



**Reliability
Dynamics**

ISO 14224 Implementation Case Histories in the Americas

Pipeline, Offshore Drilling, and Oil Production Sectors

- Tony Ciliberti, Principal Engineer, Reliability Dynamics (USA), ISO/TC 67/WG 4 member
- Thiago Amato, Asset Integrity Engineer, Queiroz Galvão Óleo e Gás S.A. (Brazil)
- Gord Sandercock, Senior Maintenance Management Specialist, Pembina Pipeline Corporation (Canada)
- Ramesh Vora, Senior SAP PM Analyst, Nexen Energy (Canada)

International ISO standardization seminar for the reliability technology and cost area

Statoil Business Centre, Stavanger, Norway, 26 April 2016



Overview

- Registered engineering company, located in Indiana, USA
- Specialize in applying ISO 14224 solutions in corporate software
- Primary product is the *Industry Standard Solution for Plant Maintenance* (ISPM®)

Clients

- Queiroz Galvão - Óleo e Gás (QGOG)
- Pembina Pipeline Corporation
- Nexen Energy
- Maersk Drilling
- Marathon Oil
- Fortis Alberta



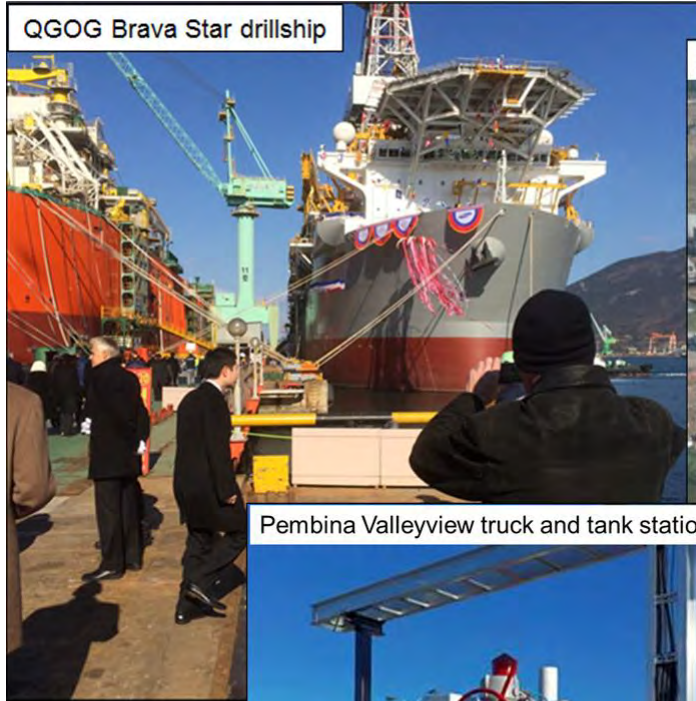
Tony Ciliberti PE

Principal Engineer | Reliability Dynamics

- BS in Chemical Engineering from Texas A&M University, 1987
- Twenty-nine years as a reliability engineer in petrochemical, oil and gas
- Licensed Professional Engineer
- Four years with SAP Americas' National Practice (EAM Solution Architect)
- International/Industry standards involvement
 - ISO TC 67/WG4/PG1 (US expert): Collection and exchange of reliability and maintenance data for equipment
 - ISO TC67/WG4/PT2 (US expert): ISO 20815 Production Assurance and Reliability Management
 - CCPS PERD ERP Subcommittee Chair



Facilities Overview: Application in Upstream, Midstream, and Downstream



QGOG Brava Star drillship



Nexen Long Lake Plant



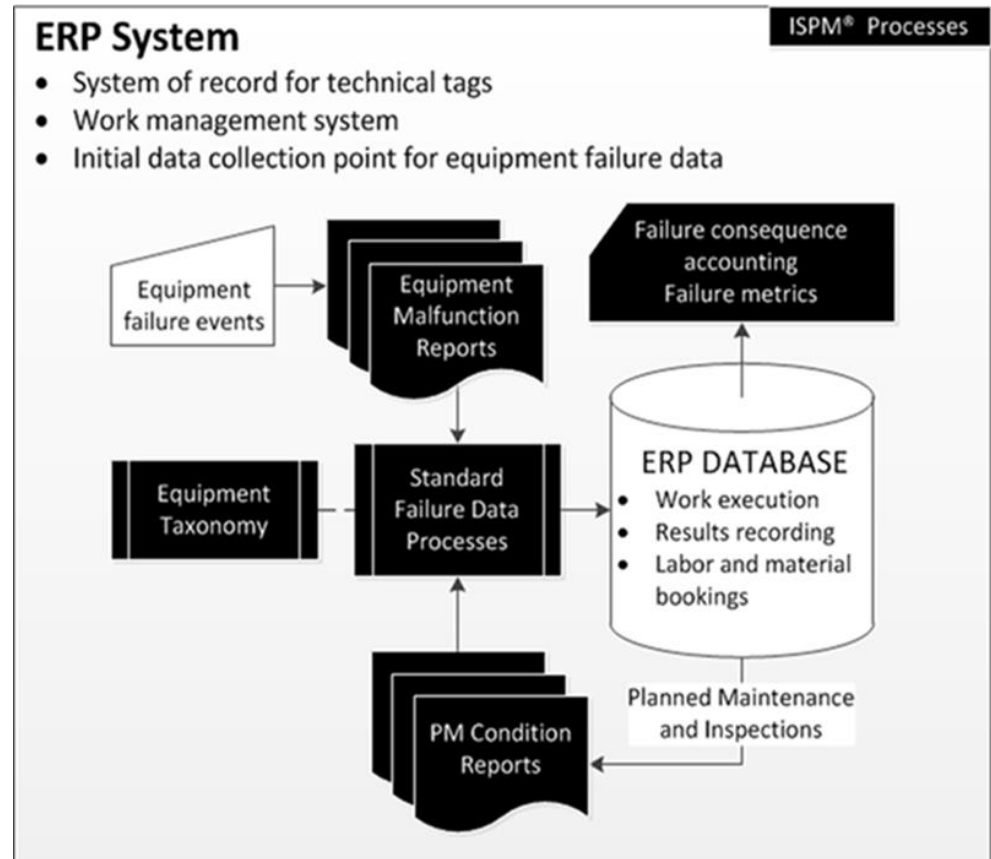
Pembina Valleyview truck and tank station



Industry Standard Solution for Plant Maintenance (ISPM®)

- Application of ISO 14224 methods in enterprise software (ERP)
 - Native to enterprise software
 - Built-into work management processes
- Equipment reliability metrics
 - Technical hierarchy
 - Malfunction reporting
 - Consequence accounting
 - PM condition reporting
 - Data quality assurance
 - Data aggregation

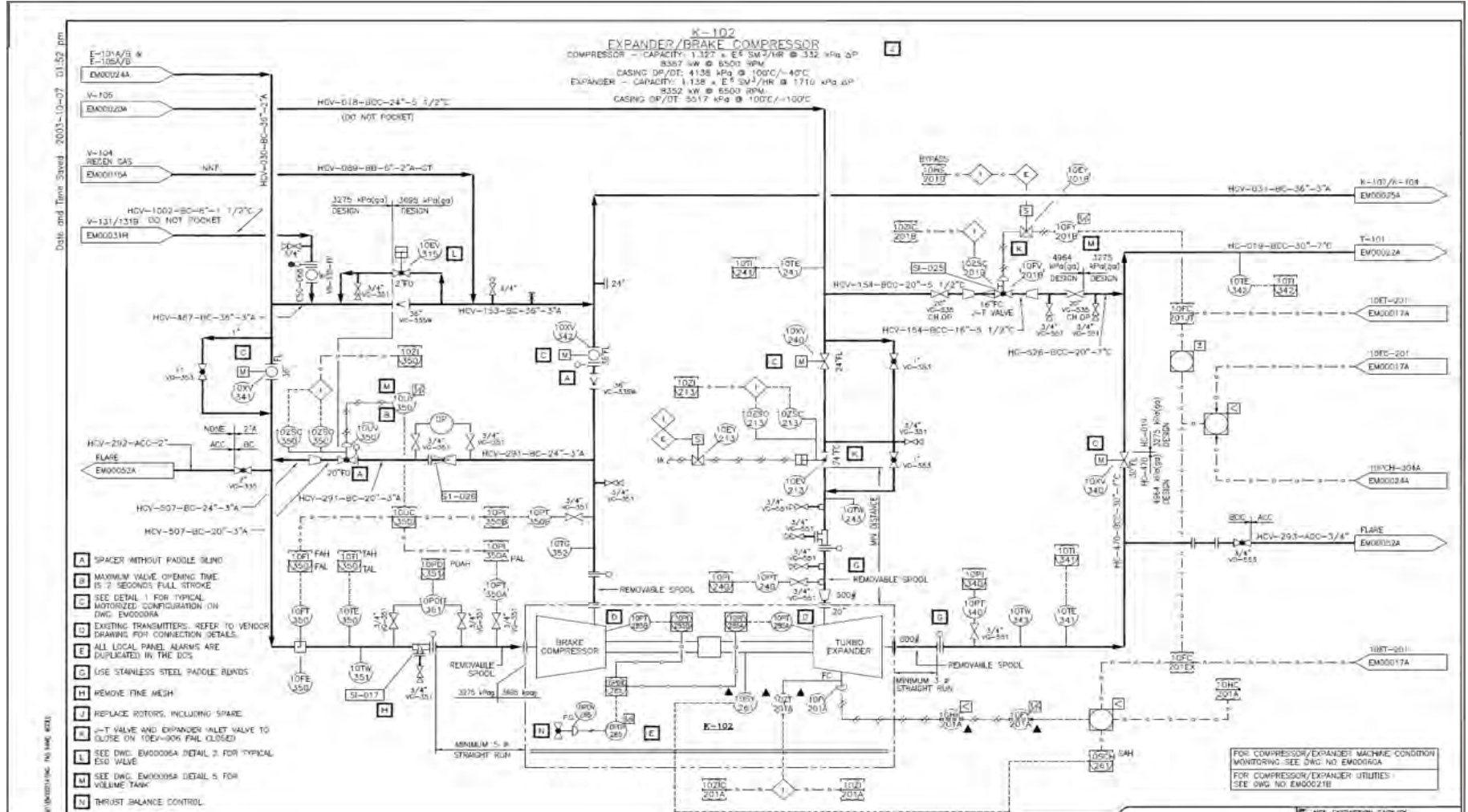
If you can't analyze 1000+ things at once, you're not doing it right!





Construction of Technical Structure

Compressor Technical Drawings





Construction of Technical Structure

Compressor Taxonomy Definition

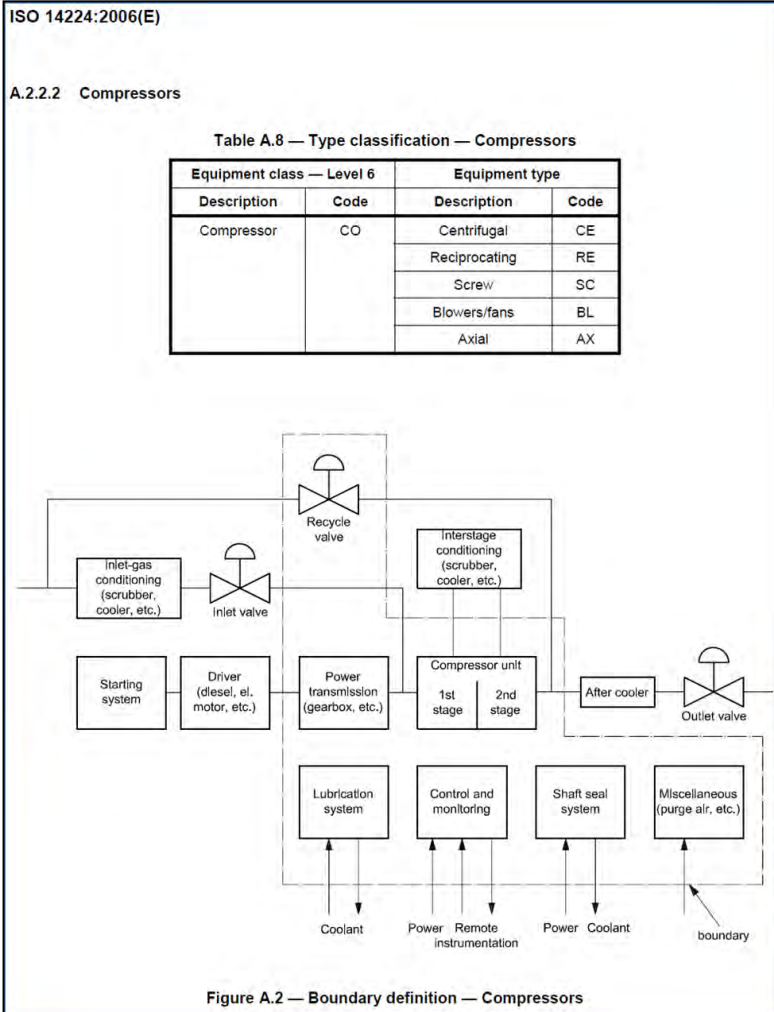


Table A.9 — Equipment subdivision — Compressors

Equipment class	Compressors					
	Subunit	Power transmission	Compressor	Control and monitoring	Lubrication system	Shaft seal system
Maintainable item/Part	Gearbox/variable drive	Casing	Actuating device	Oil tank with heating system	Oil tank with heating	Base frame
	Bearings	Rotor with impellers	Control unit	Pump	Reservoir	Piping, pipe support and bellows
	Coupling to the driver	Balance piston	Cables and junction boxes	Motor	Pump	Control valves
	Coupling to the driven unit	Interstage seals	Internal power supply	Check valves	Motor	Isolation valves
	Lubrication	Radial bearing	Monitoring	Coolers	Gear	Check valves
	Seals	Thrust bearing	Sensors ^a	Filters	Valves	Coolers
		Shaft seals	Valves	Piping	Valves	Silencers
		Internal piping	Wiring	Valves	Seal oil	Purge air
		Valves	Piping	Lube oil	Dry gas seal	Magnetic-bearing control system
		Antisurge system ^b	Seals		Mechanical seal	
		Piston			Scrubber	Flange joints
		Cylinder liner				
		Packing				

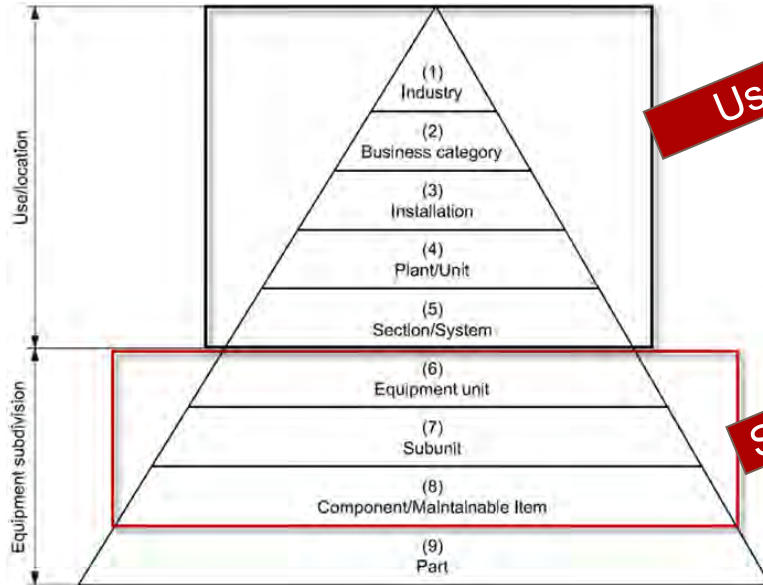
^a Specify type of sensor, e.g. pressure, temperature, level, etc.

^b Including recycle valve and controllers.



Technical Structure

- ERP is system of record for all technical tags
- One unique ID for each tag throughout all systems, records, and in the field
- Equipment interrelationships defined in system



Use/Location

Subdivision

Change Functional Location: Classification

Object: Functional loc. NBU-A6010-K-102
Description: CMP, EXPANDER / BRAKE K-102
Class Type: 003 Functional Location

Assignments:
Class Description
PE_RO_CO_CE Compressors, centrifugal

Values for Class PE_RO_CO_CE - Object NBU-A6010-K-102

Use/Loc	Concoid	Reference
01	01.01	No Entry
01	01.02	Upstream (E&P)
01	01.03	Drilling rig
01	01.04	Gas processing
01	01.05	Intervention vessel
01	01.06	Oil/gas prod facility (on/off)
02	02.01	Upstream pipeline
02	02.02	Upstream terminal
02	02.03	Midstream
02	02.04	Combined heating + power (CHP)
02	02.05	Gas to liquids (GTL) plant
02	02.06	LNG plant
02	02.07	LPG plant
02	02.08	Midstream pipeline
02	02.09	Midstream terminal
02	02.10	Shipping (LNG, O4)
02	02.11	Storage
03	03.01	Downstream
03	03.02	Downstream gas processing
03	03.03	Downstream pipeline
03	03.04	Downstream shipping
03	03.05	Downstream terminal
04	04.01	Refinery
04	04.02	Petrochemical
04	04.03	Petrochemical complex
04	04.04	Petrochemical shipping
04	04.05	Petrochemical terminal

Functional Location Structure: Structure List

Primary/Parent equipment (green high-light)

Functional loc. NBU-A6010-K-102 Valid From
Description CMP, EXPANDER / BRAKE K-102

Compressor unit boundary: 93 technical tags in total

- 6 NBU-A6010-K-102 CMP, EXPANDER / BRAKE K-102
- 7 NBU-A6010-K-102-03 CONTROL AND MONITORING
- 7 NBU-A6010-K-102-04 LUBRICATION SYSTEM
- 8 NBU-A6010-10FO-267 ELEM, FLW ORIFICE, E-109/110 EXC COOLER
- 8 NBU-A6010-10FDG-278 GAUGE, PRS DIFF, F-101A/B, K-102 EXP CMP
- 8 NBU-A6010-10FDG-279 GAUGE, PRS DIFF, F-101A/B, K-102 EXP CMP
- 8 NBU-A6010-E-109 XCHGR, COOLER E-109
- 8 NBU-A6010-FI-110 XCHGR, COOLER E-110
- 8 NBU-A6010-FI-101A VSL, FILTER FI-101A
- 8 NBU-A6010-FI-101B VSL, FILTER FI-101B
- 8 NBU-A6010-P-106 PMP, LUBE OIL DRAIN P-106
- 8 NBU-A6010-P-107 PMP, LUBE OIL DRAIN P-107
- 8 NBU-A6010-P-108 PMP, LUBE OIL FILLER P-108
- 8 NBU-A6010-S-111 TNK, OIL RESERVOIR S-111
- 8 NBU-A6010-S-113 TNK, OIL STORAGE S-113
- 8 NBU-A6010-S-114 TNK, OIL STORAGE S-114
- 8 NBU-A6010-S-115 TNK, OIL STORAGE S-115
- 7 NBU-A6010-K-102-05 SHAFT SEAL SYSTEM
- 8 NBU-A6010-FI-102A VSL, FILTER FI-102A
- 8 NBU-A6010-FI-102B VSL, FILTER FI-102B
- 8 NBU-A6010-M-102 TURBOEXPANDER, BRAKE COMFR M-102
- 5 NBU-A6010-K-102-SC RELATED SAFETY AND CONTROL

Interrelated equipment (yellow high-light)



Malfunction Reporting

Impart Data Quality on Inception

Step	Details	Responsibility
Work Initiation	Problem Report (equipment-level failure notations)	Facility personnel
Approvals and processing	Work approval, planning and scheduling, create statistical records	Operations Superintendent
Execution, repair notes, and close-out	Repair Report (item-level failure notations)	Maintenance Lead Technician
Failure data quality assurance	QA, consequence assessment , and methods feedback	Reliability Engineer



Malfunction Problem Report (Work Initiation)

Equipment-Level Notations

ISO 14224:2006(E)

9.5 Failure data

A uniform definition of failure and a method of classifying failures are essential when it is necessary to combine data from different sources (plants and operators) in a common RM database.

A common report, as given in Table 6 (see also Table 3), for all equipment classes shall be used for reporting failure data. For some equipment classes, e.g. subsea equipment, minor adaptations can be necessary.

The minimum data needed to meet the objectives of this International Standard are identified by (*). However, the addition of certain other data categories can significantly improve the potential usability of the RM data; see Annex D.

Table 6 — Failure data

Category	Data to be recorded	Description
Identification	Failure record (*)	Unique failure record identification
	Equipment identification/Location (*)	E.g. tag number (see Table 5)
Failure data	Failure date (*)	Date of failure detection (year/month/day)
	Failure mode (*)	Usually at equipment-unit level (level 6) (see B.2.6) ^a
	Failure impact on plant safety (e.g. personnel, environment, assets) ^b	Usually zero, partial or total
	Failure impact on plant operations (e.g. production, drilling, intervention) ^b	Usually zero, partial or total
	Failure impact on equipment function (*)	Effect on equipment-unit function (level 6): critical, degraded, or incipient failure ^c
	Failure mechanism	The physical, chemical or other processes which have led to a failure (see Table B.2)
	Failure cause ^d	The circumstances during design, manufacture or use which have led to a failure (see Table B.3)
	Subunit failed	Name of subunit that failed (see examples in Annex A)
Remarks	Component/Maintainable item(s) failed	Name of the failed maintainable item(s) (see Annex A)
	Detection method	How the failure was detected (see Table B.4)
	Operating condition at failure	Running, start-up, testing, idle, standby
Additional information	Give more details, if available, on the circumstances leading to the failure: failure of redundant units, failure cause(s) etc.	

^a For some equipment categories such as subsea equipment, it is recommended to also record failure modes on taxonomic levels lower than the equipment-unit level.

^b See example of failure consequence classification in Table B.2.

^c For some equipment categories and applications it may be sufficient to record critical and non-critical (degraded + incipient) failures only.

^d The failure cause and sometimes the failure mechanism are not known when the data are collected, as they commonly require a root cause analysis to be performed. Such analysis shall be performed for failures of high consequence, high repair/down time cost, or failures occurring significantly more frequent than what is considered "normal" for this equipment unit class ("worst actors").

(*) Indicates the minimum data that shall be collected.

The screenshot displays the SAP PM Notification: Malfunction Report interface. Key elements include:

- Notification Header:** Notification ID: 80000000001122, Status: OSGO, Date: 12/12/2014.
- Reference Object:** Functional Loc.: NRI-26010-K-102, Equipment: 6000017, Assembly: COMPRESSOR, EXPANDER BRAKE.
- Failure Mode Selection:** A tree view shows failure modes for 'Compressors'. A red box highlights 'Failure Mode' in the Subject field, and a red arrow points to the 'Failure Mode' selection tree.
- Failure Mode Details:** A list of failure modes is shown, including:
 - ATR - Abnormal instrument reading
 - BRD - Breakdown
 - ELF - External leakage process medium
 - ELJ - External leakage utility medium
 - ERG - Erratic output
 - FTS - Fail to start on demand
 - HIO - High output
 - INL - Internal leakage
 - LOO - Low output
 - NOI - Noise
 - ORE - Overheating
 - OTH - Other
 - FDE - Parameter deviation
 - PLJ - Plugged/choked
 - SER - Minor in-service problems
 - STD - Structural deficiency
 - SIF - Fail to stop on demand
 - UNK - Unknown
 - UST - Spurious stop
 - VIB - Vibration
- Methodology-specific glossary text (F1 key):** A pop-up window titled 'Failure Mode (ISO 14224)' provides definitions and SAP functionality for the selected failure mode.
- System checks on notification save:** A red box highlights a list of system checks that must be satisfied before saving the notification, such as 'Condition before malfunction is required' and 'Effect on system operation is required'.



Malfunction Repair Report (Work Close-out)

Component-Level Notations

Change PM Notification: Malfunction Report

Notification: 100000035 Z2 AGA4 TT Suction temperature failed

Notific. Status: ATCO NOPR NOPT ORAS APPR

Order: 200000165

Problem Report | Repair Report | Tasks | Activities | Planning | Documents

Maintainable Items | Root cause | Tasks | Activities

No.	Code gr...	Ma...	Maint. Items	Code gr...	Fail...	Failure Mech	Text	It...	Assembly	AssemblyDescriptn
1	C0000300	0700	Control and monitoring - Sensors	FM000300	3.0	Instrument failure	Gene...replace RTD			

System checks on notification completion

- Malfunction end date is required.
- Failure mechanism is required.
- Maintainable Item is required.
- Corrective maintenance activity is required.
- Root cause is required.

Equipment subdivision

- Maint. Items Maintainable Items
 - CO000100 Power transmission -
 - CO000200 Compressor -
 - CO000300 Control and monitoring -
 - 0001 No detail
 - 0100 Actuating device
 - 0200 Control unit
 - 0300 Cables and junction boxes
 - 0400 Valves
 - 0500 Internal power supply
 - 0600 Monitoring
 - 0700 **Sensors**
 - 0800 Valves
 - 0900 Wiring
 - 1000 Piping
 - 1100 Seals
 - CO000400 Lubrication system -
 - CO000500 Shaft seal system -
 - CO009900 Miscellaneous -

Failure Mechanism

- Failure Mech Failure Mechanism
 - FM000100 Mechanical failure -
 - FM000200 Material failure -
 - FM000300 Instrument failure -
 - 3.0 General
 - 3.1 Control failure
 - 3.2 No signal/indication/alarm
 - 3.3 Faulty signal/indication/alarm
 - 3.4 Out of adjustment
 - 3.5 Software failure
 - 3.6 Common cause/mode failure
 - FM000400 Electrical failure -
 - FM000500 External influence -
 - FM000600 Miscellaneous -

Display Long Text

INSTRUMENT FAILURE

3.0 GENERAL: failure related to instrumentation, but no d known.

3.1 CONTROL FAILURE: no, or faulty, regulation

3.2 NO SIGNAL/INDICATION/ALARM: no signal/indication/alar expected.

3.3 FAULTY SIGNAL/INDICATION/ALARM: signal/indication/ala wrong in relation to actual process. could be spurious, intermittent, oscillating, arbitrary

3.4 OUT OF ADJUSTMENT: calibration error, parameter drift

3.5 SOFTWARE FAILURE: faulty or no control/monitoring/ope due to software failure.

3.6 COMMON CAUSE/MODE FAILURE: several instrument items f simultaneously, e.g. redundant fire and gas detectors. al



Failure Data Quality Assurance

Failure Event Review

Set User Status

User Status with Status Number

X	N...	St...	StatusText
<input type="radio"/>	10	APRQ	Notification approval req
<input type="radio"/>	20	RJCT	Notification rejected
<input checked="" type="radio"/>	30	APPR	Notification approved
<input type="radio"/>	40	QARF	QA review in progress
<input type="radio"/>	50	QARC	QA review complete

User Status Without Status Number

X	St...	StatusText
<input type="checkbox"/>	AWIN	Awaiting Information
<input type="checkbox"/>	FDCP	Field data input complete
<input type="checkbox"/>	WAR1	Warranty claim initiated
<input type="checkbox"/>	WAR2	Warranty claim settled
<input type="checkbox"/>	QAEX	Exclude from ER database

Catalog Selection

- Task
 - MIDA0100 Data administration
 - MIMF0100 Malfunction follow-up
 - MIPM0100 Prev. Maint follow-up
 - MTQA0100 Malf. Report QA
 - 1.1 Failure details needed
 - 1.2 Training/Realignment needed
 - 1.3 Process documentation needed
 - 1.9 Other

ISO 14224:2006(E)

n) Make a plan for quality assurance of the data-collection process and its deliverables. This shall, as a minimum, include procedures for quality control of the data and recording and correcting deviations. This verification of data quality shall be documented and may vary depending on whether the data collection is for a single plant or involves several company or industry facilities. When merging individual databases, it is imperative that each data record have a unique identification.

o) It is recommended to carry out a cost-benefit analysis of the data collection by running a pilot exercise before the main data-collection phase is started and to revise the plan if necessary.

p) Review the planning measures after a period of using the system (see 7.2.3).

7.1.3 Verification of quality

During and after the data-collection exercise, analyse the data to verify consistency, reasonable distributions, proper codes and correct interpretations in accordance with the planning measures (see 7.1.2). This verification-of-quality process shall be documented and may vary depending on whether the data collection is for a single plant or involves several company or industry facilities. When merging individual databases, it is imperative that each data record have a unique identification.

Assess the quality of data being collected as early as feasible in the data-collection process in accordance with the planning measures (see 7.1.2). A suitable procedure is an assessment by the data collector, who shall be provided with guidelines for what quality measures he/she should focus on in accordance with the planning measures. The main objective of this early assessment is to look for any problems that can require the planning measures to be immediately revised to avoid unacceptable data being collected.

Personnel other than those having collected the data shall verify the quality of each individual data record and the overall reliability pattern reflected by the sum of individual events in accordance with the planning measures (see 7.1.2).

Consequence Assessment

Change PM Notification: Classification

Object: Notification 10000560 Item number 1 Outer race bent
 Class Type 015 Message item

Values for Class PE_ME_WI - Object 10000560 0001

General

Characteristic Description	Value
Consequences of failure	Consequences of failure
Equipment/Area affected	
Facility downtime	

Value Hierarchy for Char. Consequences of failure

- Consequences of failure
 - E Environment
 - O Operations
 - O1 Operations catastrophic
 - O2 Operations severe
 - O3 Operations moderate
 - O4 Operations minimal
 - O5 Operations negligible
 - P Production
 - P1 Production catastrophic
 - P2 Production severe
 - P3 Production moderate
 - P31 Production loss < US\$250K
 - P4 Production minimal
 - P5 Production negligible
 - S Safety

Table C.1 — Failure-consequence classification

Consequences	Category			
	Catastrophic Failure that results in death or system loss	Severe Severe injury, illness or major system damage (e.g. < USD 1 000 000)	Moderate Minor injury, illness or system damage (e.g. < USD 250 000)	Minor Less than minor injury, illness or system damage (e.g. < USD 50 000)
Safety	I — Loss of lives — Vital safety-critical systems inoperable	V — Serious personnel injury — Potential for loss of safety functions	IX — Injuries requiring medical treatment — Limited effect on safety functions	XIII — Injuries not requiring medical treatment — Minor effect on safety function
Environmental	II Major pollution	VI Significant pollution	X Some pollution	XXV No, or negligible, pollution
Production	III Extensive stop in production/operation	VII Production stop above acceptable limit #	XI Production stop below acceptable limit #	XV Production stop minor
Operational	IV Very high maintenance cost	VIII Maintenance cost above normal acceptable #	XII Maintenance cost at or below normal acceptable #	XVII Low maintenance cost

It is necessary to define acceptable limits for each application.



Data Aggregation

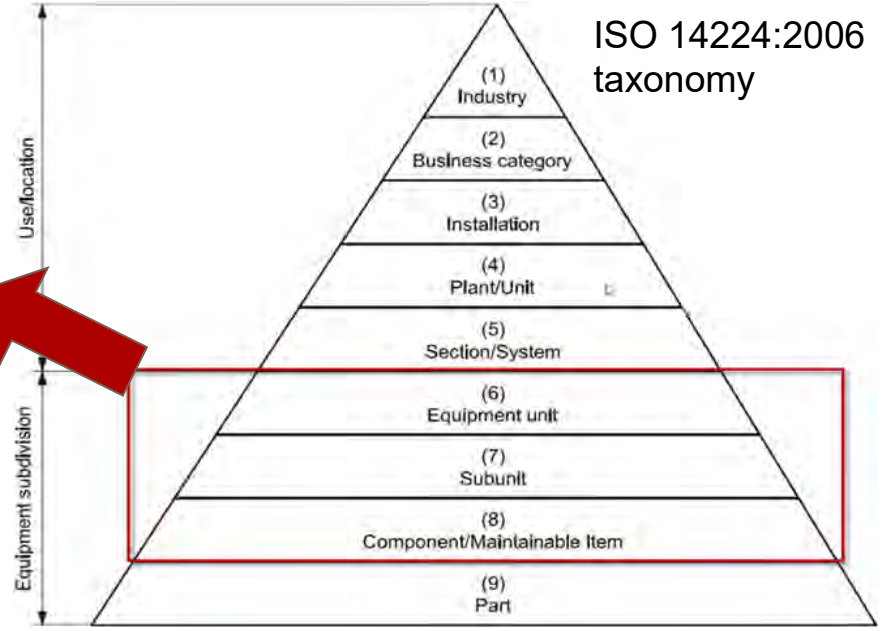
Functional Location Structure: Structure List

Primary/Parent equipment (green high-light)

Compressor unit boundary: 93 technical tags in total

Functional loc.	NBU-A6010-K-102	Valid Fro
Description	CMP, EXPANDER / BRAKE K-102	
6 NBU-A6010-K-102	CMP, EXPANDER / BRAKE K-102	
7 NBU-A6010-K-102-03	CONTROL AND MONITORING	
7 NBU-A6010-K-102-04	LUBRICATION SYSTEM	
8 NBU-A6010-10FO-267	ELEM, FLW ORIFICE, E-109/110 EXC COOLER	
8 NBU-A6010-10PDG-278	GAUGE, PRS DIFF, F-101A/B, K-102 EXP CMP	
8 NBU-A6010-10PDG-279	GAUGE, PRS DIFF, F-101A/B, K-102 EXP CMP	
8 NBU-A6010-E-109	XCHGR, COOLER E-109	
8 NBU-A6010-E-110	XCHGR, COOLER E-110	
8 NBU-A6010-FI-101A	VSL, FILTER FI-101A	
8 NBU-A6010-FI-101B	VSL, FILTER FI-101B	
8 NBU-A6010-P-106	PMP, LUBE OIL DRAIN P-106	
8 NBU-A6010-P-107	PMP, LUBE OIL DRAIN P-107	
8 NBU-A6010-P-108	PMP, LUBE OIL FILLER P-108	
8 NBU-A6010-S-111	TNK, OIL RESERVOIR S-111	
8 NBU-A6010-S-113	TNK, OIL STORAGE S-113	
8 NBU-A6010-S-114	TNK, OIL STORAGE S-114	
8 NBU-A6010-S-115	TNK, OIL STORAGE S-115	
7 NBU-A6010-K-102-05	SHAFT SEAL SYSTEM	
8 NBU-A6010-FI-102A	VSL, FILTER FI-102A	
8 NBU-A6010-FI-102B	VSL, FILTER FI-102B	
6 NBU-A6010-M-102	TURBOEXPANDER, BRAKE COMP M-102	
5 NBU-A6010-K-102-SC	RELATED SAFETY AND CONTROL	

K-102 technical structure



Interrelated equipment (yellow high-light)

Display Notifications: List of Notifications

FEL notifications are auto-generated at the equipment level when the initial "native notification is generated at a component level. These system-generated statistical notifications enable TRUE equipment-level failure metrics with standard SAP reporting.

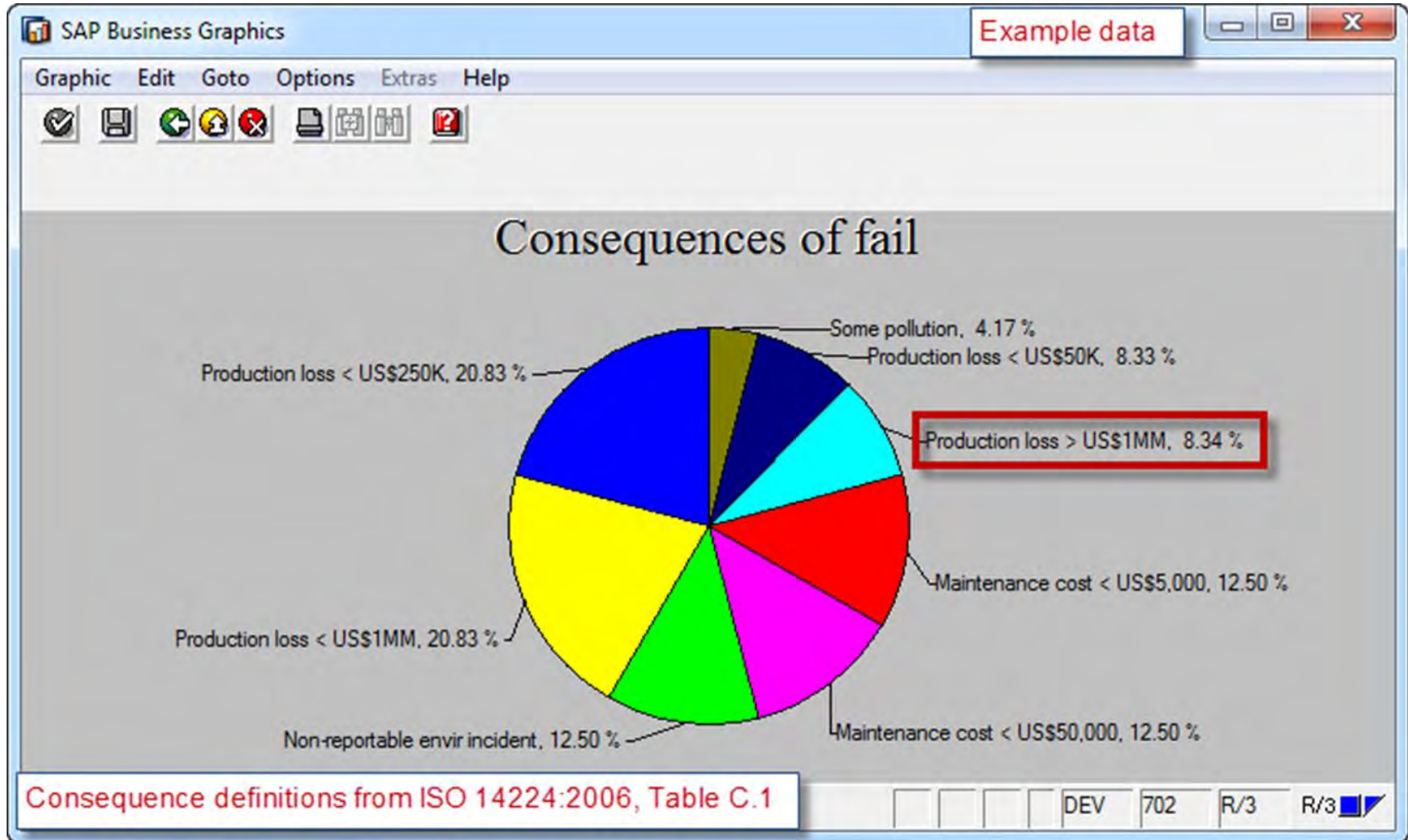
Typ	P	Notification	Description	Functional Loc.	Description of functional location	Malfuncnt. start	MalfStrt	E	CBM	B	Downtime	Unit
Z2	2	100000031	AGA4 TT Suction Temperature	NBU-A6010-K-102	CMP, EXPANDER / BRAKE K-102	2015.02.10	14:20:37	2	1		0.00	H
Z2	1	100000035	AGA4 TT Suction temperature failed	NBU-A6010-K-102	CMP, EXPANDER / BRAKE K-102	2015.02.10	07:49:38	3	1	X	424.17	H
Z5	3	100000113	PRB:LUBRICATION SYSTEM	NBU-A6010-K-102	CMP, EXPANDER / BRAKE K-102	2015.02.13	10:57:20	2	1		0.00	H
Z5	3	100000495	PRB:LUBRICATION SYSTEM	NBU-A6010-K-102	CMP, EXPANDER / BRAKE K-102	2015.04.17	09:25:37	2	1		0.00	H
Z5	3	100000508	PRB:LUBRICATION SYSTEM	NBU-A6010-K-102	CMP, EXPANDER / BRAKE K-102	2015.04.20	09:16:05	1	1		0.00	H
Z5	3	100000660	PRB:LUBRICATION SYSTEM	NBU-A6010-K-102	CMP, EXPANDER / BRAKE K-102	2015.05.21	20:20:54	2	1		0.00	H
Z5	5	100000807	PRB:LUBRICATION SYSTEM	NBU-A6010-K-102	CMP, EXPANDER / BRAKE K-102	2015.06.23	09:03:47	2	1		0.00	H
Z5	5	100000808	PRB:LUBRICATION SYSTEM	NBU-A6010-K-102	CMP, EXPANDER / BRAKE K-102	2015.06.23	09:07:57	2	1		0.00	H
Z5	3	100000925	PRB:LUBRICATION SYSTEM	NBU-A6010-K-102	CMP, EXPANDER / BRAKE K-102	2015.07.20	11:47:00	1	1		0.00	H
Z5	4	100000983	PRB:LUBRICATION SYSTEM	NBU-A6010-K-102	CMP, EXPANDER / BRAKE K-102	2015.07.30	13:41:46	1	1		0.00	H

K-102 aggregated failure data



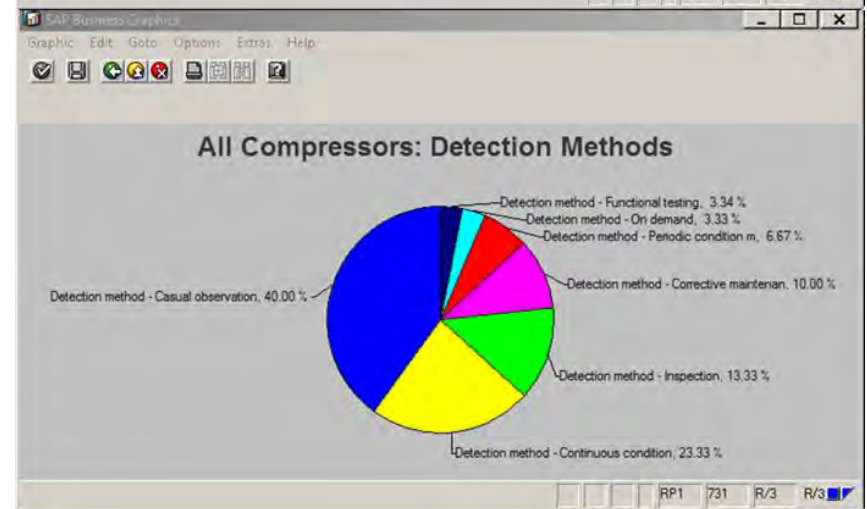
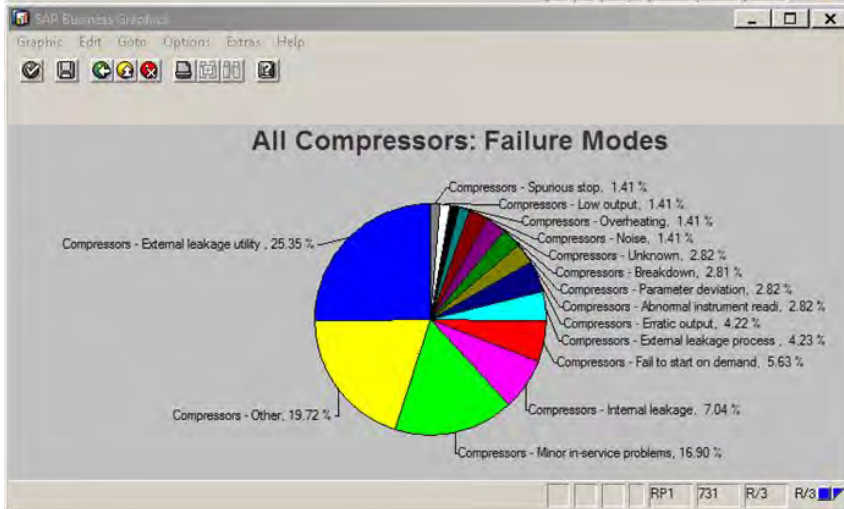
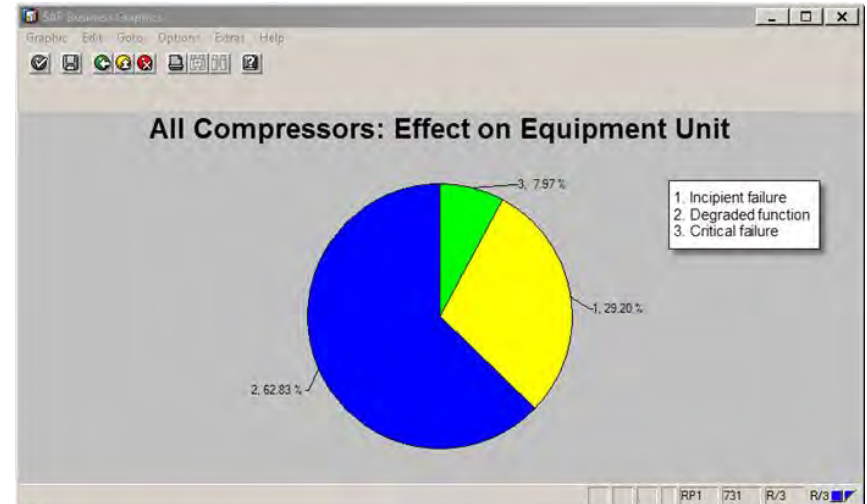
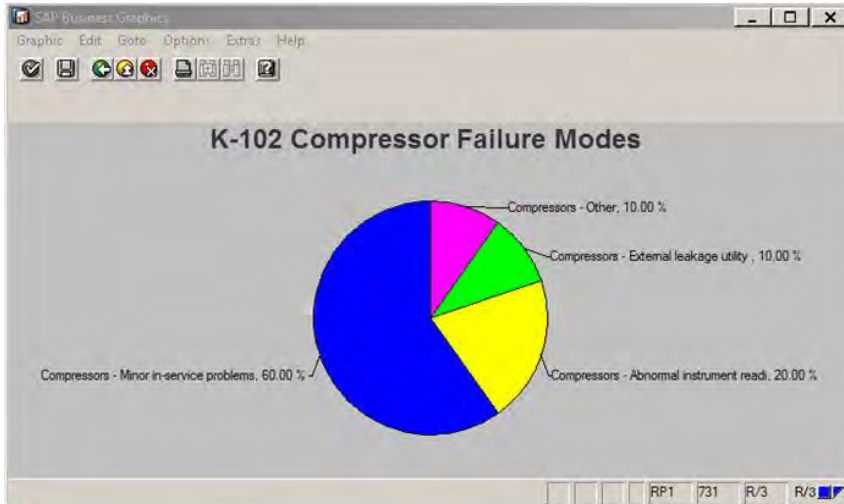
Consequence Accounting

Where is your pain?



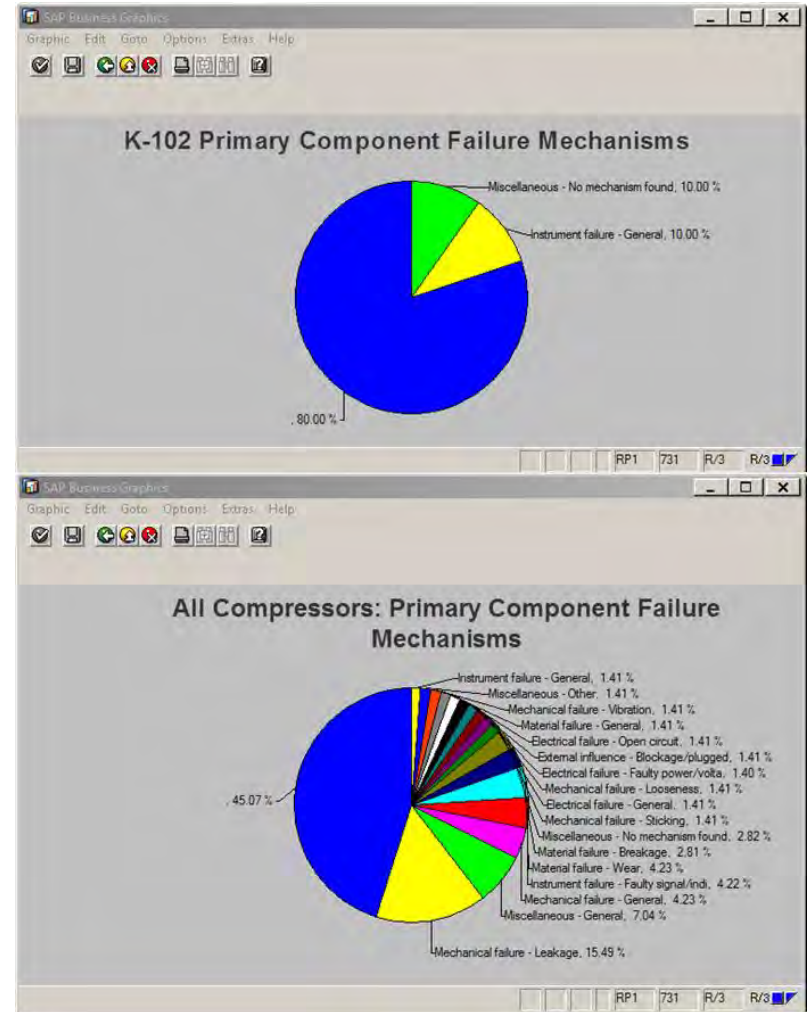
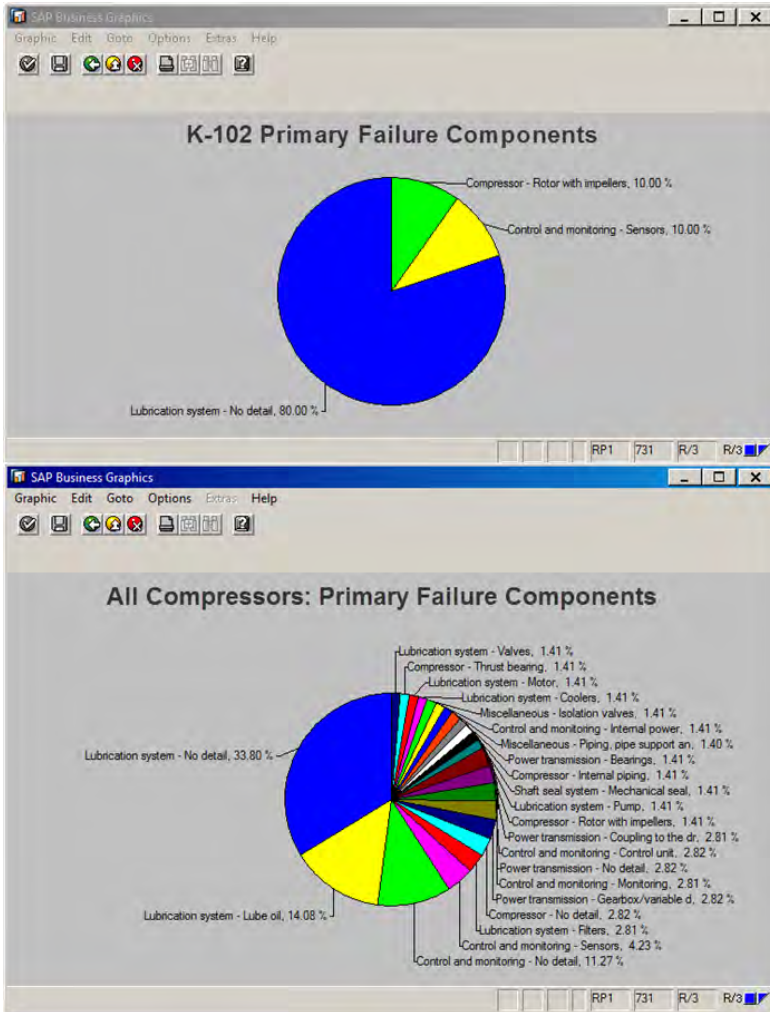


Equipment-Level Analysis



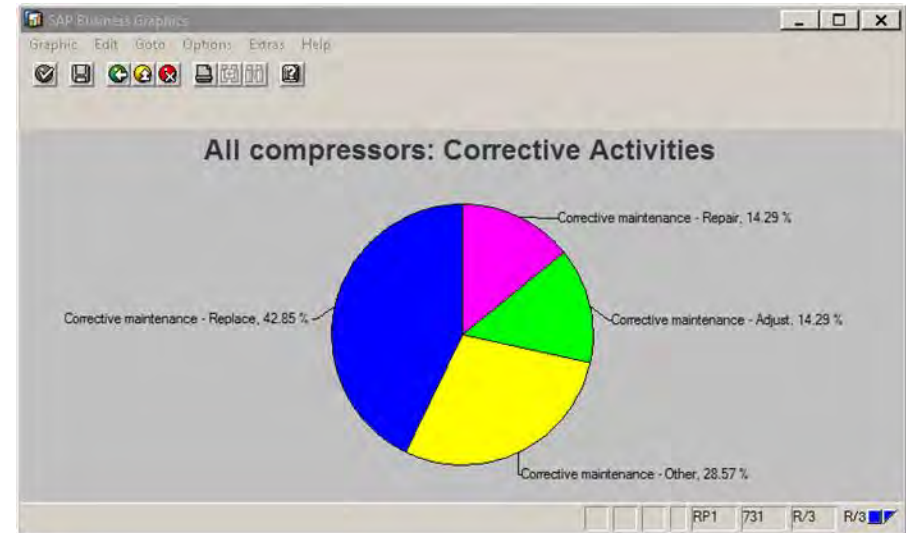
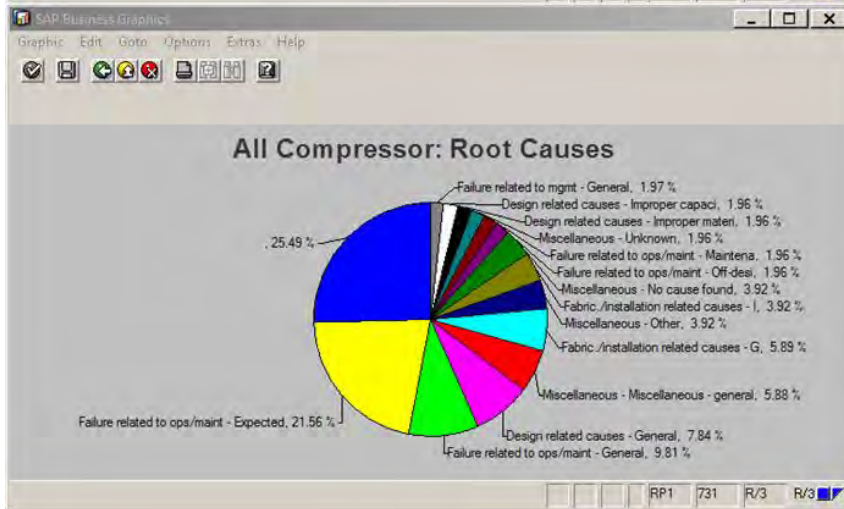
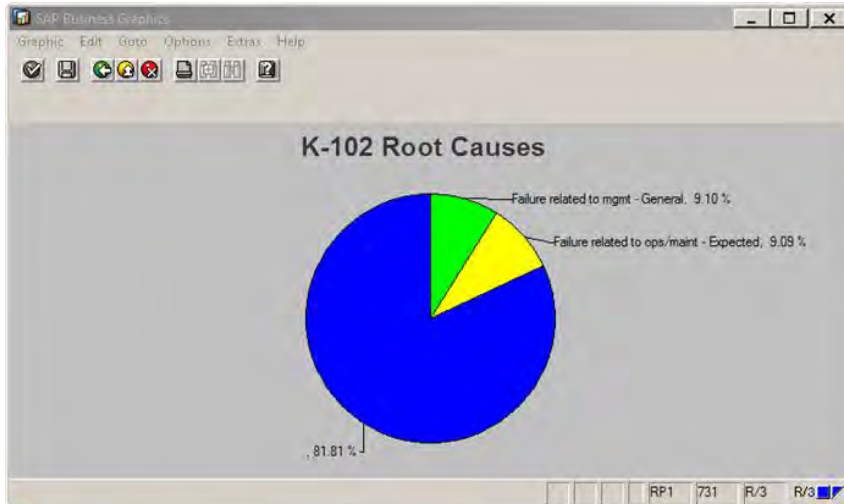


Component-Level Analysis





Component-Level Analysis





Industry Sector

- Oil and gas drilling and FPSO services

Scope

- ISO 14224 Taxonomy and failure reporting
- Maximo for Oil and Gas

Facilities (offshore drilling)

- Brava Star
- Amaralina Star
- Laguna Star
- Lone Star
- Gold Star
- Alpha Star
- Olinda Star
- Atlantic Star
- Alaskan Star



Thiago Amato

Corporate Asset Integrity Engineer | QGOG

- BS in Mechanical Engineering, State University of Rio de Janeiro, 2005
- MBA in Maintenance Management, Federal University of Rio de Janeiro, 2008
- MBA in Project Management, FGV, 2015
- Eleven years as maintenance and reliability engineer in the oil and gas sector, including Sparrows BSM, National Oilwell Varco, and Archer the Well Company
- Role with QGOG
 - Corporate maintenance expert and advisor
 - Best practice evaluation and implementation
 - Ops and Maintenance setup for new builds
 - Maintenance process reviews
 - Represent QGOG in rig audits



QGOG Taxonomy Construction

FL Category	FL Type	Description	Source (Basis and/or Standard Practice)
0	FAL	Enterprise	
1	FAL	Business Area	Onshore/Offshore
2	FAL	Rig ID	Rig ID
3	FAL	SFI Main Group	Xantic SFI Group System: N
4	FAL	SFI Group	Xantic SFI Group System: NN
5	FAL	SFI Subgroup	Xantic SFI Group System: NNN
6	FEL	ISO 14224 Equipment	Convention: [Rig ID]-[Tag number]
7	FAL	ISO 14224 Subunit	Convention: [Rig ID]-[Level 6 Tag number]-[SU]
8	FCL	ISO 14224 Maintainable Item	Convention: [Rig ID]-[Tag number]
U	FAL	Unstructured Equipment	
C	FAL	Collective failure reporting	
G	FAL	Generic Grouping Level	

Legend

1. N = numeric character
2. SU = Two-character Subunit ID
3. [Tag number] = engineering/technical tag for equipment or group



Equipment Taxonomy Example: Subsea BOP

- Integrates Xantic SFI, ISO 14224-standards into one coherent taxonomy
- All engineering tags are represented with functional and materialized master records
- Engineering tags are structured to match ISO 14424 equipment subdivision

Table A.94 — Equipment subdivision — Blowout preventer (BOP)

Equipment unit	Blowout preventer (BOP)				
Subunit	Preventers, valves and lines	Hydraulic connectors	Flexible joint (subsea BOP)	Control system	Backup control system
Maintainable items	Annular preventers	LMRP and wellhead connector	Flexible element	Subsea	Subsea
	Body	Body	Housing	Pod stingers	Solenoid valves
	Flanges		Flanges	Pilot valves	Pilot valves
	Packing element	Locking mechanism		Shuttle valves	Shuttle valves
	Hydraulic piston	Piston		Accumulators	Accumulators
	Seals	Main-bore seal ring		Pressure regulator valves	Subsea control unit
	Ram preventers			Hydraulic control fluid	Battery
	Body	Seals		Seals	Transducers
	Flanges			Piping	Surface
	Ram block			Hydraulic bundles (pilot lines and main supply)	Surface control unit
	Ram seals			Multiplex cables	Transducers
	Shear blade			Rigid hydraulic supply line	
	Piston			Surface	
	Seals			Control panels	
	Kill-and-choke valves			Surface control unit	
	Actuator			Hydraulic power unit	
	Gooseneck house			Pod reels	
	Gate			Pod selector valve	
	Seals				
	Kill-and-choke lines				
	Riser-attached line				
	Couplers				
	Seals				

Functional Location Structure: Structure List			
Functional loc.	BVS-3D3101	Valid From	01/26/2016
Description	BOP COMPLETE UNIT		
6 BVS-3D3101	BOP COMPLETE UNIT	Primary Equipment	
7 BVS-3D3101-04	PRIMARY CONTROL SYSTEM (SURFACE)		
8 BVS-3D32206	BOP HYD.POWER UNIT & FLUID MIX SYS		
8 BVS-3D32209	TEST HPU FOR ADDITIONAL BOP		
8 BVS-3D32301	BOP POD TEST STAND		
8 BVS-3D32715	BOP HIGH PRESSURE TEST UNIT		
7 BVS-3D3101-05	BACKUP CONTROL SYSTEM		
G BVS-3D3101-SC-001	BACK UP SYSTEM - EHBS POD - GROUP		
G BVS-3D3101-SC-002	BACK UP SYSTEM - ACOUSTIC POD -GROUP		
G BVS-3D3101-IP-001	PRESSURE SWITCHES - GROUP		
G BVS-3D3101-ME-011	PRESSURE GAUGES - GROUP		
G BVS-3D3101-VA-566	VALVES, SPM - GROUP		
G BVS-3D3101-VA-577	CCSV - GROUP		
G BVS-3D3101-VA-578	CHECK VALVES - GROUP		
G BVS-3D3101-VA-579	PILOT OPERATED CONTROL VALVES - GROUP		
G BVS-3D3101-VA-580	RELIEF VALVES - GROUP		
G BVS-3D3101-VA-581	REGULATOR VALVE - GROUP		
G BVS-3D3101-VE-055	ACUMULATORS - GROUP		
G BVS-3D3101-BP-001	BOP STACK #1, INCL. LMRP, CONNS, FLEX JT		
7 BVS-3D3101-01	PREVENTERS, VALVES AND LINES		
8 BVS-3D31100	BOP STACK #1, INCLUDING LMRP		
8 BVS-3D31100-AP-000	LOWER MARINE RISER PACKAGE #1		
8 BVS-3D31100-IP-005	SENSOR, TEMPERATURE/PRESSURE ASSY, LMRP#1		
8 BVS-3D31100-IP-006	SENSOR, INCLINOMETER (DUAL AXIS), LMRP#1		
G BVS-3D31100-VA-453	VALVES, LMRP #1 - GROUP		
8 BVS-3D31100-ME-001	ADAPTER, RISER TYPE FT-HB, BOP #1		
8 BVS-3D31100-AP-001	ANNULAR, UPPER, BLOWOUT PREVENTER #1		
8 BVS-3D31100-AP-002	ANNULAR, LOWER, BLOWOUT PREVENTER #1		
8 BVS-3D31100-PI-001	PIPING, CHOKE FLEX LOOP PIPING, BOP #1		
8 BVS-3D31100-PI-002	PIPING, KILL FLEX LOOP PIPING, BOP #1		
8 BVS-3D31100-SH-001	HOSE, RIGID CONDUIT "A" FLEX HOSE, BOP		
8 BVS-3D31100-SH-002	HOSE, RIGID CONDUIT "B" FLEX HOSE, BOP		
8 BVS-3D31100-RP-000	LOWER BOP STACK 18 3/4" 15K #1		
7 BVS-3D3101-02	HYDRAULIC CONNECTORS		
7 BVS-3D3101-03	FLEXIBLE JOINT		
7 BVS-3D3101-04S	PRIMARY CONTROL SYSTEM (SUBSEA)		
G BVS-3D3101-BP-002	BOP STACK #2, INCL. LMRP, CONNS, FLEX JT		
7 BVS-3D3102-01	PREVENTERS, VALVES AND LINES		
7 BVS-3D3102-02	HYDRAULIC CONNECTORS		
7 BVS-3D3102-03	FLEXIBLE JOINT		
7 BVS-3D3102-04	PRIMARY CONTROL SYSTEM (SUBSEA)		

Unit boundary



Maximo Malfunction Report

Detalhes de Falhas

Classe de Falha: Observações:
Data da Falha: Data da Observação:

Relatório de Falha no Nível de Componente

Subunidade/Código do Componente:
Comentários da Subunidade/Componente:
Código do Item/Parte Passível de Manutenção:
Comentários do Item/Parte Passível de Manutenção:

Mecanismo de Falha ISO 14224

Código do Mecanismo de Falha:
Comentários do Mecanismo de Falha:
Código da Subdivisão do Mecanismo de Falha:
Comentários de Subdivisão do Mecanismo de Falha:

Falhas no Sistema Relacionadas à Segurança

Categoria de Falha de Segurança:
Modo de Falha do Hardware:
Falha do Elemento Crítico de Segurança?
Elemento Crítico de Segurança:
Fail-Fix?
Mitigação Necessária?
Falha de Causa Comum?

Detecção e Identificação de Falha

Método de Detecção:
Falha de Barreira:
Método de Detecção de Falha de Barreira:

Códigos de Falha 0 - 0 de 0

Tipo	Código de Falha	Descrição
Não há linhas para exibir...		



Technical tags

- Tag lists provided by manufacturer were incomplete
- Many process items were not tagged

MAXIMO O&G

- Load extra failure class into MAXIMO
- Maintainable item is a free text

Translating to Portuguese

- All FL were translated to Portuguese
- All failure classes were translated to Portuguese

Quality Assurance on data reporting

- Old school technicians, need training
- Data recovery program



Results - Brava Star

Brava Star has over them 8,000 FL already in place

- The Taxonomy structure process is on going on the other rigs
- With extended content, over 80 equipment class definitions
- Every technical tag (assets) has a class ID assigned (5,331 tags)
- 200 failures class into MAXIMO O&G

The hierarchy gives flexibility in evaluating failure rates at any point in the structure

- E.g., component, equipment or process level

To ensure data quality:

- QGOG started a training program and developed MAXIMO workflows to ensure information being fed into the system
- Failure data QA being done by Asset Integrity Engineer

- [-] BVS-30:TORRE COM COMPONENTES / DERRICK WITH COMPONENTS
- [-] BVS-31:EQUIPAMENTOS E SISTEMAS DO PISO DE PERFURACAO / DRILL FLOOR EQ
 - [+] BVS-311:CONTROLE DE PERFURACAO / DRILLING CONTROL
 - [+] BVS-312:GUINCHO DE PERFURACAO & MAQUINAS / DRAWWORKS & MACHINERY
 - [-] BVS-313:MESA ROTATIVA, TOP DRIVE E EQUIPAMENTOS ASSOCIADOS / ROTARY
 - [+] BVS-3D13110A:MESA ROTATIVA PRINCIPAL (RST-755) / ROTARY TABLE MAIN. (F
 - [+] BVS-3D13110B:MESA ROTATIVA AUXILIAR (RST-605) / ROTARY TABLE AUX. (RS'
- [-] BVS-3D135A:TOP DRIVE PRINCIPAL / TOP DRIVE MAIN
 - [+] BVS-3D135A-01:MOTORES / DRIVERS
 - [-] BVS-3D135A-02:ENGRENAGEM / GEAR
 - [+] BVS-3D135A-GB-001:ENGRENAGEM, TOP DRIVE PRINCIPAL / GEAR, TOP DRIVE M
 - [+] BVS-3D135A-03:SWIVEL ROTATIVO / ROTARY SWIVEL
 - [-] BVS-3D135A-04:CONJUNTO DE MANUSEIO DE TUBOS / PIPE-HANDLER ASSY
 - [+] BVS-3D135A-PH-001:CONJUNTO DO MANUSEADOR DE TUBOS DE PERFURACAO
 - [-] BVS-3D135A-06:CONTROLE E MONITORAMENTO / CONTROL AND MONITORING

Classes de Falhas Filtro 61 - 80 de 245

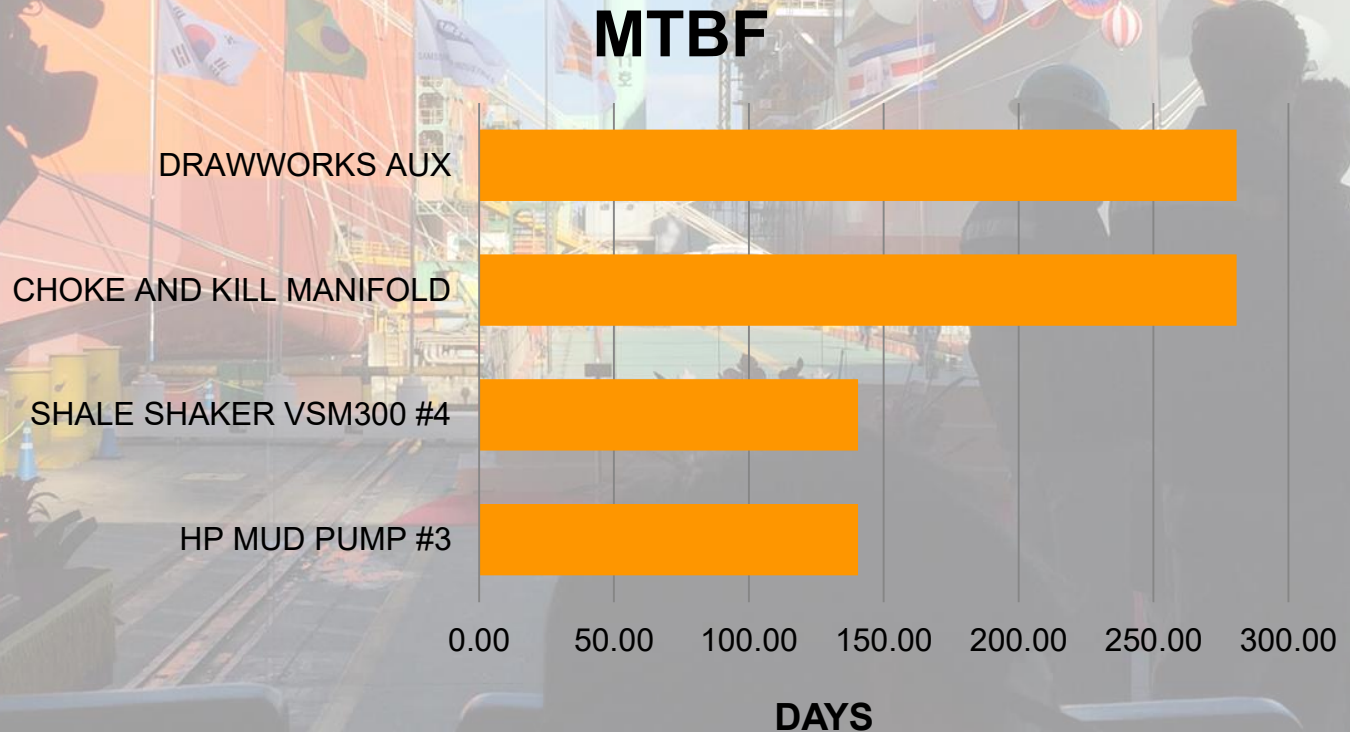
Classe de Falha	Descrição
VEPT	Vessels - Pig trap
TECE	Turboexpanders - Centrifugal
VAGA	Valves - Gate
CSTH	Subsea-production-control systems - Telemetric hydraulic



Benefits

QGOG starts collect the benefits

- Base for the root cause analysis process (process being improved)
- Base to KPIs, like MTTR, Availability, WO compliance
- Mapping the unreliable assets (MTBF)





Thank you all for attending

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**Reliability
Dynamics**

Supplementary Content



Equipment Downtime

ID	Failure mode	Failure date	Loss time	Equipment
INL1	Internal leakage	12/12/2015	01:00	HP MUD PUMP #3
INL1	Internal leakage	20/12/2015	03:00	HP MUD PUMP #3
PLU	Vibration	21/12/2015	01:00	SHALE SHAKER VSM300 #4
PLU	Plugged/choked	30/12/2015	01:00	SHALE SHAKER VSM300 #4
INL1	Internal leakage	22/09/2015	06:00	CHOKE AND KILL MANIFOLD
LOO	Low output	27/12/2015	04:30	DRAWWORKS AUX



Nexen Long Lake Technical Structure

Functional loc.	LLAK-8400	Administrative levels
Description	STEAM GENERATION	
3 LLAk-S101		LONG LAKE CENTRAL PROCESSING FACILITY
4 LLAk-8000		SAGD CENTRAL PLANT
4 LLAk-8100		INLET TREATING
4 LLAk-8200		DE-OILING
4 LLAk-8300		WATER TREATMENT SYSTEM
4 LLAk-8400		STEAM GENERATION
5 LLAk-8400-BG		BUILDINGS
5 LLAk-8400-CL		CONTROL UNITS
5 LLAk-8400-CR		CRANES, HOISTS, AND MONORAILS
5 LLAk-8400-FG		FIRE AND GAS DETECTORS
5 LLAk-8400-HB		OTSG STEAM GENERATORS
5 LLAk-8400-HE		EXCHANGERS
5 LLAk-8400-HT		HEAT TRACING
5 LLAk-8400-LI		LIGHTING
5 LLAk-8400-PD		POWER DISTRIBUTION
5 LLAk-8400-PI		8400 PIPING BY COMMODITY
5 LLAk-8400-PU		PUMPS
5 LLAk-8400-P-001		LP BFW BOOSTER PUMPS
5 LLAk-8400-P-002		HP BFW PUMPS
6 LLAk-8400-P-002-A		HP BFW PUMP A
6 LLAk-8400-P-002-B		HP BFW PUMP B
6 LLAk-8400-P-002-C		HP BFW PUMP C
6 LLAk-8400-P-002-D		HP BFW PUMP D
6 LLAk-8400-P-002-E		HP BFW PUMP E
5 LLAk-8400-P-008		STEAM CONDENSATE PUMPS
5 LLAk-8400-P-015		STEAM CONDENSATE PUMPS
5 LLAk-8400-PU-BG-001		BG-001 PUMPS
5 LLAk-8400-PU-BG-006		BG-006 PUMPS
5 LLAk-8400-PU-CH		CHEMICAL TREATMENT PUMPS
5 LLAk-8400-SY		STEAM TRAPS
5 LLAk-8400-TK		TANKS
5 LLAk-8400-TL		TELECOMM
5 LLAk-8400-UP		UPS
5 LLAk-8400-VE		PRESSURE VESSELS
4 LLAk-8500		PRODUCED GAS HANDLING
4 LLAk-8600		TANK FARM
4 LLAk-8700		UTILITIES
4 LLAk-8900		CO-GENERATION

Functional loc.	LLAK-8400-P-002-E	Equipment unit
Description	HP BFW PUMP E	
6 LLAk-8400-P-002-E		HP BFW PUMP E
7 LLAk-8400-P-002-E-02		PUMP UNIT
7 LLAk-8400-P-002-E-03		CONTROL AND MONITORING
5 LLAk-8400-CM-201		8400-P-002-E HP BFW SUCTION HEADER
5 LLAk-8425-CM-200		8400-P-002-E HP BFW PUMP SUCTION
8 LLAk-8425-FE-200		METER, FLOW
8 LLAk-8425-FII-200		TRANSMITTER, FLOW
8 LLAk-8425-FV-200		VALVE, FLOW, MODULATING
8 LLAk-8425-PIT-200		TRANSMITTER, PRESSURE INDICATING
5 LLAk-8425-CM-201		8400-P-002-E HP BFW PUMP SUCTION
5 LLAk-8425-CM-202		8400-P-002-E HP BFW PUMP DISCHARGE
5 LLAk-8425-CM-203		8400-P-002-E HP BFW PUMP WARM-UP
5 LLAk-8425-CM-210		8400-P-002-E HP BFW MOTOR BEARING MACHINE
5 LLAk-8425-CM-211		8400-P-002-E HP BFW PHASE W MOTOR MONITOR
5 LLAk-8425-CM-212		8400-P-002-E HP BFW MOTOR FILTER DIFFERE
5 LLAk-8425-CM-213		8400-P-002-E HP BFW PUMP
5 LLAk-8425-CM-214		8400-P-002-E HP BFW MOTOR BEARING OIL TO
5 LLAk-8425-CM-215		8400-P-002-E HP BFW PUMP QUENCH WATER
5 LLAk-8425-CM-216		8400-P-002-E HP BFW PUMP QUENCH WATER
5 LLAk-8425-CM-217		8400-P-002-E HP BFW PUMP BEARING OIL TO
5 LLAk-8425-CM-218		8400-P-002-E HP BFW PUMP BEARING OIL TO
5 LLAk-8425-CM-219		8400-P-002-E HP BFW PUMP MOTOR BEARINGS
5 LLAk-8425-CM-221		8400-P-002-E COOLING MEDIUM RETURN
5 LLAk-8425-CM-222		8400-P-002-E COOLING MEDIUM RETURN
7 LLAk-8400-P-002-E-04		LUBRICATION SYSTEM
8 LLAk-8400-E-010-E		COOLER, OIL (HP BFW PUMP LUBE)
8 LLAk-8400-F-001-E		FILTER, HP BFW PUMP OIL
8 LLAk-8400-P-004-E		PUMP, MAIN HP BFW PUMP LUBE OIL
8 LLAk-8400-P-005-E		PUMP, AUXILIARY HP BFW PUMP LUBE OIL
8 LLAk-8400-RS-001-E		RESERVOIR-LUBE OIL-BFW PUMP E
5 LLAk-8425-CM-207		8400-P-005-E HP BFW LUBE OIL
6 LLAk-8400-P-002-E-M		MOTOR, HP BFW PUMP E



Taxonomy Index Page

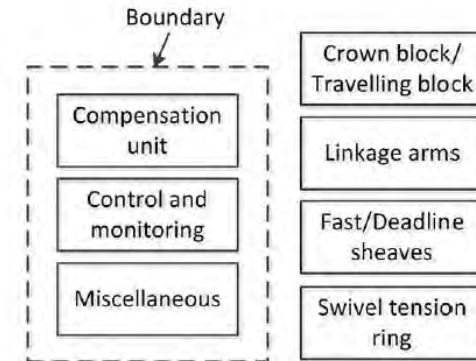
DR	Drilling equipment	
DR_CE	Cementing equipment	No subdivision
DR_DH	Drilling downhole equipment	13
DR_DH_DC	Drill collars	
DR_DH_DS	Drill string and downhole equipment	
DR_DH_DX	Drill pipe	
DR_DH_SB	Stabilizers	
DR_DH_SU	Drill string subs	
DR_FI	Fishing tools	30
DR_FI_AC	Accessory tools	
DR_FI_EF	External catch fishing tools	
DR_FI_IF	Internal catch fishing tools	
DR_FI_JF	Junk retrieval fishing tools	
DR_FI_MI	Milling and cutting tools	
DR_FI_RE	Repair and remedial tools	
DR_MD	Mud equipment	49
DR_MD_AS	Mud additive skids	
DR_MD_DS	Desanders/Desilters	
DR_MD_MS	Shale shakers	
DR_MD_MT	Mud tanks/pits	
DR_ME	Drilling mechanical equipment	69
DR_ME_BC	BOP/Subsea tree carriers	
DR_ME_CB	Crown and travelling blocks	
DR_ME_DK	Derricks	
DR_ME_DR	Drilling and completion risers	
DR_ME_DV	Diverter	
DR_ME_DW	Drawworks	
DR_ME_EL	Elevators	
DR_ME_GS	BOP over/under-hull guidance systems	
DR_ME_HC	Hydraulic catheads	
DR_ME_IR	Iron roughnecks	
DR_ME_MC	Motion compensators	
DR_ME_MF	Drilling manifolds	
DR_ME_MH	Drilling mouse holes (Fox holes)	
DR_ME_PH	Pipe handling machines	



Equipment Class: Motion compensators

Taxonomy ID: DR_ME_MC

Class Types	Taxonomy ID
Active heave system	DR_ME_MC_AH
Motion compensators, conductor tensioner	DR_ME_MC_CT
Motion compensators, drill-string	DR_ME_MC_DC
Motion compensators, guideline tensioner	DR_ME_MC_GT
Motion compensators, pod line tensioner	DR_ME_MC_PT
Motion compensators, riser	DR_ME_MC_RI



Boundary definition – Motion compensators



Marathon Oil

ISPM ISO 14224 Solution (SAP)

Marathon Alvheim FPSO





Preventive Maintenance and Inspections

Program

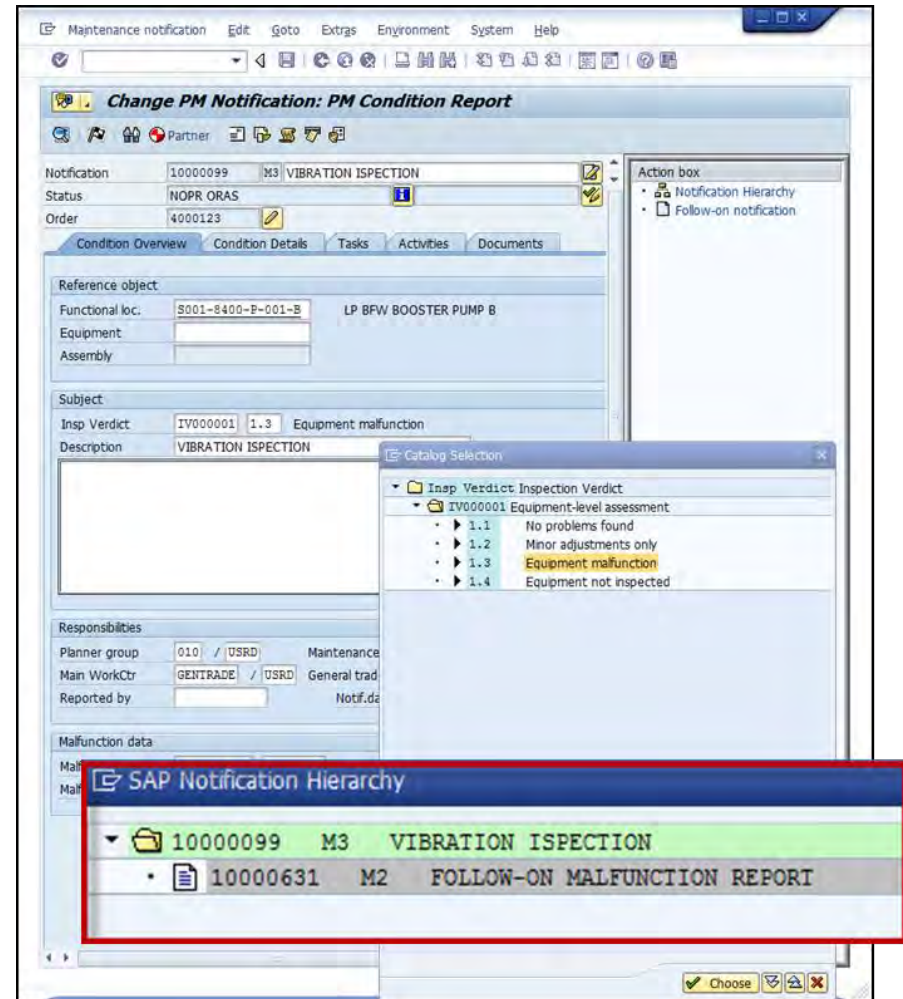
- Administered as administrative or technical tag level
- Results reported at technical tag level

PM Condition Report

- One condition report per technical tag inspected
- Inspection verdict and condition details
- Generated from object list of PM inspection order

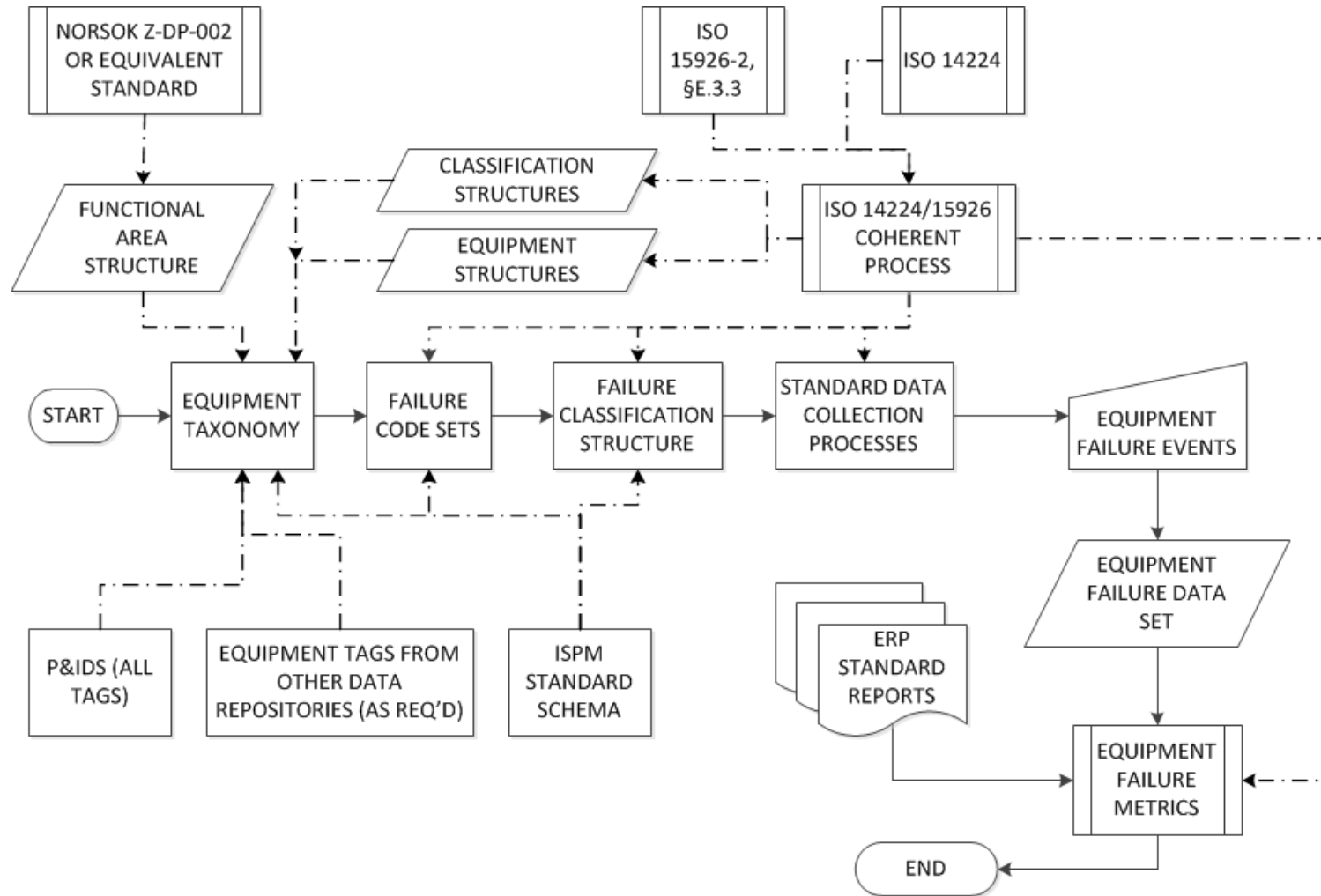
Follow-on malfunction report

- Generated for any equipment malfunction verdict
- Linked to PM Condition Report as subordinate object





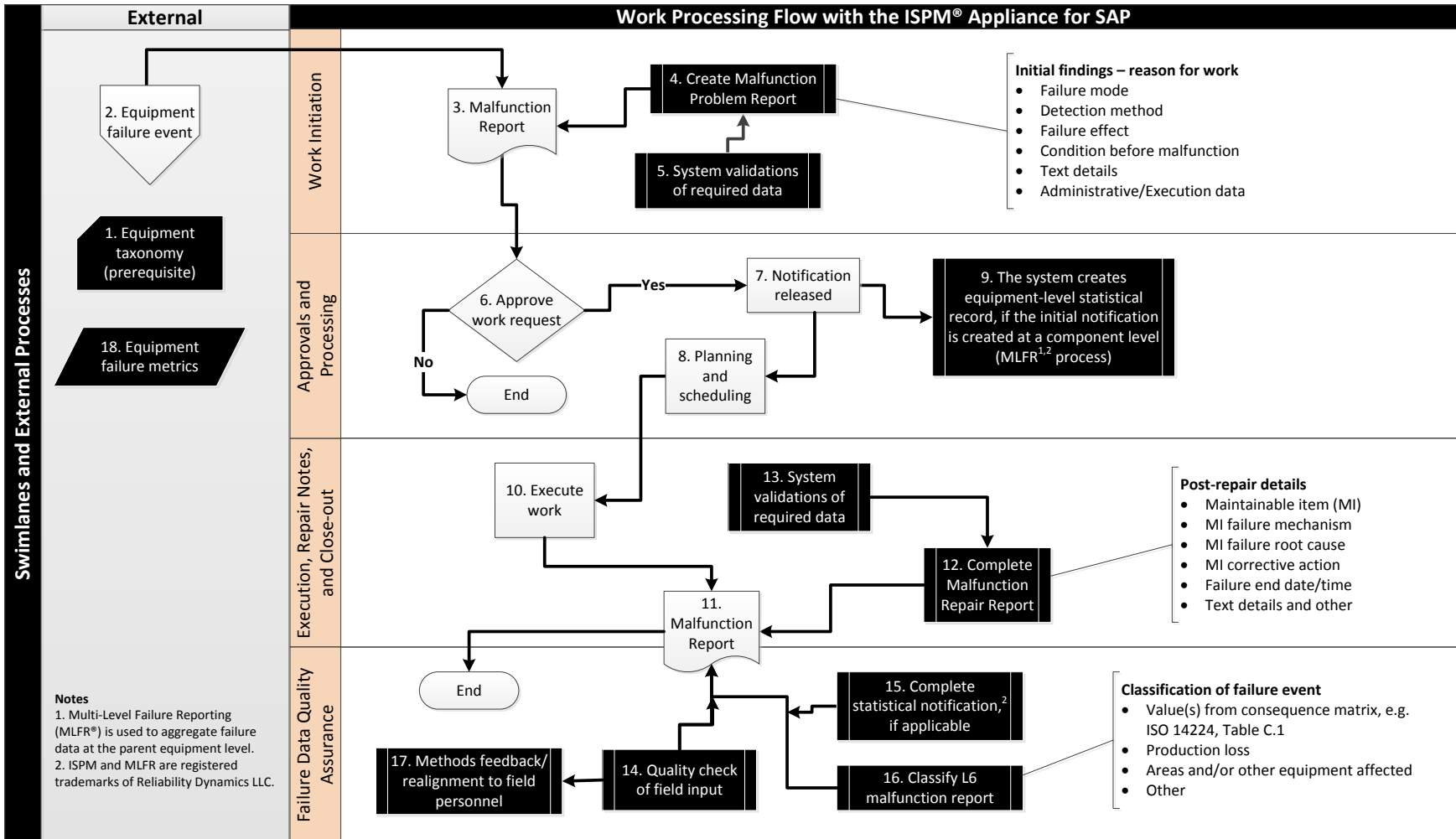
ISPM Solution Details





Malfunction Reporting Process

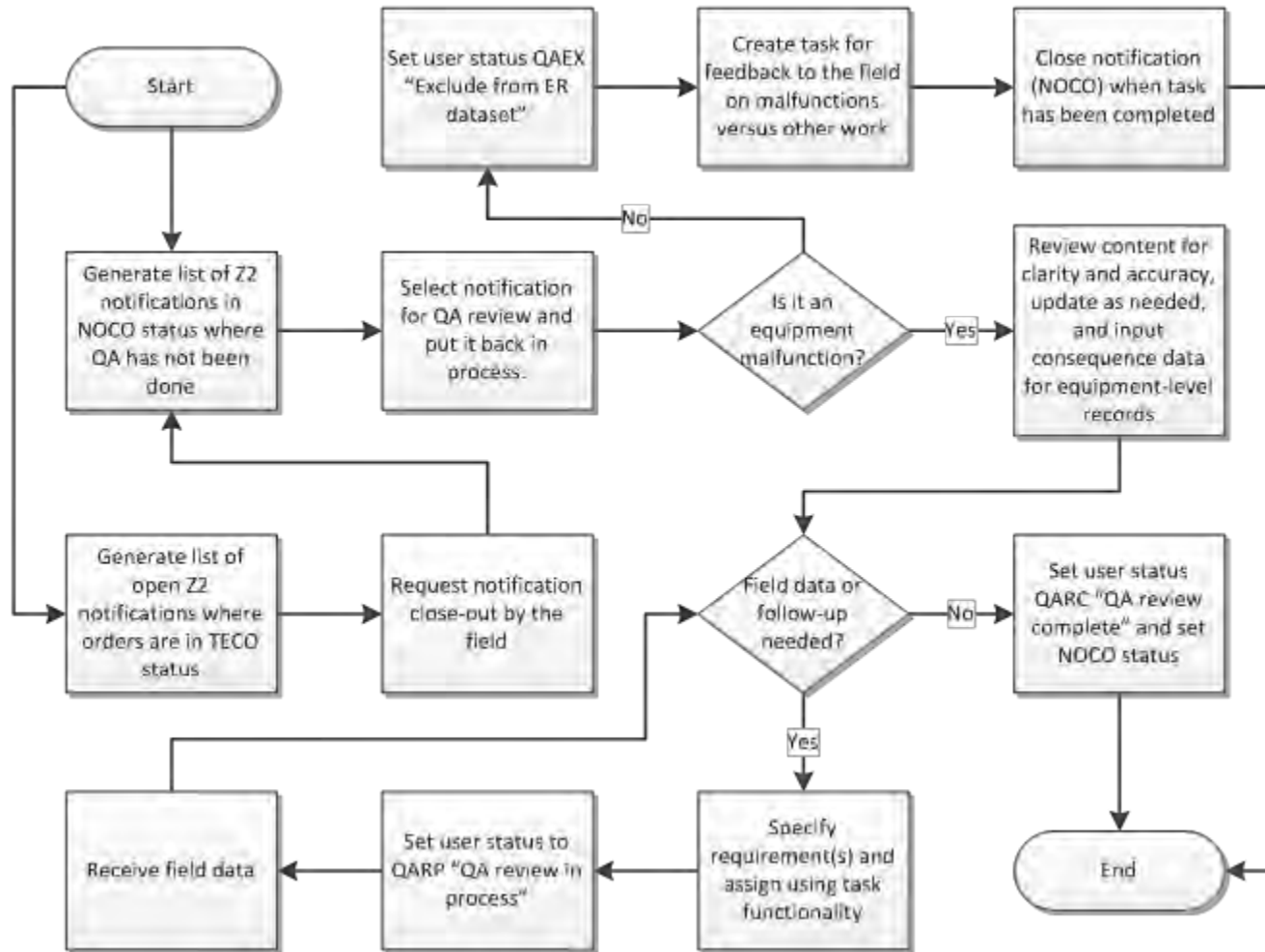
Work Processing Flow with the ISPM® Appliance for SAP



Notes
 1. Multi-Level Failure Reporting (MLFR®) is used to aggregate failure data at the parent equipment level.
 2. ISPM and MLFR are registered trademarks of Reliability Dynamics LLC.



Malfunction Report QA Process Flow





Failure Data Quality Assurance

- Review malfunction reports to ensure completeness and a clear and concise description of what happened
- Obtain and input failure consequences, area affected, etc.
- Identify “non-malfunction” malfunction reports and set user status to exclude them from the failure data dataset
- Review other ERP data to identify missing failure events, e.g. review materials booked against blanket orders of cost centers, review preventive maintenance and inspection results to ensure follow-on malfunction reporting was done, etc.
- Identify and document follow-on requirements, e.g. preventive maintenance additions, facilities change requirements, SJP requirements
- Circle-back with personnel when issues are found with completion of malfunction reports



Technical Structure

- ERP can be system of record for all technical tags
- One unique ID for each tag throughout all systems, records, and in the field
- Technical tag interrelationships defined in a manner the system can interpret
- Standard characteristic sets give operating context for failure events

Malfunction event data collection

- ERP is the work management system
 - Data collected are first-hand
- System validations help ensure a quality dataset
 - Correct taxonomic level
 - Minimum dataset
- Explicit data capture (versus inference on event reconstruction)

Quality assurance

- Ensure each event tells a coherent story
- Eliminate the need for recurrent data mining
- Checks for improper and missing malfunction reports
- Serves as training/realignment to field personnel

Other

- Client relationships allow for questions/improvements to dataset