SAP Intelligent Asset Management (IAM)

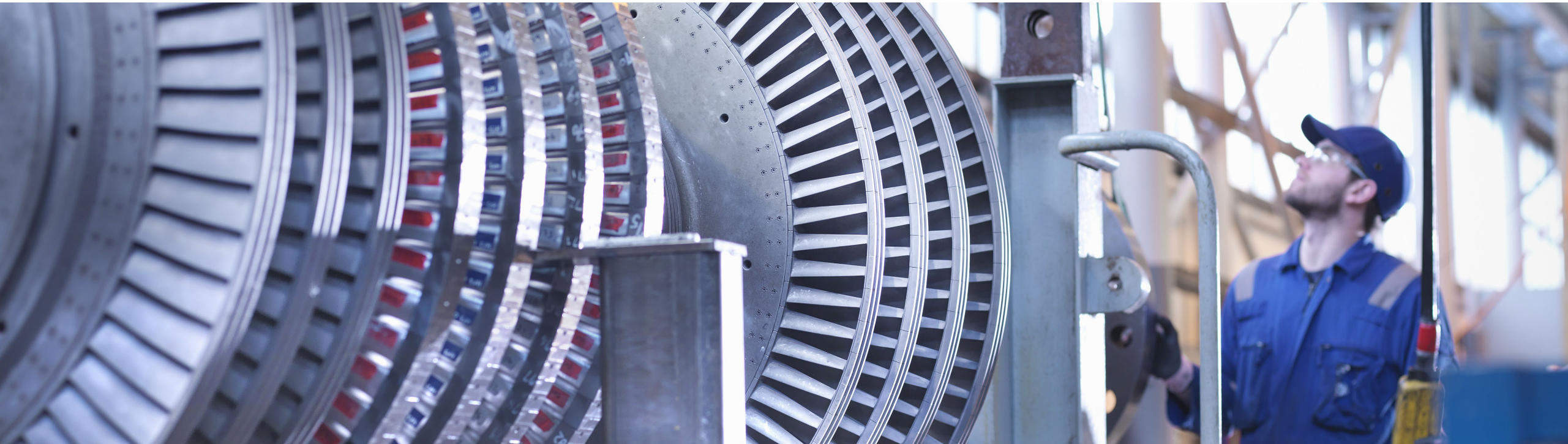
Mitigating Risk and Improving Performance: The Road Ahead with SAP Asset Performance Management

September 2022

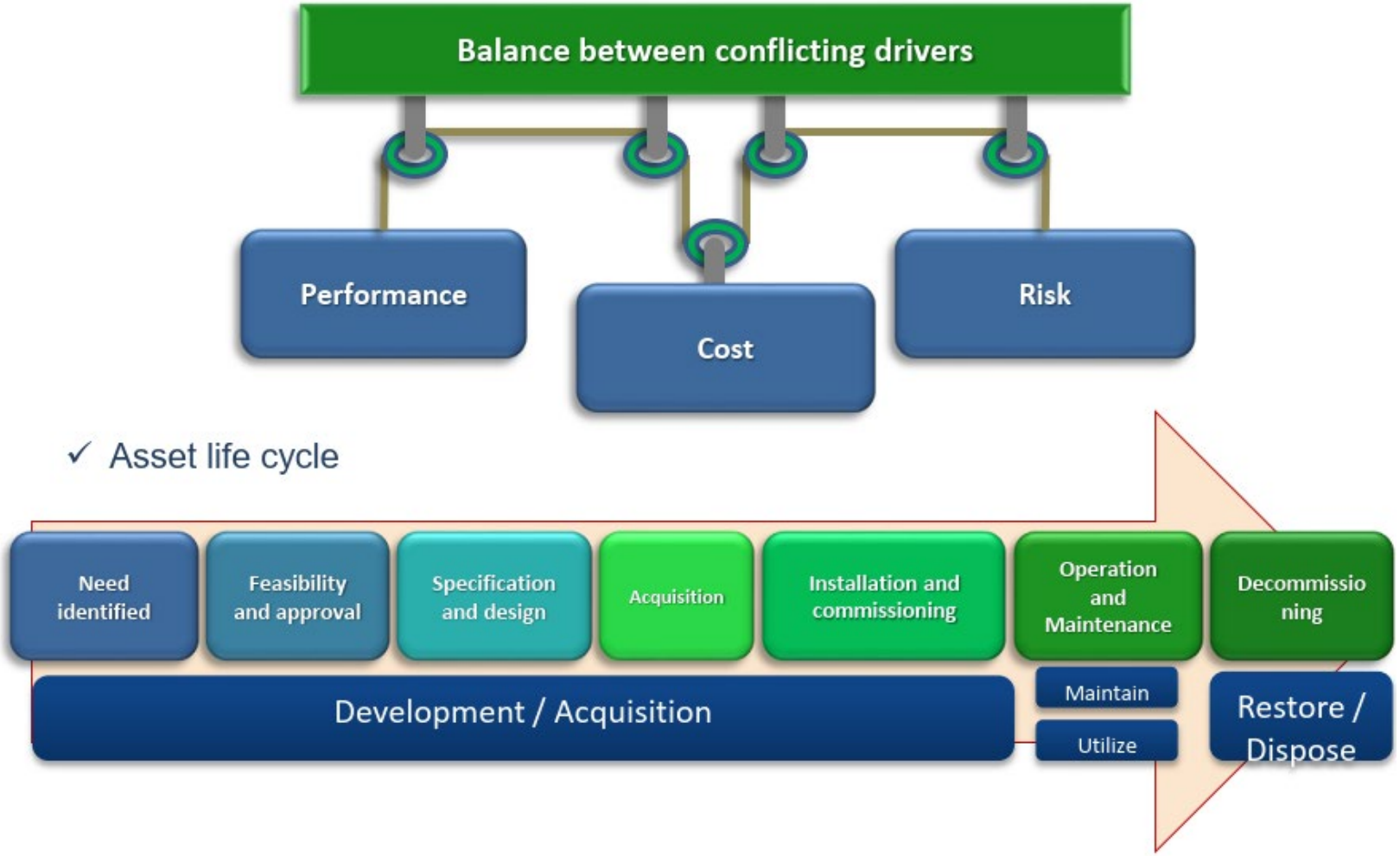
THE BEST RUN SAP

Brian Williams, Solution Owner, Asset Performance Management, DSC&I4-Digital Assets, SAP

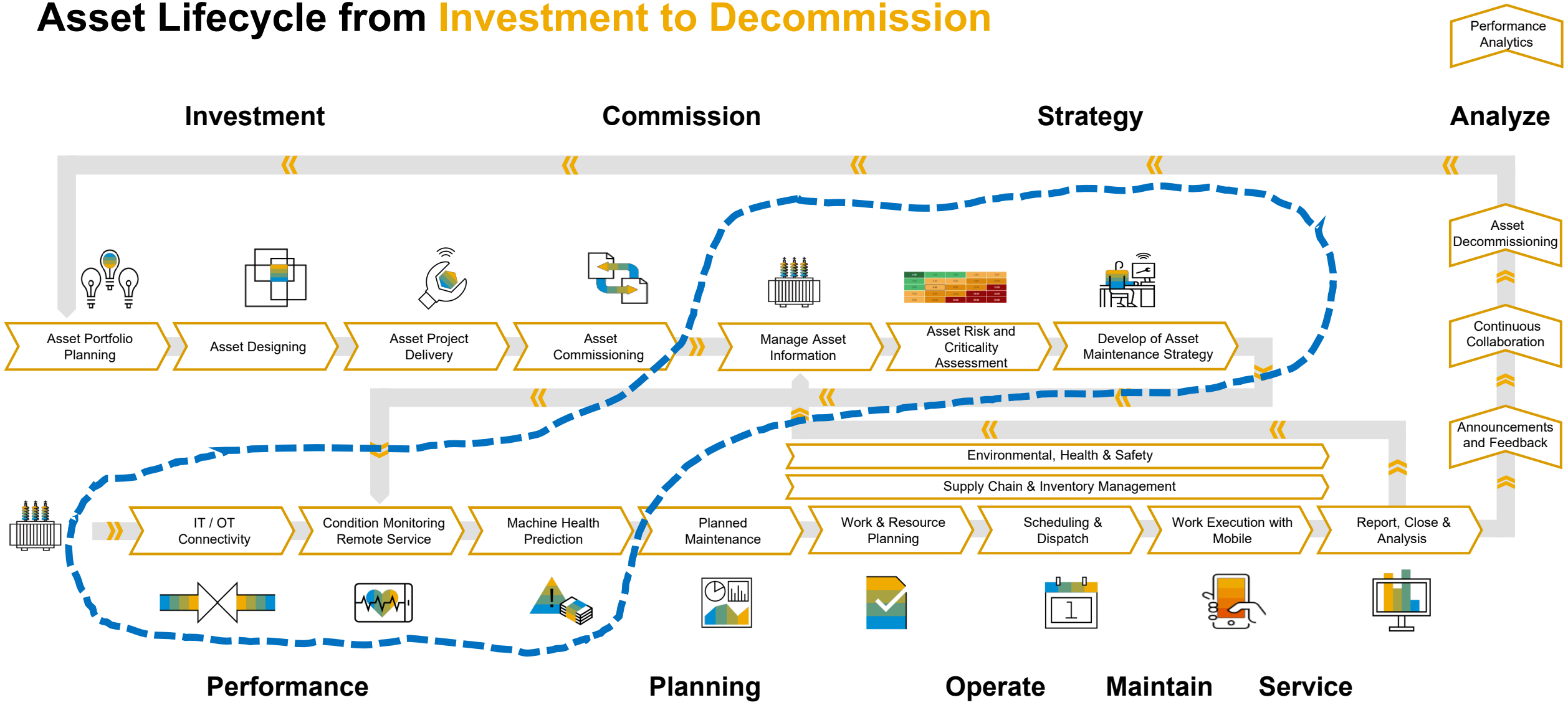
- How Asset Performance Management can take SAP S/4HANA Foundation to next level
- How to achieve a strategy driven Asset Management



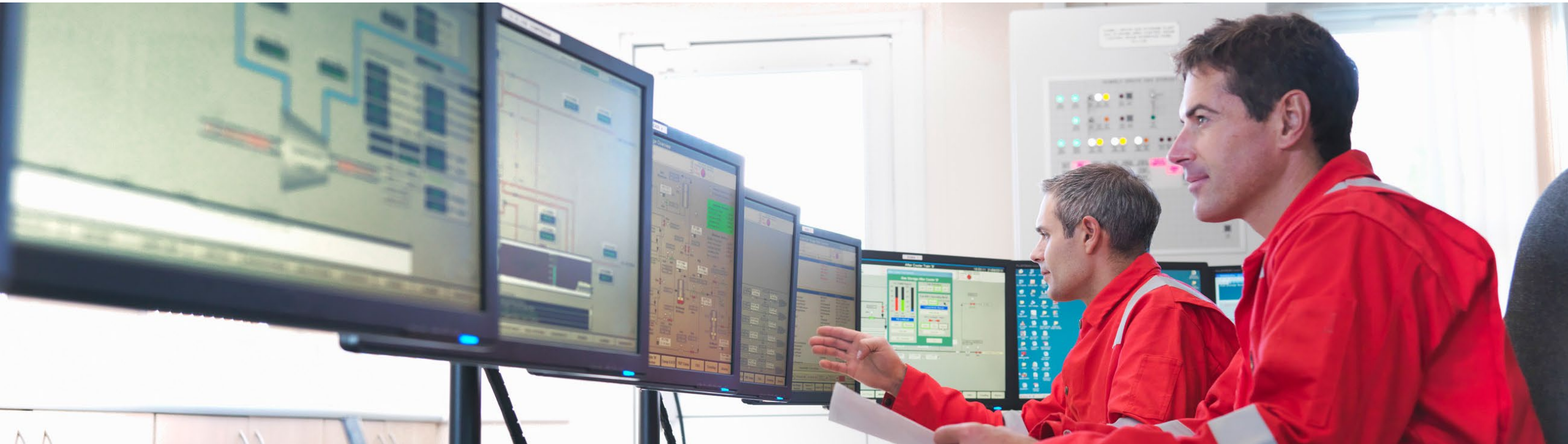
Goal: Optimizing Asset Management



Asset Lifecycle from Investment to Decommission



Intelligent Asset Management Overview



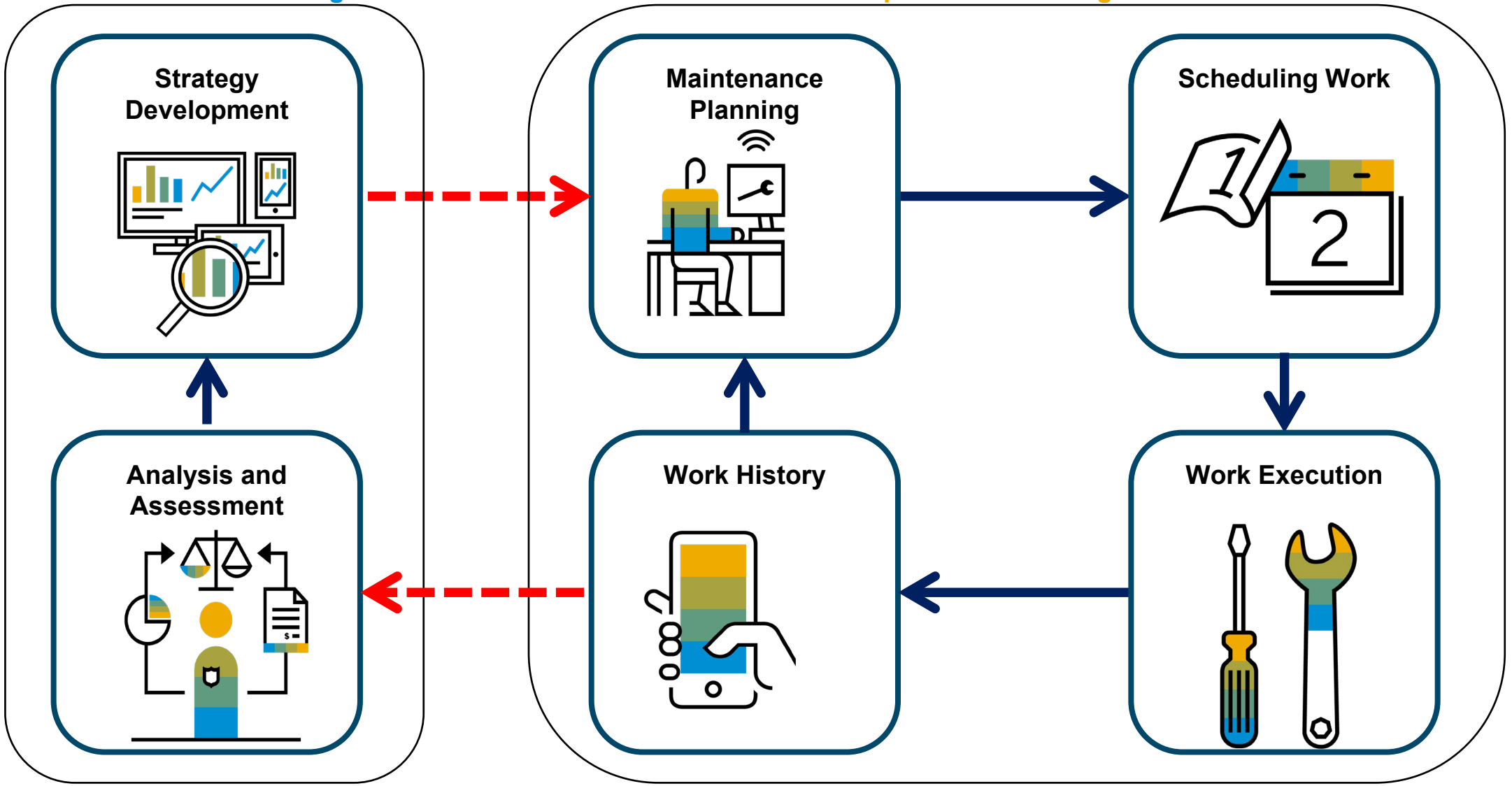
Status Quo

The Right Tasks

Asset Performance Management

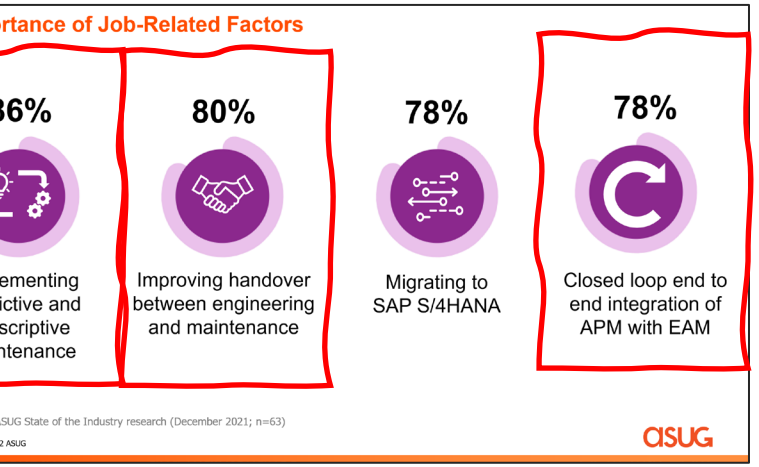
Executed Well

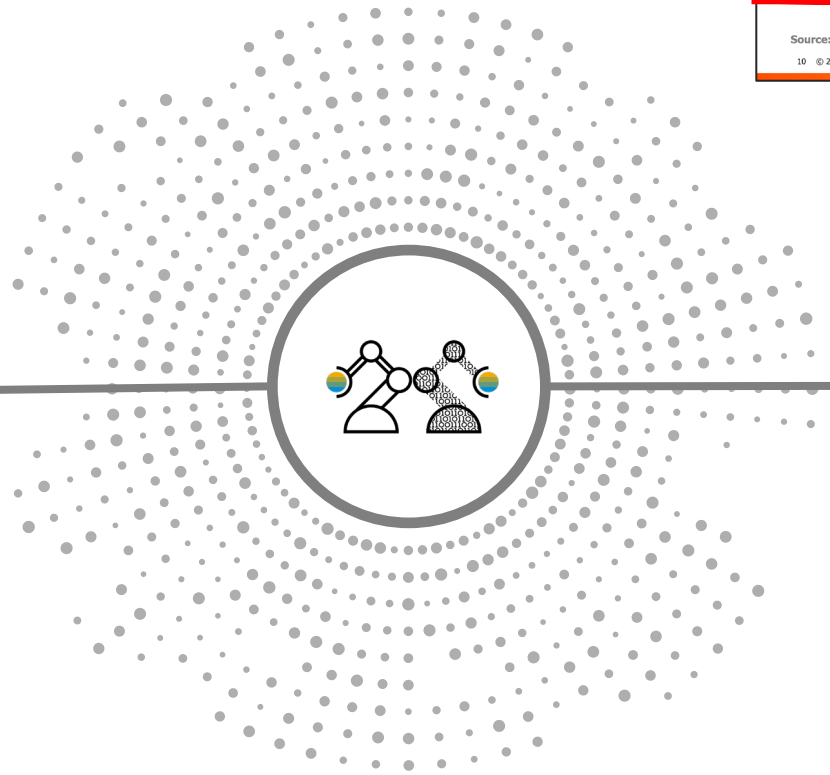
Enterprise Asset Management

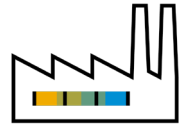


The New Way: Intelligent Asset Management

Converge Strategy and Execution







Asset Performance Management

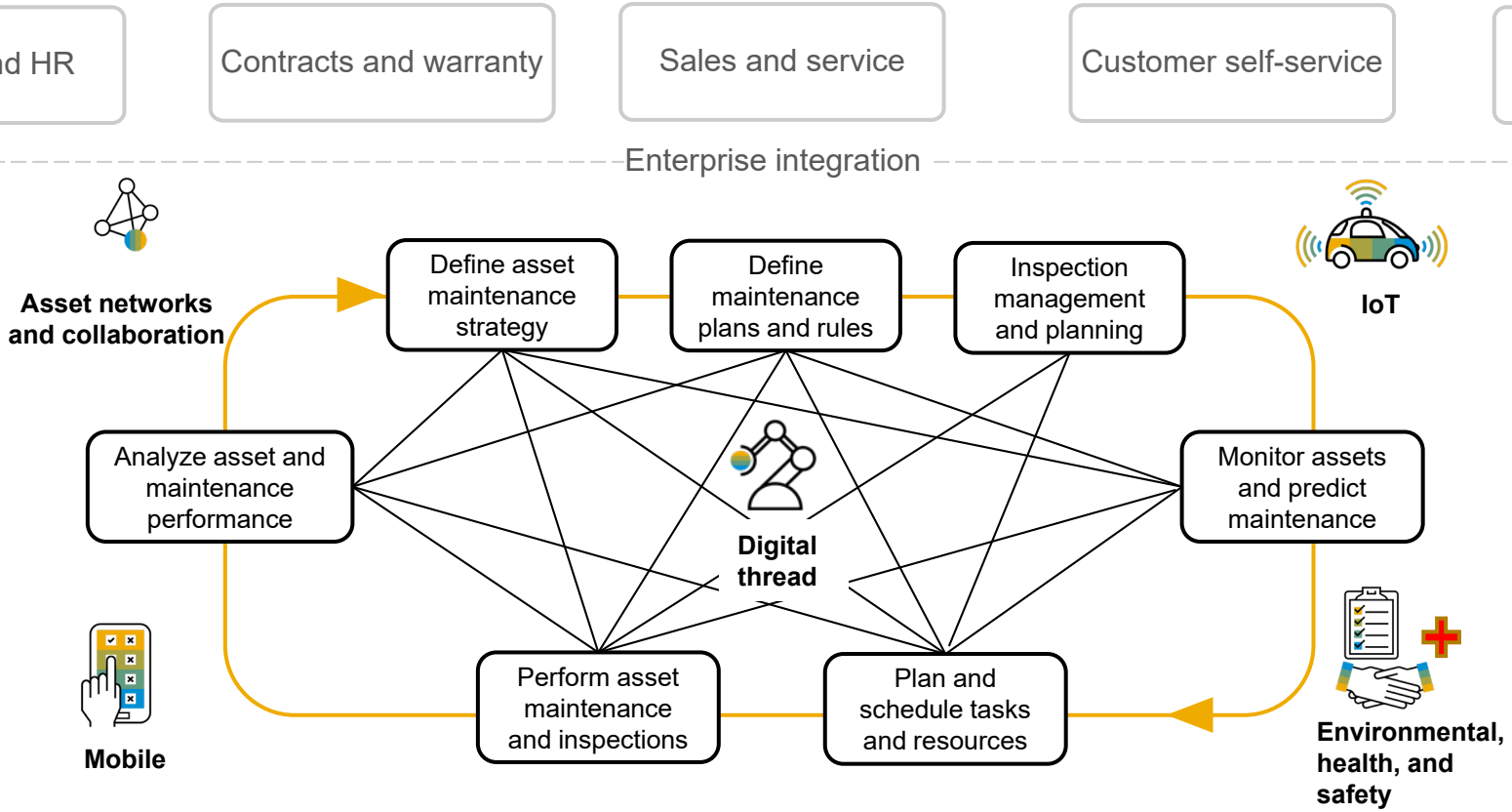
Capabilities to **constantly** assess and improve **asset availability and its output**, to extend asset life, including **risk** and **reliability management**, **predictive** and **prescriptive maintenance**, and asset **integrity management**.

Enterprise Asset Management

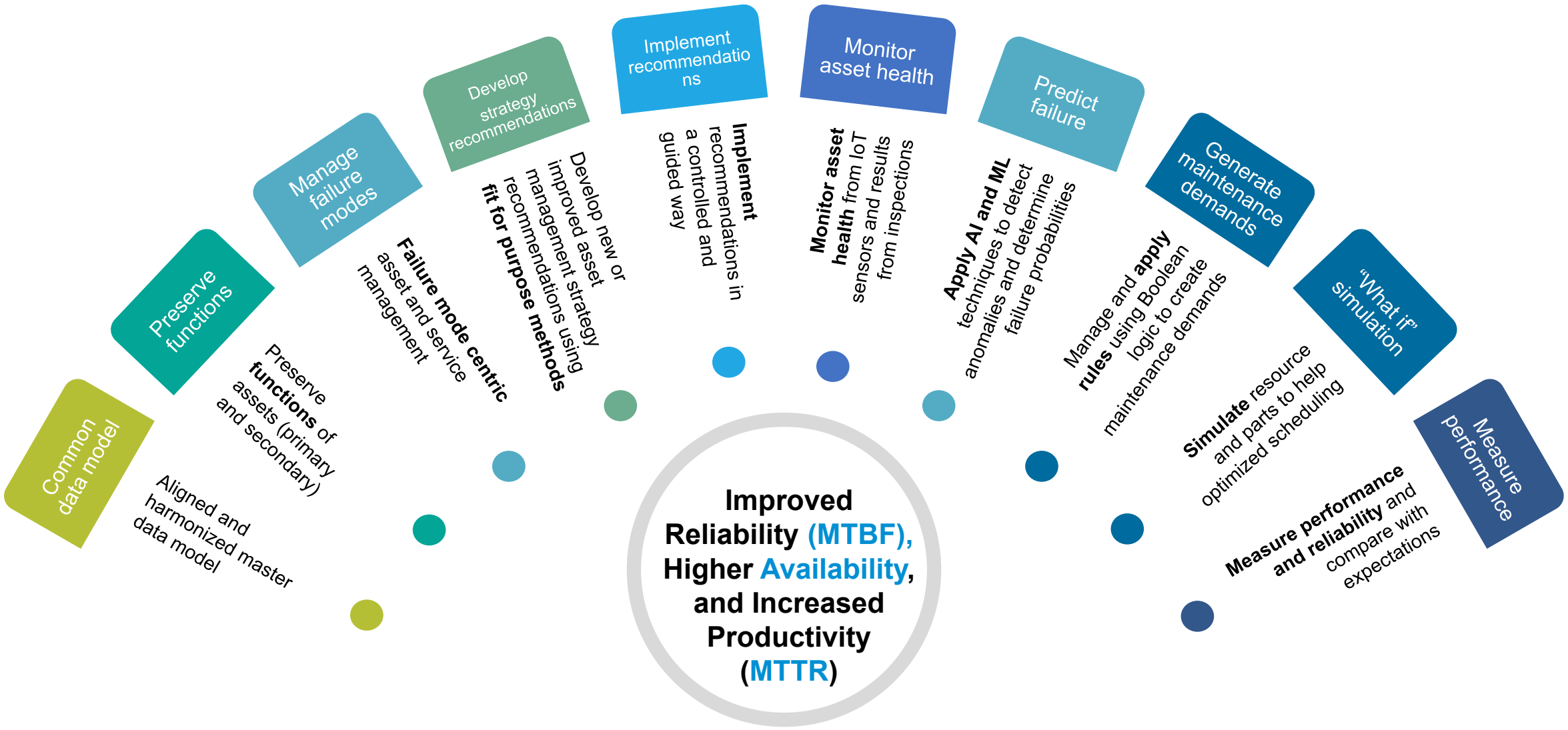
Capabilities for **managing maintenance operations** including planned and unplanned maintenance, scheduling work and resources, work order management and reporting, mobile support for maintenance technicians; it also covers solutions for asset acquisition and life cycle management, capital portfolio and project management, and environment, health and safety

Closed-loop strategy, planning, and execution

Optimizing **Asset Performance Management** and **Enterprise Asset Management** outcomes with end-to-end processes based on common data



What is Asset Performance Management ?



SAP Portfolio for Intelligent Asset Management

Increase Asset Performance, Reduce Maintenance Costs and Deliver Service Excellence

Closed-Loop strategy, planning and execution processes to optimize **Asset Performance Management**

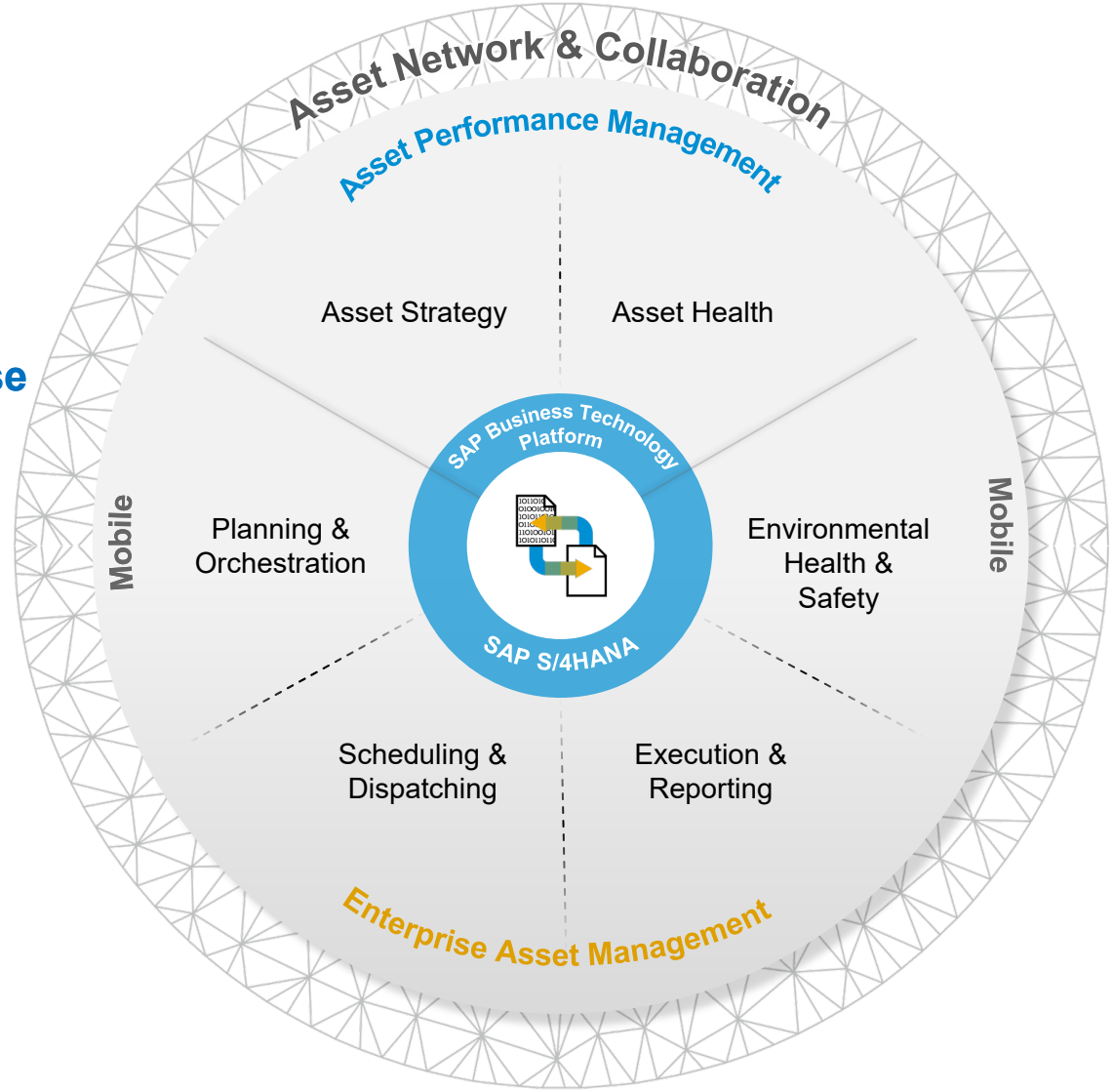
Synchronize maintenance and service across the **enterprise** for responsive customer care and supply chain **resilience**

Adopt new **collaborative** processes and 'products-as-a-service' business models across **Networks**

Manage asset health with **Industry4.0** for real time predictive maintenance and service

Optimize maintenance and service with **intelligent scheduling** and **crowd sourced** resource management

Empower users with **Mobile** asset intelligence, work automation and safe sustainable **EH&S** policies



Intelligent Asset Management Solution Capabilities

Asset Performance Management

Asset Strategy

Risk & Reliability Management

- Asset Risk and Criticality Assessment
- Reliability Assessment Management

Strategy Recommendation Management

- Maintenance Strategy Definition
- Recommendation Management

Asset Health

Health Monitoring & Prediction

- IoT & Inspection Condition Monitoring
- Asset Health Scoring
- AI Predictive Modeling

Maintenance Demand Generation

- Maintenance Rules Management
- Prescriptive Demand Generation

Operational & Performance Analytics

- Asset Health Analytics
- Asset Management Operational Analytics
- Asset Management Process Analytics

Enterprise Asset Management

Planning & Orchestration

- Maintenance Work Definition
- Maintenance Plans & Policies Management
- Maintenance Program & Project Planning
- Maintenance Backlog Management

Scheduling & Dispatch

- Resource & Capacity Planning
- Work Planning & Prioritization
- Scheduling & Resource Optimization
- Dispatch & Supervision

Execution & Reporting

- Work Order Management
- Inspection Execution
- Reporting & Accounting
- Resource & Parts Management

Mobile

- Mobile Persona Management
- Mobile work automation
- Geospatial integration
- Forms management

Extended Capabilities

Asset Network & Collaboration

- Partner Management
- Asset Content Collaboration
- Collaborative Maintenance and Service

Investment & Project Management

- Capital Investment Portfolio Planning
- Asset & Maintenance Project Management
- Project Accounting

Asset Information Management

- Asset Master Data Management

Environment, Health & Safety

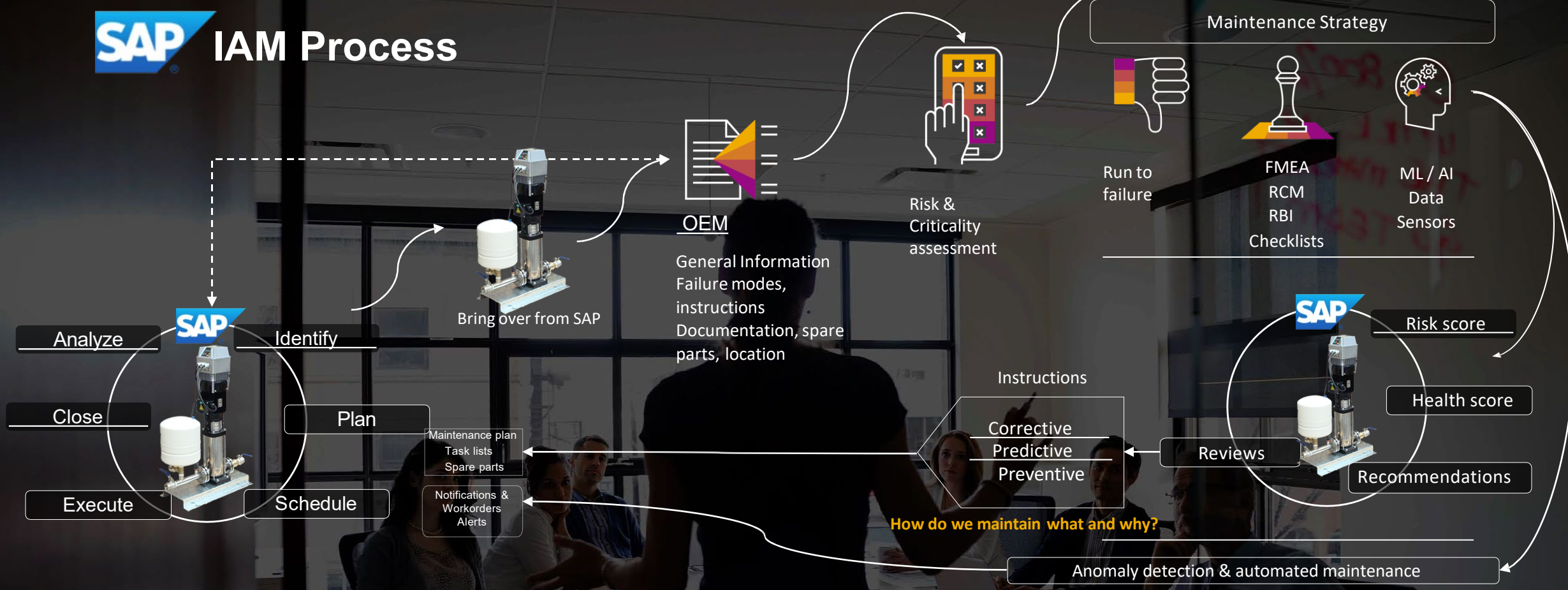
- Environmental Risk Management
- Occupational Safety Management
- Management of Change

Case Study:
Improve Reliability of a Pump

IAM Task Example: Improve Reliability of a Pump

- Assess / update information on design, attributes, vendor documents, etc.
- Build out documents via internal and external collaboration
- Risk rank the asset, and determine its Failure modes, causes, and effects
- Select risk assessment methodology , implement & generate maintenance or modification recommendations
- Based on assessment results and recommendations, develop actions such as:
  - ✓ Corrective task
  - ✓ Repetitive task
  - ✓ Predictive task
- Create changes in S/4HANA or ECC and monitor
- If predictive actions are also recommended, connect various feeds from IOT devices, plant historians, Plc's, etc. to begin predictive monitoring
  - ✓ Alert generation
  - ✓ Texts /emails
  - ✓ Auto generate maintenance notifications

IAM Process



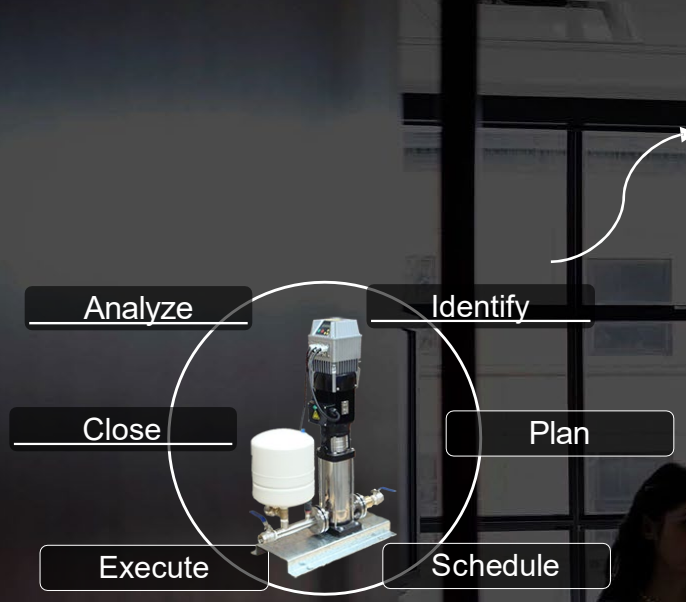
What do we do right & where do we need to adjust?

Maintenance Execution

Performance Analytics

Asset Performance Management

Improve Asset Reliability



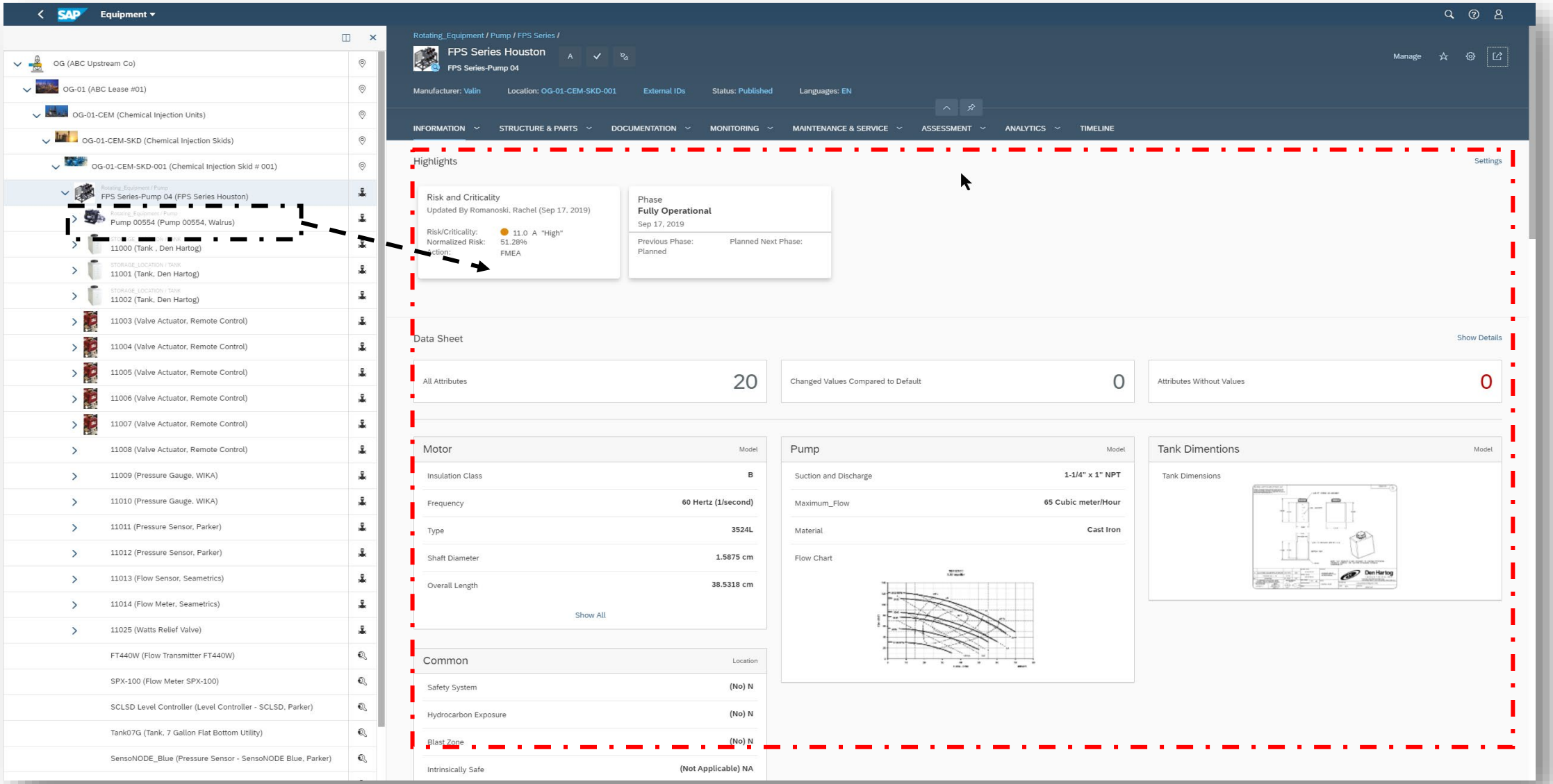
What do we do right & where do we need to adjust?

Maintenance Execution

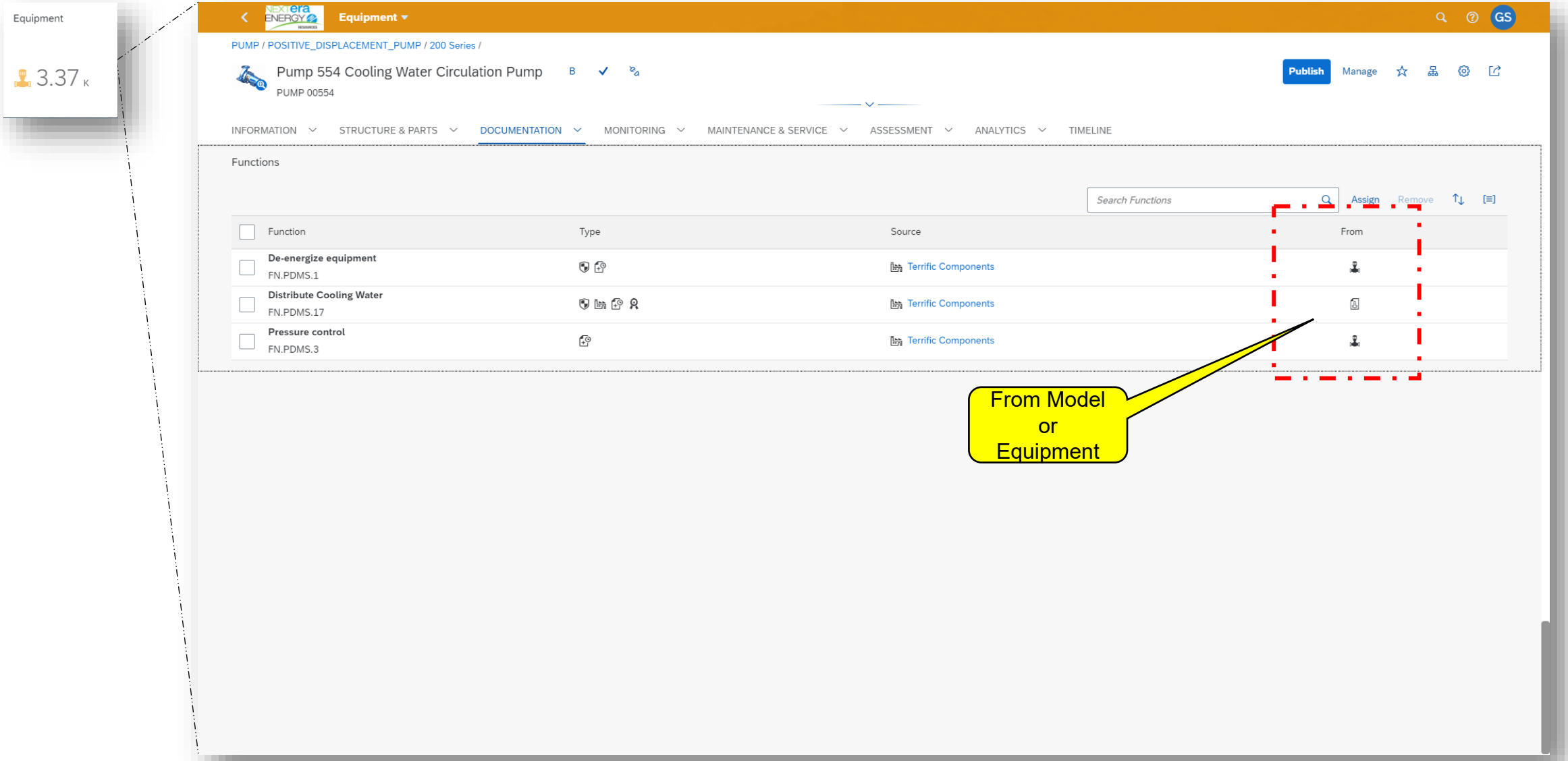
Performance Analytics

Asset Performance Management

Locate asset in the structure



Add / Update Functions



Add / Update Attributes

Equipment

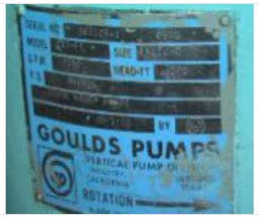
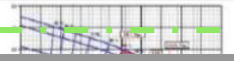
3.37 K

Equipment

Pump 554 Cooling Water Circulation Pump - Data Sheet

Edit | Order & Visibility | Add Template | Remove Template

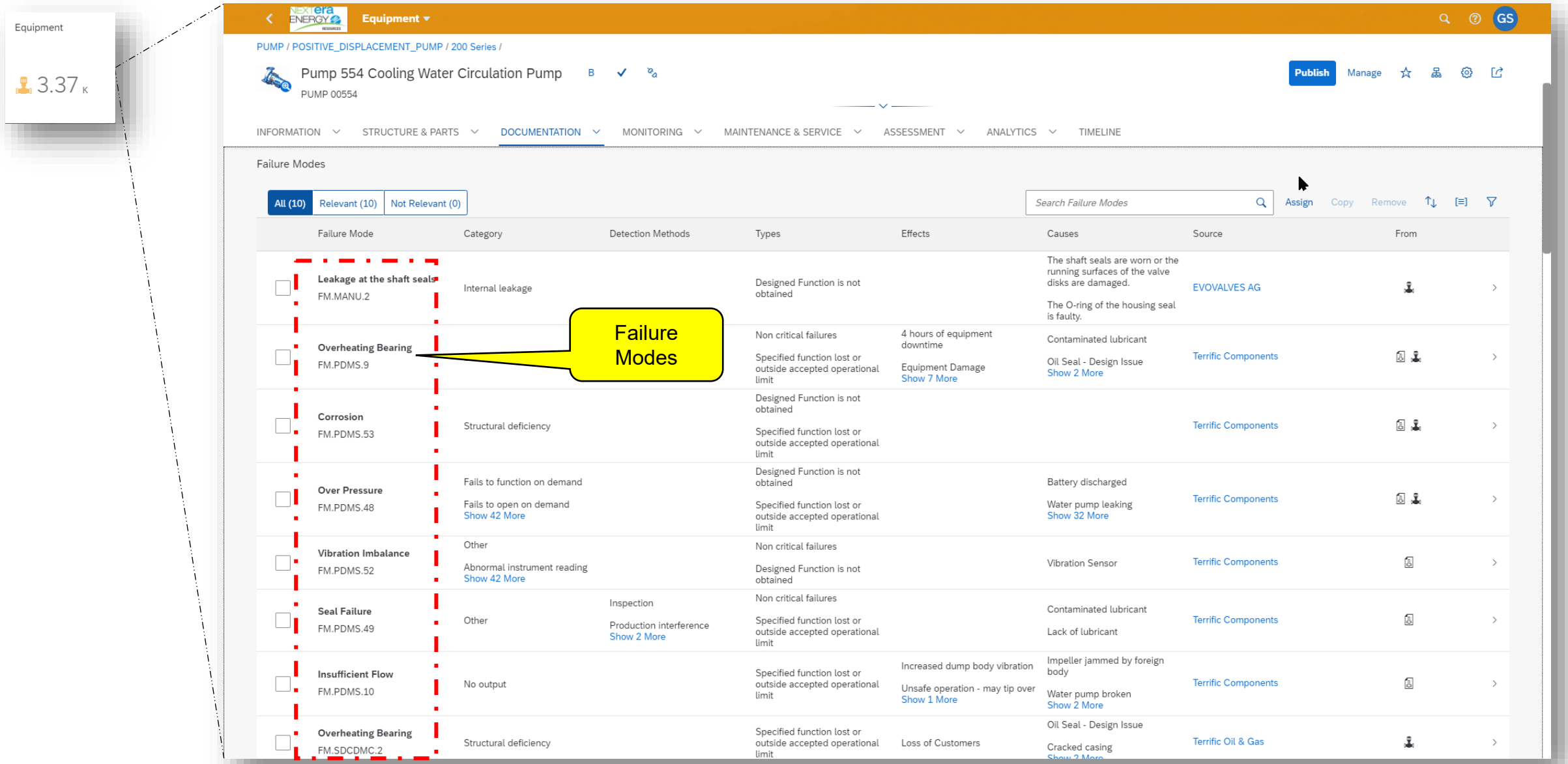
All Attributes (16) | Search Attributes | Show Alternate UoM

Attribute	Value	Default Value
MH0110_EQUI_1 (Source : Equipment)		
Date till reservation	Dec 23, 2021	No Difference
Tablet diameter	20 µm	No Difference
Status (Source : Equipment)		
Status	True	No Difference
Rotating Model (Source : Model)		
Maximum Flow	100 m3/h	-
Maximum Temperature	210 °C	-
Maximum Pressure	50 bar	-
Maximum Head	60 m	-
Rotating Equipment attributes on Equipment level (Source : Model)		
Spared	No	-
Installation Year	2010	-
Nameplate		-
Color	-	-
EAN Number	True	-
		

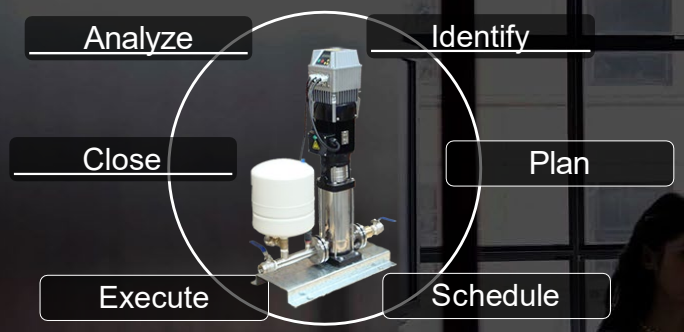
From Equipment Template

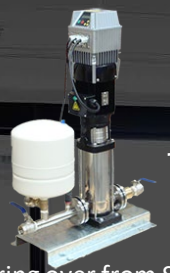
From Model Template

Add / Update Failure Modes



Vendor Collaboration





Bring over from SAP
New from OEM
Not in a system

OEM

General Information
Failure modes, instructions
Documentation, spare parts, location

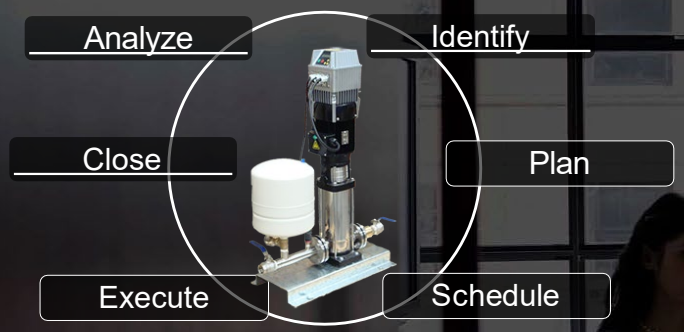
What do we do right & where do we need to adjust?

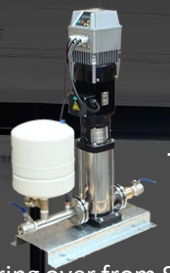
Maintenance Execution

Performance Analytics

Asset Performance Management

Risk & Criticality Assessments





Bring over from SAP
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OEM

General Information
Failure modes, instructions
Documentation, spare parts, location

Risk & Criticality assessment

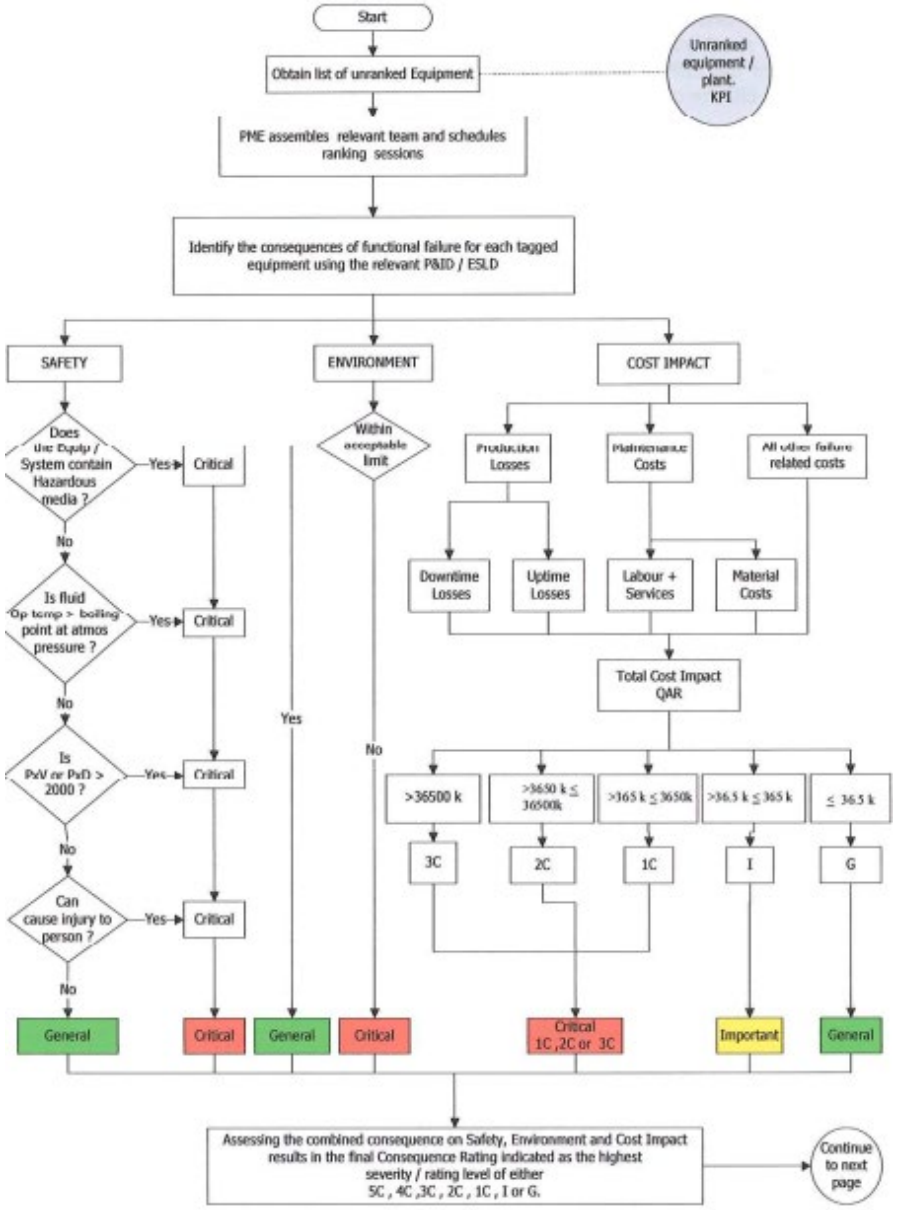
What do we do right & where do we need to adjust?

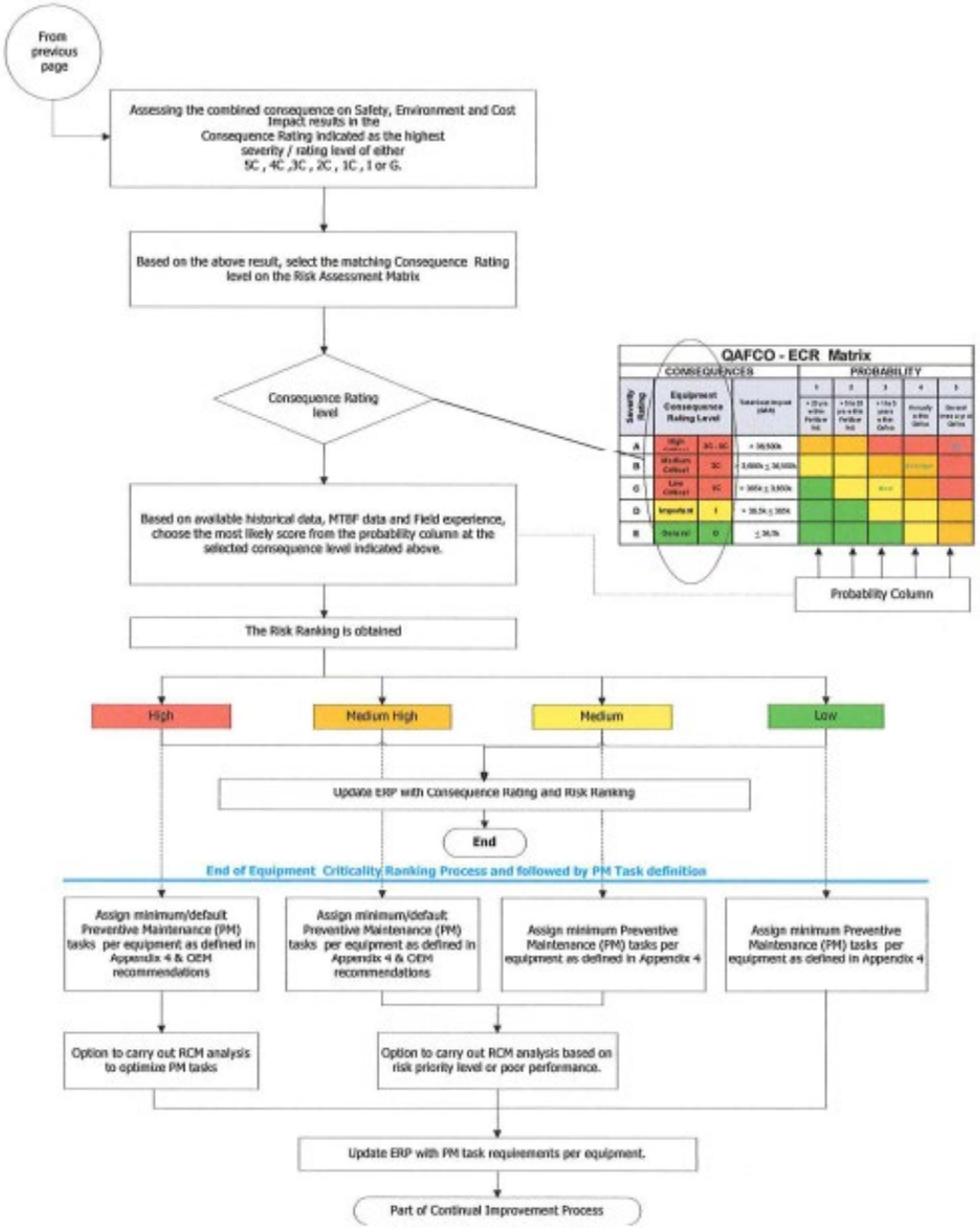
Maintenance Execution

Performance Analytics

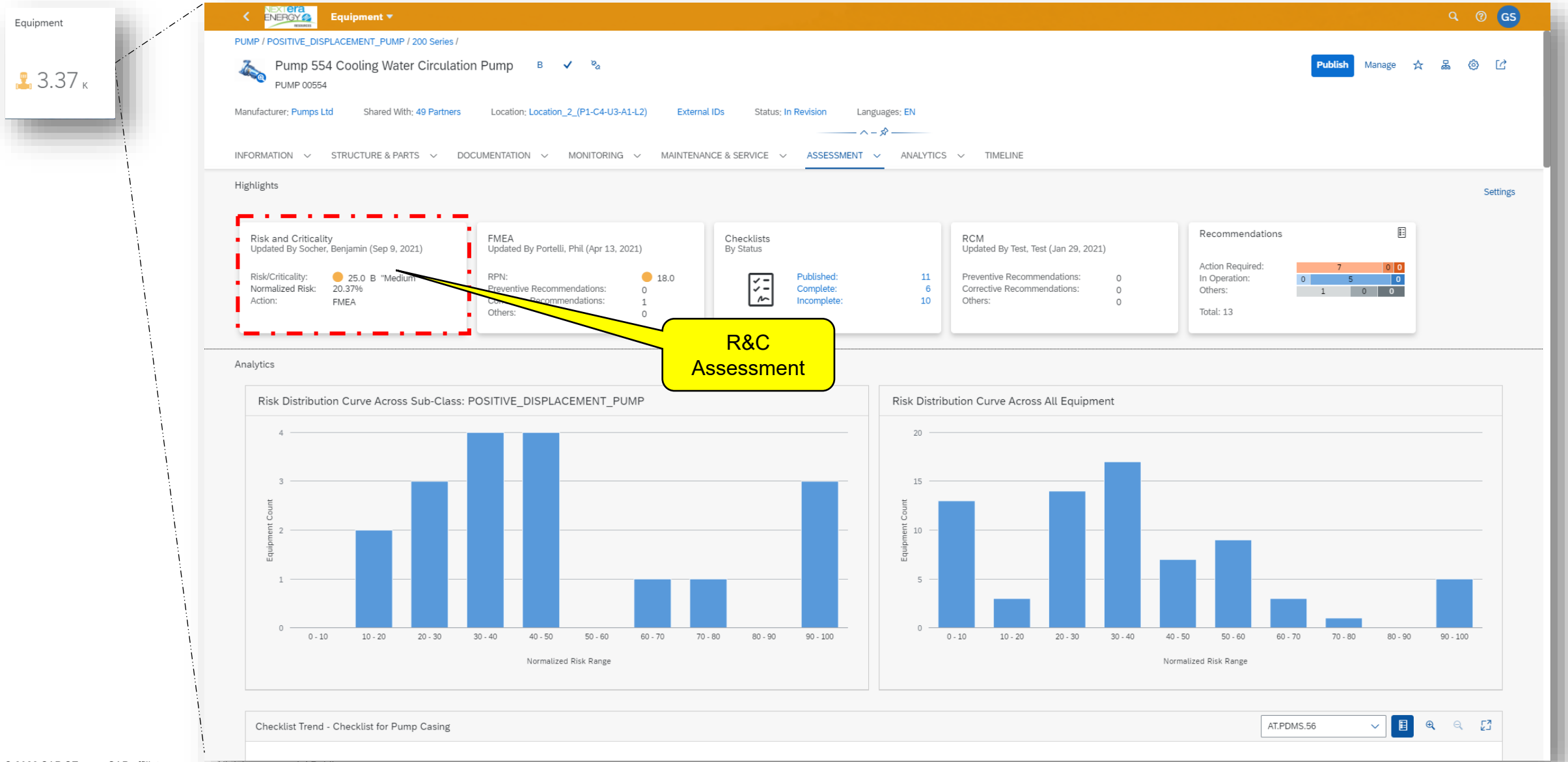
Asset Performance Management

Equipment Criticality Ranking

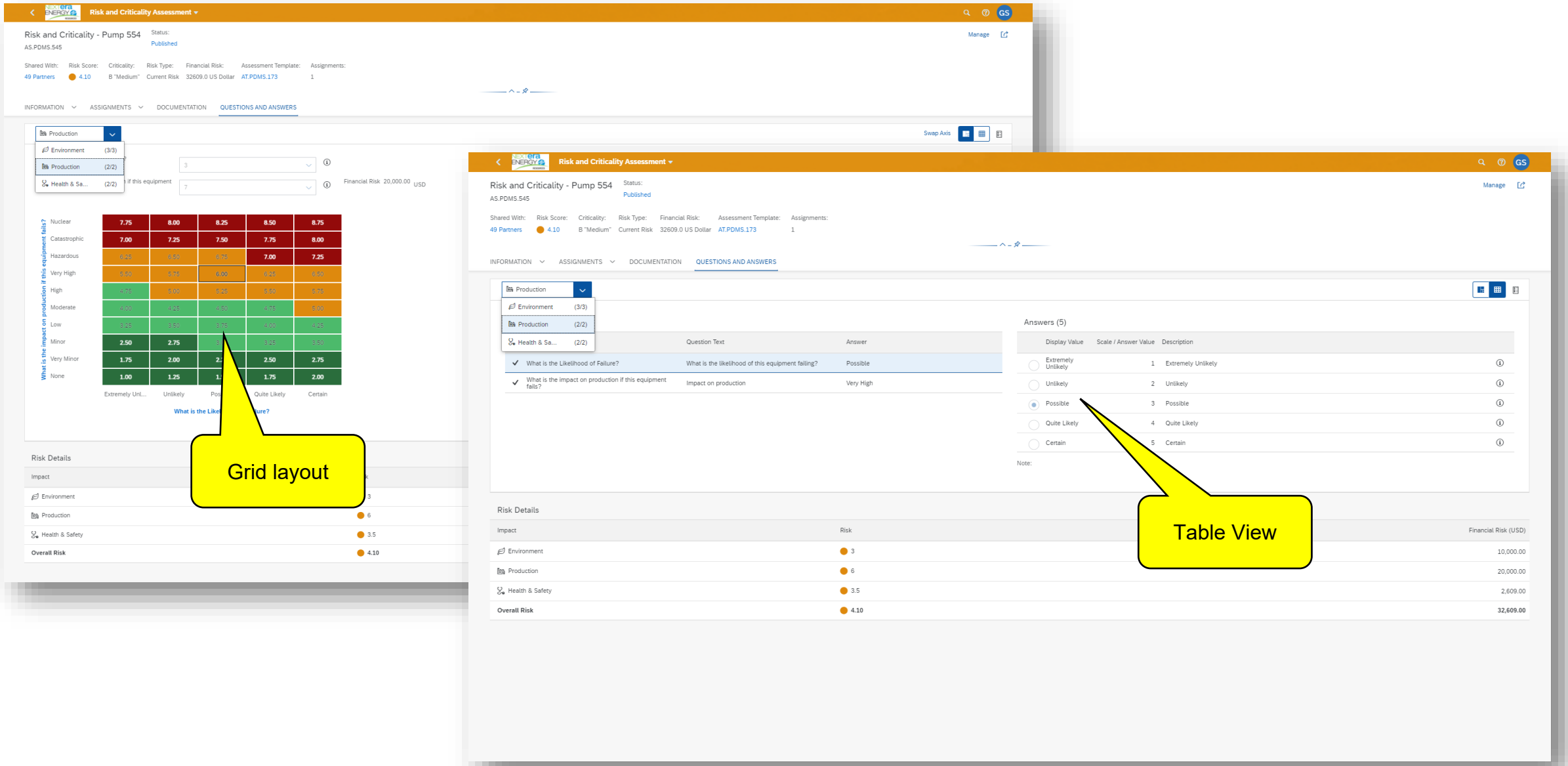




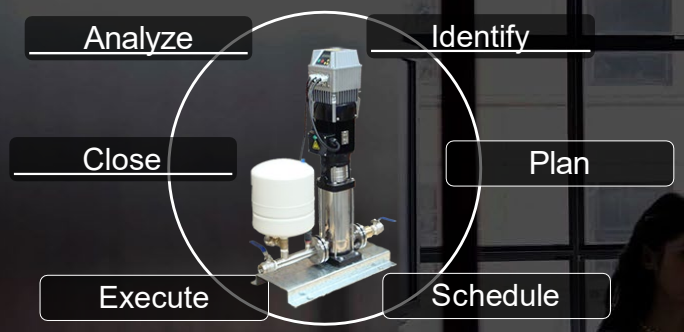
Review / Update R&C Assessments to Determine Criticality



Perform R&C Assessment



FMEA, RCM, RBI Assessments



Bring over from SAP
New from OEM
Not in a system

OEM

General Information
Failure modes, instructions
Documentation, spare parts, location

Risk & Criticality assessment

Maintenance Strategy

Run to failure

FMEA
RCM
RBI
Checklists

ML / AI
Data
Sensors

What do we do right & where do we need to adjust?

Maintenance Execution

Performance Analytics

Asset Performance Management

Reliability Centered Maintenance & Failure Mode Analysis

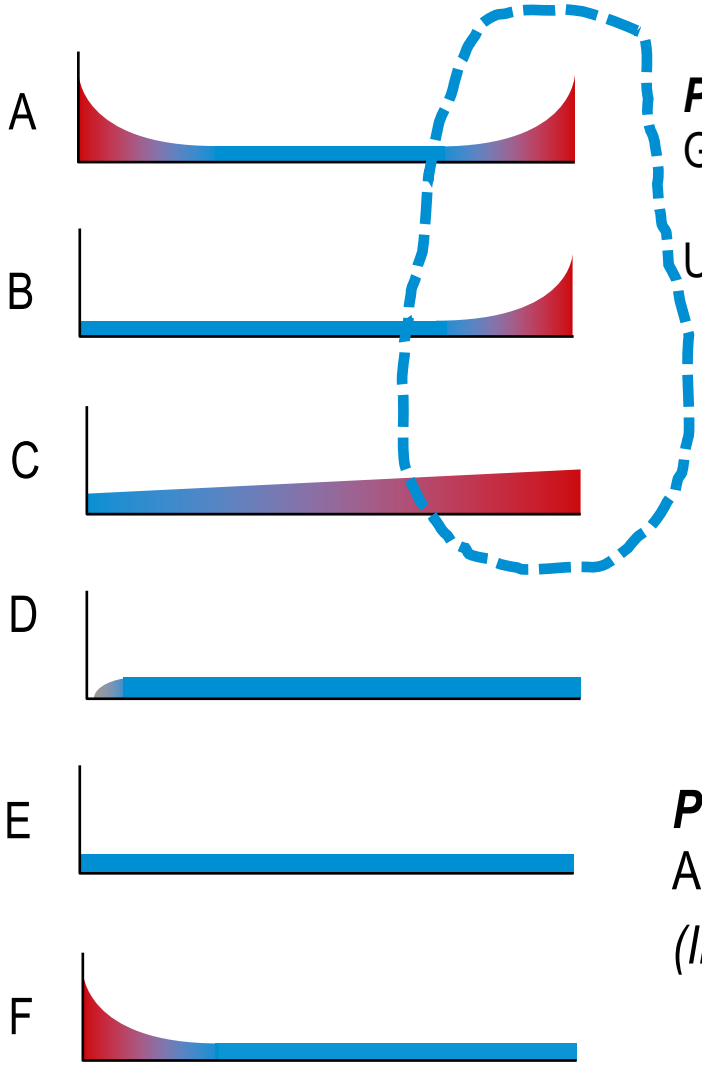
The RCM Process (RCM2 and paper based)

RCM is a process used to determine what must be done to ensure that any physical asset continues to do what its users want it to do in its present operating context.

It asks the following questions:

- What are its functions (what do its users want it to do)?
- In what ways can it fail (functional failures)?
- What causes it to fail (failure modes)?
- What happens when it fails (failure effects)?
- Does it matter if it fails (consequences of failure)?
- Can anything be done to predict or prevent the failure?
- What do we do if we cannot predict or prevent the failure?

Failure Modes: The level at which we develop Asset Management Strategy



Patterns A, B and C:
Generally apply to *simple* items or complex items that have a dominant failure mode.

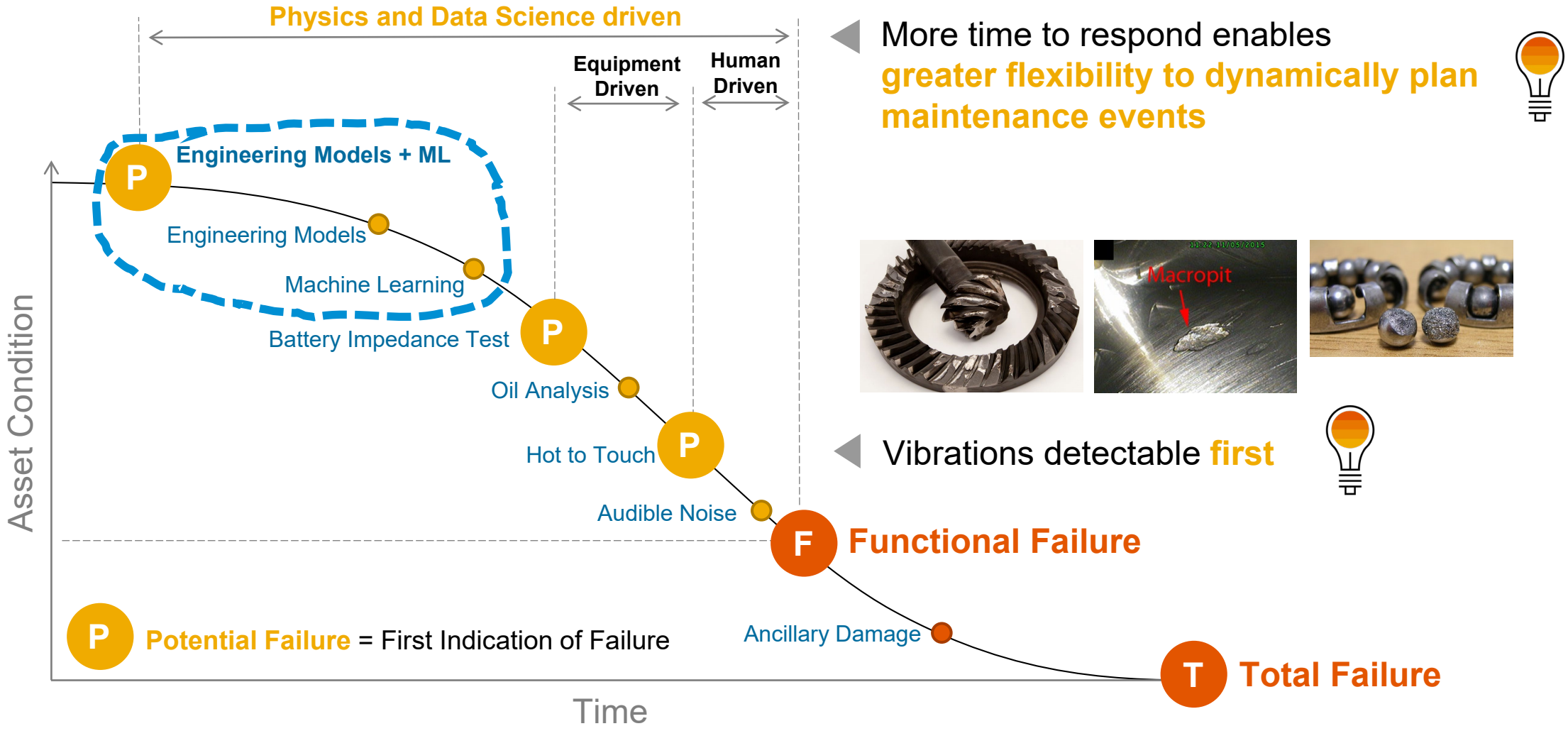
Usually associated with:
- points where the equipment comes into direct contact with the product
- fatigue
- corrosion
- evaporation

More than 90 % of failure modes are event based and are statistically random (Pattern E & F).

Patterns D, E and F:
Associated with *complex* equipment such as electronics, hydraulics and pneumatics.

(In practice, nearly all rolling element bearings conform to pattern E)

Potential Failure: Moving from time-based to condition-based maintenance



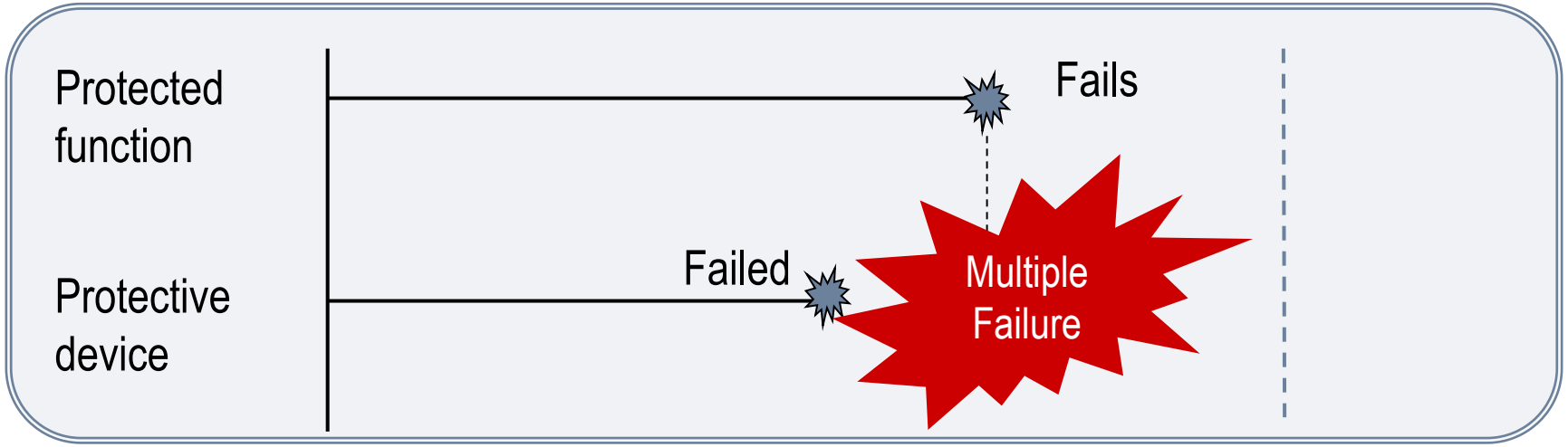
More time to respond enables **greater flexibility to dynamically plan maintenance events**

Vibrations detectable **first**

Protective Devices and Hidden Failures: How we deal with redundancy

A tolerable probability of failure for hidden failures is achieved by:

- Reducing the probability of failure of the protected function (by applying a suitable failure management strategy)



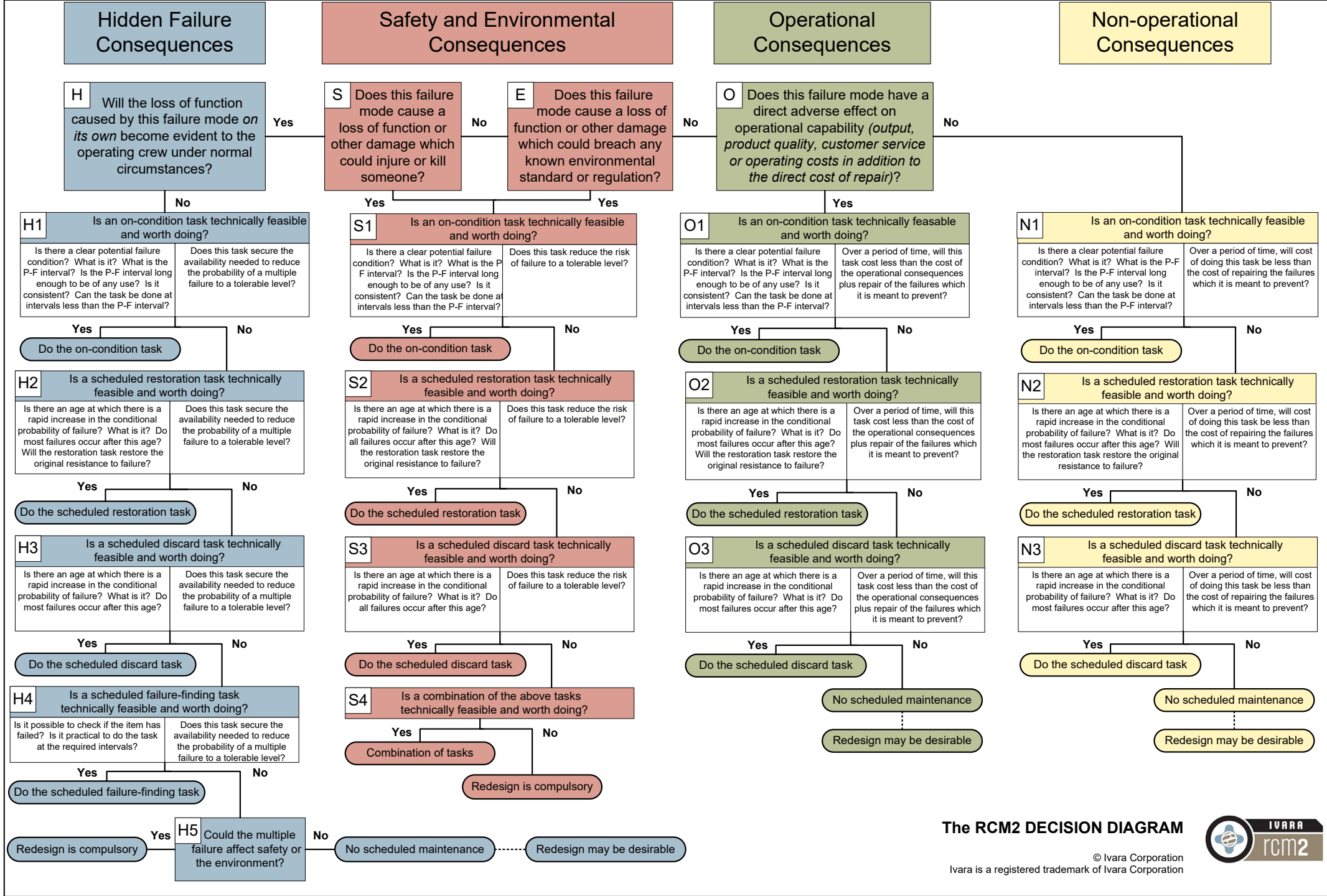
- and/or Increasing the availability of the protective device:
  - Preventing the failure of the protected function (i.e. reducing the demand rate)
  - Periodically checking whether the protective device is working and repairing it if it has failed
  - Modifying the system in some way (e.g.adding redundancy)

Science-based approach to Maintenance Strategy Development

Functions, Functional Failures, Failure Modes

Functions	Functional Failures	Failure Modes
1. To pump potable water at a flow rate from 0 to 20 m^3/hr @ 800kPa in the presence of a standby pump.	1A. Fails to pump water at all.	1A1. Electricity supply interrupted 1A2. Water supply interrupted 1A3. Major piping rupture due to a vehicle impact 1A4. Major piping rupture due to corrosion 1A5. Major foreign object blockage from upstream 1A6. Manual isolation valve left closed by operator 1A7. Lower pump bearing seizes due to contamination 1A8. Upper bearing seized due to misalignment 1A9. MOCV stuck fully closed 1A10. Standby pump removed
	1B. Pumps at pressure lower than 800kPA and a flow rate less than 20 m^3/hr.	1B1. Motor controller is faulty 1B2. Impeller is eroded (unlikely) 1B3. Impeller is encrusted (calcification) 1B4. Manual valve left partially closed by operator 1B5. MOCV stuck partly closed 1B6. Flow meter is over reading 1B7. Pressure transducer is over reading

Failure Patterns


Hidden Failure Consequences
Safety and Environmental Consequences
Operational Consequences
Non-operational Consequences
H Will the loss of function caused by this failure mode on its own become evident to the operating crew under normal circumstances?
Yes
S Does this failure mode cause a loss of function or other damage which could injure or kill someone?
No
E Does this failure mode cause a loss of function or other damage which could breach any known environmental standard or regulation?
No
O Does this failure mode have a direct adverse effect on operational capability (output, product quality, customer service or operating costs in addition to the direct cost of repair)?
No
No
Yes
Yes
Yes
H1 Is an on-condition task technically feasible and worth doing?
Is there a clear potential failure condition? What is it? What is the P-F interval? Is the P-F interval long enough to be of any use? Is it consistent? Can the task be done at intervals less than the P-F interval?
Does this task secure the availability needed to reduce the probability of a multiple failure to a tolerable level?
S1 Is an on-condition task technically feasible and worth doing?
Is there a clear potential failure condition? What is it? What is the P-F interval? Is the P-F interval long enough to be of any use? Is it consistent? Can the task be done at intervals less than the P-F interval?
Does this task reduce the risk of failure to a tolerable level?
O1 Is an on-condition task technically feasable and worth doing?
Is there a clear potential failure condition? What is it? What is the P-F interval? Is the P-F interval long enough to be of any use? Is it consistent? Can the task be done at intervals less than the P-F interval?
Over a period of time, will this task cost less than the cost of the operational consequences plus repair of the failures which it is meant to prevent?
N1 Is an on-condition task technically feasible and worth doing?
Is there a clear potential failure condition? What is it? What is the P-F interval? Is the P-F interval long enough to be of any use? Is it consistent? Can the task be done at intervals less than the P-F interval?
Over a period of time, will cost of doing this task be less than the cost of repairing the failures which it is meant to prevent?
Yes
No
Yes
No
Yes
No
Yes
No
Do the on-condition task
Do the on-condition task
Do the on-condition task
Do the on-condition task
H2 Is a scheduled restoration task technically feasible and worth doing?
Is there an age at which there is a rapid increase in the conditional probability of failure? What is it? Do most failures occur after this age? Will the restoration task restore the original resistance to failure?
Does this task secure the availability needed to reduce the probability of a multiple failure to a tolerable level?
S2 Is a scheduled restoration task technically feasible and worth doing?
Is there an age at which there is a rapid increase in the conditional probability of failure? What is it? Do all failures occur after this age? Will the restoration task restore the original resistance to failure?
Does this task reduce the risk of failure to a tolerable level?
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Over a period of time, will this task cost less than the cost of the operational consequences plus repair of the failures which it is meant to prevent?
N2 Is a scheduled restoration task technically feasible and worth doing?
Is there an age at which there is a rapid increase in the conditional probability of failure? What is it? Do most failures occur after this age? Will the restoration task restore the original resistance to failure?
Over a period of time, will cost of doing this task be less than the cost of repairing the failures which it is meant to prevent?
Yes
No
Yes
No
Yes
No
Yes
No
Do the scheduled restoration task
Do the scheduled restoration task
Do the scheduled restoration task
Do the scheduled restoration task
H3 Is a scheduled discard task technically feasible and worth doing?
Is there an age at which there is a rapid increase in the conditional probability of failure? What is it? Do most failures occur after this age?
Does this task secure the availability needed to reduce the probability of a multiple failure to a tolerable level?
S3 Is a scheduled discard task technically feasible and worth doing?
Is there an age at which there is a rapid increase in the conditional probability of failure? What is it? Do all failures occur after this age?
Does this task reduce the risk of failure to a tolerable level?
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N3 Is a scheduled discard task technically feasible and worth doing?
Is there an age at which there is a rapid increase in the conditional probability of failure? What is it? Do most failures occur after this age?
Over a period of time, will cost of doing this task be less than the cost of repairing the failures which it is meant to prevent?
Yes
No
Yes
No
Yes
No
Yes
No
Do the scheduled discard task
Do the scheduled discard task
Do the scheduled discard task
Do the scheduled discard task
H4 Is a scheduled failure-finding task technically feasible and worth doing?
Is it possible to check if the item has failed? Is it practical to do the task at the required intervals?
Does this task secure the availability needed to reduce the probability of a multiple failure to a tolerable level?
S4 Is a combination of the above tasks technically feasible and worth doing?
Yes
No
Yes
No
Yes
No
Do the scheduled failure-finding task
Combination of tasks
Redesign is compulsory
No scheduled maintenance
Redesign may be desirable
No scheduled maintenance
Redesign may be desirable
Redesign is compulsory
Yes
H5 Could the multiple failure affect safety or the environment?
No
No scheduled maintenance
Redesign may be desirable
The RCM2 DECISION DIAGRAM
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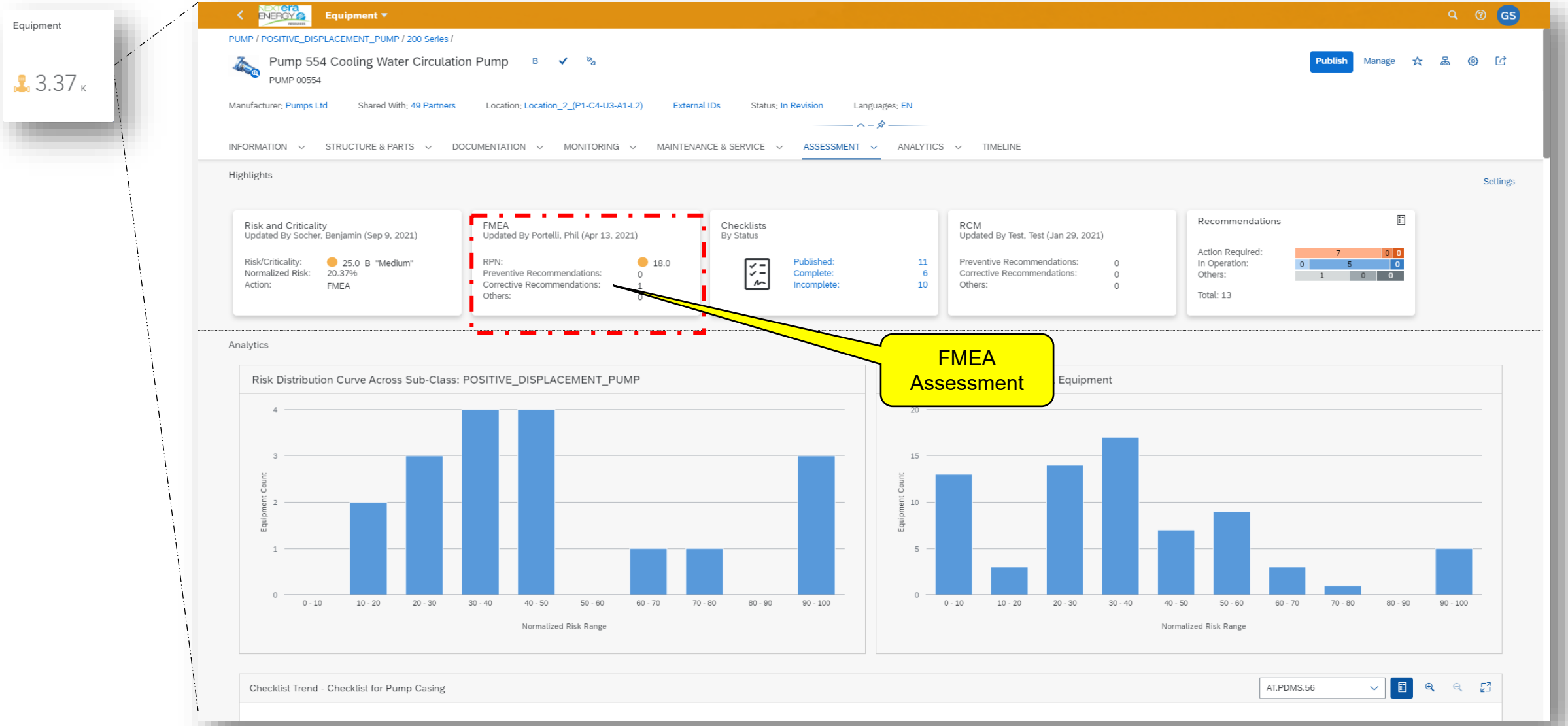
IVARA rcm2

Science-based approach to Maintenance Strategy Development

Consequence Analysis and Task Recommendation

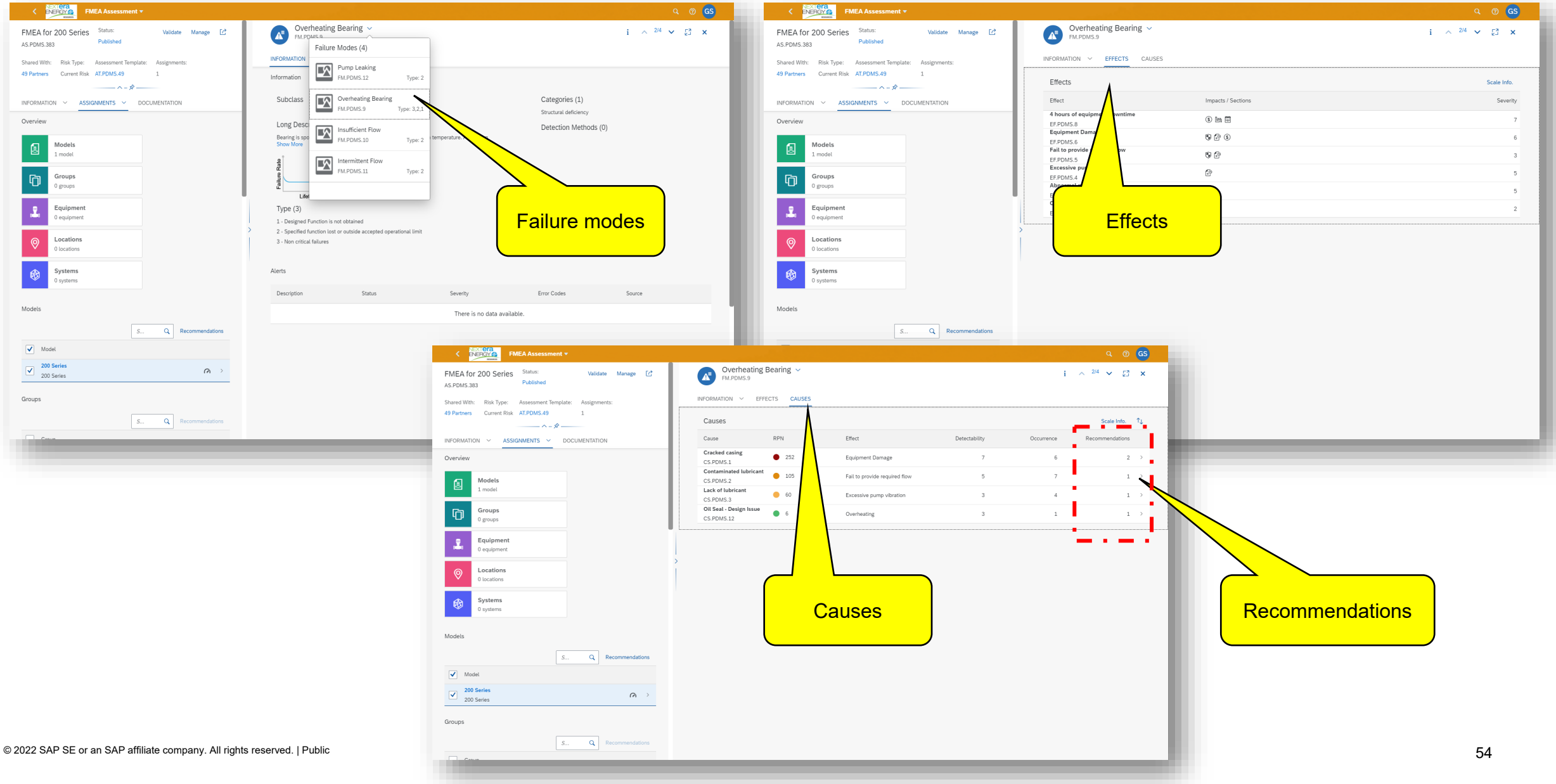
Failure Modes	Recommended Task	Performed By	Task Freq.
1A1. Electricity supply interrupted	No Scheduled Maintenance		
1A2. Water supply interrupted	No Scheduled Maintenance		
1A3. Major piping rupture due to a vehicle impact	Modification: Barrier	Engineer	
1A4. Major piping rupture due to corrosion	Pipe Thickness NDT	Mech. Integrity	Annual
1A5. Major foreign object blockage from upstream	No Scheduled Maintenance		
1A6. Manual isolation valve left closed by operator	Modification: Procedure	Operations	
1A7. Lower pump bearing seizes due to contamination	Visually check for Contamination (consider Condition Monitoring)	Maintenance	Monthly
1A8. Upper bearing seized due to misalignment	Modification: Installation Procedure	Maintenance	
1A9. MOCV stuck fully closed	FF: Test MOCV operation	Operations	6 months
1A10. Standby pump removed	FF: Test standby pump	Operations	6 months
1B1. Motor controller is faulty	No Scheduled Maintenance		
1B2. Impeller is eroded (unlikely)	Monitor Pump Performance	Maintenance	On-line
1B3. Impeller is encrusted (calcification)	As Above + Water Chemistry/ Temp	Mtnce + Lab	Monthly
1B4. Manual valve left partially closed by operator	Modification: Procedure	Operations	
1B5. MOCV stuck partly closed	No Scheduled Maintenance		
1B6. Flow meter is over reading	FF: Calibration of Flow Meter	Lab	2 years
1B7. Pressure transducer is over reading	FF: Calibration of Pressure Trans.	Lab	2 years

Review / Update / Create FMEA* Assessment

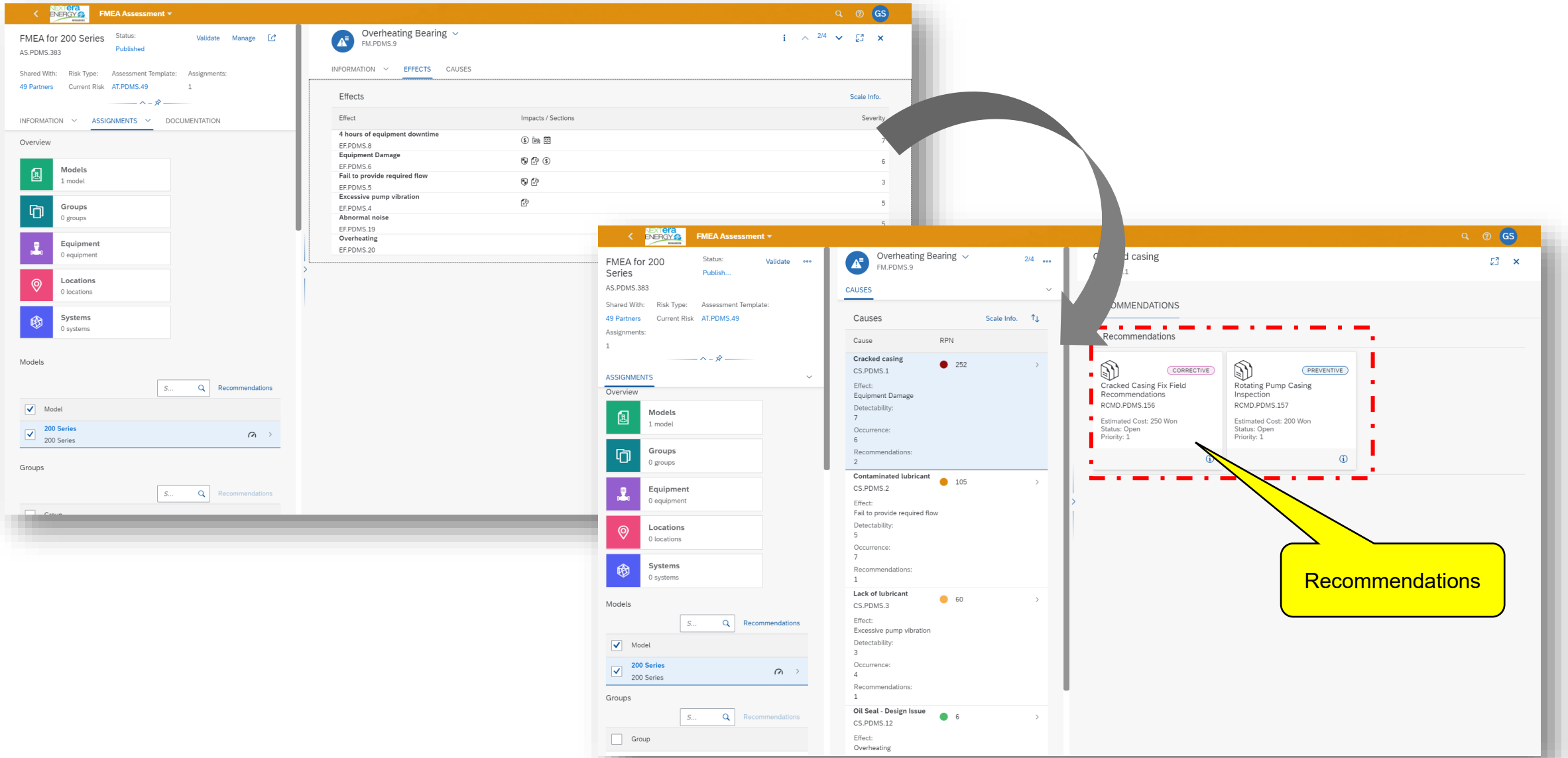


* Used and as example, other assessment tools (RCM, RBI, etc. can also be selected)

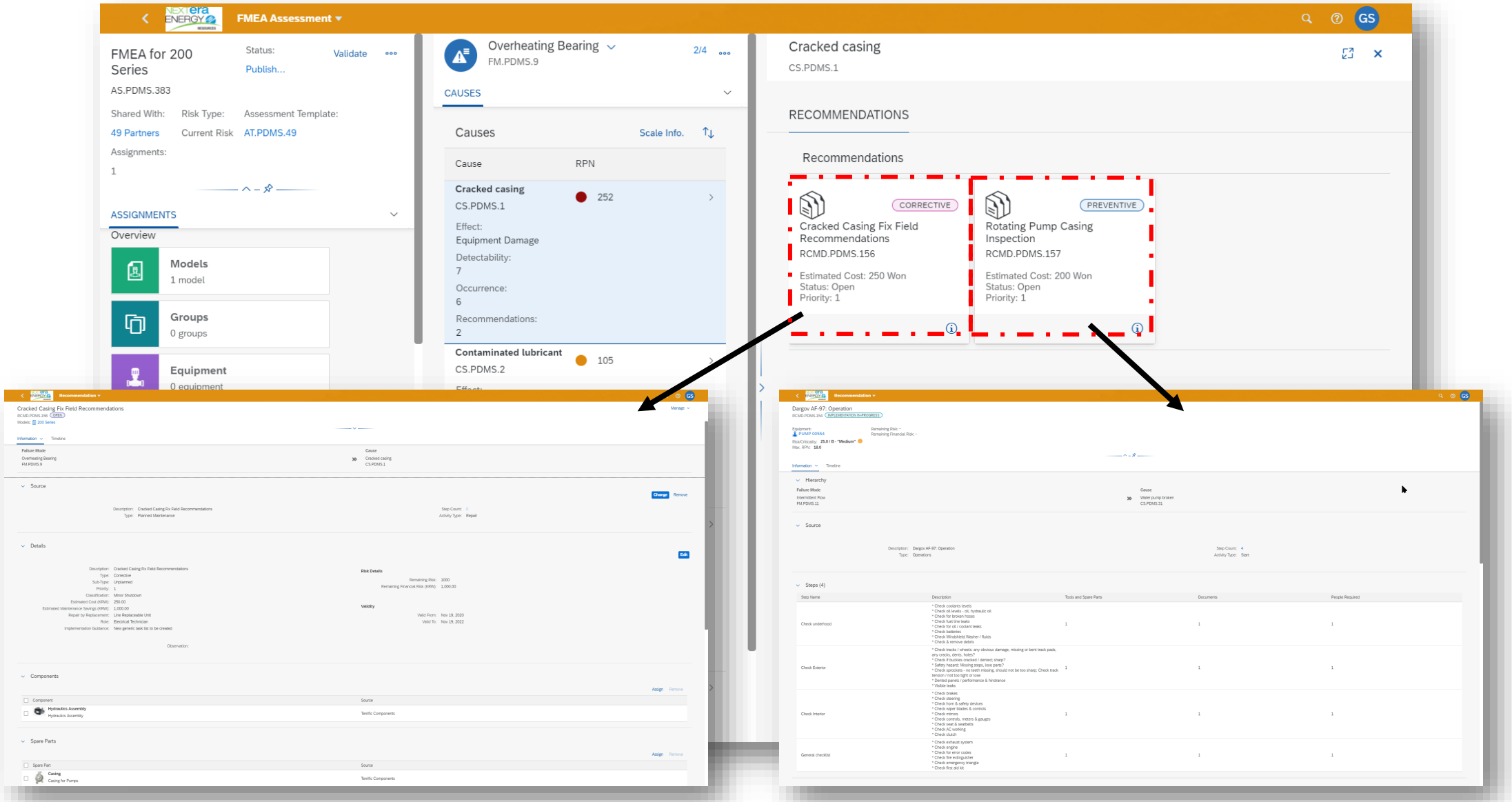
FMEA Assessment



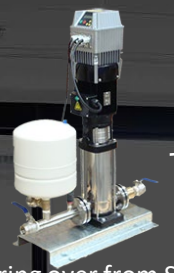
Recommendations from FMEA Assessment



Corrective, Predictive, Preventive?



Review & Implement Recommendations



Bring over from SAP
New from OEM
Not in a system

OEM

General Information
Failure modes, instructions
Documentation, spare parts, location

Risk & Criticality assessment

Maintenance Strategy

Run to failure

FMEA
RCM
RBI
Checklists

ML / AI
Data
Sensors

Risk score

Health score

Recommendations

Reviews

Instructions

Corrective
Predictive
Preventive

Maintenance plan
Task lists
Spare parts

Plan

Schedule

Execute

Close

Analyze

Identify

How do we maintain what and why?

What do we do right & where do we need to adjust?

Maintenance Execution

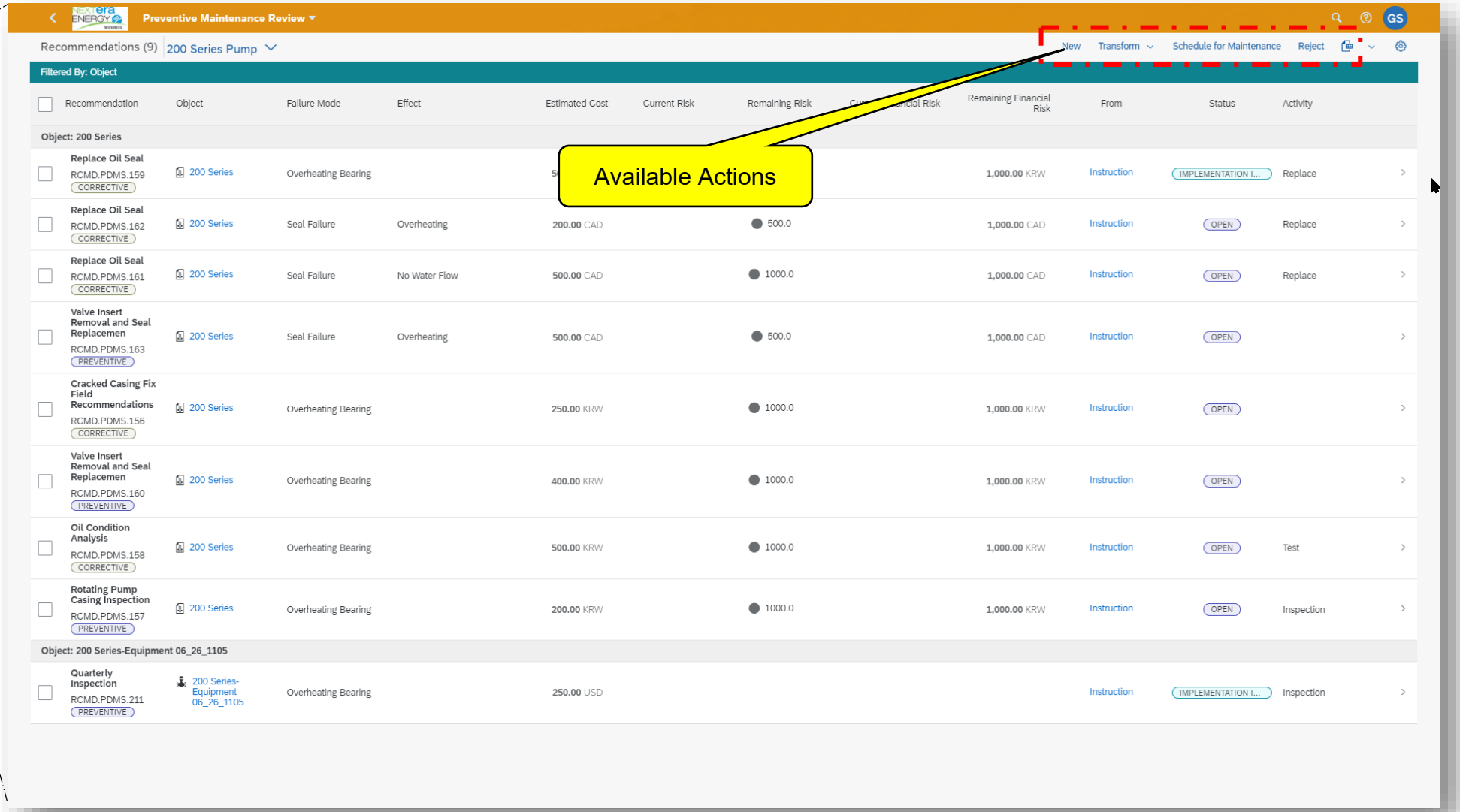
Performance Analytics

Asset Performance Management

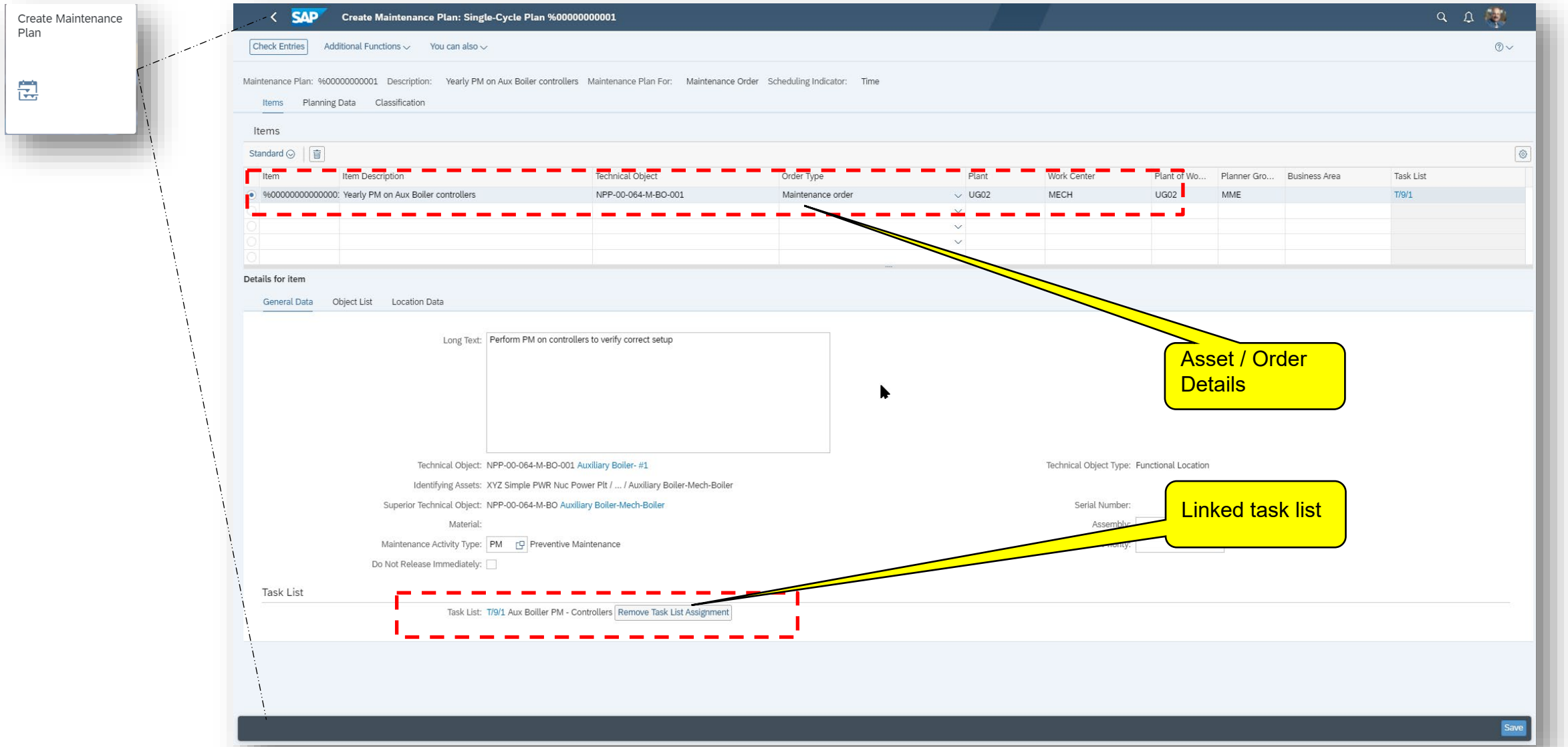
Review / Implement Recommendations (Preventive Maintenance Review)

The PMR app collects the recommendations from the various assessments and allows:

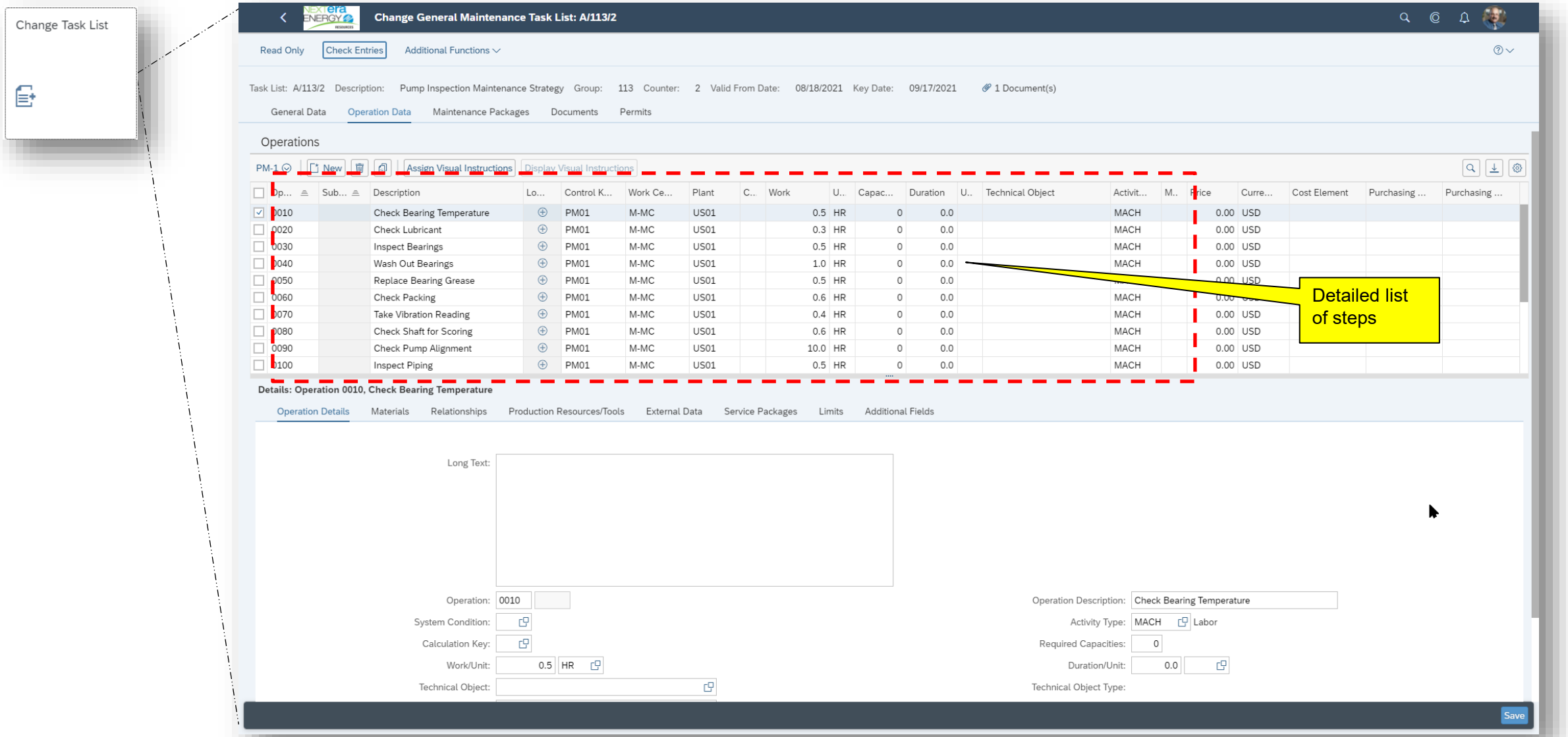
- The reliability engineer to track his recommendations
- The planner to receive assignments to implement



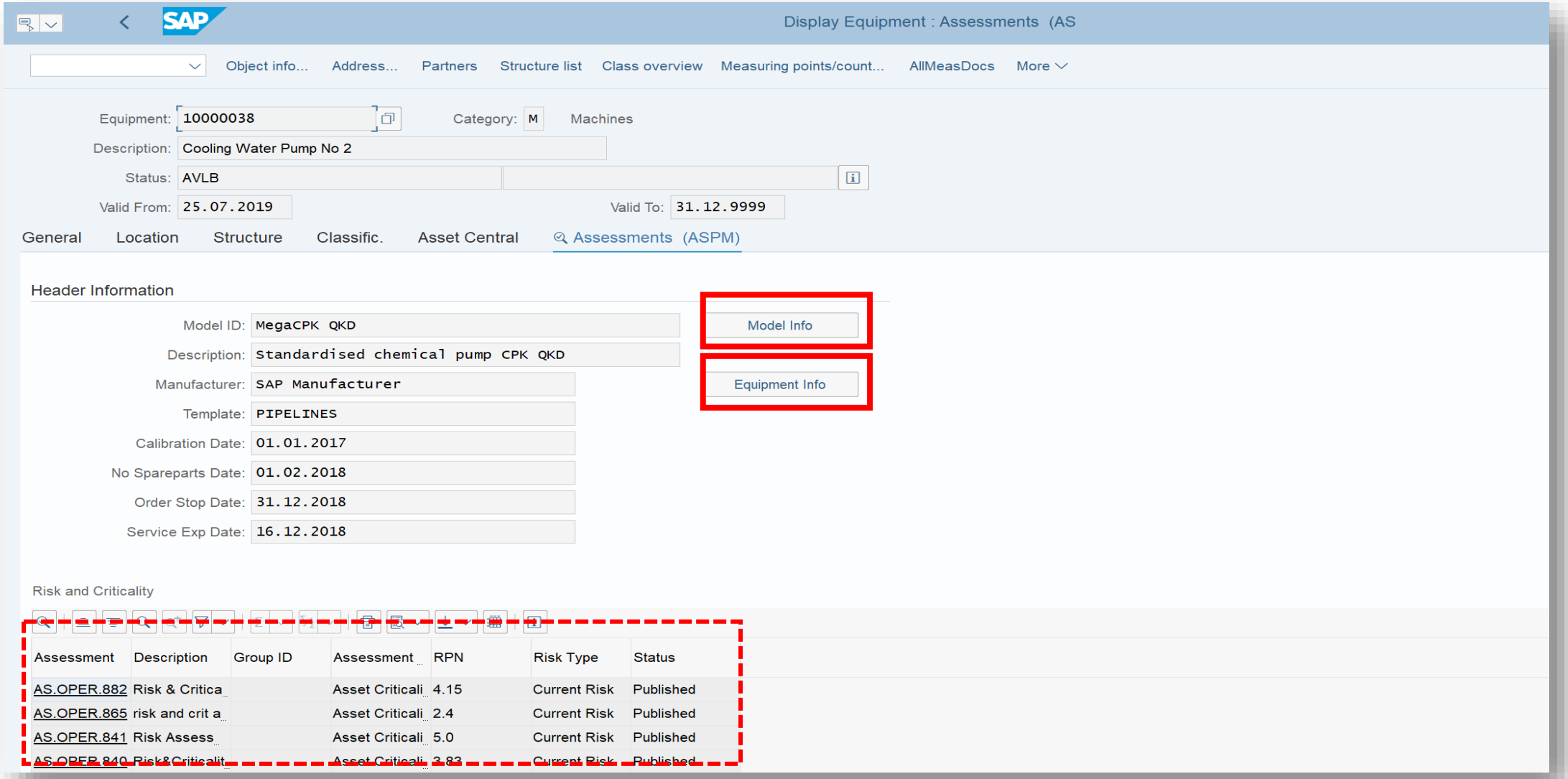
Sample Action - Update / Create / Delete Maintenance Plans



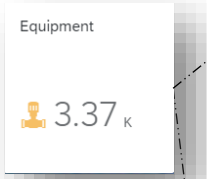
Sample Action - Update / Create / Delete Task Lists (cont'd)



Risk & Model Data are Replicated in S4/HANA or ECC Equipment Masters



Monitor “Bad Actors” by Running Risk Reports



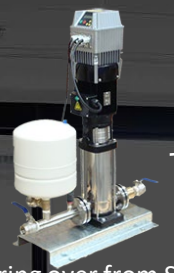
Equipment

R-2 Risk Ranking Report-200 Series Pumps | Search | Show Filter Bar | Filters (4) | Go

Equipment (17) | PM-1 Risk | New | Request Model | Publish | Group | Assess

Equipment	Subclass	Model ID	Manufacturer	Operator	Phase	Created On	Published On	Status	Criticality	Normalized Risk	Risk Score	RPN	Serial Number
PUMP 00554 Pump 554 Cooling Water Circulation Pump	POSITIVE_DISPLACEMENT_PUMP	200 Series	Pumps Ltd	Terrific Components	Fully Operational	Aug 13, 2020	Sep 17, 2021	In Revision	B "Medium"	20.37%	25.00	18	
200 Series-Equipment 06_26_1105 200 Series 06_26_1105	POSITIVE_DISPLACEMENT_PUMP	200 Series	Pumps Ltd	Terrific Components	Planned	Jun 26, 2021	Jun 26, 2021	Published	A "High"	34.17%	9.20	252	
Cooling Water Pump Pump 01	POSITIVE_DISPLACEMENT_PUMP	200 Series	Pumps Ltd	Terrific Components	Planned	Feb 9, 2021	Jun 23, 2021	In Revision	A "High"	100.00%	25.00	252	
99-P-1001-A Pump 554 Cooling Water Circulation Pump	POSITIVE_DISPLACEMENT_PUMP	200 Series	Pumps Ltd	Terrific Components	Fully Operational	Aug 13, 2020	Dec 2, 2020	In Revision	A "High"	25.00%	30.00	256	861532
Cooling Water Pump_1 Cooling Water Pump_1	POSITIVE_DISPLACEMENT_PUMP	200 Series	Pumps Ltd	Terrific Components	Fully Operational	Jan 13, 2021	Feb 9, 2021	Published	A "High"	100.00%	25.00		
Pump 00194 Pump 00194	POSITIVE_DISPLACEMENT_PUMP	200 Series	Pumps Ltd	Terrific Components	Fully Operational	Feb 12, 2020	Feb 12, 2020	In Revision	B "Medium"	19.44%	24.00		SN-444755
Pump 00163 Pump 00163	POSITIVE_DISPLACEMENT_PUMP	200 Series	Pumps Ltd	Terrific Components	Fully Operational	Feb 12, 2020	Feb 12, 2020	In Revision	A "High"	33.33%	39.00		SN-388843
Pump 00143 Pump 00143	POSITIVE_DISPLACEMENT_PUMP	200 Series	Pumps Ltd	Terrific Components	Fully Operational	Feb 12, 2020	Feb 12, 2020	In Revision	C "Low"	50.00%	3.00		SN-461756
Pump 00071 Pump 00071	POSITIVE_DISPLACEMENT_PUMP	200 Series	Pumps Ltd	Terrific Components	Fully Operational	Feb 12, 2020	Feb 12, 2020	In Revision	C "Low"	50.00%	3.00		SN-012346
Pump 00277 Pump 00277	POSITIVE_DISPLACEMENT_PUMP	200 Series	Pumps Ltd	Terrific Components	Fully Operational	Feb 12, 2020	Feb 12, 2020	In Revision	A+ "Very High"	79.17%	20.00		SN-051558
Pump 00092 Pump 00092	POSITIVE_DISPLACEMENT_PUMP	200 Series	Pumps Ltd	Terrific Components	Fully Operational	Feb 12, 2020	Feb 12, 2020	In Revision	A+ "Very High"	60.83%	15.60		SN-967966
Pump 00552 Pump 00552	POSITIVE_DISPLACEMENT_PUMP	200 Series	Pumps Ltd	Terrific Components	Planned	Nov 12, 2020	Nov 12, 2020	Published	B "Medium"	46.91%	8.66		
Pump 110 200 Series	POSITIVE_DISPLACEMENT_PUMP	200 Series	Pumps Ltd	Terrific Components	Planned	Nov 1, 2020	Nov 1, 2020	In Revision	B "Medium"	46.91%	8.66		
200_CTNR_001 200 Series Centrifugal PUMP SPP WO TEMPLATE	POSITIVE_DISPLACEMENT_PUMP	200 Series	Pumps Ltd	Terrific Components	Planned	Jun 17, 2020	Jun 16, 2020	In Revision	A+ "Very High"	100.00%	76.25		PUMP/CP/61601
963334022 200 Series Pump in Parkes	POSITIVE_DISPLACEMENT_PUMP	200 Series	Pumps Ltd	Terrific Components	Planned	Jun 4, 2020	Jun 4, 2020	In Revision	C "Low"	39.80%	7.50		
10091892 ESP system (ASPM Pump)	POSITIVE_DISPLACEMENT_PUMP	200 Series	Pumps Ltd	Terrific Components	Planned	May 12, 2020	May 12, 2020	Published	A "High"	29.90%	23.50		
20200107 Pump 200107	POSITIVE_DISPLACEMENT_PUMP	200 Series	Pumps Ltd	Terrific Components	Planned	Dec 17, 2019	Dec 17, 2019	Published	A "High"	35.90%	8.00		

Implement Predictive Monitoring



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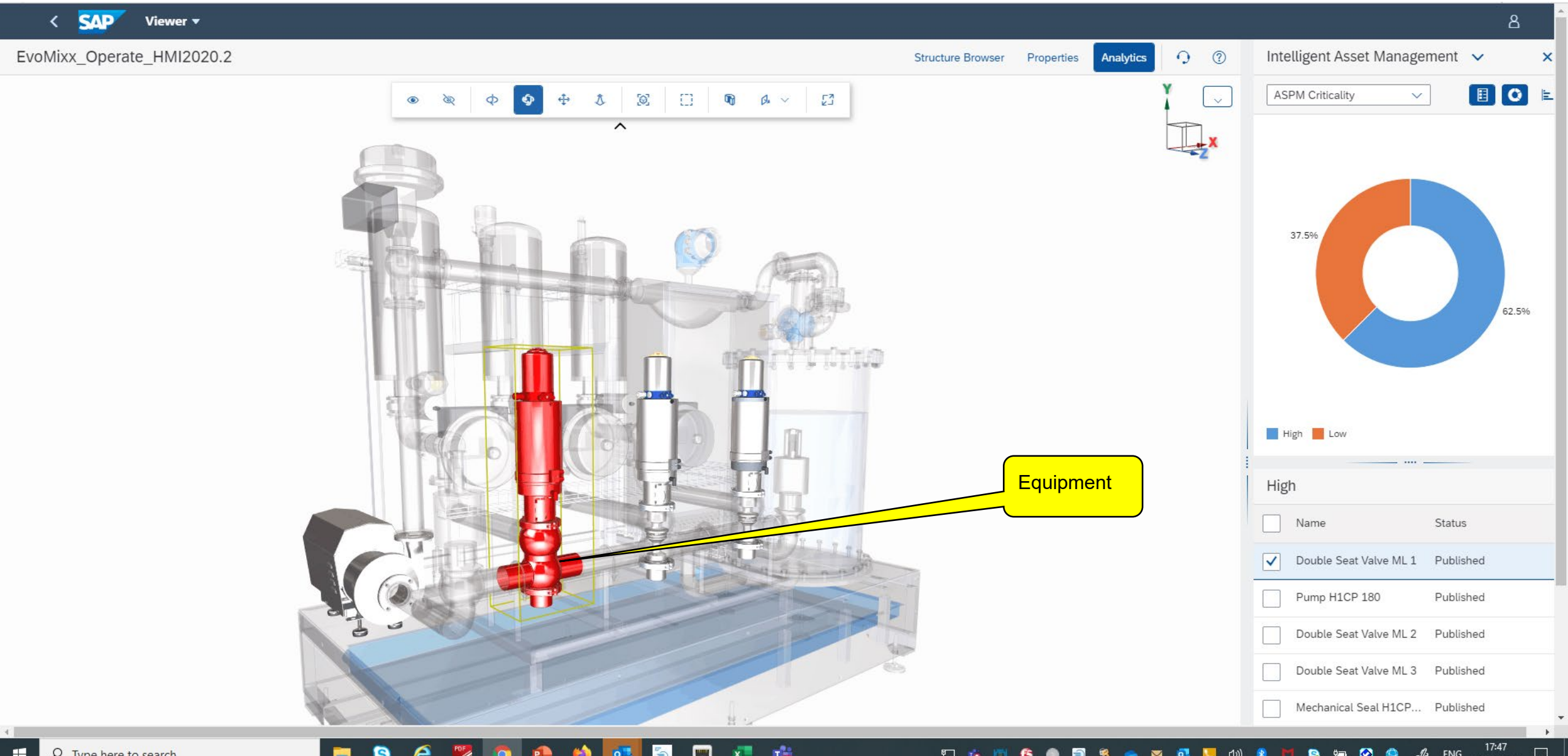
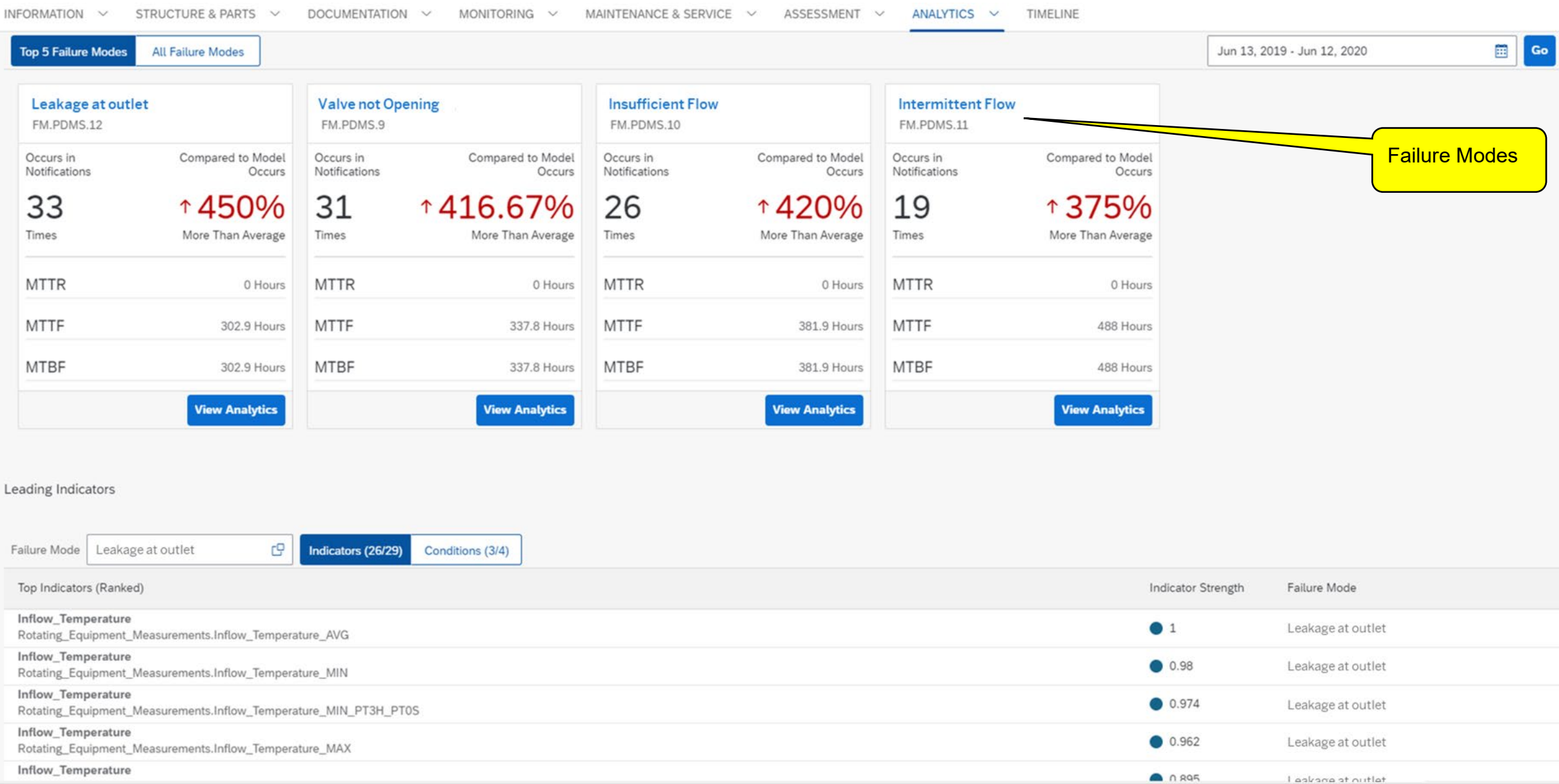
Failure-Mode-Specific Health Monitoring



Failure-Mode-Specific Health Monitoring



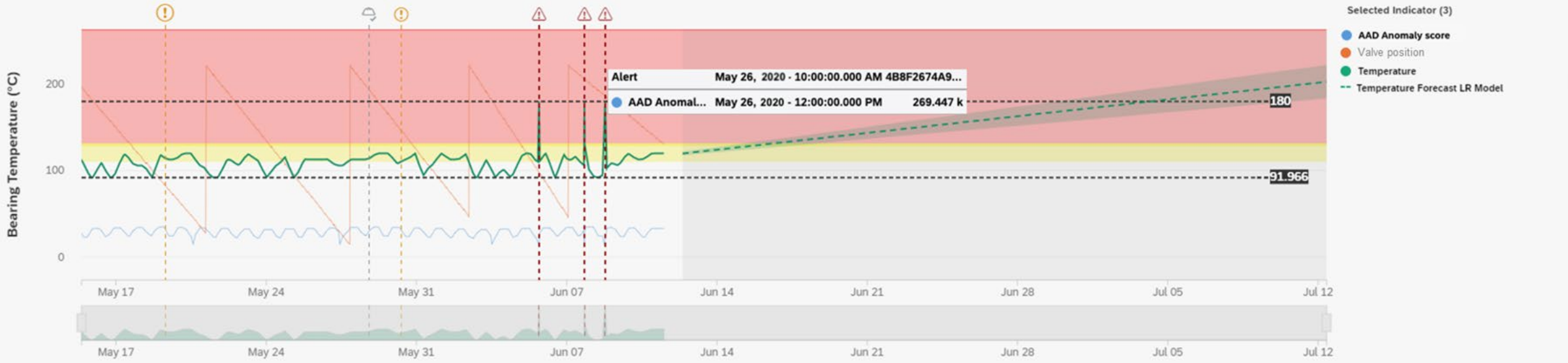
Failure-Mode-Specific Health Monitoring & Alerting

INFORMATION | STRUCTURE & PARTS | DOCUMENTATION | MONITORING | MAINTENANCE & SERVICE | ASSESSMENT | ANALYTICS | TIMELINE

Indicator Chart

Refresh

Indicator Chart - Regular Aggregation | Duration: 4 Weeks | Multi Chart | Add Evidence | Select Indicators



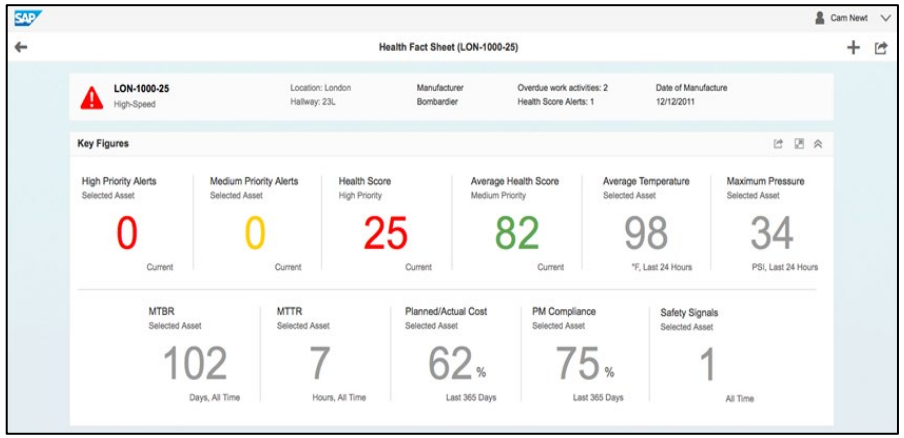
Alerts

Refresh

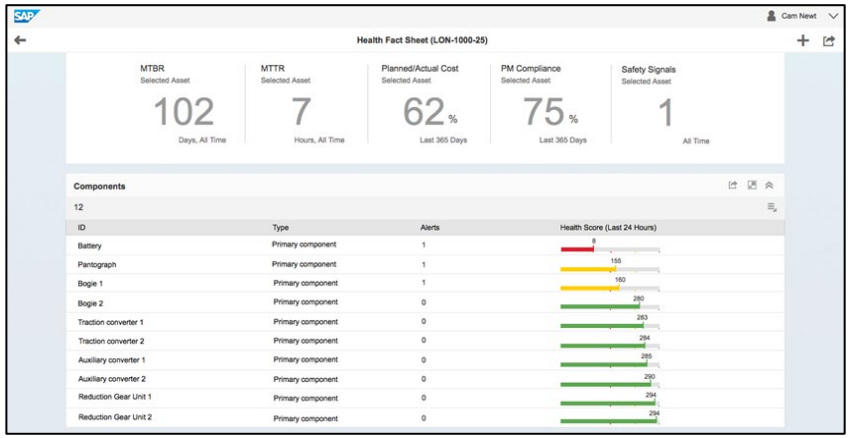
Alerts (4) SAP Standard | Set in Process | Set to Completed | Set Processor | Create Notification | Add Evidence

Type	Alert Description	Equipment	Top Equipment	Operator	Country ID	Created On	Severity	Status	Processor	Notification
double_se...	Double seat valve anomaly	Double_Seat_Valve_ML-Eq...		SAP America		May 1, 2020, 6:00:00 PM	Warning	New		

Data Science – Predictive Maintenance Applications

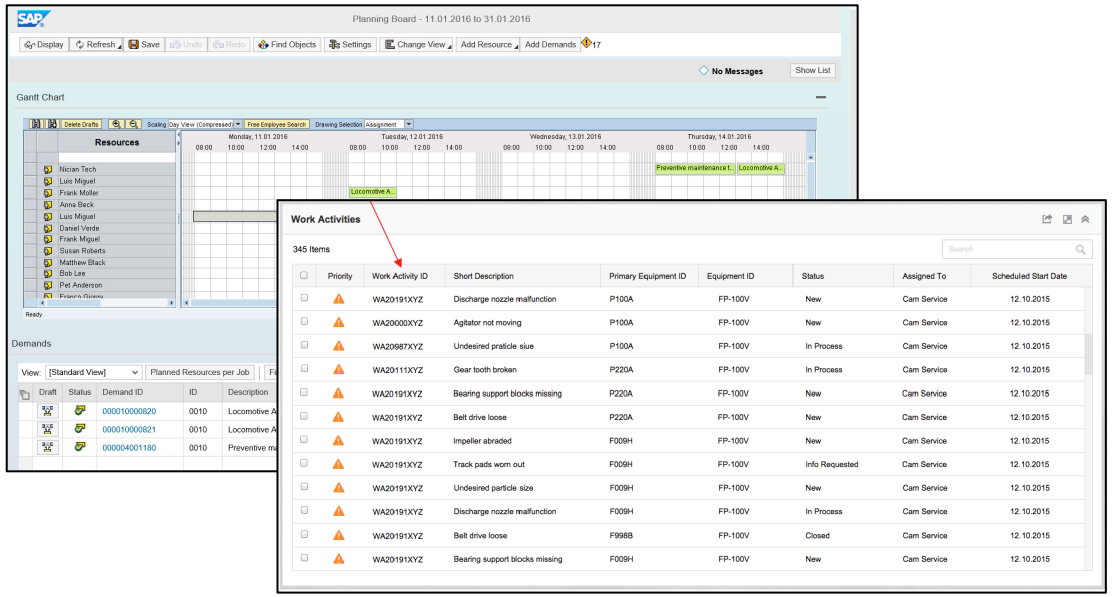


Health Fact Sheet



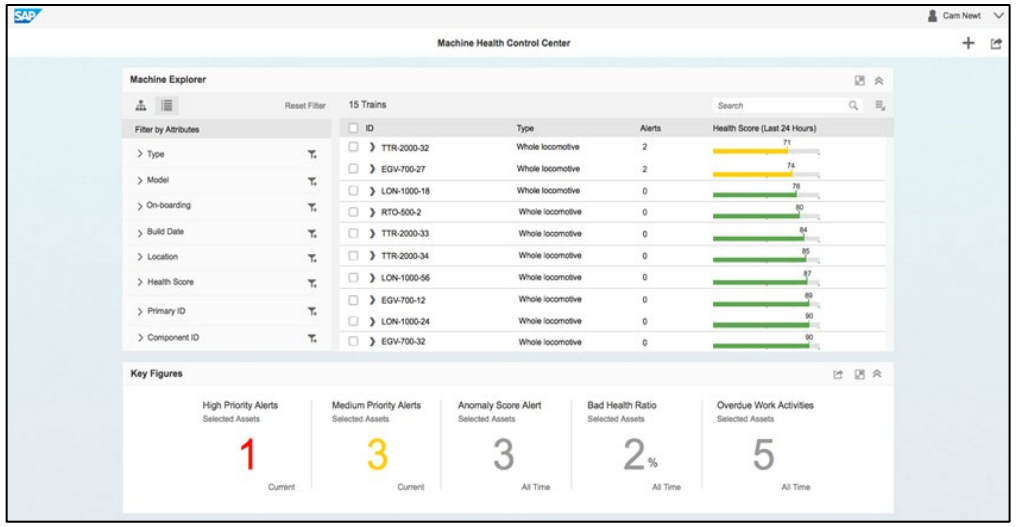
Health Fact Sheet by Components

Risk Matrix and Survival Curve

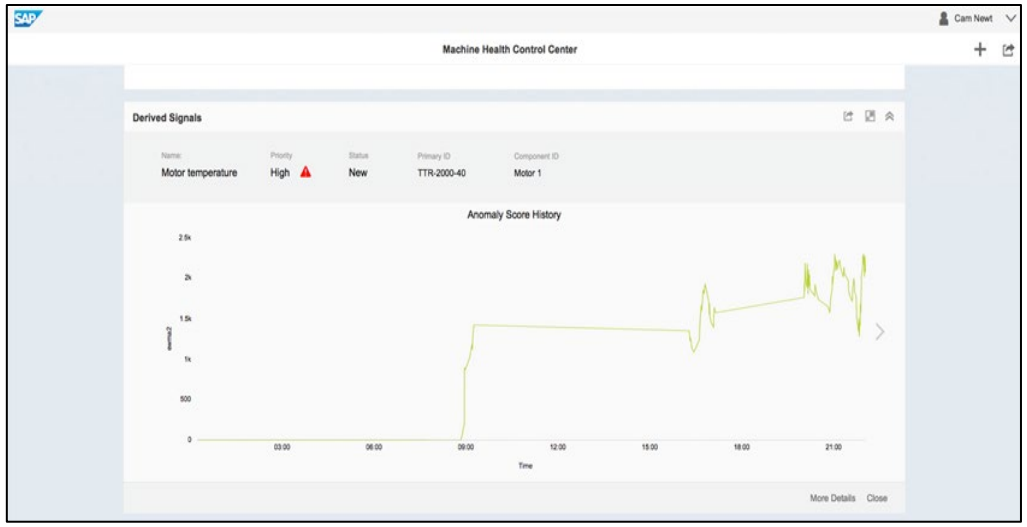


MRS Planning board with Rescheduled Maintenance

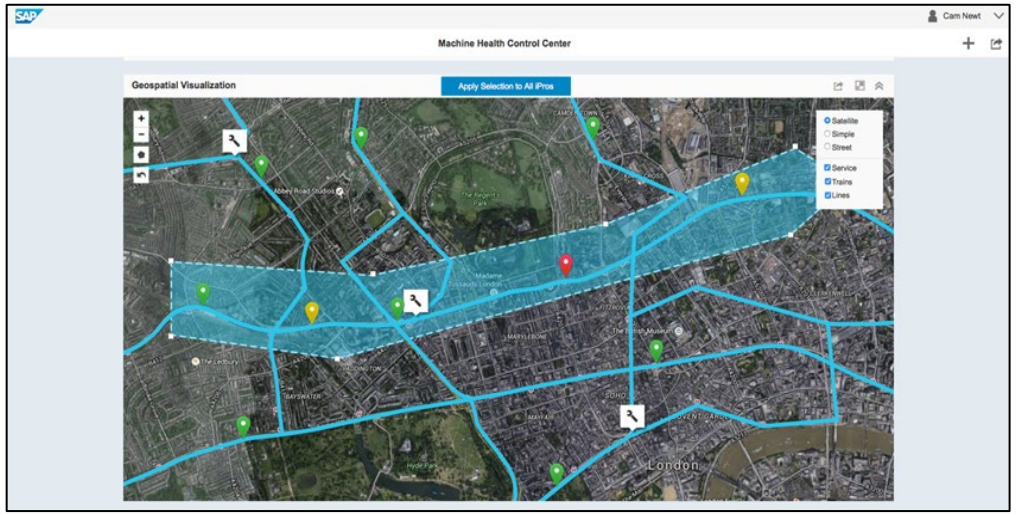
Data Science – Predictive Maintenance Applications



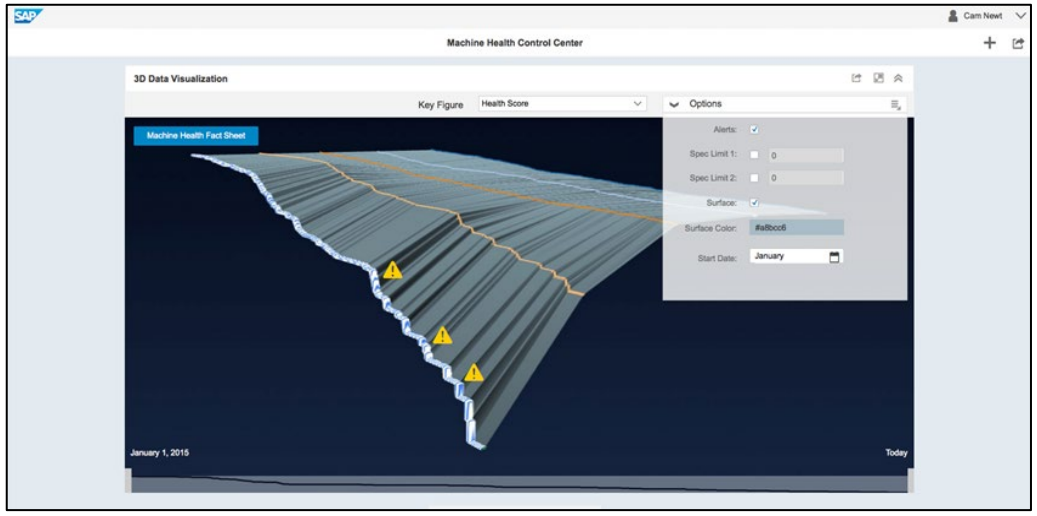
Machine Health Control Center - Machine Explorer



Machine Health Control Center - Anomaly Score History

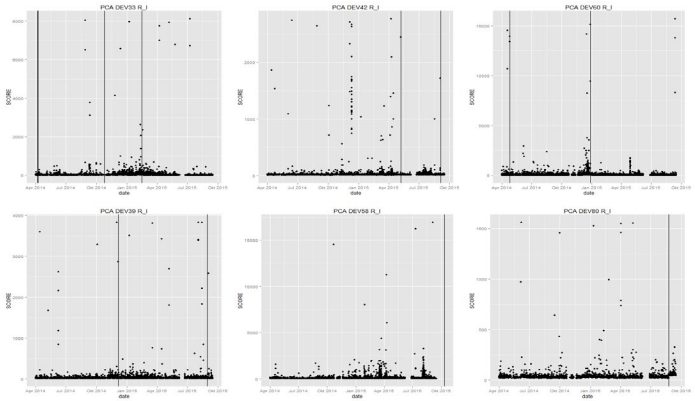


Machine Health Control Center - Geospatial Visualization

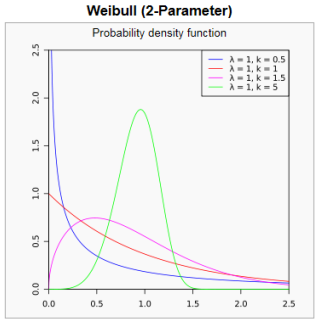


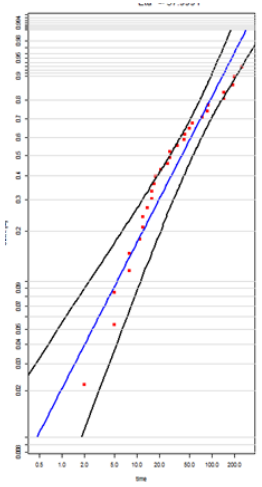
Machine Health Control Center - 3D Data Visualization

Many Data Science Algorithms are used in Predictive Maintenance



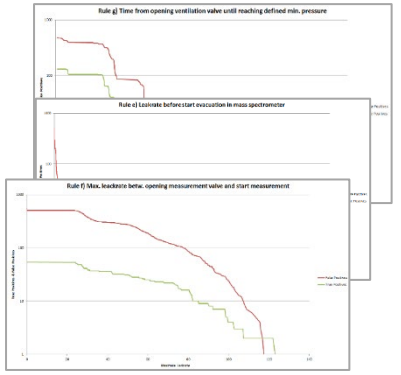
Principal Component Analysis of Switches



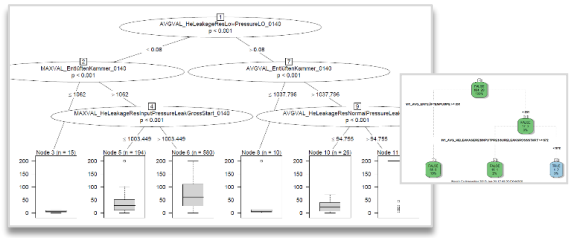


Weibull Remaining Useful Life Estimation

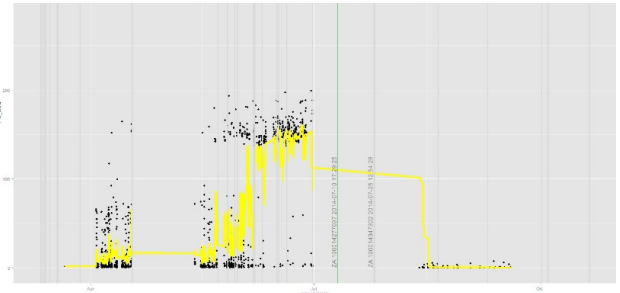
$$f(x;\lambda,k)=\begin{cases}\frac{k}{\lambda}\left(\frac{x}{\lambda}\right)^{k-1}e^{-(x/\lambda)^k} & x\geq 0,\\ 0 & x<0,\end{cases}$$



Expert Rule Validation



Automatic Rule Extraction with Decision Trees



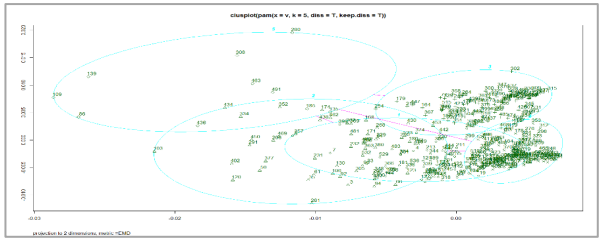
Anomaly Detection with Principal Component Analysis scores

$$\mathrm{Var}[a^T X]=\frac{1}{n}\sum_{i=1}^{n}\left\{a^T\left(X_i-\frac{1}{n}\sum_{j=1}^{n}X_j\right)\right\}^2$$
$$=a^T V_{xx}\,a.$$

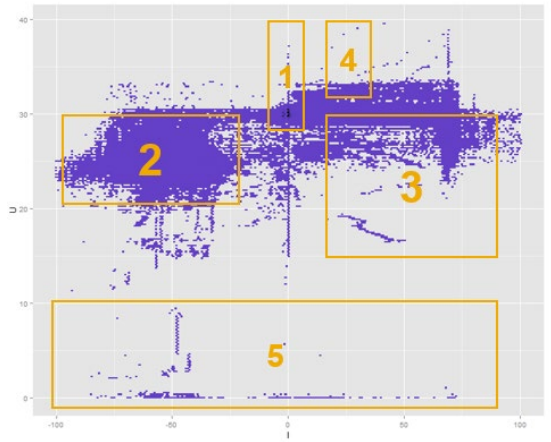
where

$$V_{xx}=\frac{1}{n}\sum_{i=1}^{n}\left(X_i-\frac{1}{n}\sum_{j=1}^{n}X_j\right)\left(X_i-\frac{1}{n}\sum_{j=1}^{n}X_j\right)^T$$

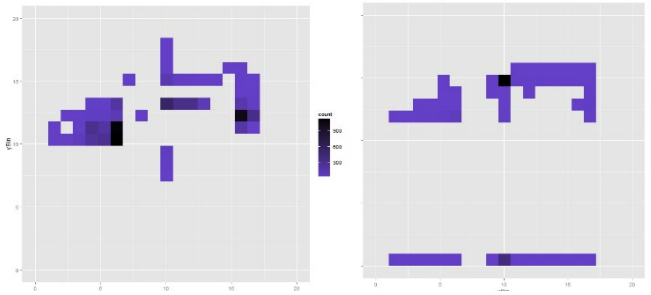
PCA



K-Mediod cluster analysis to partition the population into classes of similar devices



Battery behavioural groupings

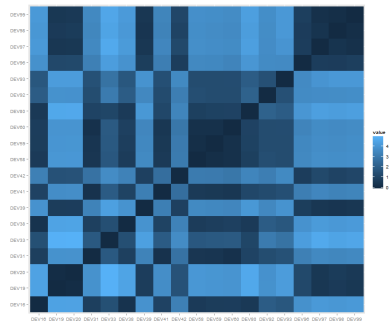


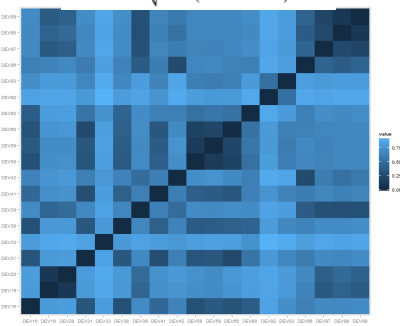
$$W(P,Q)=\min\left\{\sum_{x\in M,\,y\in M}dist(x,y)\cdot T(x,y)\,\middle|\,T:M\times M\to[0,1]\;with\;\sum_{y\in M}T(x,y)=P(x),\;\sum_{x\in M}T(x,y)=Q(y)\right\}$$

Wasserstein Metric for battery performance analysis

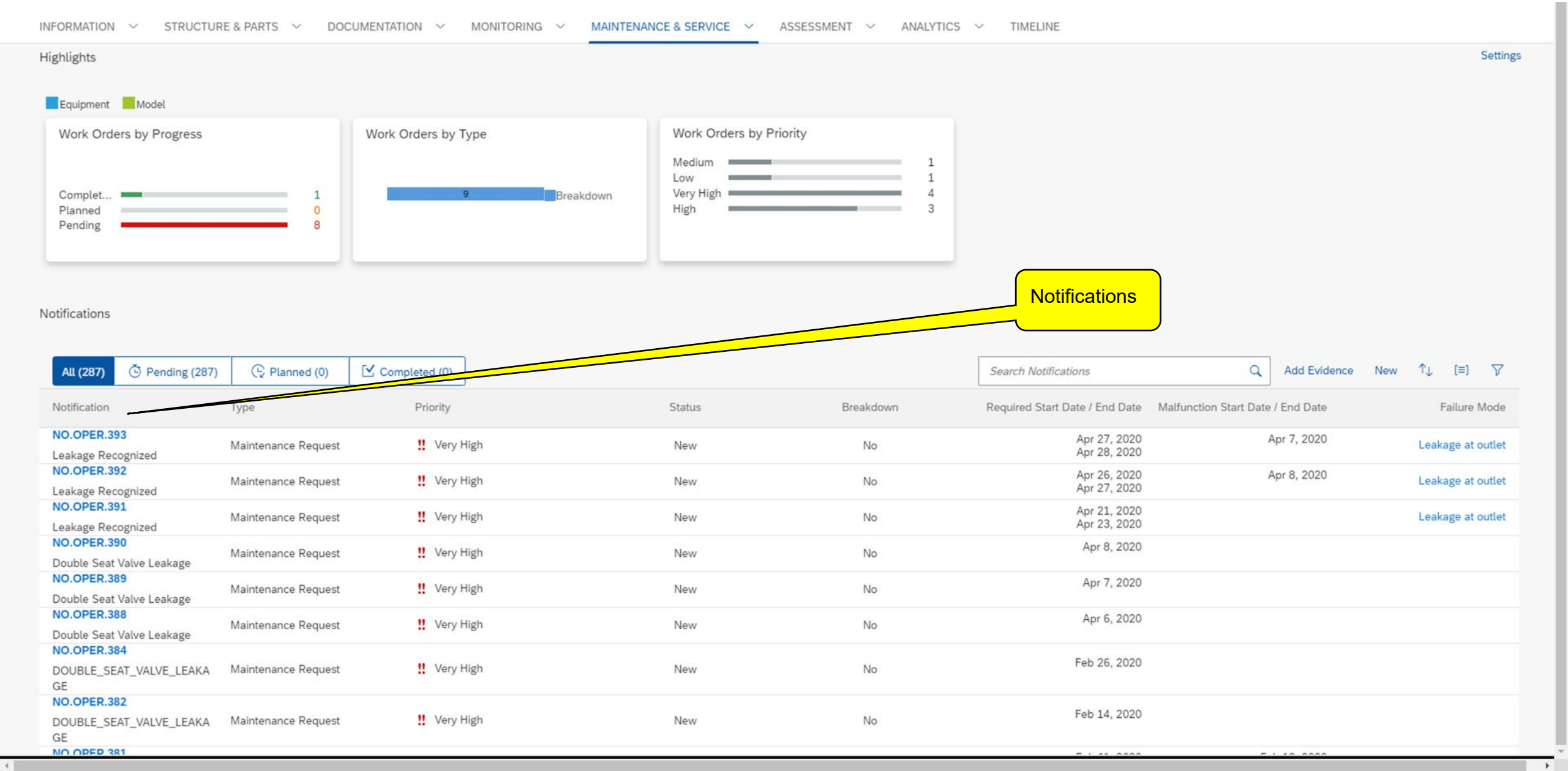
$$W_p(\mu,\nu):=\left(\inf_{\gamma\in\Gamma(\mu,\nu)}\int_{M\times M}d(x,y)^p\,\mathrm{d}\gamma(x,y)\right)^{1/p}$$

$$H(P,Q):=\sqrt{\frac{1}{2}\int\left(\sqrt{\frac{dP}{d\lambda}}-\sqrt{\frac{dQ}{d\lambda}}\right)^2 d\lambda}$$

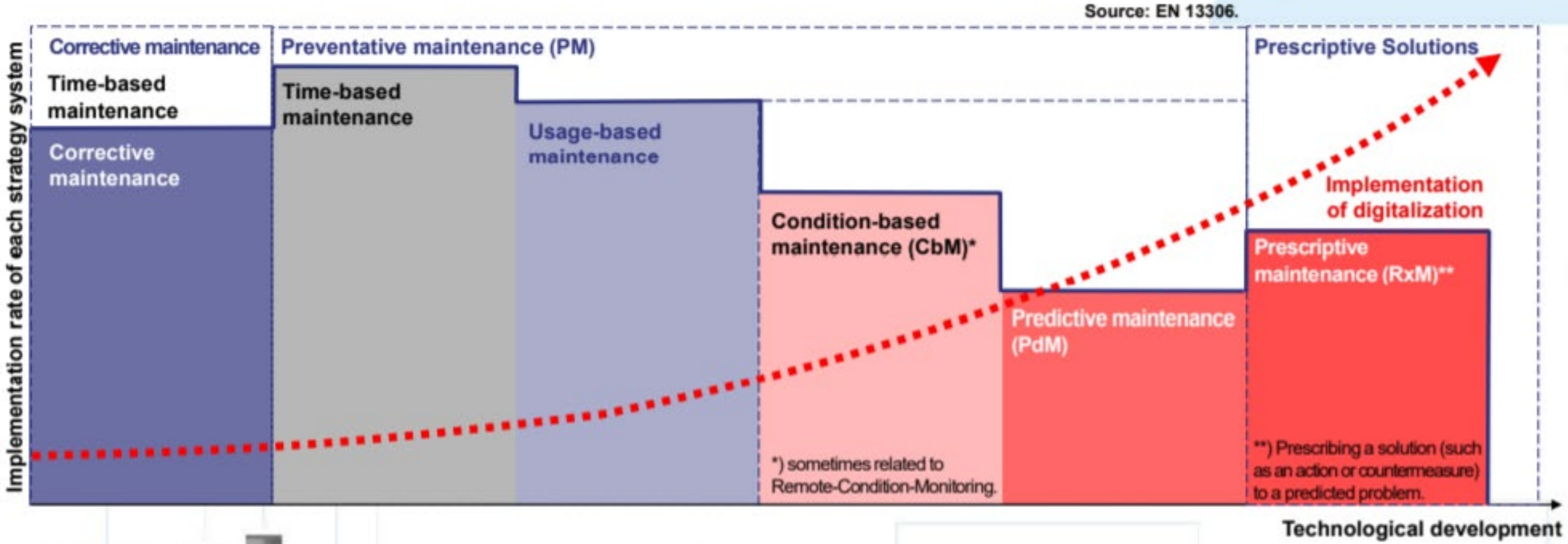




Failure-Mode-Specific Health Monitoring & Corrective Action

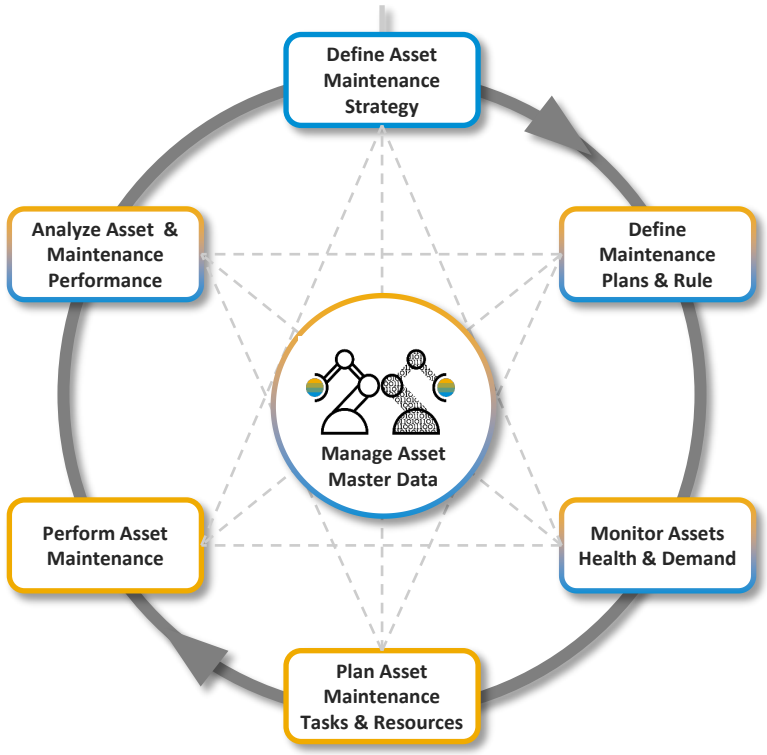


Intelligent blend (mix) of maintenance strategies for assets to optimize customer comfort, availability and cost reduction.



Intelligent Asset Management: Mitigating Risk & Improving Performance

Seamlessly extend **Enterprise Maintenance Management & Service** with **Asset Performance Management** along end-to-end processes to close the loop between maintenance strategy and execution to **define, implement, execute** and **monitor** the **optimal asset maintenance.**



Improved Reliability (MTBF)

Higher Availability

Improved Productivity (MTTR)

KPIs

Additionally:-

Mitigate consequences of failure of:

- Pressure vessels, pipelines
- Rotating equipment
- Safety instrument systems

Avoid breaking the law:

- environmental regulations
- Safety rules

Value from more production from higher availability (at quality)

Additionally:-

Reduction in Labor/ Services Costs:

- Less travel time, information searching, parts searching

Reduction in Parts Costs:

- Optimized spare parts, tools policies

Mitigate Risk by:

- Condition monitoring to detect onset of failure
- Inspections to measure deterioration
- Functional checks to assure redundancy

Result is reduced train/ unit failure/ trip rate and **improved availability and unit performance**.

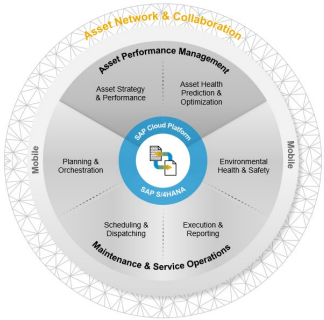
Productivity benefits from better planning of:

- Maintenance demand
- Technician/ Operator skills
- Parts/ Services

SAP S/4HANA Maintenance Management
SAP S/4HANA Service Management

SAP Asset Performance Management

SAP Intelligent Asset Management and service



Increase asset performance, reduce maintenance costs, and deliver service excellence

Closed-loop strategy, planning and execution processes to optimize **asset performance management**

Synchronize maintenance and service across the **enterprise** for responsive customer care and supply chain **resilience**

Adopt new **collaborative** processes and 'products-as-a-service' business models across **networks**

Manage asset health with **Industry4.0** for real-time predictive maintenance and service

Optimize maintenance and service with **intelligent scheduling** and **crowd-sourced** resource management

Empower users with **mobile** asset intelligence, work automation, and safe sustainable **EH&S** policies

25% lower maintenance cost

where majority of maintenance work orders are generated predictively or condition-based

SAP Performance Benchmarking, n = 94

47% lower recordable accident frequency

where standardized regulatory reports are available and there is full visibility into all regulatory violations.

SAP Performance Benchmarking, n = 81

40% decrease in work order processing

time where mobile asset management is used in the field to streamline engineer tasks and reporting

SAP Reference Example: Metropolitan Utilities District

For more information:

Refer to intelligent asset management at [sap.com/iam](sap.com/iam)

Refer to SAP's strategy paper for intelligent asset management at [sap.com](sap.com)

Thank you.

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https://www.sap.com/products/scm/apm.html

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