

BENEFITS OF INSENSITIVE MUNITIONS ON STORAGE AND OPERATIONS

Benjamin Keefe

B. Stokes Fellow

b.keefe@msiac.nato.int

Martijn M. Van der Voort

Munitions Safety, Transport & Storage TSO

+32 (0)2 707 5426

m.vandervoort@msiac.nato.int

2016 INSENSITIVE MUNITIONS & ENERGETIC
MATERIALS TECHNOLOGY SYMPOSIUM



- 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

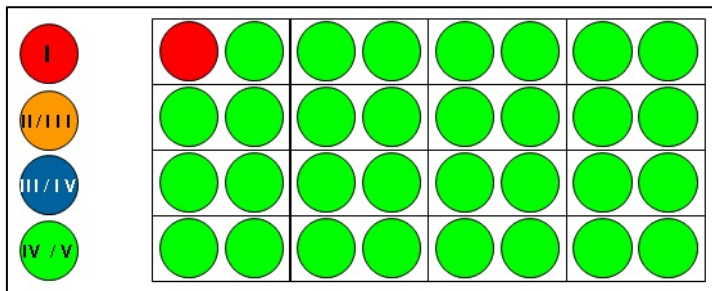
- Two assessment test groups from four documents:
- Hazard Classification:
 - Recommendations on the Transport of Dangerous Goods: Model Regulations (UN Orange Book) used to assess HD1.6
 - AASTP-3 used to assess SsD1.2.3 and matches UN Orange Book HD1.6
- IM assessment testing:
 - AOP-39: Guidance on the Assessment and Development of IM & STANAG 4439
 - Not associated with a specific HD but is used in SsD1.2.3

AASTP-3: SsD1.2.3	UN Orange Book: HD1.6	AOP-39
Test Series 6 Tests	Test Series 7 Substance Tests (a to f)	Test Series 6 Tests
Liquid Fuel/External Fire (STANAG 4240)	Test series 7g - 1.6 article external fire test	Liquid Fuel/External Fire (STANAG 4240)
Slow Heating (STANAG 4382)	Test series 7h - 1.6 article slow cook-off test	Slow Heating (STANAG 4382)
Bullet Impact (STANAG 4241)	Test series 7j - 1.6 article bullet impact test	Bullet Impact (STANAG 4241)
Sympathetic Detonation (STANAG 4396)	Test series 7k - 1.6 article stack test	Sympathetic Detonation (STANAG 4396)
	Test series 7l - 1.6 article fragment impact test	Fragment Impact (STANAG 4496)
		Shaped Charge Jet (STANAG 4526)

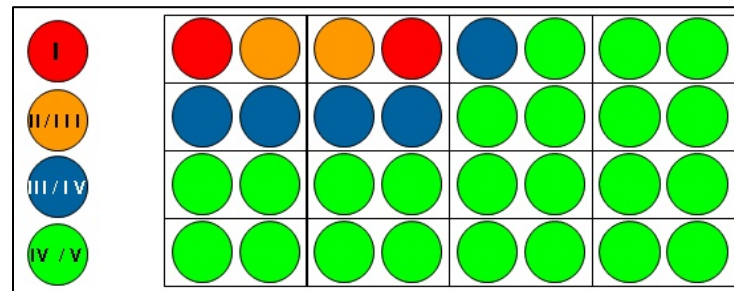
- Green: Common across all assessments.
- Yellow: Not in SsD1.2.3 assessment.
- Blue: Not in HD1.6 assessment.

- 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.

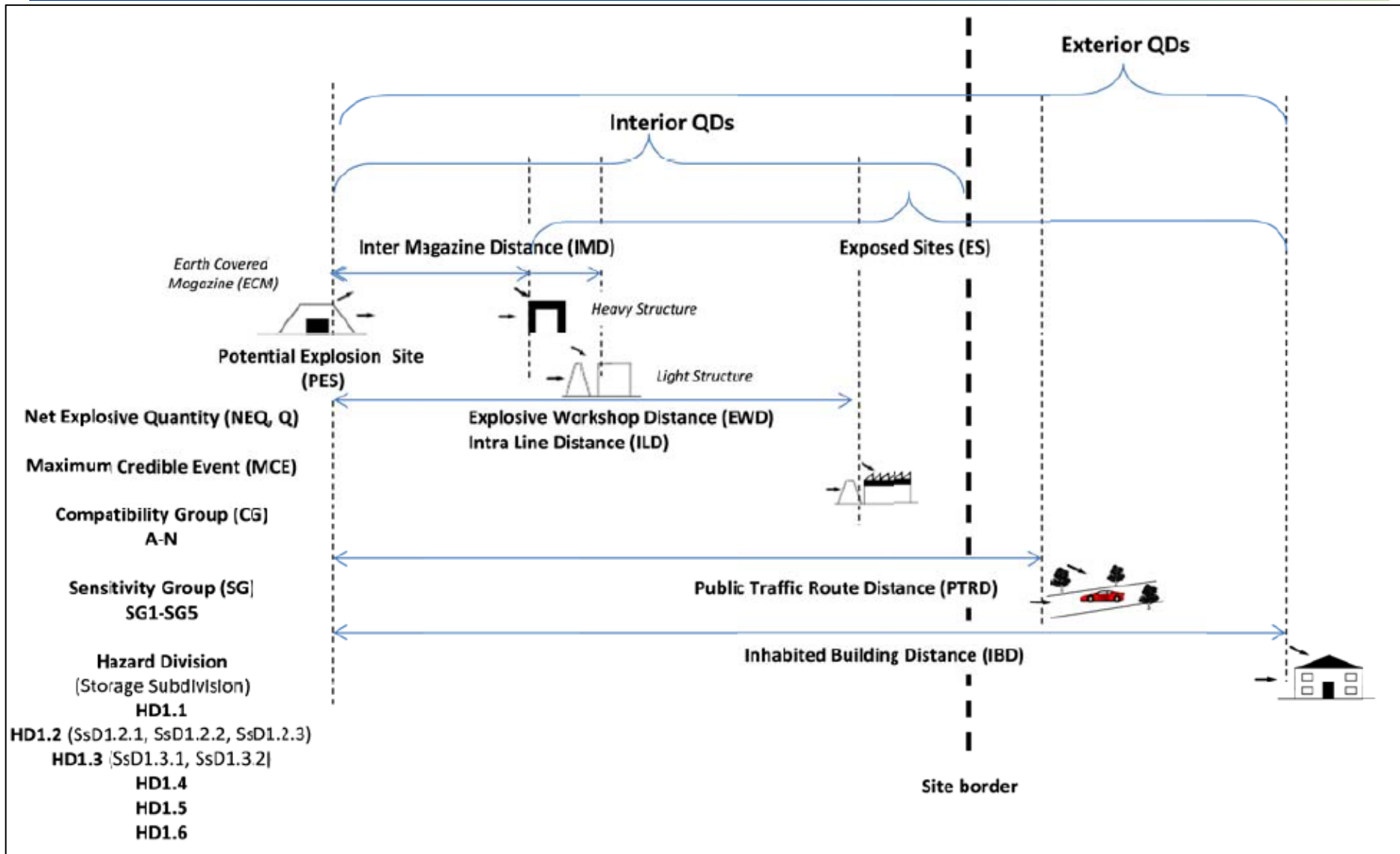
- Reality is much more complex than IM assessments
 - Ageing
 - Larger storage configurations
- Recent work implies ageing has little impact on IM but based on limited evidence
- Storage safety based on IM (transport based) tests
 - Should be validated by large storage configuration testing



Single Shell Detonation.

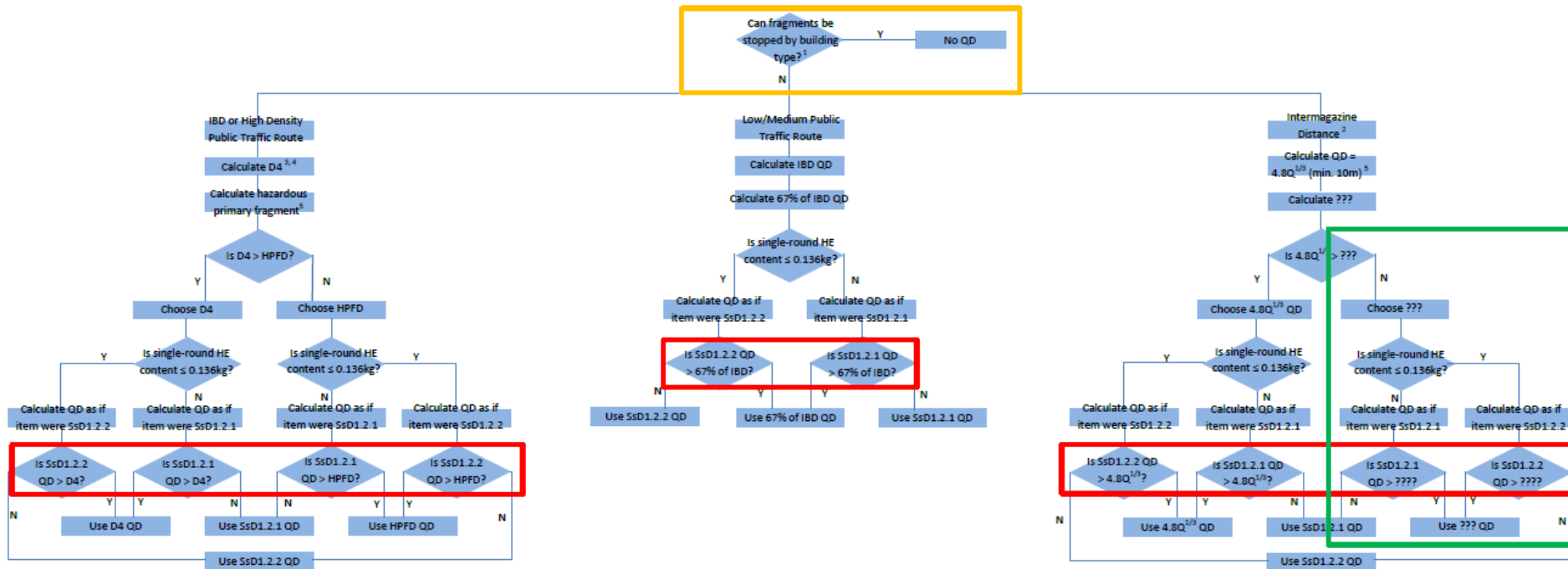


Multiple Shell Detonation.

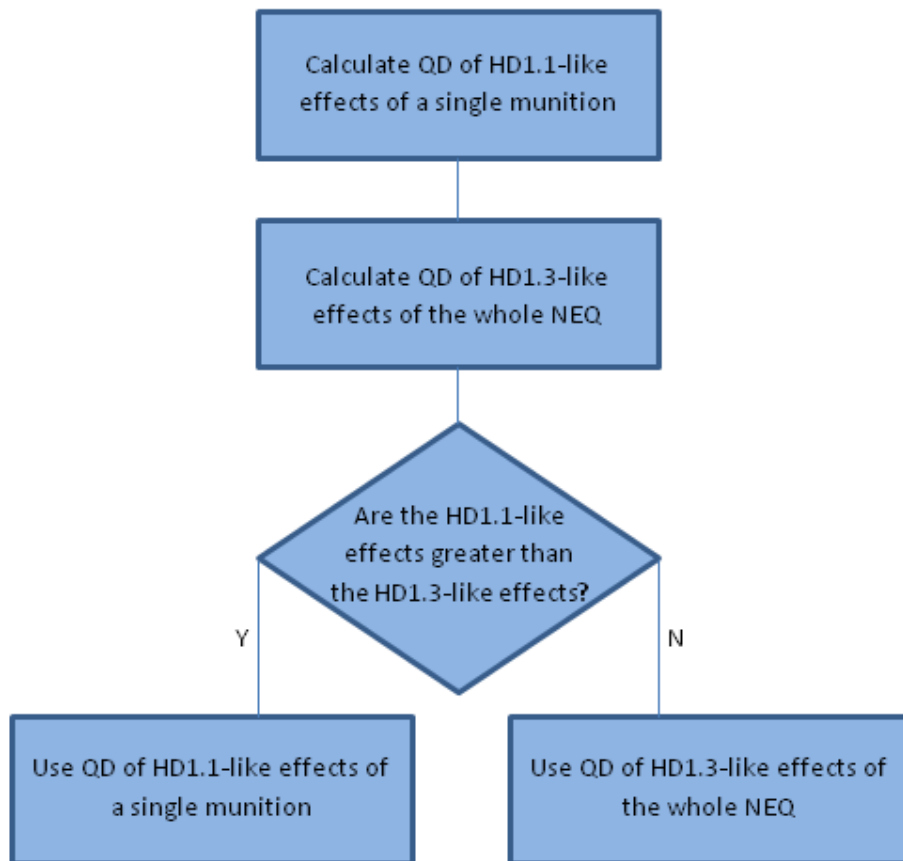


- QDs for HD1.6 and SsD1.2.3
 - Similar approach
 - Whichever gives the largest contribution of
 - Burn of the total NEQ
 - Detonation of a single article
(also known as Maximum Credible Event (MCE))

- 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.

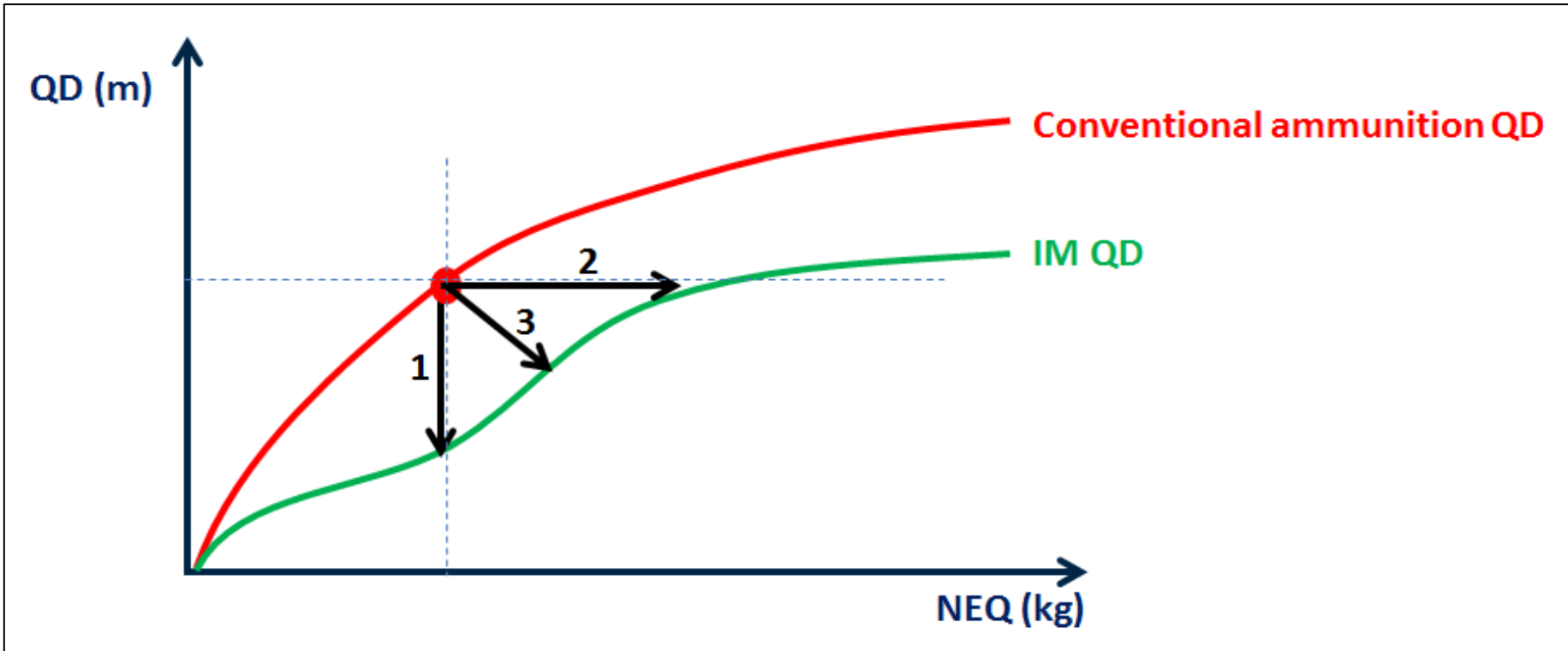


- Complex
- Contains inconsistencies

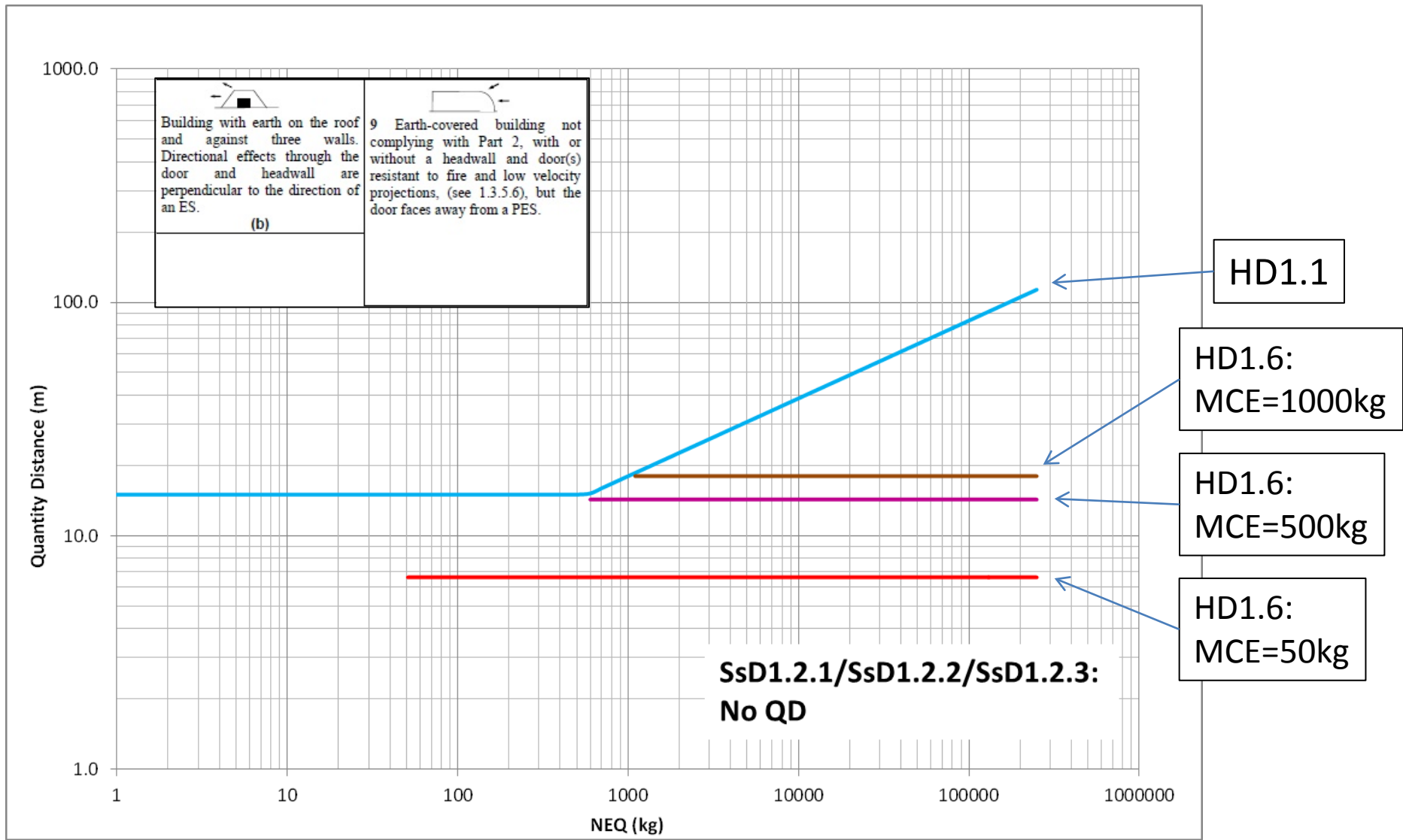


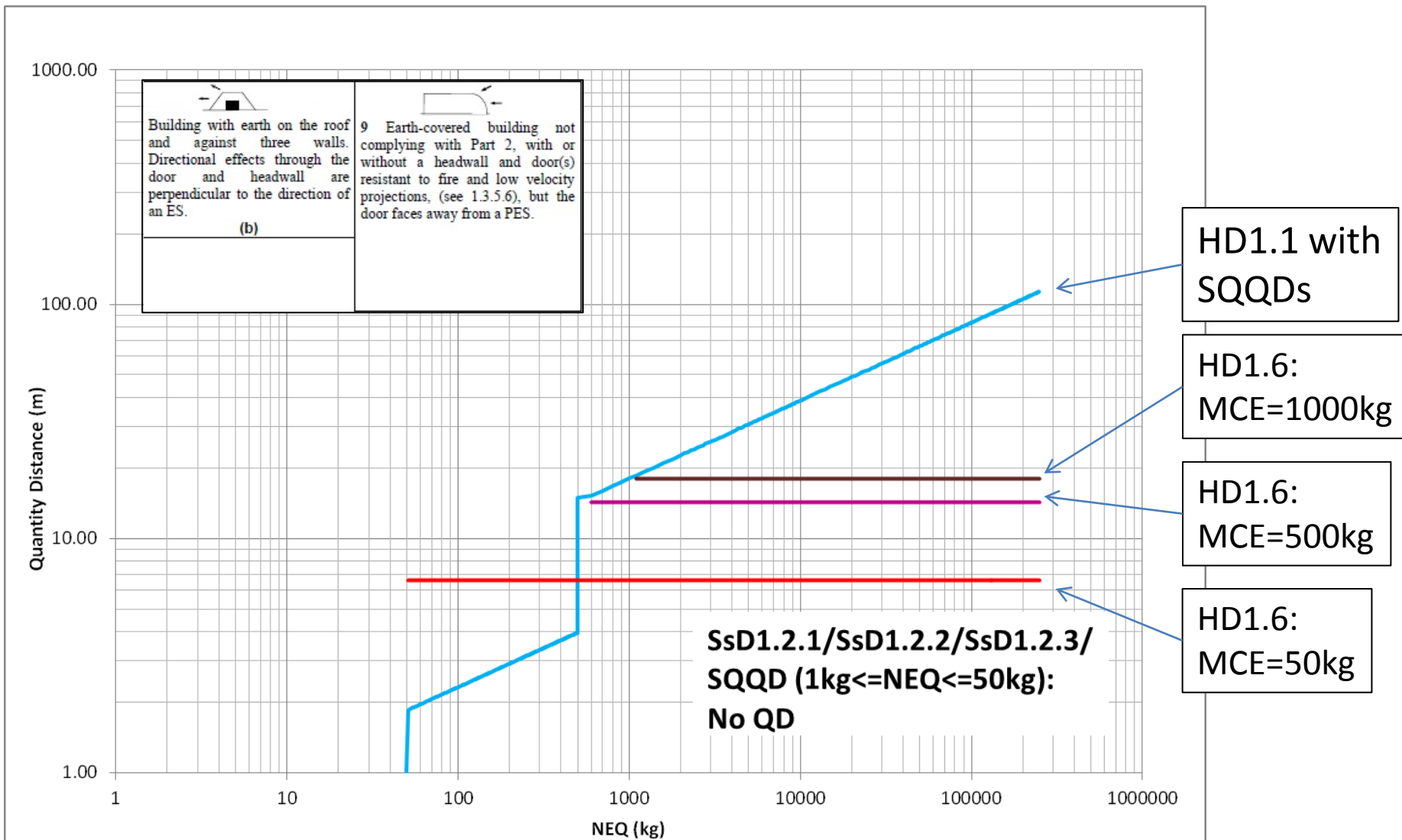
- **MUCH** easier than SsD1.2.3.
- **HD1.6 MCE:**
 - Only takes into account blast
 - Ignores fragments and structural debris

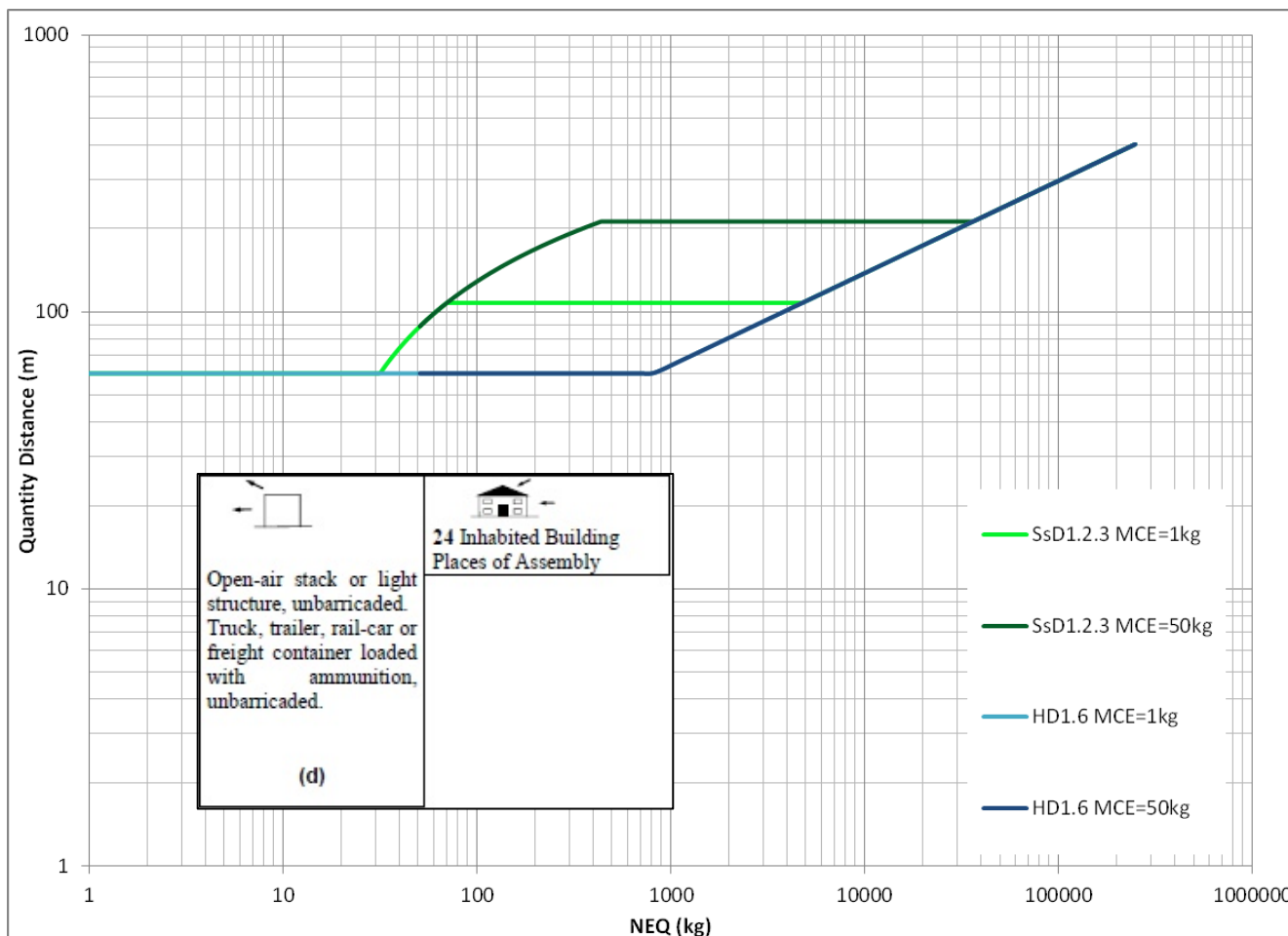
- Eight common storage scenarios
- A range of MCEs for HD1.6 and SsD1.2.3
- With and without HD1.1 Small Quantity QDs
- Comparing HD1.1, HD1.6 and SsD1.2.3



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

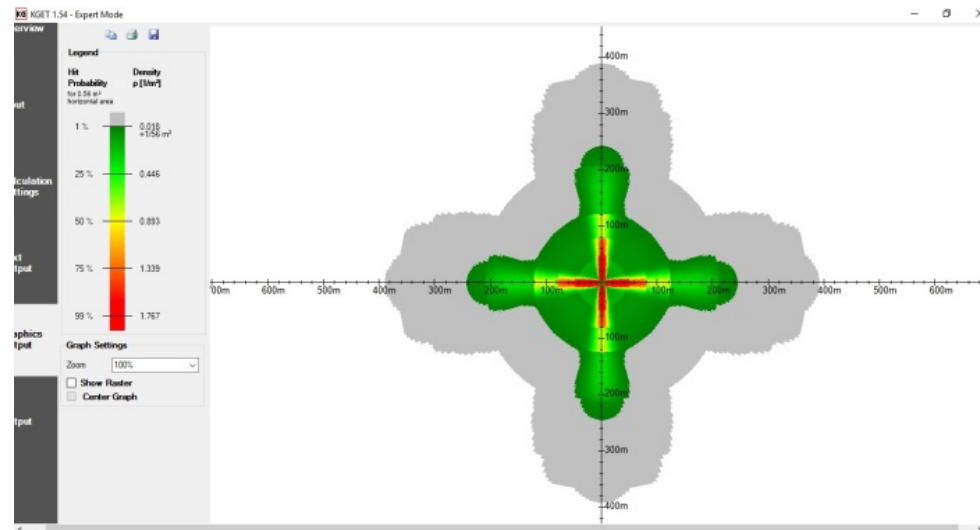






- Shows that SsD1.2.3 is not always lower than HD1.6

- 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


$$Risk = Frequency * Consequence$$

- **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.

- 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

- 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?

