

OVERVIEW

OF

**Performance Analysis
Diagnostics & Optimization
(PADO)**

First Step: low hanging fruits

- Improve efficiency by improving operation and maintenance

Next Steps:

- Audit or „map“ the plant using off line modelling tool e.g. Epsilon
- Online optimization tool PADO
- Online fault detection system using SPC and Fault trees
- Online life time monitoring SR1 for better planning of inspections and maintenance

DCS also has the information needed to do the calculation of efficiencies & heat rates

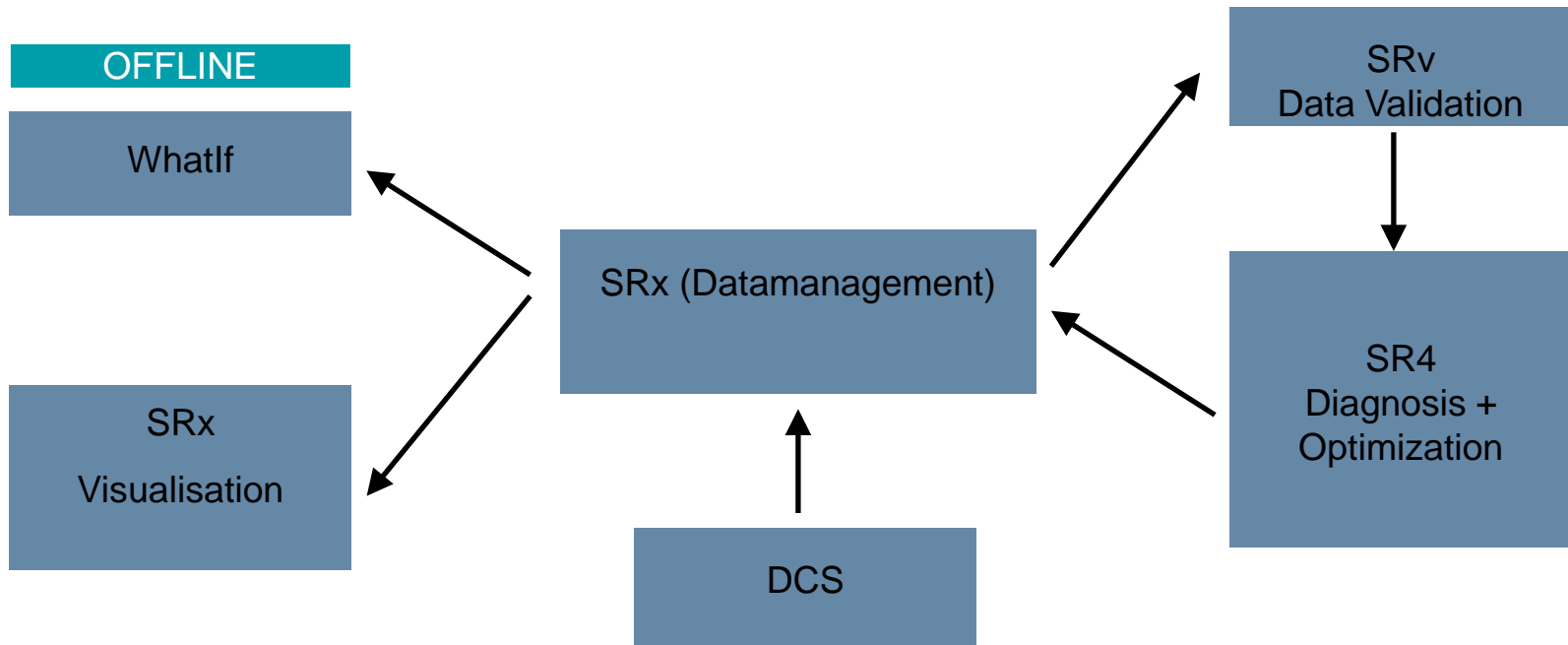
But what are the limitations ?

1. DCS does not give the system wise efficiencies so you do not know where the losses occur
2. Data from I/O points e.g. Temperature, pressure mass flow could be wrong because of sensor errors, bad connectors etc. That makes calculation erroneous.
3. DCS does not give advice on what to do

PADO: Online Optimization Sequence

1. All relevant data from DCS which goes into calculation need to be validated i.e. all implausible values have to be replaced by plausible values
2. All calculations must be done every 5 minutes so as to continuously monitor component and heating surface efficiencies.
3. Results should be presented in user friendly manner: state of components indicated by green, yellow, red and losses expressed in monetary value per hour

PADO Functions



80 units order for PADO have been placed on SESI
27 units successfully commissioned till date

National Thermal Power Corporation (NTPC)

The largest power generating major of India generating power from Coal and Gas with an installed capacity of 34,194 MW, has standardised on Steag PADO for all future units including Super-Critical Units.

Bharat Heavy Electricals Limited (BHEL)

The largest supplier of power equipment with 70% of current installed market of Thermal Power Plants has a Framework Agreement with SESI for installation of PADO for all future units including Super-Critical Units.



55 units where PADO is commissioned or under commissioning

- NTPC Simhadri 2x500 MW
- NTPC Ramagundam 1x500 MW
- NTPC Rihand 2x500 MW
- NTPC Talcher 4x500 MW
- NTPC Kahalgaon 3x500 MW
- NTPC Sipat 2x500 MW
- NTPC Vindhyachal 2x500 MW
- NTPC Korba 1x500 MW
- NTPC Dadri 2x500 MW
- NTPC Farakka 1x500 MW
- Mahagenco Khaparkheda 1x500 MW
- Mahagenco Bhusawal 2x500 MW
- NTPC Simhadri (stage II) 2x500 MW
- NTPC Jhajjar 3x500 MW
- KPCL Bellary (KPCL) 1x500 MW
- RVUNL Stage 1 and 2 Chhabra 3 x 250 MW
- Shree cement Ltd. RAS
- DVC Maithan 2x500 MW
- GEB Ukai 2x500 MW
- NTPC Korba Extn 1x500 MW
- NTPC Bongaigaon 3x250 MW
- TNEB North Chennai 2x600 MW
- CSEB Marwa 2x500 MW
- CSEB Korba 1x500 MW
- L&T Rajpura 2x700 MW
- L&T Koradi 3X660 MW
- Sterlite Jharsuguda 4X600 MW



Signing of Framework Agreement

steag



steag

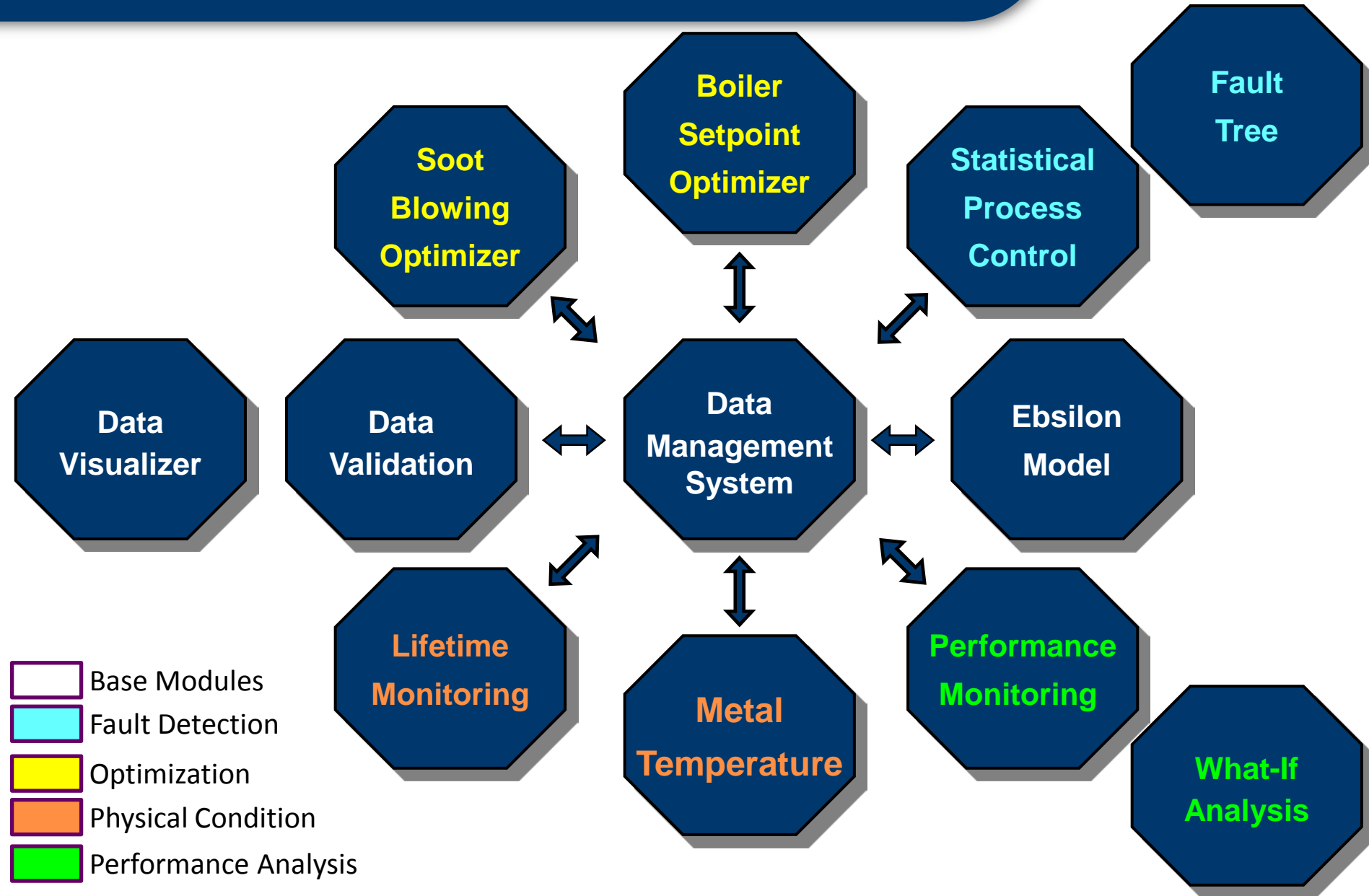


Advantages of PADO

- Improving the quality of measurements by data validation
- Evaluation of boiler, turbines, condenser and other components
- Optimization of unit operation (sootblowing, setpoints)
- Calculation of what-if scenarios
- Generation of daily and monthly reports
- Enhance the efficiency of the power plant !

Modules of PADO System

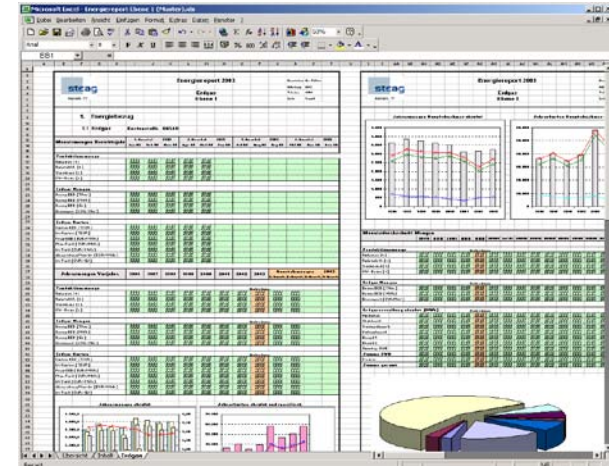
steag



SR::x Data Management System

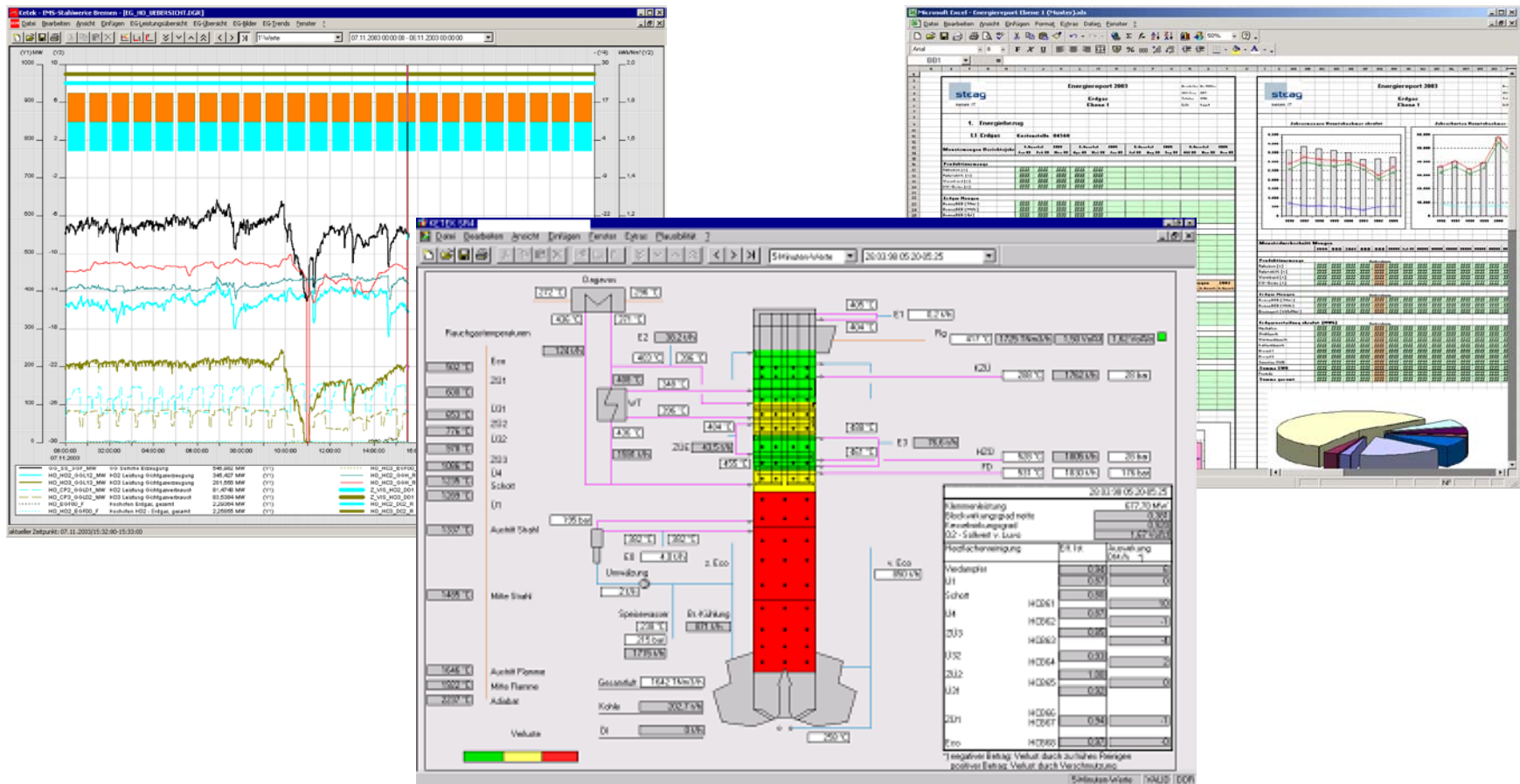
SR::x is the central data management in the SR product family

- Competitive server featuring a “state-of-the-art“ visualization
- Long-term storage of measured and computed values in time-oriented archives; base time class is ‘minute values’
- Automatic aggregation to higher time classes such as 5’-, quarterly-, hourly-, daily-, monthly- or yearly-values
- Integrated mathematical formula editor
- Excel-Add-In and HTML-List Generator allow the generation of extensive reporting systems



SR::x Data Management System

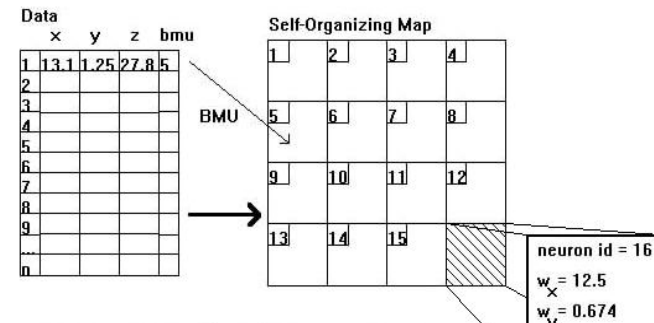
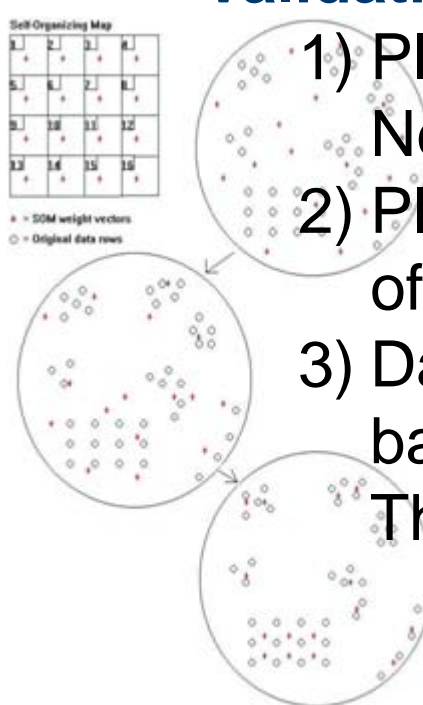
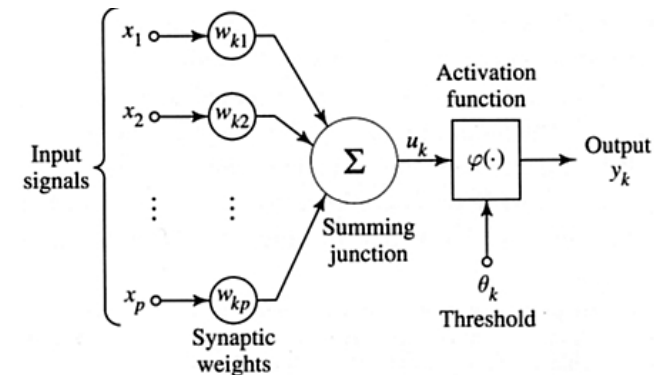
SR::x is the central data management with “state-of-the-art” visualization



Data Validation to replace data errors due to defective sensor or cable problems:
 Incorrect Data – Wrong results
 No data – No results

Validation – A 3 tier Process

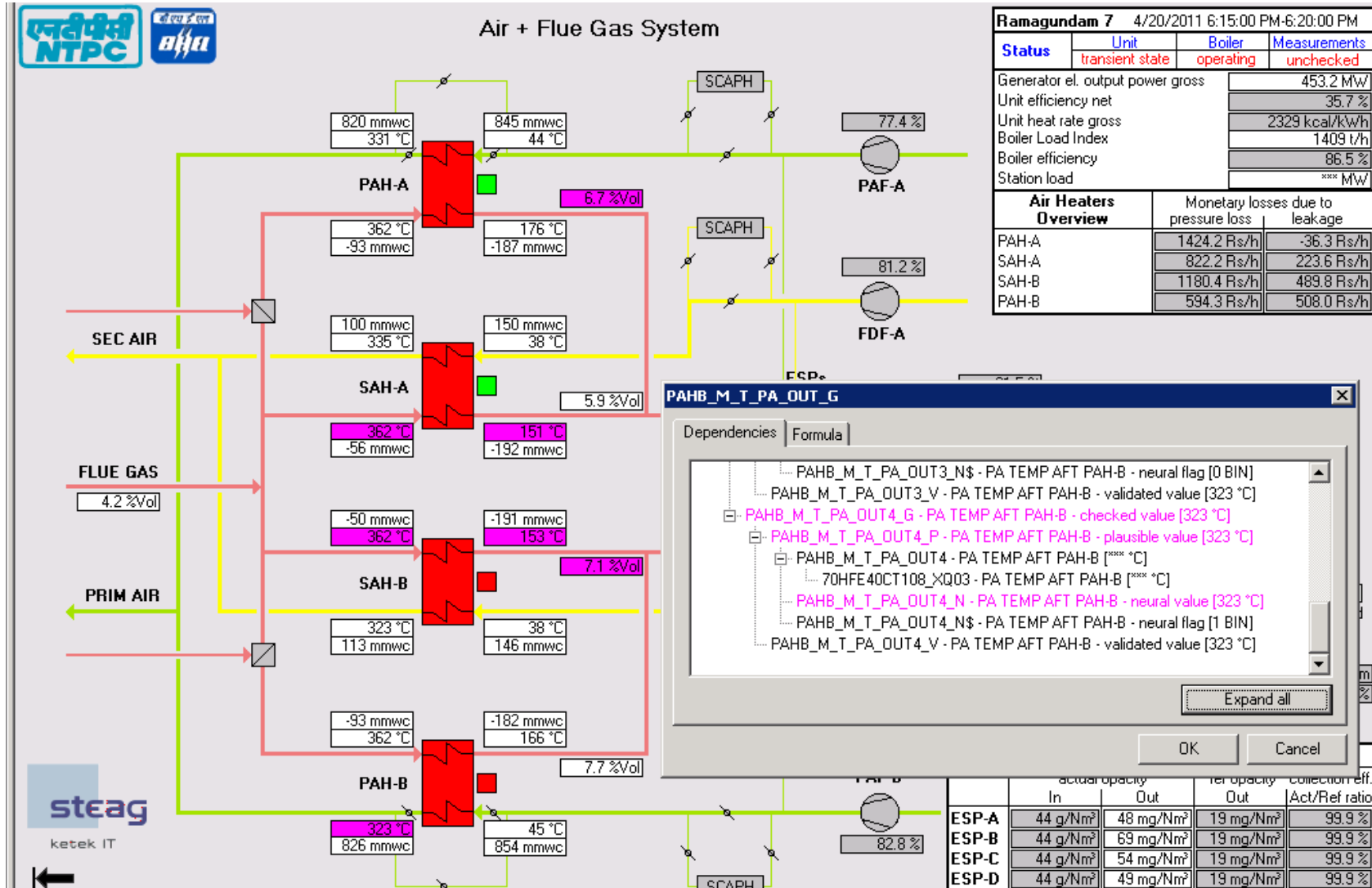
- 1) Plausibility Check using Neural Networks
- 2) Plausibility Check based on range of Values
- 3) Data validation / reconciliation based on “First Principle Thermodynamic” model



Data Validation System (1)

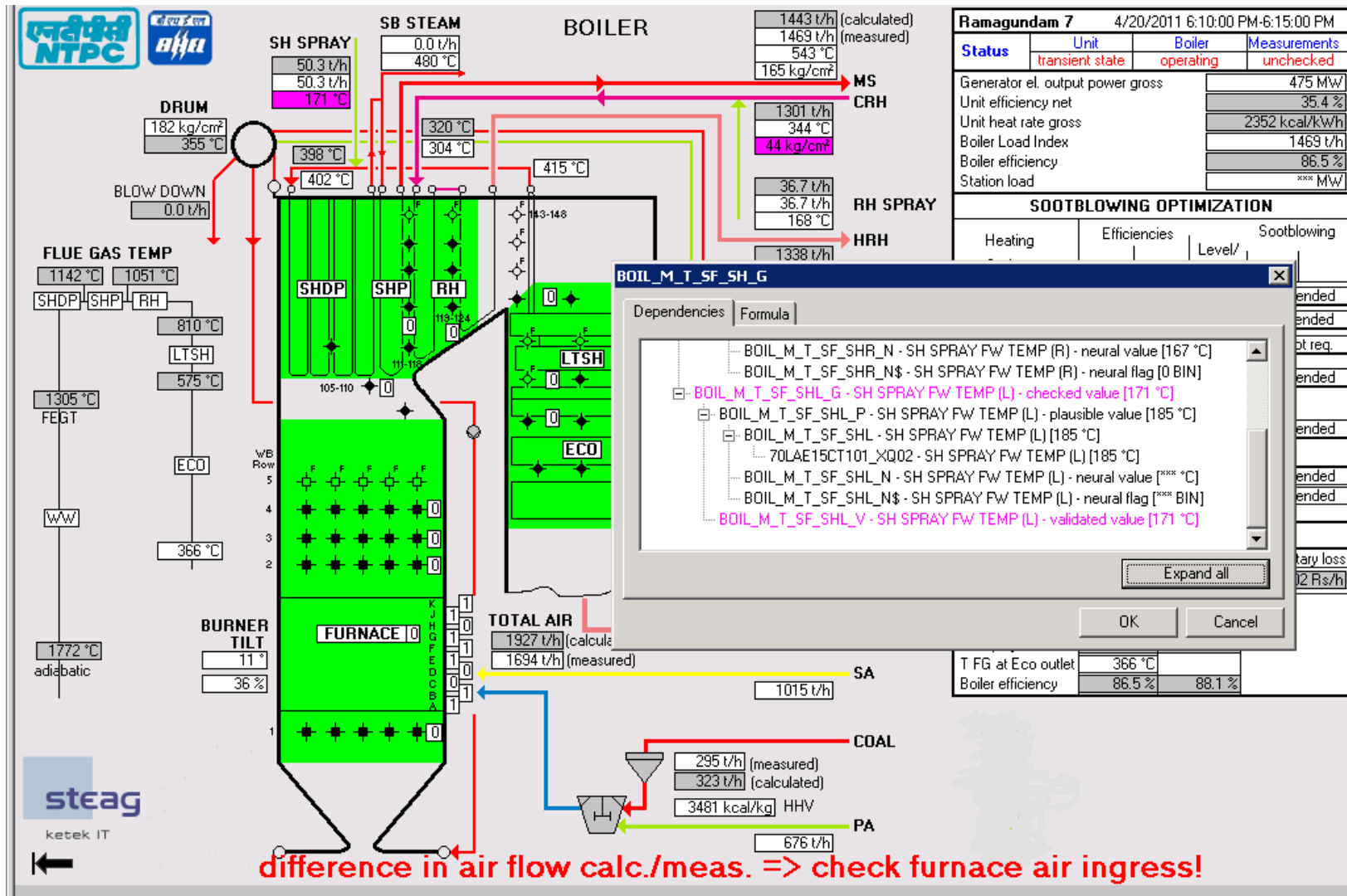


based on Neural Network...



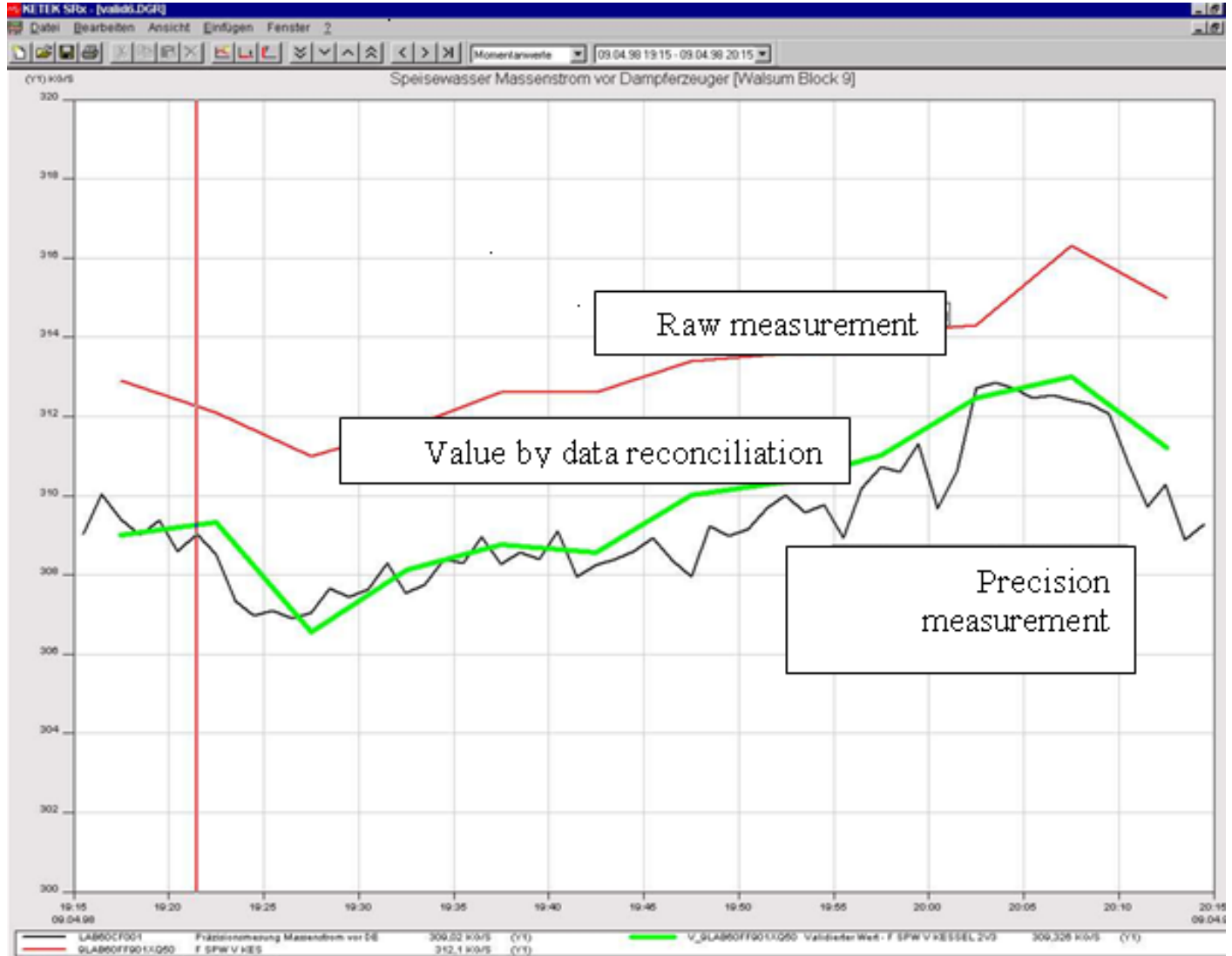
Data Validation System (2)

based on “First Principle Thermodynamics” ...

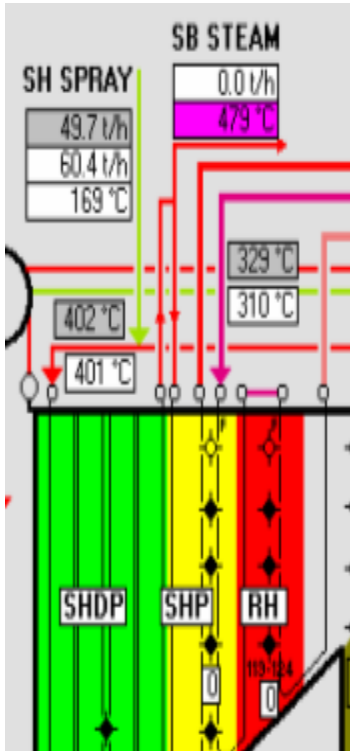


Data Validation System (3)

check the quality of measurements ...



Implausible Value - detection



SHPL_M_T_INP_G

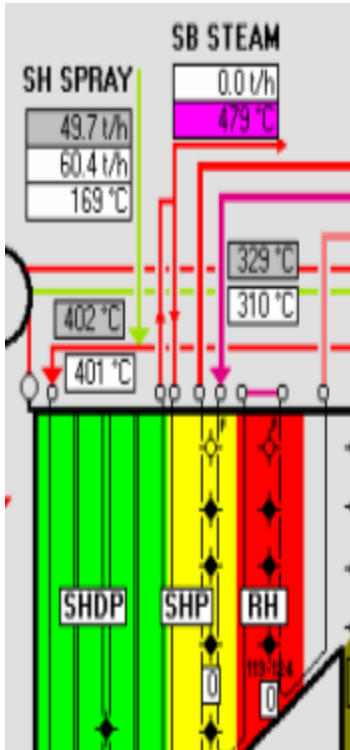
Dependencies Formula

- SHPL_M_T_INP_G - avg. value - SH PLTN I/L HDR TEM (L) - checked value [479 °C]
 - SHPL_M_T_INPL_G - SH PLTN I/L HDR TEM (L) - checked value [479 °C]
 - SHPL_M_T_INPR_G - SH PLTN I/L HDR TEM (R) - checked value [479 °C]

main steam measurements
left and right
(left not plausible)

OK Cancel

Implausible Value - replacement



The screenshot shows a software window titled "SHPL_M_T_INP_G" with a "Dependencies" tab. The tree structure is as follows:

- SHPL_M_T_INP_G - avg. value - SH PLTN I/L HDR TEM (L) - checked value [479 °C]
 - SHPL_M_T_INPL_G - SH PLTN I/L HDR TEM (L) - checked value [479 °C]
 - SHPL_M_T_INPL_V - SH PLTN I/L HDR TEM (L) - validated value [479 °C]
 - SHPL_M_T_INPL_P - SH PLTN I/L HDR TEM (L) - plausible value [**** °C]
 - SHPL_M_T_INPL_N\$ - SH PLTN I/L HDR TEM (L) - neural flag [-1 BIN]
 - SHPL_M_T_INPL - SH PLTN I/L HDR TEM (L) [**** °C]
 - 70HAH30CT129_XQ03 - SH PLTN I/L HDR TEM (L) [**** °C]
 - SHPL_M_T_INPL_N - SH PLTN I/L HDR TEM (L) - neural value [477 °C]
 - SHPL_M_T_INPR_G - SH PLTN I/L HDR TEM (R) - checked value [479 °C]

A red question mark is placed next to the tag 70HAH30CT129_XQ03, which is highlighted in pink. An arrow points from the question mark to the tag name.

Neural network generated the value 477 °C for not available value of tag 70HAH30CT129_XQ03

Data Validation Report

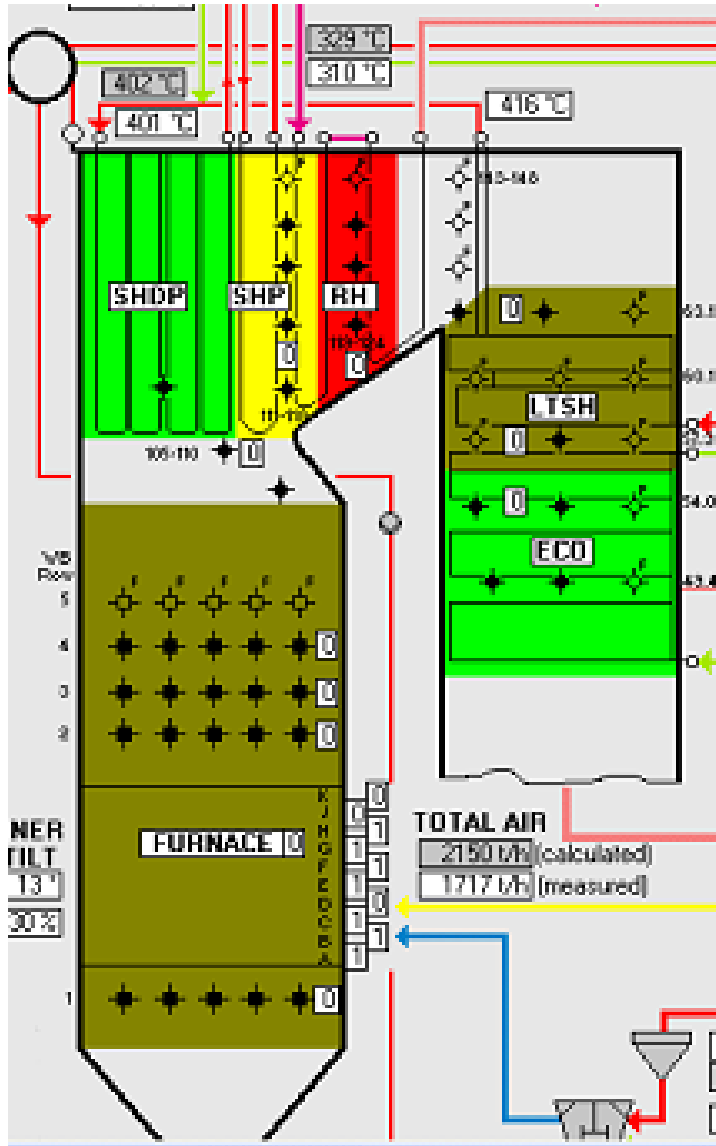
point in time: 05.05.04 11:25:00

plausible value data reconciliation successfull

implausible value data reconciliation not successfull

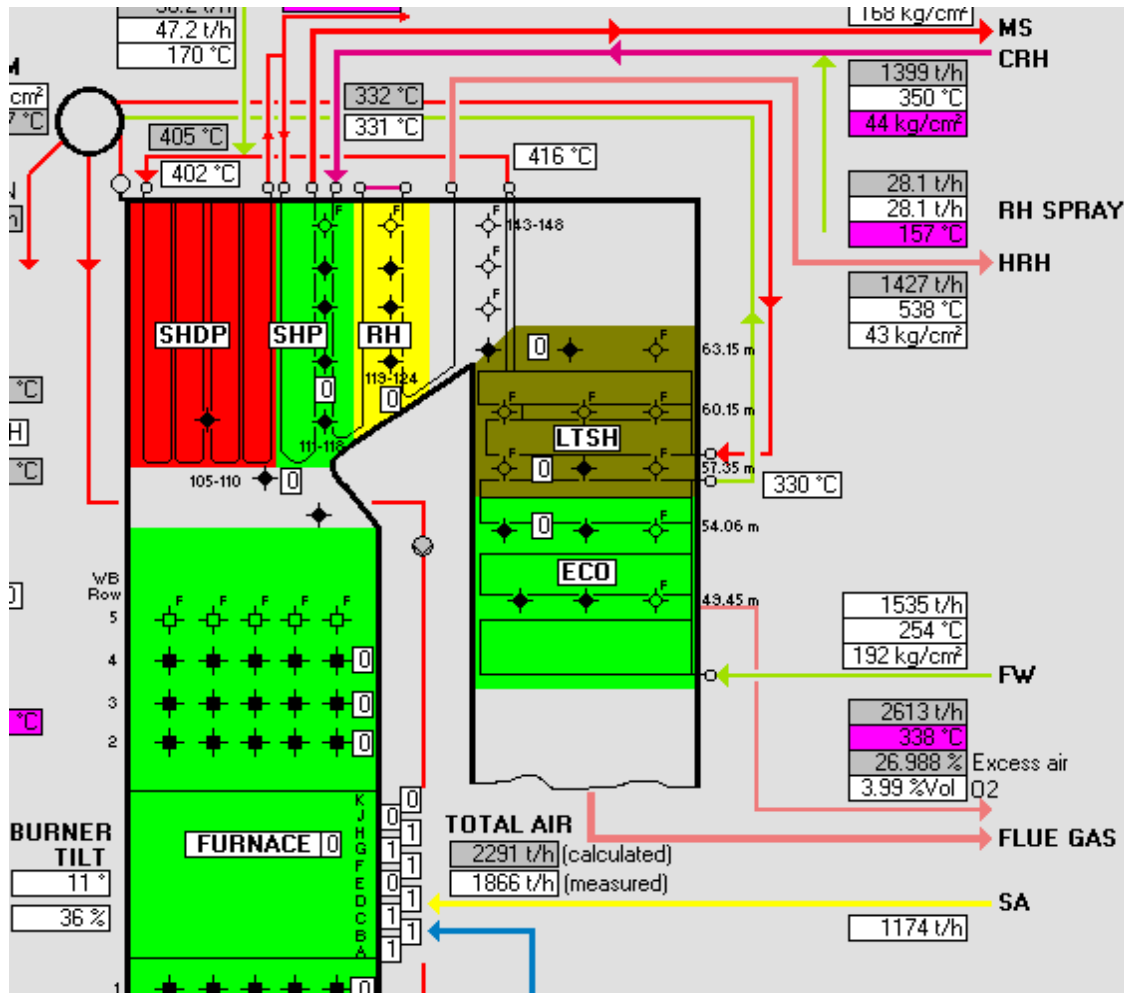
datapoint	description	raw value	plausibility checked value	reconciliation data point	value from reconcilia
20HAC10CP101	plausib. value FW PRESS AT ECO I/L	196.3 kg/cm ²	196.3 kg/cm ²	20HAC10CP101_V	196.3 kg/cm ²
20HAC10CT101	plausib. value FW TEMP AT ECO I/L	257.1 °C	257.1 °C	20HAC10CT101_V	257.1 °C
20HAD01CP101	plausib. value DRUM PRESS	190.4 kg/cm ²	190.4 kg/cm ²	20HAD01CP101_V	190.4 kg/cm ²
20HAD01CP102	plausib. value DRUM PRESS	190.0 kg/cm ²	190.0 kg/cm ²	20HAD01CP102_V	190.0 kg/cm ²
20HAD01CP103	plausib. value DRUM PRESS	189.7 kg/cm ²	189.7 kg/cm ²	20HAD01CP103_V	189.8 kg/cm ²
20HAH21CT101	plausib. value SH DESH I/L TEMP (L)	400.0 °C	400.0 °C	20HAH21CT101_V	400.2 °C
20HAH22CT101	plausib. value SH DESH I/L TEMP (R)	401.1 °C	401.1 °C	20HAH22CT101_V	401.1 °C
20HAH23CP101	plausib. value SH DESH O/L PRESS (L)	184.1 kg/cm ²	184.1 kg/cm ²	20HAH23CP101_V	183.9 kg/cm ²

Visualization Aid 1 : Traffic light coding system



Red - Critical
Yellow - Suboptimal
Light Green – Optimal
Dark Green – Time gap to next action

Visualization Aid 2 : Data values as tags & in tables with coded Background colors



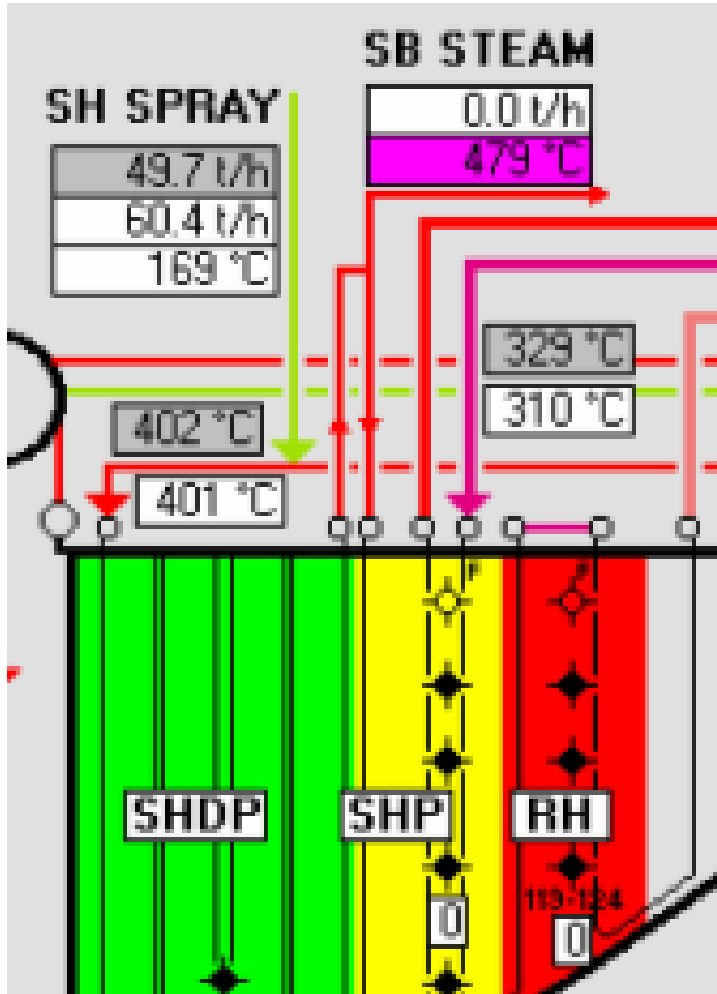
Generator el. output power gross	502 MW
Unit efficiency net	35.3 %
Unit heat rate gross	2363 kcal/kWh
Boiler Load Index	1567 t/h
Boiler efficiency	87.0 %
Station load	15.0 MW

SOOTBLOWING OPTIMIZATION				
Heating Surface	Efficiencies		Level/ SB No.	Sootblowing
	Act	Min		
Furnace/W/W	91.7	80.1	Row 1-5	SB not req.
SH Division Pan.	88.9	85.0	105-110	Comp. SB
SH Platen	93.2	85.0	111-118	SB not req.
Reheater	79.0	79.0	119-124	Next SB
Low Temp. SH	106.2	85.0	63.15 m	Suspended
			57.35 m	
Economizer	97.0	85.0	54.06 m	Suspended
			49.45 m	SB not req.

ACT-/REF-COMPARISON			
	Act	Ref	Monetary loss
O₂ at Eco outlet	3.99 %Vol	3.16 %Vol	0.02 Rs/h
Burner tilt	11 °	-4 °	
SH spray	36.2 t/h	0.0 t/h	
RH spray	28.1 t/h	0.0 t/h	
T FG at Eco outlet	338 °C		
Boiler efficiency	87.0 %	87.9 %	

Soot Blowing Legend
■ Compulsory SB

Interpretation of Background Colors



White – Measured Value

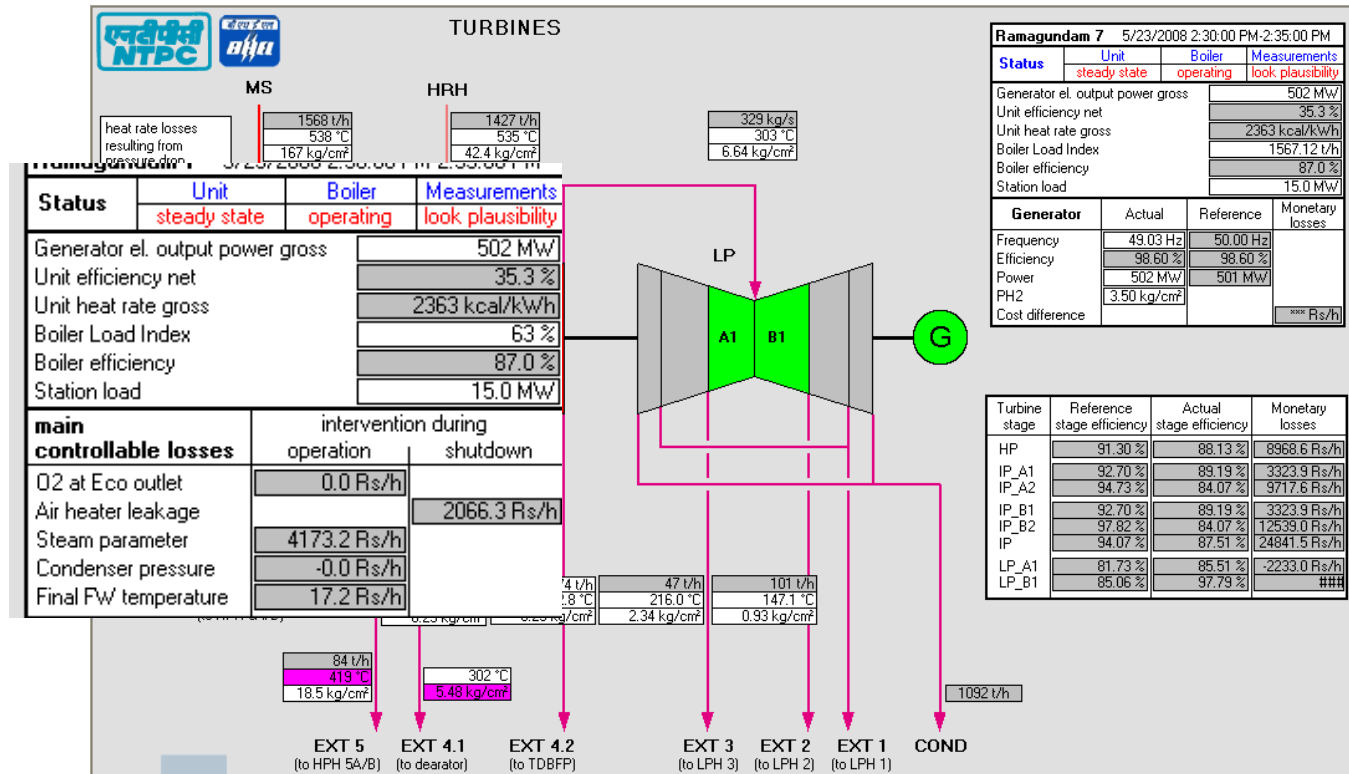
Grey - Calculated Value

Violet – Replaced value (Originally non plausible or not available)

Performance Monitoring

- ❑ Compares the actual values of critical parameters with the best achievable under current operating conditions.
- ❑ Shows monetary loss against each sub optimal operating parameter, defining the scope of improvement.

Ramagundam 7 5/23/2008 2:30:00 PM-2:35:00 PM				
Status	Unit	Boiler	Measurements	
	steady state	operating	look plausibility	
Generator el. output power gross	502 MW			
Unit efficiency net	35.3 %			
Unit heat rate gross	2363 kcal/kWh			
Boiler Load Index	1567 t/h			
Boiler efficiency	87.0 %			
Station load	15.0 MW			
SOOTBLOWING OPTIMIZATION				
Heating Surface	Efficiencies		Sootblowing	
	Act	Min	Level/SB No.	
Furnace/WW	91.7	80.1	Row 1-5	SB not req.
SH Division Pan.	88.9	85.0	105-110	Comp. SB
SH Platen	93.2	85.0	111-118	SB not req.
Reheater	79.0	79.0	119-124	Next SB
Low Temp. SH	106.2	85.0	63.15 m	Suspended
Economizer	97.0	85.0	54.06 m 49.45 m	Suspended SB not req.
ACT-/REF-COMPARISON				
	Act	Ref	Monetary loss	
O2 at Eco outlet	3.99 %Vol	3.16 %Vol	0.02 Rs/h	
Burner tilt	11 °	-4 °		
SH spray	36.2 t/h	0.0 t/h		
RH spray	28.1 t/h	0.0 t/h		
T FG at Eco outlet	338 °C			
Boiler efficiency	87.0 %	87.9 %		

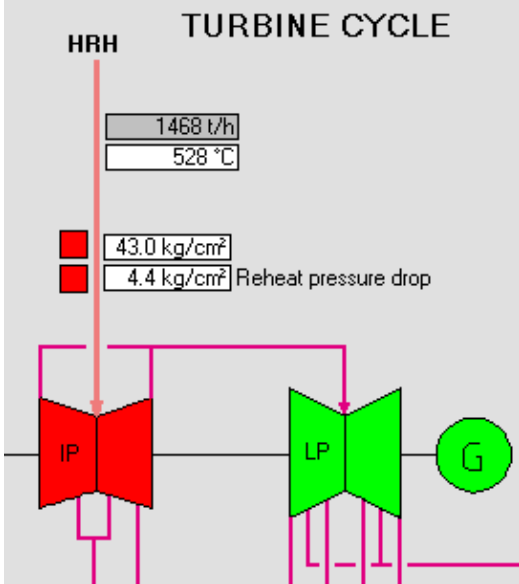


Turbine Performance Monitoring

- [TURBINE]

er Process Sheets Documentation Window Help

5'-values 5/23/2008 2:45:00 PM-2:50:00 PM



Controllable Losses	Actual	Reference	HR Dev. [kcal/kWh]	Losses expr. in extra fuel	Monetary loss [Rs/h]
Throttle temperature	538 °C	537 °C	-0.335	-0.1 t/h	-74
Throttle pressure	169 kg/cm ²	170 kg/cm ² a	2.879	0.5 t/h	634
Reheat temperature	528 °C	537 °C	4.997	0.8 t/h	1101
Reheat pressure drop	4.4 kg/cm ²	4.5 kg/cm ² a	3.672	0.6 t/h	809
Condenser back pressure	-0.87 kg/cm ²	-0.87 kg/cm ²	-2.965	-0.5 t/h	-1
Superheater spray flow	30.5 t/h	0.0 t/h	6.190	1.0 t/h	1364

Controllable Losses	Actual	Reference	HR Dev. [kcal/kWh]	Losses expr. in extra fuel	Monetary loss [Rs/h]
Throttle temperature	538 °C	537 °C	-0.335	-0.1 t/h	-74
Throttle pressure	169 kg/cm ²	170 kg/cm ² a	2.879	0.5 t/h	634
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Condenser back pressure	-0.87 kg/cm ²	-0.87 kg/cm ²	-2.965	-0.5 t/h	-1
Superheater spray flow	30.5 t/h	0.0 t/h	6.190	1.0 t/h	1364
Reheat spray flow	32.5 t/h	0.0 t/h	20.944	3.5 t/h	4614
Final FW temperature	255 °C	254.3 °C	0.346	0.1 t/h	76
Blow down flow	0.0 t/h	48.4 t/h	0.000	0.0 t/h	0
Auxiliary steam flow	13.6 t/h	10.0 t/h	8.449	1.4 t/h	1861
Frequency	49.38 Hz	50.00 Hz	0.042	0.0 t/h	23
Make-up flow	22.2 t/h	0.0 t/h	43.613	7.4 t/h	9608

TG heat rate gross, actual 2054 kcal/kWh TG heat rate net, actual 2117 kcal/kWh

TG heat rate gross, reference 2051 kcal/kWh

Boiler Performance Monitoring

Boiler thermal performance data

Fluid temperature [°C]		Fouling factor
Inlet	Outlet	
259	331	0.88
359	359	0.88
359	415	0.88
401	478	0.90
478	542	0.79
322	545	0.90
		0.64

Coal analysis

GCV [kcal/kg]	3481
---------------	------

Proximate

Total moisture [%]	12.1
--------------------	------

Ash [%]	38.1
---------	------

Volatile matter [%]	23.0
---------------------	------

Fixed carbon [%]	26.8
------------------	------

Ultimate

Carbon [%]	36.3
------------	------

Hydrogen [%]	2.6
--------------	-----

Nitrogen [%]	0.8
--------------	-----

Oxygen [%]	9.8
------------	-----

Sulphur [%]	0.4
-------------	-----

Total moisture [%]	12.1
--------------------	------

Ash [%]	38.1
---------	------

Load [MW]	513
MS flow [t/h]	1596
MS temp [°C]	542
RH temp [°C]	545

Section	Flue gas temperature [°C]	
	Inlet	Outlet
Economiser	578	362
Waterwalls	1794	1334
LTSH	826	578
Panel SH	1334	1173
Platen SH	1173	1076
Reheater	1076	826
Air heater	362	155

Coal mass flow [t/h]	325
Bottom ash removal rate [%]	20
Duct ash removal rate [%]	5
AH ash removal rate [%]	3
Fly ash removal rate [%]	72
UBC in ash [%]	0.4

Ambient air temperature [°C]	28
Relative humidity [%]	60
Flue gas oxygen at Eco outlet	3.68
Flue gas oxygen at AH outlet	6.23
Burner tilt [°]	11
Mills in operation	A on B on C off D off E on F on G on H off J on K on
Maximum metal temperature [°C]	436 °C 527 °C 589 °C 612 °C

Heat balance	Act	Ref
Boiler efficiency [%]	86.89	87.99
Losses		
Dry gas [%]	5.64	4.28
H2O in fuel [%]	2.18	2.21
H2O from H2 in fuel [%]	4.21	4.21
H2O in air [%]	0.08	0.11
UBC [%]	0.32	0.32
Radiation [%]	0.11	0.12
Others [%]	0.68	0.76
Total losses [%]	13.21	12.01
Corrected Boiler Efficiency [%]	87.03	

Boiler Mapping



BOILER MAPPING

aft. SHP bef. RH

	left	right
Temperature	850 °C	796 °C
Pressure	-15.0 mmW/C	-15.0 mmW/C
O2	xxxx %	xxxx %
Calculated temperature		1081 °C

aft. RH bef. LTSH

	left	right
Temperature	732 °C	675 °C
Pressure	25.0 mmW/C	-22.2 mmW/C
Calculated temperature		838 °C

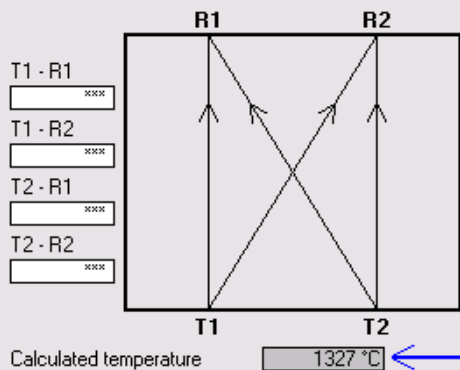
aft. SHDP bef. SHP

	left	right
Temperature	804 °C	695 °C
Pressure	-15.0 mmW/C	-15.0 mmW/C
Calculated temperature		1172 °C

Ramagundam 7 4/11/2011 11:20:00 AM-11:25:00 AM

Status	Unit	Boiler	Measurements
	steady state	operating	substitute values
Generator el. output power gross			513 MW
Unit efficiency net			35.0 %
Unit heat rate gross			2385 kcal/kWh
Boiler Load Index			1594 t/h
Boiler efficiency			86.7 %
Station load			xxxx MW

Acoustic Pyrometer Measurements Furnace Exit Plane



Furnace

	left	right
Pressure	-10.8 mmW/C	-11.9 mmW/C
Pressure	-10.3 mmW/C	-21.4 mmW/C
Pressure	-10.3 mmW/C	
Calculated adiabatic temp.		1784 °C

Metal Temperature

outside wall	528 °C	+
	586 °C	+
	606 °C	+
	439 °C	+

NOx Optimization

	act	ref
NOx	365 ppm	199 ppm
primary air	668 t/h	314 t/h
secondary air	1086 t/h	1440 t/h
overfire air		
damper upper	xxxx %	
damper lower	xxxx %	

aft. LTSH bef. ECO-1

	left	right
Temperature	521 °C	514 °C
Pressure	-49.2 mmW/C	-47.5 mmW/C
Calculated temperature		584 °C

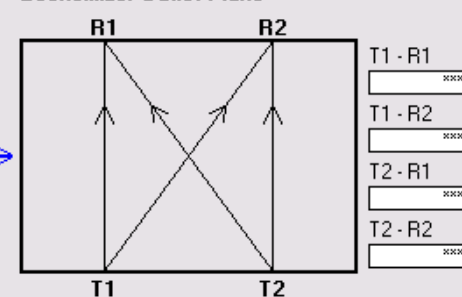
aft. ECO-2 bef. ECO-3

	left	right
Temperature	378 °C	169 °C
Pressure	-49.3 mmW/C	-60.3 mmW/C

aft. ECO-3 bef. AH

	left	right
Temperature	369 °C	369 °C
Pressure	-62.2 mmW/C	-62.2 mmW/C
O2	4.1 %	3.8 %
O2	3.6 %	4.0 %

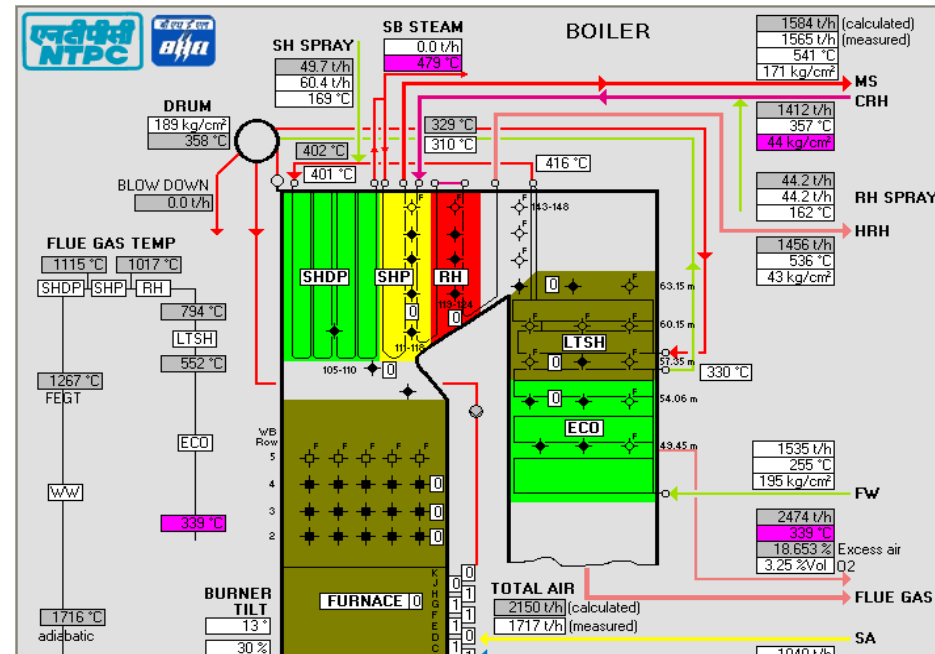
Acoustic Pyrometer Measurements Economizer Outlet Plane



Soot Blowing Optimization

- ❑ **Fouling and Slagging of boiler heating surfaces cause...**
 - Loss of efficiency due to increased flue gas temperature.
 - Loss of efficiency due to increased Reheater spray flow.
 - Shutdowns for removing persistent slag.

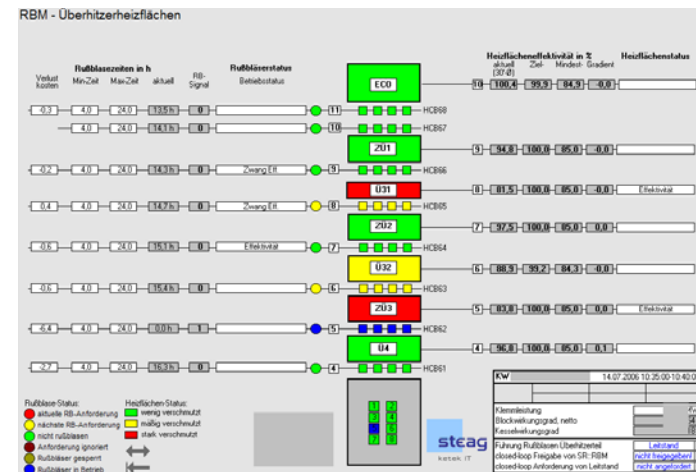
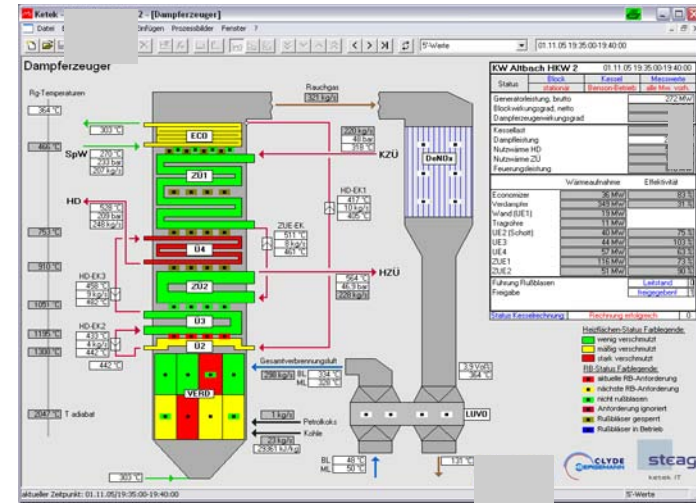
- ❑ **Use of soot blowers...**
 - Causes costs (blowing medium, wear-and-tear...).
 - Impact on control actions.
 - Erosion of the heating surfaces.
 - May be prohibited or not reasonable in some operating states.



Soot Blowing Optimization

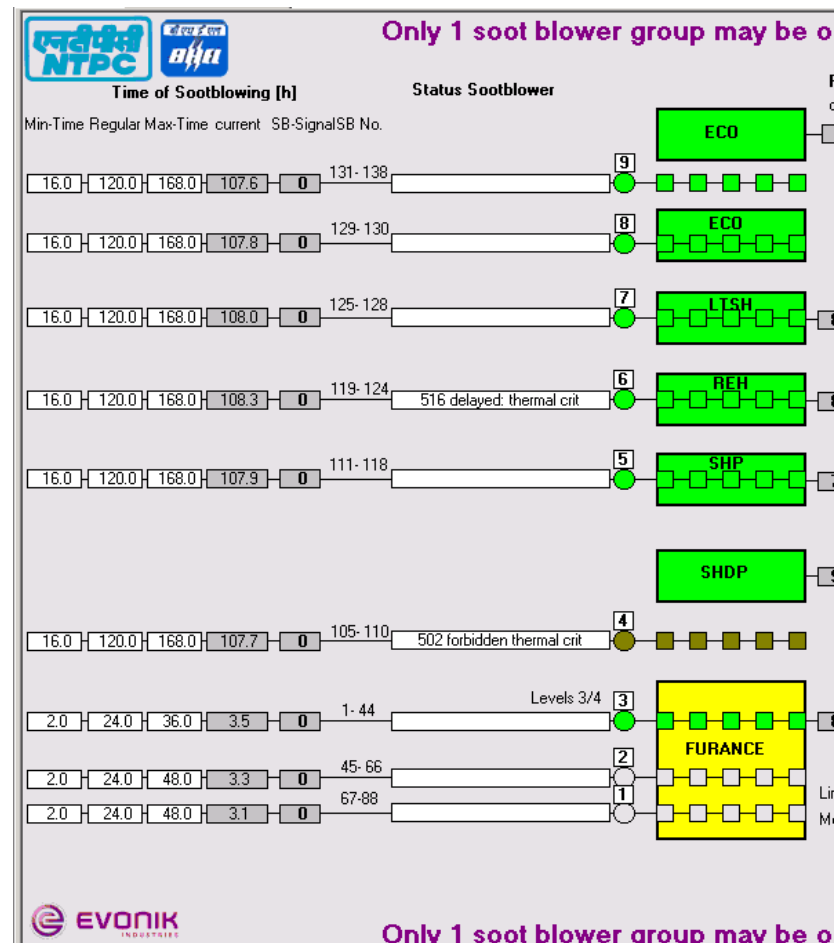
SR::EPOS::BCM is the SR product for optimizing the soot blowing

- Controlled by costs or other criteria the optimum points in time for activating the individual blower levels are calculated
- Closed-Loop application possible if desired
- Application of fuzzy technology



Criteria for Soot Blow Optimization

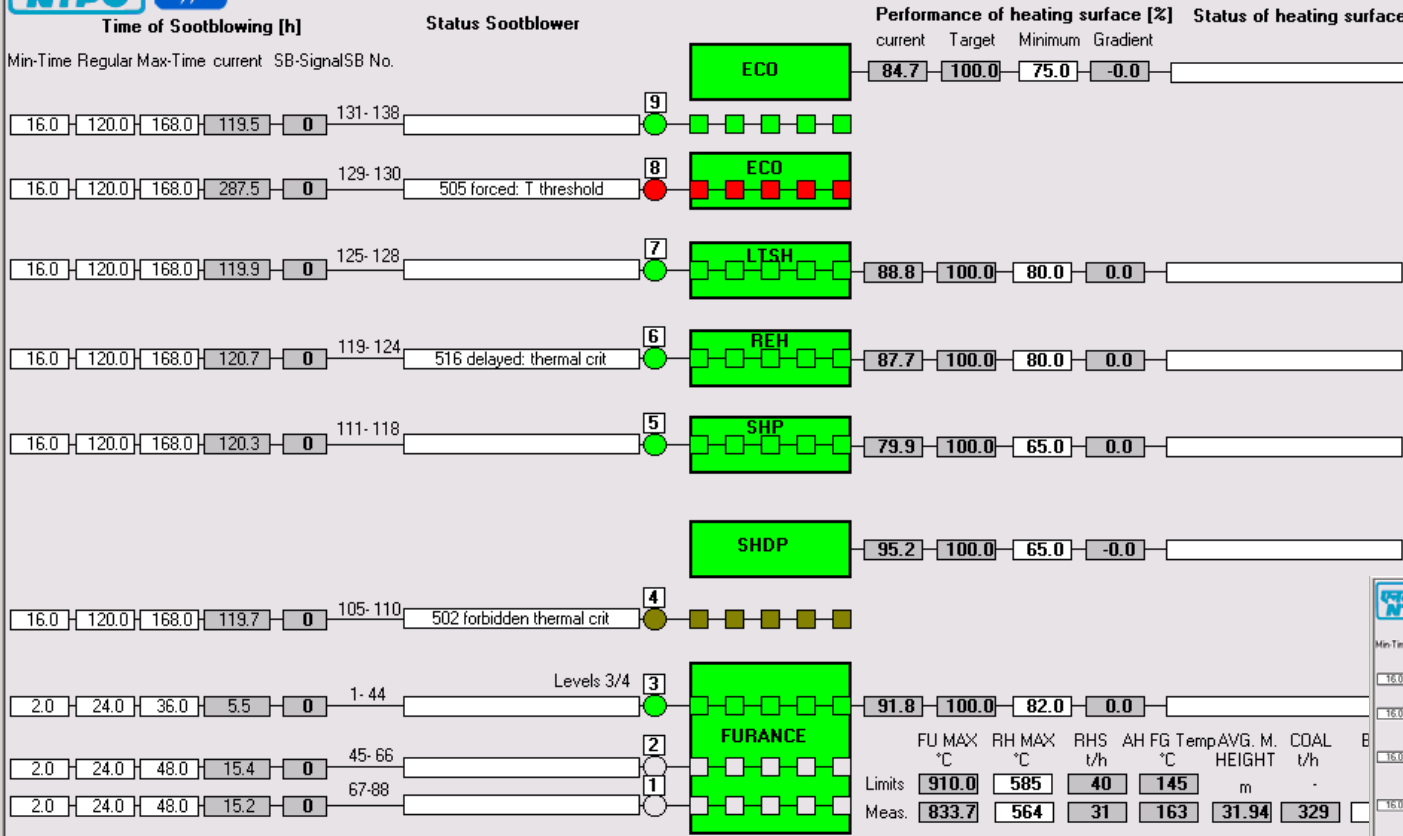
- Fouling/Slagging: Results from thermodynamic model - SR::EPOS
- Time intervals
 - Minimum frequency of soot blowing
 - Minimum-pauses
- Configurable priorities for each criterion
- Soot-blowing costs
- Process-engineering criteria, plant-specific
 - Reheat spray flow
 - Flue gas temperature before air preheater
 - Furnace exit gas temperature
 - RH Metal Temperature
 - Mills Combination
 - Coal mass flow
 - NOx-emissions



Soot Blowing Optimization



Only 1 soot blower group may be operated at a time !



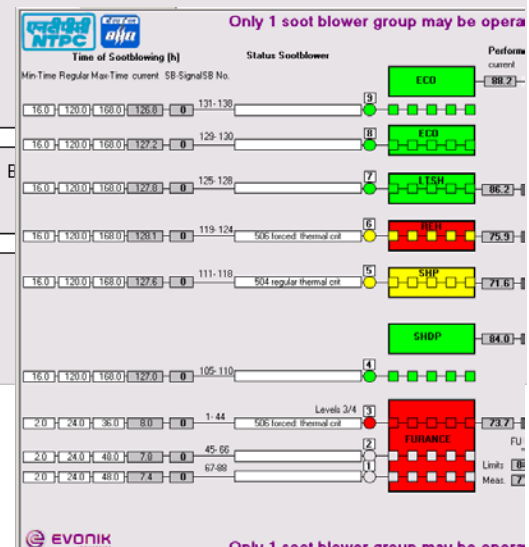
Ramagundam 7 4/17/2011 10:40:00 AM-10:45:00 AM

Unit	Boiler	Measurements
steady state	operating	substitute values
Generator el. output power gross		512 MW
Unit efficiency net		35.0 %
Boiler efficiency		86.8 %
Boiler load		107.5 %

- Sootblowing Status colors
- current SB request
 - next SB request
 - SB not required
 - SB request ignored
 - SB suspended
 - SB in operation
- Heating Surface Status colors
- low degree of fouling
 - medium degree of fouling
 - high degree of fouling



Only 1 soot blower group may be operated at a time !



Only 1 soot blower group may be operated at a time !

Boiler Setpoint Optimization

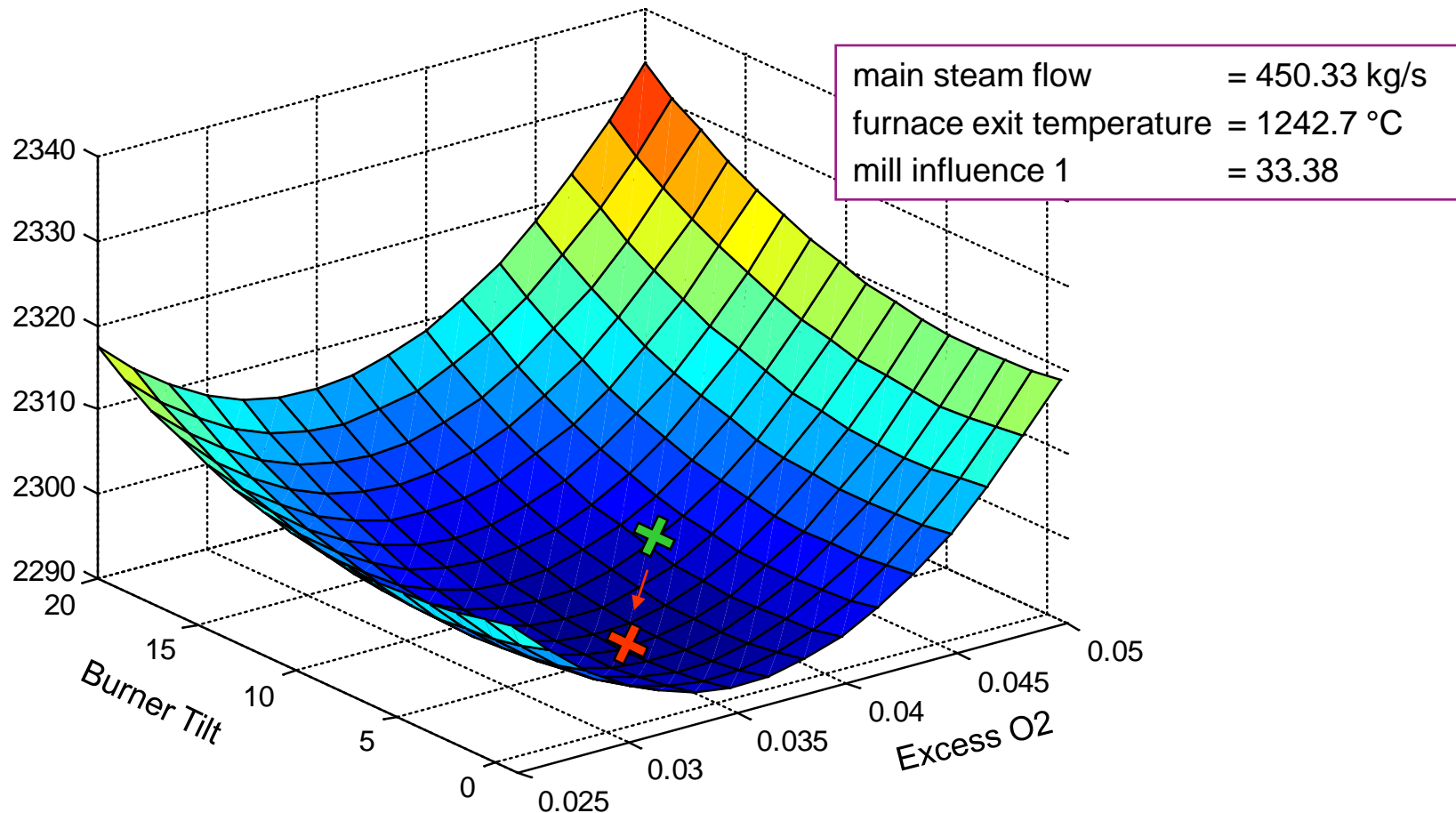
Shows the optimal against current setpoints and improvement in heat rate.

Ramagundam 7
 6/16/2010 11:10:00 AM-11:15:00 AM

Set point optimization		Mill optimization					
Boiler		Act value	Opt value	Current Status	Opt Status	Current Load	Opt Load
O2 at Eco outlet		3.62 %Vol	3.22 %Vol	MILL K	1	55.39 t/h	22.00 t/h
Burner tilt		4.3 °	0.5 °	MILL J	1	50.38 t/h	22.00 t/h
Turbine Cycle				MILL H	0	0.13 t/h	0.00 t/h
MS temperature		533.84 °C	537.42 °C	MILL G	0	0.00 t/h	0.00 t/h
MS pressure		168.85 bar	170.00 bar	MILL F	1	43.67 t/h	0.00 t/h
Reheat temperature		530.97 °C	533.32 °C	MILL E	0	0.04 t/h	0.00 t/h
Unit Heat Rate gross		2368 kcal/kWh	2365 kcal/kWh	MILL D	1	42.71 t/h	38.09 t/h
				MILL C	1	38.23 t/h	38.38 t/h
				MILL B	1	42.08 t/h	47.63 t/h
				MILL A	1	42.68 t/h	55.01 t/h

Unit Critical Calculated Outputs		Transient State Status	
Superheater Spray	13.5 t/h	Model solved	1
Reheater Spray	56.5 t/h	Plant in steady state	1
Furnace Exit Flue Gas Temp	1296 °C	Top3 Mills Status	
PAPH-A Leakage	11.713 %wt	Model solved - Constraints on top 3 mills relaxed	0
SAPH-A Leakage	12.743 %wt	Total consumption of pumps	
PAPH-B Leakage	17.147 %wt	9947.7 kW	
SAPH-B Leakage	16.596 %wt	Total consumption of mills	
Platten SH Max Metal Temp	585 °C	2264.9 kW	
RH Max Metal Temp	600 °C	Total consumption of fans	
HPH-5A Drain O/L Flow	130 t/h	7031.7 kW	
HPH-5B Drain O/L Flow	132 t/h	Total consumption of aux. consumers	
		19244.3 kW	
		Unit load	516.9 MW
		FH1 OPT	30.86

Optimized Heat Rate



In this case the optimum means to move

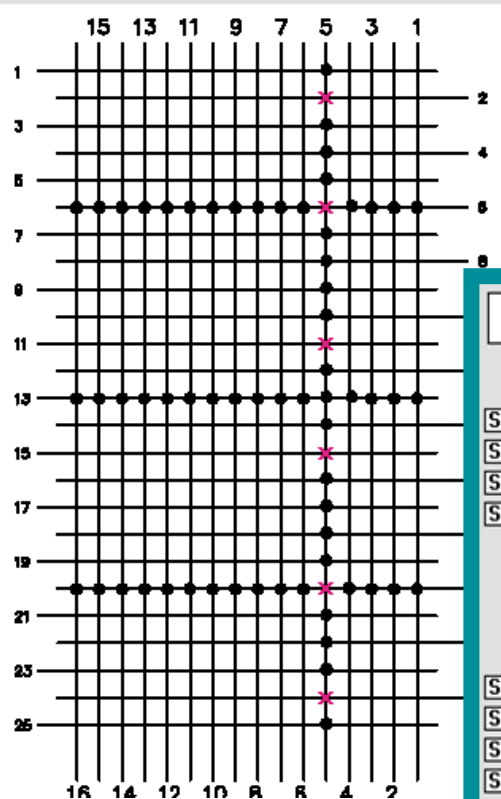
- the burner tilt down from the current 9 degree to 4.5 degree and
- the excess O2 from the current 4% to 3.55%.

Metal temperature Module

Shows the temperature profile of individual tubes of various heating surfaces of boiler and identifies the Hot spots.

SH PLATEN Metal Temperature Calculation

Section view at 66,643 (8,000 below roof)



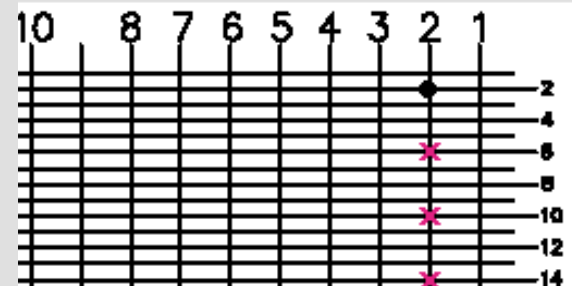
measured calculated

540 °C 537 °C

519 °C 547 °C

REH Metal Temperature Calculation

Section view at 66,643 (8,000 below roof)



measured calculated

408 °C 516 °C

522 °C 527 °C

523 °C 537 °C

527 °C 545 °C

564 °C 551 °C

565 °C 556 °C

511 °C 560 °C

525 °C 562 °C

534 °C 562 °C

499 °C 561 °C

556 °C 558 °C

HOT SPOT

Platen SH

Reheater

SHPL highest temp	584 °C	REH highest temp	600 °C
SHPL highest temp slice	13	REH highest temp slice	37
SHPL highest temp tube	4	REH highest temp tube	9
SHPL highest temp length	0 m	REH highest temp length	0 m

SH Division Panel

LTSH

SHDP highest temp	522 °C	LTSH highest temp	437 °C
SHDP highest temp slice	24	LTSH highest temp slice	63
SHDP highest temp tube	2	LTSH highest temp tube	2
SHDP highest temp length	0 m	LTSH highest temp length	0 m

Lifetime monitoring module



module aims to calculate the remaining life of thick walled components in boiler

steag SR1

ketek IT

BHEL Ramagundam 70 Allowable Operating Parameters

4/20/2011 5:00:00 PM-5:00:30 PM

Component

Pressure
allowable current

Temperature
allowable current

Difference of Temperature
upper allow. current lower allow.

1. Drum 1, upper side 70HAD01	200.0	185.6	370	360	14	0	-45
2. Drum 1, lower side 70HAD01	200.0	185.6	370	360	11	0	-48
3. HRH1, outlet header, tee, upper side 70LBB01	52.0	43.5	540	548	26	-0	-34
4. HRH1, outlet header, tee, lower side 70LBB01	52.0	43.5	540	548	26	-0	-34
5. HRH1, outlet header, middle, lower side 70LBB01	52.0	43.5	540	548	26	-0	-33
6. HRH1, outlet header, left, upper side 70LBB01	52.0	43.5	540	548	26	-0	-33
7. HRH1, outlet header, left, lower side 70LBB01	52.0	43.5	540	548	26	-0	-33
8. MSH1, outlet header, tee, upper side 70LBA01	186.0	167.7	540	540	25	2	-34
9. MSH1, outlet header, tee, lower side 70LBA01	186.0	167.7	540	540	25	2	-34
10. MSH1, outlet header, left, upper side 70LBA01	186.0	167.7	540	540	25	2	-34
11. MSH1, outlet header, left, upper side 70LBA01	186.0	167.7	540	540	25	2	-34
12. YP 1, 70LBB01	52.0	43.5	540	548	25	0	-34
13. YP 1, 70LBA01	186.0	167.7	540	540	15	2	-27
14. MSH 1, outlet header, tee, lower side 70LBA01	186.0	167.7	540	540	25	2	-34

steag SR1

ketek IT

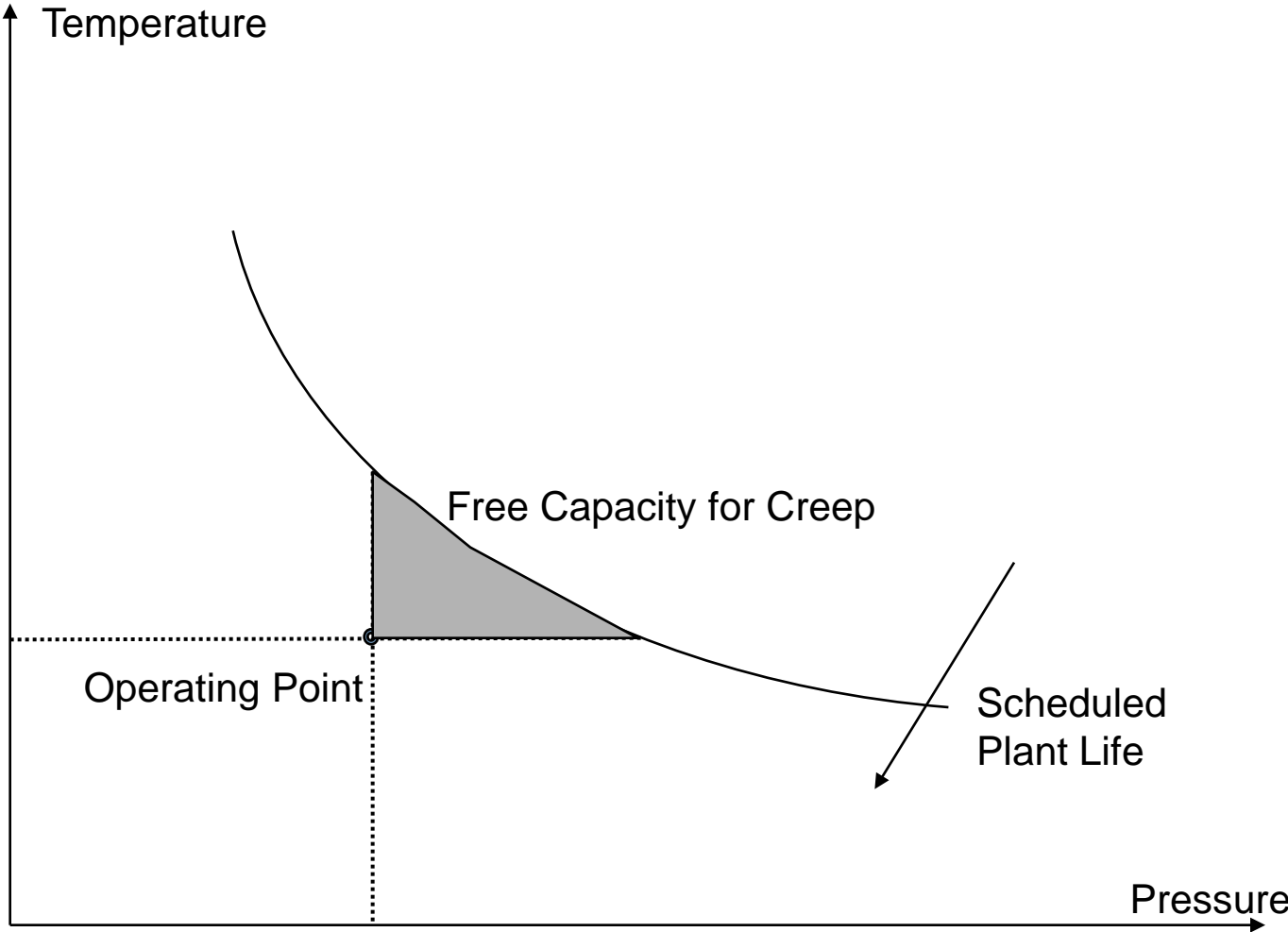
BHEL Ramagundam 70 Overview Degradation

4/20/2011 4:30:00 PM-5:30:00 PM

Component

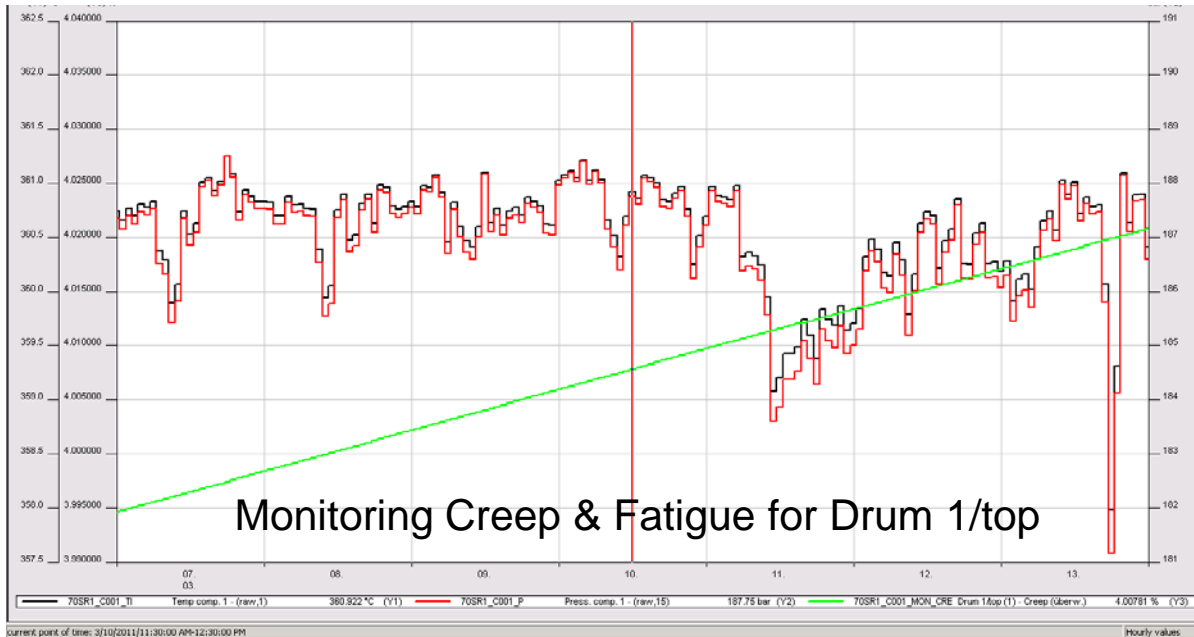
Component	operating time [h]		life time consumption [%]			
	monitored	down time	creep	fatigue	total	increment (24h)
1. Drum 1, upper side 70HAD01	35604.3 h	7765.5 h	5.201 %	0.238 %	5.439 %	0.000156 %
2. Drum 1, lower side 70HAD01	35604.3 h	7765.5 h	5.926 %	0.278 %	6.204 %	0.000178 %
3. HRH1, outlet header, tee, upper side 70LBB01	35604.3 h	8653.6 h	1.868 %	0.000 %	1.868 %	0.000069 %
4. HRH1, outlet header, tee, lower side 70LBB01	35604.3 h	8653.6 h	2.016 %	0.000 %	2.017 %	0.000075 %
5. HRH1, outlet header, middle, lower side 70LBB01	35604.3 h	8653.6 h	6.354 %	0.000 %	6.354 %	0.000232 %
6. HRH1, outlet header, left, upper side 70LBB01	35604.3 h	8653.6 h	3.822 %	0.000 %	3.822 %	0.000141 %
7. HRH1, outlet header, left, lower side 70LBB01	35604.3 h	8653.6 h	6.354 %	0.000 %	6.354 %	0.000232 %
8. MSH1, outlet header, tee, upper side 70LBA01	35604.3 h	7766.6 h	2.546 %	2.349 %	4.895 %	0.000102 %
9. MSH1, outlet header, tee, lower side 70LBA01	35604.3 h	7766.6 h	7.974 %	2.349 %	10.322 %	0.000276 %
10. MSH1, outlet header, left, upper side 70LBA01	35604.3 h	7766.6 h	27.202 %	0.937 %	28.138 %	0.000882 %
11. MSH1, outlet header, left, upper side 70LBA01	35604.3 h	7766.6 h	27.202 %	0.937 %	28.138 %	0.000882 %
12. YP 1, 70LBB01	35604.3 h	8471.3 h	3.086 %	0.032 %	3.118 %	0.000119 %
13. YP 1, 70LBA01	35604.3 h	7766.6 h	2.634 %	4.881 %	7.515 %	0.000127 %
14. MSH 1, outlet header, tee, lower side 70LBA01	35604.3 h	7766.6 h	7.974 %	2.349 %	10.322 %	0.000276 %

the consumed life of an equipment could be different from the actual age of the equipment



Lifetime monitoring module

depends upon how stressful the life of equipment has been so far in terms of temperature and pressure which effect fatigue and creep.



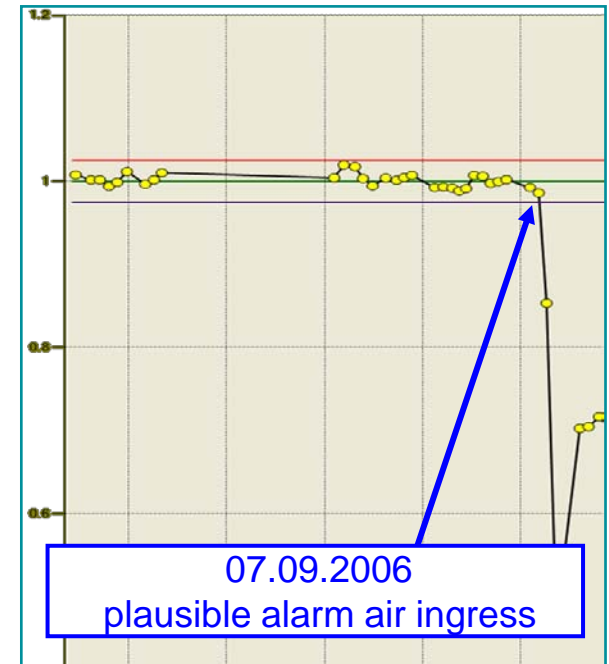
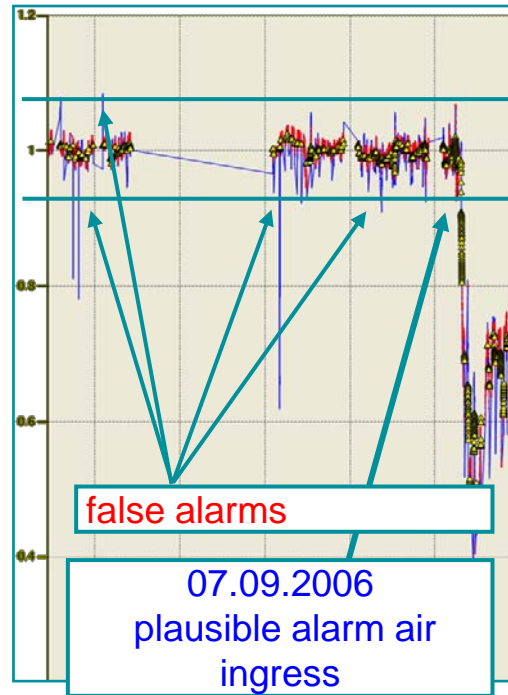
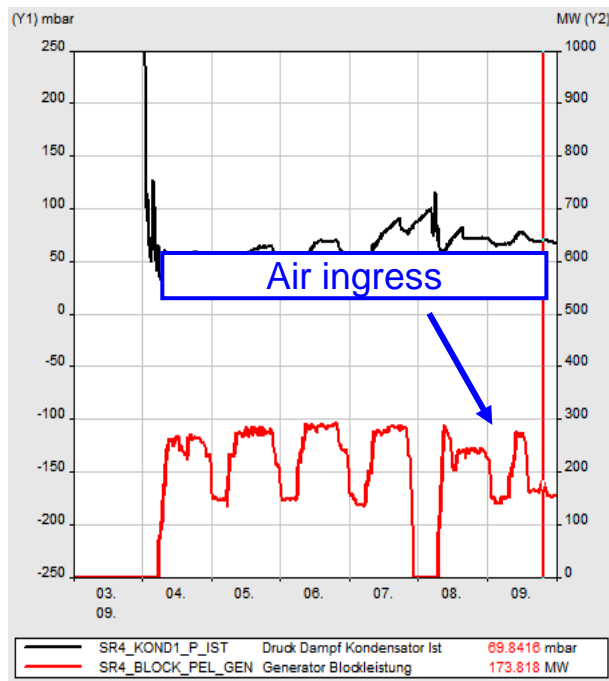
Date: 20.04.2011
Time: 17:30:00

Failure	Degradation			
	Fatigue	Creep	Total	Rem. Peaks
65.5h	0.238%	5.201%	5.439%	1.331%
65.5h	0.278%	5.927%	6.204%	0.691%
70.3 HRH 1/t-top	0.000%	1.868%	1.868%	0.000%
70.4 HRH 1/t-bot	0.000%	2.017%	2.017%	0.000%
70.5 HRH 1/m-bot	0.000%	6.355%	6.355%	0.000%
70.6 HRH 1/t-top	0.000%	3.822%	3.822%	0.000%
70.7 HRH 1/t-bot	0.000%	6.355%	6.355%	0.000%
70.8 MSH 1/t-top	2.349%	2.547%	4.895%	16.718%
70.9 MSH 1/t-bot	2.349%	7.974%	10.323%	16.718%
70.10 MSH 1/m-bot	0.937%	27.202%	28.139%	4.984%
70.11 MSH 1/t-bot	0.937%	27.202%	28.139%	4.984%
70.12 YP 1/bb	0.032%	3.086%	3.118%	0.064%
70.13 YP 1/ba	4.881%	2.634%	7.515%	4.207%
70.14 MSH 1/t-bot	2.349%	7.974%	10.323%	16.718%

current point of time: 3/10/2011/11:30:00 AM-12:30:00 PM

hourly values

Statistical methods to evaluate partly automatic, early & reliable detection of changes where deterioration is slow.



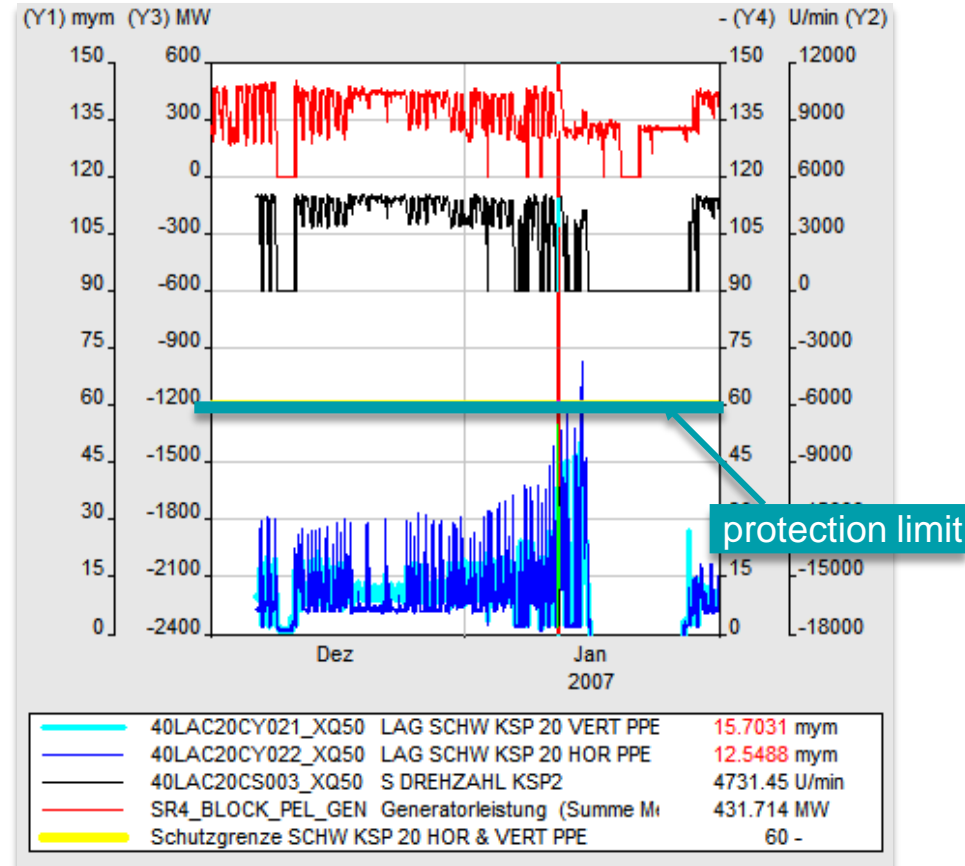
Key Performance Indicators

measured	calculated
vibration	heatrate
bearing temperature	Component quality factor
oil temperature	efficiency
power consumption	...
...	...

Key measurements in power plants usually depend on

- load,
- operation mode
- fuel quality
- ambient conditions
- etc.

And are superposed by noise

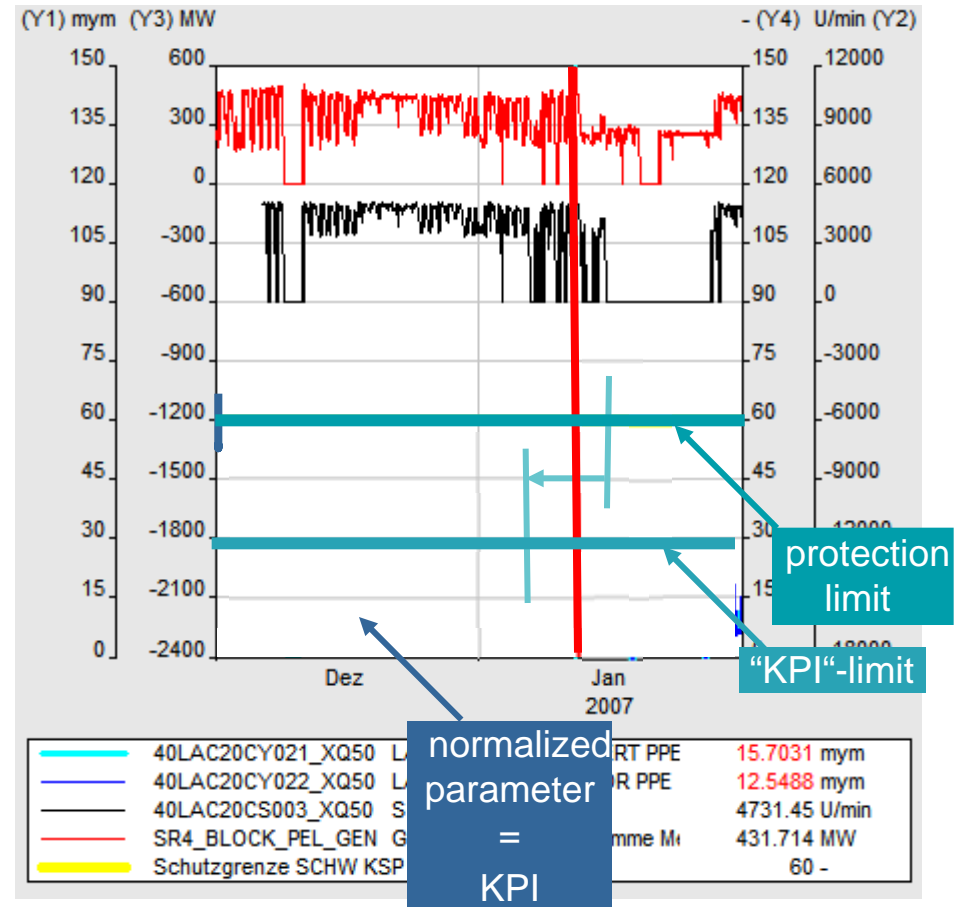


key performance indicators by Act / Ref-comparison (KPI)

KPIs measure the quality of the process / component.

They do not depend on external disturbance variables

$$\text{KPI} = \text{act-value} / \text{ref-value}$$



STATISTISCHE PROZESSKONTROLLE

04.11.2007 00:00:00 - 12:00:00

Blockstatus: In Betrieb

SPC-Status: unbekannt Pel,brutto: 9477 MWh

Prozessgüteüberwachung

- SPC_KOND, Kondensatorgüte, KPI (SR::EPOS)
- 40HLC10CP001_XQ50, Druckverlust Luvo, luftseitig (TEST)
- SPC_LWV_HYDR, LUVO Druckverlust, KPI (SR::EPOS)
- 40LBB0_CT001_XQ50, Dampftemperatur ZÜ-Austritt

SPC	KPI	Shewhart
0	0,95	0
0	1,12	0
0	0,94	0
61,44	0,99	0

Zustandsüberwachung

Kesselspeisepumpe 1

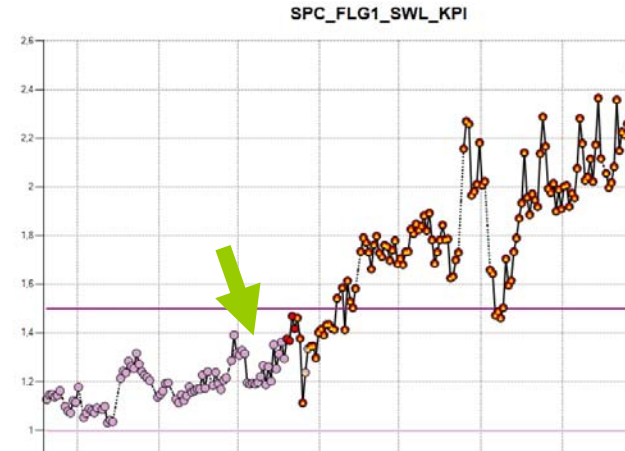
- 40LAC10CY021_XQ50, Lagerschwingung vertikal
- 40LAC10CY022_XQ50, Lagerschwingung horizontal
- 40BBA03EW383_XQ50, Stromaufnahme

0
0
0

Kesselspeisepumpe 2

- 40LAC20CY021_XQ50, Lagerschwingung vertikal
- 40LAC20CY022_XQ50, Lagerschwingung horizontal
- 40BBB03EW383_XQ50, Stromaufnahme

0
0
0



EVONIX

Color	Name
—	Reference Mean
—	AvgPrd Mean
—	UCLX
—	LCLX
●	Event
●	Alarm

- SPC Eigenschaften
 - Tagname
 - SPC_FLG1_SWL_KPI
 - Periode für Durchschnittsberechnung...
 - Durchschnittliche SamplingPeriode
 - 9Hours
 - AP Gaps Allowed 50
 - MSP Gaps Allowed 50
 - Benutzerdefinierte CL
 - True
 - Runtest: 1.5
 - Referenz Durchschnitt
 - Referenz Standardabweichung...
 - Kontrolluntergrenze 1.5
 - Kontrollobergrenze n.d.B.
 - KPI - Regel
 - 5, by 5
- Fileinformation
- XML-Dateiname:
 - Datenname des Diagrammes SPC_FLG1_SWL_KPI_Xbar
 - Clusterng
 - Erstellungsdatum 26.3.09 17:40
 - Autor
 - Anmerkung

SPC_SGZ1_SWU - Saugzug 1 - Schwingung Lager unten

SPC Ergebnisse für 20.01.2009 15:45

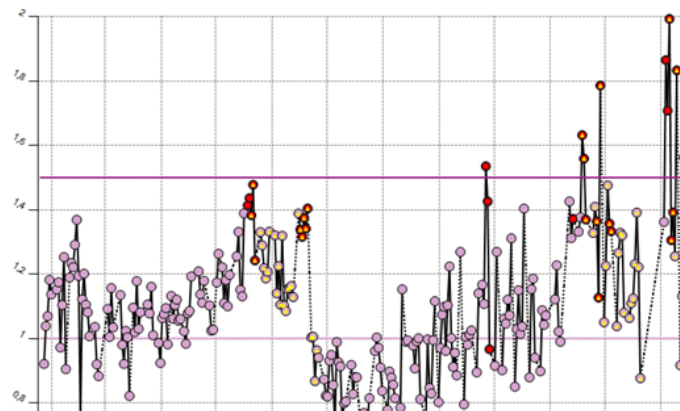
Aktueller KPI-Wert ist NaN. Ereignisse in der Shewhart-Karte. Ereignisse in der Cusum-Karte. Ereignisse in der Shewhart-Karte. Alarm ist aktiv.

Shewhart

Test 1 (Kontrollgrenze überschritten) war positiv.
Test 5 (2 von 3 Werten liegen im äußeren Kontrollbereich) war positiv.

Mittlerer Referenzwert ist 1.
Standardabweichung ist 0,25.
Kontrollbereich ist 0,5 bis 1,5.
Der äußere Kontrollbereich ist unter 0,67 bzw. über 1,33

SPC_SGZ1_SWU_KPI



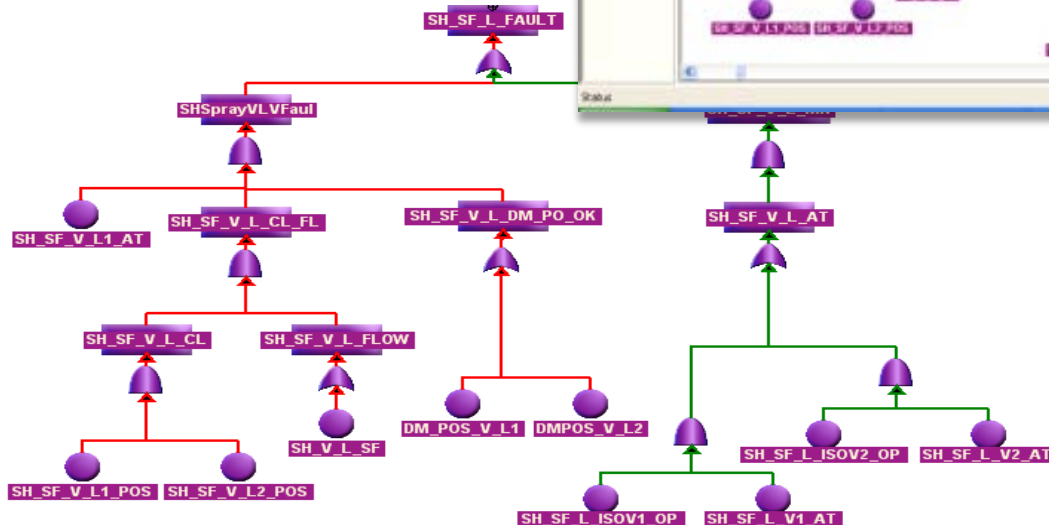
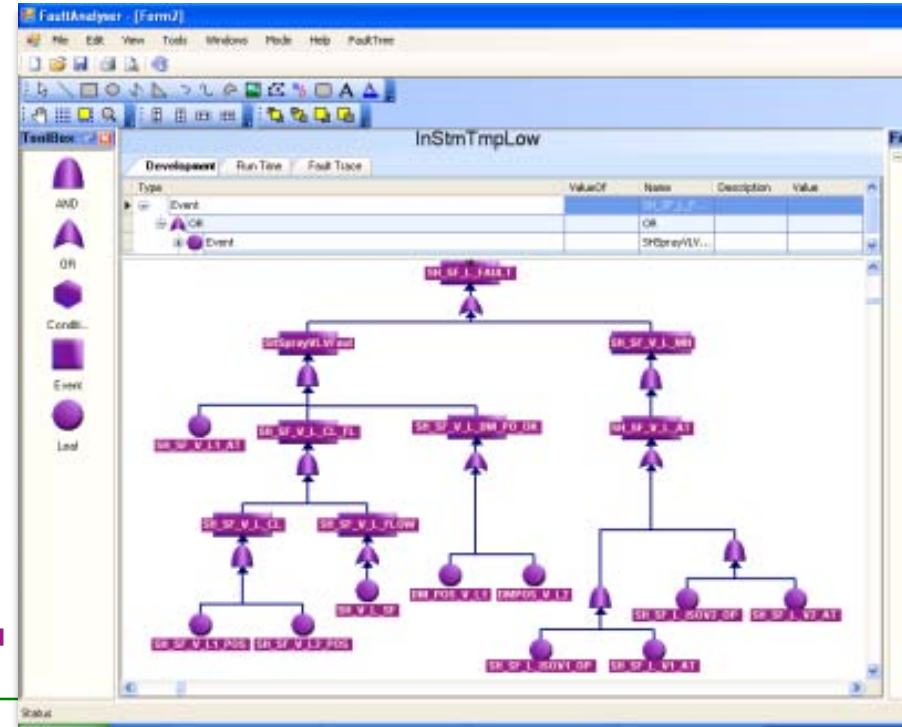
EVONIX

Color	Name
—	Reference Mean
—	AvgPrd Mean
—	UCLX
—	LCLX
●	Event
●	Alarm

- SPC Properties
 - Tagname
 - SPC_SGZ1_SWU_KPI
 - AveragingPeriod 10Days
 - Mean SamplingPeriod 6Hours
 - AP Gaps Allowed 50
 - MSP Gaps Allowed 50
 - User Supplied CL's True
 - Runtest: 1.5
 - Reference Mean 1
 - RefStdDeviation 0.25
 - Upper Control Limit 1.5
 - Lower Control Limit 0.5
- Fileinformation
- XML-Dateiname:

Fault Trees

- Models and analyzes faults in the process.
- Composed of logic diagrams that display the state of the system and the states of the components
- Constructed using Drag & Drop technique
- Does not need programming expertise for building such trees.





Thank You

... Ideas & Solutions for Tomorrow

steag