

News on the Wave Dragon project

During the coming two years a consortium will establish and test a scale 1:4.5 model of the floating offshore wave energy converter in Nissum Bredning, Denmark. The project has been secured through a grant from the Danish Energy Agency with co-funding from a number of commercial partners. The total project budget is 12.8 mill. DKK (1.7 mill. €).

The Wave Dragon is a slack moored device of the overtopping type, consisting of two wave reflectors focusing the waves towards the ramp, where water overtop into a reservoir. The pressure height in the reservoir is converted into power through a number of variable speed axial turbines.

During the last three years the Wave Dragon have been subject to a number of test and development activities, including the EU Craft project "[Low-pressure Hydro Turbines and Control Equipment for Wave Energy Converters \(Wave Dragon\)](#)".

In a project co-funded by the Danish Energy Agency and the EU, a model turbine especially suited for the low and varying heads and flows has been developed and tested with very promising results. This turbine will be installed on the scale 1:4.5 model in the coming Nissum Bredning project.

Following the EU craft project, the geometrical layout of the Wave Dragon has been somewhat modified. Wave tank tests on this new design have been performed at Aalborg University, with significantly improved overtopping characteristics without sacrificing survivability.

In the coming Nissum Bredning project this design will be implemented in scale 1:4.5. Initially the test series will focus on hydraulic behaviour and long-term testing of the turbine. The consortium is currently seeking additional funding, allowing installation of additional turbines and connection to the grid system. Due to scale effects the rated power will be 20 kW resembling 4 MW in full scale, with the optimal number of turbines installed. The scale 1:4.5 activities are expected to establish the necessary knowledge in order to deploy a full-scale offshore prototype in 2006.

The Development activities are managed in the newly established development company Wave Dragon Test ApS. Apart from the development company the consortium consist of:

SPOK ApS, Project Management Consultancy (DK)

Löwenmark F.R.I, Consulting Engineer (DK)

MT Højgaard A/S, Construction Enterprise (DK)

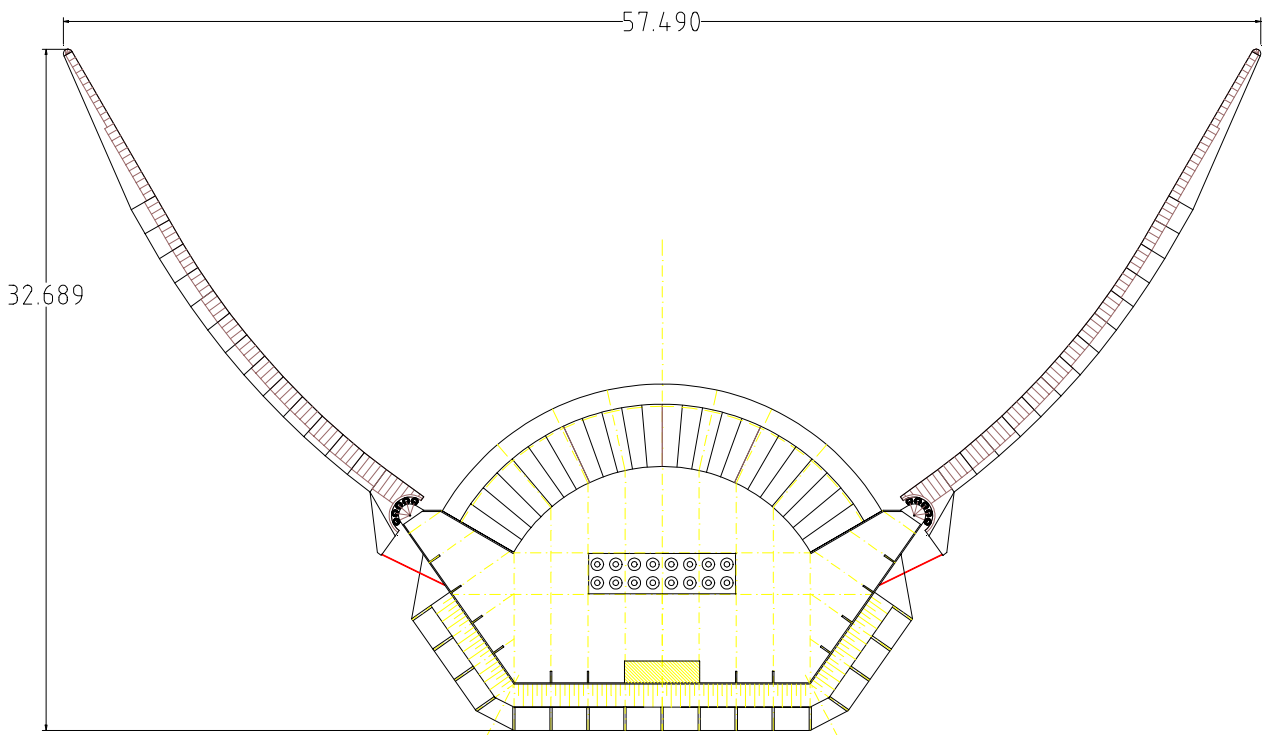
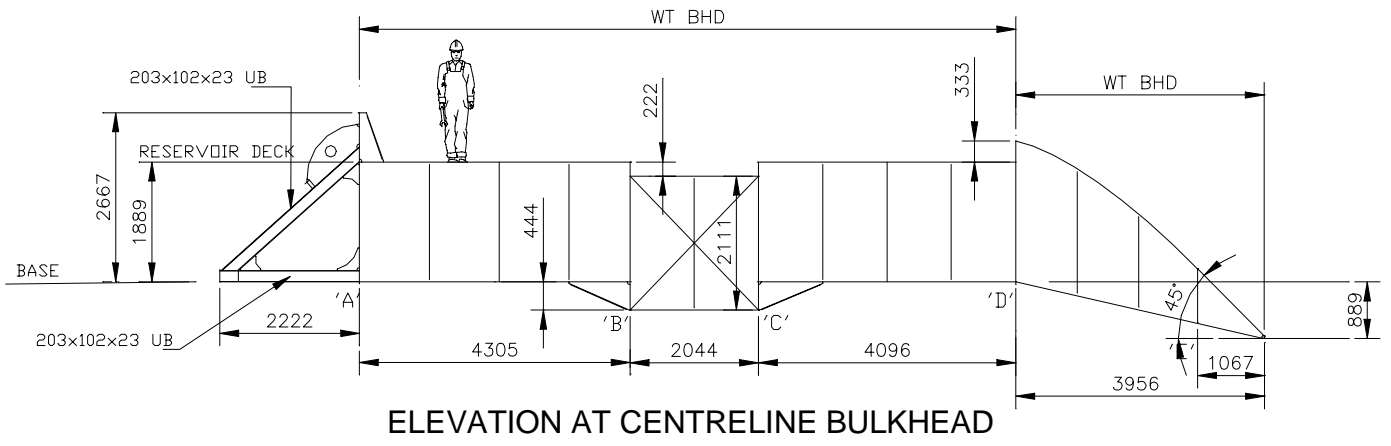
Aalborg University – Hydraulics & Coastal Engineering Laboratory (DK)

Armstrong Technology Associates Ltd., Naval Architects (UK)

VeteranKraft AB, Consulting Engineers - hydro turbine design (S)

Balslev A/S, Consulting Engineers - electrical and automation systems (DK)

For further information contact Hans Christian Soerensen consult@spok.dk or Erik Friis-Madsen loewenmark@city.dk.



Plane view, Wave Dragon model scale 1:4,5 - measures in meters, actual layout.



**The tested Wave Dragon-model at the turbine at test stand.
Same turbine to be applied in scale 1:4.5 project.**



The Wave Dragon in scale 1:50 just before wave passage.



Overtopping on the Wave Dragon scale 1:50

Data on the scale 1:4.5 Wave Dragon model

Width between the wave reflectors at opening towards the sea	57	m
Wave reflector length	28	m
Ramp crest width	27	m
Reservoir size	55	m ³
Weight: 163 tons steel + 74 tons ballast =	237	tons
Rated power	20	kW
Turbine hydraulic efficiency at 0.7 m head	87	%
Mooring	Slack moored	
Generator	Synchronous	
Project budget	1.7	Mill. €

Data on full-scale prototype

Width between the wave reflectors at opening towards the sea	260	m
Wave reflector length	125	m
Ramp crest width	120	m
Reservoir size	5,000	m ³
Weight: 21,400 tons reinforced concrete + 350 tons steel =	21,750	tons
Rated power (16 variable speed axial turbines)	4	MW
Turbine hydraulic efficiency at 3.0 m head	91	%
Mooring	Slack moored	
Generator type	Synchronous	
Est. costs	13.5	mill. €
Est. annual production, 24 kW/m wave climate	10	GWh/y
Est. production price	0.11	€/kWh
Est. Long term production price (2016)	0.04	€/kWh