

## **Hazard Division 1.3 Ordnance in the U.S. Navy Inventory**

A. I. Atwood, K. P. Ford, N.C. Davis, J. E. Wilson  
*Naval Air Warfare Center Weapons Division (NAWCWD), China Lake, California*

T. L. Boggs, P. O. Curran  
*Jacobs Technology Naval Systems Groups, Ridgecrest, California*

J. Covino  
*Policy Development Division  
Department of Defense Explosives Safety Board, Alexandria, Virginia*

### **ABSTRACT**

Two databases were merged to obtain information on the number and weight of non-nuclear ordnance items as a function of hazard division (HD) in the U.S. Navy inventory. The HD1.3 accounts for 0.6 percent of the inventory by number with HD1.4 accounting for approximately 89 percent. HD1.3 accounts for approximately 11 percent by weight with HD1.1 accounting for approximately 79 percent of the inventory by weight.

### **INTRODUCTION**

This paper describes an ongoing effort at the Naval Air Warfare Center Weapons Division (NAWCWD), China Lake, California, to assess the type, number, and amount of HD1.3 ordnance found in the U.S. inventory. This study supports a larger activity, which is looking at the storage of HD1.3 ordnance, for the determination of quantity, distance, and potential hazards risks (Reference 1).

HD1.3 includes substances and articles that present a mass fire hazard with a minor blast and/or fragment hazard. The hazard for HD1.1 substances and articles, in contrast, is mass detonation/explosion, producing blast overpressures as the primary effect. Thermal hazards are the dominant HD1.3 response and the mass conversion rates and heat fluxes are of particular importance when considering the output of these items. The HD1.3 covers a broad range of ordnance from small grenades and gun propellants to large diameter solid rocket motors. The assessment of the U.S. Navy inventory provides a means to identify the most common and the most reactive items, and therefore the most likely to be involved in an incident, that makes up this hazard division.

### **BACKGROUND**

Nine hazard classes make up the hazard classification system and are listed in Table 1. Explosives, propellants, and pyrotechnics are included in Hazard Class 1. The Class 1 hazard has been assigned six hazard divisions to further describe the character of the explosive hazard. The six Class 1 hazard divisions are listed in Table 2. HD1.2.x has been further divided to describe the characteristics of the fragments an energetic item might produce (Reference 2).

Hazard classification is related to transportation and storage only and does not consider operational and other hazard threats and conditions such as those listed in Table 3.

## Report Documentation Page

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TABLE 1. Nine Ammunition and Explosives Hazards Classes (Reference 2).

Hazard Class	Material
Class 1	Explosives
Class 2	Gases
Class 3	Flammable liquids
Class 4	Flammable solids
Class 5	Oxidizing substances and organic peroxides
Class 6	Toxic and infectious substances
Class 7	Radioactive materials
Class 8	Corrosive substances
Class 9	Miscellaneous dangerous substances and articles

TABLE 2. Hazard Class 1 Divisions (Reference 2).

Hazard Division	Hazard Type
1.1	Mass explosion
1.2.x	Non-mass explosion, fragment producing
1.3	Mass fire, minor blast or fragment
1.4	Moderate fire, no significant blast or fragment
1.5	Explosive substance, very insensitive (with mass explosion hazard)
1.6	Explosive article, extremely insensitive (no mass explosion hazard)

TABLE 3. Hazards Not Considered in Classification (Reference 2).

Hazard Exclusions
Electrostatic and electromagnetic influence
Rough handling and vibration
Effects of exposure to hot or cold environments
Mechanical defects
Solar radiation
Temperature shock
Abnormal functioning
Combat exposure
Ionizing radiation

Ordnance items are also assigned one of 13 Compatibility Groups (CGs) for transportation and storage. A one-position capital alpha character, designated Group A through Group S, identifies each of these groups as listed in Table 4. The compatibility groups are based on their similarity of function, features, and accident potential. A more detailed description of the CGs can be found in Reference 2.

TABLE 4. CGs for Hazard Class 1.

CG	Definition
A	Initiating (primary) explosives
B	Detonators and similar initiating devices not containing two or more effective protective features
C	Bulk propellant, propellant charges, and devices containing propellant
D	Bulk black powder, bulk high explosive(HE)
E	Ammunition and explosives containing HE without its own means of initiation with a solid propelling charge
F	Ammunition and explosives containing HE with its own means of initiation
G	Illuminating, incendiary, and smoke or tear producing
H	Ammunition and explosives containing white phosphorus
J	Flammable liquids or gels other than those spontaneously flammable with water or atmosphere exposure
K	Ammunition and explosives containing toxic chemical agents
L	Ammunition and explosives not included in other compatibility groups
N	Articles containing only extremely insensitive detonating substances (EIDS)
S	Ammunition and explosives that present no significant hazard

The CGs are of particular importance when examining a hazard incident involved with mixed storage. The type and kind of items that can be stored together are determined by the CGs. The storage compatibility mixing chart is given in Table 5 (Reference 3). An “x” at the intersection of the chart indicates group compatibility and a “z” indicates mixing under special conditions. Items of compatibility group “L” represent a group with particular risk and must be stored separately. A complete description of the chart can be found in Reference 3.

TABLE 5. Storage Compatibility Mixing Chart.

CG	A	B	C	D	E	F	G	H	J	K	L	N	S
A	X	Z											
B	Z	X	Z	Z	Z	Z	Z					X	X
C		Z	X	X	X	Z	Z					X	X
D		Z	X	X	X	Z	Z					X	X
E		Z	X	X	X	Z	Z					X	X
F		Z	Z	Z	Z	X	Z					Z	X
G		Z	Z	Z	Z	Z	X					Z	X
H								X					X
J									X				X
K										Z			
L													
N		X	X	X	X	Z	Z					X	X
S		X	X	X	X	X	X	X	X			X	X

The Joint Hazards Classification System (JHCS) is the source for DoD hazard classification data and serves as the official record for DoD shipment (Reference 4). The JHCS database of 22 December 2009

was used to acquire the information in this paper. The JHCS lists the hazards classification, physical security, marking, transportation and storage data, and criteria for conventional ordnance items in the U.S. inventory. Only non-nuclear, Navy ordnance were surveyed in this study. The JHCS also lists the National Stock Number (NSN), nomenclature, compatibility number, DoD Hazard Class/Division, net explosive weight (NEW), and other useful information. The list does not contain the quantity of the items found in the national inventory.

Quantification of the U.S. Navy stockpile was made using the Ordnance Information System (OIS), which is managed by the Naval Operational Logistics Support Center (NOLSC) from Mechanicsburg, Pennsylvania (Reference 5). This system provides ordnance logistics management and accountability to the Navy Conventional Ordnance Stockpile. The OIS system is also organized by NSN, which provides the key for cross referencing the two data sets. The NSN is assigned to the ordnance system/package. The NSN, in the case of a large item such as a large guided missile, will be a single unit in its shipping/storage configuration. Smaller items that are shipped and stored in multiples (for example, a canister with six missiles) will receive a single NSN assignment as would a box or carton containing a belt of linked ammunition.

## **PROCESS**

It was necessary to combine the JHCS and NOLSC OIS databases in order to assess the type and amount in each specific hazard division in the U.S. Navy inventory. Data relevant to this study contained in the JHCS database includes the ordnance item characteristics, most notably the net explosive weight (NEW) per item. The NOLSC OIS database contains the type and number of ordnance items currently housed in the Navy storage facilities by NSN, but not their hazards classification.

Data entries from the NOLSC OIS database were saved in spreadsheet format and organized through an EXCEL macro. The items were divided into five hazard categories, Hazard Class 1 Divisions 1.1, 1.2, 1.3, 1.4, and "others" for this study. The EXCEL macro performed two processes. The first process read through the JHCS database and for each entry searched the NOLSC data looking for matching entries and recorded those matches. The matched entries' information from both databases was combined and moved into the proper hazard classification spreadsheet tab. The number of ordnance items by NSN was multiplied by the NEW of each item, calculating a total NEW of the energetic material present in the U.S. Navy inventory by hazard division.

Each of the hazard divisions was searched by both number of each NSN and NEW. The inventory has been examined by both NEW and by number per NSN in order to gain an understanding of the items most likely to be found in a magazine and to identify the items that contain the largest amount of energetic material.

## **RESULTS**

The JHCS listed 16,678 NSN records as of 22 December 2009. The U.S. Navy inventory accounts for 3,020 of those records. A summary of the number of different NSNs by hazard division is listed in Table 6. The "others" category represents items that are outside the Class 1 designation. It also includes inert items as well as support hardware. The "others" category was omitted from further examination.

TABLE 6. Individual NSNs by Hazard Division.

Hazard Class/Division	Number
1.1	683
1.2	231
1.3	405
1.4	1,451
Others	250
Total	3,020

The Navy conventional ordnance stockpile consists of items ranging from small arms ammunition to cruise missiles. The ordnance inventory was examined by both number of occurring NSNs, such as with the small ammunition, and by NEW, which includes guided missiles. The four hazard class/divisions sorted by NSN numbers are summarized in Figure 1. The sort by number gives an indication of the kind and type of items that are most likely to be found in a storage magazine. HD1.4 ordnance makes up the majority (by number), approximately 89 percent, of the four groups. HD1.3 makes up approximately 0.6 percent by number.

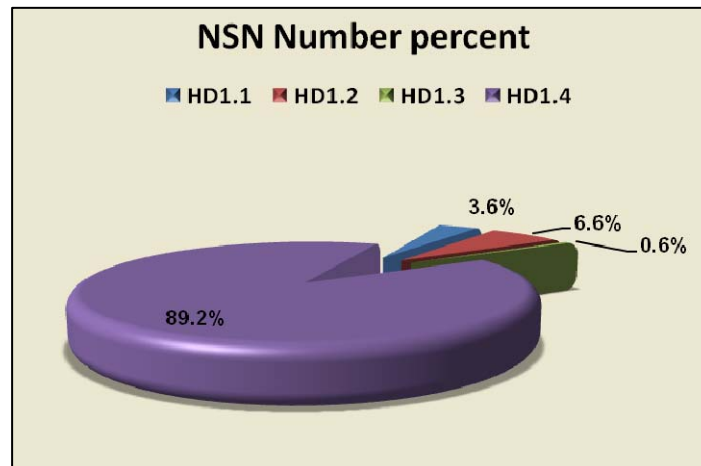


FIGURE 1. Summary of the Navy Ordnance Inventory by Number of Occurring NSNs.

The four hazard class/divisions sorted by NEW are summarized in Figure 2. The sort by NEW gives an indication of those items containing the largest amount of energetic material. Ordnance of HD1.1 makes up the majority (by NEW), approximately 79 percent, of the four groups with the HD1.3 making up approximately 11 percent by weight.

The top 10 occurring items were identified by number and weight in each of the four hazard division categories. Detonating cord and 40-mm cartridges made up the top 10 HD1.1 items by number. The top 10 HD1.1 items by number made up approximately 77 percent of the total number of HD1.1 items (Figure 3). These same items represented approximately 2.3 percent of the HD1.1 items by weight.

The top 10 occurring HD1.1 items by weight consisted of demolition charges, mines, and guided missiles. These items made up 4.8 percent of the NEW HD1.1 inventory (Figure 4). These same items account for 0.02 percent of the HD1.1 inventory by number. In HD1.1, there are relatively few of the very large items. The net explosive weight quantity distance for the guided missiles is approximately 30 percent of the total system NEW of the system. This is due to the fact that these systems have large solid rocket motors that, by themselves, are HD1.3.

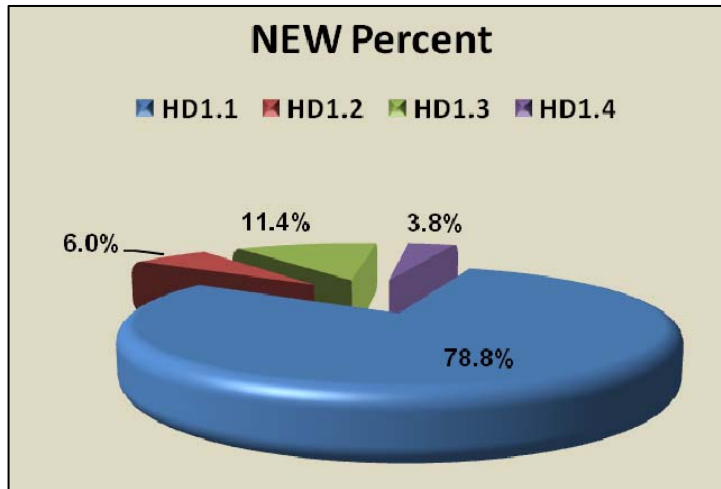


FIGURE 2. Summary of the Navy Ordnance Inventory by NEW.

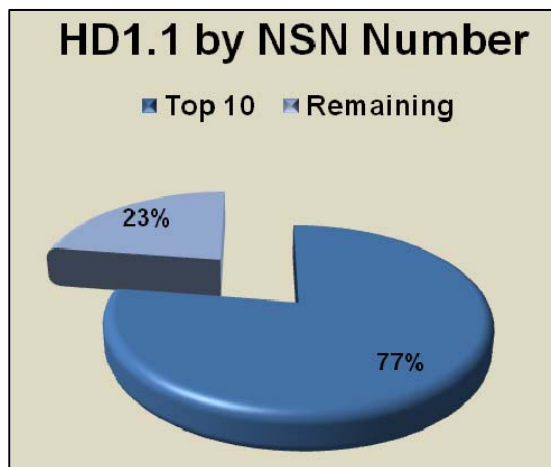


FIGURE 3. Percentage of Top 10 Out of Total HD1.1 by Number of Occurring NSNs.

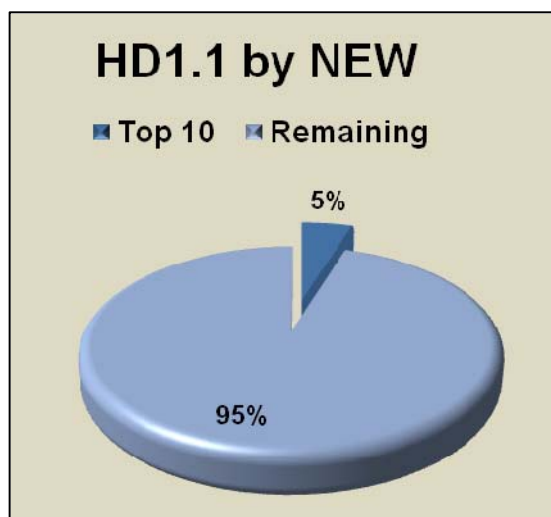


FIGURE 4. Percentage of Top 10 Out of Total HD1.1 by NEW.

The top 10 HD1.1 items by both number and weight are in CGs D and E. These two groups can be stored with groups B through G, N, and S.

The top 10 HD1.2 items by number are composed of either 0.50-caliber or 20 mm ammunition. These items make up 89.8 percent of the total HD1.2 inventory by number (Figure 5). These same items account for 24.8 percent of the HD1.2 inventory by weight.

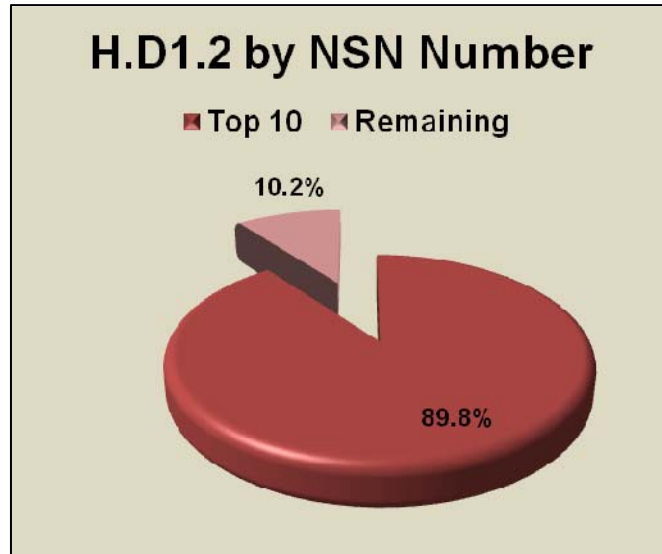


FIGURE 5. Percentage of Top 10 Out of Total HD1.2 Inventory by Number of Occurring NSNs.

The top 10 HD1.2 items by NEW consist of solid rocket motors and guided missiles. These items make up approximately 7 percent of the HD1.2 inventory by weight (Figure 6). The same items account for approximately 0.002 percent of the HD1.2 inventory by number.

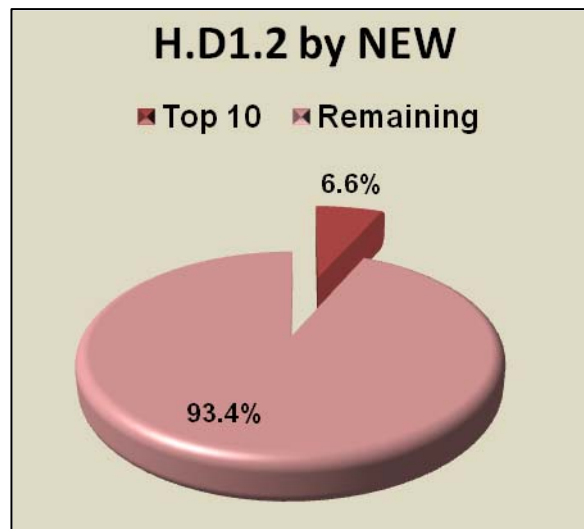


FIGURE 6. Percentage of Top 10 Items of HD1.2 Inventory by NEW.

The top 10 HD1.2 items by number are in CGs E and G and those by weight are in compatibility group C. These groups can be stored with B, D, F, N, and S.

The top 10 HD1.3 items by number are composed of fireworks, flares, smokeless powder, and gun propellant. These items make up approximately 11 percent of the total HD1.3 inventory by number (Figure 7). These same items account for approximately 18 percent of the HD1.3 inventory by NEW.



FIGURE 7. Percentage of Top 10 Items of the HD1.3 Inventory by Number of occurring NSNs.

Solid rocket motors comprise the top 10 HD1.3 by NEW. They represent approximately 23 percent of the HD1.3 inventory by NEW (Figure 8). These same items account for approximately 0.11 percent of the HD1.3 inventory by number.

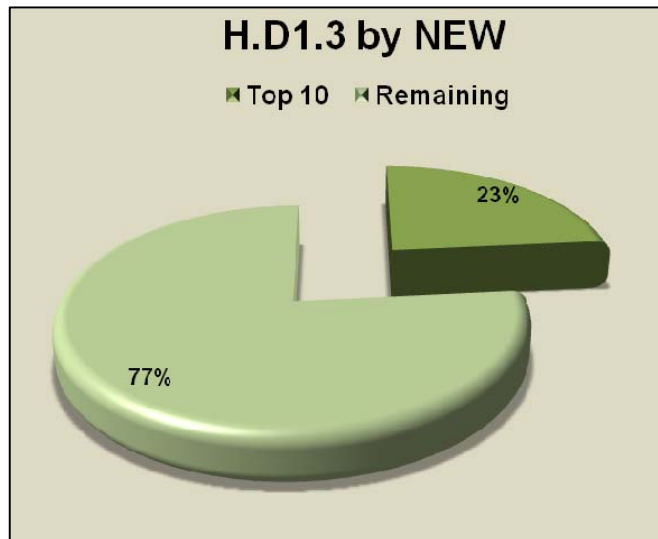


FIGURE 8. Percentage of Top 10 Items of the HD1.3 Inventory by NEW.

The top 10 HD1.3 items by number and weight are in CGs C and G. These two groups can be stored with groups B through G, N, and S.

The top 10 HD1.4 items by number are composed of small arms ammunition. These items make up approximately 51 percent of the total HD1.4 inventory by number (Figure 9). These same items account for approximately 0.3 percent of the HD1.4 inventory by number.

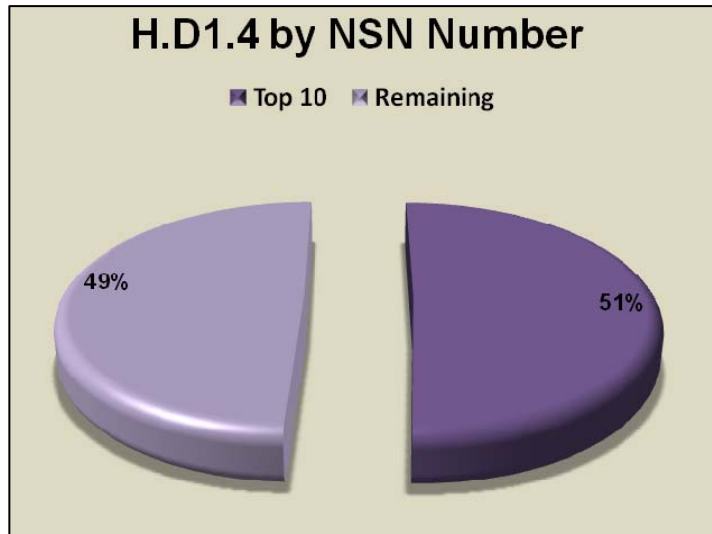


FIGURE 9. Percentage of Top 10 Items of the HD1.4 Inventory by Number of occurring NSNs.

The top 10 HD1.4 items by NEW are composed of smokes, gas generators, and signal kits. These items make up approximately 0.4 percent of the total HD1.4 inventory by NEW (Figure 10). These same items account for approximately 0.002 percent of the HD1.4 inventory by number.

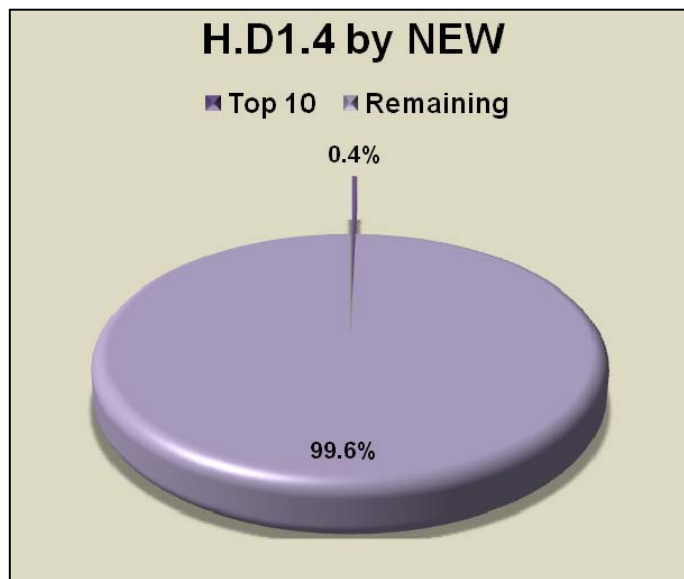


FIGURE 10. Percentage of Top 10 Items of the HD1.4 Inventory by NEW.

The top 10 HD1.2 items by number and weight are in CG S. This group can be stored with groups B through G and N.

## CONCLUSIONS

An assessment of the U.S. Navy ordnance inventory has been made relative to hazard classification. The survey required the merging of two databases in order to obtain the necessary information relative to the number of items and NEW for each hazard division.

The presence of large numbers or explosive weight of ordnance from a particular hazard division increases the probability of involvement in a hazard event. Based solely on numbers and NEW, the HD1.3 inventory, by itself, does not represent a large population, however, the presence of HD1.3 as part of the HD1.1 inventory and in mixed storage does increase the likelihood of its involvement in an incident. The survey revealed over 400 different NSNs in the inventory of HD1.3. These items cover a wide spectrum in type and kind, ranging from pyrotechnics and flares to solid rocket motors.

Based on the number of NSNs, the HD1.4 small arms ammunition is the most likely to be found in a magazine storage scenario in the U.S. Navy. HD1.1 ordnance is the most likely to be found based on NEW. The presence of the HD1.4 and HD1.3, either in mixed storage or as a component in an HD1.1 item, may increase its ease of ignition in a thermally initiated event as these devices are designed to readily ignite and burn. (Reference 6)

### **FUTURE PLANS**

It is planned to survey the ordnance inventory of each of the services in order to quantify the amount of HD1.3 found in the U.S. These data will be used to gain an understanding of the overall quantity of HD1.3 items in the DoD inventory and will be used to gain an understanding of the predominant type of ordnance found in the inventory.

The survey data will be used as input into simulations of storage conditions, in order to establish a realistic accident scenario in the computations. These simulations are being used to assess the level of reaction violence relative to magazine type, loading density, and quantity distance.

### **ACKNOWLEDGMENT**

The authors would like to acknowledge and thank Ms. S. Johnson of the Engineering and Energetics Research Department for her input regarding the OIS database and for the ammunition technicians of the NAWCWD magazines for compiling much of the data.

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**China Lake CA**

**T.L. Boggs, P.O. Curran**

**Jacobs Technology Naval Systems Group Ridgecrest, CA**



**J. Covino**

**Policy Development Division**

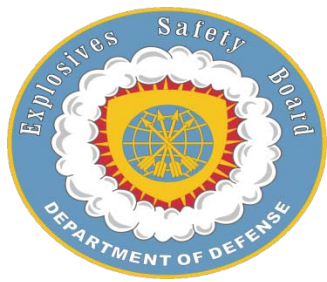
**Department of Defense Explosives Safety Board**

**Alexandria, VA**



**25<sup>th</sup> JANNAF Propulsion Systems Hazards Subcommittee Meeting**

**Portland, OR, 13-15 July 2010**



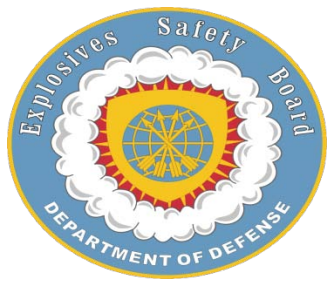
# Objective

- **Determine the type, number and amount of HD1.3 ordnance in the US Navy Inventory**
  - Part of investigation regarding the assignment of quantity distance for HD 1.3 ordnance
  - Provide input data for modeling and simulation



# Nine Hazard Classes

Hazard Class	Material
<b>Class 1</b>	<b>Explosives</b>
<b>Class 2</b>	<b>Gases</b>
<b>Class 3</b>	<b>Flammable liquids</b>
<b>Class 4</b>	<b>Flammable solids</b>
<b>Class 5</b>	<b>Oxidizing substances and organic peroxides</b>
<b>Class 6</b>	<b>Toxic and infectious substances</b>
<b>Class 7</b>	<b>Radioactive materials</b>
<b>Class 8</b>	<b>Corrosive substances</b>
<b>Class 9</b>	<b>Miscellaneous dangerous substances and articles</b>



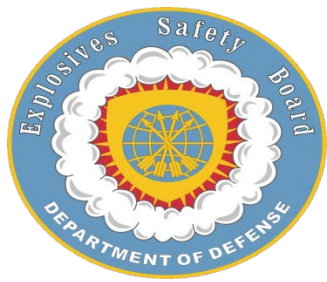
# Hazard Divisions

<b>Hazard Division</b>	<b>Hazard Type</b>
<b>1.1</b>	<b>Mass explosion</b>
<b>1.2.X</b>	<b>Non-mass explosion, fragment producing</b>
<b>1.3</b>	<b>Mass fire, minor blast or fragment</b>
<b>1.4</b>	<b>Moderate fire, no significant blast or fragment</b>
<b>1.5</b>	<b>Explosive substance, very insensitive (with mass explosion hazard)</b>
<b>1.6</b>	<b>Explosive article, extremely insensitive (no mass explosion hazard)</b>



# Compatibility

- **Thirteen compatibility groups (letter)**
  - **Similarity of function**
  - **Accident potential**
- **Example**
  - **CG A = Initiating explosive**
  - **CG C = Bulk propellant, propellant charges, Devices containing propellant**



# Mixing

C	A	B	C	D	E	F	G	H	J	K	L	N	S
G													
A	X	Z											
B	Z	X	Z	Z	Z	Z	Z					X	X
C		Z	X	X	X	Z	Z					X	X
D		Z	X	X	X	Z	Z					X	X
E		Z	X	X	X	Z	Z					X	X
F		Z	Z	Z	Z	X	Z					Z	X
G		Z	Z	Z	Z	Z	X	X	X	Z		Z	X
H													X
J													X
K													
L													
N		X	X	X	X	Z	Z	X	X			X	X
S		X	X	X	X	X	X					X	X



# Resources

- **Joint Hazard Classification System**
  - **22 December 2009**
    - Hazards Classification
    - Physical Security
    - Transportation and Storage info
    - Nomenclature
    - Compatibility code
    - NEW and NEWQD
    - **National Stock Number (NSN)**
- **Naval Operational Logistics Support Center Ordnance Information System**
  - Quantity and location by **NSN**





# NSN Complications

- **NSN changes with system configuration**
  - **Change in guidance package will require another NSN for the same system**
  - **Changes in packaging**
    - **Boxes versus barrels for packaged ordnance**
  - **One NSN per large diameter solid rocket motor**
  - **One NSN for multiple missiles in launcher**



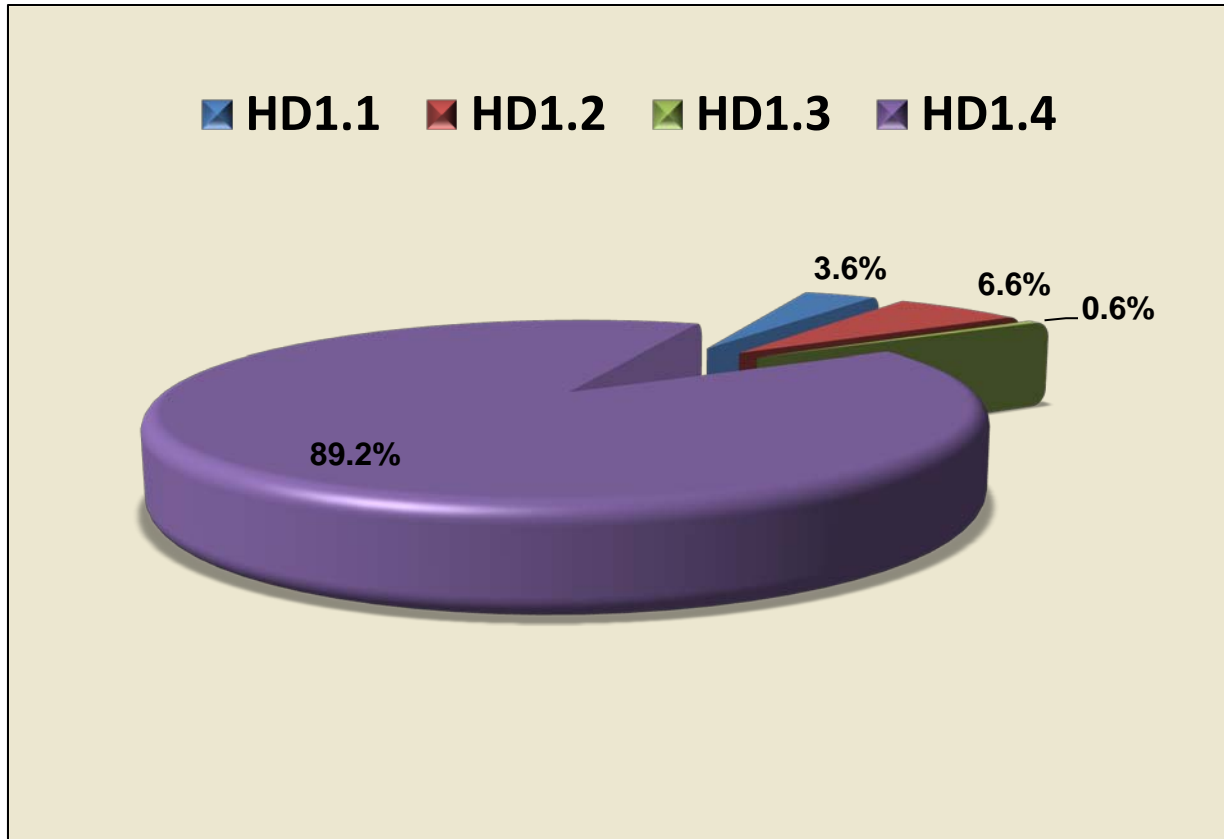
# NSNs

<b>Hazard Class/Division</b>	<b>Number</b>
<b>1.1</b>	<b>683</b>
<b>1.2</b>	<b>231</b>
<b>1.3</b>	<b>405</b>
<b>1.4</b>	<b>1451</b>
<b>Others*</b>	<b>250</b>
<b>Total</b>	<b>3020</b>

**\* Non HC 1, inert, and support items**

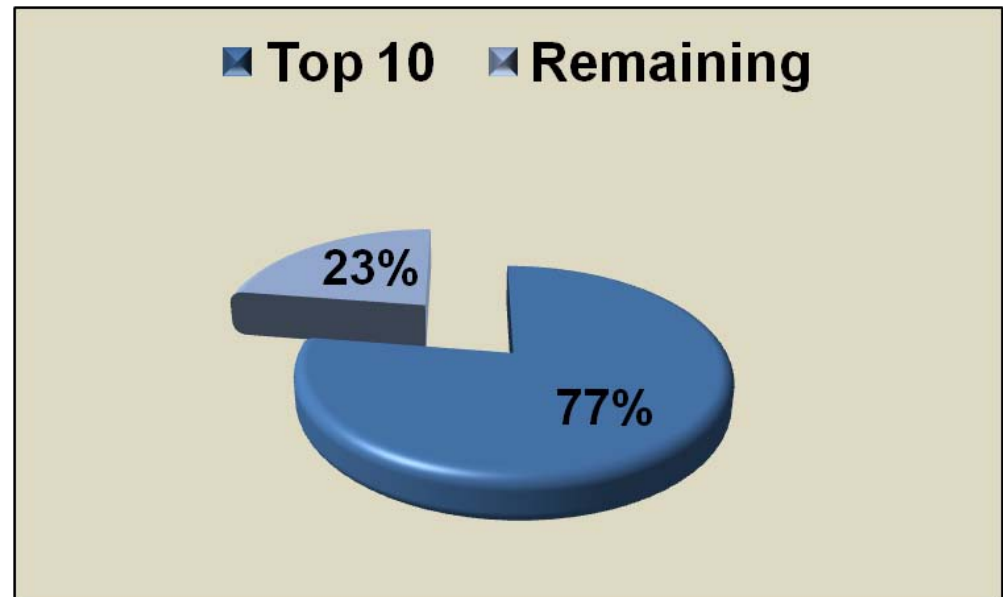
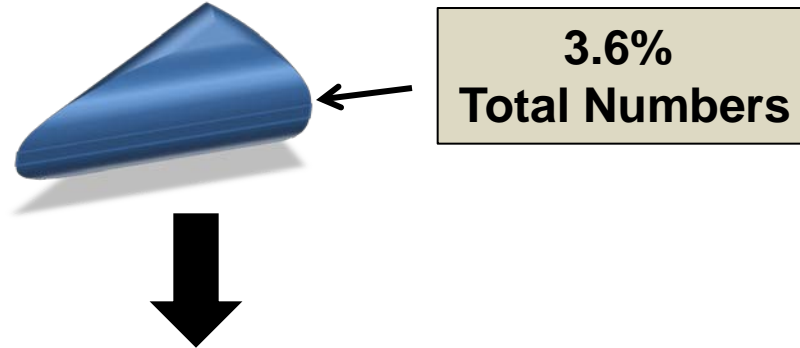


# Number Percent (Occurrences per NSN)



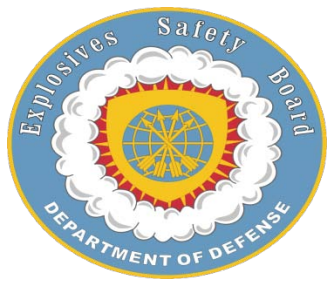


# HD1.1 Numbers

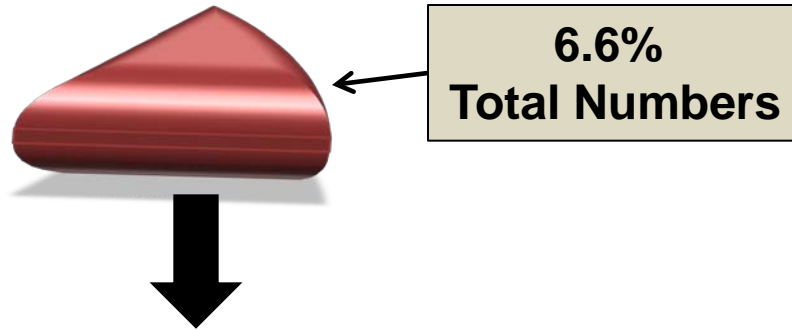


- Detonation Cord
- 40-mm cartridges

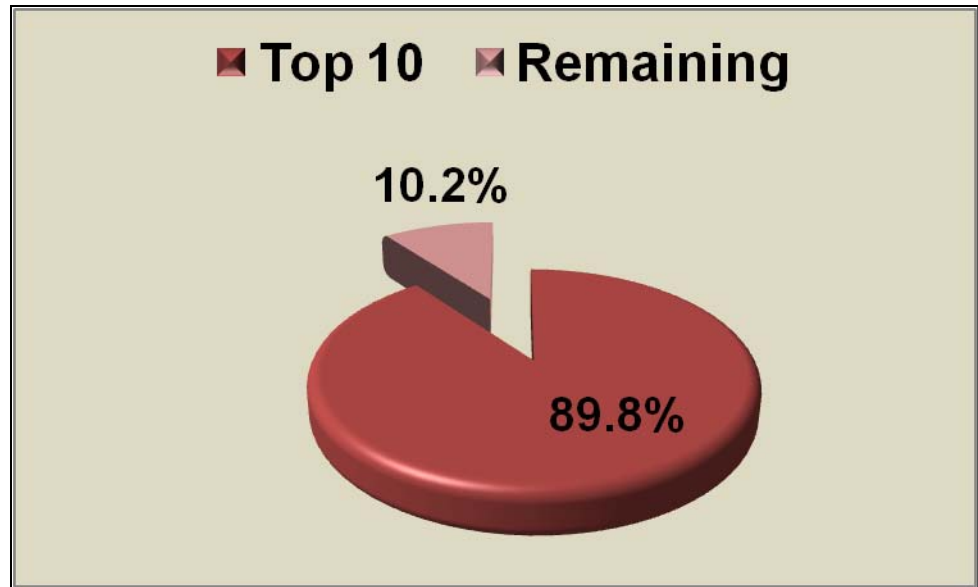
- CG = D and E
- May store with B-G, N and S



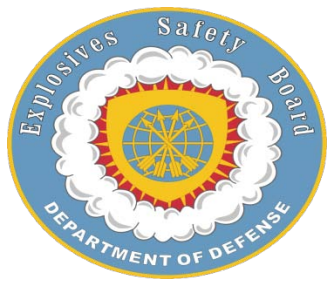
# HD1.2 Numbers



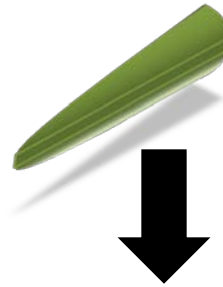
- 0.50 caliber ammunition
- 20 mm ammunition



- CG = E and G
- May store with B, D, F, N and S

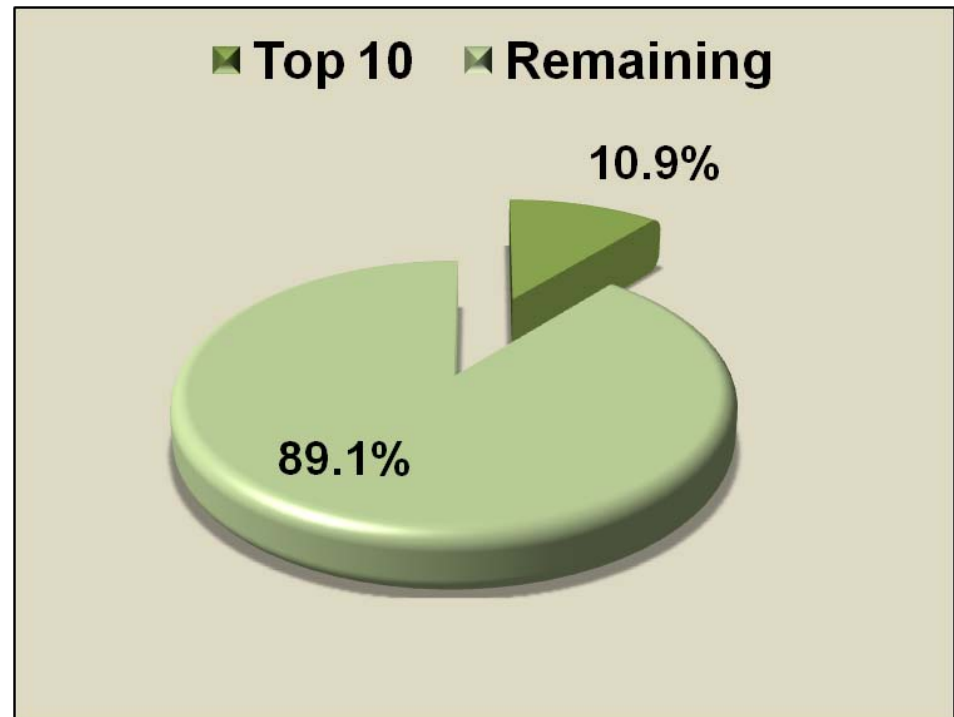


# HD1.3 Numbers



0.6%  
Total Numbers

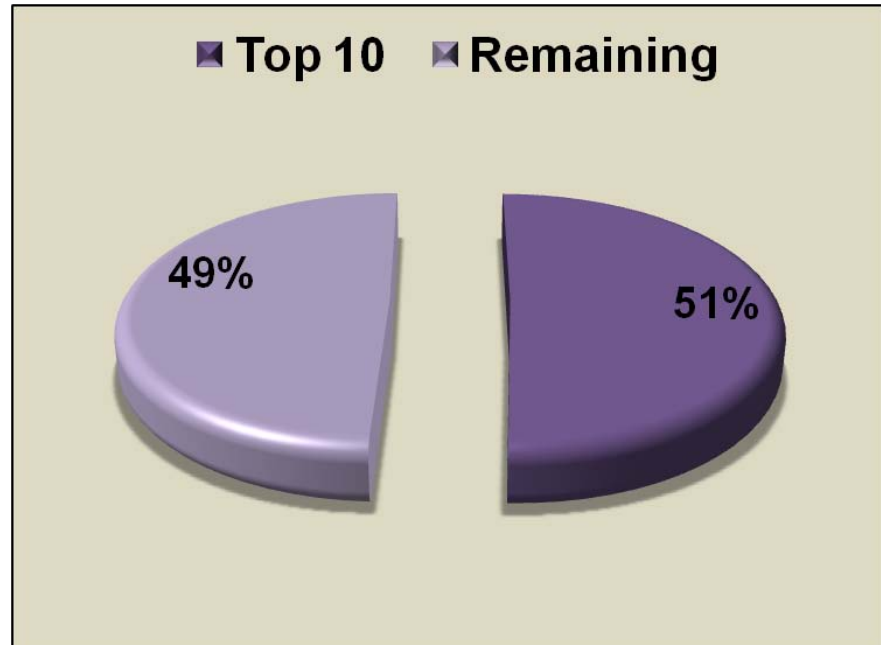
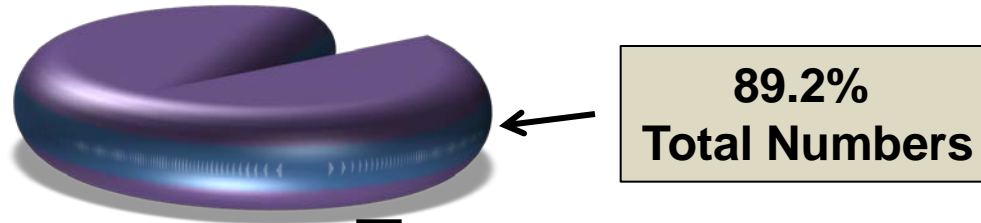
Fireworks  
Flares  
Smokeless Powder  
Gun Propellants



- CG = C and G
- May store with B- G, N and S

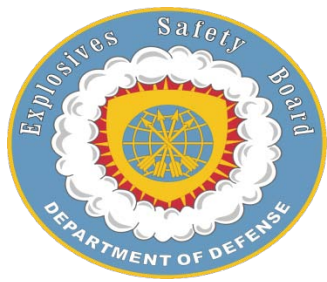


# HD1.4 Numbers

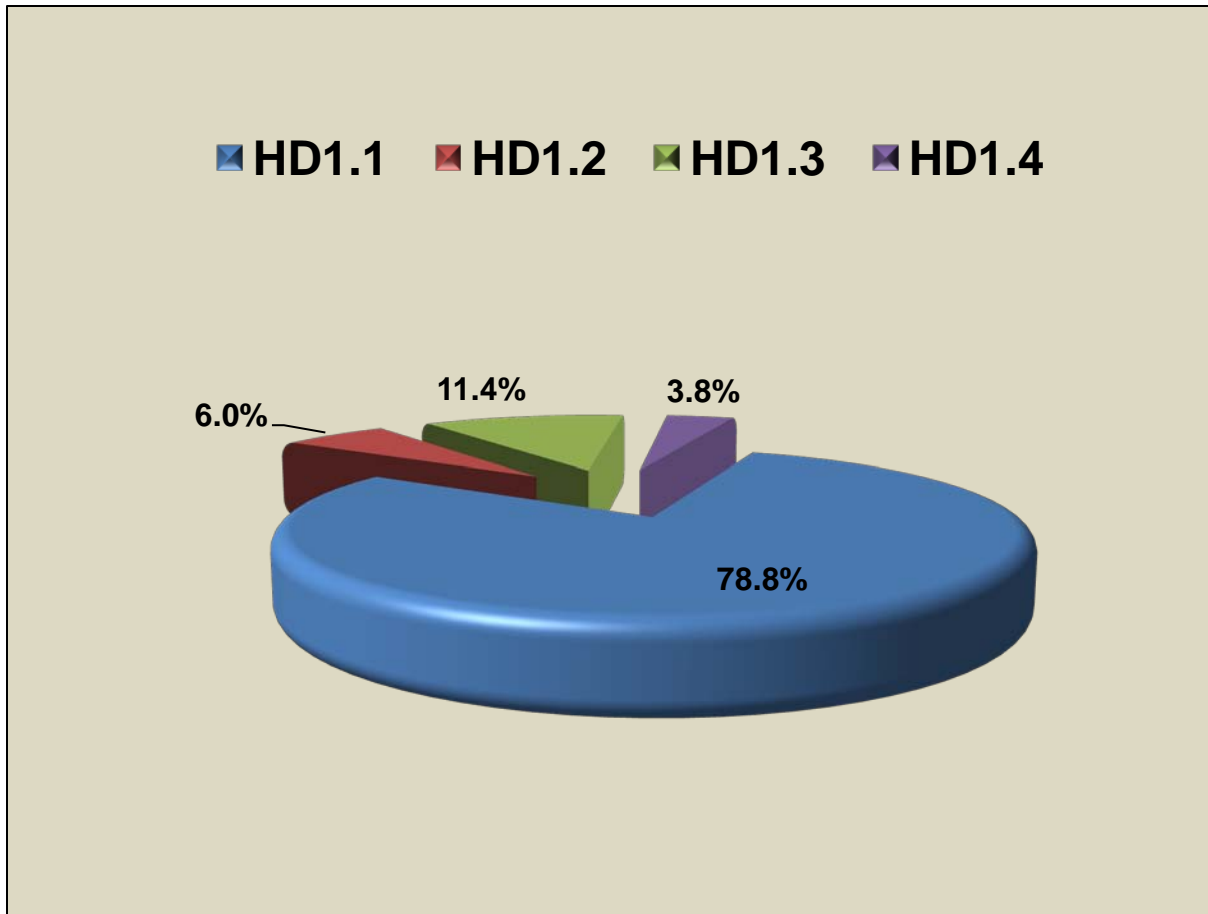


**Small arms ammunition**

- CG = S
- May store with B- G, and N

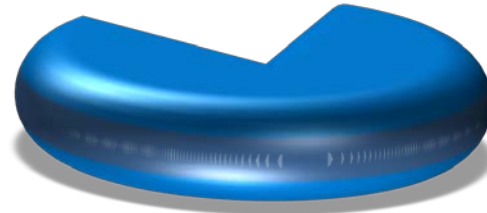


# NEW Percent





# HD1.1 by NEW

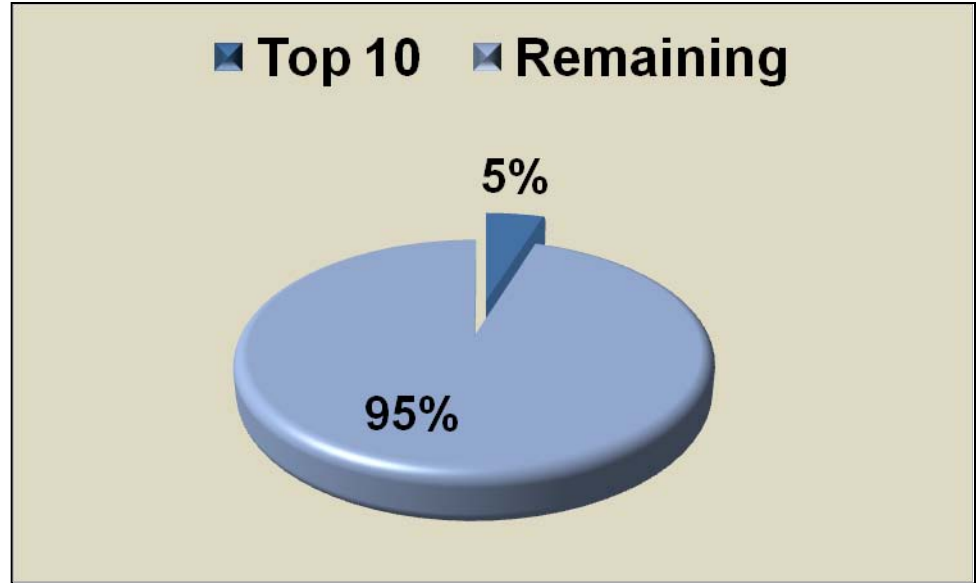


78.8%  
Total NEW



- Demolition Charges
- Mines
- Guided Missiles

- CG = D and E
- May store with B-G, N and S



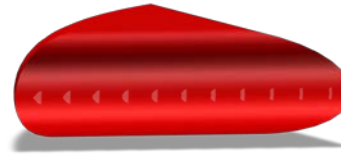


# NEW versus NEWQD

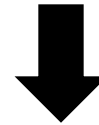
- **NEWQD is about 30 percent of total NEW for guided missiles**
  - **HD 1.3 solid rocket motor makes majority of NEW**
  - **HD1.3 solid rocket propellant is easiest to ignite at ambient pressure**



# HD 1.2 by NEW

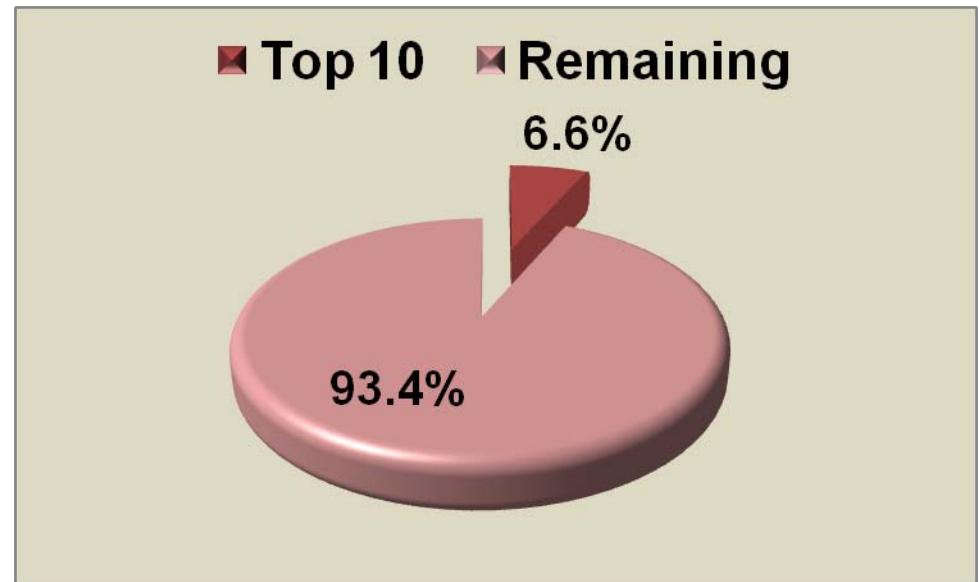


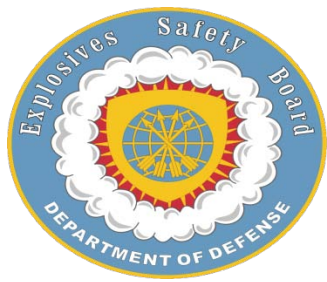
6.0%  
Total NEW



- Solid Rocket Motors
- Guided Missiles

- CG = C
- May store with B, D, F, N and S

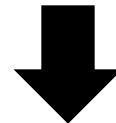




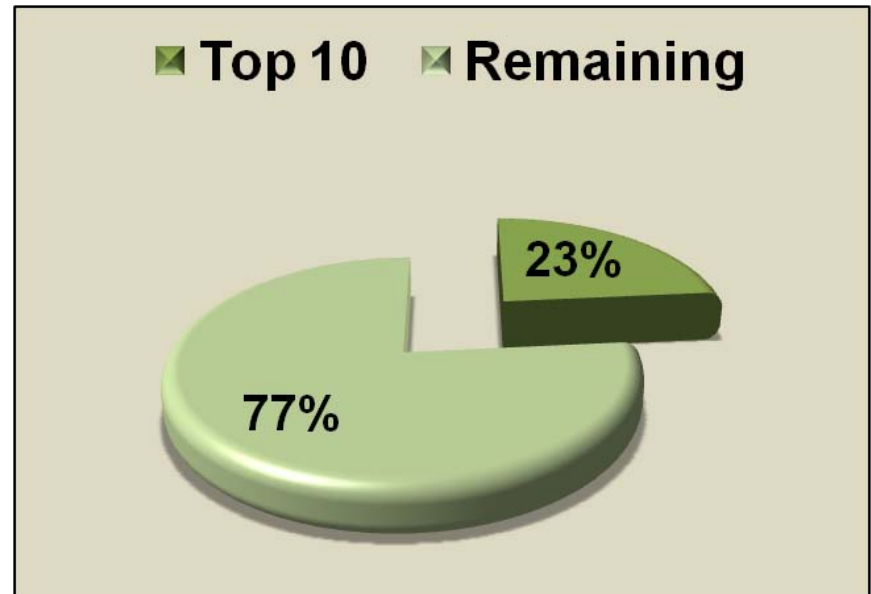
# HD 1.3 by NEW



11.4%  
Total NEW



•Solid Rocket Motors



- CG = C and G
- May store with B- G, N and S

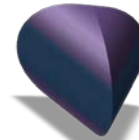


# Guided Missile

- **Same guided missile in HD1.1, HD1.2, HD1.3**
  - **Depends on warhead**
    - **Unitary HE**
    - **Fragmenting**
    - **Inert**



# HD 1.4 by NEW



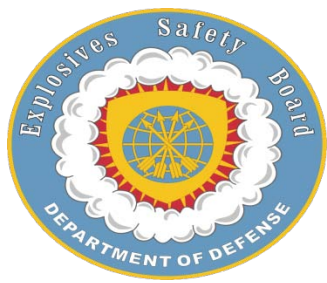
**3.8%**  
**Total NEW**



- Smokes
- Gas Generators
- Signal kits

- CG = S
- May store with B- G, and N





# Conclusions

- **Two databases were merged to obtain the type and amount of ordnance in the US Navy inventory**
- **Examined by number of NSNs and by NEW**
  - **More than 400 NSNs were HD1.3**
- **Based solely on numbers and NEW the HD 1.3 inventory does not represent a large threat**
- **HD1.3 can be found in HD1.1 items and may alter the response in a thermal hazard event**
  - **HD1.1 by NEW**
- **HD 1.4 makes up the largest amount of the US Navy inventory by number**
- **HD 1.1 contains the highest NEW in the inventory**



# Future Plans

- **Resolve some of the NSN issues**
  - Same item with different NSNs
  - Number of individual ordnance items per NSN
- **Survey the ordnance inventory for the remaining services**
- **Data will be used as input into simulations of transportation and storage incidents**