This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

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Standard Guide for Collecting Skimmer Performance Data in Ice Conditions[1]

This standard is issued under the fixed designation F3350; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide defines a procedure and measurement criteria to quantify the recovery rate and efficiency of a stationary skimmer system in drift ice conditions.

1.2 The suggested procedure and test parameters are intended to provide conditions typical of relatively sparse drift ice and relatively dense drift ice coverage.

1.3 It is accepted that the recovery rate as determined by this guide will not likely be achievable under actual conditions of a spill. The procedure in this guide does not account for such issues as changing recovery conditions, number of daylight hours, operator downtime, less than ideal control of skimmer settings, and inclement weather.

1.4 The procedure in this guide involves the use of specific test oils that may be considered hazardous materials. It is the responsibility of the user of this guide to procure and abide by necessary permits and regulations for the use and disposal of test oil.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D971 Test Method for Interfacial Tension of Insulating Liquids Against Water by the Ring Method

D1298 Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method

D2983 Test Method for Low-Temperature Viscosity of Automatic Transmission Fluids, Hydraulic Fluids, and Lubricants using a Rotational Viscometer

D4007 Test Method for Water and Sediment in Crude Oil by the Centrifuge Method (Laboratory Procedure)

F631 Guide for Collecting Skimmer Performance Data in Controlled Environments

F2709 Test Method for Determining a Measured Nameplate Recovery Rate of Stationary Oil Skimmer Systems

3. Terminology

3.1 *Definitions:*

3.1.1 *oil recovery efficiency (ORE), n*—the ratio, expressed as a percentage, of the volume of oil recovered to the total volume of fluid recovered.

3.1.2 *oil recovery rate (ORR), n*—the volume of oil recovered by the device per unit of time (m^3/h).

3.1.2.1 *Discussion*—Note that the measurement is of oil only, after netting out free and emulsified water.

3.1.3 *operational efficiency (OpEff), n*—the ratio, expressed as a percentage, of the time spent actually skimming to the total test time, having deducted time spent out of the water to re-position the device.

3.1.3.1 *Discussion*—This may be of particular interest in dense ice cover, when a significant portion of the test period may be spent re-positioning the skimmer to find thick patches of oil.

3.1.4 *skimmer system, n*—a skimmer along with its associated power supply, hydraulic lines, offloading pump, control apparatus, and accessories.

3.1.5 *total test time, n*—the period of time from the start to end of collecting recovered fluids for measurement including repositioning.

4. Significance and Use

4.1 This guide establishes test conditions that will provide a measured oil recovery rate and efficiency for a skimmer operating in drift ice.

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[1] This guide is under the jurisdiction of ASTM Committee F20 on Hazardous Substances and Oil Spill Response and is the direct responsibility of Subcommittee F20.12 on Removal.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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4.2 End users need a procedure to quantify optimum performance data for planning and selection of equipment.

4.3 The procedure in this guide will assist in verifying and accurately reporting skimmer system performance.

4.4 Tests will be conducted under well documented conditions and provide repeatable results. Other detailed testing and collection of skimmer performance data are covered under existing standards (see Guide F631 and Test Method F2709).

5. Test Facilities

5.1 Tests should be performed within a tank or boomed area that will contain the oil and constructed ice field. The minimum lateral dimensions of the test tank shall be three times the length and width of the skimmer device. For example, a skimmer with a lateral footprint of 2 m by 3 m would require a minimum test area of 6 m by 9 m. Note that the test area may have to be increased beyond the minimum test area to ensure that the skimmer has access to enough oil for a 30 s minimum collection time. The following calculation can be made to determine the minimum test area that will contain adequate oil for a 30 s skimmer test, based on estimated skimmer performance:

$$\text{Min Test Area}(\text{m}^2) = [\text{predicted recovery rate}(\text{m}^3/\text{h}) \times (\text{length of test (h)})] \div (1 - \%\ \text{ice coverage}) \times (\text{oil thickness}) \quad (1)$$

where:

length of test	=	0.00833 h,
oil thickness	=	0.025 m, and
predicted recovery rate	=	minimum recovery rate expected for the skimmer.

5.2 The tank depth shall accommodate the skimmer without grounding during the test.

5.3 Test oils shall be identified by industry-accepted name and are recommended to fall within the five categories defined in Guide F631. It is recommended that the skimmer system be tested in two or more oil types for comparison purposes.

NOTE 1—Type 1 in particular is recommended to allow comparison with other tests.

5.4 The preferred test oil is a refined product, which is selected to provide a stable test fluid over the test period (that is, minimal evaporation and emulsification) and present no breathing hazard related to oil vapors.

5.5 The oils used for testing will be characterized from samples taken at the start of a test series and when oil is replenished from a new source. A test oil log shall be generated and will indicate test oil type, sample number, temperature, and test date.

5.6 The following tests are to be conducted on test oils: viscosity (Test Method D2983), bottom solids and water (Test Method D4007), specific gravity (Test Method D1298), surface, and interfacial tension (Test Method D971). Viscosity may also be established using a published temperature/viscosity chart for the test oil.

5.7 Manual temperature measurements of the test oil will be taken in or near the skimmer sump with an accuracy of ±1 °C. Note that if testing outdoors, solar effects may significantly increase surface oil temperature. If steam or heat is introduced into the skimmer system as part of its design, additional measurements are to be taken before such heating to accurately gauge the properties of the oil.

5.8 Ambient air test temperature shall be recorded. Temperature of the water in the test basin shall be recorded.

5.9 Record water salinity if applicable.

5.10 Tanks are required for storage of recovered product and subsequent volume measurements. The collection tanks shall be elevated above the test oil surface to accommodate a required static head on the skimmer system equal to 3.5 m of fluid.

5.11 Alternatively, a variable flow restriction with pressure gauge may be substituted to simulate the static head (3.5 m) and dynamic head (frictional losses) at the flow rates expected.

5.12 For skimmers that do not include a discharge pump, the recovery rate shall be measured as oil accumulates in the skimmer's sump.

5.13 When applicable, hydraulic pressure and flow measurements shall be made during the tests. Pressure and flow values shall not exceed manufacturer recommendations.

5.14 *Ice Conditions*—Tests should be performed using two different ice concentrations, 30 % and 70 % coverage. These ice concentrations are generally regarded as thresholds for mechanical recovery in ice: below 30 % concentration, oil slick thickness equilibrium is minimally affected by the presence of ice, and above 70 % concentration, oil slick thickness equilibrium is severely restricted and, while skimming may be possible, it may require moving the skimmer from oil pocket to oil pocket within the ice.

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5.15 Ice for the tests can be salt-water or freshwater.

5.16 Prior to testing, ice will be added to the test area, to achieve the desired coverage using the following size distribution (55 % 1 × 1 m + 30 % 0.5 × 0.5 m + 15 % small fragments). This actual size distribution is based on an analysis of fields of broken pack ice and has been defined as representative and been used in previous oil-in-ice experiments.

5.17 If produced as larger size pieces, ice can be broken manually to produce the specified sizes. Ice coverage will be estimated initially by measuring the area of the ice pieces added to the test area, and will be confirmed subsequent to the test for documentation in the test report using an image area analytical technique of overhead digital photographs or other comparable technique.

5.18 Ice thickness should be approximately 200 mm (8 in.) or greater to allow for adequate freeboard.

5.19 *Slick Thickness*—Tests should be performed with a slick thickness of 25 mm (1 in.). This thickness is selected to allow comparison with previous testing performed as part of the SINTEF[3] skimmer development and testing program. It is

[3] https://www.sintef.no/en/.