Prediction of Vessel Sea Spray Icing

Algorithm:

Overland et al. (1986) and Overland (1990) developed algorithms that have proven to be useful for predicting sea spray vessel icing. These algorithms were based primarily on reports from vessels that were 20 to 75 meters in length. Here is the algorithm presented by Overland (1990):

$$PPR = \frac{V_a (T_f - T_a)}{1 + 0.3(T_w - T_f)}$$

PPR = Icing Predictor ($m^{o}Cs^{-1}$)

$\mathbf{V_a}$ = Wind Speed ($m\ s^{-1}$)

$\mathbf{T_f}$ = Freezing point of seawater (usually -1.7 ^{o}C or -1.8 ^{o}C)

$\mathbf{T_a}$ = Air Temperature (^{o}C)

$\mathbf{T_w}$ = Sea Temperature (^{o}C)

The following table shows the expected icing class and rates for 20 - 75 meter vessels that are steaming into the wind.

Table 2
Icing Class and Rate

PPR	<0	0-22.4	22.4-53.3	53.3-83.0	>83.0
Icing Class	None	Light	Moderate	Heavy	Extreme
Icing Rates (cm/hour) (inches/hour)	0	<0.7 <0.3	0.7-2.0 0.3-0.8	2.0-4.0 0.8-1.6	>4.0 >1.6

These icing rates are only a guide. Actual icing rates depend on ship characteristics, cold soaking and exposure to sea spray (see previous page).

Using the Algorithm

Follow this link for a computer calculation of the icing class and PPR value for you.

For a quick reference, when a computer or calculator is not available, you may print the following nomograms. They display sea spray icing potential class as a function of wind speed and air temperature for a given sea temperature. These nomograms are slightly different from the ones found in US Navy (1988) because they are based on the most recent work by Overland (1990). The main difference is that the effect of cold sea water is emphasized more in the nomograms shown here. Generally, icing is not a problem at sea temperatures greater than 7 ^{o}C, and no cases with higher temperatures were considered when the algorithm was derived. Because it may be possible for icing to occur at these higher sea temperatures, they have been included below.

The above interactive form and the tables below assume a freezing water temperature of -1.7 ^{o}C, which is typical for sea water. Icing can occur in fresh water lakes such as the Great Lakes. If you want to use the interactive form or nomograms for a fresh water case, subtract 1.7 ^{o}C (-3.1 ^{o}F) from the water temperature and add 1.7 ^{o}C to the air temperature before using the tool, or just use the algorithm at the top directly and use $\mathbf{T_f}$ = 0.

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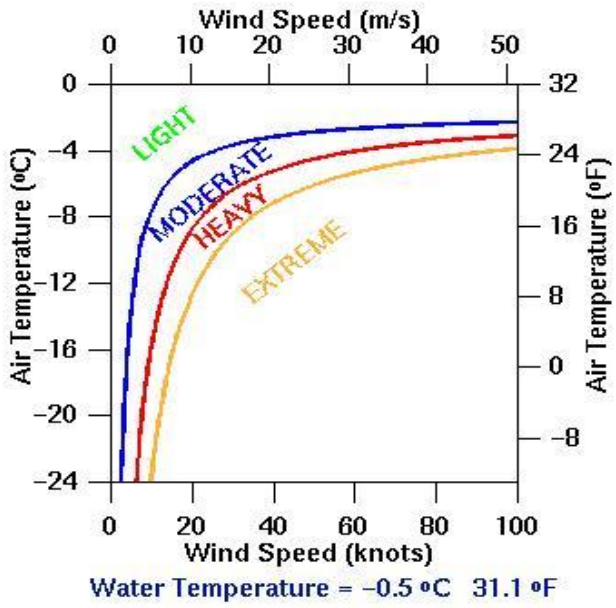
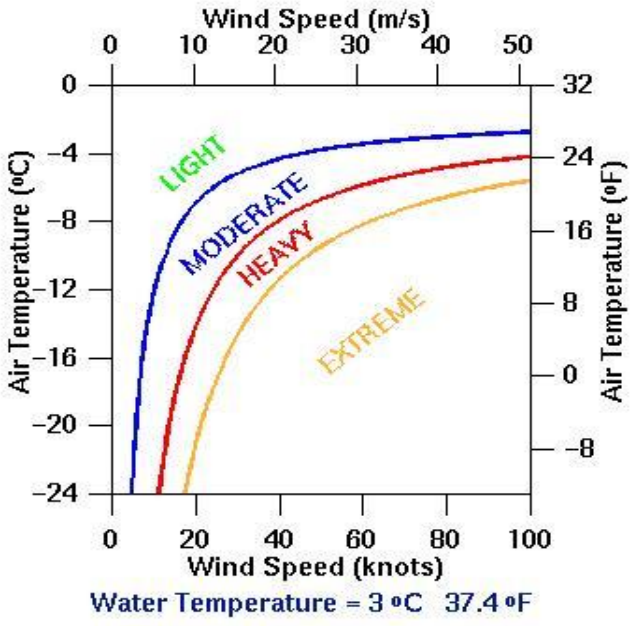
Nomograms of Icing for Various Water Temperatures

Click On a Snowflake:	Water Temperature	
	^{o}C	^{o}F
	-1.5	29.3
	-1.0	30.2
	-0.5	31.1
	0	32
	0.5	32.9
	1.0	33.8

Examples

	1.5	34.7
	2.0	35.6
	2.5	36.5
	3.0	37.4
	3.5	38.3
	4.0	39.2
	4.5	40.1
	5.0	41.0
	5.5	41.9
	6.0	42.8
	6.5	43.7
	7.0	44.6
	7.5	45.5
	8.0	46.4
	8.5	47.3
	9.0	48.2
	9.5	49.1
	10.0	50.0





Forecast Products

The algorithm can be used to predict the present icing conditions using parameters measured from the vessel. It can also be used to predict future icing conditions using the predictions of a numerical weather forecast. Use the air temperature and wind speed closest to 10 meters elevation.

Forecast maps of icing are available directly from the Internet for the November-May Northern Hemisphere icing season. The National Centers for Environmental Prediction (NCEP), Ocean Modeling Branch (OMB), has a web site with icing maps for the North Atlantic, North Pacific, Eurasian and off the U.S. East Coast ("NOPP Demonstration Area"). This site is also sponsored by the Department of Commerce, The National Oceanographic and Atmospheric Administration (NOAA) and the National Weather Service (NWS). Take a look at the forecast maps for various locations and examine the '"**About the NCEP Ice Accretion forecasts'** link therein.

- Here is the real time (Nov-May) NCEP icing prediction web site, thanks to Lawrence D. Burroughs.
- Here is an example of a map with brief explanation.

In addition to the internet web site above, the icing forecasts are also available from:

- NOAA's "Marine Significant Weather Chart" (AFOS and some FAX circuits)
- The Alaska Regional facsimile charts (AKFAX)

The latter are available only every 12 hours for 48 hours from the 0000 UTC cycle. (The web site has 6 hour predictions out to 72 hours from the 0000 UTC and the 1200 UTC cycles.)

The maps will soon be available from:

- NWS's Family of Services in gridded binary (GRIB)
- National Centers Advanced Weather Interactive Processing System (NAWIPS)
- Alaska GRIB.

See the NCEP icing prediction web site for more details and updates.

Proceed to **Methods to Avoid and Mitigate the Effects of Sea Spray Icing of Vessels**

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Please send all comments and suggestions to the author/instructor: Peter Guest: