

Explosives**SPP#1910.109****Quick Reference**

1.0 Purpose	1
2.0 Scope and Applicability.....	1
3.0 <u>References</u>	2
4.0 <u>Policy</u>	2
5.0 <u>General Responsibilities</u>	3
6.0 <u>Procedures</u>	3
6.1 <u>Definitions</u>	3
6.2 <u>General Provisions</u>	5
6.2.1 <u>Training Requirements</u>	5
6.2.2 <u>Qualifications of Explosives Specialists</u>	5
6.2.3 <u>Types of Explosives</u>	6
6.2.4 <u>Minimum Equipment Required to Initiate Explosives</u>	7
6.2.5 <u>Extraneous Electricity Hazards with Electric Blasting Caps</u>	7
6.2.6 <u>Equipment Procurement</u>	8
6.2.7 <u>Storage Requirements</u>	8
6.2.8 <u>Labels, Signs, and Markings</u>	8
6.2.9 <u>Transportation of Explosives on NCDOT Equipment</u>	8
6.2.10 <u>Security and Recordkeeping</u>	9
6.3 <u>Specific Responsibilities</u>	9
6.3.1 <u>Managers/Unit Head's</u>	9
6.3.2 <u>Supervisors</u>	9
6.3.3 <u>Employees</u>	9
6.3.4 <u>Explosives Specialists</u>	10
6.3.5 <u>Safety and Loss Control</u>	10
<u>Explosives Flow Chart</u>	11
APPENDIX A: <u>Training Requirements and Required Publications</u>	12
APPENDIX B: <u>Minimum Equipment Required for Electrically and Non-Electrically</u>	13
<u>Initiated Blasting</u>	13
APPENDIX C: <u>Electric Blasting Precautions Around Extraneous Electricity</u>	14
APPENDIX D: <u>Types of Magazines and Explosives Storage Requirements</u>	15
APPENDIX E: <u>Transportation Requirements for Explosives</u>	16
APPENDIX F: <u>Same Vehicle Transportation Requirements for Detonators and</u>	17
<u>Explosives</u>	17
APPENDIX G: <u>Security and Recordkeeping Requirements for Explosives</u>	18

1.0 Purpose

The purpose of this safety policy and procedure is to establish the guidelines and procedures through which North Carolina Department of Transportation (NCDOT) employees have the training and proper equipment when working with or in close proximity to explosives or blasting operations.

2.0 Scope and Applicability

Certain operations in NCDOT may require the use of explosives and may include:

SAFETY POLICY & PROCEDURE

- Secondary road construction
- Beaverdam demolitions
- Boulder and large rock removals
- Old bridge removals

Explosives use within NCDOT is a vital part of construction operations; however, tragic consequences can result from the unauthorized use or misuse of explosives. Therefore, this safety policy and procedure provides guidelines for safe handling and use of explosives by NCDOT employees.

This safety policy and procedure includes provisions for training and discussion of qualifications for explosives specialists. Discussion is presented on the type of explosives used in NCDOT, the minimum equipment required to initiate explosives, electric blasting precautions around radio frequencies, and how to obtain explosives equipment. It includes explosives storage and label, signs, and marking requirements. Additionally, discussion is presented on transportation, security, and recordkeeping requirements.

This document details the areas of responsibility for managers/unit heads, supervisors, employees, Explosive Specialists, and Safety and Loss Control within NCDOT.

This policy affects all NCDOT Explosives Specialists, Drillers, Handlers, Explosives Conveyance Operators, Machine Operators, and other employees who, through the performance of their duties, may be exposed to hazards involving the storage, transport, handling or use of explosives.

3.0 References

This safety policy and procedure is established in accordance with Occupational Safety and Health Administration for General Industry (29 CFR 1910.109), Occupational Safety and Health Administration for the Construction Industry (29 CFR 1926.902), US Department of Transportation Regulations (49 CFR Part 170 - 178), US Department of the Treasury, BATF Regulations (27 CFR Part 55).

4.0 Policy

It is the policy of NCDOT to provide a place of employment that is free from recognized hazards that cause or are likely to cause death or serious physical harm to employees or the public. Therefore, unauthorized use of explosives is strictly prohibited and will not be tolerated. When explosives hazards exist that cannot be eliminated, then engineering practices, administrative practices, safe work practices, and proper training regarding Explosives will be implemented. These measures will be implemented to minimize those hazards to ensure the safety of employees and the public.

5.0 General Responsibilities

It is the responsibility of each manager/unit head, supervisor, and employee to ensure implementation of NCDOT's safety policy and procedure on Explosives. It is also the responsibility of each NCDOT employee to report immediately any unsafe act to his or her supervisor. Specific responsibilities are outlined in Section 6.3.

6.0 Procedure

This section provides definitions, establishes general provisions, and identifies specific responsibilities required by NCDOT's safety policy and procedure on Explosives.

6.1 Definitions

ANFO

A blasting agent consisting of a mixture of ammonium nitrate and fuel oil.

Binary Explosive

Explosives that consist of two or more unmixed, commercially manufactured, prepackaged chemicals, including oxidizing chemicals, flammable liquids, or solids that are not independently classified as explosives. When combined, however, the mixture is classified as an explosive and is stored, transported, and handled as an explosive.

Blaster's Galvanometer

An instrument used to measure the electrical resistance of detonators (EB caps) and circuits.

Blasting Agents

Blasting agents are generally considered safer than Class A, B, or C explosives and yet, when properly initiated, they function in the same manner as Class A explosives. Not being cap sensitive, they require a strong primer. An example is Ammonium nitrate and fuel oil mixture (ANFO).

Blasting Cap

See Detonator below.

Booster Primer

An explosive charge, usually of high strength and high detonation velocity, used to improve the initiation of less sensitive explosives materials.

Class A Explosives / Explosives 1.1

Possessing detonating hazards, such as dynamite, lead azide, nitroglycerin, picric acid, black powder, detonators (blasting caps), and detonating primers.

Class B Explosives / Explosives 1.3

Possessing flammable hazards, such as propellant explosives, including some smokeless propellants.

Class C Explosives / Explosives 1.4, 1.5, 1.6

Includes certain types of manufactured articles which contain Class A or Class B explosives, or both, as components but in restricted quantities. Includes blasting agents.

Detonator

Any device containing a detonating charge that is used for initiating detonation in an explosive. The term includes, but is not limited to, electric blasting caps of instantaneous and delay types, blasting caps for use with a safety fuse, and detonating cord delay connectors.

Explosives

Any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion, i.e., with substantially instantaneous release of gas and heat.

Explosives Specialist

A trained qualified employee authorized to use, store, and transport explosives for NCDOT.

High Explosives

Explosives that are characterized by a very high rate of reaction, high pressure development, and the presence of a detonation wave in the explosive. Examples include dynamite, cap sensitive water gels, slurries, emulsions, and cast boosters.

IME

Institute of Makers of Explosives.

Low Explosives

Explosives that are characterized by deflagration or a low rate of reaction and the development of low pressure. Examples include black powder, safety fuse, igniters, igniter cords, and fuse lighters.

Magazine

Any building or structure, other than an explosives manufacturing building, used for the storage of explosives.

Slurry Explosives

An explosives product containing substantial proportions of water and high properties of ammonium nitrate, some of which are in a solution of water.

Vehicle Attendance

A motor vehicle is attended when the person in charge of the vehicle is on the vehicle, awake, or is within 100 feet of the vehicle and has it within his unobstructed field of view.

Water Gels

A Class A Explosives comprised mainly of water and ammonium nitrate.

6.2 General Provisions

This section details the provisions of this safety policy and procedure with each provision discussed in a separate subsection. These provisions are:

- Training Requirements
- Qualifications of Explosives Specialists
- Types of Explosives
- Minimum Equipment Required to Initiate Explosives
- Radio Frequency Hazards with Electric Blasting Caps
- Equipment Procurement
- Explosives Storage
- Label, Signs, and Marking Requirements
- Transportation of Explosives on NCDOT Equipment
- Security and Recordkeeping

6.2.1 Training Requirements

Safety and Loss Control will conduct comprehensive training and retraining annually on the safe storage, transport, handling, and use of explosive products. The New Explosives Specialists Certification Course will consist of 32 hours of classroom materials and field applications. The Recertification Course will consist of 16 hours of classroom materials. Emphasis will be placed on workshops and practical exercises in each course.

Comprehensive final examinations will be given to ensure each employee is capable of performing his job safely. Only those students passing the written examination and demonstrating proficiency in the practical applications will be certified or recertified as NCDOT Explosives Specialists. See Appendix A for details of the required instructional topics.

6.2.2 Qualifications Of Explosive Specialists

Explosives Specialists must successfully complete the Explosives Safety Course prior to performing their job duties. Those whose duties require

SAFETY POLICY & PROCEDURE

involvement in the storage, handling, transport or use of explosives or those in direct supervision of these activities must successfully complete the explosives safety course prior to performing their job duties.

All individuals who successfully complete the training will receive a certificate. This certificate is valid for three years at which time recertification is necessary.

Employees who are not active in explosives work during the three year period must take the full course before being recertified.

6.2.3 Types of Explosives

Explosive materials may be divided into three classes:

- High Explosives
- Low Explosives
- Blasting Agents

High Explosives are explosive materials which can be caused to detonate by means of a blasting cap. Examples include dynamite, cap sensitive water gels, slurries, emulsions, and cast boosters.

Low Explosives are explosive materials which, when confined, can be caused to deflagrate. Examples include black powder, safety fuses, igniters, igniter cords, and fuse lighters.

Blasting Agents are substances classified by the U.S. Department of Transportation as blasting agents. Ammonium nitrate and fuel oil are examples.

The type of explosives products used in NCDOT blasting operations include:

- Water gel high explosives
- Binary Explosives
- Detonators (Blasting caps)
- Booster Primers
- Blasting Agents

Water gels are the primary type of high explosive used in NCDOT blasting operations. Water gels are comprised of water and high property ammonium nitrate. Nitroglycerin-based high explosive dynamites should not be ordered or used in NCDOT blasting operations. Water gels are considered safer and equally effective.

Two component (binary) explosives are recommended for small jobs that require only a few sticks of explosives. Binary explosives are also classified as high explosives once they are mixed.

Detonators (blasting caps) are used to initiate either a chemical or thermal reaction in the explosive by means of an electric or non-electric catalyst.

Examples of some typical blasting caps are shown in Figure 1.

Booster Primers are high explosives used with detonators (blasting caps) to ensure complete detonation of water gel explosives. The initiation of water gel explosives is affected by temperature and shelf life. Therefore, NCDOT requires the use of booster primers on all electric and non-electric detonators (caps).



Figure 1

Pre-mixed ammonium nitrate and fuel oil (ANFO) is the blasting agent predominately used in NCDOT

blasting operations and is available on state contract. Mixing your own blasting agents (i.e., ANFO) is strictly prohibited. The result can be hazardous and may not give the desired results. Also, there are severe penalties for manufacturing explosives without a license.

6.2.4 Minimum Equipment Required to Initiate Explosives

Two types of explosives initiation systems are used in NCDOT blasting operations. These two initiation systems are:

- Electric Initiation System
- Non-Electric (Shock Tube) Initiation

The minimum equipment required to initiate electrical and non-electrical blasting are detailed in Appendix B. Under no circumstances will an Explosives Specialist initiate blasting without the minimum equipment detailed in Appendix B. Failure to use the minimum equipment may result in incomplete blasting or create unsafe and dangerous conditions.

6.2.5 Extraneous Electricity Hazards with Electric Blasting Caps

Premature detonations of electric blasting caps are possible due to extraneous electricity entering the electric blasting circuit. Extraneous electricity can be introduced into an electric blasting circuit by either direct contact (e.g., stray currents and static electricity) or through the effect of electric and/or magnetic fields (e.g., inductive coupling, capacitive coupling, and electromagnetic or radio waves).

SAFETY POLICY & PROCEDURE

Therefore, precautions shall be taken to prevent accidental discharge of electric blasting caps from stray ground current, static electricity, current induced by radar, radio transmitters, lighting, adjacent power lines, dust storms, or other sources of extraneous electricity. Appendix C details the required precautions against extraneous electricity.

6.2.6 Equipment Procurement

Equipment that is specific to blasting operations can be obtained through the normal inventory process. The explosives and explosives supply contract is updated bi-annually.

Non-sparking bed liners for vehicles can be obtained from the Central Equipment Unit on an as-needed basis.

Information on Type 2 portable magazines that meet IME 22 specifications can be obtained through Safety and Loss Control.

6.2.7 Explosives Storage

Proper storage prevents unauthorized access to explosives materials and reduces their deterioration. All explosives materials, including blasting agents, detonators, detonating cords, boosters, blasting caps, and electric and non-electric blasting caps should be stored in magazines.

There are three types of magazines used in NCDOT for the storage of explosives materials. These magazine types are Type 1, Type 2, and Type 3. Appendix D presents details on magazine types and explosives storage requirements by explosives class.

6.2.8 Labels, Signs, and Markings

Properties where Type 1 magazines are located and properties where Type 2 magazines are located outside buildings must be posted with signs reading: “EXPLOSIVES - KEEP OUT/OFF” as shown in Figure 2.



Figure 2

Ammonium nitrate storage bins or piles must be clearly identified by signs reading “AMMONIUM NITRATE” with letters at least 2 inches high.

6.2.9 Transportation of Explosives on NCDOT Equipment

Explosives transport shall meet several requirements to protect the life, health, and safety of the public and NCDOT employees. Appendices E and F detail these requirements.

6.2.10 Security and Record Keeping

Strict security and record keeping requirements for inventory control, illegal entries into magazines, magazine security, and explosives activity are detailed in Appendix G.

6.3. Specific Responsibilities

6.3.1 Managers/Unit Heads

Managers/Unit Heads will ensure that the necessary vehicles, equipment, test instruments, explosives products and supplies are budgeted for, acquired, and maintained in a state of readiness for use in explosives work.

Managers/Unit Heads will encourage supervisors of Explosives Specialists and blasting projects to successfully complete the Explosives Safety Course. Managers/Unit Heads are responsible for coordinating required training with the Safety and Loss Control.

Managers/Unit Heads will also ensure compliance with this safety policy and procedure through their auditing process

6.3.2 Supervisors

Supervisors will ensure that all Explosives Specialists have the required training and certification prior to handling or using explosives. Supervisors will support Explosives Specialists through the provision of appropriate vehicles, equipment, supplies, materials, and competent manpower to ensure the safe and efficient use of explosives.

Supervisory personnel who supervise Explosives Specialists and their projects should successfully complete an Explosives Safety Course.

6.3.3 Employees

It is the responsibility of each employee to identify potential hazards associated with the storage, handling, transportation, and use of explosives. It is also the responsibility of each employee to refrain from work involving explosives without training specific to the hazards of the tasks involved and/or close supervision by the Explosives Specialist.

Employees are required to follow instructions by the trained Explosives Specialist in all matters of explosives work and explosives safety.

6.3.4 Explosives Specialists

It is the responsibility of the Explosives Specialist to successfully complete the required Explosives Safety Course and possess a current Explosives Specialist certification card prior to handling, transporting, or using explosives. The Explosives Specialist also has responsibility to ensure training of employees who assist with work on their explosives projects in recognizing and avoiding hazards specific to the assigned tasks and to supervise the work of those employees. Additionally, the Explosives Specialist will always make the final decision on whether or not a shot can be safely fired.

Department of Corrections inmates are not permitted to handle any explosives. They may be permitted to work with the drilling, but must leave the shot area prior to live explosives being brought in.

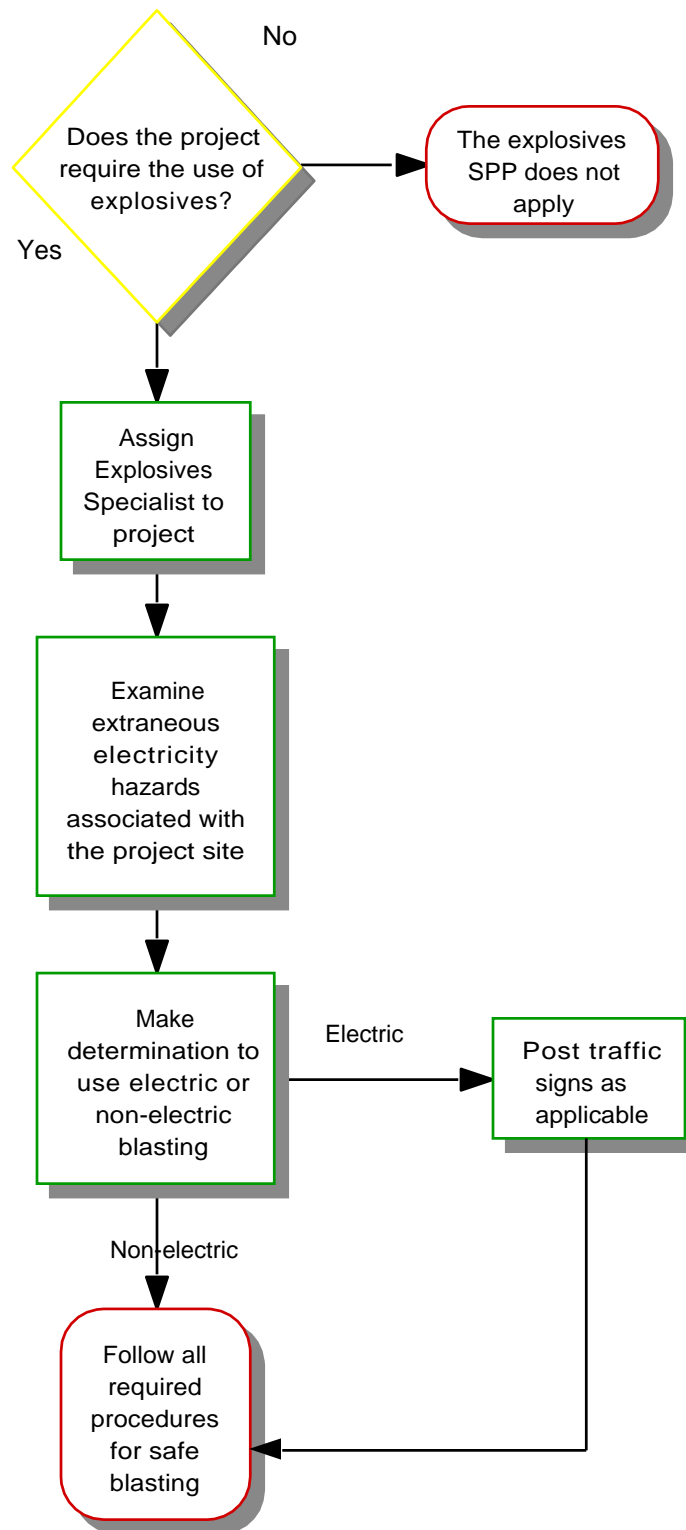
6.3.5 Safety and Loss Control

Safety and Loss Control is responsible for conducting explosives safety schools. Safety Engineers are responsible for ensuring that explosives safety training, explosives products, supplies, and related equipment that are made available to the Explosives Specialist are of the highest quality and are safe and appropriate for the work to be performed.

Safety Engineers will also make periodic explosives safety surveys to ensure safe practices are in use. Safety and Loss Control Safety Engineers may be used to evaluate shot plans, blasting sites, seismographic surveys, and electrical conditions that may present a hazard to blasting.

Safety Engineers will be available to NCDOT managers/unit heads, supervisors, Explosives Specialists, and affected employees for consultation in matters of blasting safety.

Explosives Flow Chart



APPENDIX A: Training Requirements and Required Publications

Explosives Training Requirements

Instruction will consist of the following topics:

- Definitions and Explosives Properties
- Explosives History and Types Of Explosives
- Basic Electricity
- Detonation Mechanisms
- Blasting Instruments
- Transportation of Explosives Material
- Electrical Hazards
- Fire Hazards
- Misfires
- Powder Factors and Variables Affecting Them, Placement of Boreholes
- Friction and Impact Detonations
- Fly Rock and Other Hazards
- Loading and Firing Methods
 - Electric Initiation of Explosives
 - Non-Electric Initiation of Explosives
- Storage, Security, and Recordkeeping
- Use of Check List and Shot Planning
- Policies, Standards, Rules, and Regulations

Sufficient employees must be trained to provide a NCDOT Certified Explosives Specialist for each worksite requiring the involvement of NCDOT employees in the storage, handling, transportation, or use of explosives.

Required Publications for Reading

In addition to successfully completing the Explosives Safety Course, Explosives Specialists must develop a working knowledge of the following publications:

- OSHA 29 CFR 1910.109
- OSHA 29 CFR 1926.902
- IME Publication No. 17, Safety in Transportation, Storage, Handling, and Use of Explosives
- NC Department of Labor Industry Guide #13 - A Guide to the Safe Storage of Explosives Products.
- NC Department of Labor Industry Guide #11 - A Guide to Protection Against Radio Frequency Hazards During the Use of Electric Blasting Caps (detonators)

APPENDIX B: Equipment Required for Electrically and Non-Electrically Initiated Blasting

Electrically Initiated Blasting

An Explosives Specialist will not engage in performing *electrically initiated blasting* without the following minimum equipment:

- Operational blaster's galvanometer
- Operational blasting machine with capacity adequate for the work to be performed (capacitive discharge [CD] blasting machine is preferable)
- Millisecond (ms) delay and instant electric detonators (eb caps)
- Two 500 foot lengths of 14 gauge blasters lead (firing) line (not duplex) with suitable lead line reels (wire must be solid copper, not stranded)
- Spool of 20 gauge connecting wire (wire must be solid copper, not stranded)
- Blaster's pliers and powder punch (non-sparking)
- A non-conductive tamp suitable in length
- A non-metallic measuring tape

Non-Electrically Initiated Blasting

An Explosives Specialist will not engage in performing *non-electrically (shock tube) initiated blasting* without the following minimum equipment:

- **Blaster's** shock tube initiating device
- Non-electric detonators (nonel caps or EZ-Dets)
- Shotgun primers (required for most shock tube initiators)
- 17 ms delay non-electric detonators (Primadet Primers)
- A minimum of 500 feet of non-electric lead in line (shock tube) for each shot to be fired
- Splice connectors
- **Blaster's** pliers and powder punch (non-sparking)
- A non-conductive tamp suitable in length
- A non-metallic measuring tape

APPENDIX C: Electric Blasting Precautions Around Extraneous Electricity

- Stray current is defined as current flow outside an insulated conductor system. It generally arises as a result of defective insulation on electrical power systems or on electrically operated equipment. Other sources of stray current include electrified fences, cathodic protection for underground pipelines, electric railway lines or any electric system that either accidentally or on purpose uses a ground return path. A stray current survey can be made at a blast site by a Safety Engineer if stray current sources are identified.
- Capacitive and inductive coupling refers to electrical energy that may be introduced into a blasting circuit by electric and magnetic fields, respectively, that are associated with a power line. If a blast site is in close proximity to high voltage power lines, precautions should be taken. Use non-electric initiation if possible.
- Detonators shall be short-circuited in holes which have been primed and shunted until wired into the blasting circuit.
- The prominent display of adequate signs, warning against the use of mobile radio transmitters, must be made on all roads within 1,000 feet of blasting operations. Whenever adherence to the 1,000 foot distance would create an operational handicap, a competent person shall be consulted to evaluate the particular situation, and alternative provisions may be made which are adequately designed to prevent any premature firing of electric blasting caps. Description of any such alternatives shall be made in writing by the competent person and shall be certified as preventing any premature firing of electric blasting caps. The description shall be maintained at the construction site during duration of the work, and shall be available for inspection by representatives of the NC Commissioner of Labor.
- Examples of blastings signs warning against the use of radios per the previous paragraph are shown in Figure 3.
- Mobile radio transmitters which are 100 feet or less from electric blasting caps, in other than original container, shall be de-energized and effectively locked.



Figure 3

APPENDIX D: Types of Magazines and Explosives Storage Requirements

Types of Magazines

There are three types of magazines used in NCDOT for the storage of explosives materials:

- *Type 1 magazines* are permanent magazines for the storage of high explosives. Other classes of explosives materials may also be stored in Type 1 magazines.
- *Type 2 magazines* are mobile or portable indoor and outdoor magazines for the storage of high explosives.
- *Type 3 magazines* are portable outdoor magazines for the temporary storage of high explosives while attended (a day box, for example)

Storage of Classes of Explosives Materials

In the following table, the classes of explosives materials are paired with types of magazines.

Storage of Classes of Explosives Materials by Magazine Type

Class of Explosives Materials	Magazine Type		
	1	2	3
High Explosives (dynamite; cap-sensitive water gels; slurries; emulsions; cast boosters)	•	•	•
Low Explosives (black powder)	•	•	•
Class A Detonators	•	•	•
Detonating Cords	•	•	•
Class C Detonators*	•	•	•
Safety Fuses, Electric Squibs, Ignitors, and Ignitor Cords	•	•	•
Blasting Agents	•	•	•

Note: *Detonators must never be stored in the same magazine with other explosives.*

***Includes electric detonators with leg wires 4 feet long or longer or detonators with empty plastic tubing 12 feet long or longer that contain not more than 1 gram explosives (excluding ignition and delay charges).**

SAFETY POLICY & PROCEDURE

APPENDIX E: Transportation Requirements for Explosives

- Drivers transporting explosives over public highways must have a valid Commercial Drivers License (CDL) with a Hazardous Materials endorsement.
- Only authorized persons qualified in explosives handling and/or blasting operations are allowed in or around vehicles transporting explosives materials.
- Explosives, blasting detonators, and blasting agents will not be transported with tools, equipment, materials, or other cargo.
- Tools, equipment, and/or materials of non-hazardous nature can be carried in separate compartments as long as the hazards are not increased.
- No loose cargo will be permitted in the compartment with explosives.
- OSHA regulations prohibit the transportation of electric blasting detonators and other explosives on the same vehicle. However, same vehicle transportation is permissible if both items are packed in their original containers, properly labeled, and deposited in approved containers or compartments. See Appendix F for details on same vehicle transport for detonators and explosives.
- Explosives and/or blasting detonators will not be transported on trailers unless the trailers are specifically designed and/or equipped for explosives hauling or storage.
- Explosives A or Explosives 1.1 USDOT placards will be displayed on all four sides of a vehicle carrying any amount of Class A/ Class 1.1 as shown in Figure 4.



Figure 4

- Each vehicle used for the transportation of explosives will have two fully charged fire extinguishers in good condition not less than 10 ABC rating each. The driver shall be trained in the proper use of a fire extinguisher.
- Motor vehicles carrying explosives, detonators, or blasting agents will not be taken inside a garage or shop for repairs or servicing.
- No motor vehicle transporting explosives shall be left unattended.

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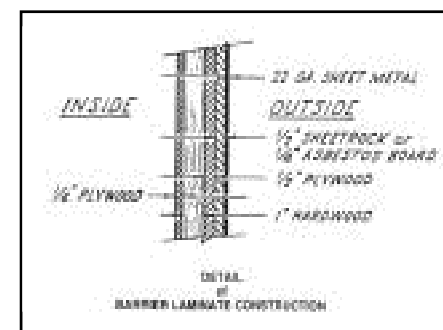
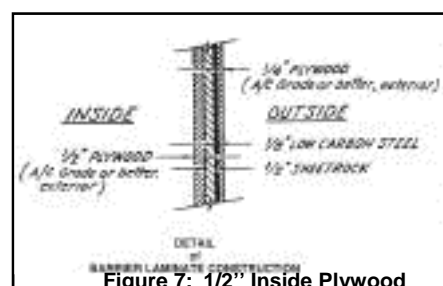
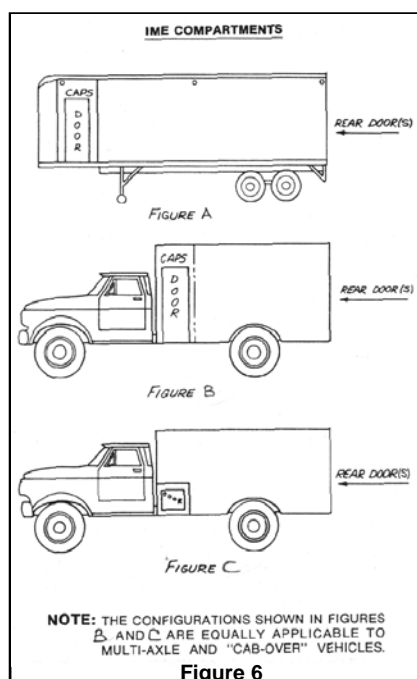
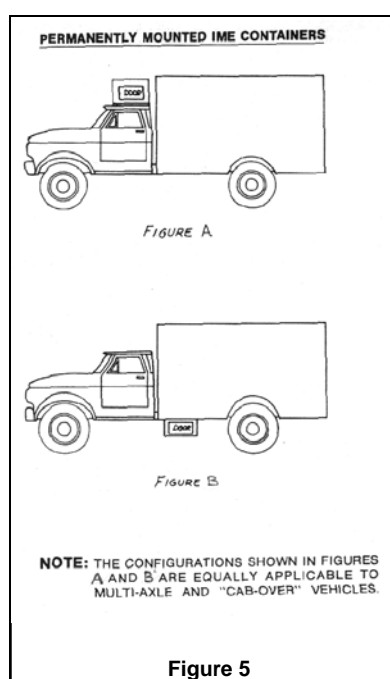
APPENDIX F: Same Vehicle Transportation Requirements for Detonators and Explosives

Same vehicle transportation of detonators and other explosives is permissible if both items are packed in original, properly labeled, and approved containers or compartments. These containers or compartments shall conform to IME Safety Library Publication Number 22. Recommended vehicle locations are as follows:

- A portable approved container placed within and readily removable from the cargo-carrying space of the vehicle
- A container securely attached to the vehicle as is shown in Figure 5
- A compartment built into the cargo space of the vehicle as is shown in Figure 6
- The cab of the vehicle is not acceptable as the compartment or container in which the detonators shall be placed

Detailed construction requirements are outlined in IME Safety Library Publication 22. General construction requirements for the container or compartment shall be as shown in Figures 7 and 8 and as listed below:

- The metal surface of the cargo compartment shall be lined with non-sparking material and the vehicle shall have tight floors.
- Open body vehicles cargo areas shall be covered with a fire and moisture resistant tarpaulin or equivalent.
- Explosives shall not be piled higher than the sides or tailgate of the transporting vehicle.



APPENDIX G: Security and Record keeping Requirements for Explosives

- All magazines should be checked for illegal entry at least every three days. Any illegal entry, theft or loss of explosives must be reported within 24 hours to:
 - US Treasury Department, Alcohol, Tobacco and Firearms Division
1-800-800-3855
 - North Carolina Department of Transportation, Safety and Loss Control
 - Local Law Enforcement Officials (Police Chief, Sheriff, Fire Marshall)
 - Division Engineer
 - District Engineer
- All magazine construction will conform to the requirements of OSHA 1910.109 and US Department of the Treasury, Bureau of Alcohol Tobacco and Firearms CFR 27, Part 55 which pertain to magazines.
- All magazines will be equipped with two five-tumbler padlocks. These locks shall be covered with one-quarter inch steel caps to prevent the use of saws or bolt cutters.
- Explosives logs for each magazine will be maintained by case, box, or bag and odd units (sticks, detonators, boosters or, in the case of bagged products, by weight) of explosives products. An entry will be made in the log each time explosives are taken from the magazine or returned to it. The log must reflect the exact quantity of each type of explosives product on hand at all times.

Note: NCDOT inventory control requirements are based on weight of the products; however, BATF and OSHA requirements are based on full case and unit count.

These requirements apply to electric and non-electric detonators, booster primers, binary (two component) explosives products, and any high explosives, low explosives, or blasting agents stored in the magazine.