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Advances in Arctic Oil-Spill Response Measures and Clean-up Techniques

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Anchorage Alaska

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Present day status

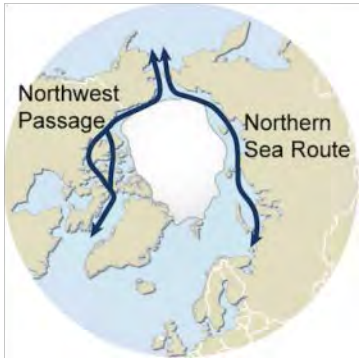
Unprecedented seasonal retreat of sea ice in the Arctic is occurring

This will drastically increase the amount of worldwide marine activity in the arctic

Including an increase in shipping of all types of vessels, oil and gas exploration, development and production activities

SO

This presents new considerations and challenges for arctic nations as the chances increase of oil being spilled in these regions of both persistent oils and non persistent oils



Behavior of spilled oil

Behavior of any oil spilled in arctic conditions is different than oil spilled in more temperate regions

The arctic conditions and especially the presence of ice create conditions that may be favorable or unfavorable for spilled oil recovery operations

Less Evaporation
Less Spreading
Increased Thickness
Reduced weathering and emulsion formation
Dampening of waves

Contingency Planning is Necessary

Know the plan . . .Work the plan

Safety of Responders

Marine safety hazards all responders may be exposed to in any location:

Noise, fire and explosions, ergonomic, crane operations, chemical and respiratory exposures, wildlife, aircraft operations

Additional concerns in the arctic regions may also include:
Cold stress (including hypothermia)
Small boat operations, which may involve ice and icing conditions
Increased risks of slips, trips and falls
…. even sunburn

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The Best Response

DISPERSANTS

BURNING

MECHANICAL RECOVERY

Applicability of Response Methods

	Open water	10%*	20%*	30%*	40%*	50%*	60%*	70%*	80%*	90%*	100%*
Mechanical Recovery	Vessel systems, oil ice separators, hand held /small skimmers, bucket skimmers, Sternmax										
In-situ Burning	Use of fireproof booms						In-situ burning in dense ice				
Dispersant Applicaiton	Aircraft, helicopter, boat spraying										

Improvements

There Have Been Many Improvements Over the Past Years for Spill Response in Arctic Waters

- In Situ Burning
- Mechanical recovery equipment
- Dispersant operations
- Herding Agents
- Predictions and Modeling
- Remote Monitoring/Sensing

Due to potential contingency planning, permitting and logistics requirements of some non mechanical response options, containment and mechanical recovery will continue to be a response option

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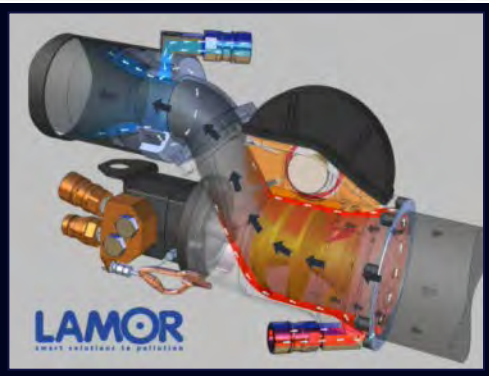
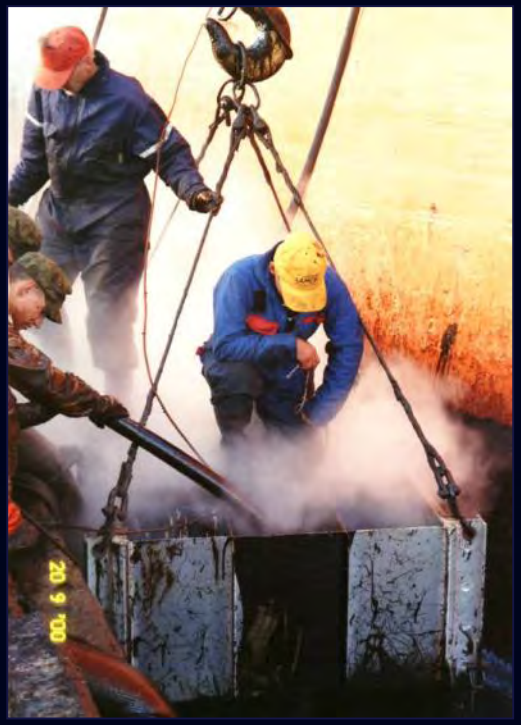
Equipment is ideally :

- Robust
- Simple
- Proven
- Fitted with cold temperature adaptations
- Able to avoid or process any ice that may be encountered

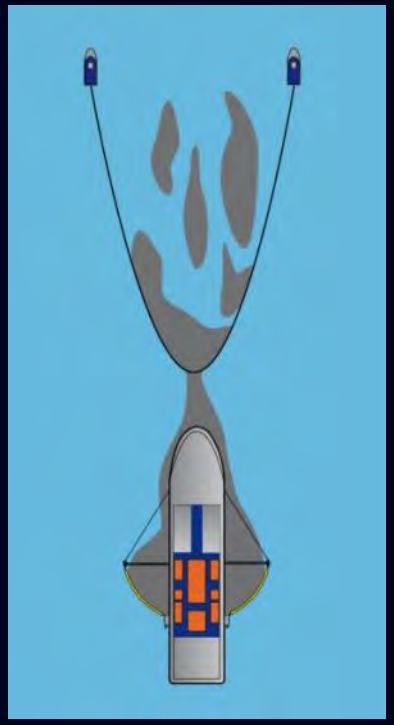
Arctic Enhancements

- Steam heated hoses
- Steam heated double plated skimmers
- Heated scrapers and cleaners
- Heated Skimmer oil collection hopper
- Heated storage tanks
- Hot water injection for oil transfer pump
- Engine pre heating
- Hydraulic oil pre heating

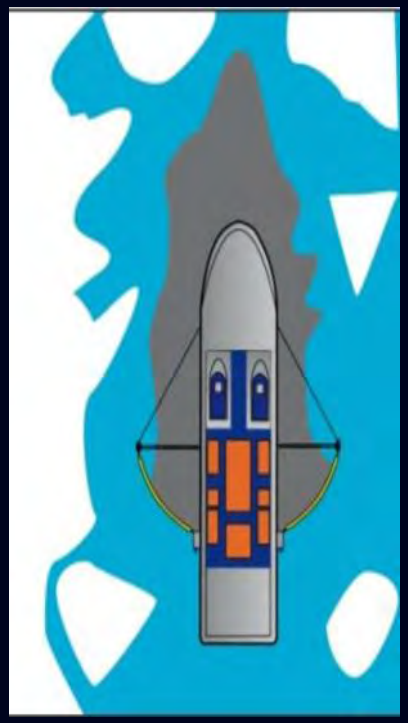




Mechanical and Non Mechanical Tactics



Open Water Deflection Booming



Reduced Deflection Boom In Ice Conditions

Pocket Oil Collection

Broken/Solid Ice Collection

Non Mechanical Response

- Dispersants
- Burning

Rope Mop

Oil and Ice Separator

Length	**mm**	**14 290**
Width	**mm**	**3 438**
Height	**mm**	**3 034**
Weight	**kg**	**27 000**
Hydraulic flow	**l/m**	**170**
Hydraulic pressure bar		**250**

Recovery Bucket

LRB	40	150	250
Length, mm	880	1800	2796
Width, mm	680	1500	2360
Height, mm	800	1200	1320
Weight, kg	75	900	1600
Certified capacity, m³/h	19*	115*	140*
Free water content	<5%	<5%	<5%
Hydraulic flow (skimmer only), l/min	20	30	30
Hydraulic pressure, bar	180	210	210
Power requirement, kW	10	15	15

Skimmer Tests in Drift Ice February – March 2013

- Recovery of oil in ice presents unique challenges
- Bureau of Safety and Environmental Enforcement (BSEE) sponsored testing of skimmers in current use
- Results used for potential improvements to the technology and assist in the development of recovery standards

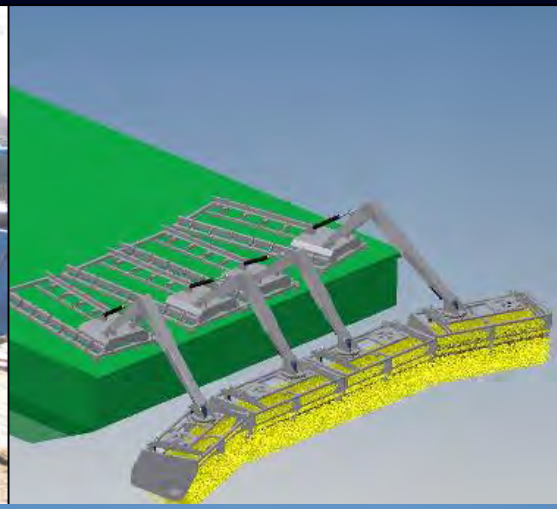
Skimmer Tests in Drift Ice
February – March 2013

Mechanical Recovery, Pocket Oil Collection

Mechanical Recovery: Reduced Deflection Boom and Pocket Recovery in Ice Conditions

Novel (Stern Brush) Oil collector

Novel oil brush collector for ice conditions installed on
the Finnish multipurpose response vessel
(developed by SYKE, Finland – Finish Environmental Institute)



Sternmax

Sternmax Features

- Innovative isolation grate is designed to block ice on one side and to allow ice to flow away freely on the inner side
- Tried and tested oleophilic stiff brush, tested to 95% efficiency
- Remote Control
- Ice dumping tilt feature allows the removal of ice from the recovery area
- System utilizing steam heating in the brush scraper, the pump, isolation grate and the oil transfer hoses
- Dual positive displacement Archimedes transfer pumps
- Vessel of Opportunity based system allows easy transportation and quick installation on numerous vessels

Sternmax Features

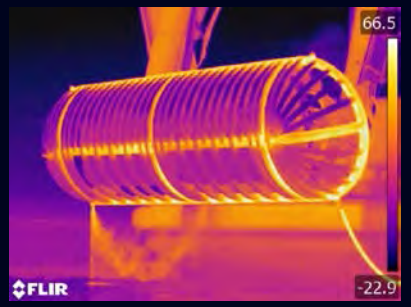
Features:

- Excellent ice handling capabilities
- A-frame mounted maneuverable system
- Ice & water/ oil separation
- Dual positive Archimedes pumps
- Hot water injection for heat & lubrication
- Steam heated isolation grate
- Hydraulically driven pivot hinges
- Tilt function for clearing isolation grate
- Removable isolation grate for non-Arctic use
- Remote control
- Single person operating system
- 28 stiff brush wheel system
- Durable and robust materials
- Heated brush scraper
- Does not inhibit regular vessel functions

“Winter” Features

Completely defrosted and operational within 15 minutes, a 200kW steam unit provides heat to all winterized features

- Heating hoses inside the oil transfer pipes
- Steam/hot water injection in transfer pumps
- A hollow isolation grate equipped with steam inlets
- Heated brush scraper
- Heated hopper
- Anti-freeze in pipes prior to storage



The full system can be transported by a truck from storage, and can be dismantled for storage

Installation within an hour, ready to operate

Placement on the stern allows normal vessel functions

IMOR Research & Testing

The Ice Management & Oil Recovery (IMOR) Project

Structured oil in ice recovery tests that systematically examined how a vessel mounted mechanical recovery skimmer works most effectively in varying ice conditions. Testing conducted from 2015 – 2017, $650k budget

The tests used rhodamine dye, orange markers and a variety of instruments to measure and identify the most effective ship position/movements, the best application of the vessel thrusters in varying ice coverage during OSR operations.

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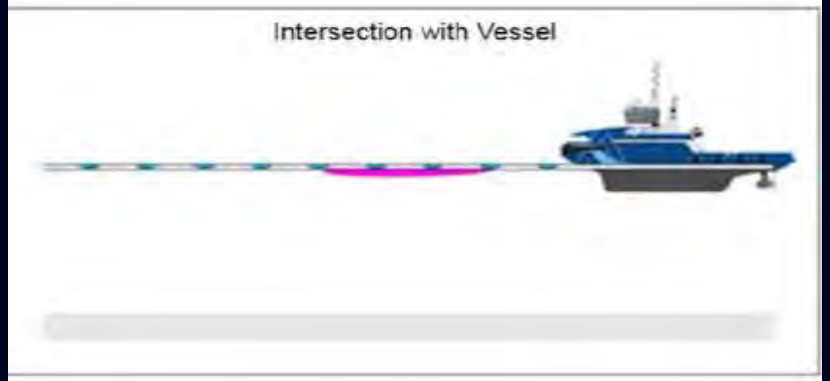
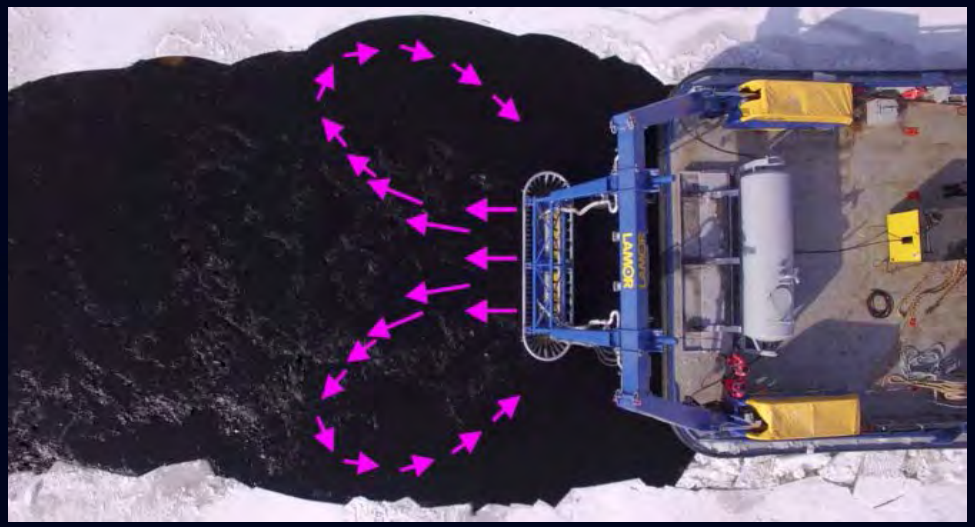
Dye Marker Placement


Intersection with Vessel


Contact with Vessel & Propulsion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Final Assessment

More efficient to not crush ice before oil recovery, but rather position the vessel on the ice downstream from the natural current

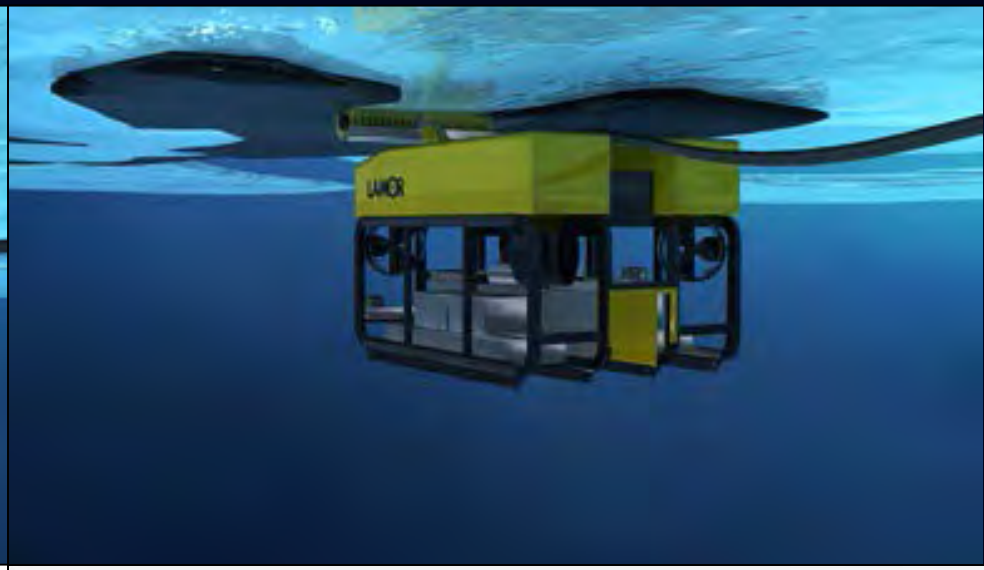
If necessary, a current should be induced by the vessel's propulsion system best is to positioned vessel bow facing the oil, the propulsion should be directed to the stern aligned to the keel of the vessel, and the propulsion should be run at roughly 10% - 20% power until an induced current carries the oil from under the ice to the recovery zone

An induced current can draw surrogate oil from at least 80 m in 20 min to the recovery area when the vessel is positioned in line with the natural current

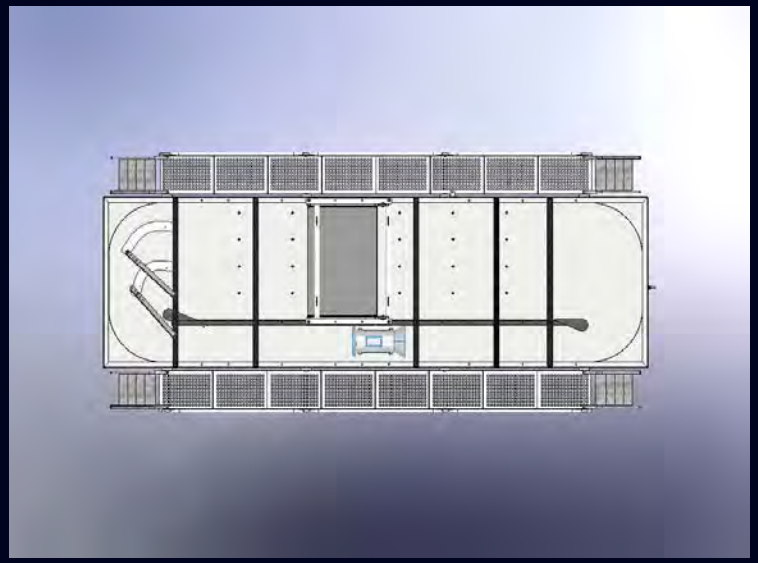
Ice handling capabilities such as with the Sternmax are essential to manage large pieces of ice to slush ice, allowing the skimmer unit to recover oil in the recovery area.

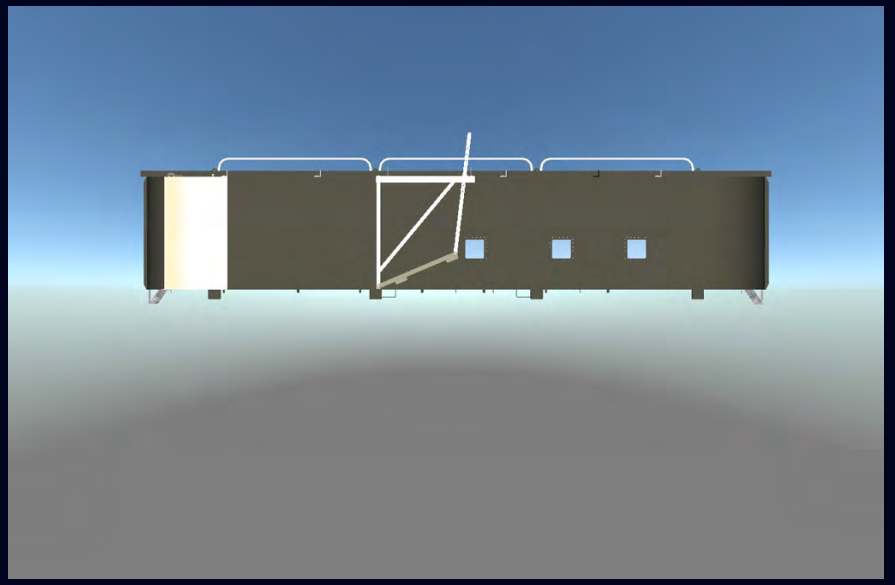
Arctic vessel solutions

Future Developments
Recovery of Oil under Ice



Current R & D Activities





Flow of oil under ice

Skimmer functions under ice

Collecting the oil under water without pumping

Collecting the oil under water with pumping

Current R & D Activities

Steel test tank, 10 x 3 x 3 m, approximately 30m3 of water (fresh water)

Hydraulic flow propeller to generate water flow

Ice thickness 130…150mm

Oil types: Dyed diesel and emulsified hydraulic

Case *M/V Godafoss*, Olso Fjord February 2011

SUMMARY

- 110 m^3 of the spilled IFO 380 was collected.
- 58 m^3 of was collected in open water recovery by the 3 Swedish Coast Guard vessels
- Keys to success:
  - Advancing system, independent vessel operation, excellent maneuverability
  - Skimmers able to collect the heavy oil and avoid ice
  - Heating arrangement from skimmer to tank
  - Skilled and well trained crew
- The brush skimmers worked very well in the demanding conditions.

KBV 050

KBV 001

KBV 051

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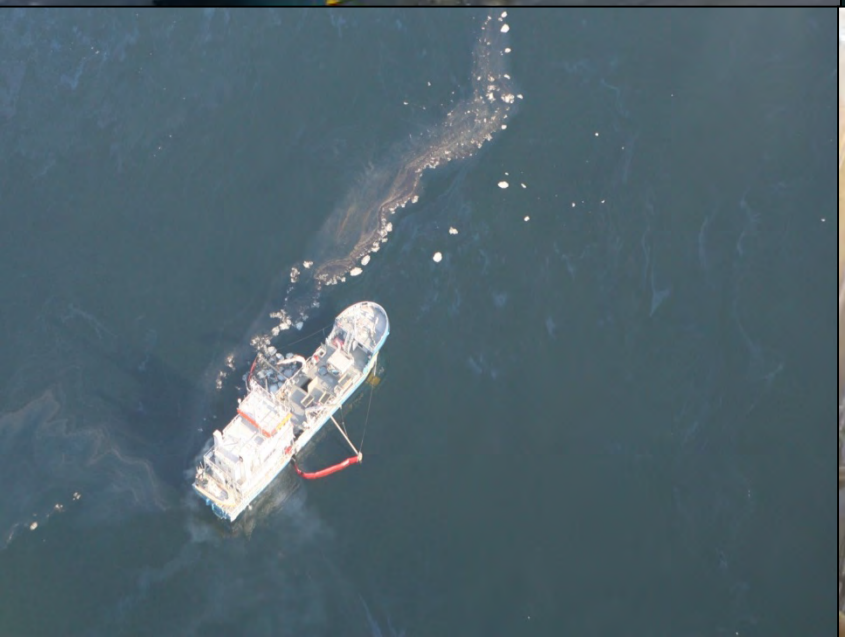
M/V Godafoss – Container Vessel
Heavy Fuel Oil – Arctic Conditions



Case Estonia, Tallinn March 2010
Airplane crash on frozen lake



Spillage: Jet Fuel and hydraulic oil spilled in fresh water lake, oil under ice recovery
Duration: Three weeks
Recovery: 1500 liters Jet Fuel and hydraulic oil collected



Case M/V *Runner 4*, Estonia, March 2006, Heavy & Light Fuel Oil Broken Ice Conditions

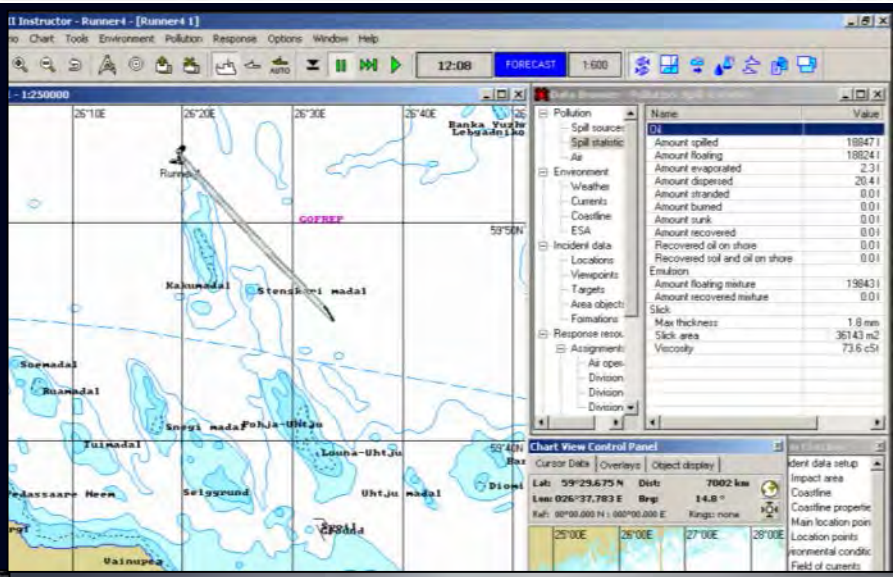
The ship Runner 4 sank after a collision with another ship, in a convoy following a Russian icebreaker

Vessels Involved in Recovery Operations

Estonian multipurpose vessel
- EVA-316

Finnish oil spill response vessels
- Hylje,
- Halli
- Seili.

Summary Est 18 000 liters oil spilled
15 000 liters oil collected



Response Strategies

How do you decide . . .

How do you decide . . .

- Contingency Planning
- Scenarios
- Drills
- Lessons Learned
- Real Events
- Continuous Improvement

Each Spill is Different

Each spill presents a different set of circumstances that must be considered as part of the response

Different circumstances
requires different response actions

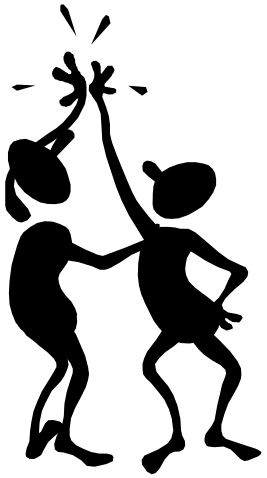
And Remember….

It is much easier to

prevent

spills than to respond
and clean them up

Teamwork



Questions ??

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