilized in the transport of explosive materials shall:
 - o Be occupied only by persons necessary for handling the explosive materials.
 - o Be attended or secured against unauthorized access.
 - o Be strictly dedicated for this purpose until the task is complete.
 - o Contain only properly secured, non-sparking tools required for the task.
 - o Never be combined with personnel-trip activities.
- Cargo spaces shall:
 - o Not be utilized to transport personnel.
 - o Have a means of securing explosive materials and non-sparking equipment.
 - o Be free of exposed sparking material or have a means of securing and covering explosive materials to prevent contact with sparking surfaces.
- Shaft transportation of explosive materials – specific
 - o In preparation for and during the transport of explosive materials in a shaft, the following shall be adhered to:
 - ◆ The hoist operator shall be notified prior to placing any explosive materials on a hoisting conveyance.
 - ◆ Personnel shall not ride with explosive materials.
 - ◆ Only those activities associated with the hoisting of explosive materials shall be performed. All other hoist related activities shall cease until all explosive materials are removed from the conveyance and in the immediate underground level/station area.

- ◆ Explosive materials transported in hoist conveyances shall be secured in a manner which prevents shifting of the cargo that could cause detonation by impact or by sparks.
- ◆ Explosive materials may be transported within the manufacturer's packaging and secured to a non-conductive pallet.
- Non-shaft transportation of explosive materials – specific
 - Vehicles and conveyances that are being used to transport explosive materials shall:
 - ◆ Be inspected prior to use and maintained in sound mechanical and electrical condition.
 - ◆ Have sides and enclosures higher than the explosive materials being transported, or have the explosive materials secured to a nonconductive pallet.
 - ◆ Have wheels chocked when parked.
 - ◆ Have 4 inches (10.16 centimeters) of separation, by hardwood or equivalent, when explosives and detonators are transported together.
- Rail transport
 - When utilizing locomotives and railcars the following is required:
 - ◆ Explosive materials shall not be transported on any locomotive.
 - ◆ Proper signage shall be displayed, e.g. “DANGER: EXPLOSIVES”.
 - ◆ The conveyance containing explosive materials shall be pulled, not pushed, whenever possible.
 - ◆ When pushing cars containing explosive materials:
 - ◇ Travel shall be reduced to walking speed or less.
 - ◇ The car(s) shall be visible to the operator or the attendant at all times.
 - ◇ A safety draw bar shall be utilized.
- Vehicle transport
 - All self-propelled mobile vehicles must:
 - ◆ Have a current, documented pre-use inspection.
 - ◆ Have a minimum of two multipurpose dry-chemical fire extinguishers each having a rating of at least 10lb–ABC or one such extinguisher and an automatic fire suppression system.
 - ◆ Display the proper signage, e.g. “DANGER: EXPLOSIVES”.
 - When explosive material-laden vehicles, designed for specific Loading applications, are unattended the:
 - ◆ Brakes must be set
 - ◆ The engine must be shut off unless powering a device that is used in the loading operation

5.9. Blast site requirements

- The blast site shall be made ready to receive explosive materials prior to transporting explosive materials from the magazine. Preparations shall include:

- The inspection and securing of face, back and ribs for loose material.
- Ensuring that only the equipment necessary for loading of the holes is present.
- Only the necessary quantity of materials for the blast shall be transported to the blast site. Explosive materials at the blast site shall be attended, and the area shall be barricaded and posted with signage.

5.10. Preparation for loading activities

- All loading and blasting activities shall be conducted under the guidance of a blaster.
- All drilling activities on a bench or face shall be completed prior to loading activities.
- Blast holes shall be checked and wherever possible, cleared of obstructions.
- Explosive materials shall be kept separated from detonators until loading begins.
- Primers shall be made up only at the time of use and as close to the blast site as conditions allow.
- The only activities permitted within the blast site are those directly related to the loading operation.

5.11. Loading activities

- During the Loading of holes, the following protocols shall be adhered to:
 - Only those holes to be blasted in a single shot shall be loaded.
 - Tamping shall be done only with non-sparking materials.
 - The primed cartridge must have an additional cartridge placed on it before tamping begins.
 - When loading blasting agents pneumatically, semi-conductive delivery hose shall be used, and the equipment shall be bonded and grounded.
 - Primers shall be prepared with the detonator contained securely and completely within the explosive or contained securely and appropriately for its design in the tunnel or cap well.
 - Loading and blasting shall be conducted in a manner designed to facilitate a continuous process.

5.12. Unused explosive materials returned to magazine

- Unused explosive materials shall be returned to the magazine as soon as practicable after loading operations are completed. When possible, unused explosive materials returned to magazines shall be utilized during the next blast.

5.13. Disposal of used packaging materials

- Explosive materials packaging shall be removed from the area and disposed of in the following manner:
 - All residual explosive materials must be removed from packaging.
 - Explosive material must be characterized to determine its waste classification — regulated or non-regulated.
 - Packaging shall be burned as per associated permits or be flattened, bundled/packaged and secured in such a manner as to prevent dispersion for disposal as per its classification.

5.14. Tying-in of blasting circuit

- Prior to tying-in any component of the blasting circuit; the blaster shall ensure that:
 - The initiation device is secured in such a manner that no one other than the blaster has the capability to activate the device.
 - The electrical blasting circuit is separated from any portion of a non-associated electrical power source.
 - Connecting the blasting circuit beyond the trunkline occurs as near as practicable to the proposed blast window, as stipulated on the ESH-(5000-F)-128500 Blast Permit.
- If extraneous electricity is suspected in an area where electric detonators are used, loading shall be suspended until tests determine that stray current does not exceed 0.05 amperes through a 1-ohm resistor when measured at the location of the electric detonators. If greater levels of extraneous electricity are found, the source shall be determined, and loading shall not take place until the condition is corrected.
- If the blasting circuit consists of any electrical blasting components, each downstream portion of the circuit must be shunted at both ends and kept physically separated from the loaded round. Shunted components are only un-shunted as the blasting circuit is sequentially tied-in as shown in Figure 1: The Blasting Circuit Tie-in Sequence. (Please note: Figure 1 is an example of a blended approach using nonelectric detonators and detonator cord at the face and an electrical blasting system for the remainder of the blasting circuit. It also details the sequence for the tying-in of the round using a five-step approach). Additionally, safety protocols are listed to reflect items that shall be addressed prior to engaging in the next step.
- Prior to engaging in step 2 of the blasting circuit sequence; the following must be performed:
 - Ensure only necessary personnel responsible for tying-in are present at the blast site.
 - Check for continuity of series if using electric detonators in the blast hole.
 - Secure the blast area.
 - ◆ Physically ensure all ventilation controls and blast doors are configured as per the ESH-(5000-F)-128500 Blast Permit.
 - ◆ Place guards, as per the blasting plan, to prevent access to the:
 - ◇ Blast area.
 - ◇ Exhaust pathways that may be impacted by blast gasses.
- Prior to engaging in step 3 of the blasting circuit sequence:
 - Ensure the shot line is shunted on the spool before tying-in to the leg wires of the detonator (step 2).
 - Ensure the lead line is shunted at both ends prior to unrolling the shot line to the lead line.

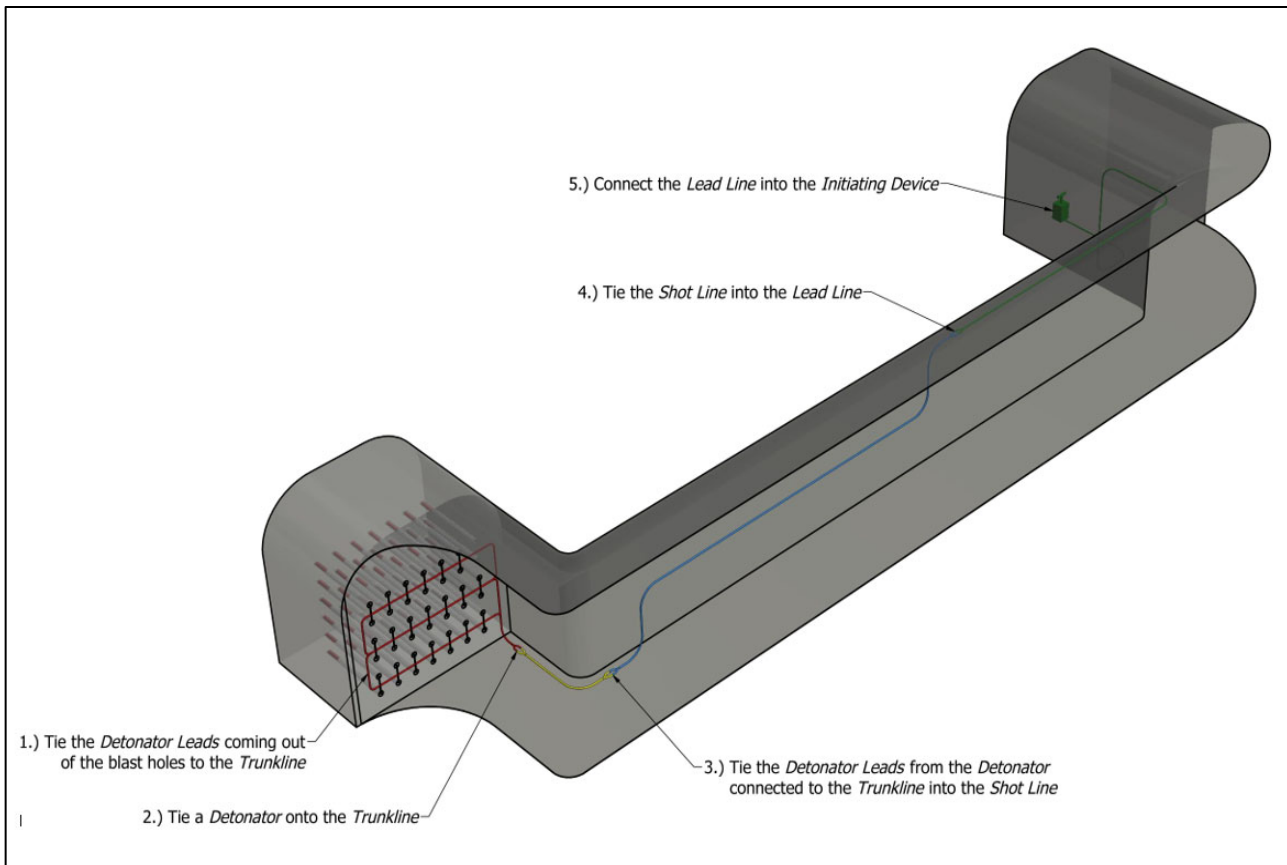


Figure 1: The Blasting Circuit Tie-in Sequence

- Prior to engaging in step 4 of the blasting circuit sequence, the following sequential steps shall take place.
 - Travel to the blast firing location.
 - Ensure all personnel in the blast area have been evacuated and that the area is secure.
 - Initiate blast warning sequence via battery-powered phone and/or radio device:
 - ◆ 15 minutes prior to blast announce the blast time.
 - ◆ 5 minutes prior to blast announce blast time.
 - Un-shunt the lead line and connect to the firing device:
 - ◆ Immediately prior to blast, announce “fire-in-the-hole” or similar warning.
 - ◆ Fire the round.
- Terminology of the components of a blasting circuit may vary; however, the tying-in sequence remains the same. Electric and nonelectric blasting systems have differing components, therefore all components as shown in Figure 1 may not be present.

5.15. Post-blast activities

- As soon as practicable, ventilation and blasting controls shall be reconfigured to allow for normal ventilation processes.
 - Allow enough time for ventilation to remove toxic gasses.

- To support re-entry activities, testing of the air for toxic gasses shall be conducted by at least two people traveling together. Measurements shall be performed for the following gasses to verify satisfactory air quality:
 - ◆ Oxygen (19.5% - 23.5%).
 - ◆ Nitrogen Dioxide/Oxides of Nitrogen (3 ppm or less).
 - ◆ Carbon Monoxide (50 ppm or less).
 - ◆ (Gasses reflect allowable threshold limit values with an 8-hour time weighted average).
- Upon verifying satisfactory air quality, the primary travelways within the blast area may be released for normal activities with barricades or guards removed and an all-clear announcement made over the communication system, e.g. radio, battery-powered phone.
- During the air quality monitoring, ground condition inspections shall be conducted throughout the travelway and into the blast area.
- Prior to entry of personnel under freshly blasted ground, the area shall be scaled down and necessary ground support must be installed.
- As entry is being made up to the vicinity of the blast site, a visual inspection shall be performed for indication of misfires.
- Following initial ground condition/misfire inspections, the freshly blasted muck and surrounding rock walls shall be wet down. As water is being applied to the rock walls and the muck pile, loose rock may be identified, and gasses liberated from the broken materials. Ensure that gas monitoring and misfire inspections are continuously performed to safely support these activities.
- Inspection for misfires
 - Immediately upon re-entry to the blast area, and during mucking and bolting activities, a thorough examination shall be conducted for misfires. Evidence of misfires may be readily visible, however at times, misfires may be discovered during post-blast activities, e.g. mucking or bolting cycles. Misfires shall be considered hazardous and detrimental to the safety of workers and must be addressed in a prompt and safe manner. All misfires shall be immediately reported to the blaster's supervisor and SDSTA upon being identified.
 - All misfires shall be documented, and records retained for two years.
 - Due to the varying and unique designs of electronic detonator systems, Misfires must be handled according to the specific manufacturer's recommended procedures.
- Addressing misfires
 - When a misfire is suspected, persons shall not enter the blast area for 30 minutes or per the manufacturer-recommended time, whichever is longer.
 - When a misfire is identified, only work that is absolutely necessary to safely access and address the misfire shall be permitted in the affected area. Necessary work may include:
 - ◆ Washing and wetting down.
 - ◆ Scaling.
 - ◆ Muck removal.

- ◆ Ground support installation.
- Once the location of the misfire can be safely accessed, all other activities are to cease, and the misfire shall be addressed. If it is necessary to blast a misfire(s), the following shall be adhered to:
 - ◆ If the misfire does not adversely impact travelways or ventilation, the misfire shall be blasted during the next scheduled blast window.
 - ◆ If the misfire does impact travelways or ventilation, a plan shall be developed to address the impacted travelways or ventilation; it must be communicated to SDSTA and affected stakeholders.
 - ◆ Misfires shall be addressed under the direction of the blaster.
 - ◆ When a misfire cannot be disposed of promptly, each approach to the area affected by the misfire shall be posted with signage at a conspicuous location to prohibit entry, and the condition shall be reported immediately to supervision.
 - ◆ Explosives and detonators/blasting caps recovered from misfires shall be returned to a magazine and separated from the other inventory.
 - ◆ Misfired explosives and blasting caps shall be disposed of in the manner recommended by the manufacturer.
- Secondary blasting
 - Blast patterns, sequencing of detonator delays and amounts of placed explosive materials are typically designed to achieve optimum fragmentation and advance rates. It is not uncommon for fragmentation to be suboptimal, resulting in oversized materials. Oversized materials may be subject to secondary blasting.
 - Secondary blasting shall only be performed in an area that minimizes harmful impacts to personnel and equipment. Consideration shall be given to:
 - ◆ Confinement of fly rock.
 - ◆ Disruption of ventilation.
 - ◆ Release and ventilation of toxic fumes.
 - ◆ Travelways.
 - ◆ Safety of all personnel.
 - Secondary blasting shall be conducted under the direction of the blaster.
 - Blasting of oversized materials shall not occur on a grizzly.

5.16. Training requirements

- All responsible persons, employee possessors and blasters shall be trained in methods, equipment usage and hazard identification in accordance with their respective role(s).
- All personnel at SURF attending the General Safety Basic Training shall receive instruction in the:
 - Recognition of explosive materials.
 - Dangers associated with explosive materials.

- o Notification process of unsecured explosive materials.
- o Toxic and asphyxiating gasses associated with explosive materials.
- o Roles and responsibilities of those authorized to handle explosive materials.
- o Placards and signage associated with the use of explosive materials.
- o Safeguards for personnel who may be indirectly impacted by blasting activities.

6.0 Documented Information/Related Document

- 6.1.** ESH-(5000-F)-128500 Blast Permit
- 6.2.** General requirements are called out sequentially throughout the document as required and are aligned with 27 CFR 555 Subpart G – Records and Reports. It is the responsibility of the explosive permittee(s) to ensure compliance with all ATF records and reporting requirements.
- 6.3.** 30 CFR Part 57, Subpart E – Explosives
- 6.4.** 27 CFR 555 – Commerce in Explosives
- 6.5.** 29 CFR 1926.901 – Blaster Qualifications
- 6.6.** 29 CFR 1910, Subpart N – Materials Handling and Storage
- 6.7.** 29 CFR 1910.109 – Explosives and Blasting Agents
- 6.8.** 29 CFR 1926, Subpart U – Blasting and the Use of Explosives
- 6.9.** 29 CFR 1926.800 (p) (1,2) – Underground Construction
- 6.10.** State of South Dakota Explosives Permit
- 6.11.** Federal Explosives License/Permit – User of Explosives
- 6.12.** (ATF Form 5400.14/5400.15 Part I)
- 6.13.** DOE-STD-1212-2012 (content evaluated for ATF equivalency)
- 6.14.** Notice of Clearance for Responsible Person and Employer Possessor
- 6.15.** Intergovernmental Agreement
- 6.16.** Memorandum of Understanding between the Department of Justice (ATF) and the Department of Labor (MSHA)