

Dynamic Positioning in Ice

Example: Offshore Sakhalin (Piltun Astokshkoye field)
May-June 1999 (Keinonen et al., Proc. of ISOPE 2000)

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Offshore Sakhalin



Offshore Sakhalin (Piltun Astokshkoye field)

May-June 1999

- Dynamic positioning (DP) operation in ice by a type B ice class vessel (CSO Constructor), in support of compression diving in 30 m WD.
- The operation was supported by 2 icebreakers; Smith Sakhalin and Magadan.
- DP Vessel, diving bell through a diving moonpool + lifts over the side of the Vessel – lee mostly clear of ice
- Tasks:
 - completion of pipeline
 - raising and completing installation of a SALM buoy
 - various repairs and testing of the oil pipeline

Offshore Sakhalin – Sakhalin II, Phase 1 (Piltun-Astokhskoye)

- Molikpaq deployed in 1998 (drilling/production)
- Water depth: 31 m
- FSO connected to a SALM (Single Articulated Leg Mooring) about 2 km away from Molikpaq
- SALM – on the seafloor during winter
- Production ~180 days/year
- Winter: repair, modifications and drilling

May05 - Smit Sibu
Don Connelly

Sakhalin II - Molikpaq



Sakhalin II - Molikpaq

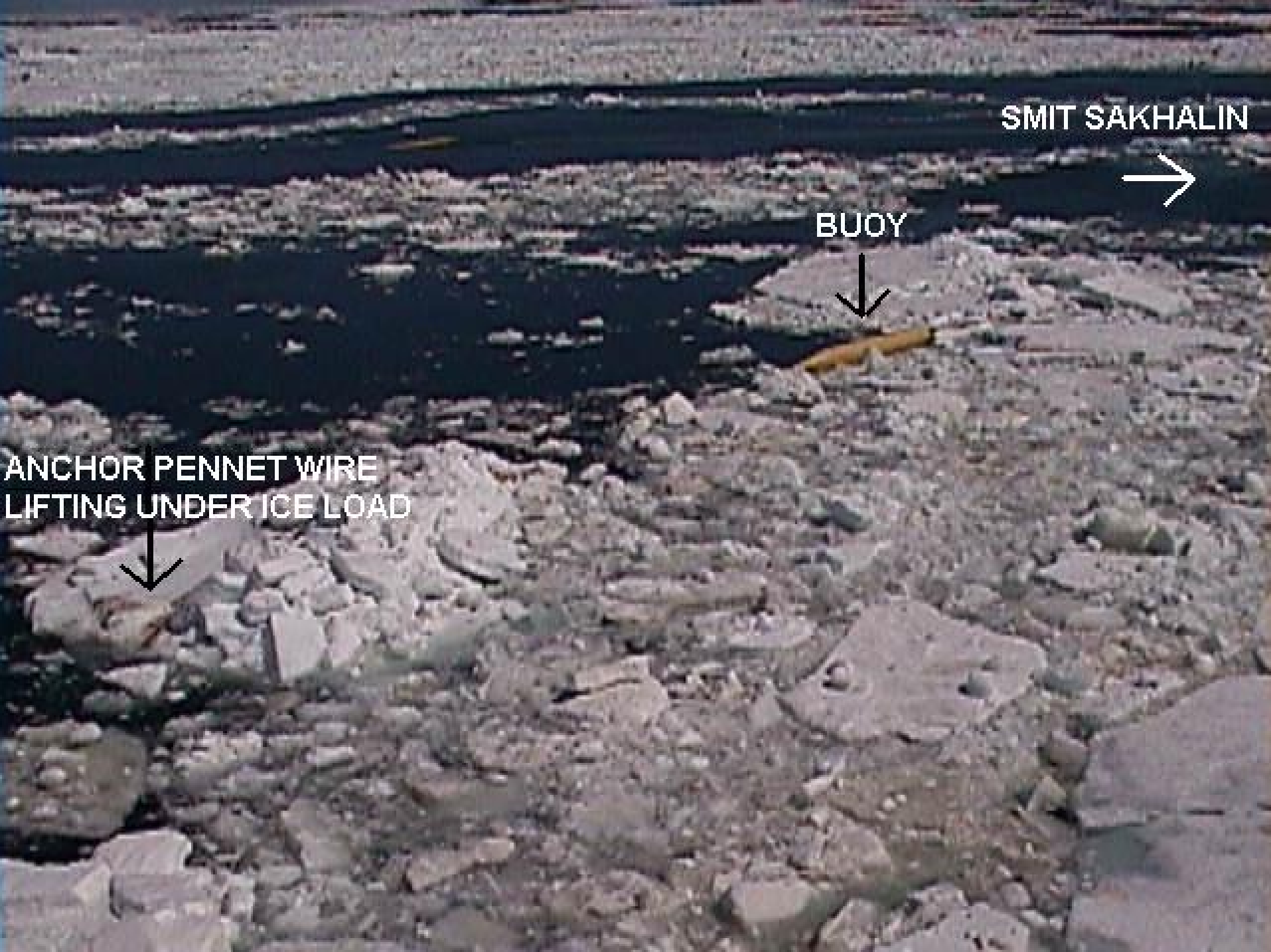


May/10 - Smit Sibu
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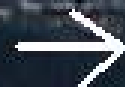
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Connecting line to buoy



SMIT SAKHALIN



BUOY



ANCHOR PENNET WIRE
LIFTING UNDER ICE LOAD





**SALM Buoy / Working 7/10 ice strip passing
through location**

**May/15 - Smit Sibb
Don Connelly**

Ice & environmental conditions

- Dynamic ice, typically travelling in an oval loop (tidal driven) about once a day
- Maximum observed speed of ice ~ 2 knots, typically daily return speed 1.5 knots
- Level ice thickness: up to 1.5 m
- Ridges, up to 5 m sails and over 10 m keels
- Ridge consolidation: up to several ice thicknesses
- Ice roughness: up to 4 balls, typically 3 (40-60 % rough ice cover)
- Ice floe size: ~ 20 m, largest about 100 m
- Ice coverage: ~ 9 tenths, max 10
- Ice floe mass: up to 40 000 tons

Operational limits

- Actual dynamic positioning ability in ice, expressed as load level of the propellers in DP operation
- Ice floe size and speed, with unacceptable mass and inertia
- Consequence to the Vessel of drifting off location (whether Molikpaq was updrift or downdrift, or not within a distance of concern)
- Ice entering either the diving or working moonpool
- Ice entering bow thrusters regularly
- Ice threatening to hull strength

Ice alert level

- Alert level 1: early warning of 6 hours till severe ice gets to site
- Alert level 2: 2 hours till severe ice gets to site
- Alert level 3: 1 hour till severe ice gets to site
- Alert level 4: imminent presence of severe ice at the Vessel.

The alert levels were intended to indicate the time of arrival of hazardous ice.

Icebreaker priority: convert hazardous ice to non-hazardous, prior to the ice entering the 1 hour safety zone.

Ice alert actions

- Alert levels 1-2: Diving allowed to continue
- Alert levels 1-3: DP operation possible
- Alert level 4: Stopping DP operations, the Vessel was escorted off location (if upstream of Molikpaq) or immediately allowed to drift with the ice.

Ice management staff – 4 people

- Ice management director. Duty:
 - to issue alerts as well as continuously monitor the level of safety
 - to update the procedures to match observed actual operational safety level
- Ice management master. Duty:
 - to coordinate all ice management between the two icebreakers
 - being in charge of locating the approaching severe ice
 - evaluating its severity by testing it with the icebreaker (stayed on one of the icebreakers)
- 2 ice observers. Duty:
 - to monitor the ice movement 24 hours a day (12 hours shift)
 - to inform the operations personnel (DP officers and icebreakers) of the direction and speed of the ice drift
 - forecast the ice drift
 - documentation of the environmental/ice conditions + effects on diving/construction operations.

Ice management procedures

- The icebreakers worked up-drift of the Vessel
- One icebreakers worked relatively close in, while the other worked further up-drift of the Vessel
- Icebreaker 1 (the further up-drift one) was important for managing ice and for evaluating the severity of the approaching ice
- Icebreaker 2 broke ice in the immediate vicinity of the Vessel
- Typically in high concentrations:
 - Icebreaker 1 operated up to 3 nm from the Vessel
 - Icebreaker 2 operated 0-0.5 nm from the Vessel

Primary role if icebreakers: To manage the largest, thickest ice floes, which exceeded the mass necessary to push the Vessel off location.

Ice management patterns

- Fast moving, highly concentrated ice drift: Most efficient with a linear (straight line) icebreaking pattern up-drift the Vessel
- Slowly moving ice: Most effective with a circular pattern, especially for Icebreaker 2.

Challenges

- The detection and changes of ice drift speed and direction, especially in low ice speed conditions from a non-fixed platform
- Pushing the heavy ice floes off the drift line – but still more efficient than ramming onto such floes to split them to small enough pieces
- Ice management in darkness and low visibility (fog or heavy snow fall) -> increased the danger of overlooking a large floe
- Pressure ice -> the icebreakers were slowed down to allow speed – used a considerable amount of time and space to make a turn in ice.

Conclusive remarks

- The first ever DP operation in ice worked successfully and allowed timely completion of the required, mainly underwater, construction.
- The operations took place in the presence of a significant amount of moving ice
- Ice downtime 22 %
- The ice management capability of the icebreakers was considered the main limiting factor
- It is now considered possible to operate DP vessels in ice with much more efficiency than anticipated
- It is also considered possible to design a DP vessel for ice operations which could, with some downtime, operate on a year round basis in the ice conditions typical for the east coast of Sakhalin Island.