



SAFETY SERVICES ORGANISATION



AMAT | GICHD

Session 1.3

UN Hazard Divisions, Compatibility Groups and Mixing Rules

IATG Foundation Course: Ammunition & Explosives Safety Module



Lesson Objectives

At the end of this lesson you should be able to:

- **Describe the Authority to Classify Ammunition and Explosives within a Nation**
- **Describe Hazard Classification Codes (HCC)**
 - Hazard Divisions (HD)
 - Compatibility Groups (CG)
- **HD Aggregation Rules and CG Mixing Rules**

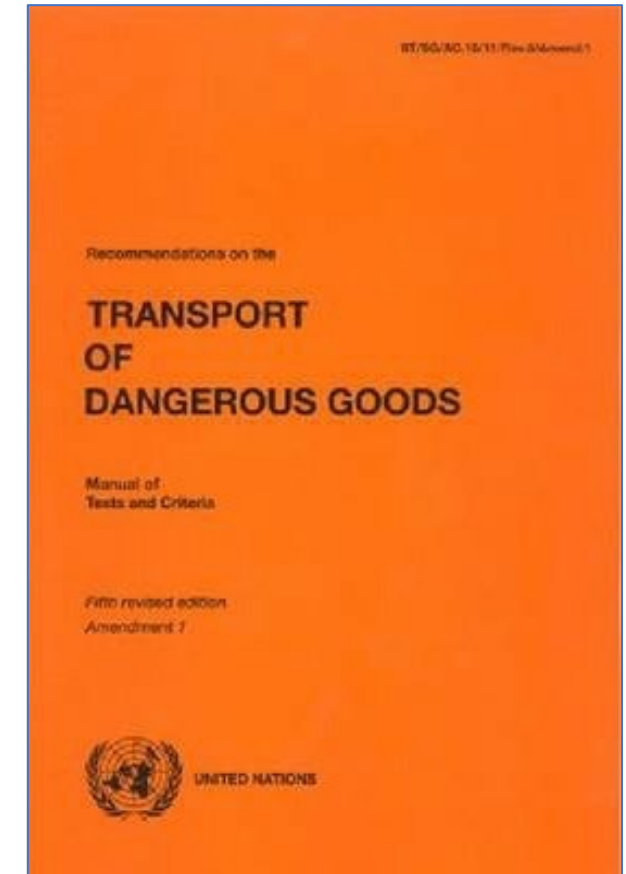
Introduction

- **UK Legislation – ER2014**
- **ADR**
- **MOD Explosives Regulations – DSA 03 OME Part 2 – In-Service Management**
- **MOD Transport Regulations**



Introduction

- The UN Orange Book - the recommendations on the Transport of Dangerous Goods Model Regulations
- A guidance document developed by the United Nations to harmonize dangerous goods transport regulations.
- Most of dangerous goods regulations based on the UN Orange Book.
- Not legally binding



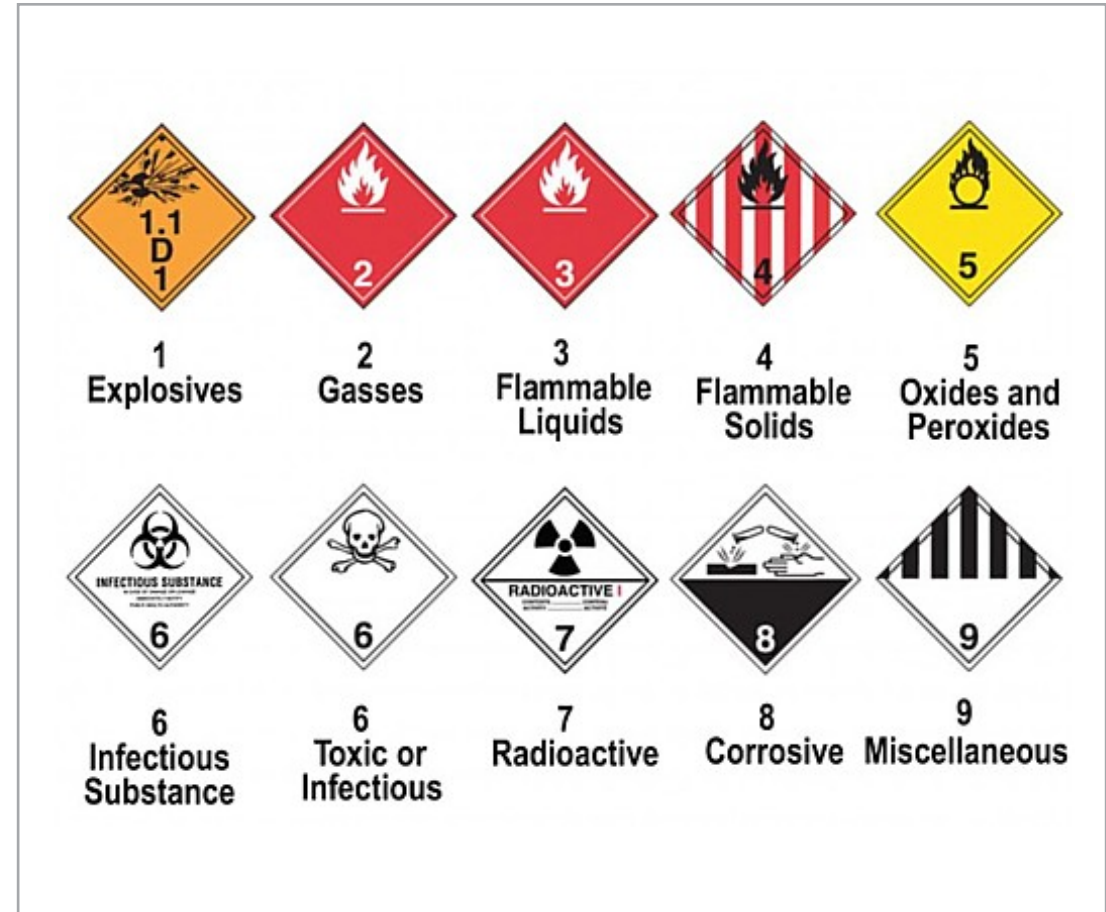
Deriving the Hazard Classification Code

- **Key Definitions:**

- Ammunition (or Munitions): Device(s) containing explosives, propellants, pyrotechnics
- Explosives is the term that includes Ammunition, Munitions, Explosive Articles or Explosive Substances
- Explosive substances are purely explosives eg. RDX, TNT NG etc
- Explosive articles are items containing explosives – eg. Mortars, shells etc
- Net Explosive Quantity (or Mass) is the total amount of explosives within an article - measured in kg

Deriving the Hazard Classification Code

- The UN classifies all dangerous goods for transportation and storage
- There are 9 Classes of Dangerous Goods
- Ammunition and Explosives are Class 1



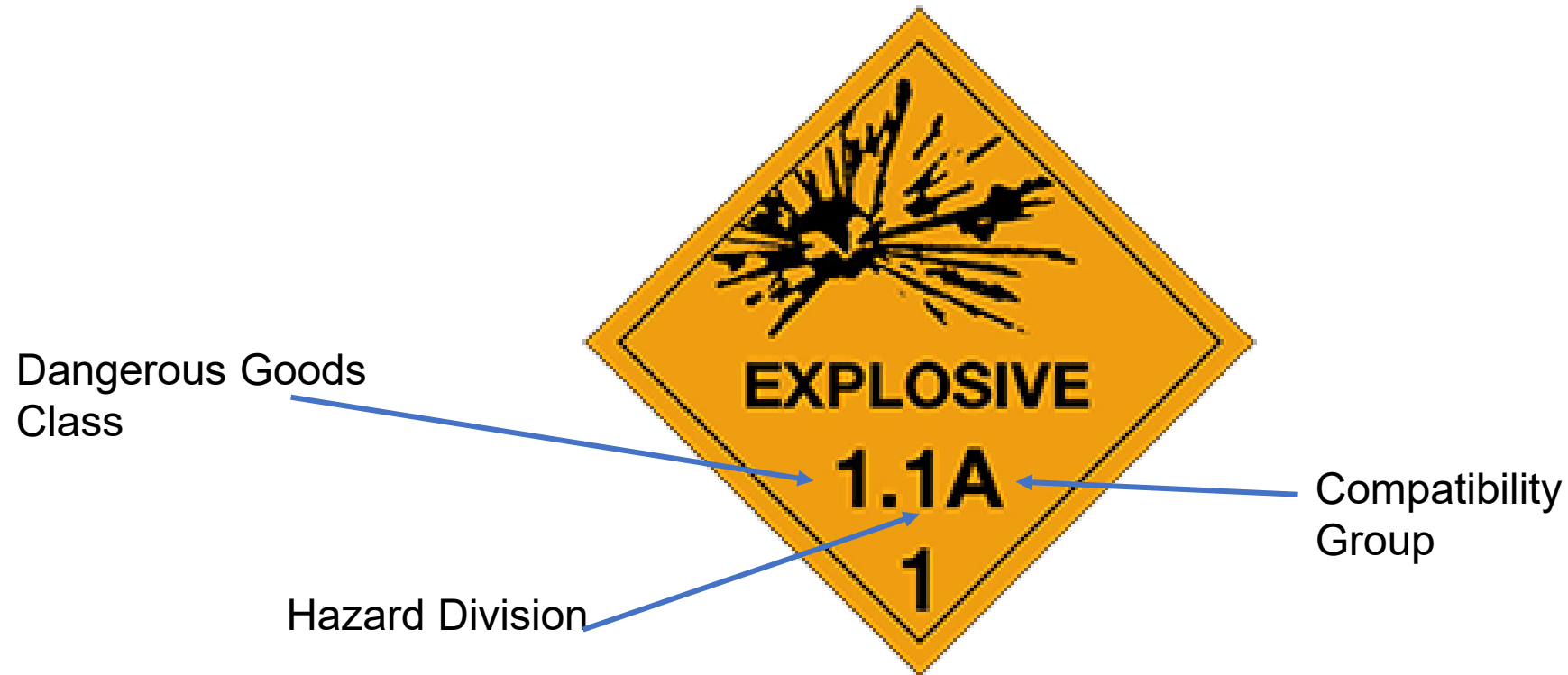
Deriving the Hazard Classification Code

- **Dangerous Goods Class (DG)**
 - Dangerous Goods Class 1
- **Hazard Division (HD)**
 - Divided according to hazard presented on initiation
 - Class 1 divided into 6 Hazard Divisions (1.1 – 1.6)
- **Compatibility Group (CG)**
 - Compatibility for storage and transportation
 - HDs assigned 1 of 13 Compatibility Groups (A-L, N, S)



Deriving the Hazard Classification Code

- Hazard Classification Code



Classification as Explosives

Criteria, test methods and procedures to be used for the classification of dangerous goods according to the provisions of the United Nations Recommendations on the Transport of Dangerous Goods, Model Regulations

Manual of Tests and Criteria

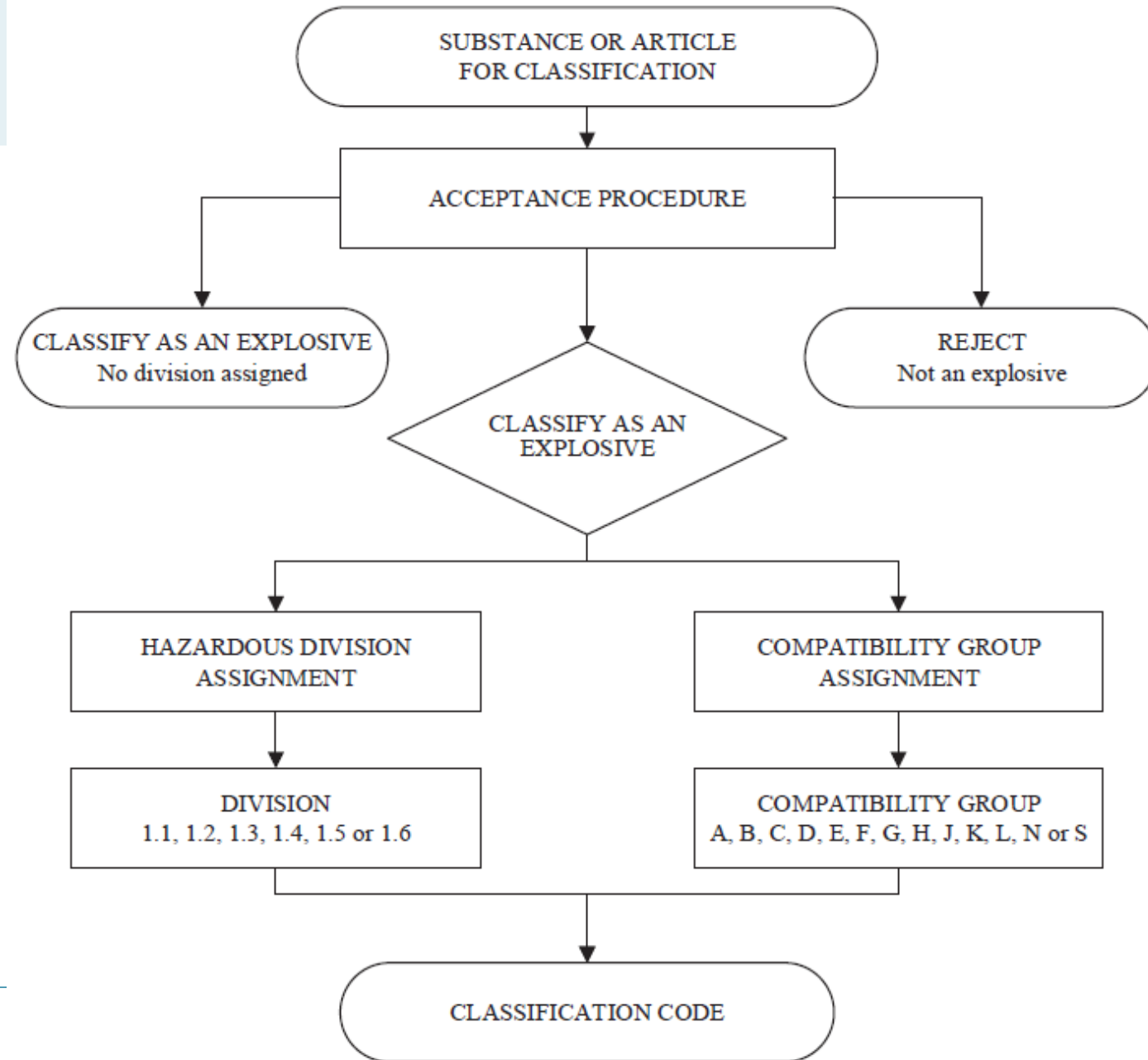
Eighth revised edition



UNITED NATIONS
New York and Geneva, 2023

The process

Figure 10.1: Overall scheme of the procedure for classifying a substance or article in the class of explosives



Test Series 1 – Is it an explosive substance?

Test code	Name of test
1 (a)	UN gap test ^a
1 (b)	Koenen test ^a
1 (c) (i)	Time/pressure test ^a
1 (c) (ii)	Internal ignition test

^a *Recommended test.*



Test Series 2 – IS the substance too insensitive for inclusion in the class of explosives?

Test code	Name of test
2 (a)	UN gap test ^a
2 (b)	Koenen test ^a
2 (c) (i)	Time/pressure test ^a
2 (c) (ii)	Internal ignition test

^a *Recommended test.*

Test Series 3 – Is the substance too sensitive to assign a division?

Test code	Name of test
3 (a) (i)	Bureau of Explosives impact machine
3 (a) (ii)	BAM Fallhammer ^a
3 (a) (iii)	Rotter test
3 (a) (iv)	30 kg Fallhammer test
3 (a) (v)	Modified type 12 impact tool
3 (a) (vi)	Impact sensitivity test
3 (a) (vii)	Modified Bureau of Mines impact machine test
3 (b) (i)	BAM friction apparatus ^a
3 (b) (ii)	Rotary friction test
3 (b) (iii)	Friction sensitivity test
3 (b) (iv)	ABL friction machine test
3 (c) (i)	Thermal stability test at 75 °C ^a
3 (c) (ii)	SBAT thermal stability test at 75 °C
3 (d)	Small-scale burning test ^a

^a *Recommended test.*



Test Series 5 – Is it very insensitive explosive substance with a mass explosion hazard?

Test code	Name of test
5 (a)	Cap sensitivity test ^a
5 (b) (i)	French DDT test
5 (b) (ii)	USA DDT test ^a
5 (b) (iii)	Deflagration to detonation test
5 (c)	External fire test for Division 1.5 ^a

^a *Recommended test.*



Test Series 6: to determine which division from 1.1 - 1.4 and if compatibility group S

Test code	Name of test
6 (a)	Single package test ^a
6 (b)	Stack test ^a
6 (c)	External fire (bonfire) test ^a
6 (d)	Unconfined package test ^a

^a *Recommended test.*

Test Series 7: Is it an extremely insensitive explosive substance?

Tests on substances

7 (a)	EIS cap test ^a
7 (b)	EIS gap test ^a
7 (c) (i)	Susan test
7 (c) (ii)	Friability test ^a
7 (d) (i)	EIS bullet impact test ^a
7 (d) (ii)	Friability test
7 (e)	EIS external fire test ^a
7 (f)	EIS slow cook-off test ^a

Test Series 7 – Is it an extremely insensitive explosive article?

Tests on articles

7 (g)	1.6 article or component level external fire test ^a
7 (h)	1.6 article or component level slow cook-off test ^a
7 (j)	1.6 article or component level bullet impact test ^a
7 (k)	1.6 article stack test ^a
7 (l)	1.6 article or component level fragment impact test

Test Series 8: Is an ammonium nitrate emulsion or suspension or gel intermediate for blasting explosives insensitive enough to be included in division 5.1?

Test code	Name of test	Section
8 (a)	Thermal stability test for ANE ^a	18.4
8 (b)	ANE gap test ^a	18.5
8 (c)	Koenen test ^a	18.6
8 (d)	Vented pipe tests ^b	18.7
8 (e)	CanmetCERL Minimum Burning Pressure (MBP) test ^a	18.8

^a This test is intended for classification.

^b These tests are intended for evaluating the suitability of ANEs for containment in portable tanks as an oxidizing substance.



The UN Hazard Divisions

- **HD 1.1**

- Ammunition that has a mass explosion hazard
- May produce a fragmentation and fire hazard
- Bulk demolition explosive



UN Hazard Divisions

• HD 1.2

- Ammunition that has a projection hazard but not a mass explosion hazard
- Severe projection hazard
- Certain types of grenades



UN Hazard Divisions

• HD 1.3

- Ammunition that has a fire hazard
- May produce a minor blast or projection hazard
- Incendiary ammunition



UN Hazard Divisions

- **HD 1.4**
 - No significant hazard in an accident
 - Small Arms Ammunition (SAA)



UN Hazard Divisions

- **HD 1.5**

- Very insensitive substances which may produce a mass explosion hazard
- Known as 'Insensitive Munitions'
- Rarely deployed on UN Missions



UN Hazard Divisions

- **HD 1.6**
 - Very insensitive substances which will not produce a mass explosion hazard



Fire Divisions

Fire Division	Symbol	Remarks
1.1		•
1.2		•
1.3		•
1.4		•
1.5		• Fire Division 1 symbol used due to similar fire-fighting hazards.
1.6		• Fire Division 2 symbol used due to similar fire-fighting hazards.



Compatibility Groups

- **What is Compatibility?**

Ammunition which may be **STORED** and **TRANSPORTED** together without **INCREASING THE PROBABILITY** or the **EFFECTS** of an accidental explosion

Compatibility Groups

Compatibility Group A

- Primary Explosive Substances
 - e.g. Mercury Fulminate, Lead Azide, Picric Acid

Compatibility Groups

Compatibility Group B

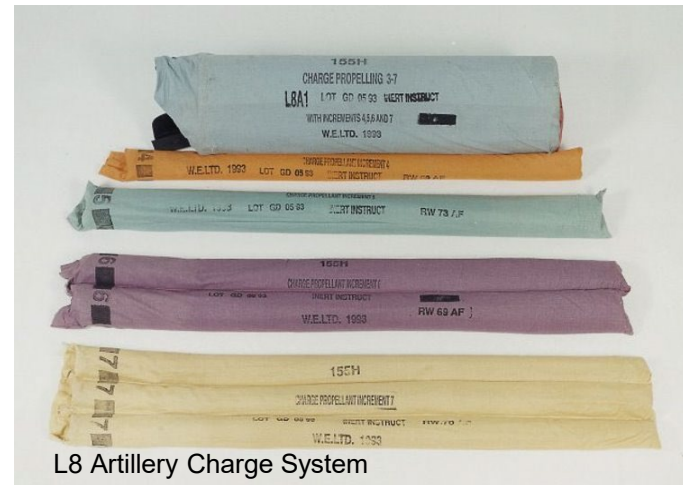
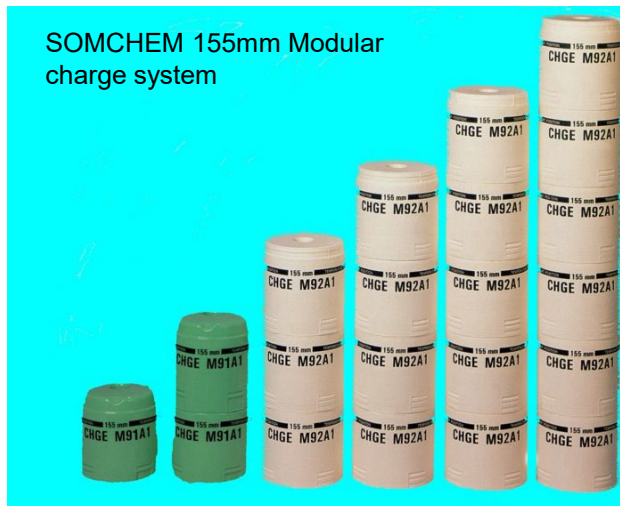
- Ammunition/articles containing Primary Explosives
 - e.g. Detonators



Compatibility Groups

Compatibility Group C

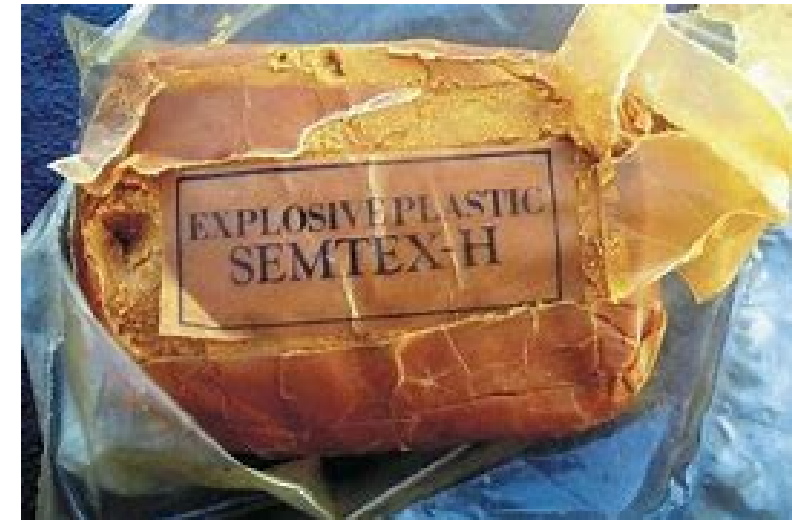
- Propellant explosive substance or other deflagrating substance or articles containing such explosive substances
 - e.g. Propelling Charges, Rocket Motors



Compatibility Groups

Compatibility Group D

- Secondary detonating explosive substance or black powder or articles containing a secondary detonating substance, in each case:
 - **Without** means of initiation and
 - **Without** a propelling charge
e.g. Demolition Stores



Compatibility Groups

Compatibility Group D – continued...

Or

- An article containing a primary explosive substance and two or more effective safety features
- In other words: initiation systems with two or more safety features are not considered as CG B when applying categorisation for storage and movement purposes

Compatibility Groups

Compatibility Group E

- Article containing a secondary detonating explosive substance:
 - **Without** means of initiation
and
 - **With** a propelling charge (but not one containing a flammable or hypergolic liquid)
e.g. HE Mortar Bomb

Compatibility Groups

Compatibility Group F

- Article containing a secondary detonating explosive substance:
 - With its own means of initiation
 - With or without a propelling charge



Compatibility Groups

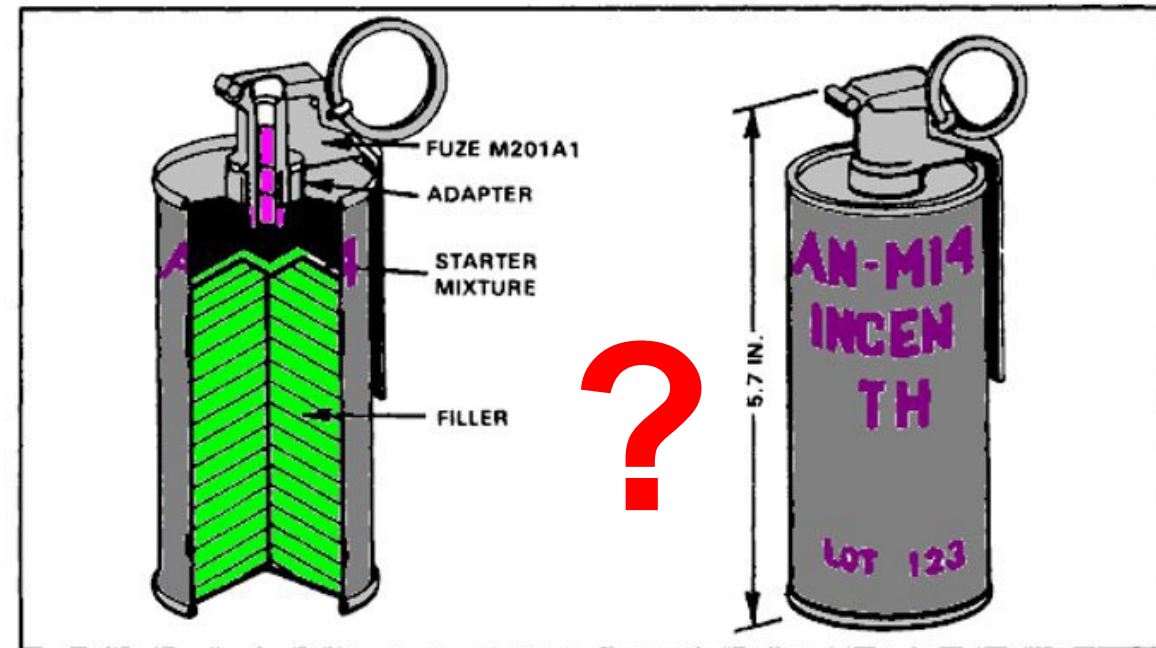
Compatibility Group G

- Pyrotechnic substance, or article containing a pyrotechnic substance, or
- Article containing both an explosive and an illuminating, lachrymatory or smoke-producing substance (other than a water-activated article or one containing white phosphorus, phosphide or a flammable liquid or gel).

Compatibility Groups

Compatibility Group H

- Article containing both an explosive substance and white phosphorus



AN-M14 TH3 incendiary grenade.

Compatibility Groups

Compatibility Group J

- Article containing both an explosive substance and a flammable liquid or gel



[RPO-A missile and launcher - RPO-A Shmel - Wikipedia](#)

Compatibility Groups

Compatibility Group K

- Articles containing both an explosive substance and a toxic chemical agent



Source: New York Times

Compatibility Groups

- **Compatibility Group L**
- Explosive substance or article containing an explosive substance and presenting a special risk, needing isolation of each type
 - e.g. Rocket systems containing hypergolic liquid propellant



LANCE
Source: US Army

Compatibility Groups

Compatibility Group N

- Article containing only extremely insensitive detonating substances
- Insensitive munitions that are chemically stable enough to withstand mechanical shocks, fire and impact by shrapnel, but that can still explode as intended to destroy their targets

Compatibility Groups

Compatibility Group S

- Substance or article so packed or designed that any hazardous effects are contained within the package *unless the package has been degraded by fire*
- In this case, all blast or projection effects will not significantly hinder or prohibit fire fighting or other emergency response efforts in the immediate vicinity of the package



Rules for Aggregation and CG Mixing

- **Compatibility Groups – identify types of stock**
- **Theoretical ideal – store each type individually**
- **Practically – this is not likely to be viable**
- **Need to compromise: mix suitable groups**
- **Aim – to reduce the risk / to improve safety**

Mixing Rules state what can be stored with what

Rules for Aggregation and CG Mixing

- **HD 1.1 to 1.6 can all be stored and transported together**
- **However, when mixing HDs, the NEQ must be aggregated to the highest risk:**
 - When any mix contains HD 1.1, it is all to be considered HD 1.1:
 - e.g. 300kg HD 1.1 + 700kg HD 1.2 + 500kg HD 1.3
= **1,500kg HD 1.1**
 - When HD 1.4 is mixed with other HDs, the NEQ of HD 1.4 is ignored:
 - e.g. 300kg HD 1.1 + 700kg HD 1.2 + 500kg HD 1.4
= **1,000kg HD 1.1**

Quick Exercise

- 500kg of HD1.1 + 300kg HD1.2, 200kg HD1.3, 1000kg HD1.4
??
- 1000kg HD1.1

Rules for Aggregation and CG Mixing

• Mixing Rules for Storage

Compatibility Group	A	B	C	D	E	F	G	H	J	K	L	N	S
A	X												X
B		X		X (1)	X (1)	X (1)							X
C			X	X	X	(2)	(3)					X (4)	X
D		X (1)	X	X	X	(2)	(3)					X (4)	X
E		X (1)	X	X	X	(2)	(3)					X (4)	X
F		X (1)	(2)	(2)	(2)	X	(3)						X
G			(3)	(3)	(3)	(3)	X						X
H								X					X
J									X				X
K										X			
L											(5)		
N			X (4)	X (4)	X (4)							X (6)	X (7)
S		X	X	X	X	X	X	X	X			X (7)	X (6)

Rules for Aggregation and CG Mixing

- Articles of HD 1.4 may be mixed in storage with articles of CGs B, C, D, E, F, G, N or S in all HDs
- Articles of HCC 1.4S may be mixed in storage with substances or articles of CGs B, C, D, E, F, G, H, J, N or S in all HDs

Questions?

Lesson Objectives

You should now be able to:

- Understand the requirement for UN HCCs
- Understand the UN system of classifying explosives
- Interpret HCC, including HD and CG
- Understand the explosives aggregation and compatibility mixing rules.



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