

NATO AC/326 SG/B  
Ammunition Systems Design and  
Assessment

Insensitive Munitions Test STANAG  
Updates (Part 2)

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SG/B

# Acknowledgements

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- During the past five years all seven of the NATO Insensitive Munitions (IM) test STANAGs and Allied Publications (AP) have been updated.
- Each document has been updated to the current NATO standardization requirements spelled out in AAP-03K.
- The overarching IM test documents STANAG 4439 and AOP-39 (*“Policy on the Development and Assessment of IM”*) were part of the update.
- The guidance provided by the updated standards will ensure more consistent testing and evaluation of ordnance hazard assessment testing.

# Background

- Last coordinated publication of IM Test STANAGs April 2003
- STANAG 4439 / AOP-39 revised twice since last Test STANAG update
  - Resulting inconsistencies
- Changing organisation and structures
- Opportunity with transition of Test STANAGs to AOPs

IM Policy:

FH:

Bl:

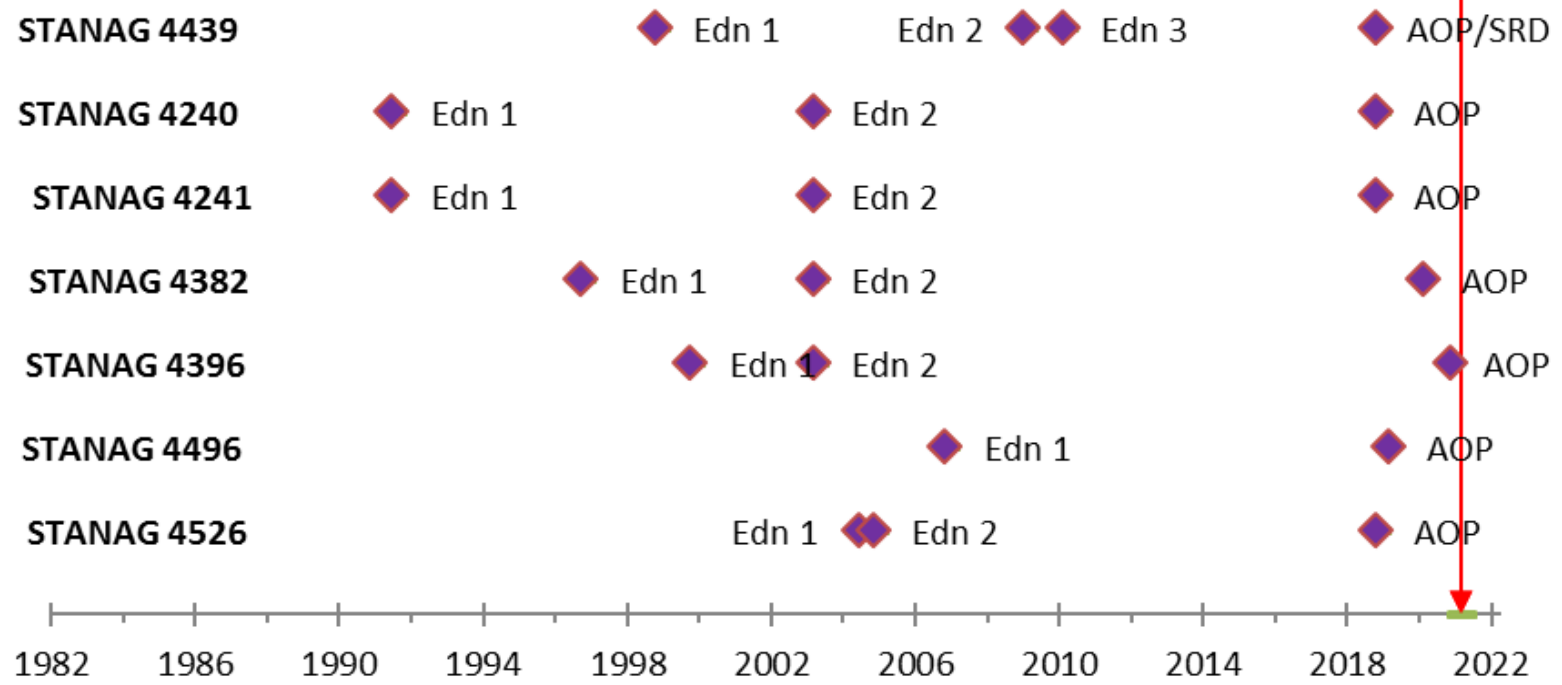
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SCJ:

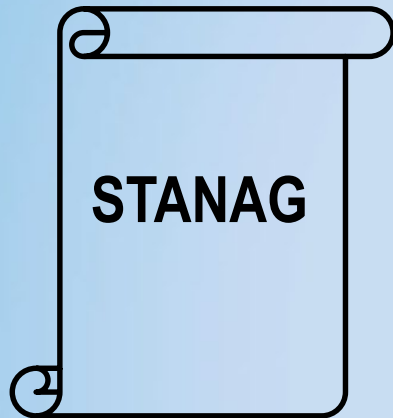
## NATO IM STANAG Timeline



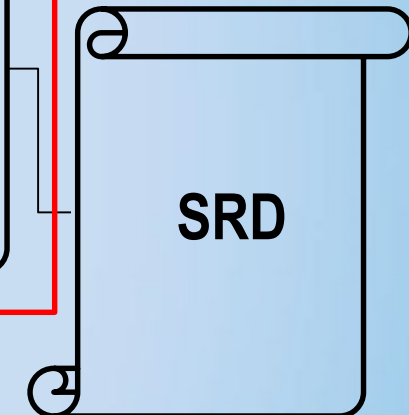
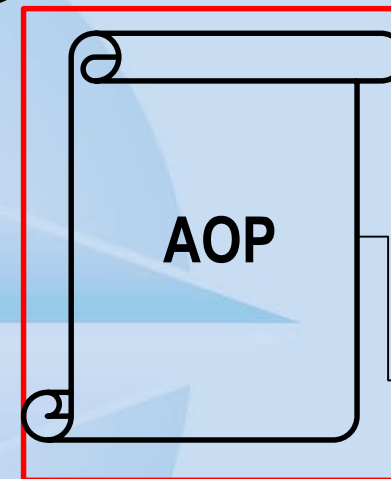
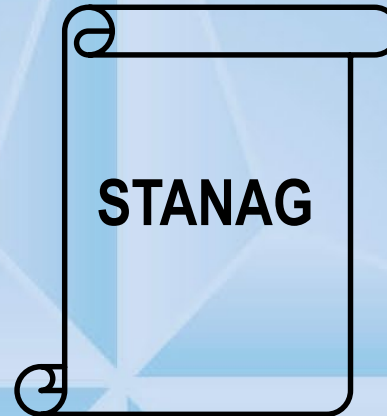
# NATO Documentation Policy

NATO Policy on document structure: AAP-03(K)

Before



Now



- STANAG : STANdardization AGreement (cover document)
- AOP : Allied Ordnance Publication (**technical document**)
- SRD : Standard Related Document (recommendations)

**Differences in ratification and promulgation:**

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# NATO Documentation Policy

## Standardization Agreement (STANAG)

- “...a NATO standardization document that specifies the agreement of member nations to implement a standard... in order to meet an interoperability requirement.”
- No technical content.
- Has to be ratified by a minimum number of nations

## Allied Publication (AP)

- Technical content – policy, requirements etc.
- Promulgated once covering STANAG has been ratified
- Change process:
  - Minor changes – Version Update (Ed. A V1 → Ed. A V2) – update of STANAG not reqd
  - Major changes – Edition Update (Ed. A V1 → Ed. B V1) – STANAG requires update & ratification

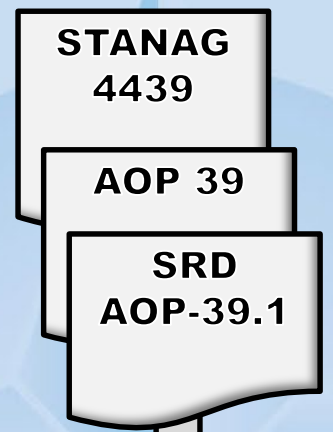
## Standards-Related Document (SRD)

- “...a NATO standardization document that facilitates understanding and implementation of one or more Allied standards”
- Provides additional data and information, but no policy or requirements (e.g. manuals, catalogues)
- All changes approved by silence procedure – not update to STANAG required.

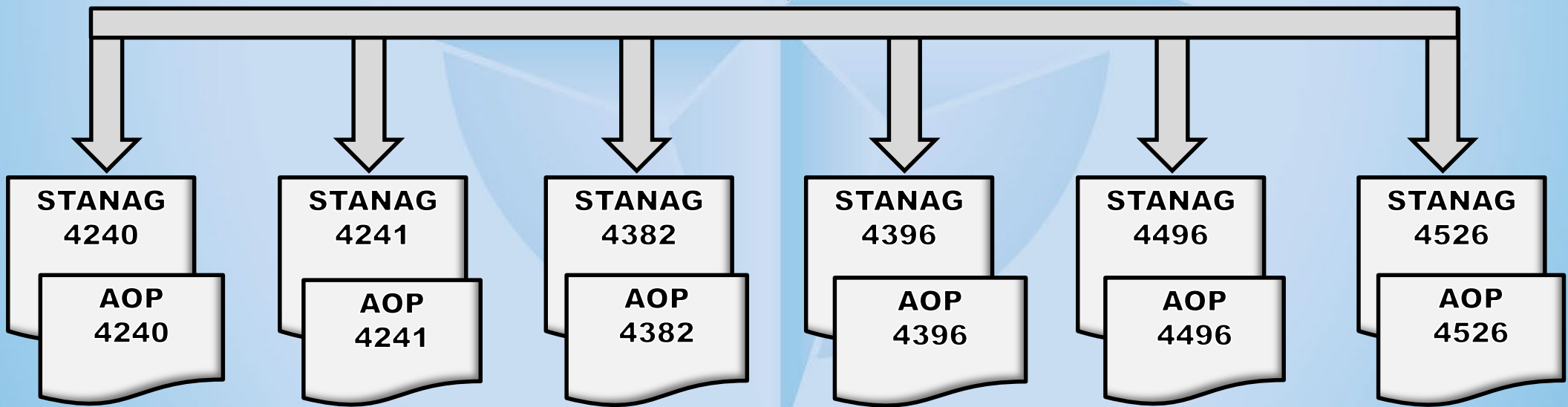
# IM Standards Hierarchy

*All documents updated or new!*

Overarching IM Policy



Individual Test Standards





# AOP-39 Update (Edition D)

- Two strands of work for AOP-39 update
  - Review of Test Conduct and Reporting (Annex H)
  - Review of IM Response Descriptors (RD) (Annex I)
- Annex H: Largely removed
  - Common aspects of conduct and documentation in SRD
  - Technical aspects in individual test AOPs
  - Test specific conduct and reporting in individual test AOPs
  - NB remaining elements now superseded by publication of 6 full-scale AOPs – Annex H will be removed from next Edition of AOP-39
- Annex I
  - IM Response Descriptors updated
    - Fragment with energy level  $> 20$  J at 15 m, regarding its mass and nature: Steel, Aluminum, Tungsten and HDPE
  - Articles Under Test more defined and prescribed
  - Calibration Testing promoted and more fully prescribed

# SRD AOP-39.1 (Edition A)

- Common aspects of conduct and documentation
  - Test framework, organization and responsibilities
  - Test program
  - Test planning and guidance
  - Test specific considerations
  - Documenting
  - Test conduct
  - Reporting

# Current Status of Test Standards

Standard	Title	Edition	Date
STANAG / AOP-4240	Fast Heating Munition Test Procedures	Ed A V1	NOV 2018
STANAG / AOP-4241	Bullet Impact Munition Test Procedures	Ed A V1	NOV 2018
STANAG / AOP-4382	Slow Heating Test Procedures for Munitions	Ed A V1	MAR 2020
STANAG / AOP-4396	Sympathetic Reaction Test Procedures for Munitions	Ed A V1	DEC 2020
STANAG / AOP-4496	Fragment Impact Test Procedures for Munitions	Ed A V1	MAR 2019
STANAG / AOP-4526	Shaped Charge Jet Munition Test Procedure	Ed A V1	NOV 2018

All available on website of NATO Standardization Office: <https://nso.nato.int/>

# AOP-4240: Fast Heating

- Test Methods – *Modified*
  - Test Method 1: Large pool fire
  - Test Method 2: Mini pool fire
  - Test Method 3: Fuel burner fire **NEW**
    - Characterized by average heat flux  $> 80 \text{ kW/m}^2$  over 30 s period once  $800 \text{ }^\circ\text{C}$  is reached
- Thermocouples – *Modified*
  - Minimum 6 TC: (40-60 mm) fore, aft, starboard, port, above and below
- Conformity – *Modified*
  - Taverage  $> 800 \text{ }^\circ\text{C}$  measured by all TC
  - $550^\circ\text{C}$  under 30 s measured by all TC



US NSWCCD 3.7 m square propane burner

# AOP-4241: Bullet Impact

## ■ Test Methods – *Modified*

- Test Method 1: 3 12.7 mm AP M2 projectiles at  $850 \pm 20$  m/s ( $600 \pm 50$  rounds/min)
- Test Method 2: 1 12.7 mm AP M2 projectile at  $850 \pm 20$  m/s
- Test Method 3: 1 or several projectiles – projectile and velocity determined by THA

**NEW**

**NEW**

- Annex A: Recommendations aiming point and target area
- Annex B: Specifications 12.7 mm AP projectiles



# AOP-4382: Slow Heating

## ■ Test Methods – *Modified*

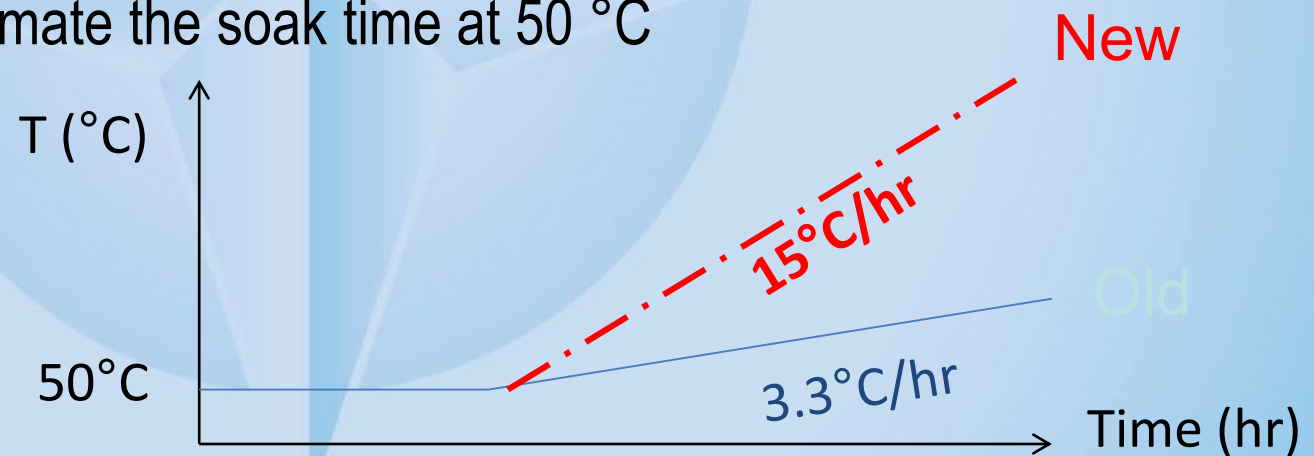
- Test Method 1: Preconditioning at  $50 \pm 3^\circ\text{C}$  until thermal equilibrium of the test item, then Heating Rate  $15^\circ\text{C/hr}$  until reaction occurs
- Test Method 2: Heating Rate determined by THA
- Test Method 3 (UN HC):  $3.3^\circ\text{C/hr}$  until reaction occurs – possibility to precondition at  $T_{\text{reaction}} - 55^\circ\text{C}$  (estimated)

## ■ Thermocouples – *Modified*

- 6 required TC at 40-60 mm around the test item, rather than 4

## ■ Annex A: Methods to estimate the soak time at $50^\circ\text{C}$

NEW



# AOP-4396: Sympathetic Reaction

## ■ Single Test Method (based on donor initiation)

- If designed to detonate, initiate the donor munition in the design mode – *Unchanged*
- For munitions which are not designed to detonate, initiate the donor munition(s) with a credible threat that produces a worst-case response (e.g. shaped charge jet, explosive charge etc.) – *Modified*
- Sand / dirt etc. not to be used for simulating external confinement – *Modified*

## ■ **Baseline test:** recommendation to perform a baseline test in order to determine the blast, fragmentation and penetration signature of the donor test item(s), and the fragmentation and spatial distribution of inert acceptors.

NEW

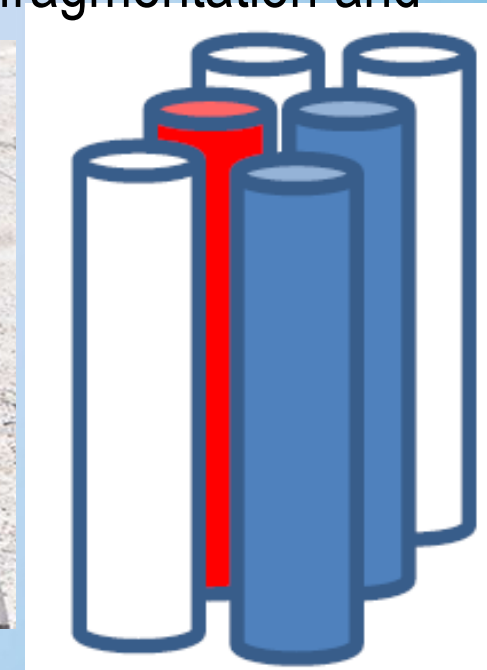
## ■ Additions in SRD AOP-39.1

- SR configuration examples
- Clarification of what is the test item in SR tests

NEW

## ■ Addition of definitions for donor/acceptor munition in official NATO terminology

NEW



# AOP-4496: Fragment Impact

## ■ Test Methods – *Unchanged*

- Test Method 1: 2530 +/- 90 m/s
- Test Method 2: 1830 +/- 60 m/s

**NEW**

## ■ Accuracy at impact

- Set to ensure response mechanism under consideration is tested
- Test item dependent
- Approved by National Authorities

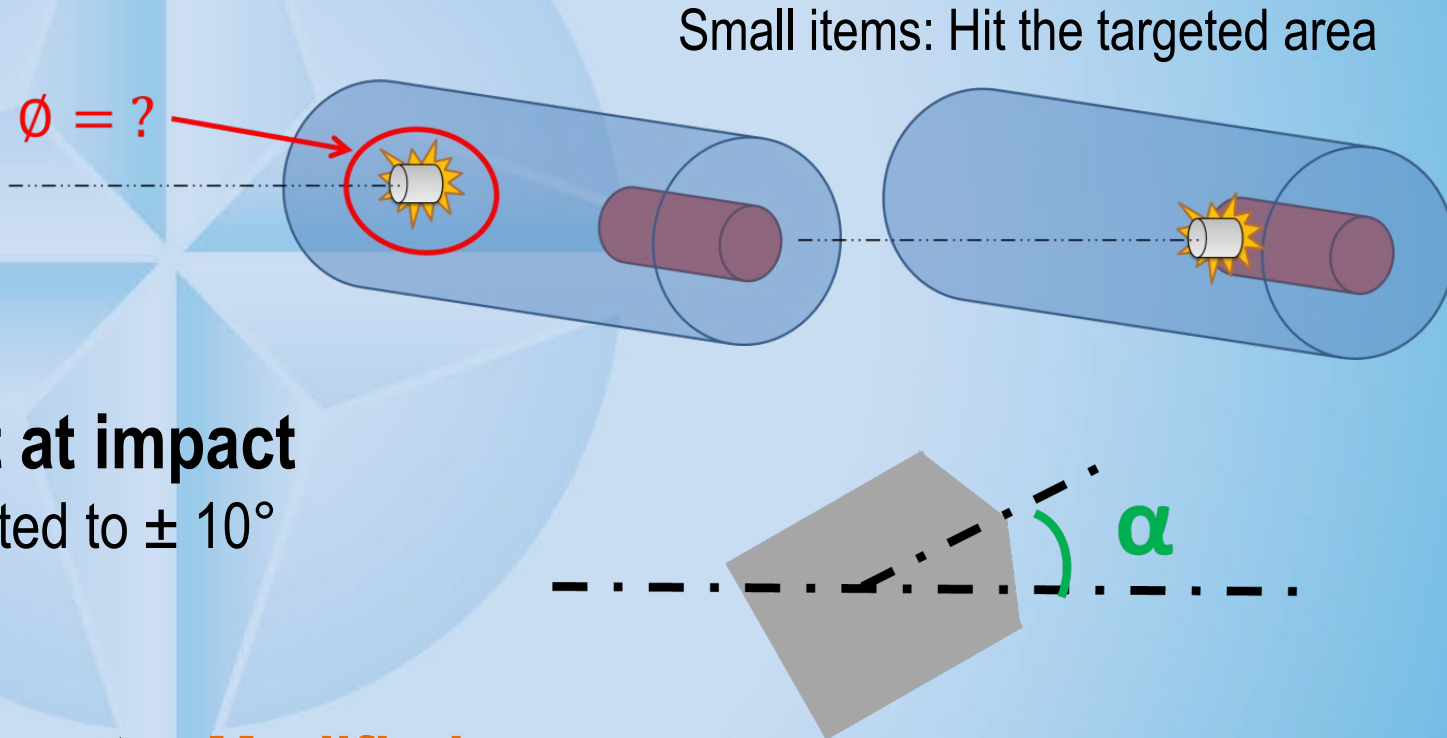
**NEW**

## ■ Orientation of the fragment at impact

- Angular deviation should be limited to  $\pm 10^\circ$

## ■ Brinell Hardness of the fragment – *Modified*

- **190** < HB < **270**





# AOP-4526: Shaped Charge Jet

NEW

## ■ Test Methods – *Modified*

- Test Method 1: SCJ characteristic of Rocket Propelled Grenade
- Test Method 2: SCJ supported by means of a THA

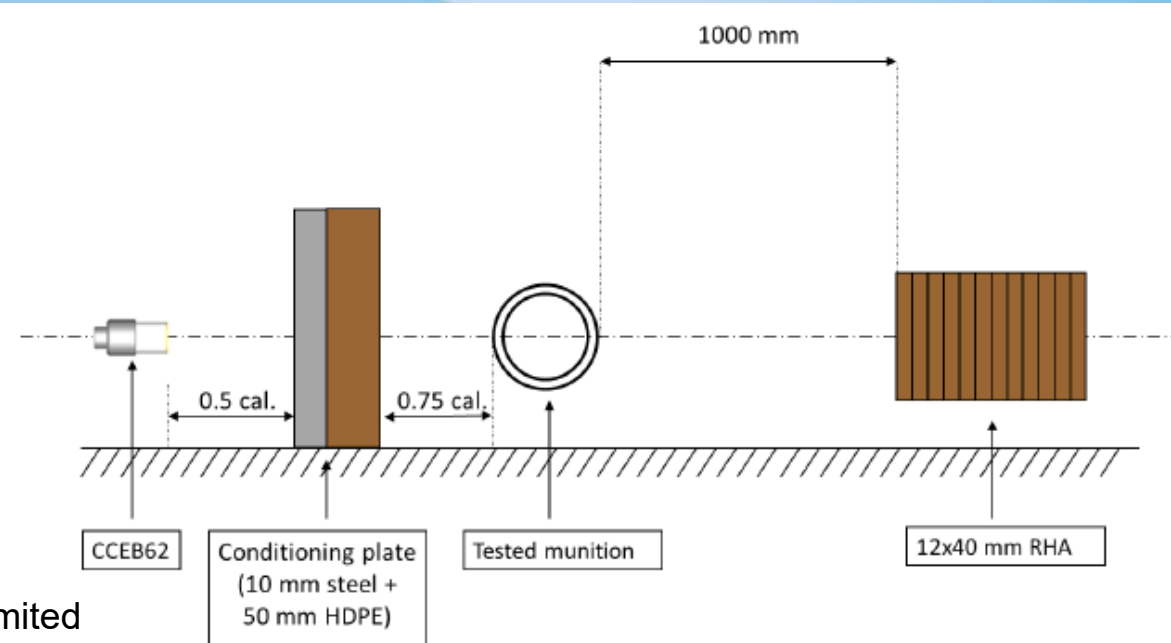
NEW

## ■ Characterization of the SCJ

- $V^2d$  at target between 120 and 140 mm<sup>3</sup>/μs<sup>2</sup>
- Jet diameter at target between 2.5 and 3.5 mm

Previous: STANAG: Rockeye 50 mm

New: SC 81 mm LX-14 (USA); France : CCEB62



# IM Test AOP Version Update

- Due to long period of development, Editorial Working Group formed under AC/326 SG/B to review consistency & formatting of all 6 IM test AOPs
- Commenced Spring 2020 – virtual meetings every 2 weeks
- Work is subject of a separate presentation
  - Dan Pudlak – Working Group Chair

# Harmonization of IM & HC Standards

- Despite similarities in testing protocols employed by IM and Hazard Classification (HC) communities, a harmonized approach to testing has yet to be achieved
- IM/HC Harmonization Working Group established under AC/326 SG/B to explore the alignment of IM & HC standards and practices
- Work is subject of a separate presentation
  - Catherine Goodwin – Working Group Chair

# Concluding Remarks

- Updated editions of all 6 full-scale NATO IM test standards have now been promulgated, along with STANAG 4439 / AOP-39 / SRD AOP-39.1
  - Those involved in testing should ensure that they are now working to the latest standards.
- Ongoing work to review test standard consistency & formatting
  - Due to publish Version updates in 2021
- Longer-term work aimed at harmonizing HC and IM testing into a combined standard structure



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# QUESTIONS?

Distribution Statement A: Approved for public release; distribution is unlimited

# References

- E. Baker and D. Hubble, “Slow Heating Test Thermal Equilibrium and Maximum Reaction Temperature”, 2019 Insensitive Munitions & Energetic Materials Technology Symposium, Seville, Spain, November 2019.
- E. Baker, “An International Review of the Sympathetic Reaction Test”, MSIAC Report O-203, December 2018.
- E. Baker, “Slow Heating Testing Survey and Historical Events Review”, MSIAC Report O-195, October 2018.
- D. Hubble, “Analysis of the Ramifications of Increasing the Slow Cook-off Test Heating Rate”, 2019 Insensitive Munitions & Energetic Materials Technology Symposium, Seville, Spain, November 2019.
- C. Jacq, K. Tomasello, E. Baker and M. Sharp, “Review and Update of Insensitive Munitions Test Procedures”, 2019 Insensitive Munitions & Energetic Materials Technology Symposium, Seville, Spain, November 2019.
- K. Tomasello, C. Jacq, E. Baker and M. Sharp, “NATO AC326 SG/B: Ammunition Systems Design and Assessment – IM Test STANAG updates”, 2019 Insensitive Munitions & Energetic Materials Technology Symposium, Seville, Spain, November 2019.