PUB. NO. 606-D:
Ice Observations

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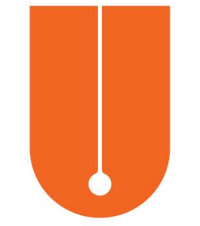

UNITED STATES NAVAL
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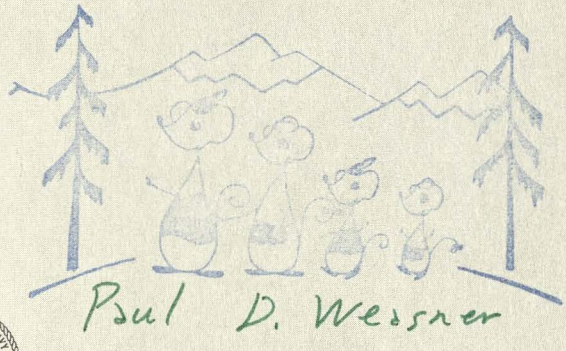
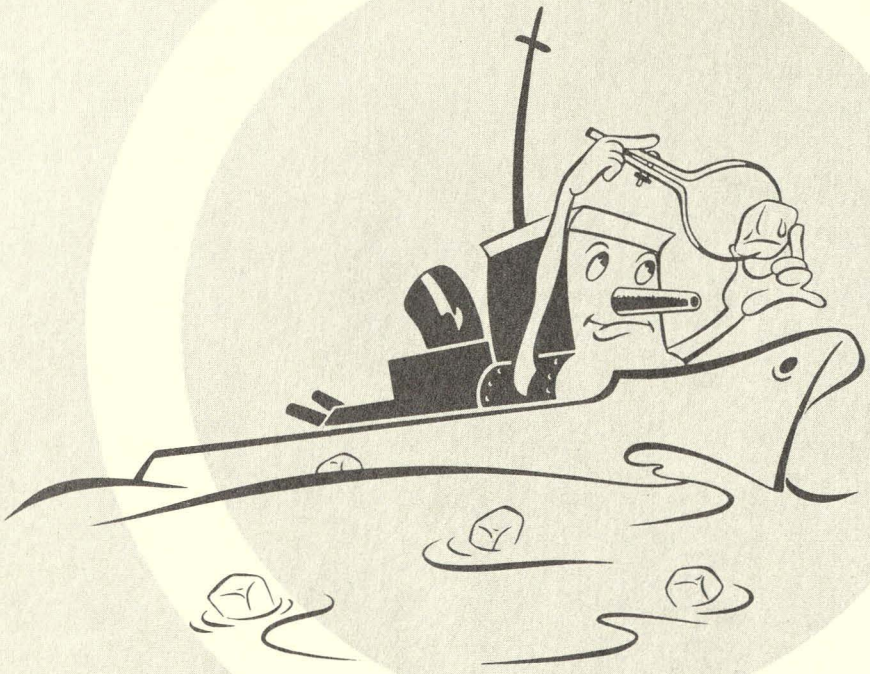
hydrographic office observers manual



Paul D. Weasner

H. O. PUB. NO. 606-d

ICE OBSERVATIONS



H. O. PUB. NO. 606-d
HYDROGRAPHIC OFFICE OBSERVERS MANUAL

ICE OBSERVATIONS

PUBLISHED BY: THE U. S. NAVY HYDROGRAPHIC OFFICE
UNDER THE AUTHORITY OF THE SECRETARY OF THE NAVY
WASHINGTON, D. C., 1954

SECOND EDITION 1956
Price: 15¢

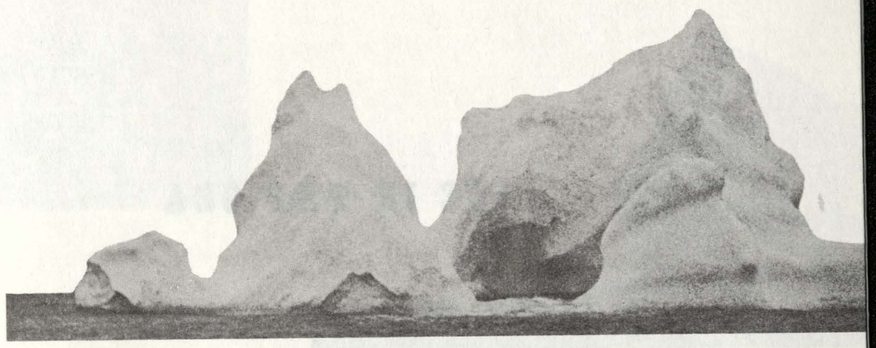
Voyages conducted by many nations during the years since World War II have added vastly to the mariner's knowledge of the seas around the poles. It has been demonstrated that modern vessels can cruise in these waters more extensively than was previously believed possible. Yet any voyage into ice-filled seas, even though conducted aboard a powerful, steel-prowed icebreaker, is attended by hazards and difficulties unknown in warmer oceans. The effects of weather are compounded by the restless ice pack. It is imperative that a vessel approaching ice operations be given all possible information on the character and distribution of the pack if it is to proceed with efficiency and safety.

To provide mariners venturing into polar regions with the information necessary for safe conduct of their operations, the U. S. Navy Hydrographic Office issues ice bulletins as part of regularly scheduled broadcasts. The bulletins are compilations of data obtained from shipboard, shore, and aircraft observers who forward their ice observations to the Hydrographic Office along with routine weather reports. For this program to be fully effective, it is essential that all vessels and air units operating in ice areas cooperate with the Hydrographic Office. Each bit of information adds to the steadily increasing knowledge of these least-travelled and remotest seas, and thus contributes to safe cruising and a successful voyage.

ICE OBSERVATIONS AND THE ICE OBSERVER

Ice observations are made from aboard ship, from land stations, and from aircraft, with each type of observation offering specified information. A comprehensive description of ice conditions requires a combination of the three types of observations.

Shipboard observers are in a position to examine closely the ice immediately around their vessel. From this vantage they can determine accurately the texture and solidity of the ice, variations in thickness, state of deterioration, and other features requiring actual contact with the ice. Shore-based observers are able to make accurate measurements of such features as topographic heights, thickness of ice, and depth of snow cover near shore.



Both ship and shore observations are limited to small areas immediately surrounding their stations, however, and the data from any one observer is therefore local in nature. The helicopter has done something to enlarge the land and ship observer's horizon, but helicopter observation must still be considered a tactical operation providing short-range reconnaissance.

The detailed and first-hand information provided by local ship and shore observers is complemented by the long-range sweeps of aircraft which provide information on the concentration and extent of the ice pack over great areas and of large-scale changes that affect sea operations and shore conditions.

Whether the observer is ashore, aboard ship, or a member of an air crew, he must be trained so that he knows what to look for and how to evaluate what he sees. Since there are few experienced observers to act as instructors, most new observers are self-taught. This manual should aid the neophyte by outlining the procedures of ice observations, listing useful publications, and illustrating methods of recording and reporting.

If possible, the observer should begin his preparation sufficiently in advance of an arctic operation so that he can obtain the necessary publications and training aids. There are a number of informative films on arctic exploration issued by the U. S. Navy which may be obtained on loan. Photographs illustrating techniques used in the various phases of ice observations are also available, and a number of publications containing useful background information have been prepared by the Navy.

Several publications issued by the Hydrographic Office must be used in observing and reporting ice conditions, namely:

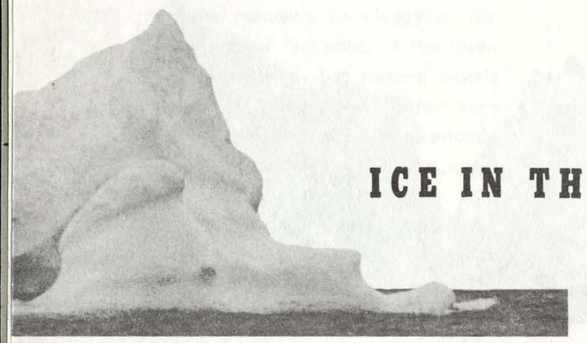
H. O. Pub. No. 609, "A Functional Glossary of Ice Terminology" (referred to in this manual as the "Glossary")

H. O. Misc. 15584 (Revised), "Ship Ice Log"

H. O. Misc. 15603, "Aerial Ice Reconnaissance"

PRNC-NHO 1367, "Shore Station Observers Ice Log"

These publications may be obtained from the U. S. Navy Hydrographic Office, Washington 25, D. C.



ICE IN THE SEA

Ice in the sea consists, for the most part, of either sea ice formed by the freezing of top layers of the ocean, or icebergs originating from glaciers or continental ice sheets. Sea ice accounts for probably 95 per cent of the area of ice encountered, but bergs are important because of the manner in which they drift from their point of origin, constituting a navigation hazard. A certain amount of ice encountered at sea originates in rivers or estuaries as fresh water ice; however, as it is already in a state of deterioration by the time it reaches the open sea its importance is local.

SEA ICE

The first sign that the sea surface is freezing is an oily opaque appearance of the water. This appearance is caused by the formation of spicules, minute ice needles, and thin plates of ice known as frazil crystals, which increase in number until the sea is covered by slush of a thick soupy consistency. Except in wind-sheltered areas, the slush, as it thickens, breaks up into separate masses, frequently in the characteristic pancake form. The raised edges and rounded shapes result from collisions of the cakes. With the continuation of low temperatures the cakes freeze into a continuous sheet.

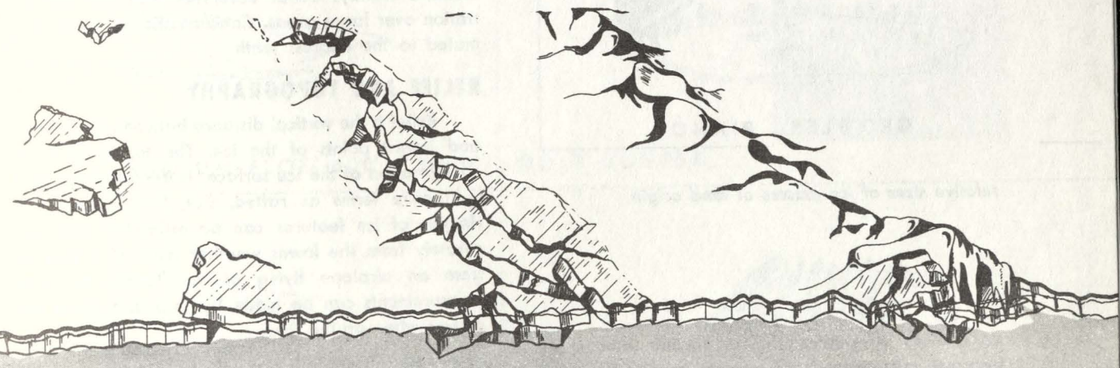
Ice may grow to a thickness of 4 or 5 inches in the first 48 hours, after which growth becomes progressively slower. Sea ice seldom becomes more than 5 to 7 feet thick the first winter. Greater thicknesses can be formed by rafting, tidal overflow, and similar causes.

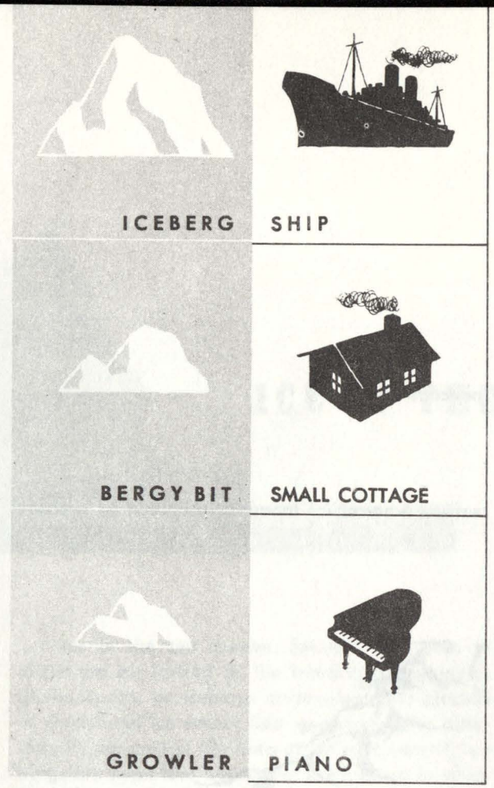
Under the influence of winds, tides, currents, and pressure, the ice is torn apart in some localities and crowded together in others. As stresses are relieved, long cracks develop which permit movement of segments within the pack. With the shifting of the ice, crowding may cause the ice to pile up into pressure ridges and hummocks. Rafting (overriding of one piece onto another) is the most common effect of pressure.

In spring or summer as snow or the surface of the ice melts, the ice becomes covered with water. Continued thawing of the ice develops honeycomb passages and holes into which the surface water drains. Sea ice less than one year old (winter ice), which is somewhat salty, melts more readily than older less saline floes. Fast ice (ice connected to the shore) ususally melts near shore first because of the relatively warm water which runs onto it from the land. Winds, waves, tides, currents, and outflow from rivers aid breakup and melting by mechanical means.

pancake ice

various types of ice topography caused by pressure





relative sizes of ice masses of land origin

As melting progresses, the ice farther from shore becomes criss-crossed with cracks caused by tides, winds, air temperature changes, and ice pressure.

ICE OF LAND ORIGIN

Ice of land origin in the sea, though often spectacular, is of minor importance in arctic operations except in localized areas.

Icebergs are large masses of ice detached from the fronts of glaciers, from glacier ice tongues, or from the shelf ice of the Antarctic. Smaller masses, termed growlers and bergy bits, originate, like bergs, from glaciers, or are formed from the disintegration of icebergs and other masses of land-formed ice.

CHARACTERISTICS

Certain properties of ice in the sea should be measured and recorded by shipboard, shore-based, and airborne observers. The following paragraphs describe briefly the ice characteristics that are observed and reported to the H. O.

CONCENTRATION

The observer should determine the total ice concentration as well as the concentration of brash and block, small and medium floes, and giant floes and fields. Shipboard and shore-station observers are concerned with the concentration in their immediate vicinity; aerial observers with the concentration over large areas. Concentration is to be estimated to the nearest tenth.

RELIEF AND TOPOGRAPHY

Relief is the vertical distance between the highest and lowest points of the ice. The topography, or configuration of the ice surface, is described by such qualitative terms as rafted, flat, hummocked, etc. Heights of ice features can be estimated most accurately from the lower weather deck of a ship or from an airplane flying at low levels. Accurate measurements can be made by ship and shore observers when on the ice.

ICE AGE

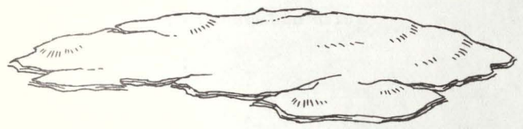
Whenever possible it is important to distinguish older, harder ice from newer, softer ice. Arctic, or older, ice will often appear in fields of winter ice as a light blue island surrounded by light green or gray-blue ice. Both the dominant and secondary ages should be determined if more than one age is present.

SNOW COVER

The depth of the snow should be estimated or measured directly by shipboard and shore-based observers. Aerial observers should simply categorize the snow as continuous, drifted, or not present.

relative sizes of sea ice ▶

FIELD: > 5 MILES



GIANT FLOE: 3000′ — 5 MILES

SMALL CITY

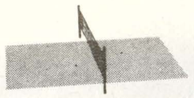
MEDIUM FLOE: 600′ — 3000′

GOLF COURSE

SMALL FLOE: 30′ — 600′

CITY BLOCK

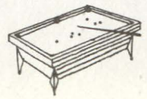
BLOCK: 6′ — 30′



VOLLEY BALL COURT

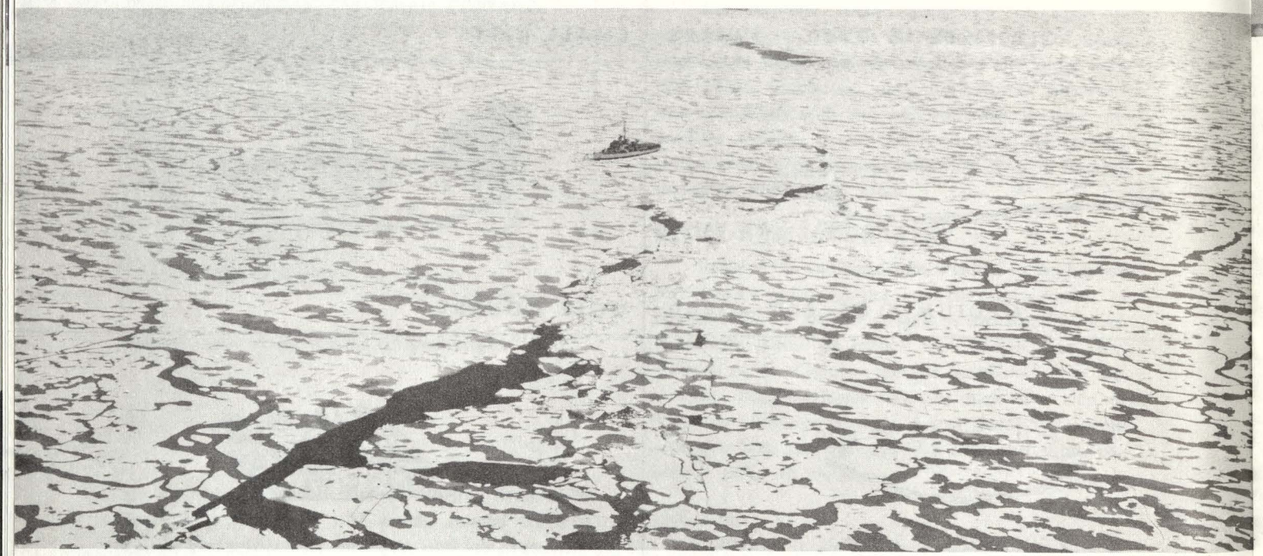
BRASH: 6′

POOL TABLE TOP



cracks, leads, and polynyi ▶

frozen and unfrozen puddles ▼



PUDDLING

Both frozen and unfrozen puddles are easily identified by any observer. Frozen puddles appear to shore and shipboard observers as greenish "ground glass" patches against a lighter background. To the aerial observer puddles beginning to freeze appear ashen gray, whereas puddles frozen solid are powder blue. To the shipboard and land-station observer, puddles that have melted through appear the same shade and color as the open water. The aerial observer sees such puddles as almost black.

▼ *fast ice*

WATER FEATURES

The number, type, and orientation of water features may be determined readily for particular areas. Shipboard and shore station observers, because of their limited scope, probably will not be able to determine the over-all characteristics of distant leads, cracks, and polynyi (large areas of open water other than leads) as well as the aerial observer. Open and newly frozen features should all be noted. Artificially formed cracks and leads should not be considered.

FAST ICE

Any sea or fresh water ice that is attached to the shore by stranding or by other means is called fast ice. Glaciers fronting the sea are considered as part of the land. Shore observers are best able to describe local changes in the characteristics of this ice.

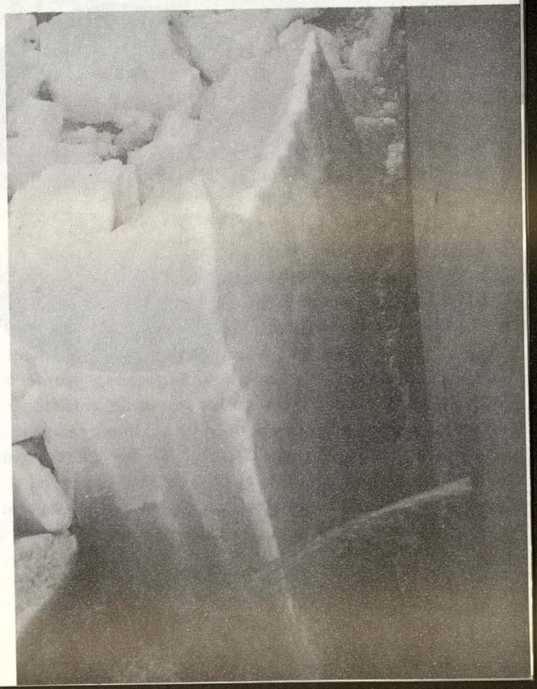
THICKNESS OF ICE

Ice thicknesses can be accurately measured by shore and ship observers if equipments such as augers or saws are available. Shipboard observers can make a reliable estimate of the thickness from the lower weather decks as the ice is turned on its edge by the progress of the ship through the ice. Aerial observers should not attempt to estimate thickness.

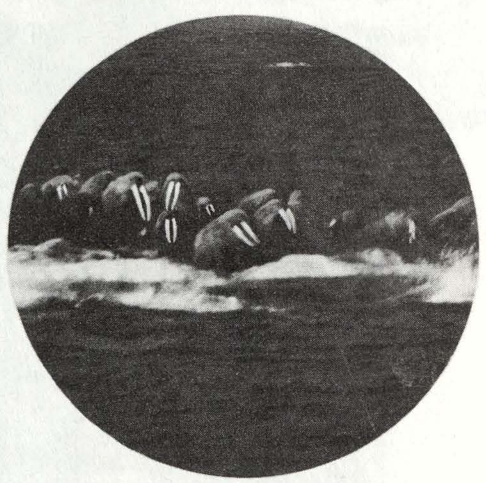
ICE OF LAND ORIGIN

The number of bergs, bergy bits, and growlers can be determined readily for a particular area. If the observer has difficulty deciding whether a number of small ice fragments are blocks or growlers, he should class them as growlers.

▼ *upended ice cakes showing snow cover*



OBSERVATIONS FROM SHIPBOARD



Systematic ice observations should be made aboard every vessel operating in the Arctic. When the vessel is operating in ice, the observer should make observations at least every six hours even though the ship is hove to or beset in the ice; and if over-all ice conditions are changing within fairly short periods, observations should be made more frequently.

The observations are to be recorded in code form in H. O. Misc. 15584 (Revised), "Ship Ice Log," provided by the Hydrographic Office. In addition to the code record, the observer should prepare a chart summarizing ice conditions along the ship's track using the basic symbols found in the section entitled "Observations from Aircraft."

The study of ice from aboard ship can provide reliable information concerning ice coverage within close range of the ship, relief and topography, age, puddling, size and orientation of water features such as cracks, leads and polynyi, and estimates of ice thickness and snow coverage.

Before entering an ice area, a shipboard observer should become familiar with particular sections of the "Glossary" and the detailed instructions accompanying H. O. Misc. 15584 (Revised), "Ship Ice Log."

OBSERVATIONAL TECHNIQUES

The shipboard observer can make detailed periodic observations of ice conditions regardless of the weather, whereas the aerial observer must limit his study to ice areas not obscured by overcast. The thickness of snow and ice can be estimated by an observer on the lower weather deck of a ship as the ship turns up sections of the ice in its passage. Whenever it is possible for the observer to get out onto the ice, he can make accurate measurements of the heights of ridges and the thickness of snow and ice. From the crow's nest or the wings of the bridge, the observer can estimate accurately the total ice coverage, the type of ice, and size and orientation of water features within several thousand yards of the ship. With the aid of radar his horizon may be extended considerably.

In estimating the size of masses of sea ice and ice of land origin, the size of the ship may be used as a convenient scale. If the ship is maintaining a constant speed, as through a lead or polynya, the observer can calculate the length of such a feature

H. O. Misc. 15584
(Revised 1-54)

U. S. NAVY HYDROGRAPHIC OFFICE

SHIP ICE LOG

TABLE 1. Concentration: total and by size. 0
No ice....1
1/10....2
2/10....3
3/10....4
4/10....5
5/10....6
6/10....7
7/10....8
8/10....9
9/10....X
10/10
Not determined..../

TABLE 2. Relief and Ice Thickness
No sea ice....0
Less than 15 cm....(6 in)....1
15-30 cm....(6 in-1 ft)....2
30-60 cm....(1-2 ft)....3
60-120 cm....(2-4 ft)....4
120-200 cm....(4-6 ft)....5
200-250 cm....(6-8 ft)....6
250-300 cm....(8-10 ft)....7
300-350 cm....(10-12 ft)....8
Greater than 350 cm..(12 ft)....9
Not determined..../

TABLE 3. Topography
No sea ice....0
Slush or pancake....1
Flat ice....2
Rafted ice....3
Ridged ice....4
Hummocks....5
Screw ice....6
Not determined..../

TABLE 4. Age or color
No sea ice....0
Grease ice (dark grease film)....1
Slush, pancake, or ice crust....2
Young ice (transparent black or ash gray)....3
Winter ice (aqua in section, white from vertical)....4
Polar ice (blue, contours rounded)....5
Not determined..../

TABLE 5. Puddling
No sea ice....0
Rotten, disintegrating ice....1
Puddles joined, extensive cracking....2
Puddles melted through....3
Puddles-7/10 to 9/10 ice area....4
Puddles-4/10 to 6/10 ice area....5
Puddles-1/10 to 3/10 ice area....6
Puddles-less than 1/10 ice area....7
Puddles frozen....8
Ice without puddles....9
Not determined..../

TABLE 6. Snow cover
Trace or no snow....0
Less than 15cm...(6 in)....1
15-30 cm....(6-12 in)....2
30-45 cm....(12-18 in)....3
45-60 cm....(18-24 in)....4
60-75 cm....(24-30 in)....5
75-90 cm....(30-36 in)....6
Greater than 90 cm..(36 in)....7
Snow in drifts....8
Continuous snow cover....9
Not determined..../

TABLE 7. Water features
Open water....0
Ice in belts or patches....1
Ice evenly distributed....2
Polynya(s) in combination with leads or cracks....3
Lead(s) in combination with cracks....4
Single polynya....5
Single lead....6
2 or more cracks....7
Single crack....8
No water features....9
Not determined..../

TABLE 8. Orientation of water features
No distinct orientation....0
NE-SW....1
E-W....2
SE-NW....3
N-S....4
Parallels shore at East....5
Parallels shore at South....6
Parallels shore at West....7
Parallels shore at North....8
Not determined..../

TABLE 9. Fast ice
Shore not observed....0
Shore entirely clear....1
Ice blocking less than 1/2 shore....2
Ice blocking more than 1/2 shore but with openings....3
Ice blocking entire shore....4
Not determined..../

TABLE 10. Ice of land origin
No land ice....0
Less than 100 growlers....1
100 or more growlers....2
Less than 50 bergy bits....3
50 or more bergy bits....4
Less than 20 icebergs....5
20 or more icebergs....6
Belt(s) of icebergs, bergy bits, or growlers....7
Not determined..../

TABLE 11. Visibility and Dimension
Less than 50 m..(50 yds)....0
50-200 m....(50-200 yds)....1
200-500 m....(200 yds-1/4 naut. mile)....2
500 m-1 km....(1/4-1/2 naut. mile)....3
1-2 km....(1/2-1 naut. mile)....4
2-4 km....(1-2 naut. miles)....5
4-10 km....(2-5 naut. miles)....6
10-20 km....(5-10 naut. miles)....7
20-50 km....(10-30 naut. miles)....8
Over 50 km....(30 naut. miles)....9
Not determined..../

TABLE 12. Water sky and Iceblink
Features not present....0
Feature to the NE....1
Feature to the E....2
Feature to the SE....3
Feature to the S....4
Feature to the SW....5
Feature to the W....6
Feature to the NW....7
Feature to the N....8
Not determined..../

Instructions for use of ice log are bound at back of pad

Concentration, total
Conc., slush, brash, block (less than 30 ft)
Conc., sml. & med. floe (30 to 3000 ft)
Conc., giant floe & field (over 3000 ft)
Relief
Topography
Age, dominant
Age, secondary
Puddling
Snow cover
Water features
Orientation of water features
Fast ice
Ice of land origin
Thickness – sea ice
Visibility
Water sky
Iceblink
Water temp. (°F.)

SUPPLEMENTAL GROUPS FOR ICE BOUNDARIES AND WATER FEATURES

GROUP INDICATORS

11000 - Positions of drift ice boundary follow
22000 - Positions of fast ice boundary follow
33000 - Width and position of lead follow
44000 - Dimensions and position of polynya follow

ORDER OF ELEMENTS

$PL_aL_aL_aL_a$ $PL_oL_oL_o$ ...... Points on boundary in degrees and minutes
$WL_aL_aL_aL_a$ $WL_oL_oL_oL_o$ .... Width and position of lead in degrees and minutes
$D_wL_aL_aL_aL_a$ $D_lL_oL_oL_oL_o$ ... Dimensions and position of polynya in degrees and minutes

KEY OF ELEMENTS

D_l – Length of polynya (Table 11)
D_w – Width of polynya (Table 11)
$L_aL_aL_aL_a$ – Latitude in degrees and minutes
$L_oL_oL_oL_o$ – Longitude in degrees and minutes
P – Point on drift or fast ice boundary, coded 0
W – Width of lead (Table 11)

ship ice log: front cover and list of supplemental code groups for transmitting additional information

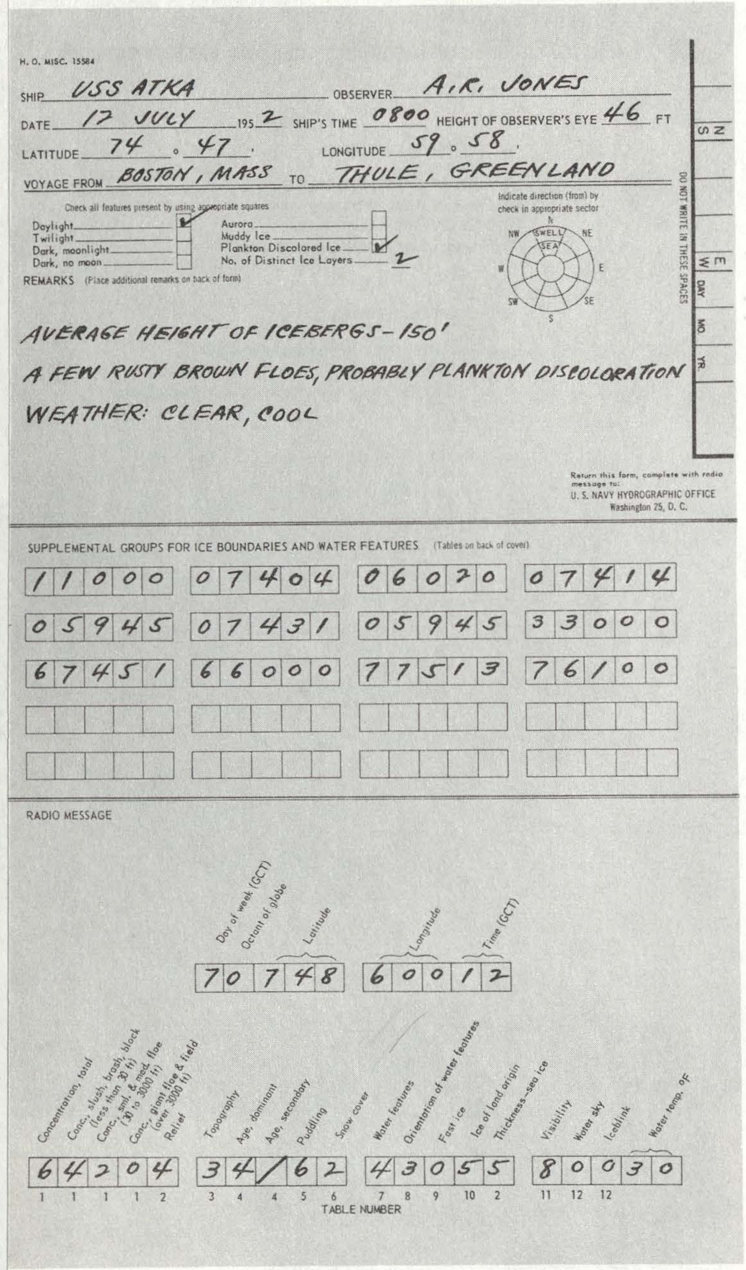
by noting the length of time required for the ship to transit.

REPORTING PROCEDURES

the ice log

The "Ship Ice Log," H. O. Misc. 15584 (Revised), has been devised primarily for coding observed ice information obtained by shipboard observers. Any observer whose geographic coordinates are subject to change, that is, observers out on sea ice (not shore based), on ice islands, and with mobile land units observing sea ice will also use this log.

It is important that all blanks at the top of the log sheets be filled in before the completed forms are sent to the Hydrographic Office. On the cover page



H. O. MISC. 15584

SHIP USS ATKA OBSERVER A.R. JONES

DATE 17 JULY 1952 SHIP'S TIME 0800 HEIGHT OF OBSERVER'S EYE 46 FT

LATITUDE 74 ° 47 ' LONGITUDE 59 ° 58 '

VOYAGE FROM BOSTON, MASS TO THULE, GREENLAND

Check all features present by using appropriate squares

Daylight ✓ / Twilight / Dark, moonlight / Dark, no moon

Aurora / Muddy Ice / Plankton Discolored Ice ✓ / No. of Distinct Ice Layers 2

Indicate direction (from) by check in appropriate sector: N, NE, E, SE, S, SW, W, NW — SWELL, SEA

DO NOT WRITE IN THESE SPACES: N S E W DAY MO. YR.

REMARKS (Place additional remarks on back of form)

AVERAGE HEIGHT OF ICEBERGS – 150'

A FEW RUSTY BROWN FLOES, PROBABLY PLANKTON DISCOLORATION

WEATHER: CLEAR, COOL

Return this form, complete with radio message to:
U. S. NAVY HYDROGRAPHIC OFFICE
Washington 25, D. C.

SUPPLEMENTAL GROUPS FOR ICE BOUNDARIES AND WATER FEATURES (Tables on back of cover)

11000	07404	06020	07414
05945	07431	05945	33000
67451	66000	77513	76100

RADIO MESSAGE

Day of week (GCT), Octant of globe, Latitude — 70748; Longitude, Time (GCT) — 60012

Concentration, total	Conc., slush, brash, block (less than 30 ft)	Conc., sml. & med. floe (30 to 3000 ft)	Conc., giant floe & field (over 3000 ft)	Relief	Topography	Age, dominant	Age, secondary	Puddling	Snow cover	Water features	Orientation of water features	Fast ice	Ice of land origin	Thickness—sea ice	Visibility	Water sky	Iceblink	Water temp. °F	
6	4	2	0	4	3	4	/	6	2	4	3	0	5	5	8	0	0	3	0
1	1	1	1	2	3	4	4	5	6	7	8	9	10	2	11	12	12		

TABLE NUMBER

of the log book is a complete set of tables with code numbers for each ice feature to be coded in the report. This cover page is cut short so the tables may be referred to directly when numbers are encoded in the spaces provided on the log sheets. Since provision is made for reporting the absence of a feature or inability to determine the characteristics of any feature, no blanks should appear in the radio message. Detailed instructions are included with each log book.

Provision has been made for encoding additional information about positions of drift and fast ice boundaries, width and position of leads, and dimensions and positions of polynyi. Tables for coding supplemental information are on the back of the cover page of the log book, and detailed instructions for use of the code groups are on the backs of the log sheets. Data concerning the ice boundaries and water features may be reported in any convenient order by using the proper code group indicators.

The original pencil copies of the completed log sheets should be forwarded by mail from the ship's next port of call to:

The Hydrographer
U. S. Navy Hydrographic Office
Washington 25, D. C.

ship ice log: completed log sheet based on information shown on following chart

The following is an example of a radio message based on the data contained in the ship ice log on page 12.

NSS RADIO WASHINGTON

HYDRO

ICE 12 JULY 1952 USS ATKA X

70748 60012 53204 35062 43056 80030 11000 07404

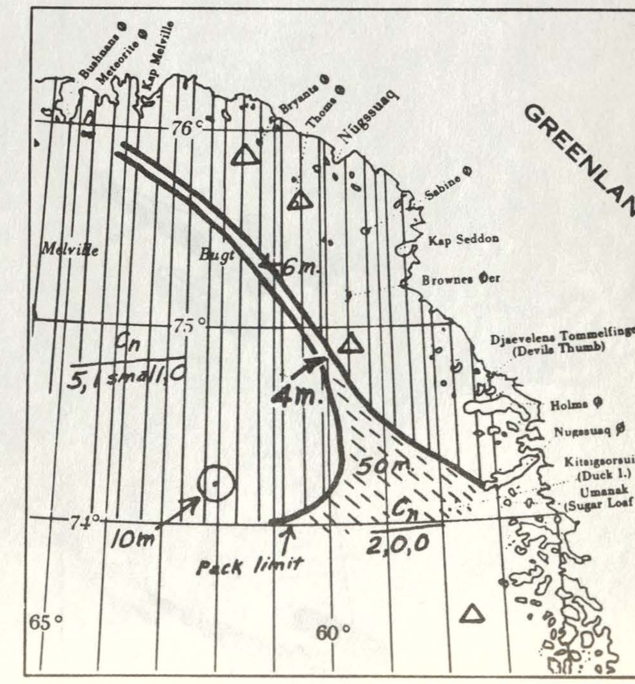
06020 07414 05945 07431 05945 33000 67451 66000

77513 76100

The above coded ice message is interpreted as follows: 7 Saturday-Meridian at Greenwich; 0 Northern Hemisphere between 0 and 90°W; 748 74.8°N; 600 60.0°W; 12 1200 GMT; 5 Total concentration 5/10; 3 consisting of 3/10 slush, brash, and block; 2 2/10 small to medium floes; 0 and no giant floes or fields; 4 highest points of snow and ice 1 foot to 18 inches above water line; 3 few rafted ice floes; 5 winter ice dominant; 0 age of secondary ice not determined; 6 1/10 to 3/10 of the ice surface puddled; 2 3-6 inches of snow; 4 leads in combination with cracks; 3 lead oriented SE-NW; 0 shore not observed; 5 less than 20 icebergs; 6 ice 2-3 feet thick; 8 visibility 10 to 25 miles; 0 no iceblink; 30 water temperature 30°F.; 11000 positions of drift ice boundary follow; 07404 latitude of point 74°04'N; 06020 longitude of point 60°20'W; (other points) 74°14'N-59°45'W; 74°31'N-59°45'W; 33000 width and position of lead follow; 6 lead 2-5 miles wide at point; 7451 74°51'N; 6 repetition of width of lead 2-5 miles; 6000 60°00'W; 7 width of lead, 5-10 miles at point; 7513 75°13'N; 7 repetition of width of lead, 5-10 miles at point; 6100 61°00'W.

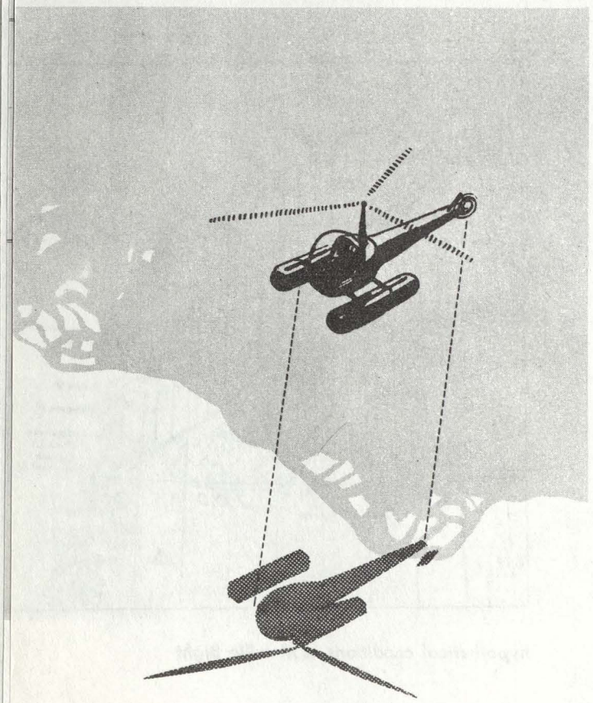
radio messages

Radio messages of ice conditions normally will be sent daily, appended to the routine weather messages and preceded by the word ICE. These messages consist of the coded 5-figure groups as recorded on the log sheets. When single messages are sent at such times the time-position groups may be omitted. When the message is sent without the weather message it will consist of the two time-position groups, the four regular ice message groups (at the base of the log sheet), and such supplemental groups as may be necessary.



hypothetical conditions in Melville Bight

OBSERVATIONS FROM AIRCRAFT



the length and wingspan of a plane in level flight equals the length and wingspan of its shadow

Unlike observations from surface craft, observations from aircraft permit visual coverage having very great horizontal dimensions. Thus a comprehensive picture of ice conditions over large areas can be supplied both to the analyst and to those concerned with the transit of surface craft through the ice. On a clear day at an appropriate altitude, an aerial ice observer can obtain a fairly accurate picture of ice coverage over many thousands of square miles within a comparatively few hours.

Visual observations should be made during all flights over ice-covered water when there is sufficient light to determine significant features of the ice. The observations are to be recorded in symbolic form on track charts to present a continuous and comprehensive picture of ice conditions as seen throughout a flight, or during any portion of the flight where ice is visible. Investigation of sea ice from an aircraft can provide information concerning ice coverage, relief and topography, age, puddling, location and orientation of cracks, leads and polynyi, and areas of easiest accessibility.

OBSERVATIONAL TECHNIQUES

A prerequisite to successful aerial ice reconnaissance is the ability to recognize and label properly the different ice features and characteristics that distinguish one type of ice from another. An important aid to the development of this ability is a familiarity with H. O. Misc. 15603, "Aerial Ice Reconnaissance," and with particular sections of the "Glossary" which define in detail the dominant types of ice usually encountered and furnish appropriate illustrations, many of which are reproductions of aerial photographs.

When aircraft are used as observational platforms, it is important for observers to select stations aboard the plane that will provide maximum visibility. Before the aircraft takes off, the observer should acquaint himself with the current positions of units transiting the ice and the track to be taken by the aircraft.

In estimating the size of ice fragments, the shadow of the plane on the ice may be used for scaling purposes. On level flight, regardless of the altitude or angle of the sun, the shadow of the plane can be used as a measure to estimate the length of the shadow cast by a ridge or hummock. The height of the ridges or hummocks can be obtained by multiplying the length of the shadow of the ridge or hummock by the tangent of the sun's altitude at the time. Dimensions of larger floes and fields can be calculated easily by measuring the time required to cross the ice mass and the ground speed of the aircraft.

REPORTING PROCEDURES

ice track charts

For purposes of facilitating the recording and transmission of ice information, base charts for certain arctic areas have been devised for use by aerial observers in plotting the ice information observed along the plane's track. An adequate supply of base track charts may be obtained from the Hydrographer. Letter symbols are used for ice, snow, or water features. To aid the memory, these symbols are composed either of the first letter or the first letter and first consonant of the type of feature, as "A" for age, "Sl" for slush, and "Pl" for polar ice. A complete list of symbols to be used on track charts appears on this page. To prevent confusion of symbols it is advisable to use colored pencils. On any one chart the same color-symbol scheme should be used throughout. Additional information and remarks may be entered in the open spaces of the charts with flow arrows leading to the point of reference. Every 2 hours of flight the observer should enter the GMT (for example 1200Z) along the track.

The date, destination, etc., should be noted on the charts before the aircraft takes off. If the aircraft returns directly to the point of departure, "To" and "From" will be the same. If the flight exceeds two hours' duration and retraces the outbound track, the inbound track may be plotted on a second chart.

All plotted charts will be submitted to the appropriate base personnel who will extract necessary information. The observer will then summarize the information on a master chart and forward the original to:

The Hydrographer
U. S. Navy Hydrographic Office
Washington 25, D. C.

ICE SYMBOLS FOR TRACK CHART

CONCENTRATION

CONCENTRATION BY SIZE

$\frac{Cn}{n_1, n_2, n_3}$

n_1 = tenths of slush, brash, and block
n_2 = tenths of small and medium floes
n_3 = tenths of giant floes and field

THICKNESS OF SEA ICE

$\frac{T}{n}$, where n = nearest ft.
Examples: $\frac{T}{3}$, $\frac{T}{5}$, etc.

RELIEF

$\frac{Rl}{n}$, where n = nearest ft.
Examples: $\frac{Rl}{4}$, $\frac{Rl}{6}$, etc.

TOPOGRAPHY

Rafted ice
Ridged ice
Hummocks
Screw ice

AGE

$\frac{A}{\text{dominant, secondary}}$

Slush = Sl
Young ice = Y
Winter ice = W
Polar ice = Pl
Examples: $\frac{A}{Sl, W}$, $\frac{A}{Pl}$, etc.

PUDDLES

$\frac{Pd}{\text{dominant condition}}$

Tenths of ice covered if not frozen or rotten
Frozen = F
Rotten = R
Examples: $\frac{Pd}{3}$, $\frac{Pd}{F}$, $\frac{Pd}{R}$, etc.

SNOW

$\frac{Sn}{\text{dominant condition}}$

Depth in feet
or
Drifted = D
Continuous = C
No snow = 0
Examples: $\frac{Sn}{2}$, $\frac{Sn}{D}$, etc.

WATER FEATURES

Crack
Lead
Polynya

FAST ICE

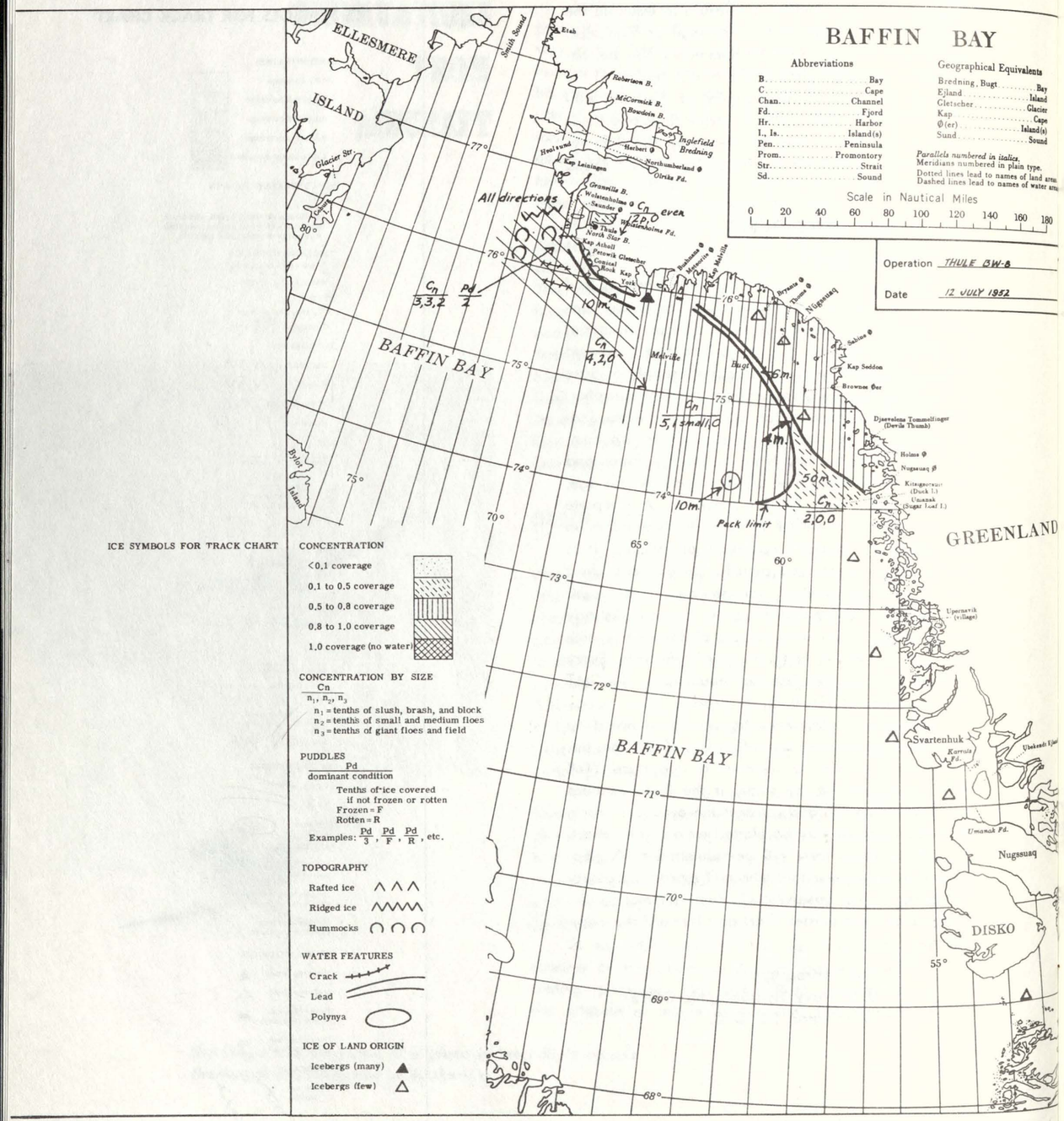
Ice blocking entire shore
Ice blocking more than half the shore
Ice blocking less than half the shore

ICE OF LAND ORIGIN

Icebergs (many)
Icebergs (few)
Bergy bits and growlers (many)
Bergy bits and growlers (few)

UNDERCAST

Undercast (limits)



sample of a completed track chart

radio messages

In addition to the preparation of ice track charts during each flight, a brief yet fully informative word message describing the ice conditions is to be prepared as soon as possible after each flight. All important data must be included in the reports. Relatively minor changes in ice conditions occasionally foreshadow radical alterations which may affect operation of vessels in the area of surveillance. It is necessary that observers composing messages avoid the use of superfluous words without impairing the clarity of the message. Areas markedly irregular will require more observing and reporting than areas having uniform concentration and features.

The following sample message based on the information included in the track chart on page 16 may serve as a useful guide in the preparation of a brief yet fully informative message:

NSS RADIO WASHINGTON

HYDRO

INFO: USS EDISTO, CTF 118

ICE 12 JULY 1952 FLIGHT THULE TO BW8 X ALTITUDE 4000 FEET VISIBILITY 70 MILES X

NORTH STAR BAY 200 TOTAL TWO EVENLY DISTRIBUTED X 7620 N 7000 W 322 TOTAL EIGHT

2 PUDDLES X RIDGES AND HUMMOCKS ALL DIRECTIONS X NUMEROUS CRACKS

EW X TEN MILE SHORE LEAD KAP ATHOL TO KAP YORK X MANY BERGS KAP YORK X

7500N 6530W 420 TOTAL SIX X FIVE MILE LEAD 7550N 6400W TO 7435N 5930W X TEN MILE

POLYNYA 7420N 6200W X FEW BERGS AT BRYANTS AND THOM X 7450N 6430W 51

SMALL O TOTAL SIX X FIFTY MILE SHORE LEAD 7412N NARROWS AND JOINS LEAD

TO NORTH X LEAD 200 TOTAL TWO X PACK LIMIT 7400N 6100W X REST OF ROUTE OCCASIONAL

BERGS COASTAL AREA X KAMINSKI HYDRO ICE OBSERVER SENDS

In the above message the ice data are interpreted as follows: The ice was noted on 12 July 1952 on the flight from Thule to BW8 at 4000 feet, with 70 miles visibility. In North Star Bay there are two-tenths slush, brash, and block ice; no small and medium floes; no giant floes and fields; total concentration two-tenths evenly distributed. At 76° 18′ North 70° 00′ West, three-tenths slush, brash, and block; three-tenths small and medium floes; two-tenths giant floes and fields; total concentration eight-tenths. Two-tenths of the ice is puddled. Ridges and hummocks are noted in all directions. There are numerous cracks running east-west. A shore lead ten miles wide from Kap Athol to Kap York. Many icebergs are off Kap York. At 70° 00′ North 65° 30′ West, four-tenths slush, brash, and block ice; two-tenths small and medium floes; no giant floes and fields; total concentration six-tenths. A lead five miles wide extends from 75° 30′ North 62° 00′ West to 74° 35′ North 59° 30′ West. A polynya ten miles in diameter is centered at about 74° 20′ North 62° 00′ West. There are a few icebergs at Bryants and Thom. At 74° 50′ North 64° 30′ West, five-tenths slush, brash, and block; one-tenth small floes and no ice of larger sizes; total concentration six-tenths. A shore lead fifty miles wide centered at about 74° 12′ North narrows and joins the lead to the north. This lead has two-tenths slush, brash, and block and no ice of larger sizes; total concentration two-tenths. The limit of the pack ice is at 74° 00′ North 61° 00′ West. Along the rest of the route to BW8 there are occasional icebergs in the coastal area.

OBSERVATIONS FROM SHORE STATIONS

A shore-stationed ice observer has certain advantages over a shipboard or aerial observer. For example, a shore-stationed observer is in a position to make accurate measurements of heights of topographic features and thickness of ice and depth of snow cover near shore. It is highly important that the analyst and those concerned with getting supplies to a shore station know the characteristics of ice in the vicinity of a shore station, particularly the ice thickness and the exact time when the ice is no longer shorefast.

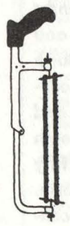
Some shore-stationed observers have been assigned the additional duty of collecting ice data from neighboring sites on other water bodies or at different places on the same water body. The sites of observation are called operating locations. There should be enough operating locations to provide a reflection of local ice conditions as complete as possible with available personnel. Each operating location for a given station is identified by a permanent number (1, 2, 3, etc.). At each station one operating location will be designated as the primary operating location. This location should be selected so that it may be reached most easily, thus assuring that ice conditions at at least one location will be recorded at prescribed times. The primary location will be designated as location (1).

Prior to, or coincindent with, taking the first ice observation or filing the first ice report, the commanding officer of the station will forward to the Hydrographic Office a written description of the operating location(s) at which ice observations have been or will be made. This description should be supplemented with annotated photographs where possible. In addition, a map of the local area with the operating location(s) noted will be submitted with the above description and photographs. The descriptions should include the position of the operating locations with respect to local topography and the degree of exposure to winds from various directions.

Observations will be made daily during the navigation season (30 April to 1 November), unless otherwise indicated for specific stations, and once a week during the remainder of the year. Special observations should be made at the primary location whenever a significant change in ice conditions occurs. Observations are especially desired during the early stages of rapid growth of the ice and immediately before and during breakup. In general, special observations at the secondary locations will not be made.

OBSERVATIONAL TECHNIQUES

These instructions are to accompany PRNC-NHO 1367, "Shore Station Observers Ice Log." Observers whose geographic coordinates are subject to change, that is, observers out on sea ice (not shore based), on ice islands, or with mobile land units observing ice in the sea will use H. O. Misc. 15584 (Revised), "Ship Ice Log." In addition to knowing the instructions issued in this manual, the shore station observer must



be familiar with certain sections of the "Glossary" and with other Navy publications in which ice is described.

Estimating the set, or direction of movement, of the ice nearest shore but not shorefast may require repeated observations of some point on the ice over a period of several hours. As elevation of the observer increases, his visibility also increases; hence, he should seek as high a point as practical when observing the concentration and extent of coverage of the ice, the type of ice, and water features. Equal emphasis must be given to each section of the area under consideration, rather than confining attention to particular sections of the area such as docks and anchorages. On the other hand, an accurate observation of a small area is preferred to an approximation of a large one. Ice coverage near the horizon cannot be estimated reliably and should be ignored. The ice thickness should be measured periodically and at as near as practicable to the same spot throughout the ice season. Various types of augers, coring devices, and saws are devised for taking sections of ice to determine the thickness, banding or layering, and internal structure.

REPORTING PROCEDURES

the ice log

The "Shore Station Observers Ice Log" has been devised for the coding of ice information that can be readily obtained by an observer on the beach. All the information is important for analysis of ice conditions in a region; hence, the information should be furnished with great care. On the inside of the cover page of the book of log sheets is a complete set of tables showing the code numbers for various ice features observed. The following page shows the back of the cover page and a log sheet from PRNC-NHO 1367, "Shore Station Observers Ice Log." If additional information is obtained for which space is not provided in the regular spaces of the log, such information should be noted in the remarks column or on the back of the log sheet with reference to the particular observation.

Carbon copies may be prepared at the time of the original entries, which should be made with a moderately hard pencil. The original pencil copies will be mailed within ten days of the end of each calendar quarter to:

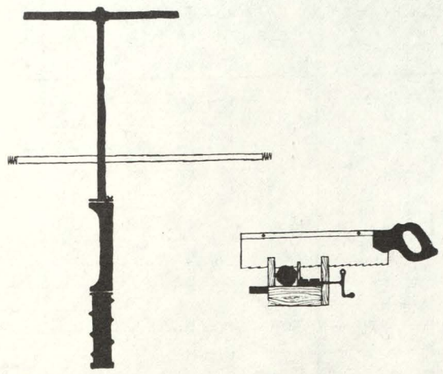
The Hydrographer
U. S. Navy Hydrographic Office
Washington 25, D. C.

Blank forms may be ordered from the same address. Each shore station will submit the completed forms from all operating locations, both primary and secondary.

radio messages

Radio messages will be prepared and sent at such times as deemed desirable by higher authority. The radio message will consist of the first five columns of 5-figure groups of the shore station observer's ice log sheet. Each ice report transmitted individually will be prefixed by the word "Ice." If several messages are sent at one time from one station, the word "Ice" will precede only the first ice report. These messages should be sent to:

The Hydrographer
U. S. Navy Hydrographic Office
Washington 25, D. C.



TABLES FOR SHORE STATION OBSERVERS ICE LOG

TABLE A. DAY OF WEEK *(GCT)*

Sunday	1
Monday	2
Tuesday	3
Wednesday	4
Thursday	5
Friday	6
Saturday	7

TABLE B. TYPE OF ICE

No ice	0
Sea ice	1
Bay ice	2
Fiord ice	3
Lake ice	4
River ice	5
Other	6

TABLE C. SKY MAP

Feature not present		0
Water sky to	East	1
	South	2
	West	3
	North	4
Snow or iceblink to	East	5
	South	6
	West	7
	North	8
Feature not determined		9

TABLE D. SET OF ICE NEAREST SHORE

No drift ice		0
Stations on open sea:		
Ice setting	East	1
	South	2
	West	3
	North	4
Stations on bays and fiords:		
Ice setting	parallel to shore away from sea	5
	parallel to shore toward sea	6
Either type station:		
All ice motionless		7
Set not determined		9

TABLE 1. CONCENTRATION: TOTAL AND BY SIZE

No ice	0
Open water -- less than 1/10	1
Scattered ice -- 1/10 to 5/10	2
Broken ice -- 5/10 to 8/10	3
Close ice -- 8/10 to 10/10	4
Consolidated ice -- 10/10. No sea surface	5
Not determined	9

TABLE 2. RELIEF

No sea ice	0
Less than 6 inches	1
6 inches to 2 feet	2
Greater than 2 feet	3
Not determined	9

TABLE 3. TOPOGRAPHY

No sea ice	0
Slush or ice cakes	1
Flat ice	2
Rafted ice	3
Ridged ice	4
Hummocks	5
Screw ice	6
Not determined	9

TABLE 4. AGE

No sea ice	0
Slush, pancake, or ice crust	1
Young ice	2
Winter ice	3
Polar ice	4
Not determined	9

TABLE 5. PUDDLING

No puddles	0
Puddles frozen	1
Puddles -- less than 1/10 ice area	2
Puddles -- 1/10 to 3/10 ice area	3
Puddles -- greater than 3/10 ice area	4
Puddles -- "melted through"	5
Puddles joined, extensive cracking	6
Rotten, disintegrating ice	7
Puddling not determined	9

TABLE 6. SNOW COVER

Trace or no snow	0
Less than 6 inches	1
6 to 12 inches	2
12 to 18 inches	3
18 to 24 inches	4
24 to 30 inches	5
Over 30 inches	6
Snow in drifts	7
Continuous snow cover	8
Snow not determined	9

TABLE 7. WATER FEATURES

Open water or scattered ice	0
Broken ice	1
Two or more polynyas	2
Two or more leads	3
One polynya	4
One lead	5
Two or more cracks	6
One crack	7
No water features	8
Not determined	9

TABLE 8. ORIENTATION

No distinct orientation	0
NE - SW	1
E - W	2
SE - NW	3
N - S	4
Parallels shore at East	5
Parallels shore at South	6

TABLE 8. ORIENTATION *(Continued)*

Parallels shore at West	7
Parallels shore at North	8
Not observed	9

TABLE 9. FAST ICE

Shore not observed	0
Shore entirely clear	1
Ice blocking less than 1/2 shore	2
Ice blocking more than 1/2 shore but some openings	3
Ice blocking entire shore	4
Not determined	9

TABLE 10. ICE OF LAND ORIGIN

No land ice	0
Less than 100 growlers	1
100 or more growlers	2
Less than 50 bergy bits	3
50 or more bergy bits	4
Less than 20 icebergs	5
20 or more icebergs	6
Not determined	9

TABLE 11. THICKNESS OF SEA ICE

No sea ice	0
Less than 4 inches	1
From 4 inches to 1 foot	2
From 1 foot to 3 feet	3
From 3 feet to 6 feet	4
From 6 feet to 8 feet	5
From 8 feet to 10 feet	6
From 10 feet to 12 feet	7
More than 12 feet	8
Not determined	9

TABLE 12. PREVAILING VISIBILITY

Less than 50 yards	0
50 - 200 yards	1
200 yards - 1/4 nautical mile	2
1/4 - 1/2 nautical mile	3
1/2 - 1 nautical mile	4
1 - 2 nautical miles	5
2 - 5 nautical miles	6
5 - 10 nautical miles	7
10 - 25 nautical miles	8
25 or more nautical miles	9
Not determined	X

TABLE 13. LIGHT CONDITIONS

Daylight	1
Twilight	2
Night - moon and aurora	3
Night - moon	4
Night - aurora	5
Night - no moon or aurora	6

Return completed forms to, and order blank forms from:

U.S. NAVY HYDROGRAPHIC OFFICE
WASHINGTON 25, D.C.

code tables and log sheet from "Shore Station Observers Ice Log" (PRNC-NHO 1367)

SHORE STATION OBSERVERS ICE LOG
PRNC-NHO-1367 (Rev. 9-56)

STATION

LATITUDE ° '	LONGITUDE ° '	MONTH 19___	
OPERATING LOCATION	NO.*	WATER BODY	
	DISTANCE FROM STATION	DIRECTION FROM STATION	ELEVATION FEET

DAY OF MONTH (GMT)	INTERNATIONAL INDEX NUMBER	TIME (GMT)	DAY OF WEEK (GMT)	OPERATING LOCATION NUMBER	TYPE OF ICE	SKY MAP (Water sky-Iceblink)	SET OF ICE NEAREST SHORE	CONCENTRATION, TOTAL	CONC., SLUSH, BRASH, BLOCK	CONC., SMALL AND MEDIUM FLOE	CONC., GIANT FLOE AND FIELD	RELIEF	TOPOGRAPHY	AGE, DOMINANT	AGE, SECONDARY	PUDDLING	SNOW COVER	WATER FEATURES	ORIENTATION (water features)	FAST ICE	ICE OF LAND ORIGIN	THICKNESS OF SEA ICE	PREVAILING VISIBILITY	LIGHT CONDITIONS	SEA WATER TEMPERATURE °F	ICE TEMPERATURE °F	REMARKS	OBSERVERS INITIALS
			TABLE A	*	B	C	D	1	1	1	1	2	3	4	4	5	6	7	8	9	10	11	12	13				

RADIO MESSAGE

NAVY-DPPO PRNC, WASH., D.C.