EXPLOSIVE HANDLING SAFETY REVIEW TRAINING

EXPLOSIVES SAFETY STANDARDS COMPLIANCE

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Explosives Safety Standards
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DoD Ammunition and Explosives Safety Standards
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Topics

- EXPLOSIVE CLASSES
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Definitions

Ammunition and Explosives (AE)—Includes, but is not necessarily limited to, all items of ammunition; propellants, liquid and solid; pyrotechnics; high explosives; guided missiles; warheads; devices; devices, and chemical agent substances and components presenting real or potential hazards to life, property and the environment.

Deflagration—A rapid chemical reaction in which the output of heat is enough to enable the reaction to proceed and accelerate without input of heat from another source. The effect of a true deflagration under confinement is an explosion. Confinement of the reaction increases pressure, rate of reaction, and temperature and may cause transition into a detonation.

Detonation—A violent chemical reaction within a chemical compound or mechanical mixture evolving heat and pressure. A detonation is a reaction or shock wave which proceeds through the reacted material toward the unreacted material at a supersonic velocity.

Electro-Explosive Device (EED)—An explosive or pyrotechnic component that initiates an explosive, burning, electrical, or mechanical train and is activated by the application of electrical energy.

Electrically Initiated Device (EID)—An EID is a single unit, device, or subassembly that uses electrical energy to produce an explosive, pyrotechnic, thermal, or mechanical output. Examples: electro explosive devices (such as hot bridge wire, semiconductor bridge, carbon bridge, and conductive composition), exploding foil initiators, laser initiators, burn wires, and fusible links.

Definitions

Energetic Liquid—A liquid, slurry, or gel, consisting of, or containing an explosive, oxidizer, fuel, or combination of the above, that may undergo, contribute to, or cause rapid exothermic decomposition, deflagration or detonation.

Explosive—A substance or a mixture of substances that is capable by chemical reaction of producing gas at such temperature, pressure and speed as to cause damage to the surroundings. The term explosive includes all substances variously known as high explosives and propellants, together with igniter, primer, initiation and pyrotechnic (e.g., illuminant, smoke, delay, decoy, flare and incendiary compositions.

Hazard Division (HD)—One of six divisions designating the predominant hazard within UN Class 1, Explosives.

High Explosives (HE)—An explosive substance designed to function by detonation (e.g., main charge, booster or primary explosives).

Net Explosive Weight (NEW)—The total quantity, expressed in pounds, of explosives material or pyrotechnics in each item or round.

Sympathetic Detonation (SD)—The detonation of AE produced by the detonation of adjacent AE.

Acronyms

AAE—Arms, Ammunitions and Explosives
AE—Ammunition and Explosives
AFSC—Air Force Safety Center
ANFO—Ammonium Nitrate/Fuel Oil
ASU—Ammunition Storage Unit
AUR—All-Up-Round
BIP—Blow-in-Place
BLAHA—Basic Load Ammunition Holding Area
BLSA—Basic Load Storage Area
BRU—Bomb Rack Unit
EED—Electro-Explosive Device
EIDS—Extremely Insensitive Detonating Substance
EOD—Explosive Ordnance Disposal
ESP—Explosives Site Plan
FAE—Fuel-Air Explosives
GP—General Purpose
HARM—Hi-Speed, Anti-radiation Missile
HAS—Hardened Aircraft Shelter
HE—High Explosive
HEI—High Explosive Incendiary
HERO—Hazards of Electromagnetic Radiation to Ordnance
HEW—High Explosive Weight
HMX—High Melting eXplosive (*Octogen*) cyclotetramethylene-tetranitramine, a powerful and relatively insensitive nitroamine high explosive
IHE—Insensitive High Explosive
LH—Liquid Hydrogen
LOX—Liquid Oxygen
MEC—Munitions and Explosives of Concern
MFD—Maximum Fragment Distance
MSA—Munitions Storage Area
MSD—Minimum Separation Distance

Acronyms (Cont')

NEQ—Net Explosive Quantity
NEW—Net Explosive Weight
NEWQD—Net Explosive Weight for Quantity Distance
NNMSB—Non-Nuclear Munitions Safety Board
NPW—Net Propellant Weight
PADS—Propellant Actuated Devices
PETN—Pentaerythritol Tetranitrate
POI—Point of Initiation
PWP—Plasticized White Phosphorus
RDX—Cyclotrimethylenetrinitramine, or Dry Cyclonite
SD—Simultaneous Detonation
STAMP—Standard Air Munitions Package
TNT—Trinitrotoluene
TO—Technical Order
UXO—Unexploded Ordnance
WP—White Phosphorus
WSA—Weapons Storage Area
WSM—Weapons Safety Manager
WST—Weapons Safety Tool
WSV—Weapons Storage Vault

EXPLOSIVE CLASSES

EXPLOSIVES

- All ammunition, munition fillers, demolition material, solid rocket motors, liquid propellants, cartridges, pyrotechnics, mines, bombs, grenades, warheads of all types, explosives elements of ejection and aircrew egress systems, air-launched missiles and those explosive components of missile systems and space systems, and assembled kits and devices containing explosive material.
- Explosives, explosives weight, net weight, and other like terms also refer to the fillers of an explosive item.
- Fillers may be explosive mixtures, propellants, pyrotechnics, and other toxic substances.
- This term does not include liquid fuels and oxidizers that are not used with missiles, rockets, and other such weapons or explosive items.

EXPLOSIVE EQUIVLALENT

The weight of a standard explosive, usually taken as TNT, required to produce a selected shockwave parameter of equal magnitude at a specific location to that produced by a unit weight of the explosive in question.(Relative Explosive Factor – **RE**)

Example:

Dynamite	0.92% RE of **TNT**
PBXN-109	1.17% RE of **TNT**
C-4	1.34% RE of **TNT**

NOMENCLATURE FOR AIR FORCE HIGH-EXPLOSIVES

AFX-645 is an insensitive high explosive based on TNT, NTO, wax and Aluminum that was developed for the IM-compliant Mk-82 General Purpose Bombs (GBU).

AFX-757 is an insensitive high explosive developed by the Energetic Materials Branch of the U.S. Air Force Research Laboratory. Initially, it was intended as a replacement for the **tritonal filler of hard target penetrator bombs.**
It is a mixture of RDX, aluminium powder, ammonium perchlorate and the plasticizer hydroxyl-terminated polybutadiene (HTPB).
AFX-757 is cast-filled into warheads, has been used in warheads including:

- **GBU-39/B -** 250lb Small Diameter Bomb
- **BLU-121A/B** - 2000lb penetrator bomb with thermobaric effects
- **BLU-122/B** - 5000lb hard target penetrator.
- **WDU-42/B** warhead of the AGM-158 Joint Air-to-Surface Standoff Missile (JASSM)

it was the first explosive certified in the lowest hazard category for transportation, essentially stating that it will not explode accidentally.

NOMENCLATURE FOR NAVY HIGH-EXPLOSIVES

Plastic-Bonded High Explosives are assigned nomenclature according to the following system.

Navy formulations are identified according to how the composition is loaded and allocated into the following classes:

- **PBX 1-99** **Pressed compositions**
- **PBX 100 - 199** **Cast compositions**
- **PBX 200 - 299** **Extruded compositions**
- **PBX 300 - 399** **Injection molded compositions**

The acronym 'PBX' is followed a further abbreviation (eg PBXN) to identify where the composition was developed or whether it is type qualified.

- **W - White Oak (ceased 1996)**
- **C - China Lake**
- **IH - Indian Head**
- **Q - Qualified for weapon development**
- **E - EAD program modification**
- **N - Type qualified in US navy weapon**

Explosive Hazard Classifications

The Department of Transportation (DOT) has established explosive hazard classifications for ammunition and explosives in shipment.

DOT defines explosives as any chemical compound, mixture, or device whose primary or common purpose is to function by explosion.

Explosives includes, but are not limited to, individual land mines, demolition charges, blocks of explosives (dynamite, TNT, C-4, and other high explosives), and other explosives (gun powder, nitroguanidine) that have a total weight of 10 pounds or more.

All naval explosives fall within three explosive hazard classifications - Class A, Class B, and Class C.

Class A Explosives

Possessing, detonating, or otherwise maximum hazard; such as:

- Black Powder
- Blasting Caps
- Detonating Primers
- Dynamite
- Fulminate of Mercury
- Lead Azide
- Nitroguanidine
- Nitroglycerin
- Picric Acid
- Warheads

Class B Explosives

Function by rapid combustion rather than by detonation for example:

- Rocket ammunition without projectiles
- Starter cartridges for jet engines
- Propellant Explosives
- Smokeless Propellants
- Photographic Flash Powders
- Some Special Fireworks.

Class C Explosives

Propellant explosive substance or other deflagrating explosive substance or article containing such explosive substance.

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

- Blasting Caps
- Electric Squibs
- Explosive Bolts
- Small Arms Ammunition

NOTE:

Remember, these explosive hazard classifications apply to ammunition and explosives during shipment only.

They do not apply to the storage classifications.

HAZARD CLASSIFICATION SYSTEM

HAZARD CLASSIFICATION SYSTEM

Ammunition and Explosives are

Class 1

Class 1 is represented by six Divisions

Hazard Classification of Energetic Liquids

The main UN hazard classification designators for energetic liquids are indicated below.

- **Class 1:** Explosives.
- **Class 2:** Compressed or liquefied gases.
- **Class 3:** Flammable liquids.
- **Class 4:** Flammable solids and self-reactive materials.
- **Class 5:** Oxidizers.
- **Class 6:** Toxic or infectious substances.
- **Class 8:** Corrosive.
- **Class 9:** Miscellaneous.

(Note: The original liquid propellant Hazard Groups I - IV and CG A - F are no longer used.)

Hazard Class 1 - Explosives

Six Subdivisions

- **1.1 - Mass explosion hazard**
- **1.2 - Projectile hazard**
- **1.3 - Fire, minor blast or projectile**
- **1.4 - Minor explosion**
- **1.5 - Very insensitive explosives**
- **1.6 - Extremely insensitive**

P bar Y Safety Consultants

Class 1 Divisions and Subdivisions

- **HD 1.1 – Mass-explosion**
- **HD 1.2 – Non-Mass Explosion, Fragment Producing**
- **HD 1.3 – Mass Fire, Minor Blast or Fragment.**
- **HD 1.4 – Moderate Fire, No Significant Blast or Fragment.**
- **HD 1.5 – Explosive Substance, Very Insensitive (With Mass Explosion Hazard).**
- **HD 1.6 – Explosive Article, Extremely Insensitive.**

HD 1.1 – Mass Explosion

- Blast is the primary hazard in this division. HD 1.1 items may be expected to mass detonate when a small portion is initiated by any means.
- These explosions generally cause severe structural damage to adjacent objects.
- Propagation may occur so rapidly to unprotected explosives stored near the initially exploding stack that the quantities will create a combined shock wave a single detonation of a charge equal to the total of the stacks (Simultaneous Detonation).
- Generally presents a fragmentation hazard, either from the case of the explosive device or from the packaging or facility in which the explosives are stored.

HD 1.1 – Mass Explosion

HD 1.1 items includes:

- Ammunition Components Having Mass-detonating Characteristics.
- Bulk High Explosives
- Bombs
- Demolition Charges
- Mass-detonating Cluster Bomb Units (CBU)
- Mines
- Palletized Projectiles Loaded With Bulk Trinitrotoluene (TNT) Or Comp B
- Some Propellants
- Some Rockets
- Some Missile Warheads

HD 1.2 – Non-Mass Explosion, Fragment Producing

- **Items in this division will not mass detonate when configured for storage or transportation if a single item or package is initiated.**
- When these items function, the results are burning and exploding progressively with no more than a few reacting at a time.
- The explosion will throw fragments, firebrands, and non-functioned items from the point of initiation (POI).
- Blast effects are limited to the immediate vicinity and are not the primary hazard.
- Events involving HD 1.2 items may lob large amounts of unexploded rounds, components, and subassemblies, which remain hazardous after impact.
- These items are likely to be more hazardous than they were in their original state because fuze safety devices or other features may sustain heat and impact damage.
- Expect the sub-munitions, such as cluster bombs, of many types of munitions, to project distances as great as the relevant inhabited building distances.

HD 1.2 – Sub Divisions

- There are three subdivisions (1.2.1, 1.2.2, 1.2.3) to account for the differences in magnitude of these effects and to set quantity-distance criteria.
- HD 1.2.1. Generally, these items have an NEWQD greater than 1.60 pounds or exhibit fragmentation characteristics similar to or greater than (higher density, longer distance) M1 105 mm Projectiles regardless of NEWQD.
- HD 1.2.2. Generally, these items have an NEWQD less than or equal to 1.60 pounds or that at most exhibit fragmentation characteristics similar to high-explosive 40mm ammunition regardless of NEWQD.
- HD 1.2.3. These items DO NOT exhibit any sympathetic detonation response in the stack test, or any reaction more severe than burning in the External Fire Test, Bullet Impact Test, or Slow Cook-off Test. (MIL-STD-2105D and STANAG 4240/4241/4382)

NOTE:

If the MCE is not available, use the default MCE determined by multiplying NEWQD in a single container by three.

HD 1.3 – Mass Fire, Minor Blast or Fragment

- Items in this division burn vigorously and the fires are difficult to put out.
- Explosions are caused by pressure ruptures of containers, which may produce fragments (especially missile motors) but will not produce propagating shock waves or damaging blast overpressure beyond intermagazine distance.
- Burning container materials, propellant, firebrands, or other debris may be projected randomly, presenting a severe fire hazard.
- Depending on the amounts of burning explosive materials, their downwind toxic effects usually do not extend beyond inhabited building distances.

HD 1.4 – Moderate Fire, No Significant Blast or Fragment

- Items in this division present a fire hazard but no blast hazard.
- There is virtually no fragmentation or toxic hazard beyond the fire hazard clearance ordinarily specified for high-risk materials.

HD 1.5 – Explosive Substance, Very Insensitive (With Mass Explosion Hazard)

Substances in this division have a mass explosion hazard but are so insensitive that there is very little probability of initiation or transition from burning to detonation under normal transport or storage conditions.

HD 1.6 – Explosive Article, Extremely Insensitive

- Items in this division contain only Extremely Insensitive Detonating Substances (EIDS), and demonstrate a negligible probability of accidental ignition or propagation.
- Fuzed HD 1.6 items must contain either an EIDS fuze or a non-explosive fuze (*i.e. the fuze contains no explosives*), otherwise the item is classified as HD 1.2.3.
- Example: The JASSM contains the WDU-42/B, a 1000-pound class, penetrating warhead with 240 pounds of AFX-757 and includes vents in the aft closure with a Thermally Reactive Retaining ring that releases at approximately 290 degrees Fahrenheit.


STOP

US/NATO FIRE SYMBOLS & PLACARDS

Placards are required on all four sides of vehicles for transportation.

CLASS 1 DIVISION 1
Fire Division Symbol #1

Bulk HE

HE Filled Bombs

Black Powder

Blasting Caps

HAZARD

Mass Detonation

Orange Octagon With Black 1

CLASS 1.1 PLACARDS

MASS EXPLOSIVE HAZARD

CLASS 1 DIVISION 2
Fire Division Symbol #2

Projectiles

Rocket Motors

Fixed Ammunition

Fuzes

HAZARD

Non-Mass Detonating

Frag Producing

Orange X Black 2

CLASS 1.2 PLACARDS

EXPLOSIVES WITH A BLAST/PROJECTILE HAZARD.

CLASS 1 DIVISION 3
Fire Division Symbol #3

WP

Incendiaries

Photo Flash Powder

Flares

White Star Signal Illumination.

HAZARD

Mass Fire

Orange Triangle with Black 3

CLASS 1.3 PLACARDS

EXPLOSIVES WITH MASS FIRE HAZARD

CLASS 1 DIVISION 4
Fire Division Symbol #4

Small Arms

Firing Devices

Fuse Igniters

Time Fuse

HAZARD

Moderate Fire

Little or No Blast

Orange Diamond with Black 4

CLASS 1.4 PLACARDS

EXPLOSIVES WITH NO SIGNIFICANT BLAST.

OTHER CLASSES PLACARDS

1.5: Very insensitive Explosives (Blasting Agents)

1.6: Extremely insensitive Explosives

1001 lb. RULE

- Primarily for following Explosive Classes:
  - 1.4
  - 1.5
  - 1.6
- **1001 lbs or more** - Should display a DANGEROUS placard.
- **Less than 1001 lbs** - Placards not required.

APPLY NO WATER

WEAR BREATHING APPARATUS

RED FIGURE/RIM (TOXIC SMOKE)

YELLOW FIGURE/RIM (RIOT CONTROL)

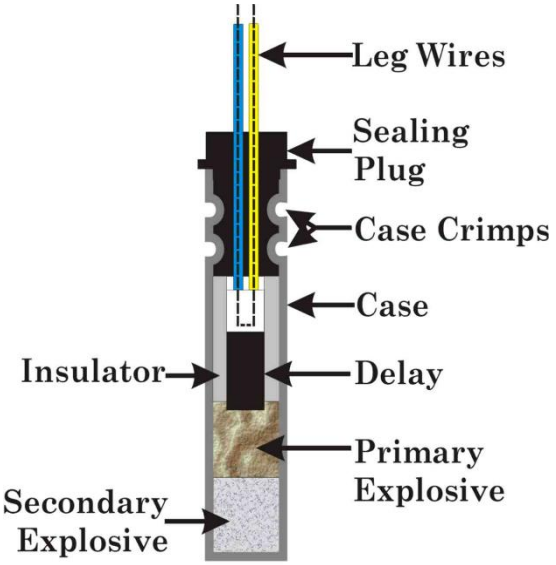
WHITE FIGURE/RIM WHITE PHOSPHROUS


STOP

INITATION DEVICES

Detonators

- **A detonator** is a device used to trigger an explosive device. Detonators can be chemically, mechanically, or electrically initiated, the latter two being the most common.
- Detonators' primary explosive is a material called ASA compound.
- This compound is formed from lead azide, lead styphnate and aluminum and is pressed into place above the base charge, usually TNT or tetryl in military detonators or PETN.



Electric Detonator

Electrical Detonators

There are three categories of electrical detonators:

- Instantaneous Electrical Detonators (IED)
- Short Period Delay Detonators (SPD) are measured in milliseconds.
- Long Period Delay Detonators (LPD) are measured in seconds

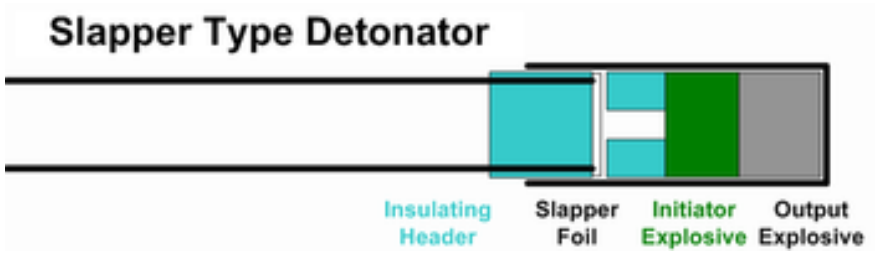
In situations where nanosecond accuracy is required, exploding-bridgewire detonators or slapper detonators are employed.

Detonator place in C-4

Slapper Detonator / EFI

Slapper Detonators, also called exploding foil initiator (EFI), uses thin plates accelerated by an electrically exploded wire or foil to deliver the initial shock. It is in use in some modern weapon systems.

The expanding plasma from an explosion of a metal foil drives another thin plastic or metal foil called a "flyer" or a "slapper" across a gap, and its high-velocity impact on the explosive (for example, PETN or hexanitrostilbene) then delivers the energy and shock needed to initiate a detonation.



Exploding Foil Initiator | EFI

Squibs

A squib is a miniature explosive device used in a wide range of industries, from special effects to military applications. Squibs can be used for generating initial mechanical force, or to provide pyrotechnic effects.

Squibs consist of two electrical leads which are separated by:

- a plug of insulating material
- a small bridge wire or electrical resistance heater
- a bead of heat-sensitive chemical composition in which the bridge wire is embedded.

Non Electrical Detonators

- Non electric detonators is a Shock Tube Detonator designed for the military use.
- Generally used to initiate explosions for the demolition of bridges, buildings and basic explosive missions.
- A hollow plastic tube delivers the firing impulse to the detonator.
- It consists of a small diameter, three-layer plastic tube coated on the innermost wall with a reactive explosive compound, which, when ignited, propagates a low energy signal, similar to a dust explosion.
- The reaction travels at approximately 6,500 ft/s (2,000 m/s).

Shock Tube Detonators

Shock Tube Initiators

AMMUNITION AND EXPLOSIVES HANDLING REQUIREMENTS

EXPLOSIVE HANDLING

- Only trained personnel under the supervision of an individual who understands the hazards and risks involved in the operation are to handle explosives.
- Handle detonators, initiators, squibs, and other such electrically or mechanically initiated devices in protective containers during storage, transportation, and inspection.
- Use containers designed to prevent item-to-item contact. Mark to identify the contents.
- Do not use bale hooks to handle explosives.

EXPLOSIVE HANDLING (CONT')

- While explosives are being handled or used, smoking shall not be permitted and no one near the explosives shall possess matches, open light or other fire or flame.
- No person shall be allowed to handle explosives while under the influence of intoxicating liquors, narcotics, or other dangerous drugs.
- Original containers or Class II magazines shall be used for taking detonators and other explosives from storage magazines to the test area.
- Persons authorized to prepare explosive charges or conduct testing operations shall use every reasonable precaution, including but not limited to warning signals, flags, or barricades to insure the safety of others.

EXPLOSIVE HANDLING (CONT')

- **Do not use nails** to secure covers or make repairs on explosives containers unless there is no hazard to the explosive item or danger of penetrating protective coverings.
- Exercise special care when using pneumatic- or cartridge-activated nail guns *(see AFI 21-201, Conventional Munitions Maintenance Management)*.
- Do not tumble, drag, drop, throw, roll, or walk munitions. Containers designed with skids may be pushed or pulled for positioning.

EXPLOSIVE HANDLING (CONT')

- **Do not roll** un-palletized conventional high explosive bombs or other explosives unless authorized by the item TO and lugs or other projections have been removed or if they are protected by dunnage rails.
- **Do not use** conveyors, chutes, hand trucks, or forklifts in atmospheres and locations where they will create hazards.
- **Interlock and support** sections of roller conveyors used to move explosives.
- **Do not use** boxes containing explosives or munitions to support conveyors.

EXPLOSIVE HANDLING (CONT')

- Always consider vehicle and handling equipment type, type of load, and prevailing weather and surface conditions when determining if safe movement is feasible.
- Use Restraining devices designed for use with vehicle and handling equipment IAW applicable TOs.
- Do not move explosives rapidly across any non-conductive surface.

Blasting Agent

Any material or mixture, consisting of a fuel and oxidizer, intended for blasting, not otherwise classified as an explosive and in which none of the ingredients are classified as an explosive.

Testing Operations

- Precautions shall be taken to prevent accidental discharge of electric blasting caps from current induced by radar, radio transmitters, etc.
- Precautions include:
  - Suspending testing operations and removal of persons from the testing area during the approach and progress of an electric storm.
  - Prohibiting the use of mobile radio transmitters on all roads within 350 feet of the testing operations.

STATIC GROUNDING

AREAS REQUIRING STATIC GROUNDING AND BONDING SYSTEMS

Static grounding and bonding systems are required for:

- Hazardous locations.
- Areas where EEDs are exposed.
- Areas where exposed explosives are handled.
- Areas where explosive components which incorporate an electrical initiating system are:
  - undergoing maintenance
  - assembly to an all-up-round (AUR) configuration
  - disassembly from, an all-up-round (AUR) configuration
  - electrical connection or disconnection.
- Areas where electrically initiated munitions and explosive devices are undergoing maintenance and electrical test operations and the responsible engineering function has determined grounding is necessary.
- Areas where explosives are loaded or unloaded on aircraft.

STATIC GROUNDING REQUIREMENTS

- Personnel, equipment, and explosives, when the responsible engineering function has determined grounding is necessary for specific maintenance or electrical test operations.
- Always avoid directly touching an electrical primer.
- Personnel handling exposed explosives; this does not apply to C-4.
- Explosive components which incorporate an electrical initiating system when undergoing maintenance; assembly to, or disassembly from, an all-up-round (AUR) configuration; or electrical connection or disconnection.

Note: Unless required by TO, static grounding is not required when replacing components of AURs which incorporate an electrical initiating system when the replacement operation does not require electrical connection or disconnection.

- Static Grounding for Handling Unpackaged EEDs. When EEDs are unpackaged and handled follow item static grounding is MANDATORY.

Static Grounding Techniques

- Protective clothing is not a substitute for personnel static grounding. Static grounding of personnel will be accomplished by any of the following:
  - The use of wrist-straps connected to the facility ground.
  - Periodically touching a grounded surface or a grounding bar.
  - Must Wear conductive footwear on conductive floors, mats or runners, if the floor, mat, or runner is properly grounded.
- Static grounding of equipment will be accomplished by any of the following:
  - Using a static ground wire, cable, or strap between the item to be grounded and the facility ground.
  - Using conductive tabletops, or conductive material coverings on the tabletop, if the conductive surface or material is properly grounded.

Anti-Static Grounding Devices

Anti-Static Wristband

Heel Grounder; Cup Style

Anti-Static Clothing

Anti-Static Mats

Anti-Static Shoe Covers

Static Grounding Techniques (Cont')

- Grounding FIRST - When making a grounding connection, attach the ground wire, cable, or strap to the item requiring grounding FIRST, then connect the other end of the ground wire, cable, or strap to the approved facility grounding system.
  - If the existing static grounding or bonding reels were permanently attached to the facility ground when installed, a temporary grounding connection using an additional cable should be made first (when possible) following all procedures before connecting the item to the permanent system.
  - When static grounding or bonding reels are installed, either in new or existing facilities, do not permanently attach them to the facility grounding system.
- Make-Before-Break Grounding - When a different or new ground is needed for an item, always make the new ground connection FIRST before disconnecting the existing ground connection.

Static Grounding for Handling Unpackaged EEDs

- When EEDs are unpackaged and handled follow item requirements for static grounding and comply with the following:
  - Personnel must periodically ground themselves. Periodic grounding is required, except where compliance would create any additional personnel safety hazard.
  - Install one or more static grounding bars or device and require personnel to touch the grounding device before handling the EED and at frequent intervals while working to discharge any static potential.
  - Every person who handles exposed EED's must be careful not to allow the EED's electrical contacts to touch any of the metal surfaces of aircraft and missile skin or structure.
  - A handler must ACTIVELY take precautions against allowing the build up or discharge of static electric energy through the EED's electrical contacts.

Static Grounding for Aircraft During Explosives Loading and Unloading.

- Combat and cargo aircraft will be grounded during explosives loading or unloading operations.
- Personnel handling the explosives will equalize their static electrical potential to that:
  - **of the aircraft**
  - **vehicle or handling equipment**
  - **before beginning operations**
  - **at frequent intervals thereafter to discharge any static buildup.**
- Grounding of aircraft during explosives loading or unloading is recommended but not required where there are unusual parking problems in operating from bare or limited bases, nonmilitary airfields, host nation airfields, etc.
- Use the best alternate method of reducing the hazard in the following order or precedence:
  - **Keep static grounding to 10,000 Ohms or less by using ground rods.**
  - Equalize the static electrical potential between the aircraft and the vehicle or handling equipment used in loading or unloading by bonding them together with an approved static ground wire, cable, or strap.

Methods to Reduce the Hazards of Static Electricity

Personnel can minimize the possibility and severity of both the buildup and discharge of hazardous static electric potentials by observing the following guidance.

- Avoid using rags or wearing outer garments made of materials which have high static-generating characteristics (e.g., 100% polyester, nylon, rayon, silk, wool, etc.). *Wool socks, glove inserts and caps and undergarments of synthetic fabrics are less of a hazard than outer garments such as jackets or pants.*
- Use rags or wear outer garments made of cotton or a cotton-synthetic blend.

MINIMIZE:

- Exposure to conditions which aid the buildup of static electricity such as cold, dry climates or dry, windy climates.
- Activities which aid the buildup of static electricity such as physical motion or contact with moving non-conductive substances. Control the discharge by touching a static grounding bar or device PRIOR to touching the system and at frequent intervals during operations.
- Activities which can cause an uncontrolled discharge of static electric potential such as the quick or repeated removal of outer garments

CLOTHING

- When working in an area or operation where static electricity would be a hazard, cashmere, fur, nylon, 100% polyester, rayon, silk, wool and other similar materials **WILL NOT** be worn as an under or outer garment.
- Remeber whenever possible, personnel should use rags or wear outer garments made of cotton or a cotton-synthetic blend. (These materials have a low hazard of static generation.)

Effects of Humidity

Voltages at Humidity

Means of Static Generation Refer to Table 7-2 in T.O. 00-25-234	Electrostatic Voltages 55% R.H.
Person Walking Across Carpet	7,500
Person Walking Across Vinyl Floor	3,000
Worker at a Bench (No wrist Strap!)	400
White Styrofoam packing	15,000
Common plastic bag picked up from bench	10,000

"Basic ESD Seminar" prepared by Burt Unger for the ESD Association, Rome, NY, P.38

Controlling Body Voltage

Wrist Straps

Purpose:

An ESD control wrist strap is used to prevent body voltage from passing ESD to ESD sensitive energetic items.

Use:

Typically, an ESD control wrist strap should be worn anytime you are handling an ESD sensitive item.

Testing Requirement:

Single conductor wrist straps shall be tested prior to first use each day per person.

Controlling Body Voltage

Wrist Straps

Advantages:

- Drains body voltage to ground
- An economical ESD solution
- Can be used almost anywhere
- Prevents body voltage buildup
- Adjustable size and cord length
- Light weight
- Ease of use

Controlling Body Voltage

Wrist Straps

Disadvantages:

You have to remember to use them.

Requires testing !

You don't know when they are working !

You have to test them periodically

Reasons for test failures:

They frequently do not make good body contact because:

Body hair, Dry skin, Loose fit

Worn Cuff, Broken cord, etc.

Controlling Body Voltage

Wrist Straps

T.O. 00-25-234 requires that all wrist straps have adjustable diameter cuffs.

Metal wrist strap cuffs have not been approved.

PROPER EQUIPMENT

Tools

- Non Sparking/Non Mag

Clothing

- Safety shoes
- Safety Glasses
- etc.

Sources of Ignition and Combustibles

- Smoking
- Matches
- Open Flames
- Spark-producing Devices
- Firearms

These items shall not be permitted inside of or within 50 feet of magazines.

Sources of Ignition and Combustibles Safety

- The land surrounding a magazine shall be kept clear of all combustible materials for a distance of at least 25 feet.
- Combustible materials shall not be stored within 50 feet of magazines.
- Magazines shall be in the charge of a competent person at all times and who shall be held responsible for the enforcement of all safety precautions.

COMPLACENCY

#1 KILLER

Can be avoided!

STORAGE CONSIDERATIONS

SITE SELECTION

Site should be level with good surface drainage

Should be free of vegetation and combustible material

BARRICADES

Barricades provide no protection against high-angle fragments or lobbed AE; some of these high-angle fragments may travel to the outer limits of protection areas set up for PTR and inhabited building (IB) distances.

To reduce hazards from high-velocity, low-angle fragments, the barricade must be placed between the PES and the ES so that the fragments of concern impact the barricade before the ES.

STORAGE ARRANGEMENT

Stability

Accessibility

Compatibility

Ventilation

TYPES OF STORAGE

OPEN STORAGE

OPEN STORAGE

CLOSED STORAGE

STORAGE

All Class A, Class B, Class C explosives, and special industrial explosives, and any newly developed and unclassified explosives, shall be kept in magazines.

MAGAZINE CLASSES

Class I magazines shall be required where the quantity of explosives stored is more than 50 pounds.

Class II magazines may be used where the quantity of explosives stored is 50 pounds or less.

Storage within magazines

- Some requirements for the storage of explosives in a magazine include:
  - Packages of explosives shall be laid flat with top side up.
  - Black powder when stored in magazines with other explosives shall be stored separately.
  - Black powder stored in kegs shall be stored on ends, bungs down, or on side, seams down.
  - Corresponding grades and brands shall be stored together in such a manner that brands and grade marks show.
  - All stocks shall be stored so as to be easily counted and checked.
  - Packages of explosives shall be piled in a stable manner.
  - When any kind of explosive is removed from a magazine for use, the oldest explosive of that particular kind shall always be taken first.
  - A wood wedge and a fiber, rubber, or wood mallet shall be used for opening or closing wood packages of explosives.

TRANSPORTING EXPLOSIVES

- Vehicles used for transporting explosives shall be strong enough to carry the load without difficulty and be in good mechanical condition.
- Packages of explosives shall not be loaded above the sides of an open-body vehicle.
- No one shall be allowed to smoke, carry matches or any other flame-producing device while in or near a motor vehicle transporting explosives.
- Blasting caps or electric blasting caps shall not be transported over the highways on the same vehicles with other explosives.

TRANSPORTATION VEHICLES

- Vehicles used for transporting explosives and oxidizing materials shall be properly marked.
- If vehicles do not have a closed body, the body shall be covered with a flameproof and moisture proof cover or other effective protection against moisture and sparks.
- All vehicles used for the transportation of explosives shall have tight floors and any exposed spark-producing metal on the inside of the body shall be covered with wood or other non-sparking materials to prevent contact with packages of explosives.
- No one will drive, load, or unload such vehicle in a careless or reckless manner.


STOP

STORAGE COMPATIBILITY

Twelve Hazard Classification/Compatibility groups

Groups A-S

GROUP COMPATIBILITY

Storage Compatibility Mixing Chart

CGs	A	B	C	D	E	F	G	H	J	K	L	N	S
A	X	Z											
B	Z	X	Z	Z	Z	Z	Z					X	X
C		Z	X	X	X	Z	Z					X	X
D		Z	X	X	X	Z	Z					X	X
E		Z	X	X	X	Z	Z					X	X
F		Z	Z	Z	Z	X	Z					Z	X
G		Z	Z	Z	Z	Z	X					Z	X
H								X					X
J									X				X
K										Z			
L													
N		X	X	X	X	Z	Z					X	X
S		X	X	X	X	X	X	X	X			X	X

An **"X"** at an intersection indicates that the groups may be combined in storage. Otherwise, mixing is either prohibited or restricted per footnote b.

A **"Z"** at an intersection indicates that, when warranted by operational considerations or magazine non-availability and when safety is not sacrificed, mixed storage of limited quantities of some items from different groups may be approved by the DoD Components. Such approval documentation must be kept on site. Component approval of mixed storage in compliance with Z intersections does not require a waiver or exemption. Mixed storage of items within groups where no X or Z exists at that pair's intersection beyond the prohibitions and limitations of footnote g, however, requires an approved waiver or exemption. Examples of acceptable storage combinations are: 1. HD 1.1A initiating explosives with HD 1.1B fuzes not containing two or more effective protective features. 2. HD 1.3C bulk propellants or bagged propelling charges with HD 1.3G pyrotechnic substances.

STORAGE AND TRANSPORTATION COMPATIBILITY GROUPS

Group A. This group includes bulk initiating explosives that have the necessary sensitivity to heat, friction, or percussion to make them suitable for use as initiating elements in an explosive train.

- Bulk lead azide
- Dry cyclonite (RDX)
- Dry pentaerythritol tetranitrate (PETN).
- Lead styphnate
- Mercury fulminate
- Tetracene

STORAGE AND TRANSPORTATION COMPATIBILITY GROUPS (CONT')

Group B. This group includes detonators and similar initiating devices which do not contain two or more effective protective features. It also includes items containing initiating explosives designed to initiate or continue the functioning of an explosive train.

- Detonators, blasting caps, small arms primers, and fuzes.

STORAGE AND TRANSPORTATION COMPATIBILITY GROUPS (CONT')

Group C. This group includes bulk propellants, propelling charges, and devices containing propellant with or without its own means of ignition.

- Bulk single-, double-, or triple-base, and composite propellants, rocket motors (solid propellant), and propelled AE with inert projectiles.

STORAGE AND TRANSPORTATION COMPATIBILITY GROUPS (CONT')

Group D. This group includes bulk black powder and Bulk HE. It also includes AE which has no propelling charge, but does contain HE without its own means of initiation, i.e., there isn't an initiating device present or the device has two or more effective protective features.

Examples include TNT, Composition B, and black powder; bulk wet RDX or PETN; bombs, projectiles, CBUs, depth charges, and torpedo warheads.

STORAGE AND TRANSPORTATION COMPATIBILITY GROUPS (CONT')

Group E. AE in this group contains high explosive (HE) without its own means of initiation but with, or containing, a solid propelling charge.

Examples include artillery AE, rockets, and guided missiles.

STORAGE AND TRANSPORTATION COMPATIBILITY GROUPS (CONT')

Group F. AE in this group contains HE with its own means of initiation, i.e., the initiating device present has less than two effective protective features, and may or may not have a solid propelling charge.

Examples include grenades, sounding devices, and similar items with less than two effective protective features in their explosive trains.

STORAGE AND TRANSPORTATION COMPATIBILITY GROUPS (CONT')

Group G. This group includes illuminating, incendiary, and smoke- (including hexachlorethane [HC]) or tear-producing AE. This excludes AE that are water-activated, contain white phosphorus (WP) or are flammable liquids or gels.

Examples include flares, signals, and pyrotechnic substances.

STORAGE AND TRANSPORTATION COMPATIBILITY GROUPS (CONT')

Group H. In this group, AE contain WP or fillers that are spontaneously flammable when exposed to the atmosphere.

Examples include WP and plasticized white phosphorus (PWP).

STORAGE AND TRANSPORTATION COMPATIBILITY GROUPS (CONT')

Group J. In this group, AE contain flammable liquids or gels other than those that are spontaneously flammable when exposed to water or the atmosphere.

Examples include liquid or gelfilled incendiary AE, fuel air explosive (FAE) devices, and flammable liquid fueled missiles and torpedoes.

STORAGE AND TRANSPORTATION COMPATIBILITY GROUPS (CONT')

Group K. In this group, AE contain toxic chemical agents or contain chemicals specifically designed for incapacitating effects more severe than lachrymation (tear producing).

Examples include artillery or mortar AE (fuzed or unfuzed), grenades, rockets and bombs filled with a lethal or incapacitating chemical agents.

STORAGE AND TRANSPORTATION COMPATIBILITY GROUPS (CONT')

Group L. This group contains AE not included in other CG, such as AE with characteristics that present a special risk that does not permit storage with other types of AE or with dissimilar AE of this group.

- Water-activated devices, pyrophorics and phosphides and devices containing these substances
- Prepackaged hypergolic liquid fueled rocket engines, triethyl aluminum (TEA), thickened TEA (TPA)
- Damaged or suspect AE of any group.

STORAGE AND TRANSPORTATION COMPATIBILITY GROUPS (CONT')

Group N. In this group, AE contain only extremely insensitive detonating substances (EIDS).

Example is HD 1.6 AE.

STORAGE AND TRANSPORTATION COMPATIBILITY GROUPS (CONT')

Group S. AE in this group present no significant hazard. AE packaged or designed so that any hazardous effects from accidental functioning are limited to an extent that they do not significantly hinder firefighting are included in this group. Projections shall not exceed 8 Joules.

- Explosive switches or valves
- Small arms ammunition.

STORAGE SAFETY PRECAUTIONS

PROHIBITED ITEMS

No Prohibited Items shall be carried in the body of any motor truck and/or vehicle transporting explosives. The following are prohibited:

- Spark-producing Metal
- Spark-producing Metal Tools
- Oils
- Matches
- Firearms
- Electric Storage Batteries
- Flammable Substances
- Acids
- Oxidizing Materials
- Corrosive Compounds

FIRE PREVENTION

No spark producing devices permitted in storage areas.

Illuminating devices must be approved for handling in explosive areas. (UL approved)

NO SMOKING!!!!!

HOUSEKEEPING

Non-explosives Waste Materials.

- DO NOT COMMINGLE non-explosives waste materials with explosives residue.
- Place non-explosives waste materials in approved containers outside of explosives facilities, except those required at work locations during operations.
- Empty non-explosives waste material containers as often as needed and once each shift.

HOUSEKEEPING

Explosives Residue.

- Provide grounded, covered, self-closing containers for explosives residue and materials containing explosives residue (e.g., rags, clothing).
- Cover explosives residue and waste materials containing explosives residue with water or oil, if this does not add to the hazard.
- Remove explosives residue and materials containing explosives residue and place in isolated point at frequent intervals and end of the duty day or shift. Do not store collected material in the disposal area.
- Dispose of explosives residue and materials containing explosives residue IAW environmental standards and locally written instructions.

HOUSEKEEPING

Cleaning Compounds.

- Do not use cleaning compounds containing wax or oil on conductive floors or surfaces.
- Do not use cleaning agents that include caustic alkalis in locations containing explosives residue (sensitive explosives compounds may be formed).
- Use non-abrasive cleaning compounds
  - such compounds are often combustible but not volatile.
  - Closed cup flash point of cleaning compounds must not be less than 230^{o} F.

INCLEMENT WEATHER

Procedures in the Event of Lightning (Electrical storms)

The following guidelines apply when a lightning watch or warning is issued for the base:

- A Lightning Watch will be in effect 30 minutes prior to thunderstorms being within a 5 nautical mile (nm) radius of the predetermined location.
  - Initiate controlled termination procedures for all explosives operations at outdoor locations equipped with an LPS, at locations (outdoor and indoor) not equipped with an LPS, and facilities containing exposed explosives, explosive dust, or explosive vapor.

INCLEMENT WEATHER (Cont')

Procedures in the Event of Lightning (Electrical storms)

- A Lightning Warning will be in effect whenever any lightning is occurring within a 5 nm radius of the predetermined location.
  - Immediately provide personnel protection equivalent to PTR (Public Traffic Route) distance from explosives facilities containing exposed explosives, explosive dust, or explosive vapor, regardless of whether the facility is equipped with an LPS; this includes providing protection equivalent to PTR for all locations within the PTR arc. PTR distances will be based on airblast overpressure only (minimum fragment distances do not apply).
  - Explosives operations in facilities equipped with an LPS (including HAS/PAS/WMT) may continue. However, assess the need and urgency for doing so.
  - Operations involving exposed EEDs shall cease and the maintenance bay where these operations are located shall be vacated. Evacuation of the non-maintenance administrative areas is not required.

INCLEMENT WEATHER (Cont')

Procedures in the Event of Lightning (Electrical storms)

- Immediately provide personnel protection equivalent to PTR distance from explosives locations (indoor and outdoor, to include parked explosives-laden conveyances and flight line Potential Explosion Site (PES) locations) which do not have an Lightning Protection System (LPS).
- This includes providing protection equivalent to PTR for all locations within the PTR arc of a facility which does not have an LPS. PTR distances will be based on airblast overpressure only *(minimum fragment distances do not apply)*.
- **CEASE** all explosives operations at outdoor locations equipped with an LPS and not specifically mentioned in the paragraphs above.

HERO

Hazards of Electromagnetic Radiation to Ordnance

Hazards of Electromagnetic Radiation to Ordnance

- **HERO SAFE** – Any Ordnance item that is proven by test or analysis to be sufficiently shielded, or otherwise so protected that all EID's contained by the item are immune to adverse effects.
- **HERO SUSCEPTIBLE** - Any Ordnance containing EID proven by test or analysis to be adversely affected by RF energy to the point that safety and/or reliability of the system is in jeopardy.

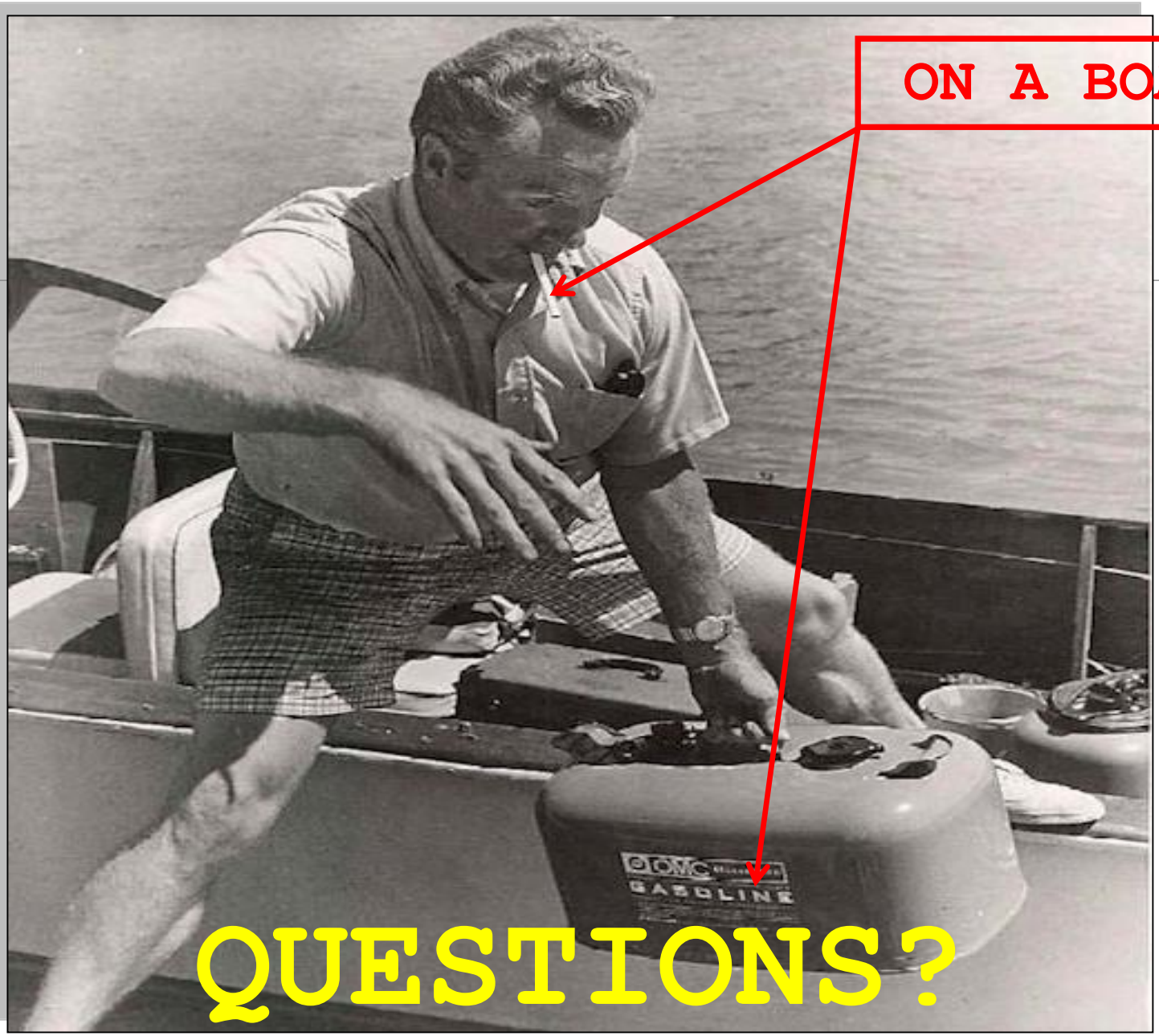
Hazards of Electromagnetic Radiation to Ordnance

- **HERO UNSAFE** – Any Ordnance item, whose inadvertent initiation or detonation causes an immediate catastrophic event that has the potential to either destroy equipment or injure personnel
- **HERO UNRELIABLE** – Any Ordnance items, whose performance is degraded due to exposure to the RF environment.

HERO (Cont’)

- HERO Warning Symbols and Labels alert the radio and portable emitter systems operators of the potential HERO hazards.

- Low-power transceiver devices such as cell phones, active pagers, Computer Tablets, and some walkie-talkies automatically transmit RF energy without operator action.


ON A BOAT?
QUESTIONS?
GASOLINE