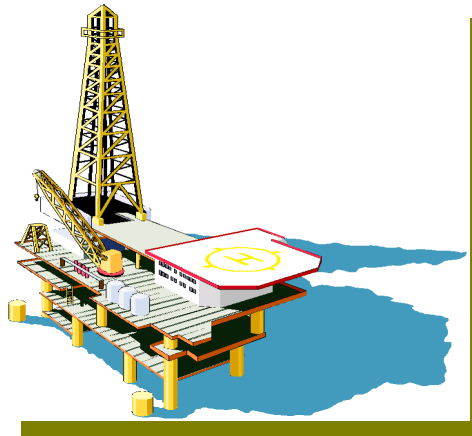
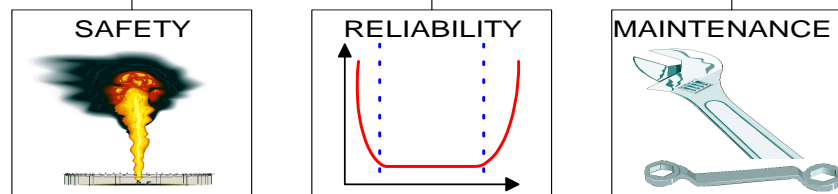


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ConocoPhillips



ExxonMobil



OREDA[®]

OFFSHORE RELIABILITY DATA

WHAT OREDA IS

- A project organization with 8 oil and gas companies as members (2009)
- 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

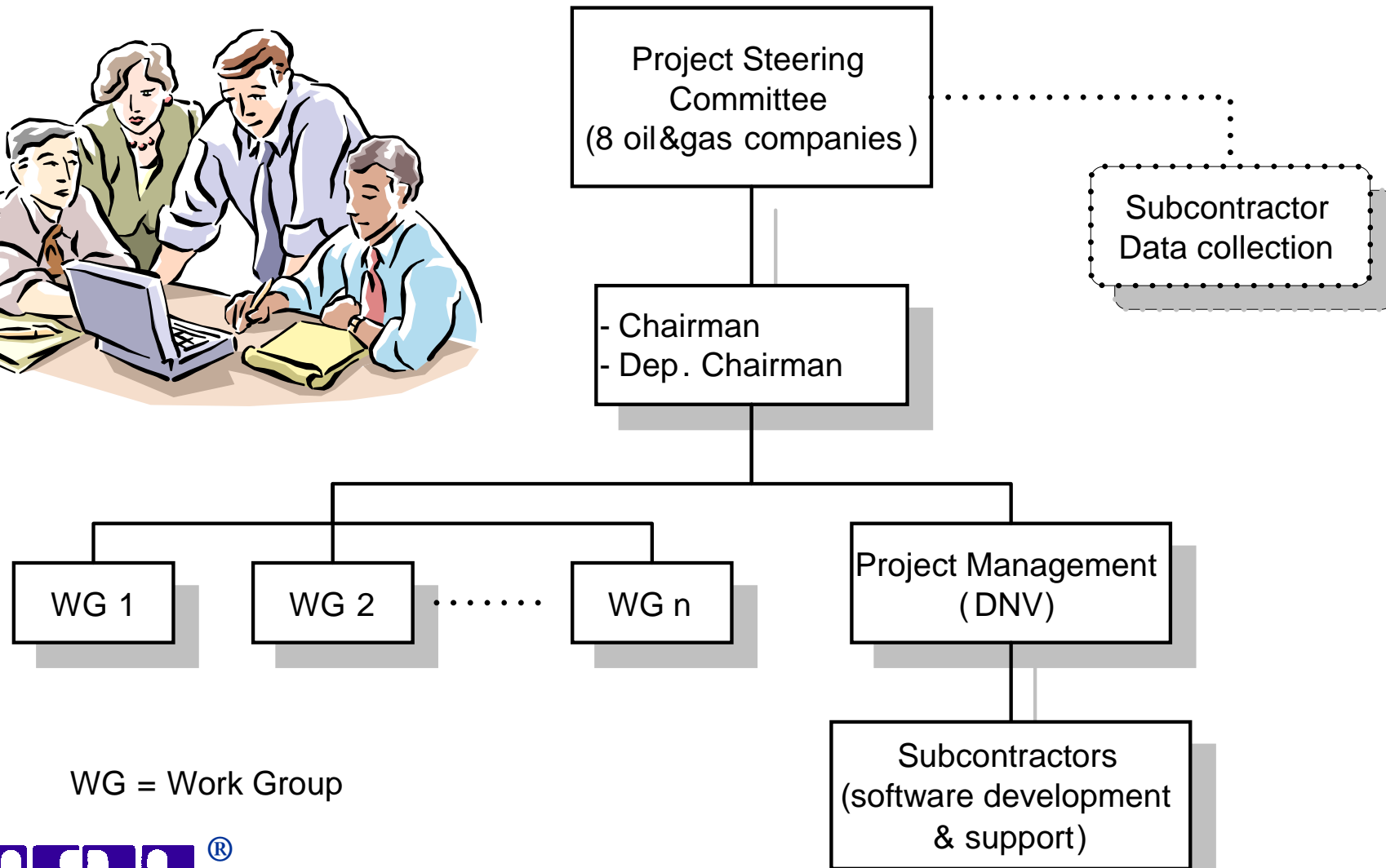


SPECIFIC OBJECTIVES

- **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 |
| 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 | 8 | <ul style="list-style-type: none"> • Continuation of phase IX • 5th Handbook planned to be issued (2009) |



MAIN OREDA ACHIEVEMENTS

- Existed in 28 years (2009) 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 13.1.9 | | 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**

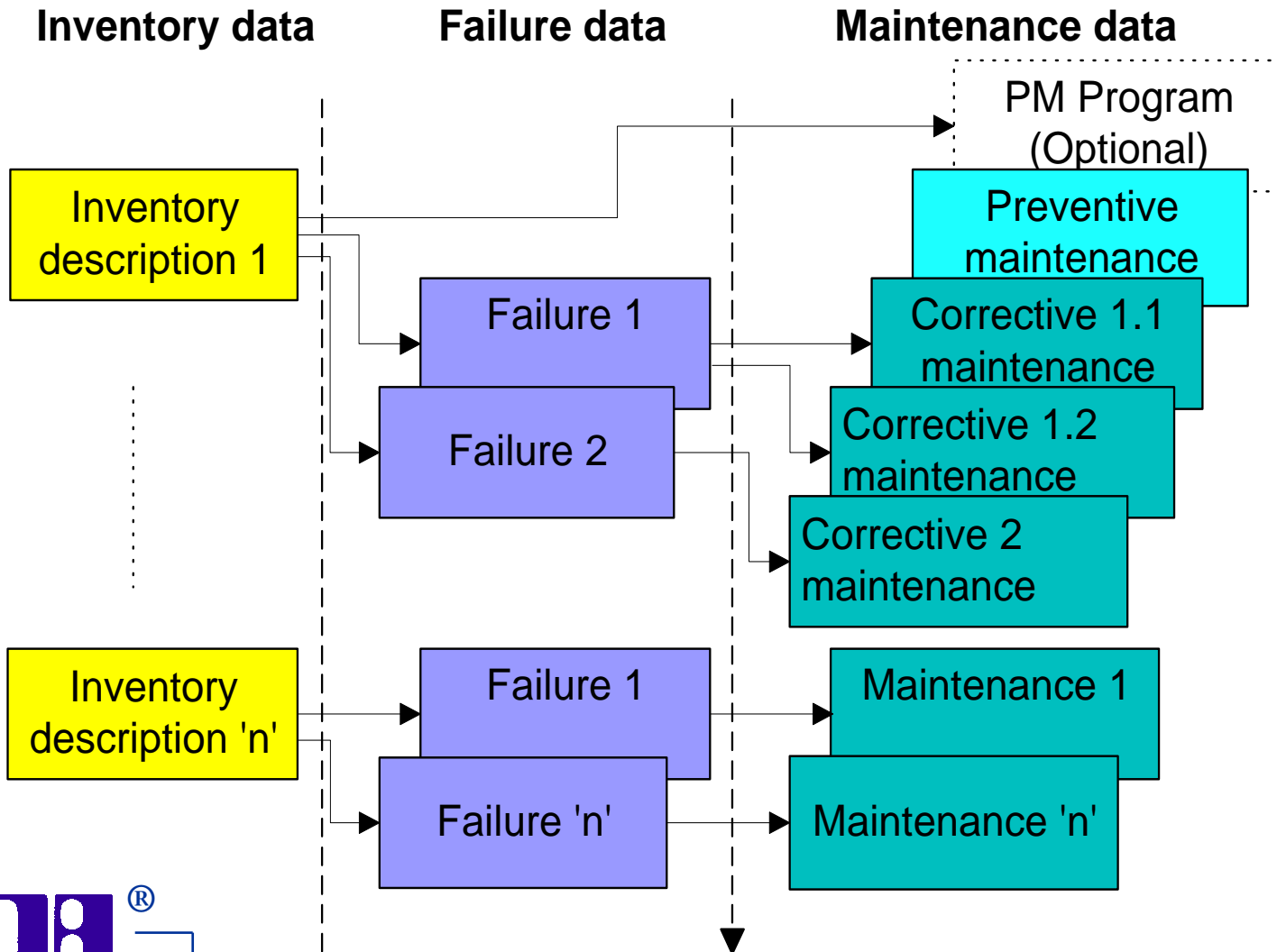
- **Identification**
- **Failure event data**
- **Remarks**

- **Maintenance event data**

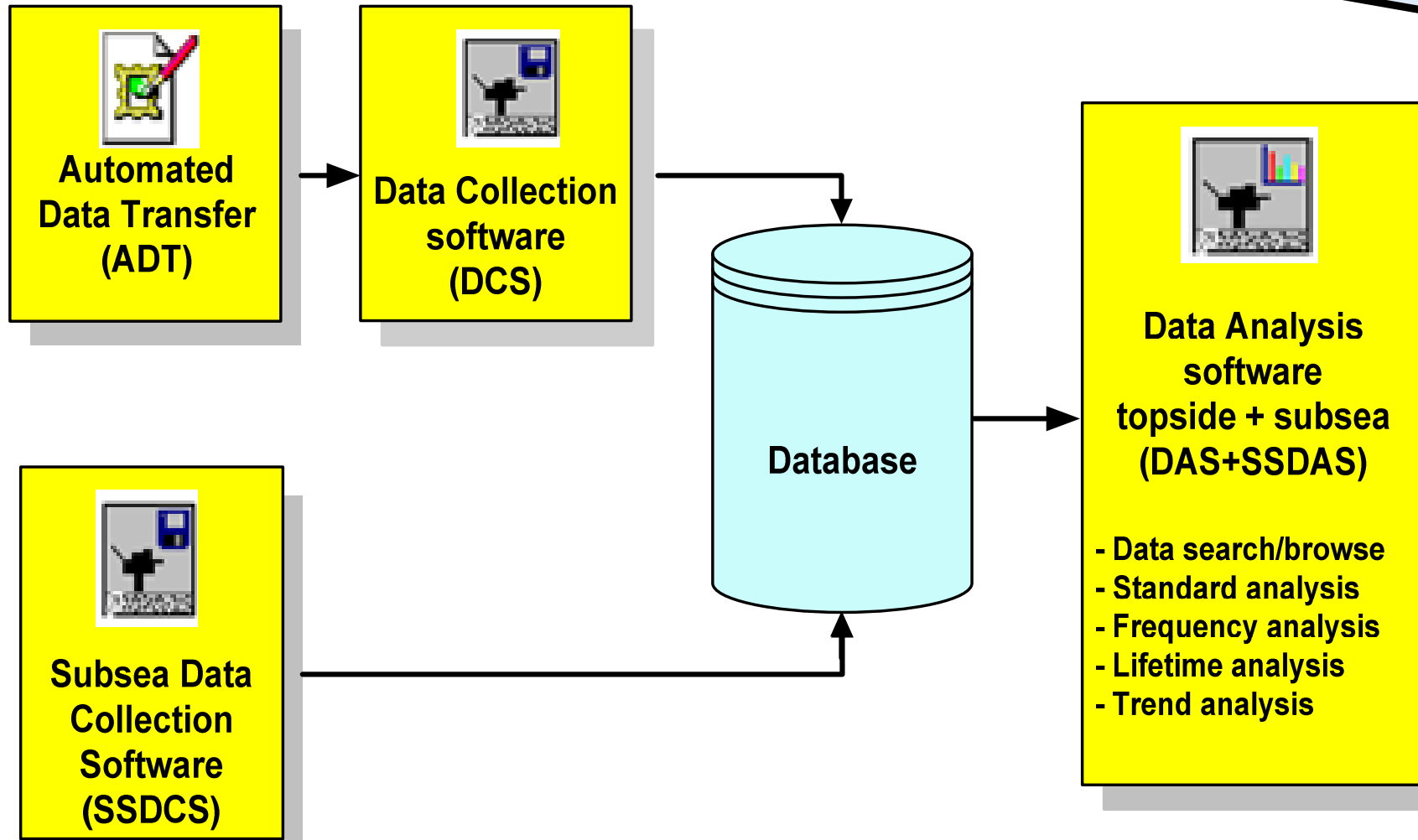
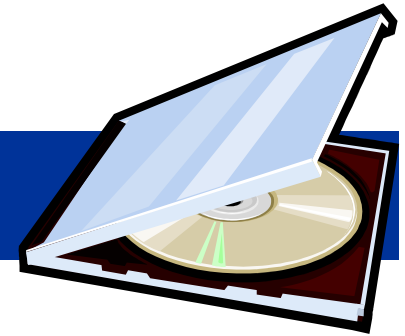
- **Identification**
- **Maintenance event data**
- **Maintenance resources**
- **Remarks**



DATABASE STRUCTURE - Topside



OREDA[®] SOFTWARE MODULES



SOFTWARE FEATURES

Data handling features

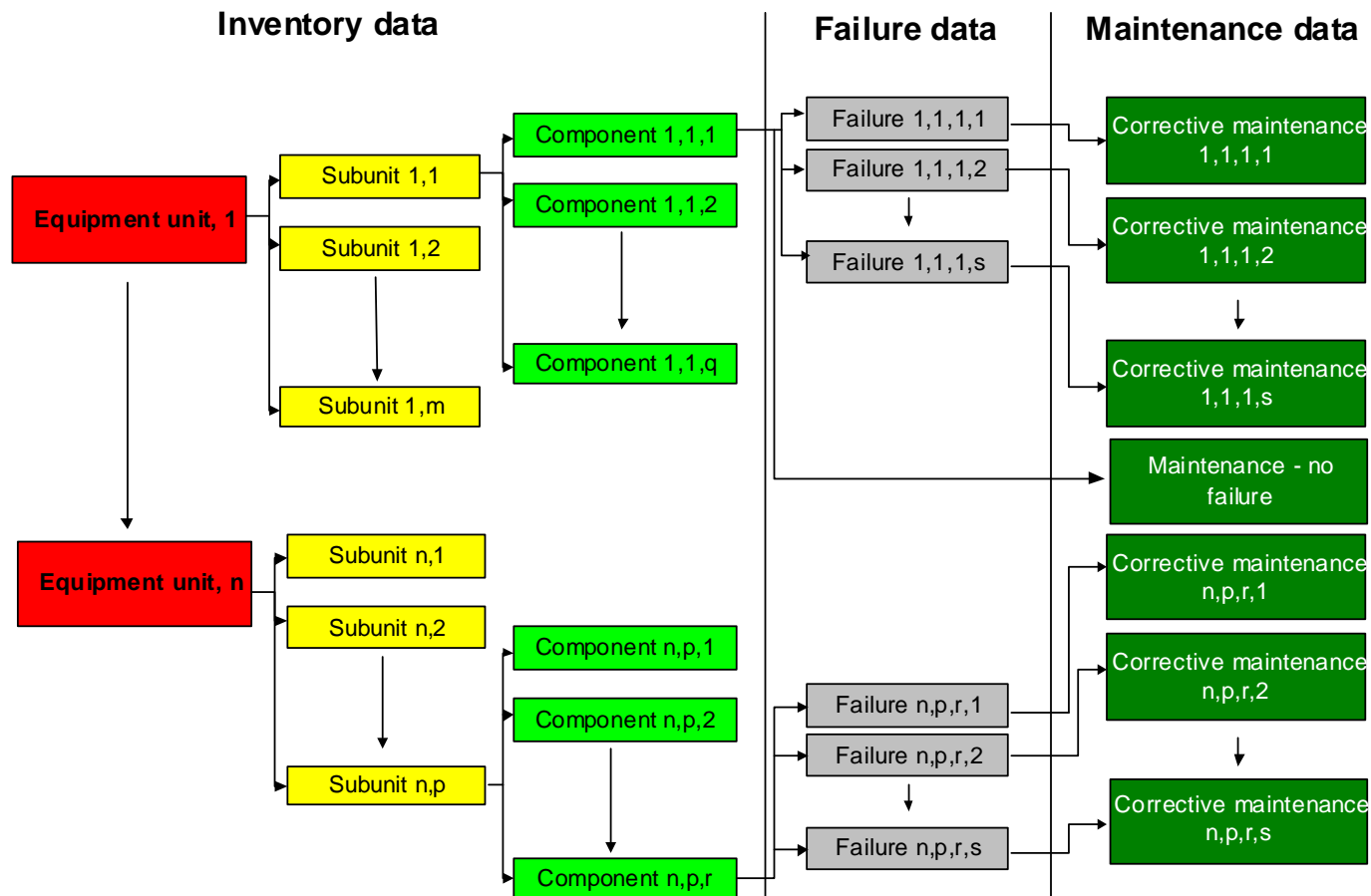
- Focused data search (filtering)
- Editing data
- In-built quality checks
- Time slicing data collection periods
- Import and export data
- Creating different data areas
- Access control

Data analysis features

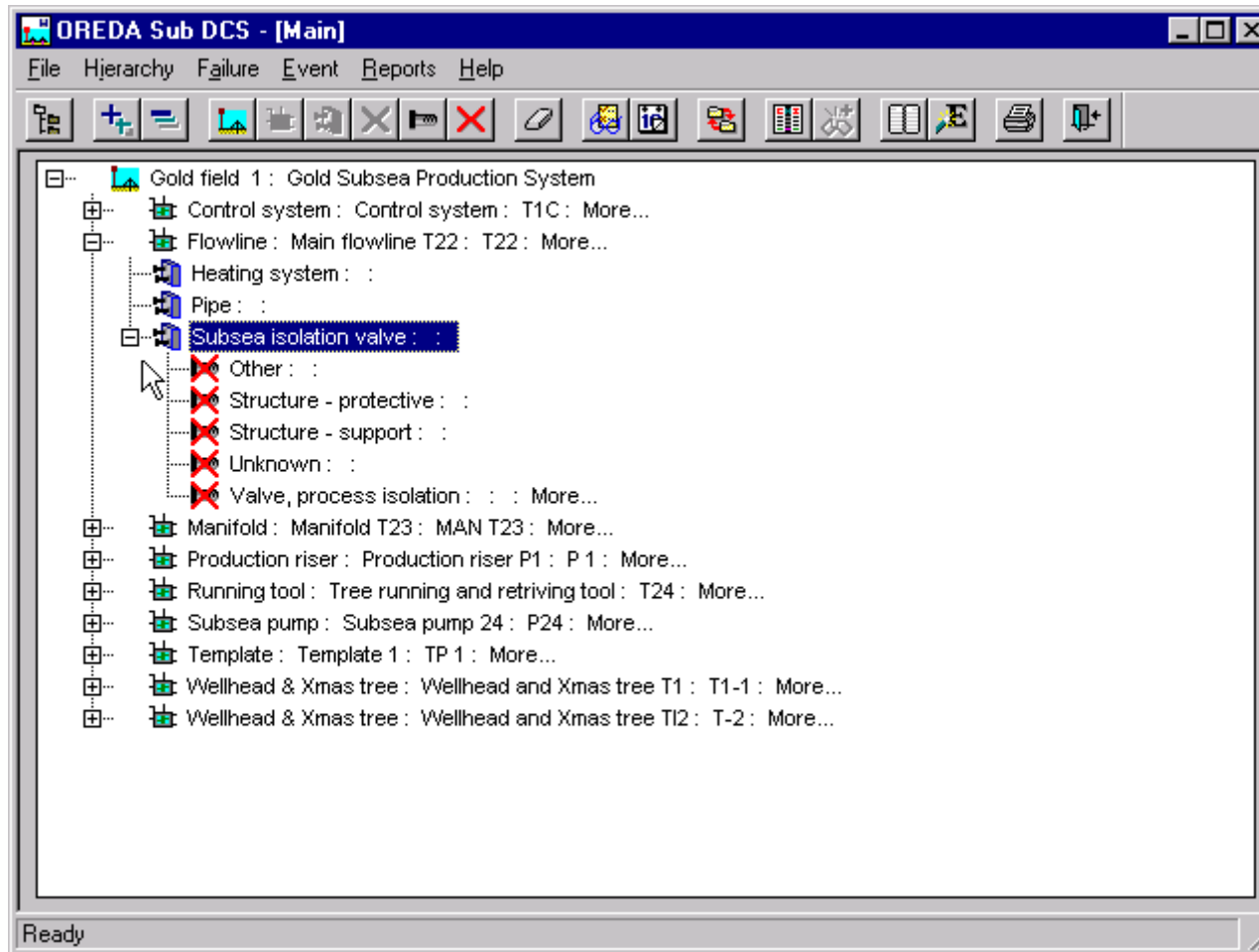
- Database content
- Failure rate/MTBF
- MTTR
- Failure modes
- Subunits/component failures
- Lifetime analysis
- Frequency analysis
- Export data/calculations



DATABASE STRUCTURE - Subsea

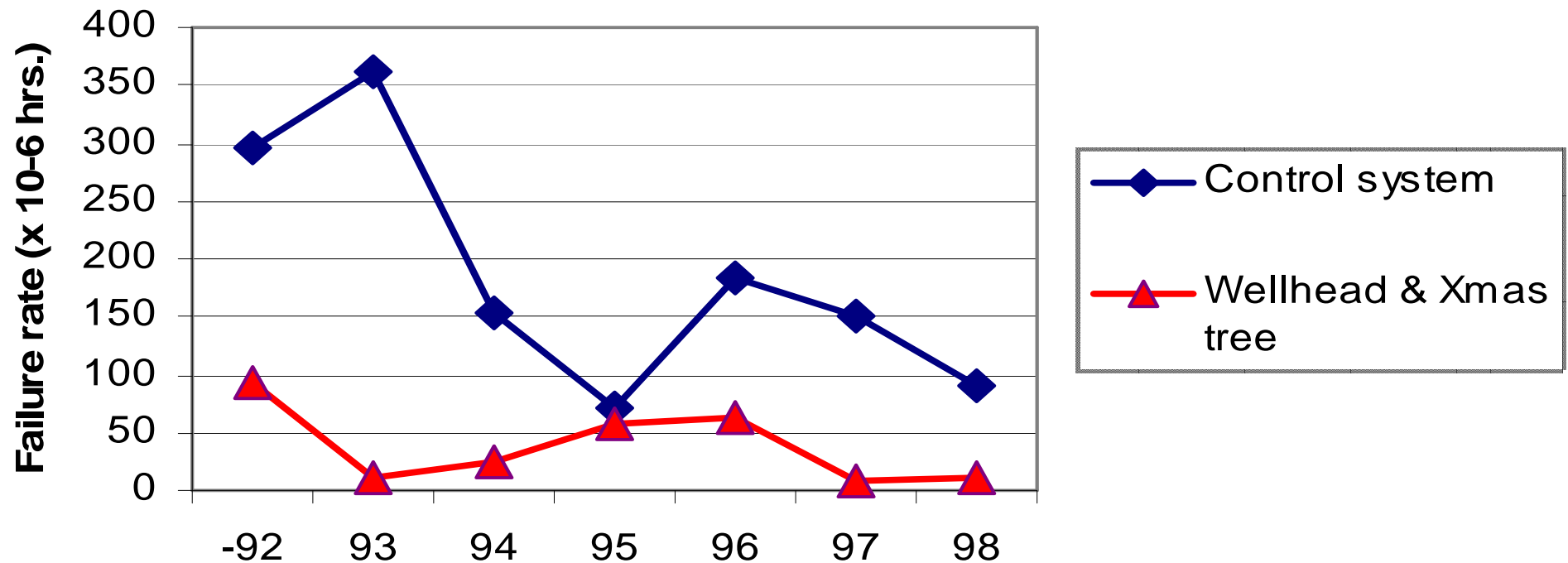


OREDA DATA COLLECTION SOFTWARE - Subsea



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



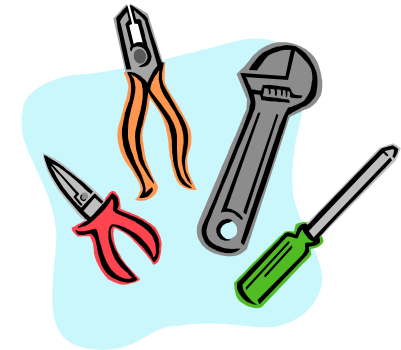
APPLICATION OF DATA

- 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

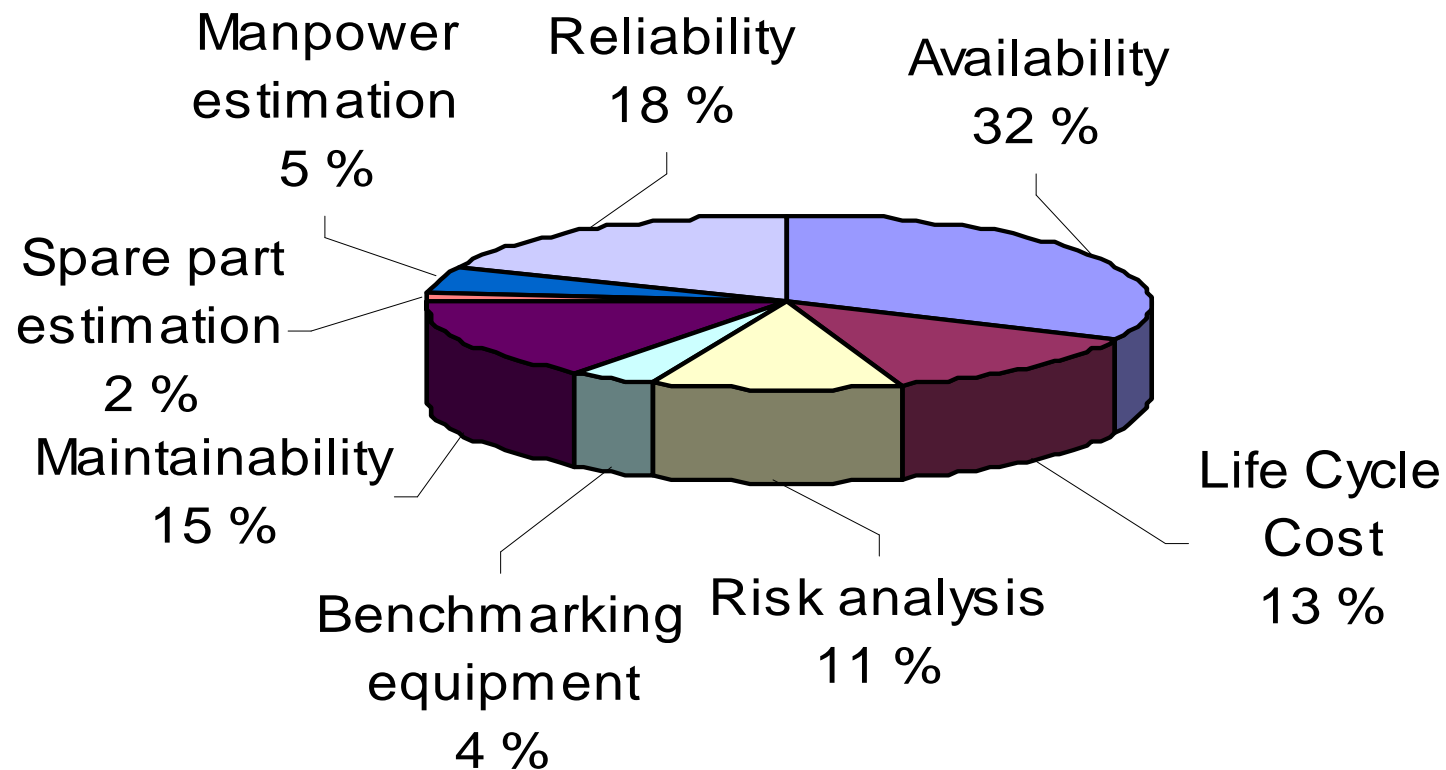


EXAMPLE: MAINTENANCE OPTIMIZATION

- **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.
- 28 years (2009) 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.

