Revisions and Improvements to the NATO Insensitive Munitions Test Doctrine Portfolio

Insensitive Munitions & Energetic Materials Technology Symposium (IMEMTS)

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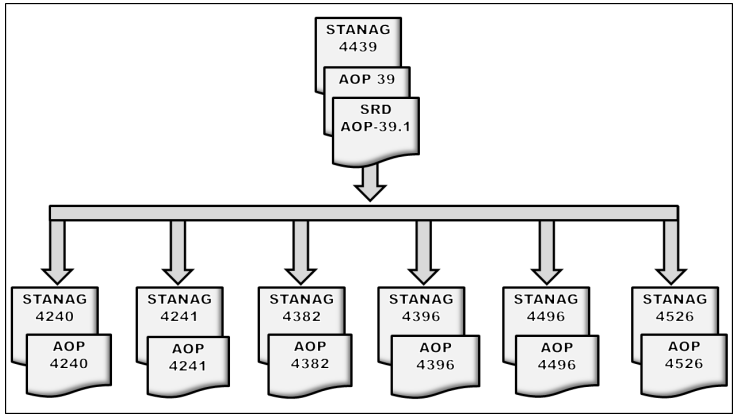
BLUF

NATO AC/326 CASG SG/B - *IM Test AOP Standardization WG*

- ❖ North Atlantic Treaty Organization (NATO)
- ❖ Conference of National Armament Directors (CNAD) Ammunition Safety Group (AC/326) (CASG)
- ❖ Sub-Group B (SG/B) Ammunition Systems Design and Assessment
- ❖ Insensitive Munitions (IM) Test Allied Ordnance Publication (AOP) Standardization Working Group (WG)



K. Tomasello, 'NATO AC326 SG/B: Ammunition Systems Design and Assessment – IM Test STANAG updates', IMEMTS, Spain, 2019.

Objective: 'Clean up' NATO IM Doctrine Portfolio to ensure the text *effectively*, *accurately* and *consistently* supports the technical metrics.

Introduction

NATO AC/326 CASG SG/B - *IM Test AOP Standardization WG*

- **Conceived** during Fall 2019 SG/B IM Sympathetic Reaction Test Custodial Working Group (SR-CWG) congregation (Koblenz, Germany).
- **Commissioned** as a result of action item to ensure consistency amongst the suite of the IM Portfolio documents (6 Test AOPs, 1 Policy AOP, 1 Guidance SRD) to ensure the new revisions comply with the WG decisions previously made.
- **Commenced** in Spring 2020 by reviewing the AOPs individually, and the respective Document Custodians were charged with incorporating the necessary changes.

    - **Members**:
        - NATO AC326 SG/B Chairman (Tomasello)
        - IM AOP Test WG Lead – (Pudlak)
        - Contractor Support – (Swierk)
        - MSIAC Support – (Ferran)
        - AOP Custodians
            - AOP-4240 – Netherlands (Bouma)
            - AOP-4241 – Germany (Hamhuis)
            - AOP-4382 – United States (Struck)
            - AOP-4396 – France (Jacq* / Weisse)
            - AOP-4496 – France (Jacq* / Weisse)
            - AOP-4526 – United States (Dr. Fuchs / Pudlak)
            - AOP-39 – France (Jacq* / Weisse)
            - AOP-39.1 – France (Jacq* / Weisse)
            - IM/HC – United Kingdom (Goodwin)

Introduction

NATO CNAD AC/326 CASG SG/B - *IM Test AOP Standardization WG*

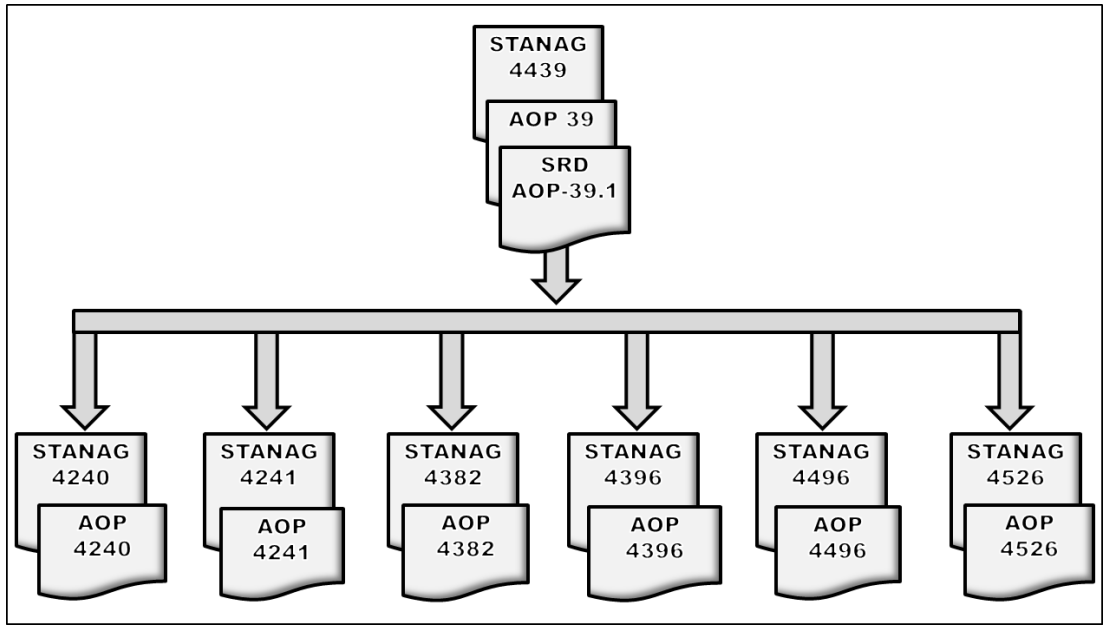
- Update to NATO IM Test Doctrine Portfolio:
  - ✓ Ensuring *consistency* amongst the test documents
  - ✓ During this process, IM Test AOP Standardization WG realized the AOPs could be improved:
    - *Textual changes* for clarity of intent
    - *Outline structural revision* to improve:
      - Readability
      - Flow logic
      - Consistency
    - *Match the latest NATO AOP Format* (provided by MSIAC)
  - ✓ Ultimately each of the updated 6 IM Test AOPs, 1 Policy AOP & 1 Guidance SRD:
    - Will undergo a *Version Update*
    - Will NOT undergo Ratification

Purpose

- This presentation will ***briefly highlight*** the ***textual changes*** that were made, as well as the ***new format*** that was developed to synchronize these documents.

- Furthermore, this presentation will ***briefly discuss*** the ***subsequent changes*** that will be made to the ***related documents*** (e.g. AOP-39, SRD AOP-39.1, IM/HC AOPs, etc.) supporting these Test AOPs.

Background – NATO Portfolio



K. Tomasello, 'NATO AC326 SG/B: Ammunition Systems Design and Assessment – IM Test STANAG updates', IMEMTS, Spain, 2019.

- New NATO Portfolio changes included *Re-organization* and *Re-structure*
  - **STANAGS** are now stand-alone Cover Documents
  - **Test AOPs** created to retain test requirements specific to each Test STANAG
  - **SRD** created to provide guidance and additional information (common amongst all Test AOPs)

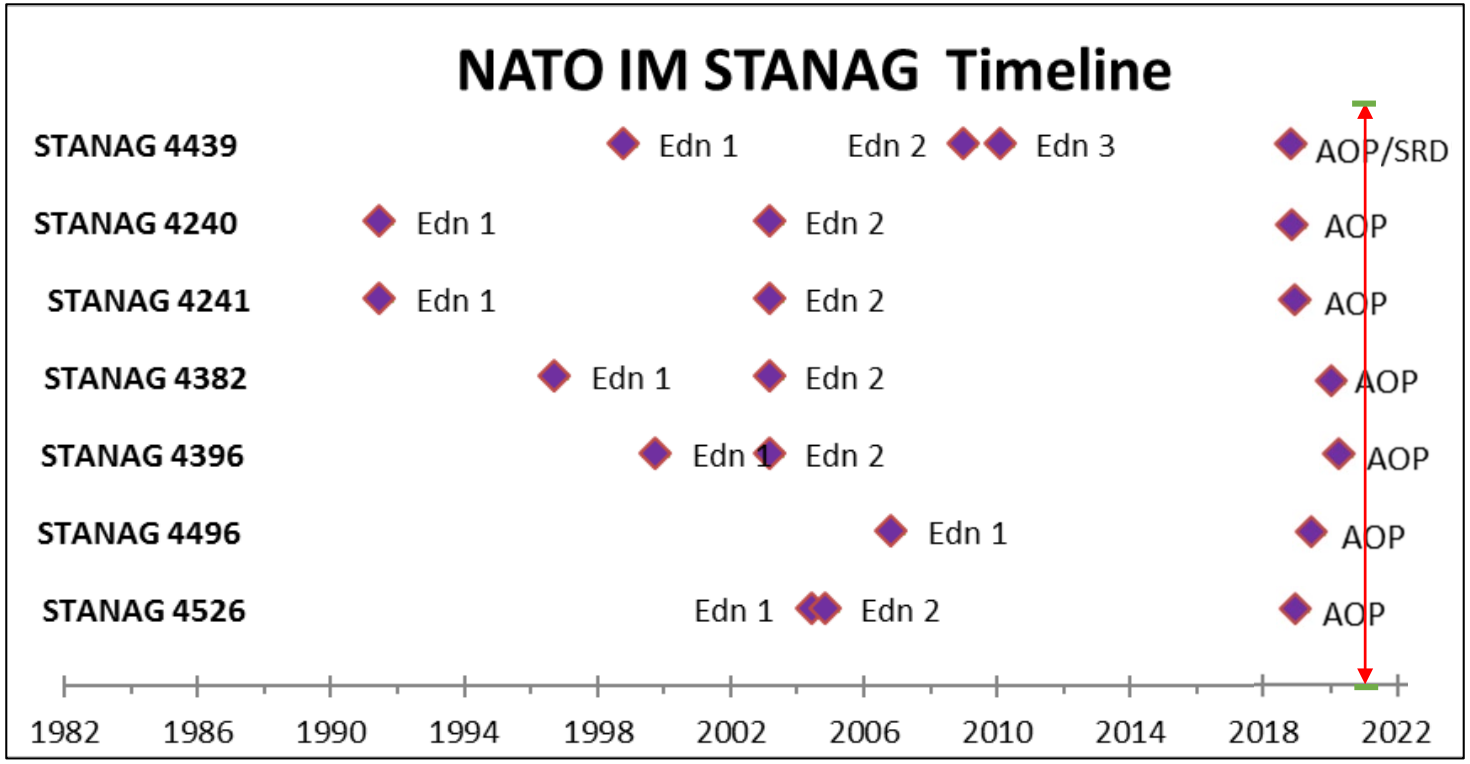
Background – Review Process

- Review and revision of the Test STANAGs started almost 10 years ago
  - During this process, new NATO changes called for formatting changes and creation of AOPs
- AOP-39 Review began during that timeframe
  - Became apparent this document needed to be stripped of unnecessary, outdated, irrelevant, inaccurate info
- Standards Related Document (SRD) was created as well
  - Obtained all the guidance and additional information from the STANAGs and AOP-39 that needed to be retained, but not lost
- Through-out this entire process, it was difficult to maintain consistency amongst the documents as well as retain justifications for changes made from one document to the next, for several reasons:
  - Participating members experience, background, and level participation
  - Language and interpretation
  - *Notes / records lost through-out the years

➢ Hence, the NATO IM Test AOP Standardization Working Group was created to ‘scrub’ the documents for clarity, readability, consistency, accuracy, and relevancy

Background – Update Timeline

- ✓ STANAG / AOP 4240 (FH) : promulgated NOV 18
- ✓ STANAG / AOP 4241 (BI) : promulgated NOV 18
- ✓ STANAG / AOP 4496 (FI) : promulgated MAR 19
- ✓ STANAG / AOP 4526 (SCJI) : promulgated NOV 18
- ✓ STANAG / AOP 4382 (SH) : promulgated MAR 20
- ✓ STANAG / AOP 4396 (SR) : promulgated DEC 20

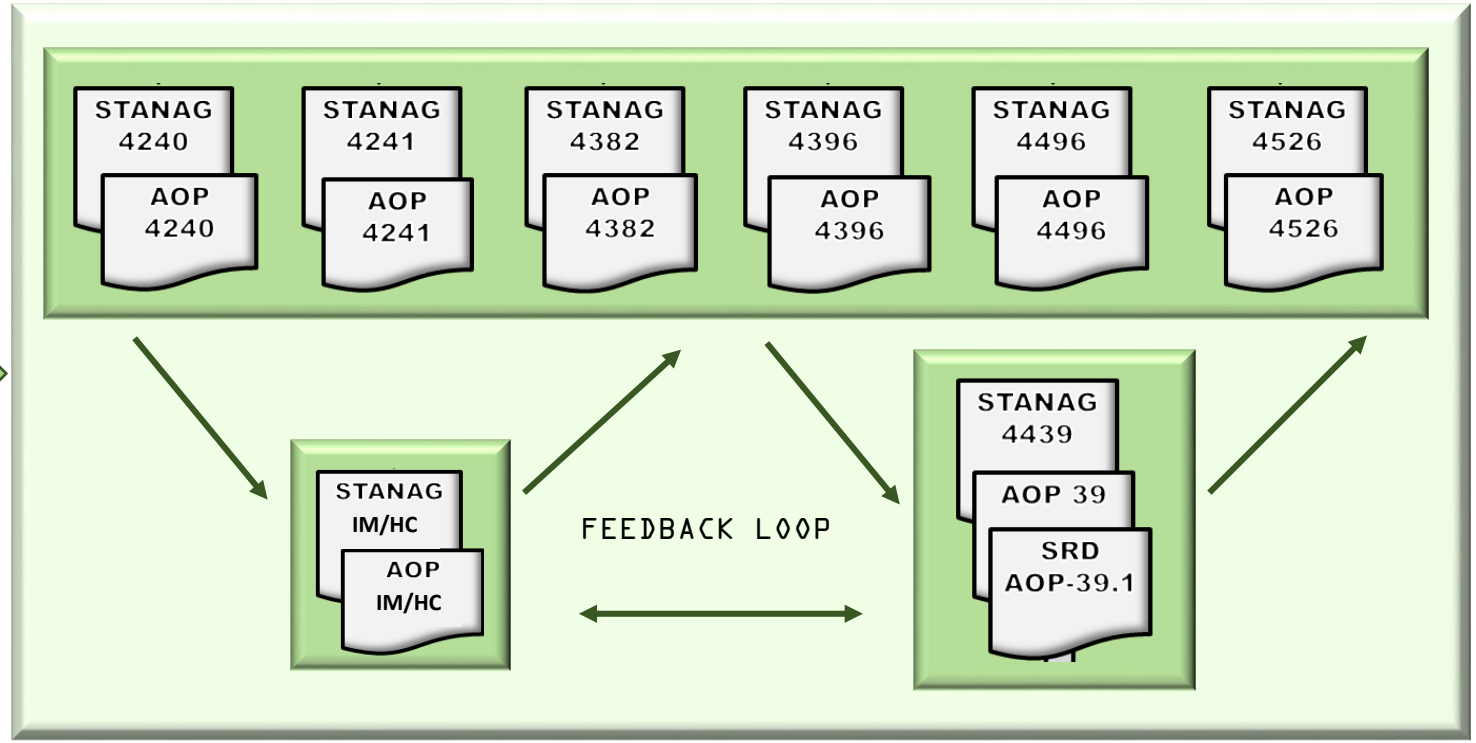


K. Tomasello, 'NATO AC326 SG/B: Ammunition Systems Design and Assessment – IM Test STANAG updates', IMEMTS, Spain, 2019.

NATO IM Test Doctrine – Consistency Standardization / Synchronization Process

Version Updates (No changes to requirements)

- ✓ Revised individual Test AOPs
  - ✓ AOP-4396
  - ✓ AOP-4241
  - ✓ AOP-4496
  - ✓ AOP-4240
  - ✓ AOP-4382
  - ✓ AOP-4526
- ✓ Re-format all Test AOPs per NATO Template
- ✓ Compare all Test AOPs to ensure consistency
- ✓ Revise SRD based on changes to Test AOPs
- ✓ Revise AOP-39 based on changes to Test AOPs & SRD
- ➢ Final Review of all doc's for consistency
- ➢ Submit all Test AOPs, SRD & AOP-39 for Version Update



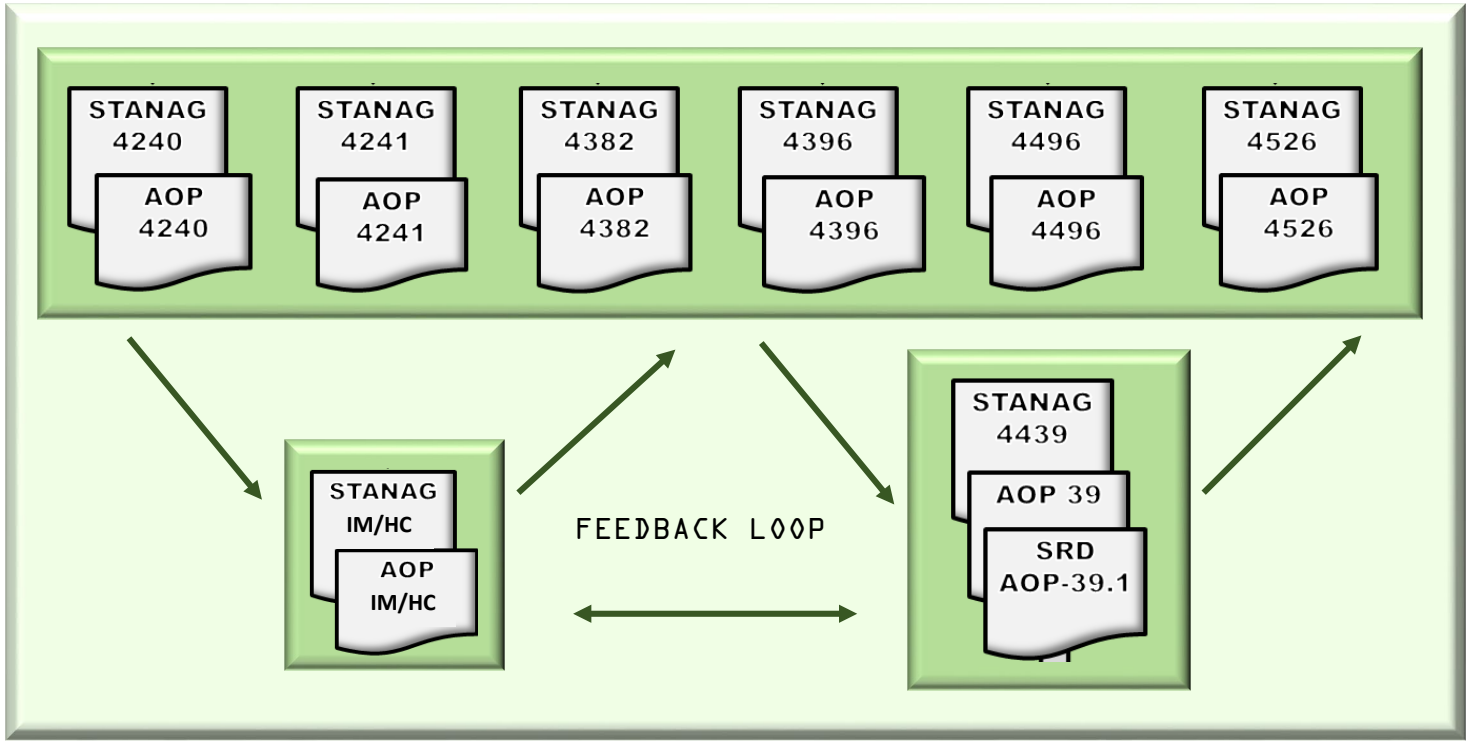
NATO IM Test Doctrine - *Revision Process Path Forward*

Version Updates (No changes to requirements) ← **Near Term**

- ✓ Revised individual Test AOPs (AOP-4396, AOP-4241, AOP-4496, AOP-4240, AOP-4382, AOP-4526)
- ✓ Re-format all Test AOPs per NATO Template
- ✓ Compare all Test AOPs to ensure consistency
- ✓ Revise SRD based on changes to Test AOPs
- ✓ Revise AOP-39 based on changes to Test AOPs & SRD
- ➢ Final Review of all doc's for consistency
- ➢ Submit all Test AOPs, SRD & AOP-39 for Version Update

Formal Updates ← **Looking Forward**

- ***Create IM/HC AOP*** based on changes to Test AOPs, SRD & AOP-39
- ***Revise Test AOPs based on technical proposals*** from IM Test AOP WG to AOP CWGs (AOP-4396, AOP-4241, AOP-4496, AOP-4240, AOP-4382, AOP-4526)
- ***Revise SRD*** based on changes to Test AOPs
- ***Revise AOP-39*** based on changes to Test AOPs & SRD
- Final Review of all doc's for consistency
- Submit Test AOPs, SRD & AOP-39 through Promulgation Process for ***Ratification***



Progression & Results

- AOP-4396
  - Last AOP created during Winter (Jan-Mar) 2020
  - First AOP to get ‘scrubbed’ during Spring (Apr) 2020
    - Pro’s
      - Benefitted from all the lessons learned through-out the AOP creation process
    - Con’s
      - Guinea pig and benefited from none of the lessons learned through-out the AOP ‘scrub’ process.
  - Subsequently set the format for the new AOP Annex format
    - Historical Overview
    - Best Practices

New Common AOP Annex Structure

- **Annexes**
  - Annex A – Best Practices
  - Annex B – Historical Overview
    - B.1 Revision Process
      - B.1.1 Creation of AOP-XXX
      - B.1.2 Changes from STANAG XXXX Ed.1
    - B.2 Background and Test Origins
      - B.2.1 Historical Overview

AOP Review Process & Outcomes

In the following slides:

- AOP-4396 will be used as an example to demonstrate unique non-technical (no changes to requirements) considerations (Terminology, Definitions, Intentions) that were deliberated over, as well as unique improvements made since the initial AOPs were developed.

- AOP-4496 will be used as an example to demonstrate info moved from an AOP to the SRD.

- AOP-4526 will be used as an example to demonstrate the common non-technical (no changes to requirements) improvements made to the entire AOP body since the initial AOPs were developed.

Deliberations & Unique Improvements to ***all*** AOPs

AOP-4396 will be used as an example to demonstrate unique **non-technical considerations (Terminology, Definitions, Intentions)** that were deliberated over, as well as **unique improvements** made since the initial AOPs were developed.

***Note** – For the purpose of this presentation, Words / Phrases are highlighted for the following purposes:*

- **Green – Indicates new / improved wording**
- **Orange – Indicates older wording that requires change / improvement, or belongs in SRD**
- **Red – Indicates older wording that was incorrect / misleading / obsolete**
- **Bold / Underlined annotate major topics for discussion**

Terminology → Definitions → Intentions

❑ AOP-4396 Old Terms that needed Clear / Updated Definitions & New Terms

- Component
- Sub-component
- Component-level
- Design Mode
- Condition
- Packaged
- Unpackaged
- **Final Production Standard**
- Donor munition
- **Adjacent**
- **Unitization**
- **Palletization**
- National Authority

*Not all-inclusive; Also appear in other AOPs

❑ Differentiation of AOP-4396 Terms

- Test Article vs. Test Item vs. Item Under Test
- **Donor vs. Donor Test Item**
- **Acceptor vs. Acceptor Test Item**
- Test Item Configuration vs. Test Configurations
- Signature vs. Score vs. **Response vs. Reaction**
- Packaging vs. Packing
- Life Cycle Phase vs. Logistical Life Cycle
- Packaged vs. Unpackaged
- **Procedure vs. Method**
- All-Up-Round vs. Prototype
- Simulants vs. Inert Simulants vs. Mass Simulants
- **Energetic Component vs. Energetic Section**
- ***Energetic vs. *Explosive vs. Propellant vs. Pyrotechnic**

*Not all-inclusive; Also appear in other AOPs

Terminology → **Definitions** → Intentions

- **Ex: AOP-4396, Section 1.5.3** The objective of the Sympathetic Reaction Test is to determine the response[1] of an acceptor test item(s)[3] when exposed to the worst-case credible reaction[4] of an identical donor test item. This test uses a worst-case credible configuration[5] experienced in its ~~l~~Life-~~c~~Cycle as defined in a THA. It is anticipated that the results of this test will be used to develop mitigation techniques to reduce the violence and consequences[6] of reactions[2] caused by accidents or hostile actions.

  - 1 - 'Response of an Acceptor Test Item' – use response when referring to / characterizing the munition's overall 'response' (i.e. score), or overall energetic event, for an entire test.
  - 2 - 'reactions' – when not necessarily referring to the overall response of an item, reaction may be used.
    - Ex: A primer *reacted* at timestamp x during the cook-off.
  - 3 - 'Response of an Acceptor Test Item' – *'Acceptor'* or *'Test Item'* not technically specific enough.
    - *'Acceptor'* may not refer to the entire Acceptor Test Item, for example, it may refer to one round in a box of multiple rounds.
    - *'Test Item'* – encompasses both the Acceptor Test Item and the Donor Test Item.
  - 4 - 'Worst-case Credible Reaction' – implies the worst credible reaction, that the donor test item can produce, must be exposed to the acceptor.
  - 5 - 'Worst-case Credible Configuration' – implies the donor test item configuration that produces the worse credible reaction must be utilized for the test.
  - 6 - 'consequences' – certain participating member nations have particular focuses / interests and we decided as a group to include their inputs/request/proposals if they do not deter the test from meeting the requirements.

Note – These are not the official NATO terms for these words / phrases. They are simply paraphrased for this presentation.

Terminology → Definitions → **Intentions**

❖ **Ex: AOP-4396, Section 2.2.2 Test Requirements (*Initial AOP, from STANAG*)**

d. External Confinement. Any confinement should represent that of a typical storage confinement. Confinement may be simulated with sandbags or sand/earth-filled containers stacked around the test stack at least 1m thick in all directions. If an existing external confinement is likely to alter the test result, the confinement should be simulated in the test. Both partial and complete confinement are possible, e.g., walls in two dimensions or an enclosed magazine. The latter can be simulated by a test structure for which the ratio of the volume of active and inert munitions to the volume of the test cell approximates that existing in the actual operational or storage configuration. Variations of up to 20% are acceptable. It is not appropriate to use inert items in the test arrangement simulating the unconfined situation, because they contribute to confinement without the possibility of reacting.

❑ **"External confinement should represent typical storage confinement"**

- ➢ Most of the content in the IM STANAGs were taken directly from Hazard Classification (HC) documents (e.g. Orange Book)
  - For example: 'walls of ma… d 'test structures'
    - Indicate wording f… IM document
    - Orange Book lists several examples of loading docks, bays, concrete walls, etc. to replace
- ➢ Historically, HC addressed 'storage configurations' while IM addressed 'operational configurations' like IM prefers
  - Without deliberating, they seem one in the same, however they are not necessarily.
- ➢ In effort to address IM concerns, we focus configurations more on the munition's logistical / operational configurations per their THA.
- ➢ For SR, historically, IM focuses on munition response from Un-Confined Test
- ➢ Confined test has been redefined / clarified in previous revision (Annex B)
  - UN expressed interest in conforming based on recent dimensional analysis conducted on NATO pallets and stack sizes.

BLUF:

- **IM doc's taken from HC**
- **Re-written to address IM concerns**
  - **Incorporated IM/HC Harmonization**
- **Include Technical Justifications for New/Legacy Metrics**

❖ **Ex: AOP-4396, Section 2.2.2 Test Requirements (*Revised AOP*)**

d. External Confinement: If an existing external confinement is likely to alter the test result, the confinement should be simulated in at least one of the two minimum required tests. Any confinement should represent that of a typical storage/transport confinement. Based on the information provided in Annex A, confinement thickness will depend on the lifecycle situation the specific test is supposed to simulate (guidance of at least 1 meter deep in all directions around the test item), and is typically represented in the palletized configuration, based on the logistical lifecycle cited in the THA. The confinement should include the packaging, unitization, and palletization material as per the packaging, unitization and palletization drawings. Common materials as per these drawings should be used to accurately represent the confinement of the fielded munition, however inert munitions and mass simulants may be used if a technical justification indicates the same conclusions will result and is approved by the National Authority. **Safety concerns shall prohibit the use of sand, dirt or similar loose granular material for simulating external confinement.** Both partial and complete confinement test configurations are possible.

❑ **'guidance of at least 1 meter deep in all directions around the test item…and is typically represented in the palletized configuration, based on the logistical lifecycle cited in the THA'**

- ➢ See Annex B for dimensional analysis of NATO pallets and stack sizes and the hypothesized technical reasoning for this metric.
- ➢ Accepted by all member nations
- ➢ Added THA as it was not emphasized well previously

❑ **Materials should be used per the packaging, unitization, palletization, etc. drawings**

❑ **Sand bags no longer tolerable for several reasons:**

- ➢ Sand is an excellent fragment, shock wave and fire suppressor
  - It inhibits the true response of the Acceptor Test Item
- ➢ Unknown / unreacted live energetics get buried in sand
  - Unsafe for test facilities
  - Difficult to find / evaluate test results

Common Improvements to ***all*** AOPs

AOP-4496 will be used as an example to demonstrate items that were moved from an **AOP to the SRD**.

Common Improvements to ***all*** AOPs

Info from AOP → SRD

From 2.2. Test Types

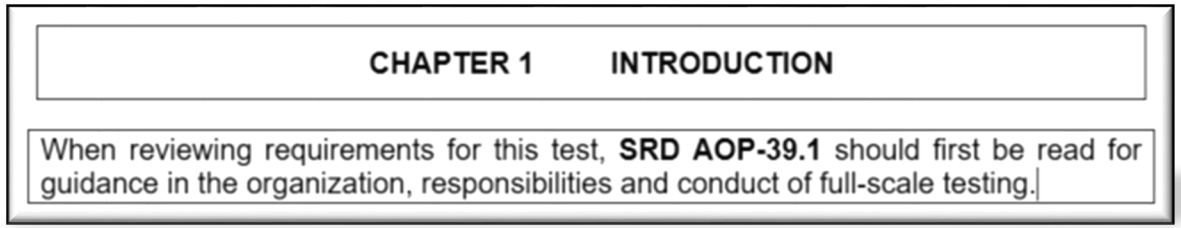
4. Aim points selection: Aim point shall be selected to create the most stressing condition on the target energetic. The aim point shall also represent a credible exposure condition, based on the THA. The shotline should avoid impact locations of low probability that may lead to irreproducible reactions. This includes, but is not limited to, welds seams or joints. The first test shall be conducted with an aim point and shotline at the centre of the energetic component. The second test shall be conducted on the most vulnerable area. Guidance for choosing the aim point and shotline can be found in SRD AOP-39.1. The aim point and shotline for each test should be approved by the national authority prior to testing.

WEISSE Quentin IETA
To move in the SRD.
There is no mention of the THA in the part B.3.3 (Aim/Impact point – shotline) of the SRD.

7. Methods shall be established to assure the fragment is aimed at the selected aimpoint and that it follows the desired path through the munition. The likelihood of getting a violent response, will normally be maximized by choosing a shotline, which provides the longest possible path length through the energetic material. However, unlikely shotlines should be avoided, which are aimed at components that are quite small when compared to the bulk of the explosive, propellant or aimed at unlikely angles. Prior to testing, shotlines should be agreed to by the national authority. In this regard, the following considerations may apply: if the energetic material contains a cavity of significant size (such as the bore of a rocket motor), aim the fragment to pass perpendicularly through the cavity. (It has been observed that such cavities can promote the occurrence of violent reactions).

WEISSE Quentin IETA
To move in the SRD such as for AOP-4241

Common Improvements to ***all*** AOPs



CHAPTER 1 INTRODUCTION

When reviewing requirements for this test, **SRD AOP-39.1** should first be read for guidance in the organization, responsibilities and conduct of full-scale testing.

Due to the portfolio structure, improvements were made to maximize clarification as much as possible.

- For example:
  - Requirements were moved from STANAG → AOP
    - AOP should no longer contain guidance
  - It is apparent (from surveys executed during the Custodial Working Group meetings), that even the WG members have different perceptions of many of the topics:
    - Terms
    - Definitions
    - Methods / Procedures
    - Quantities
    - Qualities
    - Etc.
  - SRD contains guidance and additional / supporting information
    - ✓ Added the above note to the top of the first page in Chapter 1

Common Improvements to ***all*** AOPs

AOP-4526 *will be used as an example* to demonstrate the common **non-technical improvements to each section of the AOP body** since the initial AOPs were developed.

New Common AOP Body Structure

- Cover Page
- NSO NATO Letter of Promulgation
- Record of Observations
- Record of Specific Reservations
- Table of Contents
- Chapter 1
  - 1.1 Annexes
  - 1.2 Related Documents
  - 1.3 AIM
  - 1.4 Agreement
  - 1.5 Definitions
  - 1.6 General
  - 1.7 Test Limitations
- Chapter 2
  - 2.1 Test Item Configuration
  - 2.2 Test Details
    - 2.2.1 Test Methods
    - 2.2.2 Test Requirements
      - 2.2.2.1 Generic
      - 2.2.2.2 Specific
    - 2.2.3 Test Set-Up
    - 2.2.4 Number of Tests
  - 2.3 Documentation and Compliance
  - 2.4 Observations and Records
  - 2.5 Evaluation of Test Results
- Annex A
- Annex B

Common Improvements to ***all*** AOPs

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Common Improvements to ***all*** AOPs

❖Annexes

1.1. ANNEXES

A. Shaped Charge 81 mm, LX-14 (USA)
B. Shaped Charge CCEB 62 (French)
C. Historical Overview

→

1.1 ANNEXES

A. Best Practices
B. Historical Overview

Restructured format and reorganized information / sections in a more categoric manner.

Common Improvements to ***all*** AOPs

❖ 1.2 RELATED DOCUMENTS

1.2 RELATED DOCUMENTS		
STANAG 4439	Policy for Introduction and Assessment of Insensitive Munitions (IM)	
AOP-39	Policy for Introduction and Assessment of Insensitive Munitions (IM)	
SRD AOP-39.1	Guidance on the Organization, Conduct and Reporting of Full-scale Tests	
STANAG 4526	Shaped Charge Jet Impact Test Procedures for Munitions	
AASTP-03	Manual of NATO Safety Principles for the Hazard Classification of Military Ammunition and Explosives	Suggest removal as SCJ not used in HC testing
United Nations	Manual of Tests and Criteria (ST/SG/AC.10/11)	Suggest removal as SCJ not used in HC testing

Common Improvements to ***all*** AOPs

❖ 1.~~2~~3 AIM

The aim of this Standard[1] is to specify the test requirements and procedures to provide evidence of the reaction[2] of munitions and weapon systems to the threats represented from[3] being struck[4] by a shaped charge weapon[5].	The aim of this AOP[1] is to specify the test requirements and procedures to provide evidence of the response[2] of munitions and weapon systems to the threats represented by[3] being impacted[4] by small arms projectile(s) [5].

- ➢ Standard[1] – Previous document
- ✓ AOP[1] – New document
- ➢ Reaction[2] – Constituent / Included in the description / definition of a m*unition response*
- ✓ Response[2] – Describes the wholesome energetic event; Includes single / multiple r*eactions*
- ➢ from[3] – Bad grammar
- ✓ by[3] – Better grammar
- ➢ struck[4] – Not technically accurate
- ✓ impacted[4] – Technically accurate
- ➢ shaped charge weapon[5] – Specific to individual AOP
- ✓ small arms projectile(s) [5] – Specific to individual AOP

Common Improvements to ***all*** AOPs

❖1.~~3~~4 AGREEMENT

- Participating nations agree that the requirements and ~~procedures~~ methods incorporated in this AOP will be used for determining the response of munitions and weapon systems to a shaped charge jet impact represented by the most prevalent threat (currently the RPG) or more appropriate threat.

- Participating nations further agree that national standards, orders, manuals and instructions implementing this AOP will include a reference to the STANAG 4526 for purposes of identification.

- No departure may be made from this agreement without consultation with the NATO Tasking Authority~~ies/Delegated Tasking Authorities (TA/DTAs)~~. Nations may propose changes at any time to the ~~TA/DTAs~~ NATO Tasking Authority where they will be processed in the same manner as the original agreement.

Common Improvements to ***all*** AOPs

❖1.45 DEFINITIONS

- For the purpose of this document, definitions of terms to be used to describe test details and events are given in the NATO Terminology ~~Management System~~ Database (NATOTerm) that is available by reference for all Allied Publications[1].

- [1]https://nso.nato.int/natoterm/

Common Improvements to ***all*** AOPs

❖1.5 GENERAL

1. Minimizing the reaction of ordnance to shaped charge jet impact is an ongoing commitment of weapons designers to ensure that the safety of personnel and materiel will not be unduly jeopardized.
2. This Standard addresses the situation where munitions and weapon systems may be struck by a shaped charge projectile most probably whilst on operations. This can have a significant consequence for personnel and equipment from the response of their own munitions and weapon systems to such a threat.
3. Other tests may be required to evaluate the response of munitions in tactical situations, such as when stowed on armored vehicles.

→

❖1.~~5~~6 GENERAL

1. Efforts to minimize the violence of the reaction of munitions impacted by a shaped charge jet is a continuing commitment of weapons designers in order that the safety of personnel and materiel will not be unduly jeopardized.
2. This AOP addresses the situation where munitions and weapon systems are impacted by a shaped charge jet. This can occur in peacetime as the result of an accident, a dissident/saboteur activity, or an operation as a consequence of enemy action, which can result in a significant compromise of safety.
3. The objective of the Shaped Charge Jet Impact test is to determine the response of the munition(s) when subjected to a defined shaped charge jet.

Common Improvements to ***all*** AOPs

added

deleted

sent to SRD

2.2. TEST TYPES

There are two methods for performing the Shaped Charge Jet Impact Test; a "Standard Test" and an "Alternative Test" for Munitions. For the selected test, subject the munition in either a logistical and/or tactical configuration, to a jet from a shaped charge, as documented in an approved ŧTest ~~p~~Plan.

a. Method 1 (Standard ~~Threat Test~~): Using the general guidance specified herein, subject the ~~t~~Test ~~i~~Item to the jet from a shaped charge representing the rocket propelled grenades, as described in Section 2.~~5~~2.~~1~~2, ~~m~~Method 1, of this document. The complete characterization of the jet used for the test shall be conducted to meet the requirements of this AOP, and shall be provided or referenced. Examples of tests fulfilling these requirements can be found in the ~~a~~Annexe~~s~~ A.

b. Method 2 (Alternative ~~Threat Test~~): Using the general guidance specified herein, subject a ~~t~~Test ~~i~~Item to a well characterized shaped charge jet as documented in a Threat Hazard Assessment (THA). The jet should be fully characterized and reported, as documented in ~~s~~Section~~s~~ 2.~~5~~2.~~1~~2~~, method 2~~.

Common Improvements to ***all*** AOPs

2.4 SHAPED CHARGE

1.

2.

2.5 JET CHARACTERISTIC REQUIREMENTS

2.5.1 Characterization of the Shaped Charge Jet

1.

2.

a….

…f.

3.

a…

…f.

2.5.2 Measurements

1.

2.

2.5.3 Shot line

2.2.2 Test Requirements

2.2.1 Generic

1. Shaped Charge Jet Requirements

a.

b.

2. Jet Characteristic Requirements

a…

…d

2.2.2.2 Specific

1.

a…

…f

2.

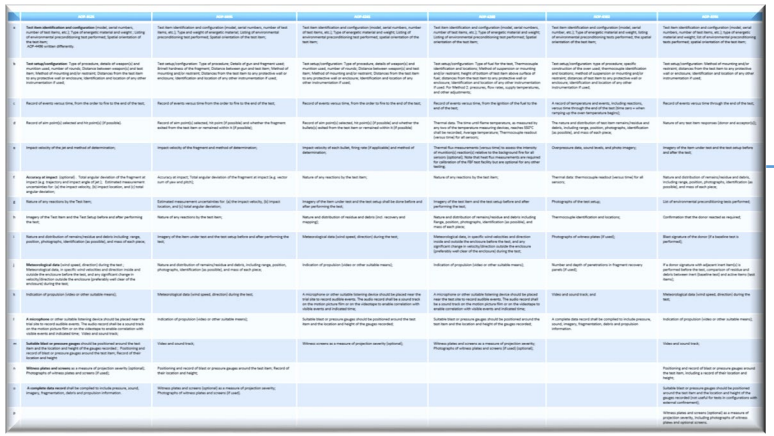
a…

…f

Common Improvements to ***all*** AOPs

	EX: AOP-4526 OBSERVATIONS & RECORDS
a	Test item identification and configuration (model, serial numbers, number of test items, etc.); Type of energetic material and weight ; Listing of environmental preconditioning tests performed; Spatial orientation of the test item;
b	Test setup/configuration: Type of procedure; Details of shaped charge used; Distance between weapon(s) and test item; Method of mounting and/or restraint; Distances between the shaped charge, the conditioning plate, and the test item; Method of mounting and/or restraint; Distances from the test item to any protective wall or enclosure; Identification and location of any other instrumentation if used;
c	Record of events versus time, from the order to fire to the end of the test;
d	Record of aim point(s) selected;
e	Details of shaped charge jet characteristics and conditioning plate.
f	No other specific observation/measurement found;
g	Nature of any reactions by the Test Item;
h	Photo Imagery of the Test Item and the Test Setup before and after performing the test;
i	Nature and distribution of remains/residue and debris including: range, position, photographs, identification (as possible), and mass of each piece;
j	Meteorological data (wind speed, direction) during the test;
k	Indication of propulsion (video or other suitable means);
l	Audio and video records: A recording device shall be placed near the trial site to record all audio and enable correlation between visible events and indicated time;
m	Suitable Blast or overpressure gauges should be positioned around the test item to record pressure-time history with a record of gauge location and height;
n	Witness plates and screens as a measure of projection severity (optional); Photographs of witness plates and screens (if used); Number and depth of penetrations in fragment recovery panels (if used);
o	A complete data record shall be compiled to include pressure, sound, imagery, fragmentation, debris and propulsion information;

OBSERVATIONS & RECORDS



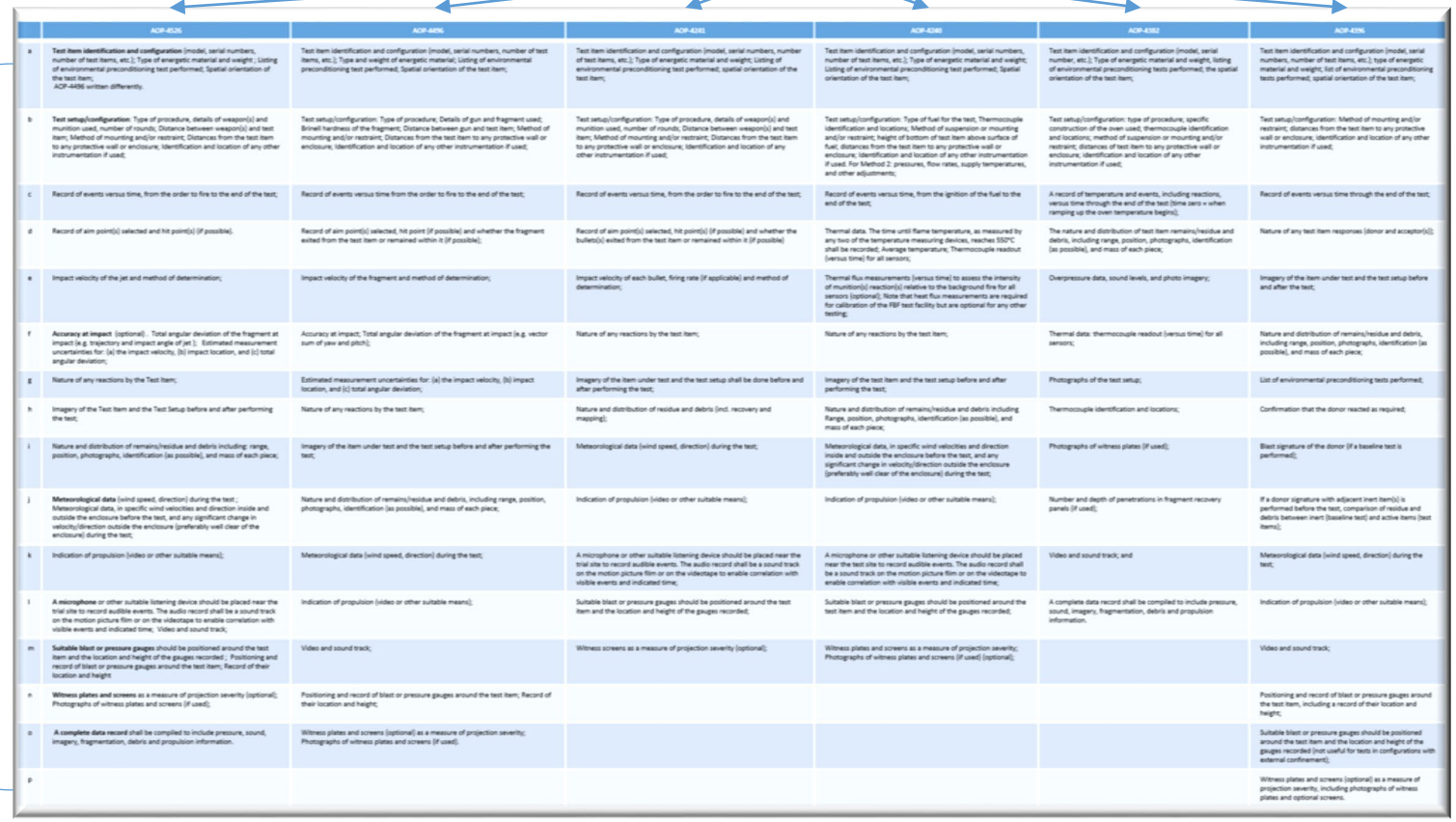
Demonstration of Revision Process

OBSERVATIONS & RECORDS

- ***Created*** **Observations & Records Comparison Chart**
  - Cut & pasted directly from the current AOPs
    - Content originally from STANAGs
      - No particular order
      - Duplications
      - Inconsistent
      - Missing / Addn'l req's
      - Misleading wording
      - Inaccurate terms

AOPs

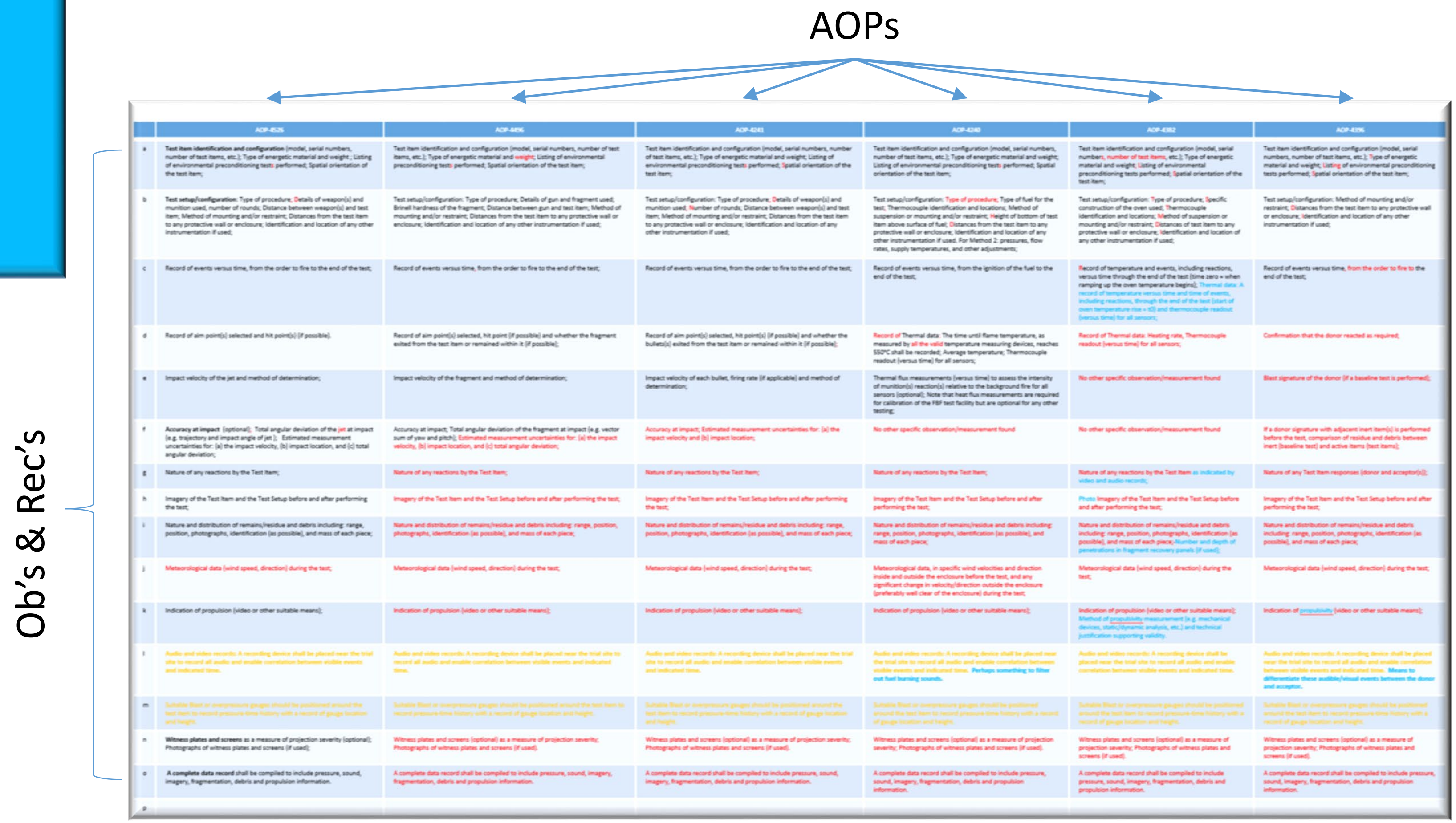
Ob's & Rec's



	AOP-4526	AOP-4496	AOP-4241	AOP-4240	AOP-4382	AOP-4396
a	**Test item identification and configuration** (model, serial numbers, number of test items, etc.); Type of energetic material and weight ; Listing of environmental preconditioning test performed; Spatial orientation of the test item; AOP-4496 written differently.	Test item identification and configuration (model, serial numbers, number of test items, etc.); Type and weight of energetic material; Listing of environmental preconditioning test performed; Spatial orientation of the test item;	Test item identification and configuration (model, serial numbers, number of test items, etc.); Type of energetic material and weight; Listing of environmental preconditioning test performed; spatial orientation of the test item;	Test item identification and configuration (model, serial numbers, number of test items, etc.); Type of energetic material and weight; Listing of environmental preconditioning test performed; Spatial orientation of the test item;	Test item identification and configuration (model, serial number, etc.); Type of energetic material and weight, listing of environmental preconditioning tests performed; the spatial orientation of the test item;	Test item identification and configuration (model, serial numbers, number of test items, etc.); type of energetic material and weight; list of environmental preconditioning tests performed; spatial orientation of the test item;
b	**Test setup/configuration**: Type of procedure, details of weapon(s) and munition used, number of rounds; Distance between weapon(s) and test item; Method of mounting and/or restraint; Distances from the test item to any protective wall or enclosure; Identification and location of any other instrumentation if used;	Test setup/configuration: Type of procedure; Details of gun and fragment used; Brinell hardness of the fragment; Distance between gun and test item; Method of mounting and/or restraint; Distances from the test item to any protective wall or enclosure; Identification and location of any other instrumentation if used;	Test setup/configuration: Type of procedure, details of weapon(s) and munition used, number of rounds; Distance between weapon(s) and test item; Method of mounting and/or restraint; Distances from the test item to any protective wall or enclosure; Identification and location of any other instrumentation if used;	Test setup/configuration: Type of fuel for the test; Thermocouple identification and locations; Method of suspension or mounting and/or restraint; height of bottom of test item above surface of fuel; distances from the test item to any protective wall or enclosure; identification and location of any other instrumentation if used. For Method 2: pressures, flow rates, supply temperatures, and other adjustments;	Test setup/configuration: type of procedure; specific construction of the oven used; thermocouple identification and locations; method of suspension or mounting and/or restraint; distances of test item to any protective wall or enclosure; identification and location of any other instrumentation if used;	Test setup/configuration: Method of mounting and/or restraint; distances from the test item to any protective wall or enclosure; identification and location of any other instrumentation if used;
c	Record of events versus time, from the order to fire to the end of the test;	Record of events versus time from the order to fire to the end of the test;	Record of events versus time, from the order to fire to the end of the test;	Record of events versus time, from the ignition of the fuel to the end of the test;	A record of temperature and events, including reactions, versus time through the end of the test (time zero = when ramping up the oven temperature begins);	Record of events versus time through the end of the test;
d	Record of aim point(s) selected and hit point(s) (if possible).	Record of aim point(s) selected, hit point (if possible) and whether the fragment exited from the test item or remained within it (if possible);	Record of aim point(s) selected, hit point(s) (if possible) and whether the bullet(s) exited from the test item or remained within it (if possible)	Thermal data. The time until flame temperature, as measured by any two of the temperature measuring devices, reaches 550°C shall be recorded; Average temperature; Thermocouple readout (versus time) for all sensors;	The nature and distribution of test item remains/residue and debris, including range, position, photographs, identification (as possible), and mass of each piece;	Nature of any test item responses (donor and acceptor(s));
e	Impact velocity of the jet and method of determination;	Impact velocity of the fragment and method of determination;	Impact velocity of each bullet, firing rate (if applicable) and method of determination;	Thermal flux measurements (versus time) to assess the intensity of munition(s) reaction(s) relative to the background fire for all sensors (optional); Note that heat flux measurements are required for calibration of the FBF test facility but are optional for any other testing;	Overpressure data, sound levels, and photo imagery;	Imagery of the item under test and the test setup before and after the test;
f	**Accuracy at impact** (optional) . Total angular deviation of the fragment at impact (e.g. trajectory and impact angle of jet); Estimated measurement uncertainties for: (a) the impact velocity, (b) impact location, and (c) total angular deviation;	Accuracy at impact; Total angular deviation of the fragment at impact (e.g. vector sum of yaw and pitch);	Nature of any reactions by the test item;	Nature of any reactions by the test item;	Thermal data: thermocouple readout (versus time) for all sensors;	Nature and distribution of remains/residue and debris, including range, position, photographs, identification (as possible), and mass of each piece;
g	Nature of any reactions by the Test Item;	Estimated measurement uncertainties for: (a) the impact velocity, (b) impact location, and (c) total angular deviation;	Imagery of the item under test and the test setup shall be done before and after performing the test;	Imagery of the test item and the test setup before and after performing the test;	Photographs of the test setup;	List of environmental preconditioning tests performed;
h	Imagery of the Test Item and the Test Setup before and after performing the test;	Nature of any reactions by the test item;	Nature and distribution of residue and debris (incl. recovery and mapping);	Nature and distribution of remains/residue and debris including Range, position, photographs, identification (as possible), and mass of each piece;	Thermocouple identification and locations;	Confirmation that the donor reacted as required;
i	Nature and distribution of remains/residue and debris including: range, position, photographs, identification (as possible), and mass of each piece;	Imagery of the item under test and the test setup before and after performing the test;	Meteorological data (wind speed, direction) during the test;	Meteorological data, in specific wind velocities and direction inside and outside the enclosure before the test, and any significant change in velocity/direction outside the enclosure (preferably well clear of the enclosure) during the test;	Photographs of witness plates (if used);	Blast signature of the donor (if a baseline test is performed);
j	**Meteorological data** (wind speed, direction) during the test ; Meteorological data, in specific wind velocities and direction inside and outside the enclosure before the test, and any significant change in velocity/direction outside the enclosure (preferably well clear of the enclosure) during the test;	Nature and distribution of remains/residue and debris, including range, position, photographs, identification (as possible), and mass of each piece;	Indication of propulsion (video or other suitable means);	Indication of propulsion (video or other suitable means);	Number and depth of penetrations in fragment recovery panels (if used);	If a donor signature with adjacent inert item(s) is performed before the test, comparison of residue and debris between inert (baseline test) and active items (test items);
k	Indication of propulsion (video or other suitable means);	Meteorological data (wind speed, direction) during the test;	A microphone or other suitable listening device should be placed near the trial site to record audible events. The audio record shall be a sound track on the motion picture film or on the videotape to enable correlation with visible events and indicated time;	A microphone or other suitable listening device should be placed near the test site to record audible events. The audio record shall be a sound track on the motion picture film or on the videotape to enable correlation with visible events and indicated time;	Video and sound track; and	Meteorological data (wind speed, direction) during the test;
l	**A microphone** or other suitable listening device should be placed near the trial site to record audible events. The audio record shall be a sound track on the motion picture film or on the videotape to enable correlation with visible events and indicated time; Video and sound track;	Indication of propulsion (video or other suitable means);	Suitable blast or pressure gauges should be positioned around the test item and the location and height of the gauges recorded;	Suitable blast or pressure gauges should be positioned around the test item and the location and height of the gauges recorded;	A complete data record shall be compiled to include pressure, sound, imagery, fragmentation, debris and propulsion information.	Indication of propulsion (video or other suitable means);
m	**Suitable blast or pressure gauges** should be positioned around the test item and the location and height of the gauges recorded ; Positioning and record of blast or pressure gauges around the test item; Record of their location and height	Video and sound track;	Witness screens as a measure of projection severity (optional);	Witness plates and screens as a measure of projection severity; Photographs of witness plates and screens (if used) (optional);		Video and sound track;
n	**Witness plates and screens** as a measure of projection severity (optional); Photographs of witness plates and screens (if used);	Positioning and record of blast or pressure gauges around the test item; Record of their location and height;				Positioning and record of blast or pressure gauges around the test item, including a record of their location and height;
o	**A complete data record** shall be compiled to include pressure, sound, imagery, fragmentation, debris and propulsion information.	Witness plates and screens (optional) as a measure of projection severity; Photographs of witness plates and screens (if used);				Suitable blast or pressure gauges should be positioned around the test item and the location and height of the gauges recorded (not useful for tests in configurations with external confinement);
p						Witness plates and screens (optional) as a measure of projection severity, including photographs of witness plates and optional screens.

OBSERVATIONS & RECORDS

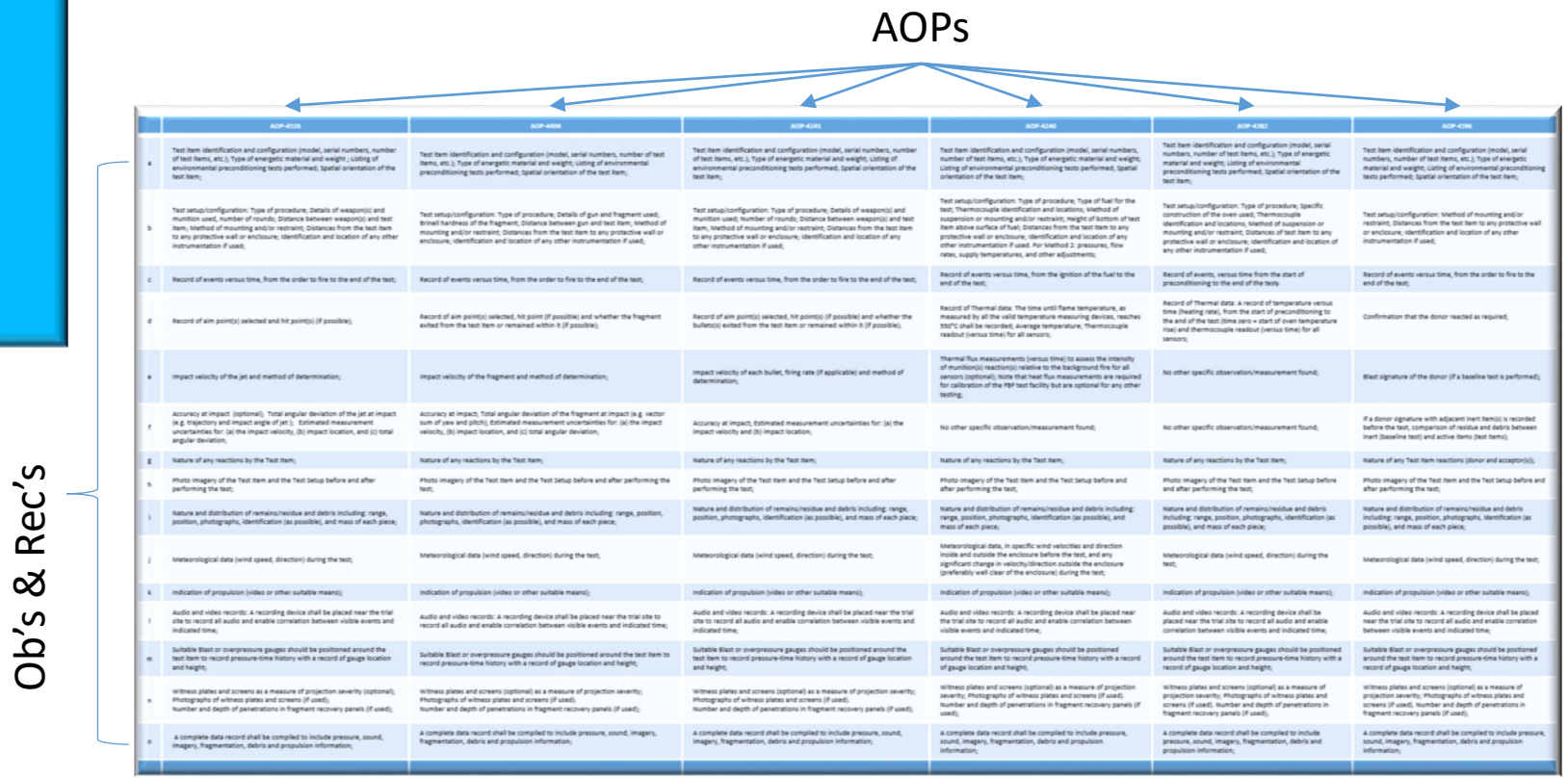
- ***Utilized* Observations & Records Comparison Chart**
  - Evaluated Ob's & Rec's for each individual AOP
  - Compared differences and similarities
  - Created an organized matrix (a-p)
  - Added / Omitted where appropriate
  - Re-worded for accuracy and clarity
  - Ensured terms match AOP content
  - Retained requirements
  - Omitted guidance



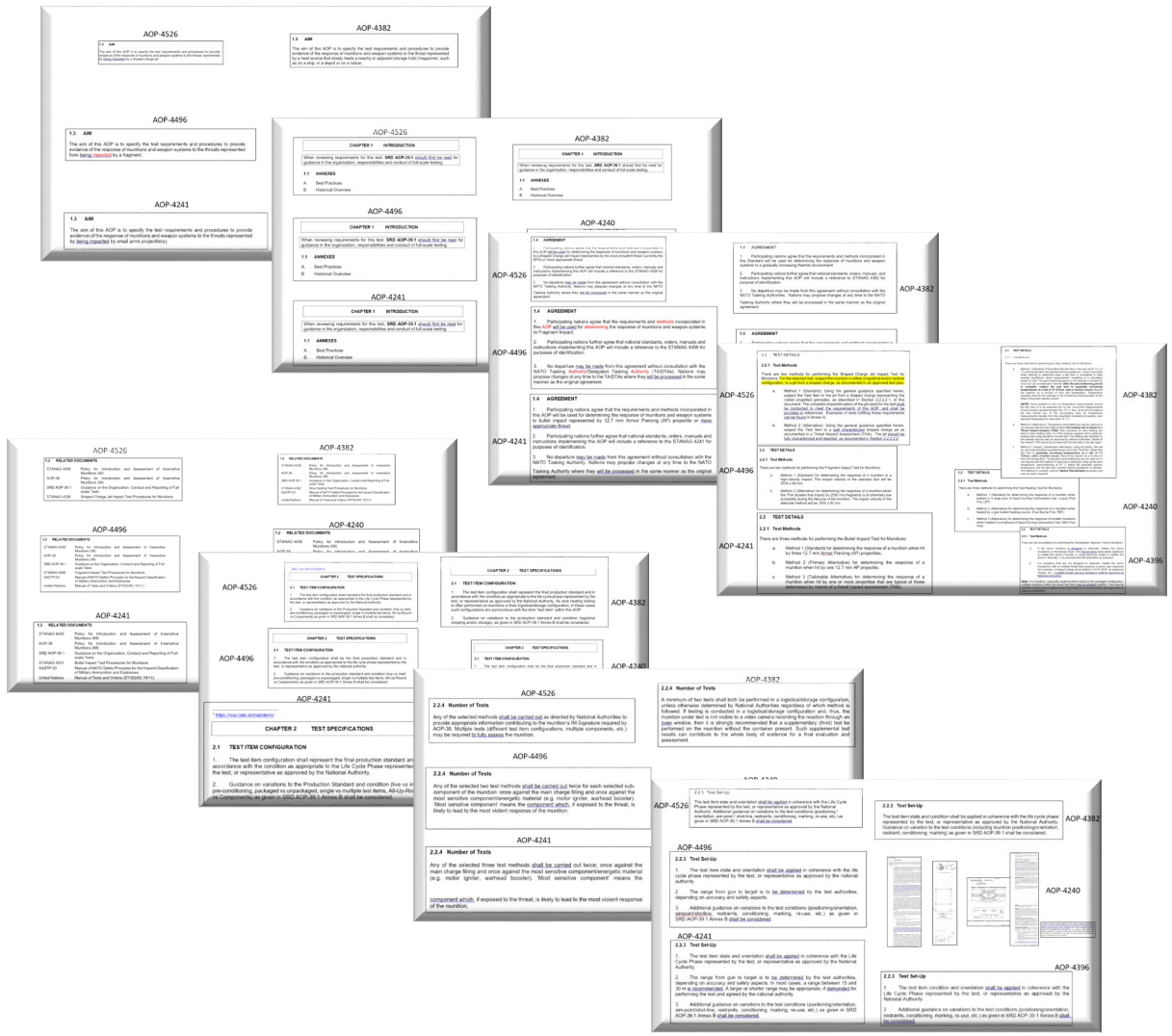
OBSERVATIONS & RECORDS

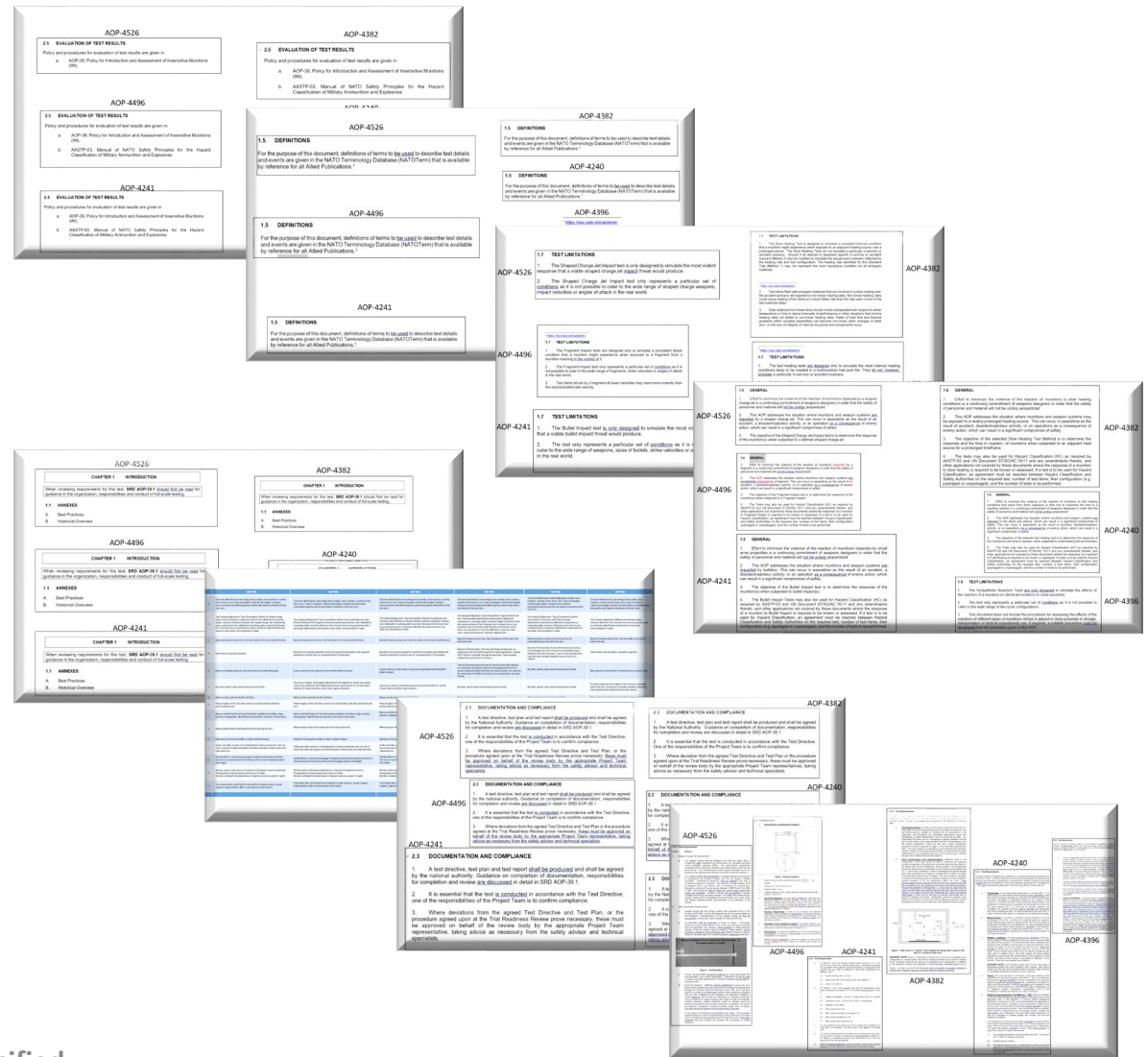
- ***Revised* Observations & Records Comparison Chart**
  - An organized matrix of (a-o) Ob's & Rec's
  - Only contains requirements found in AOPs
  - Consistent, Readable, Accurate, Clarified
  - Enabled efficient/effective comparison of section (i.e. 2.4).

- **2.4 Observations & Records**
  - Custodians currently transferring content directly to respective AOPs in NATO format



Next Meeting → Comparing Each Test AOP (Section-by-Section)





Conclusions

NATO CNAD AC/326 CASG SG/B - IM Test AOP Standardization WG

- Updating NATO IM Test Doctrine Portfolio:
  - ✓ Ensuring *consistency* amongst the test documents
  - ✓ Common changes made to AOPs:
    - *Textual changes* for clarity of intent
    - *Outline structural revision* to improve:
      - Readability
      - Flow logic
      - Consistency
    - *Match the latest NATO AOP Format* (provided by MSIAC)
  - ✓ Unique changes made to AOPs:
    - To ensure technical metrics are accurately supported
  - ✓ Transferring some information from each AOP to SRD
    - Unnecessary, Additional , Guidance
  - ✓ Ultimately each of the 6 updated IM Test AOPs
    - Will undergo a *Version Update*
    - Will NOT undergo Ratification

Conclusions

- ❑ Synchronizing changes made to AOPs with other related / supporting documents
  - ➢ AOP-39, AOP-39.1 (SRD), AOP-IM/HC, etc.
    - ➢ AOP-39 & SRD will also undergo Version Change only
- ❑ Captured and addressed necessary justifications for changes made, by deliberating over:
  - ➢ Terms
  - ➢ Definitions
  - ➢ Intentions
- ❑ Created a Record of Memorandum to record these changes / justifications for future portfolio revisions
- ❑ Utilized Comparison Chart for ease of evaluating, comparing, and cross-analyzing topics amongst the documents
  - ➢ We will retain / maintain these comparison charts in our records to make it easier for us during our next revision of the AOPs in the future.
    - Improve our revision process
    - Helped retain old information and reasons for changes
    - Perhaps even users may find these useful when running suite of IM tests.
      - Can use as ‘Reference Table’

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Thank You

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