Destruction Test for M55 Nerve Agent Rocket Mortar using Surrogate chemicals by DAVINCH™

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Outline of presentation

Introduction

1. M55 Rocket Mortar
   - Difficulties in safe storage/disposal
2. DAVINCH
   - What is it ? How does it work? etc.
3. Surrogate Test for M55
   - Conditions, results etc.

Summary

Introduction

- Conventional destruction methods for chemical munitions including neutralization and incineration
  - Require pretreatment to separate chemical agents, explosives and shells
  - Require separate facilities for different munitions/agents
- High risk munitions
  - Risk of chemical hazards
  - Risk of explosion
  - Require special considerations and special facilities
- Example: M55 nerve agent rocket

Introduction

- DAVINCH can destroy different munitions and any types of agents by one unit

- Destruction test for M55 nerve agent rocket (surrogate) to demonstrate the versatility of DAVINCH

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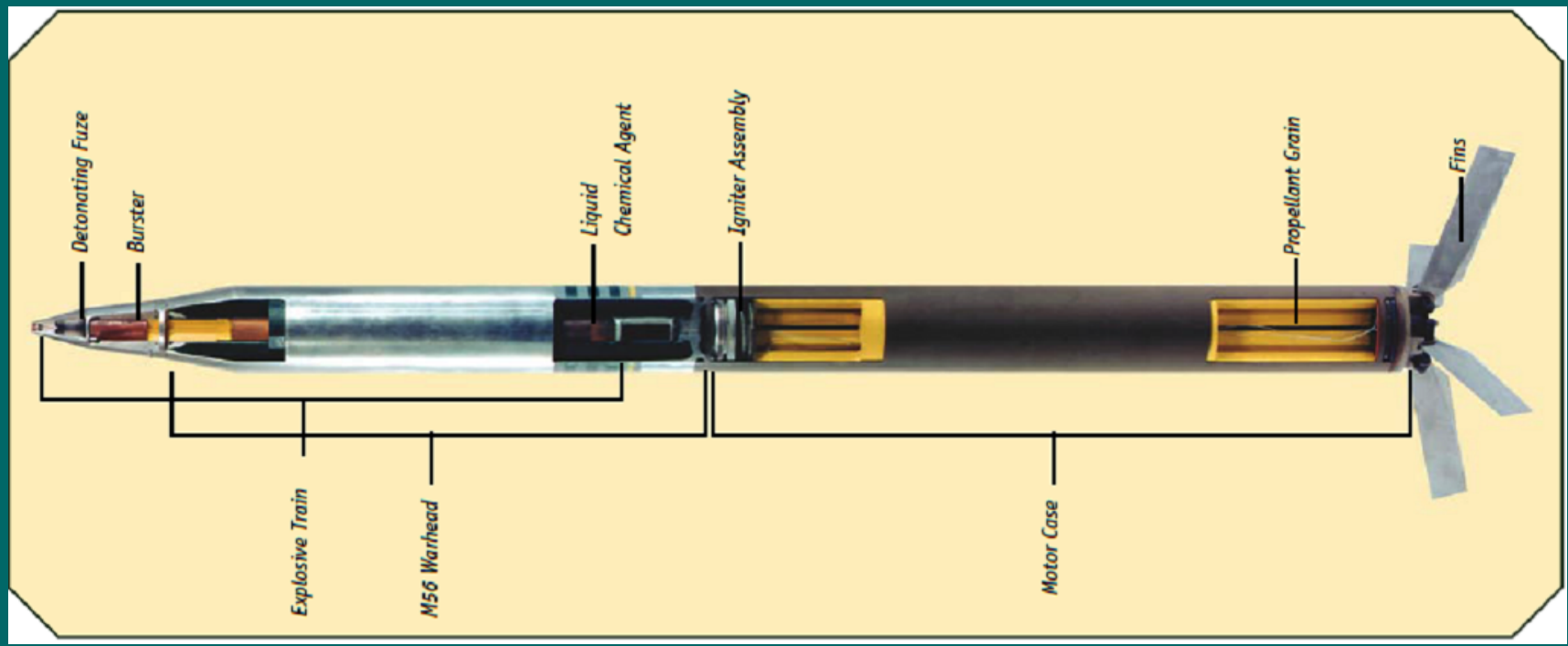
Summary

1. M55 Rocket Mortar

One of the chemical munitions most difficult to store or destroy safely in U.S. stockpiles



from: http://www.cma.army.mil/include/docrendition.asp?DocID=003675338

1. M55 Rocket Mortar

One of the chemical munitions most difficult to store or destroy safely in U.S. stockpiles

- GB or VX fill, propellant and fuze
- Hazard of leak
  - GB rockets: particularly high risk, due to corrosion of thin aluminum shell by acidic degradation products of GB
- Hazard of fire
  - Accidental / auto ignition of degraded unsteady propellant

Outline of presentation

Introduction

1. M55 Rocket Mortar
2. DAVINCH
   - What is it ?
   - How does it work?
   - High destruction efficiency
   - Record of destruction
3. Surrogate Test for M55

Summary

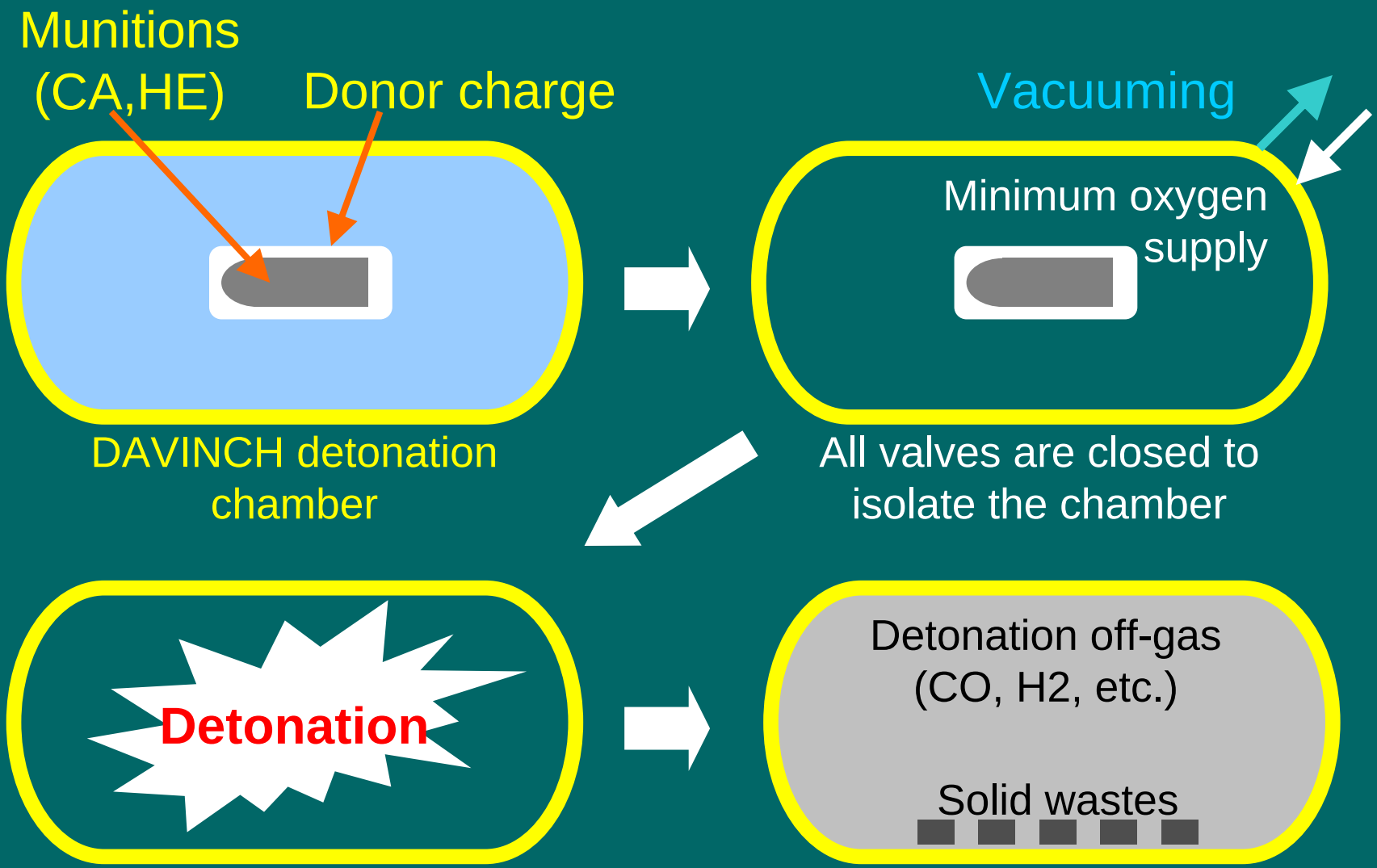
2. DAVINCH

What is it ?

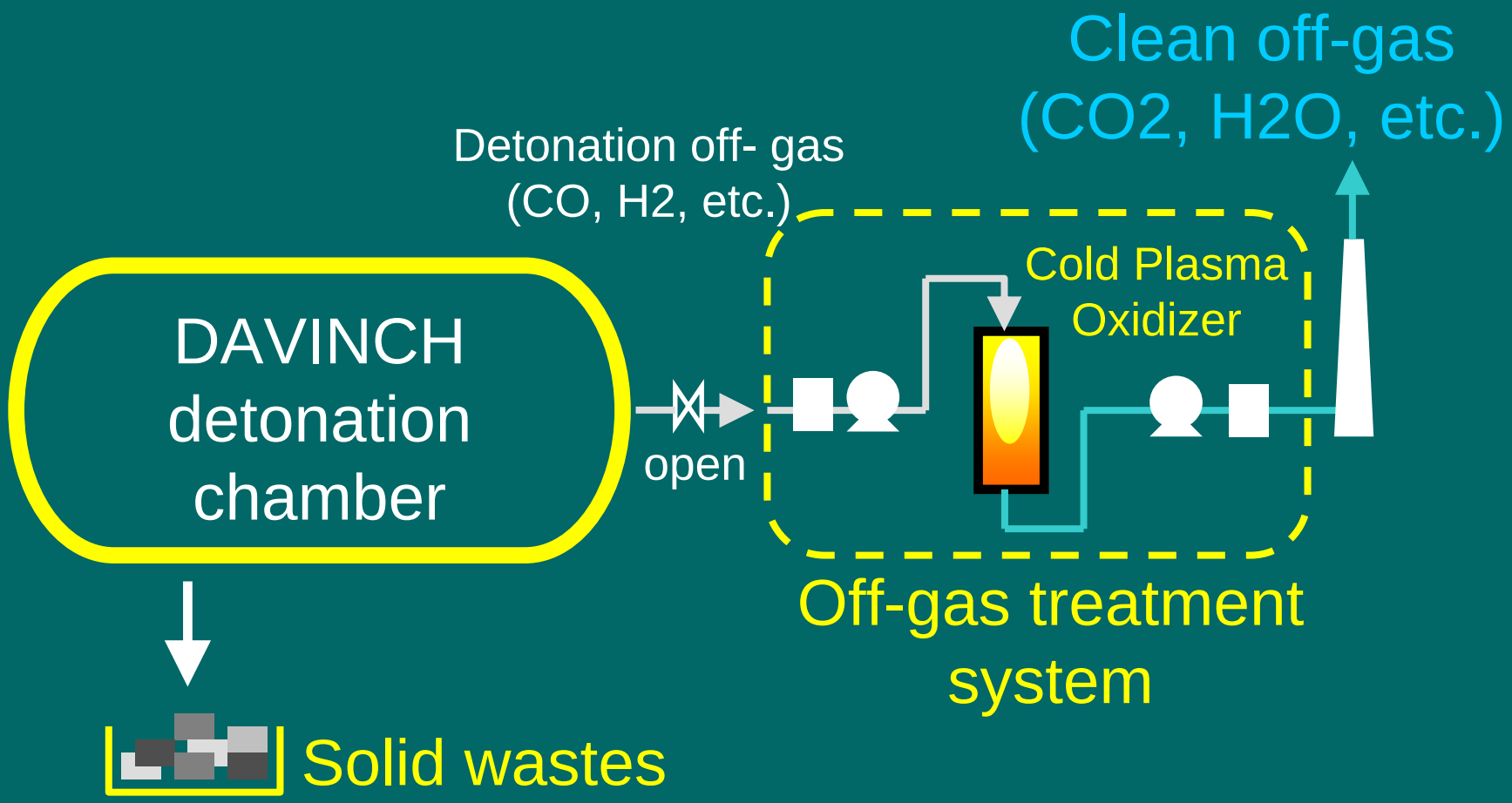
- DA VINCH™
  Detonation of Ammunition in a Vacuum Integrated Chamber
  - Controlled detonation system developed for chemical weapons destruction

DA VINCH DV60 (60kg-TNT) detonation chamber

How does it work ?



How does it work ?



High Destruction Efficiency

By utilizing explosive energy for destruction of chemical agent

- High Pressure=10GPa
- High temperature=3000K

	for off gas	for fragments and dust
Destruction Efficiency	＞ **99.9999%**	＞ **99.99%**

Record of destruction

- DAVINCH has destroyed more than **1,200** chemical bombs successfully

	15kg Red Bombs (DC, DA)	50kg Yellow Bombs (HD+L)	Total
2004	17	40	57
2005	466	72	538
2006	560	99	659
Total	1044	210	1254

Record of destruction

- Various types of munitions (non-stockpile: ocean-dumped Japanese OCW from WW2)

15kg Red Bomb

DC/DA 0.368kg
High explosives 1.3kg

50kg Yellow Bomb

HD+L 18L
High explosives 2.3 kg

Record of destruction

- Various types of munitions (simulated munitions)

77mm HD

210mm Clark

210mm CG

Livens CG

White phosphorus

245mm conventional (20kg TNT)

Outline of presentation

Introduction

1. M55 Rocket Mortar
2. DAVINCH
3. Surrogate Test for M55
   - Objectives
   - Simulated M55 rocket
   - Conditions
   - Results etc.

Summary

3. Surrogate Test for M55 Nerve Agent Rocket

Objectives

Demonstration of the versatility of DAVINCH through the test by:

- demonstrating the destruction of M55
  - chemical fill and propellant
  - by detonation, without pretreatment
- evaluating the nerve agent (GB) destruction
  - off gas quality compared to the AEL

Target concentration

GB (surrogate DMMP) Concentration in Off-gas after Cold Plasma Oxidizer < 0.0001mg/m3 (STEL)

- AELs (U.S., Revised in 2005)

Current and revised chemical warfare agent AELs*

(in milligrams per cubic meter of air)

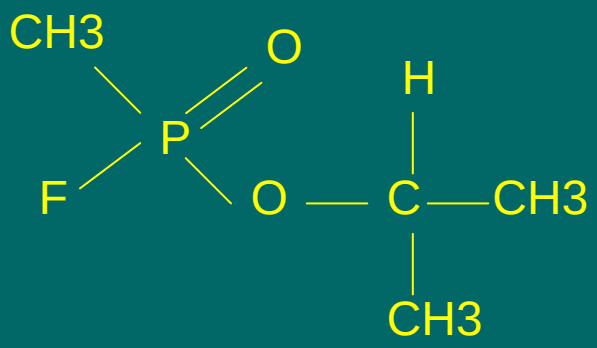
Agent type	AEL Information	AEL type			
		General population limit (GPL)	Worker population limit (WPL)	Short-term exposure limit (STEL)	Immediately dangerous to life or health (IDLH)
GA, GB	*Revised limit (current limit)*	0.000001 (0.000003)	0.00003 (0.0001)	0.0001 (none)	0.1 (0.2)
	Averaging time	24 hours	8 hours	15 minutes	≤30 minutes
VX	*Revised limit (current limit)*	0.0000006 (0.000003)	0.000001 (0.00001)	0.00001 (none)	0.003 (0.02)
	Averaging time	24 hours	8 hours	15 minutes	≤30 minutes
HD	*Revised limit (current limit)*	0.00002 (0.0001)	0.0004 (0.003)	0.003 (none)	0.7 (none)
	Averaging time	12 hours	8 hours	≤15 minutes	≤30 minutes

**The Centers for Disease Control and Prevention is responsible for setting airborne exposure limits (AELs). For the current AELs, see FR 53, No. 50, pp. 8504-7 (March 15, 1988). For the revised nerve agent AELs, see FR 68, No. 196, pp. 58348- 51 (October 9, 2003); for the revised mustard agent AELs, see FR 69 No. 85, pp, 24164-8 (May 3, 2004).*

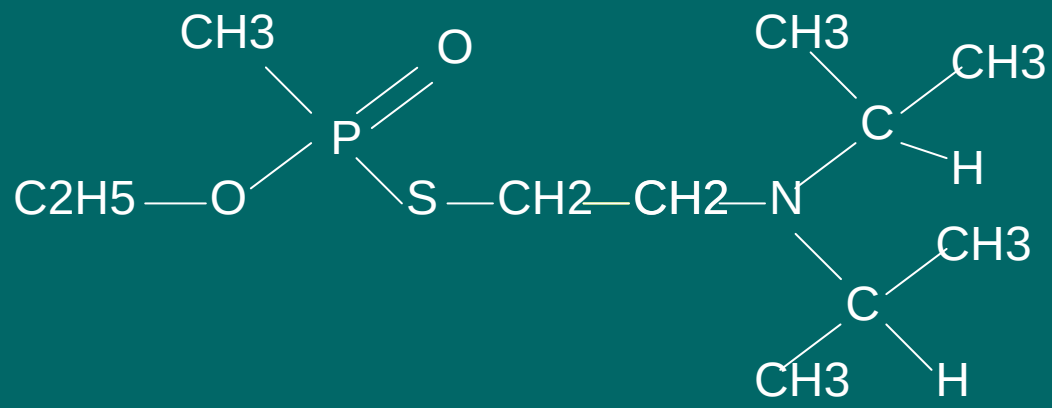
from: http://www.cma.army.mil/publications.aspx?criteria=mission&value=CMA

Surrogate for nerve agent

GB

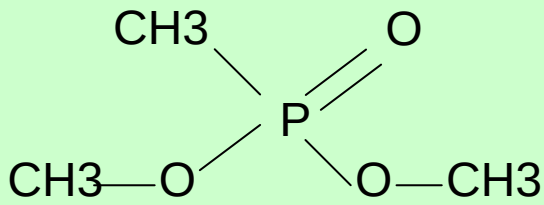


VX

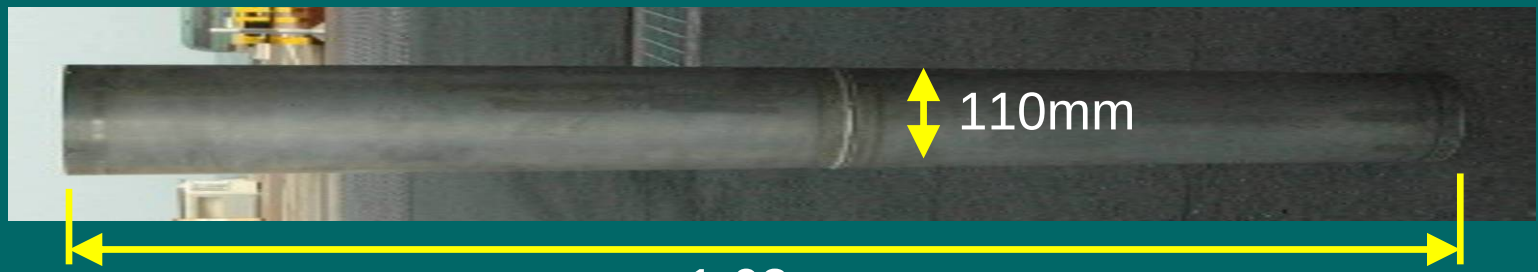


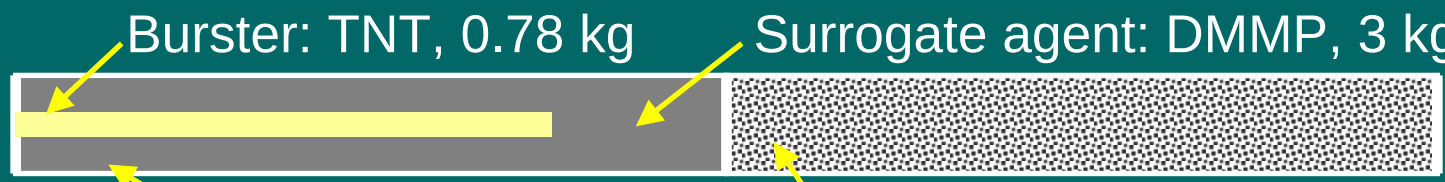
surrogate

DMMP (dimethyl methylphosphonate)

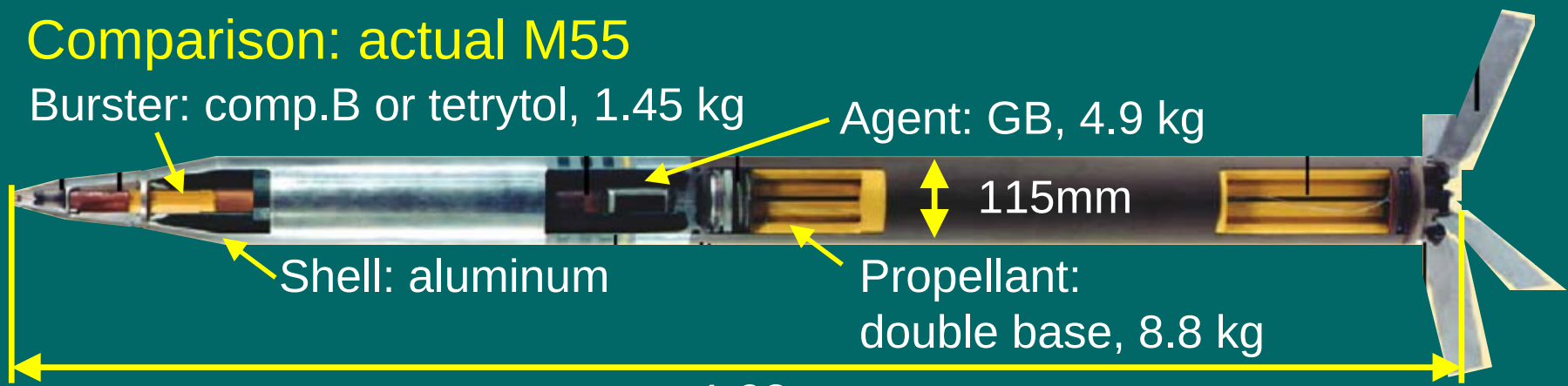


Simulated M55 rocket



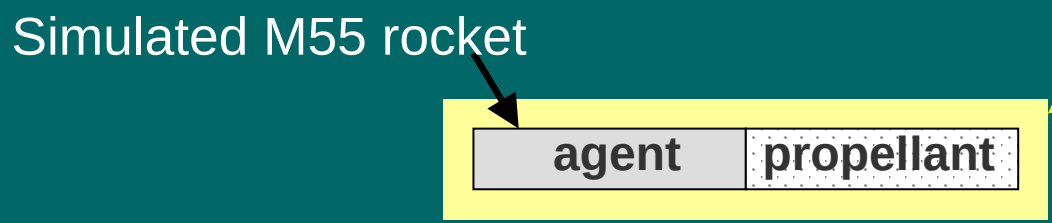


Comparison: actual M55



Conditions

	Values	Remarks
Donor charge	**22.2 kg**	emulsion explosive + booster
Net Explosive Quantity (NEQ)	**28 kg-TNTeq.**	donor charge + burster + propellant (TNTeq. of propellant was assumed as 1 kg-TNTeq.)
HE/CA ratio	**9.3**	NEQ / (mass of agent)

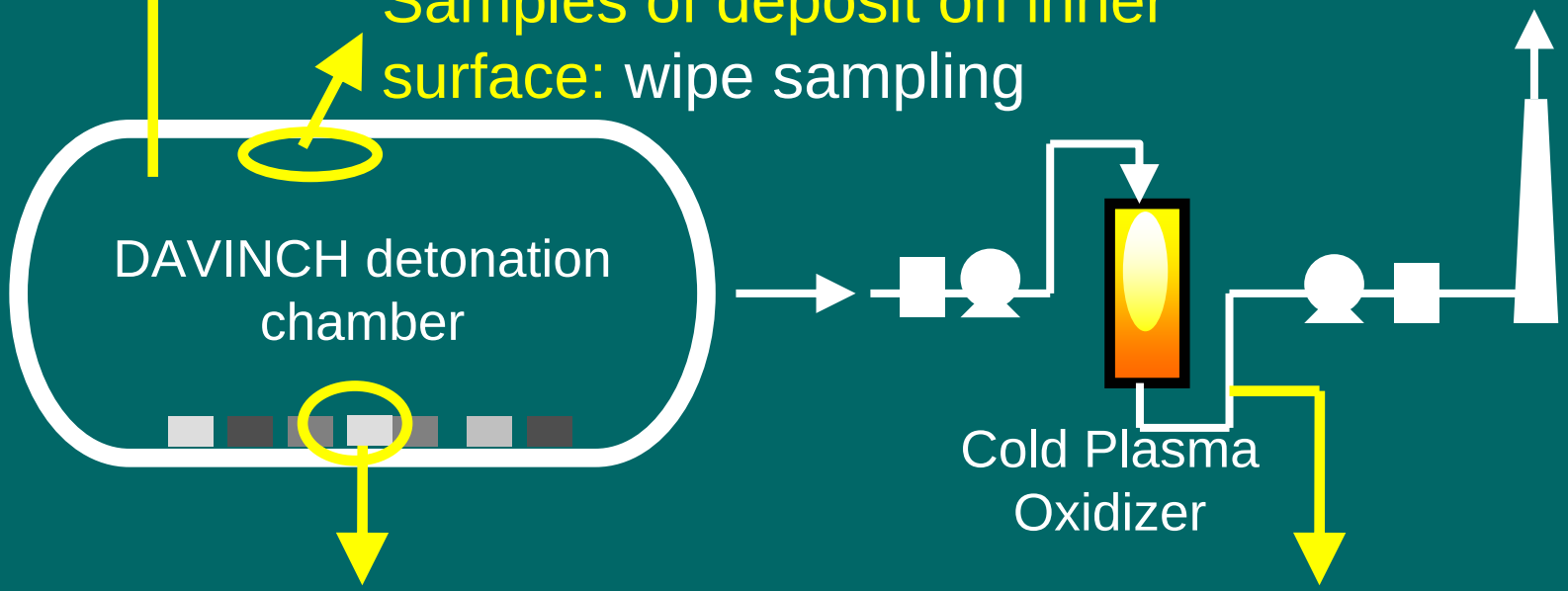


Sampling

Detonation off- gas sample

sampling directly from the chamber before evacuating

Samples of deposit on inner surface: wipe sampling



Solid waste samples

Sample of off- gas after Cold Plasma Oxidizer

Analysis

Compound	Method
DMMP In gas	Solid-phase adsorption / GC-MS
DMMP in solid waste	Solvent extraction / GC/MS
Other phosphorus compounds	Total gaseous phosphorus : Impinger collection / ICP-AES Other organic phosphorus : Solid-phase adsorption / GC-FPD

Detonation

Simulated M55 rocket with donor charge was detonated in a DAVINCH DV60 detonation chamber

Result (1)

Destruction of the rocket with agent and propellant without dismantling was demonstrated

Inside of chamber after detonation

Fragments

Dust

Result (2)

Agent destruction demonstrated

with very high destruction rate, STEL level was achieved in Cold Plasma Oxidizer off-gas

Target	Results	Remarks
Agent in chamber off-gas	**0.00138 mg/m^3**	Other organic phosphorus were under DL
Destruction Efficiency by DAVINCH	**99.999998 %**	(99.99 % including solid wastes)
Agent in Cold Plasma Oxidizer off-gas	**0.00004 mg/m^3**	**< 0.0001 mg/m^3 (STEL for GB)**
DRE of DAVINCH + Cold Plasma Oxidizer	**99.9999998 %**	

DL : detection limit.

Summary

- The capability of DAVINCH to destroy M55 nerve agent rocket was demonstrated.
  - Nerve agent fill and propellant
  - Without any special pretreatment
  - High destruction efficiency of agent: 99.999998 %
  - Agent concentration in the off-gas after Cold Plasma Oxidizer : 0.00004 mg/m3 < STEL
- The versatility of DAVINCH was demonstrated.
  - Destruction of high risk munitions like M55 by the same unit which is used to destroy OCW with HD+L and DC/DA

Acknowledgements

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Thank you for your attention.

Any questions?