Use SAP PM to Capture Quality Equipment Reliability Data

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Agenda and ISO References

• Presentation
  – Technical concepts – Tony
  – Process changes and SAP configuration - Dan

• Key learning topics/take-aways
  – Fundamentals of ISO 14224
  – How to capture ISO 14224 with SAP PM
  – BP for SAP PM technical objects and technical object structures

• ISO standards referenced
  – ISO 14224, Petroleum and natural gas industries — Collection and exchange of reliability and maintenance data for equipment
  – ISO 15926, Industrial automation systems and integration — Integration of life-cycle data for process plants including oil and gas production facilities.
Nexen and SAP

• Nexen, Inc
  – Global oil and gas company with 3000+ employees and annual revenues of US$2.9 billion

• SAP
  – First go-live in January 2002 (version 4.6C)
  – Global implementation with shared system configuration and design
  – PM system has
    • Common order and notification types
    • Unique technical object structures and classifications
Changes at Nexen

• Reasons for change
  – Incomplete and disparate equipment characteristic, reliability, and cost data
  – Data mining required for maintenance analyses

• Key changes
  – 1. Standardize technical object structures
  – 2. Capture detailed equipment characteristic and reliability data with taxonomy
  – 3. Modify work processes to facilitate complete, efficient, and accurate data capture
**Change 1: Standardize Technical Object Structures**

- Define rules for technical object configuration and classification.
  - Functional area location (FAL) versus functional equipment location (FEL)
  - Functional physical object vs. materialized physical object
  - FEL vs. primary equipment vs. sub-equipment
- Explicitly define ISO 14224 equipment unit boundaries with technical objects
SAP Functional Location Hierarchy

**Purpose/Objectives**

- Represent an enterprise’s locations and functions completely, logically, and consistently
- Catalog technical objects
- Flexible structure to accommodate both simple and complex facilities
- Facilitate data capture per ISO 14224 and data exchange per ISO 15926
# SAP Functional Location Structure: Hierarchical Asset Catalog

## Functional Location Template (XXX-XXX-XXX-XXX-XXX-XXX-XXX-XXX-XXX)

<table>
<thead>
<tr>
<th>M/O</th>
<th>Class</th>
<th>Node</th>
<th>Example</th>
<th>Node Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>BU</td>
<td>Business Unit Entity</td>
<td>YEM</td>
<td>Business and process area</td>
</tr>
<tr>
<td>M</td>
<td>FC</td>
<td>Facility</td>
<td>CPF</td>
<td>FAL</td>
</tr>
<tr>
<td>O</td>
<td>P1</td>
<td>Plant Level 1</td>
<td>CPP</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>P2</td>
<td>Plant Level 2</td>
<td>CP1</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>P3</td>
<td>Plant Level 3</td>
<td>YPG</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>P4</td>
<td>Plant Level 4</td>
<td>DG1</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>EC</td>
<td>Equipment Class</td>
<td>PMP</td>
<td>ISO 14224</td>
</tr>
<tr>
<td>O</td>
<td>ET</td>
<td>Equipment Type</td>
<td></td>
<td>Equipment characteristic</td>
</tr>
<tr>
<td>O</td>
<td>EA</td>
<td>Equipment Application</td>
<td></td>
<td>Process characteristic</td>
</tr>
<tr>
<td>M</td>
<td>EU</td>
<td>Equipment Unit</td>
<td>001</td>
<td>ISO 14224</td>
</tr>
</tbody>
</table>

1. M/O – Mandatory/Optional for equipment installation (nine levels maximum)
2. Additional plant levels are permissible
3. Abbreviations should be standardized
Figure E.10 shows this example using a space-time map. Here it is possible to see that the duty represented by TAG P101, and Pump 1234 are coincident for the period of the installation, i.e. the state S1 of Pump 1234 that is installed as TAG P101 is in fact also a state of TAG P101. Indeed, the TAG P101 consists of those states of the pumps that are installed in this place.
FAL vs. FEL vs. Primary Equipment

FAL is a grouping level

FEL – Class EU
YEM-CPF-CPP-CP1-YPG-DG1-001
Wartsila 1 Reciprocating Engine
P&ID Tag RE-91101

FEL – Class EC
YEM-CPF-CPP-CP1-YPG-DG1-PMP
Wartsila 1 Pumps

FEL – Class EA
YEM-CPF-CPP-CP1-YPG-DG1-PMP-LUB
Wartsila 1 Lube Oil Pumps

FEL is an equipment installation location and equivalent to a functional physical object

Class identifies hierarchy node

✓ Capabilities of materialized physical object must meet or exceed functional requirements at its installation point
✓ Cardinality is 1:1

Materialized Physical Object
Pump Serial No. 1234
<Specification of Capabilities>

Functional Physical Object
<Specifications of Functional Requirements>

FAL – Class P4
YEM-CPF-CPP-CP1-YPG-DG1
Wartsila 1 Power Generation Package

Wartsila 1 Power Generation Package

Wartsila 1 Reciprocating Engine
P&ID Tag RE-91101

Wartsila 1 Pumps

Wartsila 1 Lube Oil Pumps
ISO 14224 Equipment Hierarchy

- Comb. Engine i
- Comb. Engine 1
- Comb. Engine 3
- Comb. Engine n

- Start system
- Combustion engine unit
- Control and monitoring
- Lubrication system
- Cooling system
- Miscellaneous

Some maintainable items are ISO equipment class.
Decision Logic for FEL, Primary Equipment, and Sub-equipment Objects

Start

Is the item an equipment class as defined by ISO 14224 or equivalent company standard?

Yes

Is the item a component of a larger package where the complete package is routinely or logically removed as a materialized physical object?

Yes

Create equipment record for the package and a corresponding FEL. Install package as primary equipment in the FEL.

No

Create equipment record for item and install as sub-equipment.

No

Is the item a subunit or maintainable item of an ISO 14224 equipment class boundary?

Yes

When the parent equipment unit is removed, is the item removed as part of the parent?

Yes

Create equipment record for the item and a corresponding FEL. Install item as primary equipment in the FEL.

No

Is discrete tracking of location on parent equipment required?

Yes

Create equipment record for item and install as sub-equipment.

No

End
ISO 14224 Equipment Class Boundary Definition

• Boundary used for data analysis

• Establishes consistency in definition of equipment units
  – Shows what is “inside the box.”
  – Includes subunits and maintainable items

• SAP technical objects within the boundary need to be identified
  – Use Installed Base
SAP Installed Base: Equipment Unit Boundary Definitions
SAP Installed Base: Equipment Subunit Boundary Definitions

Display Installed Base: Detail Screen

Installed base: 17556
ISO_14224
SUBUNIT_START_SYSTEM

General data
Status: CRTE
IBase type: 01 IBase
Validity type: Temporal validity
Authoriz. group: 2
Comp. Store: No
Config. Store: No

Created by: CILIBERT
Created on: 2005/11/15
Changed by: CILIBERT
Changed on: 2005/11/16

Directly subordinate objects

S._ Item | Sort string | FuncLocation | Description
---------|-------------|--------------|-----------------
YEM-CPF-CPP-CP1-STA-REC-066 | | STARTING AIR RECEIVER FOR RE-91106 |
YEM-CPF-CPP-CP1-STA-REC-007 | | V-91106 AIR RECEIVER (PAL-91623B) |
YEM-CPF-CPP-CP1-STA-REC-015 | | V-91106 AIR RECEIVER (PI-91624) |
YEM-CPF-CPP-CP1-STA-REC-023 | | V-91106 AIR RECEIVER (PSL-91623) |
SAP Technical Object Record Boundary Display

Display Functional Location: Master data

FunctLocation: YEM-CPF-CPP-CP1-YPG-DG6-001
Description: RECIPROCATING ENGINE #6 FOR G-91106
Status: CRTE

Installed base: 17395
UNIT_RECIPROCATING_ENGINE_RE-91106
Time: 2006/01/24 15:03:27

Subunits:
- SUBUNIT_START_SYSTEM
- SUBUNIT_COMBUST_ENGINE
- SUBUNIT_CONTROL & MONITORING
- SUBUNIT_LUBRICATION_SYSTEM
- SUBUNIT_COOLING_SYSTEM
- SUBUNIT_MISCENNEOUS
- RECIPROCATING ENGINE #6 FOR G-91106
Change 2: Capture Detailed Equipment and Reliability Data with Taxonomy

Purpose/Objectives

• Structure for capturing equipment data
  – Characteristic data
    • Support data flow from engineering and procurement to maintenance technical objects (ISO 15926)
  – Reliability data

• Classification of equipment for data analysis purposes

• Verification of equipment capabilities versus functional requirements
ISO 14224 Equipment Classification: Combustion Engines

A.2 Process equipment

A.2.1 Combustion engines (piston)

Table A.1 — Taxonomy classification — Combustion engines

<table>
<thead>
<tr>
<th>Equipment class</th>
<th>Code</th>
<th>Type</th>
<th>Code</th>
<th>Description</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustion</td>
<td>CE</td>
<td>Diesel engine</td>
<td>DE</td>
<td>Main power</td>
<td>MP</td>
</tr>
<tr>
<td>engines - piston</td>
<td></td>
<td>Gas engine</td>
<td>GE</td>
<td>Essential power</td>
<td></td>
</tr>
<tr>
<td>(diesel/gas</td>
<td></td>
<td></td>
<td></td>
<td>Emergency power</td>
<td></td>
</tr>
<tr>
<td>engines)</td>
<td></td>
<td></td>
<td></td>
<td>Water injection</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Oil handling</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Gas handling</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Water fire-fighting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Material handling</td>
<td></td>
</tr>
</tbody>
</table>

Class: PE_CE_DE_MP
# ISO 14224 Equipment Characteristics: Combustion Engine

## Table 1 — Equipment data

<table>
<thead>
<tr>
<th>Main categories</th>
<th>Subcategories</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification</td>
<td>Equipment location</td>
<td>Equipment tag number (*)</td>
</tr>
<tr>
<td></td>
<td>Classification</td>
<td>Equipment unit class, e.g. compressor (see annex A) (*)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Equipment type (see annex A) (*)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Application (see annex A) (*)</td>
</tr>
<tr>
<td>Installation data</td>
<td></td>
<td>Installation code or name (*)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Installation category, e.g. platform, subsea, refinery (*)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operation category, e.g. named, remote controlled (*)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Geographic area, e.g. Southern North Sea, Adriatic Sea, Gulf of Mexico, continental Europe, Middle East</td>
</tr>
<tr>
<td>Equipment unit data</td>
<td></td>
<td>Equipment unit description (nomenclature)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unique number, e.g. serial number</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subunit redundancy, e.g. number of redundant subunits</td>
</tr>
<tr>
<td>Design</td>
<td>Manufacturer’s data</td>
<td>Manufacturer’s name (*)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manufacturer’s model designation (*)</td>
</tr>
<tr>
<td>Design characteristics</td>
<td></td>
<td>Relevant for each equipment class, e.g. capacity, power, speed, pressure (see annex A) (*)</td>
</tr>
<tr>
<td>Application</td>
<td>Operation (normal use)</td>
<td>Equipment uniducency, e.g. 3 x 50 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mode while in the operating state, e.g. continuous running, standby, normally closed/open, Intermittent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Date the equipment was installed or date of production start-up</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surveillance period (calendar time) (**)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The accumulated operating time during the surveillance period</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of demands during the surveillance period as applicable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operating parameters as relevant for each equipment class, e.g. operating power, operating speed, see annex A (*)</td>
</tr>
<tr>
<td>Environmental factors</td>
<td></td>
<td>Ambient conditions (severe, moderate, benign) a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interior environment (severe, moderate, benign) b</td>
</tr>
<tr>
<td>Remarks</td>
<td>Additional information</td>
<td>Additional information in free text as applicable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Source of data, e.g. process and instrumentation diagram, data sheet, maintenance system</td>
</tr>
</tbody>
</table>

a Features to be considered, e.g. degree of protective enclosure, vibration, salt spray or other corrosive external fluids, dust, heat, humidity.
b Features to be considered, e.g. for compressor, benign (gas - clean and dry), moderate (some droplets corrosion), severe (sour gas, high CO₂, high particle content).

## Table A.3 — Equipment unit specific data — Combustion engines

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Unit or code list</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver application (*)</td>
<td>Name of driven unit</td>
<td>Pump, generator, compressor</td>
</tr>
<tr>
<td>Corresponding driven unit</td>
<td>Specify identification number of driven unit</td>
<td>Numeric</td>
</tr>
<tr>
<td>Power- design (*)</td>
<td>Max. rated output (design)</td>
<td>kW</td>
</tr>
<tr>
<td>Power- operating (*)</td>
<td>Specify the approximate power at which the unit has been operated for most of surveillance time</td>
<td>kW</td>
</tr>
<tr>
<td>Speed (*)</td>
<td>Design speed</td>
<td>r/min</td>
</tr>
<tr>
<td>Number of cylinders</td>
<td>Specify number of cylinders</td>
<td>Integer</td>
</tr>
<tr>
<td>Cylinder configuration</td>
<td>Type</td>
<td>Inline, vee, flat</td>
</tr>
<tr>
<td>Starting system (*)</td>
<td>Type</td>
<td>Electric, hydraulic, pneumatic</td>
</tr>
<tr>
<td>Fuel</td>
<td>Type</td>
<td>Gas, light oil, medium oil, heavy oil, dual</td>
</tr>
<tr>
<td>Air inlet filtration type</td>
<td>Type</td>
<td>Free text</td>
</tr>
<tr>
<td>Engine aspiration type (*)</td>
<td>Type</td>
<td>Turbo, natural</td>
</tr>
</tbody>
</table>

(*) Indicates high-priority information.
SAP Classes and Characteristics: Configuration of ISO 14224

- More specific characteristics appear first
- Green check marks identify inherited characteristics
SAP Classification Assignment to Technical Objects

Characteristics inherited from Class PE_CE. More specific characteristics appear first.

Characteristics inherited from Class PE. As PE is the top level class, all equipment will have these Characteristics.
ISO 14224 Failure and Maintenance Notations

Catalog Codes

• Problem report
  – Failure modes
  – Method of detection

• Repair report
  – Failure descriptors
  – What failed
    • Subunit/maintainable item
    • assemblies/components
  – Failures causes
  – Maintenance activities to repair
SAP Notification – Problem Report

Failure Modes

Methods of Detection
SAP Notification – Repair Report
What Failed and How

- Assembly/MM Specification
  ✔ First -out, position, number of defects, etc.

- Failure Descriptions
- Subunits/Maintainable Items

- Change PM Notification: Unplanned Mtc
SAP Notification – Repair Report
Failure Cause for Maintainable Item

Change PM Notification: Unplanned Mtce

- Notification: 10171236 N1 DG 6 has high oil temp
- Status: NOPR ORAS
- Order: 20206599

For item 1:
- Item: CECS CSHE
- Failure: FDEXT 5.1
- Text: heavily corroded

<table>
<thead>
<tr>
<th>No.</th>
<th>Code gr..</th>
<th>Cause code text</th>
<th>Cause text</th>
<th>Created by</th>
<th>Created on</th>
<th>Created at</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FCOM</td>
<td>3.4</td>
<td>Expected wear and tear</td>
<td>CILIBERT</td>
<td>2005/11/12</td>
<td>04:39:25</td>
</tr>
</tbody>
</table>

Failure Causes:
- FCOM: Failure Cause - Operations/Maintenance
  - 3.0: Failure related to operation/maintenance
  - 3.1: Off-design service
  - 3.2: Operating error
  - 2.3: Maintenance error
  - 3.4: Expected wear and tear

SAP-CENTRIC EAM 2006
Driving Value from SAP-Centric EAM
SAP Notification – Equipment Unit Affected and How

System availability is used to classify failure severity.
System affected is the parent equipment unit.
Capturing Multiple Equipment Class Data Within One Equipment Unit Failure

For subunits/maintainable items that are ISO equipment class:
- Capture class-specific failure data with additional notifications)
- The affected equipment specified for sub-equipment is the parent equipment unit
ISO 14224 Equipment Class Interpretation

- Standard Interpretation of ISO 14224
  - Equipment to include/exclude
  - Clarifications of Class Boundary
    - Components to include/exclude
    - Repairs to include/exclude
    - KPI definitions

Example from Meridium
Change 3: Modify Work Processes for Complete and Accurate Data Capture

• Make SAP the single source of information
• Modify work notification process to ensure that all jobs are captured
• Customize SAP to support/enable new functionality
Current Issues

- Incomplete and improper allocation of costs and reliability data
  - N1 notifications not issued or issued after work completion
  - Improper notification sequence (N4 done before N1)
Benefits Realization

• Proper allocation of costs and reliability data to technical objects
  – All jobs captured with discrete and detailed work orders
  – Notification sequence done properly
Order and Notification Processing

System

Scheduled Events (PMs)

Non Scheduled Events

Unique order and notification types

Transaction variant

Work completed, equipment maintained and results recorded

Planning Team

Monitor Work Queue

✓ Review, assess, prioritize, update and action as required

✓ Manage backlog

Process maintenance order/notification and prepare work package

Update work order and notification

Partner functions

Capacity Planning

Performance

Unique order and notification types

Transaction variant
Notification Changes

- New Tabs in N1 type notification
  - Problem Report Details
  - Groups Required
  - Items, Failure and Causes
  - Maintenance Activities
  - System Affected

- New User Status Profile
  - To categorize how the problem was discovered
### SAP Notification – Partner Functionality

- IDs of personnel groups that routinely use or maintain equipment default from technical objects.

- Additional groups can be added as applicable.
Transaction Variants – Notification Create
Transaction Variants – “Queues” / List Edits

- Standard List Edits / Queues
- Standard variants per group (selection and display)
Summary of SAP System Changes

• Configuration changes
  – Catalog profiles and content
  – Notification screen templates
  – Functional location structure indicator
  – User status profile
• Classification
  – Class hierarchy
• Enhancements
  – Notification content
    • EXIT_SAPMIWO0_020
  – Equipment record content
    • EXIT_SAPMIEQ0_001
• Transaction simplification
  – Transaction variant
  – GUI xt
  – On-screen notification close-out process
  – Spares ordering
• Queuing by discipline
  – Partner functionality
  – Customized work lists based on partner ID
• Reporting to support new functionality
  – BIW web applications / queries
  – PM content to BW
Data and Technical Administration

- Centralized data repository with common technical and costing design
  - Master data is the foundation of sound end to end business processes
- Centralized support for technical design
  - ISO 14224 interpretations and performance measures
  - Part of the change management and governance process
- Local business ownership of data and results
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