



# Department of Defense MANUAL

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USD(AT&L)

**SUBJECT:** DoD Ammunition and Explosives Safety Standards: Contingency Operations, Toxic Chemical Munitions and Agents, and Risk-Based Siting

References: See Enclosure 1

## V6.1. PURPOSE

V6.1.1. 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.

V6.1.1.1. 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.

V6.1.1.2. 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 to a section above the signature of the volume.

V6.1.2. Volume. This Volume provides criteria for contingency operations, toxic chemical munitions and agents, and risk-based siting.

## V6.2. APPLICABILITY. This Volume:

V6.2.1. Applies to:

V6.2.1.1. OSD, the Military Departments, 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”).

V6.2.1.2. DoD-titled AE wherever it is located.

V6.2.1.3. DoD personnel and property when potentially endangered by known host-nation or off-installation AE hazards.

V6.2.1.4. DoD facilities siting and construction, except as indicated in paragraph V6.2.2.

V6.2.1.5. The evaluation of non-DoD explosives siting submissions on DoD installations (see section V4.E5.21.).

V6.2.2. Provided the documentation requirements of paragraph V6.E2.3.5. are met, does not apply to:

V6.2.2.1. Existing facilities, or those approved for construction under then-current editions of these standards. This exception applies for the balance of the useful lives of such facilities provided:

V6.2.2.1.1. The facility continues to be used for its intended purpose.

V6.2.2.1.2. The explosives safety hazards are not increased.

V6.2.2.1.3. Redesign or modification is not practicable.

V6.2.2.1.4. The quantity of AE cannot be reduced for reasons of operational necessity.

V6.2.2.2. Those planned facilities that do not meet these standards, but have been certified by the Heads of the DoD Components (see section V1.E3.4.) as essential for operational or other compelling reasons.

V6.2.2.3. Other situations that, upon analysis by the Heads of the DoD Components and the Department of Defense Explosives Safety Board (DDESB), are determined to provide the required degree of safety through use of protective construction or other specialized safety features.

### V6.3. DEFINITIONS

V6.3.1. Abbreviations and Acronyms. See Glossary.

V6.3.2. Terms. See Volume 8 of this Manual.

V6.4. POLICY. As established in Reference (c) and consistent with peacetime, contingency, or wartime operational requirements and corresponding DoD military munitions requirements from the broadest and most fundamental explosives safety management perspective, it is DoD policy to:

V6.4.1. Provide the maximum possible protection to people and property from the potential damaging effects of DoD military munitions (explosive and chemical). Applying the standards herein provides only the minimum protection criteria for personnel and property, and greater protection should always be provided when practicable.

V6.4.2. Minimize exposures consistent with safe and efficient operations (i.e., expose the minimum number of people for the minimum time to the minimum amount of explosives or chemical agents (CAs)).

V6.5. RESPONSIBILITIES. See Enclosure 2.

V6.6. PROCEDURES. See Enclosures 3 through 5. Criteria provided in this Manual are given in English units (e.g., foot or feet (ft), pounds (lbs), pounds per square inch (psi)), with metric equivalents shown in brackets (e.g., meters (m), kilograms (kg), kilopascals (kPa)).

V6.7. RELEASABILITY. UNLIMITED. This Volume is approved for public release and is available on the Internet from the DoD Issuances Website at <http://www.dtic.mil/whs/directives>.

V6.8. EFFECTIVE DATE. This Volume is effective upon its publication to the DoD Issuances Website.

#### Enclosures

1. References
2. Responsibilities
3. Contingencies, Combat Operations, Military Operations Other Than War (MOOTW), and Associated Training
4. Toxic Chemical Munitions and Agents
5. Risk-Based Siting

#### Glossary

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ENCLOSURE 1

REFERENCES

- (a) DoD 6055.09-STD, "DoD Ammunition and Explosives Safety Standards," February 29, 2008 (cancelled by Volume 1 of this Manual)
- (b) DoD Directive 5134.01, Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)), December 9, 2005
- (c) DoD Directive 6055.9E, "Explosives Safety Management and the DoD Explosives Safety Board," August 19, 2005
- (d) Military Standard MIL-STD-882D, "Standard Practice for System Safety," February 10, 2000
- (e) Department of Defense Explosives Safety Board Technical Paper 10, Change 3, "Methodology for Chemical Hazard Prediction," June 1980
- (f) U.S. Army Chemical Research Development and Engineering Center Publication (Report No. CRDEC-TR-87021, Government Accession No. A-177-622), "Personal Computer Program For Chemical Hazard Prediction (D2PC)," January 1987<sup>1</sup>
- (g) DoD Instruction 6055.1, "DoD Safety and Occupational Health (SOH) Program," August 19, 1998
- (h) DoD Instruction 6055.05, "Occupational and Environmental Health (OEH)," November 11, 2008
- (i) U.S. Army Armament and Research Development Command Publication (Contractor Report No. ARLCD-CR-80049, Government Accession No. A-095-040), "Engineering Guide for Fire Protection and Detection Systems at Army Ammunition Plants, Volume I, Selection and Design," December 1980<sup>+2</sup>
- (j) Department of Defense Explosives Safety Board Technical Paper 19, Revision 1, "User's Reference Manual for the Safety Assessment for Explosives Risk Software," July 21, 2009
- (k) Department of Defense Explosives Safety Board Technical Paper 14, Revision 4, "Approved Methods and Algorithms for DoD Risk-Based Explosives Siting," July 21, 2009

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<sup>1</sup> Available on the Internet at  
<http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA177622&Location=U2&doc=GetTRDoc.pdf>

<sup>+2</sup> Available on the Internet at  
<http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA095040&Location=U2&doc=GetTRDoc.pdf>

ENCLOSURE 2

RESPONSIBILITIES

V6.E2.1. UNDER SECRETARY OF DEFENSE FOR ACQUISITION, TECHNOLOGY, AND LOGISTICS (USD(AT&L)). The USD(AT&L) shall provide overall policy guidance for the DoD Explosives Safety Management Program.

V6.E2.2. CHAIRMAN, DDESB. The Chairman, DDESB, shall report to the Deputy Under Secretary of Defense for Installations and Environment (DUSD(I&E)) and, on behalf of the USD(AT&L) and the DUSD(I&E), shall collaborate with the Military Service-appointed voting DDESB members to maintain explosives safety standards.

V6.E2.3. HEADS OF THE DoD COMPONENTS. The Heads of the DoD Components shall:

V6.E2.3.1. Implement these DoD explosives safety standards.

V6.E2.3.2. Comply with applicable Federal and State laws and regulations. Where this Volume conflicts with such laws and regulations, ensure the safety of DoD personnel and the public while complying and notify the Chairman, DDESB, through the Component's board member, of the conflict. These standards are not intended to be so rigid as to prevent the DoD Components from accomplishing their assigned missions.

V6.E2.3.3. Issue DoD Component guidance that implements these standards and provides DoD Component unique requirements.

V6.E2.3.4. Send a copy of any implementing and supplementary guidance to these standards to the Chairman, DDESB.

V6.E2.3.5. Document the exceptions described in paragraph V6.2.2. in permanent records. These records must include:

V6.E2.3.5.1. The effective date the applicable DoD explosives safety standards were first published.

V6.E2.3.5.2. The date the deviant facility was either approved, from an explosives safety viewpoint, for use or was first used in a manner deviating from the standard.

ENCLOSURE 3

CONTINGENCIES, COMBAT OPERATIONS, MILITARY OPERATIONS  
OTHER THAN WAR (MOOTW), AND ASSOCIATED TRAINING

V6.E3.1. GENERAL

V6.E3.1.1. This enclosure provides the minimum criteria for contingencies, combat operations, MOOTW, and associated training. Full compliance with other enclosures of this Volume, as well as other volumes of this Manual, may not be possible during such operations. The DoD Components may establish implementing regulations that are more protective than these standards. In situations involving combined or joint operations, the Commanders of the Combatant Commands or the U.S. commander of a joint task force (JTF) shall designate the DoD Component's explosives safety criteria to be used.

V6.E3.1.2. The provisions of this enclosure only apply to:

V6.E3.1.2.1. Those DoD AE activities located outside the United States.

V6.E3.1.2.2. The Commanders of the Combatant Commands, the U.S. commanders of JTFs, or the DoD Component commanders in the management of these DoD AE activities. When necessary, commanders may delegate certain explosive safety responsibilities to designated subordinate commanders to ensure appropriate controls.

V6.E3.1.2.3. Contingency, combat, and MOOTW training, regardless of location, when specifically authorized by applicable DoD Component headquarters or Combatant Commander. Prior to approval of this training, a risk analysis that thoroughly assesses asset preservation and identifies the risk associated with the training shall be conducted. Quantity-distance (QD) separations provided for asset preservation shall be used for training, except where Volumes 3, 4, and 5 permit lesser distances to be used.

V6.E3.1.3. This enclosure provides optional criteria and risk management tools not available elsewhere in this Manual. These optional criteria provide greater protection (asset preservation distance) for assets deemed sufficiently critical to warrant the greater protection, and, in some circumstances, provide lesser protection (minimum separation distance) for those assets for which the mission requirements outweigh the increased risk to those assets.

V6.E3.1.3.1. Asset Preservation Distance. At this distance from the potential explosion site (PES), assets at the exposed site (ES) are expected to be usable and mission capability is maintained following an incident. This separation distance should prevent propagation between PESs. (See subparagraphs V1.E8.2.5.5. and V1.E8.2.5.6. for expected consequences for these separation distances.)

V6.E3.1.3.2. Minimum Separation Distance. At this distance from the PES, mission capability will likely be impaired or delayed. This separation distance should prevent prompt



propagation; however, late-time propagation between PESs is possible. (See subparagraphs V1.E8.2.5.2., V1.E8.2.5.3., and V1.E8.2.5.4. for expected consequences for these separation distances.)

V6.E3.2. RISK MANAGEMENT. Risks associated with AE shall be managed consistent with operational requirements (see section V6.4.). Exceptions to this enclosure's criteria are where equivalent protection is provided or where a risk analysis is performed, as follows:

V6.E3.2.1. Equivalent Protection. Analysis determining that protective construction or other specialized safety features provides a level of protection equivalent to the separation distances required by this Manual.

V6.E3.2.2. Risk Analysis. Analysis determining that an acceptable level of safety is provided. Risk analysis is a systematic procedure consisting of these four steps:

V6.E3.2.2.1. An event analysis to identify and describe possible events such as the location, type of occurrence, probability of occurrence, and quantity of explosives.

V6.E3.2.2.2. An effects analysis of the effects of the possible events to persons in the surroundings such as blast pressure, fragmentation, and thermal hazards.

V6.E3.2.2.3. An exposure analysis of the places, protection, and time history of exposed personnel in the hazardous areas.

V6.E3.2.2.4. A risk calculation.

V6.E3.2.3. Risk Management Control. The action a commander takes to minimize acceptable risk. Such actions shall include:

V6.E3.2.3.1. Development, implementation, and enforcement of applicable control measures used to eliminate the hazard or reduce its risk.

V6.E3.2.3.2. Continuous evaluation of the effectiveness of the implemented control measures.

### V6.E3.3. SITE PLAN PROCESS

V6.E3.3.1. Site Approval. All explosives locations falling within the scope of this enclosure shall be approved by the applicable commander or by the DDESB as outlined in subparagraphs V6.E3.3.2.1.2., V6.E3.3.2.2.2., V6.E3.3.2.3.2., and V6.E3.3.2.4.2., and paragraph V6.E3.3.4. Site plan packages shall be submitted for:

V6.E3.3.1.1. AE locations such as:

V6.E3.3.1.1.1. Storage locations.

V6.E3.3.1.1.2. Holding areas (e.g., basic load ammunition holding areas (BLAHAs), flight-line holding areas, port and railhead holding areas, and marshalling areas).

V6.E3.3.1.1.3. Handling and operating locations (e.g., hardened aircraft shelters (HASs), ports, AE maintenance, repair, and renovation areas and sling-out areas).

V6.E3.3.1.1.4. Forward arming and refueling points (FARPs).

V6.E3.3.1.1.5. Combat aircraft parking areas (CAPAs) and cargo aircraft parking areas.

V6.E3.3.1.1.6. Static missile batteries.

V6.E3.3.1.1.7. Locations used for the treatment or disposal (e.g., open burn or open detonation) of munitions. Exceptions are those locations used in an emergency response for burning excess propellant resulting from munitions use during training, and those involved in direct combat operations.

V6.E3.3.1.2. Non-AE-related ESs within QD arcs.

V6.E3.3.2. Documentation Requirements. The operational situation and the type and duration of the AE operations conducted at the site or facility determine the type of documentation required for a site approval. These categories of operations apply:

V6.E3.3.2.1. Permanent

V6.E3.3.2.1.1. Definition. Those AE-related facilities where operations are expected to continue for more than 12 months.

V6.E3.3.2.1.2. Documentation Requirement. A DDESB-approved site plan for such locations must be obtained once the Commander of the Combatant Command or DoD Component headquarters, as applicable, determines operations shall require the facilities' use to continue beyond 12 months.

V6.E3.3.2.2. Recurrent

V6.E3.3.2.2.1. Definition. Those AE-related facilities where operations are expected to occur on a periodic basis regardless of the duration of the operation. These locations may be sited using compensatory actions, such as facility evacuation or change-of-use, to minimize the risks associated with AE operations.

V6.E3.3.2.2.2. Documentation Requirement. These locations must have a DDESB- (or appropriate level of command, when applicable) approved site plan before commencing operations.

V6.E3.3.2.3. Temporary

V6.E3.3.2.3.1. Definition. Those AE-related facilities where operations are not expected to continue for more than 12 months and are not recurrent, or for which advanced planning and approval are impractical.

V6.E3.3.2.3.2. Documentation Requirement. A plan for the specific scenario shall be approved by the applicable commander. The plan shall include:

V6.E3.3.2.3.2.1. A risk assessment for the proposed operation. This assessment shall weigh the need for the facility against the potential effects of an accident (e.g., mission impact, loss of resources, turnaround times).

V6.E3.3.2.3.2.2. Schedule for the cessation of explosives operations or submittal of a site plan if the operations exceed 12 months.

V6.E3.3.2.4. Contingency, Combat, and MOOTW Training

V6.E3.3.2.4.1. Definition. Those operations that simulate real world combat environments using live AE to achieve training goals.

V6.E3.3.2.4.2. Documentation Requirement. Facilities or areas for training activities shall have a DDESB-approved site plan for permanent or recurrent operations, or a risk analysis approved by the applicable commander for temporary operations.

V6.E3.3.3. Site Plan Packages. See section V1.E5.1. for the requirements, with these additions:

V6.E3.3.3.1. In the absence of suitable maps or drawings, information (e.g., sketches, photographs, or other information) may be provided.

V6.E3.3.3.2. An explanation of any deviations from pertinent safety standards caused by local conditions.

V6.E3.3.3.3. A copy of the risk analysis performed by the DoD Component, if one was performed, to demonstrate equivalent protection.

V6.E3.3.4. Approval Authority for Waivers and Exemptions. The Commander of the Combatant Command, the U.S. commander of a JTF, or the DoD Component commander may, for strategic and other compelling reasons, authorize waivers to the explosives safety standards contained herein for the planning or conduct of contingencies, combat operations, and MOOTW. All waivers shall be coordinated with the host nation, as required, and consistent with international agreements.

V6.E3.3.4.1. Requests for waivers and exemptions to QD criteria shall be in accordance with (IAW) the DoD Component directives. When joint operations are being conducted from a single base or location, waivers and exemptions that affect another DoD Component must be coordinated between affected DoD Components.

V6.E3.3.4.2. Requests for waivers and exemptions to QD criteria shall contain:

V6.E3.3.4.2.1. A risk analysis for the proposed operation weighing the need to conduct the operation and violate the standards against the potential effect of an accident (e.g., mission impact, loss of resources, turnaround times).

V6.E3.3.4.2.2. A timeline listing milestones that shall eliminate the need for the waiver or exemption.

V6.E3.4. QD CRITERIA FOR CONTINGENCIES, COMBAT OPERATIONS, MOOTW, AND ASSOCIATED TRAINING. QD criteria are provided for these specific types of locations:

V6.E3.4.1. BLAHA

V6.E3.4.1.1. General. To fulfill their missions, certain units must keep their basic load ammunition in armored vehicles, trucks, trailers, and structures or on pads. This involves acceptance of greater risks to unit personnel, facilities, and equipment than permitted by other volumes of this Manual. The concept of BLAHA storage may also be used to provide QD separations during mobile operations. A basic load storage area (BLSA) is a location containing multiple BLAHAs.

V6.E3.4.1.2. Mixing of Basic Load Ammunition. Storage compatibility requirements of Volume 1, Enclosure 6 do not apply to BLAHA facilities.

V6.E3.4.1.2.1. Net explosive weight for quantity-distance (NEWQD) for use with BLAHA QD criteria shall be determined as follows:

V6.E3.4.1.2.1.1. The sum of the weights of all energetic compositions contained in munitions hazard classified as hazard division (HD) 1.1 or 1.5 shall be used.

V6.E3.4.1.2.1.2. The sum of the explosive weight of all HD 1.2 AE shall be used. The propellant weight of an HD 1.2 item (if present) may be disregarded.

V6.E3.4.1.2.1.3. The weights of energetic compositions hazard classified as HD 1.3 may be disregarded. However, if the site only contains HD 1.3 items, the criteria contained in section V3.E3.3. apply.

V6.E3.4.1.2.1.4. The weights of energetic compositions classified as HD 1.4 may be disregarded.

V6.E3.4.1.2.1.5. The explosive weight of HD 1.6 shall be computed as follows:

V6.E3.4.1.2.1.5.1. When HD 1.6 is stored alone or with HD 1.4 AE, the QD criteria of section V3.E3.3. apply.

V6.E3.4.1.2.1.5.2. When HD 1.6 is stored with AE classified as HD 1.1, HD 1.2, or HD 1.5, add the explosives weight of the HD 1.6 items into the NEWQD calculations.

V6.E3.4.1.2.1.5.3. When HD 1.6 is stored with AE classified as HD 1.3, add the explosives weights of HD 1.3 and HD 1.6. The QD criteria in section V3.E3.3. apply.

#### V6.E3.4.1.2.2. Explosives Limits

V6.E3.4.1.2.2.1. The maximum NEWQD at any BLAHA in a BLSA storing mixed compatibility must not exceed 8,818 lbs [4,000 kg]. A BLSA may have multiple 8,818-lb [4,000-kg] BLAHAs, provided the BLAHAs are separated from each other by the applicable distances (D1, D2, and D3) given in Table V6.E3.T1.

V6.E3.4.1.2.2.2. When the NEWQD of a BLSA or a BLAHA exceeds 8,818 lbs [4,000 kg], the QD computations for the site shall be IAW Volumes 3, 4, and 5; the HD mixing rules shall be IAW Volume 1, Enclosure 7; and the explosives compatibility storage criteria shall be IAW Volume 1, Enclosure 6.

#### V6.E3.4.1.2.3. QD Computations

V6.E3.4.1.2.3.1. The total NEWQD of AE in each site shall be used for computation of QD provided the required distances (Table V6.E3.T1.) necessary to prevent propagation separate these sites. If the separation distances are not met, the entire BLSA shall be considered one site and subparagraph V6.E3.4.1.2.2.2. applies.

V6.E3.4.1.2.3.2. The intermagazine distance (IMD) requirements of Volume 3 apply when using 3-Bar or 7-Bar earth-covered magazines (ECMs).

V6.E3.4.1.2.3.3. Table V6.E3.T1. contains the QD separation for BLAHAs and BLSAs.

V6.E3.4.1.2.3.4. Heavy armored vehicles are expected to contain most of the blast and fragments from an internal explosion and are well protected from an external explosion. For this reason, there is no required separation from heavy armored PESs to light or non-armored ESs. Additionally, heavy armored ESs requires no separation from other sites. The hatches of heavy armored vehicles must be kept closed to be considered heavy armored vehicles; otherwise, they are considered light armored vehicles. Use Table V6.E3.T2. to determine the applicable QD for heavy, light, and non-armored vehicles.

Table V6.E3.T1. QD for BLAHAs and BLSAs

NEWQD	D1 <sup>a</sup>	D2 <sup>b</sup>	D3 <sup>c</sup>	D4 <sup>d</sup>	D5 <sup>e</sup>	D6 <sup>f</sup>
(lbs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
[kg]	[m]	[m]	[m]	[m]	[m]	[m]
10	4	13	26	591	886	66
4.5	1.3	3.9	7.9	180	270	20
15	5	15	30	591	886	66
6.8	1.5	4.5	9.0	180	270	20
20	5	16	33	591	886	66
9.1	1.7	5.0	9.9	180	270	20
30	6	19	37	591	886	66
13.6	1.9	5.7	11.4	180	270	20
50	7	22	44	591	886	66
22.7	2.2	6.7	13.5	180	270	20
70	8	25	49	591	886	66
31.8	2.5	7.5	15.1	180	270	20
100	9	28	56	591	886	66
45.4	2.8	8.5	17.0	180	270	20
150	11	32	64	591	886	81
68.0	3.2	9.7	19.4	180	270	24.6
200	12	35	70	591	886	99
90.7	3.6	10.7	21.4	180	270	30.0
300	13	40	80	591	886	130
136.1	4.1	12.2	24.5	180	270	39.6
500	16	48	95	591	886	
226.8	4.8	14.5	29.0	180	270	
700	18	53	107	591	886	
317.5	5.4	16.2	32.5	180	270	
1,000	20	60	120	591	886	
453.6	6.1	18.3	36.6	180	270	
1,500	23	69	137	591	886	
680.4	7.0	20.9	41.9	180	270	
2,000	25	76	151	591	886	
907.2	7.7	23.0	46.1	180	270	
3,000	29	87	173	591	886	
1,360.8	8.8	26.4	52.8	180	270	
5,000	34	103	205	591	886	
2,268.0	10.4	31.3	62.5	180	270	
7,000	38	115	230	669	1,021	
3,175.1	11.7	35.0	70.0	204.0	306.0	
8,818	41	124	248	751	1,146	
4,000	12.6	37.8	75.6	229.0	343.4	

Table V6.E3.T1. QD for BLAHAs and BLSAs, Continued

a	<p>D1 is used for:</p> <ol style="list-style-type: none"> <li>1. Side-to-side, side-to-rear, and rear-to-rear exposures between undefined ECMs, provided the earth cover complies with paragraph V2.E5.5.3. and the explosives are stored at least 3 ft [1 m] from the end of the ECM.</li> <li>2. Non-armored vehicle (PES) to non-armored vehicle (ES) when an adequate barricade IAW section V2.E5.4. is located between them.</li> <li>3. Light armored vehicle (PES) to non-armored vehicle (ES) when an adequate barricade IAW section V2.E5.4. is located between them.</li> <li>4. Light armored or non-armored vehicle (PES) to light armored vehicle (ES) when an adequate barricade IAW section V2.E5.4. is located between them.</li> <li>5. Determining D1 and NEWQD for D1:</li> </ol> <p><u>English Equations (EQNs) (NEWQD in lbs, D1 in ft)</u></p> $D1 = 2 * \text{NEWQD}^{1/3} \quad \text{EQN V6.E3.T1-1}$ $\text{NEWQD} = (D1/2)^3 \text{ with a maximum of 8,818 lbs} \quad \text{EQN V6.E3.T1-2}$ <p><u>Metric EQNs (NEWQD in kg, D1 in m)</u></p> $D1 = 0.79 * \text{NEWQD}^{1/3} \quad \text{EQN V6.E3.T1-3}$ $\text{NEWQD} = (D1/0.79)^3 \text{ with a maximum of 4,000 kg} \quad \text{EQN V6.E3.T1-4}$
b	<p>D2 is used for:</p> <ol style="list-style-type: none"> <li>1. Front-to-front exposures involving undefined ECMs when there is an adequate barricade (section V2.E5.4.) at the ES.</li> <li>2. Non-armored or light armored vehicles to the side or rear of an undefined ECM.</li> <li>3. Determining D2 and NEWQD for D2:</li> </ol> <p><u>English EQNs (NEWQD in lbs, D2 in ft)</u></p> $D2 = 6 * \text{NEWQD}^{1/3} \quad \text{EQN V6.E3.T1-5}$ $\text{NEWQD} = (D2/6)^3 \text{ with a maximum of 8,818 lbs} \quad \text{EQN V6.E3.T1-6}$ <p><u>Metric EQNs (NEWQD in kg, D2 in m)</u></p> $D2 = 2.38 * \text{NEWQD}^{1/3} \quad \text{EQN V6.E3.T1-7}$ $\text{NEWQD} = (D2/2.38)^3 \text{ with a maximum of 4,000 kg} \quad \text{EQN V6.E3.T1-8}$
c	<p>D3 is used for:</p> <ol style="list-style-type: none"> <li>1. Non-armored vehicles to non-armored vehicles without an adequate barricade.</li> <li>2. Light armored vehicles to non-armored vehicles without an adequate barricade at the non-armored vehicles.</li> <li>3. Undefined ECM to undefined ECM when positioned front-to-front and no barricade is present.</li> <li>4. Non-armored vehicles, light armored vehicles, or undefined ECM to the front of undefined ECM when no barricade is present at the ES.</li> <li>5. Determining D3 and NEWQD for D3:</li> </ol> <p><u>English EQNs (NEWQD in lbs, D3 in ft)</u></p> $D3 = 12 * \text{NEWQD}^{1/3} \quad \text{EQN V6.E3.T1-9}$ $\text{NEWQD} = (D3/12)^3 \text{ with a maximum of 8,818 lbs} \quad \text{EQN V6.E3.T1-10}$ <p><u>Metric EQNs (NEWQD in kg, D3 in m)</u></p> $D3 = 4.76 * \text{NEWQD}^{1/3} \quad \text{EQN V6.E3.T1-11}$ $\text{NEWQD} = (D3/4.76)^3 \text{ with a maximum of 4,000 kg} \quad \text{EQN V6.E3.T1-12}$

Table V6.E3.T1. QD for BLAHAs and BLSAs, Continued

d	D4 is used for:		
	1. Public traffic route distance (PTRD) from non-armored and light armored vehicles.		
	2. Determining D4 and NEWQD for D4:		
	<u>English EQNs (NEWQD in lbs, D4 in ft)</u>		
	NEWQD ≤ 5,500 lbs:	D4 = 591 ft	
	5,500 lbs < NEWQD ≤ 8,818 lbs:	$D4 = 8 * \text{NEWQD}^{1/2}$	EQN V6.E3.T1-13
	D4 < 591 ft:	NEWQD = 0 lbs	
	591 ft ≤ D4 ≤ 751 ft:	NEWQD = $(D4/8)^2$ with a maximum of 8,818 lbs	EQN V6.E3.T1-14
	<u>Metric EQNs (NEWQD in kg, D4 in m)</u>		
	NEWQD ≤ 2,495 kg:	D4 = 180 m	
2,495 kg < NEWQD ≤ 4,000 kg:	$D4 = 3.62 * \text{NEWQD}^{1/2}$	EQN V6.E3.T1-15	
D4 < 180 m:	NEWQD = 0 kg		
180 m ≤ D4 ≤ 229 m:	NEWQD = $(D4/3.62)^2$ with a maximum of 4,000 kg	EQN V6.E3.T1-16	
e	D5 is used for:		
	1. Inhabited building distance (IBD) from non-armored and light armored vehicles.		
	2. Determining D5 and NEWQD for D5:		
	<u>English EQNs (NEWQD in lbs, D5 in ft)</u>		
	NEWQD ≤ 5,500 lbs:	D5 = 886 ft	
	5,500 lbs < NEWQD ≤ 8,818 lbs:	$D5 = 12.2 * \text{NEWQD}^{1/2}$	EQN V6.E3.T1-17
	D5 < 886 ft:	NEWQD = 0 lbs	
	886 ft ≤ D5 ≤ 1,146 ft:	NEWQD = $(D5/12.2)^2$ with a maximum of 8,818 lbs	EQN V6.E3.T1-18
	<u>Metric EQNs (NEWQD in kg, D5 in m)</u>		
	NEWQD ≤ 2,495 kg:	D5 = 270 m	
2,495 kg < NEWQD ≤ 4,000 kg:	$D5 = 5.43 * \text{NEWQD}^{1/2}$	EQN V6.E3.T1-19	
D5 < 270 m:	NEWQD = 0 kg		
270 m ≤ D5 ≤ 343.4 m:	NEWQD = $(D5/5.43)^2$ with a maximum of 4,000 kg	EQN V6.E3.T1-20	
f	D6 is used for:		
	1. Determining the IBD and PTRD from heavy armored vehicles. When NEWQD exceeds 331 lbs [150 kg] the IBD and PTRD specified in Volumes 3, 4, and 5 apply.		
	2. Determining D6 and NEWQD for D6:		
	<u>English EQNs (NEWQD in lbs, D6 in ft)</u>		
	NEWQD ≤ 110 lbs:	D6 = 66 ft	
	110 lbs < NEWQD ≤ 331 lbs:	$D6 = -4.49 + 0.487 * (\text{NEWQD}^{1/3}) + 2.928 * (\text{NEWQD}^{1/3})^2$	EQN V6.E3.T1-21
	D6 < 66 ft:	NEWQD = 0 lbs	
	66 ft ≤ D6 ≤ 138 ft:	$\text{NEWQD} = (0.0833 + [1.5421 + 0.3416 * D6]^{1/2})^3$	EQN V6.E3.T1-22
	<u>Metric EQNs (NEWQD in kg, D6 in m)</u>		
	NEWQD < 50 kg:	D6 = 20 m	
50 ≤ NEWQD ≤ 150 kg:	$D6 = -1.37 + 0.193 * (\text{NEWQD}^{1/3}) + 1.512 * (\text{NEWQD}^{1/3})^2$	EQN V6.E3.T1-23	
D4 < 20 m:	NEWQD = 0 kg		
20 m ≤ NEWQD ≤ 42.3 m:	$\text{NEWQD} = (0.0640 + [0.9108 + 0.6615 * D6]^{1/2})^3$	EQN V6.E3.T1-24	



Table V6.E3.T2. QD Requirements for Armored Vehicles<sup>a, b</sup>

	From →	Heavy	Light	Non-Armored
To ↓				
Heavy (IMD Exposure)		IMD Not Required	IMD Not Required	IMD Not Required
Light (IMD Exposure)		IMD Not Required	D1 from V6.E3.T1	D1 from V6.E3.T1
Non-Armored (IMD Exposure)		IMD Not Required	D3 from V6.E3.T1	D3 from V6.E3.T1
IBD Exposure		D6 from V6.E3.T1	D5 from V6.E3.T1	D5 from V6.E3.T1
PTRD Exposure		D6 from V6.E3.T1	D4 from V6.E3.T1	D4 from V6.E3.T1
a	Application of D1 distance may require the use of a barricade between PES and ES. Refer to Table V6.E3.T1. footnotes regarding the need for a barricade.			
b	For asset preservation, rather than using D1 and D3, use one of these equations:			
	<u>English EQNs (W in lbs, d in ft)</u>			
	$d = 24 * W^{1/3}$			EQN V6.E3.T2-1
	$d = 30 * W^{1/3}$			EQN V6.E3.T2-2
	<u>Metric EQNs (Q in kg, d in m)</u>			
	$d = 9.52 * Q^{1/3}$			EQN V6.E3.T2-3
	$d = 11.90 * Q^{1/3}$			EQN V6.E3.T2-4

V6.E3.4.2. Ports. The following criteria shall apply to ports where DoD AE is loaded or unloaded.

#### V6.E3.4.2.1. Explosives Piers

V6.E3.4.2.1.1. Aboveground magazine (AGM) IMD (K11[4.36]) shall be maintained between explosives piers.

V6.E3.4.2.1.2. Intraline distance (ILD) (K18 [7.14]) shall be maintained from an explosives pier to a non-explosives pier used for the handling of military cargo.

V6.E3.4.2.1.3. AGM IMD (K11 [4.36]) shall be maintained to AE holding areas based on the NEWQD at the pier.

V6.E3.4.2.1.4. Marshalling yards shall be located at PTRD from explosives piers.

V6.E3.4.2.1.5. Railheads used for long-term storage or as a transfer depot shall be sited at AGM IMD (K11 [4.36]) from an explosives pier based on the NEWQD at the pier.

V6.E3.4.2.2. Explosives Anchorages. The criteria of Volume 4 apply with these exceptions:

V6.E3.4.2.2.1. ILD (K18 [7.14]) shall be provided between the explosives loading or unloading section of the anchorage and the loaded ship section of the explosives anchorage (see Figure V4.E4.F42.).

V6.E3.4.2.2.2. An explosives anchorage shall be located at K40 [15.87] from all piers. However, where necessary for security or navigational reasons, this distance may be reduced to ILD (K18 [7.14]) when the piers are only used for DoD operations. PTRD may be applied for asset preservation. A separation distance of K40 [15.87] shall be maintained to all non-DoD-related piers.

V6.E3.4.2.2.3. ILD (K18 [7.14]) is permitted between an explosives anchorage and a non-explosives DoD-related anchorage. K40 [15.87] shall be maintained between an explosives anchorage and a non-explosives, non-DoD-related anchorage.

#### V6.E3.4.2.3. AE Facilities

V6.E3.4.2.3.1. AE Holding Areas. These holding areas are used in support of AE loading and unloading of ships. Typically, AE being held at these locations are only present for a short time. The NEWQD associated with the AE holding area shall be based on all AE present at the site. These criteria apply to AE holding areas:

V6.E3.4.2.3.1.1. ILD (K18 [7.14]) shall be maintained to both explosives and non-explosives piers based on the NEWQD present at the AE holding areas.

V6.E3.4.2.3.1.2. PTRD shall be maintained to an explosives or non-explosives marshalling yard.

V6.E3.4.2.3.1.3. Railheads used for AE holding areas storage or as a transfer depot shall be sited at AGM IMD (K11 [4.36]) from an AE holding areas based on the NEWQD at the AE holding areas.

V6.E3.4.2.3.2. Marshalling Yards. PTRD shall be maintained between marshalling yards and explosives piers or AE holding areas. The location of the marshalling yard will typically be governed by the NEWQD at the other PESs. When operational necessity dictates, marshalling yards may be separated by ILD (K18 [7.14]) to any nearby manned explosives operations and AGM IMD (K11 [4.36]) to any nearby unmanned explosives storage operations.

V6.E3.4.2.3.3. Loading Docks. Loading docks shall be sited at IMD (K11 [4.36]) from all ESs.

V6.E3.4.2.3.4. Classification Yards. Use criteria provided in section V4.E5.3.

V6.E3.4.2.3.5. Railheads. Based on its use, a railhead shall be sited as a classification yard, AE holding area, or a loading dock.

V6.E3.4.3. Field Storage and Handling Areas. These areas shall be sited IAW Table V6.E3.T3. Use separation distances from the applicable QD tables in Volumes 3 and 5 for the HD and NEWQD of the AE involved with the PES. AE will be segregated IAW Volume 1, Enclosure 6, by storage compatibility group. The clear zone surrounding the field storage and

handling areas is bounded by the applicable IBD. No unrelated, occupied structures are permitted within this clear zone.

V6.E3.4.3.1. Explosives Locations. These areas may consist of all or some of these explosives locations:

V6.E3.4.3.1.1. Field Storage Sections. These sections are used to store AE. Field storage sections are used for dispersing AE in multiple, widely separated storage sections to prevent the loss of any one section from causing the loss of other sections, thereby seriously degrading the mission. AE may be stored in existing structures, caves, and tunnels as prescribed in Volumes 3, 4, and 5. The construction and use of barricades and revetments shall be IAW Volume 2.

V6.E3.4.3.1.2. AE Staging Area. These areas are normally used for temporary holding of outgoing AE and for ready access to combat aircraft loading areas.

V6.E3.4.3.1.3. Captured Enemy Ammunition Area. A separate area shall be provided for the storage of captured enemy AE. Captured enemy AE that cannot be identified shall be treated as HD 1.1.

V6.E3.4.3.1.4. AE Operations Area. An area used for operations such as minor maintenance and repair of AE or their containers, surveillance, segregation, or weapons assembly.

V6.E3.4.3.1.5. AE Destruction Area. An area used for disposal of AE. It may consist of a burning area, a demolition area, or both.

V6.E3.4.3.1.6. Sling-out Area. An area used for moving AE by rotary-wing aircraft.

V6.E3.4.3.2. Non-explosives Locations. These areas may consist of all or some of these non-explosives locations:

V6.E3.4.3.2.1. Administration and Billeting Areas. Inhabited locations not directly related to the daily operations of the field storage and handling areas.

V6.E3.4.3.2.2. Manned Support Facilities. Facilities directly supporting AE operations (e.g., field offices and AE support equipment maintenance facilities).

V6.E3.4.3.2.3. Unmanned Support Facilities. Unmanned locations supporting AE operations (e.g., forklift charging stations, dunnage storage, and buildings that store inert materials). A minimum 50-ft [15.2-m] separation distance shall be maintained from these locations to any PES.

V6.E3.4.3.3. Modular Storage. A barricaded area comprised of a series of connected cells with hard surface storage pads separated from each other by barricades (see section V2.E5.6.).

Table V6.E3.T3. QD for Field Storage and Handling Areas<sup>a</sup>

From → To ↓	Storage Sections	AE Staging Area	Captured Enemy Ammunition Area	AE Operations Area	Sling Out Area	AE Destruction Area
Storage Sections	IMD Footnote b	IMD Footnote b	PTRD <sup>c</sup> PTRD <sup>c</sup>	IMD Footnote b	IMD Footnote b	Footnote d ↓
AE Staging Area	IMD Footnote b	IMD Footnote b	PTRD <sup>c</sup> PTRD <sup>c</sup>	IMD Footnote b	IMD Footnote b	
Captured Enemy Ammunition Area	IMD Footnote b	IMD Footnote b	IMD PTRD <sup>c</sup>	IMD Footnote b	IMD Footnote b	
AE Operations Area	IMD Footnote b	IMD Footnote b	PTRD <sup>c</sup> PTRD <sup>c</sup>	IMD Footnote b	IMD Footnote b	
Sling-Out Area	Not Required Footnote b	Not Required Footnote b	PTRD <sup>c</sup> PTRD <sup>c</sup>	IMD Footnote b	IMD Footnote b	
Administrative and Billeting Area	IBD <sup>c</sup> IBD <sup>c</sup>	IBD <sup>c</sup> IBD <sup>c</sup>	IBD <sup>c</sup> IBD <sup>c</sup>	IBD <sup>c</sup> IBD <sup>c</sup>	IBD <sup>c</sup> IBD <sup>c</sup>	
Boundaries	IBD <sup>c</sup> IBD <sup>c</sup>	IBD <sup>c</sup> IBD <sup>c</sup>	IBD <sup>c</sup> IBD <sup>c</sup>	IBD <sup>c</sup> IBD <sup>c</sup>	IBD <sup>c</sup> IBD <sup>c</sup>	
Manned Non-Explosive Support Facility	ILD Footnote b	ILD Footnote b	IBD <sup>c</sup> IBD <sup>c</sup>	ILD Footnote b	ILD Footnote b	
Unmanned Non-Explosive Support Facility	Not Required Footnote b	Not Required Footnote b	PTRD <sup>c</sup> PTRD <sup>c</sup>	Not Required Footnote b	Not Required Footnote b	
AE Destruction Area	Footnote d →					
a	The distance criteria in the upper half of each row are the minimum separation distances required by Volumes 3, 4, and 5. The distance criteria in the lower half of each row are the asset preservation distances.					
b	1. For HD 1.1 material, use one of these equations: <u>English EQNs (W in lbs, d in ft)</u> $d = 24 * W^{1/3}$ EQN V6.E3.T3-1 $d = 30 * W^{1/3}$ EQN V6.E3.T3-2 <u>Metric EQNs (Q in kg, d in m)</u> $d = 9.52 * Q^{1/3}$ EQN V6.E3.T3-3 $d = 11.90 * Q^{1/3}$ EQN V6.E3.T3-4 2. For HD 1.2, 1.3, or 1.4, apply PTRD from Volumes 3, 4 and 5.					
c	Includes minimum fragment distance.					
d	IAW Volume 5, Enclosure 3.					

V6.E3.4.3.4. Commercial Intermodal Containers. Containers used for transporting AE may be used for AE storage and shall be sited as AGMs.

V6.E3.4.4. FARP. Storing AE and fuel at the same location is inherently hazardous and should be avoided when possible. If it is necessary to refuel and rearm aircraft at the same location, all precautions must be made to minimize the hazards involved in these operations. Armament pads shall contain the minimum amount of AE to conduct efficient operations. For example, where armament pads support only one aircraft, that pad shall be restricted to the amount of ammunition necessary to rearm that aircraft. Required separations are:

V6.E3.4.4.1. Use K24 [9.52] for asset preservation between FARPs and other ESs.

V6.E3.4.4.2. FARPs shall be separated by IBD from all non-associated inhabited buildings.

V6.E3.4.4.3. AE-ready storage (i.e., AE staged to support the next load) shall be separated by AGM IMD from the armament pads with only armament pads considered as the PES. Ready AE storage structures and locations shall be separated from other ready AE storage structures and locations by AGM IMD.

V6.E3.4.4.4. Build-up locations shall be separated by AGM IMD from all other explosives storage and operations with only the build-up locations considered as the PES.

V6.E3.4.4.5. Distances prescribed by the owning DoD Component shall separate other support structures and sites.

V6.E3.4.4.6. AE shall be separated from operational fuel supplies by at least 100 ft [30.5 m]. Fuel supplies shall be diked or placed downhill from AE.

V6.E3.4.5. Airfield Operations. Special consideration must be given to phased plans where the peacetime operation and positioning of aircraft transitions to contingency operations with increased quantities and use of AE. Exposures given adequate protection under the peacetime phase may be at greater risk during the contingency phase. Commanders must consider these changes when approving these plans. The proper use of such features as barricades or earth-filled, steel-bin-type barricades (ARMCO, Inc., revetment or equivalent (see section V2.E5.4.)) can decrease the magnitude of a potential event and increase the explosives capacity of limited areas.

V6.E3.4.5.1. Airfield QD Criteria for PESs. Table V6.E3.T4. provides criteria for airfield PESs.

V6.E3.4.5.2. Airfield QD Criteria for ESs

V6.E3.4.5.2.1. Runways, Taxiways, and Aircraft

V6.E3.4.5.2.1.1. For military use only, use Table V6.E3.T4.

V6.E3.4.5.2.1.2. For joint use, use criteria in Table V4.E3.T1.

V6.E3.4.5.2.2. Combat Aircraft Support Facilities

V6.E3.4.5.2.2.1. Unhardened combat aircraft support facilities shall be separated from AE storage and operating facilities by K30 [11.9]. For asset preservation, apply incremental K40 [15.87] to K50 [19.84] based on the NEWQD.

V6.E3.4.5.2.2.2. If these functions are located in a HAS, separation may be reduced to K18 [7.14] to the sides or rear of the HAS.

V6.E3.4.5.2.2.3. Other hardened facility sitings require DDESB approval.

V6.E3.4.5.2.2.4. When operational necessity dictates, separation distances less than K18 [7.14] may be approved for ESs; however, it must be demonstrated that protection equivalent to K18 [7.14] is being provided.

V6.E3.4.6. Static Missile Battery Separation. To ensure optimal effectiveness, offensive and defensive missile batteries many times must be deployed in a static (non-mobile) role in the proximity of other AE operations such as field storage or flight lines. These criteria apply to deployed static missile batteries and associated support functions:

V6.E3.4.6.1. IMD (K11 [4.36]) shall be maintained between missile launchers, reloads, and other AE storage locations to include parked AE-loaded aircraft.

V6.E3.4.6.2. Missile batteries deployed within the IBD of AE storage areas may be sited at K18 [7.14] to manned functions considered related to area AE operations. Likewise, missile batteries deployed in the clear zones of flight-line operations may be sited at K18 [7.14] to manned flight-line facilities.

V6.E3.4.6.3. Those functions solely providing support to static missile units, such as motor pools, may be sited at K18 [7.14] to batteries and other AE activities when the missile battery is located in these areas. For asset preservation, use PTRD.

V6.E3.4.6.4. No separation is required between missile batteries and the security force structures exclusively supporting them.

V6.E3.4.7. Emergency Destruction. When it becomes necessary to destroy stores of AE to prevent them from falling to the enemy, care must be taken to ensure that assets otherwise not in danger of falling to the enemy are not destroyed by blast or fragments. The DoD Components shall develop specific guidance for implementing and training for emergency destruction of munitions. Normal disposal operations shall be conducted IAW Volume 5, Enclosure 3.

V6.E3.4.8. Separation from Fuel

V6.E3.4.8.1. Operational Storage. Quantities up to 500 gallons [1,893 liters] shall be separated from each PES by at least 50 ft [15.24 m]. Quantities between 500 to 5,000 gallons [1,893 to 18,927 liters] shall be separated from each PES by at least 100 ft [30.5 m]. Fuel should be located downhill and diked to contain a possible fuel spill.

V6.E3.4.8.2. Bulk Fuel Storage. For more than 5,000 gallons [18,927 liters] apply section V4.E5.13.

Table V6.E3.T4. QD for Contingency, Combat, and MOOTW Airfields

From → To ↓	Airfield PES	
	Minimum Separation Distance	Asset Preservation Distance
Manned functions not related to the combat mission	IBD	IBD
Base boundaries without an easement unless manifestly unsuitable	IBD	IBD
Crew support and billeting areas	IBD	IBD
Central airfield support facilities	ILD	Footnote a
Functions related to the explosives mission (manned)	ILD	Footnotes a, b
Flight-line fire and rescue services	ILD	Footnote a
Manned munitions operating locations (assembly, maintenance, refurbishment, etc.)	ILD	Footnote a
Any other explosives-loaded aircraft or CAPA	IMD	Footnotes a, b
Flight-line munitions holding area	IMD	Footnotes a, b
Military use runways and taxiways	$D = 4.5 * NEWQD^{1/3}$ $[D = 1.79 * NEWQD^{1/3}]$	Footnotes a, b
a	1. For HD 1.1 material, use one of the following equations: <u>English EQNs (W in lbs, d in ft)</u> $d = 24 * W^{1/3}$ EQN V6.E3.T4-1 $d = 30 * W^{1/3}$ EQN V6.E3.T4-2 <u>Metric EQNs (Q in kg, d in m)</u> $d = 9.52 * Q^{1/3}$ EQN V6.E3.T4-3 $d = 11.90 * Q^{1/3}$ EQN V6.E3.T4-4 For HD 1.2, 1.3, or 1.4, apply PTRD from Volumes 3, 4 and 5.	
b	For aircraft, asset preservation distances may not provide protection from fragments. To protect against low-angle, high-energy fragments, aircraft should be barricaded.	

ENCLOSURE 4

TOXIC CHEMICAL MUNITIONS AND AGENTS

V6.E4.1. SCOPE AND APPLICATION

V6.E4.1.1. This enclosure sets forth standards for protecting workers and the general public from the harmful effects of toxic chemical munitions and agents associated with research, testing, training, preservation and maintenance operations, storage, and demilitarization at laboratories, manufacturing plants, and depots as well as other DoD Component agent operations, exclusive of combat training and operations. They apply to:

V6.E4.1.1.1. Blister Agents. Examples include, but are not limited to:

V6.E4.1.1.1.1. H/HD – 2,2' Dichlorodiethyl Sulfide (common name is distilled mustard).

V6.E4.1.1.1.2. H/HT – 60 percent HD and 40 percent 2,2' Dichloroethylthiodiethyl Ether (common name is mustard-T mixture).

V6.E4.1.1.1.3. L – Dichloro (2-chlorovinyl) Arsine (common name is lewisite).

V6.E4.1.1.2. Nerve Agents. Examples include, but are not limited to:

V6.E4.1.1.2.1. GB – Isopropyl Methylphosphonofluoridate (common name is sarin).

V6.E4.1.1.2.2. GA – Dimethylaminoethoxy-Cyanophosphine Oxide (common name is tabun).

V6.E4.1.1.2.3. VX – 0-ethyl S-[2-(diisopropylamino) Ethyl] Methylphosphonothioate.

V6.E4.1.1.2.4. GD – Pinacolyl Methylphosphonofluoridate (common name is soman).

V6.E4.1.1.2.5. Mixtures of these agents.

V6.E4.1.2. Toxic chemical munitions may present additional hazards of blast, fragments, and thermal effects. Standards relating to these explosives hazards are addressed in other enclosures of this Volume, as well as other volumes of this Manual.

V6.E4.1.3. This Manual does not apply to the immediate disposal of toxic chemical munitions or decontamination of toxic CAs during an emergency when the delay will cause a greater danger to human life or health.



V6.E4.1.4. The DoD Components are responsible for developing implementing instructions and safety procedures for logistical movements, training, and field operations.

V6.E4.1.5. The requirements of Military Standard MIL-STD-882D (Reference (d)) shall be followed.

#### V6.E4.2. SITING CRITERIA

V6.E4.2.1. Hazard Distance Calculations. (See the definition of “public exclusion distance” in the Volume 8 Glossary). Hazard distance calculations shall conform to DDESB Technical Paper 10 (Reference (e)). DDESB approved software (e.g., as provided in U.S. Army Chemical Research Development and Engineering Center publication (Reference (f))) that implements the methodology of Reference (e) may be used to perform these calculations. The calculated hazard distance is based on the greater of the maximum credible event (MCE) or the toxic CA MCE and is bounded by the one percent lethality arc for a toxic CA source containing a dose of more than:

V6.E4.2.1.1. 10.0 milligram-minute(mg-min)/cubic meter (m<sup>3</sup>) of GB.

V6.E4.2.1.2. 4.3 mg-min/m<sup>3</sup> of VX.

V6.E4.2.1.3. 150.0 mg-min/m<sup>3</sup> of mustards.

V6.E4.2.1.4. 0.1 milligram (mg) for inhalation-deposition of VX.

V6.E4.2.2. Personnel Control. Positive means shall be taken to ensure that unprotected personnel do not enter hazard zones and shall include written procedures that must be reviewed and updated, as necessary. However, positive control of an area, which ensures personnel can evacuate or be protected before exposure in the case of an accident, may be developed instead of absolute exclusion. Details of such control procedures shall be included in the site and general construction plans.

V6.E4.3. WORKPLACE AIRBORNE EXPOSURE LIMIT (AEL). The Army Surgeon General establishes the maximum permissible concentrations (AELs) listed in Table V6.E4.T45. AELs are time-weighted averages (TWAs) or ceiling values that define the permissible limits of exposure for unprotected personnel.

Table V6.E4.T15. AELs

Exposure Limit	CA (mg/m <sup>3</sup> )				
	GD	GA/GB	VX	H/HD & H/HT	L <sup>a</sup>
Unmasked Agent Worker					
8-hour TWA in any work shift	$3 \times 10^{-5}$	$1 \times 10^{-4}$	$1 \times 10^{-5}$	$3 \times 10^{-3}$ (Footnote b)	$3 \times 10^{-3}$ (Footnote b)
Non-Agent Worker and General Population					
72-hour TWA	$3 \times 10^{-6}$	$3 \times 10^{-6}$	$3 \times 10^{-6}$	$1 \times 10^{-4}$ (Footnote c)	$3 \times 10^{-3}$ (Footnote b)
Ceiling Value <sup>d</sup>	$3 \times 10^{-5}$	$1 \times 10^{-4}$	$1 \times 10^{-5}$	$3 \times 10^{-3}$ (Footnote b)	$3 \times 10^{-3}$ (Footnote b)
Source Emission Limit					
1-hour TWA	$1 \times 10^{-4}$	$3 \times 10^{-4}$	$3 \times 10^{-4}$	$3 \times 10^{-2}$	$3 \times 10^{-2}$
a	All concentrations measured as lewisite.				
b	This value also represents the technologically feasible real-time detection limit. HT is measured as HD.				
c	It is recommended that this level of detection (using a 12-hour sampling time) be demonstrated and used at all sites where mustard shall be transported and destroyed.				
d	The concentration of CA that may not be exceeded for any period of time. Practically, it may be an average value over the minimum time to detect the specified concentration.				

#### V6.E4.4. TOXIC CA HAZARD ANALYSES, MEASUREMENTS, AND EXPOSURE CONTROLS

##### V6.E4.4.1. Hazard Analyses

V6.E4.4.1.1. Hazard analyses shall be conducted for all new operations involving toxic CAs or when there is a change in existing production, process, or control measures that may result in an increase in airborne or contact concentrations of toxic CAs. Hazard analyses shall be retained for 40 years.

V6.E4.4.1.2. If hazard analyses indicate that an operation may expose personnel to toxic CAs above the AEL, control measures shall be instituted and procedures shall be established so that the actual exposure is measured.

##### V6.E4.4.2. Measurements

V6.E4.4.2.1. Devices for sampling and analyzing workplace air shall measure and alarm within 10 minutes when toxic CAs are present in excess of the 8-hour TWA concentrations.

V6.E4.4.2.2. When the interior of reservoirs, pipes, and such systems are sampled, the volume of the item or system being sampled as well as the volume of the sample must be recorded and associated with the measured concentrations.

V6.E4.4.2.3. Decontaminating solutions shall not be analyzed for residual toxic CA for the purpose of certifying a level of decontamination. Suspected toxic CAs shall be extracted from samples with suitable solvents where analyses are required. Air may be an appropriate solvent for volatile agents.

V6.E4.4.3. Exposure Control

V6.E4.4.3.1. When exhaust systems are used to control exposure, measurements of system effectiveness such as static pressure shall be made at the start of each operation and at least every 3 months.

V6.E4.4.3.2. Before beginning toxic CA operations, the hazard zone associated with those operations shall be under positive control IAW paragraph V6.E4.2.2.

V6.E4.4.3.3. If personnel exposures will equal or exceed the applicable AEL, personnel shall be protected by personal protective equipment (PPE) specifically approved by the Army Surgeon General or as indicated in Table V6.E4.T~~26~~.

V6.E4.4.3.4. Procedures shall be developed to address hazards involved in maintenance and repair operations.

Table V6.E4.T26. PPE<sup>a</sup> and Employee Exposure Potential<sup>b</sup>

Occupational Scenario	Toxic CAs (mg/m <sup>3</sup> )				
	GD	GA/GB	VX	H/HD & H/HT	L
1. Unmasked agent worker					
A full facepiece, chemical canister, air purifying protective mask will be on hand for escape. (The M9, M17, or M40 series masks are acceptable for that purpose. Other masks certified as equivalent may be used.) <sup>c</sup>	3 x 10 <sup>-5</sup> (Footnote d)	1 x 10 <sup>-4</sup> (Footnote d)	1 x 10 <sup>-5</sup> (Footnote d)	3 x 10 <sup>-3</sup> (Footnote e)	3 x 10 <sup>-3</sup> (Footnote e)
2. Masked personnel in routine operations					
a. A National Institute of Occupational Safety and Health (NIOSH)-approved pressure demand full facepiece self-contained breathing apparatus (SCBA) or supplied air respirator with escape air cylinder may be used.	> 3 x 10 <sup>-5</sup> to 6 x 10 <sup>-2</sup>	> 1 x 10 <sup>-4</sup> to 2 x 10 <sup>-1</sup>	> 1 x 10 <sup>-5</sup> to 2 x 10 <sup>-2</sup>	3 x 10 <sup>-3</sup>	3 x 10 <sup>-3</sup>
b. Alternatively, a full facepiece, chemical canister, air purifying protective mask is acceptable for that purpose (i.e., M9, M17, or M40 series or other certified equivalent). <sup>c</sup>					
3. Personnel conducting emergency operations or operations in unknown but potentially high agent concentrations					
a. NIOSH-approved pressure demand full facepiece SCBA with protective ensemble. <sup>f, g</sup>					
b. During emergencies, the best available respiratory protection and personnel ensemble will be used. If protection in 3.a. is not available, use of a full facepiece, chemical canister, air purifying protective mask with hood is acceptable. Only the M9 or M40 series masks are acceptable. <sup>f, g</sup>	> 6 x 10 <sup>-2</sup>	> 2 x 10 <sup>-1</sup>	> 2 x 10 <sup>-2</sup>	> 3 x 10 <sup>-3</sup> (Footnote h)	> 3 x 10 <sup>-3</sup> (Footnote h)

Table V6.E4.T26. PPE<sup>a</sup> and Employee Exposure Potential,<sup>b</sup> Continued

a	Qualitatively fit all workers required to use respiratory protective devices. Quantitative fit testing may be performed using surrogate masks.
b	Employee exposure potential is based on an 8-hour TWA measurement. All values in this table are 8-hour TWAs unless otherwise noted. The TWA is the concentration to which workers may be repeatedly exposed, for a normal 8-hour workday and 40-hour workweek, day after day, without adverse effects. TWAs permit excursions above the limit provided they are compensated by equivalent excursions below the limit during the workday. Excursions above the TWA should be controlled even where the 8-hour TWA is within recommended limits.
c	Air-purifying masks may not be used in oxygen deficient atmospheres.
d	Determined by required continuous air monitoring.
e	This represents ceiling value determined by continuous real time monitoring (with alarm) at the 0.003 mg/m <sup>3</sup> level of detection. Respiratory protection must be immediately available in case concentration rises above 0.003 mg/m <sup>3</sup> . Engineering and work practice controls shall be used to limit employee exposure potential to the extent practical.
f	Examples of such protective ensembles include Toxicologic Agent Protective Ensemble, Self-Contained and the Demilitarization Protective Ensemble.
g	For emergency masked escape, a full facepiece, chemical canister, air-purifying protective mask (DoD Component-certified masks) is acceptable.
h	Because agents H and L are potential carcinogens, the highest level of respiratory and dermal protection shall be provided to all workers exposed. An air-purifying protective mask is not suitable for this purpose.

V6.E4.5. MEDICAL SURVEILLANCE. Before being assigned to toxic CA duties and on an annual basis thereafter, health assessments shall be provided for each employee to establish a baseline health record. Annual assessments shall be used to determine deviations from the baseline.

#### V6.E4.6. WORKER PPE

V6.E4.6.1. Positive engineering and administrative controls shall be incorporated in all operations involving toxic CAs to preclude or minimize the need for PPE.

V6.E4.6.2. A respiratory protection program shall be established in conformance with DoD Instruction 6055.1 and DoD Instruction 6055.05 (References (g) and (h)) for approved respiratory requirements. The wearer's face shall be clean-shaven to the extent that there is no interference of any facial hair growth with the sealing surfaces of the protective mask. Personnel with beards shall be denied access to agent storage and operating areas unless suitable emergency egress respirator(s) can be provided.

V6.E4.6.3. Personnel shall use PPE recommended by the hazard analysis. (See Table V6.E4.T26.)

V6.E4.7. ADMINISTRATIVE AND WORK PRACTICE CONTROLS

V6.E4.7.1. Containment

V6.E4.7.1.1. Containment is the principal control measure for prevention of exposure of personnel to toxic CAs.

V6.E4.7.1.1.1. Total containment is required for those operations involving toxic chemical munitions that contain explosive components when the operation may subject the explosives components to a potential initiating stimulus. Total containment requires the equipment or facility to be a DDESB-approved design capable of containing all the reaction gases, detectable toxic CAs, and fragments from the largest explosion or detonation that could occur without causing equipment or facility rupture or leakage. Operations requiring total containment include, but are not limited to:

V6.E4.7.1.1.1.1. Toxic chemical munition cutting, sawing, milling, drilling, punching, or shearing operations that require the machine tool to remove or displace metal before or after contact with the explosives.

V6.E4.7.1.1.1.2. Operations in which the toxic chemical munitions arming and functioning environments can be duplicated by the equipment or process.

V6.E4.7.1.1.1.3. Disassembly of armed or possibly armed toxic chemical munitions.

V6.E4.7.1.1.1.4. Disassembly of explosive components from toxic chemical munitions that requires application of significantly greater leverage or torque than that required for assembly.

V6.E4.7.1.1.2. Vapor containment is required for those operations involving toxic CAs without explosives components and for those operations involving toxic chemical munitions containing explosive components that do not subject the explosive components to a potential initiating stimulus. Vapor containment requires the equipment or facility to be a DDESB-approved design capable of containing non-explosion releases of toxic CAs. Operations requiring vapor containment include, but are not limited to:

V6.E4.7.1.1.2.1. Toxic chemical munitions punching, drilling, or sawing operations for removal of toxic CAs.

V6.E4.7.1.1.2.2. Burster-well removal.

V6.E4.7.1.1.2.3. Transfer of toxic CAs from bulk storage tanks, containers, or toxic chemical munitions into holding tanks, chemical detoxification reactors, incinerators, or similar processing equipment (e.g., may be found in a production, demilitarization, or disposal line).

V6.E4.7.1.1.2.4. Research, development, test, and evaluation chamber operations.

V6.E4.7.1.2. Containment is not required for operations associated with field storage and maintenance activities (e.g., shipping, storage, receiving, re-warehousing, minor maintenance, surveillance inspection, repair, and encapsulation).

V6.E4.7.2. Training and Information. Anyone who works with toxic chemical munitions and agents (e.g., agent workers, firefighters, and medical and security personnel) shall receive training to enable them to work safely and to understand the significance of toxic CA exposures. This training shall include, but is not limited to, information on sources of exposure, adverse health effects, practices and controls used to limit exposures, environmental issues, medical monitoring procedures, and employee responsibilities in health protection programs.

V6.E4.7.3. Recordkeeping. Recordkeeping pertaining to exposure determination and measurement, mechanical ventilation, employee training, medical surveillance, and access to records shall be consistent with Reference (h).

V6.E4.7.4. Labeling and Posting of Hazards

V6.E4.7.4.1. Signs and labels to warn personnel of hazards of toxic CAs are required for:

V6.E4.7.4.1.1. Work areas.

V6.E4.7.4.1.2. Contaminated clothing and equipment.

V6.E4.7.4.1.3. Identification of restricted-use areas.

V6.E4.7.4.2. When items or materials are contaminated or suspected of being contaminated with toxic CAs, they shall be marked as follows:

V6.E4.7.4.2.1. The applicable supplemental chemical hazard symbol (see Figure V1.E10.F34.) with “XXXXX” indicates that the items or materials have been completely decontaminated and may be released for general use or sold to the general public. Items or materials are completely decontaminated when they have been subjected to procedures that are known to completely degrade the toxic CA molecule, or when analyses, approved by the DDESB, have shown that the total quantity of toxic CA is less than the minimal health effects dosage as determined by the Office of the Surgeon General of the Army.

V6.E4.7.4.2.2. The applicable supplemental chemical hazard symbol (see Figure V1.E10.F34.) with “XXX” indicates that the items or materials have been decontaminated. Tests or monitoring shall be conducted IAW the DoD Component requirements to verify that concentrations do not exceed the AEL for an unmasked agent worker in Table V6.E4.T45.

V6.E4.7.4.2.3. The applicable supplemental chemical hazard symbol (see Figure V1.E10.F34.) with a single “X” indicates the items or materials have been partially

decontaminated of the indicated toxic CA. Further decontamination processes are required before the item is moved or any maintenance or repair is performed without the use of PPE.

V6.E4.7.4.3. When facilities or rooms are contaminated or suspected of being contaminated with toxic CAs, they shall be marked as follows (excluding magazines that use the supplemental chemical hazard symbols shown in Figure V1.E10.F34.):

V6.E4.7.4.3.1. 5R – No Agent Hazard. A supplemental chemical hazard symbol (see Figure V1.E10.F34.) with “RRRRR” indicates that all previously contaminated surfaces are decontaminated and analyzed to demonstrate the absence of residual toxic CAs, and air sampling indicates toxic CA vapor concentration is less than the 8-hour TWA for an unmasked agent worker (see Table V6.E4.T45.). The air is sampled at a temperature of 70 degrees Fahrenheit (°F) [21.1 degrees Celsius (°C)] or greater, with the facility’s ventilation system operating.

V6.E4.7.4.3.2. 4R – Controlled Agent Vapor Hazard. A supplemental chemical hazard symbol (see Figure V1.E10.F34.) with “RRRR” indicates that all previously contaminated surfaces are decontaminated using locally approved procedures and air sampling indicates toxic CA vapor concentration is less than the 8-hour TWA for an unmasked agent worker (see Table V6.E4.T45.). The air is sampled at a temperature of 70 °F [21.1 °C] or greater, with the facility’s ventilation system operating.

V6.E4.7.4.3.3. 3R – Contained Agent Hazard. A supplemental chemical hazard symbol (see Figure V1.E10.F34.) with “RRR” indicates that any toxic CAs are in containers or packaging that, if left undisturbed, will prevent agent vapor or contact hazards.

V6.E4.7.4.3.4. 2R – Agent Vapor Hazard. A supplemental chemical hazard symbol (see Figure V1.E10.F34.) with “RR” indicates that any toxic CAs are in containers or packaging that, if left undisturbed, prevent contact hazards.

V6.E4.7.4.3.5. 1R – Agent Hazard. A supplemental chemical hazard symbol (see Figure V1.E10.F34.) with “R” indicates the possibility of toxic CA contact or vapor hazards, or agents in a single container or packaging that may leak. This includes rooms being used for operations that may cause agents to be released from engineering controls due to accidental causes.

#### V6.E4.7.5. Emergencies

V6.E4.7.5.1. In case of an accidental release of a toxic CA that may result in personnel exposure, all nonessential and unprotected personnel shall evacuate immediately. Contaminated areas shall be decontaminated to applicable Table V6.E4.T45. AELs before normal operations are resumed.

V6.E4.7.5.2. Special medical surveillance shall be started within 24 hours for all personnel present in the potentially affected area at the time of the emergency.



V6.E4.7.5.3. The DoD Component shall maintain up-to-date chemical accident and incident control plans and conduct practice exercises of these plans at least annually.

V6.E4.7.6. Toxic CA Decontamination

V6.E4.7.6.1. When toxic CAs are spilled or released, immediate action shall be taken to contain the spill and clean up the agent in the immediate area of the spill.

V6.E4.7.6.2. Before leaving contaminated work areas, the external surfaces of the PPE shall be decontaminated.

V6.E4.7.6.3. When PPE becomes contaminated with toxic CAs, the outside layer of clothing shall be removed and decontaminated as soon as possible.

V6.E4.7.6.4. PPE that has been worn in known contaminated areas (toxic CA detected) shall be decontaminated and monitored before reuse. Because mustard penetrates into many protective materials with time, reuse of any PPE that has been contaminated with liquid mustard is not permitted. PPE that has been worn in potentially contaminated areas (when no agent leakage has been visually observed or detected by use of field detection equipment) shall be monitored before being moved to areas accessible to non-agent workers.

V6.E4.7.6.5. Monitoring of protective clothing and equipment shall include containerization at 70 °F [21.1 °C] or higher for at least 4 hours, with subsequent analysis of a portion of the interior atmosphere of the container for the toxic CA. The volume of the container as well as the sample volume must be noted.

V6.E4.7.6.6. PPE found to emit toxic CA concentrations above the XXX level after decontamination shall not be reused. It shall be disposed of IAW the DoD Component guidance and in compliance with all Federal, State, and local requirements.

V6.E4.7.6.7. Before toxic CA disposal systems are converted to different agents, the piping, tanks, etc. of the disposal systems shall be filled with decontaminating solution and a contact time of 10 half lives or greater shall be provided. Walls and floors of process areas shall be decontaminated to ensure the absence of contact hazards.

V6.E4.7.7. Recertification of Protective Clothing. After decontamination, clothing that has been determined to be XXX may be laundered, visually examined, and recertified by the DoD Component for use. Other PPE, such as boots and gloves, shall be tested, laundered, and recertified for use in the same manner.

V6.E4.7.8. Transportation of Items or Materials Contaminated with Toxic CAs. Items or materials contaminated with toxic CAs may be transported from one location to another. They shall be encapsulated within an agent-tight barrier. In addition, the following shall be overpacked in compatibly lined drums or provided with other suitably tested containment before being transported:

V6.E4.7.8.1. Items or materials potentially contaminated with liquid toxic CA.

V6.E4.7.8.2. Items or materials that fail a XXX determination.

V6.E4.7.8.3. Items or materials suspected of offering hazards due to skin exposure to a toxic CA.

V6.E4.7.9. Transportation of Toxic Chemical Munitions and Bulk Agents. The requirements established by the DoD Component shall be met.

V6.E4.8. ENGINEERING DESIGN GUIDANCE FOR FACILITIES. The chemical handling and maintenance areas associated with industrial operations shall be isolated from the main facility and shall be operated at a negative pressure with respect to the main facility area. The agent handling rooms shall be equipped with local exhaust ventilation that may be cascaded to more contaminated areas and exhausted out of a common exhaust stack. All air leaving the facility shall be filtered through redundant filter banks or other DDESB-approved decontamination methods. The flow of air (negative pressures) shall go from less-hazardous areas to more-hazardous areas.

V6.E4.8.1. Air Ventilation Systems. Air ventilation systems shall be designed and periodically tested to ensure that control of toxic CA-contaminated exhaust shall not exceed source emission limits of Table V6.E4.T+5.

V6.E4.8.1.1. Filters or scrubbers for exhaust air shall be designed and approved for the MCE of the operations involved.

V6.E4.8.1.2. Redundant filters shall be used when filter breakthrough of the toxic CA is expected. Filters shall be changed when agent breaks through the filter that is just upstream of the last filter.

V6.E4.8.1.3. All exhaust equipment shall have backup blowers that automatically engage if the main blower fails.

V6.E4.8.1.4. Filter systems shall be fitted with the means to measure the pressure drop across the filters.

V6.E4.8.1.5. Exhaust hoods and glove boxes shall be designed to contain toxic CAs so that concentrations specified in Table V6.E4.T+5. for unmasked agent workers are not exceeded outside engineering controls. The design of these items shall permit airflow adjustments sufficient to maintain the required protection level when laboratory equipment is in place.

V6.E4.8.1.5.1. Catch basins and traps or spill trays of sufficient capacity to contain the quantity of toxic CA involved shall be provided within hoods and glove boxes.

V6.E4.8.1.5.2. Glove boxes shall be used when the hazards analysis indicates that toxic CA aerosols or dusts may be present during an operation.

V6.E4.8.1.6. Special design features shall be used when exposed explosives are involved to segregate explosives from air ventilation systems.

#### V6.E4.8.2. Mechanical and Utilities Design for Facilities

V6.E4.8.2.1. The design parameters shall consider equipment and process layout, makeup airflow, and operational positions with regard to maintaining flow balance and cross currents. The system shall maintain negative pressure in operating areas in relation to hallways, offices, and other nontoxic CA areas.

V6.E4.8.2.2. Working surfaces, walls, floors, and ceilings within a facility likely to be contaminated shall be constructed of agent-resistant materials. Flooring material shall cover wall surfaces to a height of 6 inches [15.2 centimeters].

V6.E4.8.2.3. Access to nontoxic CA areas (e.g., utilities, mechanical rooms, etc.) shall be accomplished without entry into toxic CA areas.

V6.E4.8.2.4. Electrical systems shall be equipped with a backup power source designed to start automatically and supply sufficient power to support critical functions in the event of power outage.

V6.E4.8.2.5. Safety showers and eyewash fountains shall be readily accessible and tested.

V6.E4.8.2.6. Water outlets in a toxic CA operational facility shall be fitted with backflow devices.

V6.E4.8.2.7. Dedicated liquid waste systems shall be designed to collect and hold potentially toxic CA-contaminated effluent produced by the activity until disposal IAW applicable laws. Vents or other openings in the waste system shall be fitted with approved toxic CA filters or connected or exhausted to facility toxic CA air filtration system.

V6.E4.8.2.8. Decontamination facilities of sufficient capacity to catch and contain liquid effluents shall be provided for toxic CA operations. Adequate decontamination solution shall be available for immediate use on personnel or on facilities.

V6.E4.8.2.9. When operations require work assignments to be conducted at exposure levels above or potentially above the AEL for unmasked agent workers (see Table V6.E4.T15.), change facilities with showers shall be provided.

#### V6.E4.8.3. General Design Considerations

V6.E4.8.3.1. Facility Alarms and Monitors for Engineering Systems. Each toxic CA facility shall have a master alarm and control panel that will permit functional verification of the exhaust blowers and air handlers. Visual and audible alert alarms shall be keyed to this master alarm panel to indicate failures.

V6.E4.8.3.2. Fire Detection and Protection. Fire detection and protection systems for production and maintenance facilities shall comply with the requirements and guidelines in U.S. Army Armament and Research Development Command publication (Reference (i)).

V6.E4.8.3.3. Bulk Storage Tanks. Impermeable dikes to hold at least 110 percent of the tank capacity, plus the required volume of decontaminant solution, shall be placed around all bulk agent tanks, reactors, and mixers. However, a system designed to pump the toxic CA from the dikes to a vessel designed to accommodate the decontamination will satisfy this requirement that the dike contain sufficient volume for the decontaminating solutions.

V6.E4.8.3.4. Isolation of Facility Functions. Toxic CA facilities shall be designed to isolate unrelated activities by physical barriers or approved engineering controls. Design criteria shall prevent explosives from entering drain lines and sumps containing toxic CAs.

V6.E4.8.3.5. Monitoring. Air monitoring stations shall be established around toxic CA operational areas and storage areas to determine if Table V6.E4.T-5 AELs are exceeded. In laboratory environments, this requirement is met by routine area monitors and stack sampling.

V6.E4.8.3.5.1. Monitoring analyses conducted for the purpose of demonstrating compliance with AELs shall be based on DoD Component-certified reference materials.

V6.E4.8.3.5.2. Monitoring analyses conducted for the purpose demonstrating compliance with AELs shall be conducted under quality assurance plans that address the:

V6.E4.8.3.5.2.1. Production, characterization, and storage of DoD Component-certified reference materials.

V6.E4.8.3.5.2.2. Documentation of precision, accuracy, and quantification limits of analytical methodology.

V6.E4.8.3.5.2.3. External oversight of laboratory results.

ENCLOSURE 5

RISK-BASED SITING

V6.E5.1. SCOPE. This enclosure provides guidance and minimum requirements for quantitative risk-based siting. It provides the basis for quantifying the risks from a PES to personnel at each exposed ES (individual risk (probability of fatality ( $P_f$ ))) and at all exposed ESs (group risk (expected fatalities ( $E_f$ ))) by performing a quantitative risk assessment when the QD criteria of this Manual cannot be met. Procedures are provided for preparing, submitting, and periodically reviewing risk-based site plans.

V6.E5.2. RISK-BASED SITING TOOL

V6.E5.2.1. Safety Assessment for Explosives Risk (SAFER<sup>®</sup>) is a DDESB-approved software code (tool) for conducting risk-based explosives safety siting (DDESB Technical Paper 19 (Reference (j))). A detailed description of the approved risk and analysis approach and methodology (model) implemented in SAFER<sup>®</sup> is given in DDESB Technical Paper 14 (Reference (k)).

V6.E5.2.2. The approved model for risk-based siting (Reference (k)) provides risk estimates for individual and group risks.

V6.E5.2.2.1.  $P_f$  is a function of the probability of an explosives event, the probability of fatality given an event and exposure, and the exposure of one person.

V6.E5.2.2.2.  $E_f$  is a function of the probability of an explosives event, the probability of fatality given an event and exposure, and the exposure of all persons within the risk-based evaluation distance.

V6.E5.2.2.3. The approved model treats those risk estimates as statistical distributions.

V6.E5.2.3. The approved model is only applicable if all PESs are separated by IMD IAW this Manual, or the individual NEWQDs for each PES are summed and treated as a single PES.

V6.E5.3. RISK-BASED SITE PLANNING REQUIREMENTS. A risk-based explosives safety site plan submitted to the DDESB for approval must satisfy these conditions:

V6.E5.3.1. Have in place a current QD waiver, exemption, or Secretarial Certification, or an approved justification for the proposed siting. In the latter case, the DoD Component shall determine procedures for approving the justification. The DoD Component-approved justification shall be provided with the risk-based explosives safety site plan; this justification is provided for information purposes only and is not subject to DDESB approval.

V6.E5.3.2. Use the latest approved version of the SAFER<sup>®</sup> code or equivalent DDESB-approved analysis tools for risk-based explosives safety site plan assessments. (See section V6.E5.7. for requirements for equivalent analysis tools.) The DoD Components may submit explosives safety site plans to the DDESB for approval that were initiated under previous versions of SAFER<sup>®</sup> or the equivalent DDESB-approved analysis tool.

V6.E5.3.3. Evaluate all ESs within the ES group exposed by the PES (of the PES/ES pair not meeting QD separation criteria). The ES group contains those ESs out to a distance from the PES where contributions to  $P_f$  are no longer significant (i.e., out to the risk-based evaluation distance where  $P_f$  is equal to  $1 \times 10^{-8}$  for an individual present 24/7/365 in the open or IBD, whichever is greater).

V6.E5.3.4. Determine  $P_f$  by summing the risks from all PESs that expose the ES to significant risk (i.e., from all PESs for which the ES is in the ES group exposed by the PES).

V6.E5.3.5. Evaluate ESs exposed to a new PES and include significant risks from all other PESs.

V6.E5.3.6. Determine group risk by summing all  $P_f$ , as explained in paragraph V6.E5.3.4., for all of the ESs within the ES group, as described in paragraph V6.E5.3.3.

V6.E5.3.7. Use (i.e., input) the full siting amount (NEWQD) and full yield.

V6.E5.3.8. Accept, as the DoD Component, the risks not evaluated by the DDESB-approved risk tool (i.e., risks to facilities, equipment, assets, and mission). This risk acceptance by the DoD Component does not address other violations of this Manual.

V6.E5.3.9. Ensure the results of the quantitative risk assessment satisfy the criteria of Table V6.E5.T+7.

Table V6.E5.T+7. Risk-Based Explosives Siting Acceptance Criteria

Risk to:	Criteria:
Any one related individual – Related $P_f$	$\leq 1 \times 10^{-4}$ per year
All related individuals – Related $E_f$	$\leq 1 \times 10^{-3}$ per year
Any one unrelated individual – Unrelated $P_f$	$\leq 1 \times 10^{-6}$ per year
All unrelated individuals – Unrelated $E_f$	$\leq 1 \times 10^{-5}$ per year

V6.E5.4. RISK-BASED EXPLOSIVES SAFETY SITE PLAN DOCUMENTATION REQUIREMENTS. Risk-based explosives safety site plans submitted to the DDESB for approval must include:

V6.E5.4.1. The DoD Component approved justification for not meeting QD. (See paragraph V6.E5.3.1.)

V6.E5.4.2. Explanation of assumptions made for the inputs in the DDESB-approved risk tool to define the situation to be analyzed.

V6.E5.4.3. Explanation of inputs used in the DDESB-approved risk tool.

V6.E5.4.4. Summary of results compared to the risk-based siting acceptance criteria IAW Table V6.E5.T+7.

V6.E5.4.5. Data required IAW paragraph V1.E5.1.3. (Site plan documentation is required.)

V6.E5.5. RISK-BASED EXPLOSIVES SAFETY SITE PLAN REVIEW REQUIREMENTS.  
DDESB-approved risk-based site plan reviews shall be conducted:

V6.E5.5.1. By the originating DoD Component a minimum of every 5 years to ensure that siting conditions have not changed. If conditions have not changed, this information shall be documented in the site plan files at the installation and at the DoD Component confirming the continued acceptable status of the site plan. If conditions have changed, paragraph V6.E5.5.2. shall be applied.

V6.E5.5.2. Whenever DDESB-approved siting assumptions and the risk-based program inputs change and those changes have a potential increase on individual or group risk, or if there is uncertainty as to what the risk impact will be. Examples of changes that might increase individual and group risk are adding additional personnel to an ES, adding a new ES, increasing NEWQD at a PES, adding a new PES, a change in PES mission, and changes in ES construction. In such cases, the existing risk-based explosives safety site plan shall be updated and re-evaluated to determine the risk impact of the changes using one of these methods:

V6.E5.5.2.1. If risk does not violate the acceptance criteria in Table V6.E5.T+7., a revised risk-based explosives safety site plan shall be prepared IAW the procedures in sections V6.E5.3. and V6.E5.4. and submitted to the DDESB for approval.

V6.E5.5.2.2. If risk does violate the acceptance criteria in Table V6.E5.T+7. but does not increase beyond the DDESB-approved risk-based siting criteria in effect at the time the explosives safety site plan was previously approved, a revised risk-based explosives safety site plan shall be prepared IAW the procedures in sections V6.E5.3. and V6.E5.4. and submitted to the DDESB for approval.

V6.E5.5.2.3. If the risk violates both the acceptance criteria in Table V6.E5.T+7. and the DDESB-approved risk-based siting acceptance criteria in effect at the time the explosives safety site plan was previously approved, the DDESB-approved risk-based siting is no longer valid, and the DDESB must be so notified.

V6.E5.6. QUANTITATIVE RISK MANAGEMENT COMPARATIVE ANALYSIS. It is recommended that a DDESB-approved risk-based assessment model be used for conducting comparative analyses for risk management purposes. (See paragraph V6.E5.3.2.)

V6.E5.7. EQUIVALENT RISK-BASED ANALYSIS TOOL. An equivalent risk-based analysis tool for use in risk-based siting must meet these requirements to be approved by the DDESB:

V6.E5.7.1. Address all applicable aspects of the approved risk-based model. (See Reference (k).)

V6.E5.7.2. Document all data sources used to develop the algorithms used in the model.

V6.E5.7.3. Provide software validation and verification results to the DDESB for an assessment and have the software certified by the DoD Information Technology Security Certification and Accreditation Process.

V6.E5.7.4. Provide the results of a peer review of the model to the DDESB for an assessment.



## GLOSSARY

ABBREVIATIONS AND ACRONYMS

AE	ammunition and explosives
AEL	airborne exposure limit
AGM	aboveground magazine
BLAHA	basic load ammunition holding area
BLSA	basic load storage area
°C	degrees Celsius
CA	chemical agent
CAPA	combat aircraft parking area
DDESB	Department of Defense Explosives Safety Board
DUSD(I&E)	Deputy Under Secretary of Defense for Installations and Environment
ECM	earth-covered magazine
E <sub>f</sub>	expected fatalities
EQN	equation
ES	exposed site
°F	degrees Fahrenheit
FARP	forward arming and refueling point
ft	foot or feet
GA	dimethylaminoethoxy-cyanophosphine oxide (common name is tabun) (nerve agent)
GB	isopropyl methylphosphonofluoridate (common name is sarin) (nerve agent)
GD	pinacolyl methylphosphonofluoridate (common name is soman) (nerve agent)
HAS	hardened aircraft shelter
HD	hazard division
H/HD	2,2' dichlorodiethyl sulfide (common name is distilled mustard) (blister agent)
H/HT	60% HD and 40% 2,2' dichloroethylthiodiethyl ether (common name is mustard-T mixture) (blister agent)
IAW	in accordance with
IBD	inhabited building distance
ILD	intra-line distance
IMD	intermagazine distance

JTF	Joint Task Force
kg	kilogram
kPa	kilopascal
L	dichloro (2-chlorovinyl) arsine (common name is lewisite) (blister agent)
lbs	pounds
m	meter
m <sup>3</sup>	cubic meter
MCE	maximum credible event
mg	milligram
mg-min	milligram-minute
MIL-STD	Military Standard
MOOTW	military operations other than war
NEWQD	net explosive weight for quantity-distance
NIOSH	National Institute of Occupational Safety and Health
PES	potential explosion site
P <sub>f</sub>	probability of fatality
PPE	personal protective equipment
psi	pounds per square inch
PTRD	public traffic route distance
QD	quantity-distance
SAFER <sup>®</sup>	Safety Assessment for Explosives Risk
SCBA	self-contained breathing apparatus
TWA	time-weighted average
USD(AT&L)	Under Secretary of Defense for Acquisition, Technology, and Logistics
VX	O-ethyl S-[2-(diisopropylamino) Ethyl] Methylphosphonothioate (nerve agent)