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INTERNATIONAL

Offshore Wind Development Trends

For: LILLEHAMMER ENERGY CLAIMS CONFERENCE

08 March 2018

Offshore Wind - Industry Update

- Industry dominated by a few manufacturers (Siemens & MHI Vestas)
- New players going offshore (Senvion, GE Alstom, Goldwind, Hitachi etc.)
- Ownership mainly by large Utilities in Europe / State owned in China
- 6GW / EUR 16bn investment each year
- Asia has large growth potential (Japan/Taiwan) with a lot of development in China
- Governmental /Carbon free policies driving growth
- Cables still proving to be the *"Achilles heel"* of the industry

Developers:

Manufacturers:

Offshore Wind - Industry Update

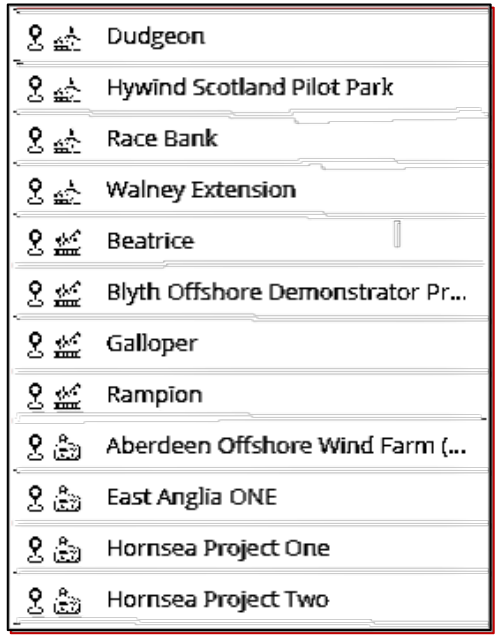
- Global Installed capacity over the next (5yrs) = 30GW+
- Average CAPEX conversion = EUR 3-4m/MW Capacity
- CAPEX Spend (5yrs) = EUR 60 -75bn
- Costs of energy halved in recent years = £58/MWh
- Hinkley Point C = £93/MWh

	Offshore wind capacity 2016	MW
1	United Kingdom	5,492
2	Germany	4,052
3	China	1,924
4	Denmark	1,257
5	Netherlands	1,120
6	Belgium	713
7	Sweden	206
8	Japan	34
9	Finland	26
10	Ireland	25
11	South Korea	5
	Total	**14,854**

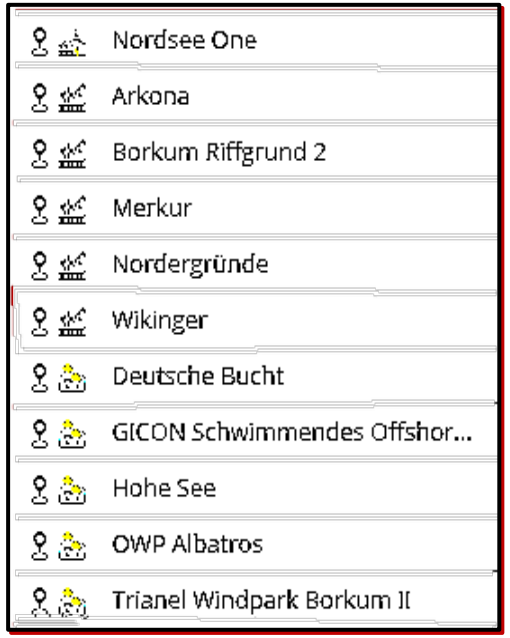
	Projected Offshore wind capacity in 2024	MW
1	China (Mainland)	16,004
2	United Kingdom	14,445
3	Germany	10,140
4	Netherlands	4,601
5	France	3,269
6	Denmark	2,635
7	Belgium	2,297
8	United States	1,400
9	Japan	1,092
10	Taiwan	926
11	South Korea	755
	Total	**57,564**

Offshore Wind - Industry Update Snapshot

UK = 12
EUR20bn



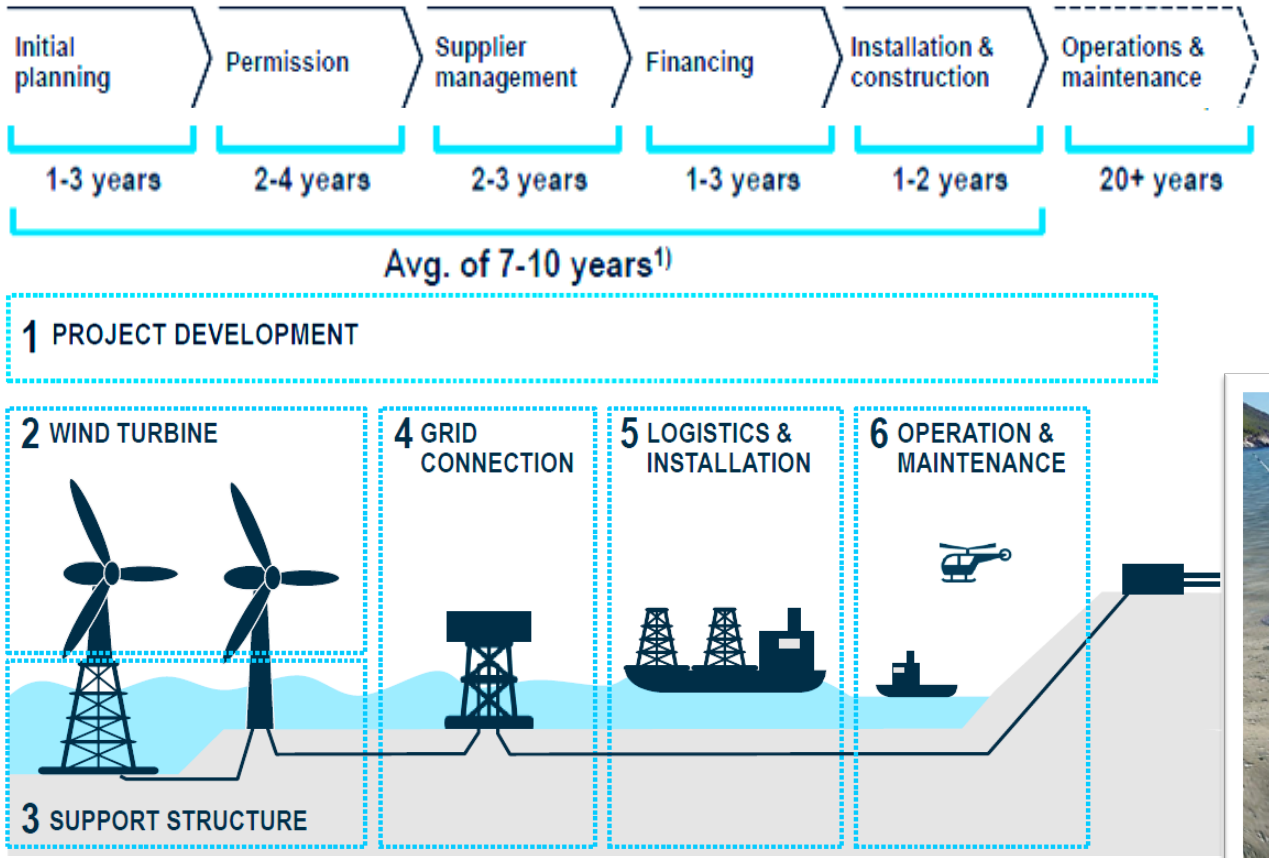
Germany = 11
EUR18bn



China = 21
EUR13bn

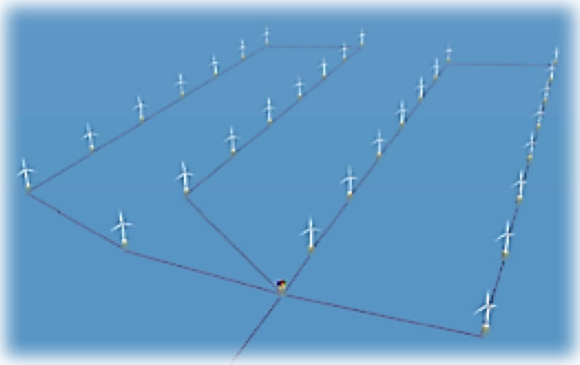
Projects currently under construction / pre-construction
Source: 4coffshore Sept 2017

Typical Project Life Cycle



A look at a Typical Project..

- 504MW Offshore wind Farm
- Water depth 20 - 32m
- Estimated Contract Value EUR 2.2 bn



Units	Item	Approx. Cost EUR (million)	Approx. Cost p/unit EUR (million)	Percentage of Capex
140	Turbines	1,188	9	54
144	Foundations	413	3	19
280	Inter array cables	106	1	5
3	Export Cables	144	49	6
2	Offshore Transformer Platforms	169	85	8
1	Onshore Substation	81	81	4
1	Project Management	94	94	4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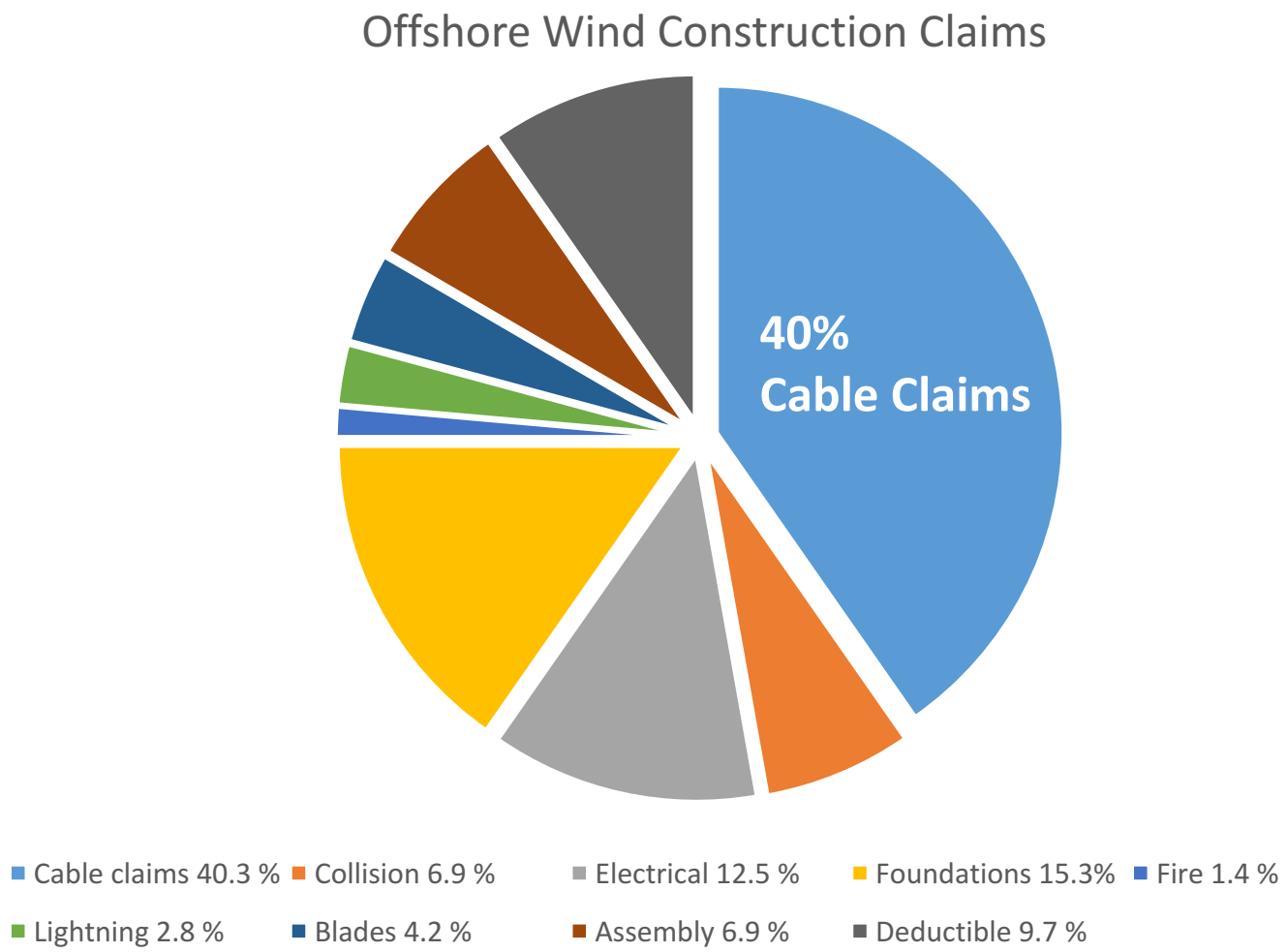
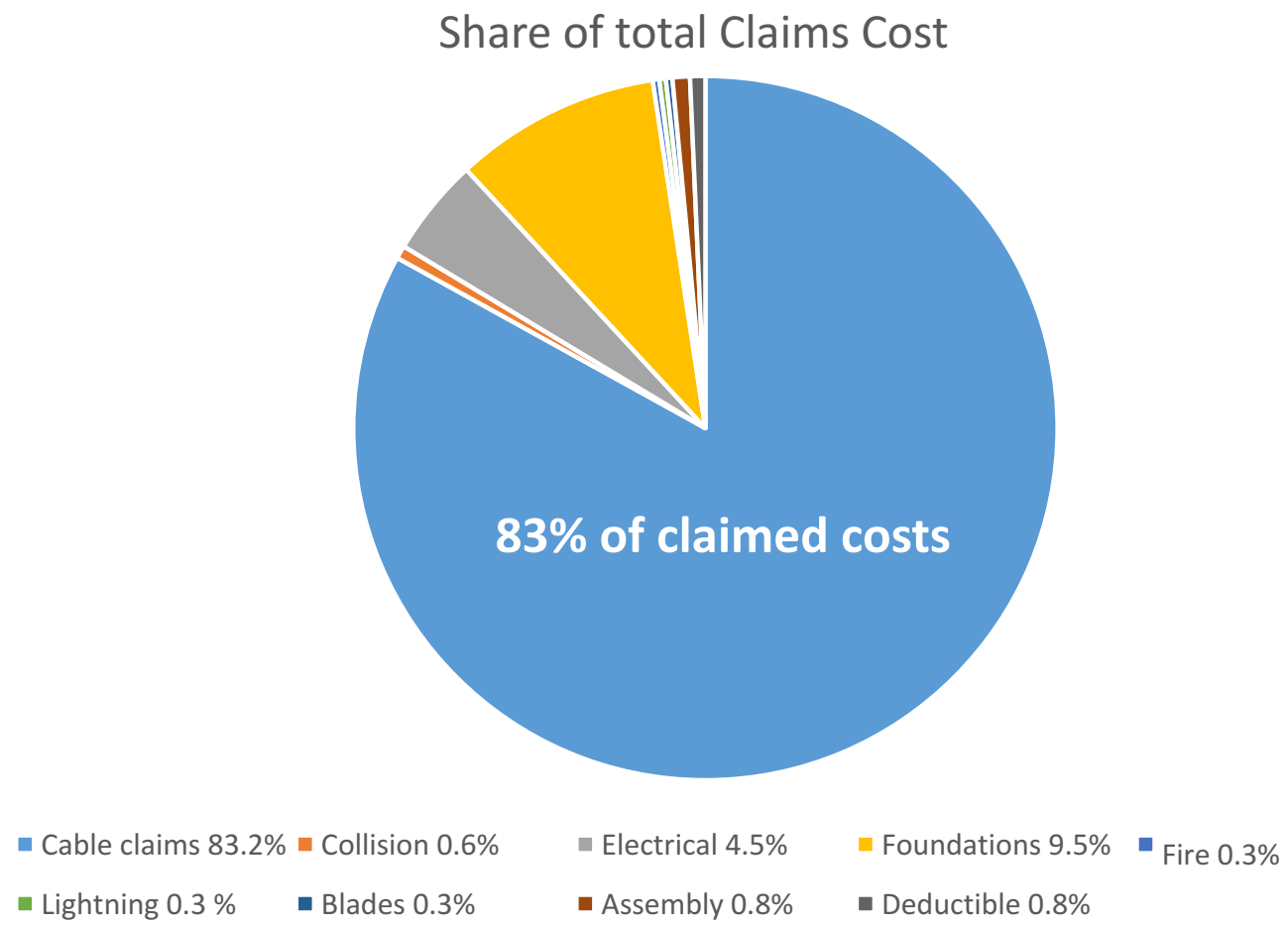
Q: Which type of loss is most common in the construction of offshore wind?

a) Blade Damages
b) Bearing/gearbox Damages
c) Cable Issues
d) Foundation issues

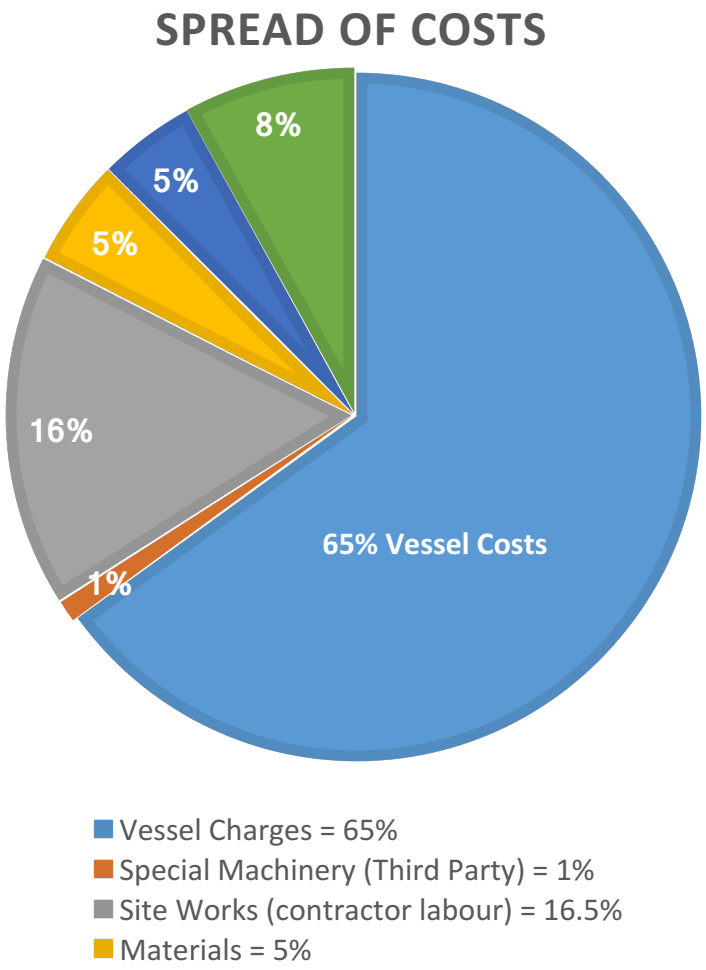
Claims Database 2002 – 2017



Claims Database 2002 – 2017



Claims Database 2002 – 2017



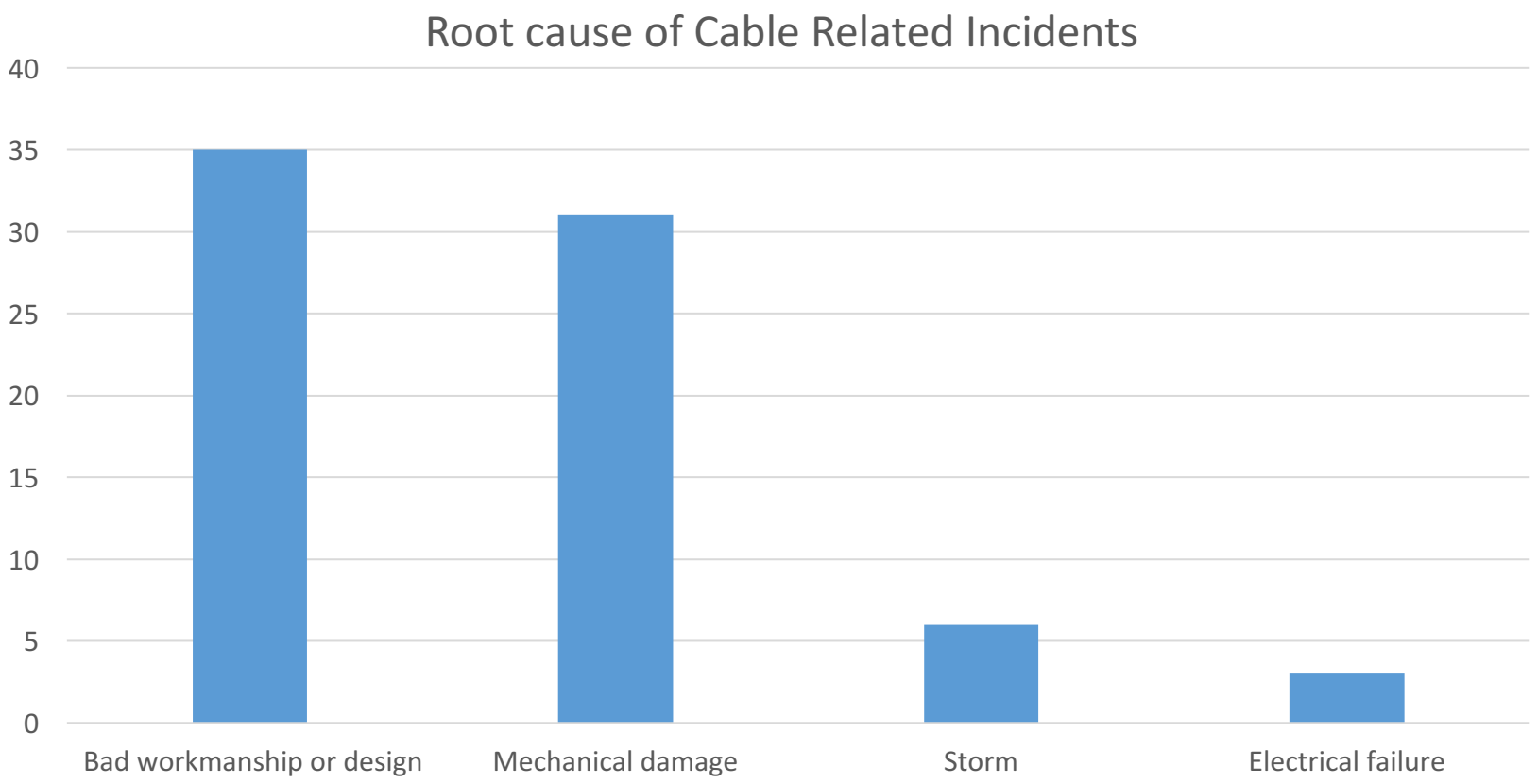
The Assets - Cables

- Average claim cost: EUR 2,250,000
- Inter- array cable damage: EUR 1,200,000 – 3,800,000
- Export cable damage: EUR 7,500,000 – 25,000,000

- 57 of the last 60 construction projects have experienced cable claims
- Over EUR 350m in claims paid/handled

- Vessel costs a major contributor (EUR 100,000 – 280,000 p/day)

Claims 2002 – 2015



Claims – Challenging Operations

Claim: Circa EUR 3,200,000

Damage: Birdcage in 132kV Export Cable

Cause:

- Tracked vehicle – Nessie V was having problems gaining traction on the mud flats
- Cable rollers were pinching the cable, not allowing it to rotate
- Torsion build up in the cable caused it to birdcage approximately 522m into the operation

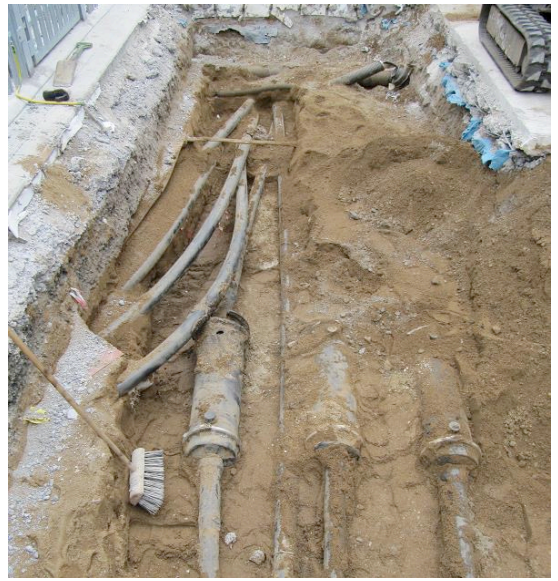
Claims – Poor Jointing / Installation

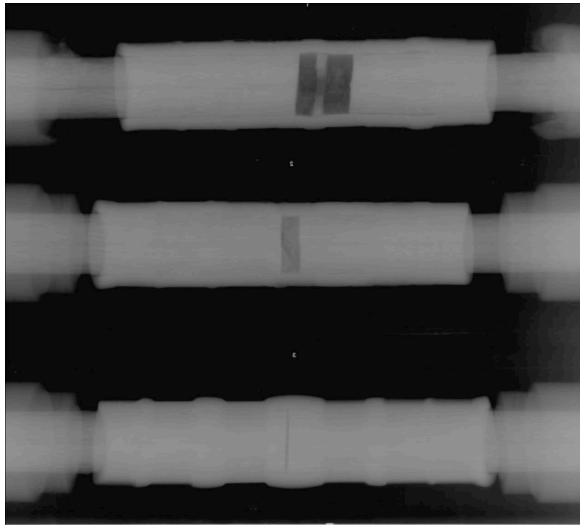
Claim: Circa EUR 1,200,000

Damage: Failed 132kV joint

Cause:

- Prolonged over heating of the cable and joint
- Air void in the bitumen filled joint
- Poor connection between the conductor and the compression ferule / connector
- Joint 1 showed gaps between the conductors and connector body





Claims – Poor Workmanship

Claim: Circa EUR 3,750,000

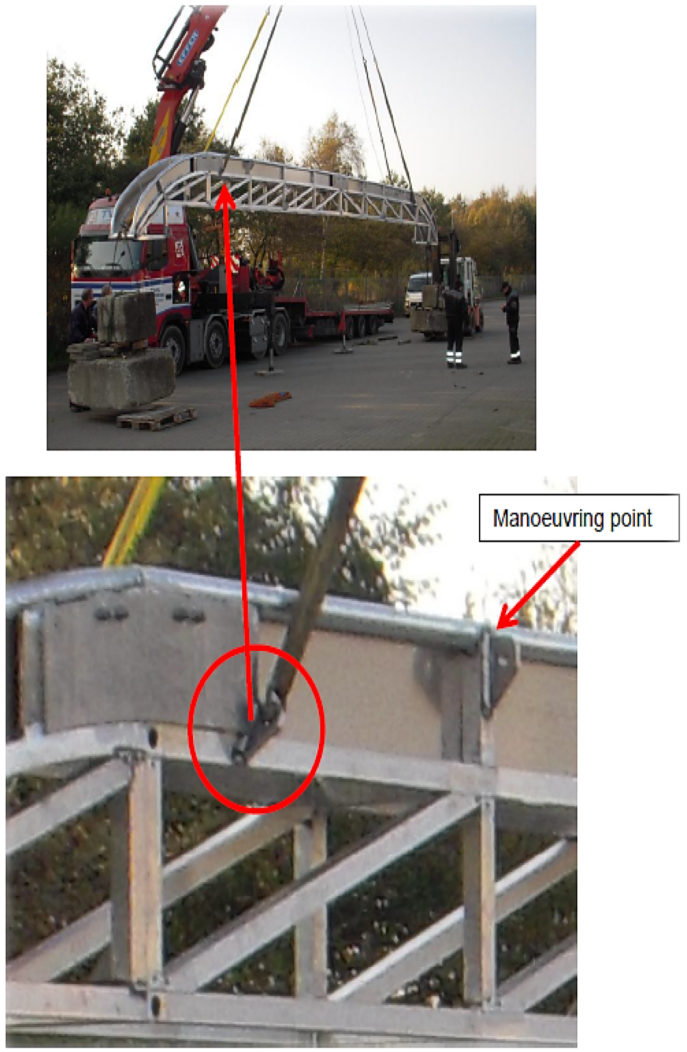
Damage: 132kV Export Cable and submarine joint

Cause:

- Lifting frame was incorrectly hooked up to manoeuvring points and not lifting points
- Manoeuvring points failed dropping the cable and frame

Lessons Learned:

- Operators were not familiar with the frame and its safe operation
- The lifting points were not clearly colour coded, which is good practice



Understanding the Risks…

Claims - Poor Catenary Management

Claim: Circa EUR 4,400,000

Damage: Significant damage to 56m of 132kV Export cable

Cause: Too much cable paid out, slack cable formed in front of the plough skid. Poor management of cable catenary

Lessons Learned:

- Plough was working within its design parameters but at its operating limits
- Cable Surveillance equipment on the plough was not ideal and has since been improved

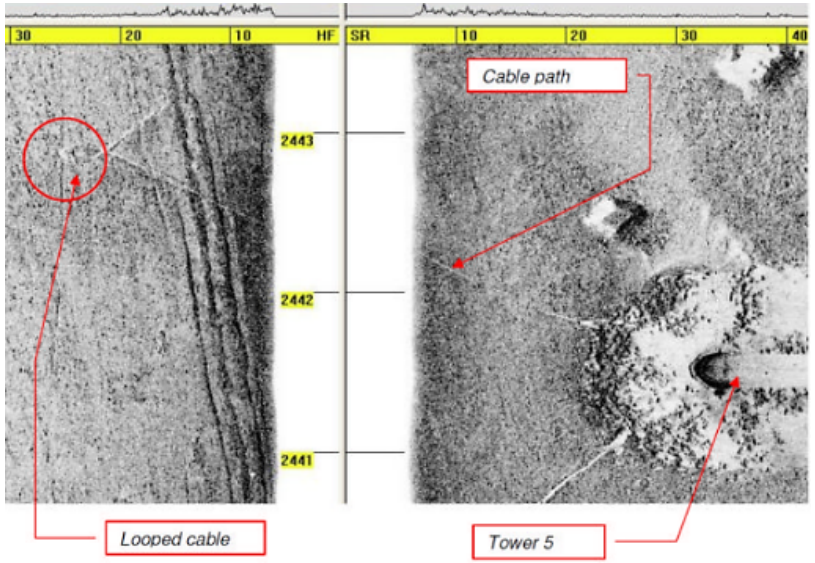
Claims – Poor Catenary Management

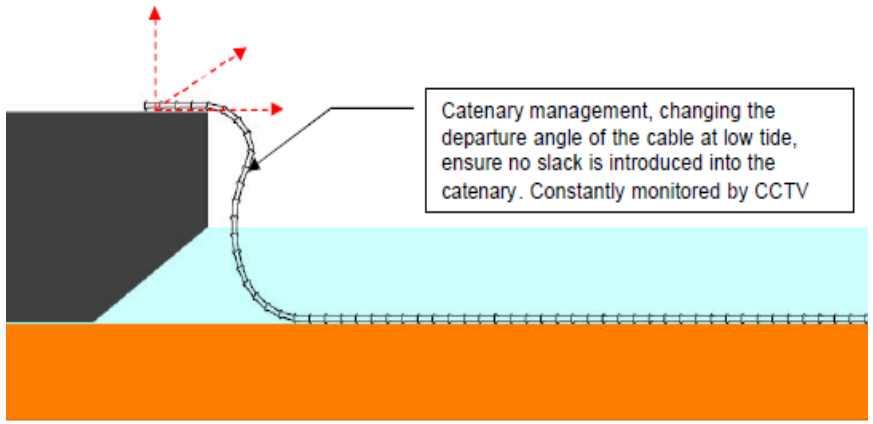
Claim: Circa EUR 1,200,000 – 3,800,000

Damage: 33kV Cable out of spec (MBR)

Cause:

- Poor catenary management
- Slack in cable, introduced a loop
- Loop tightened beyond MBR during pull in





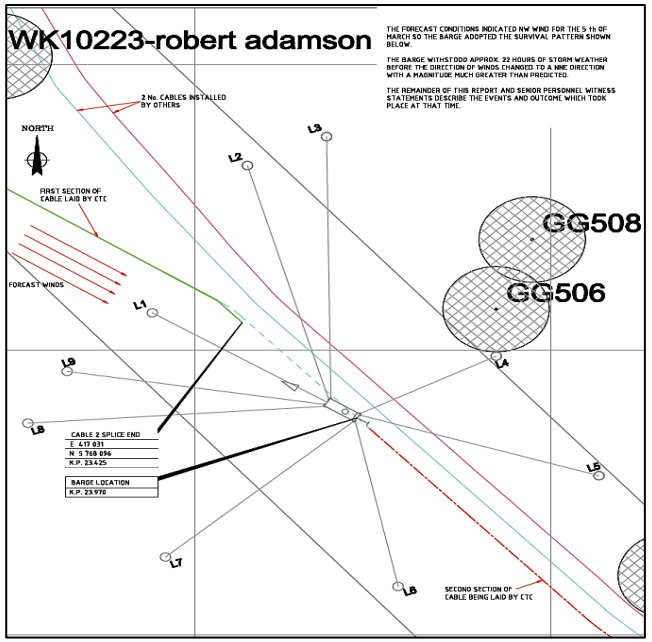
Claims - Weather

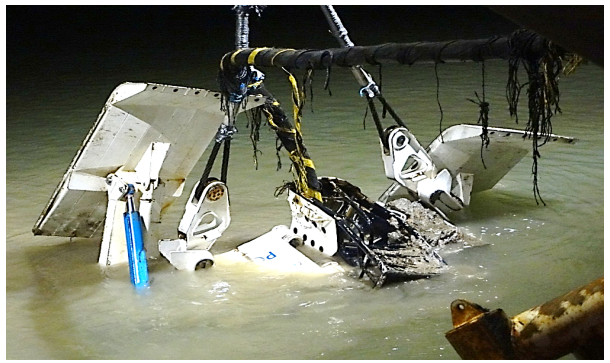
Claim: Circa EUR 8,800,000

Cause: Small weather front which was un-forecast came through the area giving unexpected direction and wind speed. The barge was in survival position, but was not able to survive the almost-beam-on winds and swells from this unexpected system

Damage: Significant damage to Export cable & Plough

Lesson Learned: MWS provided strong recommendations to consider seeking shelter, Barge Master decided to continue





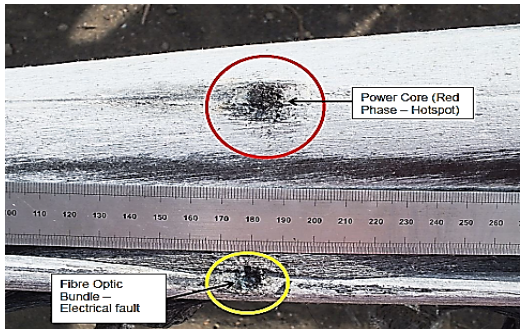
Claims – Cable Termination Issues

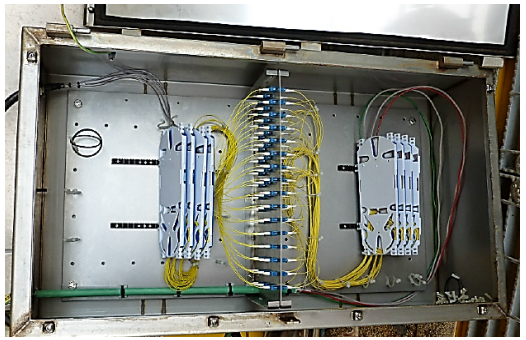
Claim: Circa EUR 20,000,000

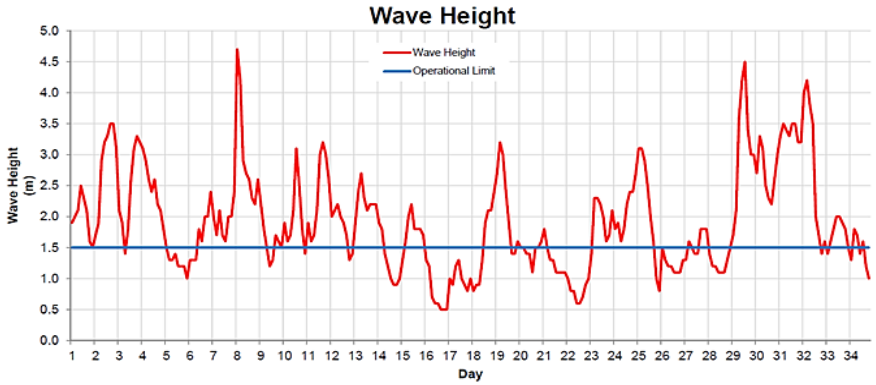
Cause: Lack of earthing on the offshore FOC end

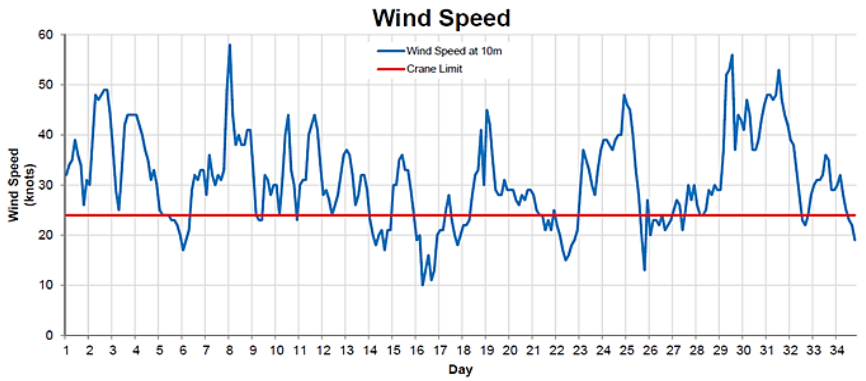
Damage: Failure of 132kV export cable near OSP

Lessons Learnt: Clear responsibilities need to be defined, extensive electrical check list required





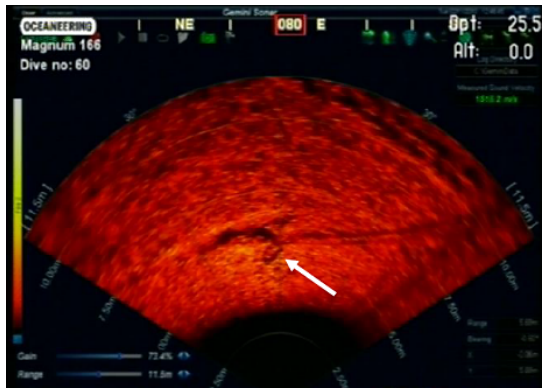




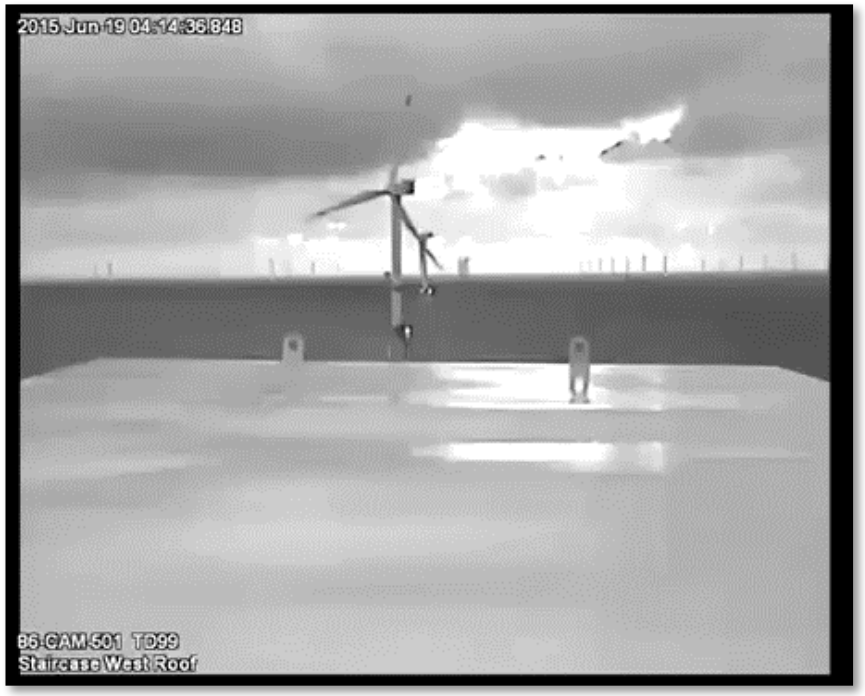
The Assets - Cables

Why are cable claims so common:

- Poor workmanship
- Sub-contractor inexperience
- Recklessness due to tight deadlines
- Use of the wrong vessel or equipment for the task
- The time allocated for these sub-contractors is kept to a minimum due to high vessel costs – sometimes shortened by weather conditions
- Cable laying is a complicated task e.g. busy shipping lanes, weather and tidal effects etc.



Claims – Wind Turbine Generators – Very Large Blades



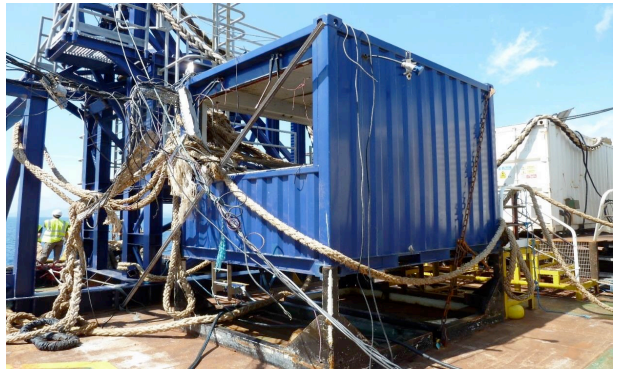
Claims – Cargo / Transit

Claim: Circa EUR 35m (cables, deck equipment, carousel)

Cause: Loose or missing hatch covers, flooding of the ballast tanks

Damage: Total loss of 2 x Export cables in 3000m+ of water

Lesson Learned: Importance of MWS suitability and towage survey



OAR Claims

- Offshore wind farms are relatively new, so portraying operational loss data requires a projected model.
- Majority of losses relate to component damage or failures. Including wear and tear.
- Increased mechanical damage compared to electrical
- Less frequent and severe workmanship claims
- Defects may be latent, manufacturing or design orientated
- BI cover more common in OAR policies

Serial defects

reNEWS 12 May 2016

Senvion gets to work on 6MW blade cracks

Turbine manufacturer Senvion is racing to tackle a serial issue with blades on 6MW offshore machines.

The Hamburg company said "anomalies have been noticed in the rotor blades" of some models in its 6.XM range. "There are small cracks at a particular area of the blades," a spokeswoman confirmed.

Faults were detected during inspections at RWE's 295MW Nordsee Ost wind farm in the German North Sea.

Engineers were investigating a summer 2015 blade loss at the project, since shown to be an isolated case caused by an error in production, when the separate serial issue was discovered.

"Based on our preliminary findings potential anomalies can be addressed in two ways," the spokeswoman said, "by an optimised design for newly produced blades and retrofit measures for existing blades."

Fifty sets need to be overhauled. These include 24 turbines of the 6.2M126 series installed at Nordsee Ost and 18 similar sets of blades produced but not yet installed at WPD's under-construction 111MW Nordergrunde wind farm, also in the North Sea. The remaining eight sets are believed to have been produced for Northland and RWE's 332MW Nordsee 1 project, which again is under construction.

"Further examinations are being conducted together with our customers, the supplier and external specialists to validate the potential cause and verify the solutions," the spokeswoman said.

Senvion expects technical availability of a solution "by the middle of 2016" and does not foresee ongoing implications for Nordergrunde or Nordsee 1, she added.

Turbine faults cost Siemens EUR 223m

6 November 2014 by Patrick Smith , Be the first to comment

GERMANY: Costs related to faulty wind turbines have hit Siemens' results, forcing the wind division into a loss for both the fourth quarter and 2014.

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Grout failures bite MT Hojgaard

MT Hojgaard has been found liable for grouting issues at Eon's 180MW Robin Rigg offshore wind farm off the UK, which will result in a Dkr195m (£21m) hit to financial results for 2014.

SSE beats Fluor in £300m wind farm legal fight

20 Nov 2012 / **Greig Cameron**, Deputy Business Editor

Share:

A £300 MILLION claim against a joint venture offshore wind farm owned by Scottish & Southern Energy (SSE) and RWE has been thrown out.

Engineering giant Fluor had submitted the claim over a dispute about foundation parts of some of the turbines operated by Greater Gabbard Offshore Winds (GGOW).

SSE confirmed yesterday a UK arbitration panel had ruled in GGOW's favour, meaning it would not have to pay Fluor.

Vestas V90 crisis takes new twist after ZF gearbox failures

25 May 2012 by John McKenna , Be the first to comment

WORLDWIDE: Lead manufacturer seeks compensation from suppliers ZF and Schaeffler after 15% of V90-3MW turbines are hit by bearings failure.

Vestas is set to seek compensation from its suppliers over a gearbox bearings fault affecting its V90-3MW turbines in what is the latest in a series of crises to engulf the firm.

The Danish manufacturer revealed in its results for the first financial quarter of 2012 that it was setting aside an additional €40 million in warranty provisions to cover a gearbox bearings

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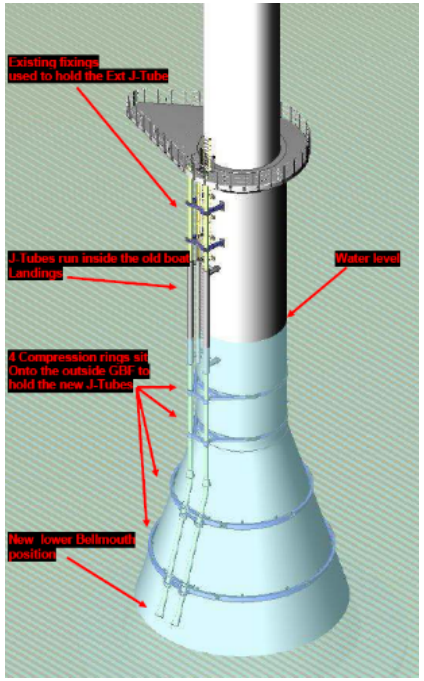
Case Example - Gravity Based Foundation

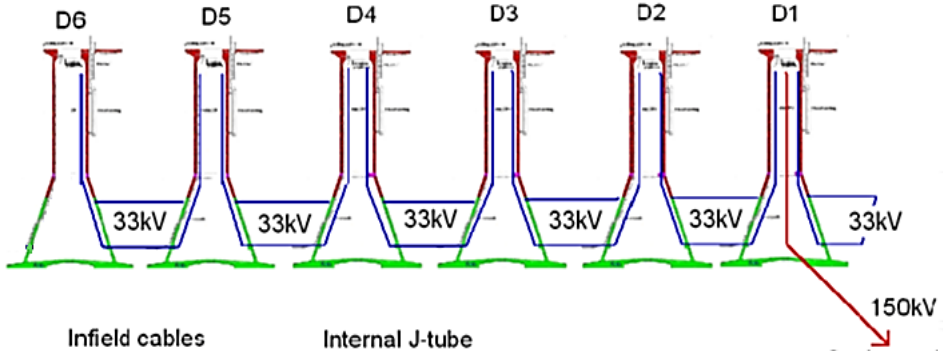
Circumstances: During the ballast infill of 6 Gravity Based Foundations, internal J-tubes collapsed.

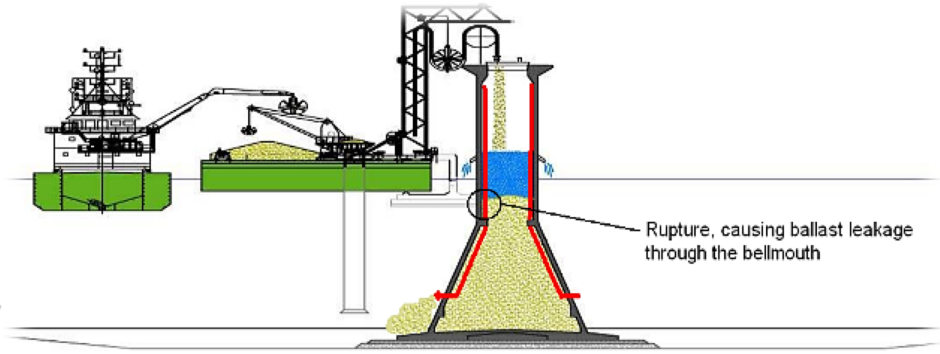
Root cause findings: J-tubes were under designed for the service environment

Repair: Fitting 11 redesigned - External J-tubes (policy LEG3 excl. applies)

Cost of repair: GBP 24,000,000 (gross)







SLC - Version 1

SERIES LOSS CLAUSE

Subject to the terms and conditions of the Policy Underwriters shall indemnify the Assureds in respect of loss or damage resulting from a fault, defect, error or omission in design, plan, specification, material or workmanship of the same nature, after application of the deductible and as covered under Clause XX and buy-back if applicable of Section I Terms and Conditions according to the following scale:

100% of the first loss amount.

75% of the second loss amount.

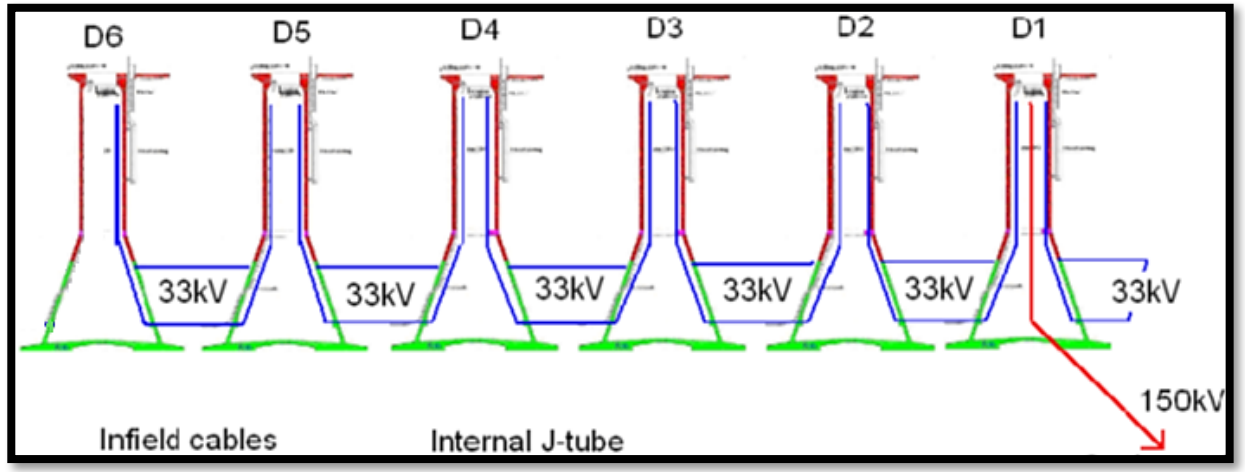
50% of the third loss amount.

No liability hereafter for third and subsequent loss amounts.

LWI - Adjustment Model

			GBP
Cost of repair (gross)			**24,000,000**
Audit adjustment			(2,000,000)
LEG3 adjustment			(1,000,000)
WOW limit adjustment			(500,000)
Adjusted claim (gross)			**20,500,000**
Less Deductible			(500,000)
Adjusted claim net (before SLC)			**20,000,000**
Number of defective parts	J-tubes	11	
Cost per loss amount	○ Weighted ◉ Even		**1,818,182**
Series Loss Clause			
First loss	100%		1,818,182
Second loss	75%		1,363,636
Third loss	50%		909,091
Fourth loss	0%		-
Adjusted claim (after SLC)			**4,090,909**

Define the Defective Part?



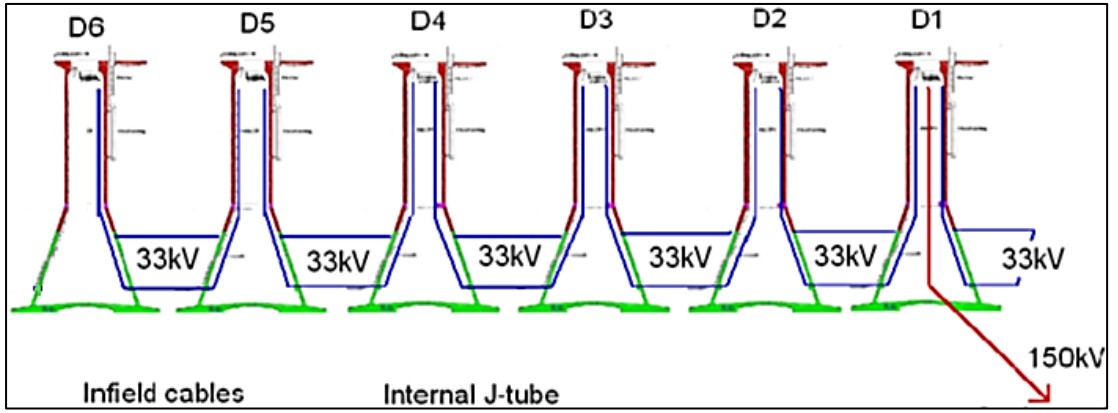
Defective part	Loss Amounts	SLC loss amount (GBP)	SLC application (GBP)
Foundation	6	3,333,333	7,500,000
J-tube	11	1,818,182	4,090,909

Adjusted Claim (after SLC – 6 foundations) GBP 7,500,000

Even vs Weighted…?

What measurement basis to use:

- Weighting using order of repair, order of discovery, order of construction, order of damage?
- Weighted using duration based on DPR review, with most favourable turbines picked



Loss #	Duration of repair (days)	Weighting (%)	Cost (GBP)	Rank
D1	16	32%	6,400,000	1st
D2	6	12%	2,400,000	
D3	13	26%	5,200,000	2nd
D4	3	6%	1,200,000	
D5	7	14%	2,800,000	3rd
D6	5	10%	2,000,000	
Total	**50**	**100%**	**20,000,000**	

Weighted Claim (after SLC) **GBP 11,700,000**

Direct or Indirect Costs…?

Direct costs = Cost which can be allocated to specific WTG's

Indirect costs = Costs will be incurred regardless of the number of WTG's repaired e.g. design costs

Should these costs form part of the SLC?

Types of costs	Allocation of costs	Cost (GBP)
Engineering	**Indirect**	**4,000,000**
Commercial	Direct	2,000,000
Operations	Direct	12,000,000
Contracts	Direct	2,000,000
Total cost		**20,000,000**

After SLC + weighting = **GBP 9,360,000**

Weighted Claim (after SLC) + indirect costs = GBP 13,360,000

Q:Should the adjusted claim be?

a) GBP 4.1m?
b) GBP 13.4m?
c) Somewhere in between?

Conclusions..

- Rapidly growing industry, a lot of opportunities for offshore energy Insurers
- Understanding the risks is key, cabling being the primary loss statistic
- Familiar technology (onshore), however Renewables are constantly evolving to reduce costs & increase efficiency
- Increasing lender requirements = more & more cover is being purchased
- Long term outlook/operational phases + decommissioning = more opportunities for existing Insurers
- Evolving wordings to address some of the issues in the current WindCAR standard form

“ I never make the same mistake twice. I make it five or six times, just to be sure.”

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