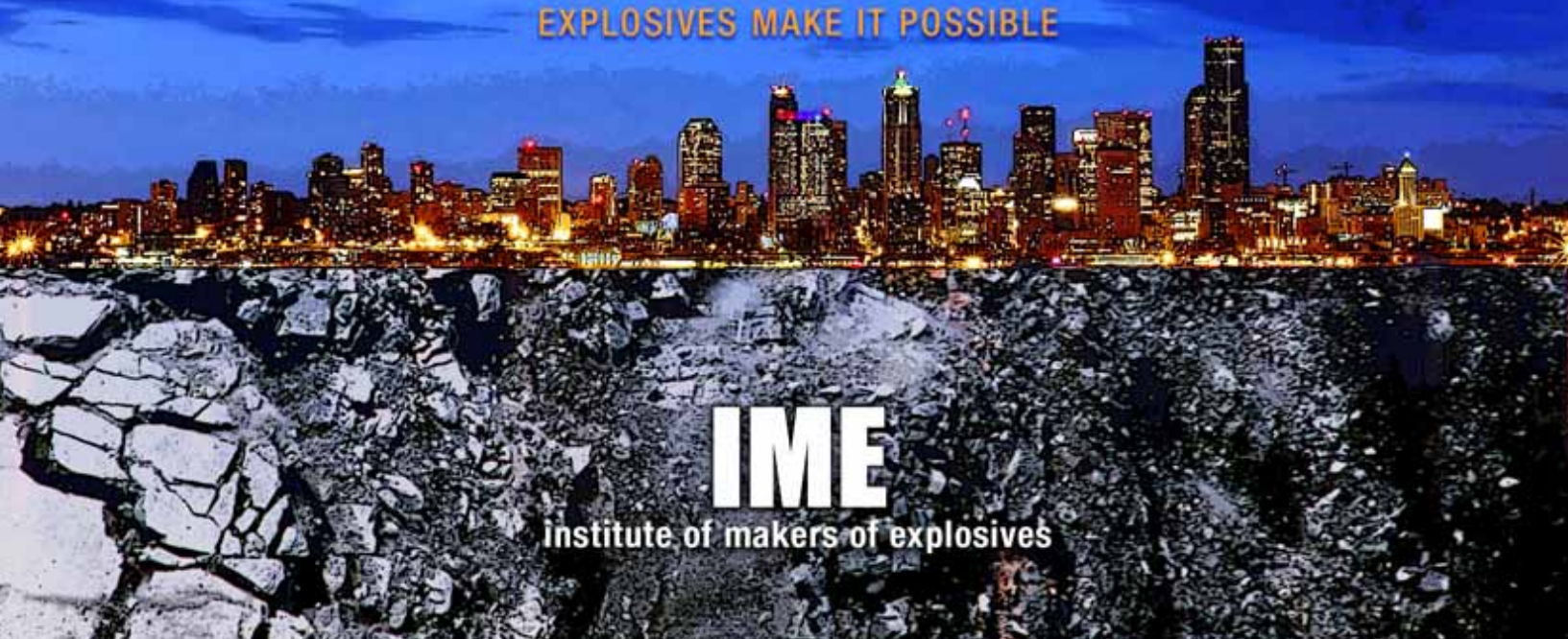
22

SAFETY LIBRARY PUBLICATION

February 2007

RECOMMENDATIONS FOR THE SAFE TRANSPORTATION OF DETONATORS IN A VEHICLE WITH CERTAIN OTHER EXPLOSIVE MATERIALS



IME
institute of makers of explosives

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The Institute of Makers of Explosives (IME) is the safety association of the commercial explosives industry in the United States and Canada. The primary concern of IME is the safety and protection of employees, users, the public, and the environment in the manufacture, transportation, storage, handling, use, and disposal of commercial explosive materials.

Founded in 1913, IME was created to provide technically accurate information and recommendations concerning commercial explosive materials and to serve as a source of reliable data about their use. Committees of qualified representatives from IME member companies developed this information and significant portions of their recommendations are embodied in regulations of federal and state agencies.

The Institute's principal committees are: Environmental Affairs; Legal Affairs; Safety and Health; Security; Technical; and Transportation and Distribution.

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SLP-22
Recommendations for the Safe Transportation of Detonators in a Vehicle with Certain Other Explosive Materials

FOREWORD

When transporting explosive materials, it is often desirable to carry detonators on the same motor vehicle with other explosive materials. Tests conducted by the IME, and witnessed by the Department of Transportation (DOT), have demonstrated that under specific conditions, certain detonators can be transported with other explosive materials on the same vehicle. DOT regulations prohibit the transport of detonators with explosives unless certain specific requirements are met.[1]

Since 1972, DOT has accepted this publication, *Recommendations for the Safe Transportation of Detonators in a Vehicle with Certain Other Explosive Materials, SLP-22* as one of these specific requirements. SLP-22 is adopted by reference by DOT at 49 CFR 177.835(g)(3)(ii). SLP-22 has remained virtually unchanged since 1972 and has proven an extremely effective standard. None of millions of shipments of detonators and explosives made using SLP-22 have resulted in a mass-detonation.

Despite this impeccable record, SLP-22 is not intended to prevent a mass detonation, although it will greatly reduce the probability of such. A container able to withstand the forces encountered in motor vehicle crashes would be impractical. The primary intent of SLP-22 is to allow sufficient time in the event of a transportation incident such as fire to evacuate bystanders to a safe distance. Testing has shown that boxes constructed to this standard will prevent mass detonation of the explosives from a detonator transported in an undamaged SLP-22 box for 30 minutes or more.

Research has shown that several modifications to SLP-22 boxes will improve their performance in fire incidents.[2] These modifications have been included in this edition of SLP-22. Containers and compartments manufactured after February 2007 should be made to this updated standard. Containers and compartments in service before February 2007 are permitted indefinitely provided they meet the May 1993 edition of SLP-22.

This edition of SLP-22 has been revised to improve clarity and incorporate four technical modifications. The first modification is to no longer require 1/2 inch of play in the door opening. IME has determined that the pressure release requirement previously required is no longer necessary for safe and secure transportation. First, overpressure from the functioning of a detonator cannot be significantly relieved by small gap around one edge of the door of an SLP-22 box. Second, a tightly closed SLP-22 box will generally provide better security against unauthorized access and less likelihood that a detonator will be thrown from the box in a fire.

The second modification is to require that door latches be securely padlocked. Testing has shown that this is necessary to prevent premature opening of the door and ejection of live detonators. Security from unauthorized access is also enhanced by this provision.

[1] Title 49 Code of Federal Regulations (49 CFR) Part 177.835(g).

[2] Santis, Lon. "Fire Protection Provided by Detonator Containers" 23rd Annual Conference on Explosives and Blasting Techniques, Las Vegas, NV, (February 2-5, 1997).

The other two modifications improve the survivability of the container or compartment in a fire. Since aluminum, plastic, and rubber melt at temperatures well below those commonly encountered in vehicle fires, steel is now required for critical structural hardware such as hinges and latches. Also, this hardware must now be attached to the metal shell of the container or compartment. Hardware attached to only the outer layer of plywood provides little integrity once the wood burns away.

BACKGROUND

DOT has essentially adopted the United Nations' explosives classification system as described in the *Recommendations on the Transport of Dangerous Goods, Model Regulations, ST/SG/AC.10/1*. Explosives are Class 1 materials and assigned a division number, indicative of the particular transport hazard of the material, and a compatibility group letter, indicative of what materials can be transported together without significantly increasing the probability or the magnitude of a transportation accident.

Explosive blasting materials such as dynamite, cast boosters, and other commonly used detonator-sensitive explosives are classified as 1.1D (Class 1, Division 1, Compatibility Group D). Blasting Agents (such as ANFO and non-detonator-sensitive emulsions, slurries, and water gels), are classified as 1.5D (Class 1, Division 5, Compatibility Group D).

Detonators that present a mass-detonation hazard are classified as 1.1B (Class 1, Division 1, Compatibility Group B).

Detonators that should not mass detonate are classified as 1.4B or 1.4S (Class 1, Division 4, Compatibility Group B or S).

See Appendix A for more information about explosives transportation classifications.

COMPATIBILITY OF CLASS 1 MATERIALS

Generally, packages with different compatibility group letters should not be transported together on the same motor vehicle. For example, 1.1B, 1.2B and 1.4B materials can be transported on the same motor vehicle since they all have the same compatibility letter (B). Likewise 1.1D, 1.2D, 1.4D and 1.5D materials can be transported together on the same motor vehicle. But 1.1B and 1.1D materials should not be transported on the same motor vehicle. There are a few exceptions to this general rule. For example, compatibility groups C, D, and E can be shipped together.

Another major exception is that 1.4B, 1.4S, and certain 1.1B detonators may be transported safely on the same motor vehicle with explosives in other compatibility groups provided the detonators are shipped in accordance with SLP-22. Only 1.1B detonators containing no more than one gram of explosives (excluding ignition and delay charges), and electric detonators with leg wires four feet (ft) [1.25 meters (m)] or longer, may be transported on the same motor vehicle with explosives. These types of 1.1B detonators are non-mass detonating regardless of their packaging.

As shown in Table 1, DOT permits the shipment of detonators, 1.4B and 1.4S and certain 1.1B detonators on the same motor vehicle with other Class 1 materials when the detonators are shipped in accordance with SLP-22 specifications.

TABLE 1
Compatibility Table for Class 1 Commercial Blasting Materials.[3]

Compatibility Group	A	B	C	D	E	G	S
A	-	No	No	No	No	No	No
B	No	-	No	No[4]	No	No	Yes[4,5]
C	No	No	-	Yes	Yes	Yes[6]	Yes[4,5]
D	No	No[4]	Yes	-	Yes	Yes[6]	Yes[4,5]
E	No	No	Yes	Yes	-	Yes[6]	Yes[4,5]
G	No	No	Yes[6]	Yes[6]	Yes[6]	-	Yes[4,5]
S	No	Yes	Yes[4,5]	Yes[4,5]	Yes[4,5]	Yes[4,5]	-

SLP-22 SPECIFICATIONS

A. Applicable Products

1. Class 1 materials that may be transported together on the same motor vehicle are limited to:
   a. Detonators, electric, 1.4B, UN 0255;
   b. Detonators, electric, 1.4S, UN 0456;
   c. Detonators, non-electric, 1.4B, UN 0267;
   d. Detonators, non-electric, 1.4S, UN 0455;
   e. Detonator assemblies, non-electric 1.4B, UN 0361;
   f. Detonator assemblies, non-electric 1.4S, UN 0500; or
   g. Detonators, electric, 1.1B UN 0030 that contain no more than one (1) gram of explosive (excluding ignition and delay charges) and with leg wires four ft (1.25 m) or longer.

-AND-

Explosive materials in other compatibility groups, as described in Table 1 above and 49 CFR 173.848.

B. Packaging, Labeling, Marking, and Loading

1. Detonators shall be packaged and loaded on a motor vehicle in accordance with Table 2. Inner packaging is not required for electric detonators that are packed inside pasteboard tubes, or wound on spools with the detonator placed inside the spool, so as to restrict freedom of movement of the detonator and protect them from impact forces.

[3] 49 CFR 177.848 (f).
[4] Allowed if SLP-22 or other DOT criteria at 49 CFR 177.835(g) are met.
[5] Division 1.4S fireworks may not be loaded on the same motor vehicle with Division 1.1 or 1.2 materials.
[6] Explosive articles in compatibility group G, other than fireworks and those requiring special handling, may be loaded, transported and stored with other explosive articles of compatibility groups C, D and E, provided that explosive substances (such as those not contained in articles) are not carried in the same vehicle.

TABLE 2
Generic loading and packaging guide

Proper Shipping Name	Division	UN #	Quantity Limitation	Minimum Packaging Requirements	Comments
Detonators, electric	1.1B	UN 0030	None	Original shipping case[7]	Leg wires must be 4 ft (1.25 m) or longer. Maximum base charge 1 gram of explosives.
Detonators, electric	1.1B	UN 0030	1,000	Carton[8]	Leg wires must be 4 ft (1.25 m) or longer. Maximum base charge 1 gram of explosives. Carton cannot contain more than 50 detonators.
Detonator assemblies, non-electric	1.4B	UN 0361	None	Original shipping case[7]	
Detonator assemblies, non-electric	1.4S	UN 0500			
Detonators, electric	1.4B	UN 0255			
Detonators, electric	1.4S	UN 0456			
Detonators, non-electric	1.4B	UN 0267			
Detonators, non-electric	1.4S	UN 0455			
Detonator assemblies, non-electric	1.4B	UN 0361	1,000	Carton[8]	Maximum base charge 1 gram of explosives. Carton cannot contain more than 50 detonators. Cartons or other inner packaging must be marked "1.4B Detonators" or "1.4S Detonators as appropriate.
Detonator assemblies, non-electric	1.4S	UN 0500			
Detonators, electric	1.4B	UN 0255			
Detonators, electric	1.4S	UN 0456			
Detonators, non-electric	1.4B	UN 0267			
Detonators, non-electric	1.4S	UN 0455			

2. No material may be loaded on top of a portable SLP-22 container which contains Class 1 materials, nor is any material to be loaded against the outside of the door of an SLP-22 compartment.

3. When Class 1 materials are loaded in a portable SLP-22 container, the warning: **"CONTAINS EXPLOSIVES, HANDLE CAREFULLY"** must be displayed on the outside of the container's lid in letters at least 1/2 inch high. Labeling and marking of the SLP-22 container or compartment containing detonators is not required when the compartment is an integral part of the vehicle body or the container is permanently attached to the motor vehicle.

[7] Outer and inner packaging authorized by DOT.
[8] Inner packaging, if any, authorized by DOT.

This applies even when the detonators are in inner packaging only, as authorized in Table 2 above, and the motor vehicle contains any quantity of Class 1 materials and is placarded accordingly.

4. The container or compartment must be locked with a padlock which meets the ASTM F-883[9] forced entry ratings of at least Grade 5.

5. Shipments of Class 1 materials in different divisions must be placarded with the lowest placardable division number of the cargo load. For example, when transporting Division 1.1 explosives with Division 1.4 detonators, the motor vehicle must be placarded Division 1.1.

6. In general, the lowest division's compatibility group is used but see 49 CFR 173.61 and 178.848 for complete information on use of the proper compatibility group with mixed shipments.

7. An SLP-22 container that is not permanently attached to the motor vehicle and used as and outer packaging or overpack must be marked and labeled in accordance with 49 CFR 172 Subparts D and E.

8. In the combined transportation of detonators and other Class 1 explosive materials, either the detonators or the other Class 1 explosive materials may be transported in the SLP-22 container or compartment.

C. Construction

1. SLP-22 containers and compartments shall be incorporated into the motor vehicle in one of the following manners. Positions of the container or compartment in the figures are examples only. Other positions may be acceptable.

   a. A portable SLP-22 container, as shown in Figure 1, must be placed within (and be readily removable from) the cargo-carrying space of the vehicle, or provide direct access to the SLP-22 container from outside the vehicle.

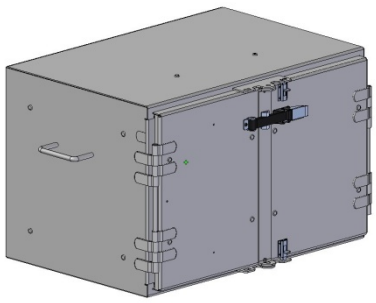


Figure 1. Portable SLP-22 Container

[9] ASTM 883-97 Standard Performance Specification for Padlocks, Jan 10, 1997

b. An SLP-22 container securely attached to the motor vehicle above or behind the cab of the motor vehicle as shown in Figures 2(a) and (b) or under the cargo space as shown in Figures 3(a) and (b).

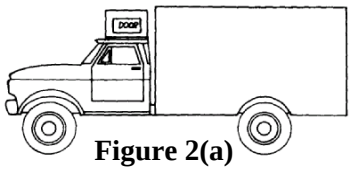


Figure 2(a)

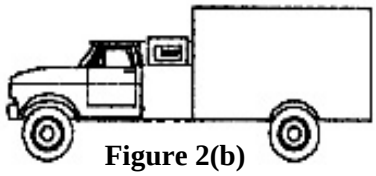


Figure 2(b)

Examples of an SLP-22 container mounted above and behind the motor vehicle cab.

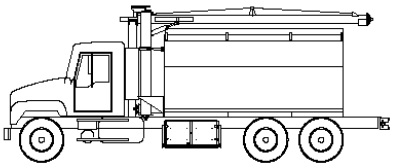


Figure 3(a)

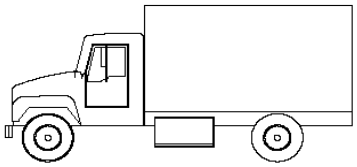


Figure 3(b)

Examples of SLP-22 containers mounted under the cargo space of a motor vehicle.

The configurations shown in Figure 3(a) and (b) are equally applicable to multi-axle and "cab-over" vehicles.

c. A built-in compartment in the cargo space of the vehicle as shown in Figures 4(a), (b), and (c).

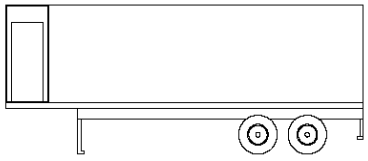


Figure 4(a)

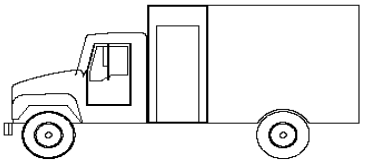


Figure 4(b)

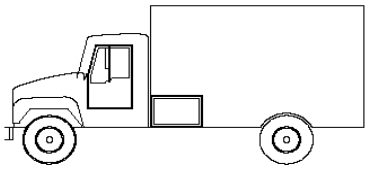


Figure 4(c)

Examples of SLP-22 compartments built into the cargo space of a motor vehicle.

2. The SLP-22 container or compartment must provide for total enclosure of the contents.

3. The exterior walls and lid or door of each SLP-22 container or compartment shall consist of a laminate constructed of not less than 11 gauge steel, continuously welded at all joints, and lined with 1/2 inch sheetrock and 1/2 inch A/C grade or better exterior plywood as shown in Figure 5.

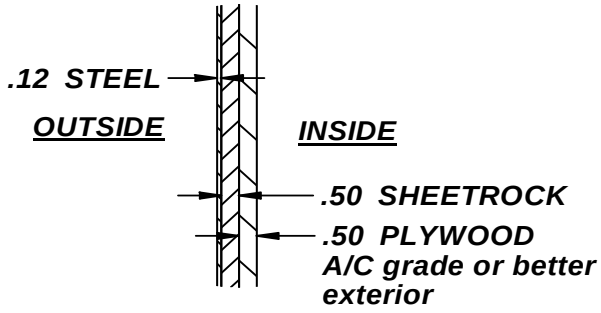


Figure 5. SLP-22 wall laminate shown with steel outer covering.

4. The exterior portion of a container or compartment must be covered with a minimum thickness 1/4 inch lamination of A/C grade or better exterior plywood as shown in Figure 6 only if other explosives carried on the vehicle contact the exterior.

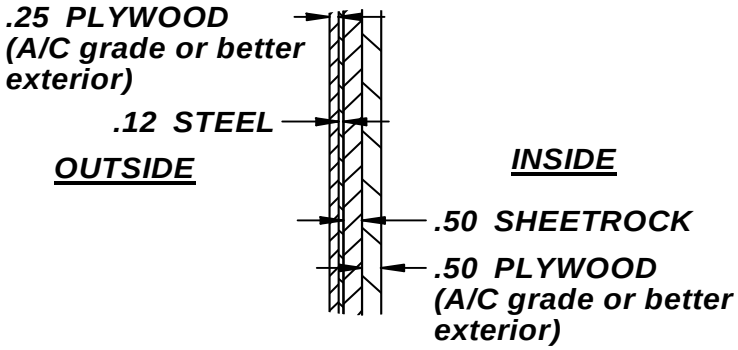


Figure 6. SLP-22 wall laminate shown with plywood outer covering for use when other explosives carried on the vehicle contact the exterior.

5. The laminated materials must be securely bound together by water-proof adhesive or other equally effective means.

6. The steel at the joints of lamination must be secured by continuous fillet welds.

7. Latches, hinges, and other structural components must be made of steel.

8. Latches, hinges, and other structural components must be attached to the steel in the wall laminate.

9. There must be direct access to the SLP-22 container or into an SLP-22 compartment from outside the vehicle.

10. Each SLP-22 container or compartment must have a snug-fitting lid or door and be equipped with a means to provide for locking or sealing.

11. The exterior of the SLP-22 container or compartment must be weather-resistant.

12. Portable SLP-22 containers shall be secured to the motor vehicle to prevent movement during transport.

D. Identification

The interior surface of the lid or door of an SLP-22 container or compartment must be marked in letters and numbers at least 1/2 inch high as follows:

BARRIER LAMINATE
MEETS SLP #22

APPENDIX A
EXPLOSIVES TRANSPORTATION CLASSIFICATIONS

DOT utilizes two numbers and a letter to classify explosives according to *Class*, *Division*, and *Compatibility Group*. Typically, an explosive classified 1.1D would indicate:

Class	Division	Compatibility Group
1	1	D

The significance of Class, Division, and Compatibility Group are noted below.

Class	A hazardous material is assigned a class number to indicate that it meets defining criteria relative to its transport hazard. Explosive substances and articles are in Class 1.
Division	Class 1 materials are subdivided into divisions and given a division number to define and describe in greater detail the hazardous characteristics and properties of the substances or article. Class 1 is divided into six divisions based on the primary hazard; 1.1 mass explosion, 1.2 projections, 1.3 fire, 1.4 minor hazard, 1.5 mass explosion but very insensitive and 1.6 very insensitive articles.
Compatibility Group Letter	Further, an explosive is assigned a compatibility group letter to indicate its compatibility with other explosives. Generally, only explosives with the same compatibility group letter can be transported together. Detonators 1.4B or 1.4S and certain detonators 1.1B may be shipped with certain other Division 1.1D materials in accordance with SLP-22 specifications.
Compatible: (Compatibility)	Class 1 materials are considered to be compatible if they can be safely transported together without significantly increasing either the probability of an accident or, for a given quantity, the magnitude of the effect of such an accident.

NOTES

NOTES

NOTES

A-P-T RESEARCH, INC.

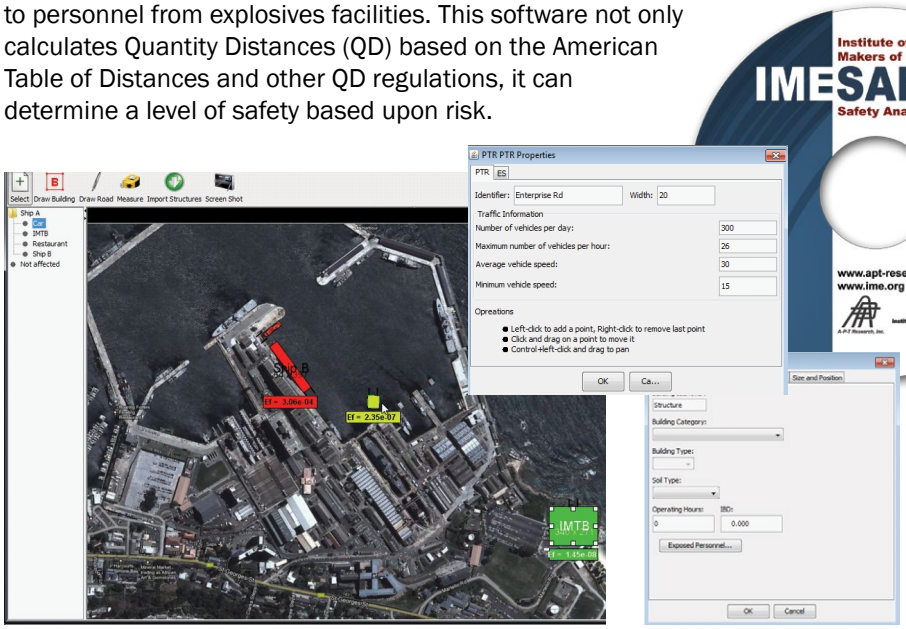
IMESAFR

Institute of Makers of Explosives Safety Analysis for Risk

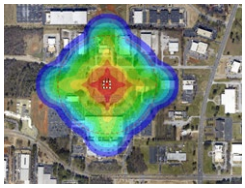
What is IMESAFR?

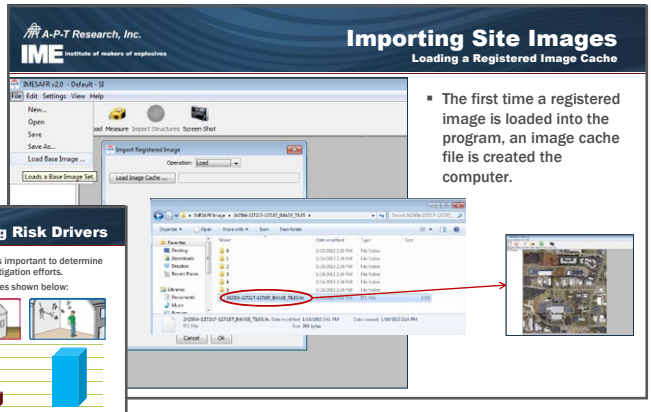
Institute of Makers of Explosives (IME) Safety Analysis for Risk (IMESAFR) is a software model that was developed through a joint effort by IME and A-P-T Research, Inc.

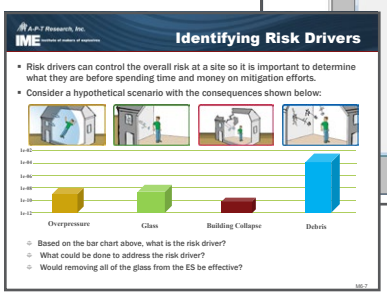
IMESAFR is a probabilistic risk assessment tool used to calculate risk to personnel from explosives facilities. This software not only calculates Quantity Distances (QD) based on the American Table of Distances and other QD regulations, it can determine a level of safety based upon risk.



IMESAFR uses the donor structure and activity, the structure of the exposed sites, and duration of exposed personnel to determine a level of safety. The program provides users with the ability to work in metric or imperial measures, and allows users to import maps or drawings of their site to assist with visualizing facility layouts and results.







Why was IMESAFR developed?

IMESAFR was developed to provide a more comprehensive assessment of the overall risk of explosives operations. The commercial explosives industry in the United States uses the American Table of Distances (ATD) as the basis for safe siting of explosives storage facilities. ATD siting involves the evaluation of a specific magazine and inhabited building or public highway, which are referred to as a Potential Explosion Site (PES)/Exposed Site (ES) pair in IMESAFR. This evaluation yields the recommended separation distance based on the factors that affect risk, including whether a barricade exists. Although the same criteria can be applied to explosives manufacturing operations, the ATD was intended for use in limited permanent storage situations. In addition to permanent storage situations, IMESAFR accounts for other activities such as manufacturing, assembly, and loading and unloading.

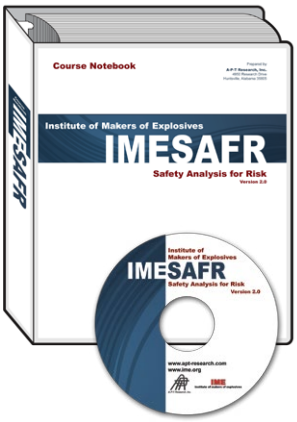
IMESAFR Training Course

The course is presented over three days with eight hours of mixed lecture and discussion each day for a total of 24 classroom hours. Daily class hours are from 8am to 5pm with an hour for lunch and breaks mid-morning and mid-afternoon. A competency test will be given at the end of the course.

Class Size: minimum of 10, maximum of 25.

Where

The class is normally held at the APT Safety Engineering and Analysis Center (SEAC) in Huntsville, AL, conveniently located in Cummings' Research Park near Redstone Arsenal.
See www.apt-research.com/contacts/contactUs.html for detailed directions.



The class may also be offered at other locations. On-site training courses can be arranged, as well as courses that run in conjunction with conferences and meetings.

Course Content

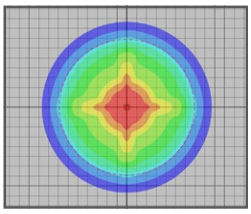
The IMESAFR Training Course will guide the user through the overall user interface of the IMESAFR Software. Some of the topics discussed are listed below.

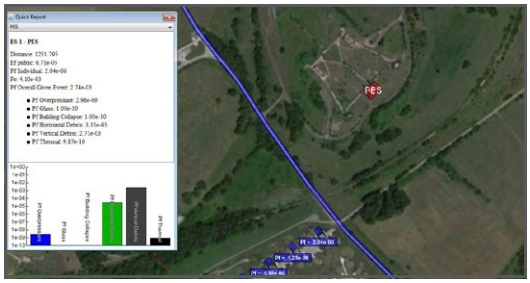
- A background on the concepts and terminology used in the IMESAFR risk assessment software.
- A thorough guide on using input screens and choosing the proper input selection.
- A description of the capabilities of IMESAFR including menu options, functions of the tool bar, help menu and generating reports.
- An overview of the 26-step process used by IMESAFR to familiarize the user with the exposure and consequence analysis.
- Multiple examples (some worked individually and some as a group) demonstrating the various capabilities of IMESAFR.
- Practical applications of the software and its use in the risk management process.

Course Outline

1. Overview
2. QD Concepts & Background
3. QRA Concepts & Background
4. IMESAFR Features
5. Class Exercise 1
6. Risk Management
7. Advanced Tools
8. Architecture - Part 1
9. Architecture - Part 2
10. IMESAFR Protocols
11. Linking Architecture to Testing
12. Class Exercise 2
13. Approval Process
14. Input Decisions
15. Group Exercise
16. Test

Each student is responsible for bringing a laptop to training. A training book is included in the course fee.





Schedule

www.apt-research.com/capabilities/training.html

CEU

Upon completion of this course, attendees will be credited with 2.0 Continuing Education Units (CEU).

Cost

New IMESAFR 2.0:
- Non IME member: US$1800
- IME member: US$750

Upgrade IMESAFR 2.0:
- Non IME member: US$750
- IME member: US$375

Training voucher: US$1800

Registration Information

To register for a class in Huntsville or if you are interested in setting up a training course at a location other than Huntsville, please contact:

Dean Nichols
256.327.3373
imesafrtraining@apt-research.com

IME
institute of makers of explosives
202.429.9280
www.ime.org

APT Point of Contact

John Tatom
256.327.3373
aptinfo@apt-research.com

A-P-T RESEARCH, INC.

4950 Research Drive
Huntsville, AL 35805
www.apt-research.com

M-09-00810

DESTRUCTION OF COMMERCIAL EXPLOSIVE MATERIALS

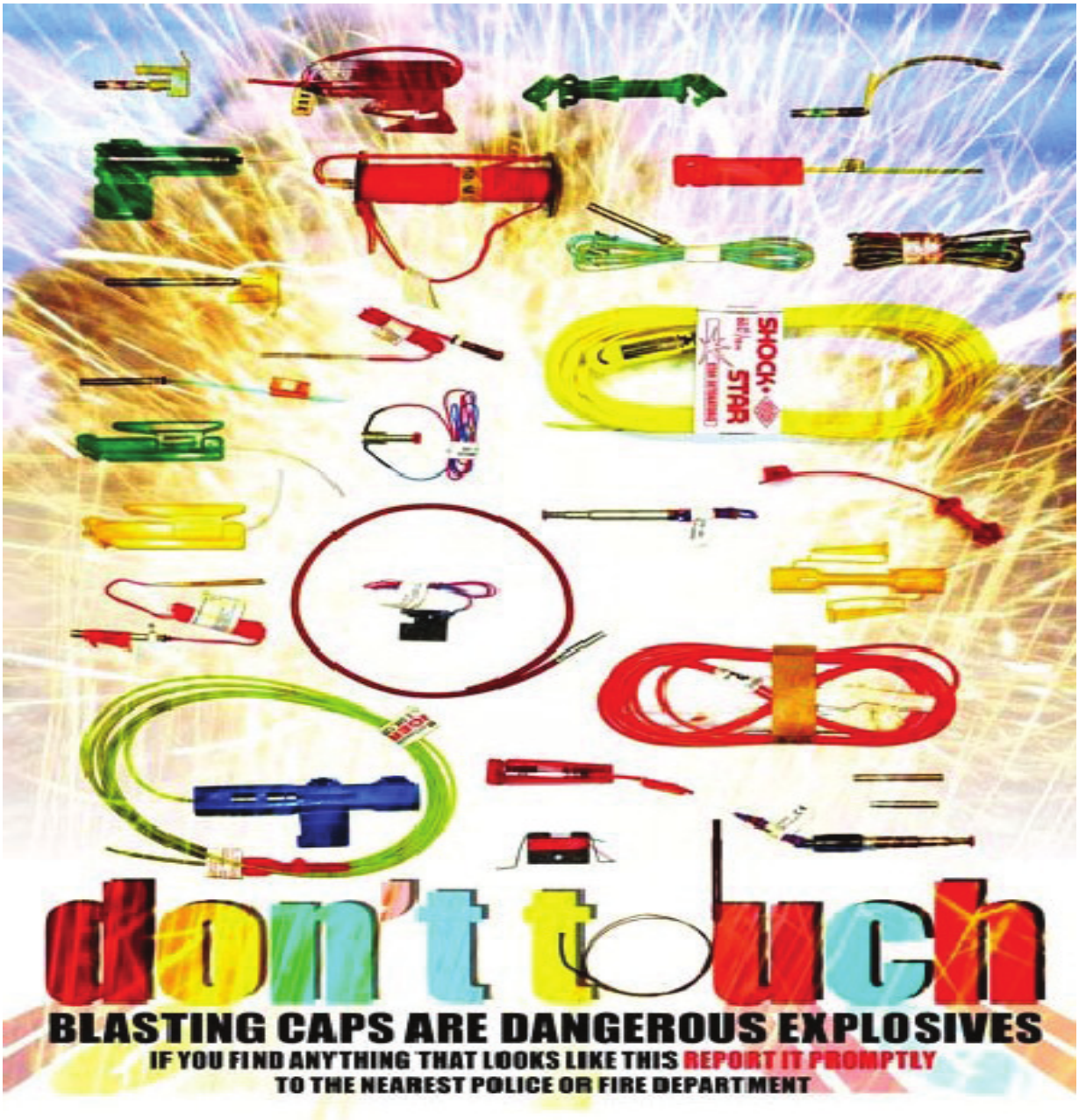
At times it may be necessary to destroy commercial explosive materials. These may consist of explosives or blasting agents from containers that have been broken during transportation or may be materials that have exceeded their recommended shelf life or are believed to be overage or are no longer needed.

Due to the many developments in explosive technology over the past few years, the appearance and characteristics of products have undergone marked changes. To be sure that you are familiar with the properties of the product that you plan to destroy, the manufacturer of that product should be consulted for the most current product information and the recommended method of disposal and/or destruction.

The member companies of the Institute of Makers of Explosives have agreed to supply advice and assistance in destroying explosives. If the manufacturer is known, seek his assistance. If the manufacturer is not known, a member company of the Institute of Makers of Explosives may provide advice or assistance.

The above policy of IME member companies relates only to commercial explosive materials. It does not include handling improvised explosive devices or bombs, military ordnance, military explosives, or homemade explosive materials.

IME member companies also cannot become involved in destroying explosive materials, which have been used for illegal purposes, are reportedly stolen property or are considered as evidence in any potential civil litigation or criminal prosecution.



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