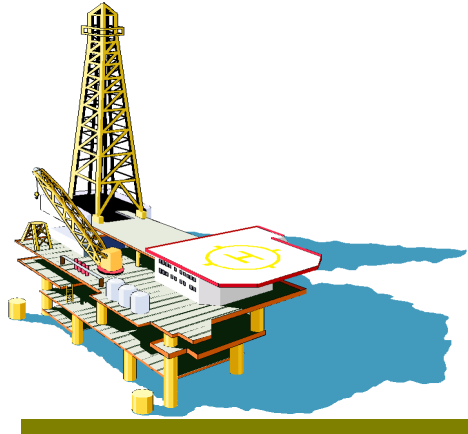
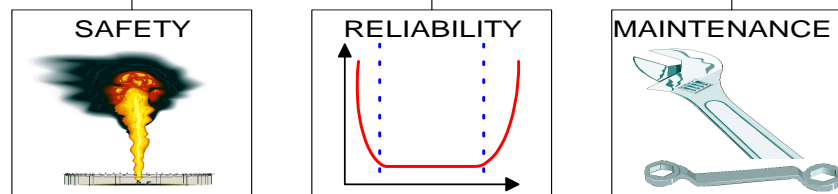


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ConocoPhillips



ExxonMobil



GDF SUEZ

BR PETROBRAS



Statoil



OREDA[®]

OFFSHORE RELIABILITY DATA

WHAT OREDA IS

- A project organization with 10 oil and gas companies as members (2010)
- A comprehensive databank with reliability data collected from different worldwide offshore installations
- A forum for exchange and development of reliability methods and know-how within the oil and gas industry



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OFFSHORE RELIABILITY DATA

GENERAL OREDA OBJECTIVES

- **Improve safety**
 - by providing experience and data on risks
- **Improve reliability and availability**
 - by use of reliability data to select most reliable equipment and configuration, and reveal weak designs for future improvement
- **Improve maintenance effectiveness**
 - by using failure data to refine maintenance strategies
- **Enhance industry reputation**
 - by demonstrating a high degree of understanding of equipment performance and characteristics
- **Reduce climate impact**
 - by use of reliability technology

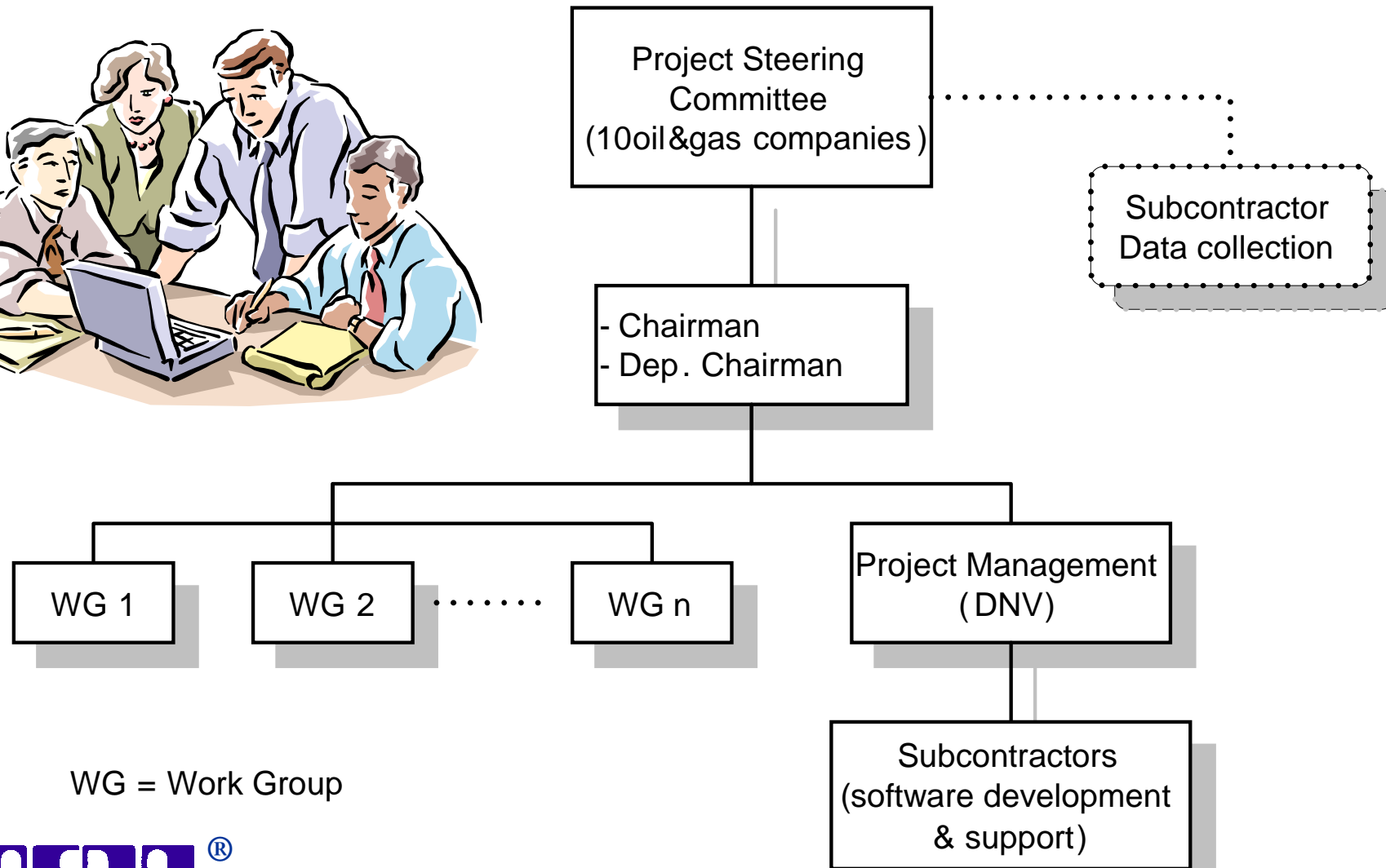


SPECIFIC OBJECTIVES

- **Collect and exchange operating experience in a common format**
- **Promote reliability engineering in E & P projects**
- **Develop a reference for the collection and analysis of reliability data in the oil and gas industry**
- **Develop cost-efficient data collection methods and tools**
- **Feed back operating experience to the equipment manufacturers**
- **Co-operate with other organizations and research institutes on data collection and analysis**



ORGANISATION



WG = Work Group



OREDA HISTORY



Phase	Time period	No. of participating companies	Achievements and milestones
I	1981-84	8	<ul style="list-style-type: none"> • OREDA Reliability Data Handbook ('84 edition)
II	1985-88	7	<ul style="list-style-type: none"> • Issued phase II reliability database • Guideline for Data Collection • Software for data storage and analysis (DOS).
III	1990-92	10	<ul style="list-style-type: none"> • Issued phase III reliability database • 2nd Handbook issued ('92 edition) • Initiated vendor cooperation
III-IV	1993	10	<ul style="list-style-type: none"> • Data analysis methods developed and tested • Cost-benefit study • Promoted the OREDA concept as ISO Standard
IV	1994-96	10	<ul style="list-style-type: none"> • New software for data collection and analysis (Windows) • Collected data on preventive maintenance • New Guideline, also included in new software
V	1997-99	10 - 11	<ul style="list-style-type: none"> • 3rd Handbook issued ('97 edition) • ISO 14 224 issued (first edition) • New subsea software • Software tool for automated data transfer (ADT)
VI	2000-01	10	<ul style="list-style-type: none"> • Strengthen focus on subsea equipment • Co-operation with subsea manufacturers established



OREDA HISTORY



Phase	Time period	No. of participating companies	Achievements and milestones
VII	2002-03	8	<ul style="list-style-type: none"> 4th Handbook issued (2002 edition) Focus on safety & subsea equipment
VIII	2004-05	9	<ul style="list-style-type: none"> Continuation of phase VII New associated member (Gassco) Involved in revised ISO 14 224 Standard (second edition)
IX	2006-08	9	<ul style="list-style-type: none"> OREDA seminar as part of 25 years anniversary (2006) Adoption of OREDA taxonomy and software to ISO 14 224 Continued focus on worldwide span of data coverage
X	2009-11	10	<ul style="list-style-type: none"> 5th Handbook issued (2009 edition) QA of existing database SIL data based on OREDA New associated members (GdF SUEZ and Petrobras)



MAIN OREDA ACHIEVEMENTS

- Existed for 29 years (2010) as an international joint industry project with 7-11 international oil and gas companies from 5 countries as members
- Established as the forum for collection and exchange of reliability data, and utilisation of reliability methods within the oil & gas industry
- A comprehensive databank with Exploration & Production (E&P) reliability data collected worldwide on:
 - Offshore topside and subsea equipment
 - Onshore E & P equipment
- Developed guidelines and software for data collection and analysis, topside and subsea
- Issued 5 comprehensive reliability data handbooks ('84, '92, '97, '02 and '09) that have been sold worldwide (>50 countries)
- Established a collaboration forum with subsea system suppliers
- Developed an ISO Standard based on the OREDA concept (ISO 14 224)
- ~ 40 Papers at various seminars and conferences



OREDA RELIABILITY DATA HANDBOOK - 5th EDITION (2009)

Topside Handbook (Volume 1)

SYSTEM	EQUIPMENT CLASS	Data from 2002 edition included in 2009 edition		New data in 2009 edition	Total 2009 edition
		Phase IV	Phase V	Phases VI + VII	
		No. of units	No. of units	No. of units	No. of units
1. Machinery	1.1 Compressors	75	56		131
	1.2 Gas Turbines	56	32		88
	1.3 Pumps		160	52	212
	1.4 Combustion Engines		75	23	98
	1.5 Turboexpanders		8	2	10
2. Electric Equipment	2.1 Electric Generators		26	6	32
	2.2 Electric Motors		128	15	143
3. Mechanical Equipment	3.1 Heat Exchangers		17	4	21
	3.2 Vessels	148	50		198
	3.3 Heaters and Boilers	11	1		12
4. Other Topside Equipment	4.1 Fire & Gas Detectors		779	139	918
	4.2 Process Sensors		69		69
	4.3 Control Logic Units			10	10
	4.4 - 4.5 Valves		331	576	907
SUM TOPSIDE		290	1732	827	2849



Subsea Handbook (Volume 2)

5. Subsea	5.1 Control Systems		17	105	122
	5.2 Flowlines		59	251	310
	5.3 Manifolds		29	77	106
	5.4 Pipelines (SSIV)		85	4	89
	5.5 Risers		42	104	146
	5.6 Running Tools		5		5
	5.7 Templates			15	15
	5.8 Wellheads & X-mas Trees		83	179	262
SUM SUBSEA			320	735	1055



EXAMPLE PAGE OREDA HANDBOOK (5th EDITION)



Taxonomy no 1.3.1.9		Item Machinery Pumps Centrifugal Oil export									
Population 4	Installations 2	Aggregated time in service (10 ⁶ hours)					No of demands 480				
		Calendar time * 0.1018		Operational time † 0.0792			Active rep. hrs		Manhours		
Failure mode	No of failures	Failure rate (per 10 ⁶ hours)					Mean	Max	Mean	Max	
		Lower	Mean	Upper	SD	n / τ					
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



OREDA EQUIPMENT COVERAGE

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

Topside/onshore data:

- 265 installations
- 16 000 equipment
- 38 000 failures
- 68 000 maintenance records



Subsea data from:

- Adriatic Sea
- Guinean Gulf
- Gulf of Mexico
- Mediterranean Sea
- North Sea
- West of Africa
- West of Shetland
- Almost 2000 well-years experience

RECORDED DATA

- **Inventory data**

- Classification data
- Identification data
- Specification data
- Maintenance data
- Operation data

- **Failure event data**

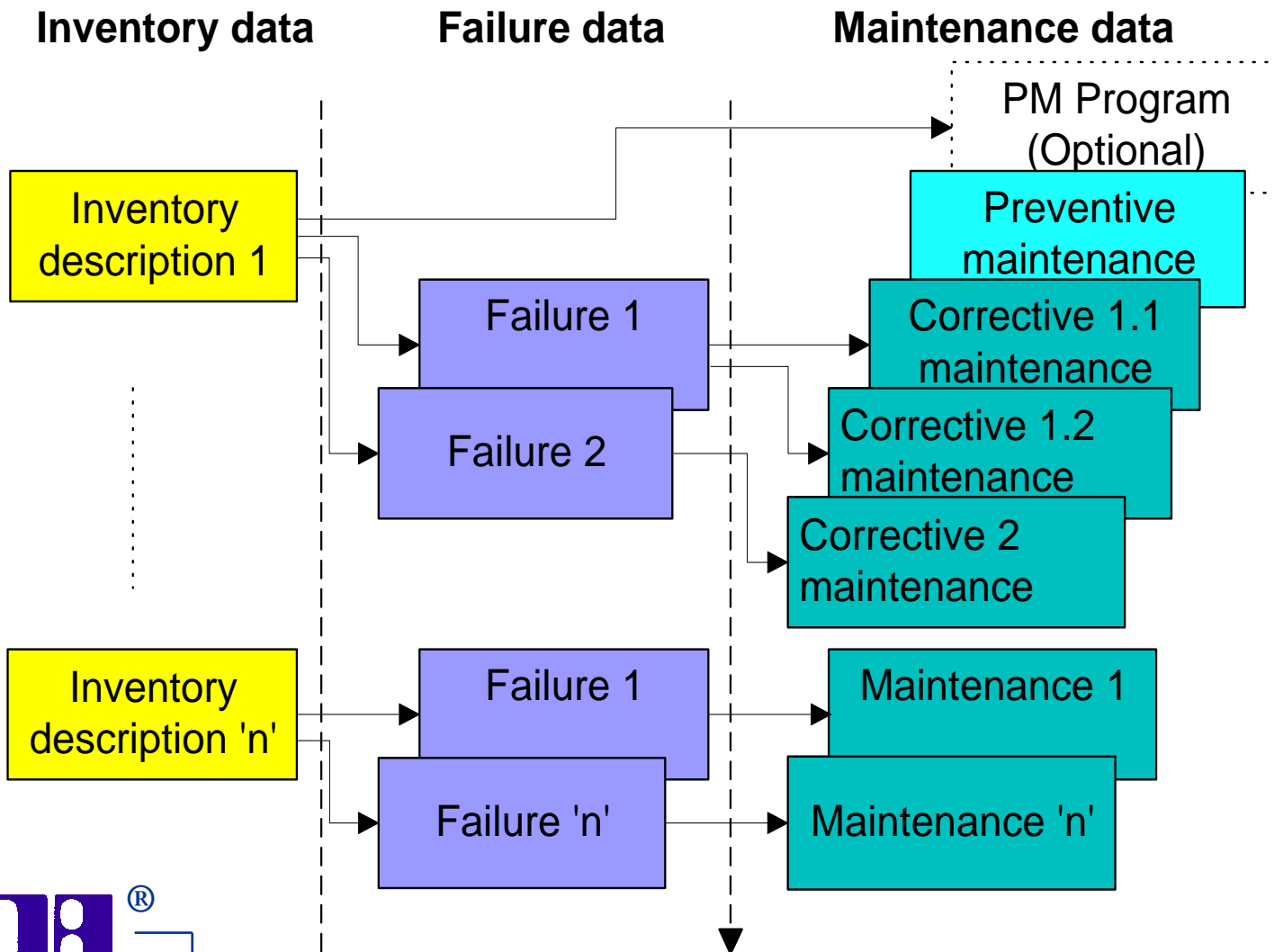
- Identification
- Failure event data
- Remarks

- **Maintenance event data**

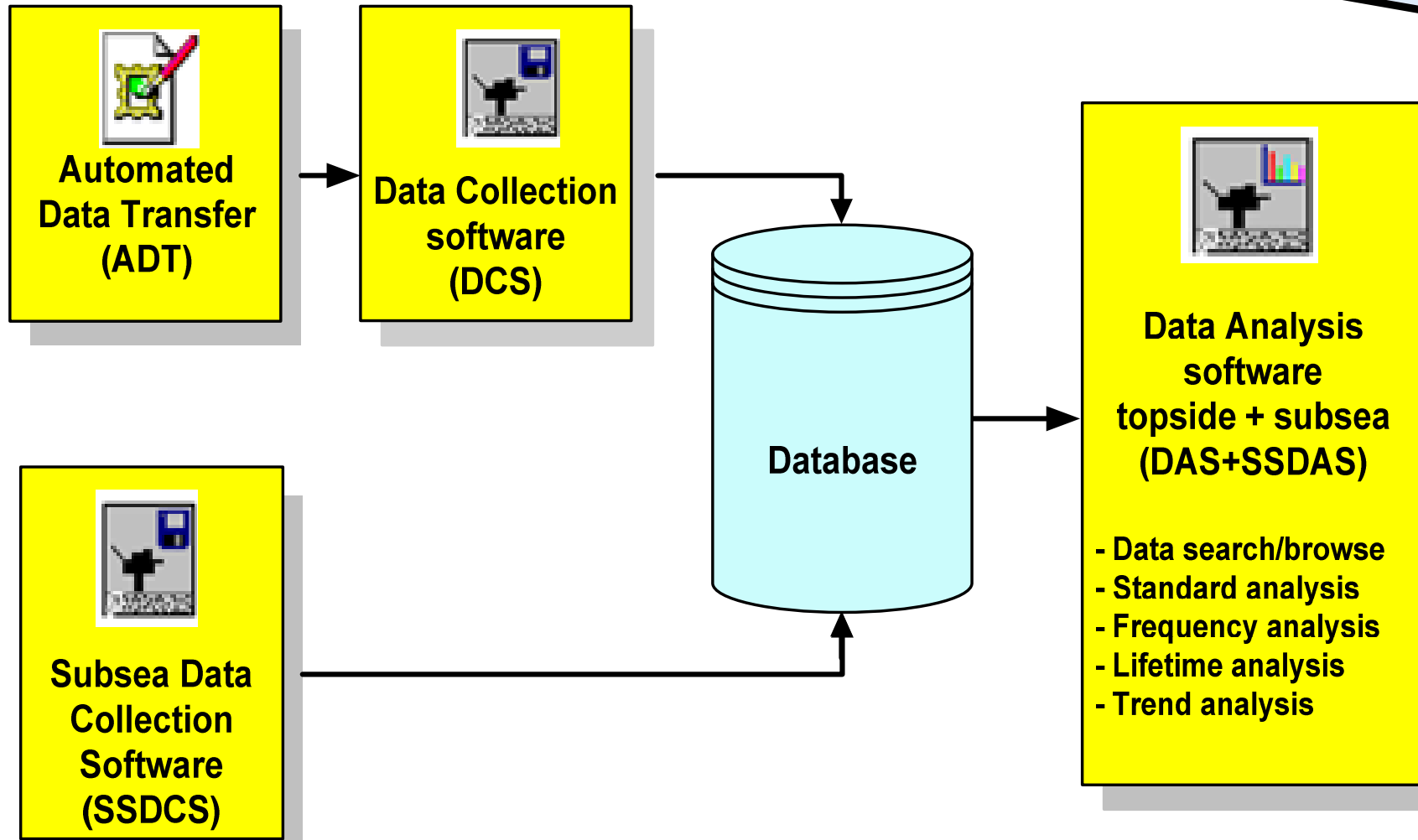
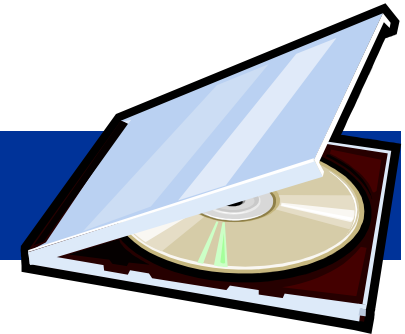
- Identification
- Maintenance event data
- Maintenance resources
- Remarks



DATABASE STRUCTURE - Topside



OREDA[®] SOFTWARE MODULES



SOFTWARE FEATURES

Data handling features

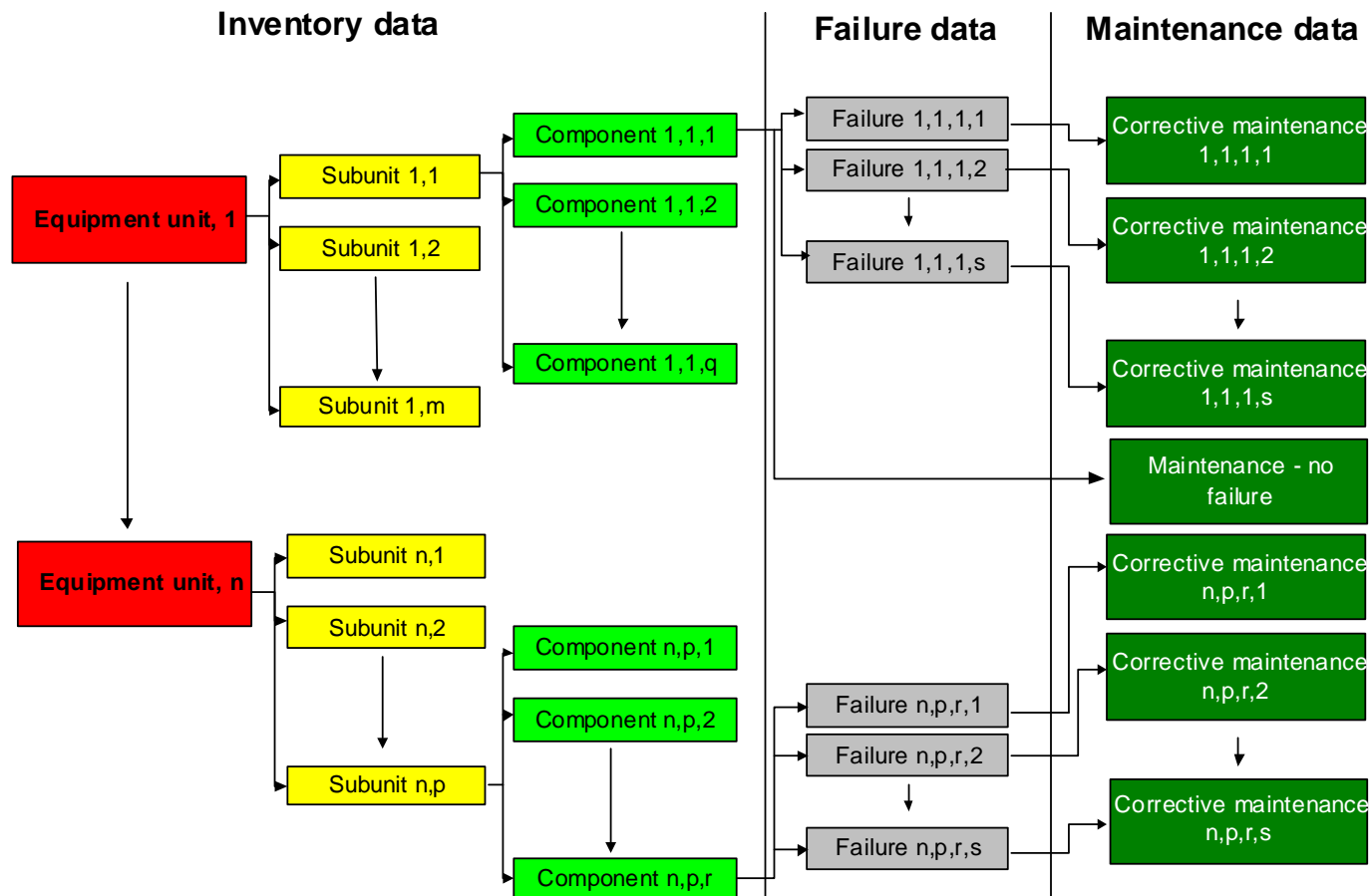
- Focused data search (filtering)
- Editing data
- In-built quality checks
- Time slicing data collection periods
- Import data from various formats
- Creating different data areas
- Access control

Data analysis features

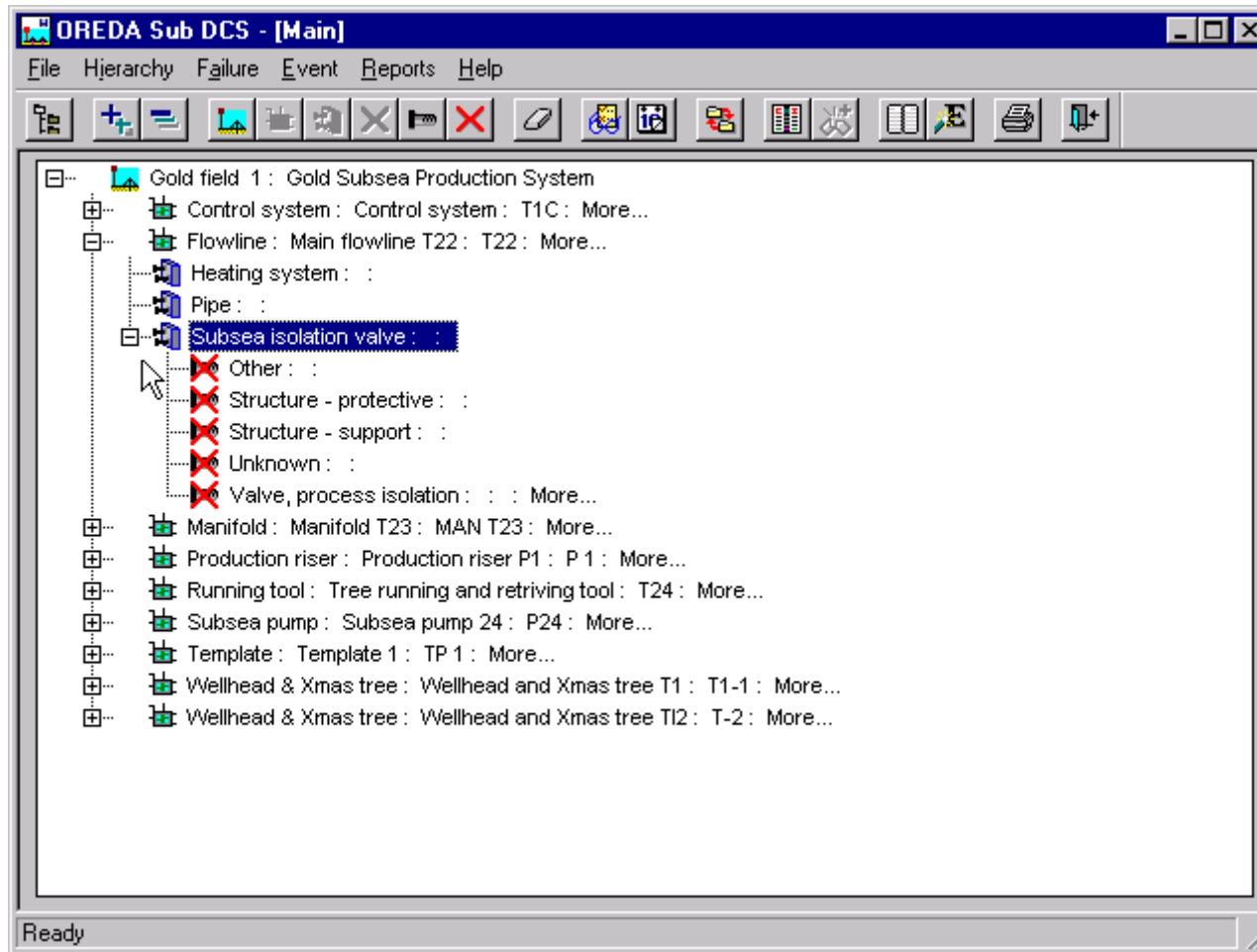
- Database content
- Failure rate/MTBF
- MTTR
- Failure modes
- Subunits/component failures
- Lifetime analysis
- Frequency analysis
- Cumulative analysis
- Export data/calculations



DATABASE STRUCTURE - Subsea

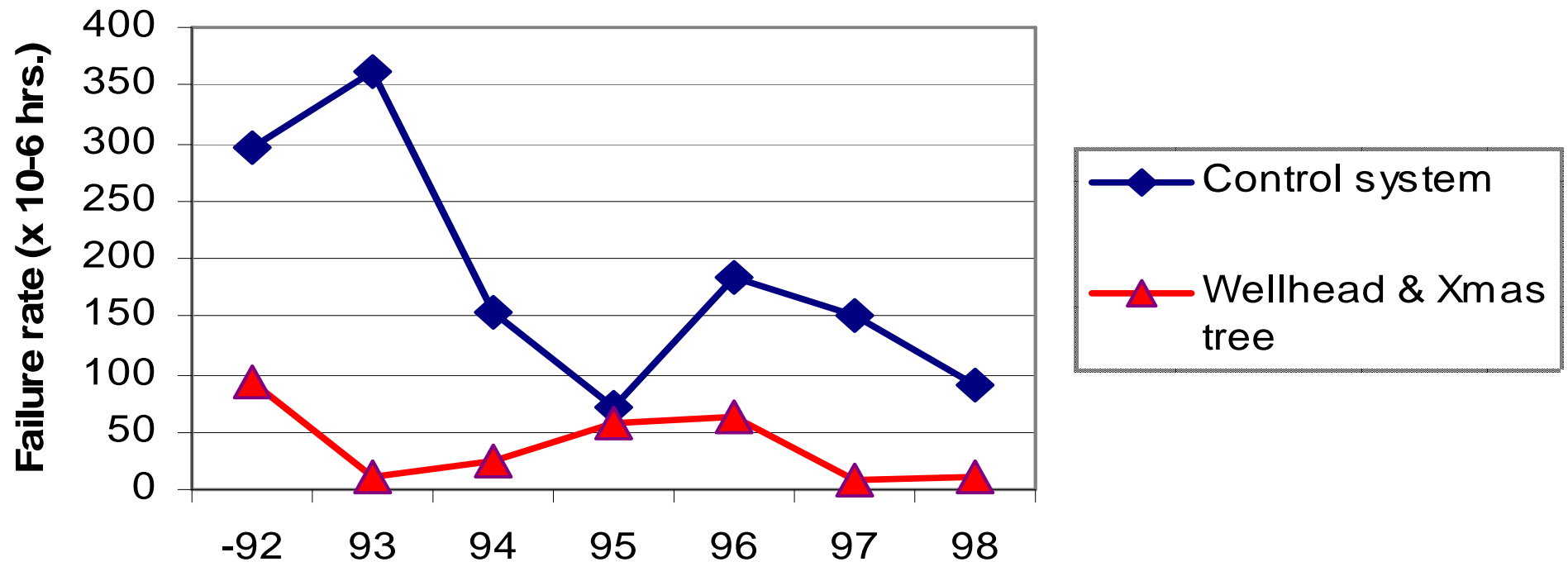


OREDA DATA COLLECTION SOFTWARE - Subsea



EXAMPLE ANALYSIS- subsea data

Subsea failure rates for the period 92-98
- All failures -



OREDA DATA COLLECTION GUIDELINES

- **Definitions – language we use**
- **Data collection procedure**
- **How to collect inventory data**
- **How to code failures**
- **How to code maintenance**
- **Boundary descriptions**
- **Quality assurance of data**



DATA QUALITY MEASURES IN OREDA

- **Data collection guidelines**

- data collection specifications (definitions, boundaries etc.)
- hints, tips and interpretation rules
- data collection planning
- quality control requirements

- **Data Collection Software**

- minimum data sets required
- data completion check
- input check (format and limits)
- Specific software for automated data collection

- **Project Manager**

- Help-desk for data collectors, and management of common quality issues
- quality check of data before acceptance to common OREDA database
- issue and updating of quality checklists

- **Data collectors forum**

- data collectors regular meetings
- exchange of common problems and improvement proposals
- exchange on experience with data collection process and method
- formalised cooperation with subsea manufacturers



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
- **LCC**
- **Benchmarking**
- **Maintenance planning and optimization**
 - RCM
 - Spare parts requirements
 - Analyze reliability characteristics
 - Reveal weak designs/design improvements
- **Operations**
 - Condition monitoring
 - Trend monitoring

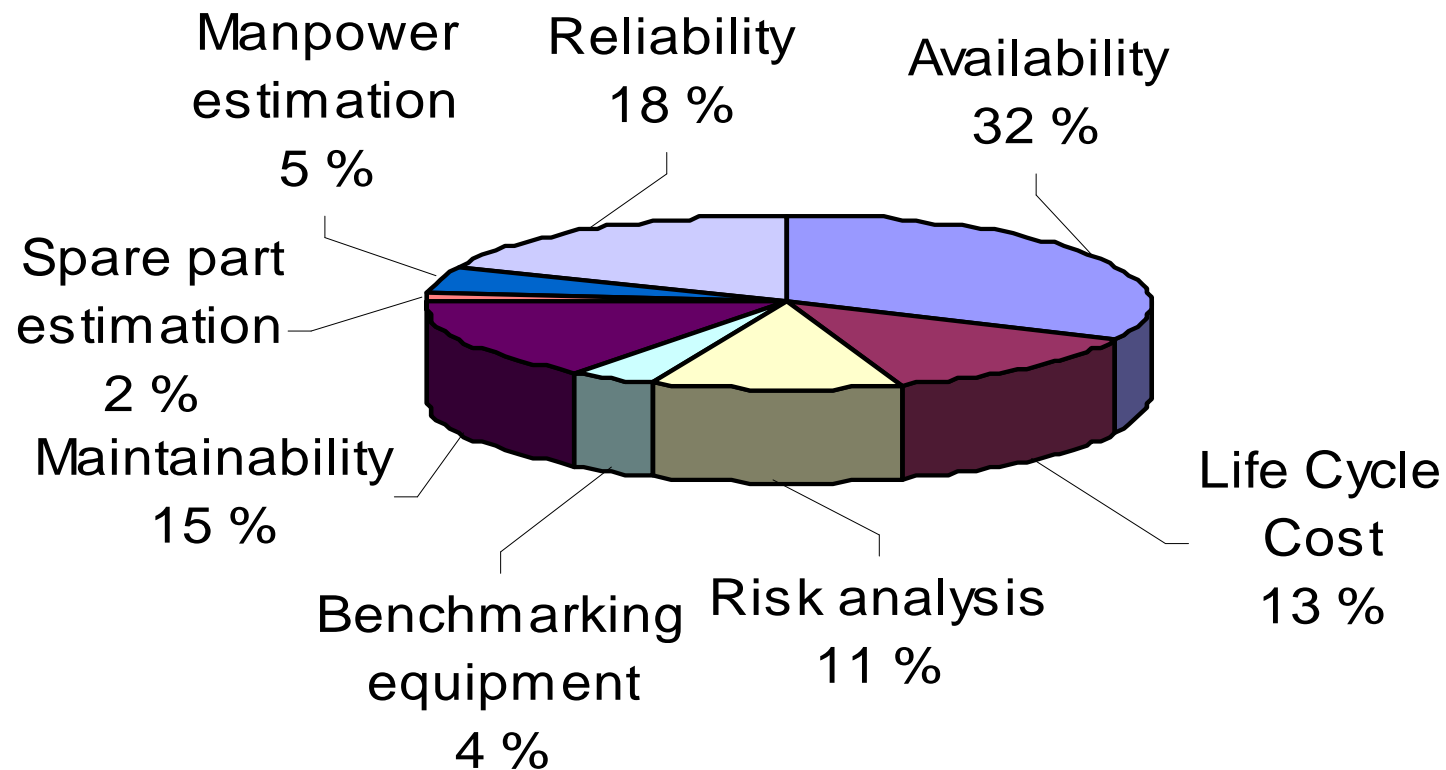


EXAMPLE: MAINTENANCE OPTIMIZATION

- **Reliability and maintenance records will assist with:**
 - Analysis of failure modes (FMEA)
 - Reveal critical problems
 - Provide lifetime characteristics (failure rate, etc.)
 - Select detection methods to prevent failure (where appropriate)
 - Monitor key maintenance and operability parameters
 - Provide basis for “de-bottlenecking” studies
 - Optimize spare parts strategy
 - Optimize manpower strategy



APPLICATION OF DATA - EXAMPLE FROM ONE OIL COMPANY



USE OF OREDA DATA – Specific case

- **Application:** Oil export
- **Installation:** Offshore oil and gas platform
- **Case:** Tie-in of a new field to an existing platform. The new equipment module includes separators, compressors, gas turbine etc. A 2 x 100% oil export system was originally planned.
- **Solution:** A 1 x 100% oil export system was selected consisting mainly of a booster pump and an export pump. Estimated production availability reduced by $\approx 0.4\%$
- **Cost saving:** Cost: \approx NOK 50 millions. Weight: \approx 20 tons of equipment, \approx 40 tons bulk. More space available.
- **Analysis:** RAM assessment
- **Use of OREDA data:** OREDA Phase pump data used as input to the RAM assessment



SUMMARY

- OREDA has become the forum for the collection and exchange of reliability data within the offshore industry, and used as model for data collection within other industries
- OREDA has been widely accepted as the source for reliability data in the offshore industry
- OREDA data and results have been used as input in many RAMS analyses to give more confidence in results
- OREDA experience have generated a more standardized approach to defining, specifying and utilizing reliability knowhow in the offshore industry.
- OREDA knowhow has been widely used in development of the international standards ISO 14 224 and ISO 20815.
- 29 years (2010) of joint industry co-operation has shown that is it possible to work for a common goal across differences in company philosophy, language, culture, distance etc.

