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ICE AND OIL RESEARCH AT HYDRAULICS RESEARCH DIVISION NATIONAL WATER RESEARCH INSTITUTE CANADA CENTRE FOR INLAND WATERS

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Ice and oil research is part of the research activities carried out at the National Water Research Institute (NWRI). The chemical and biological aspects of the research are conducted in the Process Research Division and the physical aspect of the research is conducted in the Hydraulics Research Division. Only the research work conducted in the Hydraulics Research Division is reported here.

A cold environment hydraulics research program was established at NWRI in 1972. In the first two to three years, effort was concentrated in constructing research facilities for the program. As a result, NWRI may claim today to have the best cold environment hydraulics research facilities in Canada. The unique facilities enable the conduction of research projects for which a simulated cold environment is necessary.

The cold environment hydraulics research facilities include a cold room 6 m wide x 18 m long (20'x60'). The cold room is refrigerated by two independent refrigeration systems which, when operating together, can cool the room to -35°C. The temperature of the cold room is controllable to within 0.5°C, both spacewise and timewise. A recirculating flume is installed in the cold room in which an ice cover or slush ice can be produced. This permits the study of oil behaviour in rivers in winter. A wave flume is also installed in the cold room in which one may study the behaviour of oil spilled on the sea when waves and ice are involved. Snow-making facilities are built in the cold room and this permits one to study the interaction of oil and snow. NWRI will be responsive to industrial requests in carrying out research projects to assist the industry.

NWRI has been conducting oil and ice research since 1974. The first project was to study the ice conditions in St. Clair and Detroit Rivers, the probability of oil spill in winter in these two rivers and the countermeasures should a winter oil spill occur. The research project was conducted upon the request of Operation Preparedness, a Canada-U.S. cooperative program on oil spill countermeasures for the the St. Clair and Detroit Rivers. Research (Tsang, 1975) showed that winter oil spill in the two rivers is very probable, especially if the navigation season is to be extended. The most likely form of ice at the time of an oil spill is drifting ice floes. There was no available technology to handle such an oil spill. An oblique, perforated boom was suggested as a means to separate the oil and the ice.

The above findings led to the development of an ice-oil boom in a subsequent project. Extensive theoretical and laboratory work was conducted that led to the construction of a prototype boom built by the U.S. Coast Guard for field testing in the Detroit River. The boom was found to be very effective in oil containment and recovery in ice-infested flowing waters. The ice-oil boom is presently the only available apparatus in oil spill containment and control under the above conditions. Development of the ice-oil boom was reported in the 1979 Oil Spill Conference (Tsang, 1979). Since then, more laboratory work was done to obtain more design parameters. The second-generation design should be easier to construct and will also be cheaper. Besides its use in ice-infested flowing waters, the ice-oil boom may also be used as a sweeper for concentrating the oil spilled on a calm sea, with or without ice floes, as shown in Figure 1.

In response to a request from the Prairie Region Oil Spill Containment and Recovery Advisory Committee (PROSCRAC), another technological development project was undertaken to study the recovery of oil spilled under river ice cover. Through extensive laboratory experiments, two methods were recommended, one by cutting angled slots in the ice cover to trap and divert the oil and the other by putting an imbedded

barrier through the ice cover to guide the oil to a recovery point. Criteria governing the slot and barrier geometries, flow characteristics and oil properties were established. These methods were field tested in Alberta. The slot-cutting technique was found to be especially successful. More than 99 percent of the spilled oil was recovered. This technique is now widely recommended by the oil industry. The research work for the above project was also reported at the 1979 Oil Spill Conference (Tsang, 1979; Telford and Quam, 1979).

More work will be done in ice-oil-gas research. Among the interesting topics to NWRI are the interaction between oil and slush ice and the rise of an oil and gas plume under an ice cover. Industrial cooperation will accelerate the initiation of the projects.

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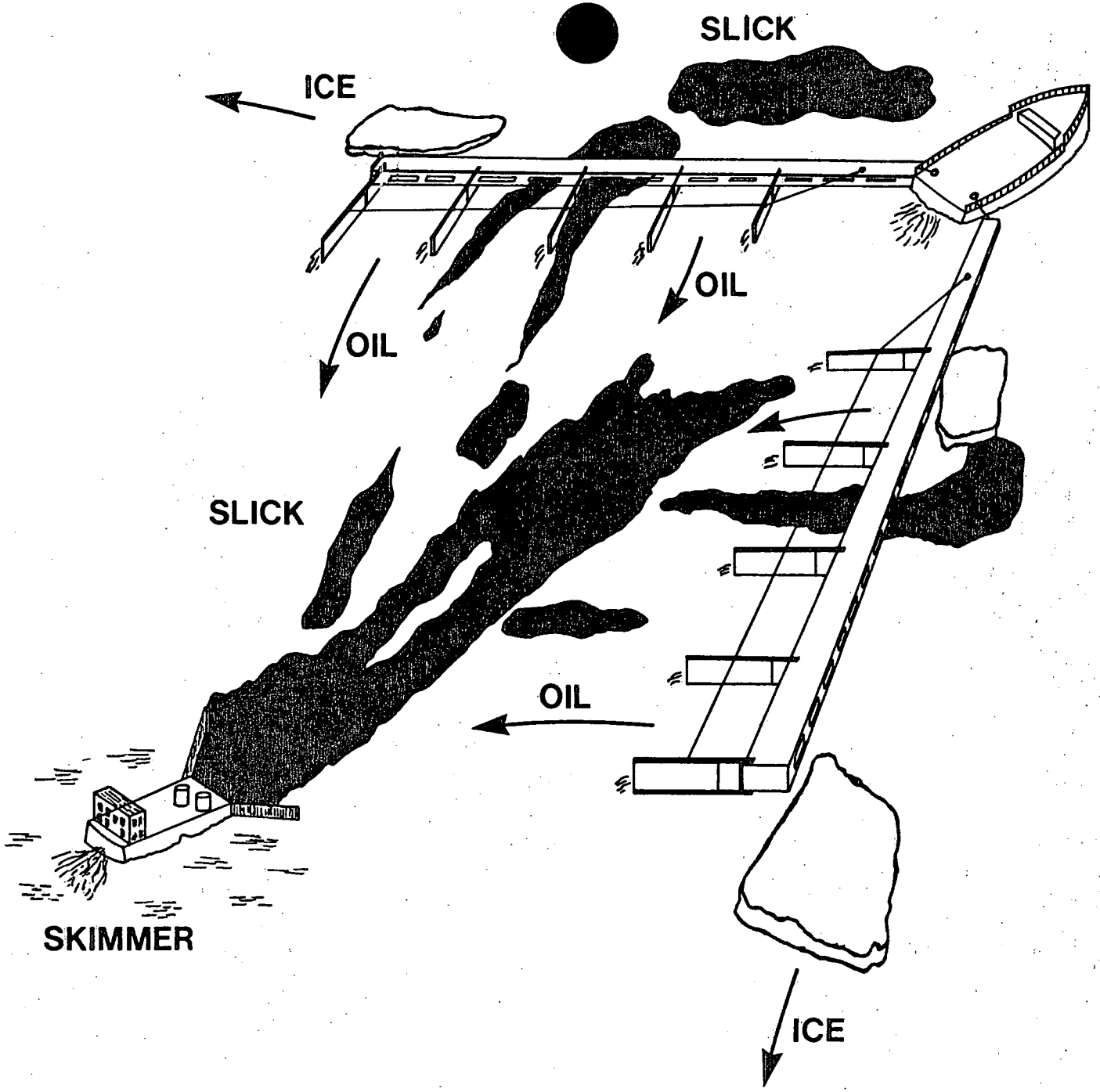

FIG.1 USE OF ICE-OIL BOOM FOR SEA SPILL OPERATION