

# Introducing the U.S. Navy Insensitive Munitions Handbook

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## ABSTRACT

The Naval Ordnance Safety & Security Activity (NOSSA) will issue the “U.S. Navy Insensitive Munitions Handbook” on the secure NOSSA website. The Handbook will be a comprehensive source of information tailored for the Navy Insensitive Munitions (IM) community, specifically for the Munitions Program Offices that are required to develop and conduct IM Programs for their munitions. This paper is intended as an introduction of the Handbook to the international IM and Munitions Safety community. The paper provides discussions of sections of the Handbook that address: (a) Selected history of the IM Program; (b) Navy IM policy and guidance; (c) The Navy IM development process; (d) The Joint IM Strategic Planning (IMSP)/Plans of Action and Milestones (POA&Ms) process; (e) IM research projects; (f) Threat Hazard Assessments; (g) IM qualification that covers: Explosives Qualification and Final (Type) Qualification, Harmonized IM/Hazard Classification (HC) Testing, Joint Standard IM Tests, and IM/HC Test Plan Template; and (h) IM compliance. The IM research projects and the relevant points of contact are based on information, from the: (a) FY17/18 IMSP/POA&Ms and (b) IM Technology Programs (Joint Munitions Program (JMP), Joint IM Technology Program (JIMTP), IM Advanced Development (IMAD) Program, and IM Technology Transition Program (IMTTP). The 2017 information is included in the Handbook to provide recent examples of the range of IM research and collaboration that is indicative of the range of possibilities for future areas for IM research and collaboration.

## INTRODUCTION

### OBJECTIVE

The objective of this paper is to inform the IM and Munitions Safety communities of an initiative by the Navy IM Office (IMO) to develop a U.S. Navy IM Handbook. The Handbook will be a comprehensive source of guidance, requirements, format, and information tailored for the Navy

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IM community, specifically for the munitions Program Offices (POs), and their program development teams who are required to develop and conduct IM Improvement Programs for their munitions. Use of the Handbook guidance by the POs will facilitate a more successful review by the Navy IMO and a timely processing of their IMSPs/ POA&M submissions.

### ORGANIZATION OF THE PAPER

This paper is structured as follows: Following this section, the paper is organized along the lines of the major elements of the Handbook listed below followed by a Concluding Remarks section, Acknowledgements, and References.

- a) Introductory Sections of the Handbook
- b) IM Background
- c) IM Policy and Guidance
- d) Navy IM Development Process
- e) IM Technology
- f) Threat Hazard Assessments (THAs)
- g) IM qualification
- h) IM Compliance

### **Introductory Sections of the Handbook**

#### The Navy Goals for the IM Program

The Navy's goal is to fully implement the Department of Defense (DoD) IM Program. The Navy's approach is to address:

- a) **IM Technology** - Identify IM technology shortfalls for Navy and Joint munitions, conduct a robust Science and Technology (S&T) program to develop solutions for the shortfalls, and identify windows of opportunity for the POs to insert the solutions in their munitions improvement/development programs.
- b) **IM Improvements** – Without regard to program acquisition category (e.g., new procurements of legacy systems, low-rate initial production research and develop programs, product improvement programs PIPs), and non-development items, etc.), all Department of Navy (DON) munitions are to be designed/improved to meet IM requirements. Operational capabilities and performance are to be attained without compromising system and platform safety.
- c) **IM Compliance** – A munition is certified to be IM compliant when it is assessed/scored by the Navy Munitions Response Evaluation Board (MREB) or by another appropriate Service Review Authority, to pass all required IM tests. The Navy Munitions POs are to conduct coordinated IM/Hazard Classification (HC) testing that addresses the passing criteria for the six IM Threats (Fast Cook-off (FCO), Slow Cook-off (SCO), Bullet Impact (BI), Fragment Impact (FI), Sympathetic Reaction (SR), and Shaped Charge Jet (SCJ)). Achieving IM compliance is to be viewed over the munition program's entire life cycle. Passing all IM tests (full IM compliance) for a munition requires:

- i. A Burn Reaction or better (No Sustained Reaction) for the FCO, SCO, BI, and FI IM tests and
- ii. An Explosion Reaction or better (Deflagration Reaction, Burn Reaction, or No Sustained Reaction) for the SR and SCJ tests.

### Objectives of the Handbook

The objective of the Handbook is to provide the Navy IM community with a reference and tutorial guide for executing a Munition's IM Program. Specifically, this document addresses:

- a) A brief history of the IM program,
- b) The current IM policy and guidance as implemented by the Navy (**NOTE:** Copies of the current IM related Navy Instructions are provided in the Appendices of the Handbook),
- c) A description of the Navy's IM development process,
- d) Guidance on how to implement the Joint IMSP/POA&Ms process for the munitions in their portfolio,
- e) Information on sources of Navy, Joint, and other Service IM technology solutions and developments that can address IM technology shortfalls identified in the Munitions POs' POA&Ms,
- f) Guidance on preparing an IM THA,
- g) Guidance on complying with Qualification and Final (Type) Qualification requirements for Navy explosives (explosives, propellants, and pyrotechnics),
- h) Guidance on complying with the harmonized IM /HC testing and analysis requirements, and
- i) Guidance on evaluating the results of the harmonized IM/HC test results to assess a munition's compliance with IM criteria.

### **IM Background**

In 1994, Ray Beauregard wrote an excellent paper entitled "History of the U.S. Navy Insensitive Munitions Program," (Reference 1) on the history of the Navy's IM program, which was subsequently revised in 2005 and 2009. Several observations from his paper are listed below:

- a) During the 1950's and on through the early 1980's, the Navy became convinced that munitions and explosives (explosives, propellants, and pyrotechnics) with reduced sensitivity and reactivity are required to reduce the number of and damage from explosives accidents and combat related explosives incidents.
- b) In 1979, to address the explosives high sensitivity/reactivity problems, the Navy established the Explosives Advanced Development (EAD) Program to develop Insensitive High Explosives (IHE) with the objective: "... *This program will address explosives material characterizations, insensitive explosives applications, pilot plant investigations, and large scale safety tests which span the surface, air, and submarine warfare areas. The anticipated benefit to each warfare area would be reduction in platform vulnerability, increased safety, in munitions handling, and increased weapon lethality.*"

- c) In the early 1980's, several incidents occurred that renewed the Chief of Naval Operations (CNO), Adm. Watkins', interest in developing insensitive ordnance.
- d) The CNO Executive Board (CEB) on IM was convened in early 1984. The briefing book included the first definition of IM: *"Insensitive Munitions are those that reliably fulfill their performance, readiness, and operational requirements on demand, but are designed to minimize the violence of a reaction and subsequent collateral damage when subjected to unplanned heat, shock, fragment or bullet impact, electromagnetic pulse (EMP), or other unplanned stimuli."*
- e) On 18 May 1984, the CNO (OPNAV) signed OPNAV Instruction (OPNAVINST) 8010.13 "Department of Navy Policy on Insensitive Munitions." With the issuance of this OPNAV instruction, the CNO established the IM program and directed that the EAD program that was established to develop IHE be renamed the Navy's IM Advance Development (IMAD) Program and be redirected to develop IM technology required to correct sensitivity problems with Navy munitions.
- f) Starting with CNO issuing OPNAVINST 8010.13, Ray Beauregard's paper provided a selected listing of DoD, Joint, and Navy guidance and policy issuances related to the U.S. Joint and DoD IM program. (**NOTE:** This listing was expanded in the handbook.)

### **IM Policy and Guidance**

The Handbook provides the Navy Munitions Program Managers (PMs) and their program development teams the relevant U.S. law and DoD, Joint, and Navy policy and guidance regarding IM

The Handbook provides excerpts of important IM policy and guidance for executing the DoD IM Program, which are taken from the U.S. Law and DoD, Joint Chiefs, and MIL-STD issuances listed below:

#### U.S. Law

**USC, Title 10, Chapter 141, Section 2389 December 2001 (Reference 2) – "§ 2389. Ensuring safety regarding insensitive munitions. The Secretary of Defense shall ensure, to the extent practicable, that insensitive munitions under development or procurement are safe throughout development and fielding when subject to unplanned stimuli."**

#### DoD Policy

**DoDD 5000.01**, The Defense Acquisition System May 12, 2003, Certified Current as of 20 November 2007, E1.1.23. Safety (Reference 3) - "... All systems containing energetics shall comply with insensitive munitions criteria."

**DoDI 5000.02**, Operation of the Defense Acquisition System, Encl. 3, System Engineering, January 7, 2015 (Reference 4) - *"For all systems containing energetics, the Program Manager will comply with Insensitive Munitions requirements in accordance with DoD and Component policy requirements (as required by 10 U.S.C. 2389 ...)"*

#### Joint Chiefs Policy

**CJCSI 3170.01I**, Joint Capabilities Integration and Development System, 23 January 2015 (Reference 5) - *“Confirm capability of resisting insensitive munitions (IM) threats per the established standardized IM protocols...”*

#### MIL-STDs.

**MIL-STD-882E**, Department of Defense Standard Practice, System Safety, 11 May 2012 (Reference 6) – *“The PM and contractor shall document the system safety approach for managing hazards as an integral part of the SE [Systems Engineering] process. ... The minimum requirements for the approach include: ... b. Identifying and documenting the prescribed and derived requirements applicable to the system. Examples include Insensitive Munitions (IM) requirements, ...”*

**MIL-STD-2105D**, Hazard Assessment Tests for Non-Nuclear Munitions, 19 April 2011. (Reference 7) (Appendix C in Handbook.) - Definition of IM: *“Insensitive munitions (IM). Munitions which reliably fulfill (specified) performance, readiness, and operational requirements on demand but which minimize the probability of inadvertent initiation and severity of subsequent collateral damage to the weapon platforms, logistic systems, and personnel when subjected to unplanned stimuli.”*

#### Navy IM Policy

The Navy implements the DoD/Joint IM Program via three Navy instructions - OPNAVINST 8010.13E (Reference 8), NAVSEAINST 8010.5C (Reference 9), and NOSSAINST 8010.1 (Reference 10) listed and summarized below:

**OPNAVINST 8010.13E**, Department of Navy Policy on Insensitive Munitions, 14 January 2014 (Reference 8). (Appendix D in Handbook.) – Reference 11 discusses the recent updates (Revision E) to this instruction. This instruction:

- a) States the Navy IM policies.
- b) Assigns levels of responsibilities for the IM Program within the DON.
- c) Establishes the IM Council (IMC) and the IM Working Group (IMWG).

**NAVSEAINST 8010.5C**, Insensitive Munitions Program Planning and Execution, 15 September 2015 (Reference 9). (Appendix E in Handbook.) – This instruction:

- a) Promulgates procedures and the Navy organizational structure for planning and executing an integrated DON IM Program, and amplifies IM Strategic Planning (IMSP) policy and guidance provided in the Department of Defense (DoD) Standard Operating Procedure (SOP) for Insensitive Munitions Strategic Planning (IMSP) and Plans of Action and Milestones (POA&Ms) Defined by Joint Services Business Rules (DoD SOP for IMSP and POA&Ms). (Reference 12). (**NOTE:** As indicated in the Reference 12 listing, the DoD SOP for IMSP and POA&Ms is Appendix A of the DoD Acquisition Manager’s Handbook for IM.)
- b) Provides procedures for out-of-cycle requests.
- c) Explains the Joint Staff’s Joint Requirements Oversight Council (JROC) responsibility to approve munitions procurement.
- d) Explains the Navy’s Weapon System Explosives Safety Review Board (WSESRB) responsibility for approval for service use.

- e) Establishes the responsibilities, with respect to the IMSP/POA&M process, for the Commander, Marine Corps Systems Command (COMMARCORSYSCOM) PM for Ammunition (PM AMMO).
- f) Establishes the responsibilities, with respect to the IMSP/POA&M process, for the IMC and its members, NOSSA N8 (Weapons Assessment Directorate), and the Naval Warfare Centers.
- g) Establishes the responsibilities for the Navy Munitions (Program Executive Officers (PEOs) to comply with the Navy IM policies and procedures for conducting an IM Program.
- h) Requires that:
  - i. All energetic material be qualified and undergo Final (Type) qualification per NAVSEAINST8020.5C Qualification and final (Type) Qualification Procedures for Navy Explosives (High Explosives, Propellants, Pyrotechnics, and Blasting Agents), 05 May 2000 (Reference 13) (Appendix I in Handbook).
  - ii. IM be integrated into a total system safety program per MIL-STD-882E, Department of Defense Standard Practice, System Safety, 10 February 2000 (Reference 14).
  - iii. Each munition address FCO, SCO, BI, FI, SR, and SCJ threats per MIL-STD-2105D (Reference 7) and applicable NATO Standardization Agreements (STANAGs). To be considered IM compliant, a munition item must, at a minimum, satisfy the passing criteria for the JROC/Office of the Under Secretary of Defense (OUSD) Joint Standard IM Tests. See Table 1. Variations from the standardized IM test requirements must be approved as part of the Joint IM Test Standards and Compliance Assessment process.

**Table 1. Joint Standard IM Tests and Passing Criteria\*** (Taken from Reference 9.)

<b>IM TEST</b>	<b>TEST PARAMETERS*</b>	<b>CONFIGURATION (Number of tests)</b>	<b>PASSING CRITERIA**</b>
Liquid Fuel Fire/ FCO	STANAG 4240E2, Reference 15, Standard Procedure (Annex A) (Revision in process)	Logistical (1) Operational (1)	No response more severe than Type V (Burning)
Slow Heating/ SCO	STANAG 4382E2, Reference 16, Procedure 1 (Revision in process)	Logistical (2)	No response more severe than Type V (Burning) or If no reaction occurs upon reaching 365°C (689°F)
Small Arms Attack/ BI	STANAG 4241E2, Reference 17, Procedure 1 (Revision in process)	Logistical (1) Operational (1)	No response more severe than Type V (Burning)

FI	STANAG 4496E1, Reference 18, Standard Procedure: Annex A Standard Fragment fired with an impact velocity of 2,530 m/s (8,300 ft/s) (Revision in process)	Logistical (1) Operational (1)	No response more severe than Type V (Burning)
SR/Sympathetic Detonation	STANAG 4396E2, Reference 19, Standard Procedure (Revision in process)	Logistical confined (1) Logistical unconfined (1)	No propagation of reaction more severe than Type III (Explosion) reaction (of like acceptor munitions)
SCJ	STANAG 4526E2, Reference 20, Procedure 2: Standardized 81mm precision shaped charge (Revision in Process)	Logistical (1) Operational (1)	No response more severe than Type III (Explosion) reaction
Thermal Stability Articles	NAVSEAINST 8020.8C, Reference 21, Paragraph 5-4b.	Logistical (1)	None of the following: explosion, ignition, substance exudation outside munition, temperature rise exceeding 5°F, damage to outside of casing / packaging, or for hypergolic systems – either fuel or oxidizer leaks from its storage tank
40-ft Drop	STANAG 4375E3, Reference 22, Procedure 1 Logistic Drop.	Logistical (3 Orientations)	No visible reaction of the energetics with effects apparent outside the article casing (if transported unpackaged) or packaging

(\*Table 1. also includes two HC-only required tests in blue font – Thermal Stability Articles and 40 Ft Drop.)

**NOSSAINST 8010.1A**, Munitions Reaction Evaluation Board (MREB), 30 August 2017 (Reference 10). (Appendix F in Handbook.) This instruction states the mission, authority, responsibilities, and membership of the DON MREB. The MREB major responsibilities are to review for concurrence (in conjunction with the DoD Explosives Safety Board (DDESB) for HC testing):

- a) Detailed IM/HC test plans in concert with NOSSA N8's approved THAs and

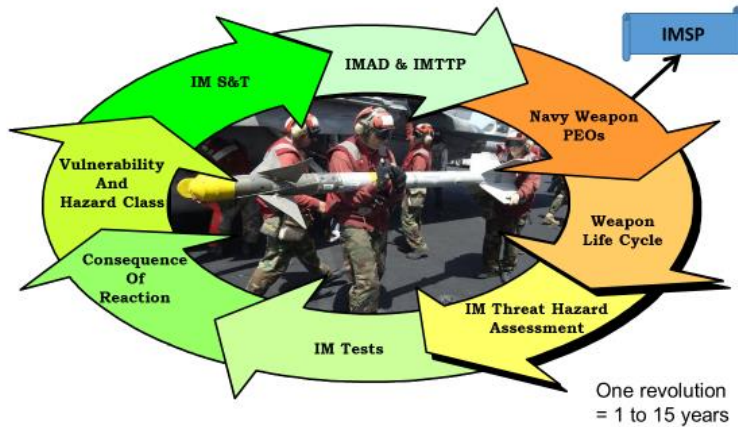
- b) IM and basic safety test results to obtain an official (score) assessment of record of the reactions.

NOSSA N8 renders a decision on final approval based on MREB recommendations for approval of test plans and test results/findings/recommendations.

### Navy IM Development Process

The elements of the Navy’s IM development process for planning and conducting an IM program, which generally takes from 1 to 15 years, is portrayed in Figure 1 and discussed below:

- a) Navy Weapons PEOs/PMs
  - i. This is the starting point when PEOs/PMs initiate planning a munition development program.
  - ii. PMs are given a requirement from the Fleet or otherwise determine that there is a requirement for a new or improved munition.
  - iii. Munition design solutions are selected based on many factors including cost, schedule, warfighter and performance requirements, safety (including IM), THA (see below), technology availability, reliability and maintainability, etc.
  - iv. One of the steps for planning a munition development is preparing an abbreviated or full IM POA&Ms.



**Figure 1. The Navy IM Development Cycle**

- b) Weapons Life Cycle
  - i. Based on requirements documentation, the PM determines (or validates if the development program is for improvement of an existing munition) the munition’s life cycle and determines:
    - 1) Operational environment - Where will the munition be used?
      - (i) Surface – land or sea.
      - (ii) Underwater.



- (iii) Air launched from fixed wing or rotary aircraft.
  - (iv) Continental United States (CONUS) or Outside the United States (OCONUS).
- 2) Logistical environment – How and where will the munition be stored and transported?
  - (i) Truck, ship or air transportation.
  - (ii) Depots and/or ship storage.
- c) IM Threat Hazard Assessment
  - i. PM evaluates the life cycle environmental profile of a munition to determine the threats and hazards to which it may be exposed throughout its entire life cycle. The THA:
    - 1) Identifies the threats and hazards that the munition may be exposed to during its life cycle.
    - 2) Analyzes the underlying causes, and assesses the potential results of exposure to these threats and hazards.
      - (i) This assessment of the potential threats and hazards includes those posed by friendly munitions, enemy munitions, accidents, handling, environmental lifecycle conditions, etc.
      - (ii) Provides rationale for which of the standard IM tests should be conducted on the munition, which tests may be deleted, as unnecessary/not appropriate and what additional testing that may be required to assess the basic safety of the munition.
  - ii. Preparation of a THA is a required step in the development of an IM Program for an IM priority munition.
  - iii. Summary of the THA, or updated changes as necessary, is a required element of the munitions' POA&M.
- d) IM Tests
  - i. Based on the approved THA and harmonized IM and HC Test Plan, the PM conducts the Joint Standard IM Tests per the JROC/OUUSD and required by MIL-STD-2105D (Reference 7). The Joint Standard IM Tests include FCO, SCO, BI, FI, SR, and SCJ.
  - ii. Note, in a harmonized IM and HC test program (See Table 1.), there are two additional HC-only required tests: Thermal Stability Articles and 40 Ft Drop.
- e) Consequences of Reaction
  - i. Based on the IM test results, what is the impact of the IM reactions on the warfighter, weapons platform, or logistical environment (storage or transportation)? Would the IM results lead to an event that could be catastrophic, resulting in potential loss of life and equipment? Or is the impact of the IM reactions so low such that there are little or no injuries or equipment damage? In other words, were the IM test results passing or failing the Joint Standard IM Tests pass/fail criteria?
  - ii. Is there technology available to reduce the severity of the IM reactions or is new IM technology needed?
- f) Vulnerability and Hazard Classification
  - i. The reactions of the munitions to the IM/HC threats/tests are used to determine the vulnerability of the munitions in the environments

- (platform/transportation/storage) that are encountered during the munitions life cycle.
- ii. PMs must hazard classify their munitions per DoD 6055.09-M, DoD Ammunition and Explosives Safety Standards: General Explosives Safety Information and Requirements (Reference 23) and NAVSEAINST 8020.8C (TB 700-2 / TO 11A-1-47 / DLAR 8220.1), DoD Ammunition and Hazard Classification Procedures (Reference 21), to address threats to the munitions during transportation and storage.
- g) IM S&T
- i. The Office of Naval Research (ONR) programs and the Office of the Secretary of Defense (OSD) JIMTP and the DoD/Department of Energy (DOE) JMP evaluate the munition program IM deficiencies as identified in IM testing and establish programs to address those deficiencies. If new less sensitive energetic molecules or binder materials are needed, efforts to fund such research would be funded by Basic Research, 6.1 Research, Development, Test & Evaluation (RDT&E) funding. If more advanced solutions are needed such as new energetic (explosive or propellant) formulations, new case materials or designs, or modeling and simulation (M&S) to predict munition energetic responses in lieu of destructive testing, then research efforts would be funded by Applied Research, 6.2 RDT&E funding, and/or Advanced Technology Development, 6.3 RDT&E funding.
  - ii. The PMs work closely with ONR, JIMTP and JMP so that those S&T programs can develop the technologies to address munitions' IM deficiencies and Fleet operational requirements.
- h) IMAD and IMTTP
- i. As S&T IM technologies mature and are successful, the next step is demonstration and validation, with 6.4 RDT&E funding, prior to implementation and transition to the Navy PMs' munitions. IMAD and IMTTP are the Navy's 6.4 Demonstration and Validation programs with the goal of maturing and transitioning 6.3 IM technologies for application by PMs in their munition development programs.
  - ii. The focus of IMTTP is Air-launched weapons. IMAD was established to develop, mature and transition IM technology for all Department of Navy munitions.
  - iii. The IM technologies available for transition include new explosives and warheads, new propellants and rocket motors, advance gun propulsion systems, new container materials and shielding. Successful IM technologies from IMAD and IMTTP reduce the munitions sensitivity to the IM threats while maintaining or exceeding operational requirements.
- i) Return to Weapon PEOs/PMs
- i. The PM's IM POA&M documents their munition programs' IM approach and progress and is included in the PEO's biennial IMSP.
  - ii. When deficiencies are found for a given developmental munition in IM testing, the development cycle may be repeated if the IM technologies do not exist to effectively address the IM deficiencies and meet operational requirements.

## Joint IMSP/POA&M Process

The Office of the Under Secretary of Defense (Acquisition, Technology and Logistics) OUSD (AT&L) issued the initial policy for IMSP in 2004. DoD SOP for IMSP and POA&Ms, 3rd Revision, March 2017 (Reference 12) is the current issuance that promulgates the policy and mandatory guidance for IMSP. In addition, the DoD SOP provides the IM community “business rules,” additional business processes, to enhance the overall management of the IMSPs, to include assigning roles and responsibilities for conducting reviews of the IM POA&Ms. The objective of Section 7. **Joint IMSP/POA&M Process** of the Handbook is to provide Navy Munitions PEOs/PMs and their munitions program development teams with a summary of the mandatory guidance in the DoD SOP.

The policy and mandatory guidance for the IMSP process provided in the DoD SOP for IMSP and POA&Ms is summarized in the Handbook Specifically, the Handbook addresses:

- a) **Schedule** - Provides a notional Navy IMSP schedule for the preparation of the IMSPs developed by the Navy Munitions PEOs, and the relevant POA&Ms developed by the munitions PMs as appendices. The IMSPs/POA&Ms are submitted to the JROC for approval biennially to address the planning process for a two-year period starting with an odd numbered year.
- b) **Approval Process** - Describes the Navy-specific IMSP approval process
- c) **Development Process** - Describes the IMSP/POA&M Development Process. Several important points include:
  - i. Each Navy Munitions PEO/PM is responsible for developing and maintaining a munitions Portfolio containing all munitions they procure, as well as for all munitions for which they have a Configuration Management (CM) role whether they are being actively procured or not.
  - ii. Approval of the IMSP by the JROC constitutes the authority to procure non-IM compliant items for the two-year period covered by the IMSP.
  - iii. The authority to procure a non-IM compliant item not contained in any Service IMSP requires an “out-of-cycle waiver,” which must be obtained from the JROC through a separate process.
- d) **Preparing IMSP/POA&Ms** - To support the Navy Munitions PEOs/PMs and their teams in preparing IMSPs and POA&Ms, NOSSA N85 maintains an IMSP/POA&Ms Scorecard Template on the NOSSA Secure Website for reviewing/scoring IMSP Key Elements prescribed in the SOP (Part A, Section 4.0) and summarized in the Handbook. The Scorecard Template is an excellent tool/guide that should be used by the Navy Munitions PEOs/PMs and their teams in their development of acceptable/approvable IMSPs/POA&Ms.
  - i. **IMSP Key Elements** - The format for the IMSP is left to the discretion of the reporting PEO/PM. However, specific key elements (Section 7.8.2 **IMSP Key Elements**. of the Handbook). are to be included in the development of the IMSP.

- ii. **POA&M Formats** - Prescriptive formats (Section **7.8.3 POA&M Formats** of the Handbook) have been established by the JSIMTP and the DoD IM IPT for the POA&Ms to ensure uniformity in documenting the IM efforts across the Joint Service IM community.

### **IM Technology**

As per NAVSEAINST 8010.5C (Reference 9) policy, Munitions PMs under cognizant PEO or Systems Command authority, are to seek every window of opportunity to incorporate appropriate technologies developed by the JMP, JIMTP, IMAD Program, and IMTTP, and similar programs of other Services, to provide IM-compliant munitions for the Naval Fleet. The objective of Section **8. IM Technology** of the Handbook is to provide Navy Munitions PMs and their munitions program development teams with a broad overview of the resources available to them that has IM RDT&E technology concepts and data that may have applicability to the IM Improvement Programs for their priority munitions. The IM efforts span 6.2, 6.3, and 6.4 RDT&E funding as well as international projects, and seek solutions to gaps in IM technology that inhibit development of IM-compliant munitions. Identifying research projects that have application to the Program's specific munition can lead to collaborative efforts to pursue, and/or leverage, relevant solutions to successfully address the standard IM threats or any additional threats identified by the munitions' THA.

The Handbook:

- a) Provides brief descriptions of the IM technology programs (JMP, JIMTP, IMAD Program, and IMTTP), discusses the missions and IM technology focus areas and provides recent (FY17) example IM research project titles, as available, and identifies the POCs. References are provided for the FY17/18 Navy IMSPs/POA&Ms. In addition, the Army, Air Force, U.S. Special Operations Command (USSOCOM), and DoD Missile Defense Agency (MDA) are conducting technology development and integration programs that have relevance to munitions for the Naval Fleet. Those programs are discussed in their respective IMSPs/POA&Ms, which are referenced in the Handbook.
- b) Discusses partnering agreements that describe an understanding of mutual interest regarding an IM technology.
- c) Describes existing (and under development) web-based repositories/portals for data generated by the IM technology programs, which include the Defense systems and Technologies Knowledge Online (DSTKOL) and IM Technology Tool (IMT2). There is also a reference to the information on sharable data generated by those NATO AC/326 nations and South Korea that are members of the Munitions Safety Information Analysis Center (MSIAC).

### **Threat Hazard Assessments**

A THA is an evaluation of the life cycle environmental profile of a munition to determine the threats and hazards to which it may be exposed throughout its entire life cycle. The munitions life cycle covers the years-long period from concept development to final disposition, whether the end state is operational employment against a target, expenditure in training or testing, or

demilitarization/disposal. The THA identifies the threats and hazards that the munition may be exposed to during its life cycle, analyzes the underlying causes, and assesses the potential results of exposure to these threats and hazards. This assessment of the potential threats and hazards includes those posed by friendly munitions, enemy munitions, accidents, handling, environmental lifecycle conditions, etc. The THA provides rationale for which of the standard tests should be conducted on the munition, and which tests may be deleted, as unnecessary. The THA may also propose additional testing that may be required to assess the basic safety of the munition.

The preparation of a THA is a required step in the development of an IM Program. And a summary of the THA, or updated changes as necessary, is a required element of the munitions' POA&M.

To support the Navy Munitions PEOs/PMs and their teams in preparing THAs, NOSSA N85 is preparing a THA Template to be maintained on the NOSSA Secure Website.

### **IM Qualification**

NAVSEAINST 8010.5C (Reference 9) requires that "IM must be successfully integrated into a total system safety program" per MIL-STD-882E (Reference 6).

As stated in Reference 13, "*Qualification is the assessment of the explosive material to determine whether it possesses properties that make it safe and suitable for consideration for use in its intended role. Final (Type) Qualification is granted when the qualified explosive has been assessed as part of the design of a specific munition and predicted to be safe and suitable for military operational or training use.*" Reference 13 applies to explosives at Navy installations and aboard Navy ships or aircraft, whether designed and built by the Navy or developed by other Services, private industry, or foreign sources and whether intended for operational use, testing, training, or transport. Fleet ballistic missile strategic weapons and nuclear weapons are excluded.

The Qualification and Final (Type) Qualification, per Reference 13, of all energetic material in Navy munitions is essential to the Navy implementation of the IM program. This ensures that the energetic materials are safe and suitable for use in Navy munitions before operational, safety and IM evaluation of the end item munition. NAVSEASYS COM is assigned the Navy-wide responsibility for energetic materials, explosives safety and IM policy. Lead Systems Command responsibilities include the approval authority for Qualification and Final (Type) Qualification of explosives.

**Harmonized IM/HC Testing.** The Joint IM community began to coordinate IM testing with the Joint Hazard Classifiers with the publication of MIL-STD 2105B in January 1994. In the 1998 edition of TB 700-2 / NAVSEAINST 8020.8B / TO 11A-1-47 / DLAR 8220.1, the Joint HC community recognized the IM tests (FCO, SCO, BI, and sympathetic detonation, now designated SR), with noted additional requirements, as acceptable alternatives to the United Nations HC tests. In 2006 JROCM 235-06 (Reference 24) concurred with the OSD (AT&L) briefing, as requested in JROCM 076-06 (Reference 25), which detailed a proposed standardized single set of IM tests and passing criteria required for IM compliance executed by all Services. OUSD Memo dated 01 February 2010 (Reference 26) approved the set of IM standardized tests and criteria recommended in Reference 24.

**Joint Standard IM Tests.** Table 1., located in the OPNAVINST 8010.13E discussion above, lists the JROC and OUSD approved set of standardized IM tests and the additional two HC required tests and their passing criteria. The STANAGs referenced in Table 1 contain the detailed IM test procedures. The referenced IM tests are also acceptable for purposes of HC. The logistical test configuration for a munition, which includes any required packaging, is the munition configuration required for storage and transportation, whereas the selected operational test configuration is that non-logistic configuration, if there is one, in the (operational) life cycle of the munition that is determined to respond the most violently to the IM threats/tests.

Munitions POs are responsible for preparing an approved munition-specific harmonized IM/HC test plan that is based on Joint Standard IM and HC tests in Table 1. and obtaining the approval of the test plan prior to testing. Upon approval of the munition-specific harmonized IM/HC test plan, Munitions POs are responsible for conducting the required IM tests in Table 1. Final test reports must be submitted to NOSSA IMO. Test responses to the IM tests must be validated by the MREB for munitions programs led by the DON or by the appropriate Service board if led by another Service. Test responses to the, as approved, IM and HC tests must be validated by the Navy IMO and other Service Joint Hazard Classifiers and the DDESB. (**NOTE:** Variances to the approved test plan during testing should be avoided so that the review/approval of the test results is not compromised. However, if any variances to the approved test plan do occur during testing they must be noted and justified in the test report for review and acceptance, or not, by the IM/HC authorities.

**IM/HC Test Plan Template.** The Navy IMO has developed a template, the **U.S. Navy Munition Test Plan Template for Combined Insensitive Munitions/Final Hazard Classifications** (Reference 27), to provide a tool for the Navy IM and HC communities to prepare coordinated IM and HC test plans with test requirements, guidance, and best practices combined into one harmonized test document. The template is to be used by the POs and their support teams to prepare/tailor munition specific IM/HC test plans for submitting to the Navy IMO for Navy review and approval. The Navy approved IM/HC test plans then need to be tri-Service coordinated for HC with the Joint Hazard Classifiers and the DDESB for approval prior to IM/HC testing. The test plan template optimizes the number of tests and assets needed to comply with the IM test requirements of MIL-STD 2105D (Reference 7) and the HC test requirements of NAVSEAINST 8020.8C (Reference 21). The paper **Insensitive Munitions (IM) and Hazard Classification (HC) Testing Guidance and Integration** (Reference 28) provides an overview of the template structure and availability, describes how the template can be tailored for munition specific applications, and explains the benefits of using the template.

### **IM Compliance**

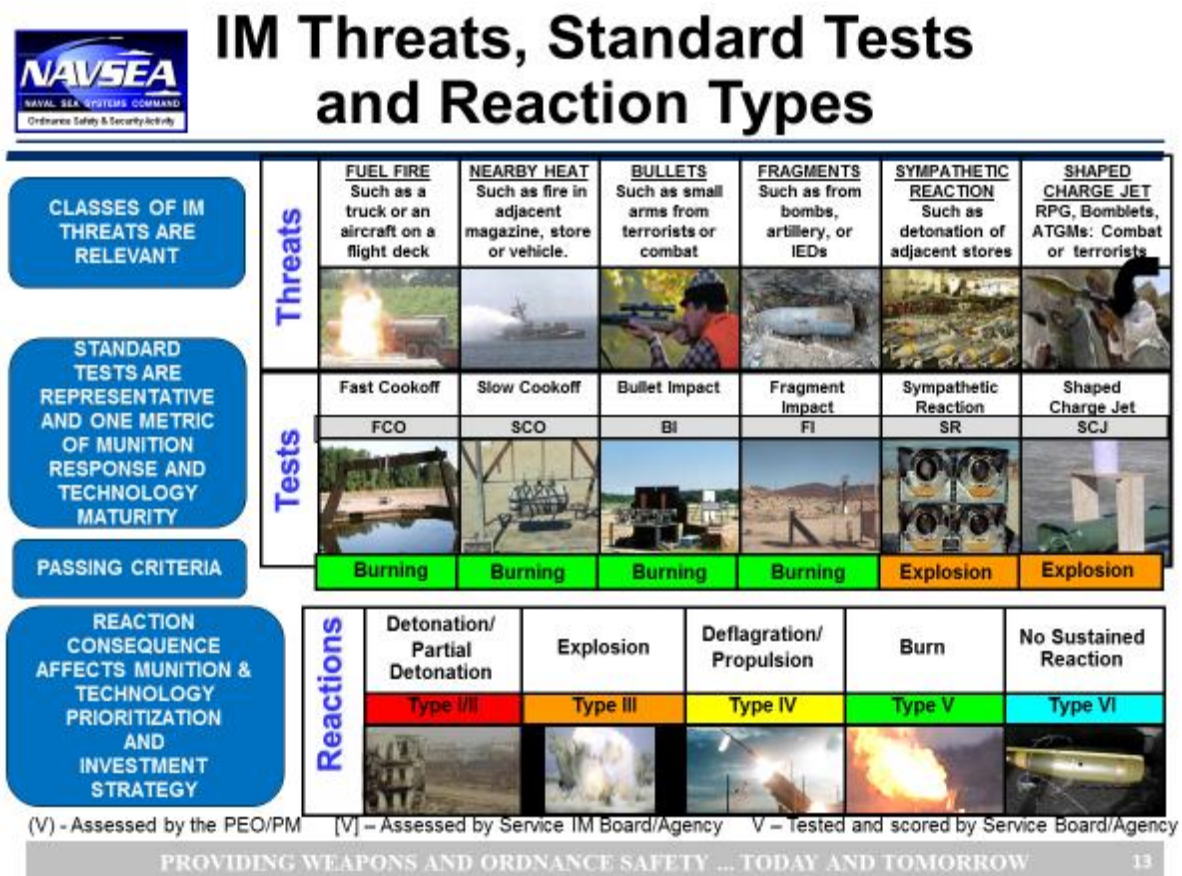
**IM Requirement.** As given above in the **IM Policy and Guidance** section of the paper, **USC, Title 10, Chapter 141, Section 2389 December 2001** (Reference 2) states “§ 2389. *Ensuring safety regarding insensitive munitions. The Secretary of Defense shall ensure, to the extent practicable, that insensitive munitions under development or procurement are safe throughout development and fielding when subject to unplanned stimuli.*”

As per OPNAVINST 8010.13E (Reference 8), all DON munitions, without regard to program acquisition category are to be designed to meet IM requirements. Operational capabilities and performance are to be attained without compromising system and platform safety. IM should be

integrated using a systems safety approach. Achieving IM compliance or incremental improvement in IM compliance is considered over the program's entire life cycle.

Munition POs' IMSP/POA&Ms, which are submitted to the JROC and OUSD(AT&L) (now OUSD (Acquisition and Sustainment (A&S)) biennially, document the program, progress and status of the POs' munitions IM improvement programs for achieving IM compliance.

**Harmonized Joint IM/HC Test Requirements and Passing Criteria.** Table 1. above provides a list of the required tests, along with the reference test procedure (STANAG) for each IM test, the required number of tests, and the test munition configuration (whether logistical or operational). Figure 2. defines the IM threats associated with each of the six Joint IM Tests, the potential munition responses (reaction types) to the IM tests, and the passing criteria for each test to obtain IM compliance.



**Figure 2. IM Threats, Standard Tests, and Reaction Types**

**Verifying IM Compliance.** The MREB, whose mission, authority, responsibility, and membership is prescribed in Reference 10, has the following mission and objective with respect to verifying IM compliance for Navy munitions:

- a) MREB Mission: To provide guidance and recommendations for the proper design and conduct of ordnance hazard assessment testing, which comprises all or some of the tests described in References 9, 7, and 21.

- b) MREB Objective: To provide evaluation of ordnance hazard assessment test plans and scoring of technical performance (test/no-test and reaction level) of hazard testing in support of IM compliance, HC, and WSESRB review processes for munitions.

Based on its Mission and its Objective listed above, the MREB is the responsible body to approve Navy IM/HC test plans for IM, to concur that the IM/HC tests were conducted as approved by the MREB, and to score the reaction types (See Figure 1. above.) of the munition during the IM/HC tests.

NOSSA maintains a MREB Process Guide and a Reporting Format as enclosures to Reference 10. that provide information on the MREB process for the POs and the required format for the MREB to report their decisions.

**Reporting IM Compliance.** Munition POs report the status of their program to achieve IM compliance in their required biennial munition-specific POA&Ms, which accompany their IMSP submission to the JROC and OUSD(A&S). Specifically, the status of IM compliance for a specific munition is reported in a POA&M “IM Reaction Table.” Table 11-1 in the Handbook is an example IM Reaction Table, which is taken from the DoD SOP for IMSP and POA&Ms (reference 12). Table 11-1. was developed for the DoD SOP to portray the progress of the POs’ IM Improvement Programs to achieve IM compliance for their munition in their munition specific POA&M.

**Full IM Compliance.** Passing all IM tests (full IM compliance) for a munition requires (See Figure 2.):

- a) A Burning Reaction or better (No Sustained Reaction) for the FCO, SCO, BI, and FI IM tests and
- b) An Explosion Reaction or better (Deflagration/Propulsion, Burn, or No Sustained Reaction) for the SR and SCJ IM tests.

### **Concluding Remarks**

This paper is an advance introduction to the Handbook, which will be issued by NOSSA on its secure website. The Handbook will have a restricted distribution (DISTRIBUTION STATEMENT C). NOSSA plans to update the Handbook on its secure website, as necessary.

The Handbook will be a comprehensive source of information tailored for the Navy IM community, specifically for the munitions POs that are required to develop and conduct IM Programs for their munitions. It will address the following topics: (a) IM Program background, (b) Navy IM policy and guidance, (c) Navy IM development process, (d) Joint IM IMSP/POA&M process (e) Selected IM research projects, (f) THAs, (g) IM qualification, and (h) IM compliance.

The IM research projects and the relevant POCs are based on information from the FY17/18 IMSP/POA&Ms and documentation from technology programs with IM related efforts (e.g., JMP, JIMTP, IMAD Program, and IMTTP). Information on 2017 research programs is included in the Handbook to provide recent examples of IM related research and collaboration that is indicative of the range of possibilities for future areas for IM research and development.



## Acknowledgements

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