Implementing ISO 14224 taxonomy and equipment model in WellMaster Reliability Management System (WRMS)

Hans Peter Jenssen, M.Sc.

Principal Consultant/Product Owner WRMS, Peloton

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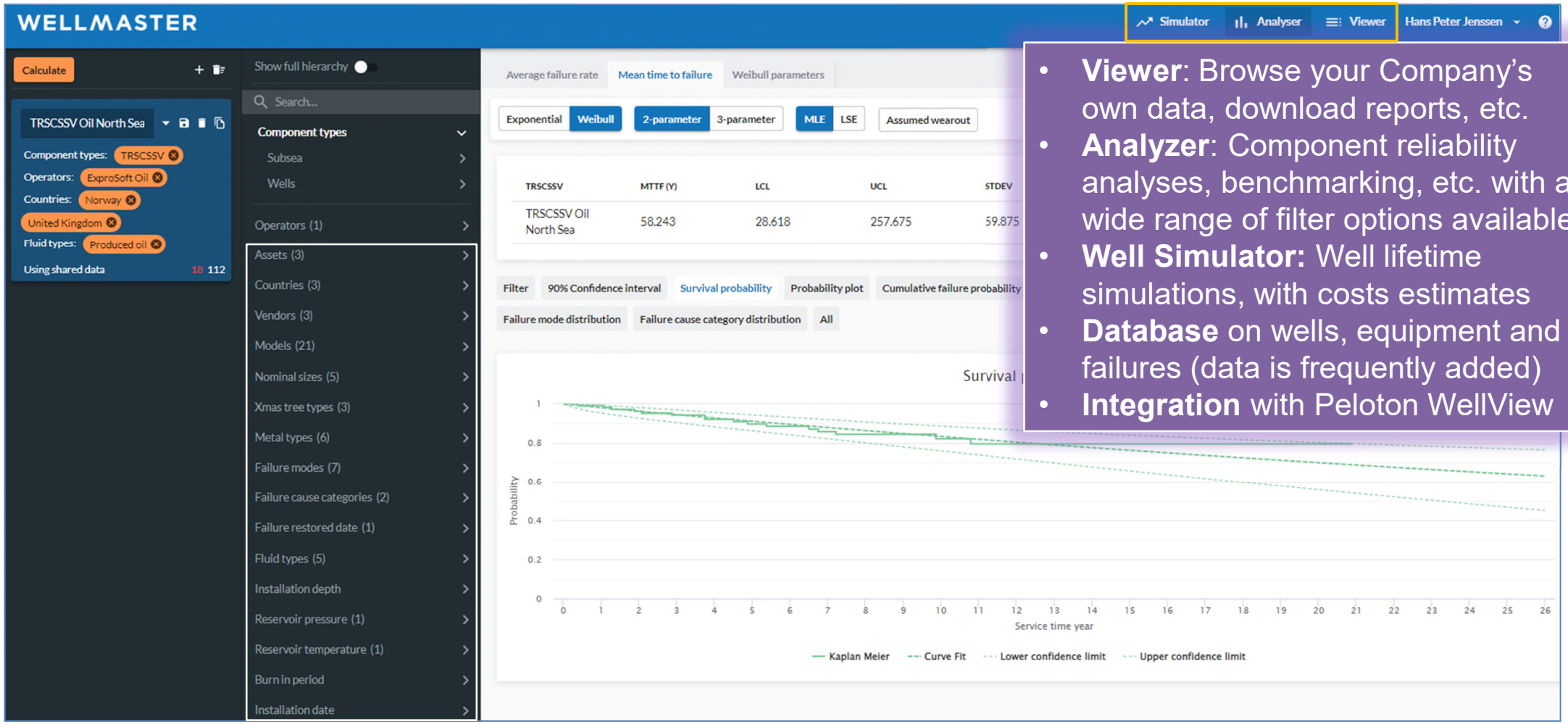
This presentation refers to the ISO 14224: 2016 standard

ISO/TC67/WG4 standards

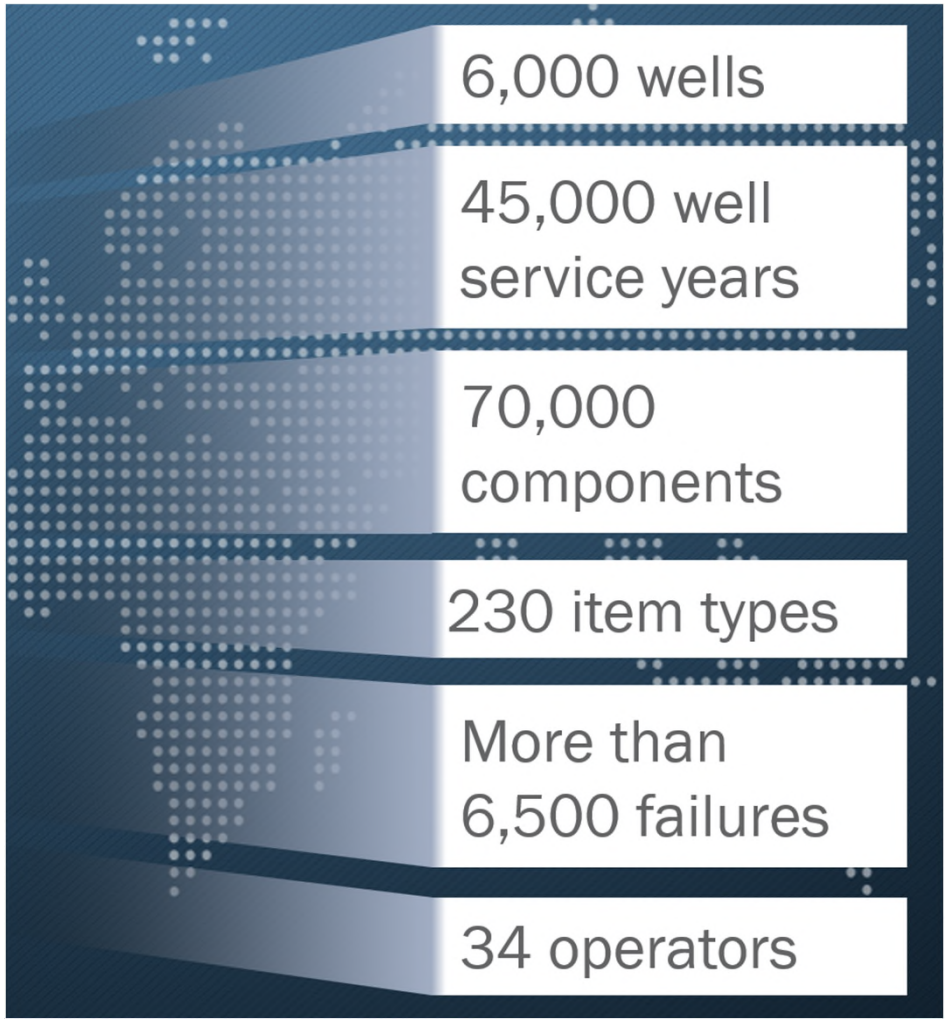
Peloton WellMaster Reliability Management System (WRMS)



- **Viewer**: Browse your Company's own data, download reports, etc.
- **Analyzer**: Component reliability analyses, benchmarking, etc. with a wide range of filter options available
- **Well Simulator:** Well lifetime simulations, with costs estimates
- **Database** on wells, equipment and failures (data is frequently added)
- **Integration** with Peloton WellView

WRMS with Industry Database

- Combine Industry data with your Company's own failure data to analyse well component reliability
- Analyse and review Vendor equipment
- Predict failures & required well interventions, downtime, with costs
- The data is anonymized with respect to Operators, Assets and Wells
- The shared database is available to all assigned WRMS license users
- 97 % of the data is related to Wells and includes the XMT with the SCM



Requirements for the WRMS taxonomy and data model

- Follows recognized international standards and commonly used terminology within the industry, based on a practical adaption to WRMS and the Database structure

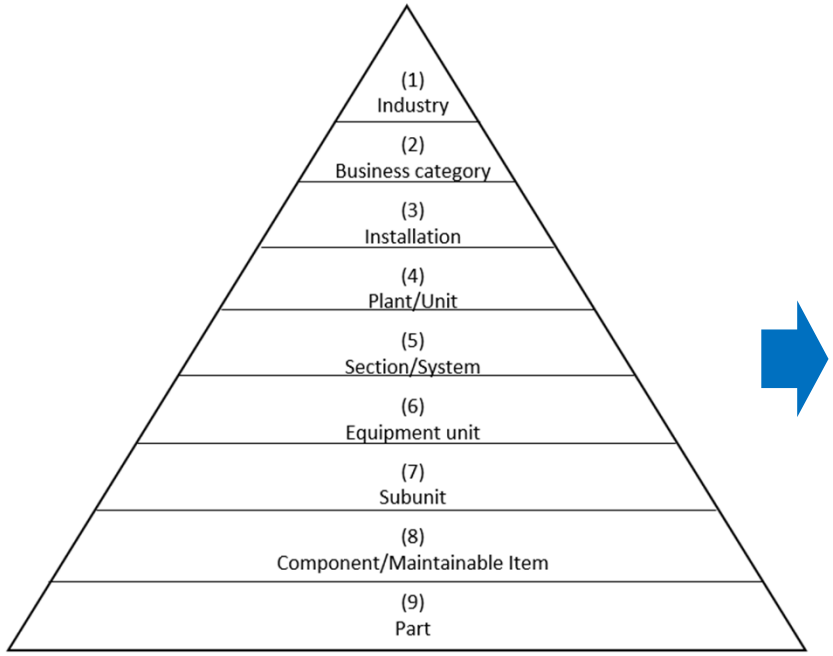
- Component types naming (level 8) is important due to pulling and uploading well equipment data from a wide and very diversified range of sources, including failures. Mapping of data is a key issue during the data collection process

- A stringent data model is also required for enabling component analyses:
  - Within an Asset/Field with several installations (offshore platforms, subsea etc)
  - Between different Assets for a specific Operator
  - Between various operators and regions for larger studies and JIPs

- It is fundamental that the data model is not too complex, but that it allows for running analyses on a level where it will provide practical and useful decision support during all well life-cycles. Focus is on the Maintainable items (component types)

WRMS Equipment taxonomy reference ISO 14224

ISO 14224 ‘pyramid’ and the WRMS taxonomy hierarchy



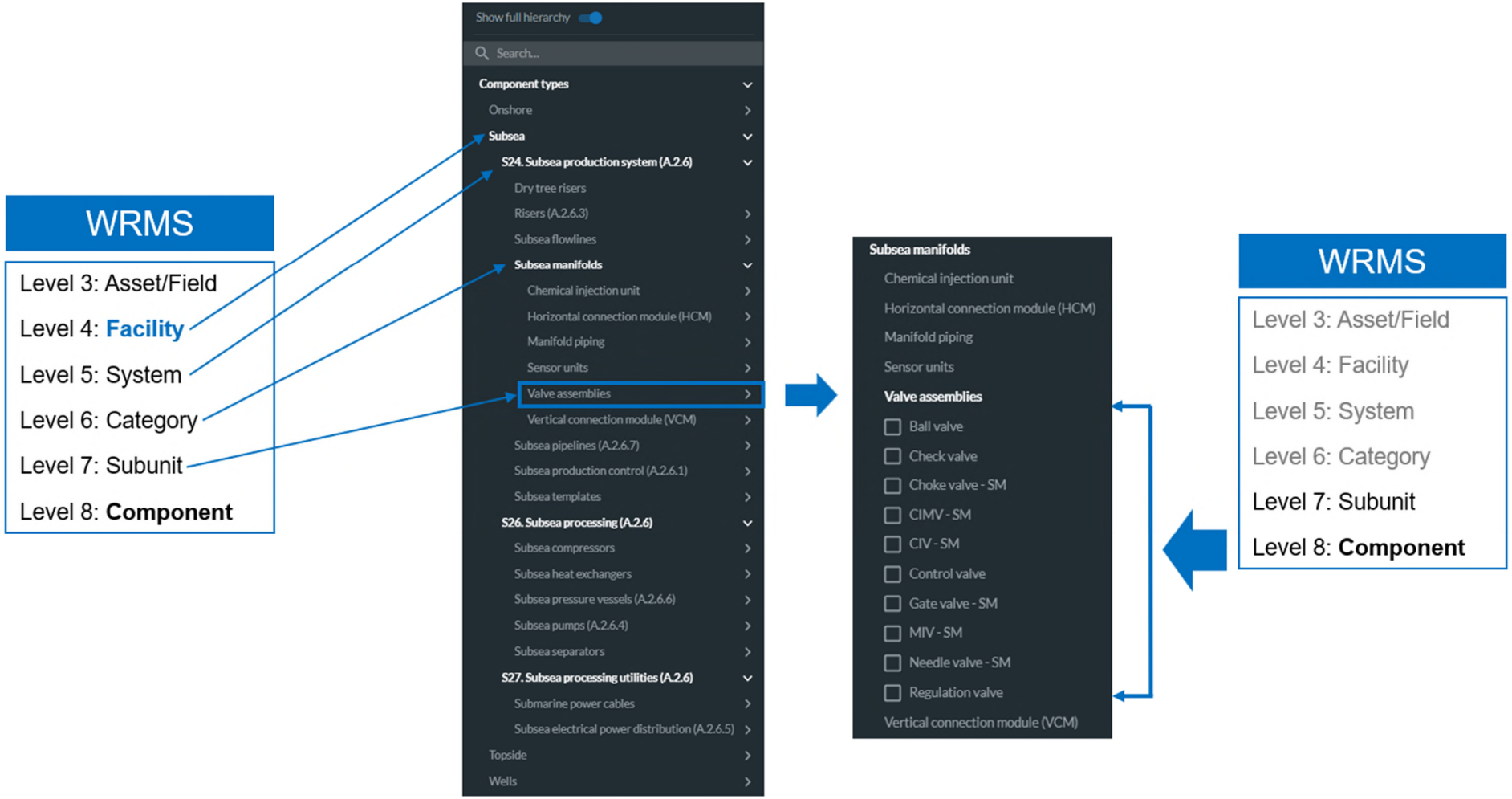
WRMS
Level 3: Asset/Field
Level 4: **Facility**
Level 5: System
Level 6: Category
Level 7: Subunit
Level 8: **Component**

Facilities defined in WRMS (Level 4. Facility):

- **Wells (all types of Wells; Onshore, Topside, Subsea, and includes the XMT)**
- **Subsea (Seabed installed equipment and systems not related to the Wells)**
- **All analyses in WRMS are on Level 8: Component (Maintainable Item)**

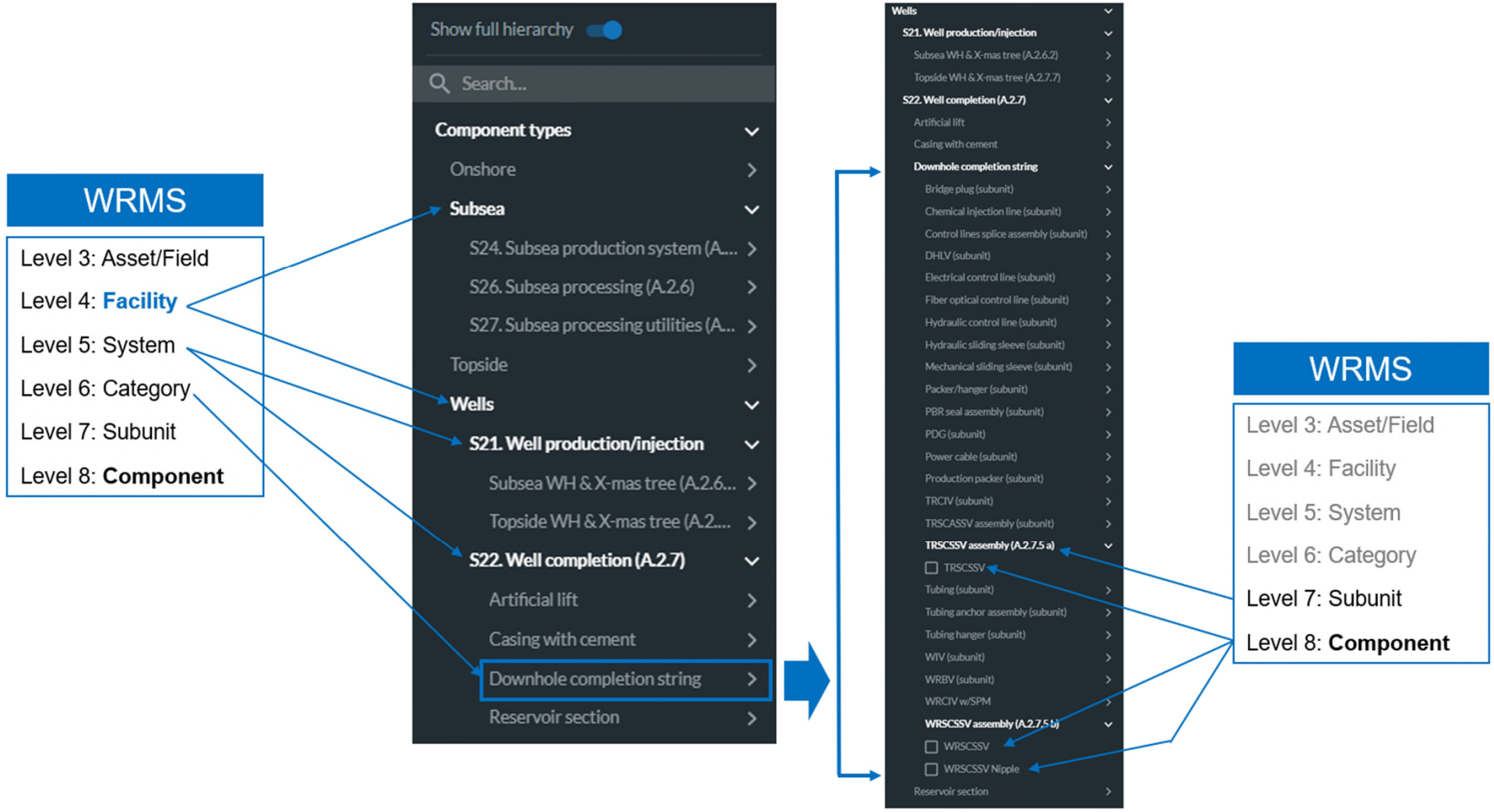
WRMS Equipment taxonomy reference ISO 14224

Facility – Subsea

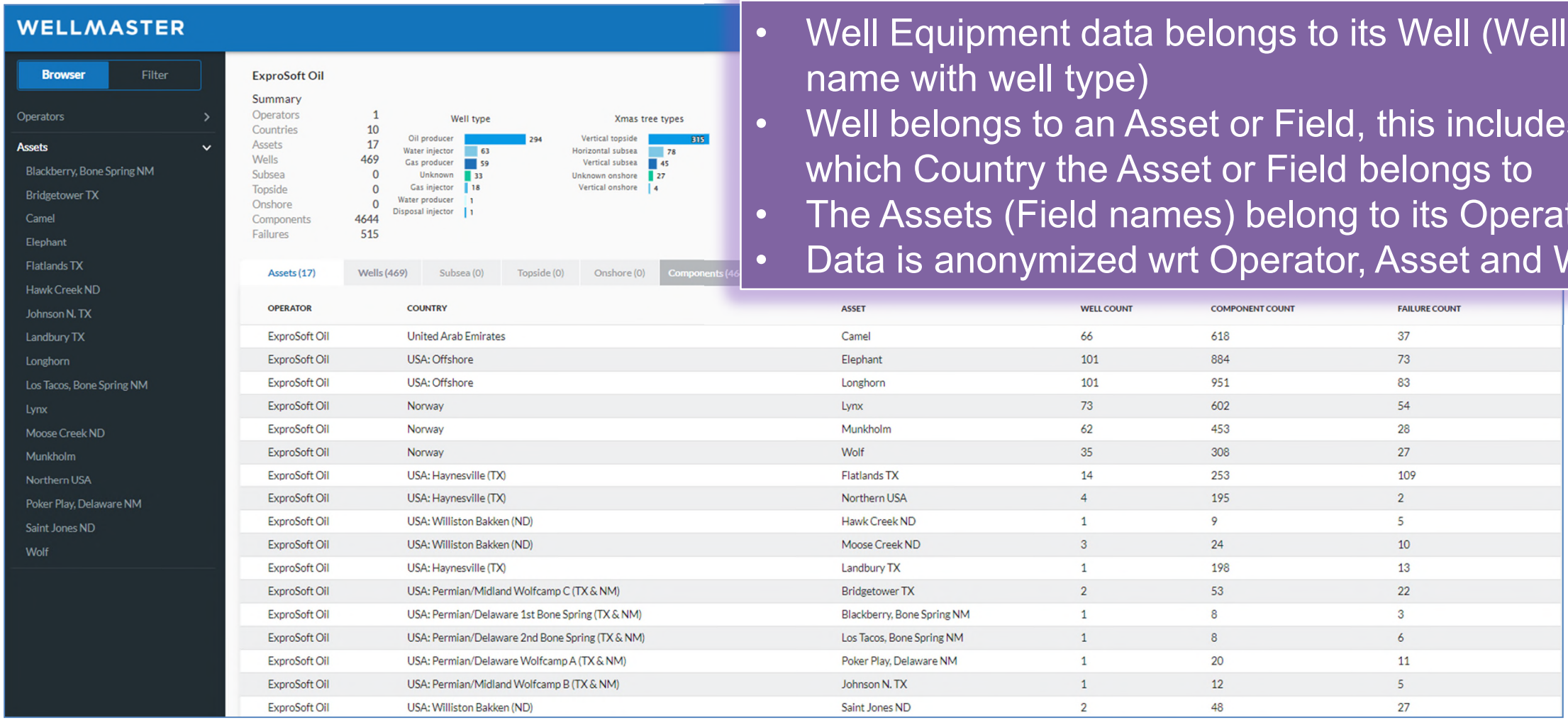


WRMS Equipment taxonomy reference ISO 14224

Facility – Wells



WRMS taxonomy model and data model – level 3



OPERATOR	COUNTRY	ASSET	WELL COUNT	COMPONENT COUNT	FAILURE COUNT
ExproSoft Oil	United Arab Emirates	Camel	66	618	37
ExproSoft Oil	USA: Offshore	Elephant	101	884	73
ExproSoft Oil	USA: Offshore	Longhorn	101	951	83
ExproSoft Oil	Norway	Lynx	73	602	54
ExproSoft Oil	Norway	Munkholm	62	453	28
ExproSoft Oil	Norway	Wolf	35	308	27
ExproSoft Oil	USA: Haynesville (TX)	Flatlands TX	14	253	109
ExproSoft Oil	USA: Haynesville (TX)	Northern USA	4	195	2
ExproSoft Oil	USA: Williston Bakken (ND)	Hawk Creek ND	1	9	5
ExproSoft Oil	USA: Williston Bakken (ND)	Moose Creek ND	3	24	10
ExproSoft Oil	USA: Haynesville (TX)	Landbury TX	1	198	13
ExproSoft Oil	USA: Permian/Midland Wolfcamp C (TX & NM)	Bridgetower TX	2	53	22
ExproSoft Oil	USA: Permian/Delaware 1st Bone Spring (TX & NM)	Blackberry, Bone Spring NM	1	8	3
ExproSoft Oil	USA: Permian/Delaware 2nd Bone Spring (TX & NM)	Los Tacos, Bone Spring NM	1	8	6
ExproSoft Oil	USA: Permian/Delaware Wolfcamp A (TX & NM)	Poker Play, Delaware NM	1	20	11
ExproSoft Oil	USA: Permian/Midland Wolfcamp B (TX & NM)	Johnson N. TX	1	12	5
ExproSoft Oil	USA: Williston Bakken (ND)	Saint Jones ND	2	48	27

- Well Equipment data belongs to its Well (Well name with well type)
- Well belongs to an Asset or Field, this includes which Country the Asset or Field belongs to
- The Assets (Field names) belong to its Operator
- Data is anonymized wrt Operator, Asset and Well

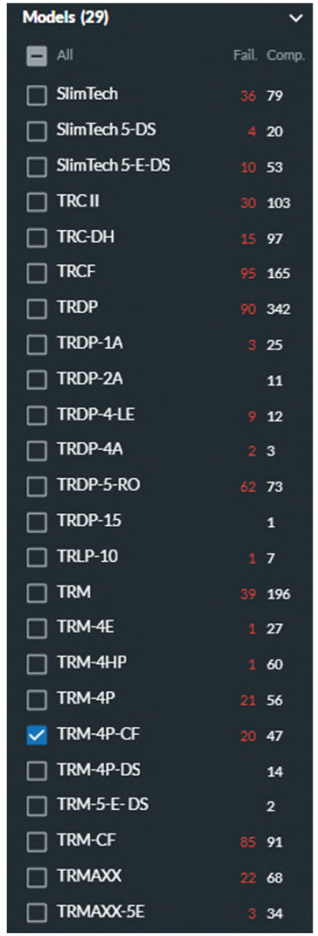
Well Equipment data model level 8 – details

- Each Component type (level 8) is defined by its name in the hierarchy
- For each Component, data on attributes, features and events is collected
- The Equipment data model is generic for all Component types
- For each Component type, there is a pre-defined set of Failure modes to be applied when uploading failure data to the database
- There is also a generic set of Failure cause categories defined
- Both the Failure modes and the Failure cause categories are filter options when setting up and running Component analyses in WRMS

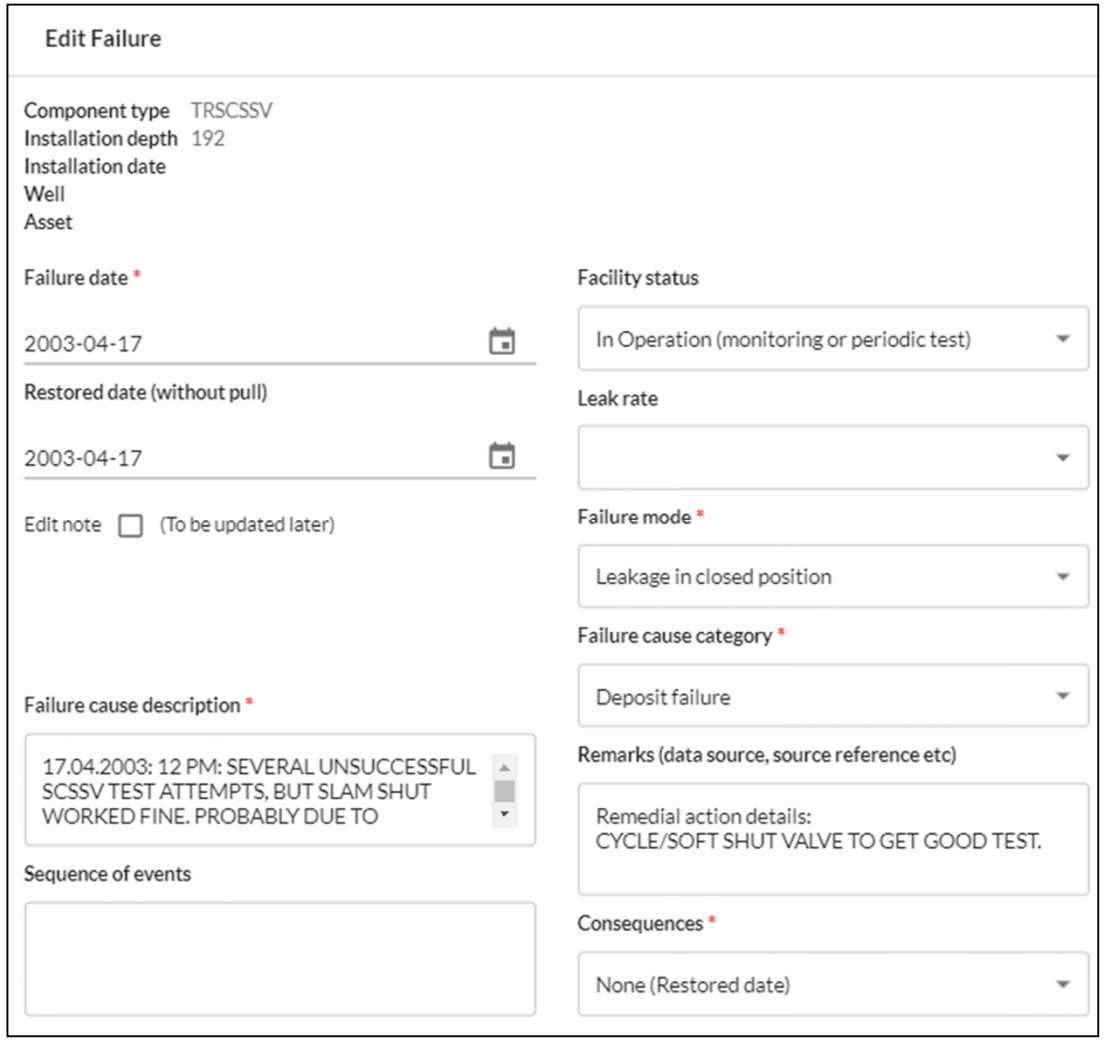
Well Equipment data model level 8 – details

Component	*Working on Production database*
Id	7902
ComponentType	TRSCSSV
Vendor	Schlumberger
Model	TRM-4P-CF
ElastomerType	Unknown
MetalType	13Cr
FluidType	
SerialNumber	
PartNumber	TRM-4P-CF 5.5"-13CR80-ID:4.562"
Remarks	
Interface	
InstallationDepthMeter	185
LengthMeter	
InstallDate	31/03/2004
OperationStartedDate	14/04/2004
EndDate	15/11/2013
EndEvent	Pulled
LastDataCollectionDate	15/04/2021
NominalSizeIn	5.5
WorkingPressurePsi	
WorkingTemperatureMinC	
WorkingTemperatureMaxC	
Tag	

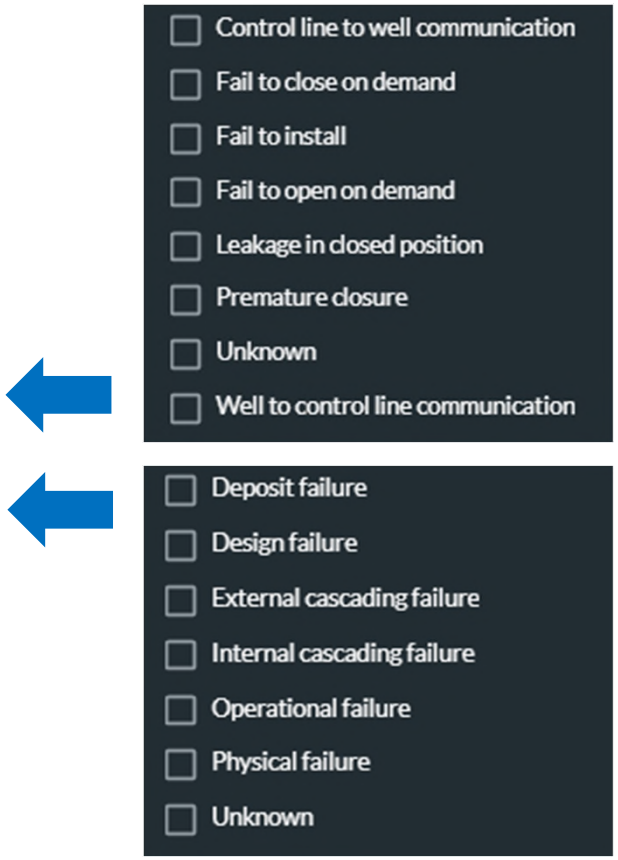
Drop-down lists defined for some of the data entries, such as Vendor, Model, Metal type etc



Well Equipment failures – data model



Drop-down lists for Failure modes (TRSCSSV) and Failure cause categories (generic):



Results from the reliability analyses in WRMS

Result tabs in WRMS	Notes
Average failure rate (AFR)	Average failure rate per year with confidence interval (LCL and UCL)

Mean time to failure (MTTF)	The MTTF is calculated for the following:
	• The Exponential distribution
	• The Weibull distribution:
	  ○ Weibull 2P MLE (Maximum Likelihood Estimation)
	  ○ Weibull 2P LSE (Least Square Estimation)
	  ○ Weibull 3P
	Weibull distribution and estimations incorporates the fact that mechanical components experience an increased failure rate over time, for various reasons (such as wear, corrosion, erosion, fatigue, ageing, etc.).

Weibull parameters	Scale and Shape parameters for 2P MLE and 2P LSE, and in addition also the Location parameter for the Weibull 3P model
90% Confidence interval	The Confidence intervals are shown for the AFR, and for the Exponential and Weibull MTTFs
Survival probability	Survival probability curves (curve fit to Kaplan Meier survivor plot function) are shown for the Exponential and Weibull MTTFs
Probability plot	This is the plot with Failure time on the X-axis and Probability on the Y-axis. It is shown under the Weibull parameters tab.
Cumulative failure probability	This is the plot with Service time year on the X-axis and Probability on the Y-axis
Components per time interval	Chart showing number of components installed per time interval (per year)
Failures per time interval	Chart showing number of Failures per time interval (per year)
Failure rate per time interval	Chart showing the Failure rate per time interval (per year)
Failure modes distribution	There is a set of pre-defined failure modes for each Component type in the WRMS data model.
Failure cause categories distribution	A generic set of failure cause categories are defined for all Component types in the WRMS data model

Some concluding remarks

- The ISO 14224 taxonomy model with organizing the equipment has been useful for developing the taxonomy equipment hierarchy in WRMS
- Practical adaptions to the ISO Equipment taxonomy have been necessary
- Flexibility in the WRMS data model allows further changes in the WRMS equipment taxonomy to be more in accordance with ISO 14224 taxonomy, primarly for the subsea installed systems/equipment not related to wells
- The ISO 14224 standard should be developed further also to cover more on taxonomy requirements and guidance for well completion equipment
- For users, WRMS has proved to be a flexible tool when it comes to defining analyses' scope and apply a range of filter settings for analyses
- A structured equipment taxonomy hierarchy is fundamental to achieve this

The WRMS Industry database is being regularly updated

Data Contributors during the period 2018 – 2022

- Chevron
- Petrobras
- Aker BP
- Total
- Lundin

Data on:	December 2017	September 2022	Increase in period 2018 -2022
Assets	298	337	39
Wells	5 509	5 985	476
Failures	5 532	6 563	1 031

Thank You for Your attention!

Questions are welcomed!