Bangalore Torpedo Replacement

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Background

- First devised in 1912 by Captain McClintock, of the British Indian Army.
- Used for exploding booby traps and barricades left over from the Boer and Russo-Japanese Wars.
- Exploded over a mine without having to approach the device.
- Placed through a barbed wire fence or other obstacle in order to clear an exploitable path.

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- **Objectives**

  - To develop the ‘Next Generation’ Bangalore Torpedo with improved Insensitive Munition (IM) signature.

    - Achieved by packaging design and use of Insensitive explosive materials.

  - To improve the performance over the existing in-service product.

    - Performance Trials conducted against replicated targets / obstacles.

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Objective

- To reduce the load on the user by minimising the mass of the product.
  - Achieved by making the tube from aluminium and ancillary parts from plastic.
- To create a flexible modular product to be used for multiple applications.
  - Single revolution thread allows for quick removal of ancillary parts and ability to link multiple tubes together.
  - Tactical Packaging allows quick deployment.

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Product Design Concept

- Pre-fragmented aluminium tube, designed to produce long ‘cutting’ strips.
- High level of blast energy due to high Theoretical Maximum Density (T.M.D.) of the pellets.
- The main fill is a Chemring explosive, DPX1 Type II.
- The booster material is a Chemring explosive known as DPX10 (Plastic Explosive).
- Both compositions are RDX based with different types and quantities of plasticisers and binders.

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Sensitivity Testing of DPX1 Type II and DPX10

- Figure of Insensitivity (F of I)
  - RDX = 80
  - DPX1 Type II = 85
  - DPX10 = 144
- Figure of Friction (F of F)
  - RDX = 3.0
  - DPX1 Type II = 4.7
  - DPX10 = >6

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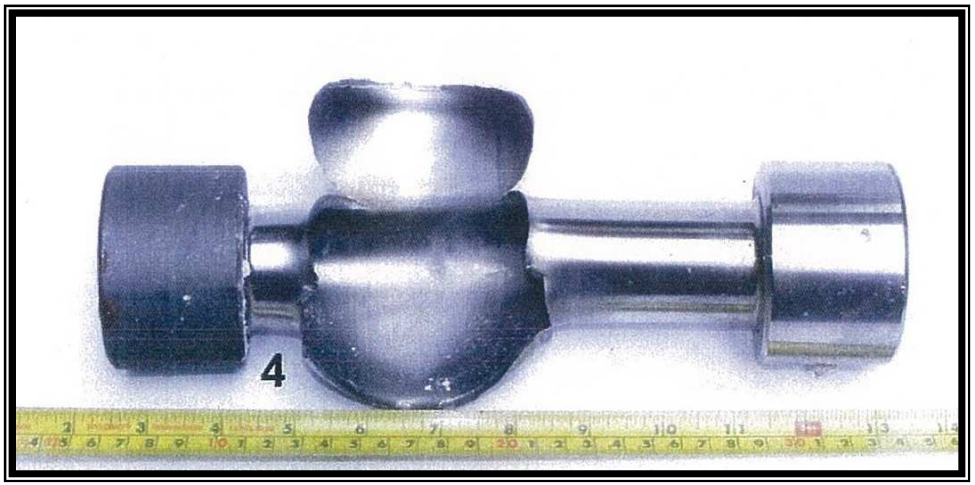
Sensitivity Testing of DPX1 Type II and DPX10

- EMTAP 35 (Tube Test)
  - Maximum no. of Fragments = 4
  - Minimum no. of Fragments = 1
  - Average no. of Fragments = 1.8



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- **Sympathetic Reaction Type**
  - Is Sympathetic Initiation caused by blast or fragment ?
  - Mitigation barriers need to be selected depending on the type of energy they have to contain / reduce.

- **Sympathetic Reaction - Fragmentation**
  - An acceptor Bangalore Tube placed 50mm away from a donor tube without any mitigation barriers in place will sympathetically detonate.

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Sympathetic Reaction – Blast

- A cardboard tube was used in lieu of aluminium.
- Cardboard provided lower fragment energy.
- The acceptor tube along with a high percentage of the explosive fill was recovered.
- Protection from fragmentation is required.

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- **Sympathetic Trials**

  - Several Blast Mitigation specialist companies were contacted.
  - Sample packaging solutions were supplied.
  - MSIAC were contacted and a search conducted on our behalf.
  - Mitigation Trials Conducted.

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Sympathetic Reaction Trial Results

- Waterproof coated aggregate bonded material, 70mm thick.
- Successfully prevented propagation.

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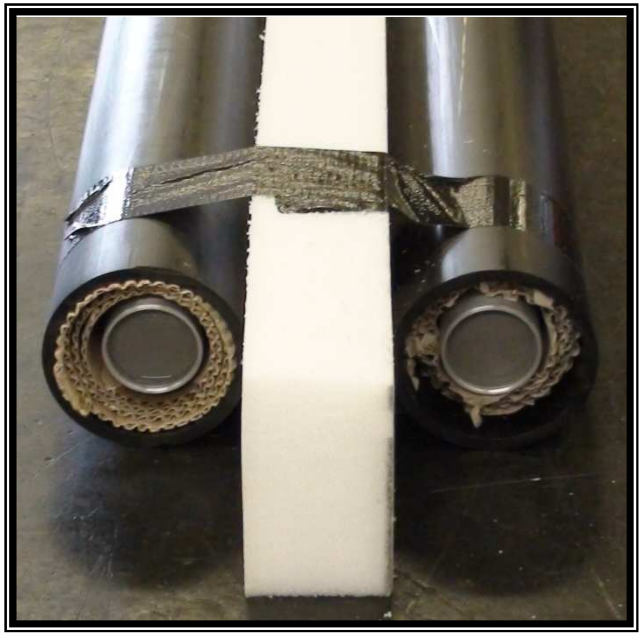
- **Sympathetic Reaction Trial Results**
  - Resin bonded aggregate contained within GRP moulding.
  - 30mm and 40mm separation.
  - Both thicknesses of material successfully prevented propagation.

Bangalore I.M. Trials

- **Sympathetic Reaction Trial Results**
  - HDPE (High Density Polyethylene) Tubes.
  - Polyethylene Foam (high density).
  - Successfully prevented propagation.



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- **Sympathetic Reaction Trial Results**
  - Polyethylene Foam Low Density.
  - Polyethylene Foam High Density.
  - Only the higher density foam prevented propagation.

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Sympathetic Reaction Trial Results

- HDPE Tubes
- Nominal air gap separation.
- Successfully prevented propagation.

Bangalore I.M. Trials

Sympathetic Reaction Trial Results

- GRP Tubes, nominal air gap separation.
- Successfully prevented propagation but acceptor tube extremely damaged and perforated through to explosive fill.

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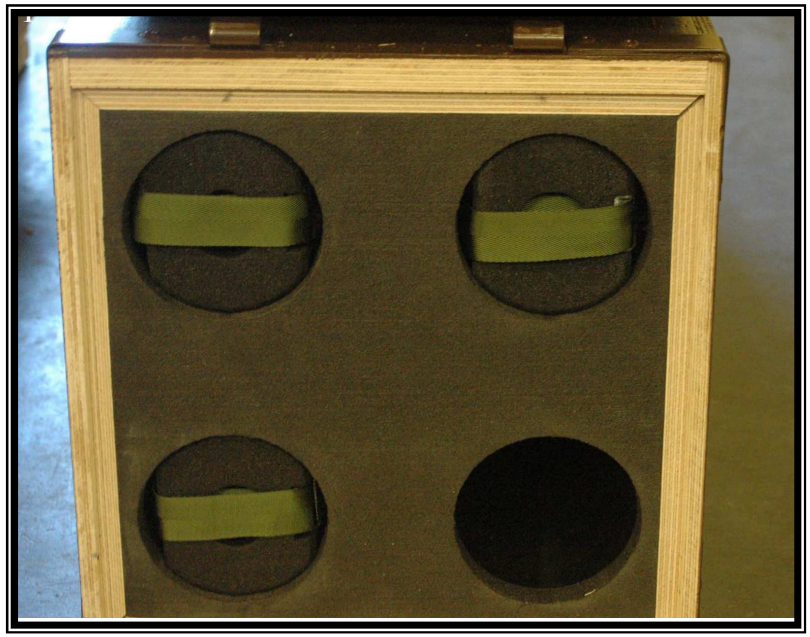
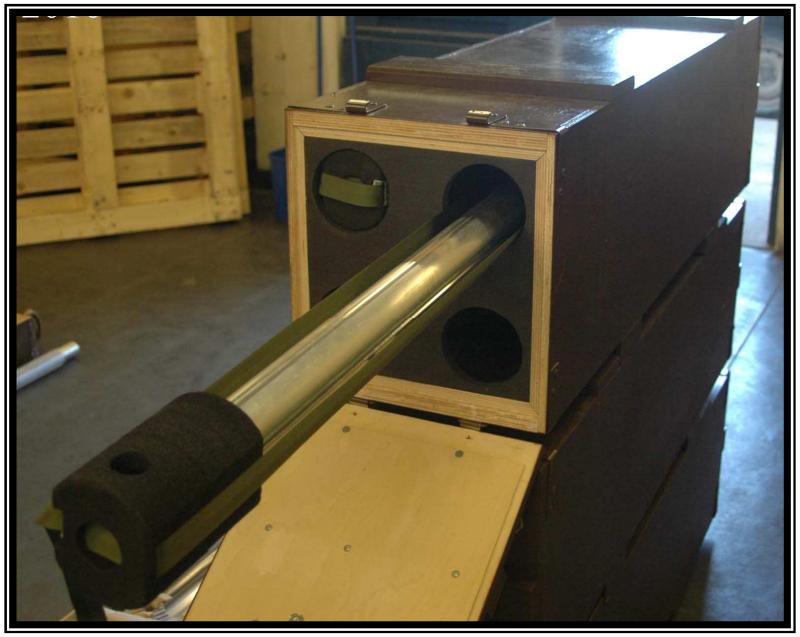
Packaging Design

- Chosen Mitigation material was HDPE tube separated by a nominal air gap.
- This solution was the most cost effective, robust, lightest and offered the most versatility in packaging design.





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UN Series 6a - Single Package Test

- A Single Package Test was conducted in accordance with the Orange Book Series 6a tests.
- One Donor tube (detonated by det cord) and three Acceptor Tubes

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- **UN Series 6a - Result**
  - Witness plate dented but not perforated.
  - Three acceptor tubes recovered.

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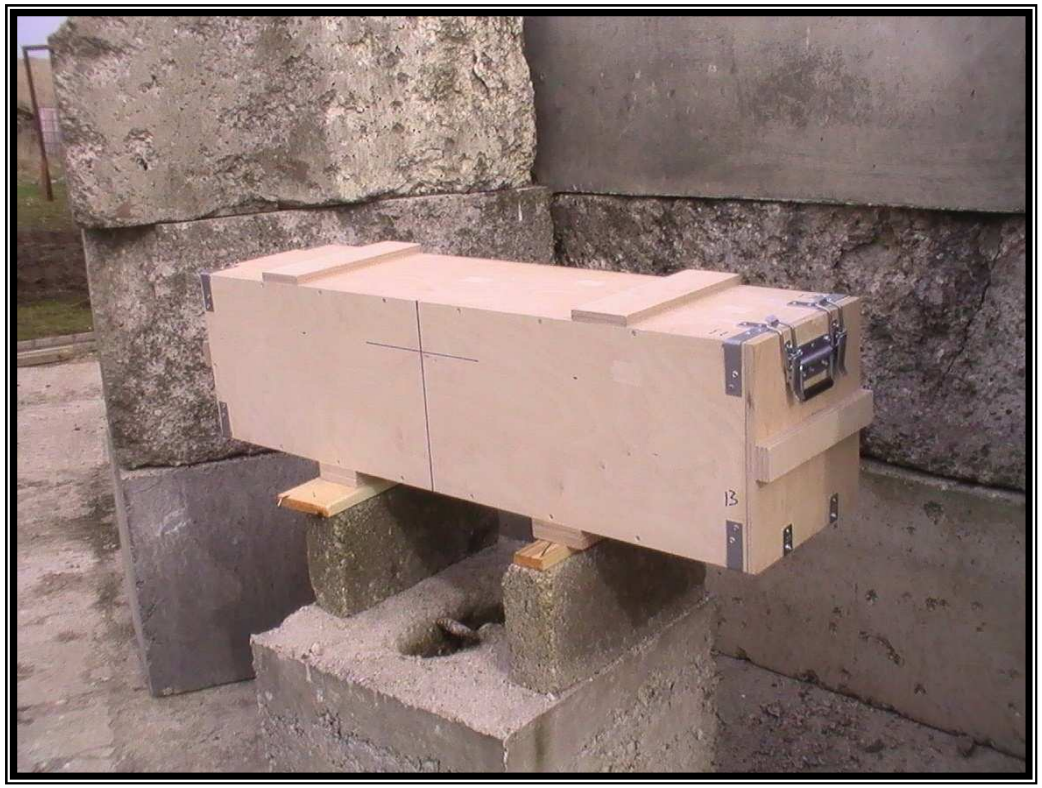
Bullet Impact

- A Bullet Impact trial was conducted on an all up logistic box containing 4 Bangalore Tube Assemblies.



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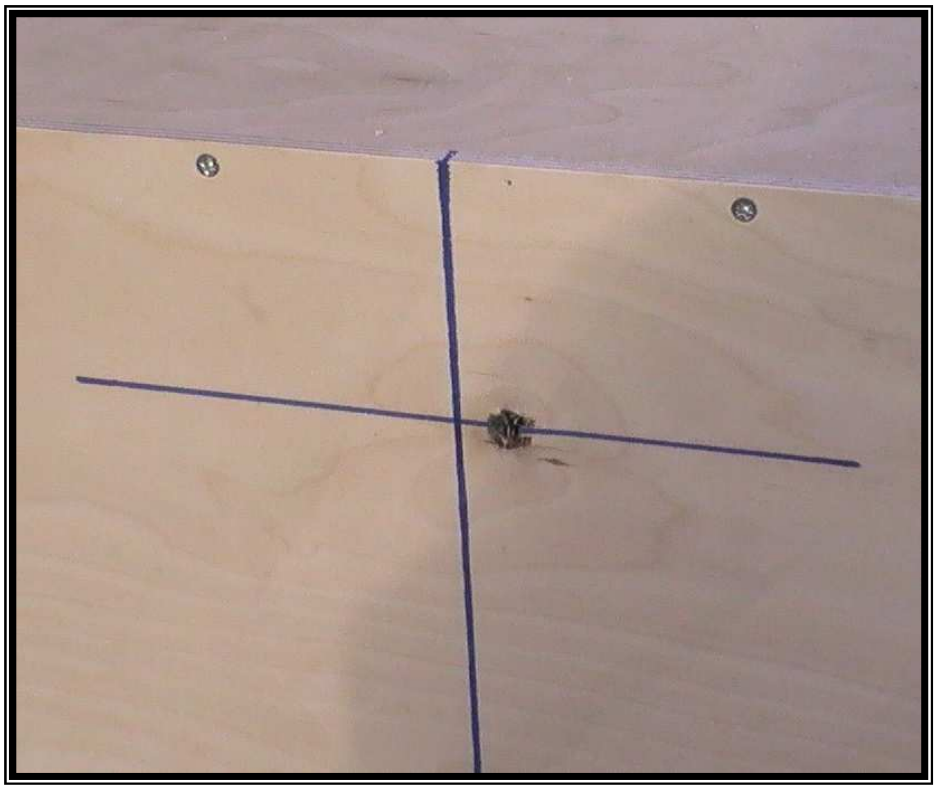
Bullet Impact – Trial Results

- The projectile passed through two tubes without causing any reaction.



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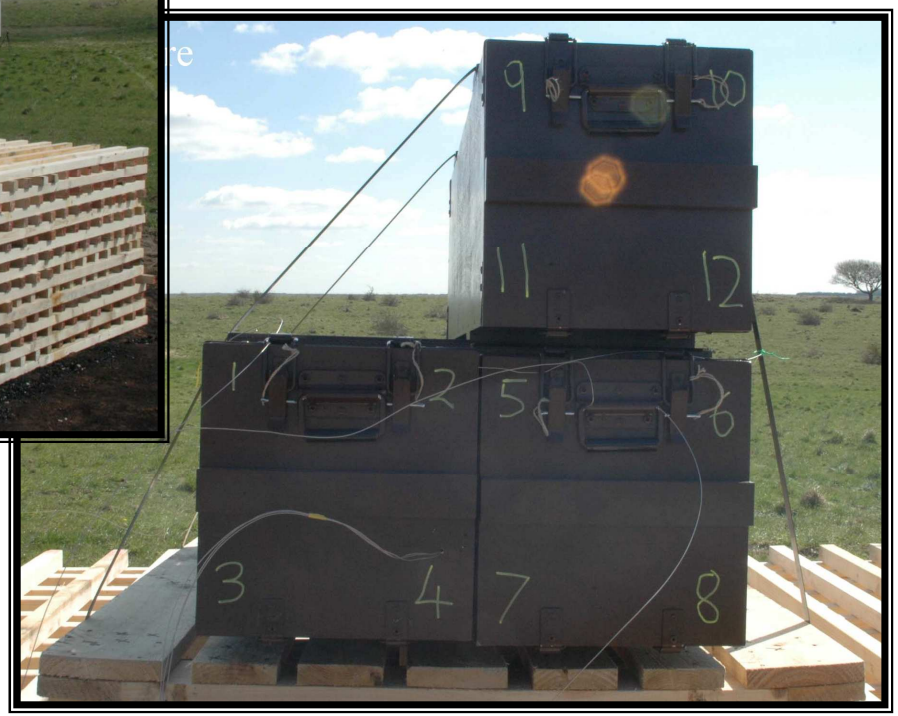
- **UN Series 6c – Bonfire**
  - Three logistic boxes were strapped to a pallet and subjected to a bonfire test.



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UN Series 6c – Results

- External temperatures of 800 – 1000 degC were recorded.
- Internal temperatures of 220 degC were recorded before any reaction was observed.
- Circa 15 mins, burning pellets were ejected from the bonfire.
- Circa 18 mins, a further reaction occurred which dispersed packaging from the bonfire.
- On completion, the majority of tubes were recovered.

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Conclusions

- The selection of explosive fill has improved the IM signature.
  - No reaction to bullet impact.
  - Small number of fragments in EMTAP35 Tube test.
- The density of the HE pellets is critical to the IM performance.
  - Lower density pellets burned in a previous bullet impact trial.
- The packaging design prevents sympathetic propagation within the logistic box and from box to box.
- The packaging protects the product for circa 15 mins in a bonfire before any reaction is observed.

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Any Questions ?