



## **Development of Insensitive Naval Countermining Charges with Improved Performance**

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# Development of Insensitive Naval Countermining Charges: Contents

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# Development of Insensitive Naval Countermining Charges:

## Background: Countermining Charges

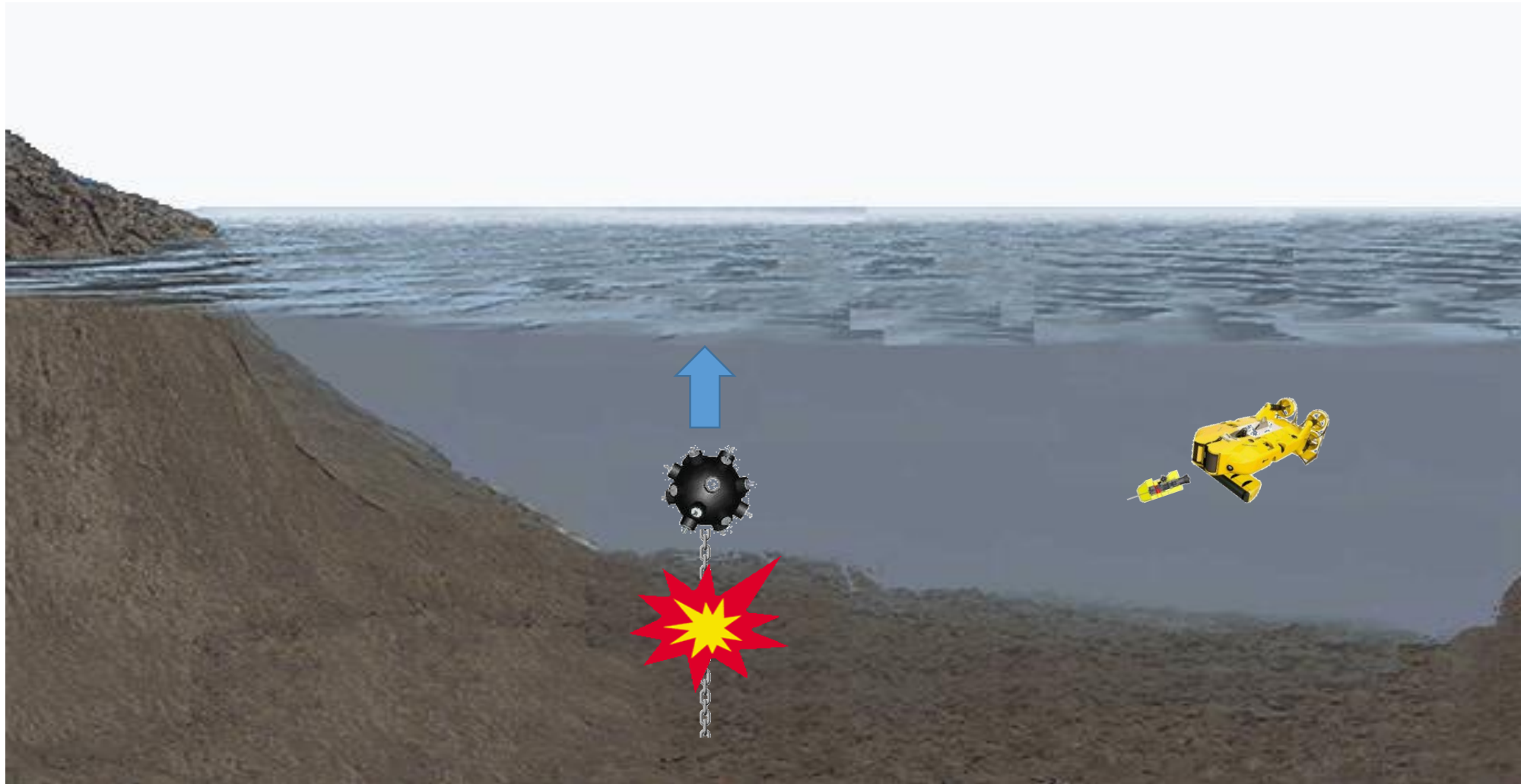
- Countermining (CM) charges are used when a minesweeping vessel detects a sea mine
- They are usually deployed by an underwater Remotely Operated Vehicle (ROV)



- RWM Italia have 30+ years experience in developing naval countermining charges
- We currently produce several types of countermining charges, in particular:
  - A small charge which the ROV attaches to the cable/chain of buoyant moored mines, and utilises a linear shaped charge to cut the cable/chain
  - A larger explosive charge which is deployed by the ROV near to a bottom mine, which when detonated is designed to induce a sympathetic reaction in the target

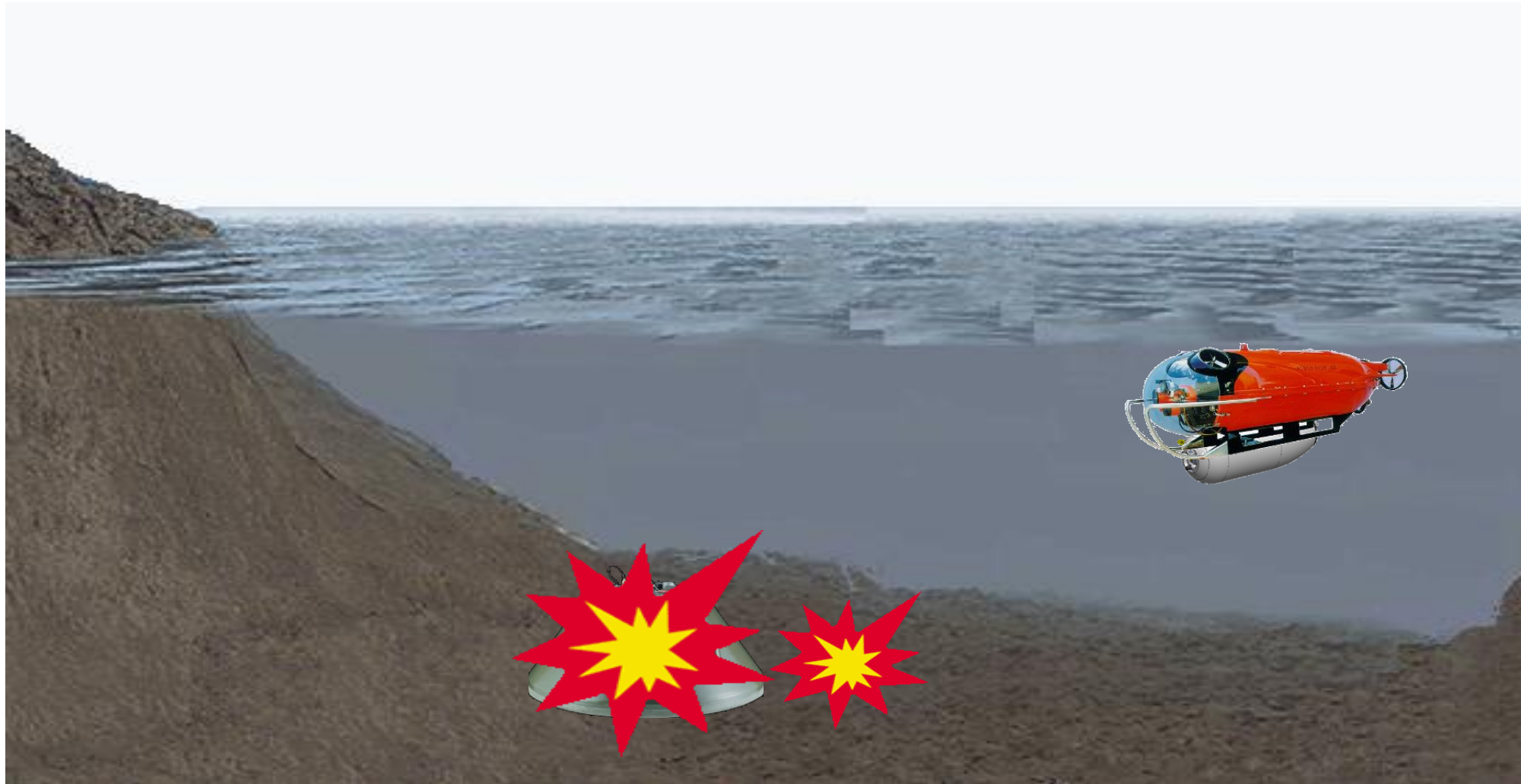
# Development of Insensitive Naval Countermining Charges:

## Background: Countermining Charges (Cutting Charge)



# Development of Insensitive Naval Countermining Charges:

## Background: Countermining Charges (Sympathetic Charge)





# Development of Insensitive Naval Countermining Charges:

## Background: Legacy Countermining Charges

- The existing charges in service with our customer had reached the end of their service life, and the National Authority had stated that they would not grant any further life extensions
- The designs of both the cutting charge and sympathetic charge were **obsolete**:

| Cutting Charge                              | Sympathetic Charge   |
|---|--|
| Detonator: out of production                | Detonator: out of production   |
| Booster explosive: Tetryl                   | Booster explosive: Tetryl  |
| Main charge explosive: TNT                  | Main charge explosive: Torpex<br>[TNT/RDX/aluminium/desensitising wax] |
| Not tested, but unlikely to be IM compliant | Not tested, but unlikely to be IM compliant                            |

# Development of Insensitive Naval Countermining Charges: Requirements for New CM Charges

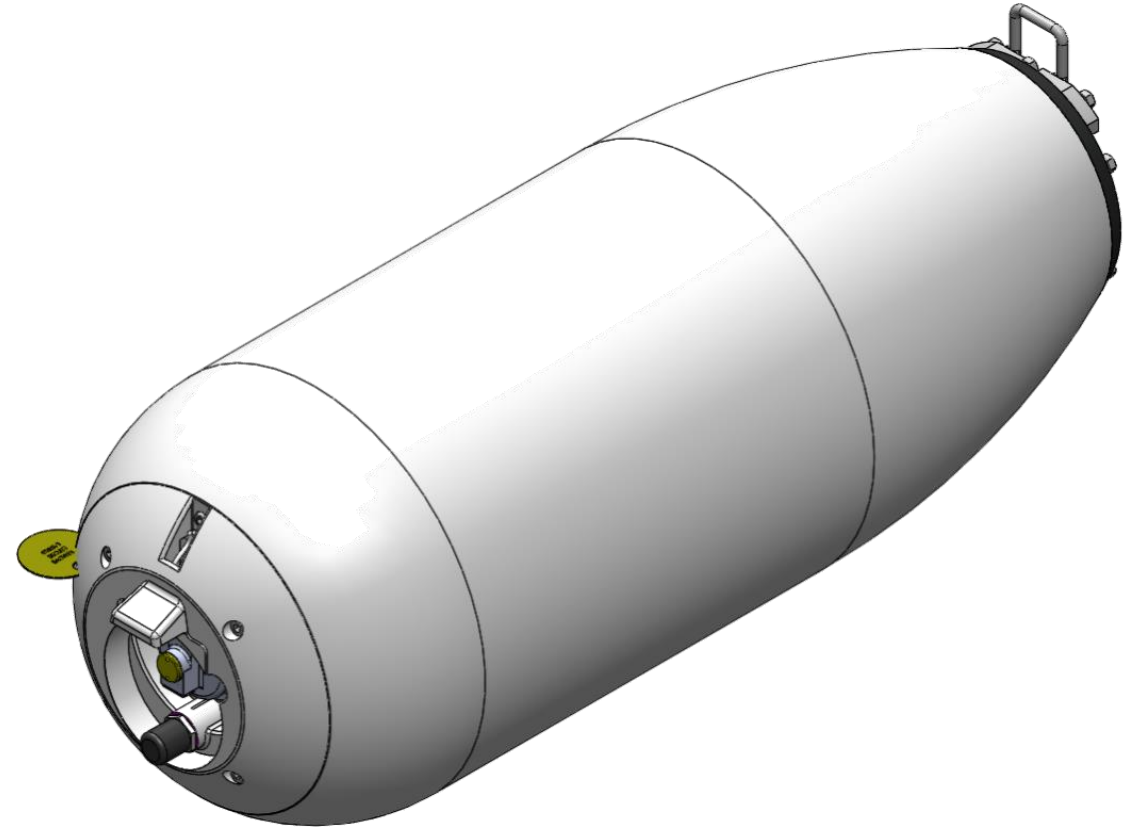
Our customer's requirements for their new countermining charges were essentially as follows:

1. "Form-and-Fit" replacement for existing countermining charges
  - Size and weight
  - Interface with the ROV
2. Performance on target at least as good as legacy charges
3. Improve on the IM characteristics
  - Not necessarily to be fully compliant with STANAG 4439

# Development of Insensitive Naval Countermining Charges: New CM Charges: CM102 and CM108



**CM102 Cutting Charge**



**CM108 Sympathetic Charge**



# Development of Insensitive Naval Countermining Charges: Choice of Explosive Materials

Less sensitive polymer-bonded explosives (PBXs) were selected for the new charges:

| CM102 Cutting Charge  | CM108 Sympathetic Charge  |
|---|---|
| Booster explosive: <b>PBXW-11</b>   | Booster explosive: <b>PBXN-7</b>  |
| Main charge explosive: <b>PBXN-110</b> (150 g)  | Main charge explosive: <b>PBXN-111</b> (85 kg)  |
| Better IM characteristics than the Tetryl/TNT used in the legacy charges, based on: <ul style="list-style-type: none"><li>• Review of data in literature</li><li>• RWM Italia experience</li></ul>        | Better IM characteristics than the Tetryl/Torpex used in the legacy charges, based on: <ul style="list-style-type: none"><li>• Review of data in literature</li><li>• RWM Italia experience</li></ul>                                     |
| Explosive performance*: <ul style="list-style-type: none"><li>• V of D (TNT) <math>\approx</math> 7000 m/s</li><li>• V of D (PBXN-110) <math>&gt;</math> 8000 m/s</li></ul> <b>Improved performance ✓</b> | Explosive performance*: <ul style="list-style-type: none"><li>• U/W shock energy (Torpex) <math>\approx</math> 1.3 TNT eq.</li><li>• U/W shock energy (PBXN-111) <math>\approx</math> 1.9 TNT eq.</li></ul> <b>Improved performance ✓</b> |

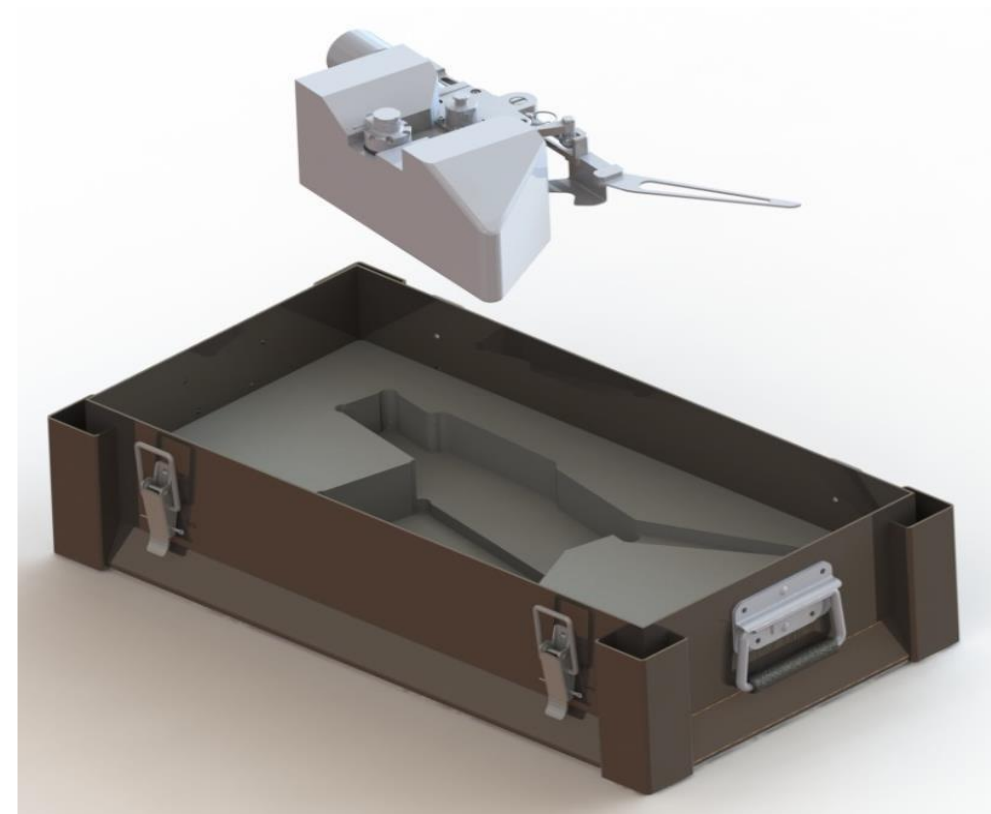
\* Explosive performance data taken from the MSIAC “Energetic Materials Compendium” database

# Development of Insensitive Naval Countermining Charges: Other “IM” Design Features (CM102)

Other design features were incorporated into the designs to help with the IM characteristics, in addition the use of less sensitive energetic materials:

## CM102 Cutting Charge

**Package:** charges packaged singly, with the linear shaped charge angled away from adjacent charges, to mitigate against Sympathetic Reaction threat



# Development of Insensitive Naval Countermining Charges: Other “IM” Design Features (CM108)

Other design features were incorporated into the designs to help with the IM characteristics, in addition the use of less sensitive energetic materials:

## CM108 Sympathetic Charge

**Package:** bespoke design from Portsmouth Aviation Ltd (UK), designed specifically for the CM108, to mitigate against Sympathetic Reaction threat:

- Heavy aluminium construction
- Foam panels internally to mitigate shock

**Venting:** fusible inserts that melt at  $\sim 130^{\circ}\text{C}$  to release the forward cover of the main charge, mitigating against Fast and Slow Heating threats



# Development of Insensitive Naval Countermining Charges:

## Qualification: Environmental and Safety Testing

- Both CM102 and CM108 countermining charges underwent comprehensive sequential and non-sequential test programmes:
  - Sequential:
    - Logistical transportation vibration and shock (road/rail/air/ship)
    - Logistical handling drop tests
    - Hot and cold temperature cycling
      - Climatic Category B3 “Humid Hot Coastal Desert”, up to +71 °C
      - Climatic Category C2 “Cold”, down to -46 °C
    - Resistance to shockwaves from nearby UNDEX (underwater explosion)
  - Non-Sequential:
    - 12 m safety drop tests
    - Fuze safety tests (in accordance with AOP-20)
    - HERO/RadHaz, ESD, and magnetic signature (particularly important on minesweepers)
- **Both charges passed all tests with no major issues, and were deemed “S3”**



# Development of Insensitive Naval Countermining Charges: CM102 Cutting Performance Tests

- That the CM102 was capable of cutting the specified targets was verified in live firing tests:



**16 mm steel chain**



**20 mm steel cable**



**40 mm polypropylene rope**



# Development of Insensitive Naval Countermining Charges:

## Qualification: Insensitive Munitions Tests

- Only limited IM tests were performed on both CM102 and CM108 CM charges, due to both budgetary constraints and also customer requirements:
  - **Fast Heating**
    - Logistical configuration (packaged)
    - CM102: Liquid Fuel Fire Test
    - CM108: Wood Bonfire Test as per UN Test 6(c), not a “true” Fast Heating liquid fuel fire test
  - **Bullet Impact**
    - Unpackaged
    - 12.7 mm (0.5”) AP
    - CM102: 3-round burst
    - CM108: Single round aimed at the booster but also passing through a large part of the main charge

# Development of Insensitive Naval Countermining Charges: CM102 and CM108 Fast Heating Tests



**CM102 Cutting Charge**  
**Assessment: Type V (Burning)**



**CM108 Sympathetic Charge**  
**Assessment: Type V (Burning)**



# Development of Insensitive Naval Countermining Charges: CM102 Bullet Impact Test



Some flame is visible in the high-speed video footage, but immediately extinguishes itself. This is a view of the rear of the CM102 after the test; the bullets passed right through the PBXW-11 booster/PBXN-110 main charge, without initiating it. Other fragments of explosive were scattered around the test pad and recovered unreacted from the ground.

**Assessment: Type VI (No Reaction)**

# Development of Insensitive Naval Countermining Charges: CM108 Bullet Impact Test



- A few seconds after impact the charge has started to burn...
- After about 10 seconds, it has developed into a vigorous burning reaction...
- Which is sustained for about 2 minutes and 30 seconds, after which it begins to die down.
- In total, the fire lasted about 3 minutes.
- The aluminium case of the CM108 was consumed in the fire; no fragments were projected, and no blast overpressure measured.

**Assessment: Type V (Burning)**

# Development of Insensitive Naval Countermining Charges:

## Qualification: Insensitive Munitions Tests

- In the IM tests performed, excellent results were achieved:

|              | Fast Heating     | Bullet Impact         |
|--------------|------------------|-----------------------|
| <b>CM102</b> | Type V (Burning) | Type VI (No Reaction) |
| <b>CM108</b> | Type V (Burning) | Type V (Burning)      |

- While only a limited suite of IM tests were carried out, we are confident that based on experience and the design of the munitions, that the CM charges would give good results in the other IM tests
- It is believed that for the CM102, a Hazard Classification of 1.4 would be achieved, if the full suite of tests in the UN Manual were to be performed





## Development of Insensitive Naval Countermining Charges: Conclusions

- The requirements from the customer were for new countermining munitions that:
  - Were a “Form-and-Fit” replacement for their existing countermining charges
  - With performance on-target at least as good
  - But also with improved IM characteristics
- All of these requirements were met, and the performance even improved on
- The new CM102 and CM108 “IM” countermining charges have been fully qualified and are currently in service with the customer’s naval forces

