Benefits of Inert Munitions on Storage and Operations

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OVERVIEW

• Introduction
• IM Assessment
• IM Assessment vs. Reality
• Quantity Distance (QDs) Background
• IM QDs
• IM and Risk
• IM and Risk-to-Stock
• Conclusions & Recommendations
• Munition spends large portion of life in storage or on operations

• Full report – MSIAC Open Report O-169
• Two assessment test groups from four documents:

• Hazard Classification:
  – Recommendations on the Transport of Dangerous Goods: Model Regulations (UN Orange Book) used to assess HD1.6
  – AASTP-3 used to assess SsD1.2.3 and matches UN Orange Book HD1.6

• IM assessment testing:
  – AOP-39: Guidance on the Assessment and Development of IM & STANAG 4439
  – Not associated with a specific HD but is used in SsD1.2.3
### MAIN ‘IM’ TESTING

<table>
<thead>
<tr>
<th>AASTP-3: SsD1.2.3</th>
<th>UN Orange Book: HD1.6</th>
<th>AOP-39</th>
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<tbody>
<tr>
<td>Test Series 6 Tests</td>
<td>Test Series 7 Substance Tests (a to f)</td>
<td>Test Series 6 Tests</td>
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<tr>
<td>Liquid Fuel/External Fire</td>
<td>Test series 7g - 1.6 article external fire test</td>
<td>Liquid Fuel/External Fire (STANAG 4240)</td>
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<td>Slow Heating</td>
<td>Test series 7h - 1.6 article slow cook-off test</td>
<td>Slow Heating (STANAG 4382)</td>
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<td>Bullet Impact</td>
<td>Test series 7j - 1.6 article bullet impact test</td>
<td>Bullet Impact (STANAG 4241)</td>
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<td>Sympathetic Detonation</td>
<td>Test series 7k - 1.6 article stack test</td>
<td>Sympathetic Detonation (STANAG 4396)</td>
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<td></td>
<td>Test series 7l - 1.6 article fragment impact test</td>
<td>Fragment Impact (STANAG 4496)</td>
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<td>• Green: Common across all assessments.</td>
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<td>• Yellow: Not in SsD1.2.3 assessment.</td>
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<td>• Blue: Not in HD1.6 assessment.</td>
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• IM may not prevent the accidents **BUT** would reduce the consequences compared to conventional munitions.

• Safety systems need to be of a high level.

• A case study of the USS Forrestal Fire in 1967 was conducted.
REALITY COMPLEXITY

• Reality is much more complex than IM assessments
  – Ageing
  – Larger storage configurations

• Recent work implies ageing has little impact on IM but based on limited evidence

• Storage safety based on IM (transport based) tests
  – Should be validated by large storage configuration testing

Single Shell Detonation.  Multiple Shell Detonation.
QDs BACKGROUND

Supporting Munitions Safety

MSIAC Unclassified 8
QDs: Guidelines

- QDs for HD1.6 and SsD1.2.3
  - Similar approach
  - Whichever gives the largest contribution of
    - Burn of the total NEQ
    - Detonation of a single article
      (also known as Maximum Credible Event (MCE))

- But there are differences!
  - HD1.6 MCE is a single round
  - SsD1.2.3 MCE is based on assessment or testing
    - Can be a single round, article, box, stack, etc.
• Complex
• Contains inconsistencies
• **MUCH** easier than SsD1.2.3.

• **HD1.6 MCE:**
  - Only takes into account blast
  - Ignores fragments and structural debris
QDs: Case Studies

• Eight common storage scenarios

• A range of MCEs for HD1.6 and SsD1.2.3

• With and without HD1.1 Small Quantity QDs

• Comparing HD1.1, HD1.6 and SsD1.2.3
WHERE ARE THE BENEFITS?

1. Lower QD for the same NEQ
2. Higher NEQ for the same QD
3. Mixture of 1 and 2
HD1.1 vs. HD1.6

HD1.1:
MCE=1000kg

HD1.6:
MCE=500kg

HD1.6:
MCE=50kg

SsD1.2.1/SsD1.2.2/SsD1.2.3:
No QD

MD1.1

Building with earth on the roof and against three walls. Directional effects through the door and headwall are perpendicular to the direction of an ES.

(b)

Earth-covered building not complying with Part 2, with or without a headwall and door(s) resistant to fire and low velocity projections, (see 1.3.3.6), but the door faces away from a PES.
HD1.1 with SQQDs vs. HD1.6

SsD1.2.1/SsD1.2.2/SsD1.2.3/SQQD (1kg <= NEQ <= 50kg): No QD

HD1.1 with SQQDs
HD1.6: MCE=1000kg
HD1.6: MCE=500kg
HD1.6: MCE=50kg
• Shows that SsD1.2.3 is not always lower than HD1.6
• The KG-ET made available by the Klotz Group
• Case studies conducted (see MSIAC report O-169)
• The KG-ET has a potential to be used to derive more detailed QDs using:
  – building parameters like dimensions, wall thickness, door properties
  – presence of barricades
• The KG-ET can also provide reduced QDs in off-normal directions
• Operational Storage defined in AASTP-5

• Rules state that any munition is aggregated to HD1.1 irrespective of HD or SsD
  – Removes all benefits of IM in storage
  – Operational bases typically are not able to match QD
  – Situation can only be accepted through risk analysis
IM AND RISK

Risk = Frequency * Consequence

- HD1.6 and SsD1.2.3 have the same consequences
  - HD1.1 like effects (MCE) and thermal effect (NEQ)
  - QDs based on consequence but does ignore probability of munition response

- HD1.6 has a smaller frequency (probability per unit of time)
  - Probability of threat stays the same
  - Probability of reaction/response changes
  - Difficult to quantify!
• Introduction of IM and lower QDs can lead to larger stockpiles or storage buildings built closer together.

• This will reduce costs associated with smaller storage facilities and simplified storage and transport.

• This will also introduce a ‘Risk to Stock’.

• With larger stockpiles in a smaller radius there is a higher chance that entire stockpiles could be lost.

• This could impact on military operations.
CONCLUSIONS

• Different combinations of testing can lead to nomenclature confusion

• Reality offers greater complexity than assessment testing but has limited understanding

• IM can offer reduced consequences in operational accidents but may not eliminate the possibility of an accident occurring.

• HD1.6 has more extensive test requirements than SsD1.2.3, but has the larger QDs
CONCLUSIONS

- HD1.1 SQQDs will have an impact on the benefits of SsD1.2.3 and HD1.6

- Harmonisation between QD regulations for HD1.6 and SsD1.2.3 is required

- The KG-ET has a potential to be used to derive more detailed QDs

- Current aggregation rules in AASTP-5 mean that IM has no benefits in operational storage

- Any benefits of reduced QDs or larger NEQs must be balanced with the increased ‘Risk-to-Stock’. 
Thank you for listening.

Any Questions?