No.34 Standard Wave Data

(1992)
(Rev.1 June 2000)
(Corr. Nov. 2001)

1. This recommendation is valid for ships carrying goods at sea, excluding vessels that operate at a fixed location (for example FPSO s), specifically aiming at ships as covered by UR S11, and focusing on extreme wave loads.

2. Wave data as described by the scatter diagram given in TABLE 1, describe the wave data of the North Atlantic as defined in FIGURE 1, covering areas 8,9,15 and 16, as defined in Global Wave Statistics/1/ with changes according to /2/.

3. When calculating design wave bending moments, it is recommended to use a return period of at least 20 years, corresponding to about 10^{-8} probability of exceedance per cycle.

4. When calculating the pressure head from green seas on horizontal deck plates and hatch covers, the relative motion in the undisturbed wave at the centre line for the considered area, at a return period of 20 years, can be applied as a first approximation.

5. Combination of loads should be performed, preferably using simultaneous values, to ensure application of the design loads at a consistent probability level.

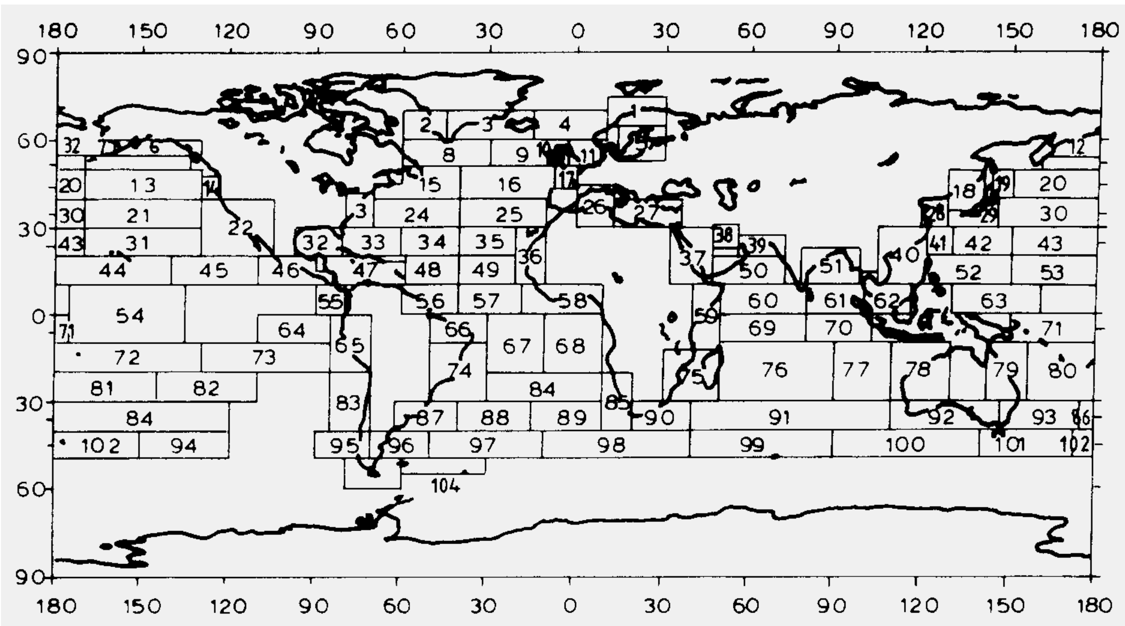

Figure 1 Definition of the extent of the North Atlantic

No.34
cont'd

Table 1, Probability of sea-states in the North Atlantic described as occurrence per 100000 observations.
Derived from BMT's Global Wave Statistics

Hs/Tz	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5	SUM
0.5	0.0	0.0	1.3	133.7	865.6	1186.0	634.2	186.3	36.9	5.6	0.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	3050
1.5	0.0	0.0	0.0	29.3	986.0	4976.0	7738.0	5569.7	2375.7	703.5	160.7	30.5	5.1	0.8	0.1	0.0	0.0	0.0	22575
2.5	0.0	0.0	0.0	2.2	197.5	2158.8	6230.0	7449.5	4860.4	2066.0	644.5	160.2	33.7	6.3	1.1	0.2	0.0	0.0	23810
3.5	0.0	0.0	0.0	0.2	34.9	695.5	3226.5	5675.0	5099.1	2838.0	1114.1	337.7	84.3	18.2	3.5	0.6	0.1	0.0	19128
4.5	0.0	0.0	0.0	0.0	6.0	196.1	1354.3	3288.5	3857.5	2685.5	1275.2	455.1	130.9	31.9	6.9	1.3	0.2	0.0	13289
5.5	0.0	0.0	0.0	0.0	1.0	51.0	498.4	1602.9	2372.7	2008.3	1126.0	463.6	150.9	41.0	9.7	2.1	0.4	0.1	8328
6.5	0.0	0.0	0.0	0.0	0.2	12.6	167.0	690.3	1257.9	1268.6	825.9	386.8	140.8	42.2	10.9	2.5	0.5	0.1	4806
7.5	0.0	0.0	0.0	0.0	0.0	3.0	52.1	270.1	594.4	703.2	524.9	276.7	111.7	36.7	10.2	2.5	0.6	0.1	2586
8.5	0.0	0.0	0.0	0.0	0.0	0.7	15.4	97.9	255.9	350.6	296.9	174.6	77.6	27.7	8.4	2.2	0.5	0.1	1309
9.5	0.0	0.0	0.0	0.0	0.0	0.2	4.3	33.2	101.9	159.9	152.2	99.2	48.3	18.7	6.1	1.7	0.4	0.1	626
10.5	0.0	0.0	0.0	0.0	0.0	0.0	1.2	10.7	37.9	67.5	71.7	51.5	27.3	11.4	4.0	1.2	0.3	0.1	285
11.5	0.0	0.0	0.0	0.0	0.0	0.0	0.3	3.3	13.3	26.6	31.4	24.7	14.2	6.4	2.4	0.7	0.2	0.1	124
12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.0	4.4	9.9	12.8	11.0	6.8	3.3	1.3	0.4	0.1	0.0	51
13.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.4	3.5	5.0	4.6	3.1	1.6	0.7	0.2	0.1	0.0	21
14.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	1.2	1.8	1.8	1.3	0.7	0.3	0.1	0.0	0.0	8
15.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.6	0.7	0.5	0.3	0.1	0.1	0.0	0.0	3
16.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.2	0.1	0.1	0.0	0.0	0.0	1
SUM:	0	0	1	165	2091	9280	19922	24879	20870	12898	6245	2479	837	247	66	16	3	1	100000

The Hs and Tz values are class midpoints.

▼

No.34
cont'd

6. For evaluation of extreme global bending moments it is recommended to use zero speed, provided the vessel does not have a service restriction, in which case the limitation should be checked as well. The effect of forward speed (2/3 of design speed) is recommended to be checked, especially for local dynamic pressures.

7. The Bretschneider or two parameter Pierson-Moskowitz spectrum is recommended for the North Atlantic, described by the following expression:

$$S(\omega) = \frac{H_s^2}{4\pi}\left(\frac{2\pi}{T_z}\right)^4 \omega^{-5} \exp\left(-\frac{1}{\pi}\left(\frac{2\pi}{T_z}\right)^4 \omega^{-4}\right)$$

where:

H_s = The significant wave height (m)

ω = Angular wave frequency (rad/s)

T_z = The average zero up-crossing wave period (s)

$$T_z = 2\pi\left(\frac{m_0}{m_2}\right)^{\frac{1}{2}}$$

The spectral moments of order n of the response process for a given heading may be described as

$$m_n = \int_\omega \sum_{\theta_0 - 90^o}^{\theta_0 + 90^o} f_s(\theta)\omega^n \cdot S\left(\omega / H_s, T_z, \theta\right) d\omega$$

using a spreading function usually defined as $f_s(\theta) = k\cos^2(\theta)$

where k is selected such that:

$$\sum_{\theta_0 - 90^o}^{\theta_0 + 90^o} f_s(\theta) = 1,$$

where

θ_o = main wave heading

θ = relative spreading around the main wave heading

▶

No.34
cont'd

8. In long term calculations, all wave headings (0-360°) can be assumed to have an equal probability of occurrence and at most 30° spacing between headings should be applied.

9. When calculating vertical bending moments (Sag and Hog) proper corrections for non-linear effects are to be applied.

10. The dynamic sea pressure can be derived above the mean waterline (WL) based on linear calculation methods by a reduction of 1-one meter pressure head per meter distance from the mean WL using a dynamic sea pressure at a return period of 20 years, corresponding to about 10^{-8} probability per cycle. In case dynamic sea pressures at 10^{-4} probability per cycle are applied, a reduction of 1/2-half meter pressure head per meter distance above the mean WL should apply to ensure dynamic sea pressures at sufficient height above the mean WL.

11. When calculating design sea pressures at ship ends, due consideration should be taken to the occurrence of non-linearity s such as slamming on the bottom and non-vertical ship sides.

References

/1/ British Marine Tec hnology (Primary contributors Hogben N., Da Cunha, L.F. and Oliver, H.N.). "Global Wave Statistics", Unwin Brothers Limited, London 1986.

/2/ Bitner-Gregersen, E.M., Cramer, E.H., Korbijin, F., "Environmental Description for Long-term Load Response of Ship Structures", ISOPE June 1995, The Hague, The Netherlands.

◄◄