RECENT U.S. OIL SPILL RESPONSE

RESEARCH RESULTS

PRESENTATION OF

JOSEPH MULLIN

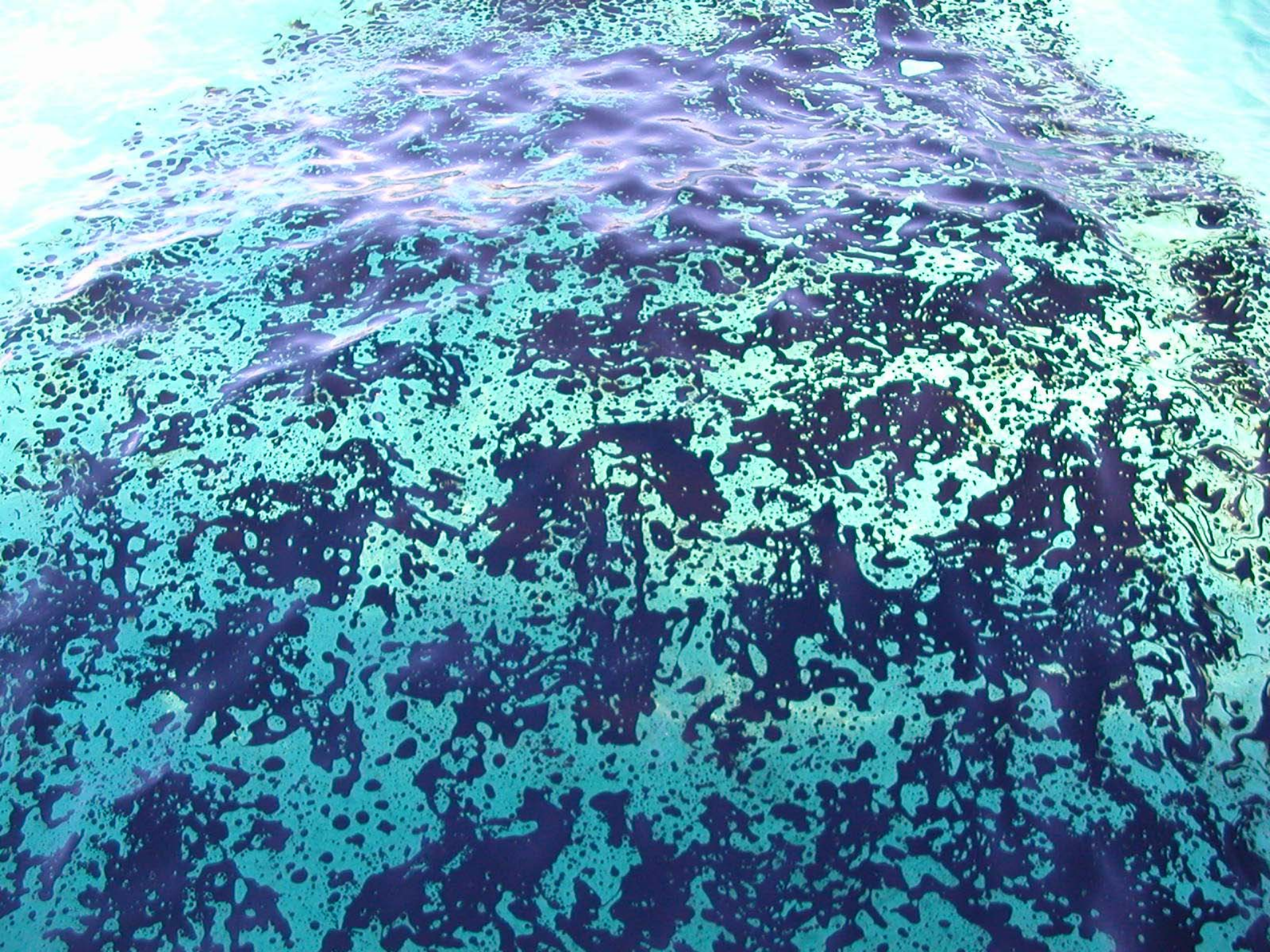
U.S. MINERALS MANAGEMENT SERVICE

Recent Results From Oil Spill Response Research

Joseph V. Mullin
Program Manager, Oil Spill Response Research
U.S. Minerals Management Service

Dispersant Effectiveness Research

MMS




U.S. COAST GUARD
U.S.
COAST
GUARD

In Situ Burning of Spilled Oil

Topics

- Research Burns
- Testing of Fire Resistant Boom
- In Situ Burning in Marsh Environments

MMS


12 14:43


ALBERT E. WATTS

In Situ Burning Research Results

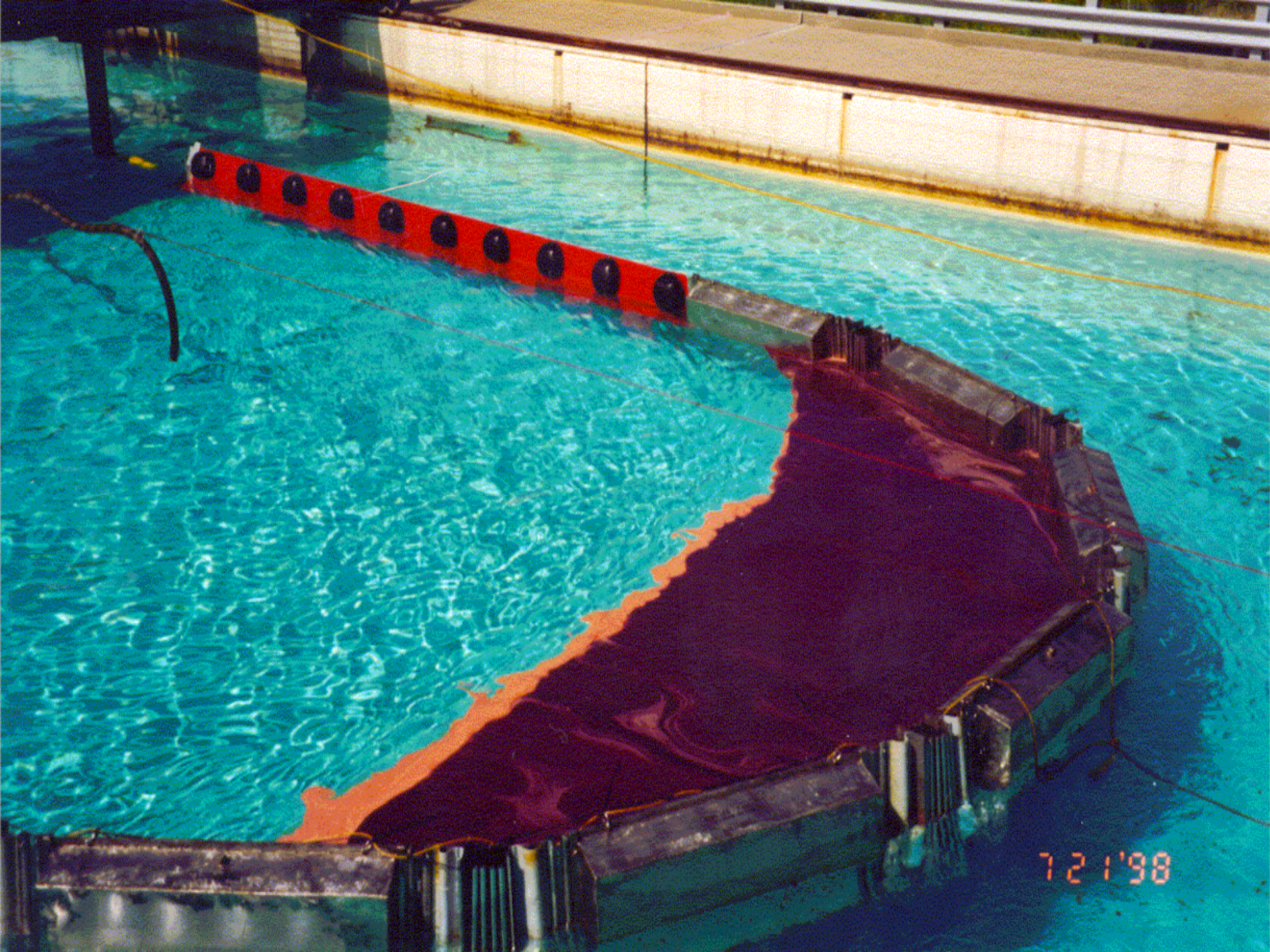
- Thickness is crucial.
- Efficiency depends on thickness
- Burning starts at 2-3mm.
- Burning rate is 3mm/min or 5,000 L per m^2 per day

MMS

In Situ Burning Research Results

- Winds less than 20 knots, Waves less than 1.2 m
- Water-in-oil emulsions detrimental
- Air emissions not a serious concern
- No aquatic toxicity

MMS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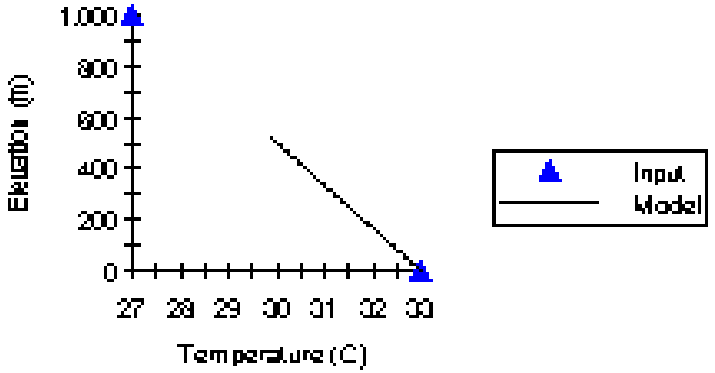
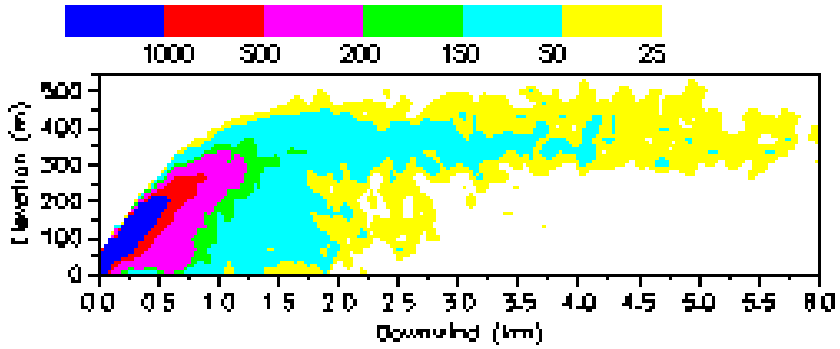
ALOFT-FT 3.04: D:\aloft\data\Test1.adf - Summary

Print | Contour Style | Contour Concentrations | Axis Ranges | Combustion Products

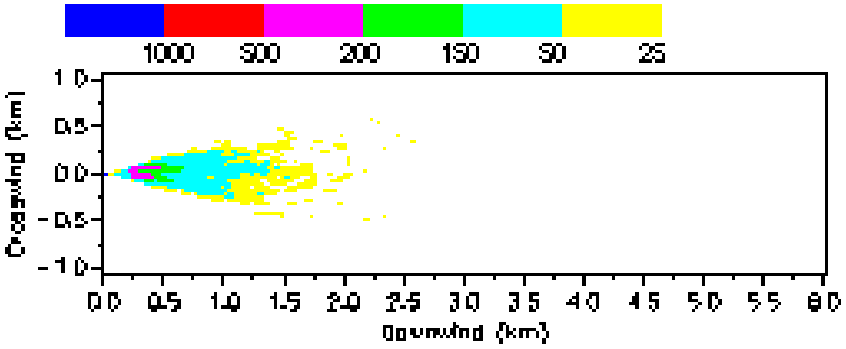
ALOFT-FT 3.04
test case 1
Alaska North Slope Crude
HRR - 1.750 (MW/m^2) BR - 0.05100(kg/s-m^2)
Wind - 5.0 (m/s) S Theta - 20.0 (deg) S Phi - 20.0 (deg)

Fire	Area (m^2)
1	33.0





Smoke Particulate PM10 Concentration (micrograms/cubic meter - one hr avg) Vertical Plane. 0 km Crosswind



Smoke Particulate PM10 Concentration (micrograms/cubic meter - one hr avg) Horizontal Plane. 0 m Elevation

Position

Downwind: 2.1551 km

Crosswind: 0 km

Vertical: 333.69 m

Product Concentration

one hour average

Smoke Particulate PM10: 60.5729

micrograms/cubic meter

In Situ Burning of Oil Spills
2 CD – Set

- Comprehensive collection of scientific information on in situ burning as a response tool.

- Contains 350 technical documents and one hour of video

- All operational aspects of burning are covered in detail.

- Human health, safety and potential environmental impacts are addressed

- MMS distributes this 2-CD set without charge

PRESENTATION ON

CURRENT TESTING, TRAINING AND RESEARCH

AT THE

OIL AND HAZARDOUS MATERIALS

SIMULATED ENVIRONMENTAL TEST TANK (OHMSETT)

JAMES LANE

U.S. MINERALS MANAGEMENT SERVICE

Ohmsett

The National Oil Spill Response Test Facility

James Lane

APEC Workshop

Oil Spill Response & Planning

Singapore

March 25, 2004


NEW YORK
NEW JERSEY
New York City
Newark
LaGuardia
JFK
Ohmsett

Ohmsett:

The National Oil Spill Response Test Facility

Tank dimensions

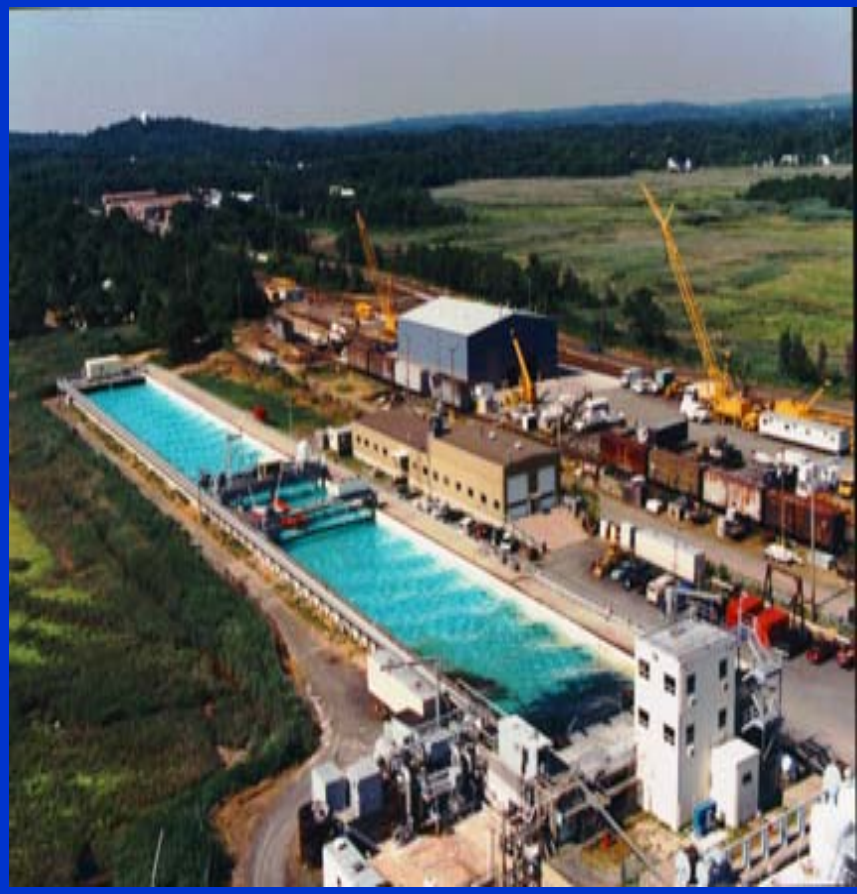
- 203 meters long
- about 20 meters wide
- about 2.4 meters deep

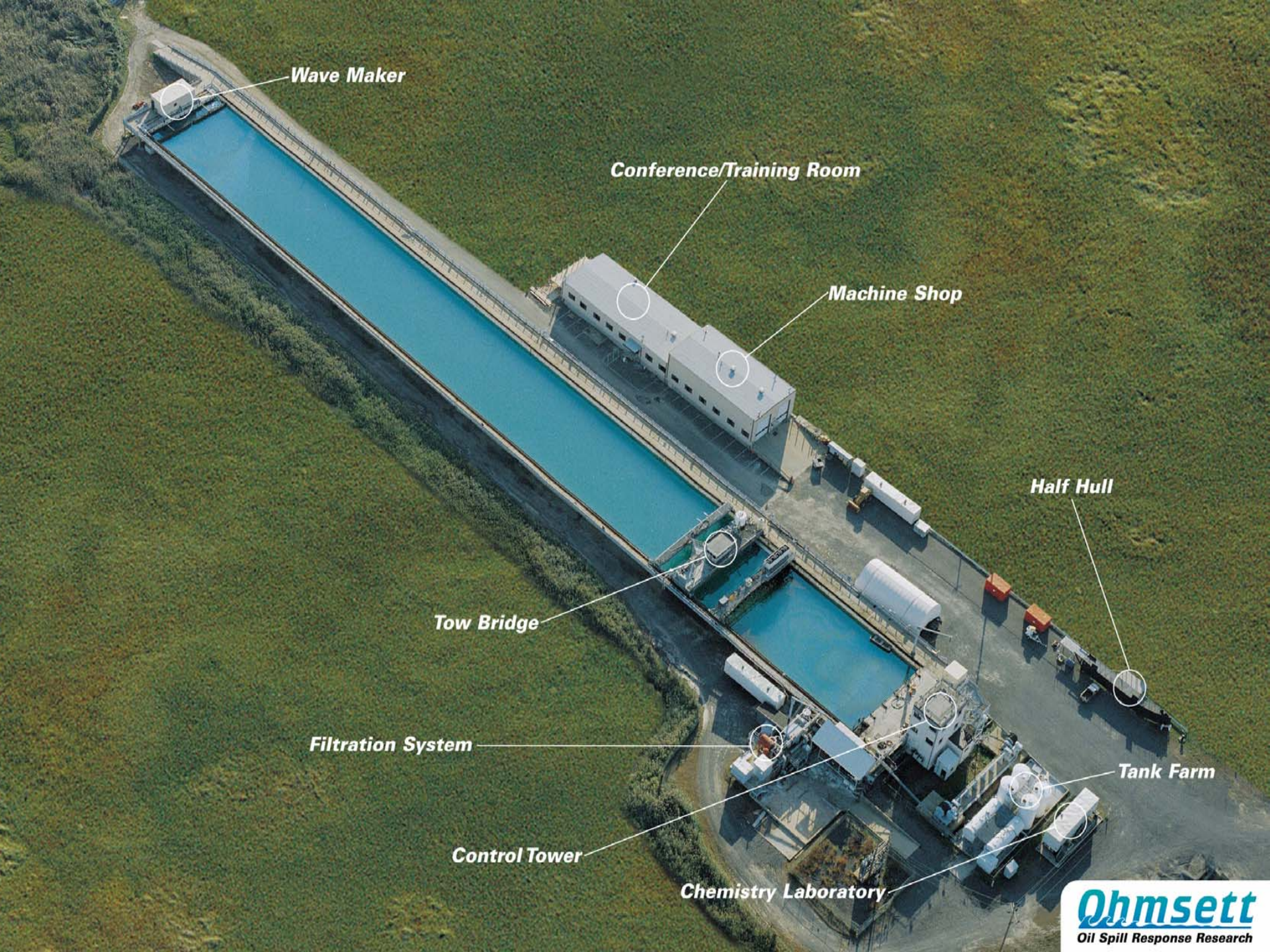
Holds 9.8 million liters of water

Tow bridge capable of speeds up to 6.5 knots

Wave generator produces 3 wave types up to a meter high

Test full sized equipment and train with oil - up to 5,700 liters per run





Ohmsett
Oil Spill Response Research

Ohmsett History

- EPA built and operated from 1974 – 1989
- Returned to U.S. Navy in 1989
- Exxon Valdez spill occurred March 1989
- Passage as OPA of 1990
- MMS assigned management responsibility
- Renovation and Re-Opening in 1992

Background

- Ohmsett is the technology demonstration test bed for the TAR Oil Spill Response Research Program (OSRR).

- Funds to conduct MMS's OSRR Program and to operate Ohmsett are appropriated from the Oil Spill Liability Trust Fund, i.e. potential polluters pay to fund research and Ohmsett (5 cent/bbl tax).

- Supports MMS objective of protecting marine environment by:
  - improving oil spill response technology and equipment
  - increasing responder effectiveness through realistic training

- Supports MMS approval process for oil spill contingency plans by providing independent testing and evaluation data on equipment.

Ohmsett

Oil Spill Response Research

Types of Testing

- Containment Boom
- Skimmers
- Sorbents
- Research & Development
- Emulsions and other oil properties
- Viscous Oil Pumping
- In-situ Burning
- MORICE
- Dispersant Testing
- Remote Sensing


35
NOFI Current Buster 600
22 9:26AM


24 10:46AM

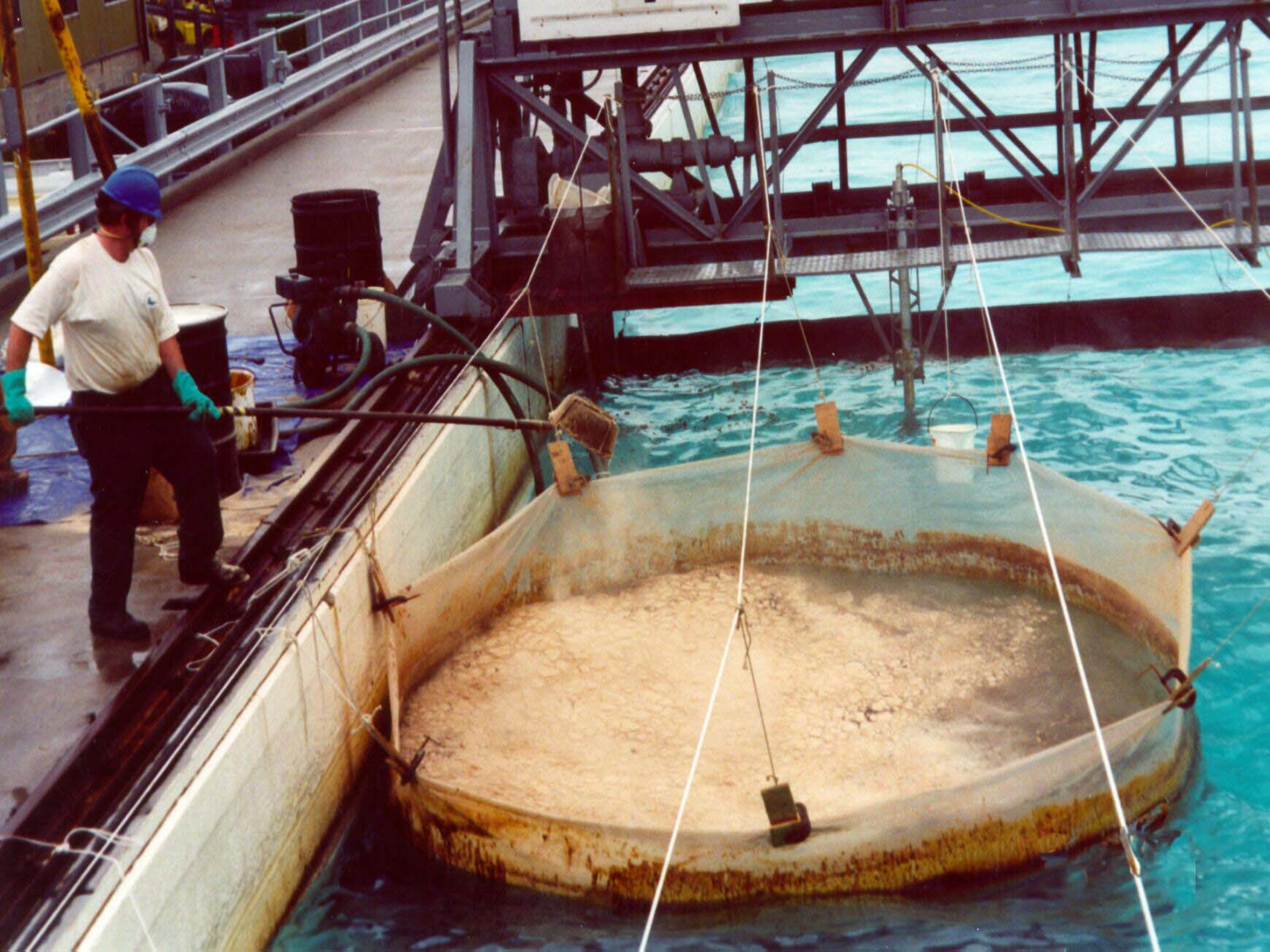

1 2 3 4 5 6 7 8
9
USN 01
NAVY
SUPSALV
14 9:32AM

Improvements in Mechanical Containment & Recovery

- Increase in tow speeds for oil spill containment booms
- High speed skimming systems (>3 knots)

- About 90% of independent test data on oil containment booms and skimmers was collected at Ohmsett
- First article testing of mechanical equipment

MMS

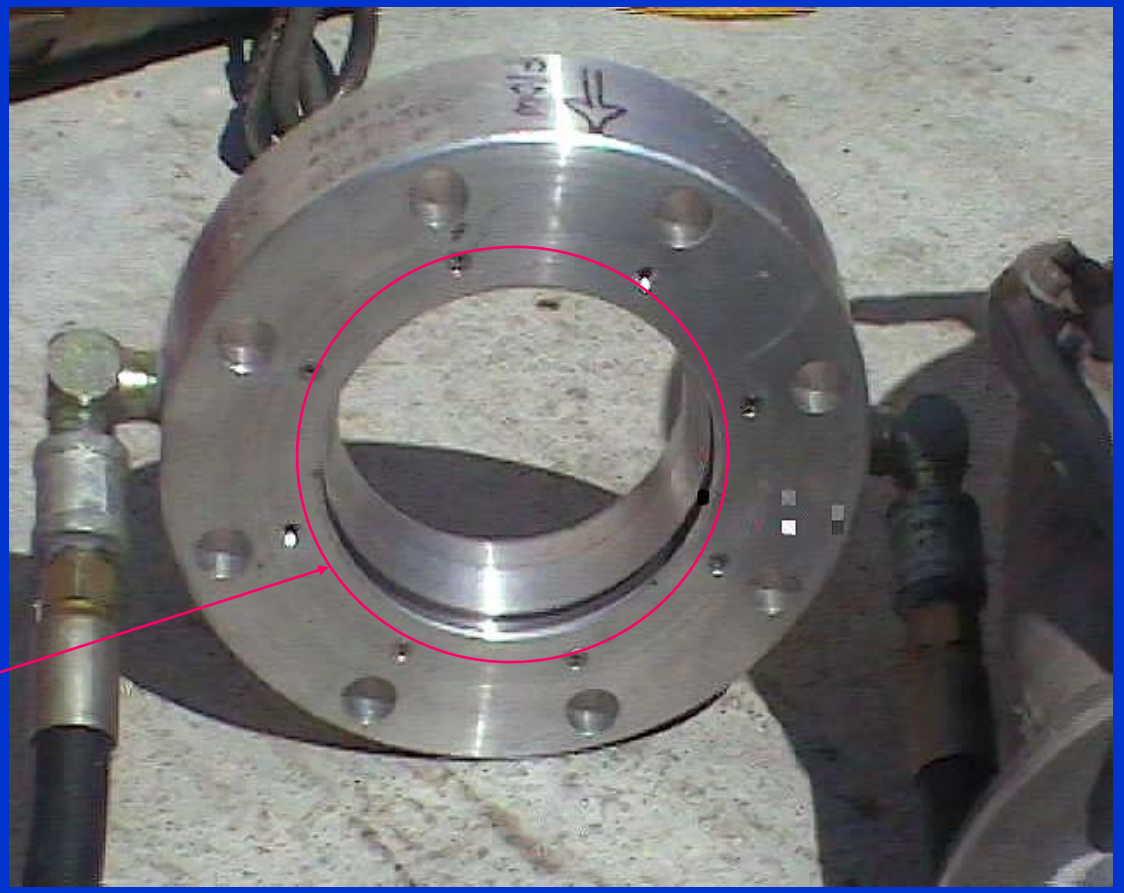


Oil Emulsification Study

Viscous Oil Pumping System Tests

VOPS Components

Water Injection Flange



Removable Ring for easy Cleaning


3M
6%
AFFF

Fire Boom Testing with Propane

In-situ Burns

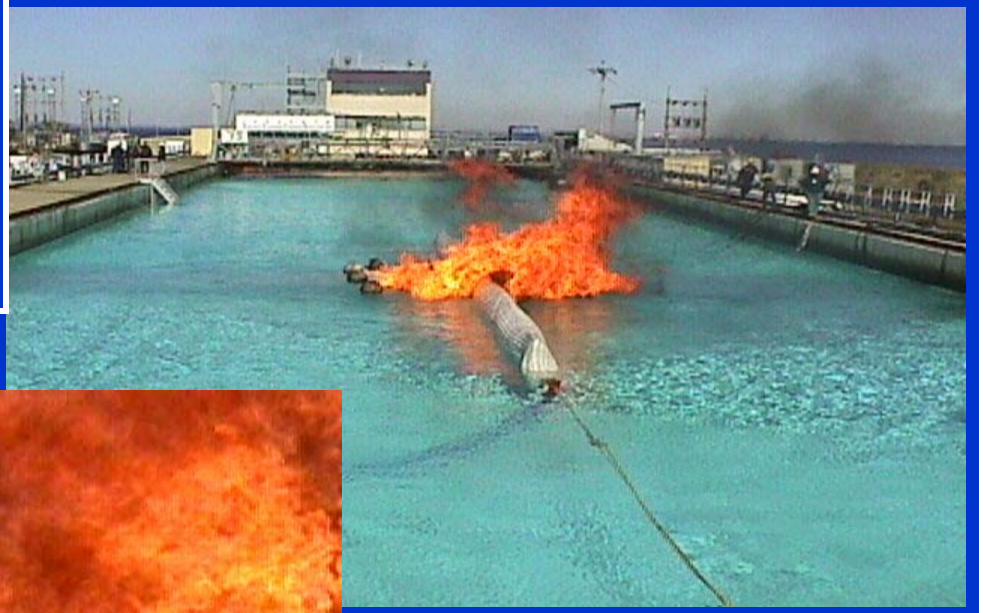
- ✔ Near full scale screening tests for the ***effectiveness*** & ***durability*** of fire resistant oil containment booms
- ✔ Ability of boom exposed to fire to ***contain thick, hot oil*** & ***survive extended exposure to wave action***
- ✔ Propane flames produce a ***total heat flux*** to the surface in the range of ***110-130 kW/m^2*** and ***flame temperatures near*** **900 C°**
- ✔ Underwater bubbler has a propane ***flow rate of 1500 kg/hr*** over a ***water surface area of ~10m2***, yielding a ***heat release rate of 2 MW/m^2***
- ✔ Compressed ***air injected*** near the base of the flame ***at a rate of 2900 kg/hr*** to enhance the combustion process and increase total heat fluxes and flame temperatures

PROPANE BUBBLER SYSTEM

FLOATATION DEVICES

TEST SETUP

Propane Supply Tankers



Test of Oil Stop Blanket

MORICE Testing Program
January 14-25 2002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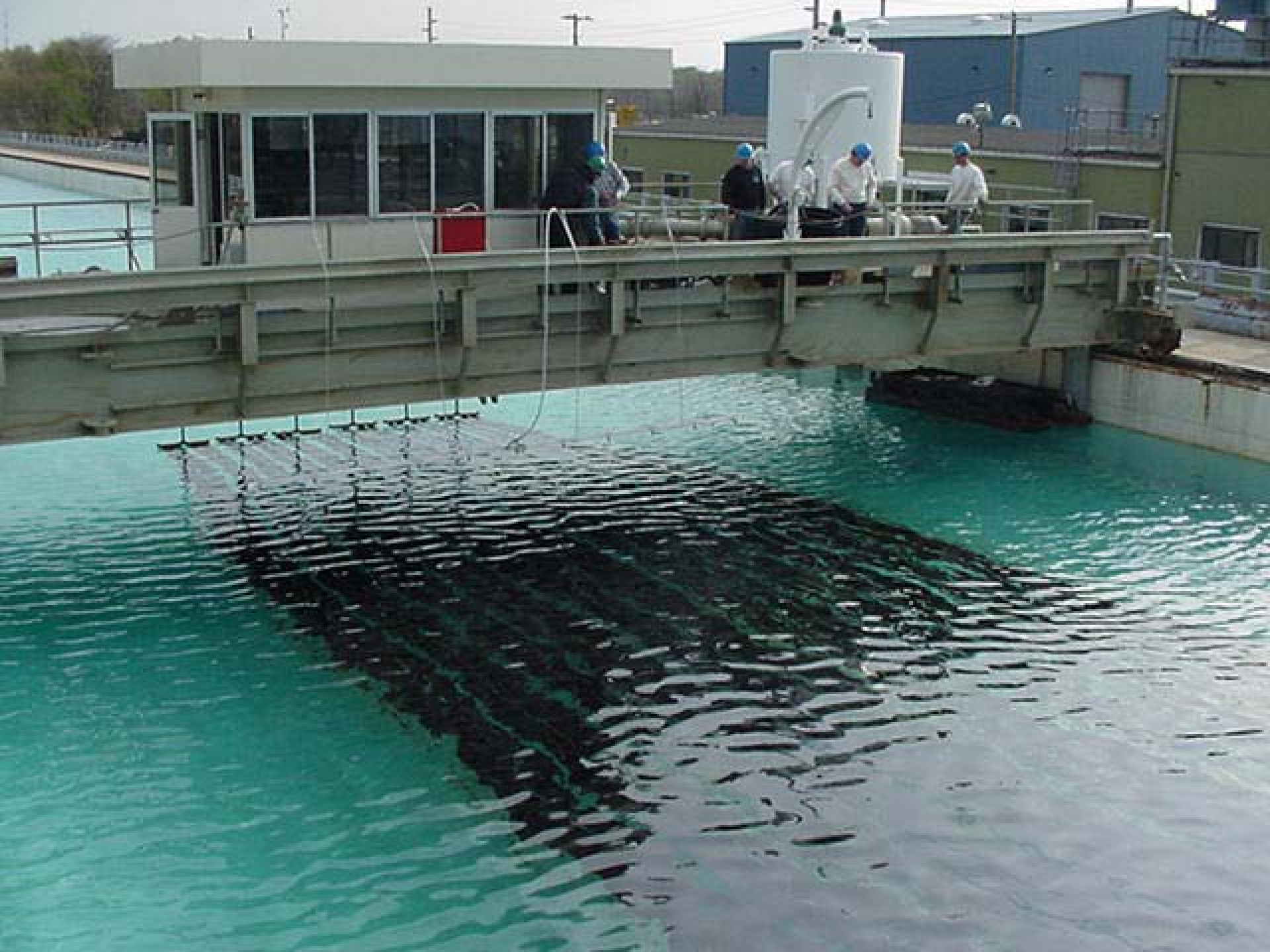
Oil has been added along the entire length of the ice field prior to test initiation.

Dispersant Testing



Oil Evaporation Setup

Evaporated or “weathered” oil generated by bubbling air through heated drums of oil

Weight of oil was monitored during air sparging using a weight scale and a drum lift

Elastic-American Marine
Neat Sweep Test

Training at Ohmsett

Benefits of Training at ***Ohmsett***

- Emphasis on practical hands-on use of response equipment with oil and waves.

- Students review their performance
  - Through video recording of each training session
  - Using oil recovery effectiveness measurements

- *Typically students improve their oil recovery effectiveness by <u>80%</u>*

- Cost is $995 dollars US per student for a 5-day introductory, management oriented class. Advanced class emphasizing hands on exercises in tank and a visit to a local spill cooperative is $1,300 US.

- USCG and BP Alaska training site of choice.

WWW.OHMSETT.COM

CURRENT STATE OF THE ART IN OIL SPILL RESPONSE TECHNOLOGY AND RECENT RESEARCH RESULTS - ALTERNATIVE RESPONSE MEASURES IN THE PACIFIC REGION

PRESENTATION OF

HO YEW WENG

EAST ASIA RESPONSE LIMITED (EARL)

SINGAPORE

Ho Yew Weng
Operations Manager

OSRL EARL Alliance

State of the art of technical response to oil spills

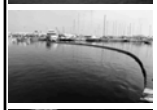
- Good news
  - the problems are not changing
- Bad news
  - neither are the strategic solutions
- But technical developments are taking place

Response Strategies

Monitor and evaluate

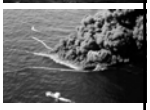
Dispersants

Containment and Recovery



Shoreline Protection

In-situ Burning

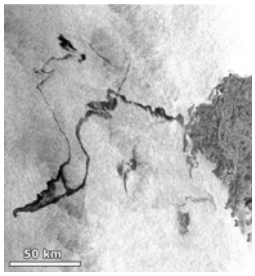


Shoreline Clean-up

Surveillance and monitoring

- Still most important facet of response
- Equipment
  - Satellite imagery
    - deterrent
    - weather
    - real time ability
    - interpretation
  - SLAR
    - search system
  - IR/ UV
    - tactical response tool
  - Mk 1 eyeball
    - training

Satellite imagery



- Ideal deterrent
  - prosecution difficult
  - identifying source
- Footprint/ frequency of passes
- Time to receive image
- Impact of weather
- Interpretation

Dispersant systems

- Large Aircraft
  - Nimbus
- Small aircraft
  - Cessna 406
  - Bandeirante

Nimbus

- Modular spray system
  - 12 ton capacity
  - Rapid mobilisation
  - Simplified operation

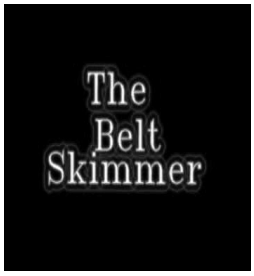
Small aircraft system #1

- Cessna 406
- 1.2 ton payload
  - based in UK North Sea
- 200 knots

Small aircraft system # 2

- Embraer Bandeirante EMB 100 P2
- 2 ton payload
  - based in West Africa
- 200 knots

Containment and recovery



- Heavy oil recovery
  - major problem
- Systems under development to deal with material
- Mechanical in operation
- Pumping of material is a major issue

Pumping of materials

- Conducted by USCG/ MMS
- 1,000,000 Cst oil
- Range of pumps tested
- Water injection
- Steam injection

Waste management

- Still major hurdle
  - Storage
  - Segregation
  - transfer
  - treatment
  - disposal
- Limits recovery operations
- High costs

Conclusions

- Technology can solve technical problems
- Developments are being made
- Equipment is being developed to deal with specific problems

BUT……..

Conclusions

Prevention **Management**

Training **Technology alone is not enough** **Planning**

Communication **Exercising**

Co-operation

Thank you

CURRENT STATE OF THE ART IN OIL SPILL RESPONSE TECHNOLOGY AND RECENT RESEARCH RESULTS - ALTERNATIVE RESPONSE MEASURES IN THE UNITED STATES OFFSHORE

PRESENTATION OF

DOUGLAS O'DONOVAN

MARINE SPILL RESPONSE CORPORATION

UNITED STATES OF AMERICA

ASIA-PACIFIC ECONOMIC COOPERATION (APEC)

WORKSHOP ON OIL SPILL RESPONSE AND PLANNING

Singapore

March 25, 2004

Presentation

"*Current State of the Art in Oil Spill Response Technology and Recent Research Results - Alternative Response Measures in the United States Offshore*"

Douglas C. O'Donovan
Marine Spill Response Corporation
Technical Services Manager

United States Spill Response Philosophy

- Based on Oil Pollution Act 1990
- The private sector is responsible for response and clean-up
- National Planning and response system
  - A response plan shall identify, and **ensure by contract or other means approved by the President the availability of private personnel and equipment** necessary to remove to the maximum extent practicable a worst case discharge and to mitigate or prevent a substantial threat of such a discharge.
- In some parts of the world, Governments are the lead response and clean-up agency.

U.S Spill Response Options

Containment &
Recovery

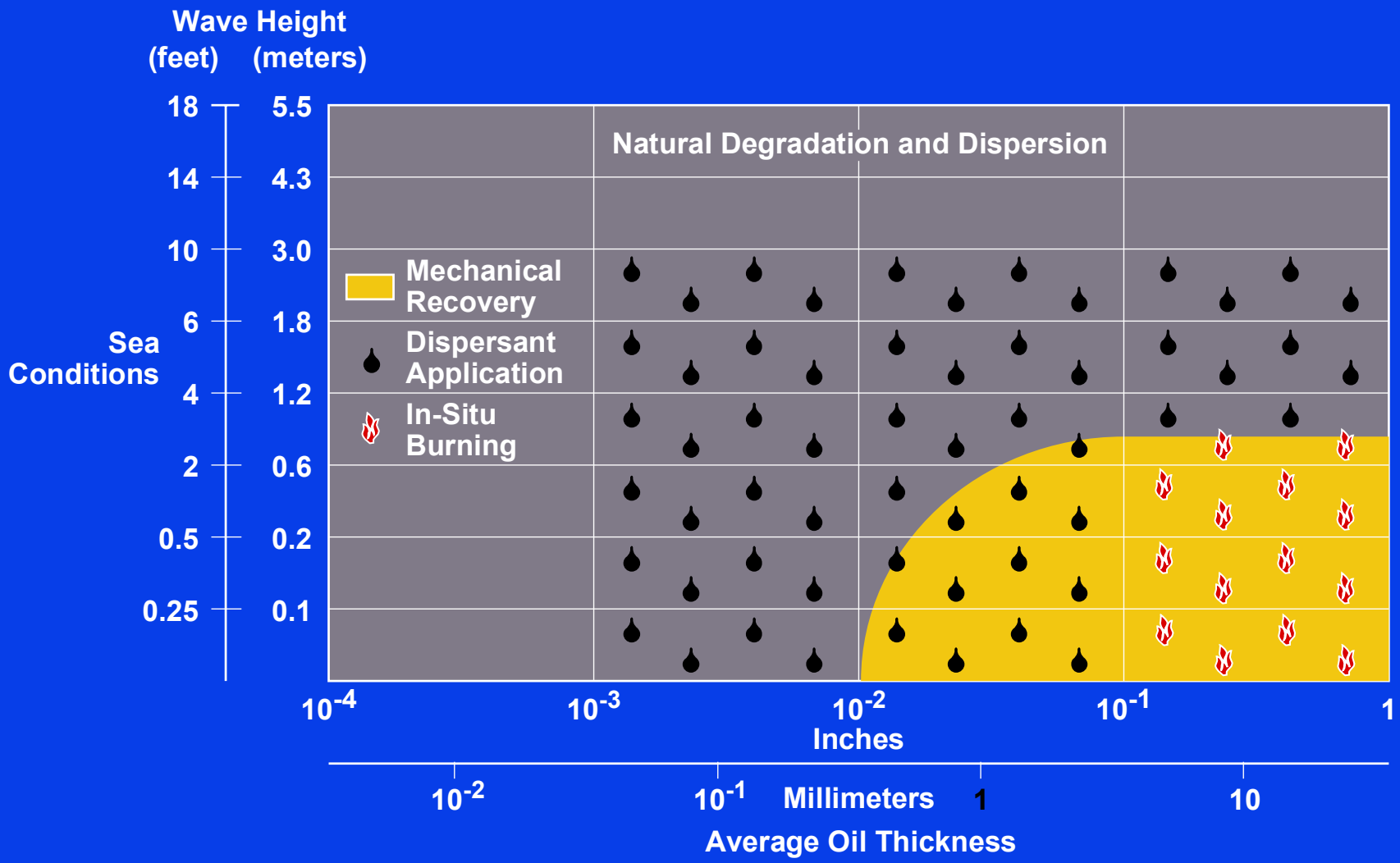
Dispersants

In-Situ Burning

Shoreline protection

Shoreline Clean-up

Windows of Opportunity



Courtesy of A. Alen

Shoreline Impact - What you Hope to Minimize!

Shoreline Clean-Up - A Major Effort

Shoreline Water-washing

Note the Wearing of Proper Personal Protection Equipment (PPE)

Things to Remember

- Various response tools are available
- Tools may be used in combination during a spill
- Each tool presents a variety of challenges

CHALLENGES TO OIL SPILL RESPONSE

- Weather
  - Recovery Difficult In Rough Seas or High Winds
  - Unsafe In Very High Seas
- Thousands of Different Crude Oils
  - Wide Range of Properties
- Crude Properties Constantly Changing
  - Weathering Effect
- Remote Locations
  - No Immediate Logistical Support
- Wide Range of Impacted Habitats
  - Rocky Beaches to Sensitive Marshes
- Very Little Daylight During Winter

MECHANICAL CONTAINMENT & RECOVERY

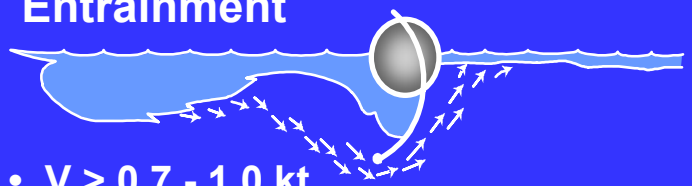
- Three Primary Components
  - Containment Boom
  - Skimming/Recovery
  - Temporary Storage

Considerations for Booming and Boom Selection

- Operating Constraints
  - Wave height and wave steepness
  - Current or towing speed
  - Surface current strength
  - Winds
  - Visibility and darkness
  - Water depth (inshore)

Boom Limitations

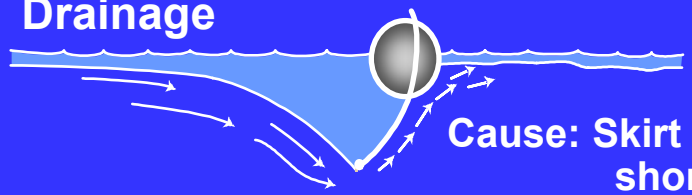
1. Entrainment



- V > 0.7 - 1.0 kt

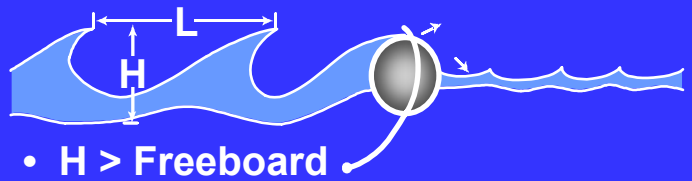
Cause: Current too fast

2. Drainage



Cause: Skirt too short for oil amount

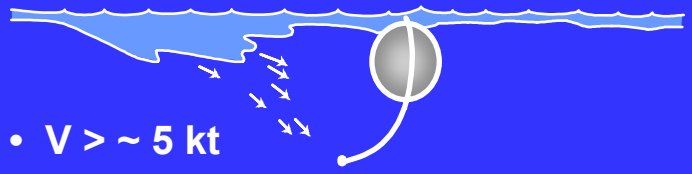
3. Splashover



- H > Freeboard
- H/L > ~1/10

Cause: Waves too high

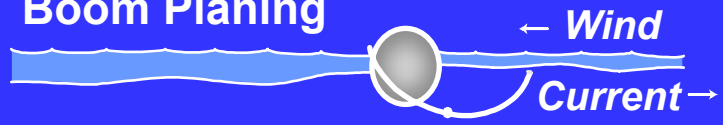
4. Boom Submergence



- V > ~ 5 kt

Cause: Currents too high

5. Boom Planing

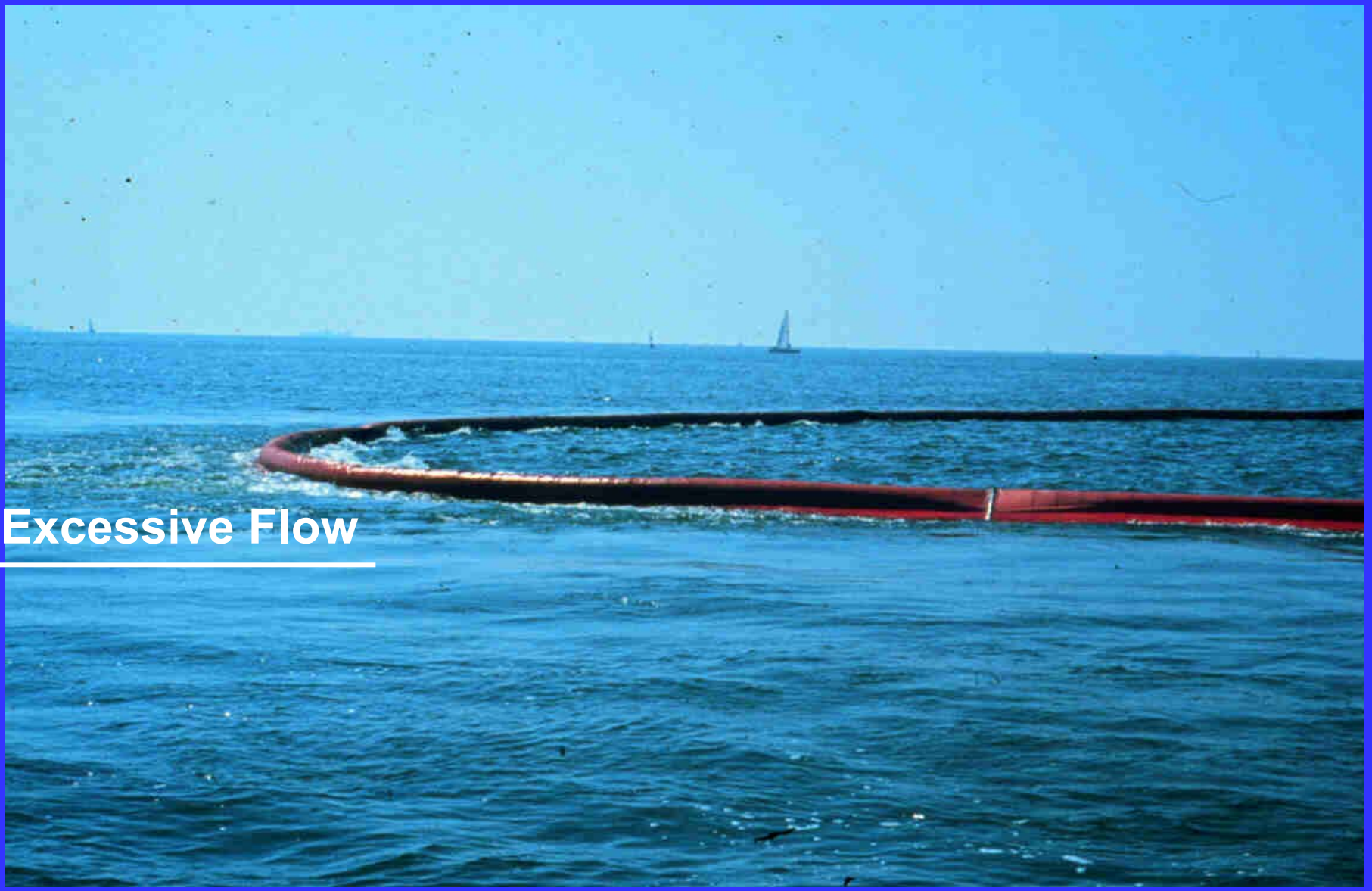


Cause: High wind and current velocity

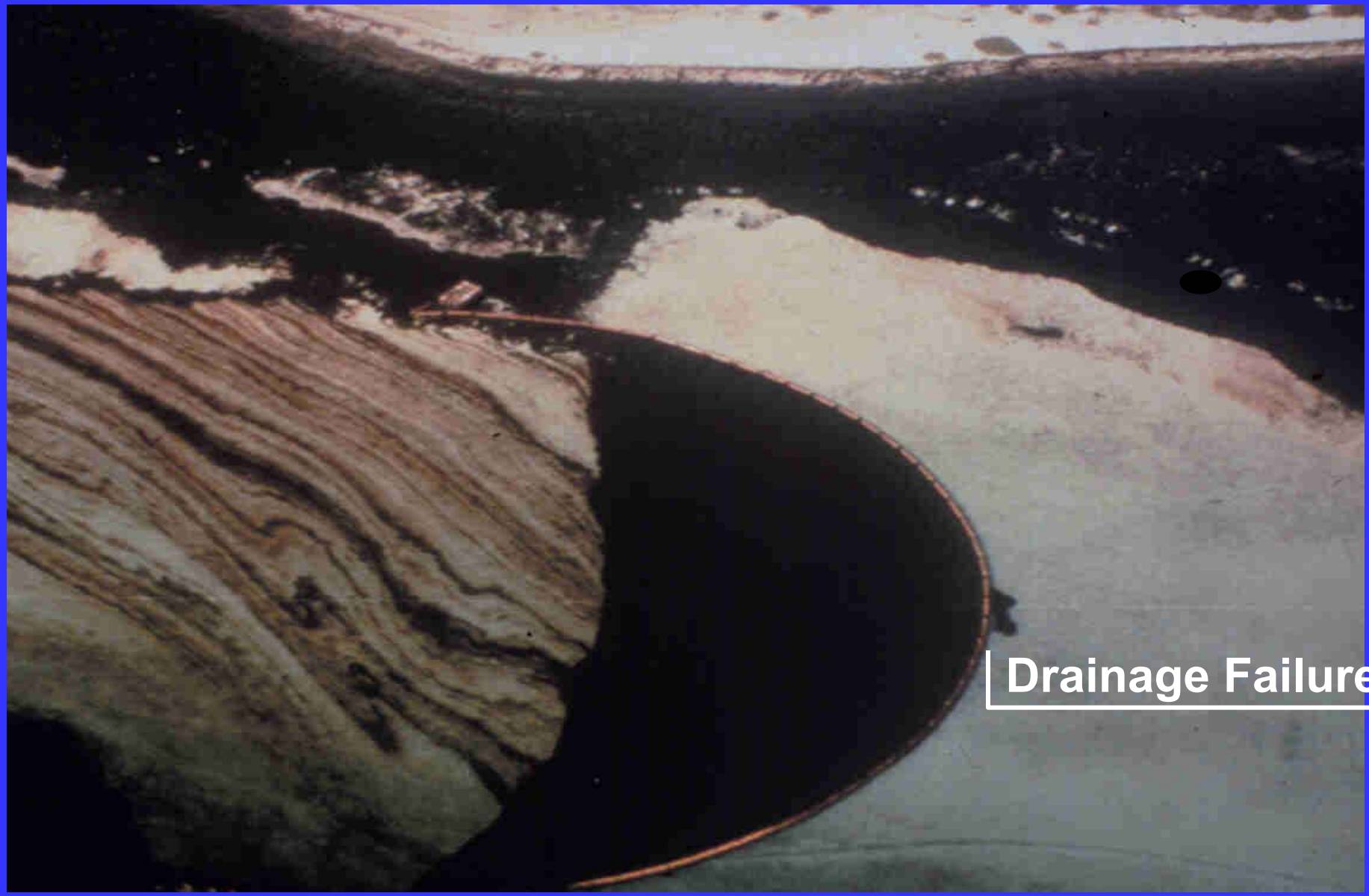
Wind and current direction opposed

Tension line near waterline

Oil Loss due to Excessive Flow

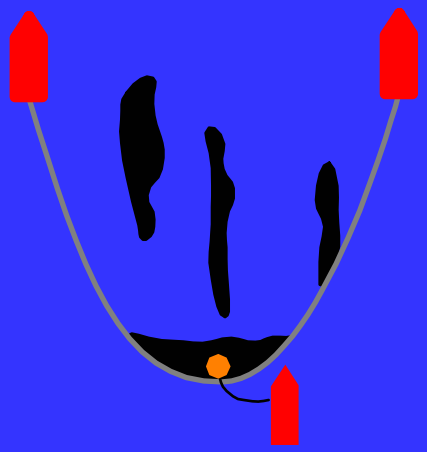


Oil Loss due to Drainage Failure

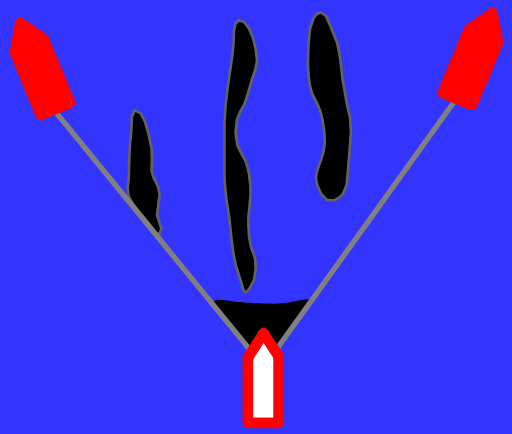


Containment at Source - Reduces Spreading of Oil

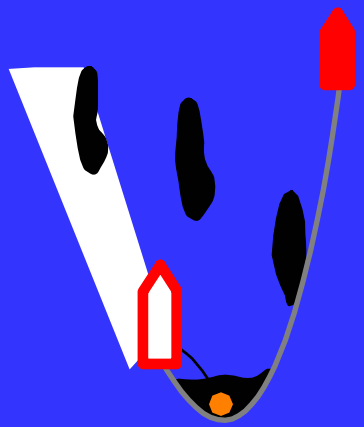
Ocean Booming Techniques



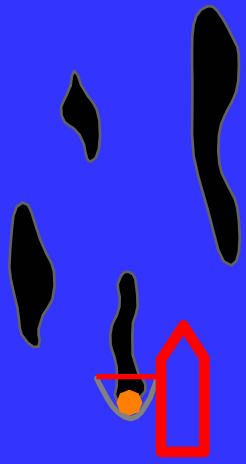
U configuration



V configuration



J configuration



Single ship system

Skimming/Recovery

Skimming Vessels

- Skimming vessels
  - Oil Spill Recovery Vessels – larger vessels designed for on-water /open ocean recovery
  - Shallow Water Barges – smaller vessels designed for in-shore and near-shore recovery
  - Vessel of Opportunity Skimming Systems (VOSS) – vessels modified to carry a skimmer and some temporary storage to the response scene

Oil Spill Response Vessel (OSRV)

Design Characteristics

- Transrec skimmer
- Oil-water separators for continuous operations (15 ppm)
- Dedicated full-time navigation crew of six, berthing for 38

Inflating Containment Boom

Transrec - 350 Open Ocean Skimmer Ready for Deployment

Skimmer in Apex of J-Boom Configuration

Skimming Limitations

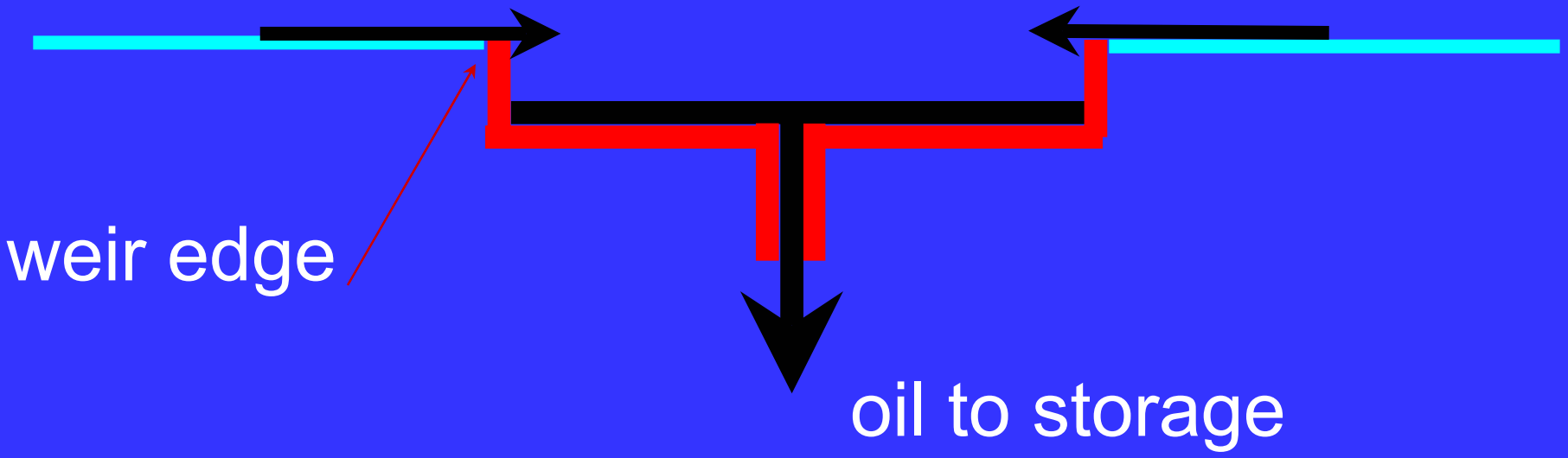
- Depending on the equipment used, mechanical containment and recovery become hampered when:
  - current exceeds 0.75-1 knot,
  - the wind is stronger than 20-25 knots,
  - and/or wind-induced waves are higher than 4 to 6 ft.

- Some skimmers and transfer pumps are not designed to handle viscous oils or products; different skimmers are often needed for oils with different viscosity.

Main Skimmer Types

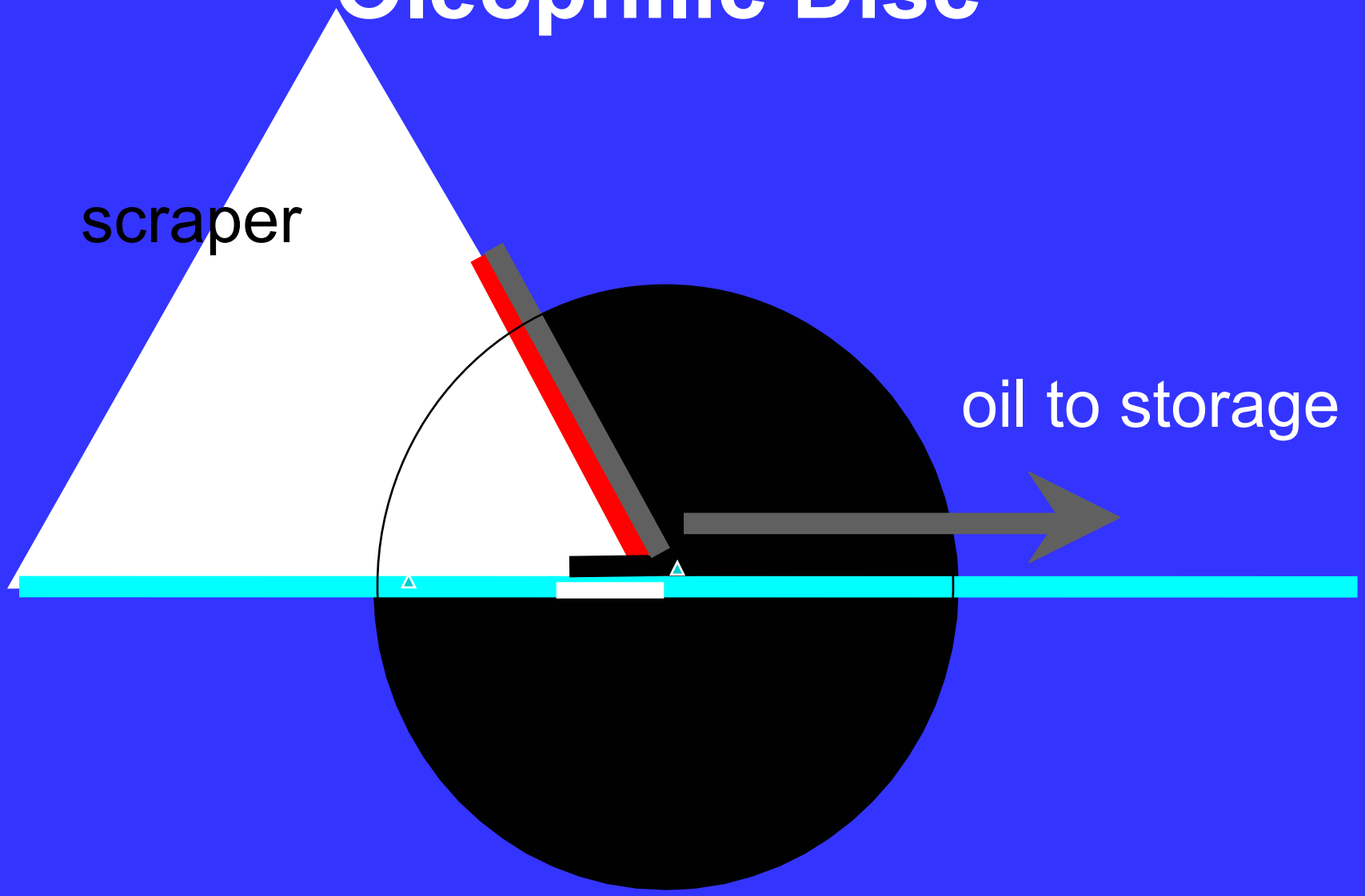
- Weir
- Oleophilic
- Vacuum
- Mechanical

Weir

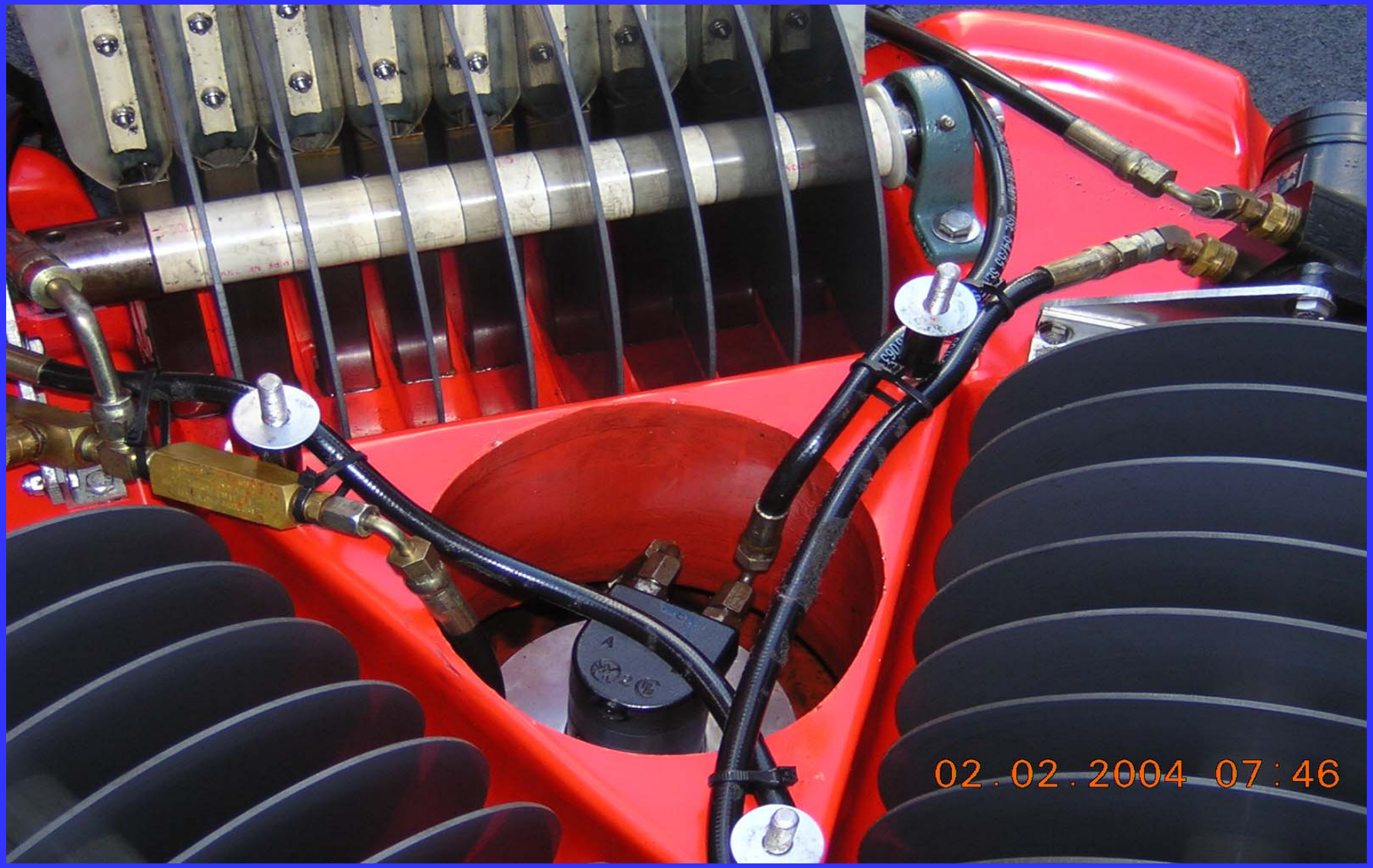


Desmi 250 Weir Skimmer

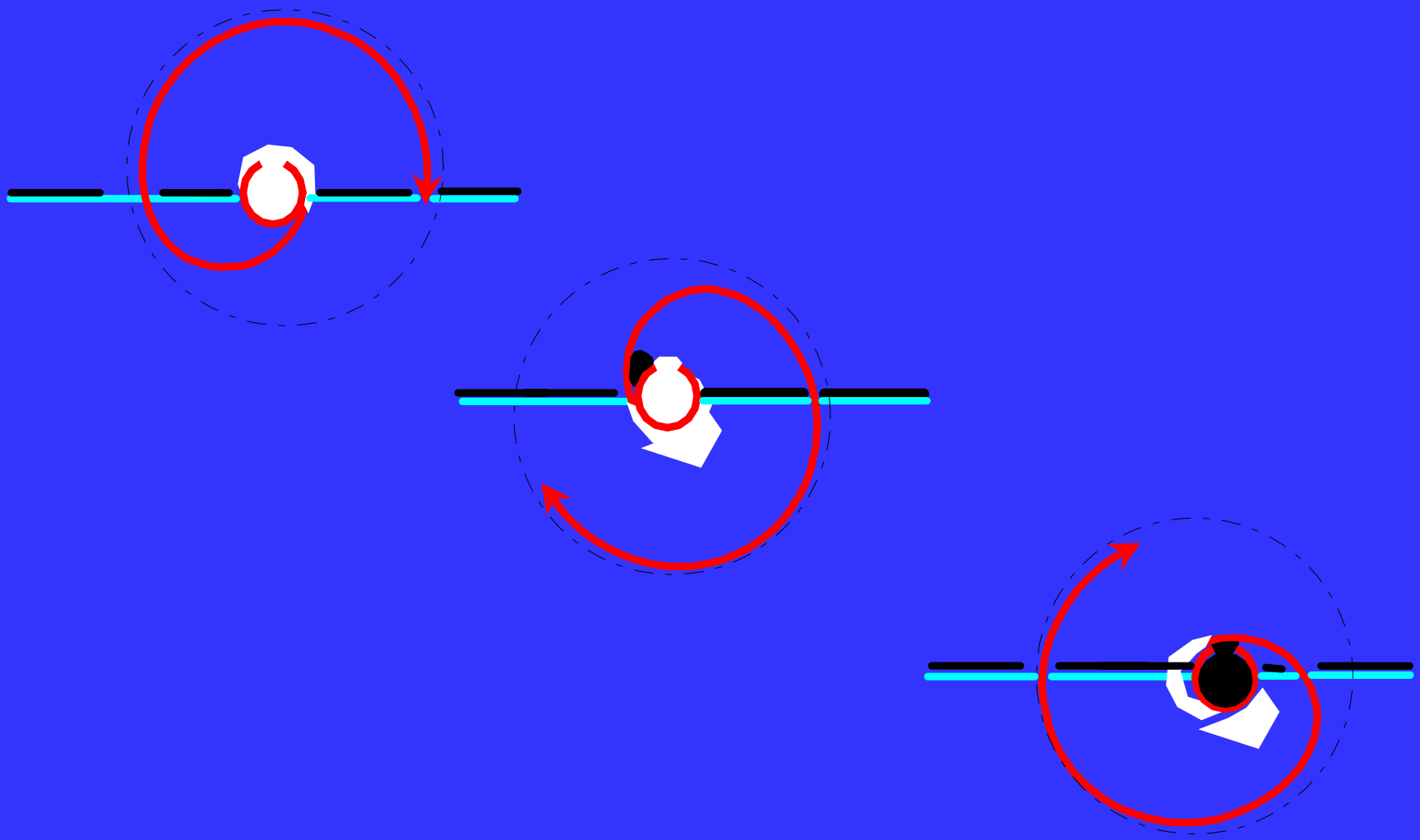
Oleophilic Disc



Oleophilic Disc Skimmer



Drum Skimmer



Oleophilic Drum Skimmer

Oleophilic Brush Skimmer

Temporary Storage

Types of Temporary Storage Devices

- Barges
  - Tank barges (large and small)
  - Deck barges with deck tanks
  - Hopper barges
  - Supply boats with deck tanks
- Towable tanks
  - Towable Storage Bladders
  - Open tank “barges”
  - Flat tanks
- Stationary tanks
  - Purpose-built
    - Open, frame-based pools, i.e., fast tank
    - Open, inflatable pools
  - General purpose
    - 55-gal oil drums
    - Pick-up or dump truck
    - Plastic trash bags
    - Pits (lined)

Oil Spill Response Barge

- Storage is key constraint on spill recovery
- Avoids relying on commercial barges

Shallow Water Barge

- Ready-transportable on trailers or in-water
- Skimming, booming operations, hard-to-get-at areas
- 3 foot draft when fully laden
- 400 bbl storage

Mechanical Equipment Research

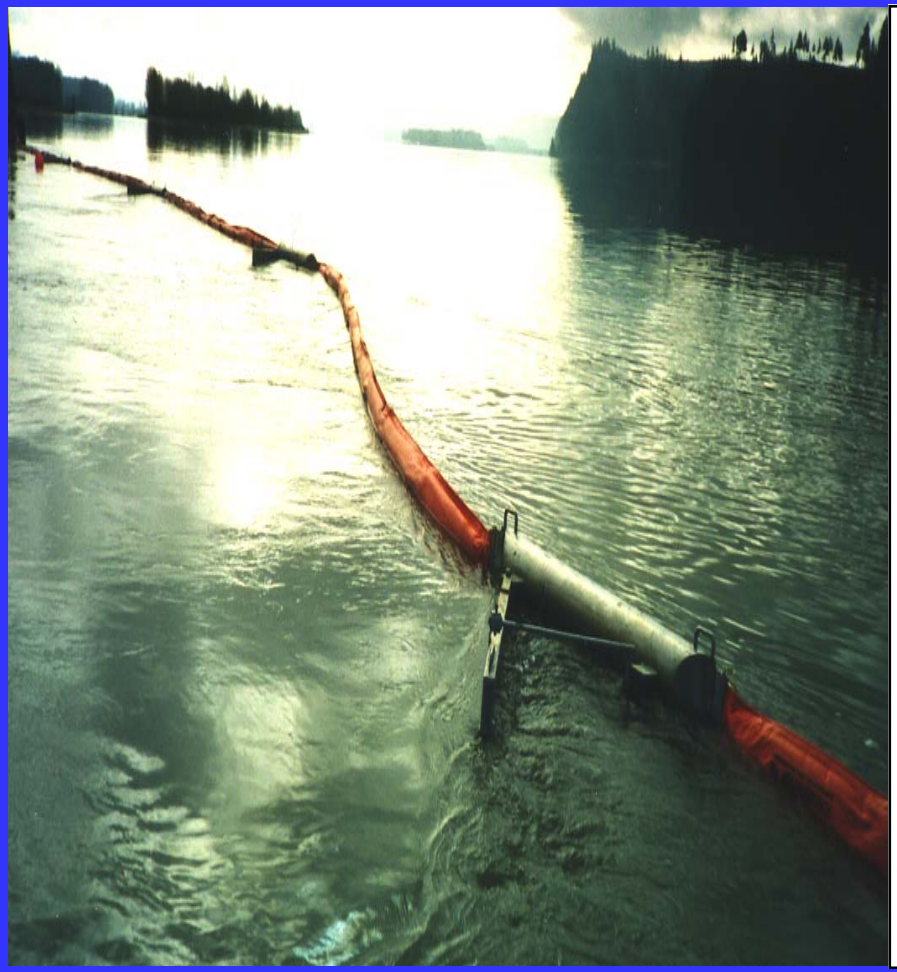
- Boom Deflectors
- Boom vane systems
- Fast water skimming systems

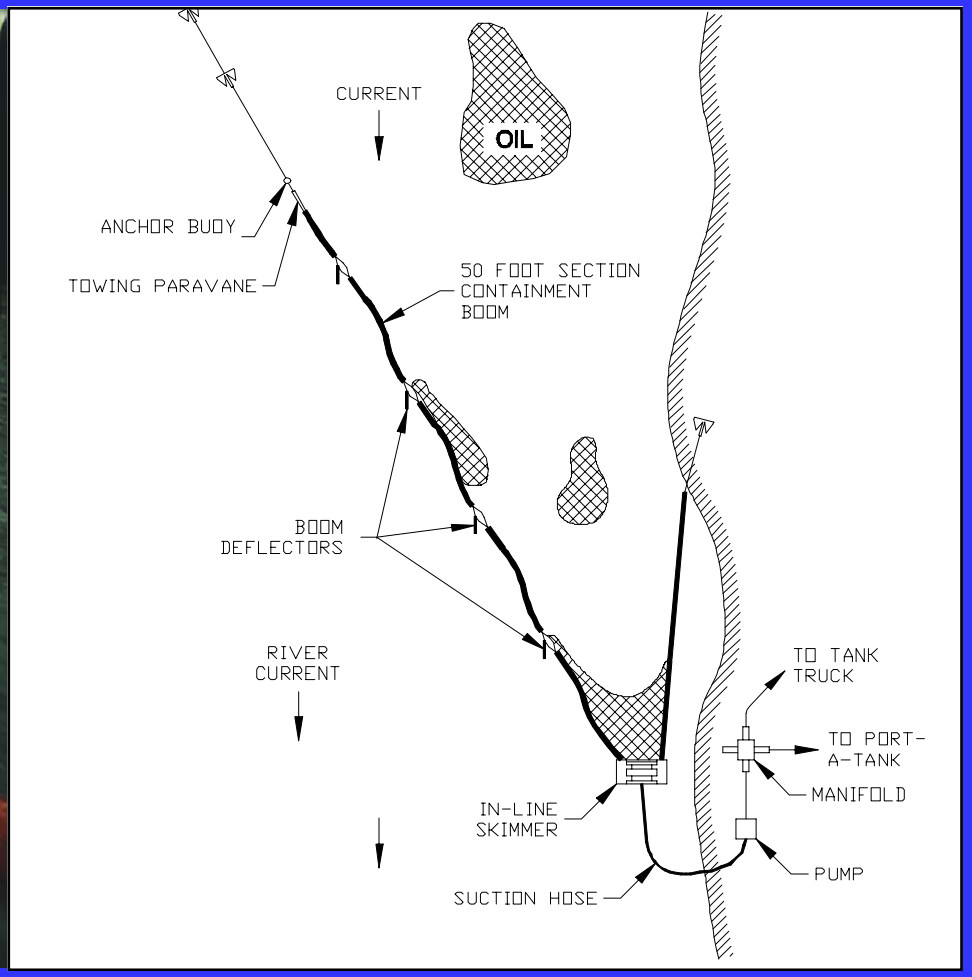
Boom Deflector Systems

- A deflector is placed between each section of boom and uses the force of the water to push the boom out into the current and the shape of the boom is maintained as long as a steady current continues.

- These devices deflect boom into the current at an average angle of about 15 degrees at current speeds of 0.5-1.5 meters/second (1-3 knots).

Boom Deflectors



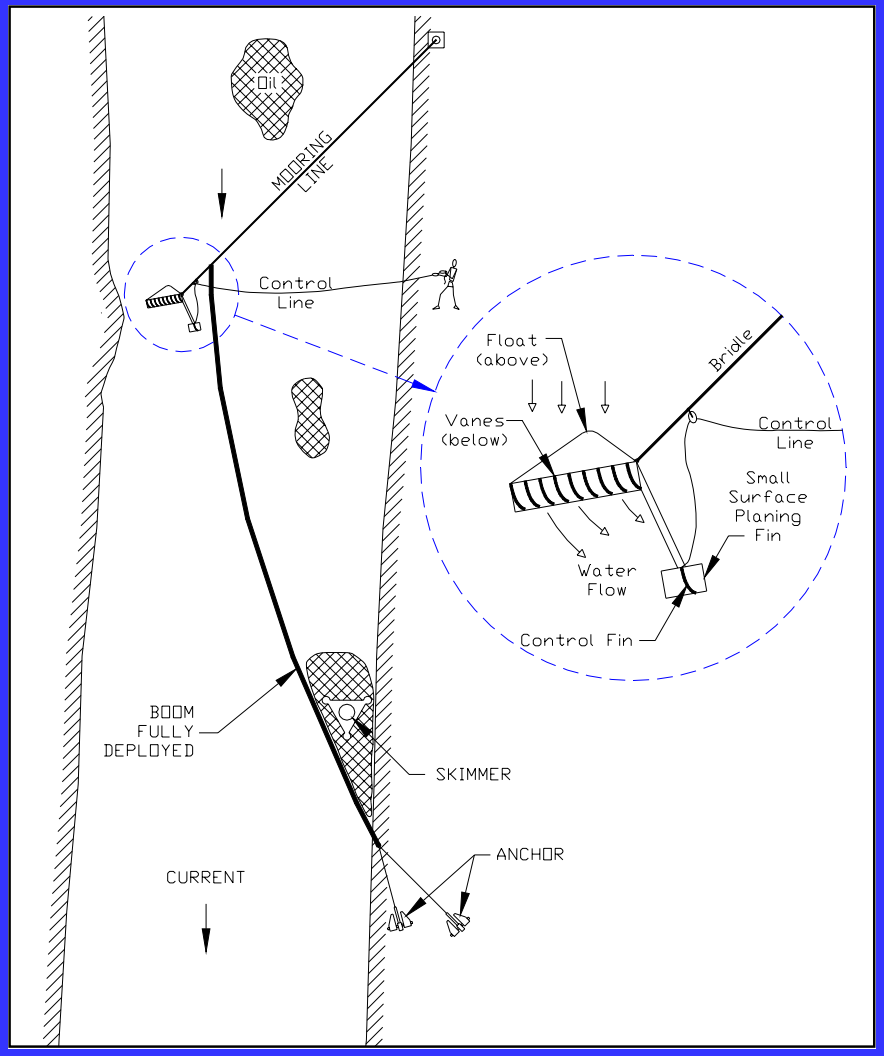


Boom Vane Systems

- Developed in Sweden based on the trawl doors that fishermen use.

- The vane uses the hydrodynamic force of the passing current to pull the boom away from the shore.

Boom Vane

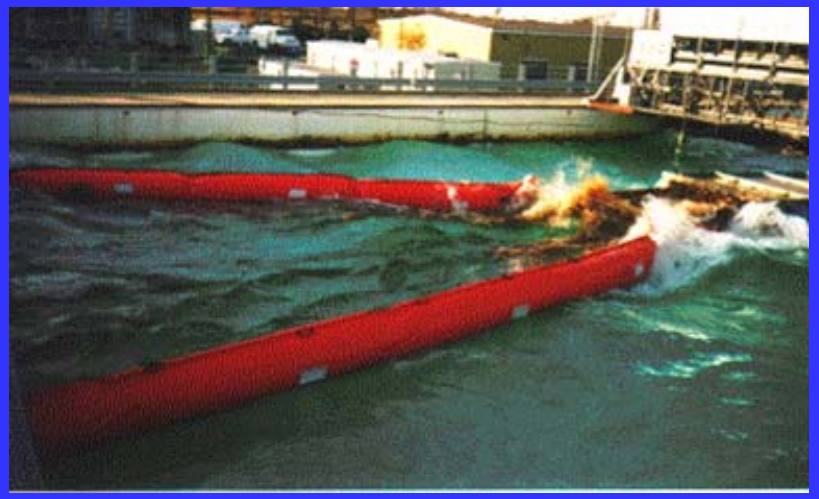

Oil
MOORING LINE
Control Line
Float (above)
Bridle
Vanes (below)
Control Line
Small Surface Planing Fin
Water Flow
Control Fin
BOOM FULLY DEPLOYED
SKIMMER
ANCHOR
CURRENT

Fast Water Skimmers

- Current Buster (from NOFI, Norway)
- During tests the Current Buster recovered over 80% of the oil at speeds up to 3.5 knots.

Fast Water Skimmers

(Some units can recover oil at 5 knots)

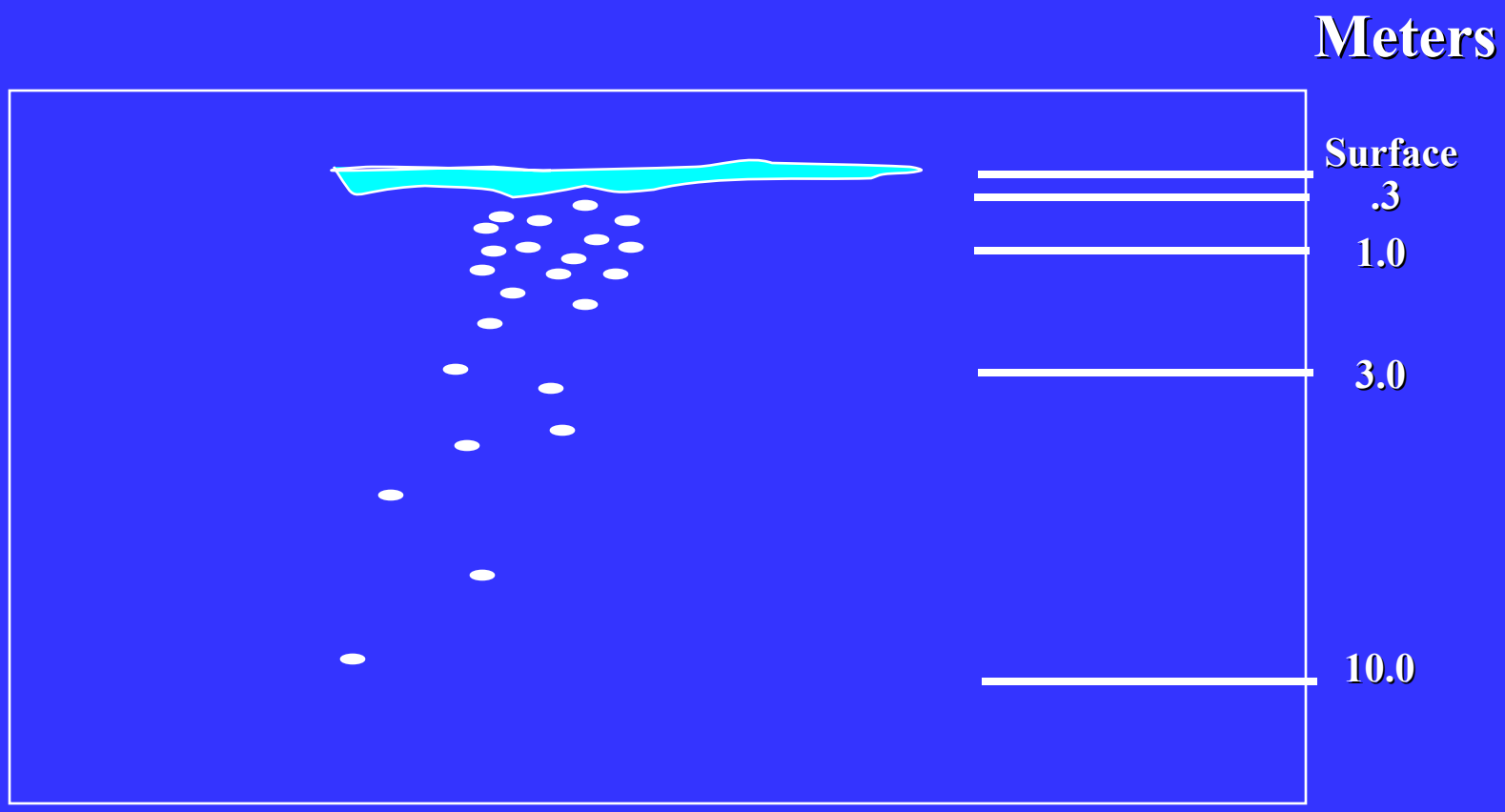


Dispersants

Dispersants

- What is a dispersant?
  - Solvents - The solvent enables the surfactants (active ingredients) to be applied and helps get them through the oil film to the water interface.
  - Surfactants - At the interface the surfactants reduce the surface tension allowing the oil to enter the water as tiny droplets that are degraded by natural bacteria.
- What does it do?
  - Enhances natural dispersion by reducing the oil-water ‘interfacial tension’
  - Redistributes oil into the water

Dispersant Dilution Action



Dispersant Application Techniques

Current U.S. Dispersant Aircraft Platforms

DC-4
2,000 gallon payload

C-130 w/ADDS PAC
5,000 gallon payload

AT-802
800 gallon payload

OSRL Hercules with ADDS PAC

U.S.Air Force C-130 with MASS Kit

Helicopter Bucket Sprayer

General Dispersant Limitations

Time:	Within 24-72 Hours*
Material Spilled:	Viscosity less than 20,000 cs*
Sea State:	>1 Beaufort and < 6 Beaufort
Water Depths:	> 10 meters*
Distance Offshore:	> 3 nautical miles*
Dispersant:	On National Approved List
Dispersant Plan:	Government Approvals

Advantages

- Rapid response over large distances and areas is possible
- Applicable in relatively rough weather
- Reduces the risk of contamination of birds and shorelines
- May ‘break’ or inhibit the formation of emulsions
- Reduces recoverable waste
- Minimize Shoreline Stranding of Oil
- Minimize Contamination of Marshes, Mangroves

Disadvantages

- Oil is not removed, but re-distributed
- Can adversely affect sensitive resources
  - farmed fish, shellfish and coral reefs
  - industrial water intakes
- “Window of Opportunity” for effective use
- Generally inappropriate in shallow water

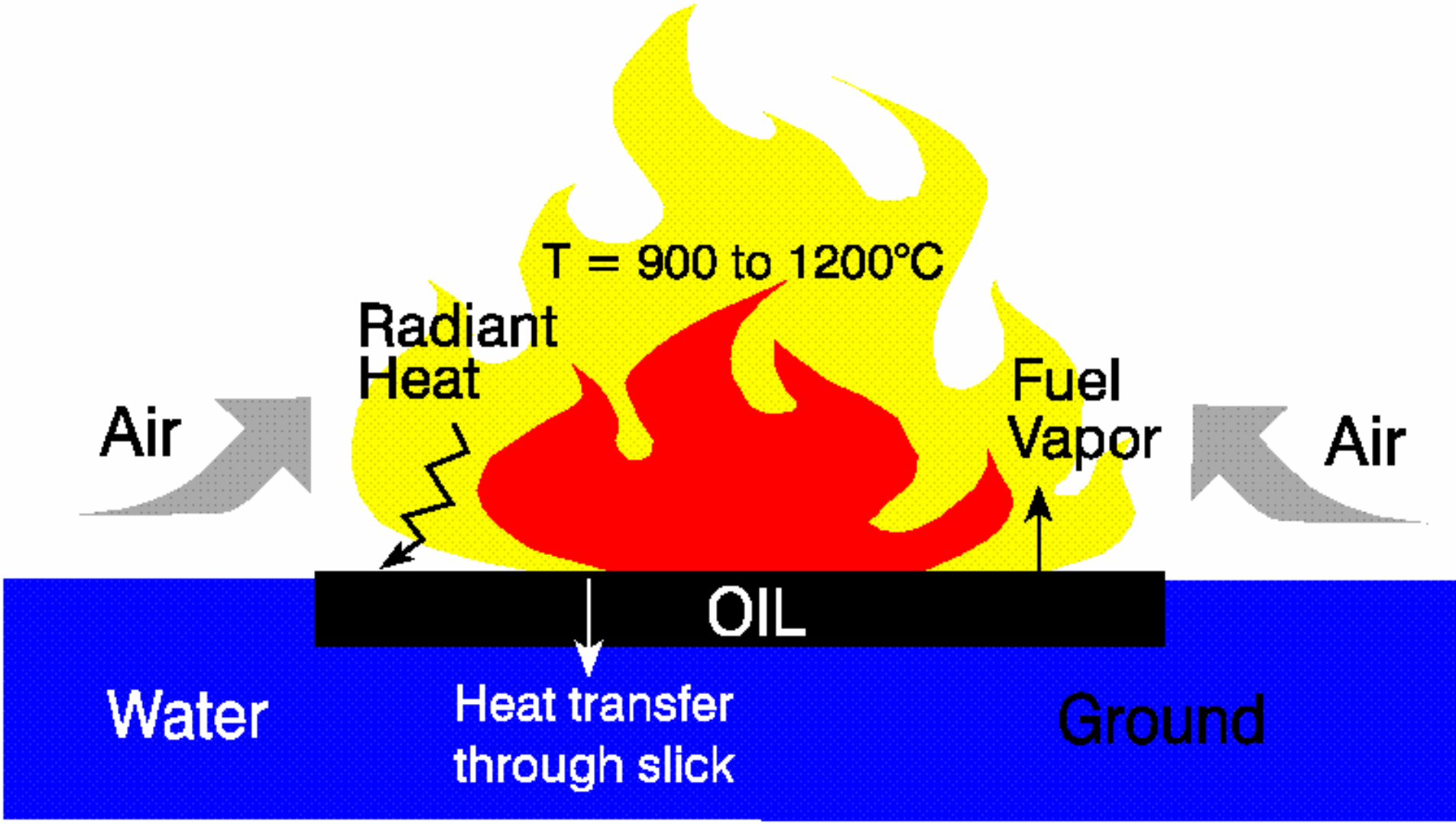
Current Dispersant Research

- Dispersant effectiveness tests have been conducted to provide qualitative assessment of the dispersibility of heavy fuel oils using different dispersants and a range of dispersant to oil (DOR) ratios
- Cold water dispersant research, particularly in Arctic region.
- Developing standards for shipboard dispersing monitor application system.
- Jet aircraft application
- Evaluating use of dispersants in shallow water

Testing Dispersants in Heavy Fuel Oil

In-Situ Burning

BASIC PROCESS



Required Equipment

- Containment
  - Specialized fire booms and boom towing vessels
  - Helicopter directing
- Ignition
  - Helitorch or hand-held igniters
  - Helicopter for aerial ignition
- Monitoring
  - May be necessary to monitor smoke plume

Operational Constraints

- Oil thickness is crucial. Minimum oil thickness (~3mm) Burning starts at 2-3mm. Ends at 1-2mm
- Efficiency depends on thickness
- Winds < 20 knots, waves < 132 cm (4.3 feet)
- Presence of natural gas from blowout detrimental
- Daylight

Types of Fire-Boom

- Stainless steel
- Fire-resistant fabrics; often these systems can not be reused.
- New methodology using an active water-cooling systems; these systems are designed to be reused.
- All In-Situ Burn boom is rigorously tested under approved protocols and operational conditions.

Deploying Water-Cooled Fire Boom

Testing Fire Boom

Failed Fire-Boom Test

Ignition Sources

- The ignition source is used to provide sufficient heat to vaporize some of the oil to sustain burning.
  - Helitorch - an incendiary device deployed from a helicopter and drops a burning gelled gasoline substance onto the area to be burned. A trained flight crew is required.
  - Other simple devices can also be used by trained personnel.
  - Oil-soaked rags or other sorbent material
  - Road flares

Helitorch Igniter

Helitorch with Streaming Gel

Hand Igniters

Simplified Burn Procedure

- Two vessels contain a patch of oil in fire-resistant boom. Rule of thumb is to fill about 1/3 of the area inside the boom.
- The contained oil is towed away from the main body of oil.
- Ignite the oil inside the boom. It is best to tow into the wind to help contain the oil and keep the smoke plume astern of the towing vessels.
- The size of the burn can be controlled by the speed of the tow. Slowing down or releasing one end of the boom will reduce the thickness of the oil, allowing the burning to stop.
- This procedure can be repeated as often as necessary.

At Sea In-Situ Burn

Vessel In-Situ Burn

Monitoring - The SMART Process

- The smoke plume may contain particulates which might have an impact on the general public.
- In the U.S. there is a monitoring process in place called Special Monitoring of Applied Response Technologies (SMART).
- This SMART monitoring is required if the particulates in the smoke plume could reach the ground and impact populated areas.

Burning Trade-offs

Advantages

- Remove oil from surface
- Reduce temporary storage
- Relatively simple
- Fast
- Efficient
- Good areial coverage

Disadvantages

- Smoke plume
- Secondary fires
- Residue
- Permits

Current In-Situ Burn Research

- Application in cold water and broken ice, particularly in Arctic region.

Testing in Ice

Waste Management

Waste Generated from a Spill

- Recovered oil, emulsion, and oily water
- Oiled sand, gravel, soils
- Oiled debris, driftwood
- Oiled wildlife carcasses
- Oiled kelp, seaweed, etc.

Other Wastes Generated from Cleanup

- Oiled sorbents, plastic bags, protective clothing
- Rainwater runoff from waste storage areas
- Wash water - boat, boom, equipment, and gear cleaning
- Chemical drum cleaning water
- Decontamination site - wash waters / rinse waters
- Chemicals - lab, wildlife
- Anti-freeze, solvents, containers
- Used engine oils, hydraulic fluids, batteries

Generating Waste

Proper Disposal of Waste is Essential

Responder Safety

- Health and safety, for both the general public and responders, is of utmost importance. People and the environment must be protected from the effects of an oil spill, not harmed by one. General topics which must be considered include:
    - Management and communications
    - Risk assessment
    - Oil and Response chemical safety issues
    - The working environment and safety during operations
    - Personal protective equipment (PPE)
    - Management of Volunteers

Reference Material

- American Petroleum Industry (API) Publications
  - api-ep.api.org/filelibrary/ACF1B6.pdf
    - Pollution Prevention
    - Surface Water Research
- IPIECA Oil Spill Report Series
  - www.ipieca.org/publications/oilspill.html
- World Catalog of Oil Spill Response Products
  - Technical data and guidelines on selection for all types of response equipment
  - Summaries of field and tank trials
  - For information: SL Ross Environmental Research WorldCatalog@SLRoss.com