

Synchronization of IM and HC: The Navy Perspective

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Munich, Germany*

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- **Purpose**
- **IM and HC background**
- **Testing criteria**
- **Navy synchronization of IM and HC**
- **Summary**

- **Introduce IM and HC**
- **Provide a background of the US Navy IM and HC Office**
- **Define Navy IM and HC roles and responsibilities**
- **Describe current IM and HC processes and topics**
 - **Joint IM Test Standards**
 - **Synchronization of testing criteria**
 - **The IMHCO**

Ordnance Accidents

Providing Ordnance Safety For Our Warfighters

IM can save lives and resources.



Bomb explosion following the tractor-trailer collision in Checotah, OK (1985).

*Failures
Don't
Forgive*



Ammunition train explosion, Roseville, CA. (1973)



U.S. Army Camp Doha, Kuwait (1991)



Indian Head, MD (1994)



Bien-Hoa Air Base, Vietnam (1965)



USS Oriskany (1966)



USS Forrestal (1967)



USS Enterprise (1969)



USS Nimitz (1981)



➤ IM is ...

- A CNO initiative to increase ship survivability
- Acquisition-driven to integrate energetic materials and munitions design technologies that reduce weapons' reaction violence and collateral damage to heat, shock and impact stimuli while maintaining performance

➤ IM compliance requires ...

- Passing standardized test series per JROC guidance
 - Thermal (fast cook-off; slow cook-off)
 - Impact (bullet, fragment, shaped charge jet)
 - Shock (sympathetic detonation)
- Systems approach for comprehensive solution
 - Less sensitive energetic materials (explosives, propellants)
 - Novel materials (rocket motor cases; warhead materials)
 - Packaging



IM is important to the Fleet to protect platforms and personnel from reactions of our own weapons – whether through accident, combat or terrorist activities.

Congressional Special Interest

- **USC, Title 10, Chapter 141, Section 2389 December 2001:** “ 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.”

Department of Defense Policy

- **DoDD 5000.01, May 12, 2003:** E1.1.23. Safety. “... All systems containing energetics shall comply with insensitive munitions criteria.”

Joint Chiefs Policy

- **Joint Capabilities Integration and Development System: 31 July 2009**
“Munitions used will be capable of resisting Insensitive Munitions (IM) threats (accidental and combat) per the established standardized IM protocols unless variations for unique circumstances are validated by the JROC.”

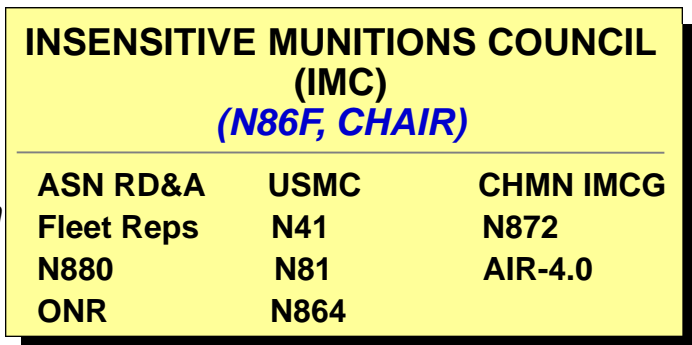
OSD(AT&L) Policy

- **OSD Memorandum: 21 July 2004.** “.....annual IM Strategic Plans will be the vehicle to submit and consolidate IM waiver requests.”
- **OSD Memorandum: 19 March 2007.** “IM Strategic Plans will be required biennially beginning with the FY09/10 plans.”

Navy IM Roles & Responsibilities

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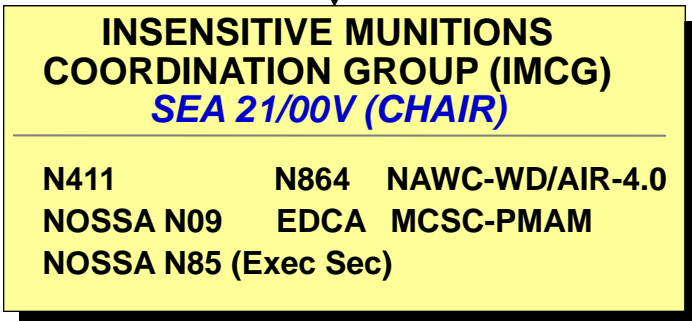
OPNAV
*IM Policy
Development
& Implementation*



“Munitions designed to fulfill their performance, readiness and operational requirements on demand, while minimizing the violence of their response to unplanned stimuli, such as heat, shock and impact.”

- **OPNAVINST 8010.13D**

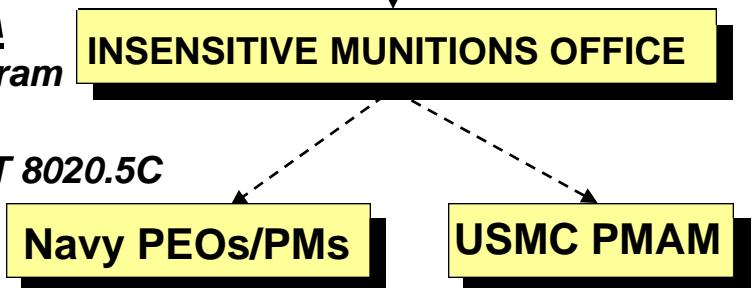
NAVSEA
*Technical
Direction*



“The Naval Sea Systems Command is the Lead SYSCOM for Explosive Materials, Energetic Materials and Inensitive Munitions and is responsible for the overall coordination of the IM Program.”

- **NAVSEAINST 8010.5B**

NOSSA
*Navy IM Program
Execution*
- **NAVSEAINST 8020.5C**



The Navy’s IM policy applies to all conventional munitions – regardless of the source of design or manufacture – that are used, stored or transported aboard U.S. Navy platforms or held at Naval activities ashore.

Joint IM Test Standards

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- Single set of IM Standard tests approved by JROC
 - JROCM 235-06 Nov 2006
- OUSD Memo Feb 2010
 - Test Standards Codified



ACQUISITION,
TECHNOLOGY
AND LOGISTICS

THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

FEB 01 2010

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
CHAIRMAN OF THE JOINT CHIEFS OF STAFF
COMMANDER, U.S. SPECIAL OPERATIONS COMMAND
DIRECTORS OF THE DEFENSE AGENCIES

SUBJECT: Joint Insensitive Munitions Test Standards and Compliance Assessment

The November 6, 2006, Joint Requirements Oversight Council (JROC) memorandum recommended a standardized, single set of Insensitive Munitions (IM) tests and passing criteria for use by all Components for assessing IM compliance. I approve these standard protocols, which are attached, and I also endorse the JROC's activities in validating any unique variations thereto within the Joint Capabilities Integration Development System.

Although the IM standard tests and passing criteria have been implemented for all programs since their recommendation by the JROC, and this process has been overseen by my office through the Joint Services IM Technical Panel, they have not been officially documented. Through their issuance in this memorandum, I wish to clearly direct their use for making assessments of IM compliance for all conventional munitions.

Ashton B. Carter











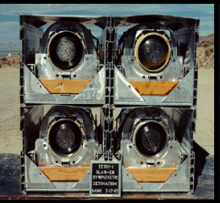

Attachment:
As stated

IM Technical Requirements






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IM CLASSES OF THREATS ARE RELEVANT

STANDARDS ARE REPRESENTATIVE AND ONE METRIC OF MUNITION RESPONSE AND TECHNOLOGY MATURITY

Threats	<p><u>FUEL FIRE</u> Such as a truck or an aircraft on a flight deck</p> 	<p><u>NEARBY HEAT</u> Such as fire in adjacent magazine, store or vehicle.</p> 	<p><u>BULLETS</u> Such as small arms from terrorists or combat</p> 	<p><u>FRAGMENTS</u> Such as from bombs, artillery, or IEDs</p> 	<p><u>SYMPATHETIC REACTION</u> Such as detonation of adjacent stores</p> 	<p><u>SHAPED CHARGE JET</u> RPG, Bomblets, ATGMs: Combat or terrorists</p> 
	<p>Fast Cook-off FCO</p>  <p>Type V Burn</p>	<p>Slow Cook-off SCO</p>  <p>Type V Burn</p>	<p>Bullet Impact BI</p>  <p>Type V Burn</p>	<p>Fragment Impact FI</p>  <p>Type V Burn</p>	<p>Sympathetic Detonation SD</p>  <p>Type III Explosion</p>	<p>Shaped Charge Jet SCJ</p>  <p>Type III Explosion</p>
Tests & Passing Reactions						

REACTION CONSEQUENCE AFFECTS INVESTMENT STRATEGY FOR MUNITION INCREMENTAL IMPROVEMENTS & IM SCIENCE & TECHNOLOGY

Reactions	Detonation/ Partial Detonation	Explosion	Deflagration/ Propulsion	Burn	No Sustained Reaction
	Type I/II	Type III	Type IV	Type V	Type VI
					

Joint IM Standards - Test Configurations

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IM Test	Number of Required Tests	Test Configuration	Test Procedure
FCO	2	1 Operational, 1 Logistical	STANAG 4240, Standard Procedure, Excluding Annex B
SCO	2	2 Logistical	STANAG 4382, Procedure 1
BI	2	1 Operational, 1 Logistical	STANAG 4241, Procedure 1
FI	2	1 Operational, 1 Logistical	STANAG 4496, Standard Procedure
SR/SD	2	2 Logistical	STANAG 4396, Procedure 1
SCJ	2	1 Operational, 1 Logistical	STANAG 4526, Procedure 2, PG-7V Surrogate (81mm precision Shaped Charge)**

•Additional testing may be required for additional threats per Threat Hazard Assessment (THA).

** PG-7V Surrogate configuration is identified by ARDEC Picatinny Arsenal DWG 7GP20078

- Identification of the damage potential in ***transporting and storing*** hazardous materials
- Includes Hazard Class/Division, Compatibility Group, Proper Shipping Name, UN Number, and Explosive Weight

1.4C
Cartridges, Power Device
UN0276
0.0243 lbs

Regulations

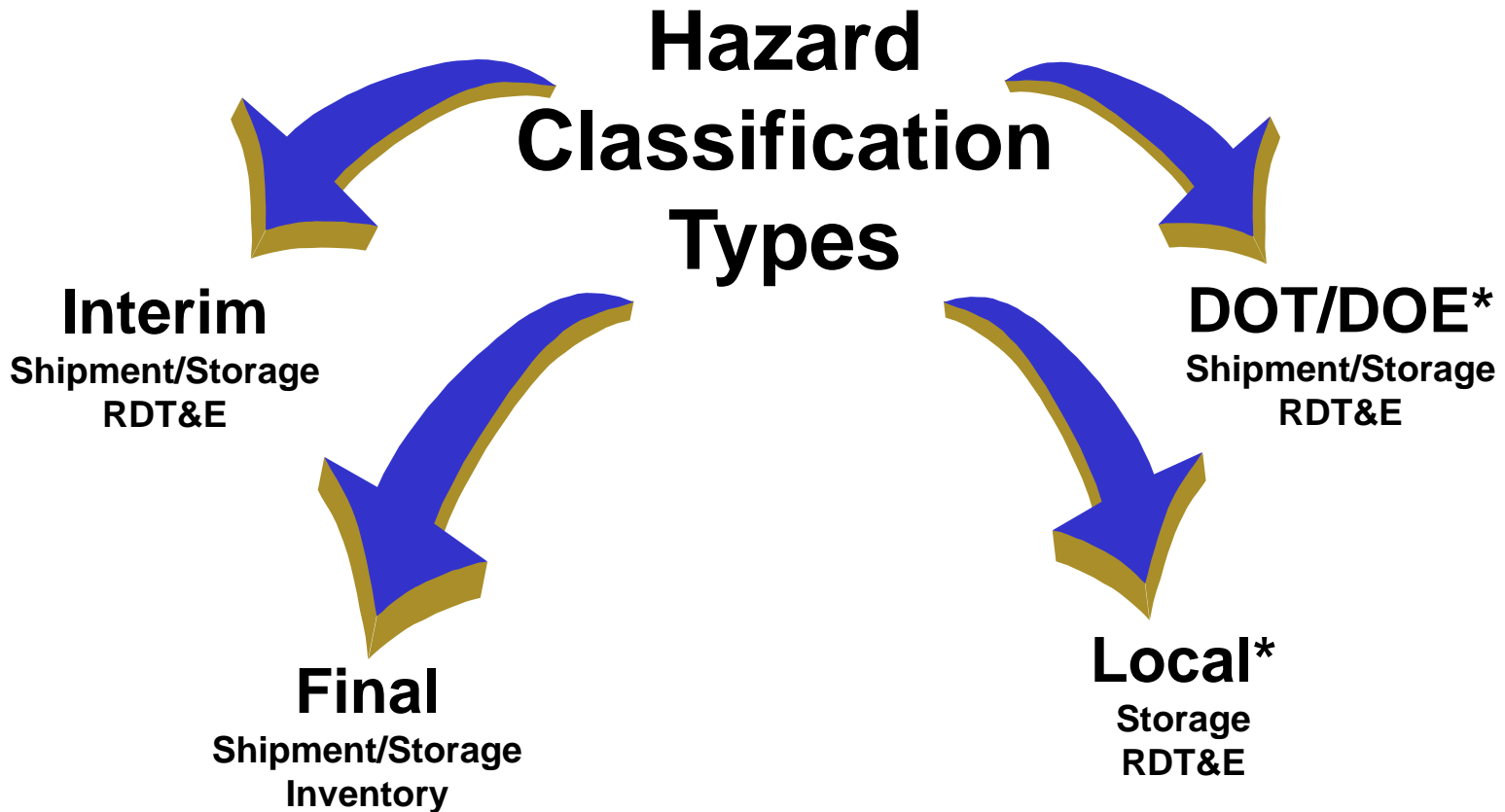
- DoD
 - DoD Ammunition and Explosive Safety Standards (DoD 6055.09-STD)
 - **DoD Ammunition and Explosive Hazard Classification Procedures (NAVSEAINST 8020.8B)**
 - Transportation and Storage Data for Ammunition, Explosives and Related Hazardous Materials (NAVSEA SW020-AC-SAF-010)
 - Ammunition and Explosives Safety Ashore (OP 5 Vol 1)

- National
 - Code of Federal Regulations, Title 49, Transportation

- International
 - UN Recommendations on the Transport of Dangerous Goods
 - Determination of the Hazard Classification of Military Ammunition and Explosives (STANAG 4123)

Hazard Classification Process

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*Navy only

Interim

- Need during development
- Approved by Service
- Transportation and Storage in CONUS (Can be used for OCONUS in limited scenarios)
- Material tests and evaluation
- Requires some planning but can be assigned within 30 days

Final

- Need for deployment
- Approved by DoD/DOT
- Transportation and Storage DOD-wide
- Full-scale testing on articles
- Requires long range planning

**Interim Hazard
Classification**

Requester



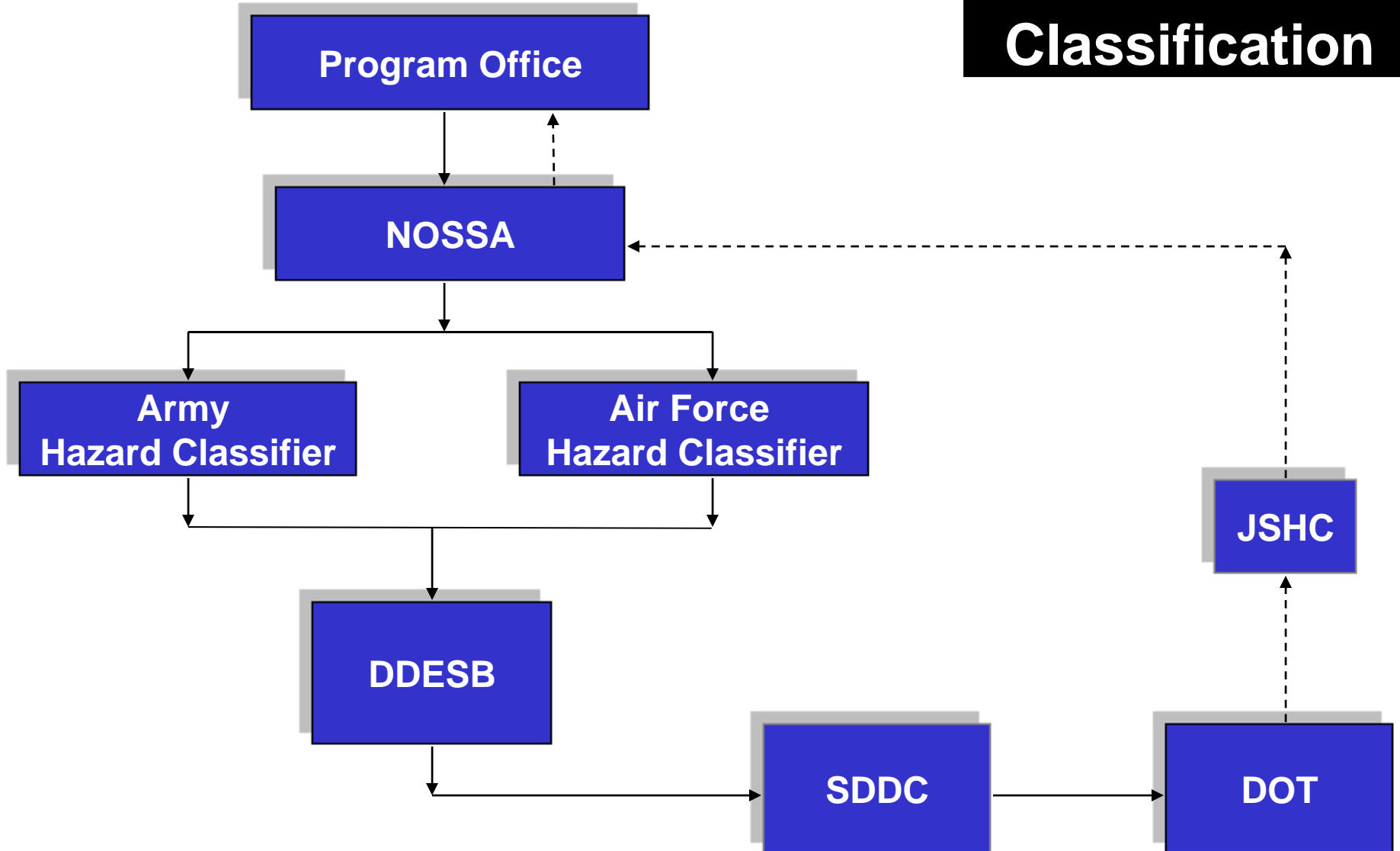
NOSSA*

*** Army/Air Force
classification offices**

Hazard Classification Process

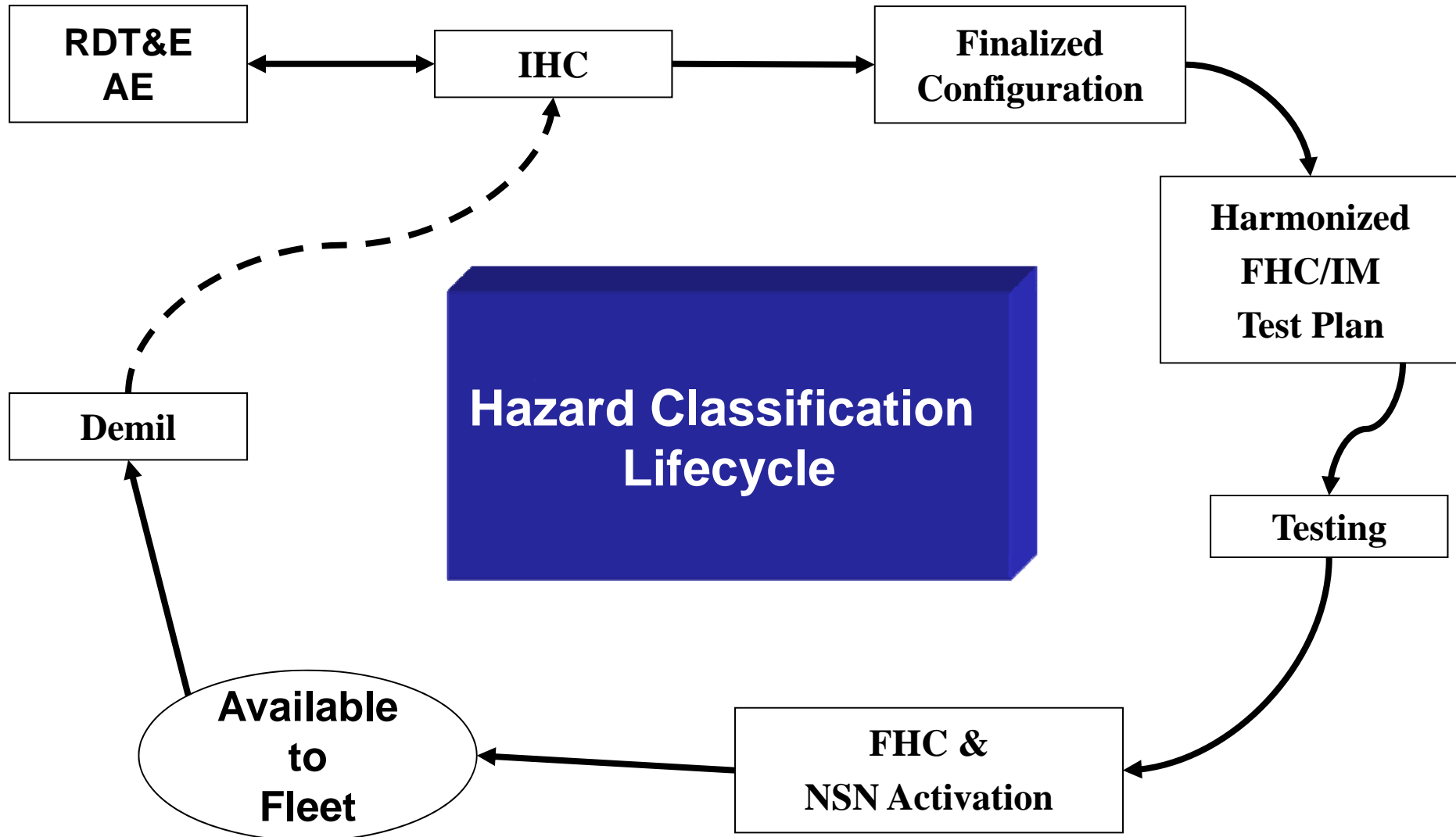
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Final Hazard Classification



Hazard Classification Process

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- Thermal Testing:
 - UN Test Series 3C for Substances
 - UN Test Series 4A for Articles
- Sensitivity Testing:
 - Article Drop Testing: UN Test series 4B
 - Impact: UN Test series 3A
 - Friction: UN Test Series 3B
 - Article Small Scale Burn: UN Test Series 3D
- Identifying a classification
 - Single Package: UN Test 6A
 - Sympathetic Reaction: UN Test 6B/7K
 - Liquid Fuel/External Fire: UN Test 6C/7G
 - Slow Heating: UN test 7H
 - Bullet Impact : UN Test 7J
 - Extremely Insensitive Detonating Substance (EIDS) tests: UN Test 7A through UN Test 7F

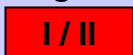
Standardized IM Tests/Passing Criteria

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JROC on 6 Nov 06 (JROCM 235-06)

	Threat	Passing Criteria	Comments	STANAG
FCO	 Liquid Fuel Fire (e.g., truck or an aircraft on a flight deck)	Burning	HC Relation : Required for hazard classification Stimulus : Rapid heating response Comments : None	4240
SCO	 Slow Heating 3.3 C/Hr (e.g., fire in adjacent magazine, store or vehicle)	Burning	HC Relation : Required for reduced hazard classification Stimulus : Slow heating response Comments : Additional technical studies appropriate	4382
BI	 .50 Cal M2AP 3 round burst (e.g., small arms from terrorists or combat)	Burning	HC Relation : Required for reduced hazard classification Stimulus : Low level kinetic impact Comments : Relevant small arms threat More severe threats exist Additional studies appropriate	4241
FI	 18.6 gram fragment 8300 +/- 300 fps (e.g., bombs, artillery, or IEDs)	Burning	HC Relation : Not required for hazard classification Stimulus : Combine shock, mechanical, thermal Comments : Artillery fragments slower Some KE and EFP threats more severe	4496
SD	 Detonation of a single donor (detonation of adjacent stores)	Explosion	HC Relation : Required for hazard classification Stimulus : Output of a like munition Comments : Does not address mixed storage Does not address multiple donor	4396
SCJ	 81-mm Precision shaped charge (e.g., RPG, Bomblets, ATGMs: Combat or terrorists)	Explosion	HC Relation : Not required for hazard classification Stimulus : Shock Comments : More severe threats exist Pragmatic threat considering technology potential	4526

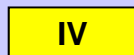
Legend



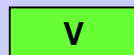
Detonation/
Partial Detonation



Explosion



Deflagration or
propulsive reaction



Burning



No sustained reaction

Fast and Slow Cook Off

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FCO Test Standard	Req.	Pass/Fail
MIL-STD-2105A (1991)	≥1600°F	≤ Type V (Burning)
STANAG 4439 AOP-39 (2010)	≥800°C (1472°F)	≤ Type V (Burning)

IM Policy

- Flame Temp w/ wind addressed in MIL-STD 2105C in 2003 (*Levine, Gregory, et. al.*)
- HC Harmonization w/ TB 700-2 LF/EF Test

SCO Test Standard	Req.	Pass/Fail
MIL-STD-2105A (1991)	6°F/hr	≤ Type V (Burning)
MIL-STD-2105C (2003)	3.3°C/hr (~6°F/hr)	≤ Type V (Burning)
STANAG 4439 AOP-39 (2010)	3.3°C/hr (~6°F/hr)	No Burn, Deflag, Det @ <300°F

IM Policy

**Harmonize w/
TB 700-2 HC Slow Heating test**

Bullet and Fragment Impact

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BI Test Standard	Req.	Pass/Fail
MIL-STD-2105A (1991)	3 - .50 cal M2 AP 2800 ±200 ft/s	≤ Type V (Burning)
STANAG 4439 AOP-39 (2010)	3 Rd Burst .50 cal M2 AP 850 ±20 m/s (~2800 ±66 ft/s)	No violent Exp Reaction (Det, deflag.)

Harmonize w/
TB 700-2 HC BI test

IM Policy

FI Test Standard	Req.	Pass/Fail
MIL-STD-2105A (1991)	2-5 ½-in. 250 gr. @8300 ±200 ft/s	≤ Type V (Burning)
MIL-STD-2105C (2003)	18.6gm (287gr) cylindrical frag 2530 ±90 m/s	≤ Type V (Burning)
STANAG 4439 AOP-39 (2010)	18.6gm (287gr) cylindrical frag 2530 ±90 m/s (8300 ±300 ft/s)	≤ Type V (Burning)

IM Policy

Fired from gas gun – Test
repeatability (impact angle &
vel) (*Fisher & Peugeot*
(MSIAC) 2002)

SD/SR Test Standard	Req.	Pass/Fail
MIL-STD-2105A (1991)	Test per THA	Acc: No Type I (Det)
MIL-STD-2105C (2003)	Configuration determined by THA	≤ Type III (Explosion)
STANAG 4439 AOP-39 (2010)	Donor/Acc., Config. Determined by THA	≤ Type III (Explosion)

•Optional “Propagation Test” in WR-50

Based on stowage, transportation, service use, design

Harmonize w/ TB 700-2 HC SR test

SCJ I Test Standard	Req.	Pass/Fail
MIL-STD-2105C (2003)	50mm Rockeye SC	≤ Type III (Explosion)
STANAG 4439 AOP-39 (2010)	50mm Rockeye SC Alt: 81 mm (Req'd for US)	≤ Type III (Explosion)

•81 mm SC – UN 2008
•81 mm BRL precision SC – new standard per JROC memo, Feb 2010

- NOSSA IMHCO reviews synchronization of IM/HC test plans.
- Navy Munitions Reaction Evaluation Board (MREB) reviews all Ordnance Assessment Test plans and scores the test. (Ref: NOSSAINST 8010.1)
- Program IM/HC test plan submittal
 - IMHCO, MREB concurrence required
 - Joint approvals may be required (JSIMTP, JROC, DDESB)
- Variations from the Joint IM Test Standards require JROC approval.

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- NOSSA IM Webpage –
<https://nossa.nmci.navy.mil/nrws2/Programs/InsensitiveMunitions/tabid/265/Default.aspx>
 - Test Plan Webpage in development
- NOSSA Webpage – HC Link
https://dap.dau.mil/policy/Documents/Policy/2008_OUSD_IM_Handbook_FINAL_05302009.pdf
- DOD Acquisition Manager's Handbook for Insensitive Munitions dated 6 Nov 2008
https://dap.dau.mil/policy/Documents/Policy/2008_OUSD_IM_Handbook_FINAL_05302009.pdf
- Munitions Safety Information Analysis Center (MSIAC)
<http://www.msiac.nato.int/>
 - MSIAC is a NATO project office. Its scope covers Munitions Safety (including Insensitive Munitions (IM) issues) across the total Life Cycle of munitions

Summary

- Mature IM and HC technology is being inserted in priority munitions where technically, programmatically, and fiscally practicable
- Navy has a well-structured IM and HC Program responsive to evaluation, policy/guidance and statute
- Shipping containers/packaging upgrades/modifications require IM and HC testing/assessment and provide a window of opportunity for IM and HC improvements.



Backup

IM Terminology Guide

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Table Values		Reaction Type	Color
Tested	Assessed		
I	(I)	Detonation	Red
II	(II)	Partial Detonation	Red
III	(III)	Explosion	Light Orange
IV	(IV)	Deflagration	Yellow
V	(V)	Burn	Bright Green
VI	(VI)	No sustained reaction	Turquoise
P	(P)	Pass (SD & SCJ)	Bright Green
F	(F)	Fail (SD & SCJ)	Red
THA		Determined not to be a credible threat per approved Threat Hazard Assessment	No color
NT		Not tested - Applicable only to baseline section	No color

Reaction types are defined in MIL-STD 2105C

Terms	Definition
Priority Munition	All munitions/items containing energetic material, determined by the PEO to benefit from IM-improvement based on prioritization criteria. All developmental items shall be categorized as Priority Items.
Tier I	Non IM-compliant priority items w/fully funded POA&Ms
Tier II	Non IM-compliant priority items w/o fully funded POA&Ms
Tier III	Non IM-compliant, non-priority items being procured by another PEO/Service
Tier IV	Non IM-compliant, non-priority items being procured by reporting PEO/Service
Tier V	Non-priority items w/no further procurement and no window of opportunity anticipated
Tier VI	IM-compliant, non-priority items being procured by another PEO/Service (compliant equivalent of Tier III)
Tier VII	IM-compliant, non-priority items being procured by reporting PEO/Service (compliant equivalent of Tier IV)

Score Characteristics	
<i>Note: () denotes assessment</i>	
I/II	DETONATION/ PARTIAL DETONATION <i>Intense shock, large craters and blast pressure, damage to nearby structures.</i>
III	EXPLOSION <i>Large fragments, fire/smoke hazard, blast and damage to nearby structures, possible minor craters</i>
IV	DEFLAGRATION <i>Non-violent pressure release, no fragmentation, possible projection of covers, no blast damage</i>
V	BURNING <i>Burning, non-propulsive possible non-violent case rupture, melting, no fatal debris beyond 50 ft</i>
VI	NO SUSTAINED REACTION (Unofficial) <i>No sustained combustion, smoking or brief combustion, almost all energetics remain</i>

- **Logistical Configuration (Storage, Shipping, or Transportation):** The logistical configuration is intended to be synonymous with the packaged configuration in which the munition is stored, shipped, or transported. In the event that ammunition has different storage, shipping, or transportation configurations, multiple configurations or at least the configuration expected to result in the reaction providing the maximum credible event will be tested.
- **Operational Configuration:** The operational configuration is intended to be synonymous with the tactical configuration in which a munition is ready to be employed as in an All-Up-Round (AUR) in a bare state. In the case where a munition is not removed from its packaging and shipping container prior to employment, the logistical configuration testing should be replicated where standardized testing specifies any operational configuration tests.

Ref: OUSD Memo Feb 2010

- Munitions Reaction Evaluation Board (MREB) formed (2009)
 - NOSSAINST 8010.1
- MREB Objectives
 - Ordnance Hazard Assessment Testing (IM/HC/Basic Safety)
 - Evaluates/Provides Guidance on Test plans
 - Provides Official Assessment of Record of Test Reactions
 - Establishes Process Guide and Reporting Format
- NOSSA approves/disapproves final MREB recommendations/findings and reactions



DEPARTMENT OF THE NAVY
NAVAL ORDNANCE SAFETY AND SECURITY ACTIVITY
FARRAGUT HALL
3317 STRAUSS AVENUE, SUITE 108
INDIAN HEAD, MD 20640-6151

NOSSAINST 8010.1
Ser N832/1830
24 Jul 09

NOSSA INSTRUCTION 8010.1

From: Commander, Naval Sea Systems Command (NAVSEA)

Subj: MUNITIONS REACTION EVALUATION BOARD (MREB)

Ref: (a) NAVSEAINST 8010.5
(b) MIL-STD-2105, Hazard Assessment Tests for Non-Nuclear Munitions
(c) NAVSEAINST 8020.8
(d) JROCM 235-06
(e) JROCM 102-05

1. Purpose. To state the mission, authority, responsibility, and membership of the Department of the Navy (DON) Munitions Reaction Evaluation Board (MREB).
2. 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 (a), (b), and (c).
3. 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 Insensitive Munitions (IM) compliance, Hazard Classification (HC), and Weapon Systems Explosives Safety Review Board (WSESRB) review processes for munitions.
4. Background. Since the implementation of the IM policy by the Chief of Naval Operations (CNO) in 1984, IM issues have received increasing attention within the Department of Defense (DoD). One example is that Joint Requirements Oversight Council (JROC) has approved Standardized IM tests per reference (d). In its execution of IM policy and procedures, the Office of the Secretary of Defense (OSD) is also striving to harmonize IM and HC testing. Weapon system programs are frequently Joint Service programs or the weapons are operating in a Joint Warfighter Environment per reference (e). Therefore, Joint safety requirements are becoming more important to implement and evaluate. With the increased levels of Joint oversight, it is