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SCIENTIFIC STUDIES DURING THE "KURDISTAN" TANKER INCIDENT:  
PROCEEDINGS OF A WORKSHOP

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Edited by  
J.H. Vandermeulen  
Marine Ecology Laboratory  
Bedford Institute of Oceanography  
Dartmouth, Nova Scotia  
Canada B2Y 4A2

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WAVE CLIMATE OVER THE CONTINENTAL SHELF AND ITS IMPACT ON THE  
OILSPILLS OF THE ARROW, ARGO MERCHANT and KURDISTAN

by

H.J.A. Neu

Atlantic Oceanographic Laboratory  
Bedford Institute of Oceanography  
Dartmouth, N.S.

In the open waters of the Continental Shelf of Atlantic Canada and New England States, waves are the most disturbing factor in tanker accidents and in the recovery of the oil which has been spilled. Wave heights vary with location and season, increasing from the New England coast to Newfoundland by about 1 to 2 m and being highest in the winter and about half of that during the summer. In this brief presentation, the impact of this seasonally varying seastate on the major tanker accidents, on salvage efforts and on recovery of the spilled oil is analyzed.

TANKER SPILLS

The tanker Arrow, which grounded during a storm on February 4, 1970, sank during the subsequent storm on February 12, 1970. At the approaches to Chedabucto Bay, the waves of both storms were in the order of 6 to 7 m, close to the monthly maximum value of the region. At the site, conditions were aggravated by refraction from shoals and ledges which focused wave energy from the SE toward Cerberus Rock on which the tanker was resting (Fig. 1).

In contrast, the Argo Merchant ran aground in calm weather on a sand bank near Nantucket Island on December 15, 1976, initially with minor damage and little oil spilled. Failure to salvage the vessel quickly and the continuous action of waves 1 to 2 m high weakened the vessel. Six days later a storm with 2 to 3 m waves broke the tanker and spilled the entire oil load into the ocean.

Completely different again is the experience of the Kurdistan on March 15, 1979, at the entrance to Cabot Strait. In heavy pack ice and with waves in the order of 6 to 7 m (Fig. 2), a crack developed in the hull and later the vessel broke into two parts, spilling more than 7,000 tons of

Bunker-C oil into the ice-infested waters of the Strait. The bow and stern sections remained intact and proved surprisingly seaworthy. Eventually, the stern section was brought into Port Hawkesbury, in the Strait of Canso and the bow section was sunk off the edge of the Continental Shelf.

From this brief account of the accidents, it is obvious that waves played an important role in the destruction of the tankers. All three mishaps occurred during the winter months when more than 250 North Atlantic weather disturbances propagate along the coast of North America and across the North Atlantic. These storms generate wave heights which vary with location. In Figure 3, the largest monthly significant wave heights of the North Atlantic, based on the 1970 to 1972 data, are given for the months December to March. It can be seen immediately that the waves which destroyed the tankers were, in the case of the Arrow and the Kurdistan, close to being the largest in the respective months.

#### SALVAGE EFFORTS

As soon as a tanker is in distress, salvaging the vessel and preventing oil from entering the sea is the priority task. In cases of groundings, these operations usually take weeks and require calm seas, a rare occurrence during the winter months.

Monthly height distributions are given in Figure 4, for the Scotian Shelf and for the 12 months of the year. Waves are large and frequent during the winter from November to March but grow appreciably smaller and less frequent until the summer months of June and July. Assuming 3 to 4 metre waves as the wave height limit for salvage operations on tankers in the open sea (wave heights given here are  $H_{sig} = 4$  m and therefore include heights up to a maximum of 7.2 m), then it can be expected that during the summer months from May to August salvage operations can be performed during a large part of the time without undue interference from waves. However, during the winter, the critical wave height is exceeded about 25% of the time, equivalent to 7 days integrated time each month, or more realistically 12 to 14 storms of about half a day duration each month. Under these circumstances it would be extremely difficult to conduct successful salvage or repair operations on stricken oil tankers. But it should be noted that even 4 m waves can cause problems, as was demonstrated with the Kurdistan

where towing just the bow section alone in a seastate with only 4 m waves was very difficult for the tugs available for the operation. This indicates the need for larger and more powerful sea-going tugs on the Atlantic Coast to meet such requirements.

#### OIL RECOVERY

For the recovery of oil from the surface of the ocean, oil booms and clean-up equipment have been developed; however, in none of the three accidents under discussion has oil been recovered from the surface of the ocean in any significant amount. The reason for this is that the most up-to-date equipment and recovery methods do not yet work in ocean conditions; even in the case of the Argo Merchant with its lower sea state no effort was made to apply them.

The question therefore arises whether oil recovery from the open ocean is at all feasible. In order to evaluate this, an upper wave height limit is again assumed at which oil booms, surface skimmers and other equipment are still useful. Disregarding specialized heavy duty equipment developed for specific applications on oil platforms in that North Sea, the critical height is about 1.5 to 2 m. Applying this wave height to the monthly wave height distributions in Figure 4, it is seen that only 25% of the waves in the summer months exceed this value. Provided that the equipment is sufficiently seaworthy to withstand higher waves during the waiting periods for calmer weather, oil can probably be recovered during the summer with a relatively high degree of success. During the winter, however, 80% of the waves exceed this critical value. Recovery of oil during this period then becomes very impractical.

#### OBSERVATIONS AND CONCLUSIONS

- (1) The destruction of the tankers Arrow, Argo Merchant and the breaking of the Kurdistan into two parts took place during the winter, coinciding with high wave activity.
- (2) During the destruction, waves were close to the maximum monthly level, except for the Argo Merchant where it was only half that value.

- (3) The difficulties encountered in towing the bow section of the Kurdistan demonstrates the need for tugs on the Atlantic coast powerful enough to handle stricken tankers in heavy seas.
- (4) With the exception of towing stricken tankers into protected areas or harbours, salvage operations in open sea during the winter are very impractical.
- (5) With the present state of the art in the field of oil recovery and with equipment available today, oil can be recovered from the surface of the ocean only during the summer. During the winter months, efforts to do so will generally fail.

#### ACKNOWLEDGEMENT

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#### BIBLIOGRAPHY

- NEU, H.J.A. 1970. The hydrodynamics of Chedabucto Bay and its influence on the Arrow oil disaster. Atlantic Oceanographic Laboratory, Bedford Institute of Oceanography, Report 1970-76, Dartmouth, N.S.
- NEU, H.J.A. 1976. Wave Climate of the North Atlantic - 1970. Atlantic Oceanographic Laboratory, Bedford Institute of Oceanography, Report/BI-R-76-10, Dartmouth, N.S.
- WALKER, R.W. 1976. Wave statistics for the North Atlantic - 1970. Atlantic Oceanographic Laboratory, Bedford Institute of Oceanography, Data Series/BI-D-76, Dartmouth, N.S.
- WALKER, R.E. 1977. Wave Statistics for the North Atlantic - 1971. Atlantic Oceanographic Laboratory, Bedford Institute of Oceanography, Data Series/BI-D-77, Dartmouth, N.S.
- WALKER, R.E. 1978. Wave statistics for the North Atlantic - 1972. Atlantic Oceanographic Laboratory, Bedford Institute of Oceanography, Data Series/BI-D-78, Dartmouth, N.S.

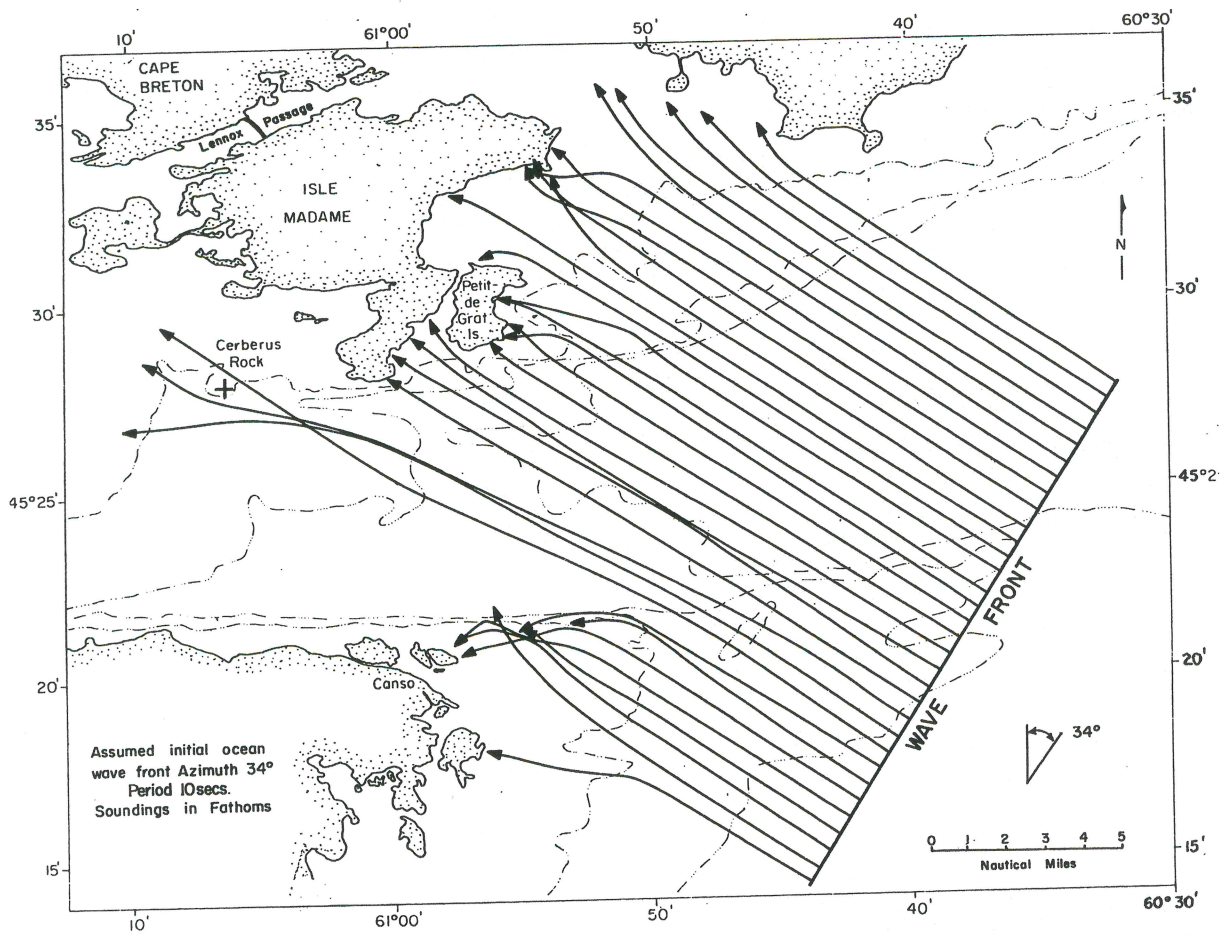


Figure 1. Wave refraction diagram of a 10-second wave train in Chedabucto Bay - 34° wave front.

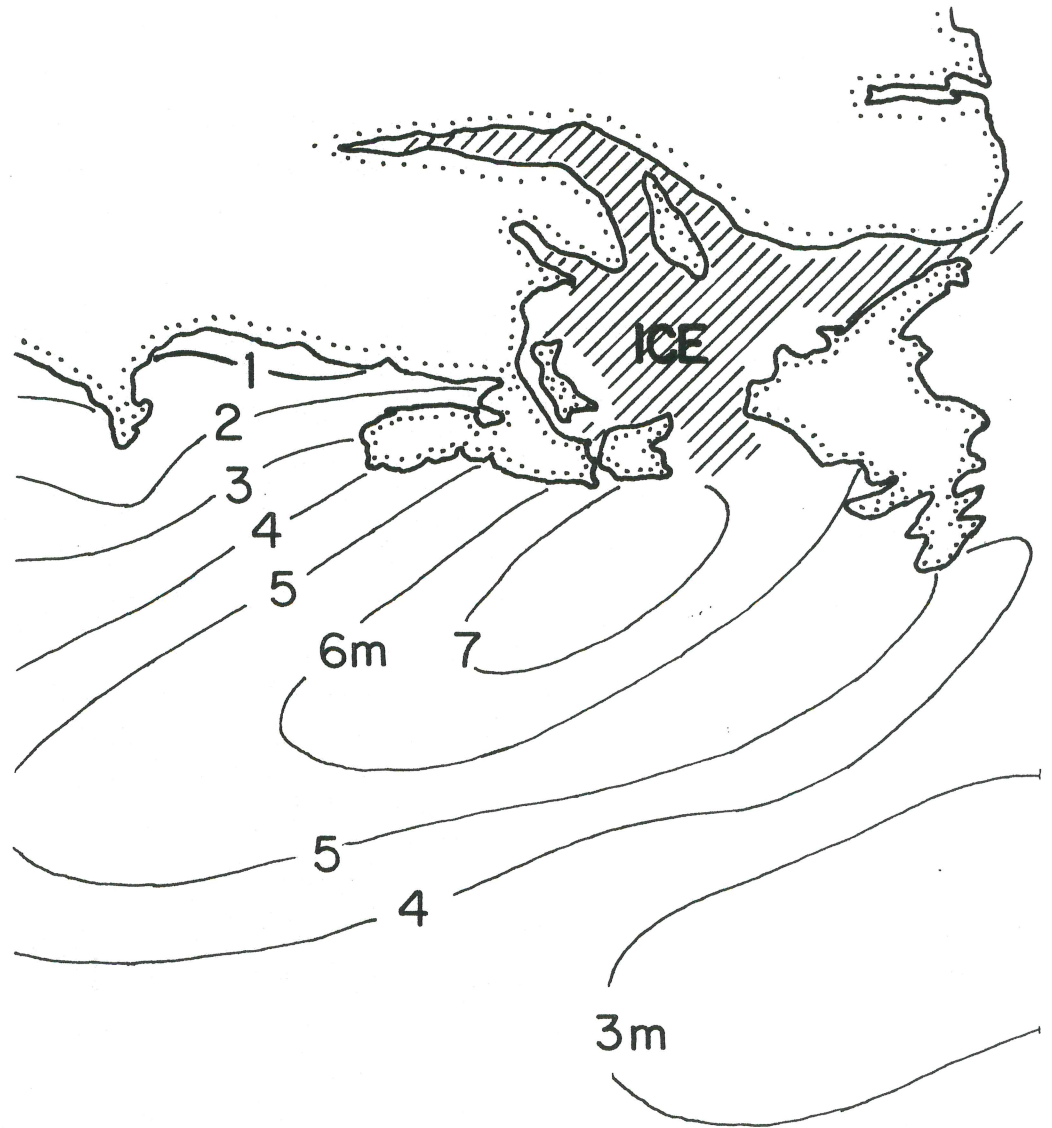


Figure 2. Wave data chart, 15 March 1979, 1200Z (from C.F. METOC Centre).

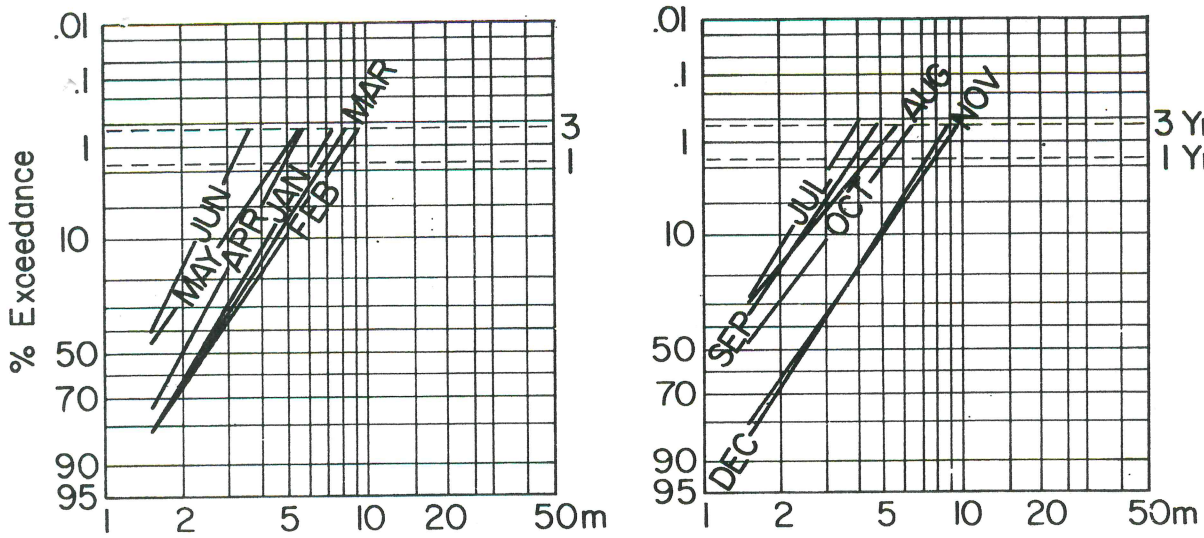


Figure 3. Largest monthly wave height ( $H_{sig}$  in m) of the North Atlantic from December to March.

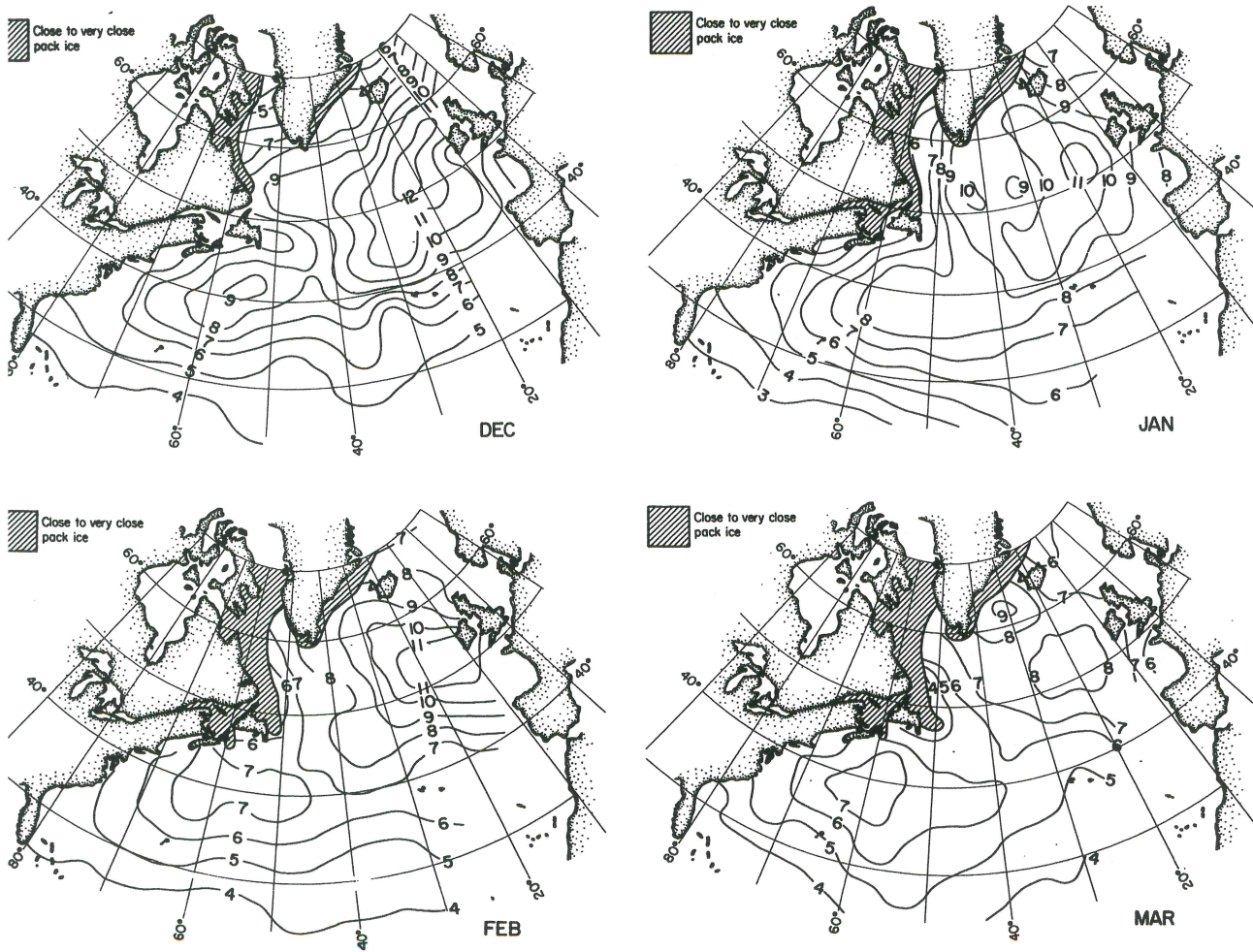


Figure 4. Monthly wave height distribution ( $H_{sig}$ ) of the Scotian Shelf.