Supporting Operational Availability with PI System and SAP PM connection

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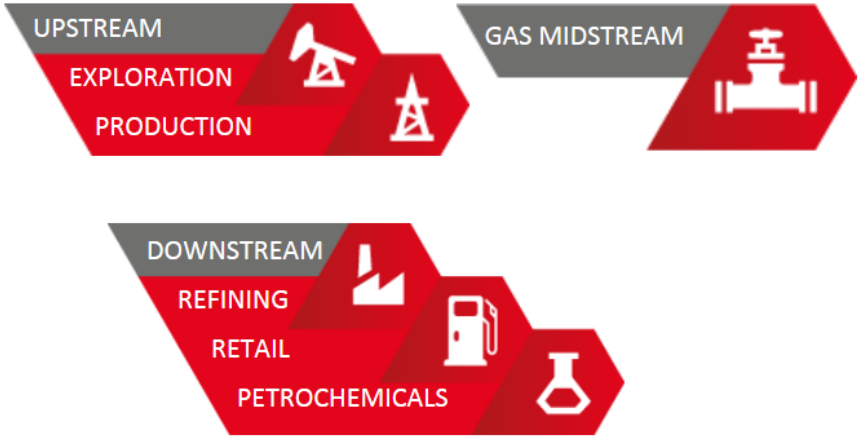
MOLGROUP

Agenda

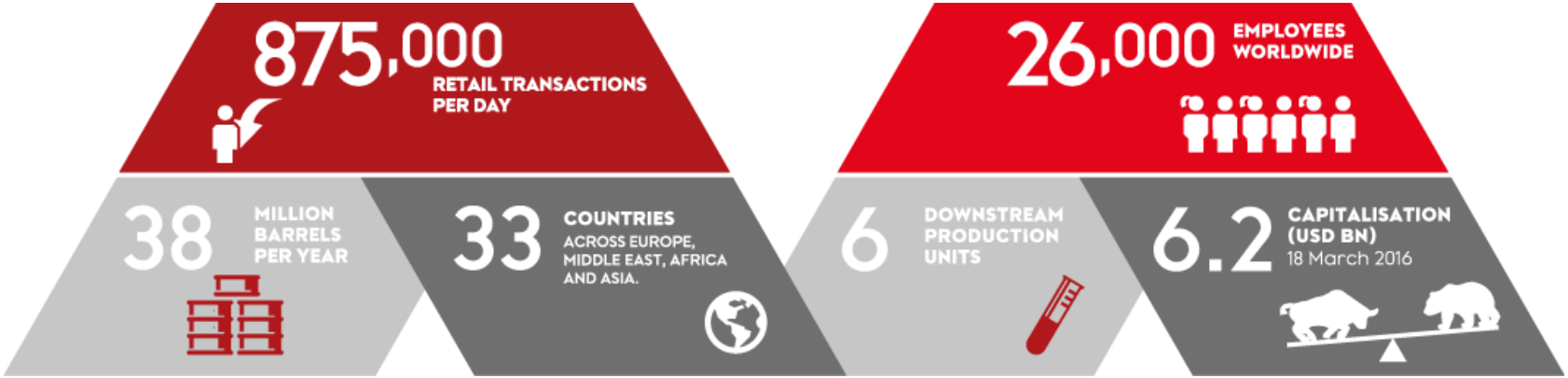
- Introduction
- Business Challenge
- Focus on Predictive and Preventive Maintenance
- Implementation Details
  - Corrosion & integrity predicting High Temperature Hydrogen Attack (HTHA)
  - Preventive maintenance aided by the connection of OSIsoft's PI System and SAP PM
- Summary

MOL Group

MOL is an integrated, independent, international oil and gas company, headquartered in Budapest, Hungary with a track record of over 100 years in the industry.



MOL Group in numbers



OSIsoft and MOL Hungary

200.000
PI Points

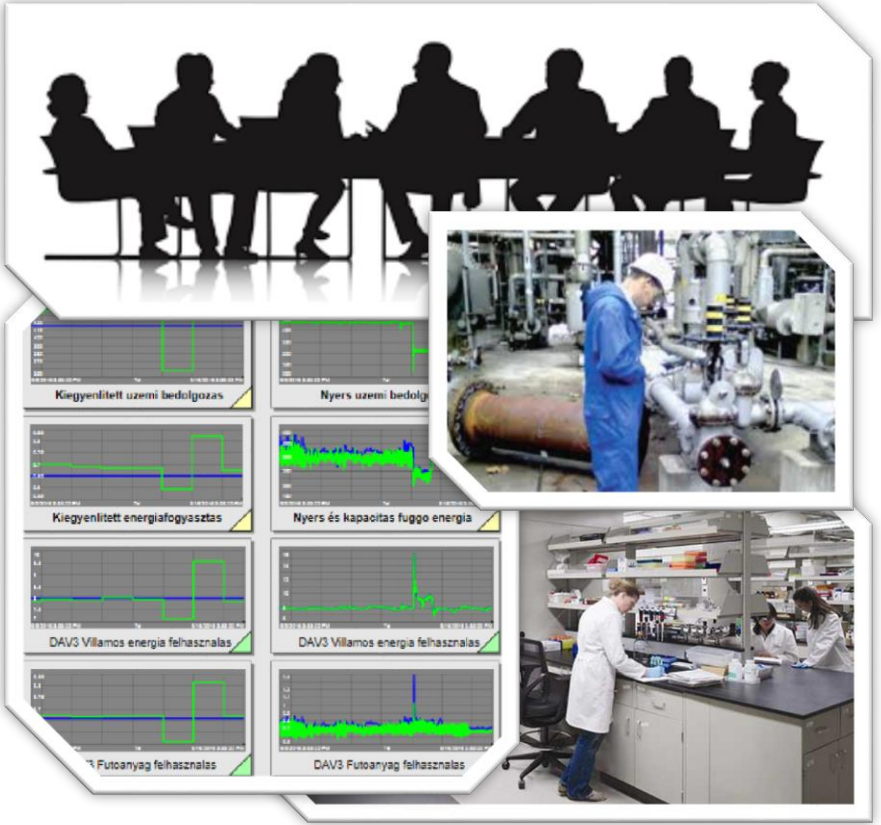
20.000
Asset Analytics
Formulas

5.000
PI System
Notifications

Role of PI System in Danube Refinery

Primary process database and operational intelligence tool

- Production Management
- Reporting
- Operation
- Quality Management
- Maintenance
- Energy Monitoring
- …



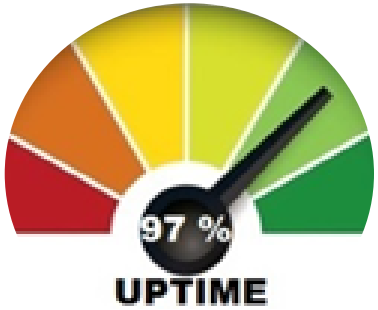
Business Challenge

Reliability and preventive programs

- NxDSP – increase operational excellence
- UPTIME - reliability improvement program (FMEA, LFF, RCFA)
- PSM (Process Safety Management)

Our goal is to **keep our assets healthy** to avoid unplanned shutdowns

- Avoid harmful process conditions
- Increase the ratio of preventive maintenance



Focus on predictive and preventive maintenance

Two new PI System-based solutions to support the **maintenance** team

Predictive
Fix it before it breaks

Preventive
Routine repairs

Reactive
Fix it after it breaks

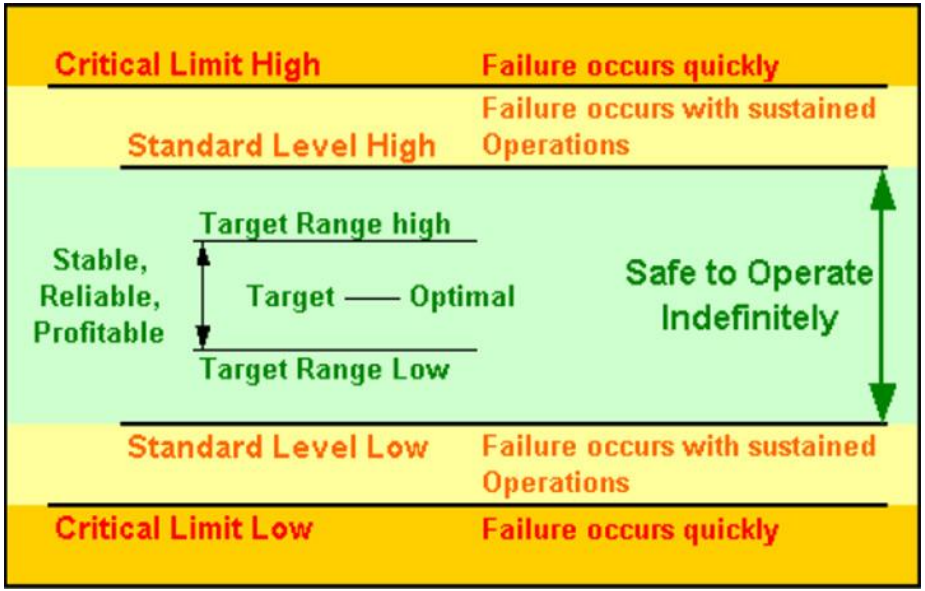
SAP-PM

HTHA

Corrosion & Integrity Predicting High Temperature Hydrogen Attack (HTHA)

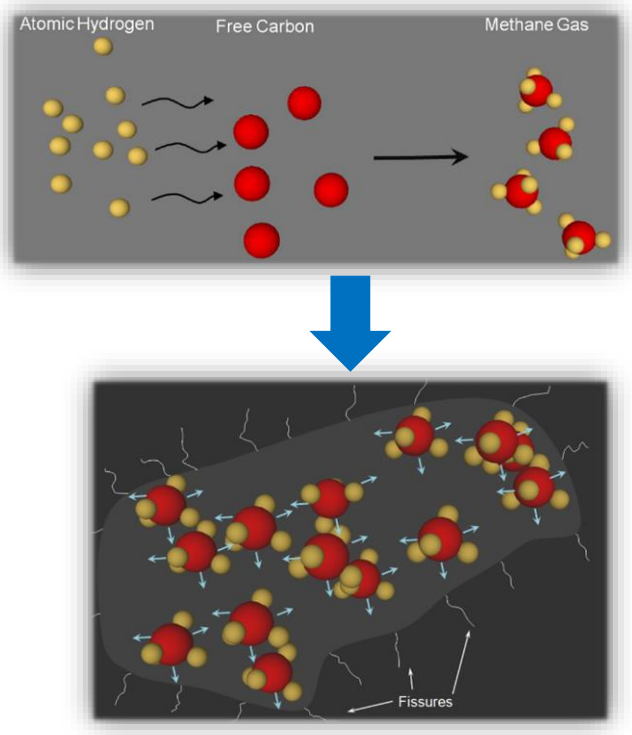
BACKGROUND - IOW

Definition of **Integrity Operating Windows** (IOW): Established **limits for process variables** (parameters) that can **affect the integrity or reliability of the equipment** if the process operation deviates from the established limits for a predetermined length of time.



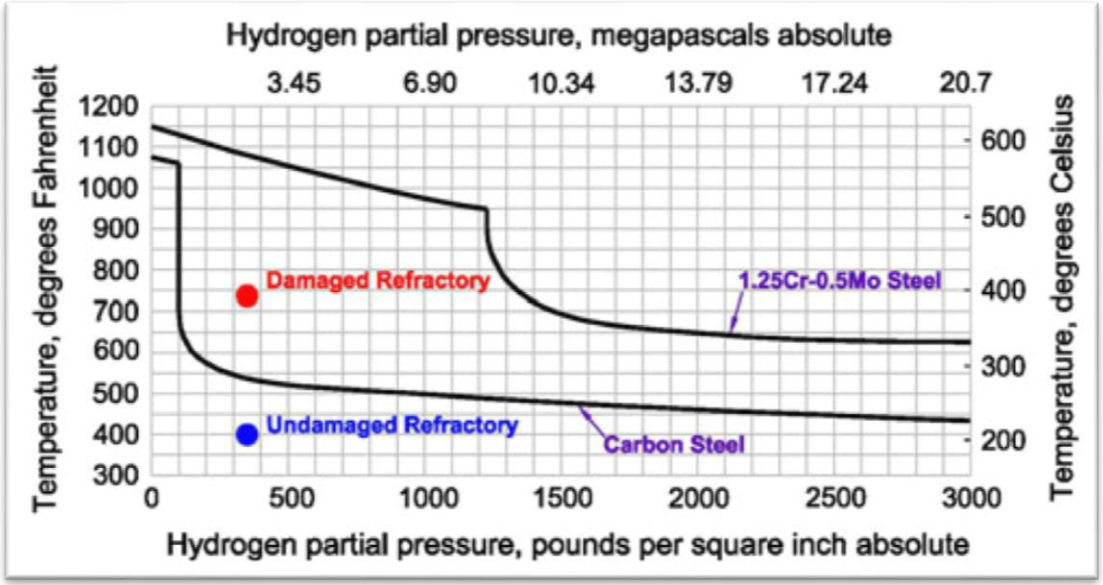
BACKGROUND - HTHA

- Tesoro, Anacortes refinery, 2010
- Fatal injury of seven employees
- Heat exchanger catastrophically ruptured because of an HTHA - high temperature hydrogen attack
  - HTHA occurs when atomic **hydrogen diffuses into the steel walls** of process equipment
  - The hydrogen reacts with carbon in the steel, **producing methane gas**
  - Methane molecules cannot diffuse out of the steel, they **accumulate** inside of the steel, creating **high pressure**, forms **fissures** in steel
  - This reaction **removes carbon** from the steel (decarburization)



BACKGROUND – Nelson Curves API 941

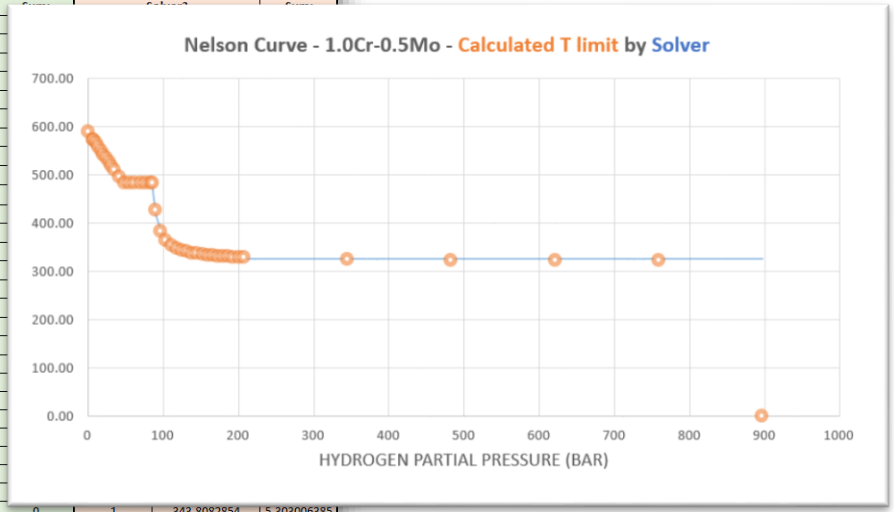
- A **Nelson Curve** is an empiric curve used in production units which shows the permissible **hydrogen partial pressure** and **temperature** for the given **pipe class** (material of construction) to avoid HTHA.



IMPLEMENTATION– Nelson Curves with solver

- Estimate T-p data values from the Nelson curves
- Minimize the squared deviation by the help of Excel Solver
- Tune the Excel Solver parameters to fit better on the points

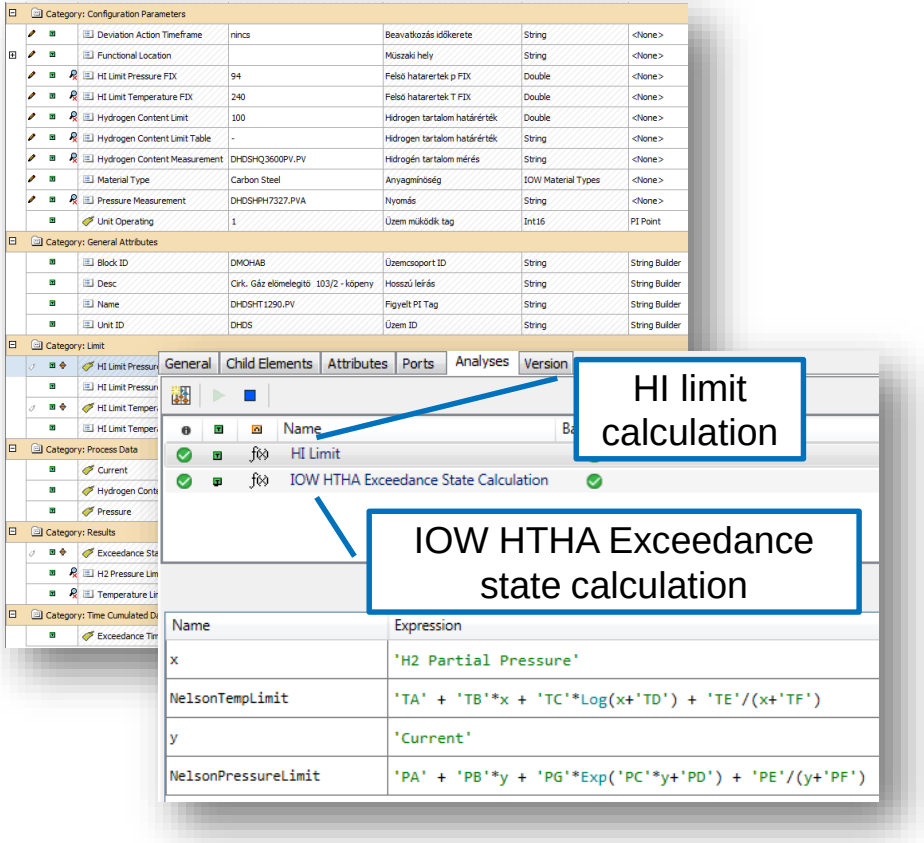
	A	B	C	D	E	F	G	H	I	J	K	L	M
1	1.0Cr-0.5Mo				Solver1		Sum:		Solver2				
2							24.57587847						
3	P(H2) (pounds/inch2)	Temp (F°)	P(H2) (Bar)	Temp (C°)	Factor1	Temp (C°) Solver1	Dev^2	Factor2	Temp (C°) Solver2				
4	0	1100	0	593.33	1	588.9601409	19.1248117	0	482.2222222				
5	100	1065	6.89475729	573.89	1	573.3659054	0.273511718	0	482.2222222				
6	100	1065	6.89475729	573.89	1	573.3659054	0.273511718	0	482.2222222				
7	150	1050	10.34213594	565.56	1	565.5687876	0.000175088	0	482.2222222				
8	200	1035	13.78951458	557.22	1	557.7716699	0.301892731	0	482.2222222				
9	250	1020	17.23689323	548.89	1	549.9745521	1.178664647	0	482.2222222				
10	300	1010	20.68427187	543.33	1	542.1774344	1.336102452	0	482.2222222				
11	350	995	24.13165052	535.00	1	534.3803166	0.38400753	0	482.2222222				
12	400	980	27.57902916	526.67	1	526.5831988	0.006966881	0	482.2222222				
13	450	965	31.02640781	518.33	1	518.7860811	0.204980504	0	482.2222222				
14	500	950	34.47378645	510.00	1	510.9889633	0.978048399	0	482.2222222				
15	600	925	41.36854374	496.11	1	495.3947278	0.513205097	0	482.2222222				
16	700	900	48.26330103	482.22	0	479.8004922	0	1	482.2222222				
17	800	900	55.15805832	482.22	0	464.2062567	0	1	482.2222222				
18	900	900	62.05281561	482.22	0	448.6120212	0	1	482.2222222				
19	1000	900	68.9475729	482.22	0	433.0177856	0	1	482.2222222				
20	1100	900	75.84233019	482.22	0	417.4235501	0	1	482.2222222				
21	1200	900	82.73708748	482.22	0	401.8293146	0	1	482.2222222				
22	1240	900	85.4949904	482.22	0	395.5916204	0	1	482.2222222				
23	1300	780	89.63184477	415.56	0	386.2350791	0	0	482.2222222				
24	1400	725	96.52660206	385.00	0	370.6408435	0	0	482.2222222				
25	1500	695	103.4213594	368.33	0	355.046608	0	0	482.2222222				
26	1600	675	110.3161166	357.22	0	339.4523725	0	0	482.2222222				
27	1700	665	117.2108739	351.67	0	323.8581369	0	0	482.2222222				
28	1800	655	124.1056312	346.11	0	308.2639014	0	0	482.2222222	0	1	343.8082854	5.303006385



IMPLEMENTATION– Create the system in Asset Framework (AF)

Challenges

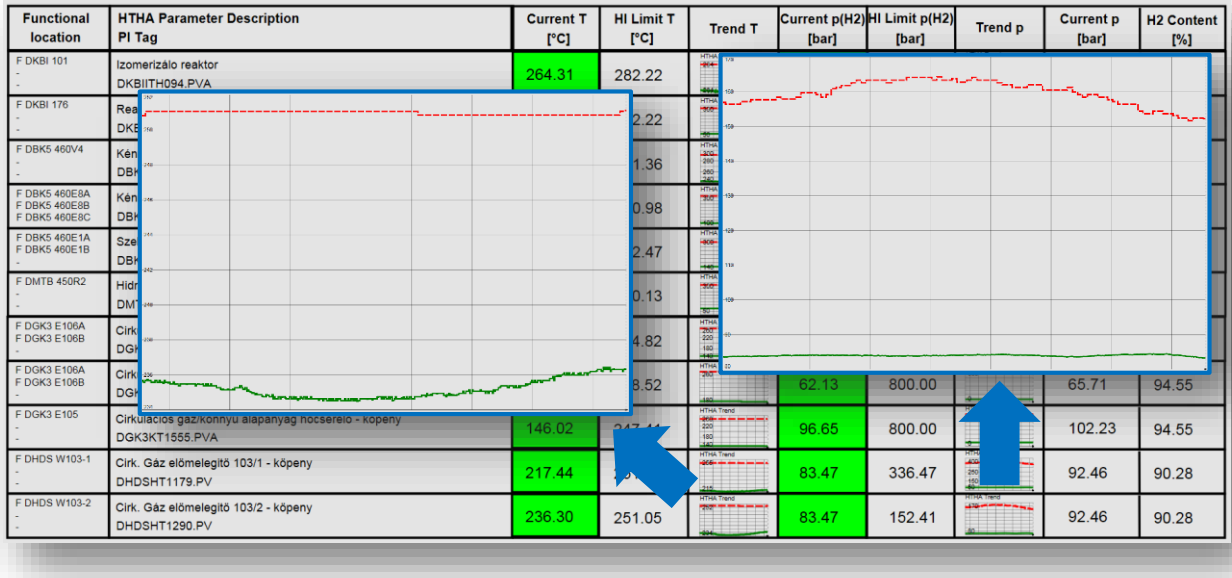
- Suitable attributes structure
- Analyses with ONE general equation
- Nelson curves based on material of construction
- Table contains the constants for table lookup
- Calculate the temperature and pressure limits as well



IMPLEMENTATION– Continuous Monitoring / PI Coresight

- Support collaboration and decision making
- Visualization management - Multi-state symbol

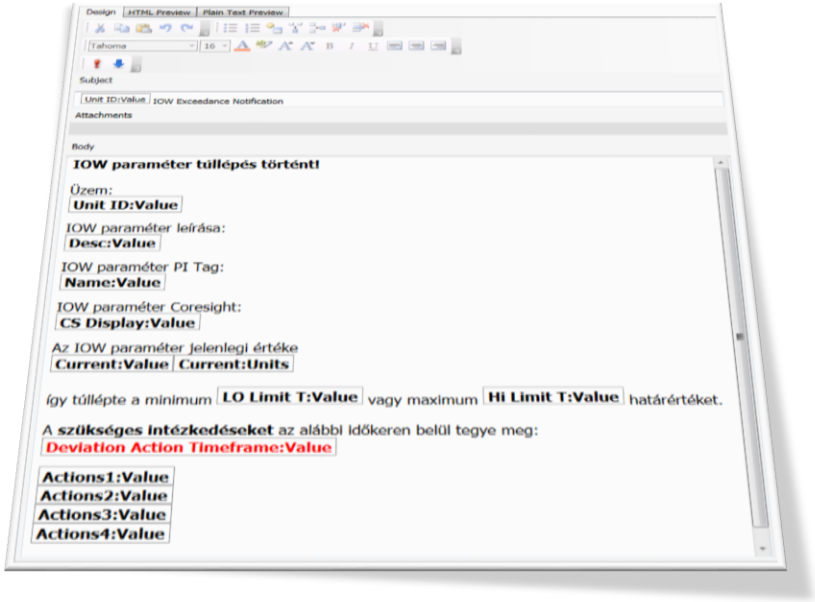
- Easy to use
- Dynamic limits
- Mini trends



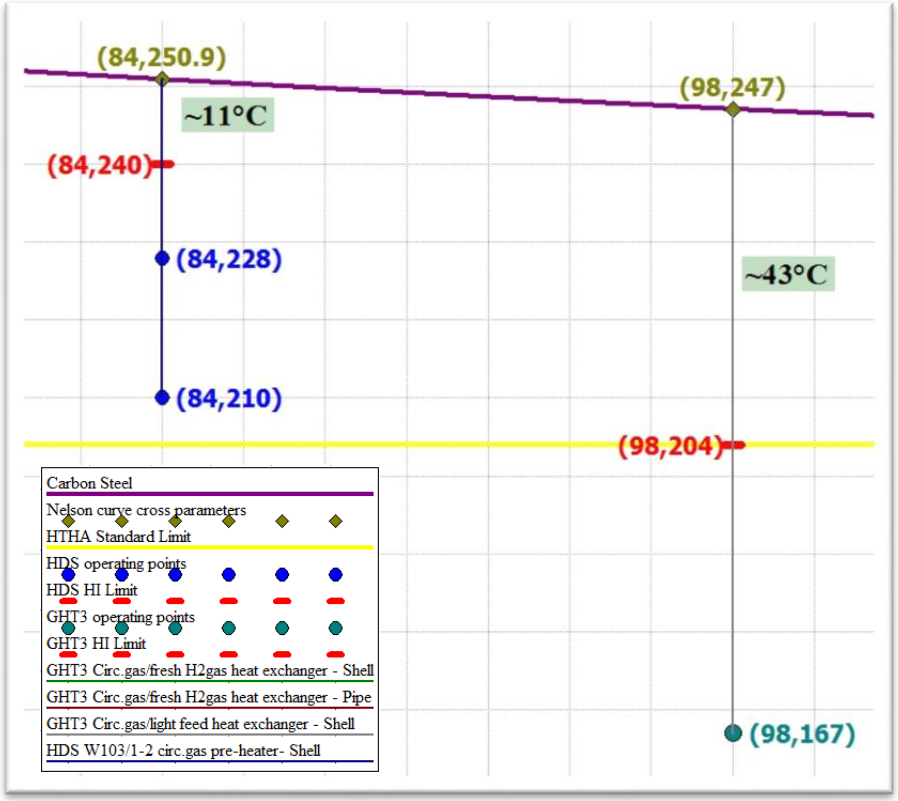
Functional location	HTHA Parameter Description PI Tag	Current T [°C]	HI Limit T [°C]	Trend T	Current p(H2) [bar]	HI Limit p(H2) [bar]	Trend p	Current p [bar]	H2 Content [%]
F DKBI 101	Izomerizáló reaktor DKBIITH094.PVA	264.31	282.22						
F DKBI 176	Rea DKB		2.22						
F DBK5 460V4	Kén DBK		1.36						
F DBK5 460E8A F DBK5 460E8B F DBK5 460E8C	Kén DBK		0.98						
F DBK5 460E1A F DBK5 460E1B	Sze DBK		2.47						
F DMTB 450R2	Hidr DMT		0.13						
F DGK3 E106A F DGK3 E106B	Cirk DGK		4.82						
F DGK3 E106A F DGK3 E106B	Cirk DGK		8.52		62.13	800.00		65.71	94.55
F DGK3 E105	Cirkulációs gáz/könnyu alapanyag hőcserélő - köpeny DGK3KT1555.PVA	146.02			96.65	800.00		102.23	94.55
F DHDS W103-1	Cirk. Gáz elömelegitő 103/1 - köpeny DHDSHT1179.PV	217.44			83.47	336.47		92.46	90.28
F DHDS W103-2	Cirk. Gáz elömelegitő 103/2 - köpeny DHDSHT1290.PV	236.30	251.05		83.47	152.41		92.46	90.28

IMPLEMENTATION– Message / PI System Notifications

- Immediate problem solving
- Reduced the alerts by 90%
- E-mails include all of the relevant information
- Link to the PI Coresight display
- Contain the intervention possibilities



Results of Action – Knowledge



- Deeper understanding of the corrosion processes
- Operating points distance from the Nelson Curve
- Collect the corrosion related parameters in one Asset Framework structure

Results of Action - Attitude

- Reduced corrosion → Cost savings
- Changed the material for a better alloy
- Improved the preventive approach
- Better communication between departments
- Maintenance team has a continuous monitoring tool

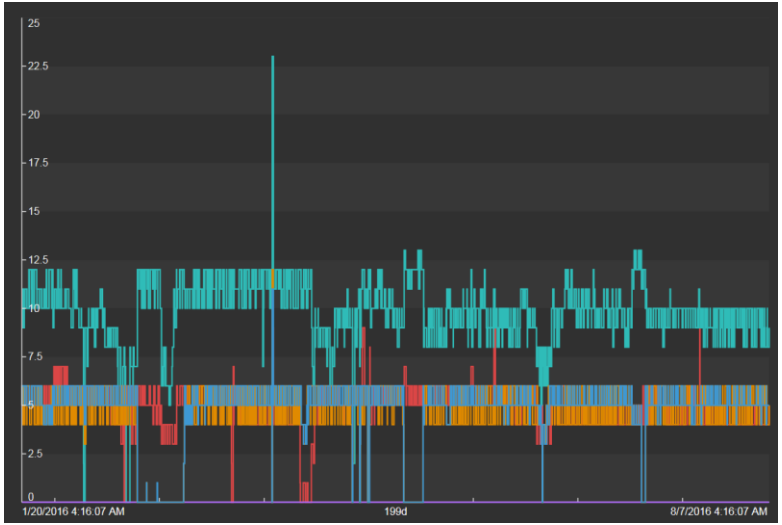
Preventive Maintenance aided by connecting the PI System and SAP PM

Challenge – Critical Availability Problems

- Hydrogen Production Plants (HPP) are critical units in the refinery
- Pressure Swing Adsorbers (PSA) are critical equipments in unit operation
- Cyclic operation – Heavy load on valves (9-10 open-close hourly)
- **$1.2 million USD loss in three years due to PSA valve failures**
- UPTIME program: **97% operational availability**

Solution – Preventive Maintenance

- Maintenance Engineering created a preventive maintenance strategy to keep valves in operation
- Problem: Time-based scheduling can not be used
  - Valves in each position are replaced regularly
  - Load on given valve position depends on unit feed
- **Process data (Cycle Number) has to be used to schedule maintenance**



Hourly cycle number of PSA valves

Phase 1 – Separated OSIsoft's PI System and SAP PM

- Aim: test the maintenance strategy
- Criteria:
  - No CAPEX, no IT development
  - Only existing software, tools
- **System:**
  - **Valve cycle count was collected in the PI System**
  - **Analysis, data evaluation in MS Excel**
  - **Manual order creation in SAP PM**

RFID név	Dátum	Tartalék	Beépítve	Össz-tartalék (nap)	Össz-üzemidő (nap)	RFID mozgás (db)	Pozícióban eltöltött idő (nap)	Megjegyzés
PSA006	2014-08-05	FALSE	TRUE				692	MAINT: 2014-08-05 12:23:10 Beépítve KXV5110E
PSA006	2014-01-28	TRUE	FALSE				189	MAINT: 2014-01-28 12:00:00 Tartalék
PSA006	2013-08-27	FALSE	TRUE				154	MAINT: 2013-08-27 10:06:50Beépítve kxv5103e
PSA006	2011-08-12	TRUE	FALSE				746	MAINT: 2011-08-12 Tartalék
PSA006	2011-03-02	FALSE	TRUE	935	1009	4	163	MAINT: 20110302 KXV-5105F
PSA007	2016-04-20	TRUE	FALSE				68	MAINT: 2016-04-20 09:22:45 Tartalék
PSA007	2014-01-28	FALSE	TRUE				813	MAINT: 2014-01-28 12:00:00 Beépítve KXV5103B
PSA007	2011-08-12	TRUE	FALSE				900	MAINT: 2011-08-12 Tartalék
PSA007	2011-03-02	FALSE	TRUE	968	976	3	163	MAINT: 20110302 KXV-5105B
PSA010	2014-08-05	FALSE	TRUE				692	MAINT: 2014-08-05 12:14:12 Beépítve KXV5110A
PSA010	2014-01-28	TRUE	FALSE				189	MAINT: 2014-01-28 12:00:00 Tartalék
PSA010	2013-08-27	FALSE	TRUE				154	MAINT: 2013-08-27 10:10:05Beépítve kxcv5103a
PSA010	2011-08-12	TRUE	FALSE				746	MAINT: 2011-08-12 Tartalék
PSA010	2011-03-02	FALSE	TRUE	935	1009	4	163	MAINT: 20110302 KXV-5110A
PSA011	2014-08-05	FALSE	TRUE				692	MAINT: 2014-08-05 12:24:16 Beépítve KXV5105B
PSA011	2014-01-28	TRUE	FALSE				189	MAINT: 2014-01-28 12:00:00 Tartalék
PSA011	2013-08-27	FALSE	TRUE				154	MAINT: 2013-08-27 10:15:50Beépítve kxv5103b
PSA011	2011-08-12	TRUE	FALSE				746	MAINT: 2011-08-12Tartalék
PSA011	2011-03-02	FALSE	TRUE	935	1009	4	163	MAINT: 20110302 KXV-5105A

	HG2 - 2011.03.02 / HGY 2016-01-01 -óta		
Jelenlegi hely	PSA_szelep	Össz-tartalék (nap)	Össz-üzemidő (nap)
F-D-HG2-KXV5101A	PSA098	277	770
F-D-HG2-KXV5101B	PSA026	264	1680
F-D-HG2-KXV5101C	PSA073	319	1462
F-D-HG2-KXV5101D	PSA029	264	1680
F-D-HG2-KXV5101E	PSA077	250	1531
F-D-HG2-KXV5101F	PSA071	250	1531
F-D-HG2-KXV5102A	PSA067	133	1665
F-D-HG2-KXV5102B	PSA069	133	1665
F-D-HG2-KXV5102C	PSA097	116	1665
F-D-HG2-KXV5102D	PSA093	169	1612
F-D-HG2-KXV5102E	PSA087	116	1665
F-D-HG2-KXV5102F	PSA076	356	1425
F-D-HG2-KXV5103A	PSA066	354	1571

Phase 2 – Connection of OSIsoft's PI System and SAP PM

- Aim: robust IT system to support preventive maintenance strategies

- Criteria:
  - Support the scheduling of PSA valve maintenance
  - **Flexibility and scalability** (further strategies expected)
  - **Integrated solution** (utilization of existing softwares)

- Tools:
  - PI System → Main process database + Real-time analysis
  - SAP PM → Equipment database + Maintenance management tool

- Missing component: Connection between systems

Architecture – Roles of components

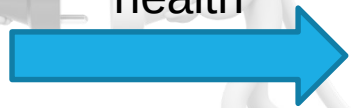
PI Server

- Process database
- Online analysis of process information
- Calculation of asset health
  - Asset condition
  - Running hours
  - Performance
- User Interface
  - PI Coresight
  - PI DataLink

Connection

(WebLogic)

Calculated asset health



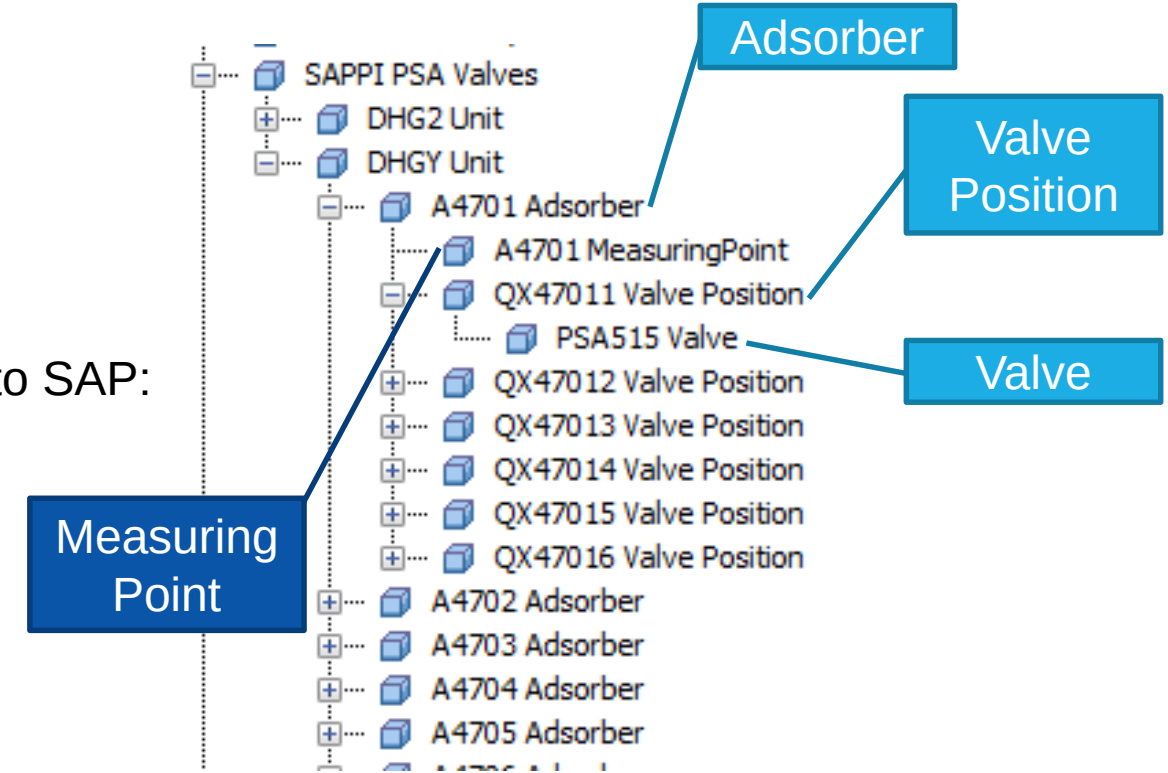
Maintenance related information

SAP PM

- Maintenance database
- Management of maintenance processes
- Creation of work orders or notifications
- Trigger maintenance strategies based on asset health

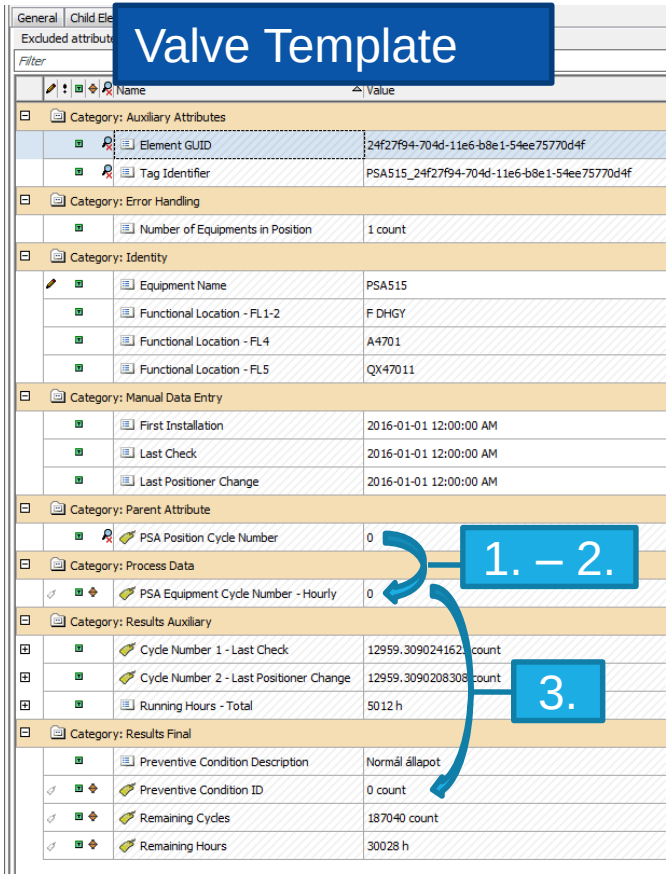
AF Structure

- Structure for calculation:
  - Adsorber
  - Valve positions
  - Valves
- Structure for moving data into SAP:
  - Adsorber
  - Measuring Points



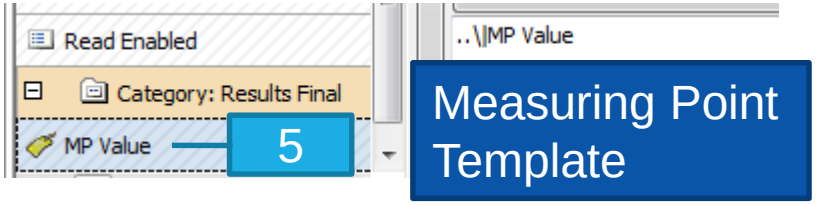
AF Calculation 1.

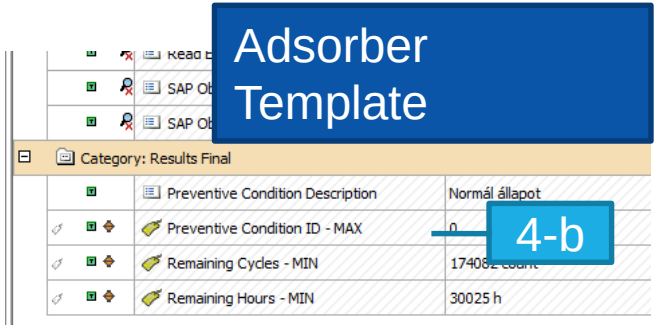
- Calculation steps:
  1. Cycle number of valve positions (PI Points)
  2. Cycle number of valves (read the attribute from the current parent)
  3. Preventive maintenance state of valves (based on valve cycle number and last repair time)
  4. Two aggregation steps (one with formula data reference, one with Roll Up analysis)
  5. Collecting results to move data into SAP Measuring Points

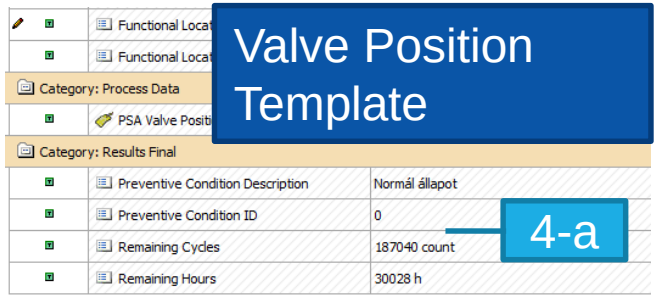


AF Calculation 2.

- Calculation steps:
  1. Cycle number of valve positions (PI Points)
  2. Cycle number of valves (read the attribute from the current parent)
  3. Preventive maintenance state of valves (based on valve cycle number and last repair time)
  4. Two aggregation steps (one with formula data reference, one with Roll Up analysis)
  5. Collecting results to move data into SAP Measuring Points



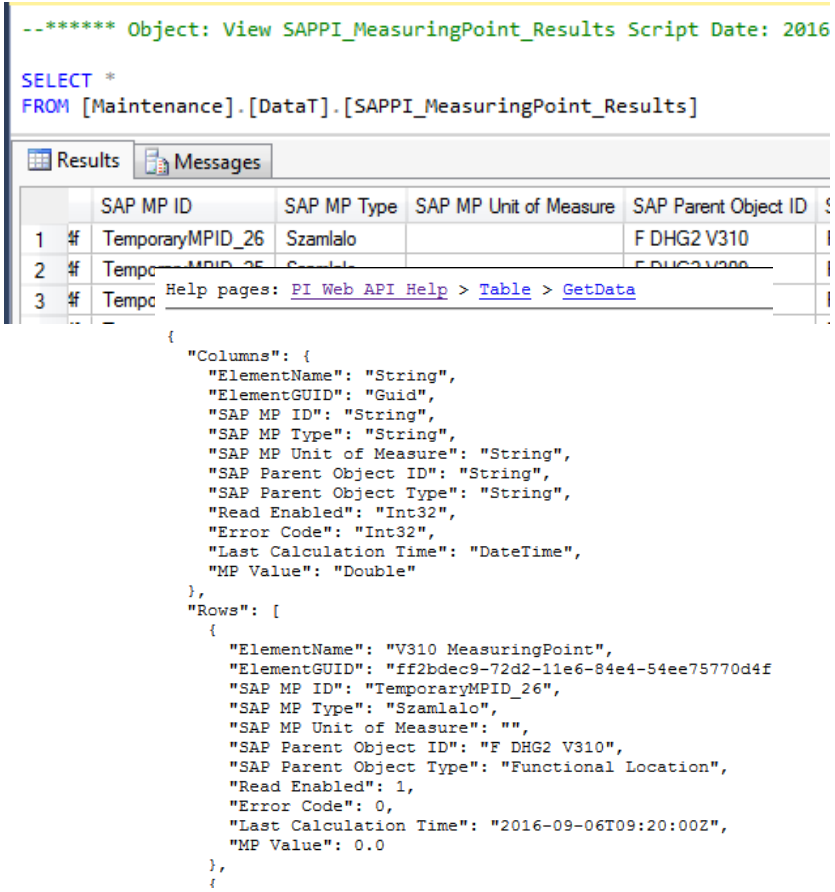




PI System-SAP Connection

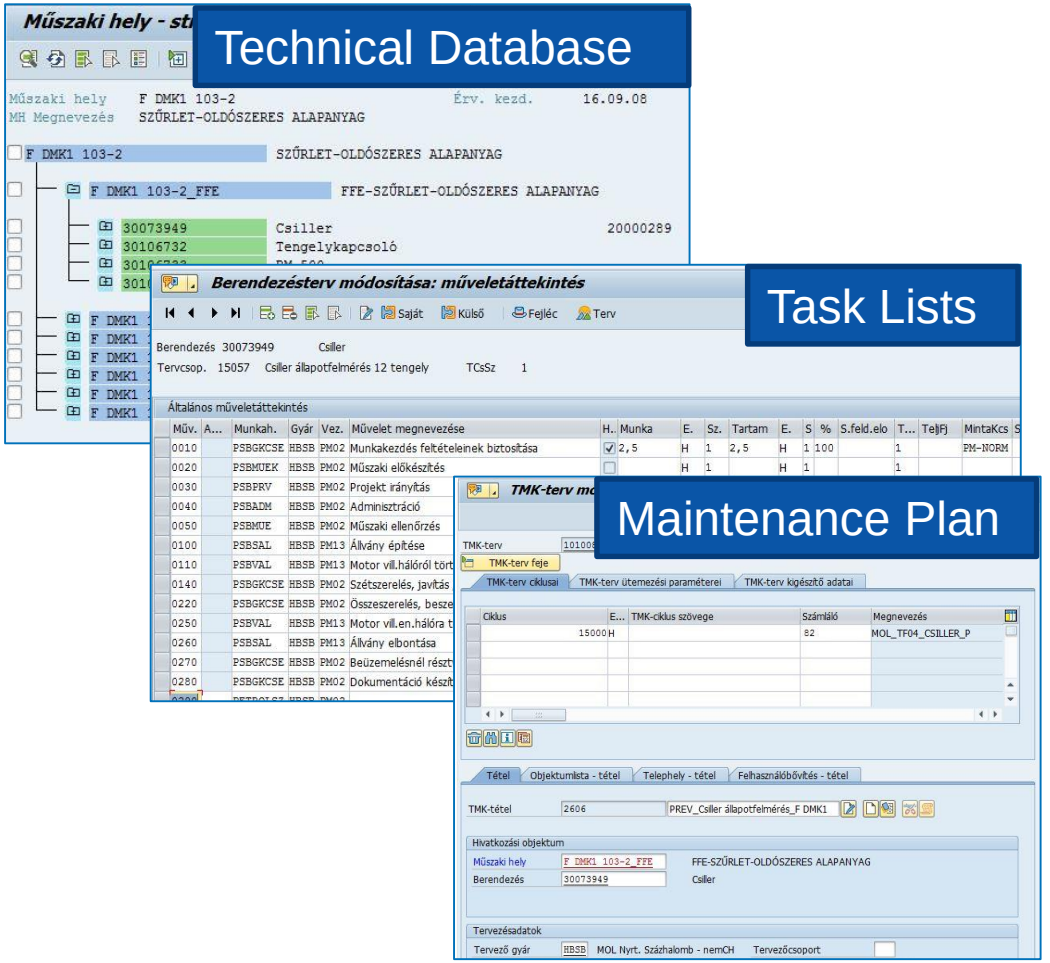
- Collect data from elements with Measuring Point template
  - PI OLEDB Enterprise
  - AF linked table

- Expose these data to the WebLogic middleware (Linux+Java)
  - PI JDBC did not fit into our existing environment
  - WebLogic reads through PI Web API



Asset Policy – SAP PM

- Maintenance management →Asset policy
- Asset policy:
  - Where to do?
  - What to do?
  - When to do?
- SAP PM covers these functionalities
  - Technical database
  - Task lists
  - SAP maintenance plan based on measuring points (with data from PI System)

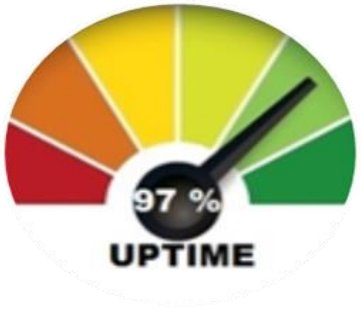


Expected Results

- Contribution in strategic operational availability program (UPTIME) goal: **97% Operational Availability**

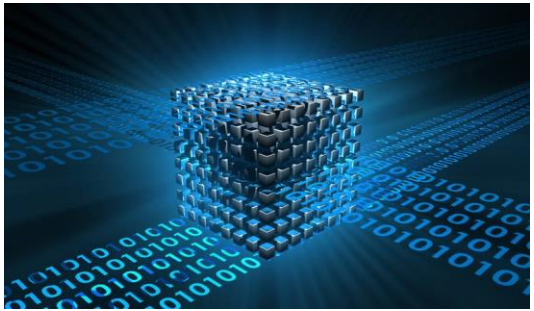
- Preventive maintenance strategies in operation (e.g. PSA valves, Furnace tubes)
  - Estimated reduction of unplanned shutdowns caused by these equipments: **10-15 %**
  - Saving due to increased operational reliability of these eqipments: **$230,000/year**

- Flexible, scalable system
  - **Further assets to be involved in preventive maintenance**



Next Steps

- Short-term
  - System roll out for other assets
- Mid- and long-term
  - System roll out for other assets
  - Utilization of advanced analytic possibilities (SAP HANA, PI Integrator for Business Analytics)
- Identification of further possibilities to utilize process data in maintenance



Reliability can be increased significantly with the PI System

COMPANY and GOAL

MOL operates thousands of assets, therefore reliability is a key factor in success; asset availability is a pillar of our efficiency programs.

MOLGROUP
THE ENERGY OF POSITIVE CHANGE

CHALLENGE

Challenging strategic operational availability goals (97%)

- This level of OA can not be achieved with reactive maintenance
- Critical PSA valve failures have to be prevented

SOLUTION

PI Server-based solution to support operational awareness and preventive maintenance

- Integrity Operating Windows (IOW) and HTHA implementation in PI Server to avoid corrosive, harmful situations
- Connection of PI Server and SAP PM to support preventive maintenance

RESULTS

Effective tools for maintenance engineers to keep asset healthy

- Less corrosive process conditions
- Longer asset life
- Increased availability of PSA valves ($230,000/year)
- Flexible architecture for further preventive strategies

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Questions

Please wait for the **microphone** before asking your questions

State your **name & company**

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http://ddut.ch/osisoft

감사합니다

谢谢

Danke

Gracias

Merci

Thank You

Köszönöm

ありがとう

Спасибо

Obrigado

„In God we trust; all others bring data.”

W. E. Deming