

Reliability Dynamics

Industry Standard Solution for Plant Maintenance (ISPM®)

Tony Ciliberti PE, Founder and Principal Engineer, Reliability Dynamics

SAP® Certified
Integration with SAP S/4HANA®

The logo for ISPM Add-on for SAP is displayed on a solid orange background. The letters 'ISPM' are rendered in a large, bold, black, sans-serif font. Below 'ISPM', the text 'Add-on for SAP' is written in a smaller, bold, black, sans-serif font.

ISPM
Add-on for SAP

Objectives and Business Benefits

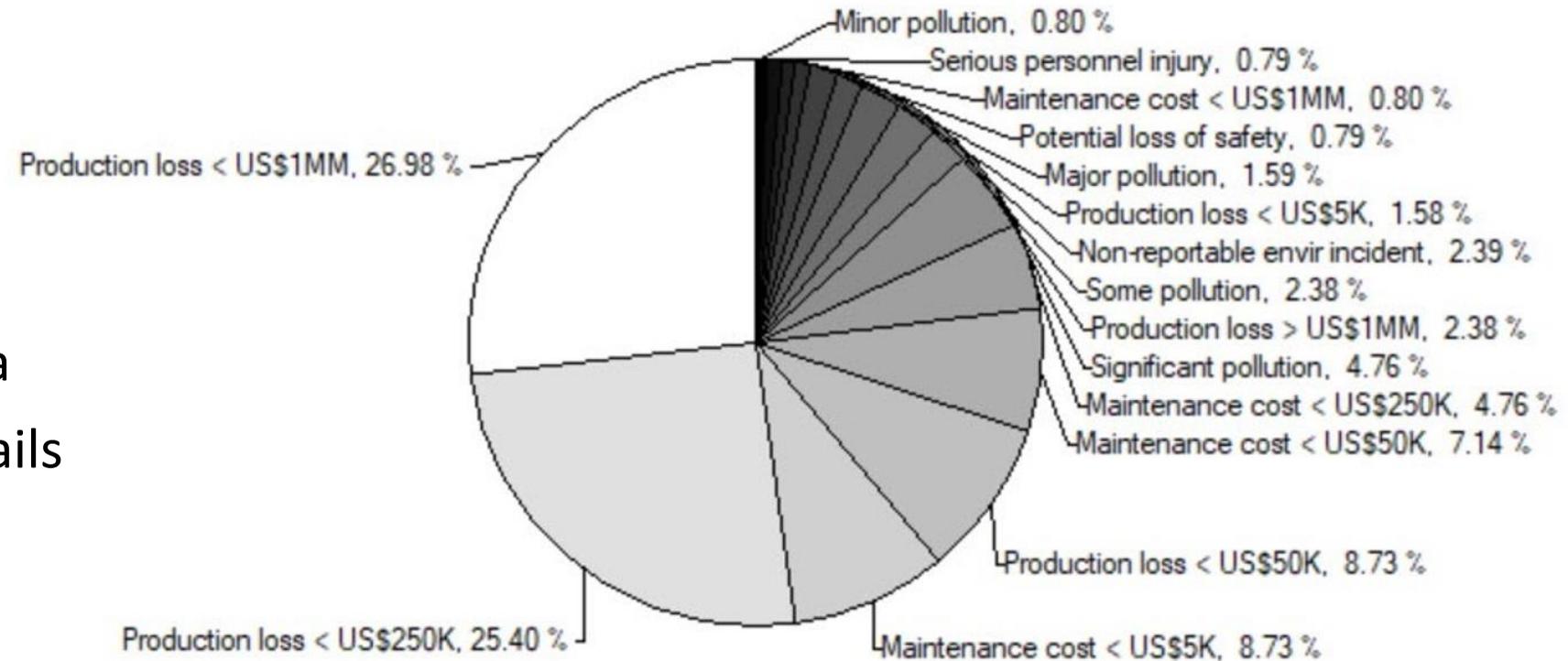
- Use high-quality equipment performance data to optimize equipment decisions and plant operations
- Reduce risk and improve production throughput and profitability

Failure Events versus Consequences - Corporate¹

Key Business Metrics

SAP Report IW69

- Corporate view of data
- Drillable to failure details



Notes

1. Value set adapted from ISO 14224:2016, Table C.2

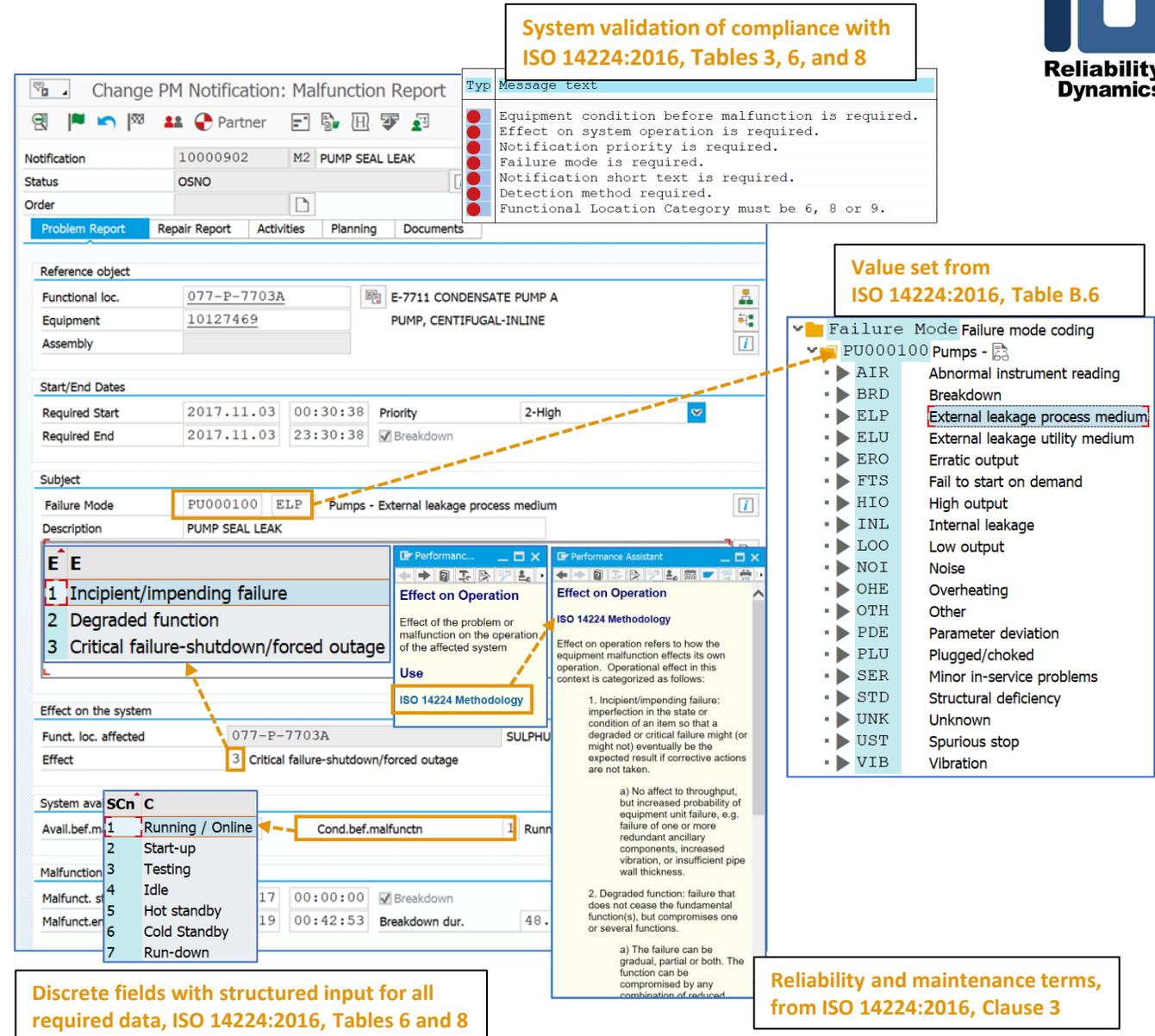
Data Digitalization

Failure Reporting Example

- Logical work categorization, with one input form per category¹
- Specifications of required data per work category^{2,3,4}
- Discrete fields with structured input for each required datum
- System-validations to ensure compliance with specifications

Notes - ISO 14224:2016

1. Figure 6 – Maintenance categories
2. Table 6 – Failure data
3. Table 8 – Maintenance data
4. Table 3 – Reliability and maintenance parameters in relation to taxonomy levels



System validation of compliance with ISO 14224:2016, Tables 3, 6, and 8

Value set from ISO 14224:2016, Table B.6

Discrete fields with structured input for all required data, ISO 14224:2016, Tables 6 and 8

Reliability and maintenance terms, from ISO 14224:2016, Clause 3

ISO 14224 Methodology

Effect on Operation

Effect on the system

System availability

Avail. bef. m.

Malfunction

Malfunction s

Malfunction e

Cond. bef. malfnctn

Run-down

External leakage process medium

External leakage utility medium

Incipient/impending failure

Degraded function

Critical failure-shutdown/forced outage

Running / Online

Start-up

Testing

Idle

Hot standby

Cold Standby

Run-down

Abnormal instrument reading

Breakdown

External leakage process medium

External leakage utility medium

Erratic output

Fail to start on demand

High output

Internal leakage

Low output

Noise

Overheating

Other

Parameter deviation

Plugged/choked

Minor in-service problems

Structural deficiency

Unknown

Spurious stop

Vibration

Effect of the problem or malfunction on the operation of the affected system

Effect on operation refers to how the equipment malfunction effects its own operation. Operational effect in this context is categorized as follows:

1. Incipient/impending failure: imperfection in the state or condition of an item so that a degraded or critical failure might (or might not) eventually be the expected result if corrective actions are not taken.

a) No affect to throughput, but increased probability of equipment unit failure, e.g. failure of one or more redundant ancillary components, increased vibration, or insufficient pipe wall thickness.

2. Degraded function: failure that does not cease the fundamental function(s), but compromises one or several functions.

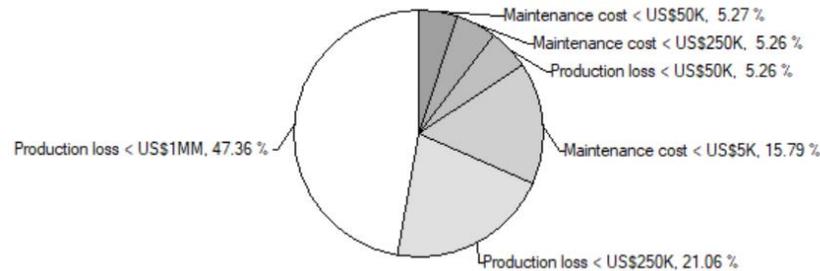
a) The failure can be gradual, partial or both. The function can be compromised by any combination of reduced

Example of failure details

IW69 - Durco Pumps in Claus Service – Corporate

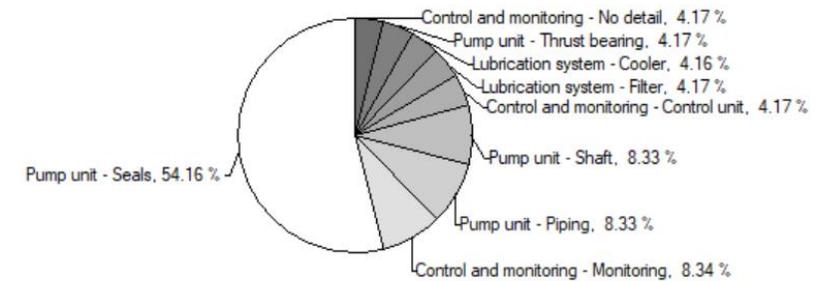
Failure Consequences

Ref. ISO 14224:2016, Table C.2



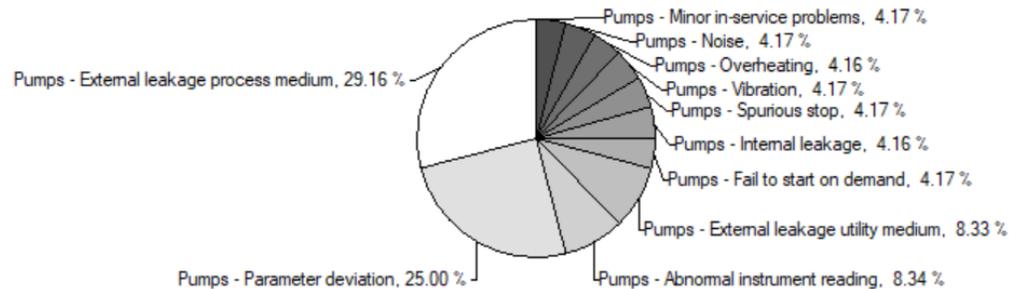
Primary Failure Components

Ref. ISO 14224:2016, Table A.21



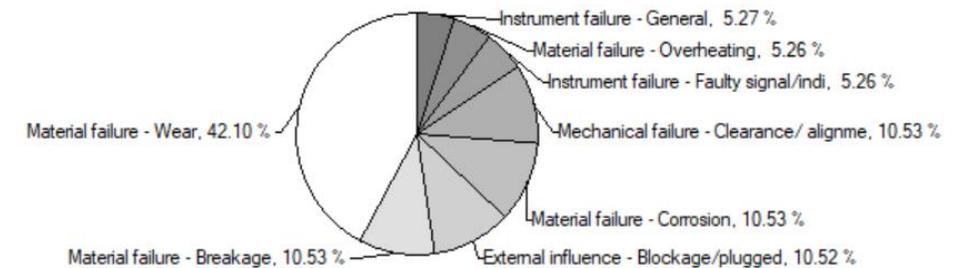
Failure Modes

Ref. ISO 14224:2016, Table B.6



Failure Mechanisms

Ref. ISO 14224:2016, Table B.2



Breakdown Analysis/Repair Time KPIs

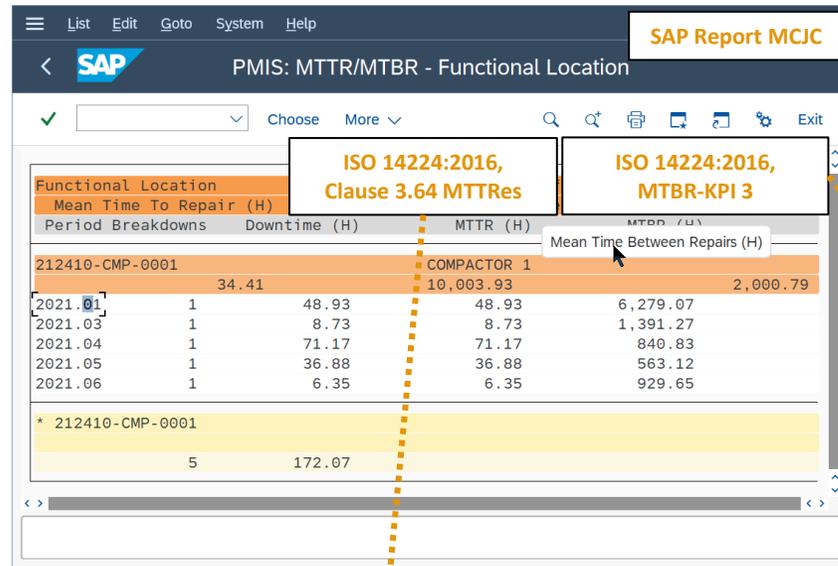
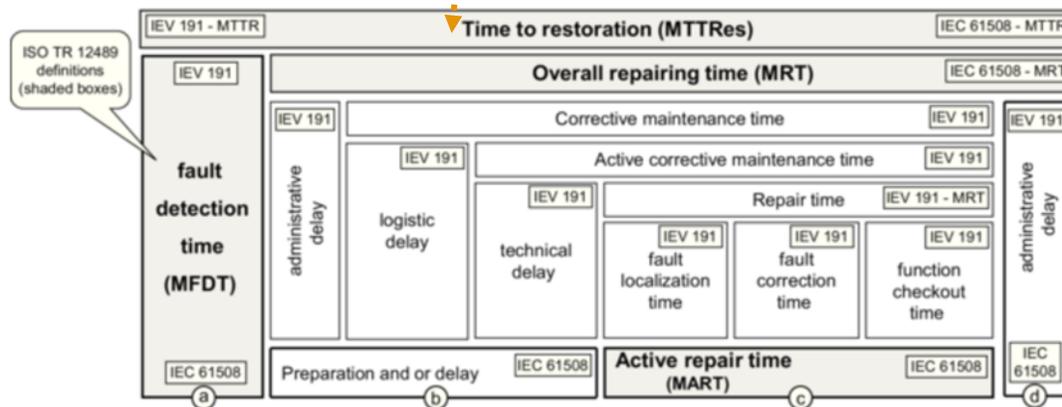


Figure 5 — Repair time taxonomies as per IEC 61508^[2] and ISO/TR 12489^[14]



ISO/TR 12489:2013(en)

Petroleum, petrochemical and natural gas industries — Reliability modelling and calculation of safety systems

ISO 14224:2016

Table E.3 — Examples of KPIs^a

KPI	Relevant taxonomic levels ^b	Units	Explanation and calculation	Purpose and value	Involved personnel
1) METBF Mean elapsed time between failures	6 to 8	Time (hours, days, weeks, months, years) For different classes or types of equipment Trends are shown over a period of time	Indicates the average time between failure for components, equipment or units. Definition of failure is given in Clause 3 (general) and Annex F (safety equipment). Use of METBF implies that down time/repair is included. Guidelines for calculating METBF (and MTTF) are given in Annex C.	Indication of increasing or decreasing reliability of components, equipment or unit/plant	Equipment subject-matter experts (SMEs) Reliability engineers (REs) Middle management (MM) Inspection
2) MTTF Mean time to failure	6 to 8	As above	Is similar to METBF, but does not take into account the down time/repair time. METBF is the sum of MTTRes and MTTF. MTTF equals the reciprocal of the failure rate.	As above Note that MTTF, in principle, concerns only the first time to failure of a new item before any maintenance task has been performed	As above
3) MTBR Mean time between repairs	6 to 8	Time (hours, days, weeks, months, years) For different classes or types of equipment Trends are shown over a period of time	Indicates the average time between repairs for components, equipment or units. Although a failure typically results in a repair, this is not always the case. Repairs (e.g. major overhauls) can be undertaken on a time basis independent of failure. Calculation based on total time between repairs divided by number of repairs over a specified time period or to date. For subsea equipment, one may rename the KPI to "Mean time between interventions" (MTBI).	Indication of increasing or decreasing reliability of components or equipment within a plant/unit	SMEs REs MM Maintenance Inspection

^a Other/more KPIs can be useful depending on industry and application.
^b See Table E.2.
^c CM is sometimes used as an abbreviation for corrective maintenance, but in this document CM refers to Condition monitoring

Poor Quality Equipment Performance Data

A Prevalent Issue for Asset-Intensive Companies



Best Practices Framework for Improving Maintenance Data Quality to Enable Asset Performance Analytics

Article (PDF Available) · October 2019 · with 165 Reads

DOI: 10.36001/pbmconf.2019.v11i1.836

[Cite this publication](#)

Abstract

 Sarah Lukens
i12.9 · General Electric

 Manjish Naik
General Electric

 Kittipong Saetia
i18.96 · General Electric

 Xiaohui Hu
i14.74 · General Electric

Field maintenance data is often captured manually and is prone to having incomplete and inaccurate information in the structured fields. However, unstructured fields captured through work order planning, scheduling, and execution contain a wealth of historical information about asset performance, failure patterns, and maintenance strategies. The prevalent data quality issues...

[Click articles to open](#)

Six common issues that cause poor equipment performance data quality

All are addressed by the ISPM Product

Issue 1: Lack of Digitalization

Digitization

- Converting hard-copy or non-digital records into digital format

Digitalization

- The conversion of data into a digital form that can be processed by a computer
- Data stored in relational data tables as discrete values
- A subset of digitization

Data Storage Technology			
	Paper	Digitized	Digitalized
Format	Manual files	Images, scans, spreadsheets, unformatted text	Relational data tables
Storage	File Cabinet	Corporate software	Corporate software
Data accessibility, records/analysis	1	1	100,000+
System validations possible	No	No	Yes

Issue 2: Lack of Common Terms and Definitions

- Common terms and definitions are imperative for collecting, merging and analyzing data from different sources
- Otherwise, the merging and analysis is based on incompatible data

ISO 14224:2016(E)

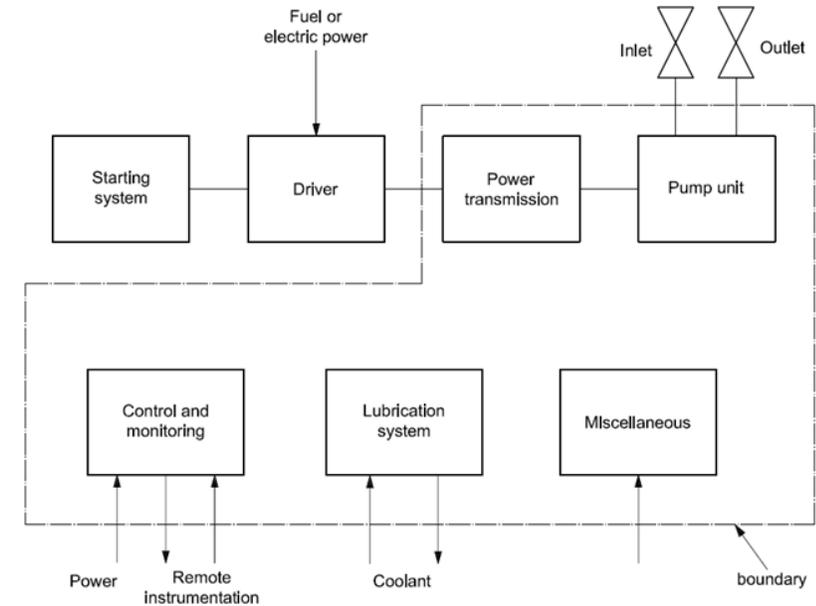


Figure A.7 — Boundary definition — Pumps

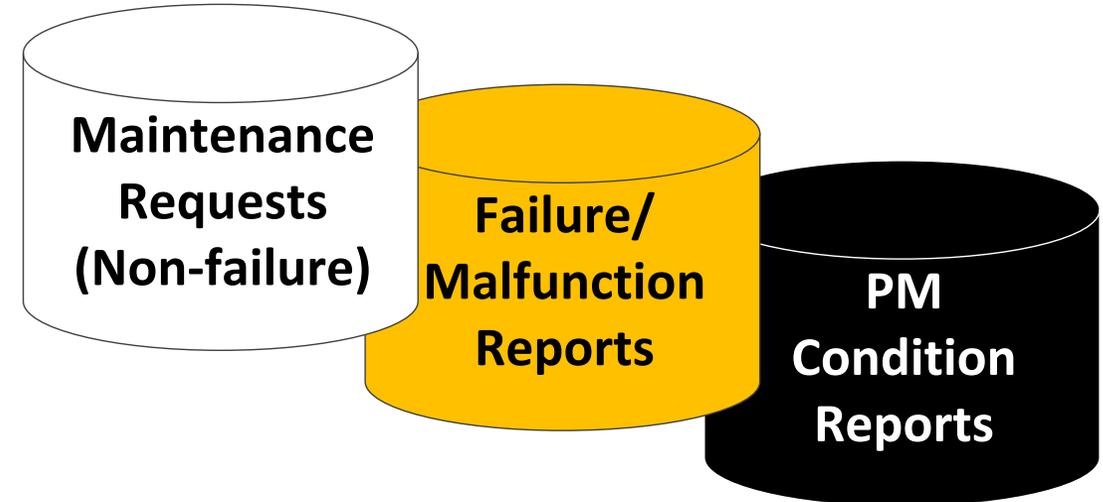
Table A.21 — Equipment subdivision — Pumps

Equipment unit	Pumps				
Subunit	Power transmission	Pump unit	Control and monitoring	Lubrication system	Miscellaneous
Maintainable items	Gearbox/variable drive Bearing Seals Coupling to driver Coupling to driven unit Belt/sheave	Support Casing Impeller Shaft Radial bearing Thrust bearing Seals Valves Piping Cylinder liner Piston Diaphragm	Actuating device Control unit Internal power supply Monitoring Sensors ^a Valves Wiring Piping Seals	Reservoir Pump Motor Filter Cooler Valves Piping Oil Seals	Purge air Cooling/heating system Cyclone separator Pulsation damper Flange joints

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

Issue 3: Improper Maintenance Categorization

- Many companies combine dissimilar work in the same data collection form
 - E.g., maintenance requests and failure/malfunction reports
 - Different data requirements in the same form cannot be system-validated
 - Metrics require manual separation of records
- Data sets should align with maintenance categorization
 - ISO 14224:2016, Figure 6



System data validations – malfunction report initiation

Typ	Message text
●	Equipment condition before malfunction is required.
●	Effect on system operation is required.
●	Notification priority is required.
●	Failure mode is required.
●	Notification short text is required.
●	Detection method required.
●	Functional Location Category must be 6, 8 or 9.

Validations check compliancy with ISO 14224:2016, Tables 3, 6, and 8

Issue 4: Lack of Data Specifications

- Data specifications for digitalization
 - What to collect
 - How to collect it
- In the data collection form
 - Create a discrete field with structured input for each datum
 - System-validate compliance with specifications

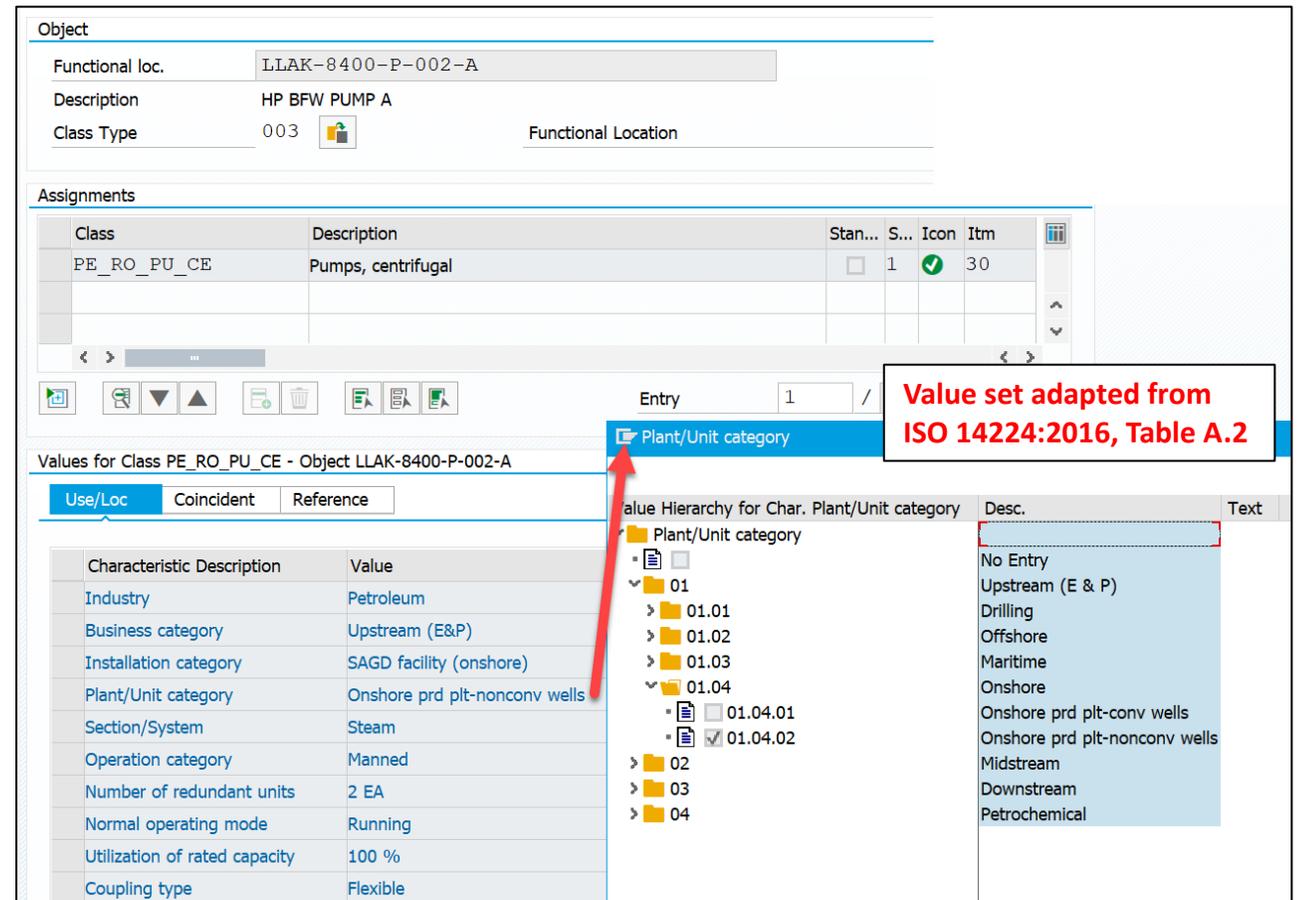
Table 6 — Failure data

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	Qualitative or quantitative failure consequence categorization (see also C.1.10)
	Failure impact on plant operations (e.g. production, drilling, intervention) ^b	Qualitative or quantitative failure consequence categorization (see also C.1.10)
	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)
	Component/Maintainable item(s) failed	Name of the failed component/maintainable item(s) (see Annex A)
	Detection method	How the failure was detected (see Table B.4)
	Operating condition at failure (*)	Run-down, start-up, running, hot standby, idle, cold standby, testing
	Operational phase at failure ^e	Type of operation at the time of failure
	SIS failure mode classification ^f	Classify the failure for the specific event (DU, DD, SU, SD; see F.2) ^g
Remarks	Additional information	Give more details, if available, on the circumstances leading to the failure: failure of redundant units, failure cause(s) etc.

Issue 5: Lack of Use/Location Data

Use/Location data

- Specify how equipment is used (operating context)
- Are essential for merging data and assessing equipment performance



The screenshot displays a software interface for equipment management. The 'Object' section shows the following details:

- Functional loc.: LLAK-8400-P-002-A
- Description: HP BFW PUMP A
- Class Type: 003 (Functional Location)

The 'Assignments' table lists the following entry:

Class	Description	Stan...	S...	Icon	Itm
PE_RO_PU_CE	Pumps, centrifugal	<input type="checkbox"/>	1	<input checked="" type="checkbox"/>	30

The 'Values for Class PE_RO_PU_CE - Object LLAK-8400-P-002-A' section is shown with the 'Use/Loc' tab selected. The 'Plant/Unit category' is highlighted with a red arrow and a callout box stating: **Value set adapted from ISO 14224:2016, Table A.2**.

The 'Value Hierarchy for Char. Plant/Unit category' is displayed as follows:

- Plant/Unit category
 - 01
 - 01.01
 - 01.02
 - 01.03
 - 01.04
 - 01.04.01
 - 01.04.02
 - 02
 - 03
 - 04

The 'Desc.' column lists the following categories:

- No Entry
- Upstream (E & P)
- Drilling
- Offshore
- Maritime
- Onshore
- Onshore prd plt-conv wells
- Onshore prd plt-nonconv wells
- Midstream
- Downstream
- Petrochemical

Issue 6: Lack of Failure Data Aggregation

- Equipment unit is the ISO 14224 common reporting level
- Equipment unit failure metrics are the aggregate of all failures within the equipment boundary

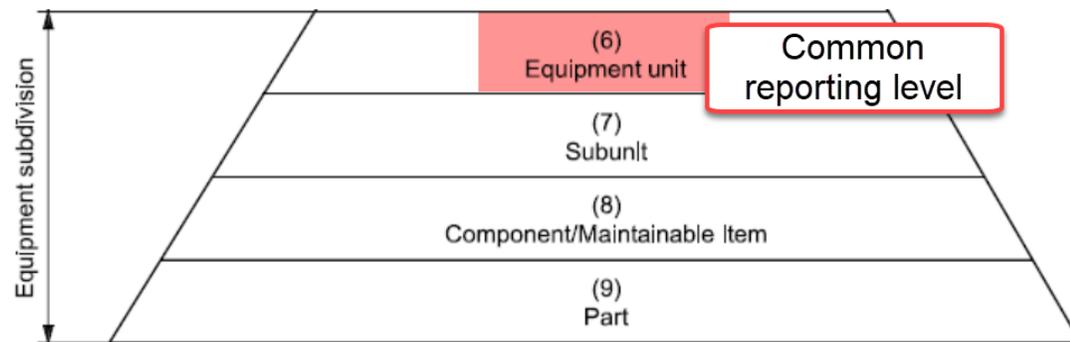


Figure 3 — Taxonomy classification with taxonomic levels

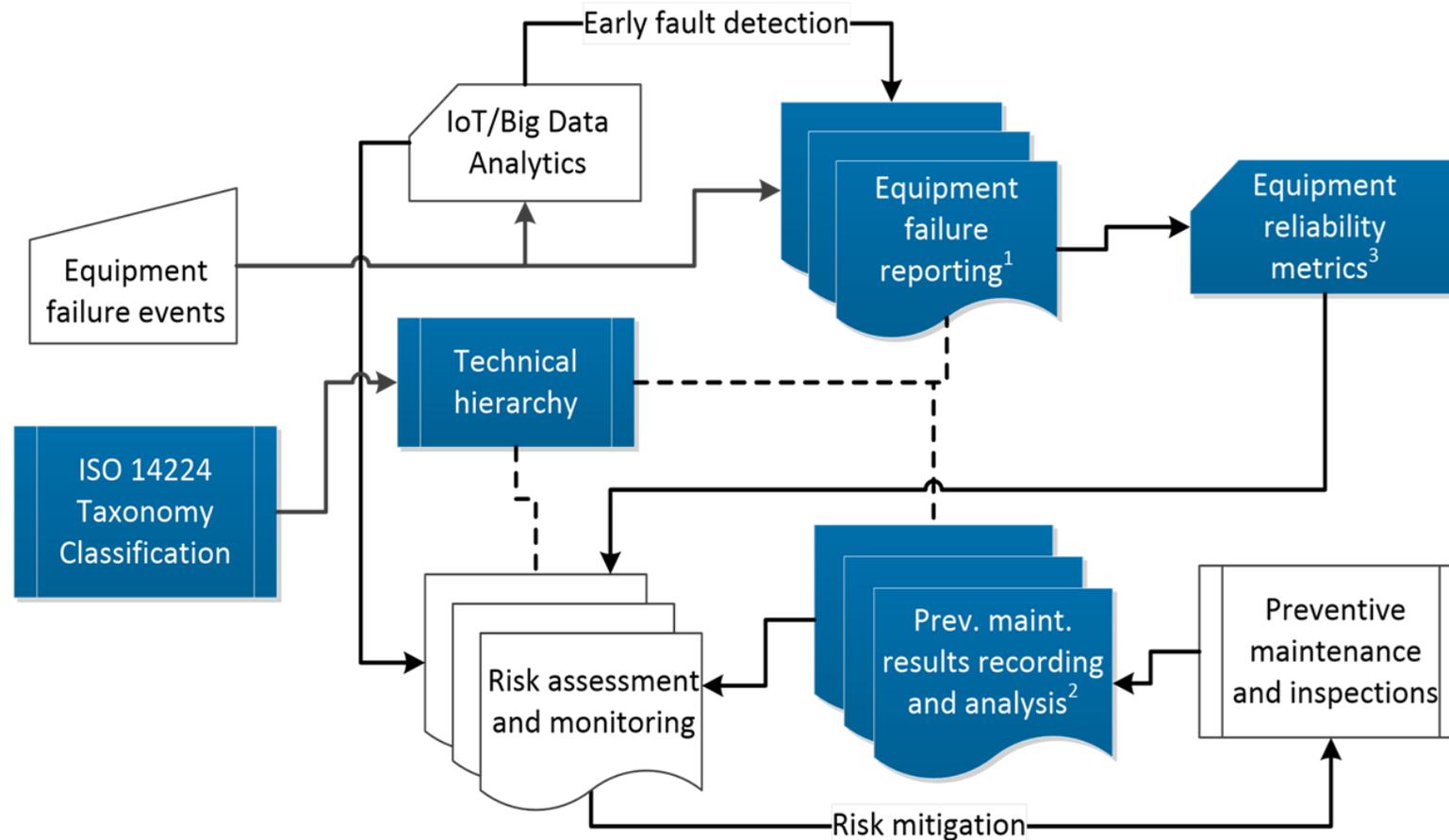
Item ID	Description	Boundary
5 LLAk-8400-P-002	HP BFW PUMPS	Pump Boundary
6 LLAk-8400-P-002-A	HP BFW PUMP A	
10055213	PUMP-UTILITY GRADE, MULTISTAGE, RING SEC	
7 LLAk-8400-P-002-A-02	PUMP UNIT	
7 LLAk-8400-P-002-A-03	CONTROL AND MONITORING	
5 LLAk-8421-CM-200	8400-P-002A HP BFW PUMP SUCTION	
5 LLAk-8421-CM-201	8400-P-002A HP BFW PUMP SUCTION	
5 LLAk-8421-CM-202	8400-P-002A HP BFW PUMP DISCHARGE	
5 LLAk-8421-CM-203	8400-P-002A HP BFW PUMP WARM-UP	
5 LLAk-8421-CM-213	8400-P-002A HP BFW PUMP	
8 LLAk-8421-TE-213-A	ELEMENT, TEMPERATURE	
8 LLAk-8421-TE-213-B	ELEMENT, TEMPERATURE	
8 LLAk-8421-TT-213-A	TRANSMITTER, TEMPERATURE	
8 LLAk-8421-TT-213-B	TRANSMITTER, TEMPERATURE	
8 LLAk-8421-VXI-213	INDICATOR, VIBRATION	
8 LLAk-8421-VXT-213	VIBRATION PROXIMITOR	
8 LLAk-8421-VYI-213	INDICATOR, VIBRATION	
8 LLAk-8421-VYT-213	VIBRATION PROXIMITOR	
5 LLAk-8421-CM-215	8400-P-002A HP BFW PUMP QUENCH WATER	
5 LLAk-8421-CM-216	8400-P-002A HP BFW PUMP QUENCH WATER	
5 LLAk-8421-CM-217	8400-P-002A HP BFW PUMP BEARING OIL TO R	
5 LLAk-8421-CM-221	8400-P-002A COOLING MEDIUM RETURN	
5 LLAk-8421-CM-222	8400-P-002A COOLING MEDIUM RETURN	
7 LLAk-8400-P-002-A-04	LUBRICATION SYSTEM	
6 LLAk-8400-P-002-A-M	MOTOR-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	

Industry Standard Solution for Plant Maintenance (ISPM[®])

Product Brief

ISPM Solution Overview

Equipment Reliability and Maintenance (RM) Data Processes



ISO 14224 processes

Notes

1. Failure reporting is registration of failure data and corrective maintenance data. Reference ISO 14224, Tables 6-Failure data and Table 8-Maintenance data, and Figure 6-Maintenance categorization
2. Reference ISO 14224, Table 8 and Figure 6
3. Reference ISO 14224, Table E.3-Examples of KPIs

Transactional Data Governance (TDG)

Equipment Performance Data Quality Management

Quality Assurance

- Proactive measures to increase the likelihood data records are compliant with specifications
- System-driven, at data inception

Quality Control

- Review of completed records to ensure data compliance
- Feedback to relevant personnel



The ISPM Add-on for SAP

- SAP solution extension, certified for S/4HANA On-premise and Cloud
- Compliant application of the ISO 14224:2016 standard in SAP¹
- Tried, tested, and refined through 19 years of application in industry

Notes:

1. Compliant with ISO/TC67/WG4/PG1 guidance to industry, in ISO Course [Use of ISO 14224 for optimizing Safety and Profitability in the Oil and Gas Industry – in a digitalized perspective.](#)



Certificate

SAP INTEGRATION CERTIFICATION

SAP SE hereby confirms that the interface software for the product **Industry Standard Solution for Plant Maintenance 101** of the company **Reliability Dynamics** has been certified for deployment on SAP S/4HANA 2020 via the SAP integration scenario **ABAP Add-On Deployment for SAP S/4HANA**.

This certificate confirms the technical compliance of **Industry Standard Solution for Plant Maintenance 101** with SAP certification procedures.

The certification test is documented in report no. **19110** and expires on **September 10, 2024**.

SAP Test System: SAP S/4HANA 2020

The certification is listed on the SAP Certified Solutions Directory: sap.com/csd.

Certified Functions:

Assign Software Component and Namespace
Package Add-On using SAP Add-On Assembly Kit
Deploy using SAP Add-On Installation Tool (SAINT)
Integration with SAP S/4HANA
Technical Uninstallation Test
SAP Solution Manager Ready functionality
Compatible with SAP S/4HANA Cloud, private edition

Saurav Chetry

Remote, September 10, 2021

SAP® Certified
Integration with SAP S/4HANA*

THE BEST RUN 

SAP certification focuses on technical integration with SAP solutions. Vendor is responsible for the product itself, its error-free operation, and adherence to applicable laws.

Reliability Dynamics

An Engineering and Technology Company

Oil and Gas Customers

Organization	Software	Work Scope
US Department of Energy	SAP	Complete ISPM ISO 14224 implementation for Strategic Petroleum Reserves
Precision Drilling	SAP	ISPM ISO 14224 content and configuration, domestic and international
Pembina Pipeline	SAP	Complete ISPM ISO 14224 implementation, corporate-wide
QGOG-Constellation	Maximo	Complete ISPM ISO 14224 implementation, entire offshore drilling fleet
Maersk Drilling	SAP	Taxonomy definition development for offshore drilling equipment
Nexen Energy	SAP	<ol style="list-style-type: none"> 1. Complete ISPM implementation for Yemen Masila Block, methods later adopted corporate-wide 2. ISPM ISO 14224 Technical hierarchy restructuring for Long Lake Facility
Marathon Oil	SAP	ISO 14224 template development and implementation for Alvheim FPSO
ExxonMobil	SAP	Equipment Taxonomy Assessment, United States and International Operations

Tony Ciliberti PE

Founder | Reliability Dynamics

Bachelor of Science, Chemical Engineering, Texas A&M University

Thirty years experience as a reliability engineer in petrochemical, oil and gas

Four years with SAP Americas' National Practice as a Principal Consultant and Solution Architect

ANSI-appointed US Expert in ISO/TC67/WG4 – Reliability engineering & technology

- PG1: ISO 14224 – Collection and exchange of reliability and maintenance data for equipment
- PG2: ISO 20815 – Production assurance and reliability management

Thank you

Tony Ciliberti PE

US Expert ISO/TC67/WG4 Reliability engineering & technology
Principal Engineer, Reliability Dynamics

