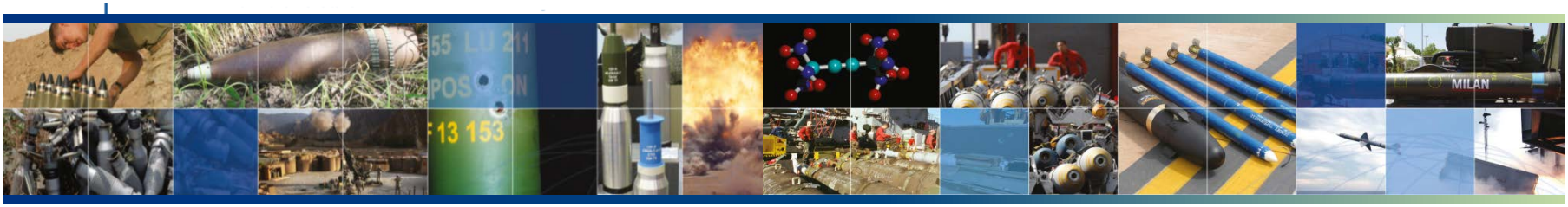
MSIAC

Munitions Safety Information Analysis Center

Supporting Member Nations in the Enhancement of their Munitions Life Cycle Safety



STANAG 4396
Review of Sympathetic Reaction Tests

Insensitive Munitions and Energetic Materials Technology Symposium
Portland, OR, USA – April 2018

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Agenda

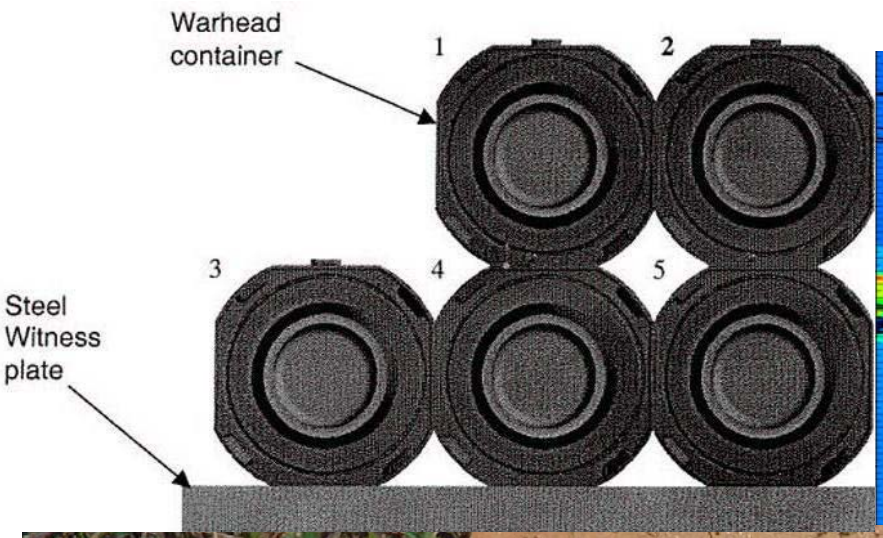
- Background
- Process / Questionnaire
- Standards
- Analysis and Comments
- Conclusion

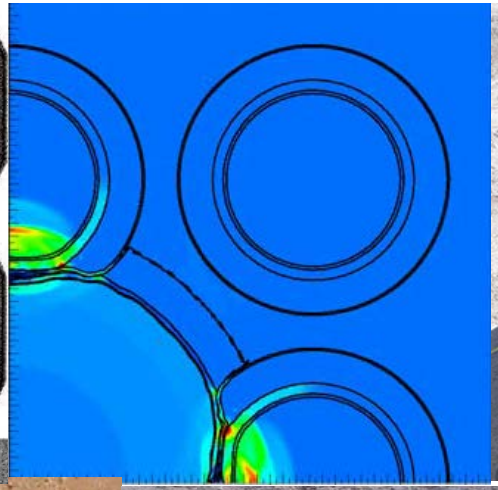
Background

- In 2016, MSIAC initiated a review of STANAG 4382 (Slow Heating Tests) that led to a list of recommendations to update the document.
- NATO AC/326 SG/B tasked MSIAC to initiate the same type of review for the IM Sympathetic Reaction test.

Stated aim of the test

To provide a standard test procedure to assess the potential for a munition to sympathetically react to the initiation of an adjacent munition.





Procedure

- MSIAC has written a survey related to the Sympathetic Reaction Test
- The survey was reviewed by the custodian of STANAG 4396 (France)
- The survey was sent to the nations
- After reception & analysis of the answers and other related documents, MSIAC is summarizing the results in a report.

Test Standards

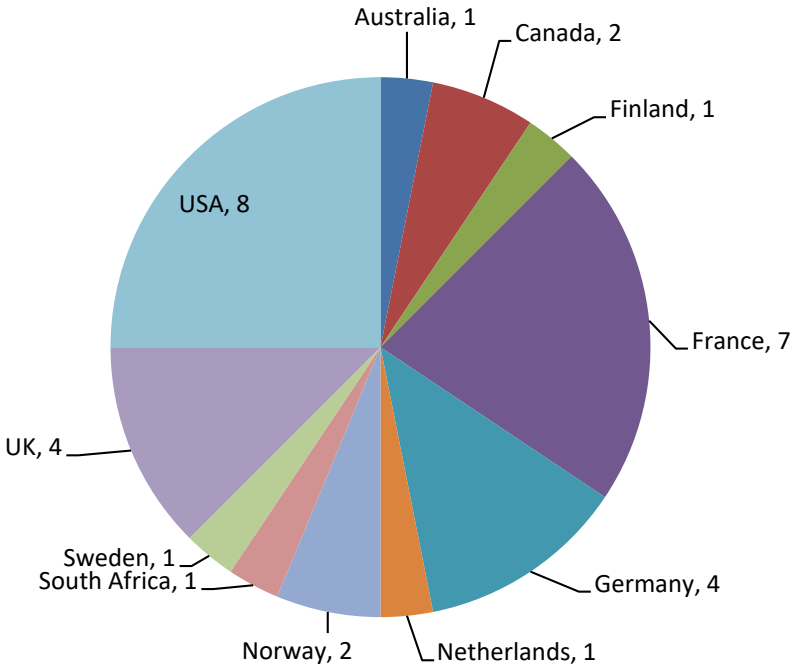
- The sympathetic reaction test is defined within several documents.
  - In NATO:
    - STANAG 4396 ed.2 (Reaction level)
    - AOP-39 ed.3 (Requirements and Guidance)
  - In UN, for HC 1.6:
    - Test 7 (h) of UN Recommendations on the transport of dangerous goods – Manual of tests and criteria, 6th revised edition

Origin of the answers

Supporting Munitions Safety

32 responses from 10 nations.
59%/41% government /private

Answers by nations



THANK YOU

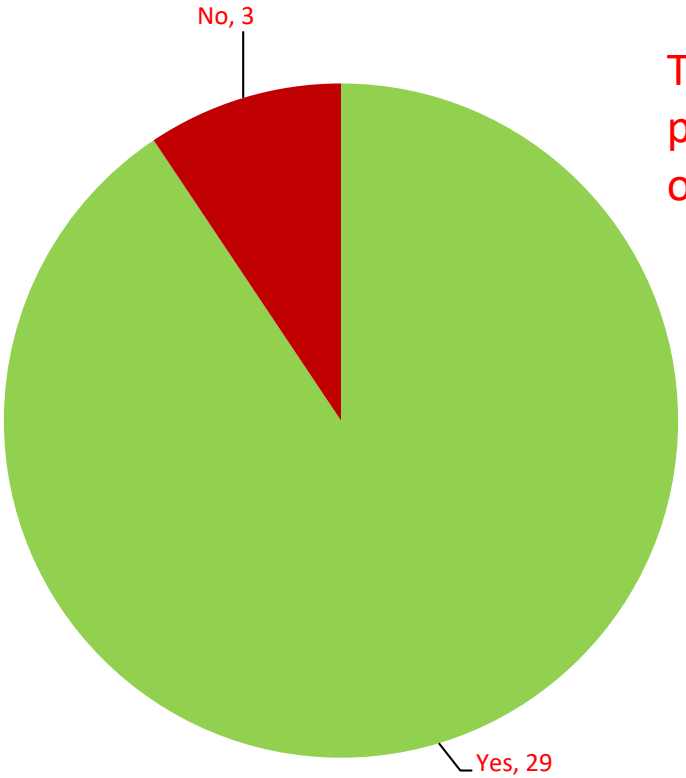
for the number and the quality of your answers

Organisation	Country	IM Function
Directorate of Ordnance Safety	Australia	Other: Government
Consultant - Defence R&D Canada	Canada	Test Scorer
Defence R&D Canada - Valcartier Reserach	Canada	Other: Government
FDF/Explosives Centre	Finland	Test Center
ArianeGroup SAS	France	Test Center
DGA	France	Other: Government
DGA Missile Testing	France	Test Center
DGA Techniques Terrestres	France	Test Scorer
DGA/INSP/SM	France	Other: Government
THALES LAS FRANCE	France	Munition Developer
THALES LAS France - domaine VTS France (	France	Munition Developer
Bundeswehr	Germany	Test Center
Diehl Defence	Germany	Munition Developer
MBDA-TDW	Germany	Munition Developer
Rheinmetall Waffe Munition GmbH / EZU	Germany	Test Center
MOD / KCW&M	Netherlands	Test Center
Forsvarets forskningsintitutt	Norway	Government Oversight
Nammo	Norway	Test Center
RDM & National IM Steering Committee	South Africa	Test Center, Munition Developer
Bofors Test Center	Sweden	Test Center
BAE Systems Land UK	UK	Munition Developer
Health and Safety Laboratory	UK	Test Center
MBDA	UK	Munition Developer
Ordnance Test Solution Ltd	UK	Test Center
Navy Munitions Reaction Evaluation Boar	USA	Test Scorer
96 Test Wing/Systems Safety Office	USA	Test Scorer
780TS Eglin AFB FL	USA	Other: Government
AF Research Laboratory	USA	Test Scorer
Air Force Live Cycle Management Center,	USA	Munition Developer
Army IM Board	USA	Test Scorer
NSWC/Hart Technologies	USA	Other: Government
Redstone Test Center, ATEC	USA	Test Center

Many responses are organizational, rather than of an individual

Test Purpose

What is the purpose of conducting the SR test?
To provide a standard test procedure to assess the potential for a munition to sympathetically react to the initiation of an adjacent munition.

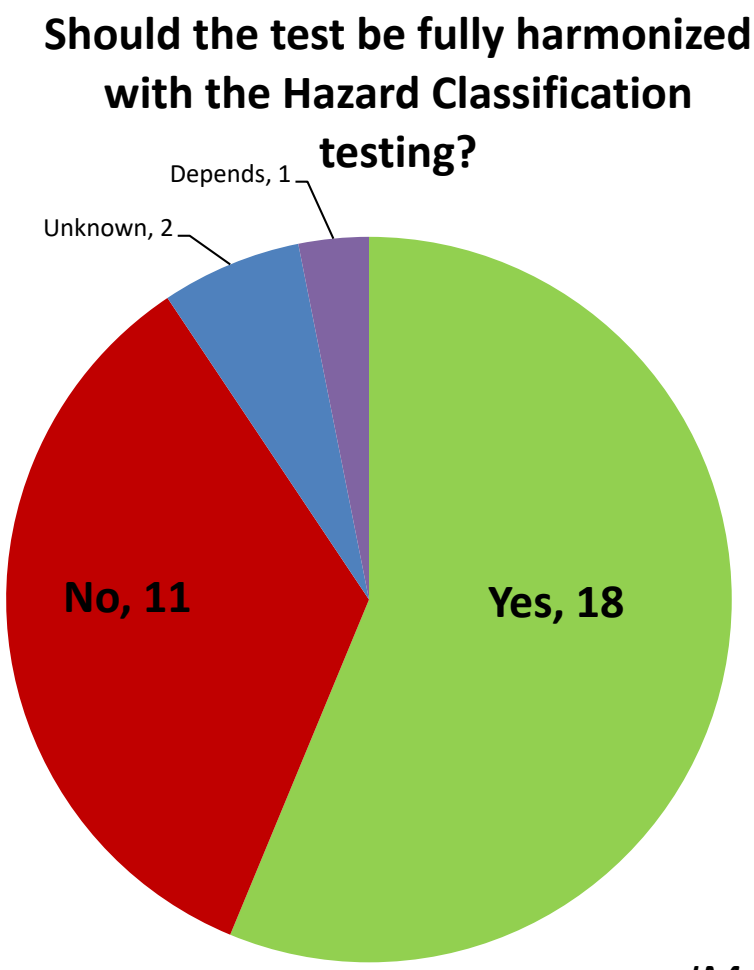


To evaluate the severity of an SR event for purpose of improving the Hazard Classification of a munition for storage and shipping.

To provide input for IM signature evaluation and HC evaluation

To characterize a munitions sympathetic reaction profile from the initiation of an adjacent munition representative of the users storage, transport or deployed configuration using a generic test procedure.

IM & HC Harmonization



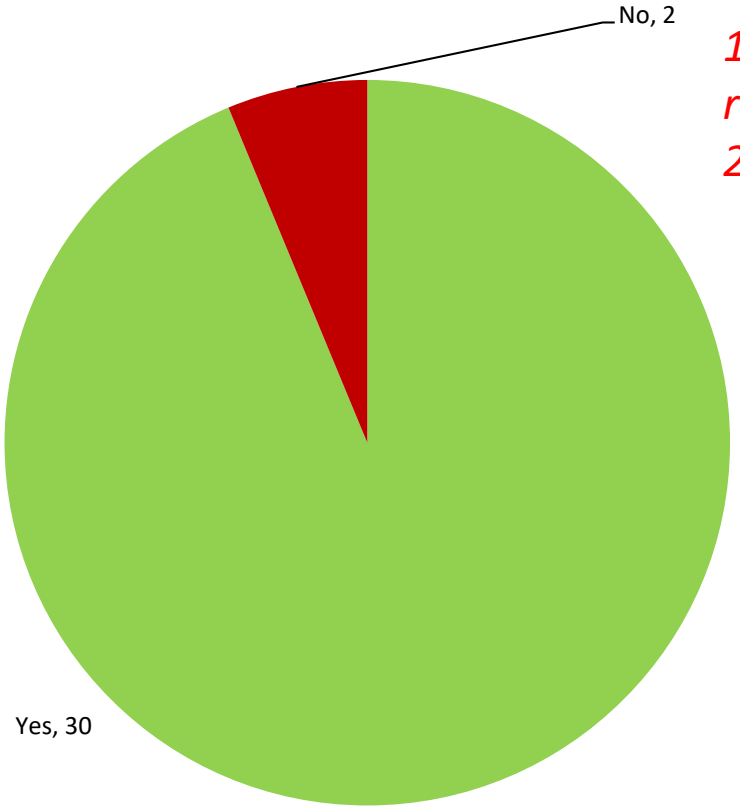
There should be two procedures,
- *Standard Test - that does not have variations on setup, therefore providing comparable results where ever it is done, this could be in line with the HC testing.*
- *Tailorable/Generic Test - that allows variance for user configurations that will provide an output depending on other factors such as storage, packaging etc."*

The test setup should allow for evidence gathering which can be used for both IM and Hazard Class scoring. This should ensure that only one test is needed.

IM sympathetic reaction test must not be merged with the transportation stack test, because their objectives are different and not compatible.

Test Procedure

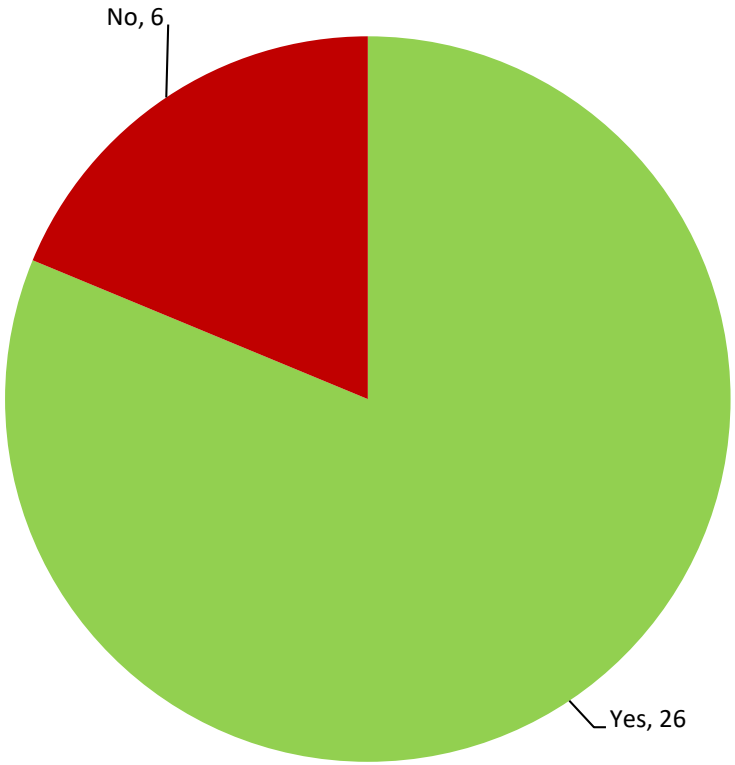
Do you conduct your SR tests as required by the STANAG 4396 test procedure?



1)Variation always required due to customer requirements or item particularities (UK).
2)Conducts HC SR testing …not IM (USA).

THA

Should the test configuration be determined by a Threat Hazard Assessment (THA)



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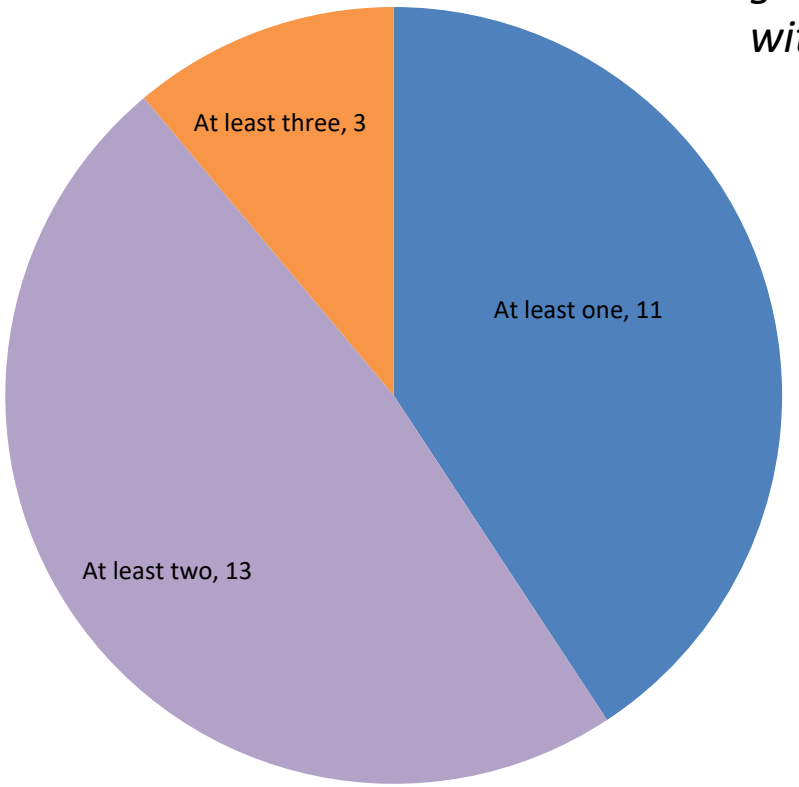
Number of tests

How many tests should be conducted?



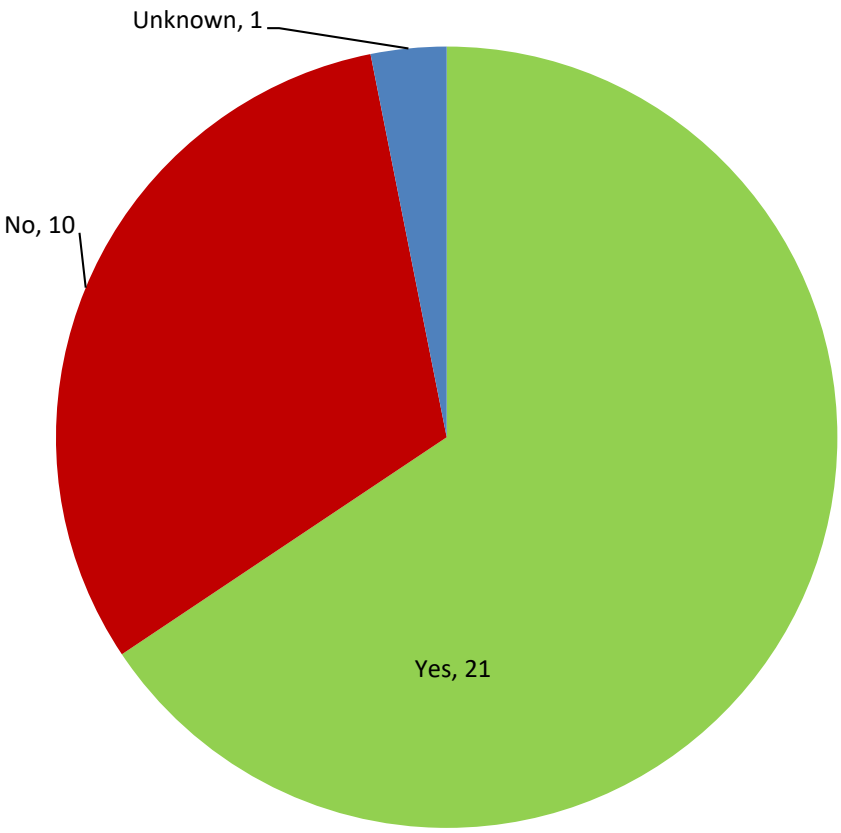
Good statistical question, and one that could get quite expensive. I would suggest that 3 without failure should provide good confidence

minimum of 1, if a pass, then a 2nd to confirm/validate the result.

One, to prevent excessive costs

Confined Test

Should a confined test be conducted?



Potential Safety Issue: Sand Confinement

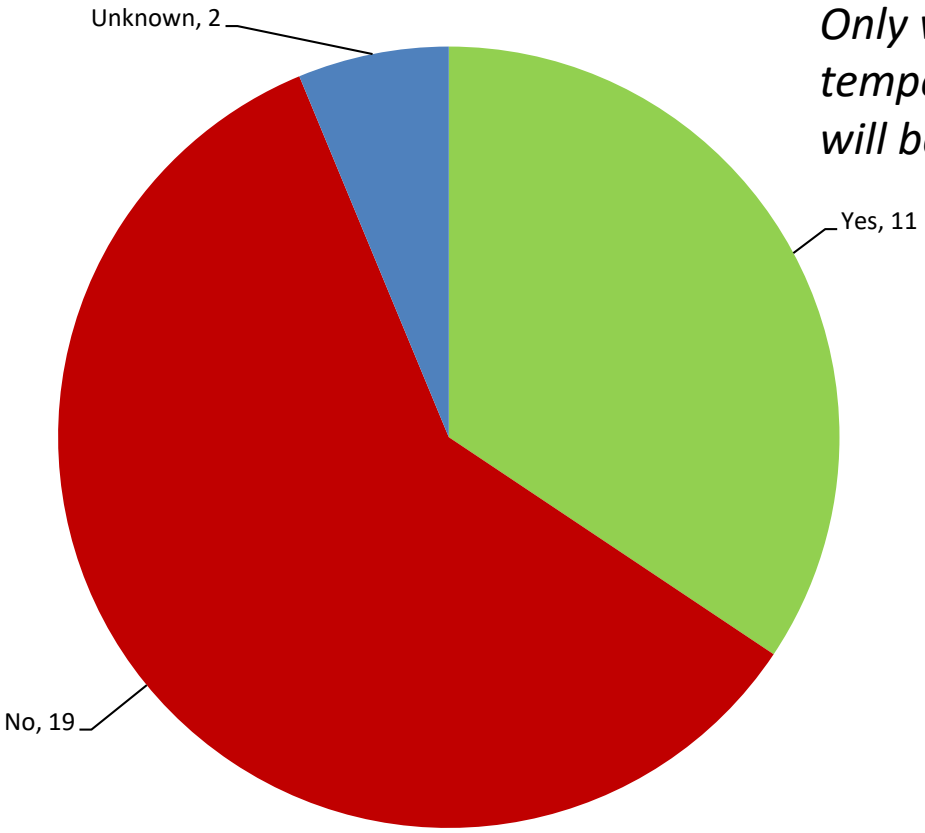
The confinement should be established in the threat hazard assessment for realistic scenarios. An equivalent confinement can then be designed.

When is it acceptable to replace live items with inert items?

1) When confinement is needed to replicate actual storage/tactical environments but it is unnecessary to add extraneous live rounds to obtain a pass/fail result. For example a situation where the adjacent round is likely to detonate but not continue to propagate the detonation further.
2) When used as confinement.
3) When trying to differentiate the response from 2 parts of a munition, i.e. the warhead vs. the propellant or motor.

Preconditioning

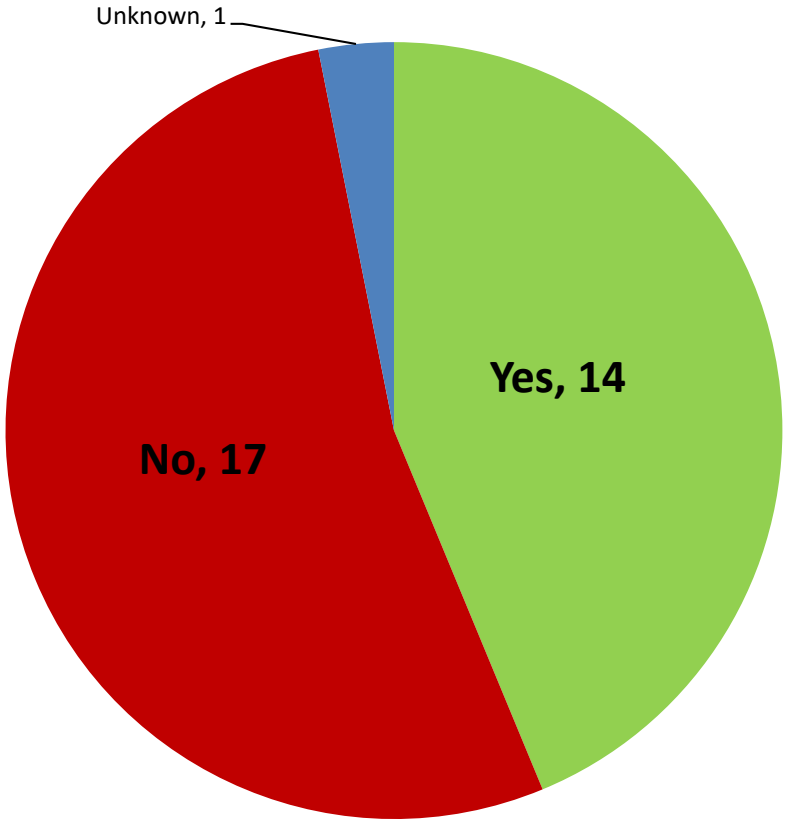
Should preconditioning be used?



Only when the item tested has sensitivity to temperature and there is likelihood that this will be seen as defined by a THA

Restraining Devices

Should restraining devices be defined in the STANAG?



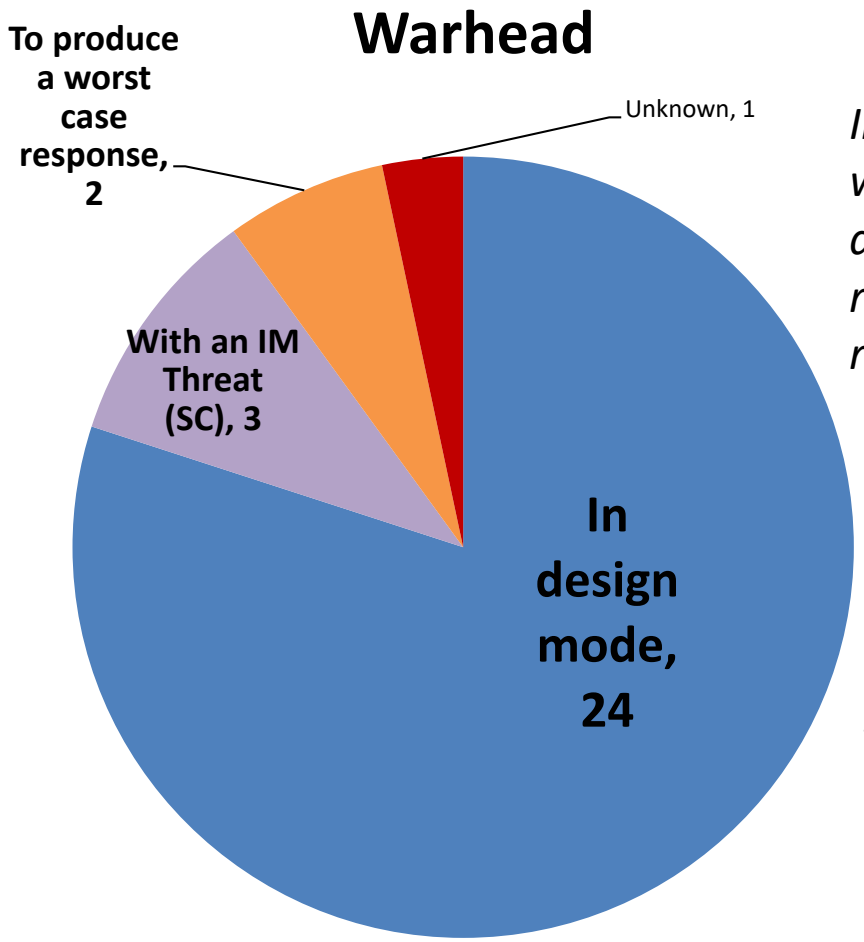
As per current STANAG: They shall not disturb the result analysis.

To replicate in service configurations
These should be mentioned as suggestion for organizations facing space limitation

Could be used sometimes but should depend on the test item configuration. Shouldn't be a mandatory requirement.

Donor Initiation

How should the donor be initiated?



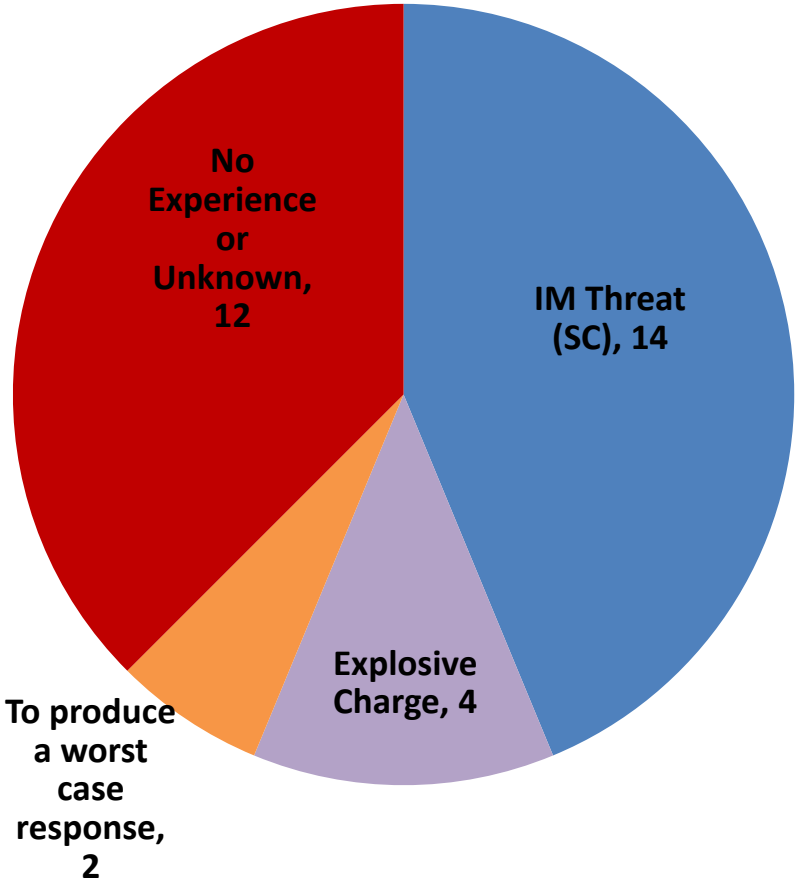
In a way that is closest to the real initiation, without compromising safety at the site. A dummy fuze with a hole and a small representative booster would be my recommendation.

If the fuzing device is equipped with two or more independent effective protective features, then fuze disfunctionning could be excluded. Then the initiation of the donor with a credible IM threat that produces the worst case donor reaction, in general the Shaped Charge Jet (SCJ).If the fuze is not safe then it in logic to use the normal means of initiation.

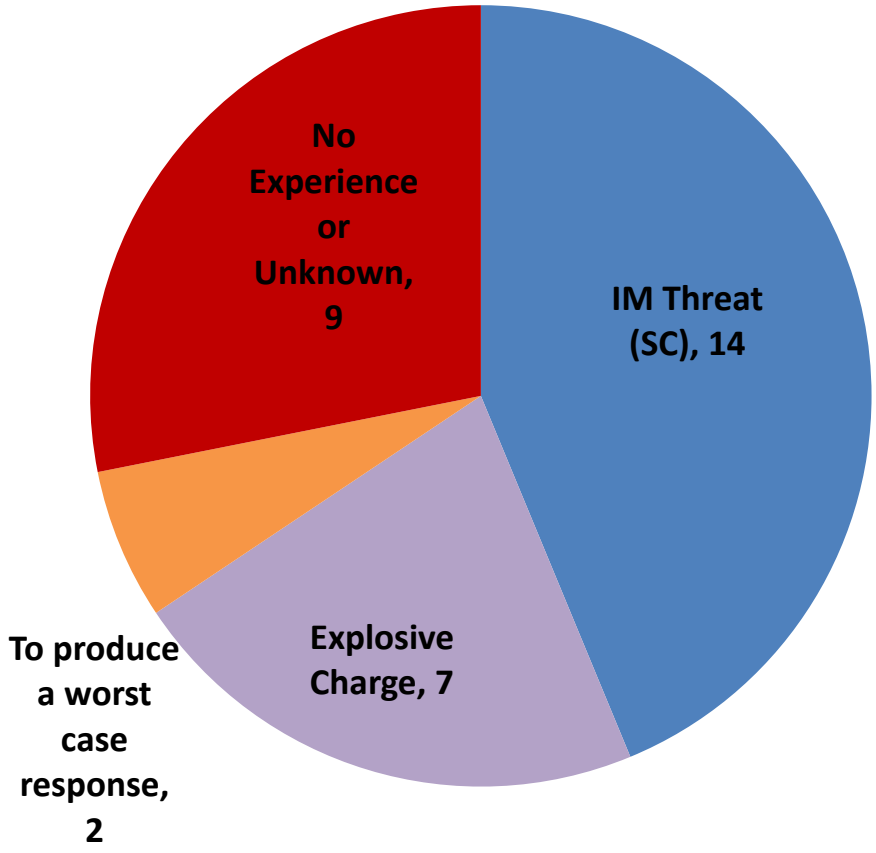
Donor Initiation

How should the donor be initiated?

Rocket Motor

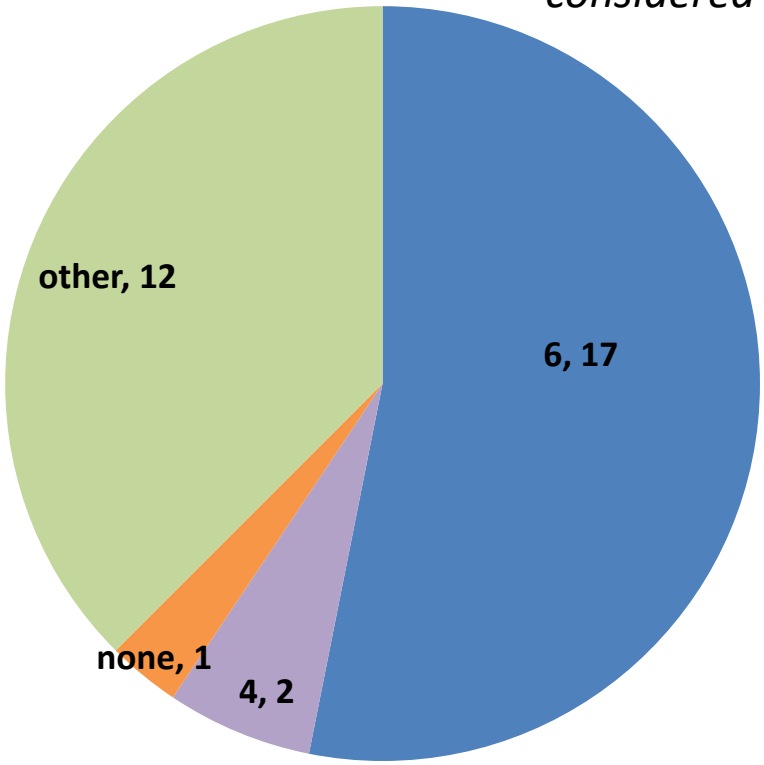


Gun Propellant



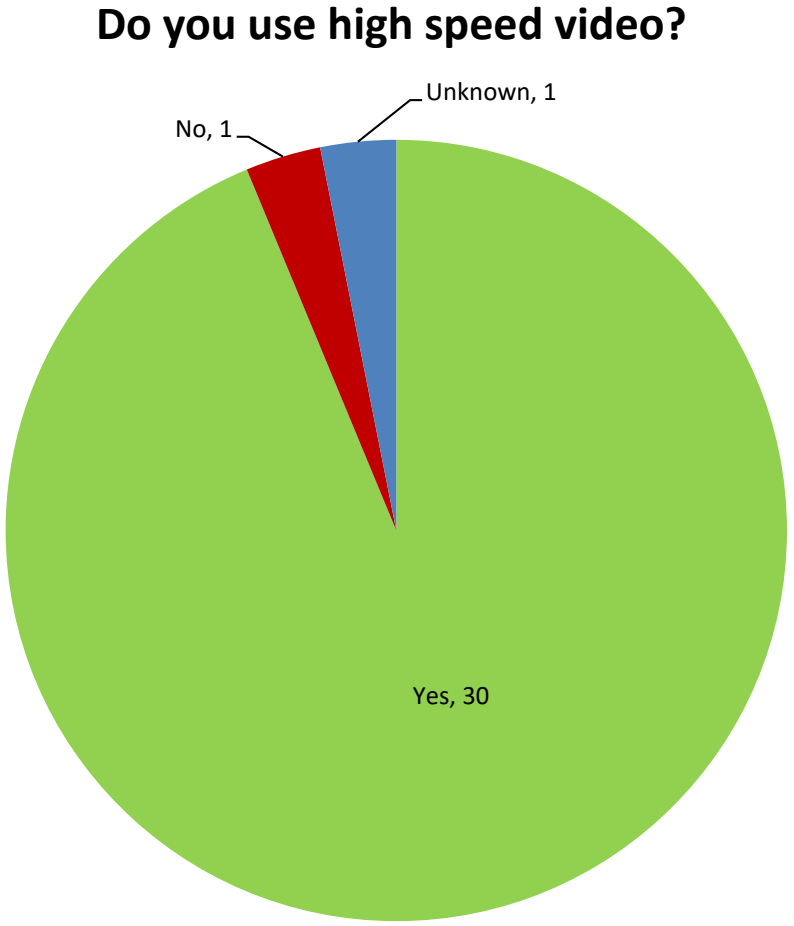
How many blast gauges?

- *Same as current STANAG 4396 requirement: "Pressure gauges may be used to measure the air shock. The transducers should be placed in arrays some distance from the test configuration; they may be in ground or in elevated mounts. The fixtures shall not interfere with the air flow. Precalibration shall be considered if external sensors are used."*



- *6 (2 lines of 3 distances)*
- *The test center has to place enough gauges to be sure to have enough information to use the response descriptors table*
- *Firstly, donor test evaluation. Gauges (number, position) are chosen to evaluate the response descriptors.*
- *As many as necessary to be able to compare with the pressure history generated by a lone donor charge*
- *We use two lines of five blast gauge each.*
- *Depends on the munition and magnitude of the response.*

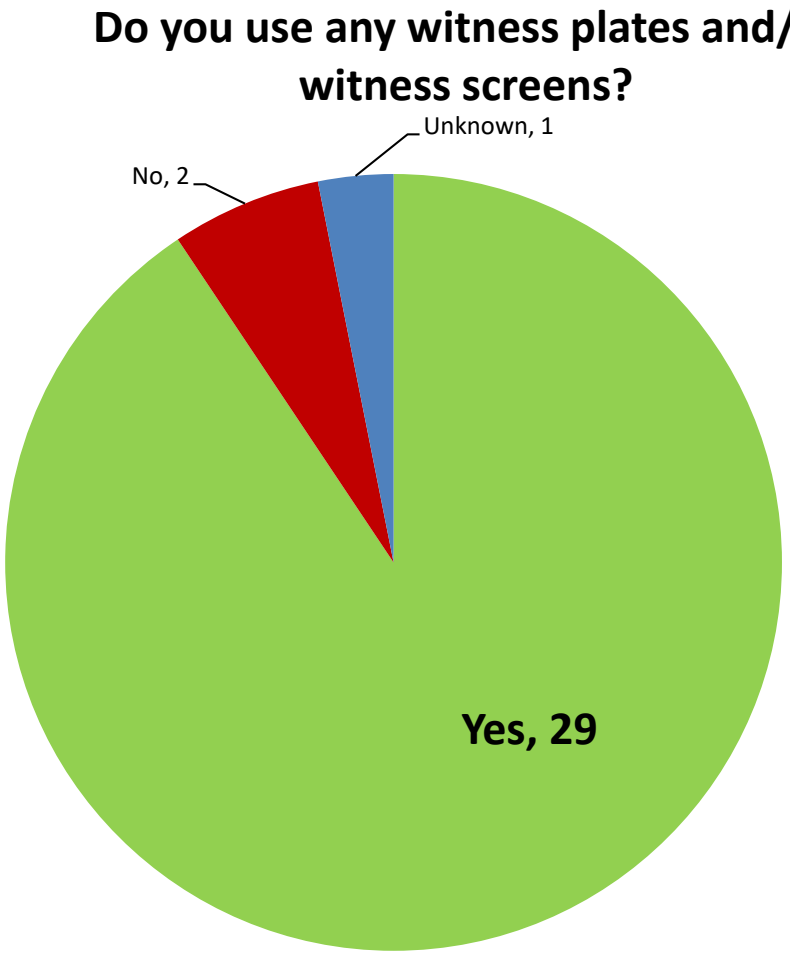
High Speed Video



Reported frame rates (fps)

- 30
- 120
- 1000
- 2000
- 5000
- 7000
- 10000
- 12000
- 20000
- 30000
- 50000
- 75000
- 100000

Witness Panels



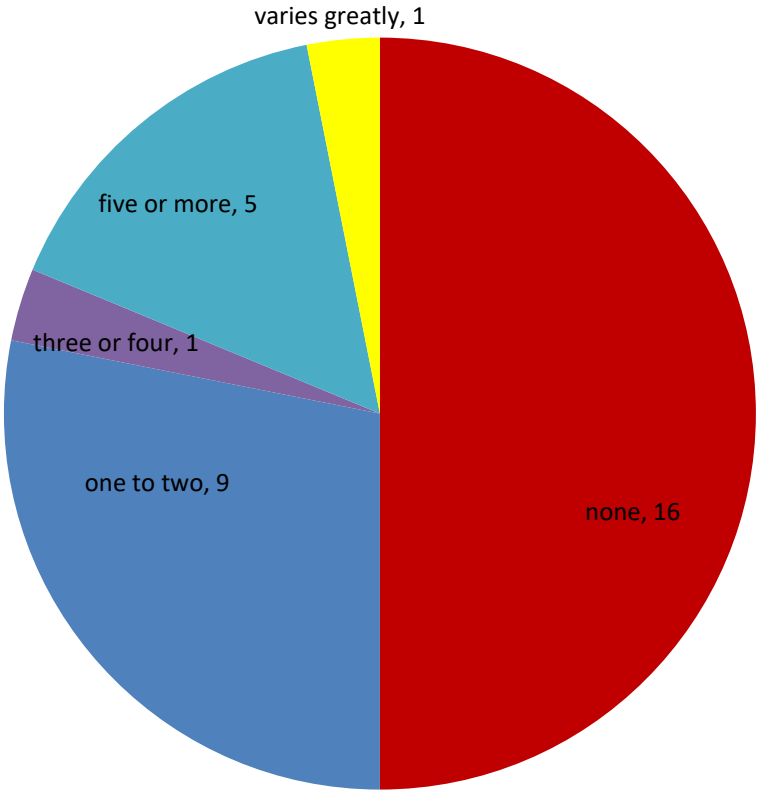
- We use steel or aluminum plate. The thickness depends on the munition characteristics. (5 responses)
- When high explosives charge are involved in the ammunition: 2.5 cm (1 inch thick) mild steel plates of size depending on the item tested. For gun propellant: 2.5 cm (1 inch thick) aluminum plates.

Annual Testing

How many qualification SR tests do you typically perform per year?

None includes no answer

How many developmental engineering SR tests do you typically perform per year?



Much greater number of development engineering tests:
In excess of 15 per year, 8 to 20, few dozens, >100

Conclusion

Baseline Test Data Comment (many similar)

- *I think it is a good idea to introduce a calibration test where only the donor is initiated (or ignited) to its most severe reaction. In such test all other acceptors shall be inert. By doing this you will get a very good (and necessary for the assessment of the result) reference of e.g. blast pressure levels, fragmentation of the acceptors and eventual projection distances when you know that only the donor reacted. A calibration test should be mandatory.*

NATO AC/326 SG/B Sympathetic Reaction Custodial Working Group is using this information as part of the process to update STANAG 4382