

# Department of Defense Explosives Safety Board (DDESB)



## Operationalizing the Munitions Risk Management Assessment Process

August 2018



# ESMRM Assessment Process Agenda

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- Why? The case for ESMRM
- DoDD 6055.9E Explosives Safety Management
- DoDI 6055.16 Explosives Safety Management Program
- DoDM 6055.09 Ammunition and Explosives Safety Standards
- Joint Staff Policy on ESMRM
- NATO Policy on ESMRM
- ESMRM Assessment Purpose
- ESMRM Assessment Tools
- Munitions Risk Assessment System Example



# Why? The case for ESMRM...

- In 2014, The Small Arms Survey, Graduate Institute of International and Development Studies published a handbook on unplanned explosions at munitions sites. The Study highlighted the pervasiveness of incidents worldwide:
  - Documented over 500 incidents in a 35 year period between 1979-2013
  - Noted explosives incidents in over 100 countries, including 10 NATO countries
  - Estimated that since 1993 there were an average of 20 incidents per year
  - Recorded fatality rates in excess of 800 annually
  - Identified various social, economic, geopolitical consequences associated with unplanned explosions at munitions sites<sup>1</sup>

<sup>1</sup> Berman, E., Gobinet, P., King, B., & Reina, P. (2014). *Unplanned Explosions at Munitions Sites (UEMS) Excess Stockpiles as Liabilities rather than Assets*. Graduate Institute of International and Development Studies. Switzerland: Small Arms Survey.

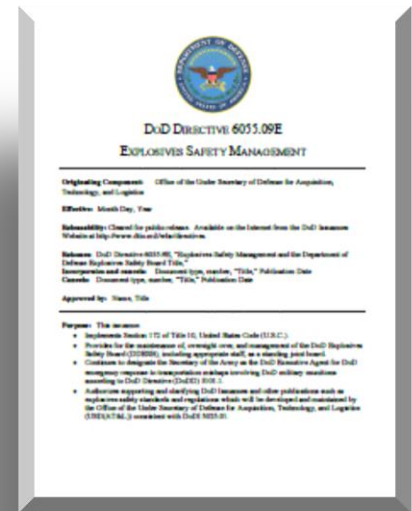
***“There are known knowns. These are things we know that we know. There are known unknowns. That is to say, there are things that we know we don't know. But there are also unknown unknowns. There are things we don't know we don't know.”***

***Donald Rumsfeld, Secretary of Defense (Rumsfeld n.d)***



# DoDD 6055.9E *Explosives Safety Management*

- DoD policy on explosives safety states that the DoD:
  - Protects people and property from the unintentional, potentially-damaging effects of DoD military munitions
  - Exposes the minimum number of people for the minimum time to the minimum amount of DoD military munitions required to safely and effectively execute the mission
  - Provides for the explosives and chemical agent safety of DoD military munitions throughout the munition's life cycle as a DoD military munition and without regard to its location
  - Requires DoD Components to implement and maintain an effective ESM Program (ESMP)

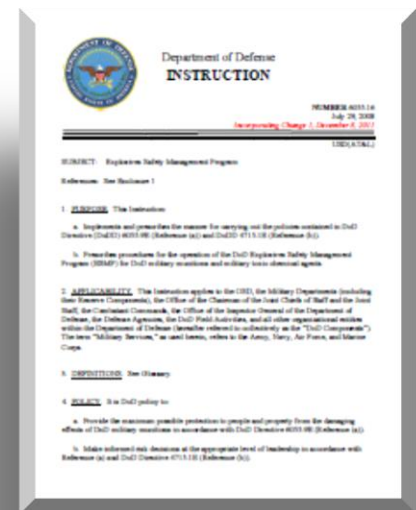


*An approved site plan or a risk decision, at the appropriate level, is required for all locations where DoD-titled munitions are located or forecasted to be located*



# DoDI 6055.16 *Explosives Safety Management Program*

- Deviations from Standards:
  - The term “deviation” refers to the mechanism(s) by which a DoD Component can accept, assess, and document the risk for not complying with or “deviating” from the requirements of DoDM 6055.09E
  - In certain situations, strict compliance with explosives safety standards could adversely affect the successful outcome of DoD operations
  - In such situations, any DoD military munitions safety risk must be weighed against strategic or compelling operational requirements. DoD Components will ensure:
    - ✓ Informed risk decisions are made at the appropriate leadership level
    - ✓ Hazards or the risk associated with deviations from explosives safety standards are appropriately mitigated following DoD Component-specific requirements

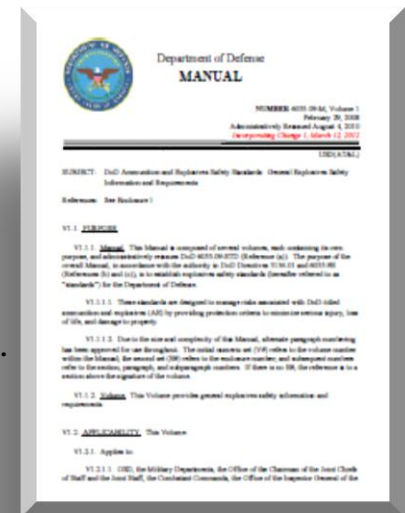


*Deviations Mechanisms. Waivers, exemptions, and Secretarial exemptions or certifications are used to accept risk and document deviations from explosives safety standards*



# DoDM 6055.09 *Ammunition and Explosives Safety Standards*

- DoDM 6055.09 provides additional guidance on deviating for explosives safety standards
  - Deviations - When strategic or compelling operational requirements necessitate deviation from these standards, the DoD Components shall:
    - ✓ Acknowledge and accept the added risk to personnel or property
    - ✓ Document both the risk and methods used to reduce it to an acceptable level in relation to the operational requirements
  - Three types of Deviations:
    - ✓ A **Waiver** is a written authority that permits temporary deviation from standards.
      - Not to exceed 5 years / Requires review every 2 years
      - Subsequent re-issuances require next higher approval authority (up to the CCDR level)
    - ✓ An **Exemption** is written authority that permits long-term noncompliance from standards. Requires review every 5 years
    - ✓ A **Secretarial Exemption or Certification** allows for construction in violation of standards. Requires review every 5 years

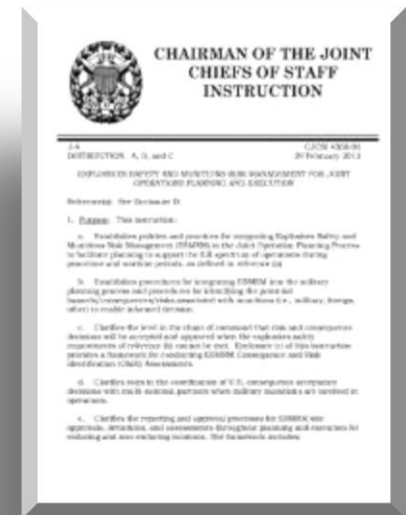


*Applying the standards herein provides only the minimum protection criteria for personnel and property, and greater protection should always be provided when practicable*



# Joint Staff Policy on ESMRM

- CJCSI 4360.01B, *Explosives Safety and Munitions Risk Management for Joint Operations Planning, Training, and Execution*
  - Establishes procedures for integrating ESMRM into the military planning process and for identifying the potential hazards/consequences/risks associated with munitions operations to enable informed risk decisions
  - Clarifies the **level of U.S. leadership** that will approve and accept munitions-related risk decision when explosives safety requirements cannot be met
  - Clarifies the staffing and approval process for explosives safety site plans and deviations identified in planning and execution for **overseas enduring, contingency, training, and exercise locations**
  - Provides a framework for conducting Munitions Risk Management Assessments (MRMAs)



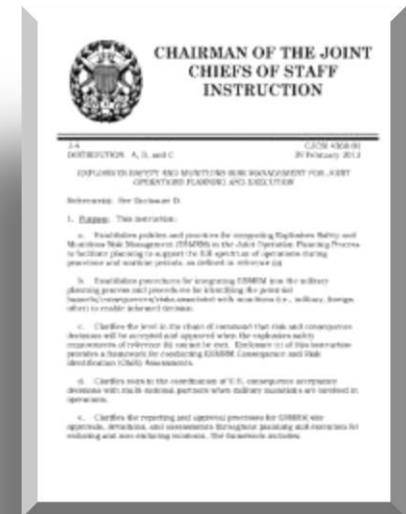
*This instruction provides a process to incorporate ESMRM into planning, training, and execution, and to enable the appropriate level within the operational chain of command to make munitions risk decisions*





# Joint Staff Policy on ESMRM

- Acceptance of munitions-related risk requires CCDR approval unless the commander delegates risk decision authority in writing to a general/flag officer (GO/FO), subordinate commander, component commander, or staff directorate
  - At no time will risk decision authority for high/serious or greater risk be delegated below the GO/FO level
  - In each case, both the MRMA and the derived quantitative measures used to identify the hazards severity will be forwarded up the operational chain of command as a consolidated package
- The MRMA methodology provides a framework on how to assess munitions-related risks when the explosives safety requirements cannot be met
- Deviations accomplished for enduring locations will be **executed in accordance with the lead Service's process and approved by the CCDR or delegated authority**



*Combatant Command, command authority (COCOM) "...provides full authority for a CCDR to perform those functions of command over assigned forces involving organizing and employing commands and forces, assigning tasks, designating objectives, and giving authoritative direction over all aspects of military operations, joint training..., and logistics necessary to accomplish the missions assigned to the command"*





# NATO Policy on ESMRM

- NATO ESMRM Policy is outlined in NATO Standard ALP-16 “*Explosives Safety and Munitions Risk Management (ESMRM) in NATO Planning Training, and Operations*”
- Provides a systematic approach that integrates Munitions Risk Assessment (MRAs) into:
  - Operations planning
  - Military training exercises
  - Contingency operations
- The goal of NATO ESMRM is to:
  - Identify potential consequences associated with munitions operations
  - Develop risk-reduction alternatives
  - Produce risk decision criteria to support informed risk decisions



Source: 5.  
(DigitalGlobe,  
Inc 2014-2018)

***Munitions and munitions-related risk decisions by appropriate senior decision makers are both NATO commander and national responsibilities.***



# ESMRM Assessment Purpose

- To identify, analyze, and reduce munitions-related risks in support of DoD explosives safety policy tenets:
  - To protect personnel and property from the potentially-damaging effects of DoD military munitions
  - To expose the minimum number of people for the minimum time to the minimum amount of DoD military munitions required to safely and effectively execute the mission
- Explosives safety is a critical function where the Combatant Commander (CCDR) can influence decisions relating to identifying and reducing munitions-related risks
- Planning for risks and potential consequences from the unintended initiation of DoD military munitions, procedures, and processes provides commanders the necessary information needed to make informed risk decisions based on ESMRM principles and contributes to mission success

***The foundational premise of ESMRM involves upfront identification and clear communication, to the appropriate level of command, of the risks and consequences to and from DoD/NATO military munitions during all phases of military planning, training, and operations***



# ESMRM Assessment Purpose

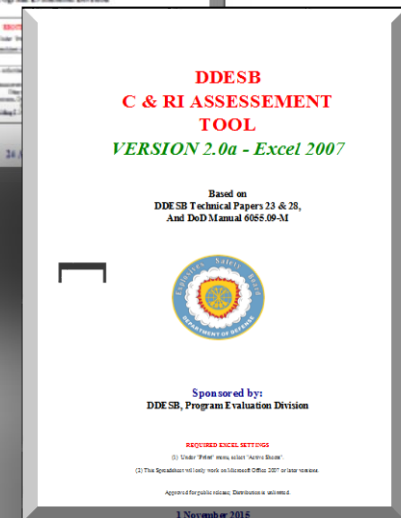
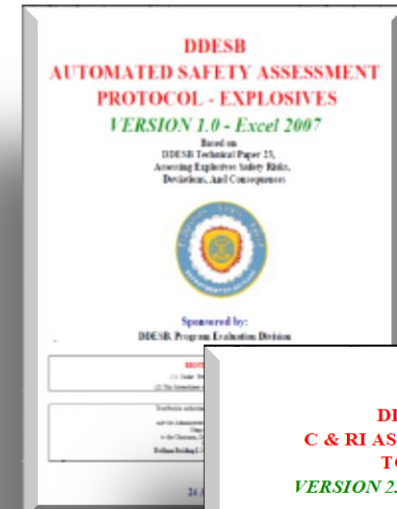
- ESMRMs analyze potential consequences of an incident...estimates:
  - Personnel exposure, to include potential fatalities and injuries
  - Infrastructure exposures and associated costs
  - Operational impact due to loss/damaged equipment/infrastructure
- ESMRM Assessment analyze risks **to and from** explosives and munitions and their related operations
- Assessment and the qualitative measure used to identify the hazard severity will be coordinated for approval as a single package to:
  - Risk decision authority
  - Responsible Combatant Commander (CCDR)
  - Service
  - DDESB

***Primary: Inform leaders/decision authorities of the risk associated with explosives and/or munitions based on the potential consequence associated with an explosives incident...when DoD explosives safety requirements cannot be met.***



# ESMRM Assessment Tools

- The *Automated Safety Assessment Protocol – Explosives* (ASAP-X) and the *Consequence & Risk Identification* (C&RI) tool:
  - Analyzes Potential Explosion Site (PES) (ECM, Open, Other) to Exposed Sites (ESs)
  - Analyzes consequences based on overpressure and fragmentation based on K-factors (K-6, K-9, K-11, K-18, K-24, K-40/K-50)
  - Estimates fatalities, injuries, and infrastructure losses
  - This is a consequence tool that doesn't take into consideration the probability of event
  - Excel Spreadsheet based
- Currently the primary tool used to conduct ESMRM Assessments



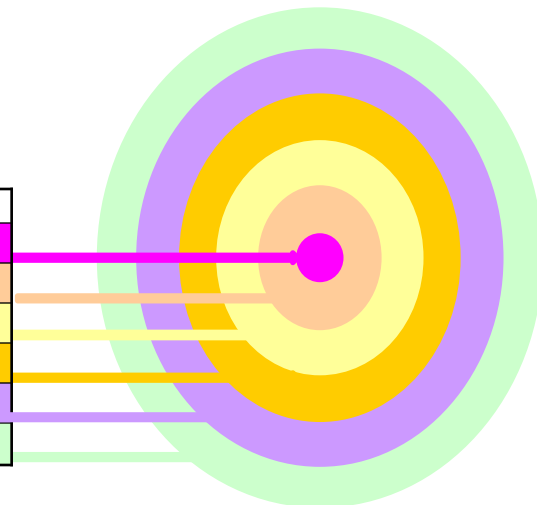
*ASAP-X was developed to assist in the risk assessment process, the derived information may be presented to leadership for review with the deviation package. It provides the information necessary to assist leaders in making informed risk decisions.*



# ESMRRM Assessment Tools

- *Consequence & Risk Identification (C&RI) tool (Cont.)*
- Estimates the potential number of fatalities, injuries, and infrastructure damage
  - The C&RI tool doesn't take into consideration the probability of event
  - The tool is currently Excel spreadsheet based and is being integrated into the DoD's Explosives Safety Siting (ESS) Software program in 2018/2019

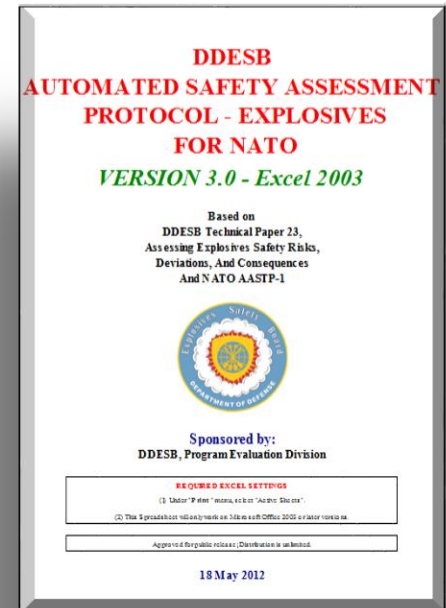
Zone US = NATO	U.S.		
	Facility Damage %	Fatality %	Injury %
1 (K6) = Q2.4	100%	100%	0%
2 (K9) = Q3.6	100%	90%	10%
3 (K11) = Q4.7	100%	80%	20%
4 (K18) = Q7.1	50%	20%	40%
5 (K24/30) = Q9.5/Q12	20%	2%	4%
6 (K40/50) = Q15.9/Q19.8	5%	1%	2%





# ESMRM Assessment Tools

- A NATO version of the tool “*NATO Automated Safety Assessment Protocol – Explosives (NASAP-X)*” is available.
  - Analyzes potential risks based the distance between Potential Explosion Sites (PESs) (ECM, Open, Other) to Exposed Sites (ESs).
  - Analyzes consequences associated with overpressure and fragmentation based on Q-factors derived from Allied Ammunition Storage and Transportation Publication (AASTP-1), “*Manual of NATO Safety Principles for the Storage of Military Ammunition and Explosives.*”



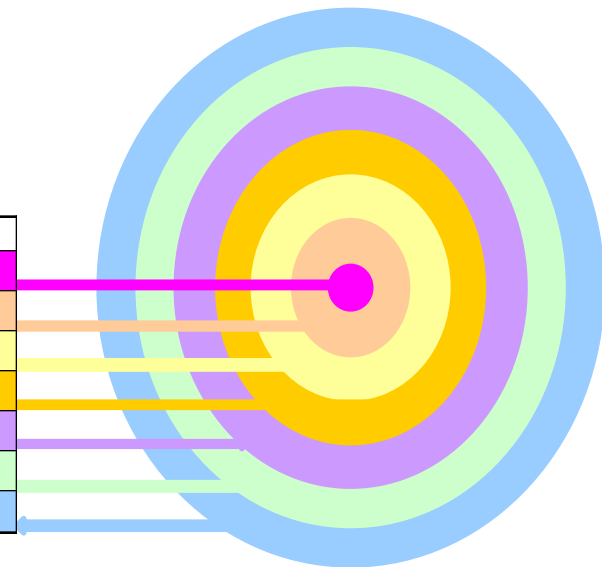




# ESMRM Assessment Tools

- *NATO Automated Safety Assessment Protocol - Explosives (NASAP-X)* (Cont.)
  - Estimates the potential number of fatalities and infrastructure damage (not injuries)
  - The NASAP-X tool doesn't take into consideration the probability of event
  - Excel spreadsheet based

Zone NATO = US	NATO Facility Damage %	Fatality %
1 (Q2.4) = K6	100%	100%
2 (Q3.6) = K9	100%	91%
3 (Q7.2) = K18	50%	21%
4 (Q9.6) = K24	20%	3%
5 (Q14.8/PTRD) = K37	10%	2%
6 (Q22.2/IBD) = K56	5%	1%
7 (Q44.4/2IBD) = K112	1%	1%



NATO ASAP-X Tool



# Munitions Risk Assessment System Example



Legend	
	078 - K11
	143R - K18
	750R - K30PTRD
	718 - K9
	1,260R - K501RD

**Point Loma, San Diego**  
ESQD Arcs for 500 lbs NEW

0 250 500 Feet  
Projection: Transverse Mercator  
Datum: WGS 1984 UTM Zone 11N



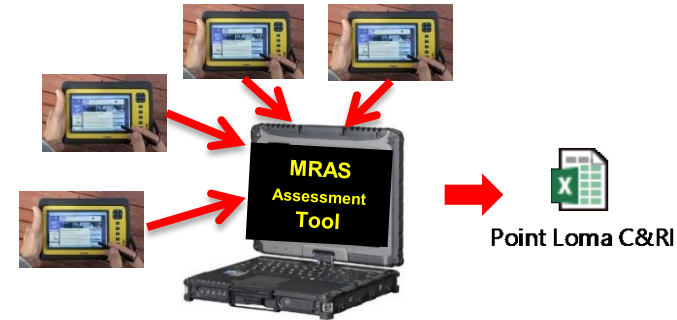
Example ESQD Arcs and Groupings

Source: 4. (DigitalGlobe, Inc 2014-2018)<sup>16</sup>



# Munitions Risk Assessment System Example

- Analyzing potential Risk
  - Exposed infrastructure and personnel census data is entered into the ASAP-X/C&RI Excel Spreadsheet or into the MRAS
  - Potential consequences are analyzed based on the Net Explosives Weight (NEW) at the Potential Explosion Site (PES) and the distances to the exposed sites(ESs)



OUTPUT DATA FOR								
ZONE	DISTANCE	FATAL	BUILDING DAMAGE LOSS	% FATAL	% BLDG DAMAGE	Total # Personnel	INJURIES	
1	1 (K6)	3	660,000	100%	100%	3	0	All non-fatal are injuries
2	2 (K9)	3	660,000	100%	100%	3	0	All non-fatal are injuries
3	3 (K11)	3	660,000	100%	100%	3	0	All non-fatal are injuries
4	4 (K18)	2	494,359	67%	75%	3	1	Sliding scale from "all non-fatal" to 2X fatalities
5	5 (K24/PTRD)	92	64,974,617	10%	33%	952	184	Twice the # of fatalities
6	6 (K40/IBD)	30	47,680,198	2%	13%	1,905	60	Twice the # of fatalities



Injury Worksheet

Total Fatalities	133
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Total # Personnel	2,869	245	Total Injuries
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- Potential consequences spreadsheet:



Potential Consequences



# Munitions Risk Assessment System Example

## ■ Risk Analysis

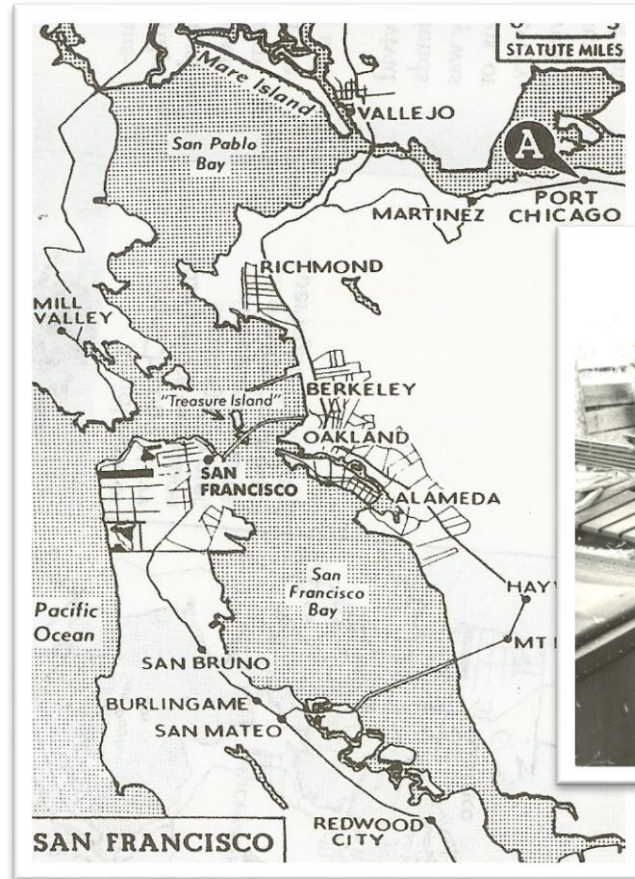
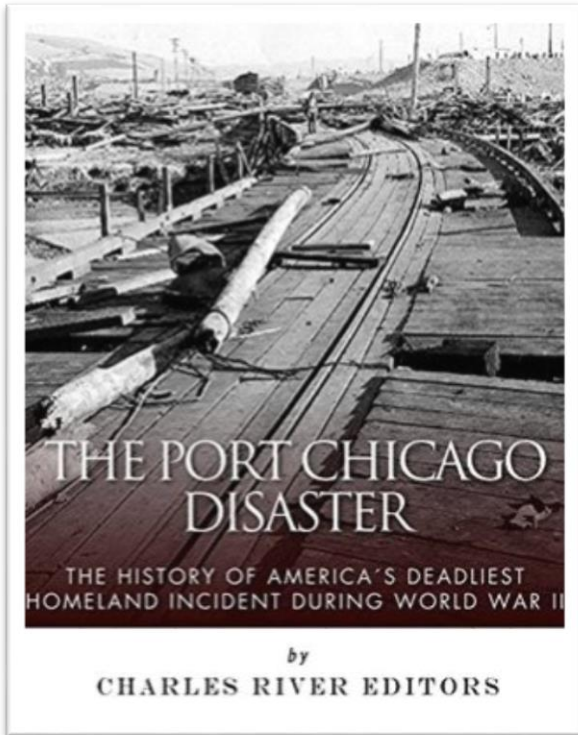
- Hazard Severity and Probability - Based on the analysis determine the overall risks to and from munitions related processes
- Military Standard 882E, “*Department of Defense Standard Practice System Safety,*” or the Services’ Safety process can be used to quantify the potential risks.

Description	Severity Category	Mishap Result Criteria					
<b>Catastrophic</b>	<b>1</b>	<b>Could result in one or more of the following: death, permanent total disability, irreversible significant environmental impact, or monetary loss equal to or exceeding \$10 million (M).</b>					
Critical	2	Could result in one or more illness that may result in hospitalization, permanent disability, or significant environmental impact, or more than one lost work day(s), reversible injury, or monetary loss exceeding \$100 thousand (K) but less than \$1 million (M).	<b>Probability</b>	<b>Severity</b>			
Marginal	3			Catastrophic (1)	Critical (2)	Marginal (3)	Negligible (4)
Negligible	4	Could result in one or more lost work day(s), reversible injury, or monetary loss exceeding \$100 thousand (K) but less than \$1 million (M).	Frequent (A)	High	High	Serious	Medium
			Probable (B)	High	High	Serious	Medium
Remote	D	Unlikely but possible to occur in the life of an item.	Occasional (C)	High	Serious	Medium	Low
			Remote (D)	Serious	Medium	Medium	Low
Improbable	E	So unlikely it can be assumed occurrence may not be experienced in the life of an item.	Improbable (E)	Medium	Medium	Medium	Low
Eliminated	F	Incapable of occurrence. This level is used when potential hazards are identified and later eliminated.	Eliminated (F)	Eliminated			
Remote	D	Unlikely but possible to occur in the life of an item.	Unlikely but can be reasonably expected to occur.				
Improbable	E	So unlikely it can be assumed occurrence may not be experienced in the life of an item.	Unlikely to occur, but possible.				
Eliminated	F	Incapable of occurrence. This level is used when potential hazards are identified and later eliminated.	Incapable of occurrence. This level is used when potential hazards are identified and later eliminated.				





# Questions / Comments / Discussion



Source 6. Charles River. The Port Chicago Disaster: The History of America's Deadliest Homeland Security Incident During World War II. Charles River Editors, 2015

**Port Chicago, California Ship Explosion of 17 July 1944.** The explosion of about 3,500,000 pounds of explosives in railroad cars on the pier and in the holds of a ship resulted in the death of 320 people, injuries to 390, and property damage estimated to be \$13,000,000. This incident provided empirical data based on the damage relationships by types, magnitude, direction and distance from the pier are recorded in the report by description, charts, tables, maps and in many cases by the determination of a formula for the fitted curve for the amount of damage per locality. Worst explosives incident of WWII Editors,



# References

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1. Berman, E., Gobinet, P., King, B., & Reina, P. (2014). Unplanned Explosions at Munitions Sites (UEMS) Excess Stockpiles as Liabilities rather than Assets. Graduate Institute of International and Development Studies. Switzerland: Small Arms Survey.
2. Wikipedia. n.d. [https://en.wikipedia.org/wiki/2008\\_G%C3%ABrdec\\_explosions](https://en.wikipedia.org/wiki/2008_G%C3%ABrdec_explosions) (accessed July 5, 2018).
3. Sharp, Michael, Thomas Taylor, and MSIAC Staff. Ammunition Accident at the Evangelos Florakis Naval Base, Zygi, Cyprus 11 July 2011. Brussels: Munitions Safety Information Analysis Center MSIAC, 2013.
4. rensen.com. n.d. [rensen.com/general96/casu.html](https://www.rensen.com/general96/casu.html) (accessed July 5, 2018).
5. DigitalGlobe, Inc. National Geospatial-Intelligence Agency EnhancedView Web Hosting Service. 2014-2018. <https://evwhs.digitalglobe.com/myDigitalGlobe> (accessed 2017-2018).
6. Editors, Charles River. The Port Chicago Disaster: The History of America's Deadliest Homeland Security Incident During World War II. Charles River Editors, 2015.





# Why? The case for ESMRM...

(2. Wikipedia n.d.)



**Gerdic, Albania (2008) – 26 Fatalities**

(3. Sharp, Taylor and Staff 2013)



**Evangelos Florakis NB, Cyprus (2011) – 13 Fatalities**

(4. rense.com n.d.)



**FOB Falcon, Afghanistan Iraq (2006)**

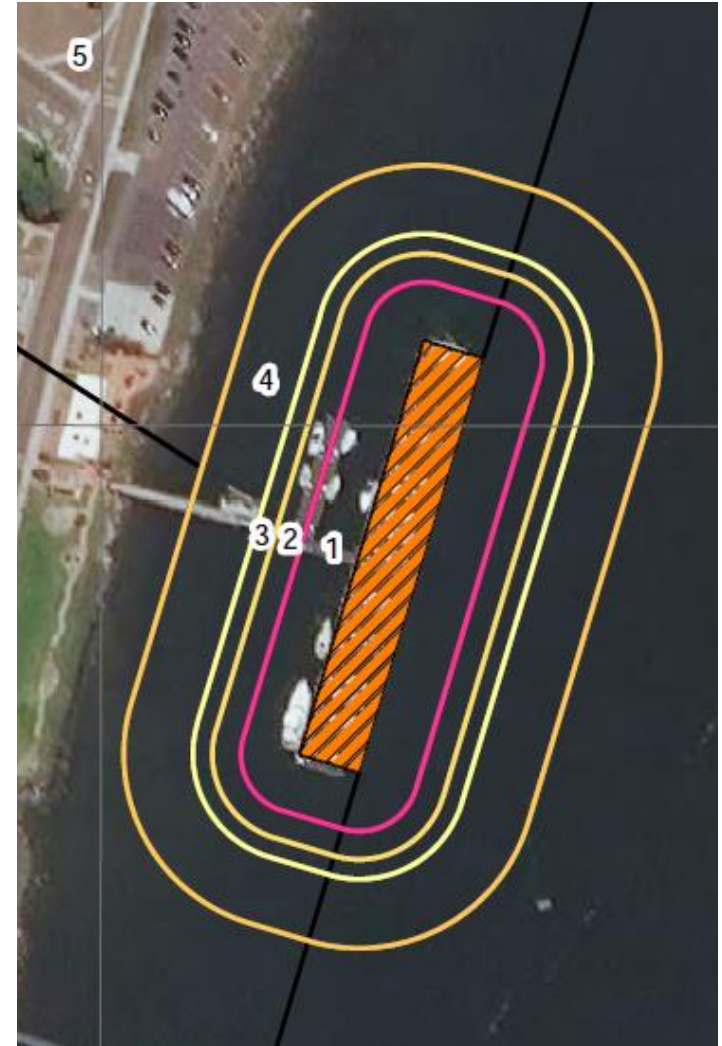


# Munitions Risk Assessment System Example

## ■ Conducting the On-site ESMRM Assessment

### ➤ On-site Assessment goals include:

- ✓ Validate mission scope and pre-planning assumptions
- ✓ Identifying risks to and from munitions at and around the PES
  - Facilities/equipment/capabilities to support operations, lightning protection, hazardous materials etc...
  - Each assessment is unique and having experienced explosives safety personnel and personnel familiar with the proposed operating location is critical





# Munitions Risk Assessment System Example

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- Collecting ES infrastructure data within ESQD arcs (continued)
  - The most accurate method is to physically measure each facility
  - Measurements can also be taken from imagery when conducting desktop assessments provided the images are scaled. (Determining the number of stories is very challenging)
  - Large numbers of buildings make physically measuring each building impractical
    - ✓ When estimating building sizes the use of “Equivalent Units” helps to scope the issue
    - ✓ Equivalent Units are pre-defined square footage sizes that can be used to quickly estimate a buildings size
    - ✓ As an example a 40’ x 40’ building is 1600 square feet. When looking at a building simply estimating how many 40’ x 40’ cubes can fit in the building can be used to estimate the total square footage
    - ✓ Counting the number of equivalent units, of each property type, in an assessment grouping is an acceptable method for estimating property exposures
- Infrastructure Data collected within each group is characterized based on the facility type (Industrial, commercial, instructional, residential, agricultural, and other)



# Munitions Risk Assessment System Example

- Determining personnel exposures
  - There are a number of ways to estimate the populations in a given area
    - ✓ Census can be used as a means to help validate data collection efforts
    - ✓ Occupancy placards
    - ✓ Asking local government officials
    - ✓ Asking owners/supervisors at commercial, industrial and government facilities
    - ✓ Estimating the number of personnel in various types of properties
    - ✓ A combination of methods is often used in an assessment
  - Establishing general guidelines for each of the data collection teams helps to maintain data consistency (i.e., the average number of personnel per residence is 3)

TEAM #: _____	ES GROUP #: _____		
Property Types:	<b>COM</b> mmercial, <b>RES</b> idential, <b>IND</b> ustrial, <b>INST</b> itutional, <b>AGR</b> icultural, <b>OTHer</b>		
Equivalent Unit Size:	_____ ft <sup>2</sup>		
Personnel Per Unit:	_____ ( <i>unless otherwise noted</i> )		
PROPERTY TYPE	EQUIVALENT UNITS	TOTAL PERSONNEL	NOTES