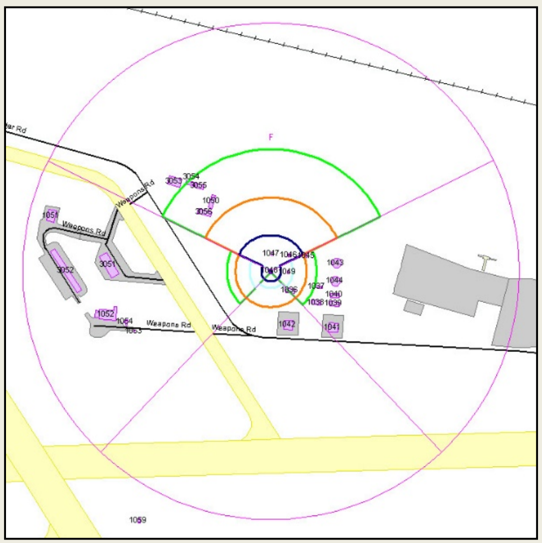
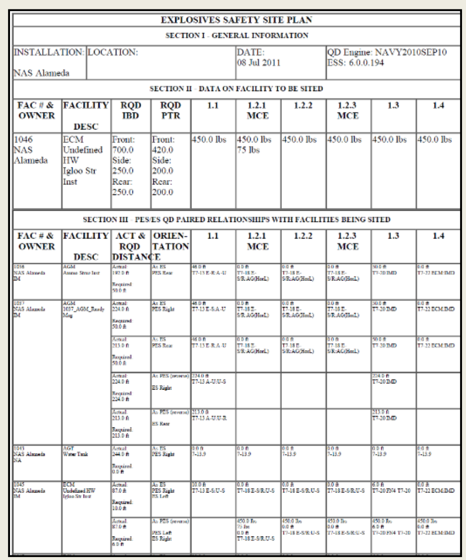
Explosives Safety Site Planning

NDIA International Explosives Safety Symposium & Exposition

6 August 2018

Based on Course Material from AMMO-36 by the U.S. Army Defense Ammunition Center and Naval Ordnance Safety and Security Activity





EXPLOSIVES SAFETY SITE PLAN			
SECTION I - GENERAL INFORMATION			
INSTALLATION: NAS Alameda	LOCATION:	DATE: 08 Jul 2011	QD Engine: NAVY2010SEP10 ESS: 6.0.0.194

SECTION II - DATA ON FACILITY TO BE SITED

FAC # & OWNER	FACILITY DESC	RQD IBD	RQD PTR	1.1	1.2.1 MCE	1.2.2	1.2.3 MCE	1.3	1.4
1046 NAS Alameda	ECM Undefined HW Igloo Str Inst	Front: 700.0 Side: 250.0 Rear: 250.0	Front: 420.0 Side: 200.0 Rear: 200.0	450.0 lbs	450.0 lbs 75 lbs	450.0 lbs	450.0 lbs	450.0 lbs	450.0 lbs

SECTION III - PES/ES QD PAIRED RELATIONSHIPS WITH FACILITIES BEING SITED

FAC # & OWNER	FACILITY DESC	ACT & RQD DISTANCE	ORIENTATION	1.1	1.2.1 MCE	1.2.2	1.2.3 MCE	1.3	1.4

Lea Ann Cotton, CSP, P.E.

Policy Development Division

DoD Explosives Safety Board

This briefing is for training use only

In the beginning…

…there was an explosives accident at Lake Denmark, New Jersey in 1926

…and the DDESB was established in 1928

Photos: http://www.pica.army.mil/ead/cultural/picatinnyhistoricdistricts/OrdnanceTesting/index.html

Explosives Safety Responsibilities

- **Safety – to include explosives safety – is a Command responsibility.**

- Commanders must take the same active and aggressive leadership in safety that they take in other areas of command responsibility.

- Explosives Safety Officers (ESO), Weapons Safety Managers (WSMs), and Quality Assurance Specialists Ammunition Surveillance (QASAS) assist commanders in implementing this responsibility…
  …and **explosives safety site planning** is just one aspect of implementation.

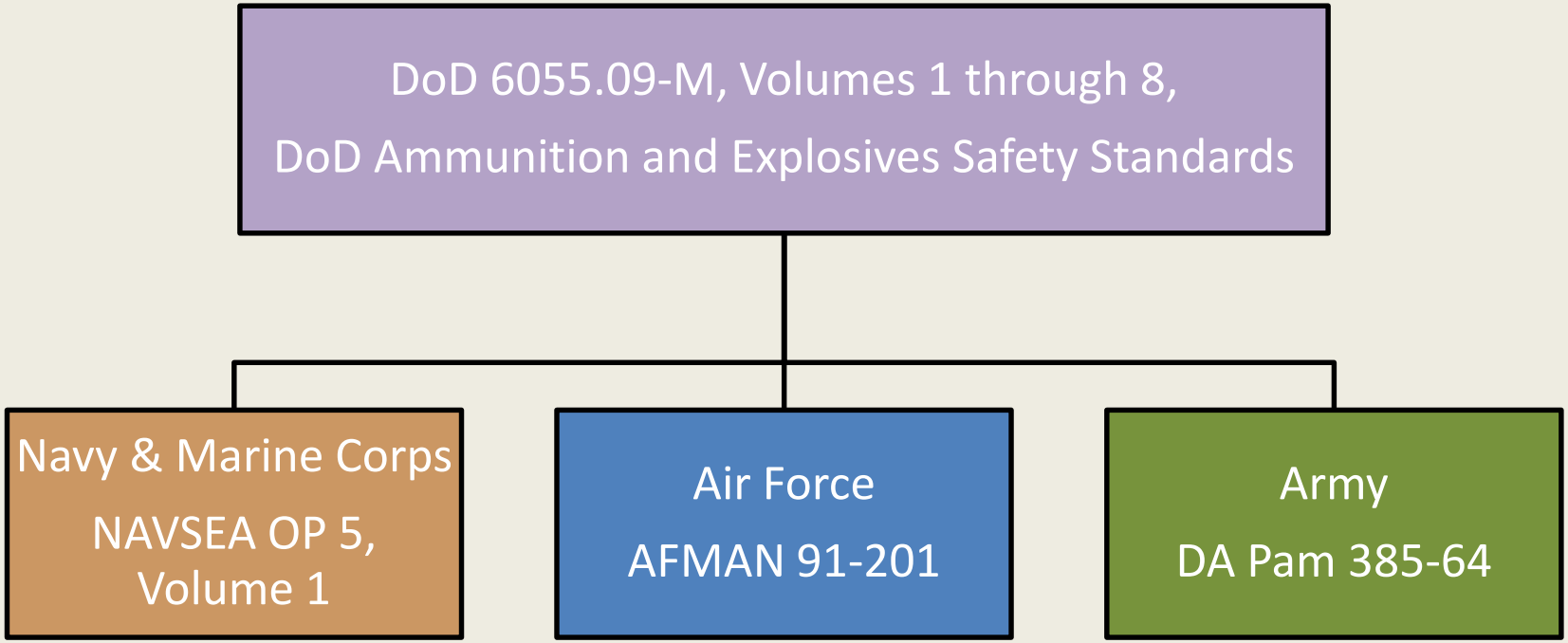
- Explosives safety site planning **<u>does not</u>** prevent explosive accidents – it's just intended to mitigate the consequences.

Aspects of Explosives Safety

- **Design of safe weapons systems**
  - Acquisition/system safety/HERO
  - Hazard classification/insensitive munitions
- **Risk assessment of explosives operations**
  - Acquisition/system safety
  - Operational risk management (and like programs)
  - Process safety management, occupational safety and health
- **Design of facilities to safely store or handle explosives**
  - Lightning protection systems, electrical bonding and grounding, power lines
  - Protective construction to mitigate hazards
  - Approved designs for some types of facilities
- **Personnel Training & Certification**
- **Evaluation, Inspection & Assistance**
  - DoD Explosives Safety Management Program Evaluations
  - Various Military Service inspection programs and site assistance processes
- **Explosives Safety Site Planning**

Explosives Safety Standards

DoD and Military Service
explosives safety site planning standards



Explosives Safety Standards

Who?

- The Office of the Secretary of Defense, the Military Departments, the Office of the Joint Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities in the DoD (collectively referred to as the “DOD Components”)

What and Where?

- DoD AE, wherever it is located
- DoD personnel and property exposed to host-nation or off-installation explosives
- DoD facilities siting and construction
- Non-DoD explosives on DoD installations

When?

- Explosives safety standards apply across the lifecycle of explosives, to include: development, manufacturing, testing, transportation, handling, training, storage, maintenance, demilitarization and disposal

Explosives Safety Standards

Why?

- Provide the maximum possible protection to people and property from the damaging effects of DoD explosives, and minimize exposures consistent with safe and efficient operations
- Explosives safety separation distances do not provide absolute protection; they represent a compromise deemed acceptable by DoD between absolute safety and practical considerations including costs and operational requirements

How?

- Expose the **minimum** number of people for the **minimum** amount of time to the **minimum** amount of explosives – **Cardinal Rule of Explosives Safety**
- Explosives safety standards provide only the minimum protection criteria for personnel and property, and **greater protection should always be provided when practicable**

Training Scope – DoD 6055.09-M Only

- **QD Siting**

	Unintentional Aboveground	Unintentional Underground (Tunnel)	Intentional
HD 1.1 thru HD 1.6	Volumes 3 & 4	Volume 5, Encl 5	Volume 5, Encl 3
HD 6.1/CA	Volume 6, Encl 4		
Energetic Liquids	Volume 5, Encl 4		

This training only addresses Volumes 3 & 4

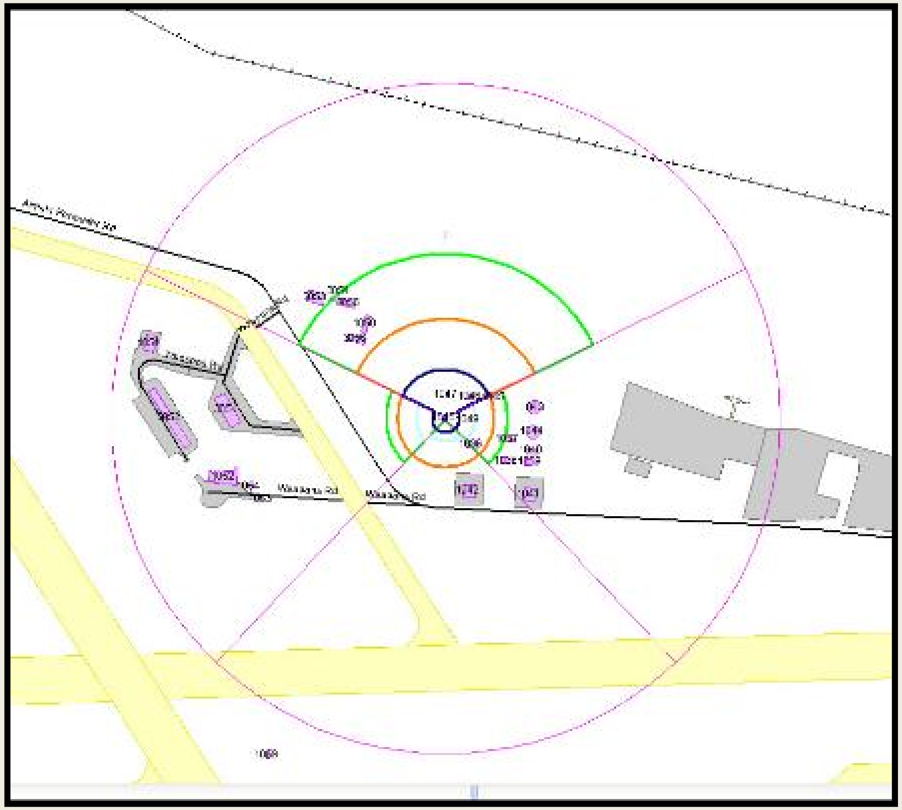
- **Risk-Based Siting – Volume 6, Encl 5**
- **UXO, MR, WMM, MPPEH – Volume 7**

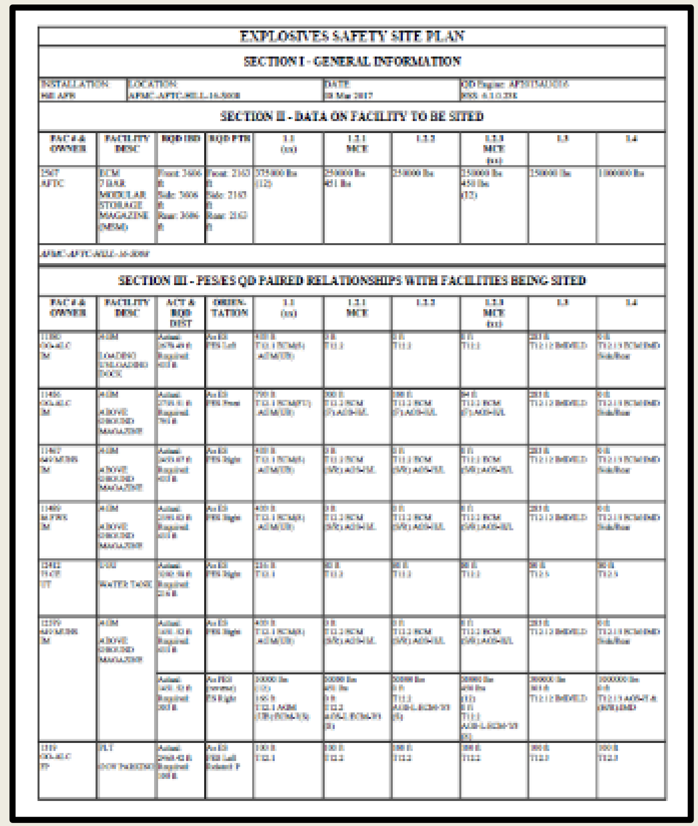
Site Planning Overview

- At its core, explosives safety site planning is a form of community planning
- Explosives safety site planning involves the use of explosives safety separation distance (ESSD) [née explosives safety quantity-distance or ESQD] intended to
  - Protect the public and personnel
  - Protect DoD property and assets
  - Protect the mission!
- Application of ESSD provides a simplified approach for providing an acceptable level of protection
- If ESSD cannot be met, protective construction may be used to show equivalent protection
- Explosives safety site planning and ESSD
  - Are only a part of the DoD Explosives Safety Program
  - Do not prevent accidental explosions

Site Planning Overview

- Step 1: Draw IBD arc around the PES
- Step 2: Identify all ESs within the IBD arc
- Step 3: Determine required and actual distance to all ESs





EXPLOSIVES SAFETY SITE PLAN

SECTION I - GENERAL INFORMATION

INSTALLATION	LOCATION	DATE	QD Engine
[illegible]	[illegible]	[illegible] Mar 2017	[illegible]

SECTION II - DATA ON FACILITY TO BE SITED

FAC # & OWNER	FACILITY DESC	RQD IBD	RQD PTR	1.1 (xx)	1.2.1 MCE	1.2.2	1.2.3 MCE (xx)	1.3	1.4
2507 AFTC	ECM 7 BAR MODULAR STORAGE MAGAZINE (MSM)	Front: 3606 ft Side: 3606 ft Rear: 3606 ft	Front: 2163 ft Side: 2163 ft Rear: 2163 ft	375000 lbs (12)	250000 lbs 451 lbs	250000 lbs	250000 lbs 450 lbs (12)	250000 lbs	1000000 lbs

SECTION III - PES/ES QD PAIRED RELATIONSHIPS WITH FACILITIES BEING SITED

FAC # & OWNER	FACILITY DESC	ACT & RQD DIST	ORIEN-TATION	1.1 (xx)	1.2.1 MCE	1.2.2	1.2.3 MCE (xx)	1.3	1.4
[illegible]	LOADING UNLOADING DOCK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ABOVE GROUND MAGAZINE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ABOVE GROUND MAGAZINE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ABOVE GROUND MAGAZINE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	WATER TANK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ABOVE GROUND MAGAZINE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

DOT Hazard Classes

DOT Hazard Class	Material
Class 1	Explosives
Class 2	Gases
Class 3	Flammable liquids
Class 4	Flammable solids
Class 5	Oxidizing substances, organic peroxides
Class 6	Poisonous (toxic) and infectious substances
Class 7	Radioactive material
Class 8	Corrosive substances
Class 9	Miscellaneous dangerous substances

Hazard classified based on predominant hazard

Not Regulated (NR) Category: Explosive substances or hazardous materials in an article that do not meet the criteria for assignment to one of the 9 classes

DOT/DoD Hazard Classes & Divisions

Class 1

Hazard Division	Hazard
1.1	Mass Explosion
1.2	Non-mass explosion, fragment producing
1.2.1	Contains more than 1.6 lb (0.752 kg) net explosive weight quantity distance (NEWQD) or that exhibit a single-round hazardous fragment distance (as estimated using the principles of DDESB TP-16) of more than 250ft (76 m) regardless of NEWQD
1.2.2	Contains less than or equal to 1.6 lb (0.752 kg) NEWQD and that exhibit a single-round hazardous fragment distance (as estimated using the principles of DDESB TP-16) of 250ft (76 m) or less regardless of NEWQD
1.2.3	No SD; Burning Only in FCO, BI, and SCO
1.3	Mass fire, minor blast or fragment
1.4	Moderate fire, no blast or fragment
1.5	Explosive substance, very insensitive (with mass explosion hazard)
1.6	Explosive article, extremely insensitive (no mass explosion hazard)

Classes 2 through 9

Hazard Division	Materials
Class 2	**Gases**
2.1	Flammable Gases
2.2	Non-flammable, compressed gas
2.3	Toxic gases
Class 3	**Flammable & Combustible Liquids**
Class 4	**Flammable Solids**
4.1	Flammable solids, desensitized explosives, self-reactive materials, readily combustible solids
4.2	Spontaneously combustible materials
4.3	Dangerous when wet materials
Class 5	**Oxidizing Sub & Organic Peroxides**
5.1	Oxidizer
5.2	Organic peroxides
Class 6	**Toxic & Infectious Substances**
6.1	Toxic materials
6.2	Infectious substances
Class 7	**Radioactive materials**
Class 8	**Corrosive materials**
Class 9	**Miscellaneous hazardous materials**

DoD-unique Subdivisions

Hazard Division (HD) 1.1 thru 1.6

- **HD 1.1** (mass-detonating) – Damage from mass-detonating hazardous materials is caused by concussion, blast, or sympathetic detonations. An entire stack of HD 1.1 items may detonate en masse. A secondary hazard is fragmentation.
- **HD 1.2** (non-mass-detonating, fragmentation producing) – The principle hazard of this division is fragmentation. These items will project fragments more or less a constant distance, regardless of the amount of ammunition involved.
- **HD 1.3** (mass fire) – Items in this division burn vigorously and are very difficult if not impossible to extinguish. There will be neither a violent shock wave nor high velocity fragments. The degree of hazard is proportional to the quantity of explosive material.
- **HD 1.4** (moderate fire) – Items in this division present a fire hazard but no blast hazard, and virtually no fragmentation hazard beyond the fire zone.
- **HD 1.5** (very insensitive substance) – Extremely insensitive detonating substances (EIDS) are HD 1.1 explosive substances that, although mass-detonating, are *so* insensitive that there is negligible probability of initiation or transition from burning to detonation in transport or storage. HD 1.5 explosives are sited as HD 1.1.
- **HD 1.6** (extremely insensitive) – Ammunition items that contain EIDS.

HD 1.1 Examples

https://www.mda.mil/global/images/system/aegis/_n7r0023.jpg

SM3 Standard Missile

Bulk Explosives

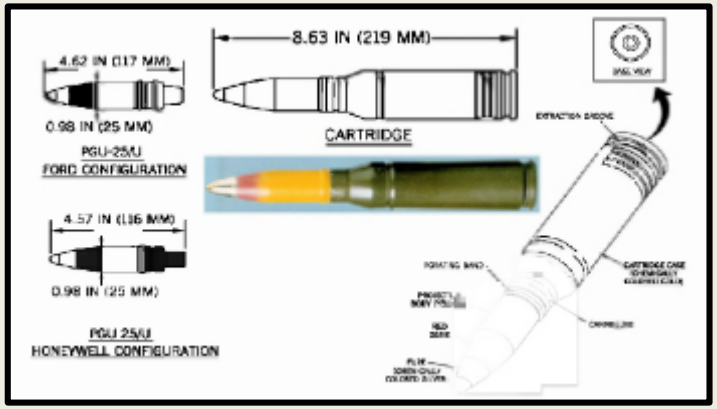
https://www.denix.osd.mil/mmrp/photogallery/bulk-demolition/bulk-demolition/

http://www.eielson.af.mil/News/Photos/igphoto/2000155210/

General Purpose Bombs

HD 1.2 Examples

HE-filled 25mm Ammunition



http://bulletpicker.com/cartridge_-25mm-hei_-pgu-25_u.html

HE-filled 20mm Ammunition

http://www.af.mil/News/Photos/igphoto/2000510655/

AGM-84H SLAM ER

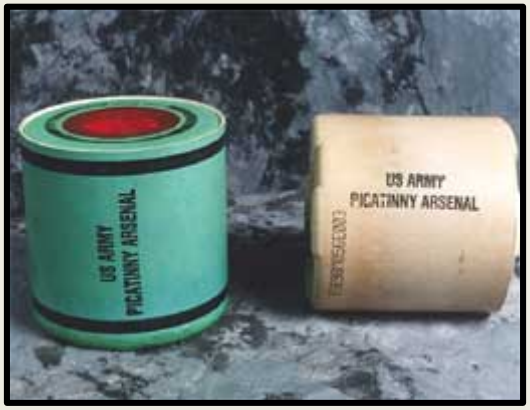
https://militaryedge.org/armaments/agm-84hk-slam-er/

HD 1.3 Examples

NASA Shuttle Solid Rocket Boosters

https://www.nasa.gov/mission_pages/shuttle/images

Modular Artillery Charge System (MACS) for 155mm Artillery



https://picac2cs9.pica.army.mil/ConventionalAmmo/Products/Macs/

MJU-7 Flare

http://www.kilgoreflares.com/solutions/products/air-countermeasures/rectangular-format/mju-7a-b.aspx

HD 1.4 Examples

Safe and Arm Device

https://psemc.com/products/electromechanical-safe-and-arm-device-esad/

7.62 mm Small Arms Ammunition

https://gundigest.com/gear-ammo/reloading/greatest-cartridges-7-62x51-nato-308-either-way-packs-punch

https://en.wikipedia.org/wiki/Ammunition_box

HD 1.5 and HD 1.6 Examples

Used for mining and quarrying blasting

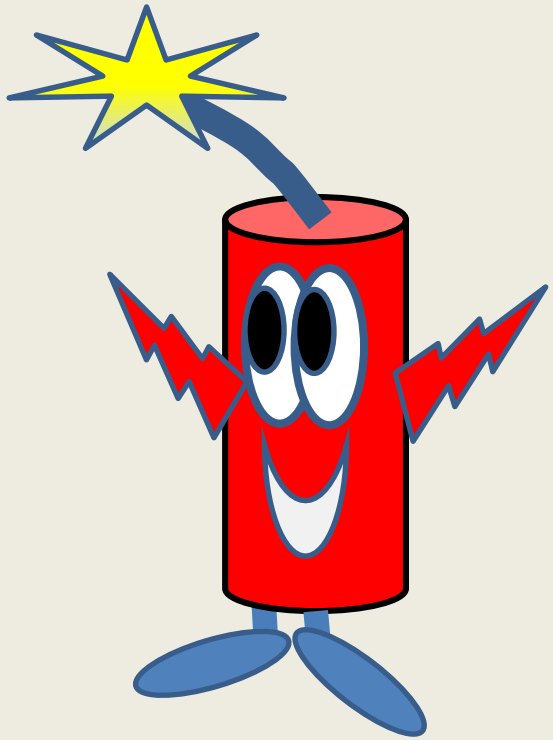
- Blasting GEL and ANFO, when mixed on site, are HD 1.5

None in the DoD Inventory

https://www.jjkeller.com/shop/Product/Division-1-5-Explosives-Placard-Worded
https://www.jjkeller.com/shop/Product/Explosives-1-6-Placard-Worded

HD 1.1 – High Order Explosives

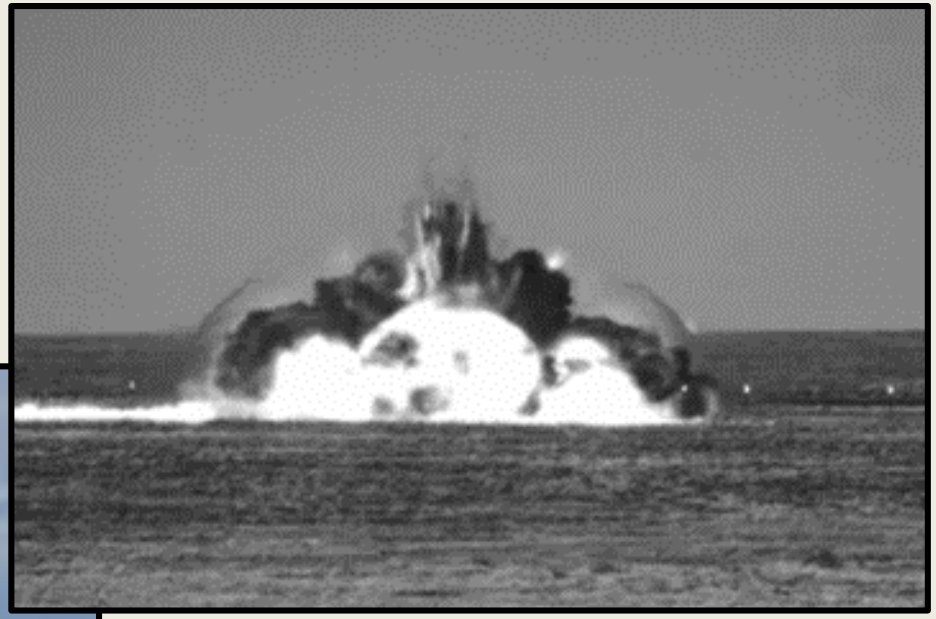
- **Detonate** when function as designed or from outside stimuli of sufficient energy
- Decompose extremely rapidly
- Produce supersonic blast wave
  - Faster than speed of sound
  - Travels at speeds 900+ mph
  - Large volumes of superheated gas
- Produce high-speed fragments
  - Travel at thousands of mph



HD 1.3 – Low Order Explosives

- **Deflagrate** when function as designed or from outside stimuli of sufficient energy
- Must be in a compressed or enclosed state to explode
- React violently by decomposing at subsonic speeds
- Pressure wave is subsonic
- Produce mass fire with large volumes of super-heated gases
- Large chunks of debris and burning propellant

Blast Overpressure and Fireball



DDESB: Screen shot from ISO-1 video

Image credit: Defence Research and Development Canada
https://io9.gizmodo.com/a-suprisingly-clear-photo-of-an-explosions-shock-wave-1691631397

Fragments

Primary Fragments

A fragment from material in intimate contact with reacting AE. Usually small in size and initially travel thousands of feet per second. Trajectory tends to be low and long.

Secondary Fragments

Fragments produced by the impact of primary fragments or airblast into surrounding structures, AE, or earth. Larger in size and initially travel hundreds of feet per second. Trajectory tends to be higher and shorter than for primary fragments.

Hazardous Fragment or Debris

Fragments or debris having an impact energy of 58 ft-lbs or greater.

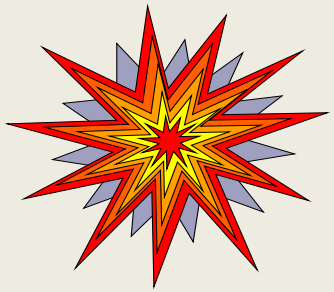
Hazardous Fragment/Debris Distance (HFD/HDD)

Distance at which the areal number density of hazardous fragments or debris becomes one per 600 square feet. Equates to a 1% probability of an average person being struck.

NOTE: For a given siting scenario, the actual fragment/debris hazard may be more or less at the HFD/HDD.

341st DDESB Meeting: DDESB Explosives Safety Testing Update, NAVFAC/EXWC

Blast and Fragmentation Effects



IMD	ILD	PTRD	IBD
 KILLED	 SERIOUS INJURIES	 INJURIES LIKELY	 INJURIES UNLIKELY
 DESTROYED	 MAJOR AIRFRAME DAMAGE	 SOME AIRFRAME DAMAGE	 OPERATIONAL
 DESTROYED	 EXTENSIVE BODY DAMAGE	 VERY LITTLE DAMAGE	 LIKELY NO DAMAGE
 DESTROYED	 SERIOUS DAMAGE	 MODERATE DAMAGE	 MINOR DAMAGE

Source: AMMO-36 Course

QD is Not Without Risk

DDESB: Screenshot from test video

- Conventional structures are typically designed to withstand roof snow loads of 30 psf and wind loads of 100 mph. These loads equate to blast overpressures of 0.2 psi.
- Blast pressure at the HD 1.1 barricaded ILD (K9) is 12 psi. At the unbarricaded ILD (K18), it is 3.5 psi.
- At IBD overpressure distance (K40/K50), blast pressure is 0.9 to 1.2 psi. Comparing these pressures with the design capacity of conventional structures, it is evident that these buildings will be damaged even at IBD.

Vulnerable Construction

https://www.nola.com/education/index.ssf/2013/04/a_virtual_tour_of_new_orleans.html

DDESB: Mark Center Visitor Guide

Vulnerable Construction and Populations

- Large glass surfaces
- Curtain wall construction
- Large footprint (square footage)
- High-rise buildings
- Schools, hospitals, nursing homes
- Places of public assembly

http://www.stouffvilleglass.com/cs-bloor-gladstone-library.html

Should not be located near QD IBD arcs!

Compatibility & Sensitivity Groups

Compatibility Group (CG): Letter designation assigned to AE to indicate what may be stored or transported together without significantly increasing either the probability of an accident or, for a given quantity, the magnitude of the effects of such an accident.

Sensitivity Group (SG): A category used to describe the susceptibility of HD 1.1 and HD 1.2.1 military munitions to sympathetic detonation for the purpose of storage within an HPM, ARMCO revetment, or SDW. There are five SGs.

Storage Compatibility Mixing

Table V1.E6.T1. Storage Compatibility Mixing Chart[a, b, c, d, e, f, g, h, i, j]

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

X = May be mixed in storage
Z = DoD Components may approved mixing of limited quantities
BLANK = Mixing requires an approved waiver or exemption

Explosive Weight

Net Explosive Weight (NEW): The total weight of all explosive substances (i.e., high explosives weight (HEW), propellant weight, and pyrotechnic weight) in the AE. NEW is used for transportation purposes.

Net Explosive Weight for Quantity-Distance (NEWQD): The total weight of all explosive substances (i.e., HEW, propellant weight, and pyrotechnic weight) in the AE, unless testing has been conducted to support an approved different value due to the contribution of HEs, propellants, or pyrotechnics. For all HD 1.3 or 1.4 (other than CG S) AE, NEWQD is equal to NEW. NEWQD is used when applying QD and other criteria in this document.

Explosive Weight

Maximum Credible Event (MCE):

- In hazards evaluation, the MCE from a hypothesized accidental explosion, fire, or toxic chemical agent release (with explosives contribution) is the worst single event that is likely to occur from a given quantity and disposition of AE. The event must be realistic with a reasonable probability of occurrence considering the explosion propagation, burning rate characteristics, and physical protection given to the items involved. The MCE evaluated on this basis may then be used as a basis for effects calculations and casualty predictions.
- MCE may be determined by site-specific analysis for HD 1.1 and HD 1.3.
- MCEs for all HD 1.2.1 and HD 1.2.3 items are listed in the JHCS.

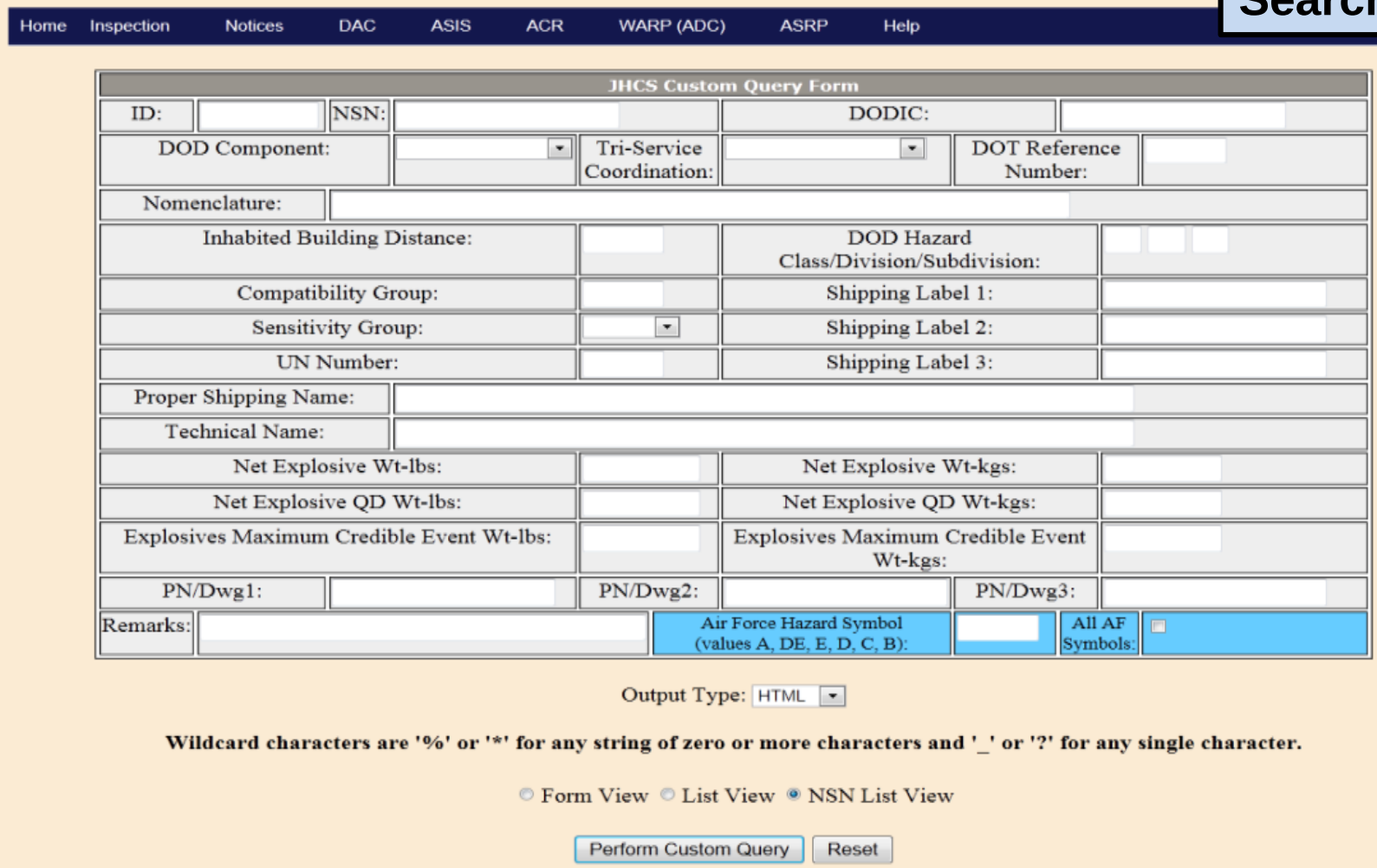
Parenthetical Fragment Distance

Parenthetical Fragment Distance (xx):

- A parenthetical number is used to indicate the minimum separation distance (in hundreds of feet) necessary for protection from debris, fragments, and firebrands when distance alone is relied on for such protection. This number is placed to the left of the HD designation (e.g., (18)1.1, (08)1.2.3, or (02)1.3).
- Parenthetical fragment distances for HD 1.1 and HD 1.3 items, if assigned, may be listed in the JHCS or may be provided in a DDESB approval letter.
- Parenthetical fragment distances for all HD 1.2.3 items are listed in the JHCS.

Joint Hazard Classification System (JHCS)

Search Page



Item Page

		JHCS Data Item Detail		
JHCS ID NO: 19860708	NSN:	1234-56-789-1011 Click for Unit Load Data (CAPULDI)	DODIC:	X111 Click for CAPULDI
Nomenclature:		MK 33.5 RETIREMENT BOMB		
Proper Shipping Name:		PROJECTILES		
Technical Name:				
(Change) DOT Reference Number:		EX20191231		
DOT Letter:		Data from the JHCS (e.g., DOT reference numbers) may be used in lieu of DOT letters; however, if a carrier insists on seeing a DOT letter, consider alternate carriers or contact the appropriate Service Hazard Classifier for assistance (Air Force, Army, Navy). Note: Obtaining a DOT letter can be a lengthy process.		
(Change) Proper Shipping Description:		UN2222, PROJECTILES, 1.1A		
		Shipping Label 1:	EXPLOSIVE 1.1D	Primary Hazard EXPLOSIVE 1.1D
DOD Hazard Class / Division :	1.1	Shipping Label 2:		
Compatibility Group:	A	Shipping Label 3:		
UN Number:	333	Part/Dwg1:	08-06-2018	
DOD Component:	ARMY	Part/Dwg2:		
TRI-Service Coordination:	NO	Part/Dwg3:		
WEIGHT		POUNDS	KILOGRAMS	TYPE OF WEIGHT
Net Explosive Weight (NEW):		100.00000	45.35900	Transportation Qty
Net Explosive QD Weight (NEWQD):		100.000000	45.35900	Storage Quantity
Sensitivity Group Code:			SG5	
Special Remarks:			SEE YOU LATER ALLIGATOR.	

Date Last Changed: 07/20/2018

PESs and ESs

Separate an ES from a PES based on the required level of protection at the ES.

Potential Explosion Site (PES): The location of a quantity of explosives that will create a blast, fragment, thermal, or debris hazard in event of an accidental explosion of its contents.

Exposed Site (ES): A location exposed to the potentially hazardous effects (blast, fragments, debris, and heat flux) from an explosion at a PES.

Functional Types of PESs

Magazine: Any building or structure used exclusively for the storage of explosives.

Operating Location: Any site, facility, or structure, except a magazine, in which operations associated with explosives are conducted (e.g., manufacturing, processing, handling, loading, or assembling).

Physical Types of PESs

Earth-Covered Magazine (ECM): An aboveground, earth-covered structure that meets soil cover depth and slope requirements. ECMs are categorized as 7-bar, 3-bar or Undefined based on their ability to resist external blast loads.

Aboveground Magazine (AGM): Any open area, vehicle, or any aboveground structure not meeting the requirements of an ECM that is used for explosives storage.

Aboveground Structure/Site (AGS): Any aboveground, non-earth-covered structure or site. *[Note: Could be a magazine or an operating location.]*

ECM Types

- As a PES, it doesn't matter whether an ECM is 7-bar, 3-bar or Undefined (with one small exception).
- As an ES, a 7-bar ECM provides the highest level of asset protection and permits the use of the least restrictive IMD from another PES.
- Arch-type ECMs can have a metal or concrete arch. Most existing ECMs are arch-type; however, there are several box-type designs and they're generally used for new construction.

DDESB Photo

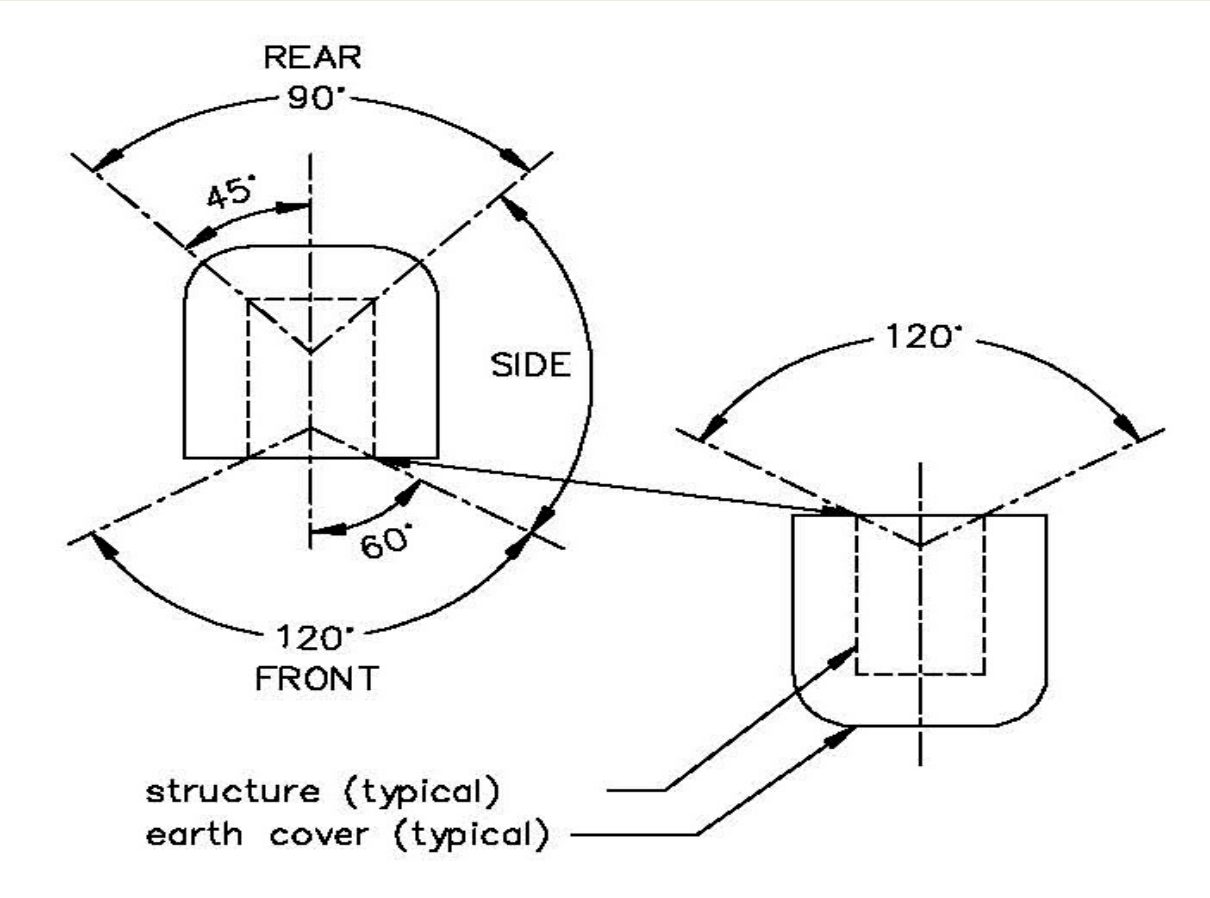
ECM Types

DDESB Photo

DDESB Photo

DDESB Photo

ECM Segmentation & Orientation



- ECMs, HPMs and HASs are “segmented” facilities, but segmentation definitions vary between them
- Criteria varies depending on the PES and ES segment orientation

K-Factors

K-factor: Often times, the numerical K-factor – *which only provides a quantitative prediction of overpressure hazards* – is used interchangeably with the type of distance or level of protection it prescribes, regardless of HD being evaluated.

$$\mathbf{D = K(W^{1/3})}$$

D = distance in feet

K = a factor depending upon the risk assumed or permitted

$W^{1/3}$ = cube root of the NEW in pounds

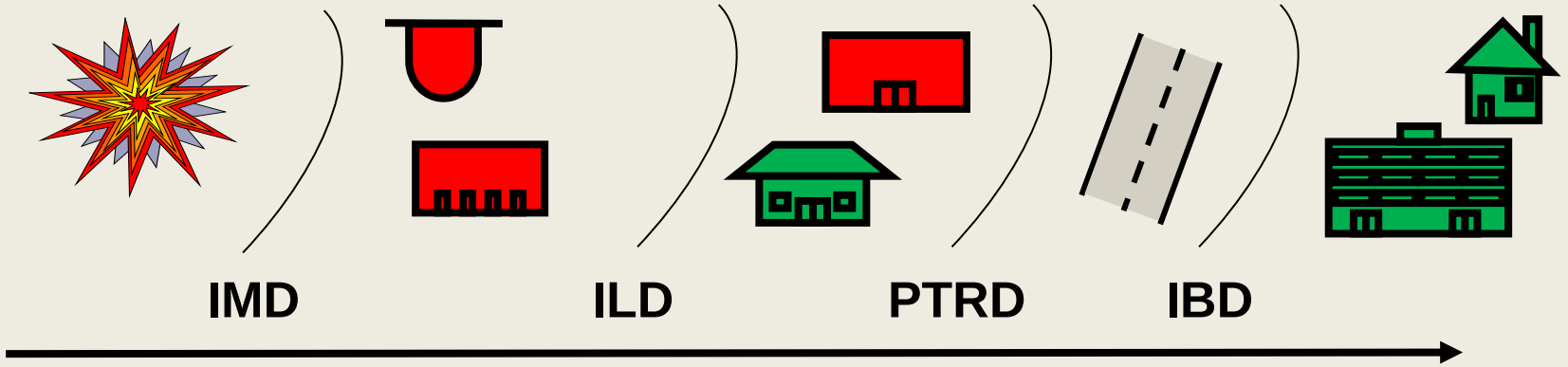
Separation Distances

- **IMD:** Distance to be maintained between two AE storage locations.

NOTE: Two PESs at less than IMD must be summed and treated as a single PES

- **ILD:** The distance to be maintained between any two AE-related buildings or sites within an AE related operating line.
- **PTRD:** Distance to be maintained between a PES and a PTR exposure.
- **IBD:** Distance to be maintained between a PES and an inhabited building.

Separation Distances



- Separation distances from PESs generally fall into one of these four categories based on the degree of safety deemed appropriate.

- For a given amount of explosives, the four distances generally fall into the order given in the drawing above – facilities sited at IMD from a PES are considerably closer and will suffer more damage than facilities at IBD from the PES.

K-Factor Separation Distances

K-Factor	Type Of ESSD
6	Barricaded Intermagazine Distance (IMD)
9	Barricaded Intraline Distance (ILD)
11	Unbarricaded IMD
18	Unbarricaded ILD
24/30	Public Traffic Route Distance (PTRD) K24 ≤ 100,000 lbs NEW Formula in between K30 ≥ 250,000 lbs NEW
40/50	Inhabited Building Distance (IBD) K24 ≤ 100,000 lbs NEW Formula in between K30 ≥ 250,000 lbs NEW

PTRD and IBD K-factors vary by NEW in order to account for increased impulse at larger NEWs

Required Levels of Protection and Allowable Exposures

Separate an ES from a PES based on the required level of protection at the ES.

How do you determine the required level of protection for an ES?

DoD 6055.09-M does this by identifying allowable exposures at various separation distances.

The various separation distances have a certain level of protection built into them…but it's not *really* quantitatively defined, and it varies based on the situation being sited.

Factors to Consider in Determining Allowable Exposures

Relationship?

PES  **ES**

- Related versus unrelated
- Continuous versus intermittent
- Related versus integral
- Relationship to a single PES versus multiple PESs
- Criticality

Allowable Exposures at Various Separation Distances

- **Paragraph V3.E3.1.1 –** Permissible Exposures to Airblast Overpressure
- **Table V4.E3.T1 –** Application of AE Separation Distances for Airfields and Heliports
- **Figure V4.E4.F2 –** Application of Separation Distances for Ship or Barge
- **Enclosure V4.E5 –** Specific Facilities
- **Separation Between Magazines –** Built into IMD tables; generally IMD, unless otherwise specified
- **Others –** Power lines, energetic liquids, munitions response sites

Paragraph V3.E3.1.1 – Permissible Exposures to Airblast Overpressure

List of specific separation distances and allowable exposures at those distances

K9 (Barricaded ILD)

- Compared to K18 (unbarricaded ILD), barricading significantly reduces low-angle fragment hazard, but there will still be high angle fragments & debris, and the overpressure hazard is significantly increased (no presumption that barricade provides overpressure protection)
- Something that doesn't have to be part of or integral to the PES, but probably can't be as far as K18
- Very limited application, such as successive steps in an operating line

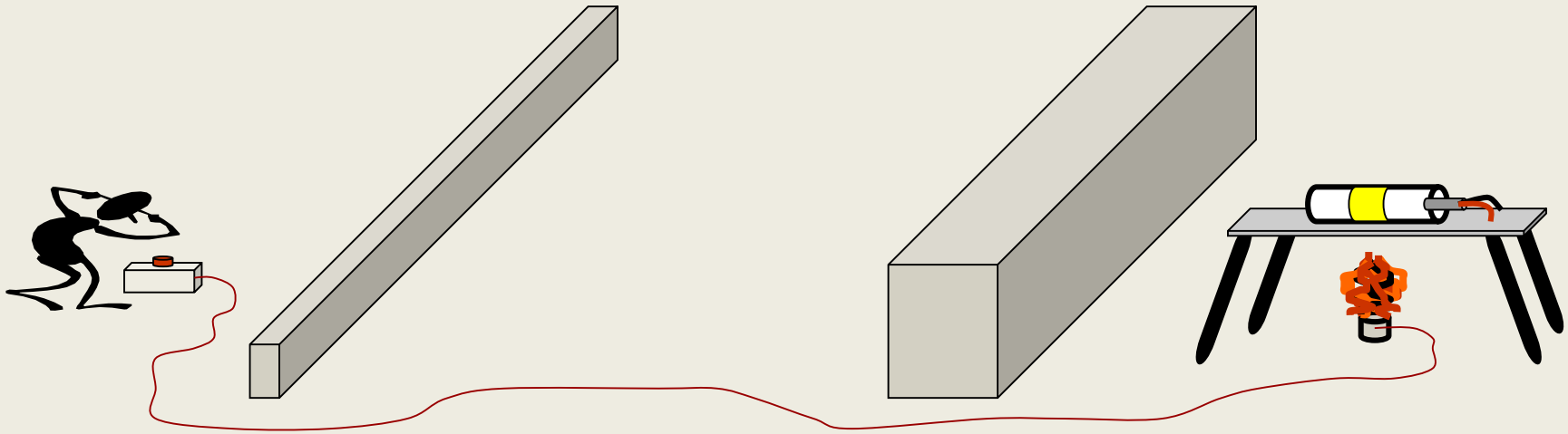
K18 (Unbarricaded ILD)

- Generally, related facilities or operating locations
- Combat aircraft support facilities

Paragraph V3.E3.1.1 – Permissible Exposures to Airblast Overpressure

K24 (Remote Operations)

- Increased separation (from ILD) for operations at greater risk of accidental explosion, as determined by the Service
- Paragraph V1.E9.3.1 for personnel protection from accidental ignition or initiation of explosives provides more specific blast, thermal and fragment protection criteria, to include the use of shielding



Source: AMMO-36 Course

Paragraph V3.E3.1.1 – Permissible Exposures to Airblast Overpressure

K24/30 (PTRD)

- Public traffic routes, such as medium or low density traffic roads or waterways
- Open air locations only accessed intermittently, such as ball fields
- On-base roads
- K-factor varies by NEW in order to account for increased impulse at larger NEWs

K30 (Aircraft Protection)

- Level of acceptable overpressure damage to aircraft with presumption that fragment damage is repairable

Paragraph V3.E3.1.1 – Permissible Exposures to Airblast Overpressure

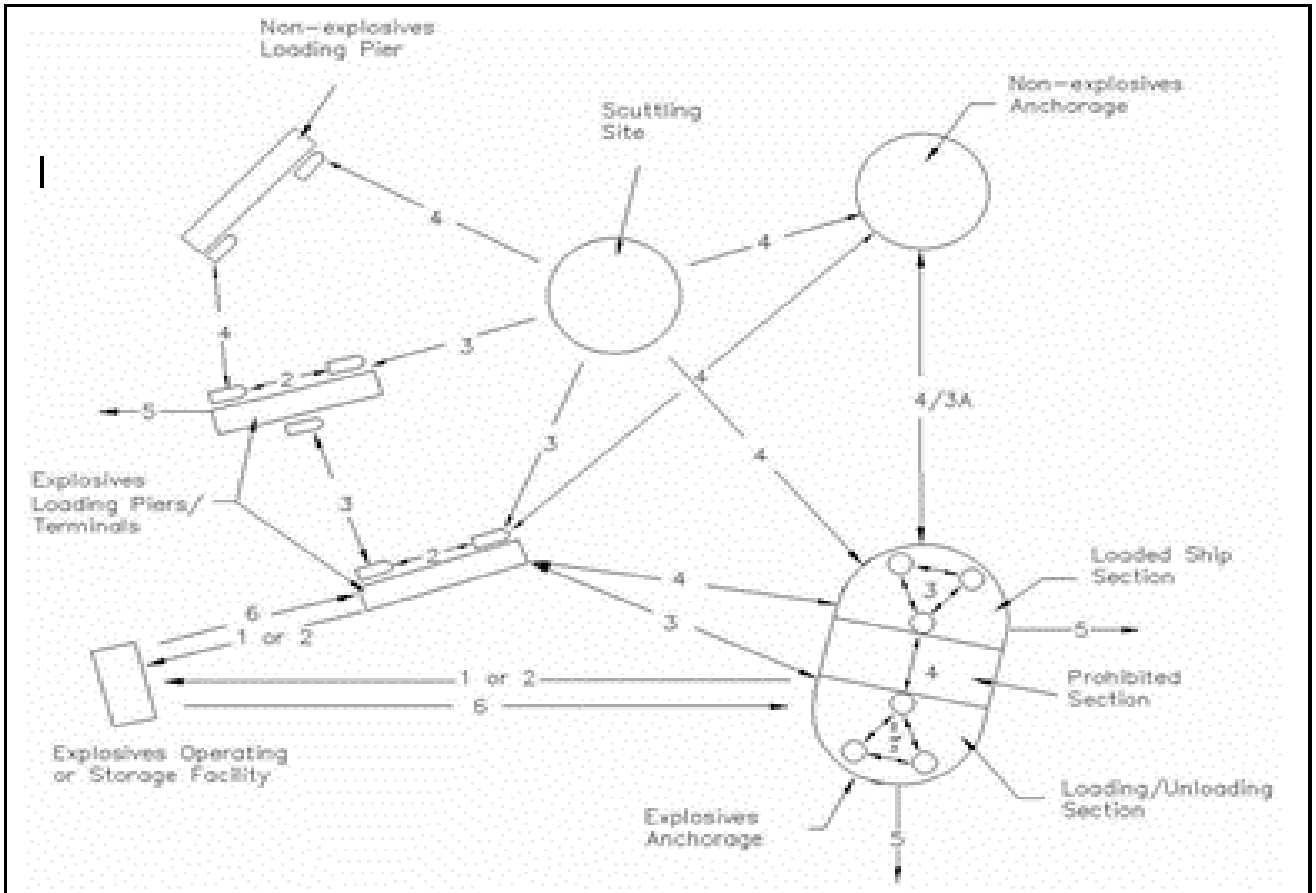
K40/50 (IBD)

- Unrelated exposures
- Base boundary
- PTR exposures with structures
- Critical assets or infrastructure
- K-factor varies by NEW in order to account for increased impulse at larger NEWs

Table V4.E3.T1. Application of AE Separation Distances for Airfields and Heliports

From ➔ / To ↓	Hardened Aircraft Shelter	Combat Aircraft Parking Area	AE Cargo Area	AE Storage Facility	AE Operating Facility	Ready Ammunition Storage Facility
Hardened Aircraft Shelter (HAS)	a	b	b	c	c	d
Maintenance HAS	e	f	f	c	c	g
Combat Aircraft Parking Area	h	h	h	i	i	h
AE Cargo Area	h	h	h	h	h	h
AE Storage Facility	h	h	h	h	h	h
AE Operating Facility	j	j	j	j	j	j
Ready Ammunition Storage Facility	d	h	h	h	h	h
Inhabited Building	k	k	k	k	k	k
Public Traffic Route and Taxiway (joint DoD-Non DoD use)	l	l	l	l	l	l
Runway (joint DoD-Non DoD use)	k	k	k	k	k	k
Runway/Taxiway (DoD Component use only)	None	None	None	m	l	None
Aircraft Parking Area	n	n	n	o	o	n
Aircraft Passenger Loading/Unloading Area	p	p	p	p	p	p
Recreation Area	q	q	r	r	r	q

Figure V4.E4.F2. Application of Separation Distances for Ship or Barge



1 - K6 [K_ 2.38]
2 - K11 [K_ 4.36]
3 - K18 [K_ 7.14]
3A - K18 [K_ 7.14] (See paragraph V4.E4.4.8. for pre-positioning program ships.)
4 - K40W$^{1/3}$ [K_ 15.87]
5 - Table V3.E3.T1. IBD or PTRD (Other PES columns), as applicable.
6 - Table V3.E3.T1. IBD, as applicable.

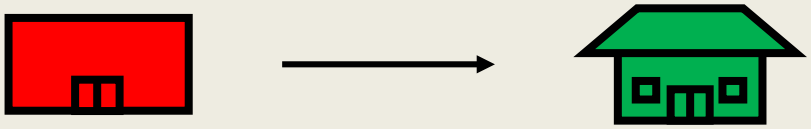
Ship or Barge

V4.E5 – Specific Facilities

List of specific exposures, noting in some cases:

- Siting not required
- Restrictions apply
- Approval level reduced
- Allowable separation distance

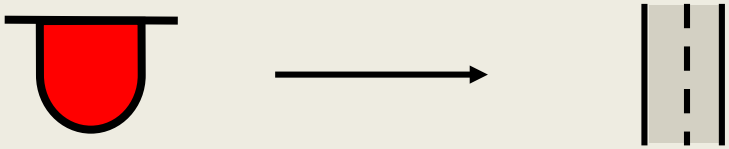
PES to ES Separation – Examples



EOL

Training Facility for people that work at the EOL

ILD per Paragraph V3.E3.1.1.2.1.5



Storage Area ECM

Runway/Taxiway in the US (DoD Component use only)

PTRD per Table V4.E3.T1, Footnote L

PES to ES Separation – Exercises

Work in teams!

PES to ES Separation – Exercises

1. Dunnage preparation building used only by personnel employed at the PES, if there is a barricade in between them?
   K9, Barricaded ILD, Paragraph V3.E3.1.1.1.1.5

2. Between parallel (not performing successive steps of a single production operation) operating lines when each line presents similar hazards?
   K18, Unbarricaded ILD, Paragraph V3.E3.1.1.2.1.3 – in both directions

3. Between parallel operating lines when it is critical that one of the operating lines survives?
   K40/50, IBD, Paragraph V3.E3.1.1.2.1.3 – to the one that must survive
   K18, Unbarricaded ILD, Paragraph V3.E3.1.1.2.1.3 – to the other one

4. Public traffic route with medium traffic density?
   K24/30, PTRD, Paragraph V3.E3.1.1.4.1

5. Open air recreation facilities without structures?
   K24/30, PTRD, Paragraph V3.E3.1.1.4.3

6. Installation boundary?
   K40/50, IBD, Paragraph V3.E3.1.1.6.2

PES to ES Separation – Exercises

7. Inert storage structure accessed by personnel not related to the explosives mission?
   K40/50, IB, Paragraph V3.E3.1.1.6.9

8. AGM in the storage area to a combat aircraft parking areas?
   K30, Aircraft Protection, Table V4.E3.T1, Footnote i and Table V4.E3.T2; PTRD for other than HD 1.1

9. Combat aircraft parking area to a runway (DoD Component use only)?
   No QD separation required, Table V4.E3.T1

10. Ready ammunition storage facility to an aircraft passenger loading/unloading area that has a structure?
    K40/50, IBD, Table V4.E3.T1, Footnote p

11. Explosives loading pier to a non-explosives anchorage?
    K40, IBD, Figure V4.E4.F2, Note 4

12. Between two explosives loading piers?
    K18, ILD, Figure V4.E4.F2, Note 3 – in both directions

PES to ES Separation – Exercises

13. Between an explosives anchorage and an explosives operating facility?
    K6/K11, Barricaded or Unbarricaded IMD, Figure V4.E4.F2, Notes 1 & 2 – from the anchorage to the operating facility
    K40/50, IBD, Figure V4.E4.F2, Note 6 – from the operating facility to the anchorage

14. Security post from the PES it supports?
    No QD separation required, Paragraph V4.E5.2.2 – fire protection distance applies

15. Between a detached loading dock and the multiple magazines it services?
    K6/K11, Barricaded or Unbarricaded IMD, Paragraph V4.E5.7.1 – from the loading dock to the magazines
    No QD separation required, Paragraph V4.E5.7.1 – from the magazines to the loading dock

16. Between AE truck groups in a holding yard?
    K6/K11, Barricaded or Unbarricaded IMD, Paragraph V4.E5.8.2 – in both directions

17. Between a non-DoD storage facility and a shared launch facility?
    K40/50, IBD, Table V4.E5.T10 – in both directions

PES to ES Separation

The basics….

- Separate two magazines by IMD (both directions)
- Separate a magazine from an EOL by IMD
- Separate an EOL from any PES by ILD
- Separate a related facility from any PES by ILD
- Separate a PTR from any PES by PTRD
- Separate any unrelated facility from any PES by IBD

PES to ES Separation

The world is not black and white….

- When does a magazine become an explosives operating location?
- When does a related facility become an inhabited building?
- When does an intermittent exposure become an inhabited building exposure?

HD 1.1 – IBD and PTRD

- **V3.E3.1.2 – Minimum Fragment Distances**
  - **V3.E3.1.2.1.1 – Populous Locations**
    - **V3.E3.1.2.1.1.1 – NEWQD ≤ 450 lbs**
    - **V3.E3.1.2.1.1.2 – NEWQD of 451 to 30,000 lbs**
    - **V3.E3.1.2.1.1.3 – NEWQD > 30,000 lbs**
    - **V3.E3.1.2.1.1.4 – Sparsely Populated Locations**
    - **V3.E3.1.2.1.1.5 – PTR Densities**
  - **V3.E3.1.2.1.2 – HFD applies to**
  - **V3.E3.1.2.1.3 – HFD does not apply to**
- **V3.E3.1.3 – IBD & PTRD**
- **Tables**
  - **V3.E3.T1 – HD 1.1 IBD and PTRD**
  - **V3.E3.T2 – HD 1.1 HFD (Primary Fragments & Debris)**
  - **V3.E3.T3 – Specific Items HFD for Primary Fragments**

HD 1.1 – IBD and PTRD

- **V3.E3.1.2.1.1.1 – NEWQD ≤ 450 lbs**
  - **7-bar & 3-bar ECM, use ECM columns**
  - **Undefined ECM with low loading density, use ECM columns**
  - **Undefined ECM with high loading density**
    - **Side/rear – Use ECM side/rear columns**
    - **Front – Use greater of ECM front column or Table V3.E3.T2**
      - **If headwall meets AGS(H) or AGS(H/R), use Structure column**
      - **Otherwise:**
        - **Use Open column for fragmenting AE**
        - **Use Structure column for non-fragmenting AE**
  - **Non-ECM structure that meets AGS(H) or AGS(H/R), use Structure column**
  - **Fragmenting AE in the open or structure that meets AGS(L), use Open column**
  - **Non-fragmenting AE in structure that meets AGS(L), or truck/trailer/railcar, use Structure column**
  - **(xx) from JHCS or specific item HFD per Table V3.E3.T3**
  - **Non-fragmenting AE in open, use K40**

HD 1.1 – IBD and PTRD

- **V3.E3.1.2.1.1.2 – NEWQD of 451 to 30,000 lbs**
  - **For any structure, use 1,250 ft**
  - **(xx) from JHCS or specific item HFD per Table V3.E3.T3 for items in the open**
  - **Non-fragmenting AE in open, use K40**
- **V3.E3.1.2.1.1.3 – NEWQD > 30,000 lbs**
  - **7-bar & 3-bar ECM ≥ 26 ft x 60 ft, use ECM columns**
  - **Undefined ECM ≥ 26 ft x 60 ft, use ECM side/rear columns and Other PES column for the front**
  - **ECMs < 26 ft x 60 ft and all other PESs, use Other PES columns**

Table V3.E3.T1. HD 1.1 IBD and PTRD

NEWQD	IBD From:				PTRD From:			
	ECM			Other	ECM			Other
	Front[a, b]	Side[a]	Rear[c]	PES[d]	Front[e, f]	Side[e]	Rear[e]	PES[e]
(lbs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
1	500	250	250	**Footnote d**	300	150	150	**Footnote e**
100	500	250	250		300	150	150	
150	500	250	250		300	150	150	
300	700	250	250		420	150	150	
450	700	250	250		420	150	150	
500	1,250	1,250	1,250	1,250	750	750	750	750
1,000	1,250	1,250	1,250	1,250	750	750	750	750
10,000	1,250	1,250	1,250	1,250	750	750	750	750
45,000	1,250	1,250	1,250	1,423	750	750	750	854
50,000	1,289	1,289	1,250	1,474	774	774	750	884
100,000	1,625	1,625	1,250	1,857	975	975	750	1,114
500,000	3,969	3,969	3,969	3,969	2,381	2,381	2,381	2,381

Footnote a. NEWQD < 45,000 lbs, IBD is controlled by fragments. If no fragments or HFD < blast, use:

NEWQD ≤ 100,000 lbs	$D = 35*NEWQD^{1/3}$	[K35]
100,000 lbs < NEWQD ≤ 250,000 lbs	$D = 0.3955*NEWQD^{0.7227}$	[K35/50]
NEWQD > 250,000 lbs	$D = 50*NEWQD^{1/3}$	[K50]

Footnote c. NEWQD < 45,000 lbs, IBD is controlled by fragments. If no fragments or HFD < blast, use:

NEWQD ≤ 100,000 lbs	$D = 25*NEWQD^{1/3}$	[K25]
100,000 lbs < NEWQD ≤ 250,000 lbs	$D = 0.004125*NEWQD^{1.0898}$	[K25/50]
NEWQD > 250,000 lbs	$D = 50*NEWQD^{1/3}$	[K50]

Footnote d. NEWQD < 100,000 lbs, IBD is controlled by fragments. If no fragments or HFD < blast, use:

NEWQD ≤ 100,000 lbs	$D = 40*NEWQD^{1/3}$	[K40]
100,000 lbs < NEWQD ≤ 250,000 lbs	$D = 2.42*NEWQD^{0.577}$	[K40/50]
NEWQD > 250,000 lbs	$D = 50*NEWQD^{1/3}$	[K50]

Table V3.E3.T2. HD 1.1 HFD[a, b]

NEWQD (lbs)	Open[c, d] (ft)	Structure[e, f] (ft)
≤ 0.5	236	200
10	474	200
30	561	200
31	563	200
50	601	388
100	658	658
450	1,243	1,243
> 450	1,250	1,250

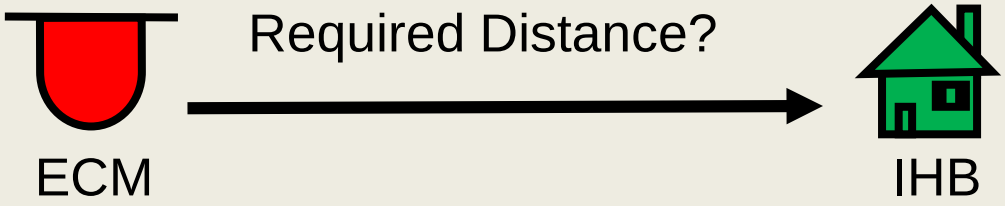
c	NEWQD < 100 lbs: NEWQD ≥ 100 lbs:	HFD = 291.3 + [79.2*ln(NEWQD)], with a minimum distance of 236 ft HFD = -1133.9 + [389*ln(NEWQD)]
e	NEWQD ≤ 31 lbs: 31 lbs < NEWQD ≤ 450 lbs:	HFD = 200 ft HFD = -1133.9 + [389*ln(NEWQD)]

Table V3.E3.T3. HFD for Open Stacks of Selected HD 1.1 AE[a]

Nomenclature	Number of Units									
	1	2	3	4	5	6	7	8	9	10
	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
Sparrow, AIM-7[b]	280	565	770	955	1,120	1,245				
Sidewinder, AIM-9	400	400	400	400	400	400	400	400	400	400[c]
Chaparral, MIM-72H	400	400	400	400	400	400	400	400	400	400[c]
Cluster Bomb Unit-87[e]	800	800	910	945	965	982	1,000	1,020	1,035	1,055[f]
Maverick, AGM 65 A/B/D	400	500	500							
Tomahawk[e]	500	600[h]	600[h]	600[h]						

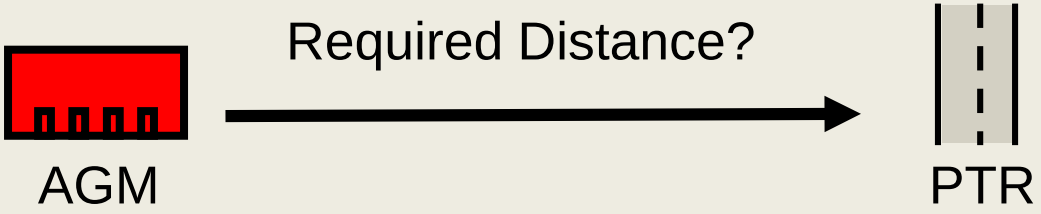
a	All of the HFDs in this table may be applied to both packaged and unpackaged configurations.
b	Those items with a WAU-17 warhead.
c	Ten units or more until the point is reached at which this distance is exceeded by the distance requirements of Table V3.E3.T1.
e	HFDs include fragments from shipping or storage container(s).
f	More than 10 units may be involved before 1,250 ft is exceeded. For distances involving more than 10 units, consult the applicable Service guidance.
h	When handling more than one missile, the missiles must be transported or handled in a nose-to-tail configuration and in their launch capsule or shipping container; furthermore, they must be aligned and handled so that each group of two missiles is located outside of the warhead fragment beam spray region of the other two missiles.

HD 1.1 IBD and PTRD – Examples



IBD of 1,289 ft
Per Table V3.E3.T1

50,000 lbs NEWQD of HD 1.1



PTRD of 750 ft
Per Table V3.E3.T1

3,000 lbs NEWQD of HD 1.1

HD 1.1 IBD and PTRD – Exercises

Work in teams!

HD 1.1 IBD and PTRD – Exercises

1. From the side of a 7-bar ECM with 50 lbs NEWQD of HD 1.1 to a public traffic route?
   PTRD, 150 ft, Paragraph V3.E3.1.2.1.1.1.1 and Table V3.E3.T1

2. From the front of an Undefined ECM (with a loading density greater than 0.028 lbs/ft3, and an AGS(H) front wall) with 300 lbs of HD 1.1 to an inhabited building?
   IBD, 1,085 ft, Paragraph V3.E3.1.2.1.1.1.3; greater of Table V3.E3.T1 for ECM front, or Table V3.E3.T2 “Structure” column

3. From an explosives operating facility (AGS(L)) with 70 lbs of HD 1.1 to a public traffic route?
   PTRD, 377 ft, Paragraph V3.E3.1.2.1.1.1.6 and Table V3.E3.T2 “Open” column; 60% of the HFD of 628 ft per Footnote b of Table V3.E3.T2

4. From three Cluster Bomb Unit-87 bombs (presume total NEWQD is less than 450 lbs) in the open to a public traffic route?
   PTRD, 546 ft, Paragraph V3.E3.1.2.1.1.1.8 and Table V3.E3.T3; 60% of the HFD of 910 ft per Paragraph V3.E3.1.2.1.1.1

5. From the rear of an Undefined ECM (greater than 26 ft x 60 ft) with 20,000 lbs NEWQD of HD 1.1 to an inhabited building?
   IBD, 1,250 ft, Paragraph V3.E3.1.2.1.1.2.4 and Table V3.E3.T1

HD 1.1 – ILD

- **V3.E3.1.2 – Minimum Fragment Distances**
  - **V3.E3.1.2.1.1.1 – NEWQD ≤ 450 lbs**
  - **V3.E3.1.2.1.1.2 – NEWQD of 451 to 30,000 lbs**
  - **V3.E3.1.2.1.1.3 – NEWQD > 30,000 lbs**
- **V3.E3.1.4 – ILD**
- **V3.E3.1.5 – IMD**
  - **V3.E3.1.5.4 – Barricaded ILD & IMD from an ECM**
  - **V3.E3.1.5.5 – Barricaded ILD & IMD from an HPM**
- **Tables**
  - **V3.E3.T4 – HD 1.1 ILD**
  - **V3.E3.T5 – HD 1.1 ILD from ECM**

Table V3.E3.T4. HD 1.1 ILD

NEWQD	Barricaded Distance[a]	Unbarricaded Distance[b]
(lbs)	(ft)	(ft)
50[c]	33	66
70	37	74
500	71	143
10,000	194	388
50,000	332	663
100,000	418	835
500,000[d]	714	1,429
1,500,000	1,030	2,060
5,000,000	1,539	3,078

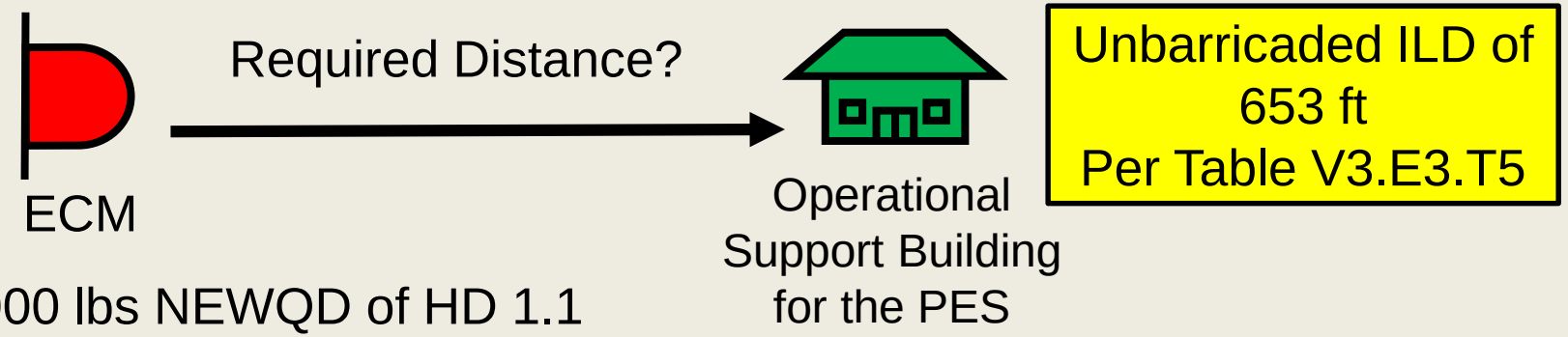
a	$D = 9*NEWQD^{1/3}$
b	$D = 18*NEWQD^{1/3}$
c	For less than 50 lbs [22.7 kg], less distance may be used when structures, blast mats, and the like can completely contain fragments and debris. This table is not applicable when blast, fragments, and debris are completely confined, as in certain test firing barricades.
d	Quantities above 500,000 lbs [226,795 kg] NEWQD are authorized only for HD 1.1 energetic liquids.

Table V3.E3.T5. HD 1.1 ILD from ECM

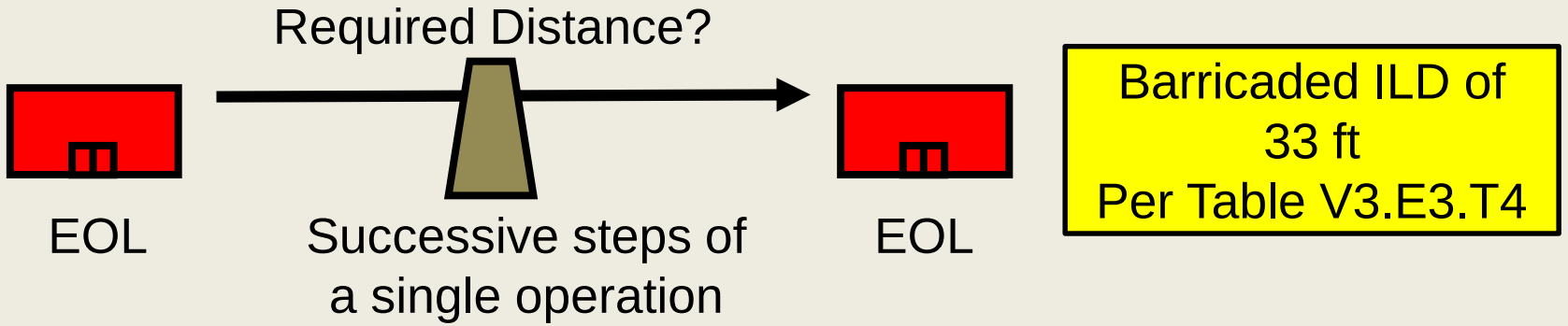
NEWQD	Barricaded Distance			Unbarricaded Distance		
	Front[a]	Side[b]	Rear[c]	Front[d]	Side[e]	Rear[f]
(lbs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
50	37	26	22	66	59	44
70	41	29	25	74	66	49
500	79	56	48	143	127	95
10,000	215	151	129	388	345	259
50,000	368	258	221	663	589	442
100,000	464	325	278	835	743	557
500,000	715	714	714	1,429	1,429	1,429

a	NEWQD ≤ 300,000 lbs:	$D = 10*NEWQD^{1/3}$
	300,000 lbs < NEWQD ≤ 500,000 lbs:	$D = (13.659 - 1.6479 \times 10^{-5}*NEWQD + 1.4358 \times 10^{-1}*NEWQD^{2}) *NEWQD^{1/3}$
b	NEWQD ≤ 300,000 lbs:	$D = 7*NEWQD^{1/3}$
	300,000 lbs < NEWQD ≤ 400,000 lbs:	$D = (1.0848 + 1.986 \times 10^{-5}*NEWQD)*NEWQD^{1/3}$
	NEWQD > 400,000 lbs:	$D = 9*NEWQD^{1/3}$
c	NEWQD ≤ 300,000 lbs:	$D = 6*NEWQD^{1/3}$
	300,000 lbs < NEWQD ≤ 400,000 lbs:	$D = (-3.059 + 3.0228 \times 10^{-5}*NEWQD)*NEWQD^{1/3}$
	NEWQD > 400,000 lbs:	$D = 9*NEWQD^{1/3}$
d	NEWQD ≤ 500,000 lbs:	$D = 18*NEWQD^{1/3}$
e	NEWQD ≤ 300,000 lbs:	$D = 16*NEWQD^{1/3}$
	300,000 lbs < NEWQD ≤ 400,000 lbs:	$D = (9.9683 + 2.0135 \times 10^{-5}*NEWQD)*NEWQD^{1/3}$
	NEWQD > 400,000 lbs:	$D = 18*NEWQD^{1/3}$
f	NEWQD ≤ 100,000 lbs:	$D = 12*NEWQD^{1/3}$
	100,000 lbs < NEWQD ≤ 300,000 lbs:	$D = (11.521 + 1.9918 \times 10^{-6}*NEWQD + 2.0947 \times 10^{-11}*NEWQD^{2}) *NEWQD^{1/3}$
	300,000 lbs < NEWQD ≤ 400,000 lbs:	$D = (1.9389 + 4.0227 \times 10^{-5}*NEWQD)*NEWQD^{1/3}$
	NEWQD > 400,000 lbs:	$D = 18*NEWQD^{1/3}$

HD 1.1 ILD – Examples



150,000 lbs NEWQD of HD 1.1



30 lbs NEWQD of HD 1.1

HD 1.1 ILD – Exercises

Work in teams!

HD 1.1 ILD – Exercises

1. From an EOL with 10,000 lbs NEWQD of HD 1.1 to a change house used exclusively by personnel operating the EOL, if there is a barricade in between them?
   K9, Barricaded ILD, 194 ft, Paragraph V3.E3.1.1.1.1.4 and Table V3.E3.T4

2. From an AGM with 200 lbs NEWQD of HD 1.1 to a training facility that only personnel that operate the PES use?
   K18, Unbarricaded ILD, 105 ft, Paragraph V3.E3.1.1.2.1.5 and Table V3.E3.T4

3. From the rear of a 3-bar ECM with 50,000 lbs NEWQD of HD 1.1 to a training facility that only personnel that operate the PES use, if there is a barricade in between them?
   K16/ECM, Unbarricaded ILD, 442 ft, Paragraph V3.E3.1.1.2.1.5 and Table V3.E3.T5

4. From the side of a 7-bar ECM with 300,000 lbs NEWQD of HD 1.1 to an EOL closely related to the ECM?
   K16/ECM, Unbarricaded ILD, 1,071 ft, Paragraph V3.E3.1.1.2.1.1 and Table V3.E3.T5

5. From the rear of an Undefined ECM with 200,000 lbs NEWQD of HD 1.1 to a dunnage preparation area used only by personnel employed at the PES, if there is **no** barricade in between them?
   K6/ECM, Barricaded ILD, 351 ft, Paragraphs V3.E3.1.1.1.1.5 and V3.E3.1.5.4.2, and Table V3.E3.T5

HD 1.1 – IMD

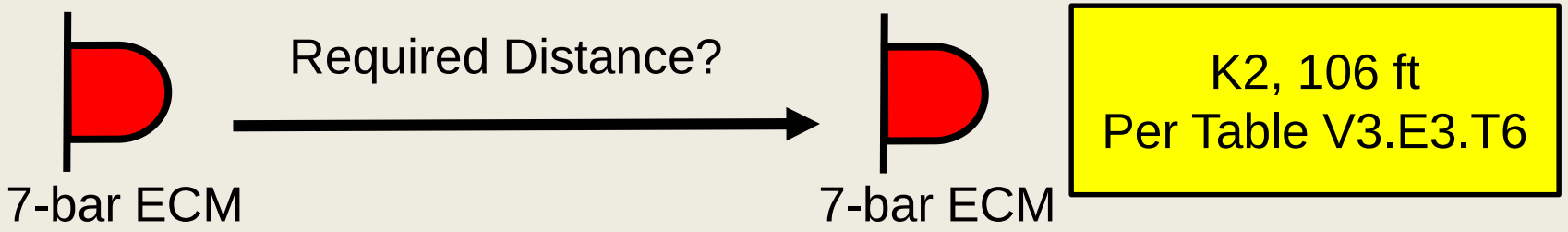
- **V3.E3.1.5 – IMD**
  - **V3.E3.1.5.1 – Siting Rules**
  - **V3.E3.1.5.2 – Barricaded IMD from ECM**
  - **V3.E3.1.5.3 – ECM Storage Limitations**
  - **V3.E3.1.5.4 – Barricaded ILD & IMD from an ECM**
  - **V3.E3.1.5.5 – Barricaded ILD & IMD from an HPM**
- **Tables**
  - **V3.E3.T6 – HD 1.1 IMD Hazard Factors**
  - **V3.E3.T7 & T8 – For People Without Calculators**

Table V3.E3.T6. HD 1.1 IMD Hazard Factors

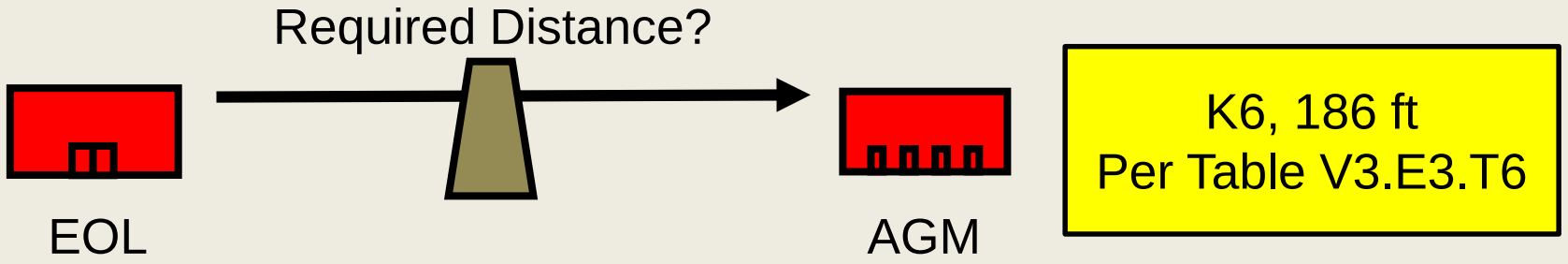
To ES		From PES									
		ECM[a]				AGM or Aboveground Operating Building[b]		Modules or Cells		HPM[c, d]	
		S	R	FB	FU	B	U	B	U	S	F[e]
		(ft/lb$^{1/3}$)	(ft/lb$^{1/3}$)	(ft/lb$^{1/3}$)	(ft/lb$^{1/3}$)	(ft/lb$^{1/3}$)	(ft/lb$^{1/3}$)	(ft/lb$^{1/3}$)	(ft/lb$^{1/3}$)	(ft/lb$^{1/3}$)	(ft/lb$^{1/3}$)
ECM (7-Bar)	S	1.25	1.25	2.75	2.75	4.5	4.5	4.5	4.5	1.25	2.75
	R	1.25	1.25	2	2	4.5	4.5	4.5	4.5	1.25	2
	FU	2.75	2	6	6	6	6	6	6	2.75	6
	FB[f]	2.75	2	4.5	6	4.5	6	4.5	6	2.75	6
ECM (3-Bar)	S	1.25	1.25	2.75	2.75	6	6	6	6	1.25	2.75
	R	1.25	1.25	2	2	6	6	6	6	1.25	2
	FU	4.5	4.5	6	9	6	9	6	9	4.5	9
	FB[f]	4.5	4.5	6	6	6	6	6	6	4.5	6
ECM (Undefined)	S	1.25[g]	1.25[g]	4.5[g]	4.5[g]	6	6	6	6	1.25	4.5
		2[h]	2[h]	6[h]	6[h]						
	R	1.25	1.25	2	2	6	6	6	6	1.25	2
	FU	6	6	6	11	6	11	6	11	6	11
	FB[f]	6	6	6	6	6	6	6	6	6	6
AGM	U	6	6	6	11	6	11	6	11	6	11
	B	6	6	6	6	6	6	6	6	6	6
Modules or Cells	U	6	6	6	11	6	11	1.1[i]	11	6	11
	B	1.25	1.25	6	6	6	6	1.1[i]	1.1[i]	1.25	6
HPM	S,F[d]	1.25	1.25	2.75	2.75	4.5	4.5	4.5	4.5	1.25	2.75

g	Use this K-factor for NEWQD in PESs up to 250,000 lbs.
h	Use this K-factor for NEWQD in PESs greater than 250,000 lbs.

HD 1.1 IMD – Examples



150,000 lbs NEWQD of HD 1.1



30,000 lbs NEWQD of HD 1.1

HD 1.1 IMD – Exercises

Work in teams!

HD 1.1 IMD – Exercises

1. From the side of a 7-bar ECM with 200,000 lbs NEWQD of HD 1.1 to the rear of a 3-bar ECM?
   K1.25, 73 ft, Table V3.E3.T6

2. From a barricaded AGM with 70,000 lbs NEWQD of HD 1.1 to the barricaded front of a 7-bar ECM?
   K4.5, 185 ft, Table V3.E3.T6

3. From the side of an Undefined ECM with 100,000 lbs NEWQD of HD 1.1 to the side of an Undefined ECM?
   K1.25, 58 ft, Table V3.E3.T6 Footnote g

4. From the side of an Undefined ECM with 300,000 lbs NEWQD of HD 1.1 to the side of an Undefined ECM?
   K2, 134 ft, Table V3.E3.T6 Footnote h

5. From an EOL with 5,000 lbs NEWQD of HD 1.1 to an unbarricaded service magazine?
   No QD separation required, Table V3.E3.T6 Footnote b and Paragraph V3.E3.1.1.2.1.9

HD 1.2 QD

- **V3.E3.2 – HD 1.2**
  - **V3.E3.2.1 – Progressive nature of HD 1.2 events**
  - **V3.E3.2.2 – Treat "single" HD 1.2.1 events as HD 1.1**
  - **V3.E3.2.3 – NEW of HD 1.2.1 versus HD 1.2.2**
  - **V3.E3.2.4 – MCE of HD 1.2.1**
  - **V3.E3.2.5 – Results of HD 1.2 events**
  - **V3.E3.2.6 – Reference to tables**
    - **Start with Table V3.E3.T9**
    - **For HD 1.2.1 in structures with a debris hazard, use greater of Table V3.E3.T10 for NEWQD or Table V3.E3.T11 for MCE**
  - **V3.E3.2.7 through V3.E3.2.9**
    - **More info on IMD, PTRD and ILD**
    - **Reference to Table V3.E3.T12**
  - **V3.E3.2.10 – HD 1.2 subdivision mixing rules**
  - **V3.E3.2.11 – Operational quantities exception**
  - **V3.E3.2.12 through V3.E3.2.14 – HD 1.2.3**
- **V3.E3.1.5.6 – 100-lb rule between ECMs**

Table V3.E3.T9. Summary of HD 1.2.1, 1.2.2, and 1.2.3 QD[a, b, c]

To ES		From PES				
		ECM		AGS		
		S or R	F	(H)	(H/R)	(L)
ECM (7 Bar/ 3 Bar) (IMD)	S	0[d]	0[d]	0[d]	0[d]	0[d]
	R	0[d]	0[d]	0[d]	0[d]	0[d]
	FU	0[d]	0[d]	0[d]	0[d]	0[d]
	FB	0[d]	0[d]	0[d]	0[d]	0[d]
ECM (Undefined) (IMD)	S	0[d]	0[d]	0[d]	0[d]	0[d]
	R	0[d]	0[d]	0[d]	0[d]	0[d]
	FU	0[d]	200/300/100 ft	200/300/100 ft	200/300/100 ft	200/300/100 ft
	FB	0[d]	0[d]	0[d]	0[d]	0[d]
AGS (H/R) (IMD)	U or B	0[d]	0[d]	0[d]	0[d]	0[d]
AGS (H or L) (IMD)	U or B	0[d]	200/300/100 ft	200/300/100 ft	200/300/100 ft	200/300/100 ft
ILD[e]		0[d]	Footnote f	Footnote f	Footnote f	Footnote f
PTRD[e]		200/300/100 ft	Footnote g	Footnote g	Footnote g	Footnote g
IBD[e]		200/300/100 ft	Footnote h	Footnote h	Footnote h	Footnote h

a	For PES-ES combinations where three distances are given: the first refers to a PES containing HD 1.2.1 AE with an MCE<100 lbs; the second to a PES containing HD 1.2.1 AE with an MCE≥100 lbs; and the third refers to a PES containing HD 1.2.2 AE. Where three IMD are given, the IMD from a PES containing only HD 1.2.3 AE to an ES containing other than HD 1.2.3 is K11 based on the largest MCE of the HD 1.2.3 AE in the PES.
b	For an ES containing only HD 1.2.3 items, the IMD from any PES to such an ES is 0 (Footnote d).
c	When the NEWQD and the MCE of the packaged HD 1.2.1 items fall within the ranges specified in the equation NEWQD≤MCE≤450 lbs, the HD 1.2.1 will be treated as HD 1.1 and the criteria of paragraph V3.E3.1.2.1.1.1., as applicable, will be used (see paragraph V3.E3.2.2.).
d	Practical considerations such as firefighting and security will dictate specific separation distances as specified by the DoD Component.
e	See paragraph V3.E3.2.13. for HD 1.2.3.
f	ILD = 36 percent of IBD with a minimum distance equal to the IMD given in this table for the applicable PES-ES combination.
g	PTRD = 60 percent of IBD with a minimum distance equal to the IMD given in this table for AGS (L).
h	For HD 1.2.1 items in any structure, truck, trailer, or railcar, use the larger of the two applicable values given in Tables V3.E3.T10. and V3.E3.T11.; for HD 1.2.1 items in the open, use Table V3.E3.T10.; for HD 1.2.2 items, use Table V3.E3.T12.

Table V3.E3.T10. HD 1.2.1 QD (IBD, PTRD, ILD) for AE with NEWQD > 1.60 lbs[a, b]

Explosive Weight[c] (lbs)	IBD[d, e, f] (ft)	PTRD[g] (ft)	ILD[h] (ft)
2	200	200	200
70	200	200	200
100	268	200	200
150	348	209	200
300	481	288	200
500	576	346	207
10,000	1,090	654	392
50,000	1,335	801	481
200,000	1,528	917	550
500,000	1,646	988	593
>500,000	Footnote f	Footnote g	Footnote h

a	The QD criteria for HD 1.2.1 items are based on the hazards from primary fragments. When stored in structures that may contribute to the debris hazard (secondary fragments), the IBD for HD 1.2.1 items whose MCE is greater than 31 lbs is determined by using the larger of two distances: those given in this table for the appropriate explosive weight or those given in Table V3.E3.T11. for the appropriate MCE. Structures that may contribute to the debris hazard for storage of HD 1.2.1 AE include: (a) all ECM frontal exposures (side and rear exposures have fixed minimum distances for IBD); (b) all AGS, including (H), (H/R), and (L), unless data or analyses are provided to show that the structural debris contribution is less.
d	71 lbs < Explosive Weight: IBD = -735.186 + [237.559*(ln(Number of items*NEWQD))] – [4.274*(ln(Number of items*NEWQD))^2], with a minimum of 200 ft

Table V3.E3.T11. HDD for HD 1.2.1 AE Stored in Structures That Can Contribute to the Debris Hazard[a, b]

MCE	HDD[c, d, e]	PTRD[f]	ILD[g]
(lbs)	(ft)	(ft)	(ft)
≤ 31	200	200	200
50	388	233	200
70	519	311	200
100	658	395	237
450	1,243	746	447
> 450	1,250	750	450

c	31 lbs < MCE ≤ 450 lbs: HDD = -1,133.9 + [389*ln(MCE)], with a minimum distance of 200 ft

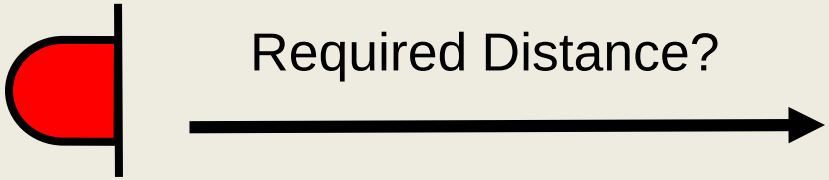
Does this equation look familiar to anyone?

Table V3.E3.T12. HD 1.2.2 QD (IBD, PTRD, ILD) for AE with NEWQD ≤ 1.60 lbs,[a, b, c]

Explosive Weight[d] (lbs)	IBD[e, f, g] (ft)	PTRD[h] (ft)	ILD[i] (ft)
1	100	100	100
30	107	100	100
300	179	107	100
2,000	279	168	101
10,000	394	236	142
50,000	535	321	193
200,000	678	407	244
500,000	783	470	282
>500,000	Footnote g	Footnote h	Footnote i

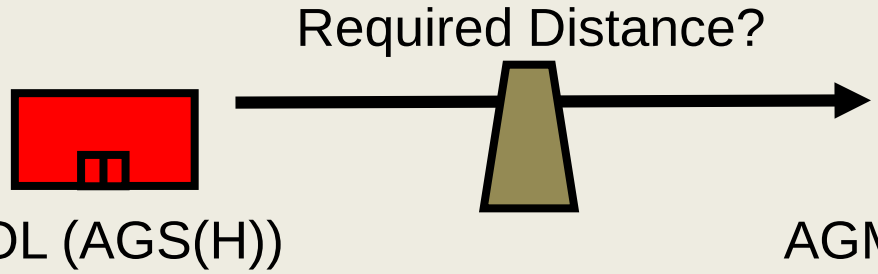
a	The QD criteria for HD 1.2.2 items are based on the hazards from primary fragments.
c	See paragraph V3.E3.2.11. for storage and operations involving limited quantities of HD 1.2.2 without the need for siting as a PES.
e	20 lbs < Explosive Weight: IBD = 101.649 – [15.934*(ln(Number of items*NEWQD))] + [5.173* (ln(Number of items*NEWQD))^2], with a minimum of 100 ft

HD 1.2 QD – Examples



IBD of 647 ft
Per Table V3.E3.T9, Footnote h, and Table V3.E3.T12

150,000 lbs NEWQD of HD 1.2.2



IMD of 300 ft
Per Table V3.E3.T9

30,000 lbs NEWQD of HD 1.2.1
with an MCE of 200 lbs

HD 1.2 QD – Exercises

Work in teams!

HD 1.2 QD – Exercises

1. From the front of an Undefined ECM with 100,000 lbs NEWQD of HD 1.2.1 with an MCE of 280 lbs to the unbarricaded front of an Undefined ECM?
   IMD of 300 ft, Table V3.E3.T9 Footnote a

2. From an EOL (AGS(L)) with 20,000 lbs NEWQD of HD 1.2.2 to an unbarricaded AGM (AGS(L))?
   IMD of 100 ft, Table V3.E3.T9 Footnote a

3. From an AGM (AGS(H/R)) with 7,000 lbs NEWQD of HD 1.2.1 with an MCE of 200 lbs to an inhabited building?
   IBD of 1,033 ft, Table V3.E3.T9 Footnote h, greater of Table V3.E3.T10 for 7,000 lbs NEWQD and Table V3.E3.T11 for 200 lbs MCE

4. From the front on a 7-bar ECM with 1,000 lbs NEWQD of HD 1.2.1 with an MCE of 150 lbs to an EOL (AGS(H))?
   ILD of 300 ft
   Table V3.E3.T9 Footnote f says ILD = 36% of IBD with a minimum of IMD
   Table V3.E3.T9 Footnote h says IBD is greater of Table V3.E3.T10 for the 1,000 lbs NEWQD and Table V3.E3.T11 for the 150 lbs MCE; these values are 702 ft and 815 ft, respectively, so IBD is 815 ft
   ILD = 36% of IBD = 293 ft, **BUT**….IMD is 300 ft per Table V3.E3.T9 Footnote a

HD 1.3 QD

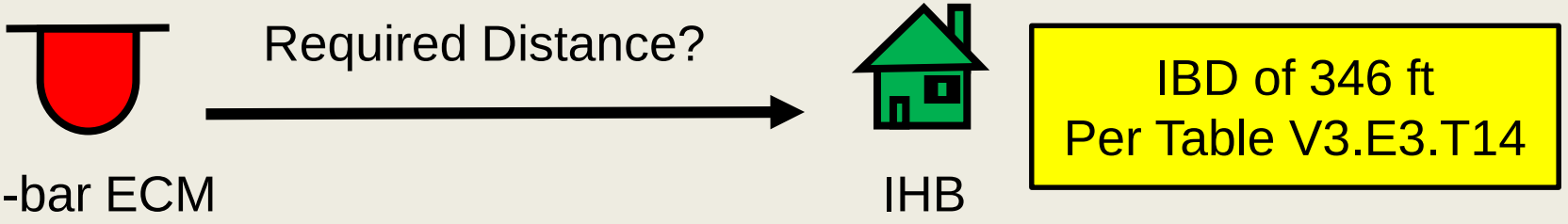
- **V3.E3.3 – HD 1.3 includes items that burn vigorously with little or no possibility of extinguishment in storage situations. Explosions normally will be confined to pressure ruptures of containers and will not produce propagating shock waves or damaging blast overpressure beyond the magazine distance specified in Table V3.E3.T14. A severe hazard of spread of fire may result from tossing about of burning container materials, propellant, or other flaming debris.**

Table V3.E3.T14. HD 1.3 QD[a, b]

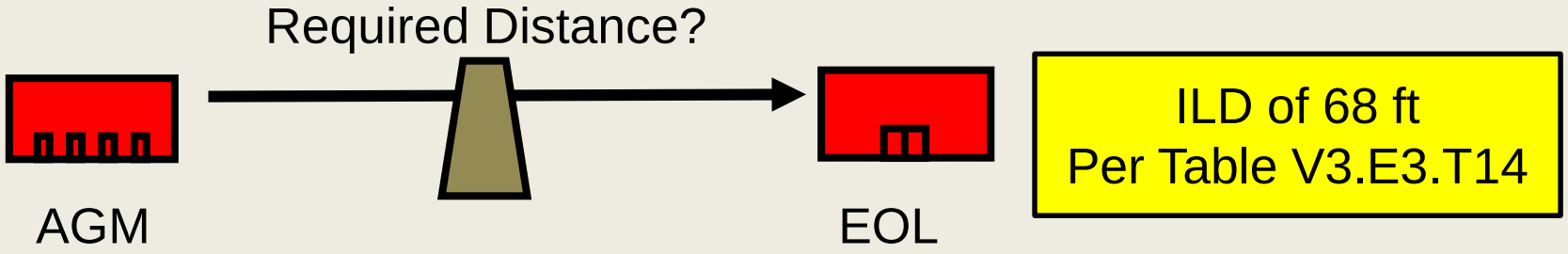
NEWQD	IBD & PTRD[c]	Aboveground IMD & ILD[d]
(lbs)	(ft)	(ft)
≤ 1000[e]	75	50
20,000	180	122
100,000	300	204
500,000	569	372
1,000,000	800	500
2,000,000	1,008	630

a	Operational quantities	
b	ECM 100-lb rule	
c	NEWQD ≤ 1,000 lbs:	$D_{IBD,PTRD} = 75$ ft
	1,000 lbs < NEWQD ≤ 96,000 lbs:	$D_{IBD,PTRD} = \exp[2.47 + 0.2368*(\ln(NEWQD)) + 0.00384*(\ln(NEWQD))^2]$, with a minimum distance of 75 ft
	96,000 lbs < NEWQD ≤ 1,000,000 lbs:	$D_{IBD,PTRD} = \exp[7.2297 - 0.5984*(\ln(NEWQD)) + 0.04046*(\ln(NEWQD))^2]$
	1,000,000 lbs < NEWQD:	$D_{IBD,PTRD} = 8*NEWQD^{1/3}$
d	NEWQD ≤ 1,000 lbs:	$D_{IMD,ILD} = 50$ ft
	1,000 lbs < NEWQD ≤ 84,000 lbs:	$D_{IMD,ILD} = \exp[2.0325 + 0.2488*(\ln(NEWQD)) + 0.00313*(\ln(NEWQD))^2]$, with a minimum distance of 50 ft
	84,000 lbs < NEWQD ≤ 1,000,000 lbs:	$D_{IMD,ILD} = \exp[4.338 - 0.1695*(\ln(NEWQD)) + 0.0221*(\ln(NEWQD))^2]$
	1,000,000 lbs < NEWQD:	$D_{IMD,ILD} = 5*NEWQD^{1/3}$
e	For quantities less than 1,000 lbs [453.59 kg], the required distances are those specified for 1,000 lbs [453.59 kg]. The use of lesser distances may be approved when supported by test data or analysis.	

HD 1.3 QD – Examples



150,000 lbs NEWQD of HD 1.3



3,000 lbs NEWQD of HD 1.3

HD 1.4 QD

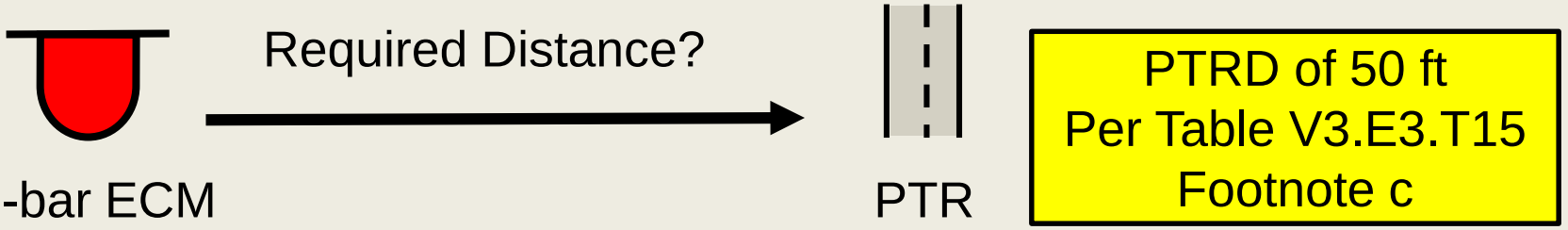
- **V3.E3.4 – HD 1.4**
  - **V3.E3.4.1 – Reference to Table V3.E3.T15**
  - **V3.E3.4.2 – Don’t include HD 1.4 in NEWQD when other HDs are present, but QD for HD 1.4 NEWQD itself must still be addressed**
  - **V3.E3.4.3 – HD 1.4S doesn’t require siting**
- **V3.E3.1.5.6 – 100-lb rule between ECMs**

Table V3.E3.T15. HD 1.4 QD[a]

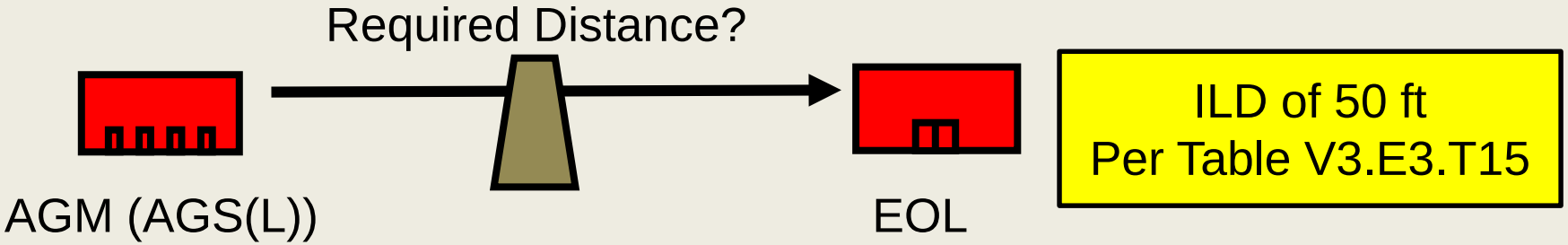
NEWQD[b]	IBD/PTRD[c]	ILD[d, e]	AGS (L) IMD[e]	AGS(H) & (H/R) IMD[e, f]	ECM IMD[e]
(lbs)	(ft)	(ft)	(ft)	(ft)	(ft)
≤ 3000[g]	75	50	50	0 to and from	0 to and from the sides and rear; see Footnote j for the front
>3000[h]	100	100/50[i]	100/50[i]		

a	HD 1.4 AE may be stored in a general supplies warehouse area rather than in an AE storage area. Such a structure will be separated from all other warehouses in accordance with the AGS (L) IMD column of this table.
b	See paragraph V1.E7.2.3.1.1. for the applicability of HD 1.4 QD criteria and the determination of NEWQD when HD 1.4 and other HD AE are located in the same site.
c	IBD and PTRD are 50 ft from the sides and rear of an ECM. IBD and PTRD are 50 ft from an AGS (H), an AGS (H/R), and an ECM front that meets the definition of AGS (H); doors and other openings will be barricaded in accordance with section V2.E5.4., or the IBD or PTRD column of this table applied from these doors and openings.
d	ILD is 0 ft from the sides and rear of an ECM. ILD is 0 ft from an AGS (H), an AGS (H/R), and an ECM front that meets the definition of AGS (H); doors and other openings will be barricaded in accordance with section V2.E5.4., or the ILD column of this table applied from these doors and openings.
e	Magazines storing only HD 1.4 AE may be located at these IMD or ILD from all other magazines or operating buildings regardless of the HD or NEWQD authorized in those adjacent structures. (DoD Component must accept application of this provision with consideration given to the value of HD 1.4 assets at risk.)
f	Doors and other openings will be barricaded in accordance with section V2.E5.4., or the AGS (L) IMD column of this table applied to and from these doors and openings.
g	Operational quantities
h	There is no upper limit on the NEWQD specifically required for safety reasons.
i	Use the smaller distance when the ES is of non-combustible construction.
j	Apply the appropriate AGS column of this table based on whether the ECM front meets the definition of AGS (L) or AGS (H).

HD 1.4 QD – Examples



150,000 lbs NEWQD of HD 1.4



2,000 lbs NEWQD of HD 1.4

HD 1.6 QD

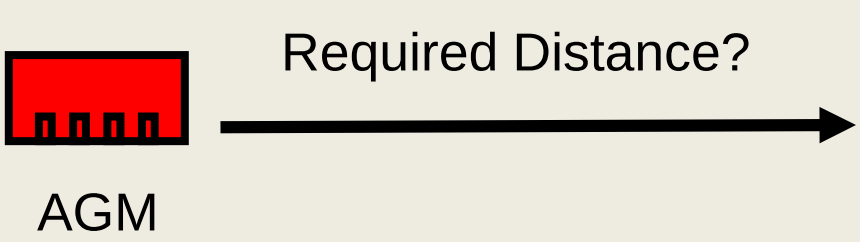
- **V3.E3.6 – QD separations for HD 1.6 AE are based on the storage location and configuration. This information is detailed in Table V3.E3.T16. A maximum of 500,000 lbs NEWQD is permitted at any one location. Any special storage configuration and siting approved for HD 1.1 AE may be used for storage of like explosive weights of HD 1.6 AE.**

Table V3.E3.T16. HD 1.6 QD

NEWQD	Aboveground		ECM		
	IBD or PTRD[a, b, c]	IMD or ILD[a, c, d]	IBD or PTRD	ILD	IMD
(lbs)	(ft)	(ft)	(ft)	(ft)	(ft)
≤100[e]	37	23	Footnote c	Footnote c	Footnote c
5,000	137	85			
50,000	295	184			
200,000	468	292			
500,000	635	397			

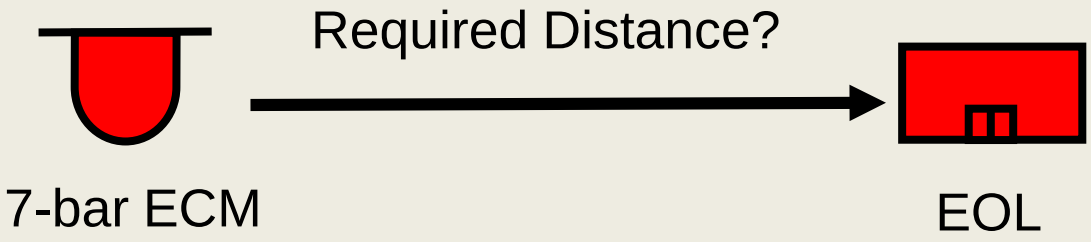
a	MINIMUMS: For IBD or PTRD, based on the NEWQD for the largest single round of AE: $D_{IBD,PTRD} = 40*W^{1/3}$ For IMD or ILD, based on the NEWQD for the largest single round of AE: $D_{IMD, ILD} = 18*W^{1/3}$
b	$D_{IBD,PTRD} = 8*W^{1/3}$
c	For HD 1.6 AE packed in non-flammable pallets or packing and stored in an ECM, provided it is acceptable to the DoD Component and the DDESB on a site-specific basis, these QD apply unless a lesser distance is permitted by this table for aboveground sites (These lesser distances can be applied to ECM storage): $D_{IBD,PTRD} = 100$ ft $D_{ILD} = 50$ ft D_{IMD} = no specific requirement.
d	$D_{IMD, ILD} = 5*W^{1/3}$
e	For quantities less than 100 lbs, the required distances are those specified for 100 lbs. The use of lesser distances may be approved when supported by test data or analyses.

HD 1.6 QD – Examples



PTRD of 425 ft
Per Table V3.E3.T16
Footnotes a and b

150,000 lbs NEWQD of HD 1.6
Largest single round of 100 lbs

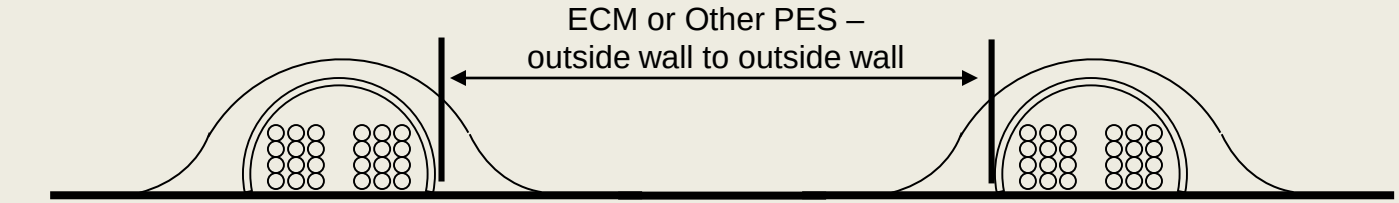


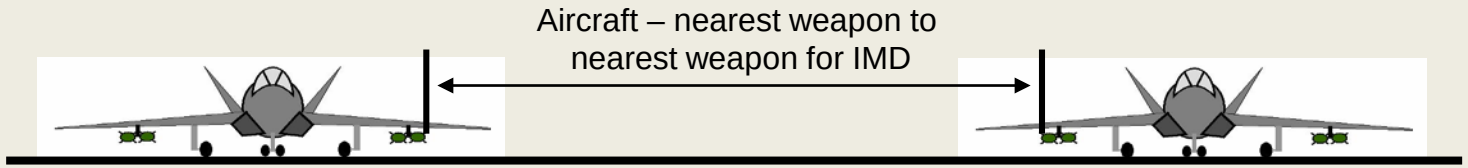
ILD of 50 ft
Per Table V3.E3.T16
Footnote c

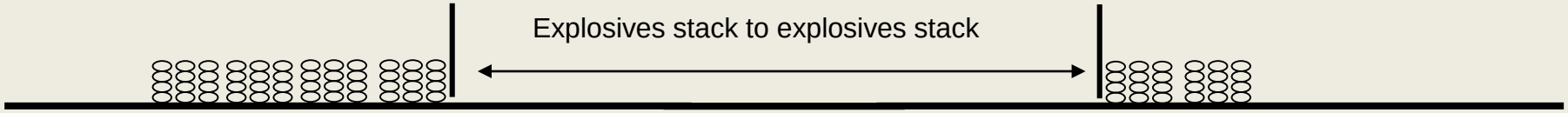
2,000 lbs NEWQD of HD 1.6
Largest single round of 50 lbs

Measuring Separation Distance

- **V1.E7.4**
  - Weapon-to-weapon or cargo hold-to-cargo hold on AE loaded aircraft or ships
  - To the skin of aircraft or ships for personnel or asset protection
  - To the edge of taxiways and centerline of runway



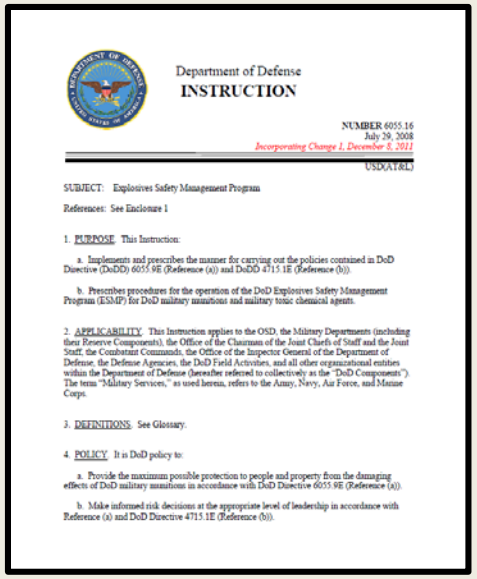




Source: AMMO-36 Course

Types of Site Plans

- **DoDI 6055.16, Enclosure 10**
  - QD Safety Submission
  - Munitions Response Chemical Safety Submission (MRCSS)
  - Munitions Response Explosives Safety Submission (MRESS)
  - Risk-Based Safety Submission
  - Hybrid Safety Submission (HSS)



Department of Defense
INSTRUCTION

NUMBER 6055.16
July 29, 2008
Incorporating Change 1, December 8, 2011

USD(AT&L)

SUBJECT: Explosives Safety Management Program

References: See Enclosure 1

1. PURPOSE. This Instruction:

a. Implements and prescribes the manner for carrying out the policies contained in DoD Directive (DoDD) 6055.9E (Reference (a)) and DoDD 4715.1E (Reference (b)).

b. Prescribes procedures for the operation of the DoD Explosives Safety Management Program (ESMP) for DoD military munitions and military toxic chemical agents.

2. APPLICABILITY. This Instruction applies to the OSD, the Military Departments (including their Reserve Components), the Office of the Chairman of the Joint Chiefs of Staff and the Joint Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities within the Department of Defense (hereafter referred to collectively as the "DoD Components"). The term "Military Services," as used herein, refers to the Army, Navy, Air Force, and Marine Corps.

3. DEFINITIONS. See Glossary.

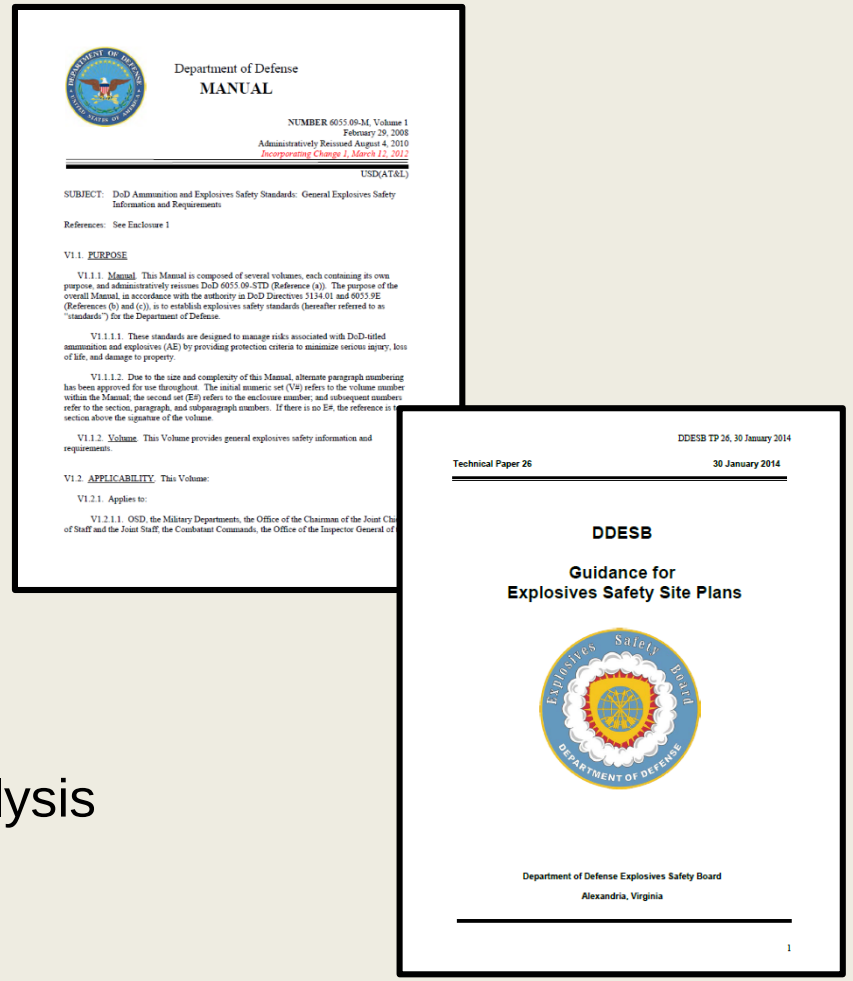
4. POLICY. It is DoD policy to:

a. Provide the maximum possible protection to people and property from the damaging effects of DoD military munitions in accordance with DoD Directive 6055.9E (Reference (a)).

b. Make informed risk decisions at the appropriate level of leadership in accordance with Reference (a) and DoD Directive 4715.1E (Reference (b)).

Site Plan Contents

- **V1.E5.2.3**
  - Preliminary or Final
  - Contents
    - Submittal letters
    - Site map
    - Submittal drawing
    - PES/ES submittal form
    - Facility drawings
    - LPS drawings
    - Risk acceptances
    - Protective construction analysis
    - Mitigation measures
    - Waivers & exemptions



Department of Defense
MANUAL

NUMBER 6055.09-M, Volume 1
February 29, 2008
Administratively Reissued August 4, 2010
Incorporating Change 1, March 12, 2012
USD(AT&L)

SUBJECT: DoD Ammunition and Explosives Safety Standards: General Explosives Safety Information and Requirements

References: See Enclosure 1

V1.1. PURPOSE

V1.1.1. Manual. This Manual is composed of several volumes, each containing its own purpose, and administratively reissues DoD 6055.09-STD (Reference (a)). The purpose of the overall Manual, in accordance with the authority in DoD Directives 5134.01 and 6055.9E (References (b) and (c)), is to establish explosives safety standards (hereafter referred to as "standards") for the Department of Defense.

V1.1.1.1. These standards are designed to manage risks associated with DoD-titled ammunition and explosives (AE) by providing protection criteria to minimize serious injury, loss of life, and damage to property.

V1.1.1.2. Due to the size and complexity of this Manual, alternate paragraph numbering has been approved for use throughout. The initial numeric set (V#) refers to the volume number within the Manual; the second set (E#) refers to the enclosure number; and subsequent numbers refer to the section, paragraph, and subparagraph numbers. If there is no E#, the reference is t section above the signature of the volume.

V1.1.2. Volume. This Volume provides general explosives safety information and requirements.

V1.2. APPLICABILITY. This Volume:

V1.2.1. Applies to:

V1.2.1.1. OSD, the Military Departments, the Office of the Chairman of the Joint Ch of Staff and the Joint Staff, the Combatant Commands, the Office of the Inspector General of

DDESB TP 26, 30 January 2014

Technical Paper 26 — 30 January 2014

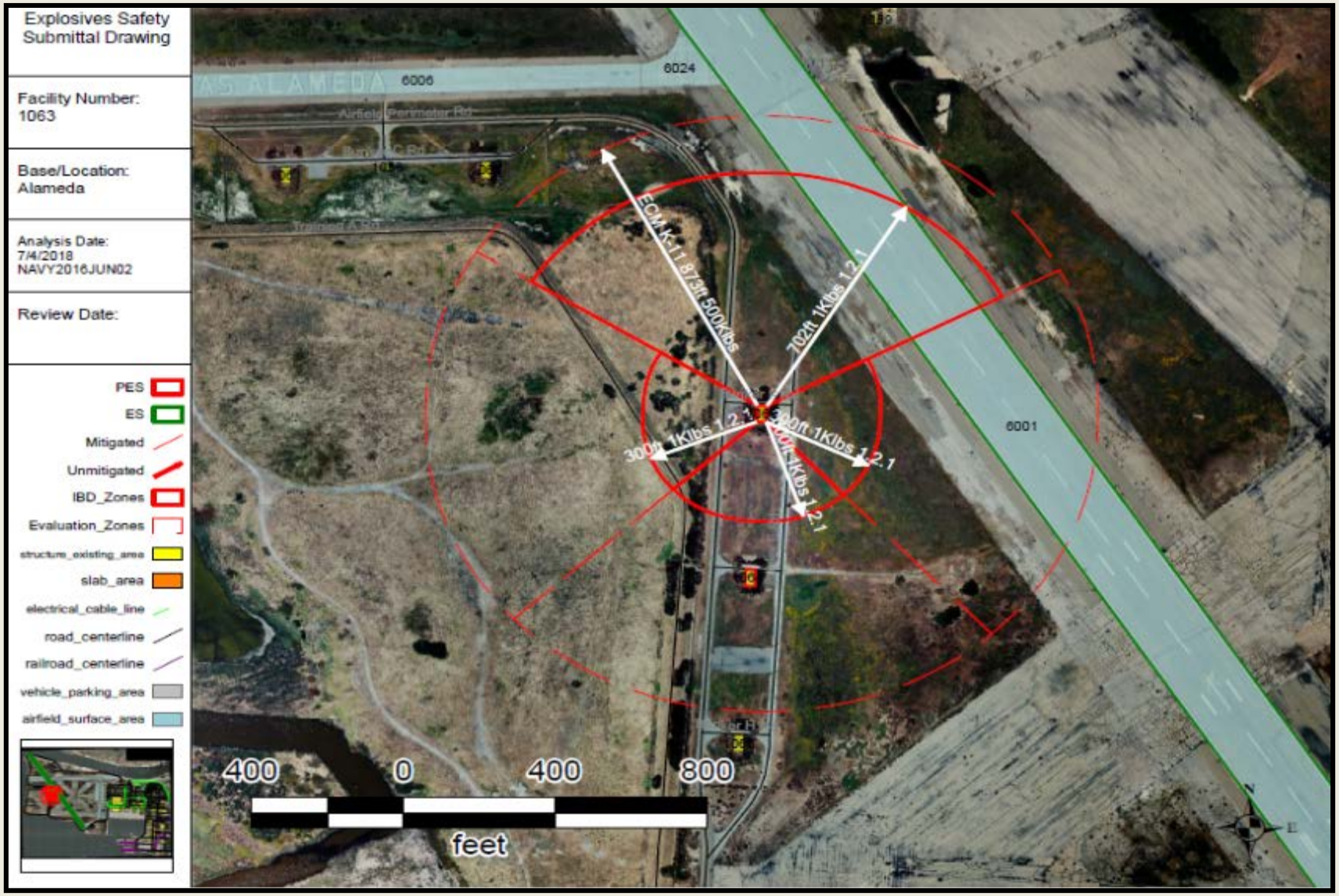
DDESB

Guidance for
Explosives Safety Site Plans

Department of Defense Explosives Safety Board
Alexandria, Virginia

1

PES/ES Submittal Drawing



PES/ES Submittal Form

EXPLOSIVES SAFETY SITE PLAN

SECTION I - GENERAL INFORMATION

INSTALLATION:	LOCATION:	DATE:	QD Engine: NAVY2010SEP10
NAS Alameda		08 Jul 2011	ESS: 6.0.0.194

SECTION II - DATA ON FACILITY TO BE SITED

FAC # & OWNER	FACILITY DESC	RQD IBD	RQD PTR	1.1	1.2.1 MCE	1.2.2	1.2.3 MCE	1.3	1.4
1046 NAS Alameda	ECM Undefined HW Igloo Str Inst	Front: 700.0 Side: 250.0 Rear: 250.0	Front: 420.0 Side: 200.0 Rear: 200.0	450.0 lbs	450.0 lbs 75 lbs	450.0 lbs	450.0 lbs	450.0 lbs	450.0 lbs

SECTION III - PES/ES QD PAIRED RELATIONSHIPS WITH FACILITIES BEING SITED

FAC # & OWNER	FACILITY DESC	ACT & RQD DISTANCE	ORIEN-TATION	1.1	1.2.1 MCE	1.2.2	1.2.3 MCE	1.3	1.4
1036 NAS Alameda IM	AGM Ammo Struc Inst	Actual: 192.0 ft Required: 50.0 ft	As ES PES Rear	46.0 ft T7-13 E-R:A-U	0.0 ft T7-18 E-S/R:AG(HorL)	0.0 ft T7-18 E-S/R:AG(HorL)	0.0 ft T7-18 E-S/R:AG(HorL)	50.0 ft T7-20 IMD	0.0 ft T7-22 ECM:IMD
1037 NAS Alameda IM	AGM 1037_AGM_Ready Mag	Actual: 224.0 ft Required: 50.0 ft	As ES PES Right	46.0 ft T7-13 E-S:A-U	0.0 ft T7-18 E-S/R:AG(HorL)	0.0 ft T7-18 E-S/R:AG(HorL)	0.0 ft T7-18 E-S/R:AG(HorL)	50.0 ft T7-20 IMD	0.0 ft T7-22 ECM:IMD
		Actual: 213.0 ft Required: 50.0 ft	As ES PES Rear	46.0 ft T7-13 E-R:A-U	0.0 ft T7-18 E-S/R:AG(HorL)	0.0 ft T7-18 E-S/R:AG(HorL)	0.0 ft T7-18 E-S/R:AG(HorL)	50.0 ft T7-20 IMD	0.0 ft T7-22 ECM:IMD
		Actual: 224.0 ft Required: 224.0 ft	As PES (reverse) ES Right	224.0 ft T7-13 A-U:U-S				224.0 ft T7-20 IMD	
		Actual: 213.0 ft Required: 213.0 ft	As PES (reverse) ES Rear	213.0 ft T7-13 A-U:U-R				213.0 ft T7-20 IMD	
1043 NAS Alameda NA	AGT Water Tank	Actual: 244.0 ft Required: 0.0 ft	As ES PES Right	0.0 ft 7-13.9	0.0 ft 7-13.9	0.0 ft 7-13.9	0.0 ft 7-13.9	0.0 ft 7-13.9	0.0 ft 7-13.9
1045 NAS Alameda IM	ECM Undefined HW Igloo Str Inst	Actual: 87.0 ft Required: 10.0 ft	As ES PES Right ES Left	10.0 ft T7-13 E-S:U-S	0.0 ft T7-18 E-S/R:U-S	0.0 ft T7-18 E-S/R:U-S	0.0 ft T7-18 E-S/R:U-S	6.0 ft T7-20 FN4 T7-20	0.0 ft T7-22 ECM:IMD
		Actual: 87.0 ft Required: 6.0 ft	As PES (reverse) PES Left ES Right		450.0 lbs 75 lbs 0.0 ft T7-18 E-S/R:U-S	450.0 lbs 0.0 ft T7-18 E-S/R:U-S	450.0 lbs 0.0 ft T7-18 E-S/R:U-S	450.0 lbs 6.0 ft T7-20 FN4 T7-20	450.0 lbs 0.0 ft T7-22 ECM:IMD

1 – PES Type, QDs, HDs, NEWs

2 – ES Type, HDs, NEWs

ECM 2567

3 – QD Required from ECM 2567 to AGM 12579

4 – QD Required from AGM 12579 to ECM 2567

AGM 12579

5 & 6 – Actual & Required Distances

SECTION II - DATA ON FACILITY TO BE SITED

FAC # & OWNER	FACILITY DESC	RQD IBD	RQD PTR	1.1	1.2.1 MCE	1.2.2	1.2.3 MCE	1.3	1.4
1046 NAS Alameda 1	ECM Undefined HW Igloo Str Inst	Front: 700.0 Side: 250.0 Rear: 250.0	Front: 420.0 Side: 200.0 Rear: 200.0	450.0 lbs	450.0 lbs 75 lbs	450.0 lbs	450.0 lbs	450.0 lbs	450.0 lbs

SECTION III - PES/ES QD PAIRED RELATIONSHIPS WITH FACILITIES BEING SITED

FAC # & OWNER	FACILITY DESC	ACT & RQD DISTANCE	ORIEN-TATION	1.1	1.2.1 MCE	1.2.2	1.2.3 MCE	1.3	1.4
1045 NAS Alameda IM 2	ECM Undefined HW Igloo Str Inst	Actual: 87.0 ft Required: 10.0 ft (5 & 6)	As ES PES Right ES Left 3	10.0 ft T7-13 E-S:U-S	0.0 ft T7-18 E-S/R:U-S	0.0 ft T7-18 E-S/R:U-S	0.0 ft T7-18 E-S/R:U-S	6.0 ft T7-20 FN4 T7-20	0.0 ft T7-22 ECM:IMD
		Actual: 87.0 ft Required: 6.0 ft (5 & 6)	As PES (reverse) PES Left ES Right 4	450.0 lbs 75 lbs 0.0 ft T7-18 E-S/R:U-S	450.0 lbs 0.0 ft T7-18 E-S/R:U-S	450.0 lbs 0.0 ft T7-18 E-S/R:U-S	450.0 lbs 6.0 ft T7-20 FN4 T7-20	450.0 lbs 0.0 ft T7-22 ECM:IMD	

Site Plan Approval Implementation

- **Putting QD arcs on installation master map**
  - Why do we specify in our approval letters that the installation map must be updated to reflect the approved QD arcs?
  - To aid in the process of ensuring new exposures within existing QD arcs are identified and properly assessed for compliance with explosives safety criteria.
- **Complying with HD and NEWQD limits**
  - Who is responsible for ensuring compliance with our sited limits?
  - Usually, the facility user/owner. This is typically managed via a logistics software program that should be using information from the site plan, the JHCS, and HD mixing rules to ensure the sited limits are not exceeded at any given time.
- **Implementing mitigation measures**
  - How are mitigation measures implemented?
  - Depends on the specific measure, but most are controlled by local operating instructions or SOPs. For protective construction, they may involve the facility construction process.

HD Mixing Rules

- **V1.E7.2.3**
  - **Do not include HD 1.4 NEWQD when mixing with other HDs**
  - **Treat HD 1.5 as HD 1.1**
  - **HD 1.1 with HD 1.2, use greater of**
    - **Sum treated as HD 1.1**
    - **HD 1.2.x requiring largest QD**
  - **HD 1.1 with HD 1.3 = Treat sum as HD 1.1**
  - **HD 1.1 with HD 1.6 = Treat sum as HD 1.1**
  - **HD 1.2.1 with HD 1.2.2 = Use HD 1.2.x requiring largest QD**
  - **HD 1.2.1 with HD 1.2.3 = Use HD 1.2.x requiring largest QD**
  - **HD 1.2.2 with HD 1.2.3 = Use HD 1.2.x requiring largest QD**
  - **HD 1.2.1 with HD 1.2.2 with HD 1.2.3 = Use HD 1.2.x requiring largest QD**
  - **HD 1.2 with HD 1.3 = Use HD requiring largest QD**
  - **HD 1.2 with HD 1.6 = Treat HD 1.6 as HD 1.2.3 and apply rules above involving HD 1.2.3**
  - **HD 1.3 with HD 1.6 = Treat sum as HD 1.3**

HD Mixing Rules – Examples

Sited Limits

5,000 lbs NEWQD of HD 1.1
20,000 lbs NEWQD of HD 1.2.1 > 450
20,000 lbs NEWQD of HD 1.2.2
100,000 lbs NEWQD of HD 1.3
300,000 lbs of HD 1.4

Approved QD Arc

1,250 ft IBD based on the HD 1.1

Can I put the following in my AGM?

- 6,000 lbs HD 1.1? — No
- 4,000 lbs HD 1.1, 1,000 lbs of HD 1.2.1 > 450, and 250,000 lbs HD 1.4? — Yes
- 3,000 lbs HD 1.1 and 50,000 lbs HD 1.3? — No
- 20,000 lbs HD 1.2.1 > 450 and 20,000 lbs HD 1.2.2? — Yes
- 10,000 lbs HD 1.2.1 > 450 and 100,000 lbs HD 1.3? — Yes

Addressing QD Violations

- **Validate “input” information**
- **Eliminate**
  - Reduce NEW and/or HD
  - Increase separation distance
- **Protective Construction**
  - Reduce the MCE, or reduce the QD, or show equivalent protection is provided
  - Engineering analysis or testing
- **Mitigate**
  - Incorporate Compensatory Measures
- **Justify**
  - Facility met criteria at time of construction
- **Formal Deviation**
  - Waiver/Exemption
  - Secretarial Certification (New Construction)

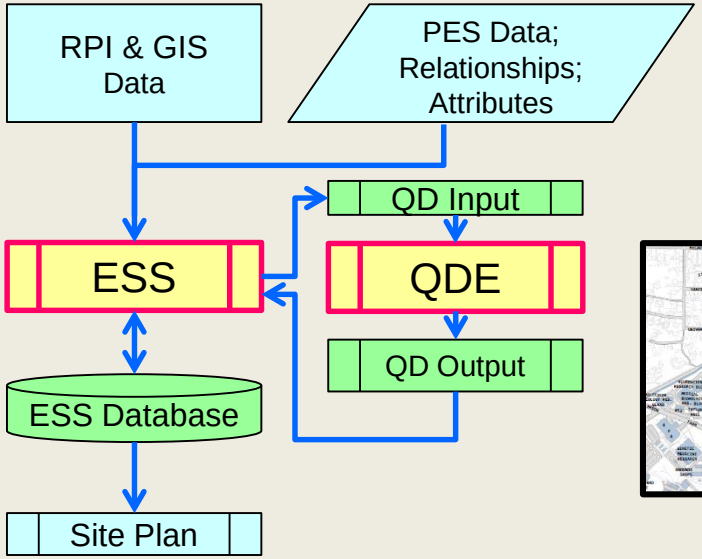
Waivers & Exemptions

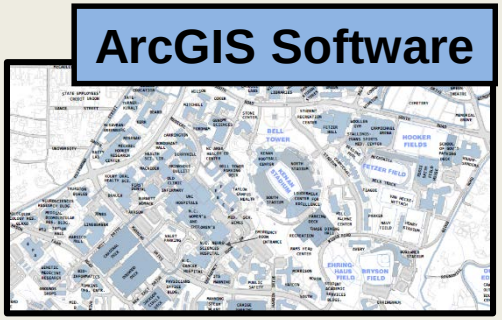
- **V1.E3 and DoDI 6055.16, Enclosure 13**
  - **Event Waiver, Waiver & Exemption**
    - Vary by time involved
    - Approval level left to Service to determine
  - **Secretarial Exemption or Certification**
    - Required for new construction in violation of QD
    - Intended to discourage MILCON projects that violate QD to begin with

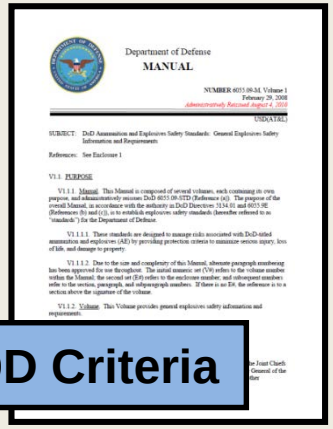
Site Plans Required

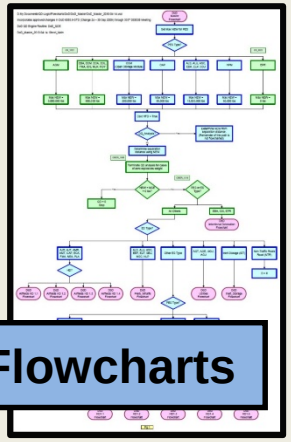
- **V1.E5.2**
  - New Construction of AE facilities
  - New construction of non-AE facilities within QD arcs
  - AE facility modifications, change of mission, or change of operations that increase explosive hazards (e.g., personnel exposures, NEW, change in HD, nature of operation)
  - Change of use of non-AE facilities within QD arcs that requires application of more stringent explosives safety criteria (e.g., an airfield previously restricted to DoD use only changed to joint DoD and non-DoD use)

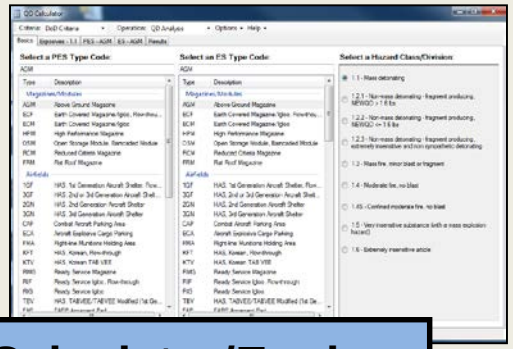
Automated Site Planning



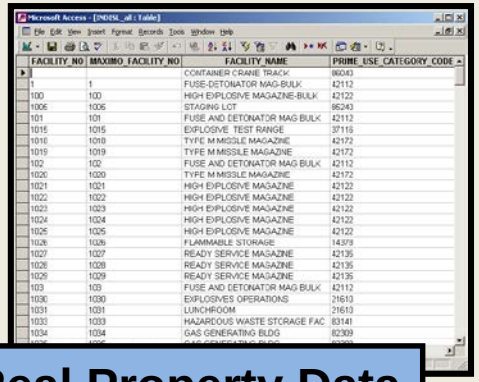




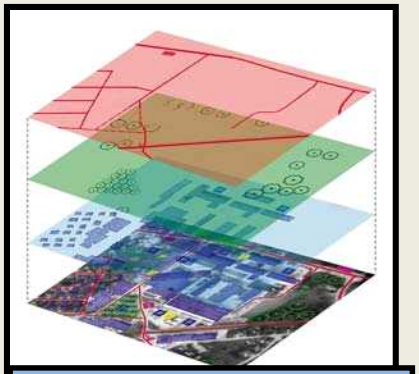




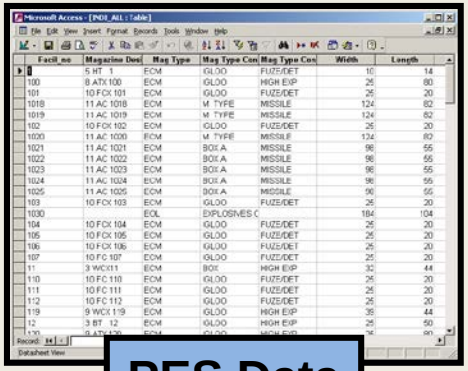
Automated Site Planning



Real Property Data

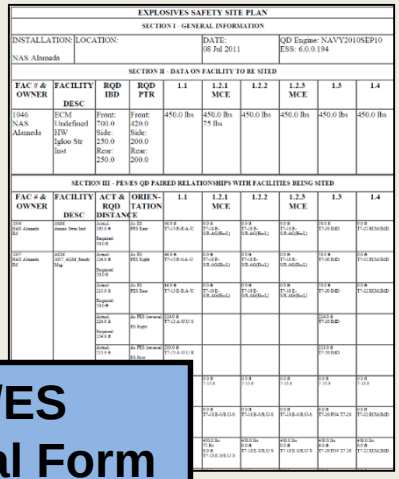


GIS Map Layers

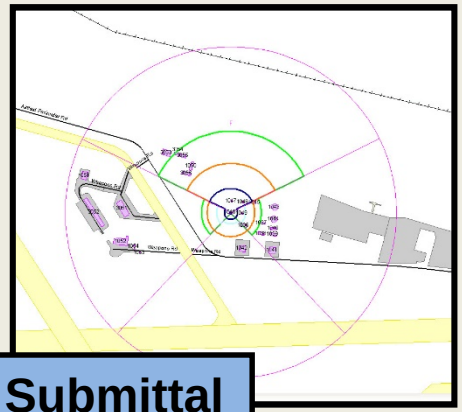


PES Data

INPUT



PES/ES Submittal Form



Submittal Drawing

OUTPUT

Benefits of Automated Site Planning

- Fewer errors interpreting criteria
- Elimination of “math” errors
- More accurate & complete submittals
- Enables “what-if” analysis
- Identification of unknown violations
- Optimize explosives storage capacity
- Moves explosives safety data into an enterprise format

BUT…..

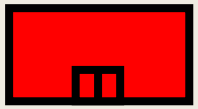
- Garbage in, garbage out
- Does not replace or eliminate the need for a knowledgeable explosives safety site planner

Congratulations!

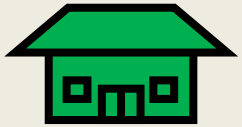
Symbols Used in This Training

Earth-Covered Magazine (ECM)

Aboveground Magazine (AGM)

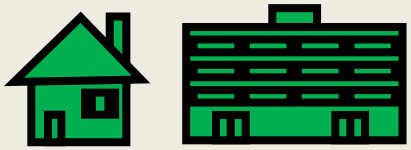


Explosives Operating Location (EOL)



Related Facility

Public Traffic Route (PTR)



Inhabited Building (IHB)

Barricade