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# Unmanning procedures

Source: https://factpages.sodir.no/pbl/field_jpgs/43590_Heimdal.jpg

# What triggers unmanning

## 11.2 Assessment principles

Existing facilities where the main load-bearing structure do not meet the criteria for ULS or ALS in NORSOK N001:2020+AC:2021, related to environmental actions that can be forecasted (like wave and wind actions), may continue to be used if the following five requirements are fulfilled:

a) shutdown and unmanning procedures are implemented, in accordance with procedures given in 13.3;

b) the environmental actions will not jeopardize any other (non-structural) required main safety functions, taking into account the shutdown and unmanning procedure, for the facility during the storm, as given in 13.3.1;

c) the risk related to significant pollution is found acceptable, according to 13.3.3;

d) failures do not have unacceptable consequence for nearby facilities, see requirements in 13.3.~~2~~**1**;

e) the main load-bearing structure can resist either of

   1) the ULS action (action combination "b") for wave, current and wind action with a partial action factor of 1,15, or

   2) a wave, current and wind combination action with an annual exceedance probability of 1x$10^{-3}$, checked according to the principles for ALS and the requirements given in 11.4.3.3, list item a).

# 13.3 Shutdown and unmanning

The threshold for shutdown and unmanning shall be based on **the worst of**:

- an annual probability of $1 \times 10^{-4}$ of the main safety functions being impaired;
- the probability of the main safety functions being impaired in a forecasted storm are:
  - less than 10 %, or
  - less than 5 %, if only the worst 3-hourly sea state in the storm is considered.
- The unmanning procedure shall consider uncertainties in the forecasted weather conditions.

# 13.3.2 Shutdown and unmanning criteria for jacket structural integrity

For jacket structures with significant redundancy, the threshold for shutdown and unmanning may be based on a $5 \times 10^{-4}$ annual probability of the relevant limit states being exceeded. Significant redundancy in this context includes structures which do not display global brittle failure modes.

Note: It is assumed that this gives a safety level in accordance with N-001. The basis for this assumption is further described in A.13.3.2

# A.13.3 Shutdown and unmanning - commentary to 13.3

## A.13.3.1 General - commentary to 13-3-1

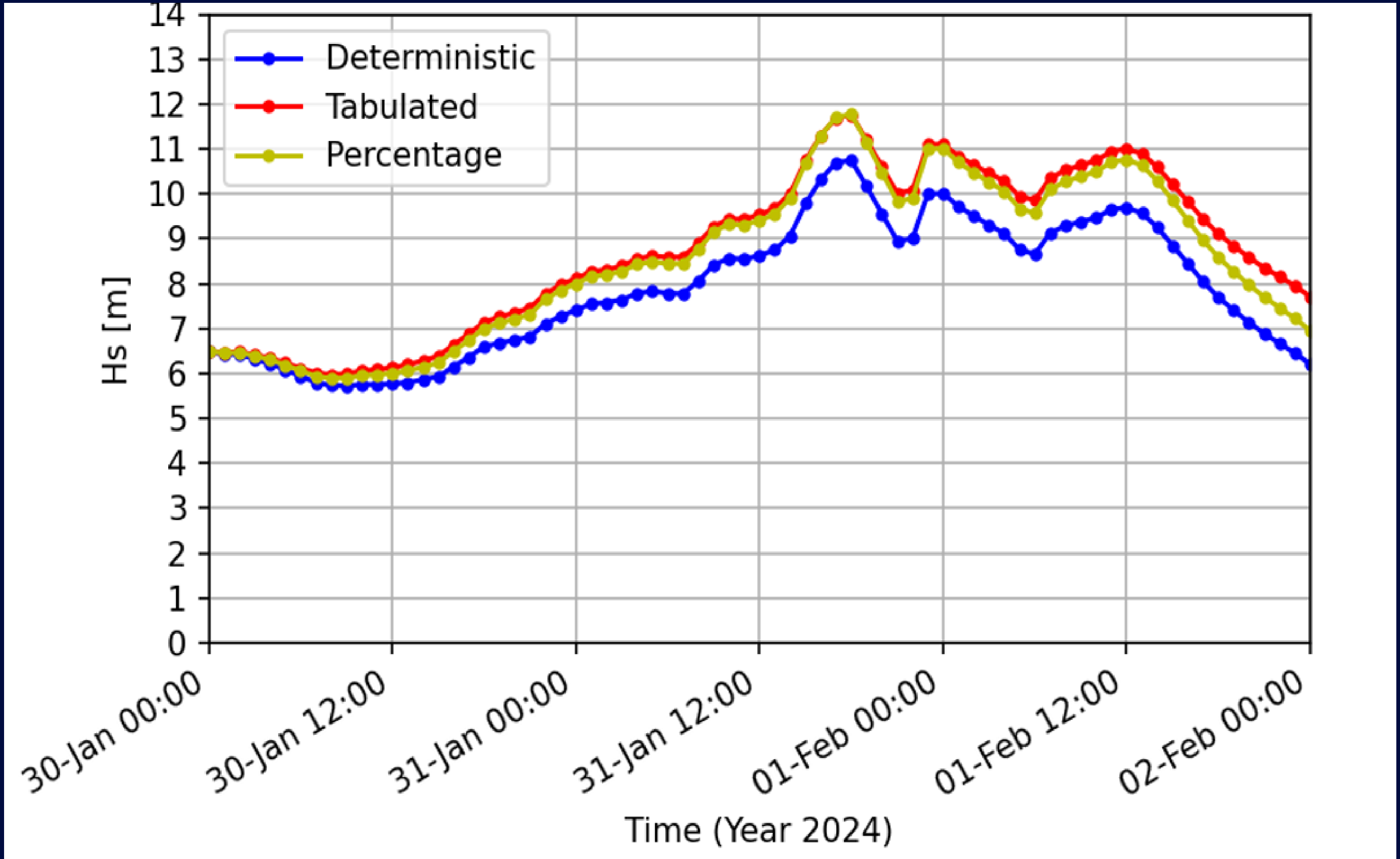
- The implementation of shutdown and unmanning criteria needs to consider all aspects of structural reliability and probability of major pollution.
- Decision to start unmanning is typically taken 3-days ahead of the predicted storm peak, and further actions considered, and final unmanning is normally performed 1-day ahead of the storm peak.
- The unmanning procedure normally considers the forecast uncertainty by increasing the forecasted $h_s$ according to the uncertainty of the forecasted storm. Forecast uncertainty will vary based on the lead time of the forecast.

# Forecast uncertainty

- The uncertainty can be estimated by evaluating the skills of historical forecasts or from ensemble forecast.
- Unless other data are available, uncertainties in weather forecast may be accounted for by the following safety margins:
  - 72 h forecast: Increase the forecasted $h_s$ by min($h_s$+1,5 m; 1,12$h_s$)
  - 48 h forecast: Increase the forecasted $h_s$ by min($h_s$+1,1 m; 1,10$h_s$)
  - 24 h forecast: Increase the forecasted $h_s$ by min($h_s$+0,7 m; 1,08$h_s$)

- The sea state steepness may be assumed preserved.

# Tabulated forecast uncertainty



# Shutdown and unmanning criteria related to upwell on floating structures

- Procedures for shutdown, unmanning and relocation of personnel related to upwell on a floating structure shall include platform motions.
- The criteria for shutdown, unmanning and relocation of personnel may be established by the response at a $1 \times 10^{-4}$ level of exceedance probability obtained from either of
  - an in-storm criteria based on the forecasted storm profile (including at least $H_s$ and $T_p$), or
  - a long-term analysis at the peak of the storm condition $H_{sp}$.
- The associated uncertainty in the storm profile may be addressed either by applying the simplified approach provided in this clause (for 72 h, 48 h and 24 h forecast), or by using an ensemble of forecasted storms.

# Example of establish unmanning criteria

$$F_{C_{3h}}(c) = \frac{1}{\kappa} \int_{h_s=0}^{h_s=h_{s,thr}} \int_{t_p=0}^{\infty} F_{C_{3h|HsTp}}(c|h_s,t_p) f_{Hs,Tp}(h_s,t_p) \, dt_p \, dh_s$$

$h_{s,thr}$ = 16 m

Unmanned installation

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21-22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20-21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| 19-20 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1 | 3 | 3 | 2 | 1 | 0 |
| 18-19 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 6 | 9 | 8 | 4 | 1 | 0 |
| 17-18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 11 | 25 | 29 | 18 | 7 | 2 | 0 |
| 16-17 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 15 | 55 | 89 | 73 | 34 | 9 | 2 | 0 |
| 15-16 | 0 | 0 | 0 | 0 | 0 | 1 | 16 | 95 | 232 | 260 | 151 | 50 | 10 | 1 | 0 |
| 14-15 | 0 | 0 | 0 | 0 | 0 | 11 | 123 | 484 | 789 | 611 | 252 | 61 | 9 | 1 | 0 |
| 13-14 | 0 | 0 | 0 | 0 | 5 | 113 | 783 | 1975 | 2142 | 1141 | 333 | 58 | 7 | 1 | 0 |
| 12-13 | 0 | 0 | 0 | 1 | 72 | 952 | 3958 | 6335 | 4573 | 1688 | 354 | 46 | 4 | 0 | 0 |
| 11-12 | 0 | 0 | 0 | 31 | 855 | 6205 | 15375 | 15704 | 7649 | 2000 | 310 | 31 | 2 | 0 | 0 |
| 10-11 | 0 | 0 | 10 | 582 | 7616 | 30115 | 44979 | 30004 | 10213 | 1979 | 239 | 19 | 1 | 0 | 0 |
| 9-10 | 0 | 3 | 326 | 7624 | 48011 | 105856 | 98841 | 45303 | 11492 | 1782 | 183 | 13 | 1 | 0 | 0 |
| 8-9 | 1 | 175 | 6822 | 65206 | 206723 | 268715 | 168141 | 57587 | 11999 | 1660 | 164 | 12 | 1 | 0 | 0 |
| 7-8 | 108 | 6213 | 81874 | 349177 | 607216 | 510538 | 237355 | 68066 | 13174 | 1853 | 202 | 18 | 1 | 0 | 0 |
| 6-7 | 6520 | 104535 | 544560 | 1180968 | 1273322 | 782860 | 306370 | 83456 | 17021 | 2758 | 373 | 44 | 5 | 0 | 0 |
| 5-6 | 145886 | 837568 | 2080873 | 2688624 | 2074119 | 1064497 | 396161 | 114537 | 27187 | 5539 | 1004 | 166 | 26 | 4 | 1 |
| 4-5 | 1325115 | 3482183 | 5013577 | 4544926 | 2881988 | 1386477 | 539060 | 177967 | 51868 | 13760 | 3404 | 800 | 182 | 40 | 9 |
| 3-4 | 5680791 | 8548794 | 8536236 | 6266839 | 3649375 | 1784474 | 765019 | 297196 | 107316 | 36736 | 12105 | 3886 | 1226 | 383 | 119 |
| 2-3 | 13469315 | 14006654 | 11206177 | 7406854 | 4256234 | 2206940 | 1061405 | 483335 | 211671 | 90217 | 37764 | 15634 | 6436 | 2646 | 1089 |
| 1-2 | 19303468 | 15938067 | 11267763 | 7140566 | 4187492 | 2324506 | 1241574 | 645804 | 330062 | 166867 | 83873 | 42074 | 21126 | 10642 | 5386 |
| 0-1 | 7626391 | 5573428 | 3701426 | 2304779 | 1373858 | 795238 | 451472 | 253183 | 140977 | 78237 | 43394 | 24105 | 13431 | 7515 | 4226 |
| Hs/Tp | 7-8 | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 | 18-19 | 19-20 | 20-21 | 21-22 |

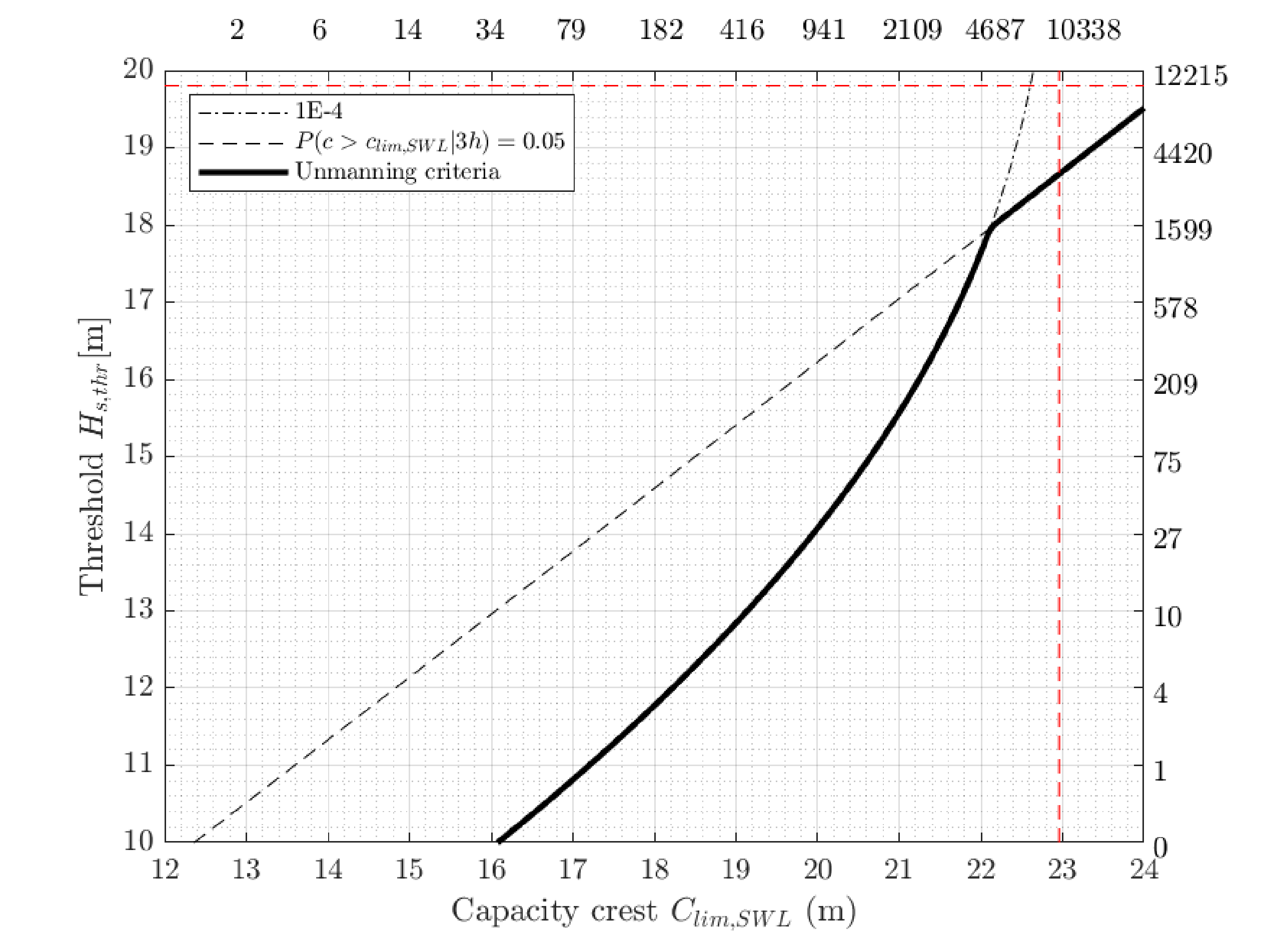
for $q = 5x10^{-4}$ $c_{lim} = 19.8$ m

for $q = 1x10^{-4}$ $c_{lim} = 21.2$ m

Storm constraint

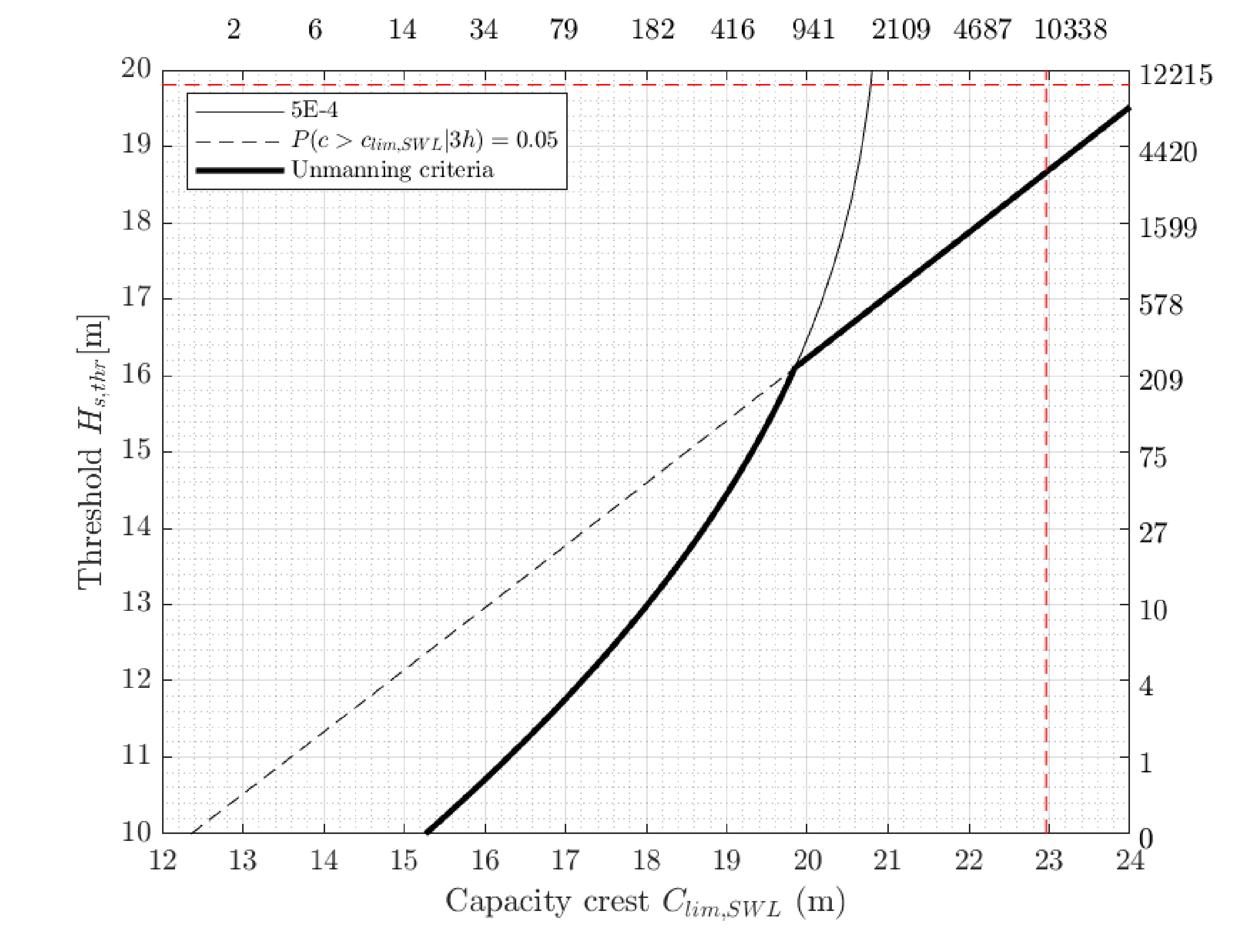
$$c_{\mathrm{P95}} = \alpha_C H_S \left[-ln\left(1 - 0.95^{\frac{1}{n_{3h}}}\right)\right]^{\frac{1}{\beta_C}} = 19.7 \text{ m}$$

# Unmanning / relocation for safe area using 1 x10$^{-4}$



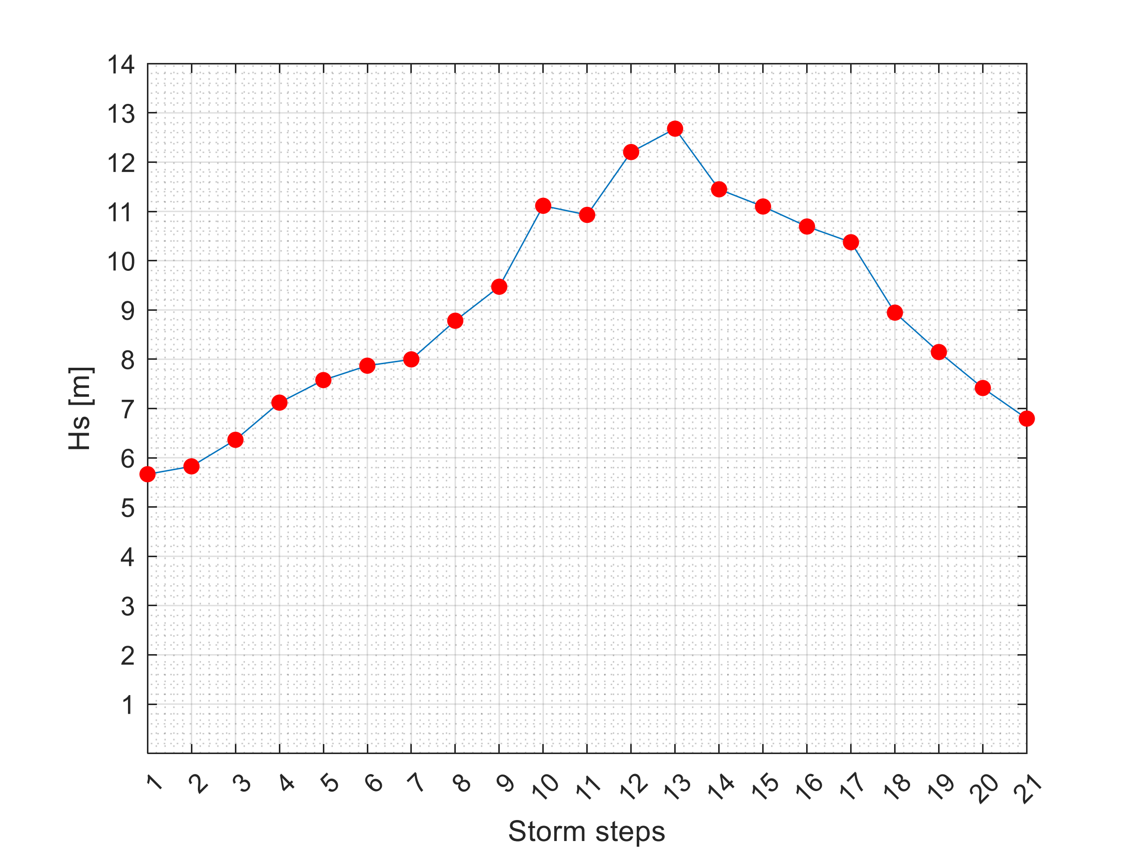

| $h_{s,thr}$ | $c_{lim}$ $q = 1x10^{-4}$ | $c_{lim}$ P95 | Return Period $h_{s.thr}$ | Fractile $c_{lim}$ for $q = 1x10^{-4}$ |
|---|---|---|---|---|
| 12.0 | 18.2 | 14.8 | 3.5 | 0.99953 |
| 12.5 | 18.7 | 15.4 | 5.9 | 0.99928 |
| 13.0 | 19.1 | 16.1 | 9.8 | 0.99891 |
| 13.5 | 19.6 | 16.7 | 16.3 | 0.99836 |
| 14.0 | 19.9 | 17.3 | 27.2 | 0.99754 |
| 14.5 | 20.3 | 17.9 | 45.3 | 0.99632 |
| 15.0 | 20.6 | 18.5 | 75.4 | 0.99454 |
| 15.5 | 21.0 | 19.1 | 125.5 | 0.99193 |
| 16.0 | 21.2 | 19.7 | 208.8 | 0.98815 |
| 16.5 | 21.5 | 20.3 | 347.5 | 0.98268 |
| 17.0 | 21.7 | 20.9 | 578.0 | 0.97494 |
| 17.5 | 21.9 | 21.5 | 961.4 | 0.96401 |
| 18.0 | 22.1 | 22.2 | 1598.9 | 0.94880 |
| 18.5 | 22.3 | 22.8 | 2658.7 | 0.92797 |

# Unmanning for structural integrity of jacket using 5 x 10$^{-4}$




| $h_{s,thr}$ | $c_{lim}$ $q = 5x10^{-4}$ | $c_{lim}$ P95 | Return Period $h_{s.thr}$ | Fractile $c_{lim}$ for $q = 5x10^{-4}$ |
|---|---|---|---|---|
| 12.0 | 17.2 | 14.8 | 3.5 | 0.99790 |
| 12.5 | 17.6 | 15.4 | 5.9 | 0.99685 |
| 13.0 | 18.0 | 16.1 | 9.8 | 0.99529 |
| 13.5 | 18.4 | 16.7 | 16.3 | 0.99299 |
| 14.0 | 18.7 | 17.3 | 27.2 | 0.98963 |
| 14.5 | 19.0 | 17.9 | 45.3 | 0.98474 |
| 15.0 | 19.3 | 18.5 | 75.4 | 0.97768 |
| 15.5 | 19.6 | 19.1 | 125.5 | 0.96764 |
| 16.0 | 19.8 | 19.7 | 208.8 | 0.95341 |
| 16.5 | 20.0 | 20.3 | 347.5 | 0.93367 |
| 17.0 | 20.2 | 20.9 | 578.0 | 0.90666 |
| 17.5 | 20.3 | 21.5 | 961.4 | 0.87045 |
| 18.0 | 20.5 | 22.2 | 1598.9 | 0.82294 |
| 18.5 | 20.6 | 22.8 | 2658.7 | 0.76251 |

# Distribution of the largest response in a «storm»



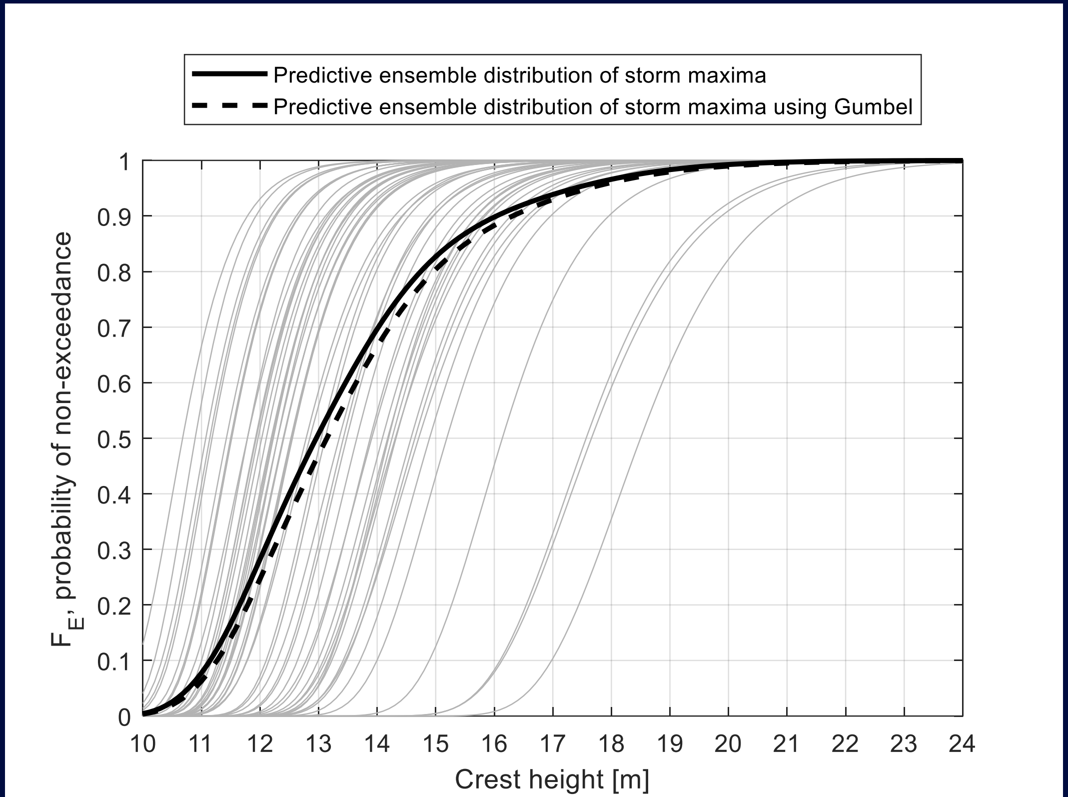

By assuming that the adjacent steps in a storm are statistically independent, the distribution function for the extreme value $y$ for a storm profile with m storm steps is given by:

$$F_Y(y) = P[(Y_1 \leq y) \cap (Y_2 \leq y) \cap \cdots (Y_m \leq y)] = \prod_{i=1}^{m} F_{Y_{3h}m}(y)$$

where $$F_{Y_{3h}m}(y) = F_{Ym}^{n_{3h}}(y)$$

All relevant data for the response under consideration can be included at each time step.

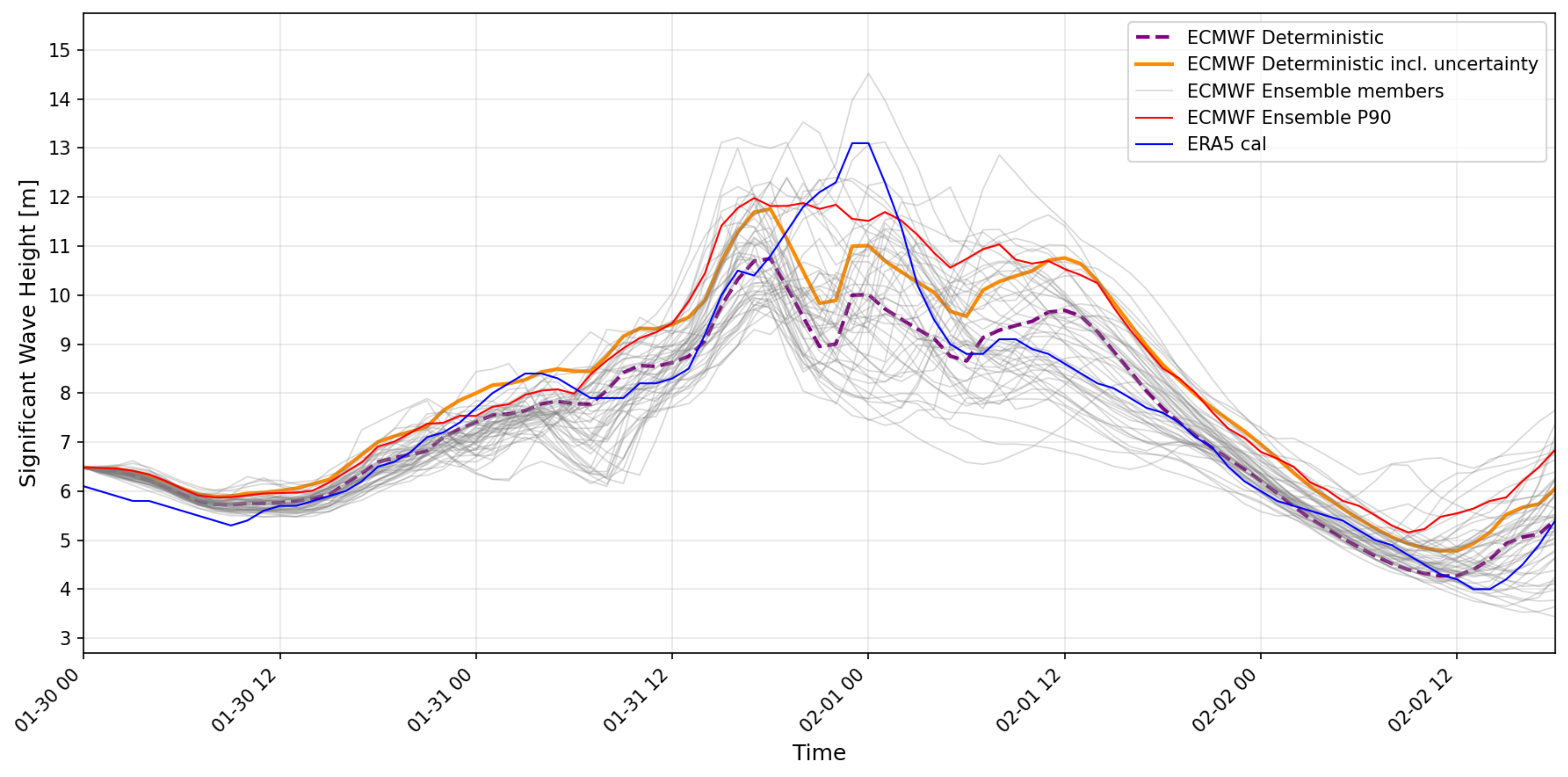
# Predictive distribution of maximum response derived from an ensemble



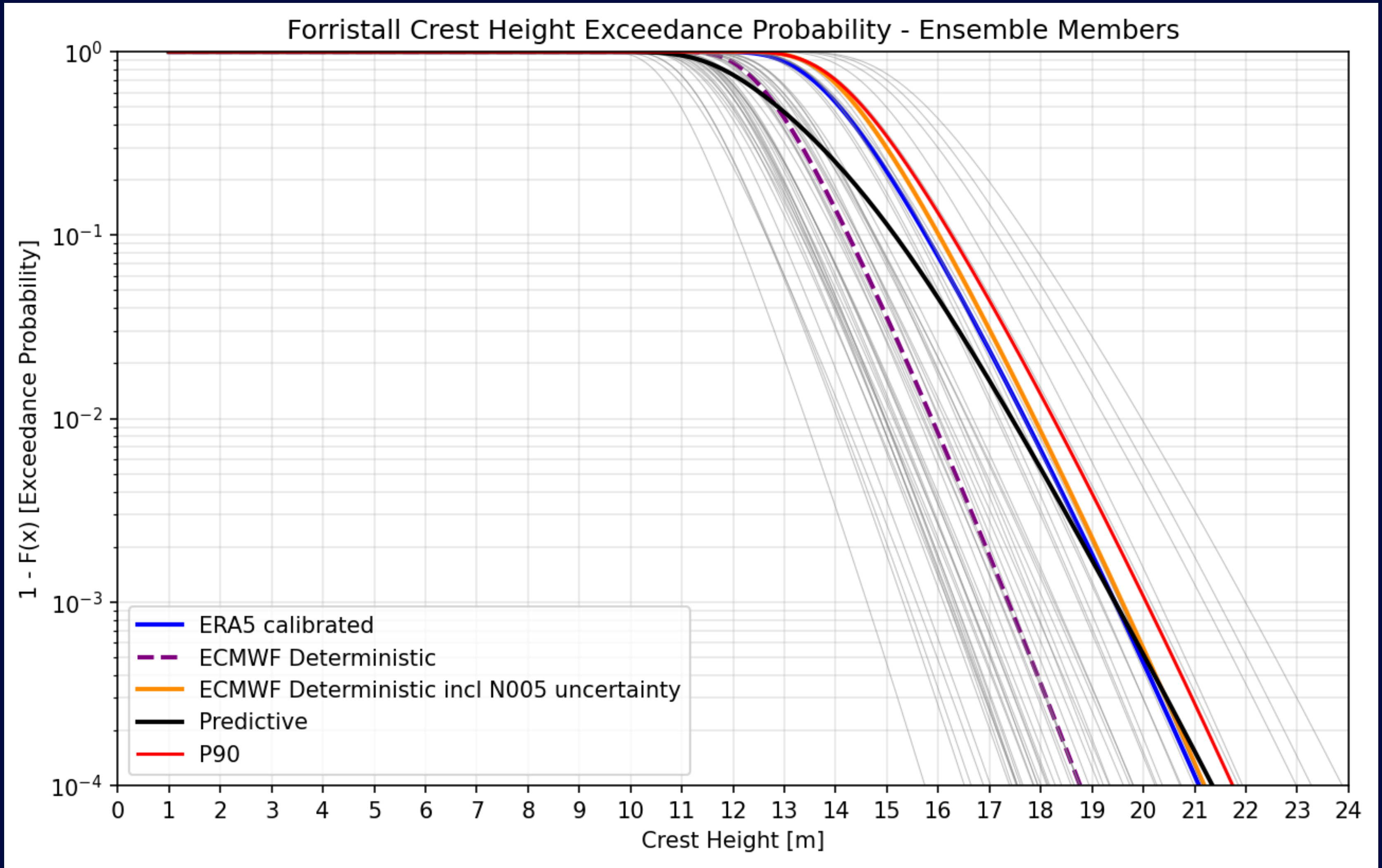

Each ensemble member is considered equally likely, with a probability of $1/k_0$. The marginal distribution of the maximum response over the storm is then obtained by averaging the probability distributions across all ensemble members.

$$F_Y(y) = \frac{1}{k_0} \sum_k F_{Y|k}(y|\mathrm{k})$$

# Example of storm



# Distribution of the largest crest in the storm



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