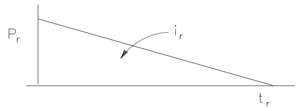
Peak blast pressure, P_r , in MPa
Duration of blast pressure, t_r, in milliseconds (ms)
Total Impulse, $i_r = P_r \cdot t_r/2$ MPa-ms
Allowable deflection shall be within elastic limits.
Door shall be designed to be fully operable after an incident in an adjacent storage chamber.
Door shall be designed for 100 percent rebound.
Dynamic increases of 10 percent may be used for material allowances.
Safety factor shall be 1.0.

d). Example of Triangular Pressure-Time Loading



d. Operations Support Systems

1). Ground Water Control Requirements. The drainage system required will depend on the design of the facility, its depth, ground water conditions, and the local surface hydrology. Ground water and surface hydrology surveys and investigations should be performed as part of the initial site investigations.

a). Leakwater control of storage chamber. A waterproofing system which does not permit leakage must be applied to storage chamber design. Recommended alternatives for water proofing include a concrete lining with water proof materials, construction of a waterproof inner structure, or installation of water proof plastic fabric liner. The space between the excavated rock surface and a water proof structure should be 0.6m minimum to allow inspection and maintenance of the structural walls and the liner.

b). Drainage System. Drainage from tunnels and storage chambers shall be by gutters, sloped 2% minimum and located at or near the base of tunnel or chamber walls. An open grating shall be installed over the gutter or, for larger gutters, the gutter volume may be filled with a coarse graded crushed rock. Drainage from these areas may require a sump and pump, depending of the location of the outlet end. See drainage gutter details on Sheet S-8.

2). Humidity Control Requirements. The relative humidity requirement in the storage chambers should be based on the ammunition and equipment being stored. The relative humidity level should be at 55% or less. The rise in the humidity level by inflow of outside humid air should be recovered within 24 hours by a central humidity control system, or separate control systems. A humidity sensor, which controls dehumidifier operation, must be placed in each chamber to continuously monitor the chamber air conditions.

3). Ventilation System. Design of a ventilation system should be based on applicable health and safety regulations for underground operations, on the overall facility layout, and the types of loading/unloading equipment and transportation vehicles that will operate in the facility. For a large storage facility, one or more vertical shafts to the surface may be required provide intake or exhaust ventilation paths.

a). Natural Ventilation. Two exits in opposite directions at different elevation levels can contribute to good natural ventilation.

b). Mechanical Ventilation. Types of ventilation systems that could be designed are ducts for air supply and exhaust, jet fan, concentrated exhaust shaft, etc. Any mechanical ventilation system to be used in the tunnel should be designed to allow a change of air flow direction in the case of an emergency.

4). Electrical Requirements. Minimum requirements are contained in Chapter 6 of reference DOD 6055.9-STD.

a). Lighting Fixtures. Lighting fixtures, i.e. sodium or metal halide lamps, should be designed for durability and ease of maintenance. All fixtures should be explosion-proof and fire resistant. The fixtures should be located as to not interfere with operation of equipment.

b). Illumination. Tunnels shall have adequate illumination for loading/unloading operations based on applicable regulations.

c). Emergency Exit Lighting System. Water proof emergency exit lights and/or signs should be located at 20-30m intervals and at turning points in all tunnels and chambers.

5). Fire Detection/Control Systems. Fire alarm and fire suppression systems must be designed to detect and alarm automatically. Systems installed in areas where dehumidifier systems are not available should have operating parts which are corrosion-resistant. Quantity and types of fire detectors, sprinklers, foam sprayers, etc., should be determined based on control area, installation height, and fire protection policies.

6). Construction Materials. Construction materials, including ventilation and utility ducts, to be used in ares where dehumidifier systems are not available, shall be corrosion resistant.

7). Finish of Rock Surface and Tunnel Floor. Rock surfaces should be reinforced by shotcrete or other appropriate methods to prevent damage to personnel, ammunition, or equipment by loose rock. Pavement materials of tunnel/adit floor should be carefully selected to minimize small particles/dust caused by transport vehicles and MHE.

US Army Corps of Engineers

Symbol	Description	Date	Approved	Symbol	Description	Date	Approved

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DEFINITIVE DRAWINGS
UNDERGROUND AMMUNITION STORAGE FACILITY
GENERAL NOTES

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G - 3
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