Recovered Sea-Dumped Chemical Weapons – possibilities for on- and off-shore treatment

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Both chemical and conventional munitions have been extensively dumped at sea since WW I worldwide.

There are three basic types of hazard resulting from sea-dumped chemical weapons (CW):

- Direct contact with agent from leaking rounds resulting in threats to human health
- Agent contamination of marine organisms and the environment in the vicinity of the munitions and the consequent potential for some concentration of toxic contaminants entering wild and human food chains
- Explosions, which can be both life threatening and have the potential to spread material away from the dump site.

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I. Introduction

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Characteristics of sea-dumped CW

- very often dumped with fuzes;
- munitions usually packed in boxes or containers but may have been dumped loose
- Incomplete records on location, munition type(s), fill etc.
- munitions status is unpredictable
- Dumps may contain mixtures of different CW agents or munitions
- some of the agent may have already decomposed or degraded
- Countries are reluctant to provide information

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Historical Aspect

- ✓ disposal of CW at sea was seen as the best disposal method at the time, especially after WW II;
- ✓ there was simply too much CW to store, incinerate or dispose of on-land after WW II;

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Sea-dumped CW and Chemical Weapons Convention

The CWC uses in Article III (Declarations) and Article IV (Chemical Weapons) the following phrase:

"The provisions of this Article and the relevant provisions of Part IV of the Verification Annex shall not, at the discretion of a State Party, apply to chemical weapons buried on its territory before 1 January 1977 and which remain buried, or which had been dumped at sea before 1 January 1985."

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Sea-dumped CW – Scope of the Problem

Main known dumping areas:

- Baltic Sea region,
- Skagerrak,
- the Barents Sea region
- the waters around Europe and the UK including Irish sea
- Japanese waters
- Australian waters
- waters around US
- waters around Canada

➢ estimates indicate over ***300,000 tonnes*** of CW munitions in the waters around **Europe** alone plus ***4,900 tonnes*** of CW munitions was dumped off **Japan** and over ***21,000 tonnes*** disposed in **Australian** waters

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Physical and chemical properties of those agents dumped in the largest quantities

Trivial Name	Chemical Name	Melting point [°C]	Boiling point [°C]	Vapour Pressure [mm Hg] 20°C	Density [g/cm3]	Solubility in Water [g/l]
CAP	Chloroacetophenone [CAS: 532-27-4]	54-56	244	0.013	1.32	1
Clark I	Dipenylchlorarsine [CAS: 712-48-1]	38-44	307-333	0.0016	1.442	2
Clark II	Dipenylcyanorarsine [CAS: 23525-22-6]	30-35	290-346	0.00047	1.45	2
Adamsite [Agent DM, Sternite]	Diphenylaminechlorarsine, 10-chloro-5,10-dihydrophenarsazine [CAS: 578-94-9]	195	410	$2x10^{-13}$	1.65	0.002
Phosgene	Carbonyl dichloride [CAS: 75-44-5]	-128	7.6	1178	3.4	9
Diphosgene [Agent DP]	Trichloromethyl chloroformate [CAS: 503-38-8]	-57	127	10.3	1.65	
Mustard Gas HD, [Yperite,Lost]	Bis-(dichloroethyl)-sulphide [CAS: 505-60-2]	14	228	0.72	1.27	0.8
'Winter Mustard'	Bis-(dichloroethyl)-sulphide [63%] and 2-Chlorovinyl dichlorarsine [37%] [CAS: 505-60-2 and CAS: 541-25-3]	-14	<190		1.66	<1
N-Mustard [N-Lost, HN-1]	N-ethyl-2,2-dichlorodiethylamine [CAS: 538-07-8]	-4	235	0.011	1.24	0.16
Lewisite I [Agent L]	2-Chlorovinyl dichlorarsine [CAS: 541-25-3]	-18	190	0.35	1.89	0.5
Tabun [Agent GA]	Ethyl N,N-dimethylphosphoramidocyanidate [CAS: 77-81-6]	-50	246	0.07	1.07	120

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Options for sea-dumped CW

- CW on the sea-bed can remain undisturbed (no action option, may have public acceptance problems)
- CW munitions can be recovered and treated
- There may be ways in which the material can be rendered completely harmless *in situ* (requires advanced R&D, may not be feasible).

Problems for possible recovery operations

- deep water operations
- Munitions will be heavily corroded;
- Munitions are known to be unstable during recovery/transport
- munitions filled with gaseous or water soluble CW agents may leak when disturbed

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Available experience with UXB and DYNASAFE:

- UXB has experience in munitions recovery operations on land and underwater;
- UXB has experience in transportation of explosive materials and UXO
- UXB has experience in operating destruction plants for recovered munitions
- DYNASAFE is a producer of transport chambers for conventional and chemical munitions
- DYNASAFE is a producer of Static Detonation Chambers (hot detonation technology) for destruction of conventional and chemical munitions
- DYNASAFE is a producer of Controlled Detonation Chambers (cold detonation technology) for destruction of chemical munitions

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II. UXB and DYNASAFE experience

Underwater explosive clearance

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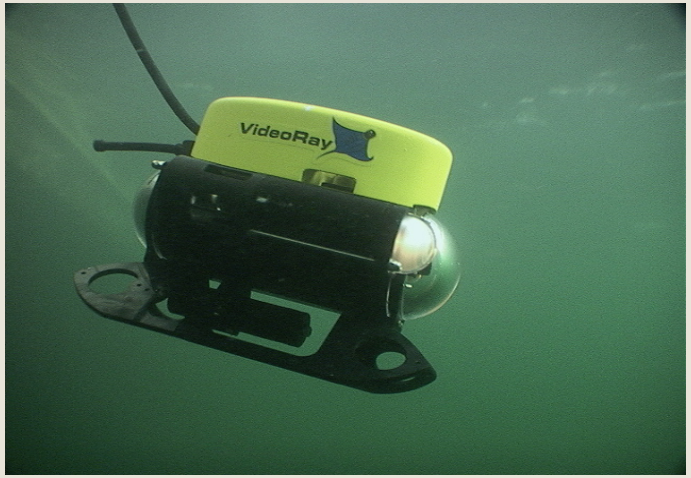
ROV examples



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Underwater explosive clearance

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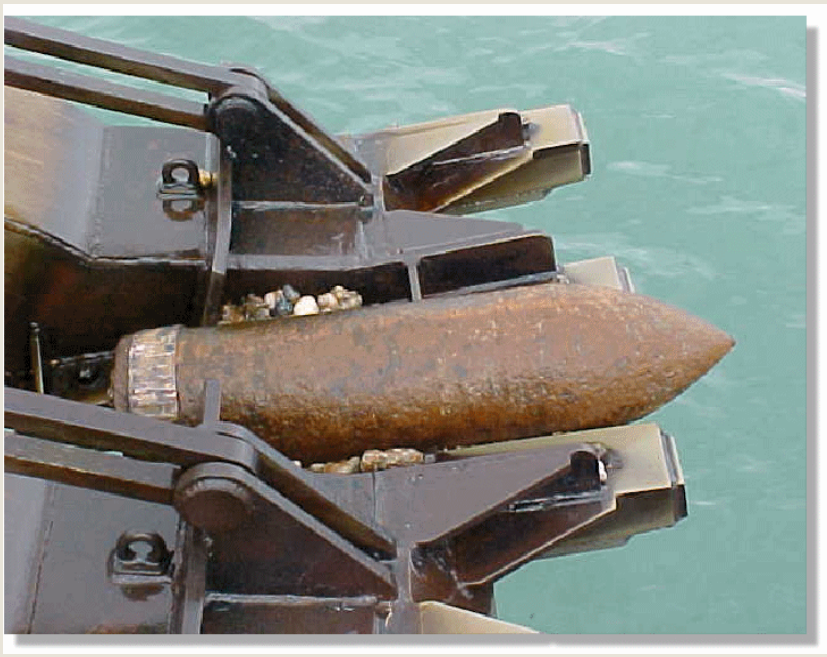
Underwater explosive clearance



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Underwater surveys. Including ROV Inspections

- Multi beam technology
- DGPS
- Magnetometer
- Side scans
- Echo sounding depths
- Sub bottom profiler
- Geophysical samples
- All computer integrated, enabling highly accurate charts to be drawn.

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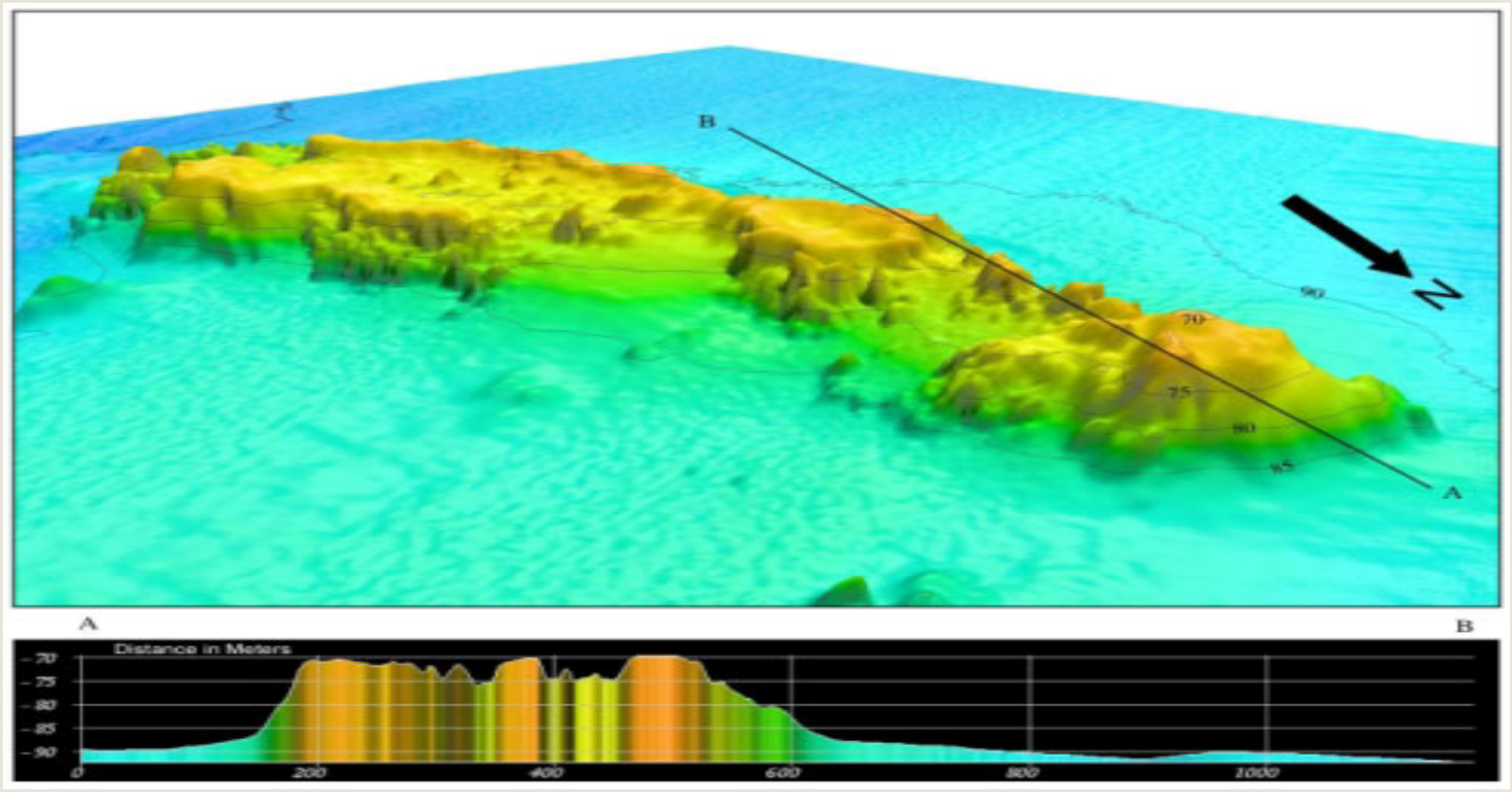
Survey Picture



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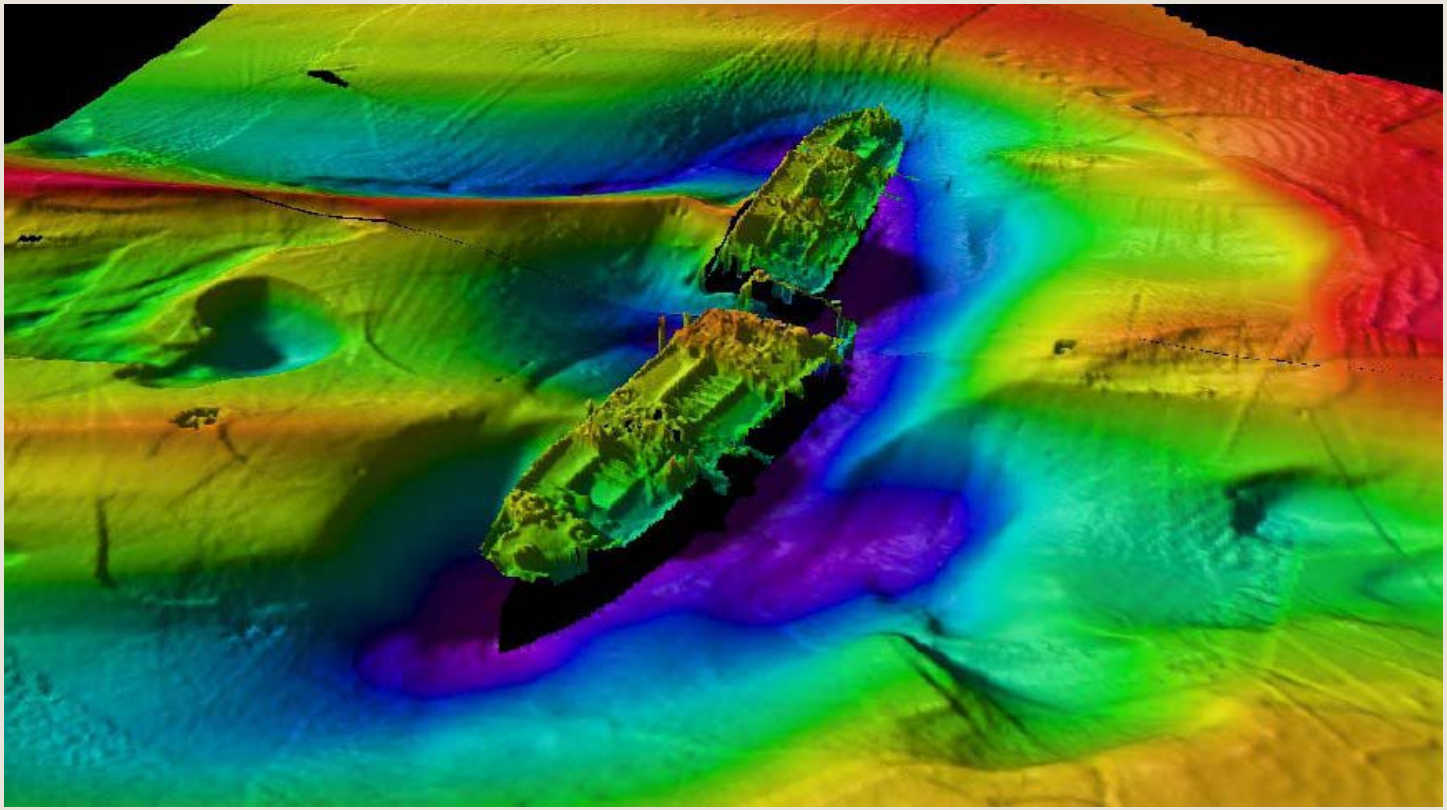
Wreck of the Richard Montgomery



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Based upon the available experience the following approaches are feasible:

(1)Off-shore

- sea-platform/ship or barge with SDC 1200/2000 and secondary containment structure

(2) On-shore

- vessel/ship with transportation chambers for storage and transport of the recovered munitions onto a land disposal site;
- destruction at a land site with an SDC 1200/SDC 2000;

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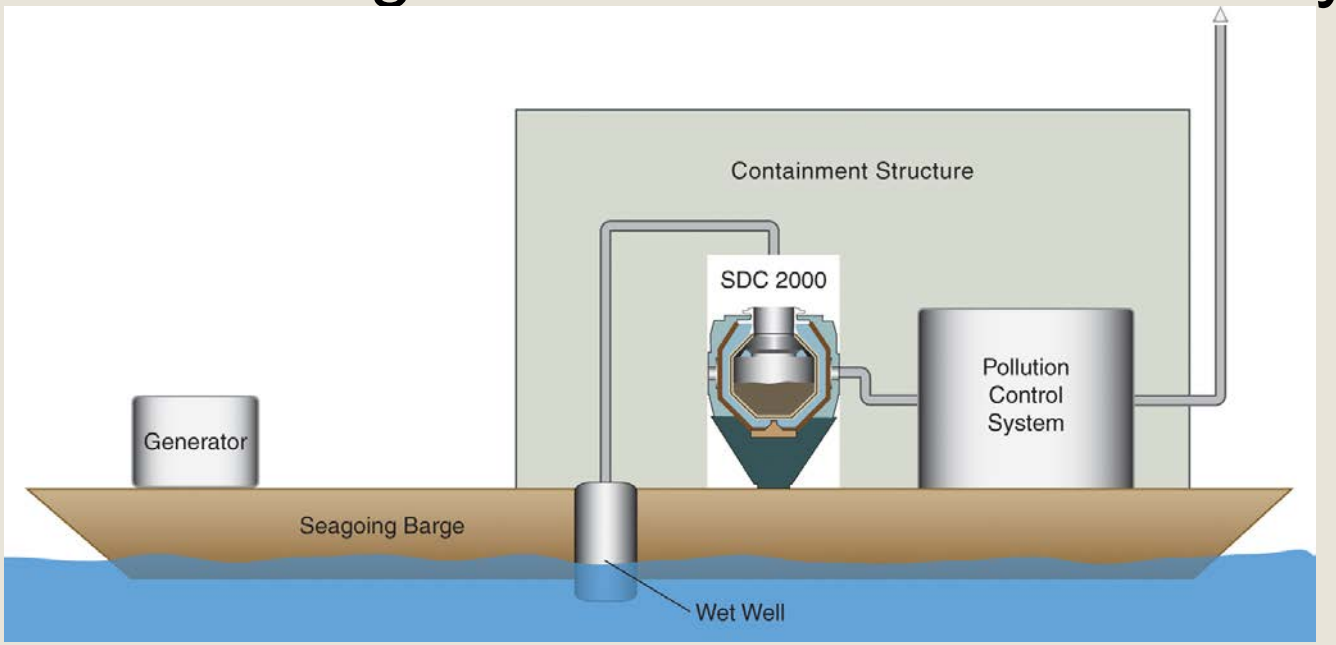
UXB/Dynasafe Concept

- Based on Adaptation of proven technologies
- Zero handling of munitions after recovery



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Munitions recovered from sea floor in watertight containers

- Containers hold sea floor pressure as well
- Containers are disposable, provide containment while munition is raised to surface, prevents contamination
- Munition remains in container while being fed to SDC
- High temperature in SDC causes container breach
- Once breached, munition inside container is exposed to high temperatures and pyrolysis reaction occurs, destroying agent and explosive at same time

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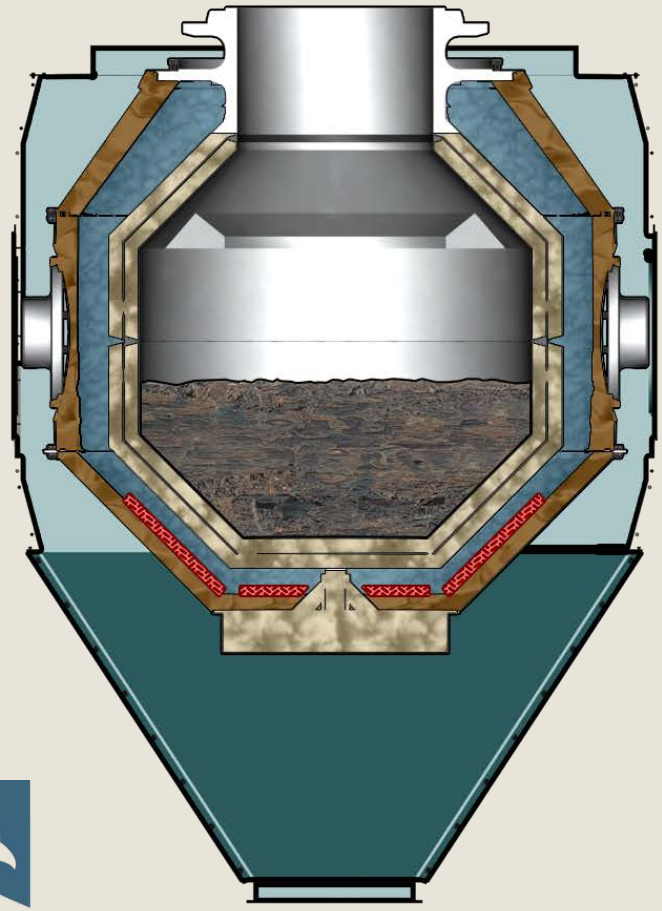
Basic structure of the DYNASAFE SDC



Outer chamber with heat insulation

Air

Inner chamber

Electrical heating elements

Scrap bed

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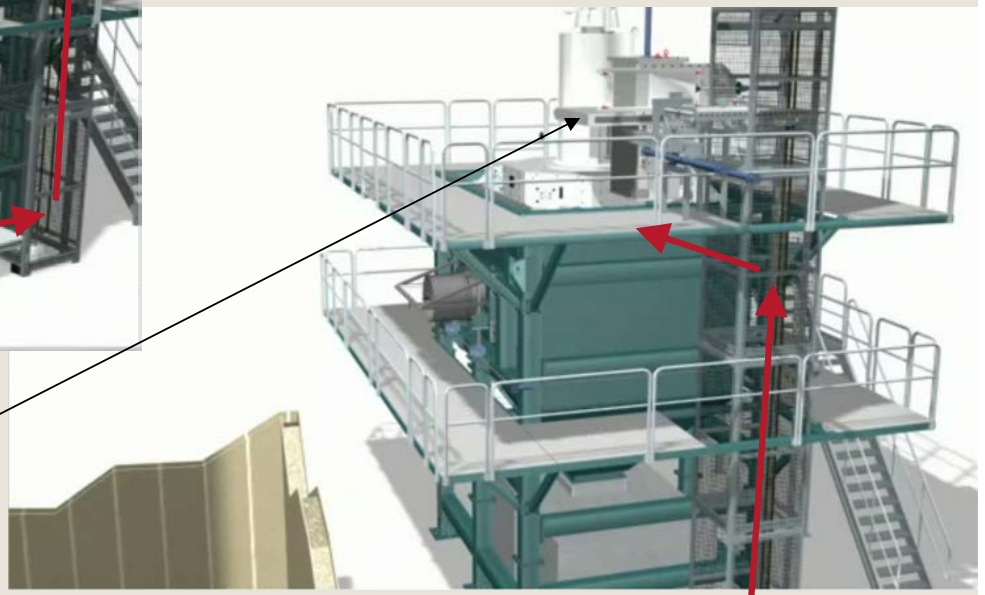
III. Technical approach for destruction of sea-dumped CW

The munitions in their containers are transported via a conveyor system to the feeding system

On top of the unit the munitions are fed into the SDC via a gastight, interlocked feed system



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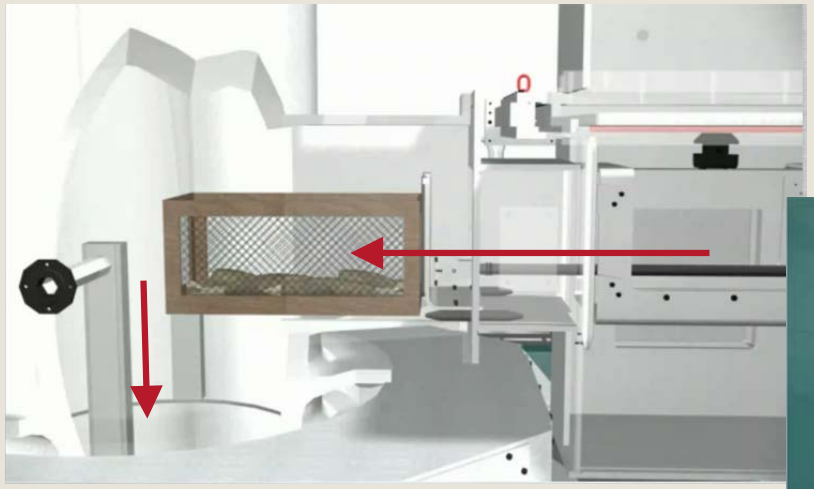
III. Technical approach for destruction of sea-dumped CW

In the next step the munitions (inside their container) fall into the hot SDC



Detonation resistant multilayer wall system

The complete destruction of explosives and agent takes place in the hot inner chamber

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Absolute Minimum munitions handling

- automated feed system
- interlocked
- fail safe

Most munitions need NO preparation

- NO cutting
- NO opening
- NO fuze removal
- NO removal of munitions from watertight containers
- NO Countercharging

Double walled main chamber

- 300% safety margin

Feed chambers designed to take full rated detonation

Interlocked feed chambers (2)

- System is never open to outside during operation

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The Dynasafe SDC series is proven technology for destruction of CW

- Installation of an SDC 2000 in Munster Germany has resulted in safe destruction of many types of CW
  - •Mustard
  - •DA
  - •DC
  - •Clarke I
  - •Clarke II
  - •Adamsite
- •Germany has now destroyed ALL agent under the CWC in less than one year using one SDC 2000 and is treaty compliant.
- •DRE of 99.99999998% demonstrated
- •Provides for destruction of agent, energetic, and decontaminates scrap to 5X in one step, without additional explosives and without handling of munition
- •Hold-test-release capable

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III. Technical approach for destruction of sea-dumped CW

Installations of SDC units worldwide

SDC 400 pilot scale, Bofors LIAB, Sweden, delivered 1997

SDC 1200, FEAX El Gordo, Spain, delivered 1997

SDC 800, FMV-Provplats, Sweden, delivered 1999

SDC 1200, NOF Hokkaido, Japan, delivered 2000

SDC 1200, IDD, Portugal, delivered 2001

SDC 1200, JIIA, Japan, CW munition demo plant, 2002

SDC 1200, Asia, UXB International, 2003

SDC 2000, Asia, UXB International, 2004

SDC 2000, Germany, GEKA Munster, 2005

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IV. Final – Pre-conditions for sea-dumped CW destruction

Destruction of sea-dumped chemical weapons requires:

- That the environmental and safety threat is great enough to justify a recovery and destruction effort
- advanced detection and identification of munitions as well as a good estimate of the total amount of munitions of concern
- thorough planning of recovery and destruction operation
- A safety plan for the whole recovery and destruction operation has to be developed and implemented
- Sufficient budget has to be allocated for the whole operation

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