



AUSTRALIAN
DEFENCE FORCE



PARARI 2022

REVISION OF AUSTRALIAN DEFENCE BURNING AND DEMOLITION GROUND SITING CRITERIA

GPCAPT Matt Grant
Director, Ordnance Safety

&

WGCDR Gary Gibbs
Directorate of Ordnance Safety (RES)



Scope

- Introduction & Context
- DOS Review & Literature Survey
- Hazard Criteria
 - Fragmentation Criteria
 - Blast Criteria
 - Noise Criteria
 - Ground Shock Criteria
 - Thermal Radiation Criteria
- Development of Demolition Ground Boundary Criteria
- Development of Burning Ground Boundary Criteria



Introduction

The Australian Department of Defence (Defence) promulgates policy to control its obligations to legislative requirements. The general principles and practices associated with the storage, transport and handling of explosives in the Defence environment, many of these leveraged from the international community, are further defined within eDEOP101 *Department of Defence Explosives Regulations* (Commonwealth of Australia 2020).

During a desktop review of eDEOP101, the Directorate of Ordnance Safety (DOS) identified that Defence's approaches to Siting and Licencing Burning and Demolition Grounds (eDEOP101 Regulation 5.5) had not been reviewed for a significant time. This observation lead to a detailed activity aimed at updating eDEOP101, and this paper describes DOSs activity to revise Defence's criteria for siting Burning and Demolition Grounds, including the development of a simple formula for identifying Demolition Ground limits and considerations towards meeting Australian legislative obligations.

Context

- In the Australian context, Burning and Demolition Grounds are areas specifically designated for controlled disposal of explosives.
- A Burning Ground or Demolition Ground is not to be confused with a 'demolition range' (otherwise described as Ranges and Training Areas in Defence) that is an area used for the primary purpose of conducting demolition and operational Explosive Ordnance Disposal training.
- This means of disposal is mainly applicable when the item is damaged or otherwise non-repairable and breakdown is either hazardous or uneconomical.
- A Burning Ground is an area specifically set aside for disposal of explosives by burning only. Some explosives may be disposed of by burning with no risk of a mass detonation occurring, although some explosions will probably occur
- A Demolition Ground is an area specifically set aside for disposal of explosives by demolition. With this method of disposal, mass detonations are likely.

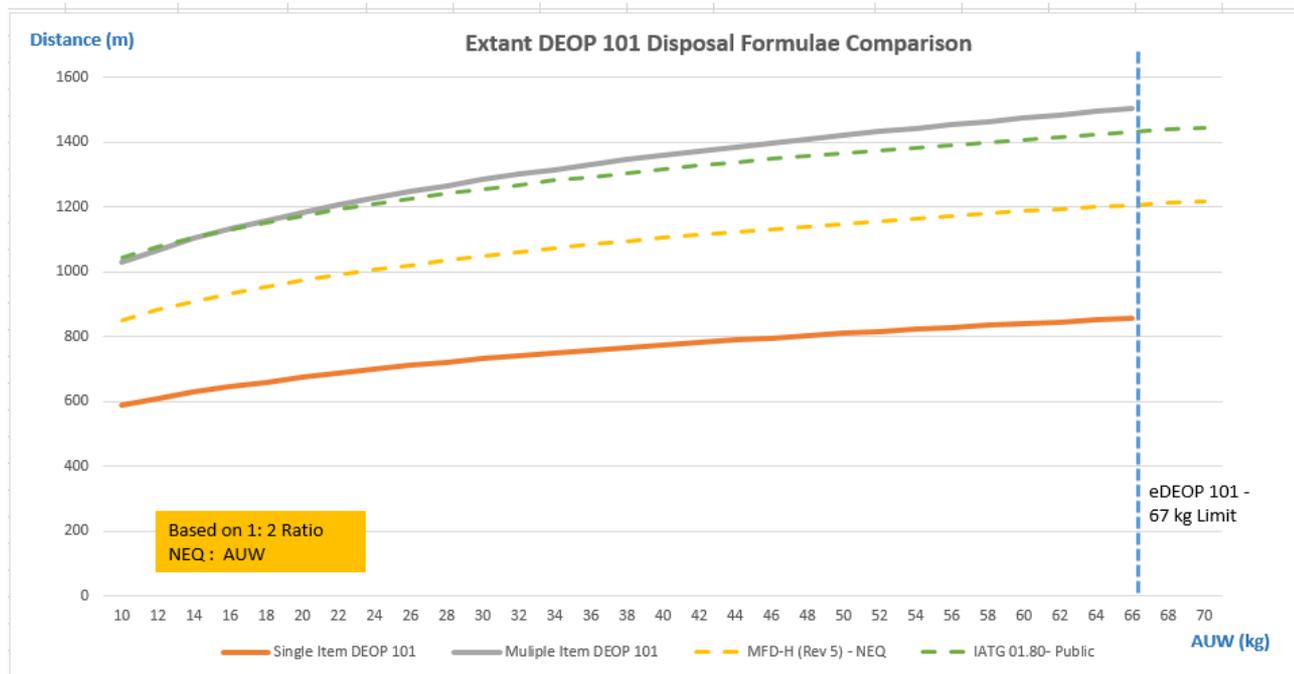
DOS Review

- DOS conducted a detailed review of its policy for Siting and Licensing Burning and Demolition Grounds (eDEOP101 Regulation 5.5) and identified that:
- **Understanding of Context.**
 - General lack of understanding as to the nature of Burning and Demolition Grounds
 - Relationship and difference with sites classified as Training Areas and Ranges
- **Hazard Safety Distance Formulae - Use.**
 - Promulgated formulae intended to ensure that there is a low probability of explosives effects departing the Burning/Demolition Ground Boundary, they were termed Hazard Safety Distance Formulae.
 - Language in policy ambiguous and formulae not used as intended
- **Hazard Safety Distance Formulae – Currency.**
 - The formulae used for Hazard Safety Distance Envelopes had not been reviewed for a significant time. DOS requested assistance from the NATO Munitions Safety Information Analysis Centre (MSIAC) which identified that the Australian formulae under-estimated the effects for some munitions (MSIAC 2021).



Hazards for Burning & Demolition Grounds

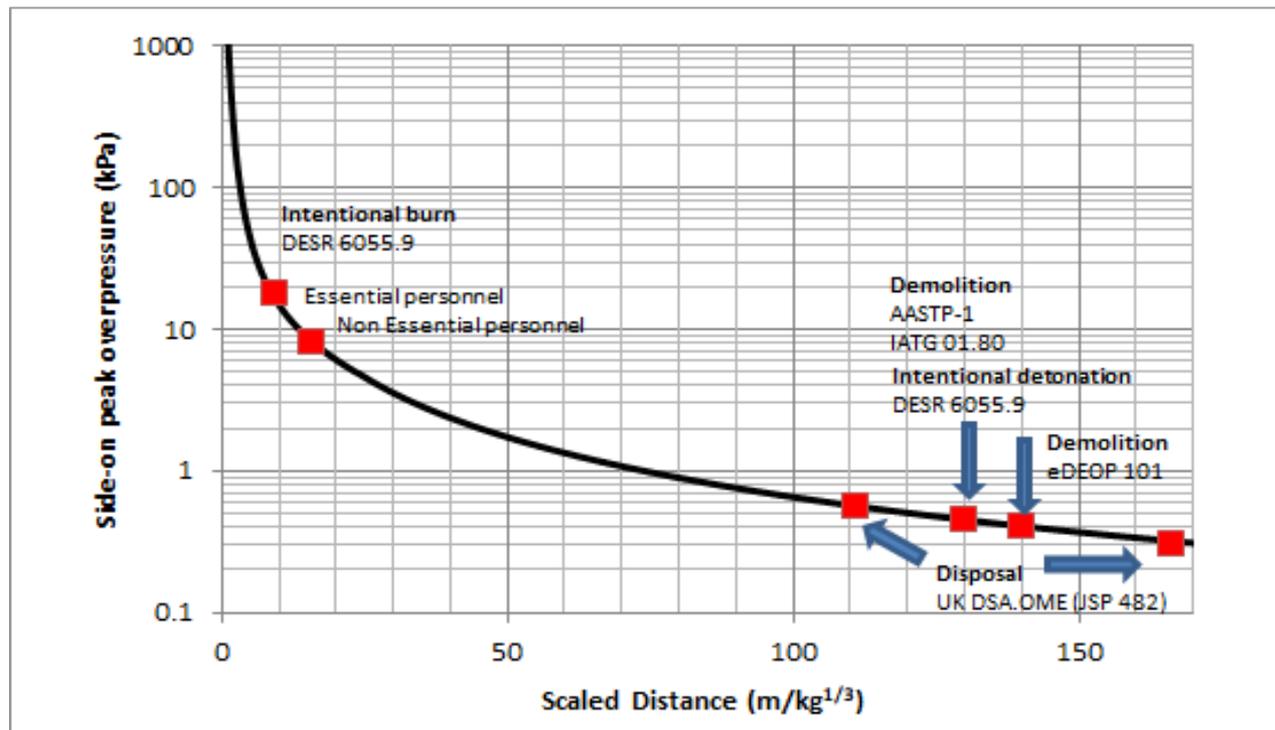
- Blast
- Fragmentation
- Noise
- Ground Shock
- Thermal Radiation



The chart shows Hazard Distances based on extant DEOP 101 policy compared to other international formulae

Blast Criteria

- When considering blast, MSIAC (2021) compared the existing Australian criteria against that of international practice using the US DDESB Blast Effects Calculator (below).
- Given the MSIAC analysis, the existing Australian criteria were deemed appropriate for retention by the authors and remained characterised as ‘window and dish rattle threshold’ (0.4kPa side-on peak overpressure).



Fragmentation Criteria

- Hazardous fragment distances were modelled upon either:
 - criteria such as the density of fragments having an impact energy of 79 Joules or greater being below 1 per 55.7m², or
 - the maximum distance that a 'predictable' fragment would travel.
 - the latter criteria selected as the most appropriate convention for intentional (rather than accidental) initiation of explosives.
- There are several schemas employing the selected criteria:
 - eDEOP101
 - US DDESB: TP-16
 - NATO: AASTP-1
 - United Nations: IATG 01.80 and TMNA Technical Note 10.20
- Catering for multiple items
 - The 33% multiplier from AASTP-1 for multiple item demolition was incorporated to cater for all demolition circumstances.

Noise Criteria

- Noise hazard distance is a subjective and based Sound Pressure Level (SPL) expressed in dB that would be expected at the boundary. The equation promulgated in IATG 01.80 was used to predict the SPL distance for 140dB.

$$D = 215 Q^{1/3}$$

Where D is the 140 db noise distance in m and Q is the total net explosives weight (NEW).

Ground Shock Criteria

- Demolitions are normally carried out far from buildings, power lines or pipelines, or from installations containing delicate electronic gear. If circumstances dictate the demolitions of mines or munitions must be carried out near such facilities, ground shock needs to be taken into account. For the purposes of determining hazard distances from ground shock a threshold of 10mm/s (sensitive site category) was used based upon AS2187.2-2006 criteria (50% probability of exceedance).

$$\text{Vector Peak Particle Velocity} = 1140(D / Q^{1/2})^{-1.6} \quad \text{..mm/s}$$

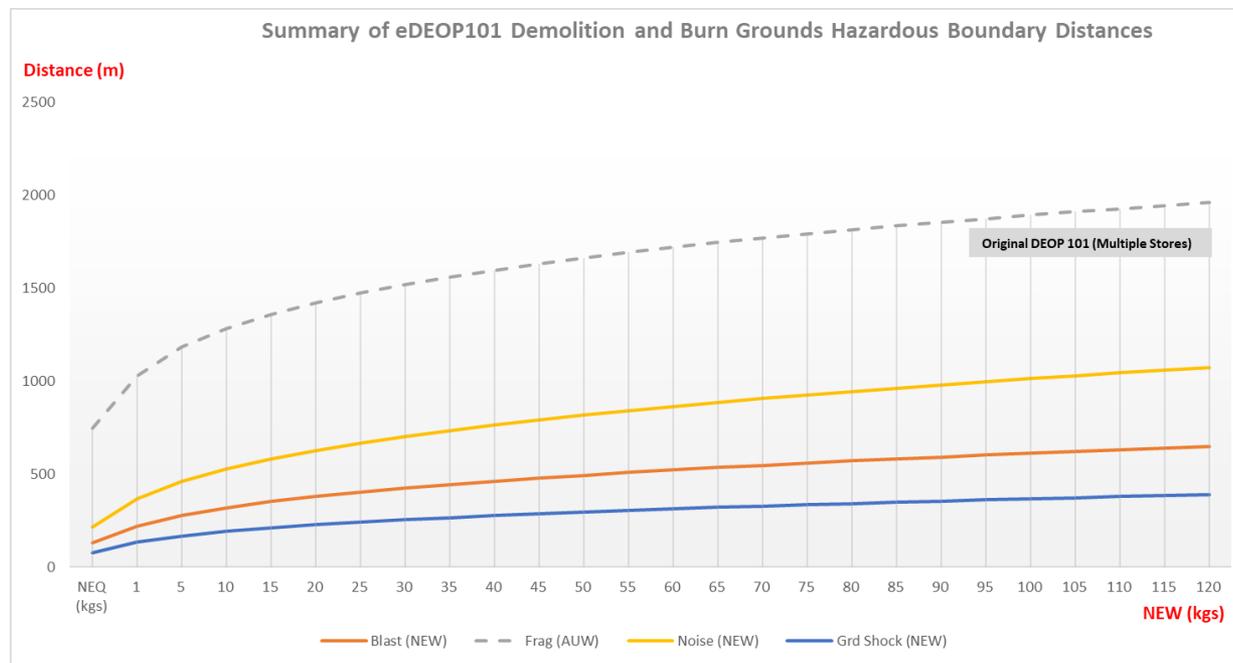
where Q is the TNT equivalent of the total mass of explosive, D is the boundary distance. Units in m and kgs.

Thermal Radiation Criteria

- Thermal Radiation was identified as a credible hazard only for open burning as blast and fragmentation would be the prevailing hazards for demolition.
- The hazard of thermal radiation is associated with thermal dose, which comprises of the radiation intensity (or thermal flux) and exposure duration, and in our context no pain or injury to personnel must be experienced at the Burning Ground boundary.
- Recent research compiled through MSIAC identifies that the hazard distances for storage of HD1.3 within AASTP-1 are conservative with respect to thermal dose, and as a result provide a good basis for identifying thermal effects criteria for disposal of munitions by burning.
- The Quantity Distance formula within AASTP-1 for HD 1.3 of $6.4Q^{1/3}$ (D4) anticipates that occupants of traditional types of inhabited buildings would not suffer injury unless standing in front of windows; such people and others in the open are likely to experience reddening of any skin areas.

Demolition Ground Boundary Criteria

- The authors commenced consideration for Demolition Ground Boundary Criteria by comparing relative values associated with each of the identified hazards. Chart below demonstrates that the fragmentation hazard remains the primary concern for demolition grounds.



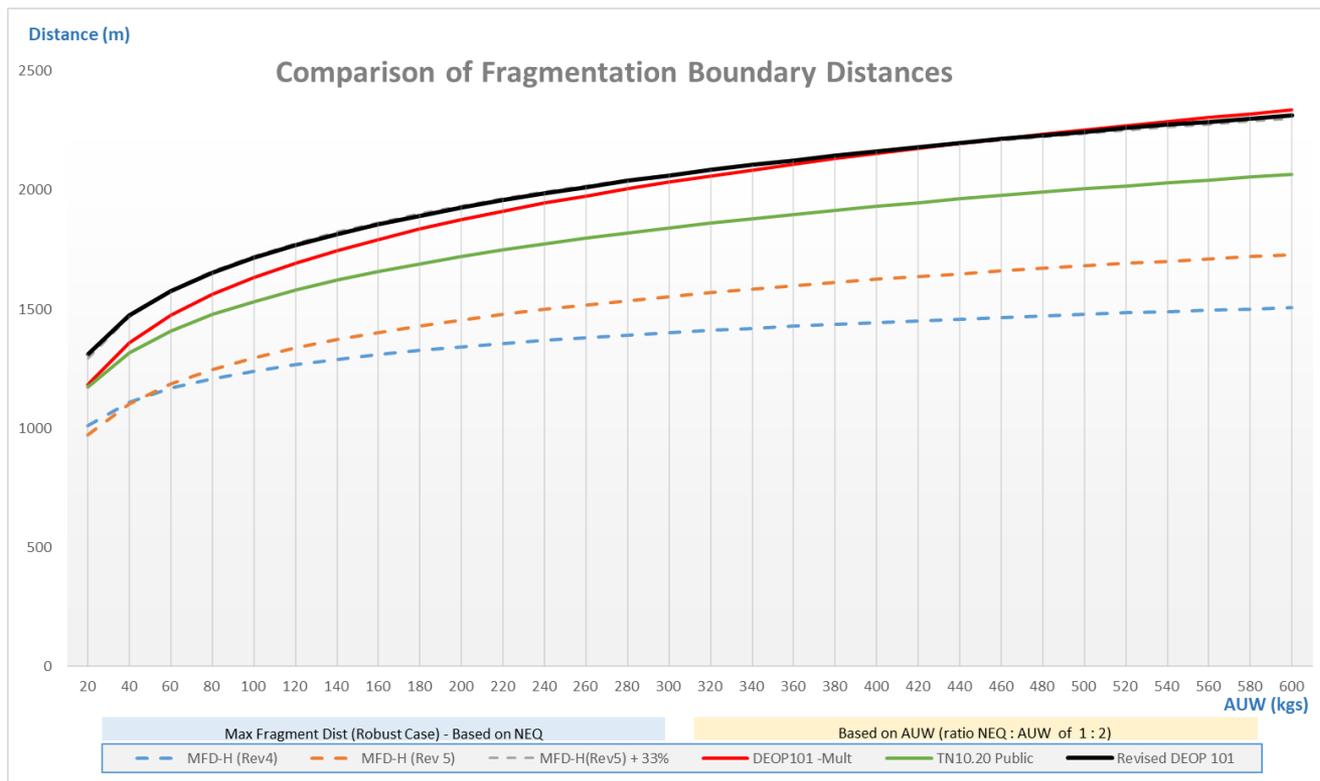
After determining that fragmentation is the dominant factor for consideration, a review of the appropriate formulae available indicated differences in approaches, in particular, some formulae were based on the NEW while others on AUW.

Demolition Ground Boundary Criteria

- Schema for comparing formulae was needed, and the authors decided comparison would be based upon:
 - Net Explosive Weight (NEW) and Net Explosive Quantity (NEQ) :
 - *Formulae using NEW and NEQ would be based upon Robust stores (MSIAC 2021) and AASTP-1.*
 - All-Up Weight (AUW):
 - Case weight is an important parameter when considering AUW. The criteria for *robust* and *non-robust* munitions for NEW were reviewed, with a ratio of 1.2 being considered the divide between the two criteria.

Demolition Ground Boundary Criteria

- Criteria reviewed by US Army Engineering and Support Center, Huntsville against the DDESB fragment database:
 - showed good correlation for encapsulating known data points with a multiple item factor of 33%.
 - one data point beyond the proposed formula for less than 1000kg NEW.
 - the formula was considered sufficiently conservative for the majority of data points to meet reasonably practicable criteria, particularly given its apparent conservatism less than 100kg where most Demolition Grounds close to inhabited areas are licensed.



Recommended criteria for Demolition Grounds

- The following formula to identify the maximum permissible AUW for a demolition activity for a given Demolition Ground boundary distance from the firing point:

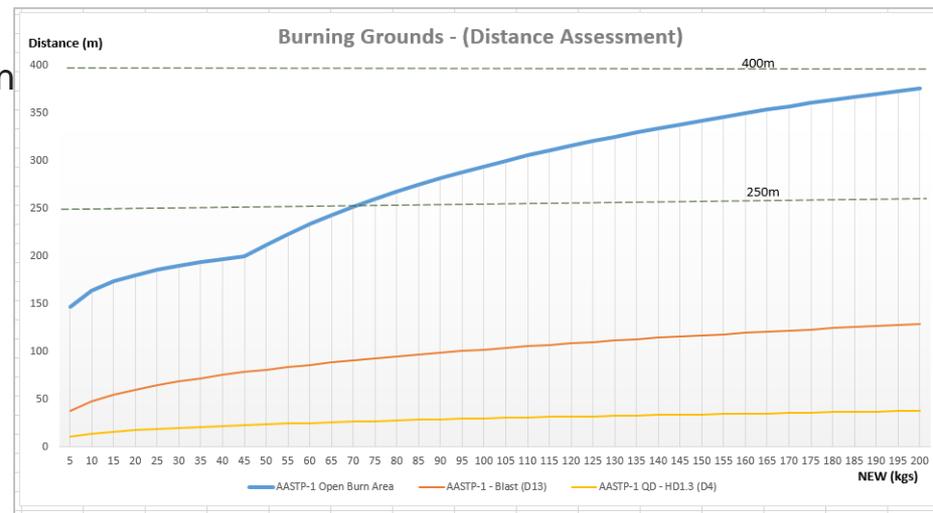
$$\text{AUW} = (D/710)^6$$

where D is the required boundary distance in metres and AUW is the total All-Up-Weight (including demolition explosives) that will be detonated in a single event. In all situations, a 400m minimum boundary distance is to apply.

- Given that criteria could not be established to eliminate unpredictable hazards, further effort is required to demonstrate that risk has been minimised SFARP, and as such it was recommended:
 - The explosive ordnance disposal Capability Manager ensure that that appropriate doctrine is established to seek to control the unpredictable hazards associated with demolition operations.
 - Training organisations ensure that demolition training incorporates the need to control the unpredictable hazards associated with demolition operations through the application of doctrine and demolition techniques.
 - Acquisition authorities identify munition structures that could create 'rogue' fragments within item publications.
- For situations where Demolition Grounds employ permanent protective works, criteria are to include limitations identified within or derived from the safety argument and design limits of the infrastructure such that explosive effects arising from destruction are controlled effectively.

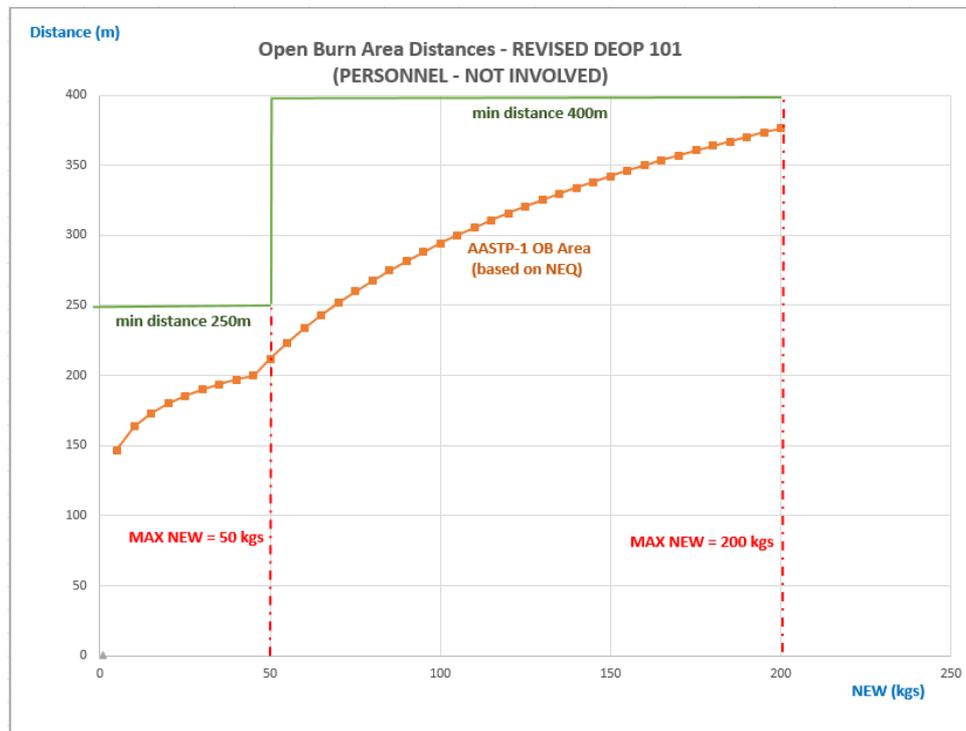
Burning Ground Boundary Criteria

- Consideration for Burning Grounds was established as their use being only for items with no risk of mass detonation (by definition).
- The authors identified that existing criteria were far more conservative than those for Thermal Radiation Hazards.
- It is assumed that existing criteria are in place on the basis of potential explosions that may occur during burning activities:
 - eDEOP101 states the need to apply Inhabited Building Distances (IBD) with a minimum 400m in relation to exposed sites for Burning Grounds with a maximum limit of 100kgs for the specific situation of burning items that may detonate.
 - AASTP-1 provides a modified Maximum Fragment Distance (MFD) formula for people not involved in the burning activity and further states that the disposal areas should be as far as possible from exposed sites.
 - DSA 03 requires the use of not less than IBD for disposal by burning for HD1.3 and/or HD 1.4 munitions - effectively a minimum 400m.



Burning Ground Boundary Criteria

- The AASTP-1 criteria were selected as the basis for new criteria, replacing NEQ with NEW producing a slightly more conservative approach if the TNT Equivalency value is less than 1 thereby reducing the amount of explosive within each burning activity.



Burning operations are only to be conducted for disposal where there is no risk of a mass explosion or projection hazard.

Techniques used for burning operations are to minimise risk of explosion such as not providing confinement, burning in thin layers and wetting of pyrotechnic compositions with oil.

Recommended criteria for Burning Grounds

- Burning operations are only to be conducted for EO disposal where there is no risk of a mass explosion or projection hazard. Techniques used for burning operations are to minimise risk of explosion such as not providing confinement, burning in thin layers and wetting of pyrotechnic compositions with oil.
- The following criteria are to be used to determine the minimum boundary distance.
 - Boundary Distance = 250m: $NEW \leq 50$ kgs
 - Boundary Distance = 400m: $50\text{kgs} < NEW \leq 200$ kgs

NOTE: Net Explosive Weight (NEW) must not exceed 200kg for any single event
- Where the burning ground utilises ovens, incinerators, protective works or other infrastructure, criteria are to be appended to Burning Ground licenses that accord with the limitations identified or derived from the safety argument and design limits of the infrastructure to be employed such that explosive effects arising from destruction are controlled effectively.



AUSTRALIAN
DEFENCE FORCE



Questions

