

**Oil Spill Response Planning for
Shell's Offshore Exploration Program in
the Alaskan Beaufort Sea**

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Two Floating Drill Systems

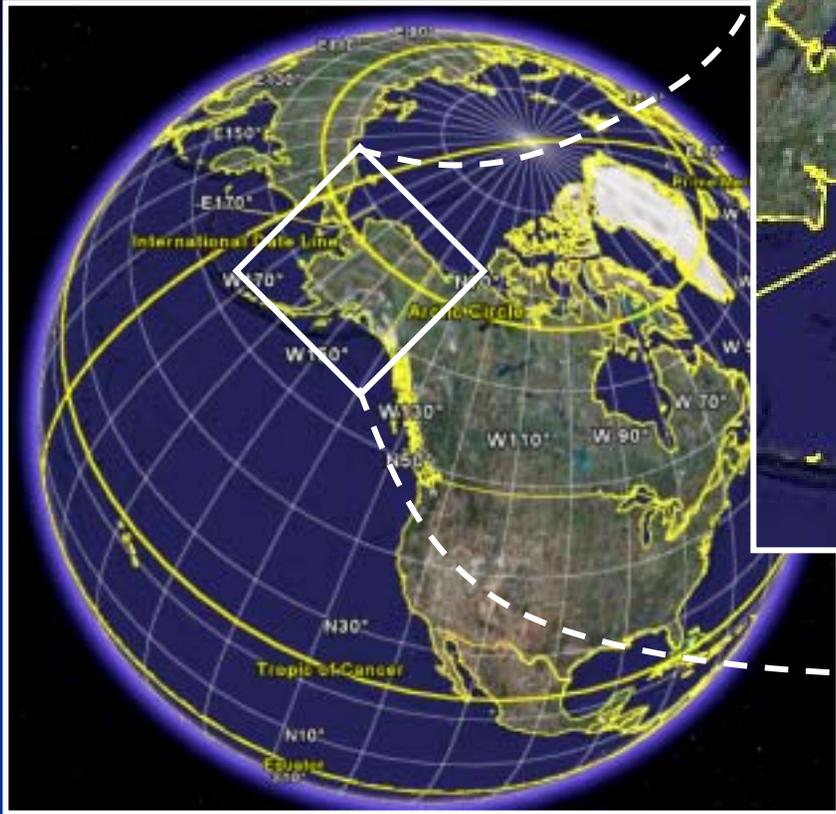
Two OSR Platforms



Four Polar Ice Breakers

Tanker





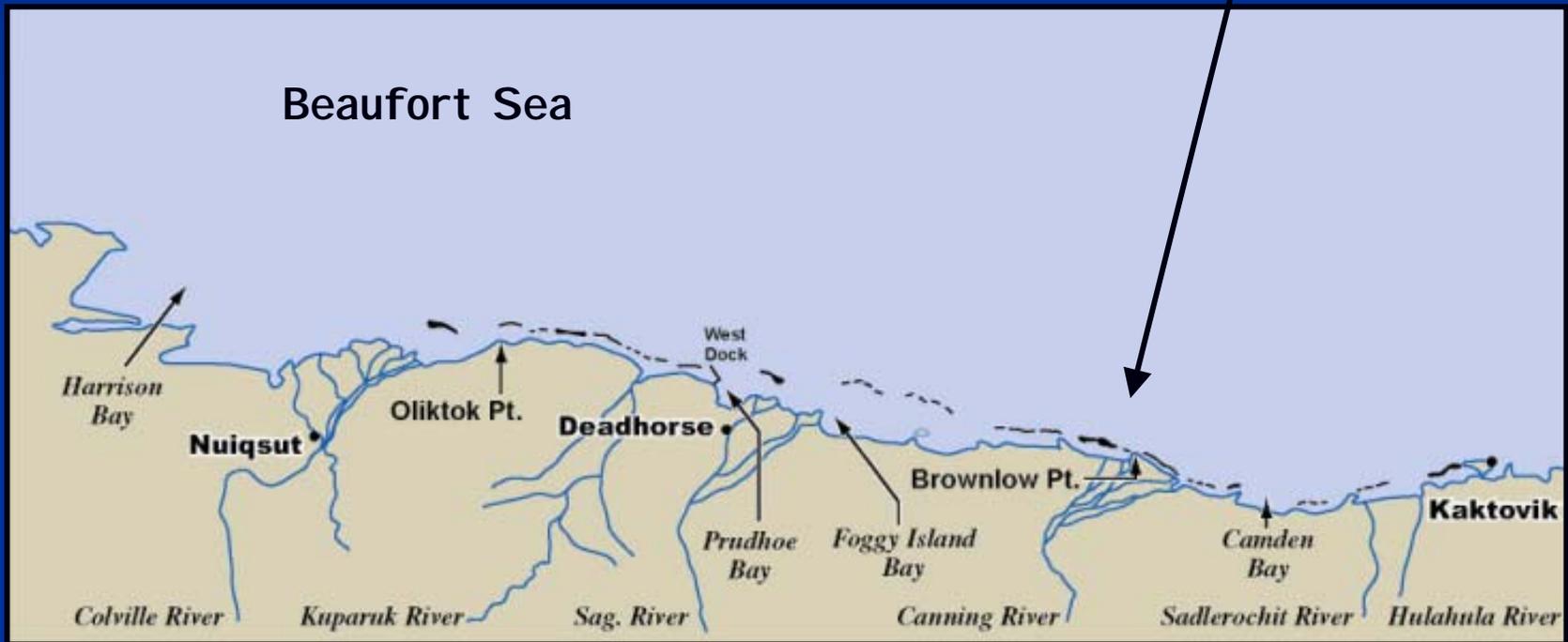
Location: Beaufort Sea (12 to 15 miles offshore)

Timing: July through October

(primarily Open Water)

(Off Flaxman I.s.)

Depth: ~ 30 meters (100 feet)

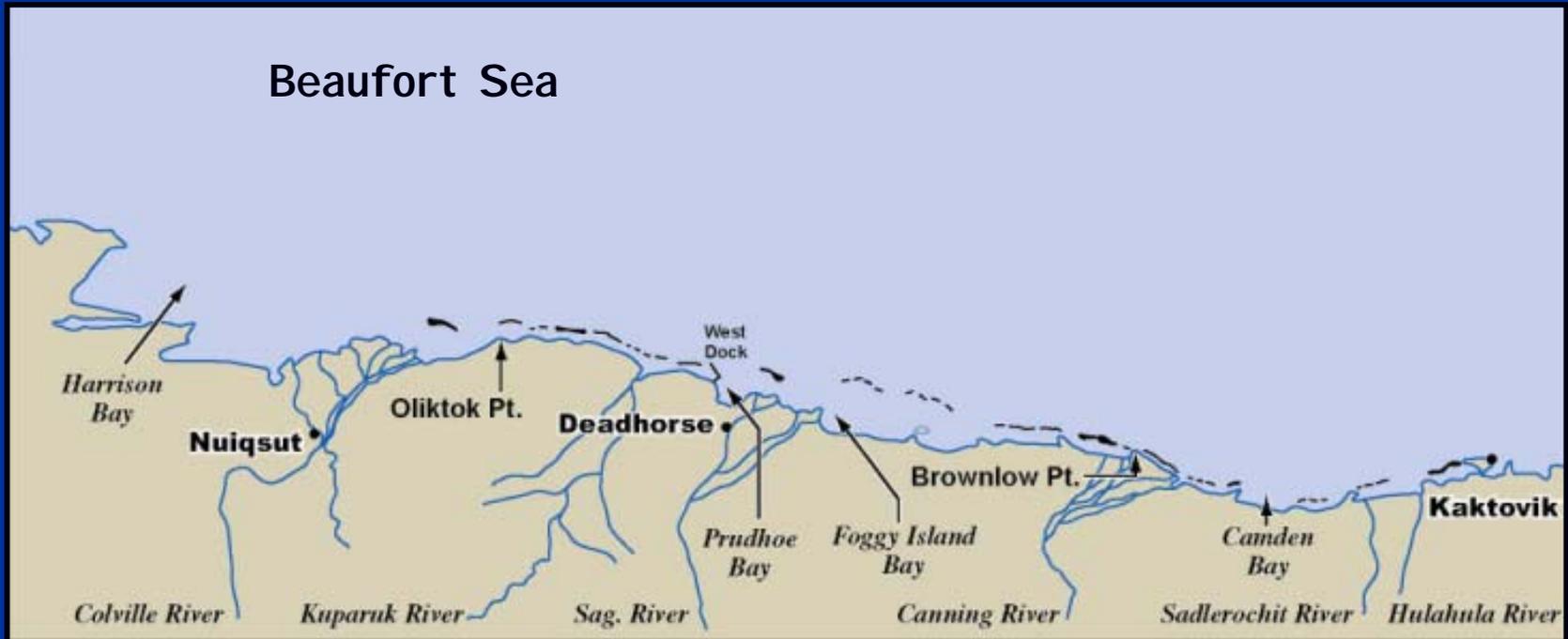


Key Spill Response Planning Issues:

Worst Case Discharge: Subsea Blowout (5,500 bbl/day
(WCD) or ~230 bbl/hour)

Duration of Release: State (15 days); MMS (30 days)

Overall Storage (emulsion + H₂O): ~ 287,000 bbl



Operating Environment (Open Water)



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Possible Pack Ice
Incursions

&/or

Early Stages of
Freeze-up



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Operating Environment (Open Water)

Winds: Gentle to Moderate, ENE 40 – 60 % of the time
WSW 20 – 40 % " " "
Strong Winds (>15 kt) Westerly, ~24% (Aug.)
~37% (Oct.)
Gale Force Winds (34-40 kt), <2% of the time

Visibility: July/Aug. <1 mile ~ 25 % of the time
October (freeze-up) <1 mile ~ 17% of the time
Daylight Hours: ~21 hrs (Aug.) to ~11 hrs (Oct.)

Waves/Current: Generally low wave-energy environment; mixed semidiurnal tides of ~6"-12"; wind-driven waves/currents.

A Beaufort Scale (Wind Force) "4" (11 to 16 kt), capable of producing wave heights of 3 to 5 feet, could be exceeded ~30% of the time during the late open-water season.



Potential Operating Environment (Freeze-up)

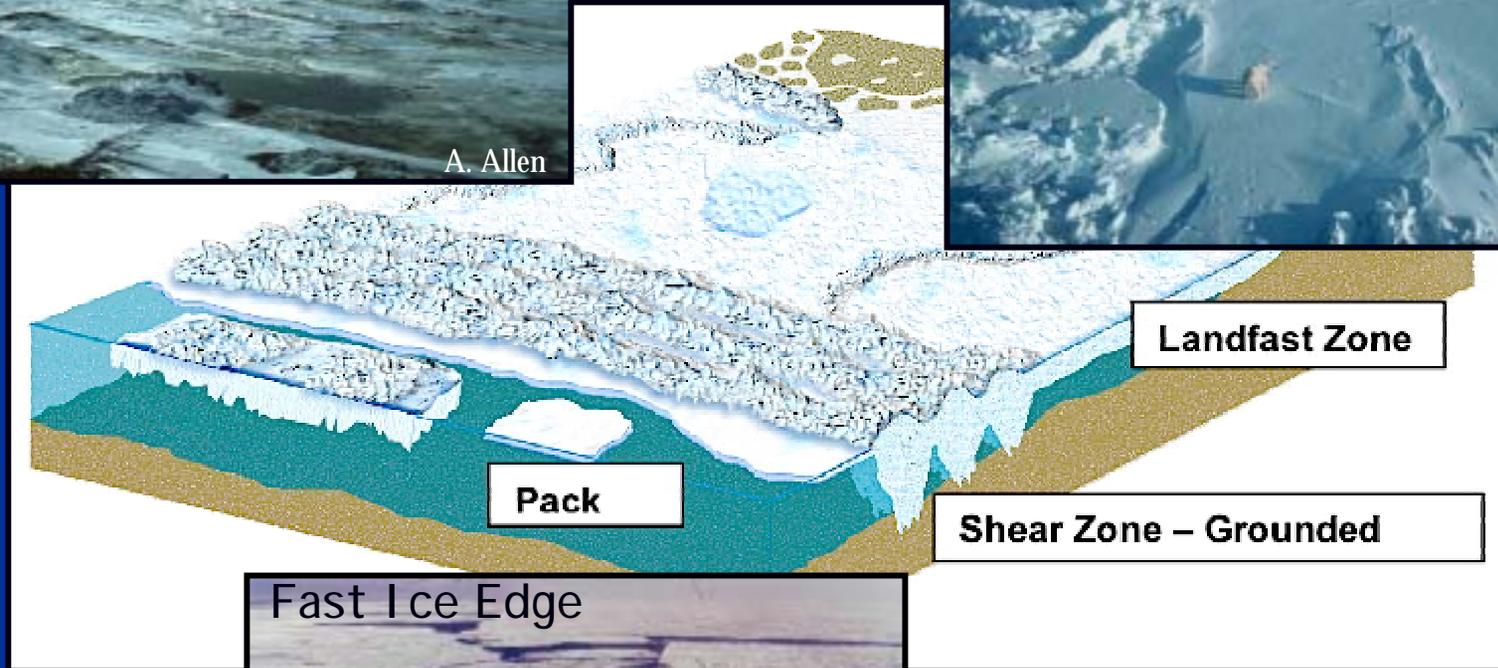
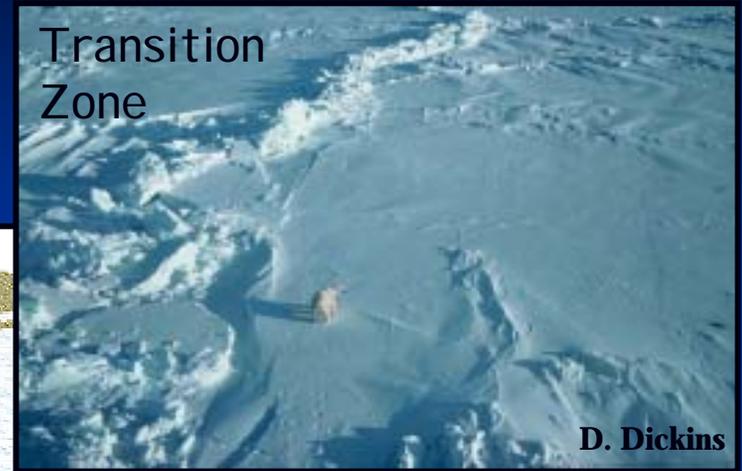
Initial stages (grease ice & slush)

- * Transition to 8/10+ may occur rapidly
- * First ice along coast & lagoon areas
- * Typically mid-to-late October offshore
- * Consolidation slower offshore, wind & waves breaking ice as it forms;

As freeze-up continues, fast ice edge expands seaward, thickens and becomes more stable out to water depths of 4 to 5 meters in October/November, & nearly 15-meter depths in December.



Ice Environment (Late Freeze-up to Mid-Winter)



RESPONSE GOALS

1. Immediate

Large mobile response system (OSRV) at each drill site
Trained Response Crews on location - at all times

2. Sustainable

Trained Backup Response Crews
Ready Nearshore/Shoreline Response
Pre-staged Equipment
Logistics, Berthing, Food, Medical, etc.

3. Flexible

Changing Wind/Sea Conditions
Cold Viscous Oil & Emulsions
Nature & Amount of Ice

4. Advanced

State-of-the-Art Vessels & Equipment
High-Volume Recovery & Elimination
World-Class Training & Team Building



RESPONSE SOLUTIONS

1. Immediate



2. Sustainable



3. Flexible

Mechanical Removal



Burning



Dispersants

Potentially



4. Advanced



Nanuq

300+ Feet
Ice Class A1



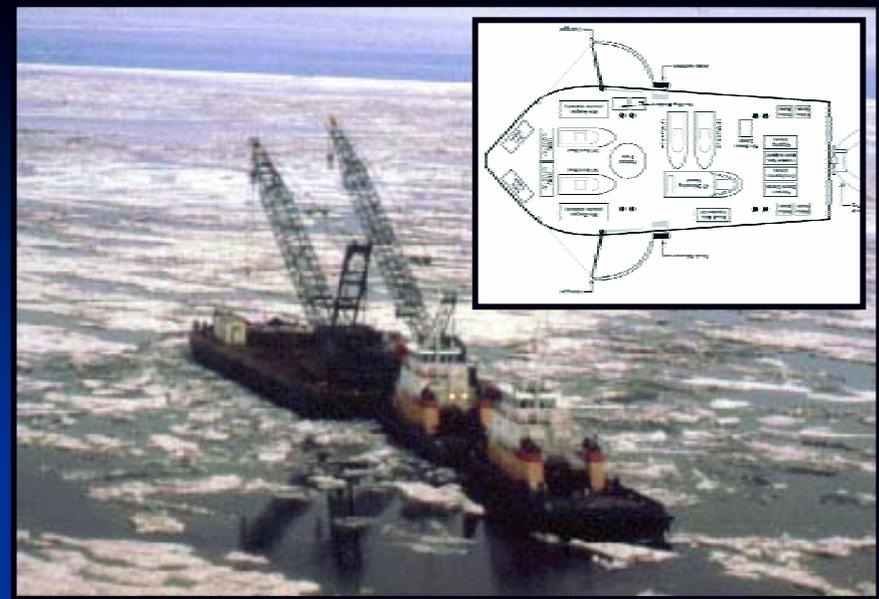
- Multi-Purpose Vessel
 - Spill Response
 - Onsite Command
 - Anchor Handling
 - Ice Management
 - Supply
- Dynamic Positioning
- 41 crew and responders
- Rapid Transit for lightering recovered oil
- Skimmers (over-the-side)
 - (2) Lamor 5-brush
 - Rope Mop & Mini-Brush
- Work Boats
 - (2) 34-ft + Rescue
- Boom
 - Conventional & Fire Resistant
- Onboard Storage
 - 12,000 bbl, (1) 100-bbl BI.)
- High Volume, Viscous Oil Lightering capability

Arctic Endeavor

205 Feet

Ice Strengthened

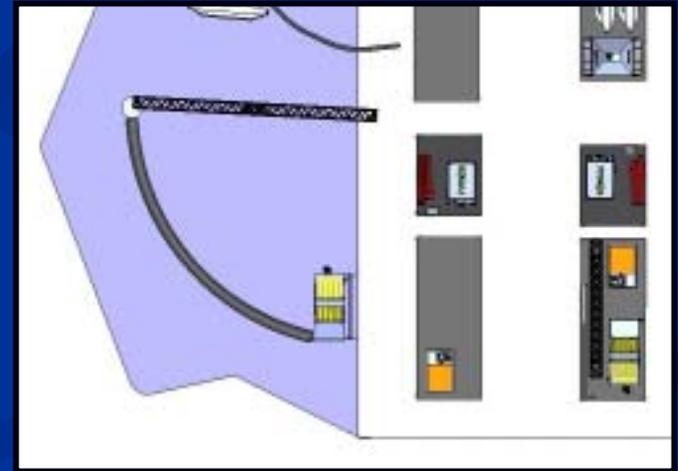
- History of operations in the Beaufort Sea
- Skimmers (over-the-side)
 - (2) Lamor 5-brush Rope Mop & Mini-Brush
- Self-propelled Skimmer
 - 47-ft with (2) Built-in Lamor Brush Units
- Work Boats
 - (4) 34-ft + Rescue
- Tug Support
 - Point Barrow



- Boom - Conventional & Fire Resistant
- Onboard Storage
 - 16,800 bbl
 - (4) 249-bbl Barges
 - (2) 100-bbl Bladders
- High Volume, Viscous Oil Lightering capability

LAMOR Brush Skimmer

- State-Of-The-Art Recovery System - (2) per OSRV
- Each with 5 Durable Brush Conveyor Belts
- High-Volume Recovery Rate (up to 205 m³/hour or >1,200 bbl/hour)
- With 20% Derating (>250 bbl/hr), exceeds WCD
- Effective with fresh or weathered viscous oils
- High efficiency (>80%) in light to moderate seas
- Rapid Deployment
- Can lift quickly to avoid ice



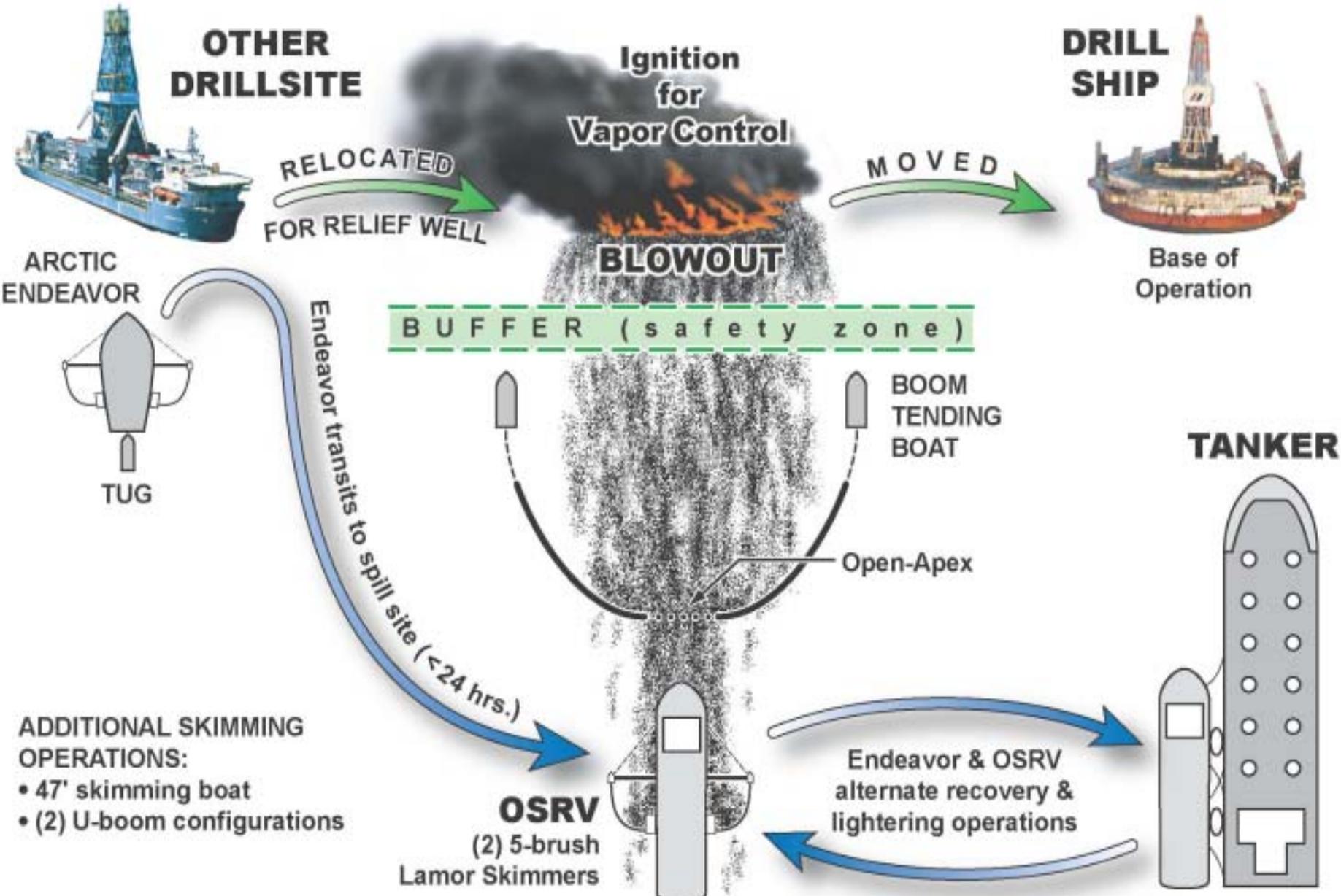
Advancing Brush Skimmer

47-ft with (2) Lamor 2-Brush Built-in Units

Shallow Draft
High Speed Transit
Good Maneuverability
(in and around ice)



Primary Response Strategy



Response Plan: Offshore

Open Water

- 💧 Ignition of Oil/Gas at Surface for Vapor Control & Partial Removal of Oil
- 💧 Concentration of Oil Escaping the Blowout with Open-Apex Boom
- 💧 Containment & Recovery of Oil with OSRV & Endeavor Barge
- 💧 Containment & Recovery of Oil with 47-ft Skimmer & U-boom Configurations
- 💧 Controlled Burning of Oil with Fire Boom downstream of Blowout



Controlled Burning Downstream



Controlled Burning

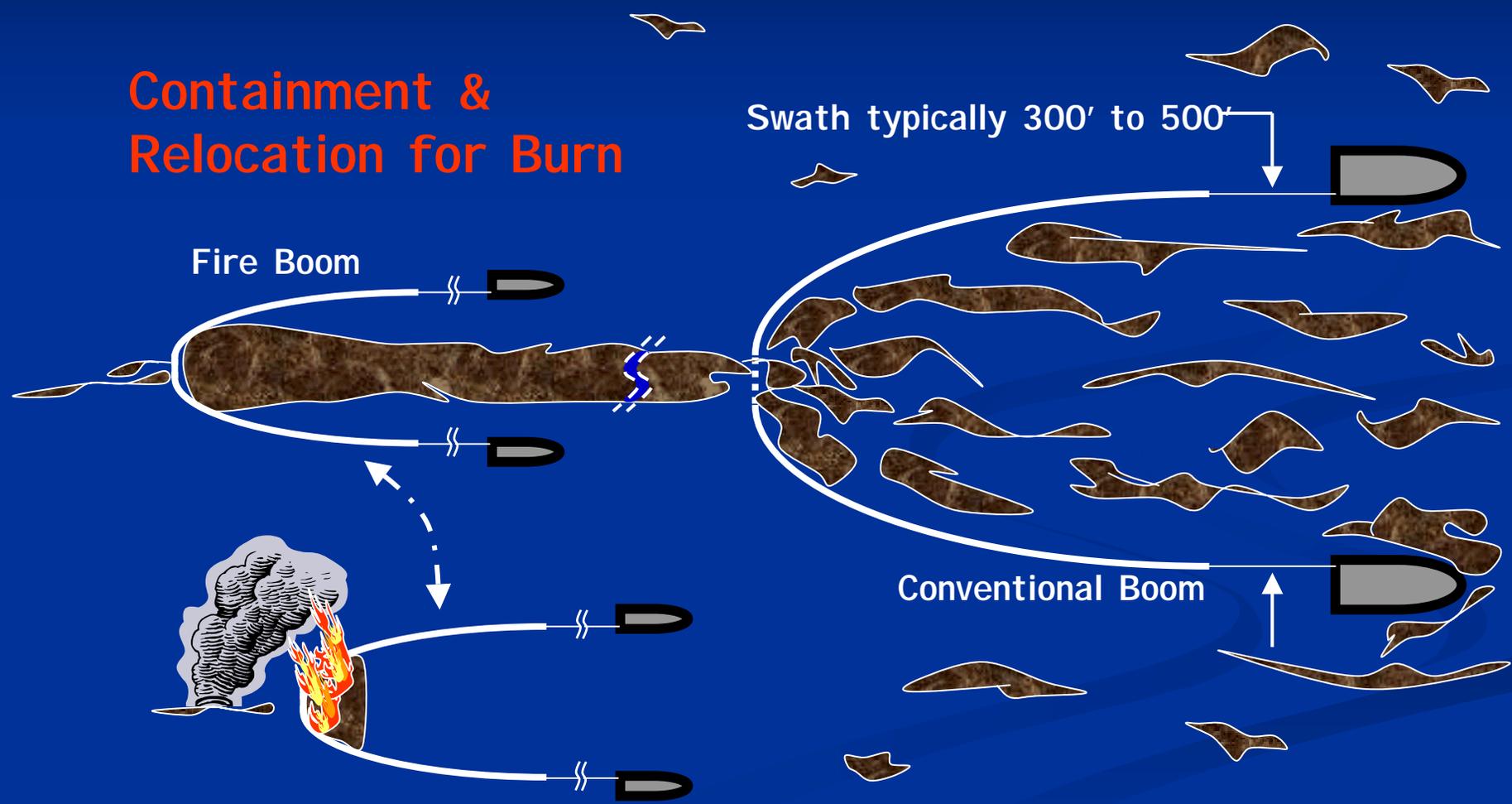
(Concentration of Oil with Open Apex)

Containment &
Relocation for Burn

Swath typically 300' to 500'

Fire Boom

Conventional Boom



Response Plan: Offshore

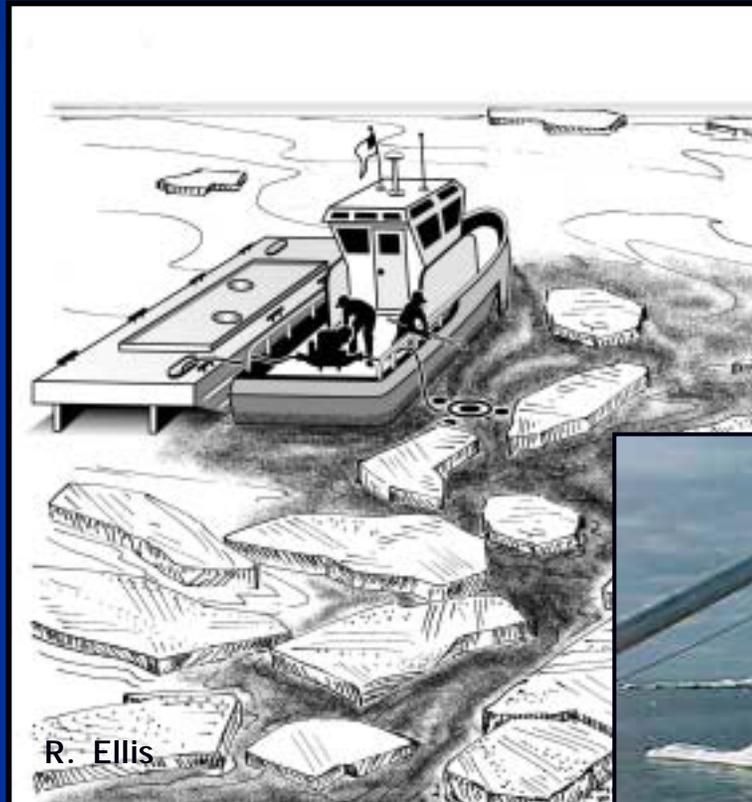
Freeze-Up

- ◆ Use of Ice Breakers and Blowout “Lift” to Keep Oil Exposed at the Surface
- ◆ Ignition of Oil/Gas at Surface for Vapor Control & Partial Removal of Oil
- ◆ Concentration of Oil without Large Boom Configurations (rely on short out-rigger boom deflection, wind-herding of oil against ice & natural containment)
- ◆ Recovery of Oil with Nanuq, Endeavor & 47-ft Skimmer (working along the edge of heavy ice concentrations and in pockets of oil trapped by ice)
- ◆ Aerial Ignition of Oil without Fire Boom (burning oil herded against heavy ice concentrations and in pockets of oil trapped by ice)



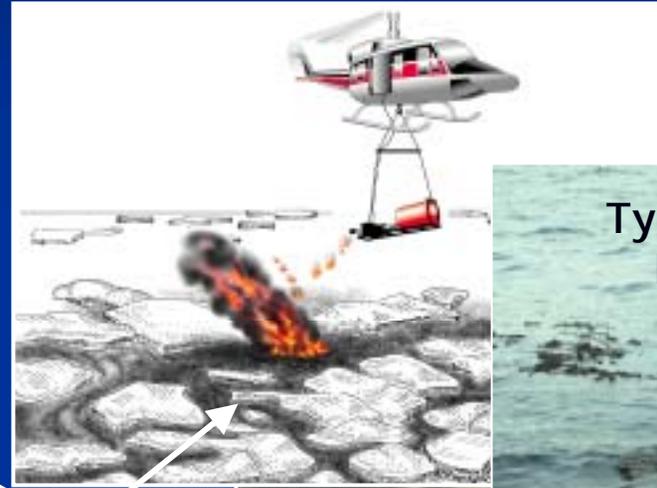
Broken Ice

Recovering Isolated Pools of Oil



Broken Ice

Burning Isolated Pools of Oil



Oil trapped in pockets

Oil herded against ice by the wind



Enhanced Oil Spill Response

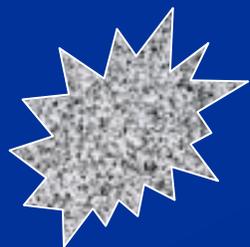
❑ Ice Management



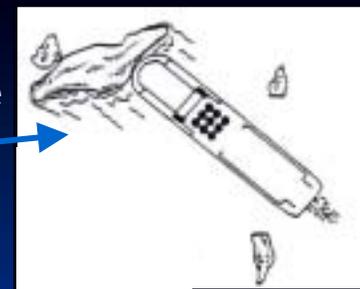
Management/Deflection of Ice

By angling the deflection barge with a cross-wind, oil can be herded by the wind against the deflected row of concentrated ice to enhance burning & recovery.

Blowout



Movement of large ice floes



Breaking of continuous light ice cover to enhance deflection



Enhanced Oil Spill Response

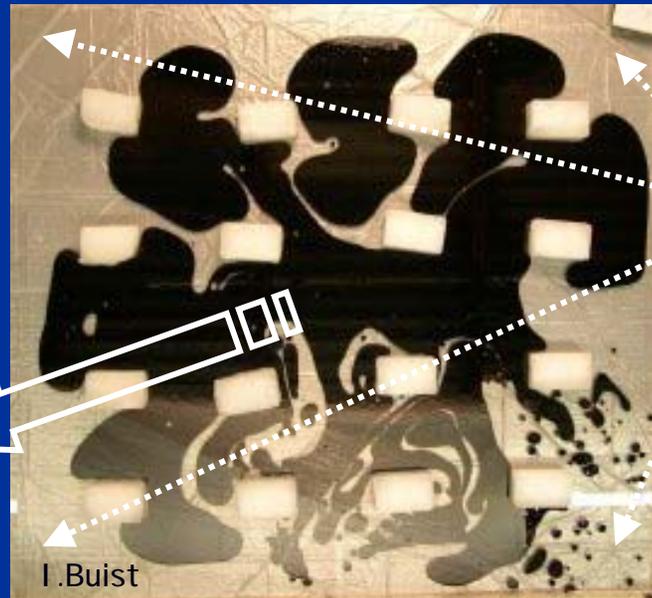
❑ Ice Management

❑ Recovered Oil Transfer



Enhanced Oil Spill Response

- ❑ Ice Management
- ❑ Recovered Oil Transfer
- ❑ Oil Herding



Enhanced Oil Spill Response

- ❑ Ice Management
- ❑ Recovered Oil Transfer
- ❑ Oil Herding
- ❑ Oil Detection/Tracking



Ground penetrating radar
Tests in Norway 2006
(Dickins/Boise State/SINTEF)

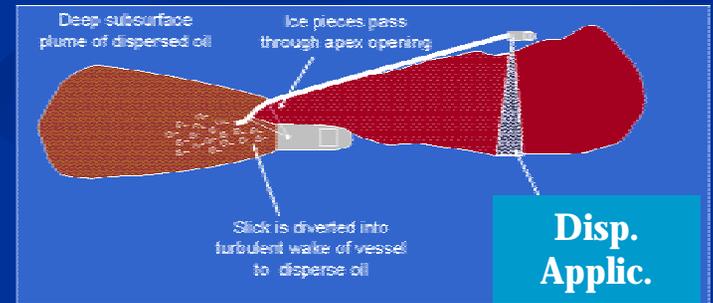
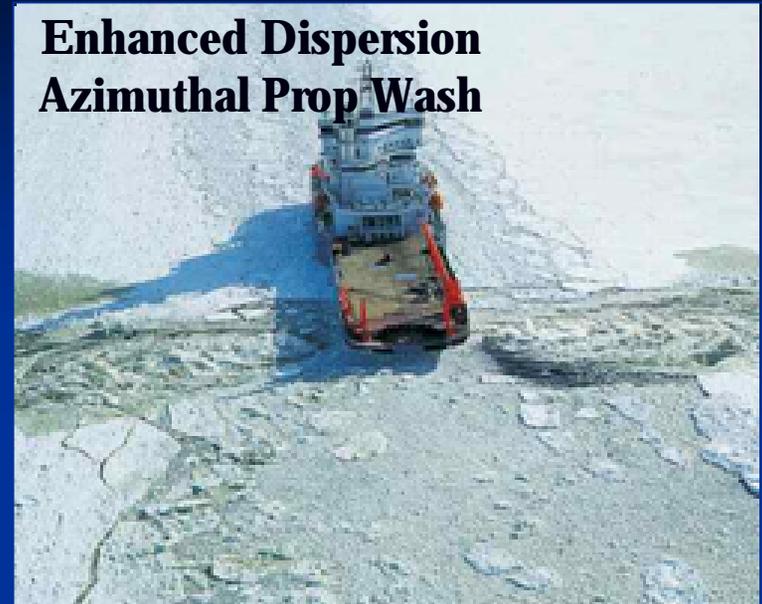


Ice Tracking
Buoy
(Metocean)



Enhanced Oil Spill Response

- ❑ Ice Management
- ❑ Recovered Oil Transfer
- ❑ Oil Herding
- ❑ Oil Detection/Tracking
- ❑ Dispersant Application



Figures/Photos:
ExxonMobil



"Summary"

Oil Spill Response in Ice

Response Goals

Immediate
Sustained
Flexible
Advanced

Resources

Vessels & Equipment
Mechanical & Burning
Transfer & Storage
Trained Responders

Enhancements

Ice Management
Recovered Oil Transfer
Oil Herding
Oil Detection/Tracking
Dispersant Application

Key Ingredient For Success ?





Shell Response Team

