

2019

A Critical Analysis of the Wind Generated Effect on the Rate of Overtopping on the Hinkley Point C Sea Wall Through the use of Physical Modelling

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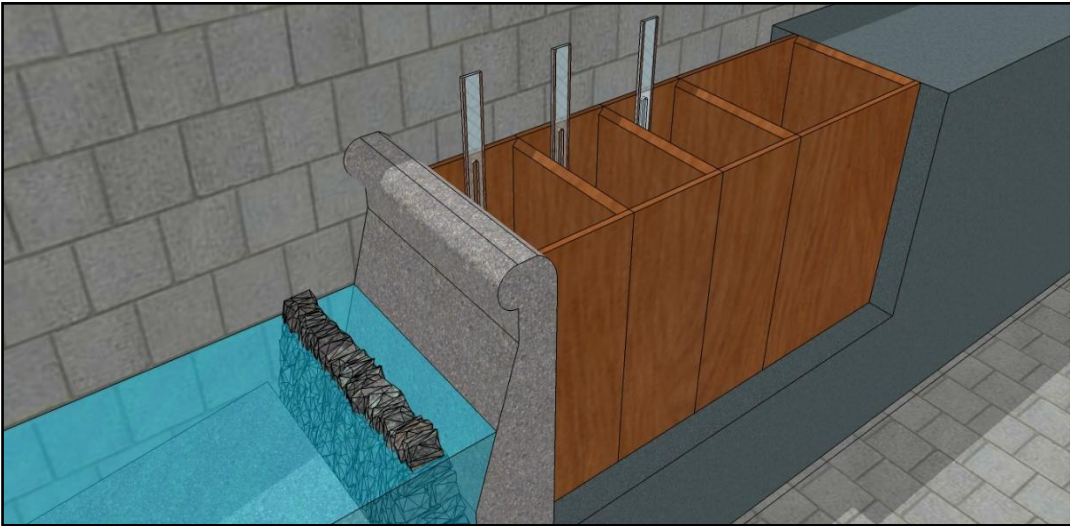
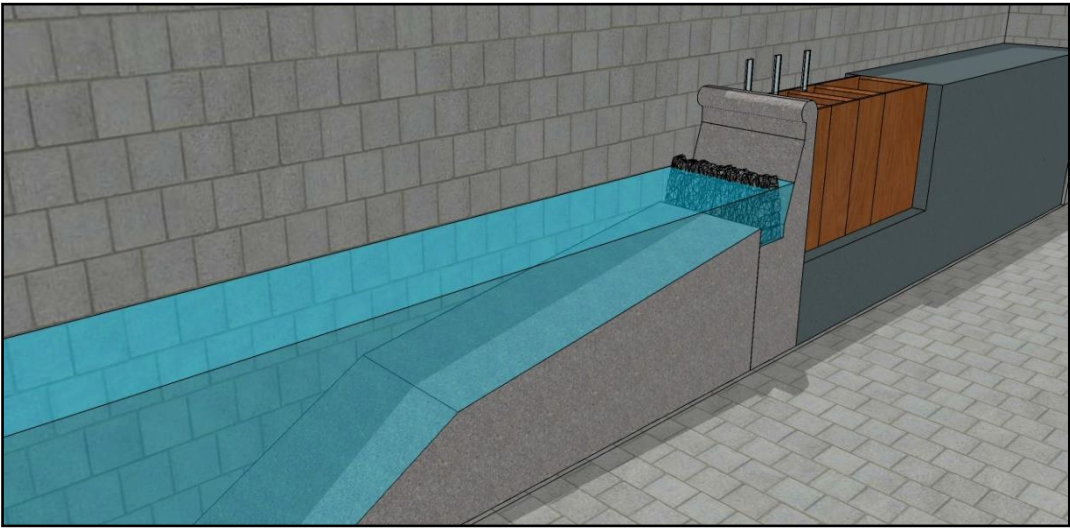
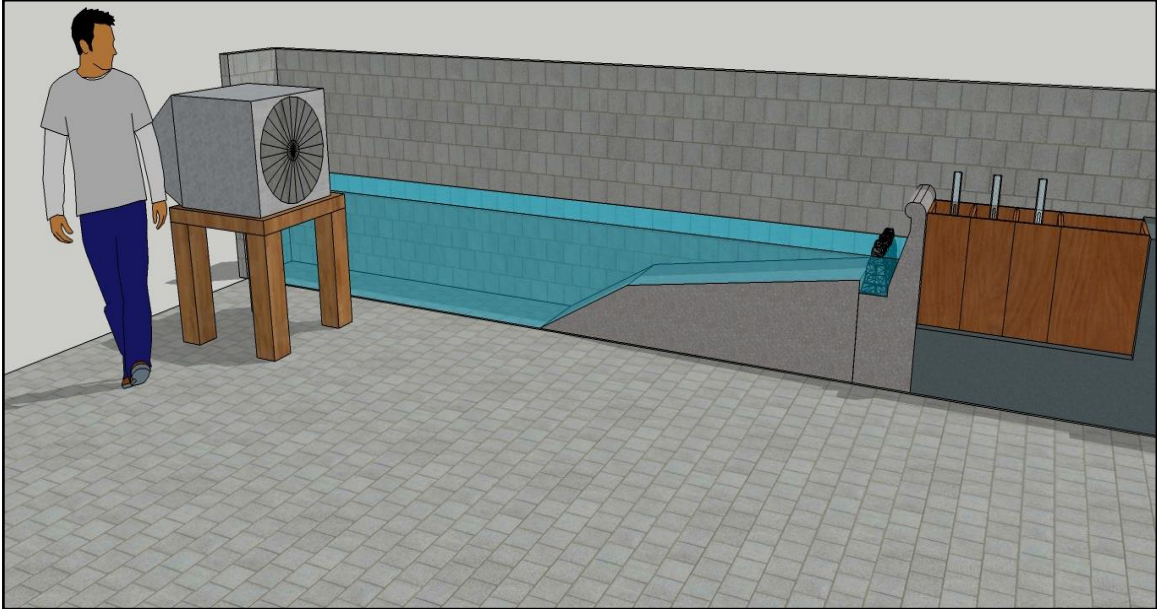
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University of Plymouth

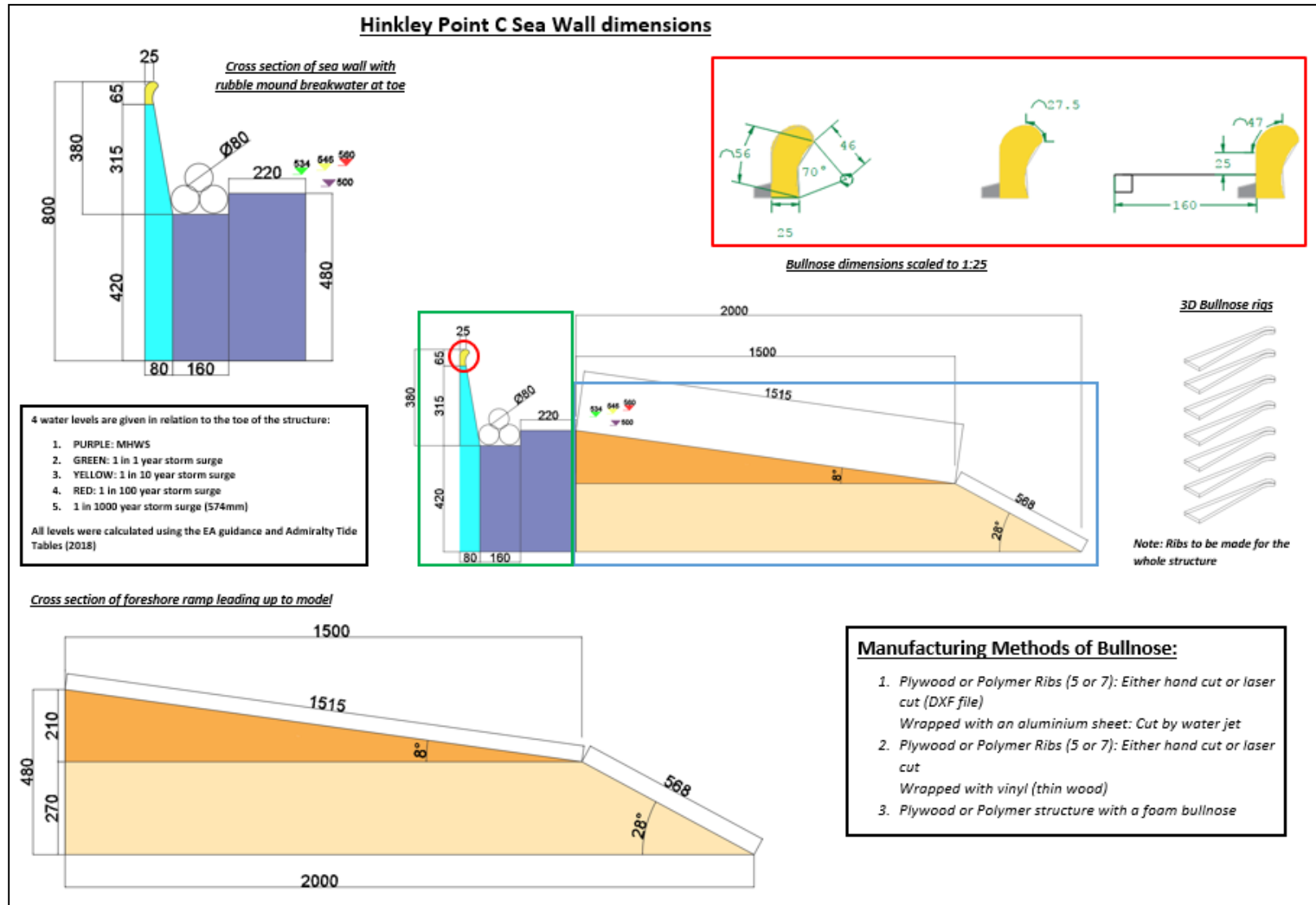
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Appendices

Appendix a – Visual representation of the model and setup (not to scale)

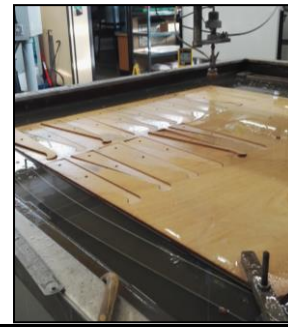
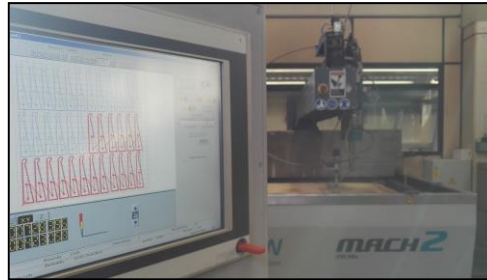
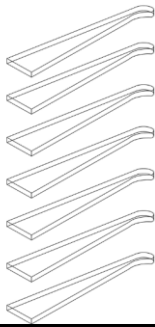


Appendix b – Experimental Matrix and Preliminary Designs



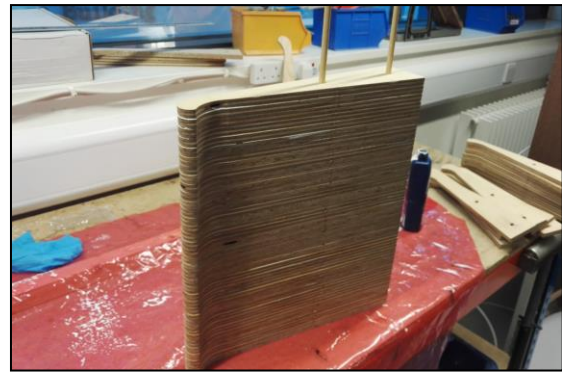
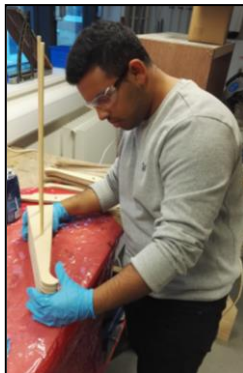
Appendix c – Model seawall construction process

Step 1:



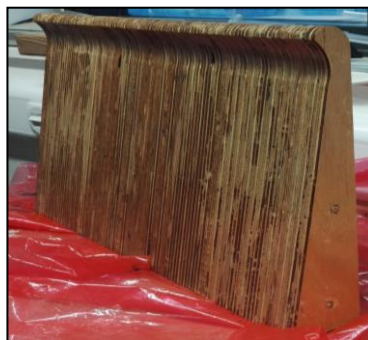
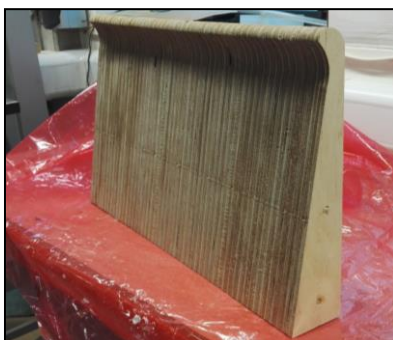
A DXF file was made on AutoCAD providing accurate dimensions of the Hinkley Point C seawall and imported onto the computer software required for the water jet. Using the help of the technicians, the water jet was set up to cut 50 offcuts from a sheet of 8m by 4m, marine plywood, costing roughly £60.

Step 2:



Using a wooden dowel, the 50 offcuts were aligned and glued for structural strength. Cracks did form as a result of the wood losing shape from the water jet process and thus did not align accurately at times – filler was used to fill this in.

Step 3:



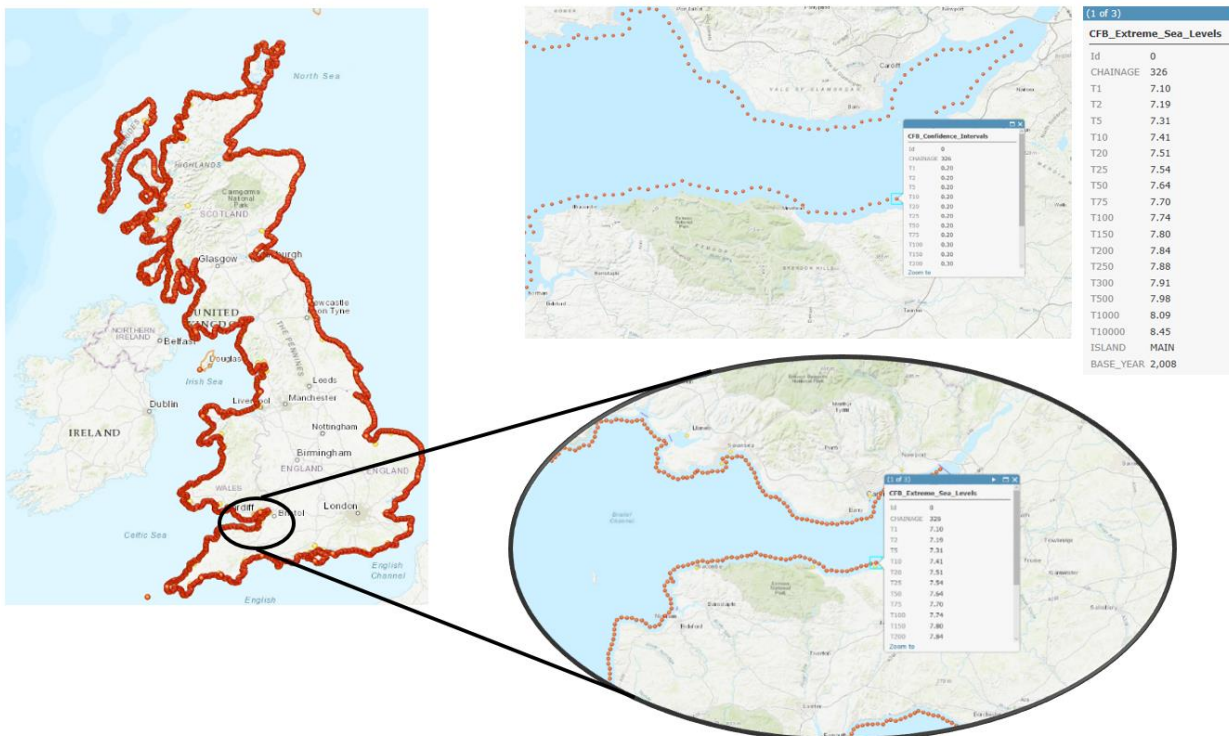
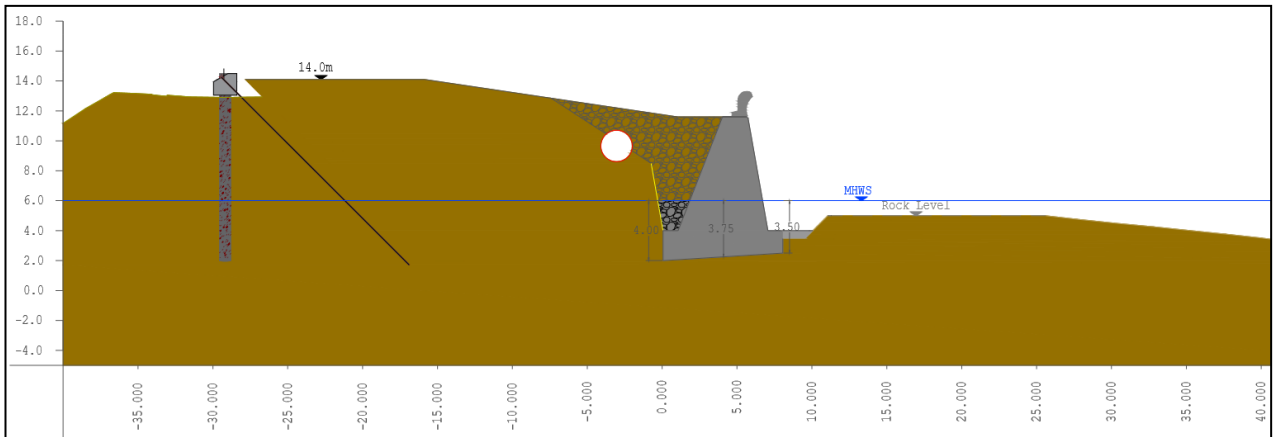
Once constructed, several coats of varnish were applied to ensure the structure remained waterproof within the flume. Further filler was applied at any visible

Appendix d – Amended Tidal Curve process

Extreme Sea Level

The extreme sea level for Hinkley Point C:

HPC – MHWs (6.0m) – HR Wallingford (AutoCAD), HAT (7.1m), Base Tide (6.55m)
 – ArcGIS website for the Estuary Boundaries providing the extreme water levels.
 Location plan for Hinkley Point C is shown below:



The extreme sea levels above are given for each of the return periods relative to the Ordnance Datum along with the chainage point.

Consider allowance for uncertainty – At this point, a consideration for uncertainty was required e.g. the confidence interval for the 100 year return period was $\pm 0.3m$.

Base astronomical tide

A level between HAT and MHWS identifies an astronomical tide which corresponds to an accurate level.

1. **Identify standard port** - This method of generating a base tide curve involves using the Admiralty Tide Tables (ATT). Hinkley Point was not a standard port so a secondary port which was the nearest port was chosen. This was the Port of Bristol (Avonmouth)
2. **Choose predicted high tide level between HAT and MHWS** - The base astronomical tide should be high enough to represent a larger than 'normal' event but also reach an appropriate level to reflect an event which occurs every year. The basis of our design tidal graph was based on a spring tide. However, spring tides vary substantially over time due to the influence of the lunar cycle. A level between the highest astronomical tide (HAT) and mean high water

Site name	MHWS (mCD)	HAT (mCD)	Base tide curve level (mCD)
Hinkley Point C	6.0	7.1	6.55
Avonmouth (Port of Bristol)	6.7	8.15	7.43

spring (MHWS) is selected for the Port of Bristol.

3. **Identify date and time for selected level between HAT and MHWS** - The ATT contains predicted times and levels for high and low tides for a 1 year duration. In the tables, the level between HAT and MHWS for the standard port is chosen along with its respective date and time.
4. **Choose a base astronomical tidal cycle duration** - Choose a duration for the base astronomical tidal cycle. The date and time of your selected high tide (between HAT and MHWS) should be the centre of the base astronomical tide. The tide curve is extended to two days before the peak and two days after, giving a total duration of approximately 100 hours - this ensures an adequate time for a number of high tides.

Site name	Peak Level (mCD)	Date and time of peak	Design tide curve dates
Avonmouth (Port of Bristol)	7.4	31 st March 2018	29 th March 2018 – 2 nd April 2018

5. **Identify harmonic constants** - To produce the base astronomical tide curve, the harmonic constants had to be identified. The harmonic constants represent the multiple influences which contribute to an astronomical tide, including: rotation of the Earth, positions of the Moon and the Sun relative to Earth, the moon's altitude above the Earth, and bathymetry. Hinkley Point C's harmonic constants are shown and used below:

M2 – 3.92H.m and **S2** – 1.41H.m

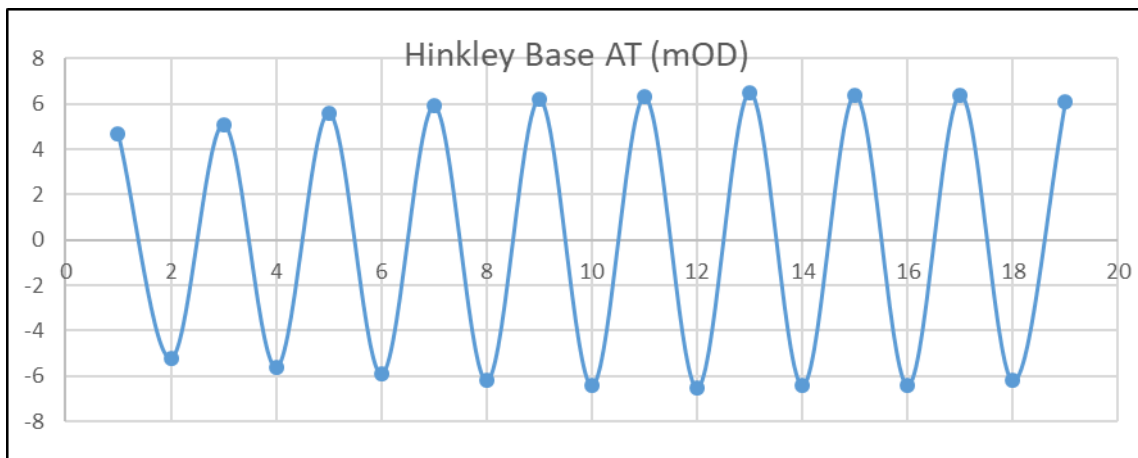
6. Levels in the Admiralty Tide Tables are quoted to Chart Datum whereas extreme level estimates are quoted to Ordnance Datum and a conversion is

Site name	CD OD Conversion
Hinkley Point C	-6.50

required.

Port of Bristol (Avonmouth)					Hinkley Conversion
Date	Time	Date & Time	Level (mCD)	level (mOD)	Level (mOD)
29/03/2018	05:28:00	29/03/2018 05:28:00	12.3	5.8	4.7
29/03/2018	12:13:00	29/03/2018 12:13:00	1.4	-5.1	-5.2
29/03/2018	17:59:00	29/03/2018 17:59:00	12.7	6.2	5.1
30/03/2018	00:36:00	30/03/2018 00:36:00	1	-5.5	-5.6
30/03/2018	06:18:00	30/03/2018 06:18:00	13.2	6.7	5.6
30/03/2018	13:07:00	30/03/2018 13:07:00	0.7	-5.8	-5.9
30/03/2018	18:46:00	30/03/2018 18:46:00	13.5	7	5.9
31/03/2018	01:28:00	31/03/2018 01:28:00	0.4	-6.1	-6.2
31/03/2018	07:04:00	31/03/2018 07:04:00	13.8	7.3	6.2
31/03/2018	13:56:00	31/03/2018 13:56:00	0.2	-6.3	-6.4
31/03/2018	19:29:00	31/03/2018 19:29:00	13.9	7.4	6.3
01/04/2018	02:16:00	01/04/2018 02:16:00	0.1	-6.4	-6.5
01/04/2018	07:47:00	01/04/2018 07:47:00	14.1	7.6	6.5
01/04/2018	14:41:00	01/04/2018 14:41:00	0.2	-6.3	-6.4
01/04/2018	20:10:00	01/04/2018 20:10:00	14	7.5	6.4
02/04/2018	02:59:00	02/04/2018 02:59:00	0.2	-6.3	-6.4
02/04/2018	08:26:00	02/04/2018 08:26:00	14	7.5	6.4
02/04/2018	15:20:00	02/04/2018 15:20:00	0.4	-6.1	-6.2
02/04/2018	20:47:00	02/04/2018 20:47:00	13.7	7.2	6.1

Data obtained from the ATT. A graph below was plotted which plots the Level (mOD) on the

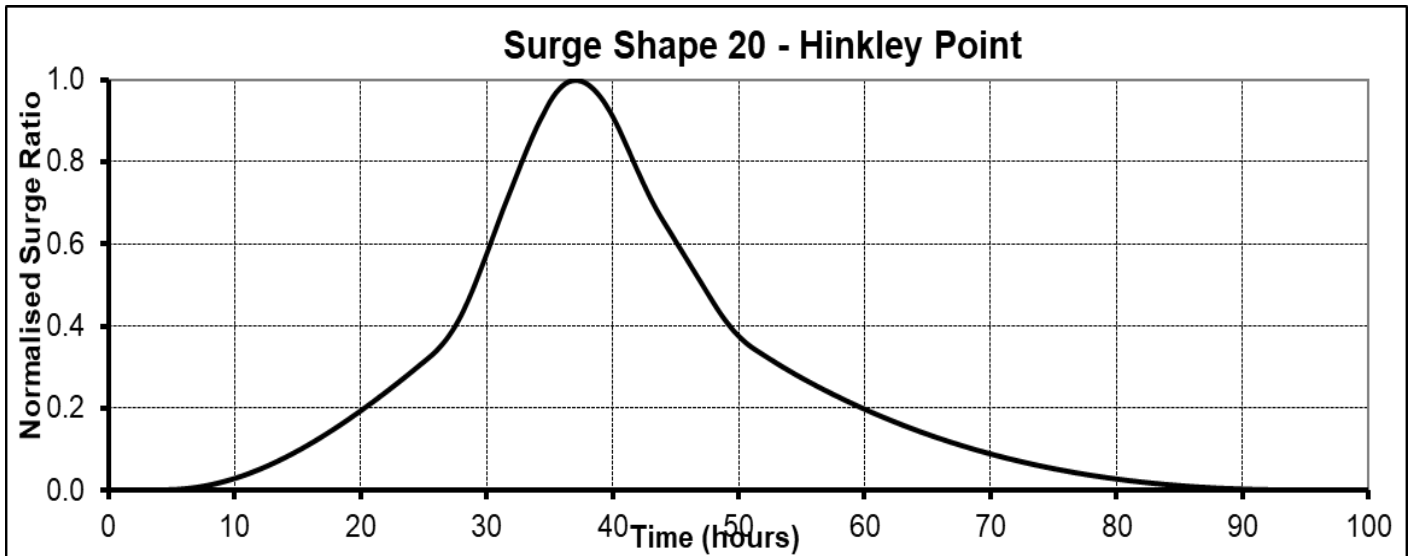


Surge Component

The steps so far have led to selection of an extreme sea level and a base astronomical tide curve which reaches a peak between HAT and MHWS.

- Skew surge is the difference between an observed high tide and the nearest predicted high tide

- The surge itself will include the rise in sea level caused by the pertaining low pressure weather system and its associated storm winds. The surge shape will vary between different sections of the coast.



- Surge shape 20 was selected for our site using the GIS data (CFB_Surge_Shape.shp).

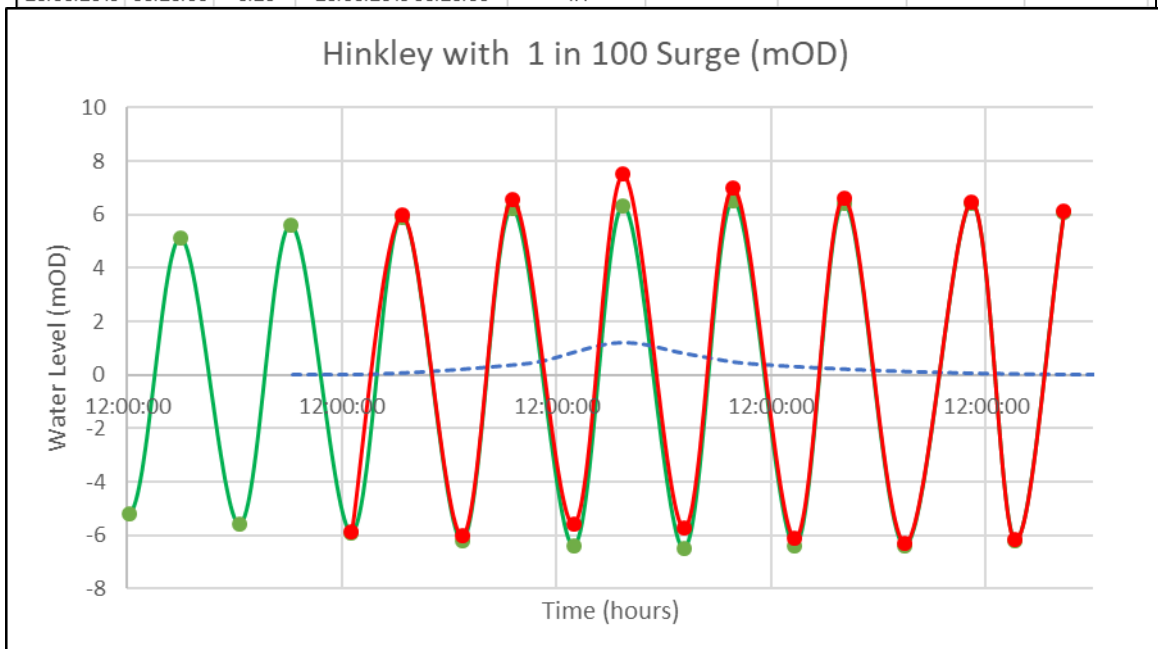
For practical purposes the extreme sea level, peak astronomical tide level and peak surge height should occur coincidentally. The surge shape should be positioned so its peak height is coincident in time with the peak level in the base tide sequence. The surge shape is scaled so the surge height added to the peak of the base tide equals the target peak sea level desired. Adding the scaled surge heights to the base tide levels gives the net design event tide curve.

e.g For a 1 in 100 storm surge – varies for each Water level: 0.86 for 1 in 10, 0.55 for 1 in 1

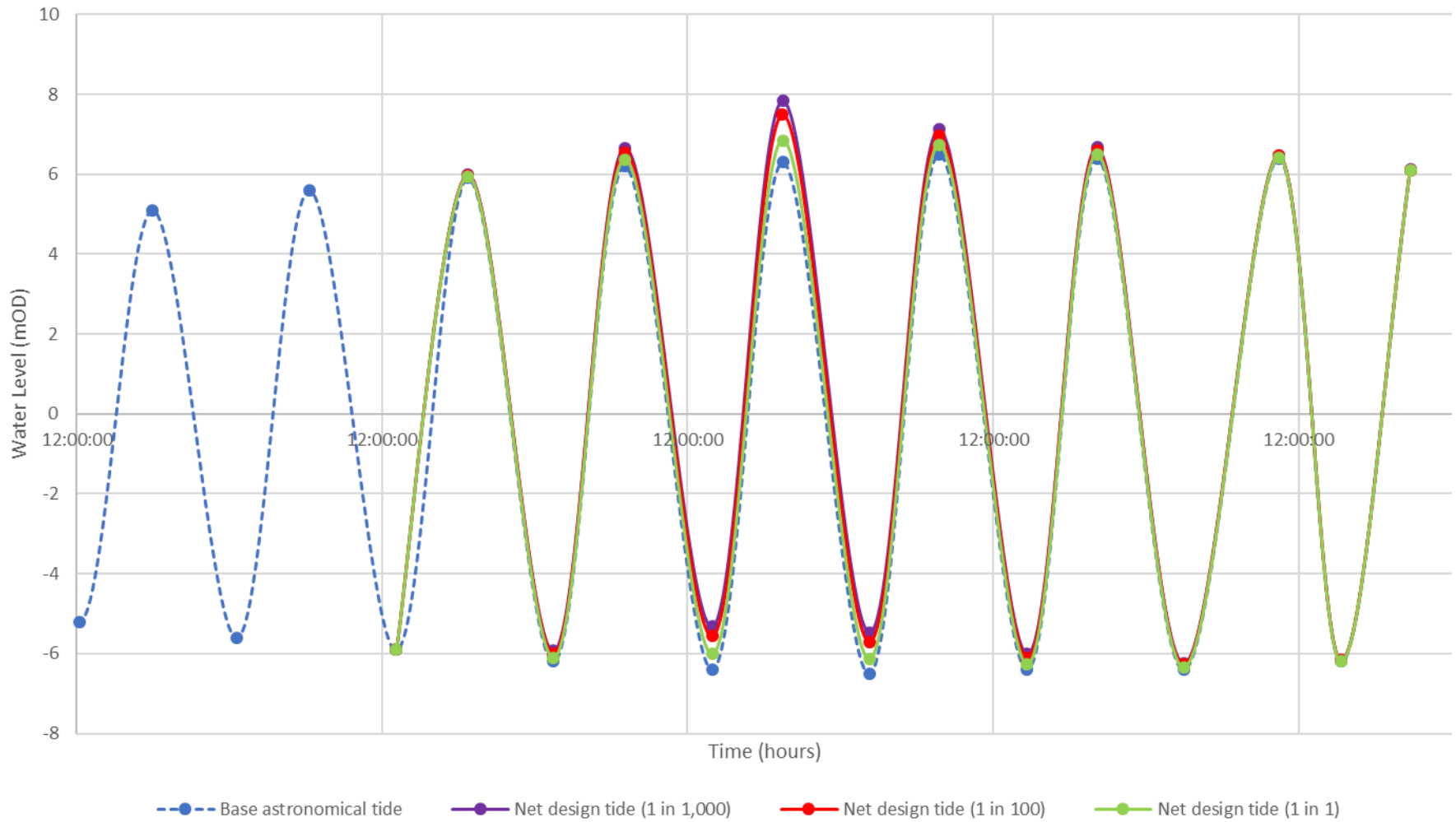
$$7.74 - 6.55 = 1.19$$

$$1.19/1 = 1.19 \text{ (scaling factor)}$$

Date	Time		Date & Time	Hinkley Base AT Level (mOD)	1 in 100 Level (mOD)	1 in 50 Level (mOD)	1 in 10 Level (mOD)	1 in 1 Level (mOD)
29/03/2018	05:28:00	5.28	29/03/2018 05:28:00	4.7				



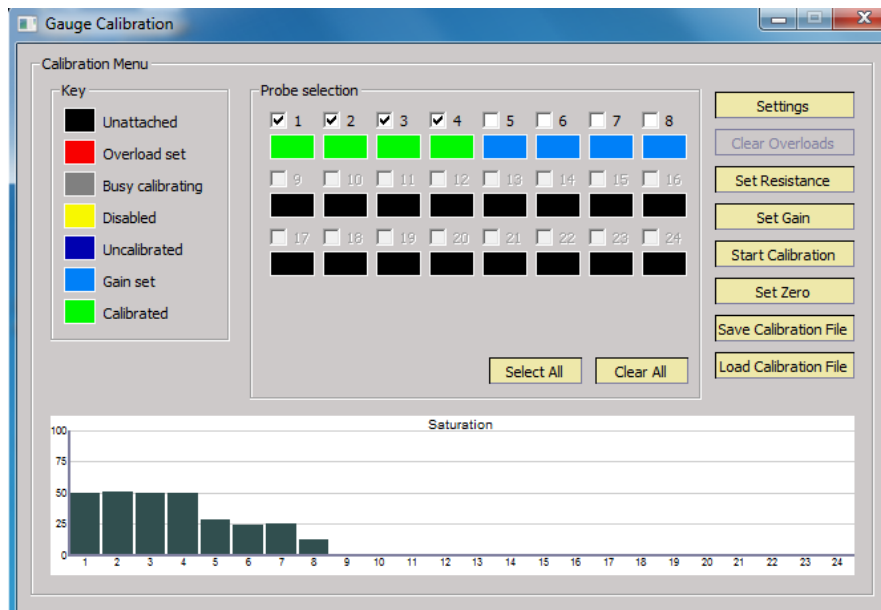
Resultant design tide curve for Hinkley: 1, 100 & 1000 year Return Periods (mOD)



Appendix e – Testing Procedure

1. At the start of each day, calibrate all 8 gauges. The 4 gauges upstream are calibrated through a specific process - raise 100mm, lower 100mm and return to the original position. Repeat for Gauge 1-4.

For Gauges 5-8 in the collection buckets, the gauges are calibrated through filling them up in 1L intervals and waiting for the water to settle. This is repeated until all boxes have 8L in them. Below shows the readings post calibration.



2. Power up the paddle
3. Set desired wave conditions on Njord software
4. Create a named file for the given conditions (purely for the saving of the gauges data to differentiate between varying conditions) – type of spectrum, duration of run, significant wave height and irregular/regular waves
5. Set desired wind speed – anemometer is used to convert percentage into m/s reading.
6. Switch on the fan and wait until the fan reaches full speed.
7. Press start on the Njord software to initiate the test
8. Wait for the duration of the test
9. Turn off the blower
10. Run an “after test” shortly after for roughly 15s with a different file name – mainly for analysis purposes on MATLAB to measure the overtopping volume. This also means the boxes don’t need to be emptied if vast amounts of overtopping did not occur saving time. If boxes are full, vacuum the water out.
11. Ensure the water level is still at the desired level
12. Repeat Process

Appendix f – Clapotis Effect

