ACCESSING THE FAR SHORE WIND FARM

C. Cockburn
S. Stevens
E. Dudson

BMT Nigel Gee

ACCESSING THE FAR SHORE WIND FARM

SUMMARY

- Operation and maintenance of offshore wind farms
- Current wind farms are relatively small and positioned close to shore
- Round 2 and 3 sites will be significantly further offshore
- Rougher seas and longer transits
- Requires a change in the current regulations and vessel designs

This presentation aims to:-

- Assess the likely availability and operability of wind farm support vessels
- Assess the likely requirements for future vessels
- Suggest a forward looking strategy to meet the predetermined service requirements

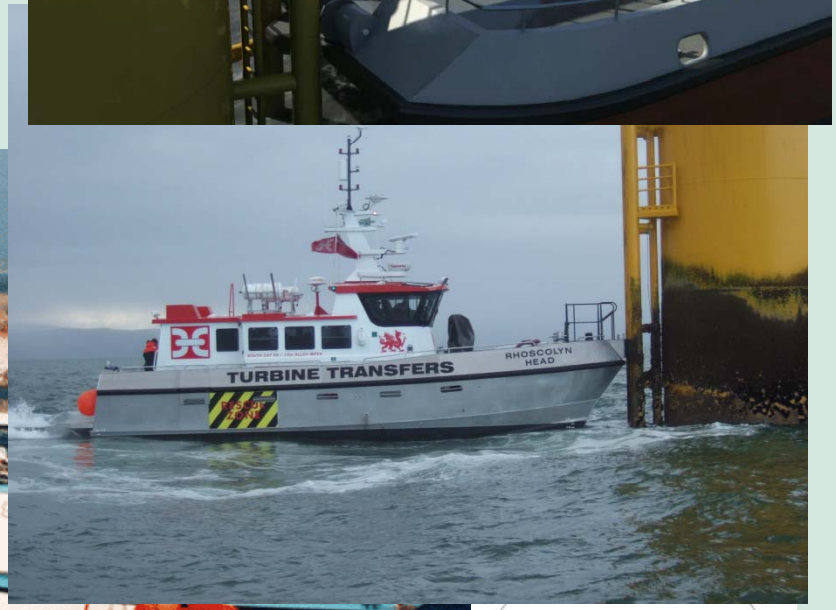
INTRODUCTION

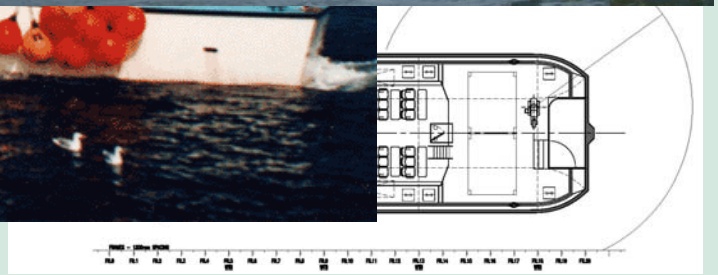
- 25% of UK electricity supplied from offshore wind energy by 2020
- Approximately 5,000 offshore units
- A large number of vessels will be required
- Finite time and number of ship yards
- Current vessels inappropriate for longer transits and increasing wave heights

BACKGROUND

AN EVOLUTION IN VESSEL DESIGN

- **First vessels were small work boats and fishing boats**
- **Dedicated vess**
  - Relatively fas
  - Aluminium
  - Catamarans
  - Custom bow f
  - Tailored powe
- **Lengths of 15 r increasing to 2**
- **Now bespoke a**

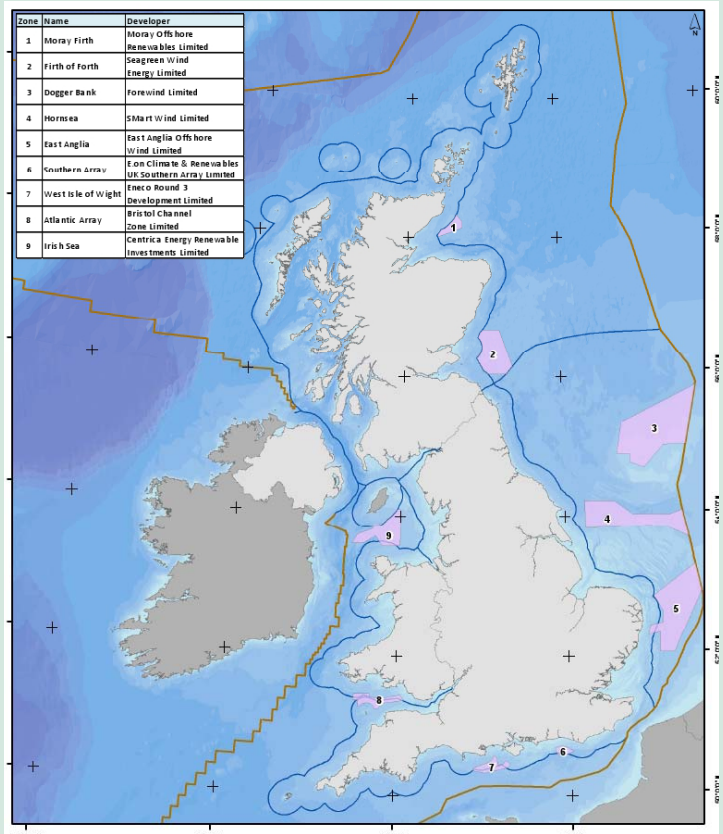




INTRODUCTION

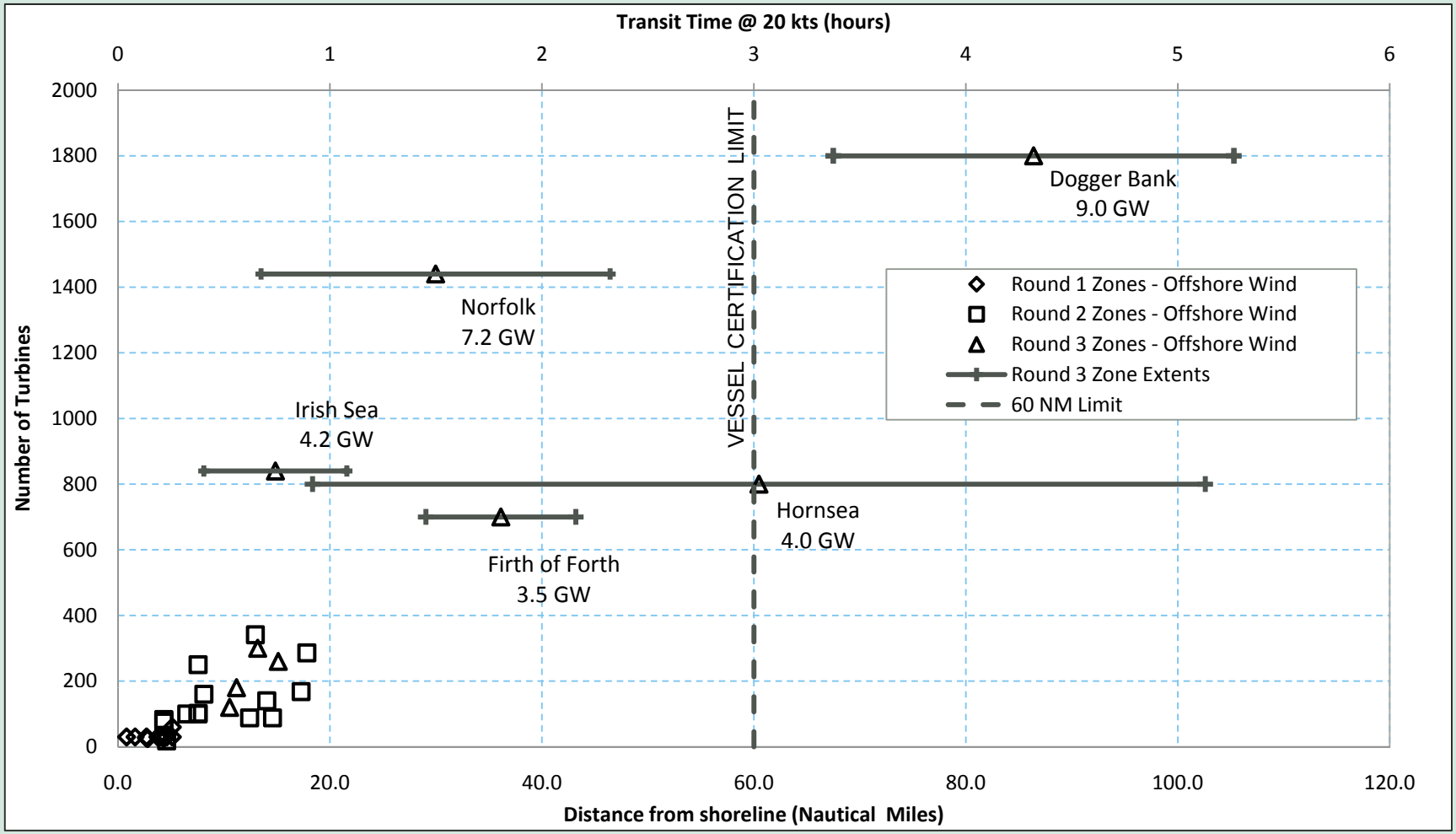
AN EVOLUTION IN WIND ENERGY INDUSTRY

- The UIK has adopted a highly progressive policy of wind energy generation
- After Round 1 – UK Total of ~400 Turbines, 1.3GW
- After Round 2 – UK Total of ~2000 Turbines, 7.6GW
- After Round 3 – UK Total of ~6000 Turbines, 32.2GW
- Size of turbines



'Offshore Wind - Round 3 Zones' supplied by The Crown Estate

RELATIVE SIZE AND DISTANCE OFFSHORE OF UK WIND FARMS



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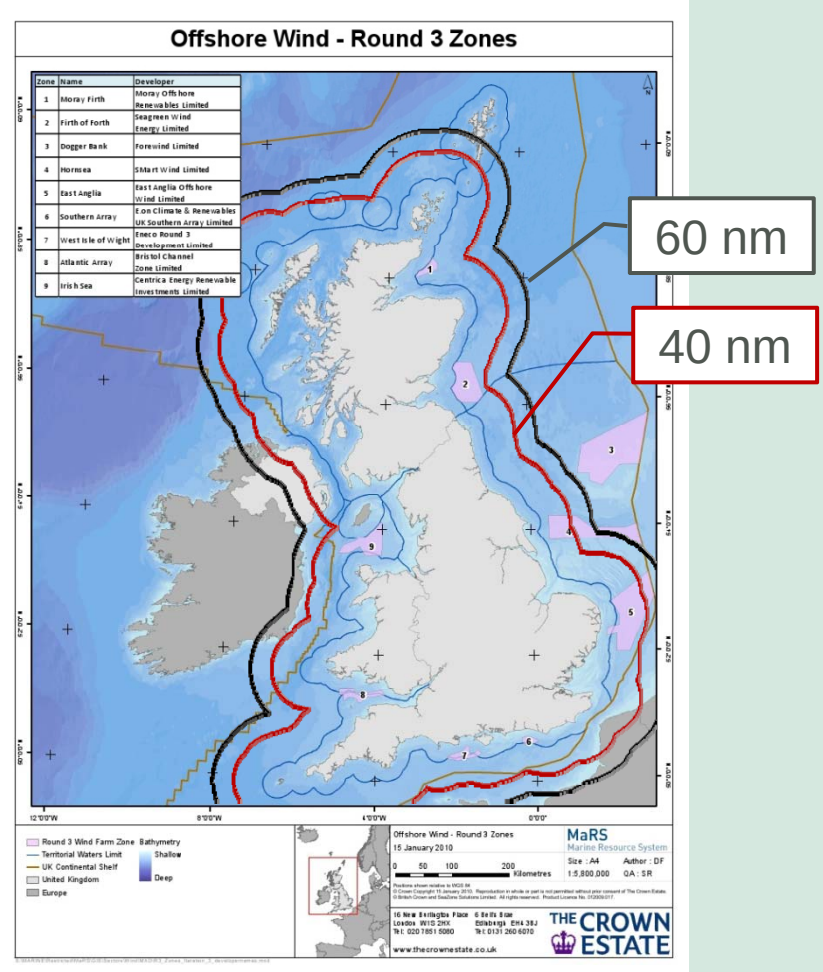
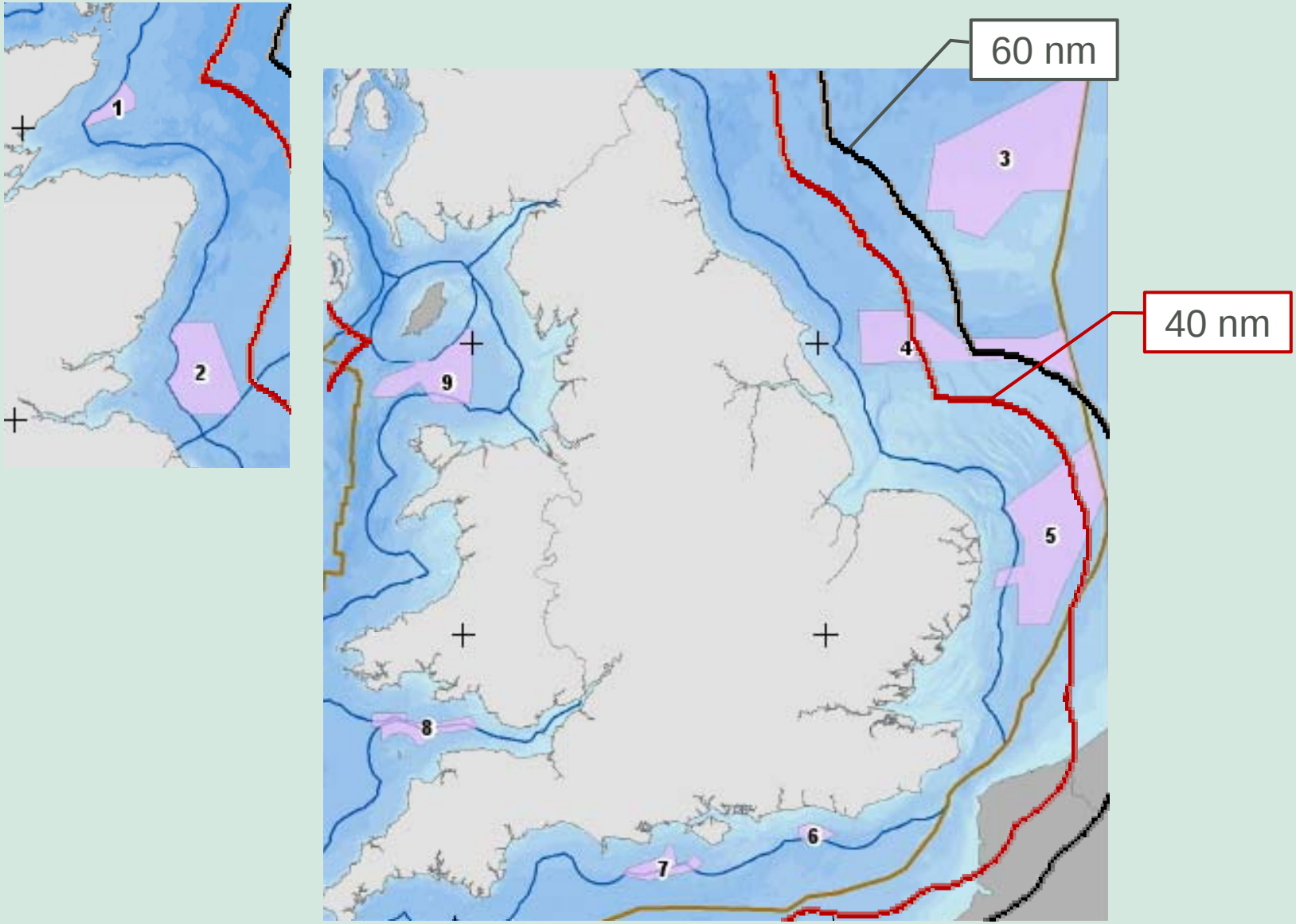
EXISTING FLEET CAPABILITY

DESIGN LIMITATIONS

- **MCA Small Commercial Vessels Code**
- **60 nautical mile limit**
- **2 hour desirable transit time**
  - Assuming an average transit speed of 20 knots
  - Restricts the range to 40 nautical miles



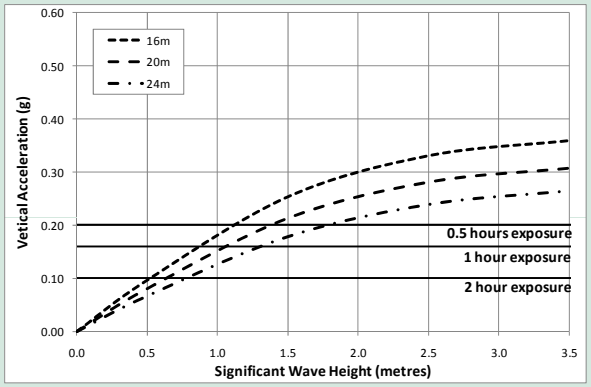


ACCESSING THE FAR SHORE WIND FARM

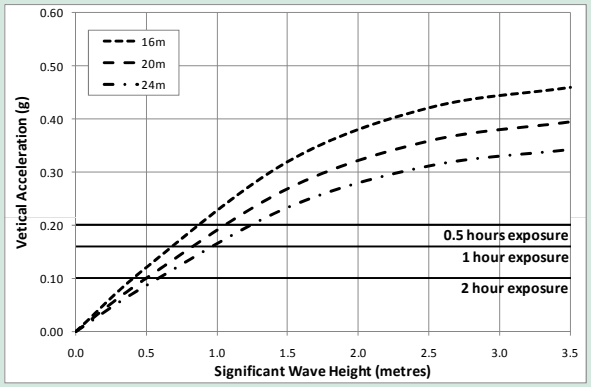
EXISTING FLEET CAPABILITY

VESSEL CAPABILITY

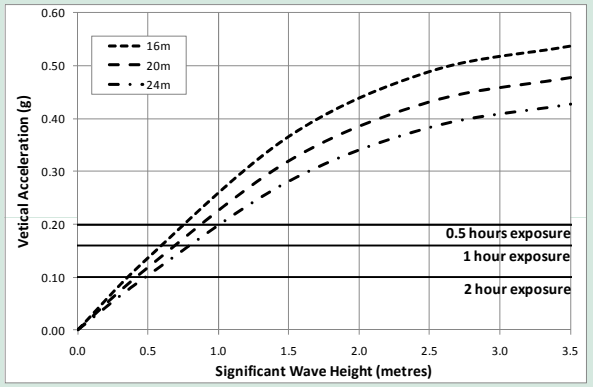
- ISO 2361 Limits for 0.5, 1 and 2 hours, 10% MSI
- Double for technicians more used to travelling at sea
- Vertical accelerations averaged over head, bow quartering and beams seas
- Possible to approximate the wave height at which the ISO limits are exceeded



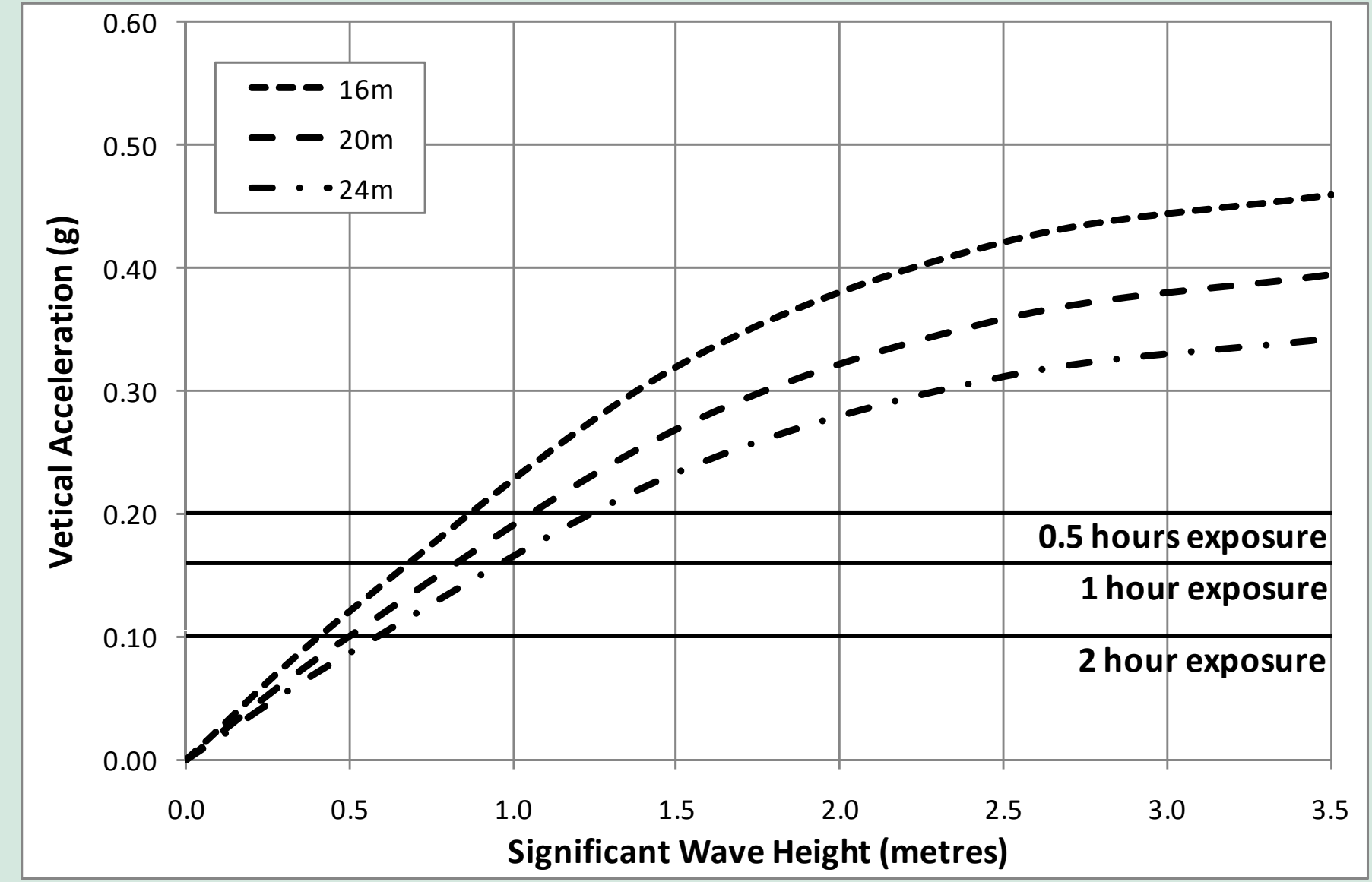
Vertical Acceleration Response at 16 Knots



Vertical Acceleration Response at 20 Knots



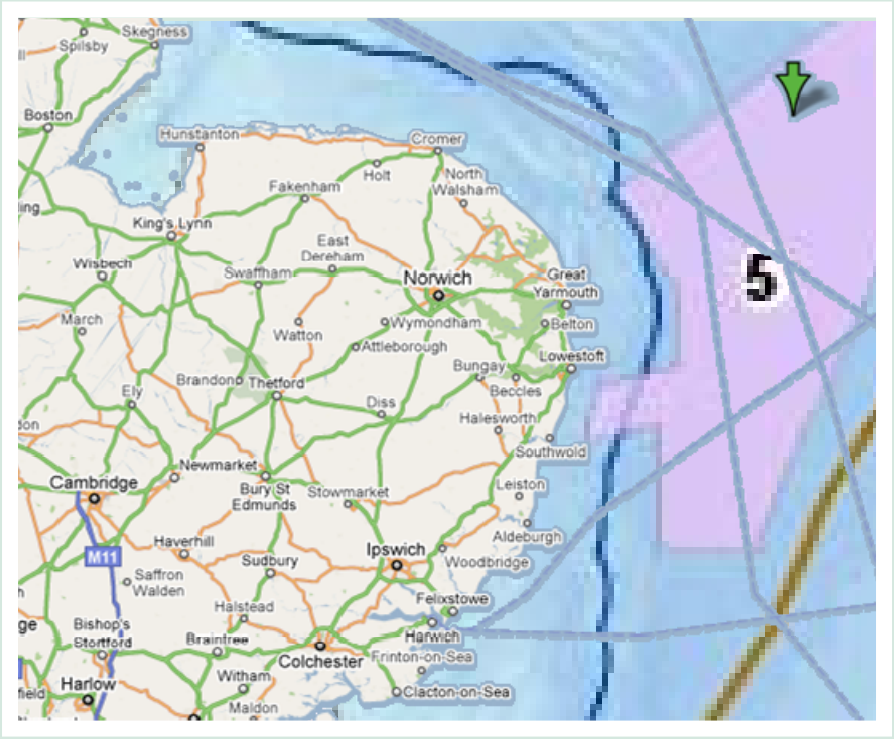
Vertical Acceleration Response at 24 Knots



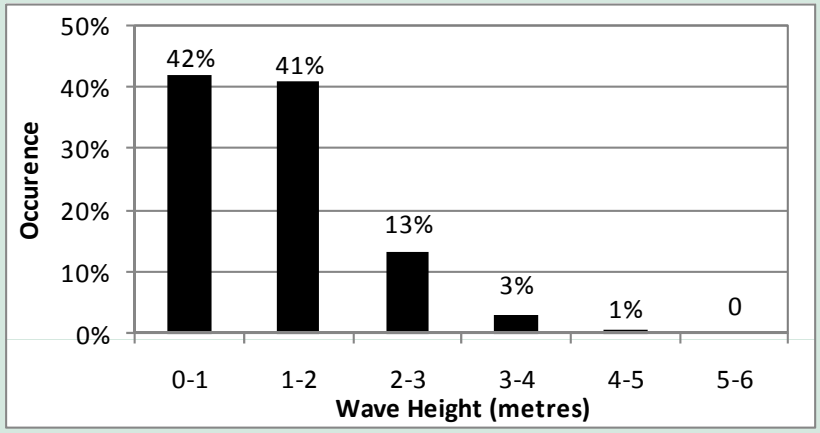
Vertical Acceleration Response at 20 Knots

APPLICATION TO WIND FARMS

WAVE ENVIRONMENT



- Based on data from BMT ARGOSS
- 53° 00'N, 2° 30'E
- Northern end of the Norfolk site



APPLICATION TO WIND FARMS

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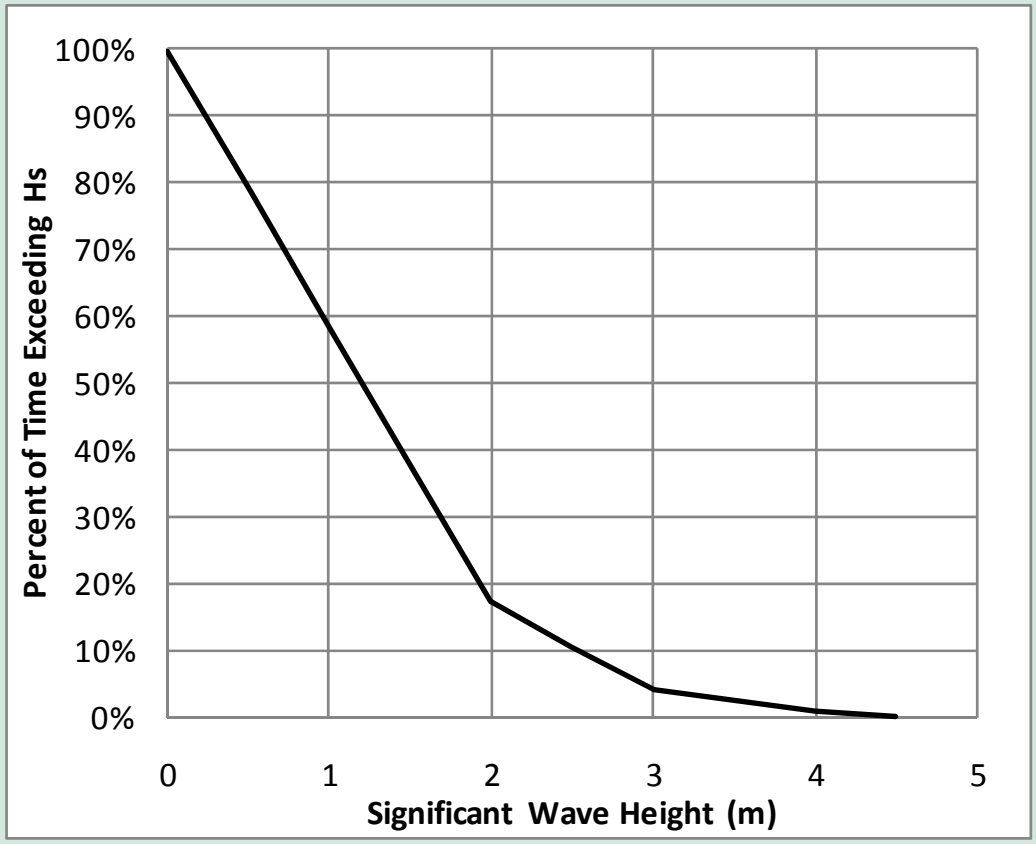
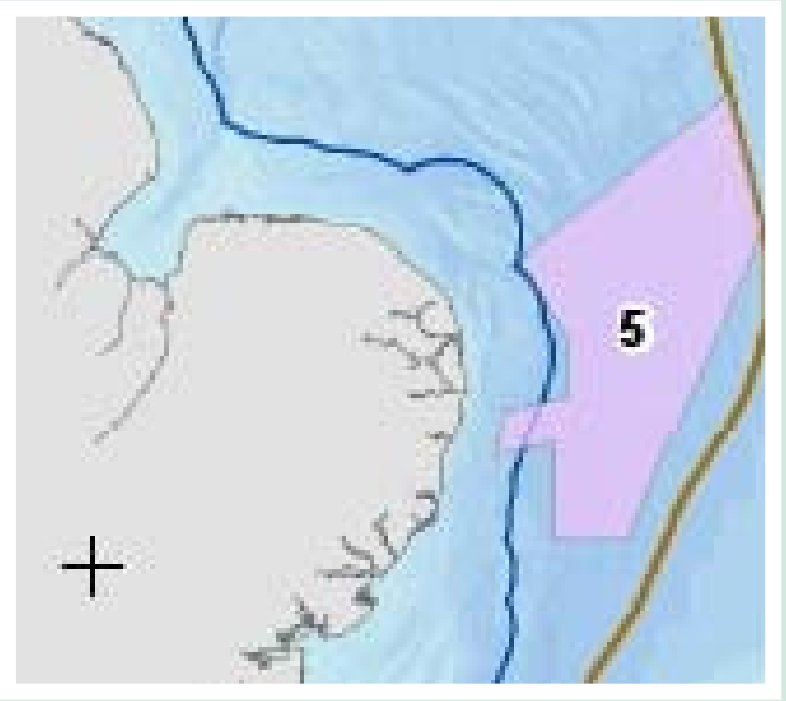


APPLICATION TO WIND FARM SITES

Round 3 Site - Norfolk

- **1440 turbines**
- **30 nm average distance offshore**
- **Calculated duration based on speed**
- **Estimated wave height limit for each length of vessel at each speed**
- **Seem low but driven by increased duration and use of offshore spectrum for entire transit**

Speed	Duration	Max Wave Height		
Kts	hrs	16m	20m	24m
16	1.88	0.59	0.70	0.86
20	1.50	0.55	0.65	0.78
24	1.25	0.54	0.63	0.73

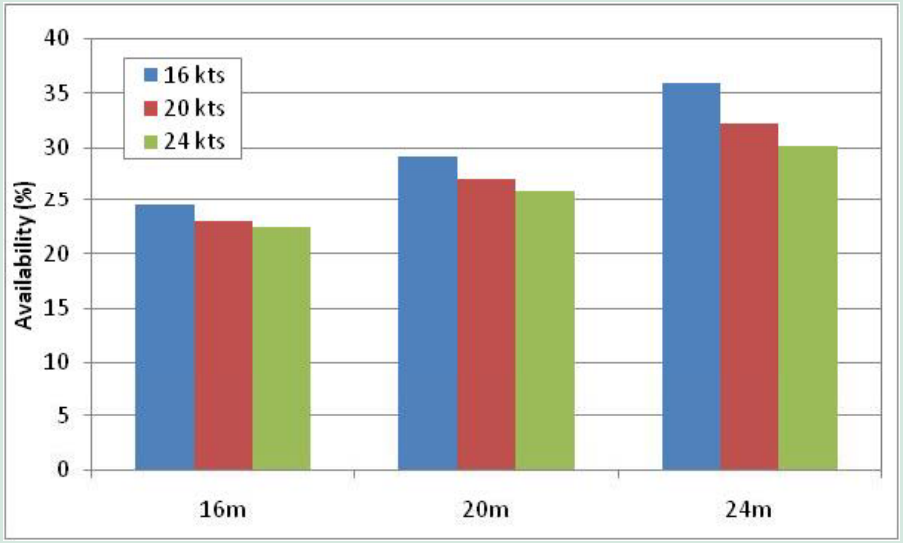


APPLICATION TO WIND FARMS

OPERABILITY

- Using the wave statistics and motions analysis
- Determine the percentage that the sea state exceeds the derived limits
- Increase in length increases availability
- Increase in speed, reduces availability
- Lower speeds will induce higher durations and reduce the acceptable ISO limits

Speed	Availability (%)		
Kts	16m	20m	24m
16	25	29	36
20	23	27	32
24	22	26	30



APPLICATION TO WIND FARMS

MAINTENANCE REGIMES

- Norfolk site – 1440 turbines
- 1 turbine takes 3 technicians 5 days (15 man days)
- 12 technicians per boat, 4 turbines per boat
- Calculate the required number of vessels based on the availability
- Unscheduled maintenance not accounted for

	16 metre Vessel	20 metre vessel	24 metre vessel
16 knots	21	17	14
20 knots	22	19	16
24 knots	22	19	17

APPLICATION TO WIND FARMS

IMPROVING OPERABILITY

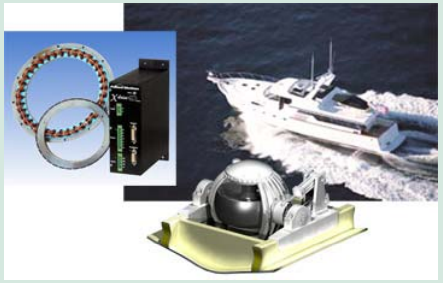
- Example of the 24 metre @ 20 knots
- Increase sea keeping ability, increases operability and availability
- Increased availability reduces number of required boats
- Reduces number of technicians
- Reduces time of boats and crew on standby

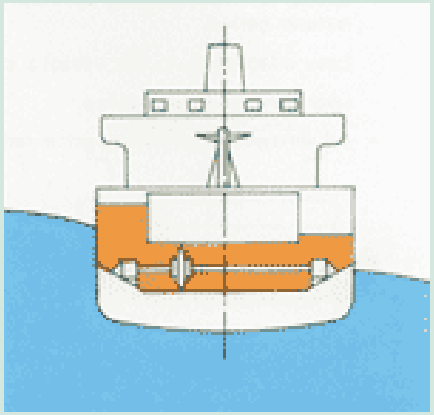
Wave Height (metres)	Vessels (#)	Technicians (#)	Availability (%)
0.78	16	192	32
1	12	144	42
1.5	8	96	62
2	6	72	83

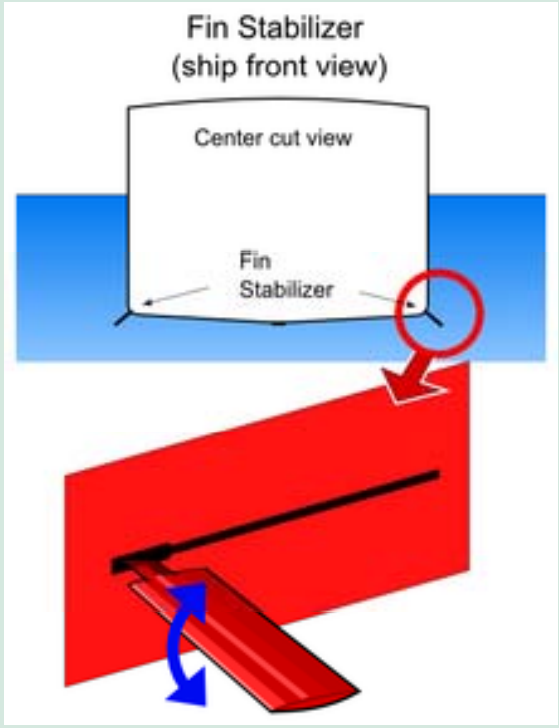
IMPROVING OPERABILITY

RIDE CONTROL SYSTEMS

- **Potentially allow for 20% increase in wave height**
- **Increase in cost**
- **Control Systems**
  - Foils
  - Fins
  - Gyros
  - Ballast tanks



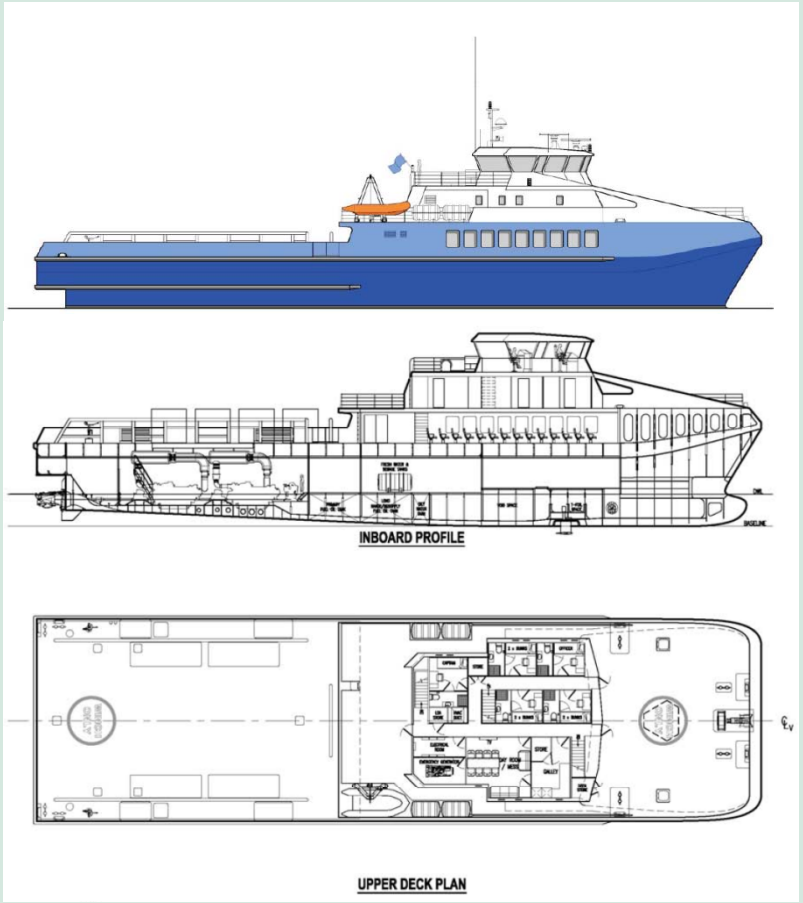




IMPROVING OPERABILITY

LONGER VESSELS

- Increase above 24 metres in length
- Increase construction costs, fuel costs, etc.
- Require a change in the MCA regulations
- Potentially could take more technicians
- More technicians would service more turbines per boat reducing the required number of boats further



BMT Nigel Gee MODCat 50m Crewboat

IMPROVING OPERABILITY

SMALL WATER-PLANE AREA TWIN HULL (SWATH) HULL FORMS

- Significant reduction in ship motions
- Much more costly to build and operate
- Considerable increase in availability would significantly reduce the number of vessels required

Mothership Technology

Purpose : Determine a suitable Hull Form for Offshore Accommodation Module

- **Define Requirements**
- **Concept Design**
  - 80-100m OSV
  - 50-70m SWATH
- Regulatory Review
- Seakeeping Calculations
- Launch and Recovery Discussions

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CONCLUSION

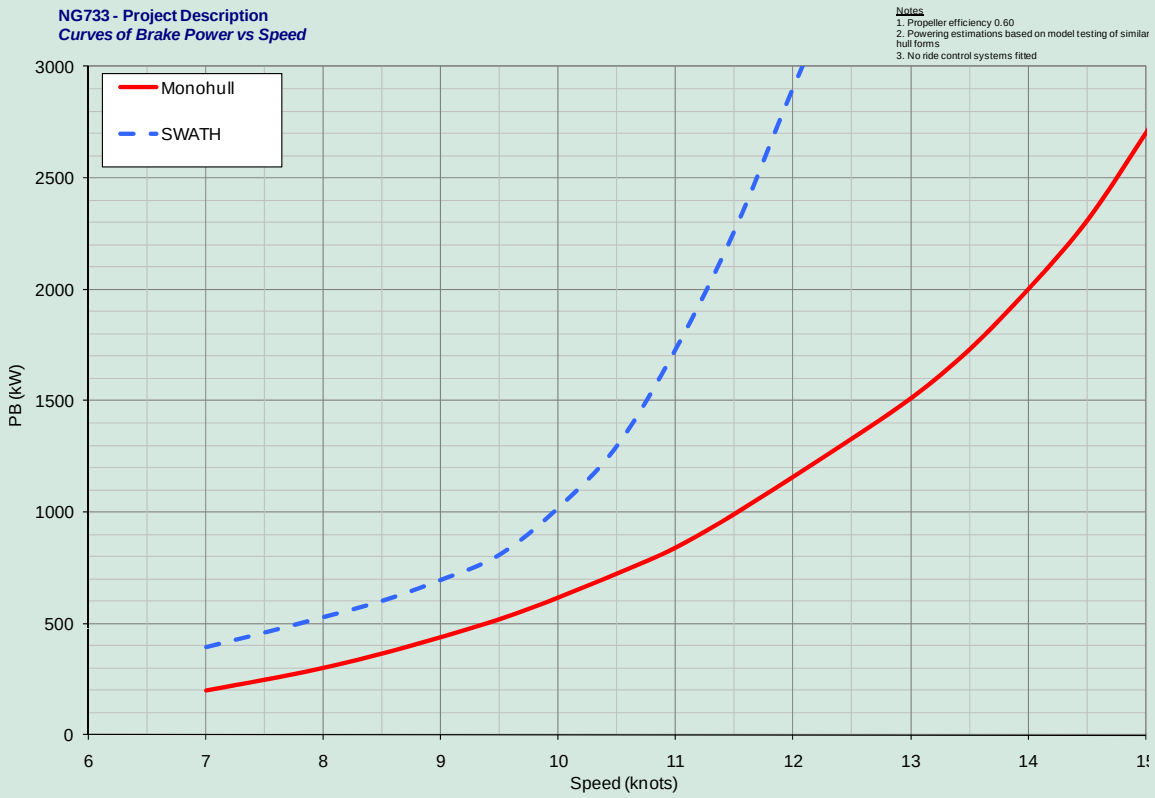
- Current wind farm vessels are inappropriate
- The increases in wave height will result in low availability due to increased exposure times and high vertical accelerations
- The size of fleet required to accommodate the reduction in vessel availability is not in economically practical
- More effort is clearly required to increase the operability
- In order to improve the operability different technology from the currently accepted wind farm support vessel will be required

Mothership Technology

Efficiency and Seakeeping

90m Monohull

60m SWATH



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Mothership Technology

Efficiency and Seakeeping

90m Monohull

60m SWATH

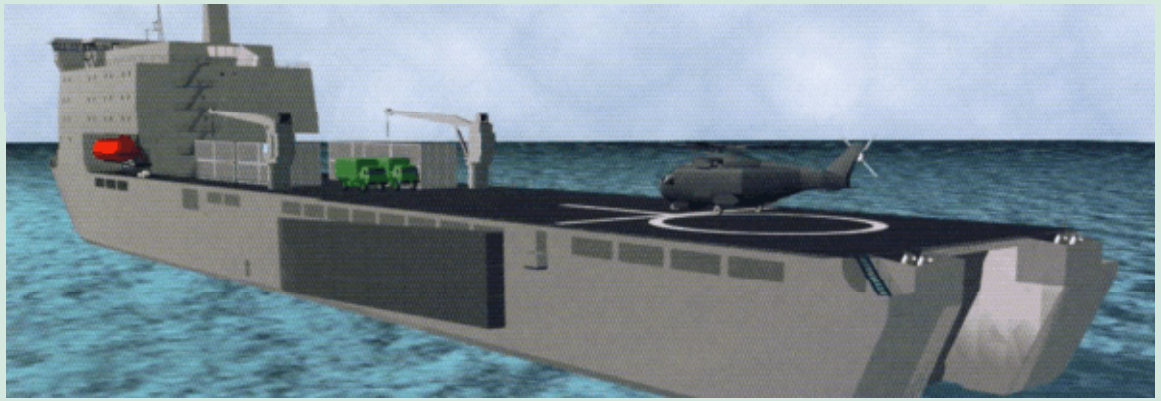
Description	Vertical Accelerations	Lateral Accelerations	Roll Angle
Light manual work	0.20g	0.10g	6.0
Heavy manual work	0.15g	0.07g	4.0
Intellectual work	0.10g	0.05g	3.0
Transit passenger	0.05g	0.04g	2.5
Cruise liner	0.02g	0.03g	2.0

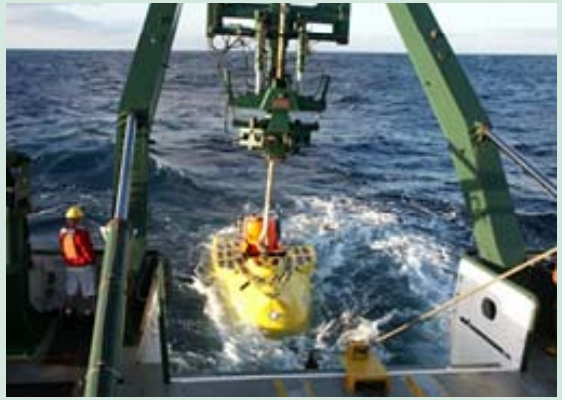
Description	Limiting Significant Wave Height (m)					
	Vertical Acceleration		Surge Acceleration		Pitch Angle	
	Mono	SWATH	Mono	SWATH	Mono	SWATH
Light Manual	-	-	-	-	-	-
Heavy Manual	3.2	-	-	-	-	-
Intellectual	2.4	-	-	-	-	-
Transit Passenger	2.0	5.0	-	-	-	-
Cruise Liner	1.6	4.0	4.5	-	4.2	-

Launch and Recovery Systems

Purpose : Initial Investigation into Available Technologies and their Application

- **Review Technologies**
- **Assess Application of Technologies**
- **Estimate Operating Limits for the technologies**





Launch and Recovery Systems

Objective Analysis

Related to type of Mothership

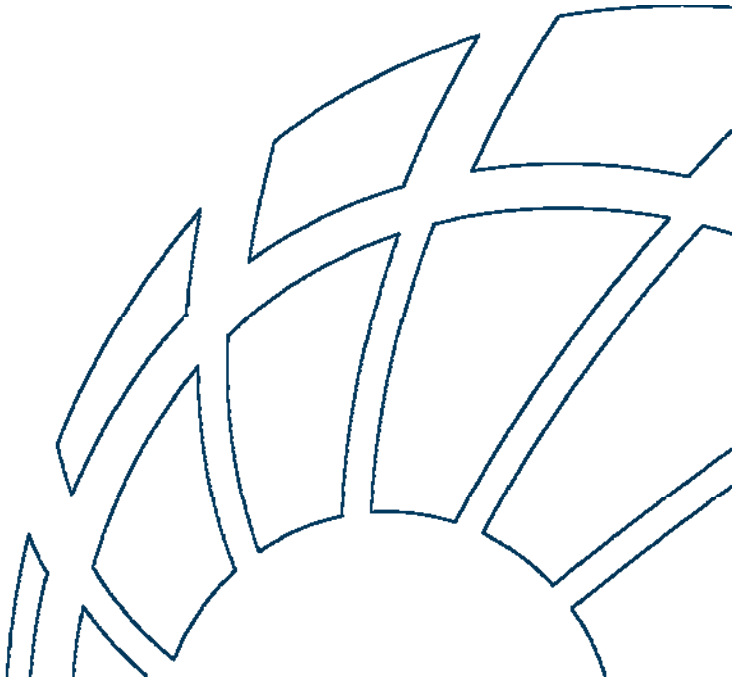
Related to required type of ITV

System	Limiting Max Hs	
	Without HC	With HC
Monopole crane	1.0 m	1.5 m
Davits	1.5 m	2.0 m
Stern A-frame crane	2.0 m	2.5 m
Stern ramp	2.0 m	N/A
Floating docks	2.5 m	N/A
Semi-submersible	2.5 m	N/A
Open transom	2.0 m	N/A

Constants										
ITV Range	mins	30			Variable					
ITV Speed	kts	10			Calculated					
Turbine Spacing	km	1								
No. of ITVs per MS		4								
Windfarms										
Location		Dogger Bank	Moray Firth	Firth of Forth	Hornsea	Norfolk	Hastings	IOW	Atlantic Array	Irish Sea
Area	km^2	8660	520	2852	4735	6037	270	724	950	2200
Distance from Port Max	km	125								
Distance from Port Min	km	290								
Distance from Port Average	km	160	28	67	112	56	20	21	24	28
Water depth Max	m	18	30	30	30	5	19	28	20	28
Water depth Min	m	63	57	80	70	70	62	56	61	78
Capacity	GW	9	1.3	3.5	4	7.2	0.6	0.9	1.5	4.2
Number of Turbines		1800	260	700	800	1440	120	180	300	840
ITV Operability	%	60	60	60	60	60	60	60	60	60
MS Operability	%	90	90	90	90	90	90	90	90	90
Calculated										
ITV Range Dist	nm	5	5	5	5	5	5	5	5	5
No. of turbines in ITV Range	#	273	273	273	273	273	273	273	273	273
Number of man days (3 techs, 5 days per turbine)	days	6825	6825	6825	6825	6825	6825	6825	6825	6825
Number of ITV days (12 techs per ITV)	days	569	569	569	569	569	569	569	569	569
Number of MS days per location (=ITV days/No. ITVs)	days	142	142	142	142	142	142	142	142	142
No. of locations done by MS (=365*MS Operabiliy/MS days)	#	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31
Number of Locations (=Total No. Turbs/Turbs in ITV Rng)	#	6.59	0.95	2.56	2.93	5.27	0.44	0.66	1.10	3.08
No. of MS Required	**#**	**3**	**1**	**2**	**2**	**3**	**1**	**1**	**1**	**2**
Reduncacy (Time Each MS not required)	%	5	59	45	37	24	81	71	52	33

THANK YOU

Any questions?



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