DoD Weapons/Explosive Safety Service – Unique, Inconsistent, Duplicate and Common Testing Standards/Requirements - Are Yours Here?

An OSD Study Led by the U.S. Marine Corps Systems Command

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Agenda

- Study Overview
- Methodology
- Data Collection and Analysis
- Results and Conclusions
- Next Steps

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- **Study Overview**
  - **Task Description**
  - **Problem**
  - **Phase I Objectives**
  - **What I Need From You**
- Methodology
- Data Collection and Analysis
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Problem

- The Services' safety review boards use different safety testing criteria.
- When one Service wants to use another Service's existing weapon system, additional safety testing is typically required by the new Service's safety board when the equipment has already been approved by a safety board. Some of these tests are essentially redundant.
- Common safety standards become of greater importance as the Services develop more explosive weapon systems with planned use in a joint operating environment.
- Study was initiated with the following long term goals
  - Determine a common definition of "acceptable" weapon safety test criteria and acceptable results for each and every possible environment the weapon could be certified for.
  - Develop a common understanding of the attributes that constitute a safe weapon.

Phase I Objectives

- Clearly define the requirements for explosive weapon systems safety tests and execution methodologies required by the Services and Service review boards.
  - Identify safety tests across the Services
  - Analyze safety tests among different operating environments and within each Service
- Assess requirements for current safety tests to identify common, inconsistent, duplicate and singular tests.
  - What are the drivers for inconsistent and duplicate safety tests
  - What are the processes behind inconsistent and duplicative safety test
  - Identify Service specific board processes
- Identify specific differences in safety tests between the Services.
  - Identify differences in how the tests are conducted and measured by each Service
  - Identify the drivers for the differences resulting in opportunities and benefits
- Identify potential opportunities or benefits.
  - What are the facing opportunities for fixing duplicate and inconsistent tests?
- Gather content on the known and existing problems that are faced in the field, potentially resolved by common safety tests.

What I Need from You

- Needs
  - Do you agree with the approach?
  - Do the modes cover all operational environments?
  - Where do you see / have you seen differences in safety testing requirements among the Services?
  - Where have you seen differences in implementation of the same safety testing requirements?
- Contacts
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- Study Overview
- **Methodology**
  - **Hypothesis Statement**
  - **Work Plan and Detailed Approach**
  - **Data Structure Hierarchy**
  - **Definitions of Key Terms**
- Data Collection and Analysis
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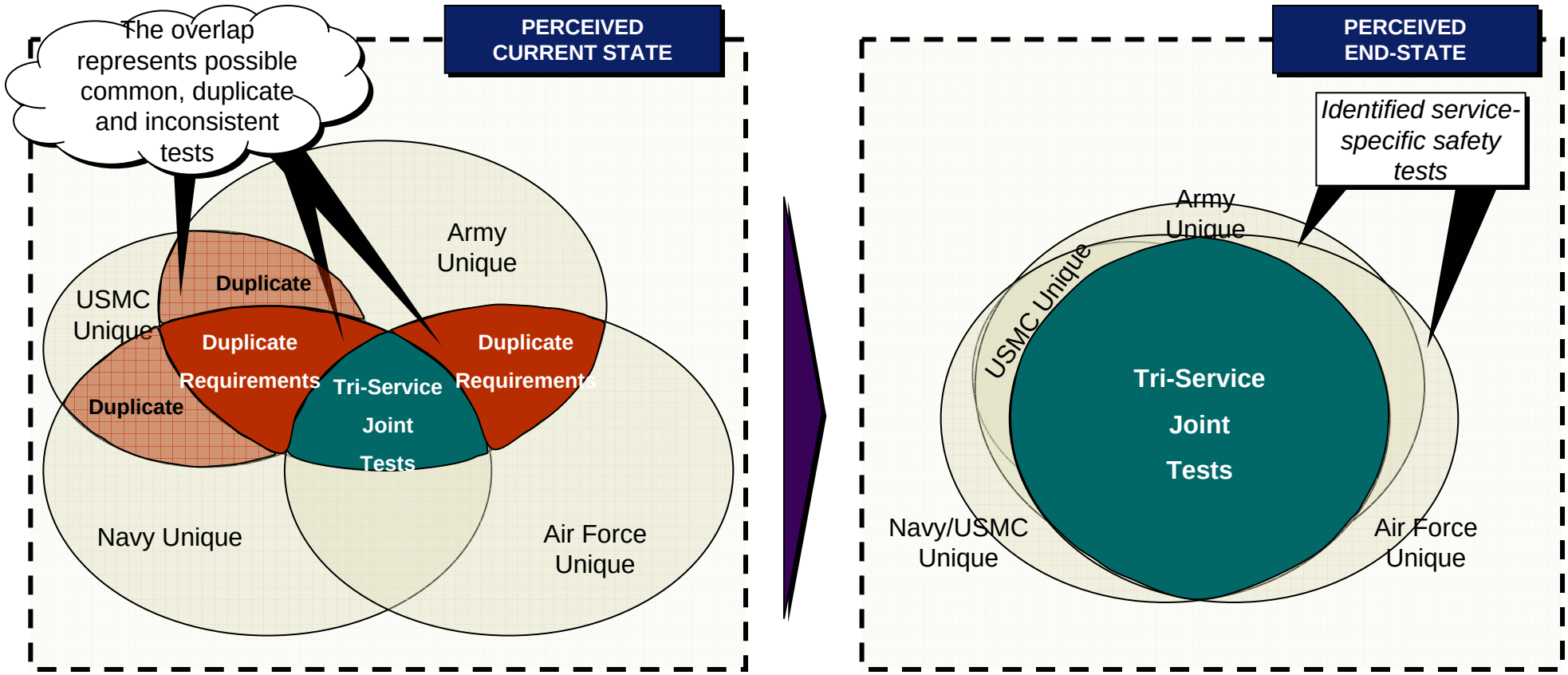
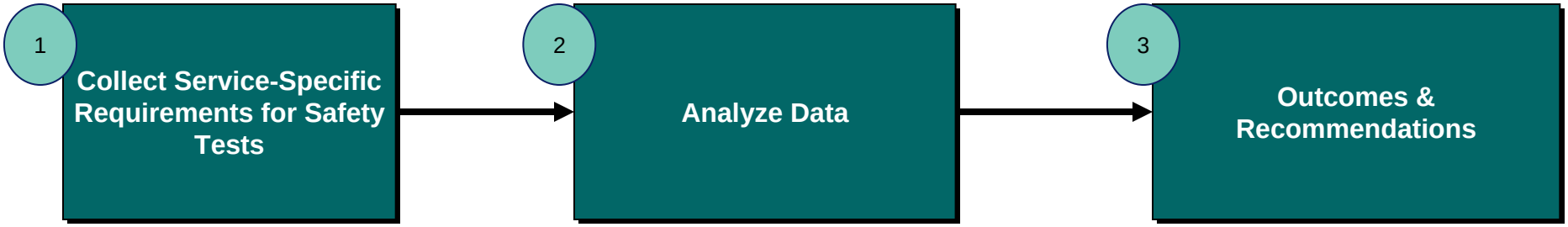
Hypothesis Statement

- Given the increasingly joint nature of American military deployment, services are increasingly hindered and delayed by the current need to require duplicate and inconsistent safety tests in order to qualify for use and shipment to a deployed site.



Work Plan and Detailed Approach



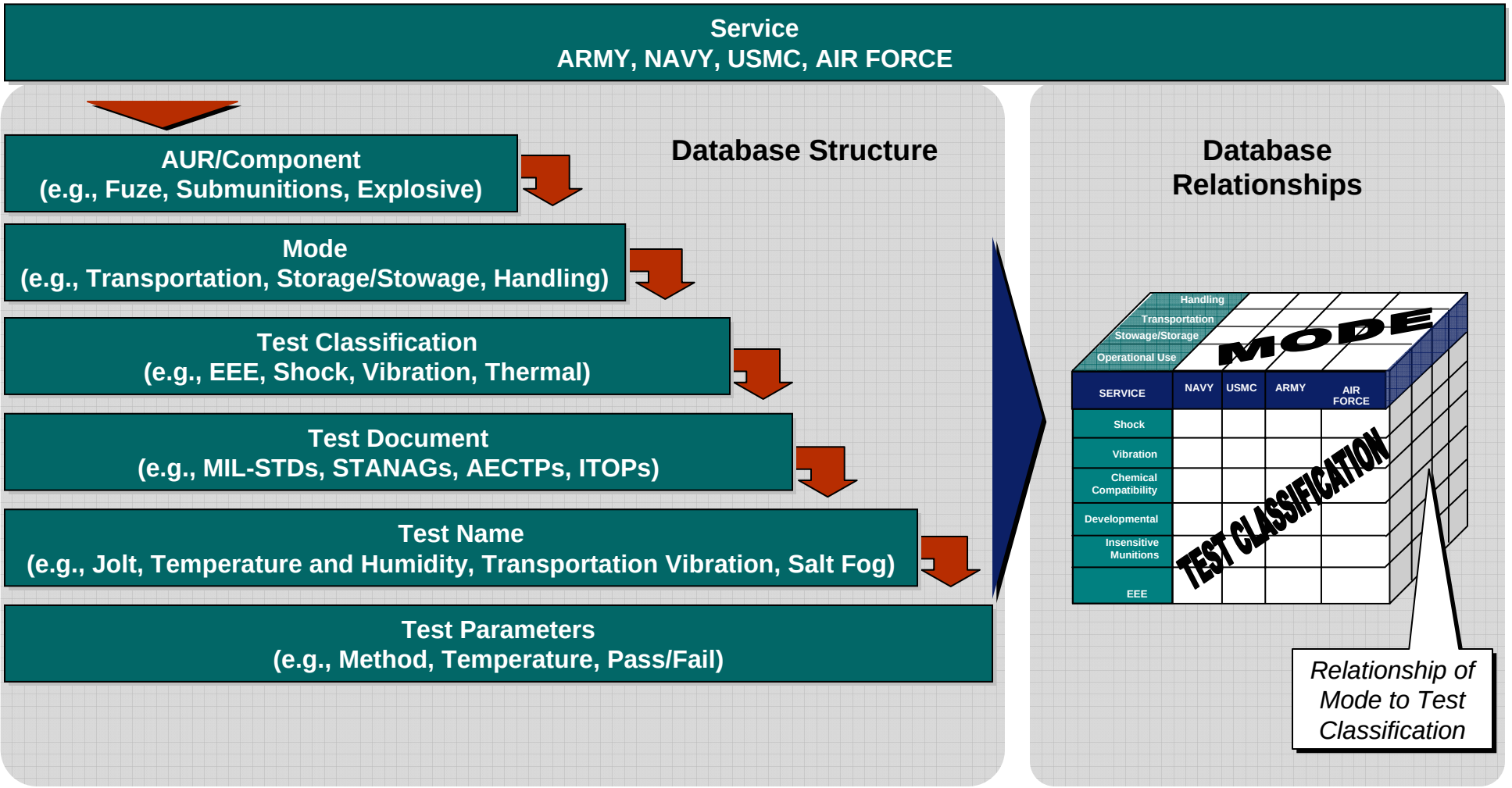
- Data gathering of existing and required DOD weapons safety tests.
- Interviews with safety board representatives, program managers, system safety leads and service-specific testers to confirm tests identified, gather additional tests and identify differences among the services about how the tests are setup, implemented and assessed.
- Relational database to assist with the gathering and organization of data.

- Data analysis for potential test duplication, inconsistency and single service instances exist.
- Select comprehensive sample of data collected by the team.

- Vetting of conclusions based on the analysis and collection efforts.

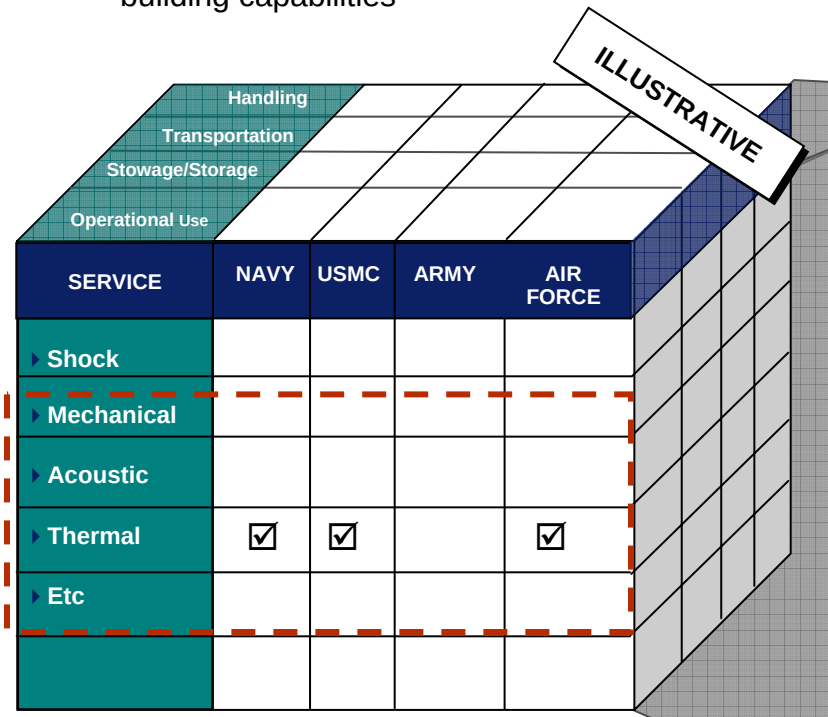
No Stovepipe Mentality - Approach is Representative of All Types of Systems for All Services.

Data Structure Hierarchy provides the means to compare the Mode to the Test Classification



The database provides insight into identifiable inefficiencies (details in the following pages) by service…

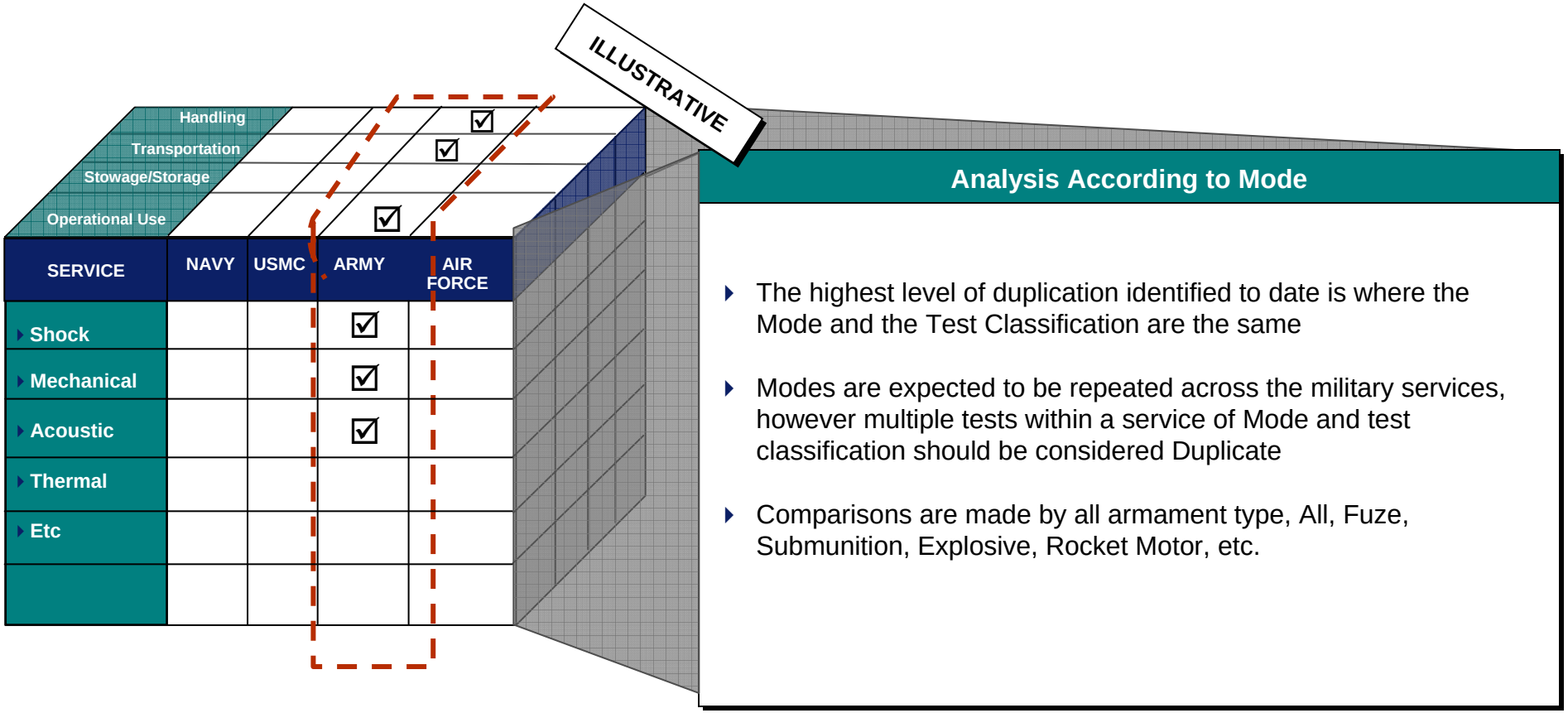
- Current data is in the form of picture and text based documents that was parsed to fit into the database tables
- Utilizing a complex set of queries the database was produced a detailed cross-sectional report of the requirements for common, inconsistent, duplicate and singular tests used within the services
- The database output can be easily incorporated into any MS Office application for refined graphical analysis or added report building capabilities



Analysis According to Test Classification

- The database houses information according to Mode and Test Classification
- The data detailed by Test Classification allows for comparison by all similar test types (shock for example), within and across all military services
- The replication of similar tests by Test Classification expands when tests within a certain classification (Mechanical) also include test types within another Test Classification (Acoustic)

…and identifiable inefficiencies by Mode

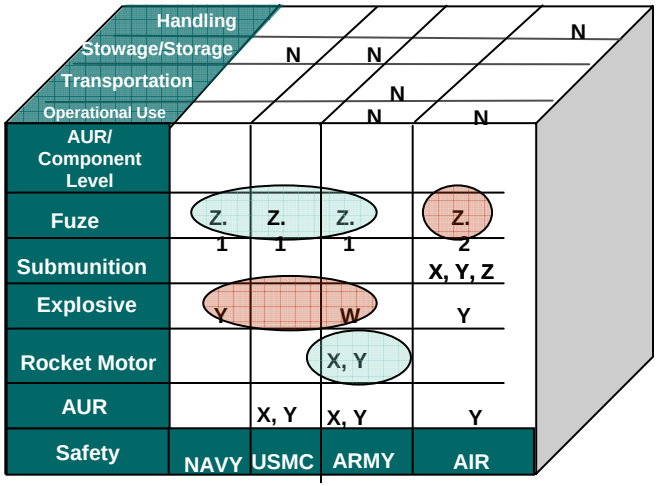


Analysis According to Mode

- The highest level of duplication identified to date is where the Mode and the Test Classification are the same
- Modes are expected to be repeated across the military services, however multiple tests within a service of Mode and test classification should be considered Duplicate
- Comparisons are made by all armament type, All, Fuze, Submunition, Explosive, Rocket Motor, etc.

Data Analysis Methodology – Database supports validation of hypothesis

Form Hypothesis based on Database Content

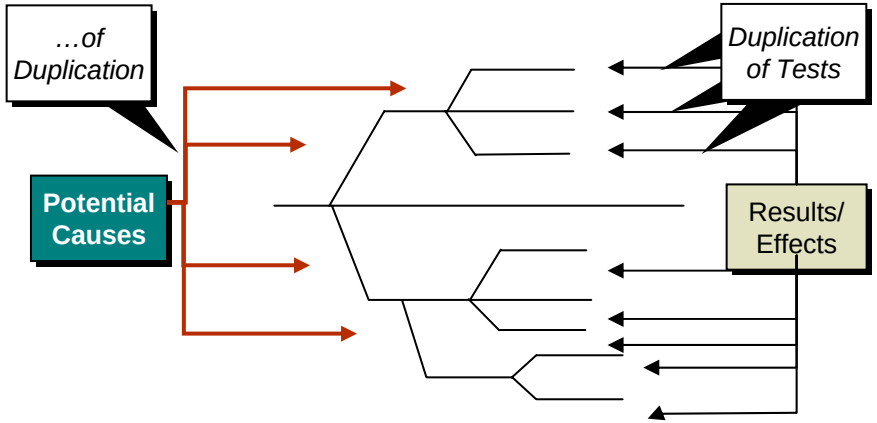


Assumptions

- The Army has the highest level of duplication evident in the database
- Duplication and Redundancy (if any) may be the result of identified needs over time

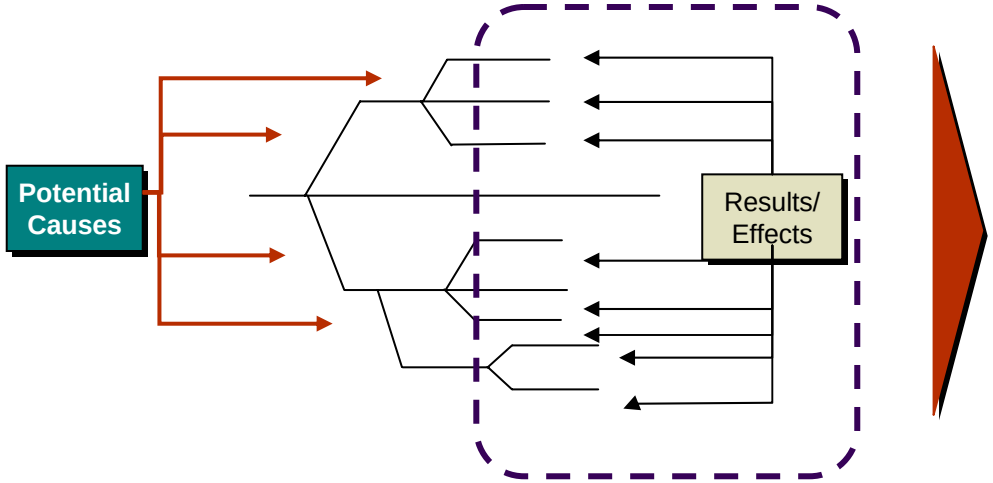
Set-Approach to Find Proof Hypothesis is Correct

	Army	Navy	USMC	Air Force	ALL
Mode					
Handling	☑	☑		☑	☑
Operational Use	☑			☑	☑
Packaging					
Storage/Stowage					
Transportation	☑				☑
ALL UP ROUNDS/COMPONENTS					



Scoring Methodology: Five different weights were employed to gain a high level sense of the varying levels of duplication…

Where the Database Identifies Duplication, the Level of Duplication is Addressed using the Scoring Criteria



Scoring Criteria	
4	Duplication of effort identified
3	Potential duplication
2	Limited duplication
1	Marginal duplication
0	No duplication evident

…Yielding initial proof of the hypothesis that duplication exists

Assumptions
▸ The Army has the highest level of duplication evident in the database
▸ Duplication and Redundancy (if any) may be the result of identified needs over time

Definitions of Key Terms

- Opportunity - Where duplicate and inconsistent test requirements exists, causing inefficiencies, loss or waste and providing an opportunity for improvement.
- Benefit - Where common and singular test requirements exists.
- Test Types
  - Common - More than one Military Service uses the same safety test, test parameters and test parameter values given the same AUR/Component, mode and test classification.
  - Inconsistent - More than one Military Service uses the same safety test and test parameters and at least one of the test parameter values is different given the same AUR/Component, mode and test classification.
  - Duplicate - More than one Military Service uses different safety tests for the same AUR/Component, mode and test classification. Different safety tests may be driven by the following reasons:
    - Lack of coordination, knowledge or focus on joint requirements during development
    - Higher levels of rigor applied to one test over another
    - Programmatic legacy
    - Unique mission environment
  - Singular - Only one Military Service uses the safety test for the same AUR/Component and test classification and either the same or different mode.

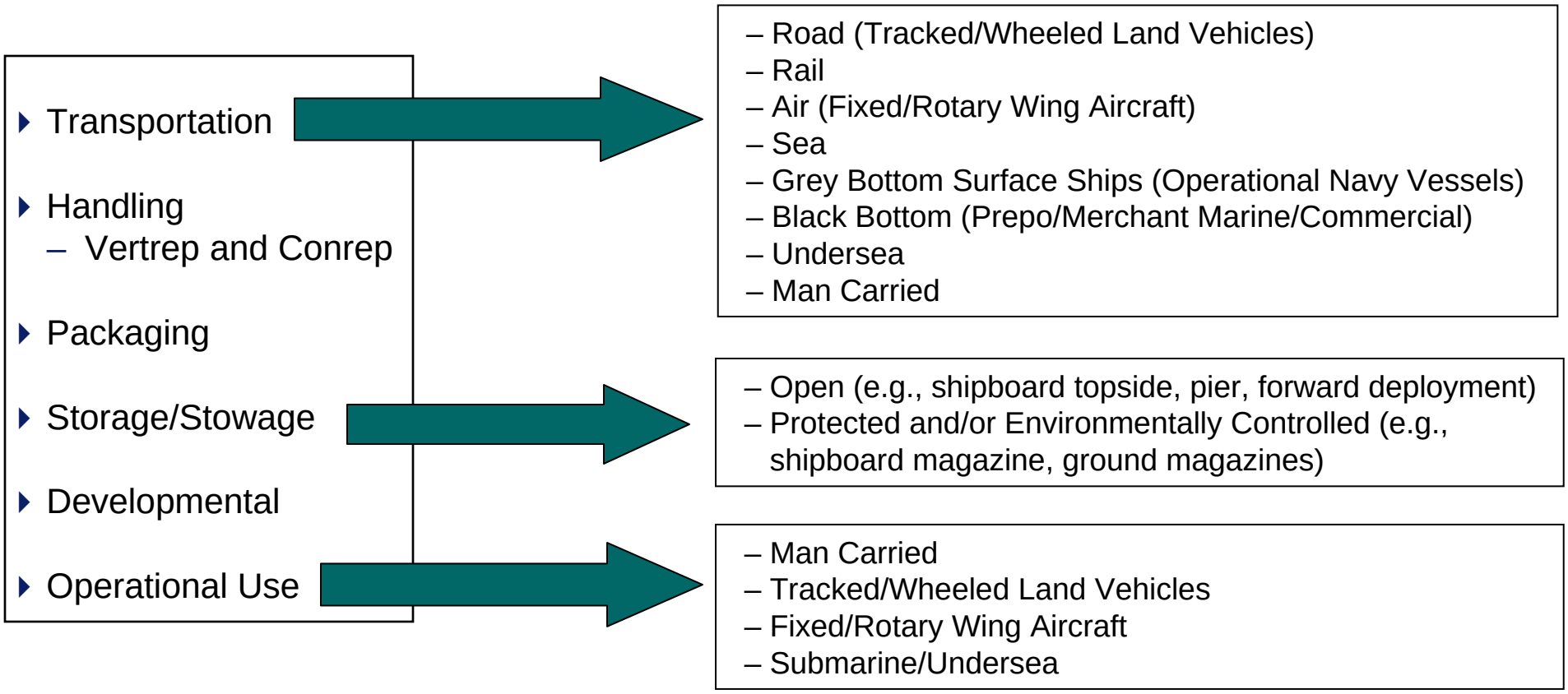
AUR/Components

- System, Subsystem, All (Generic)
- System-Specific
- Ammunition
- Cannon
- Electric Initiators
- Explosives
- Fuze
- Power Sources
- Rocket Motors
- Software
- Submunitions
- Unmanned Targets

- Field Mortar Munitions
- Munitions Carried in Tracked Vehicles
- Munitions with EEDs
- Shipboard Equipment
- Shipboard Machinery Equipment
- Surface Launched Munitions
- Underwater Launched Munitions
- Underwater Munitions

AUR/Components were determined by the safety testing documents.

Modes



Ground Rules

(1) Mode is determined by when the mode will actually influence the item; not when the item will be affected by the influence of the mode.

(2) Tests assigned to the Developmental Mode define the characteristics of the item; are not typically tested in a shipping or operational configuration; and do not simulate a mechanical, climatic or electrical environment.

Safety Test Classifications

- Chemical Compatibility
- Contamination
- Corrosion
- EEE
- Electrical
- ESD
- Explosive Characteristics
- Function
- Icing
- Impact
- Initiation
- Insensitive Munitions
- Leak (external)
- Leak (internal)
- Lifting
- Pressure – High
- Pressure – Low
- Safe Separation
- Sequential
- Shock
- Shock – Acoustic
- Shock – Mechanical
- Shock – Thermal
- Shock and Temperature
- Shock/Vibration
- Shock-Mechanical (long drop)
- Shock-Mechanical (short drop)
- Software
- Storage - Long Term
- Temperature
- Temperature – Extreme
- Temperature – High
- Temperature – Low
- Temperature and Humidity
- Temperature Shock Humidity
- Transportation
- Unknown
- Various
- Vibration
- Wear/Fatigue

Ground Rule - Tests assigned a test classification must simulate a mechanical, climatic or electrical environment.

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Data Collection and Analysis - Data Collection

- Coordinated with Stakeholders
  - Briefed JWSTAP - June 06
  - Briefed DDESB Seminar - August 06
  - Briefed NDIA's Systems Engineering Conference - October 2006
- Selected Comments from Selected Service SMEs, Safety Board Members and POCs at Testing Facilities
  - Preston Parker, AAC/SES Eglin AFB
    - The Air Force will not accept any other Service's Safety Certification "Carte Blanche".
  - Sharon Craven, Navy Explosive Qualifications
    - The Navy will consider archived explosives that have been proven safe for use over many years; however, instead of qualifying it – the explosives would be Final (Type) Qualified only for use under certain/individual circumstances. The explosives would not be considered "Qualified."
  - Dr. Rao Surapaneni, Co-Chair Army's Energetic Materials Qualification Board
    - MIL-STD-1751A is still being used along with AOP-7 primarily because it is uncertain if AOP-7 captures all of the MIL-STD requirements.
  - Chau Nguyen, Army's Explosives Safety and Quality Assurance Department
    - The Navy will not deviate from specific Gap Card test requirements that they have done forever.
  - Jeff Craven, Testing, Army's Huntsville, AL
    - There are subtle differences in the implementation of EEE tests due to available testing equipment, facility limitations, or that it has always been done that way.

Data Collection and Analysis - Data Collection (cont'd)

- Selected Comments from Selected Program Managers/System Safety Leads
  - TOW and JAVELIN (Army/Marine Corp), Mr. Sam Taylor (Marine Corps); Principal for Safety
    - For Submunitions: Navy relies on "WSESRB Position on Submunitions" 8020 Ser N7133/860, dated 6 Sept 2000 and Army relies on "DoD Policy on Submunitions Reliability" dated 10 Jan 2001.
  - Joint Direct Attack Munition (Navy/Air Force), Ms. Larraine Hebb (Air Force), System Safety Lead
    - For JDAM, she specifically noted the HERO requirements for the Navy are often more stringent than the Air Force's requirements; however, as a rule the Air Force will yield to the more stringent requirement.
  - Lightweight 155 (Army/Marine Corps), Gaby Jarani (Army), Principal for Safety
    - The WSESRB's safety requirements and the Army's Material Release process are completely different approaches.
- Identified and Collected Testing Requirements
  - Over 75 different testing documents collected resulting in 530 distinct tests
- Established and Maintaining the Explosive Safety Testing Knowledge Center

Data Analysis - Content of database shows that some duplication of safety tests exists when defined by Mode and Military Service

Identified Area of Duplication by Mode & Test Classification

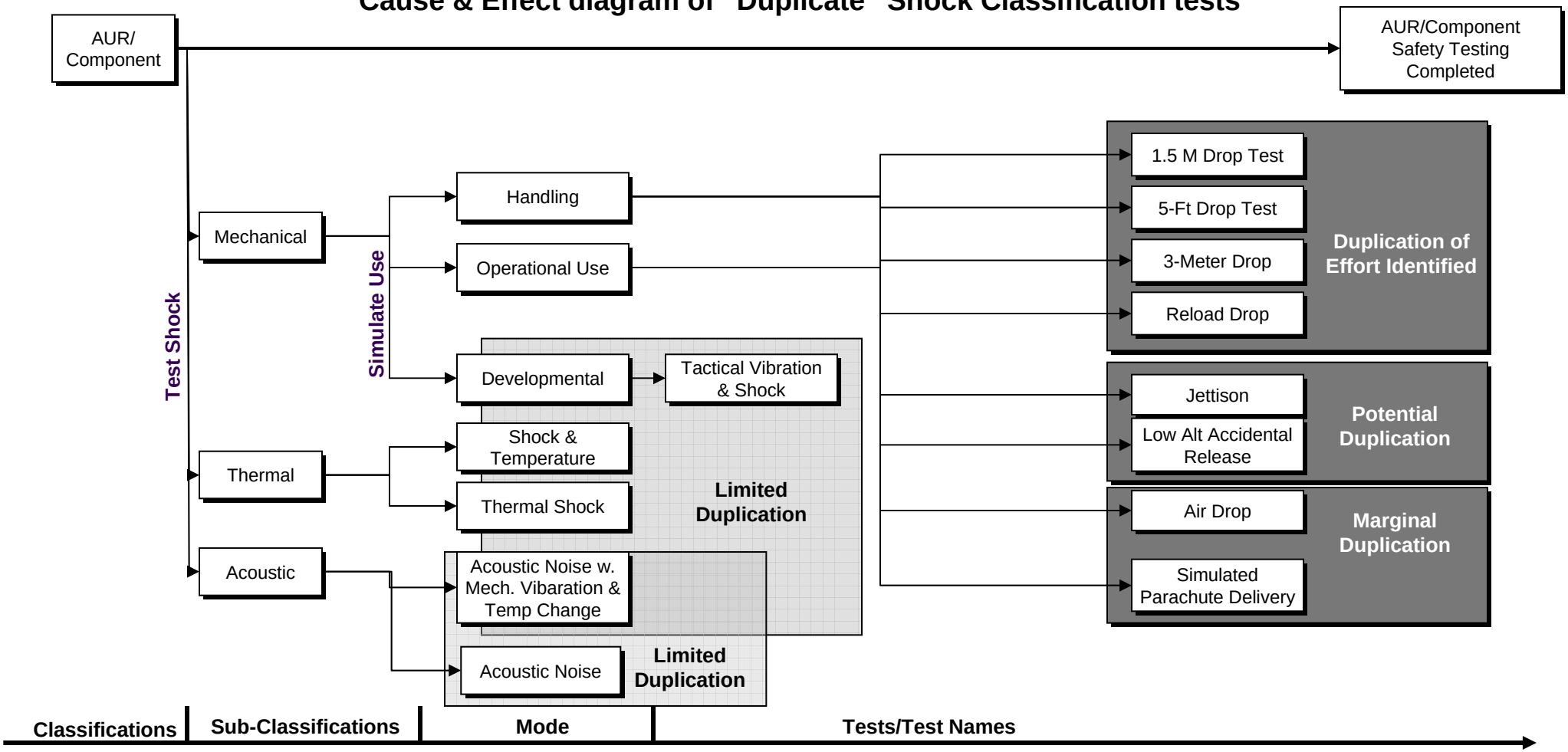
	Army	Navy	Marine Corps	Air Force	ALL
Mode					
Handling	☑	☑		☑	☑
Operational Use	☑			☑	☑
Packaging					
Storage/Stowage					
Transportation	☑				☑
ALL UP ROUNDS/COMPONENTS					

Initial Results of Analysis

- Preliminary analysis shows that duplication exists, but singularities, commonalities, and inconsistencies have yet to be determined.
- Although duplication has been identified, we can not be certain to what degree of duplication exists in each mode; varying levels have been established.
- Duplication appears both across different services as well as within a single service.

Data Analysis - Within Shock Testing a range of duplication exists, from limited overlap to identifiable duplication of effort

Cause & Effect diagram of "Duplicate" Shock Classification tests



Data Analysis - The level of estimated duplication for Shock Testing is more evident in the mechanical short drop testing area

Level of Duplication by Short Drop Tests

TESTS	1.5-M Drop	5-Ft Drop	3-M Drop	Reload Drop
1.5-M Drop		4	3	2
5-Ft Drop	4		4	2
3-M Drop	3	4		4
Reload Drop	2	2	4	

Short Drop Results

- Duplication of existing tests appears to exist
  - Causes for duplication are unknown as all are Army tests, hypothesis is due to lack of transparency into other program testing
  - 3-Meter Drop and Reload drop are executed from the exact same height
  - 1.5M and 5-Ft tests also from the same height
- Research indicates all tests would be run on the same explosive round (munitions)
- Duplication at equal height is apparent (Reload Drop vs. 3M Drop)
  - Recommend further analysis on cost and pass/fail differential between 3M and 1.5M tests to gauge the performance difference between tests

Data Analysis - The level of estimated duplication for Shock Testing is more evident in the mechanical short drop testing area

Level of Duplication by Long Drop Tests

TESTS	Jettison	Low Altitude Accidental Release	Air Drop	Simulated Parachute Delivery
Jettison		3	1	1
Low Altitude Accidental Release	3		2	1
Air Drop	1	2		3
Simulated Parachute Delivery	1	1	3	

High Drop Results

- Duplication may exist and should be subject for further review
  - Causes for duplication are suspected to be due to perceived unique mission need of each test.
- Duplication is assumed to be between Army and Air Force Safety Tests
- Given the different operating environments and modes identified, duplication should be further explored but is not expected to be area of considerable inefficiency

Data Analysis - Vibration is constantly measured against additional safety considerations

Level of Duplication by Vibration Tests

TESTS	Tactical Vibration & Shock	Shock & Temperature	Thermal Shock	Acoustic Noise	Acoustic Noise w/ Mechanical Vibration & Temp Change
Tactical Vibration & Shock		2	0	0	1
Shock & Temperature	2		2	0	1
Thermal Shock	0	2		0	1
Acoustic Noise	0	0	0		4
Acoustic Noise w/ Mechanical Vibration & Temp Change	1	1	1	4	

Vibration Tests Results

- Lower levels of duplication exist than at the Short Drop Test, yet areas of overlap may merit consideration for additional analysis
- Overlap is likely due to expansion of tests to create and simulate extreme tests under a variety of environments (hypothesis)
  - In testing extreme and variety of environments, elements of overlap emerges
  - Thermal Shock and Shack & Temperature address same elements
  - Acoustic Noise with Mechanical Vibration & Temp change tests acoustic noise

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Results and Conclusions

- Derived hypothesis from the defined problem and objectives
- Mapped out work plan and approach
- Defined database structure hierarchy
- Built relational database to capture analysis
- Defined key terms for the purpose of this study
- Classified test modes and test classifications
- Collected comments from Service Board SMEs
- Performed analysis on database input and SME input
- Phase I clearly indicates that there are potential savings to support a Phase II effort

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Next Steps – Phase II

- The next phase will focus on general agreement of the required tests for each mode.
- Continue identifying commonalities and differences between test requirements.
- Conduct benefits and opportunity analysis on duplicate, inconsistent and unique test requirements.
- Provide recommendations for duplicate and inconsistent tests to JWSTAP.
- Prepare draft JWSTAP document describing the required tests by mode.