Offshore & onshore reliability data (OREDA®) collection – OREDA JIP status

Siegfried Eisinger, DNVGL, Norway, OREDA JIP Project Manager
Nicolas Clavé, Total, France, OREDA JIP Steering Committee Chairman

4th ISO seminar on international standardization
in the reliability technology and cost area

Statoil, Houston, USA

4 May 2018

What is OREDA

- A project organization with between 7 -11 oil and gas companies as members that has been running for more than 35 years.
- A comprehensive databank of reliability data collected on Topside (& Subsea) equipment from offshore & onshore operations in the North Sea, GOM, WOS, Angola, Adriatic, Caspian, etc.
- A forum for exchange and development of reliability methods and know-how within the oil and gas industry, production of ISO Standards & API
- The cradle if ISO 14224 & ISO 20815
- It is not just a Handbook !

OREDA

OREDA is a Joint Industry Project sponsored by eight oil and gas companies with worldwide operations. **OREDA**'s main purpose is to collect and exchange reliability data among the participating companies and act as The Forum for co-ordination and management of reliability data collection within the oil and gas industry. **OREDA** has established a comprehensive databank with reliability and maintenance data for exploration and production equipment from a wide variety of geographic areas, installations, equipment types and operating conditions. The **OREDA** data is stored in a database available for our member companies and contractors working on their behalf.

Want to join **OREDA**? Contact us on post@oreda.com.

Data

Collected data is stored in a database containing data from 278 installations, 17 000 equipment units with 39 000 failure and 73 000 maintenance records. The databank also includes subsea fields with over 2000 years operating experience. Only the OREDA member companies have access to the computerised database with its comprehensive data collection, search and analysis software. Temporary access may be granted to contractors working for the OREDA companies or for research projects in collaboration with an OREDA partner.

Brief history

The Petroleum Safety Authority initiated the OREDA Project in 1981 and was formally started as an oil company Joint Industry Project in 1983. The primary objective was to collect reliability data for safety equipment. The objective of OREDA was subsequently expanded to collect experience data from the operation of offshore and onshore oil & gas production facilities to improve the basic data in reliability studies.

OREDA handbook

For the benefit of the Oil & Gas community, OREDA reliability data is also presented in the **OREDA handbook**. This book is for sale at the OREDA web page. A new revision of the book will be launched in 2015.

Buy the book at www.oreda.com

For more information about OREDA, see our new updated web page:

www.oreda.com

Achievements

In addition to the build-up of a large reliability databank, and the use of data by the participating companies, achievements in the OREDA Joint Industry Program include:

- ISO 14224 "Collection and exchange of reliability and maintenance data for equipment" based on OREDA concept.
- Reliability Data Handbook issued in 6 editions from 1986 to 2015 and sold in more than 50 countries world-wide.
- Guidelines and software for data collection and data analysis.
- Data used in analyses for decision support for e.g. concept selection, design optimisation.
- Exchange of reliability knowledge between the OREDA participants.
- Publication of more than 40 papers based on OREDA data research.

OREDA

OREDA Topside Equipment Coverage

OREDA JIP Topside Database

Filter Settings

Connection	Release
Time Window	Jan 1983 - Dec 2015

Summary

Installation	292	Corrective Maintenance	41,823
Inventory	18,160	Periodic Maintenance	35,200
Failure Events	41,662	Surveillance hrs (avg)	29,044
Items Failed	35,999	Operating hrs (avg)	25,493

Rotating machinery	**Mechanical equipment**	**Control & Safety**
Combustion engines	Cranes	Control Logic Units
Compressors	Heat exchangers	Fire & Gas detectors
Electric generators	Heaters and Boilers	HVAC
Electric motors	Loading arms	Input devices
Gas turbines	Swivels	Nozzles
Pumps	Turrets	Power transformers
Steam turbines	Vessels	UPS
Turboexpanders	Winches	Valves
		Frequency converters
		Switchgear

OREDA Subsea Equipment Coverage

OREDA JIP Subsea Database

Filter Settings

Connection	Release
Time Window	May 1983 - Dec 2015

Summary

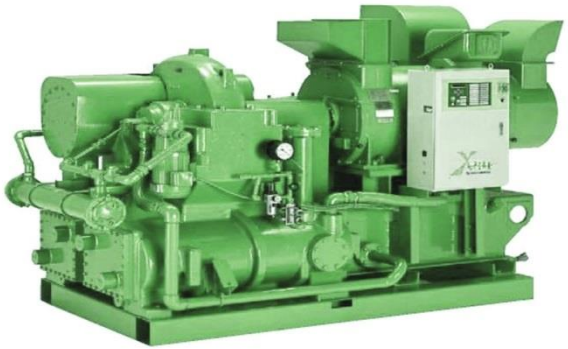
Installation	166	Intervention	1,103
Equipment Unit	2,742	Surv. hrs Equip. Unit (Avg)	42,782
Subunit	6,760	Surv. hrs Subunit (Avg)	43,616
Component	54,614	Surv. hrs Component (Avg)	40,374
Failure	2,755	Nr Components	280,263

Subsea equipment
Control systems
Dry tree riser
El. power distribution
Flowlines
Manifolds
Pipelines
Production risers
Running tools
Subsea pumps
Subsea vessels
Templates
Wellhead & X-mas trees

OREDA Data Structure

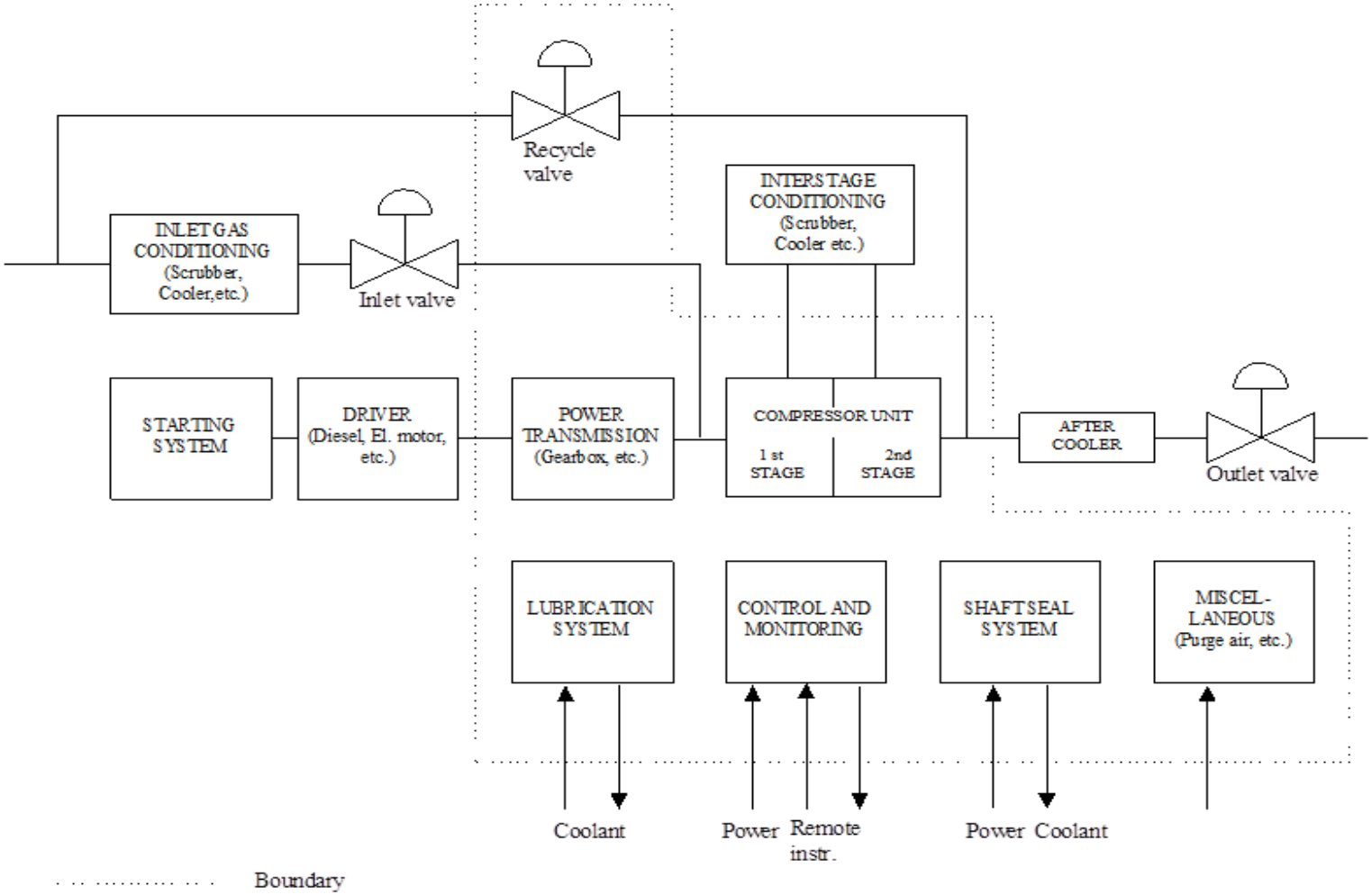
- **Inventory data**
  - Classification data
  - Identification data
  - Specification data
  - Maintenance data
  - Operation data
- **Failure event data**
  - Identification
  - Failure event data
  - Remarks
- **Maintenance event data**
  - Identification
  - Maintenance event data
  - Maintenance resources
  - Remarks

OREDA System Hierarchy

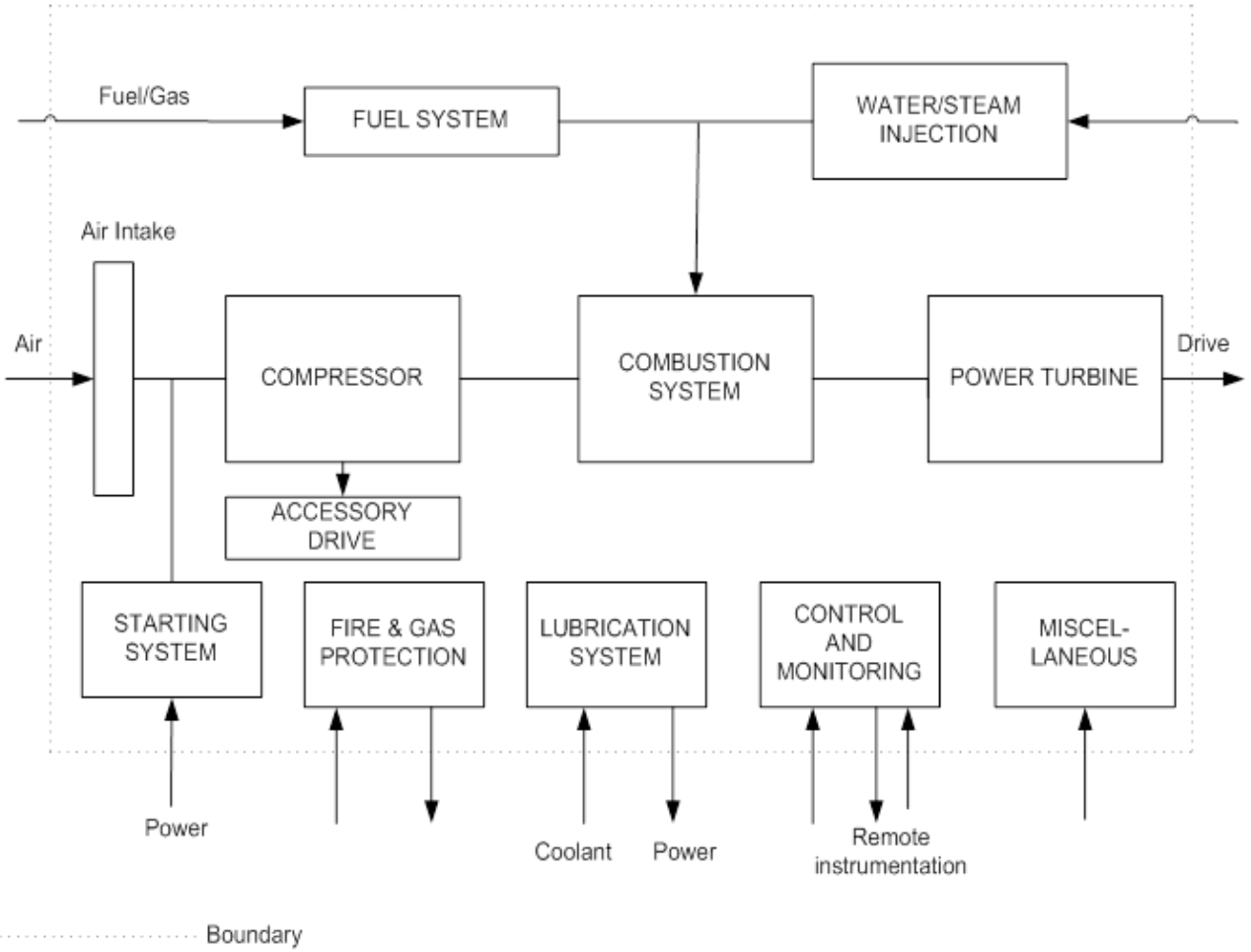


- Equipment Unit (Compressor)
  - Subunit (Compressor)
    - Maintainable Item No 1 (Casing)
    - Maint Item No 2 (Shaft seals)
    - Maint Item No 3
  - Subunit (Power Trans)
    - Maint Item No 1
    - Maint Item No 2
  - Subunit (Control)
    - Maint Item No 1
    - Maint Item No 2

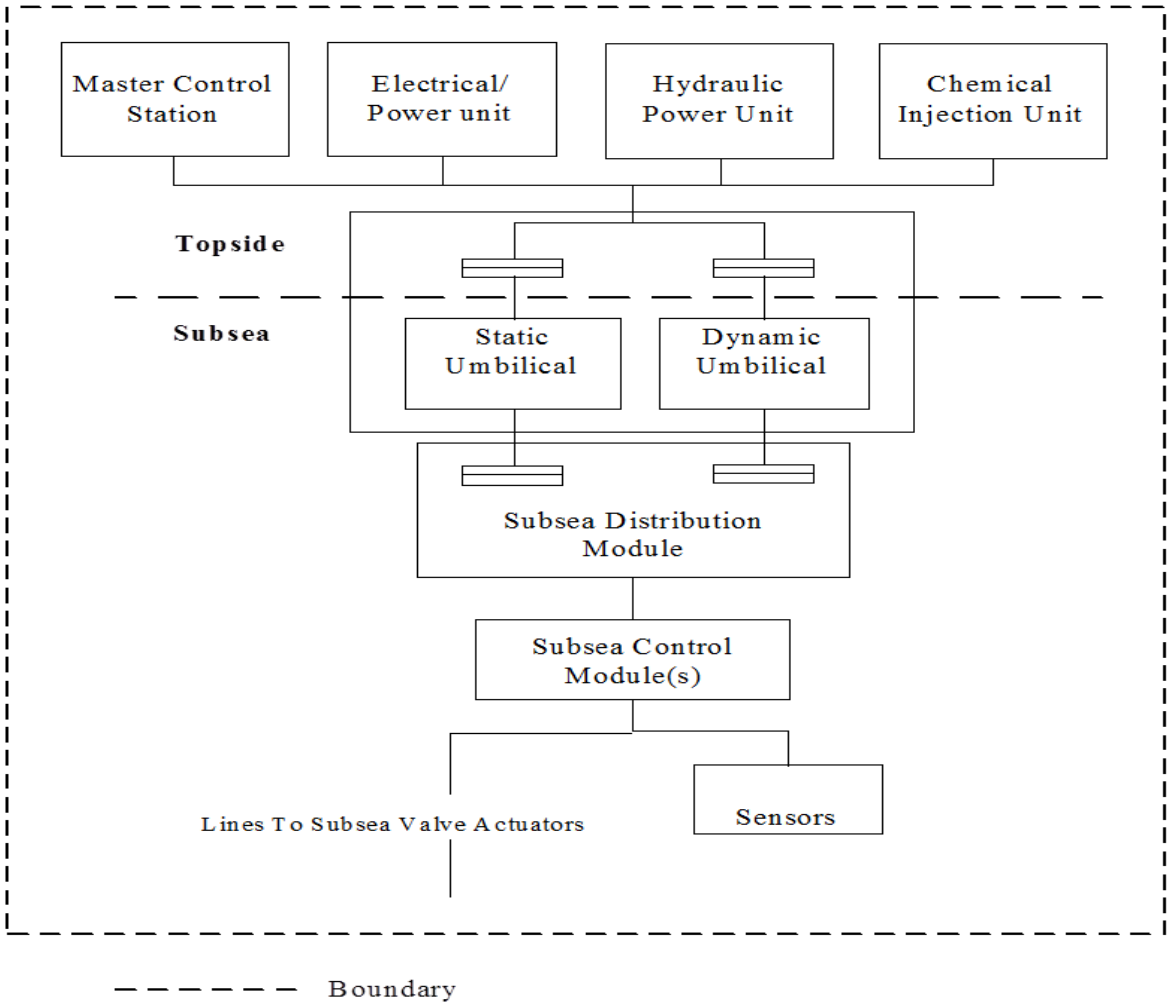
OREDA Equipment Boundary - Compressor



OREDA Equipment Boundary – Gas Turbine



OREDA Equipment Boundary – Control System



Failure Definition

Failure: The termination or the degradation of the ability of an item to perform its required function(s).

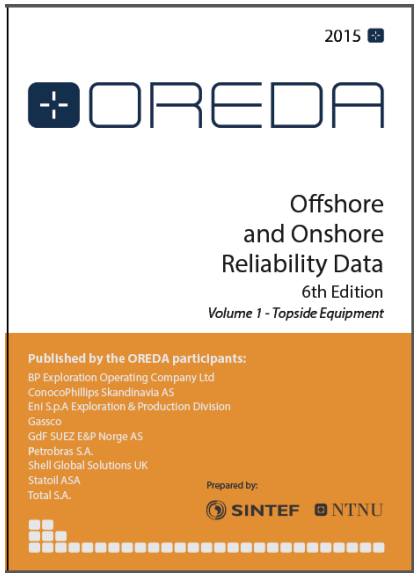
- **It includes:**
  - Complete failure of the item
  - Failure of part of the item that causes unavailability of the item for corrective action
  - Failure discovered during inspection, testing, or preventive maintenance that requires repair
  - Failure on safety devices or control/ monitoring devices.
- **The following outages are not considered as failures:**
  - Unavailability due to preventive or planned maintenance
  - Shutdown of the item due to external conditions, or where no physical failure condition of the item is revealed. A shutdown is not to be considered a failure unless there is some recorded maintenance activity

Failure Definition

- **Failure mode:**
  - The effect by which a failure is observed on the failed item.
- **Severity class:**
  - The effect on equipment unit level, not with-standing the configuration outside the equipment boundaries.
  - Critical failure:
    - Immediate and complete loss of function
  - Degraded failure:
    - Does not cease all function, but compromises that function
  - Incipient failure:
    - An imperfection in the state or condition of an item which has no immediate effect on function.

Handbook overview

- **In-service reliability data from offshore and onshore petroleum installations**
- **Last release in March 2015**
- **Data on 25 equipment classes**
- **Two volumes: *Topside* and *Subsea***
- **A collaboration project:**
  - Issued by OREDA JIP
  - Prepared by SINTEF/NTNU
  - Distributed by DNV GL



SINTEF

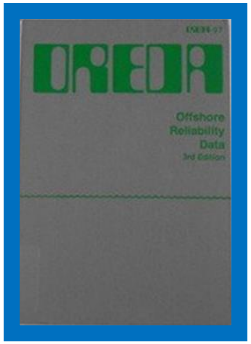
NTNU

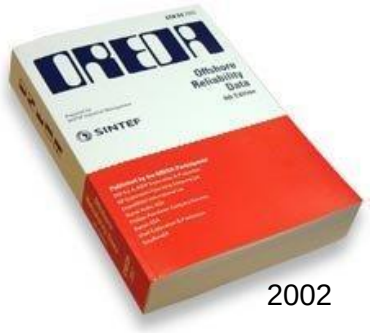
DNV·GL

OREDA

History

1992

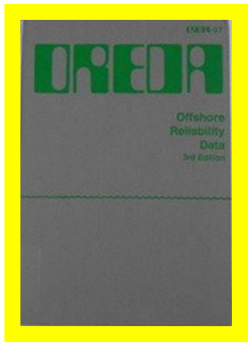




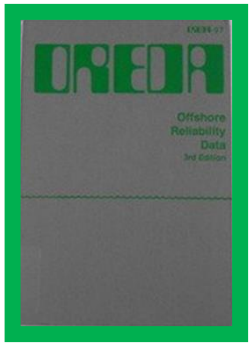
2002

2015

Phase	1	2	3	4	5	6	7	8	9	10	11	12
	'81	'85	'89	'94	'97	'00	'02	'04	'06	'09	'12	'15



1984



1997

2009

OREDA equipment classes

SYSTEM	EQUIPMENT CLASS
1. Machinery	1.1 Compressors
	1.2 Gas Turbines
	1.3 Pumps
	1.4 Combustion Engines
	1.5 Turboexpanders
	1.6 Steam Turbines
2. Electric Equipment	2.1 Electric Generators
	2.2 Electric Motors
	2.3 Battery and UPS
	2.4 Power Transformers
3. Mechanical Equipment	3.1 Heat Exchangers
	3.2 Vessels
	3.3 Heaters and Boilers
4. Control and Safety Equipment	4.1 Fire & Gas Detectors
	4.2 Input Devices
	4.3 Control Logic Units
	4.4 Valves (described by application code)
	4.5 Valves (described by taxonomy code)

SYSTEM	EQUIPMENT CLASS
5. Subsea*	5.1 Control Systems
	5.2 Flowlines
	5.3 Manifolds
	5.4 Pipelines
	5.5 Risers
	5.6 Running Tools
	5.7 Templates
	5.8 Wellheads and X-mas Trees

Additional classes in the OREDA database:

- Cranes
- Fire water systems
- Frequency converters
- HVAC systems
- Loading arms
- Nozzles
- Subsea power cables
- Switchgear
- Swivels
- Turrets
- Wellhead & X.mas tree (dry)
- Winches

- Subsea control system
- Dry tree riser
- Electrical power distribution
- Subsea pumps
- Subsea vessels
- Common components

Data table: Reliability

- Failure rates
- Failure mode distribution
- Repair times
- …

Taxonomy no	Item
1.3.1.9	Machinery Pumps Centrifugal Oil export

Population	Installations	Aggregated time in service (10^6 hours)		No of demands
		Calendar time *	Operational time †	
4	2	0.1018	0.0792	480

Failure mode	No of failures	Failure rate (per 10^6 hours).					Active rep. hrs		Manhours	
		Lower	Mean	Upper	SD	n/τ	Mean	Max	Mean	Max
Critical	**19***	**121.72**	**186.12**	**261.64**	**42.80**	**186.58**	**14**	**45**	**23**	**90**
	19†	**144.86**	**238.62**	**351.32**	**63.30**	**240.00**				
Breakdown	1*	0.04	9.67	36.47	13.45	9.82	18	18*	35	35*
	1†	0.06	12.21	44.87	16.57	12.63				
External leakage - Process medium	6*	0.35	60.58	214.15	79.09	58.92	8.6	16*	11	16*
	6†	0.44	81.27	291.26	107.62	75.79				
External leakage - Utility medium	10*	0.50	95.46	344.12	127.16	98.20	16	45*	29	90*
	10†	0.66	118.26	421.59	155.76	126.32				
Noise	1*	0.54	9.93	29.48	9.82	9.82	-	-	-	-
	1†	0.79	12.99	38.07	12.63	12.63				
Spurious stop	1*	0.04	9.67	36.47	13.45	9.82	8.0	8.0*	8.0	8.0*
	1†	0.06	12.21	44.87	16.57	12.63				
Degraded	**12***	**2.61**	**115.19**	**354.81**	**124.67**	**117.84**	**5.5**	**15**	**8.6**	**30**
	12†	**4.47**	**143.92**	**437.00**	**150.66**	**151.58**				
External leakage - Utility medium	7*	7.90	67.69	176.19	55.26	68.74	4.7	15*	7.1	30*
	7†	13.04	85.56	211.15	64.53	88.42				
Vibration	5*	0.37	47.89	162.25	59.66	49.10	6.6	8.5*	11	17*
	5†	0.54	59.66	198.12	72.54	63.16				
Incipient	**32***	**100.04**	**310.91**	**616.58**	**162.23**	**314.24**	**3.4**	**12**	**3.7**	**12**
	32†	**152.50**	**395.56**	**731.12**	**180.34**	**404.21**				
Abnormal instrument reading	25*	54.80	242.28	539.20	154.61	245.50	2.9	10.0	3.0	10.0
	25†	83.90	307.08	644.45	177.34	315.79				
External leakage - Utility medium	2*	3.49	19.65	46.60	13.89	19.64	7.0	12*	7.0	12*
	2†	4.52	25.31	59.98	17.86	25.26				
Minor in-service problems	1*	0.54	9.93	29.48	9.82	9.82	1.0	1.0*	1.0	1.0*
	1†	0.79	12.99	38.07	12.63	12.63				
Vibration	1*	0.04	9.67	36.47	13.45	9.82	5.0	5.0*	10.0	10.0*
	1†	0.06	12.21	44.87	16.57	12.63				
Other	3*	7.98	29.36	61.73	17.01	29.46	7.0	8.0*	7.0	8.0*
	3†	10.18	37.64	79.28	21.88	37.89				
Unknown	**1***	**0.04**	**9.67**	**36.47**	**13.45**	**9.82**	-	-	-	-
	1†	**0.06**	**12.21**	**44.87**	**16.57**	**12.63**				
Unknown	1*	0.04	9.67	36.47	13.45	9.82	-	-	-	-
	1†	0.06	12.21	44.87	16.57	12.63				
All modes	**64***	**158.90**	**620.35**	**1330.15**	**372.09**	**628.49**	**6.6**	**45**	**10**	**90**
	64†	**238.75**	**786.19**	**1592.22**	**426.23**	**808.42**				

Comments

On demand probability for consequence class: Critical and failure mode: Fail to start on demand = 0

Data table: Maintainable item vs. failure mode

Maintainable item versus failure mode, continued
Item: Pumps - Centrifugal

	OTH	PDE	PLU	SER	STD	STP	UNK	UST	VIB	Sum
Actuating device	-	0.11	-	0.11	0.21	-	-	-	-	0.69
Bearing	-	-	-	-	-	-	-	-	0.05	0.16
Cabling & junction boxes	0.11	-	-	-	-	-	-	0.11	-	0.53
Casing	-	-	-	-	-	-	0.11	-	-	0.43
Control unit	0.21	0.32	-	-	-	0.11	0.11	0.21	0.11	5.28
Cooler(s)	-	-	-	-	-	-	-	-	-	0.89
Cooling/heating system	-	-	-	0.21	-	-	0.21	-	-	1.07
Coupling to driven unit	-	-	-	-	-	-	-	-	0.64	0.75
Coupling to driver	0.21	-	-	0.11	-	-	-	0.05	-	0.69
Diaphragm	0.21	-	-	-	-	-	-	-	-	0.21
Filter(s)	-	0.11	0.43	-	-	-	-	-	-	0.64
Gearbox/var.drive	-	-	-	0.11	-	-	-	0.05	0.11	0.96
Impeller	-	-	-	-	-	-	-	-	0.11	0.78
Instrument, flow	-	0.21	0.53	-	-	-	-	0.05	-	4.80
Instrument, general	0.11	0.21	-	-	-	-	-	0.53	0.11	2.56

Data table: Failure mechanism vs. failure mode

Failure mechanism versus failure mode, continued
Item: Pumps - Centrifugal

	OTH	PDE	PLU	SER	STD	STP	UNK	UST	VIB	Sum
Blockage/plugged	-	-	2.67	0.43	-	-	-	0.11	-	5.34
Breakage	0.21	-	-	0.32	0.11	-	-	-	-	1.17
Burst	-	-	-	-	0.11	-	-	-	-	0.21
Cavitation	-	-	-	-	-	-	-	-	-	0.32
Clearance/ alignment failure	0.11	0.11	-	-	-	-	-	-	0.21	0.85
Combined causes	-	-	-	-	-	-	-	-	-	0.53
Common mode failure	-	-	-	-	-	-	-	-	-	0.11
Contamination	0.11	0.43	0.11	0.11	-	-	-	-	-	0.85
Control failure	0.32	0.53	-	-	-	-	-	0.43	-	3.52
Corrosion	0.75	0.21	0.11	0.64	0.53	0.11	0.11	-	-	3.42
Deformation	0.11	0.11	-	-	-	-	-	-	-	0.32
Earth/isolation fault	0.21	-	-	0.11	-	-	-	-	-	0.43
Electrical failure - general	-	-	-	0.43	-	-	0.11	0.21	-	0.96
Erosion	-	-	-	0.11	1.17	-	-	-	-	3.52
External influence - general	-	-	-	-	0.11	-	-	-	-	0.11
Fatigue	-	-	-	-	-	-	-	-	-	0.32
Faulty signal/indication/alarm	-	0.21	-	-	-	-	-	0.96	-	9.07
Instrument failure - general	0.32	0.11	-	-	-	-	0.21	0.32	0.11	5.44

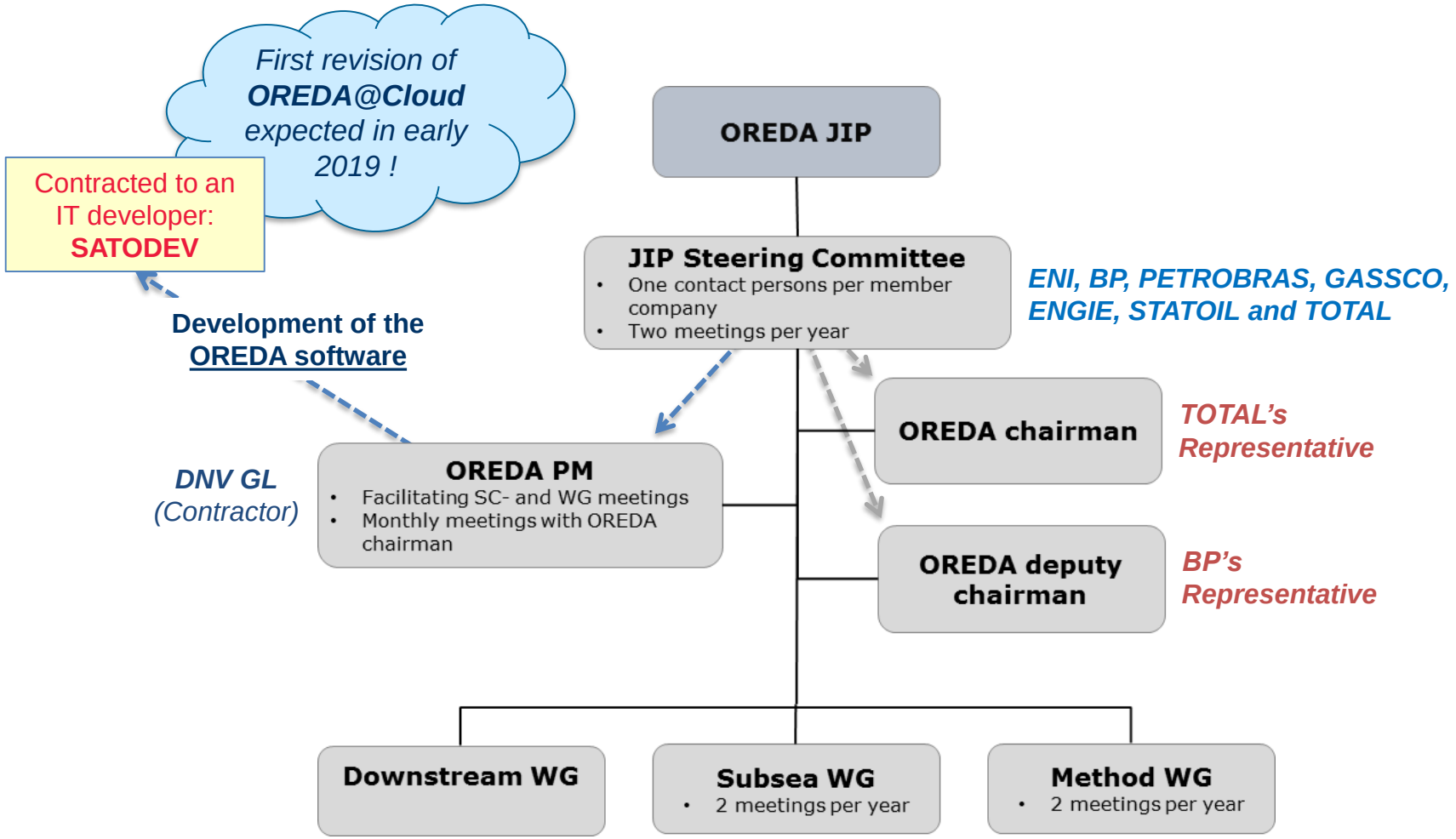
Application of data

- **Availability studies**
  - Availability estimates
  - Design optimization
  - Equipment selection
- **Risk analysis**
  - Estimate probabilities of critical events
  - Estimate survival time for safety-critical items
  - Risk Based Inspections
- **Benchmarking**
- **Maintenance planning and optimization**
  - RCM
  - Spare parts requirements
  - Analyze reliability characteristics
  - Reveal weak designs/design improvements
- **Operations**
  - Condition monitoring
  - Trend monitoring
- **LCC**

Why use OREDA data?

- Widely recognized and used in the industry
- Credibility of analyses and results
- No real good alternatives
- Specific reliability data will often be better, but rarely exist

JIP organisation & OREDA IT development



WG = Work Group / PM = Project Manager / SC = Steering Committee

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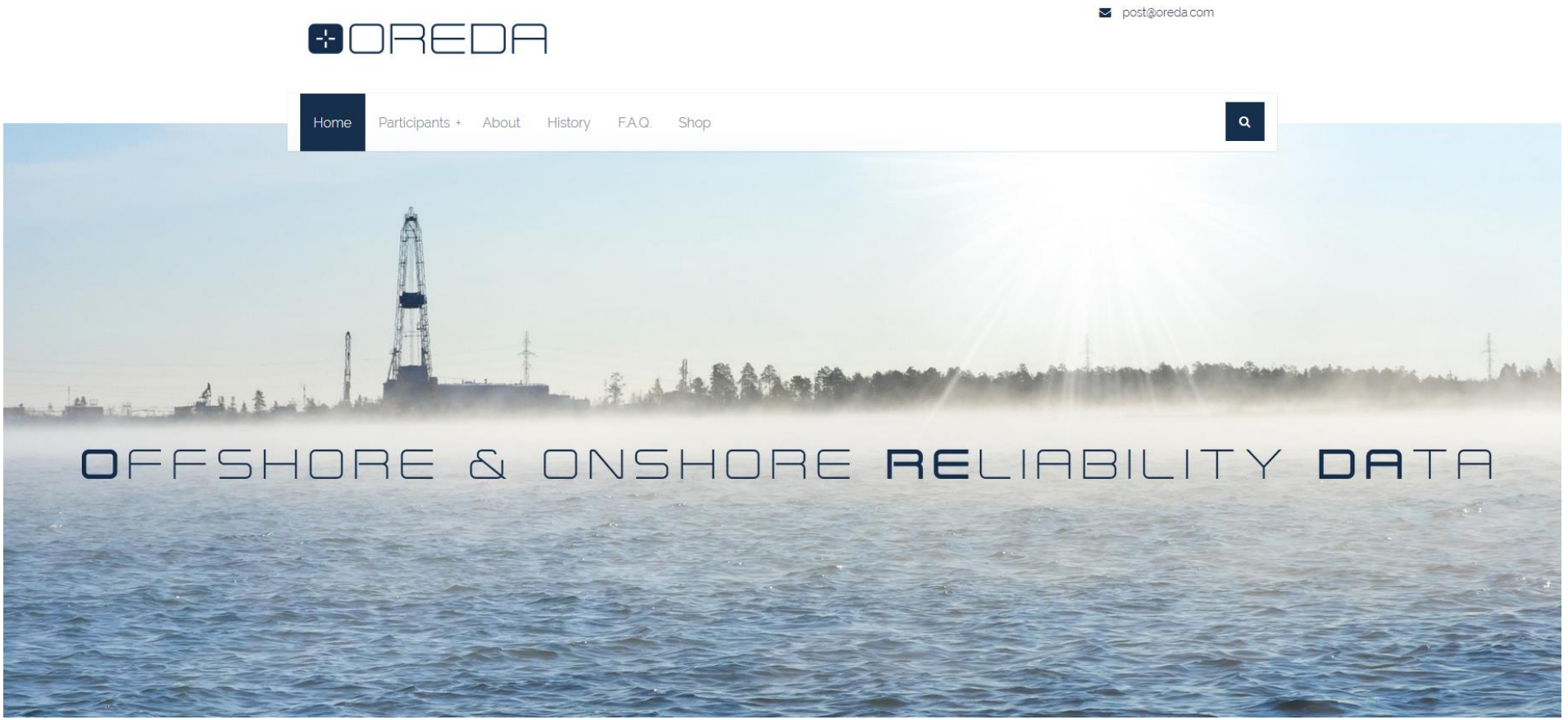

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