V2.E5.1.7.3.5. **(Added)(AF)** A memorandum from the submitting MAJCOM Civil Engineer, or Air Force Installation and Mission Support Center Detachment Commander, verifying that the protective construction design modifications comply with this manual and UFC 3-340-02 requirements. **(T-0).** Base verification upon a quality control review by a competent DoD blast design agency such as the Naval Facilities Engineering and Expeditionary Warfare Center or the U.S. Army Engineering and Support Center, Huntsville. AFSEC/SEWC will provide appropriate contact information upon request. Because both of these organizations operate on a cost reimbursable basis, projects must arrange payment for these organization's services.

V2.E5.1.8. (Added)(AF) New Protective Construction Designs. For a new protective construction design, the submitting MAJCOM must provide:

V2.E5.1.8.1. **(Added)(AF)** The criteria being met; a complete description of both the design's capabilities and the basis for the design, and the level of explosives safety protection level it affords.

V2.E5.1.8.2. **(Added)(AF)** The protective construction design and MAJCOM review data as stated in paragraph **V2.E5.1.7.3.**

V2.E5.1.8.3. **(Added)(AF)** Once approved, a standard protective construction design can be site-adapted, provided the conditions and limitations of the DDESB approval are met. The DDESB will document new standard approved protective construction designs in DDESB TP 15.

V2.E5.2. SPECIAL STRUCTURES. The DDESB has approved reduced QD for structures and containers listed in Table AP1-4. of DDESB Technical Paper 15.

V2.E5.3. AGMs. There are no DDESB construction criteria for AGM. However, such structures must meet the criteria of Enclosures **3** and **4** of this volume.

V2.E5.4. BARRICADES

V2.E5.4.1. General

V2.E5.4.1.1. Properly constructed and sited barricades and undisturbed natural earth have explosives safety applications for protecting against low-angle fragments and reducing shock overpressure loads very near the barricade. Barricades provide no protection against high-angle fragments or lobbed AE. If the barricade is destroyed in the process of providing protection, then secondary fragments from the destroyed barricade must also be considered as part of a hazards analysis.

V2.E5.4.1.2. To reduce hazards from high-velocity, low-angle fragments, the barricade must be placed between the PES and the ES so that the fragments of concern impact the barricade before the ES. The barricade must be thick enough to reduce fragment velocities to acceptable levels and high enough to intercept the ballistic trajectories of the fragments of concern.

V2.E5.4.1.3. A barricade placed between a PES and an ES interrupts the direct line-of-sight motion of the shock wave. If the barricade has sufficient dimensions and is located close enough to the ES, there may be significant reductions in shock loading to selected areas of the ES.

V2.E5.4.1.4. **(Added)(AF)** Barricades around the ES can be used to reduce minimum separations required by Table **V3.E3.T17.** or fragment distances from 1.2 munitions. Do so if tests or engineering analysis show the barrier will stop the low-angle, high-velocity fragments, and the building will provide protection from the high-angle fragments expected from the PES. The distance cannot be reduced below that required to provide adequate overpressure protection to the ES.

V2.E5.4.1.5. **(Added)(AF)** A secondary barricade at sites of mission-essential equipment and personnel (such as wing communications and trim pads) can provide some additional protection; however, high-angle, low-velocity fragments will still impact the ES.

V2.E5.4.1.6. **(Added)(AF)** Barricades meeting the requirements of paragraph **V2.E5.4.3.2.** may be modified by substituting a retaining wall for the slope on one side. The slope and thickness of the retaining wall (preferably of concrete) must ensure a wide enough top to hold the earth firmly in place.

V2.E5.4.2. Barricade Designs

V2.E5.4.2.1. DDESB-Approved Designs. Chapter 6 of DDESB Technical Paper 15 lists DDESB-approved designs and construction materials for barricades. Use of these designs and materials satisfies barricading criteria.

V2.E5.4.2.2. Alternate Barricade Designs. Alternate barricade designs (e.g., earth-filled steel bins) may be approved by the DDESB, provided that testing or analysis demonstrates their effectiveness in stopping high-velocity, low-angle fragments.

V2.E5.4.2.3. Barricade Size and Orientation to Prevent Prompt Propagation Due to High-Velocity, Low-Angle Fragments. The location, height, and length of a barricade to prevent prompt propagation due to high-velocity, low-angle fragments are determined in paragraphs **V2.E5.4.2.3.1.** through **V2.E5.4.2.3.3.**

V2.E5.4.2.3.1. Location. The barricade may be placed anywhere between the PES and the ES; however, placing it closer to either the PES or ES will provide slightly greater asset protection. For AE stacks of different height (elevation), the location determines the barricade's required height.

V2.E5.4.2.3.2. Height. To determine the required barricade height:

V2.E5.4.2.3.2.1. Establish a reference point at the top of the far edge of one of the two AE stacks between which the barricade is to be constructed. When both stacks are of equal height, the reference point may be established on either stack. If the tops of the two stacks are not of equal height (elevation), the reference point must be on the top of the lower stack, as

shown in Figure **V2.E5.F1.** To preclude building excessively high barricades between AE stacks of different height (elevation), the barricade should be located as close as possible to the lower stack.

V2.E5.4.2.3.2.2. Draw a line from the reference point to the highest point of the other stack. This line is the line-of-sight.

V2.E5.4.2.3.2.3. The barricade's height must be such that the entire width of the barricade crest is at least one ft [0.3 m] above the line-of-sight, as established in paragraph **V2.E5.4.2.3.2.2.** The barricade height must be measured at the time of construction and at intervals throughout the life of the barricade to ensure that the specified thickness and height of the barricade are maintained. If the specified thickness and height of the barricade are not maintained, the AE stack height must be reduced as necessary or the AE stacks must be sited again appropriately. Consideration should be given to making the barricade higher than required for safety purposes to account for accuracy of storage practices regarding AE stack heights, potential mission changes (requiring higher AE stacks), and barricade settling, erosion, etc., that could seriously degrade AE storage capability.

V2.E5.4.2.3.2.4. Where there is no acceptor stack at the ES, the height of the barricade is determined using the height of the highest personnel location (e.g., 6 ft [1.9 m] from highest personnel floor in ES) in place of the height of the acceptor stack in paragraphs **V2.E5.4.2.3.2.1.** through **V2.E5.4.2.3.2.3.**

V2.E5.4.2.3.3. Length. The barricade's length is determined in accordance with Figure **V2.E5.F1.**

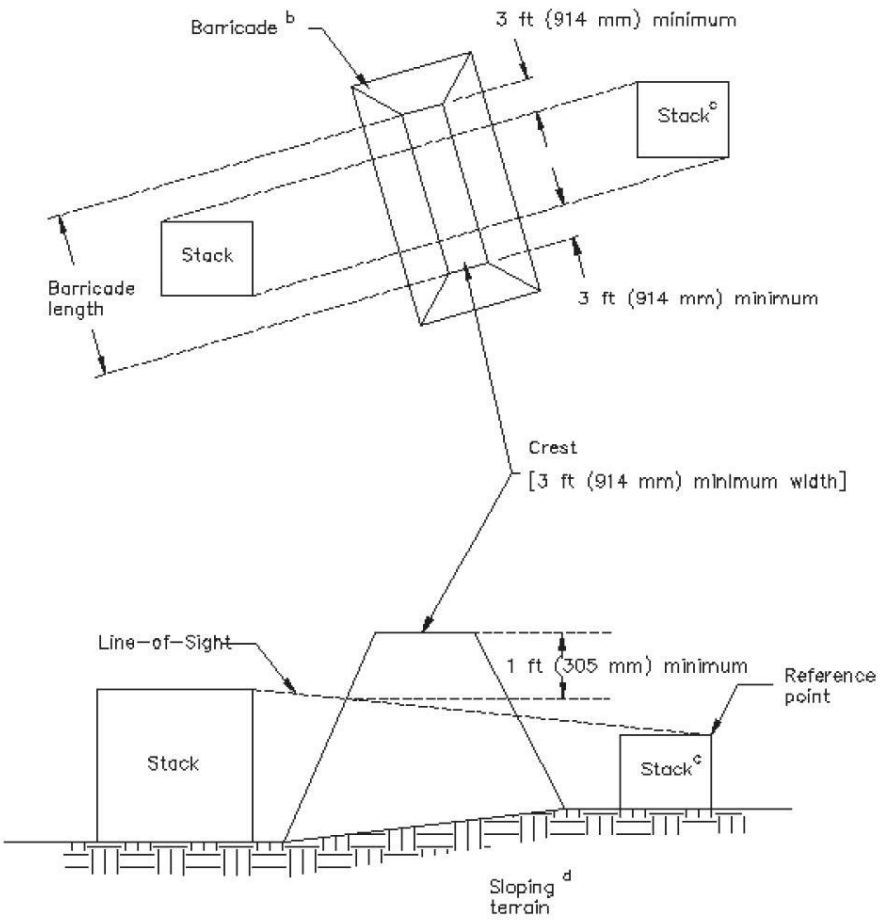
V2.E5.4.2.4. Barricade Size and Orientation for Protection Against Overpressure. General procedures to predict pressure mitigation versus barricade design and location have not been developed. However, based on direct-experimental work, the overpressure loading on a surface area shielded by a barricade is reduced by approximately 50 percent when these conditions are met:

V2.E5.4.2.4.1. Location. The barricade's standoff distance is within two barricade heights of the protected area.

V2.E5.4.2.4.2. Height. The top of the barricade is at least as high as the top of the protected area.

V2.E5.4.2.4.3. Length. The length of the barricade is at least two times the length of the protected area.

Figure V2.E5.F1. Determination of Barricade Length and Height to Prevent Prompt Propagation Due to High-Velocity, Low-Angle Fragments[a]



[a] See paragraph V2.E5.4.2.3.
[b] Barricade must meet construction and siting criteria of section V2.E5.4.
[c] See paragraph V2.E5.4.2.3.2.4.
[d] This illustration is for sloping terrain; however, a similar approach is used for level terrain.

V2.E5.4.3. Barricade Construction Materials

V2.E5.4.3.1. Materials for earthen barricades must be reasonably cohesive and free from harmful or toxic matter, trash, debris, and stones heavier than 10 pounds (lbs) [4.54 kilograms (kg)] or larger than 6 inches [152 millimeters (mm)] in diameter. The larger of acceptable stones must be limited to the lower center of fills. Earthen material must be compacted and prepared, as necessary, for structural integrity and erosion control. Solid or wet clay or similar types of soil must not be used in barricades because they are too cohesive. If it is impossible to use a

cohesive material (e.g., in sandy soil), the barricade must be finished with a suitable material (e.g., geotextiles, gunnite) that does not produce hazardous debris but ensures structural integrity.

V2.E5.4.3.2. The slope of an earthen barricade must be two horizontal to one vertical, unless erosion controls are used. Earthen barricades with slopes no greater than one and one half horizontal to one vertical that were approved before 1976 may continue to be used. However, renovations to these facilities must meet the two horizontal to one vertical slope criteria when feasible.

V2.E5.4.4. Portal Barricades for Underground Storage Facilities. Portal barricades allow reduction in IBD for underground magazines. Criteria for the location and construction of portal barricades are illustrated in Figure **V2.E5.F2.** and include:

V2.E5.4.4.1. Location. Portal barricades for entrances or exits must be located immediately in front of an outside entrance or exit to a tunnel leading to an explosives storage point. The portal barricade should be centered on the extended axis of the tunnel that passes through the portal and must be located a distance of not less than one and not more than three tunnel widths from the portal. The actual distance should be no greater than that required to allow passage of any vehicles or materials-handling equipment that may need to enter the tunnel, based on the turning radius and operating width of the vehicles or equipment.

V2.E5.4.4.2. Height. The height of the barricade, along its entire width, must be sufficient to intercept an angle of 10 degrees above the extended height of the tunnel.

V2.E5.4.4.3. Width and Length

V2.E5.4.4.3.1. The width of the central face typically equals the width of the tunnel at the portal.

V2.E5.4.4.3.2. The front face (i.e., the face toward the entry or exit) must be vertical and concave in plan view, consisting of a central face oriented perpendicular to the tunnel axis and wing walls.

V2.E5.4.4.3.3. The wing walls must be of sufficient width so that the entire barricade length intercepts an angle of 10 degrees (minimum) to the right and left of the extended tunnel width.

V2.E5.4.4.4. Construction. To withstand the impact of debris ejected from the tunnel, the front face (including wing walls) must be constructed of reinforced concrete, with a minimum thickness equal to 10 percent of the barricade height, but in no case less than 12 inches [30.5 centimeter]. The concrete wall must have a spread footing of sufficient width to prevent significant settlement. In addition, the central wall, wing walls, and footing must be structurally tied together to provide stability. The backfill behind the concrete wall may be composed of any fill material, to include rock rubble from the tunnel excavation, with a maximum particle size of 6 inches [15.2 centimeter] within the area extending out to 3 ft [0.9 m] from the rear face of the wall.