# Aqueous Foam for Explosive Containment

## Mitigating High Explosive Detonations

Sandia National Laboratories' Emergency Response Program has developed a practical and expedient method to mitigate high explosive (HE) detonations.

Primarily engineered to capture explosively dispersed aerosols (e.g., radioactive material associated with "dirty bombs"), aqueous foams also effectively reduce pressures from an HE blast. The resulting decrease in exposure to the population and contamination to downwind property can be dramatic.

## System Description

Fabric enclosures, which restrain the aqueous foam around a device, have been designed in various sizes to mitigate the effects of up to several hundred pounds of HE. Together with foam-generation equipment, the system has been packaged for deployment. A human-portable containment system exists and can be quickly deployed for smaller explosive charges.

Advantages of aqueous foam:

- Scrubs aerosolized particles
- Shock/blast wave mitigation
- Cloud buoyancy suppression
- Pressure attenuation
- Ease of emplacement

**Portable Containment System**

**Unmitigated Blast**

**Blast Mitigated with Aqueous Foam**

Using standard commercial foam generators, large volumes of foam can be generated quickly (950 to 2000 CFM). The foam flows readily, therefore requiring some sort of containment to confine the foam in a volume around the HE. Covering the HE with a layer of aqueous foam can substantially reduce aerosol dispersal as well as attenuate blast pressure and noise from the detonation.

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## Aqueous Foam Characteristics

- A cubic foot of water and surfactant creates 60 to 300 $ft^3$ foam.
- The surfactant was engineered for increased stability, so that only 10% water drainage will occur after 60 min. Thus, the mitigating benefits of the foam remain effective for several hours.

## Aerosol Capture

Water drops suspended in the foam are the key to effectively scrubbing the otherwise dispersed aerosols. Performing extensive experimental tests, Sandia National Laboratories developed an empirical relationship for determining the capture fraction of aqueous foams. For a defined HE mass, foam density (60-300:1) and thickness, the resulting capture fraction (i.e., fraction aerosol captured compared to an unmitigated dispersal) can be calculated.

## Blast Mitigation and Noise Abatement

Noise reduction is dependent upon the ratio of foam to explosive mass. A reduction of about 10 decibels (db) is achieved for 1.5 $m^3$ of foam per kilogram of TNT.

The peak overpressure of the blast wave within several hundred charge radii is decreased by more than an order of magnitude for foams having an expansion ratio 60-300:1.

The pictures below illustrate the blast damage mitigation benefits. For this test 100 lb of explosives were detonated approximately 30 feet from a van. The left picture shows the damage from the unmitigated blast, while the van on the right was relatively undamaged when a 25-foot thickness of aqueous foam was used.

**Unmitigated blast, left, and mitigated blast, right**

## Deployment Considerations

- Aqueous foams are electrically conducting
- Depending upon the size of the containment required, it takes labor time to implement and, therefore, people are at substantial risk of death or injury during the implementation
- Compromises to the render-safe and re-entry procedures should be considered

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