

On-line Performance Monitoring and Optimization experience in Indian Power Plant

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**Optimization of Efficiency
Systematically**

Performance Analysis Diagnostics
Optimization (PADO)

Signing of Framework agreement

INDO-GERMAN
ENERGY
PROGRAMME



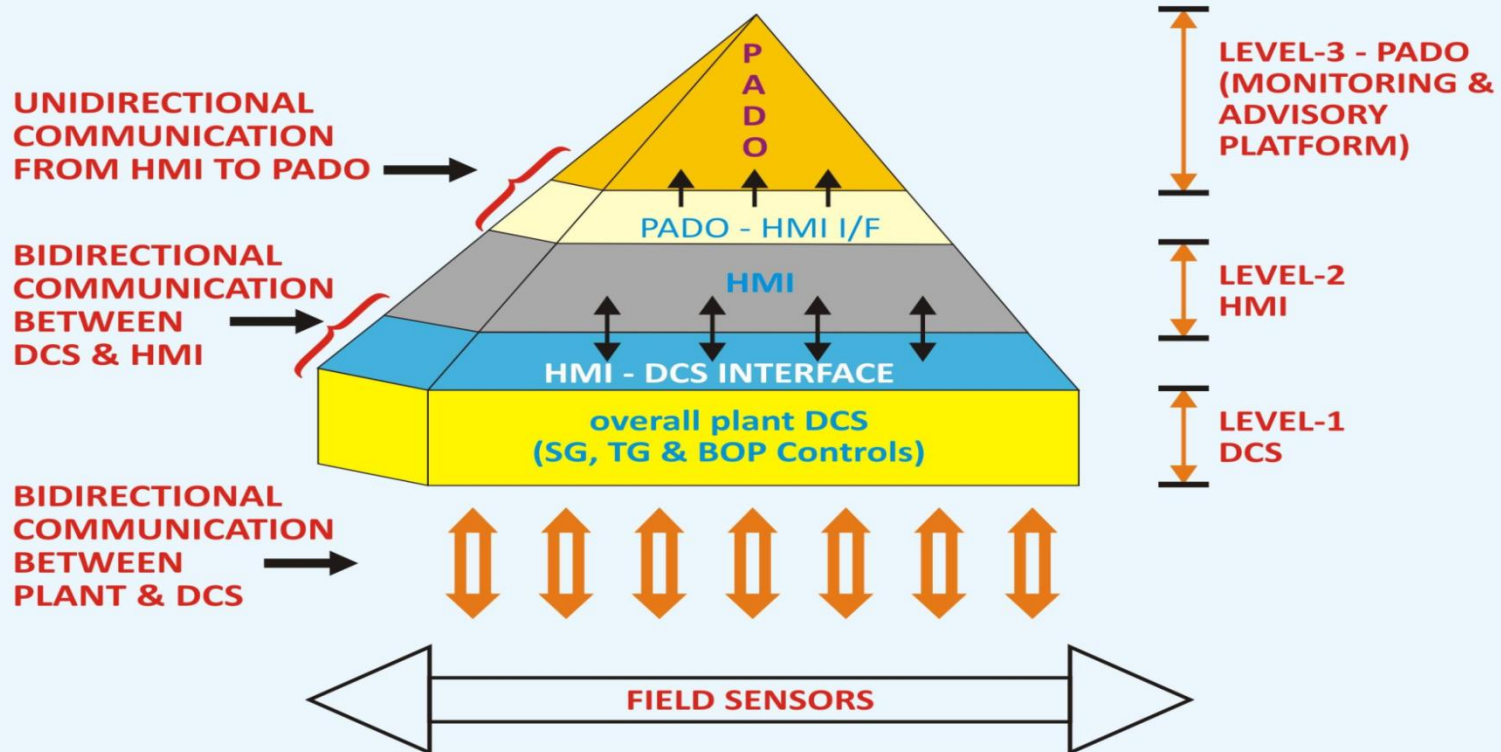
WHAT IS PADO?

INDO-GERMAN
ENERGY
PROGRAMME

- PADO is a software based optimisation and diagnostics system based on client-server architecture.
- It's a package rich in intensive information which aids plant operator to run the plant with most optimum efficiency , availability and maintainability.
- Massive Computation Engine for Performance Parameters of Power Plant.

POWER PLANT CONTROL & SUPERVISION PYRAMID

INDO-GERMAN
ENERGY
PROGRAMME



CONTROL AND MONITORING HIERARCHY IN A TYPICAL MODERN POWER PLANT

Current PADO Projects

INDO-GERMAN
ENERGY
PROGRAMME



- Simhadri Stg I 2X500 MW (In operation)
- Ramagundam Stg III 1X500 MW (SAT done)
- Rihand Stg II 2X500 MW (SAT done)
- Talcher Stg II 4X500 MW (Commissioned)
- Vindhyachal Stg III 2X500 MW (Commissioned)
- Kahalgaon 3X500 MW (FAT done)
- Sipat 2X500 MW (FAT done)

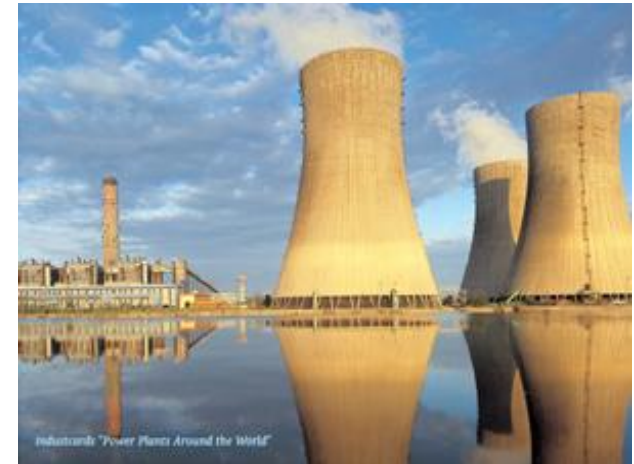
PADO for 16 units of NTPC
An On-line implementation of SR::EPOS that compares the actual status of plant operation with the “best” status by simulating the entire process and identifying potential cost savings to be realised.

Also a life time monitoring SR1 package that computes continuously the residual life of the plant. The above packages are in *operation for both units of NTPC's Simhadri Plant for more than 4 years.*

New PADO Projects

INDO-GERMAN
ENERGY
PROGRAMME

- Dadri Stg II 2X500 MW
- Korba Stg III 1x500 MW
- Farakka Stg III 1x500 MW
- Khaparkheda Stg III 1X500
- Bhusawal Stg I 2X500 MW
- Simhadri Stg II 2X500 MW
- Jhajjar 3X500 MW
- Bellary Stg I 1X500 MW
- GEB Ukai 1X 490 MW
- DVC Maithan 2x 500 MW
- And many more..

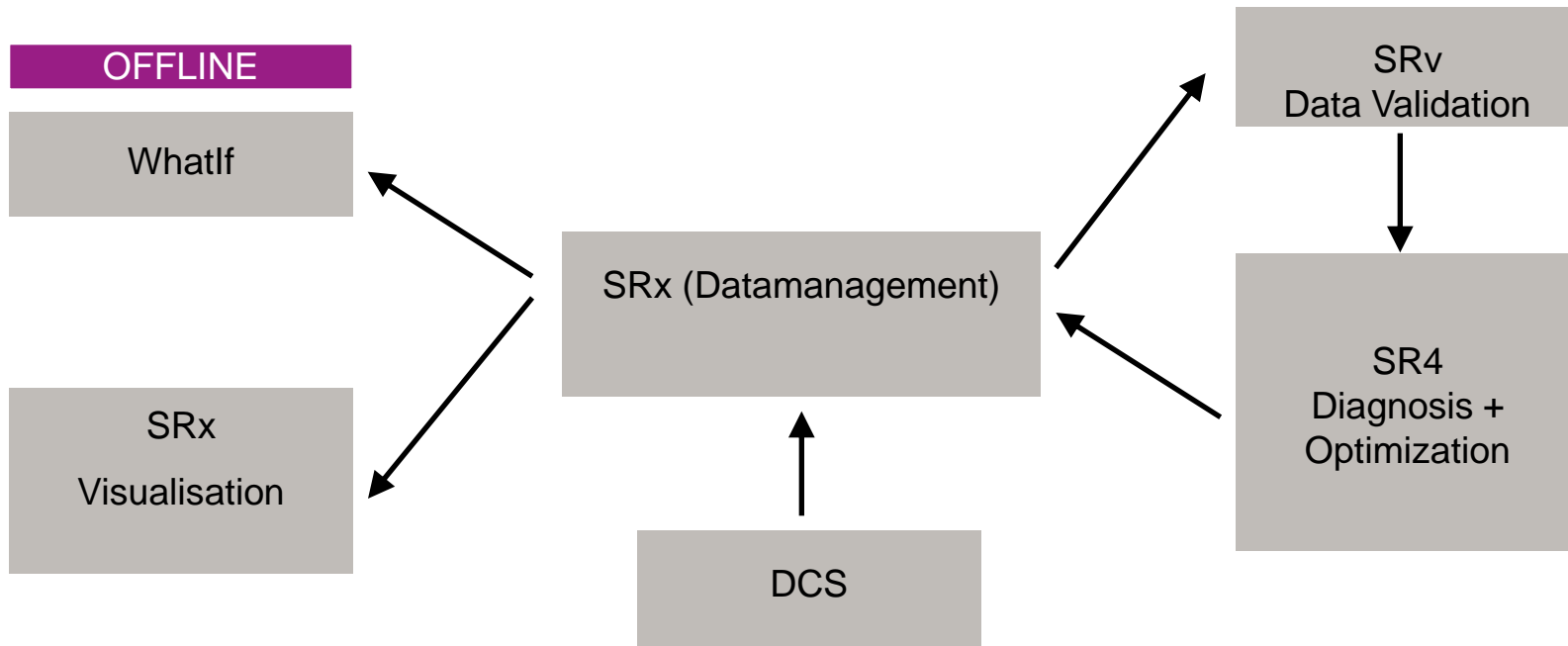


Online Tool: Optimization Sequence

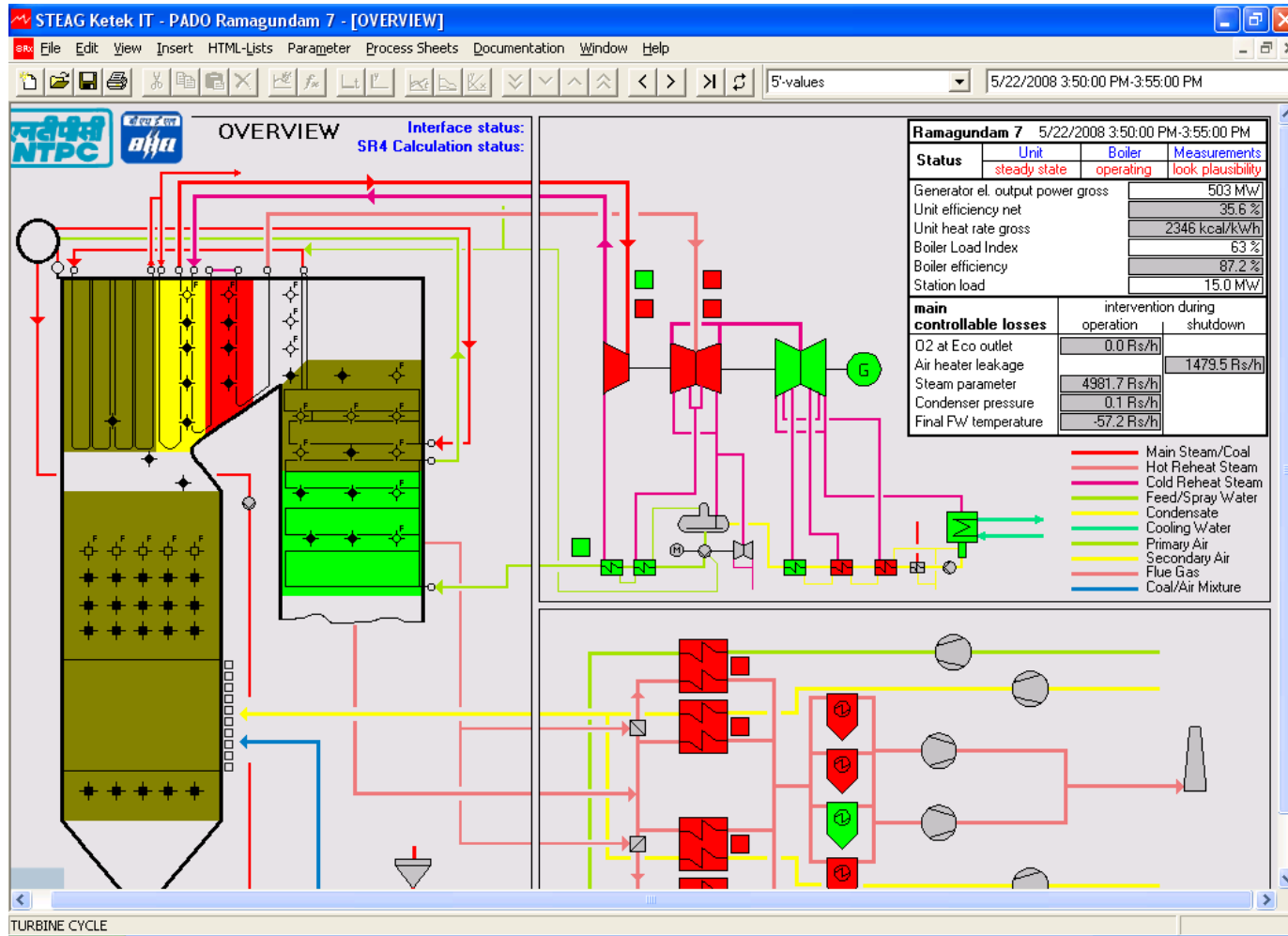
1. All relevant data from DCS which goes into Optimisation need to be validated i.e. all implausible values have to be replaced by plausible values
2. All calculations are done every 5 minutes (not only once a day) since the quality of coal and combustion process is changing. Therefore the state of heating surfaces must be monitored constantly.
3. Results are presented in user friendly manner: state of components indicated by green, yellow, red and losses expressed in Rp per hour



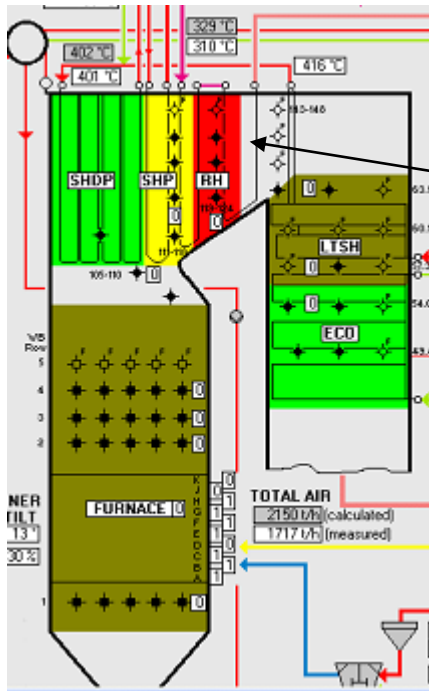
Online Tool Functions



Online Tool Screens (Overview)



Boiler (traffic light colours)



Indicating the state of heating surfaces by traffic light colours
red = „bad“
yellow = „not good“
green = „good“

Online Tool: Data Validation (1)

STEAG Ketek IT - PADO Ramagundam 7

File Edit View Insert HTML-Lists Parameter Process Sheets Documentation Window Help

5 values 5/23/2007 1:55:00 PM-2:00:00 PM

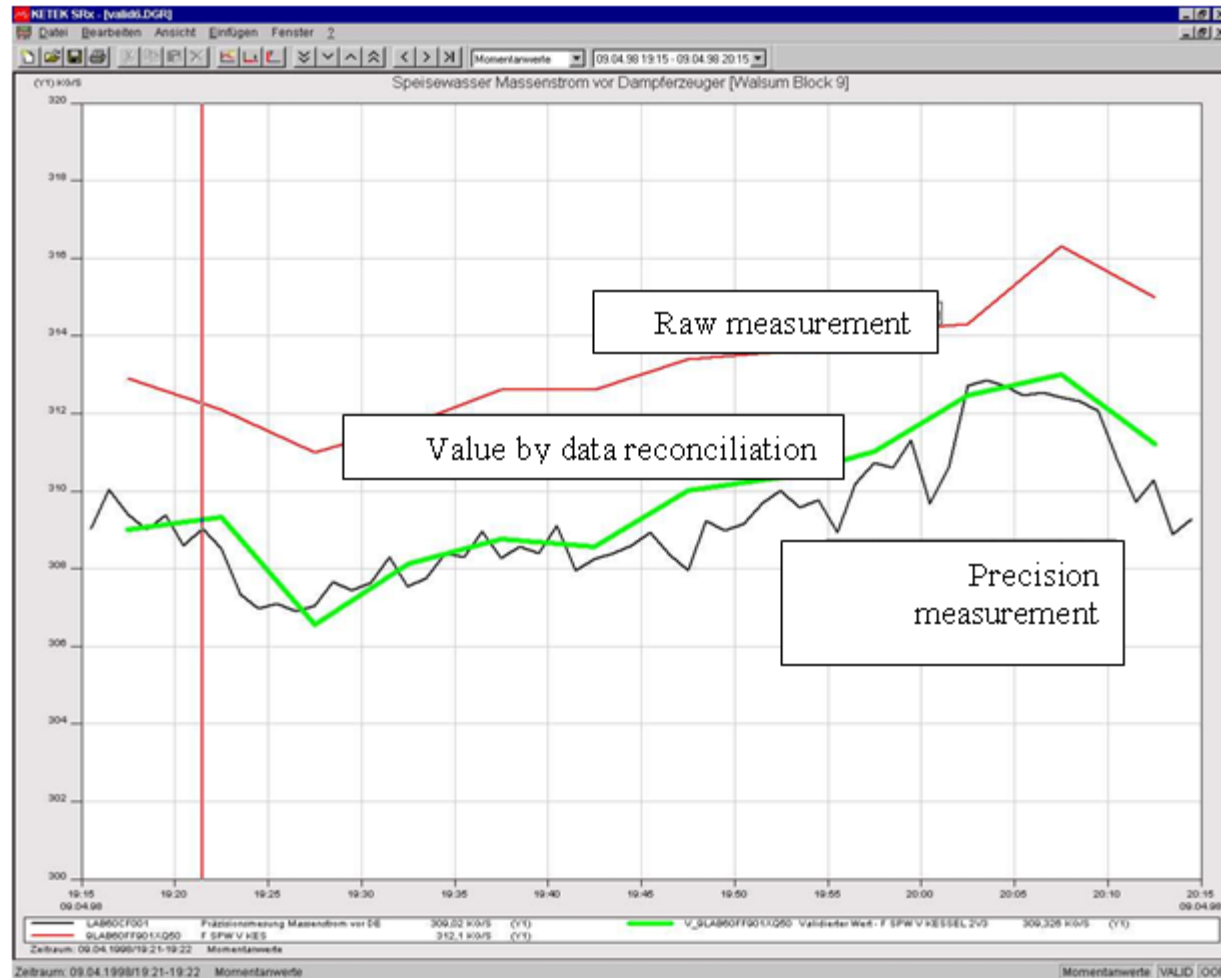
	RAW VALUE 1	RAW VALUE 2	"RAW VALUE"	CALCULATED VALUE
MS FLOW	1584 t/h	1584 t/h	AVG 1584 t/h	1625 t/h
FW FLOW	1549 t/h	1567 t/h	AVG 1558 t/h	1612 t/h
SH SPRAY	16 t/h	2 t/h	SUM 18 t/h	18.4 t/h
SB STEAM	6 t/h		6 t/h	5.6 t/h
BLOW DOWN	0 t/h		0 t/h	0 t/h
MASS BALANCE (SHOULD BE ZERO) ->			13 t/h	-0 t/h
MS FLOW - FW FLOW - SH SPRAY + SB STEAM + BLOW DOWN = 0				

Online Tool: Data Validation (2)

	RAW VALUE 1	RAW VALUE 2	"RAW VALUE"	CALCULATED VALUE
MS FLOW	1584 t/h	1584 t/h	AVG 1584 t/h	1625 t/h
FW FLOW	1549 t/h	1567 t/h	AVG 1558 t/h	1612 t/h
SH SPRAY	16 t/h	2 t/h	SUM 18 t/h	18.4 t/h
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BLOW DOWN	0 t/h		0 t/h	0 t/h
MASS BALANCE (SHOULD BE ZERO) ->			13 t/h	-0 t/h

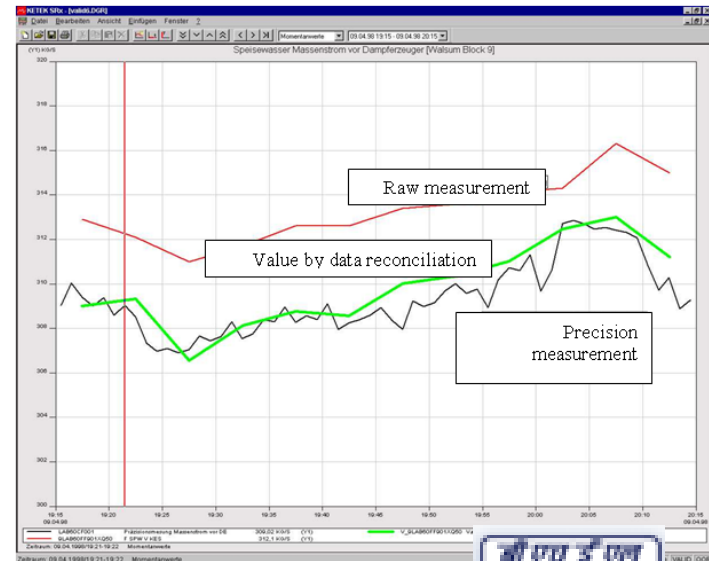
**RAW VALUES FROM
DCS
DO NOT MATCH THE
BALANCE !**

Online Tool: Data Validation (3)



Support of PTC 6 by data validation

1. Installation of precision sensors
2. Enter the readings from sensors to Epsilon model
3. Check the quality of measurements with data validation



PADO Data Validation (5)

point in time: 05.05.04 11:25:00

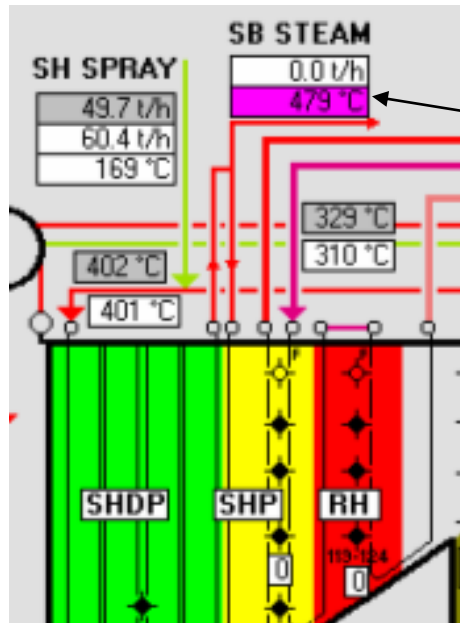
plausible value data reconciliation successfull

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

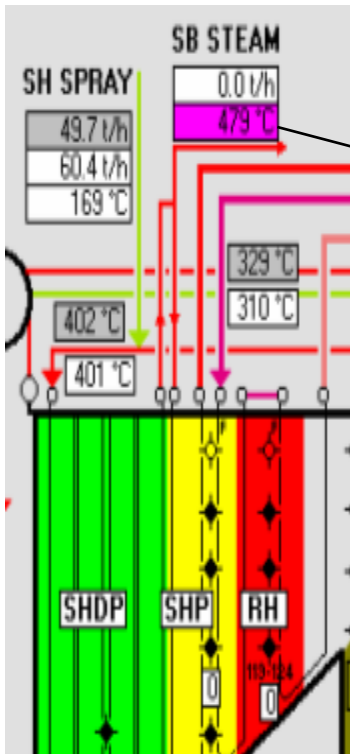


Presentation of Measurements (1)



Indicating not correct measurements with violett colour

Presentation of Measurements (2)



SHPL_M_T_INP_G

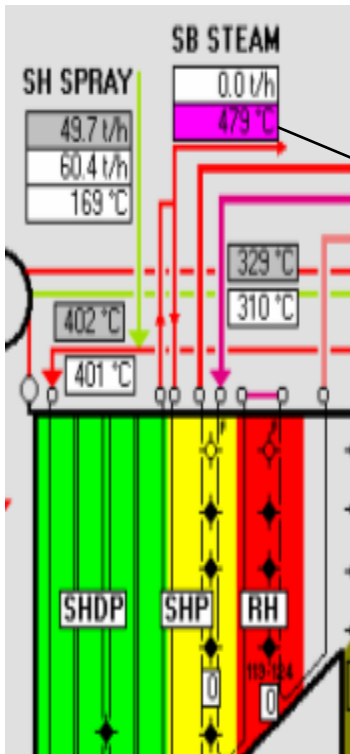
Dependencies | Formula

- 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]

SB steam temperatures measurements left and right (left not plausible)

OK Cancel

Presentation of Measurements (3)



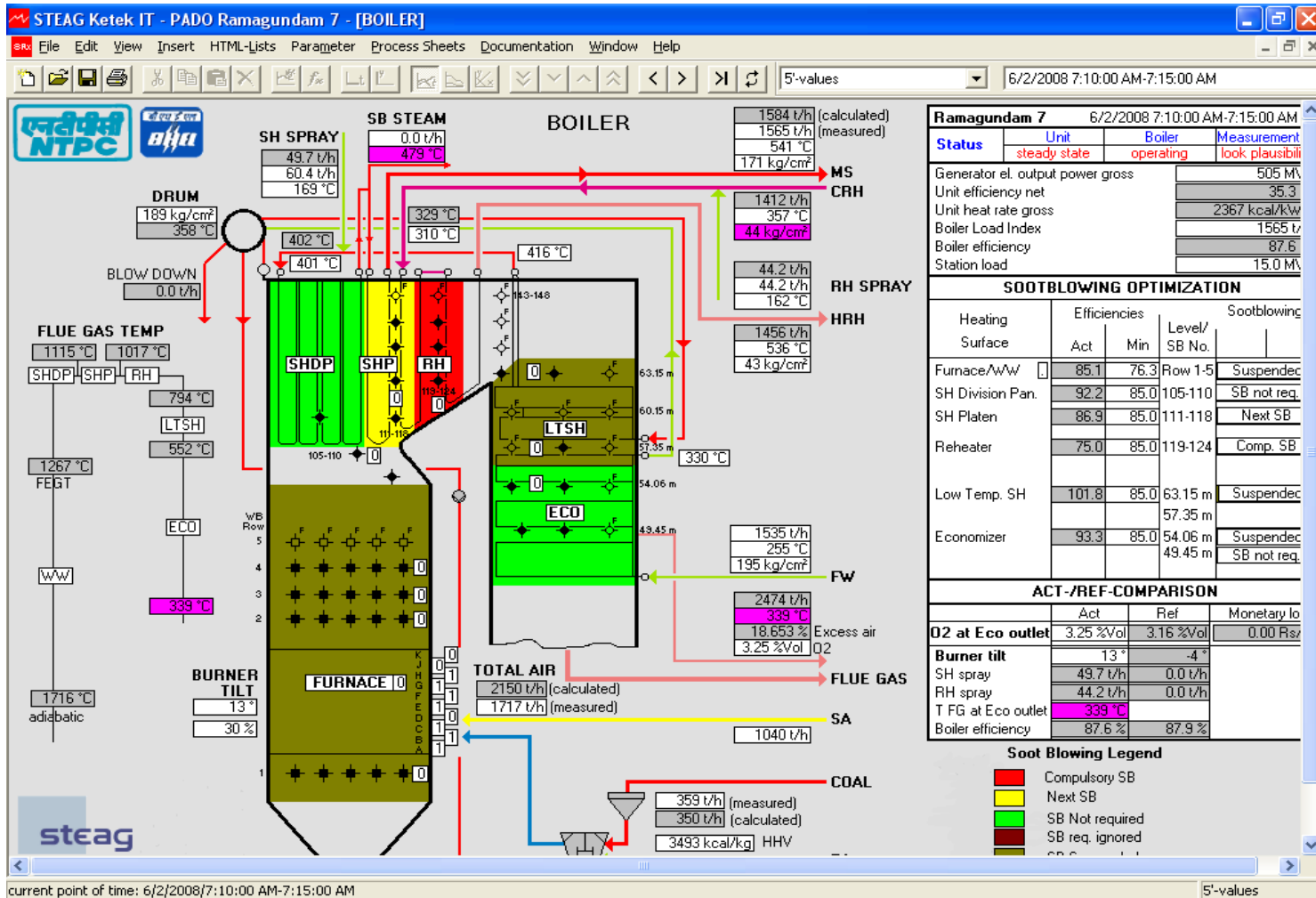
The screenshot shows a software window titled "SHPL_M_T_INP_G" with two tabs: "Dependencies" and "Formula". The "Dependencies" tab is active, showing a tree structure of dependencies for the variable "SHPL_M_T_INP_G". The tree is as follows:

- 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]

An arrow points from the "SHPL_M_T_INPL_N" node to the text box below. A red question mark is placed next to the "SHPL_M_T_INPL_N" node.

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

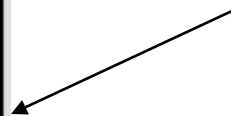
Online Tool: Boiler



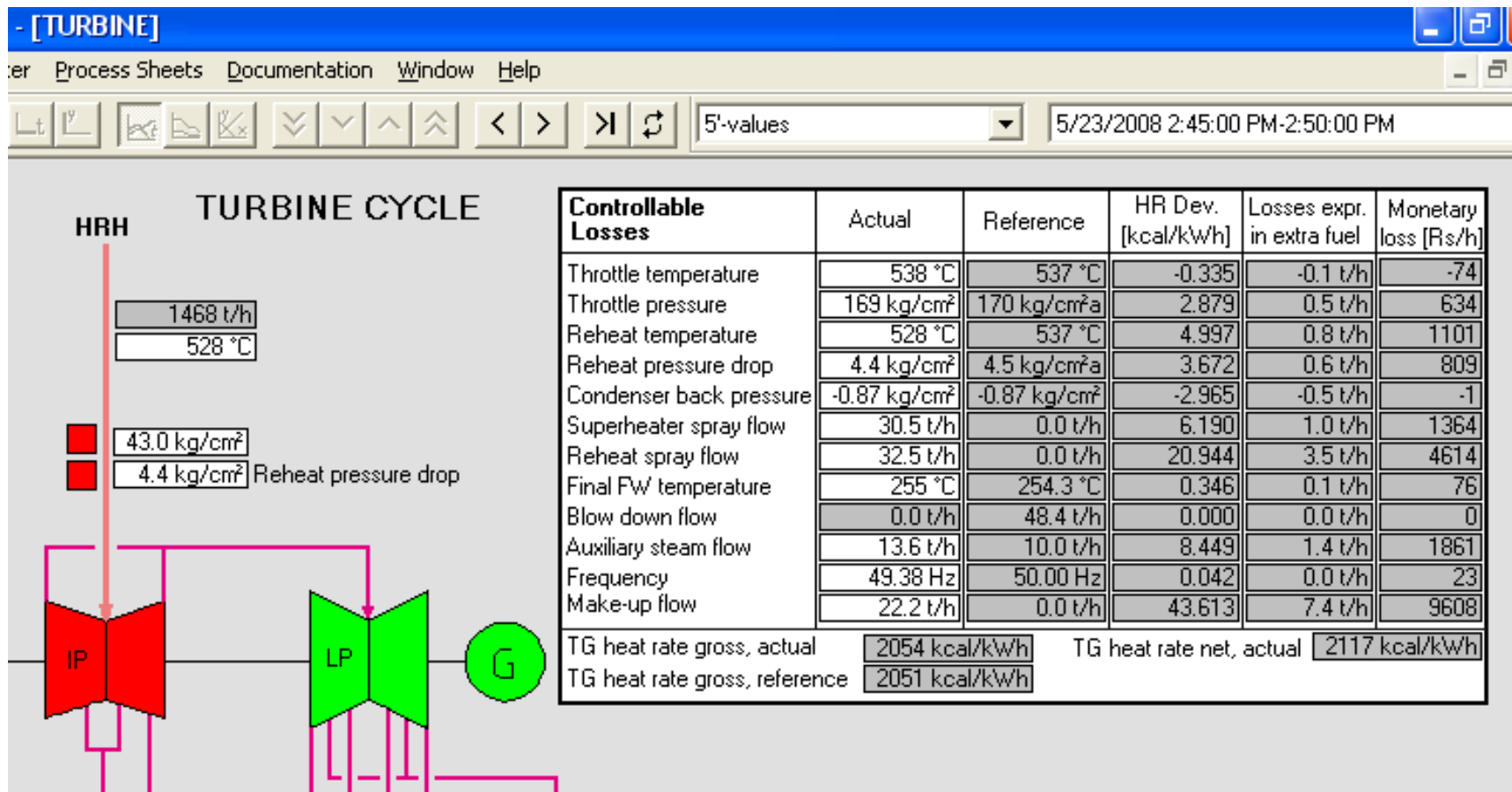
Sootblowing Optimization

Ramagundam 7		6/2/2008 7:10:00 AM-7:15:00 AM			
Status	Unit	Boiler	Measurements		
	steady state	operating	look plausibility		
Generator el. output power gross		505 MW			
Unit efficiency net		35.3 %			
Unit heat rate gross		2367 kcal/kWh			
Boiler Load Index		1565 t/h			
Boiler efficiency		87.6 %			
Station load		15.0 MW			
SOOTBLOWING OPTIMIZATION					
Heating Surface	Efficiencies		Level/ SB No.	Sootblowing	
	Act	Min			
Furnace/AW	85.1	76.3	Row 1-5	Suspended	
SH Division Pan.	92.2	85.0	105-110	SB not req.	
SH Platen	86.9	85.0	111-118	Next SB	
Reheater	75.0	85.0	119-124	Comp. SB	
Low Temp. SH	101.8	85.0	63.15 m	Suspended	
			57.35 m		
Economizer	93.3	85.0	54.06 m	Suspended	
			49.45 m	SB not req.	

Compulsory Cleaning



Controllable Losses (1)



Controllable Losses (2)

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
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				

Setpoint Optimization (1)

STEAG Ketek IT - PADO Ramagundam 7 - [Set]

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Set point optimization

	act value	opt value
Boiler		
O2 at Eco outlet	3.25 %	3.00 %Vol
Burner tilt	13 °	13 °
Turbine Cycle		
MS temperature	540.81 °C	545.00 °C
MS pressure	171.31 kg/cm ²	170.00 kg/cm ²
Reheat temperature	536.37 °C	545.00 °C
Condenser back pressure	-0.88 kg/cm ²	-0.88 kg/cm ²
Windbox Furn. pressure	78.57 mmWC	69.35 mmWC
PA HDR Pressure	809.02 mmWC	8158270.4
Unit Heat Rate gross	2366.67	2321

Setpoint Optimization (2)

Set point optimization

Ramagundam 7
5/23/2008 2:40:00 PM

Boiler

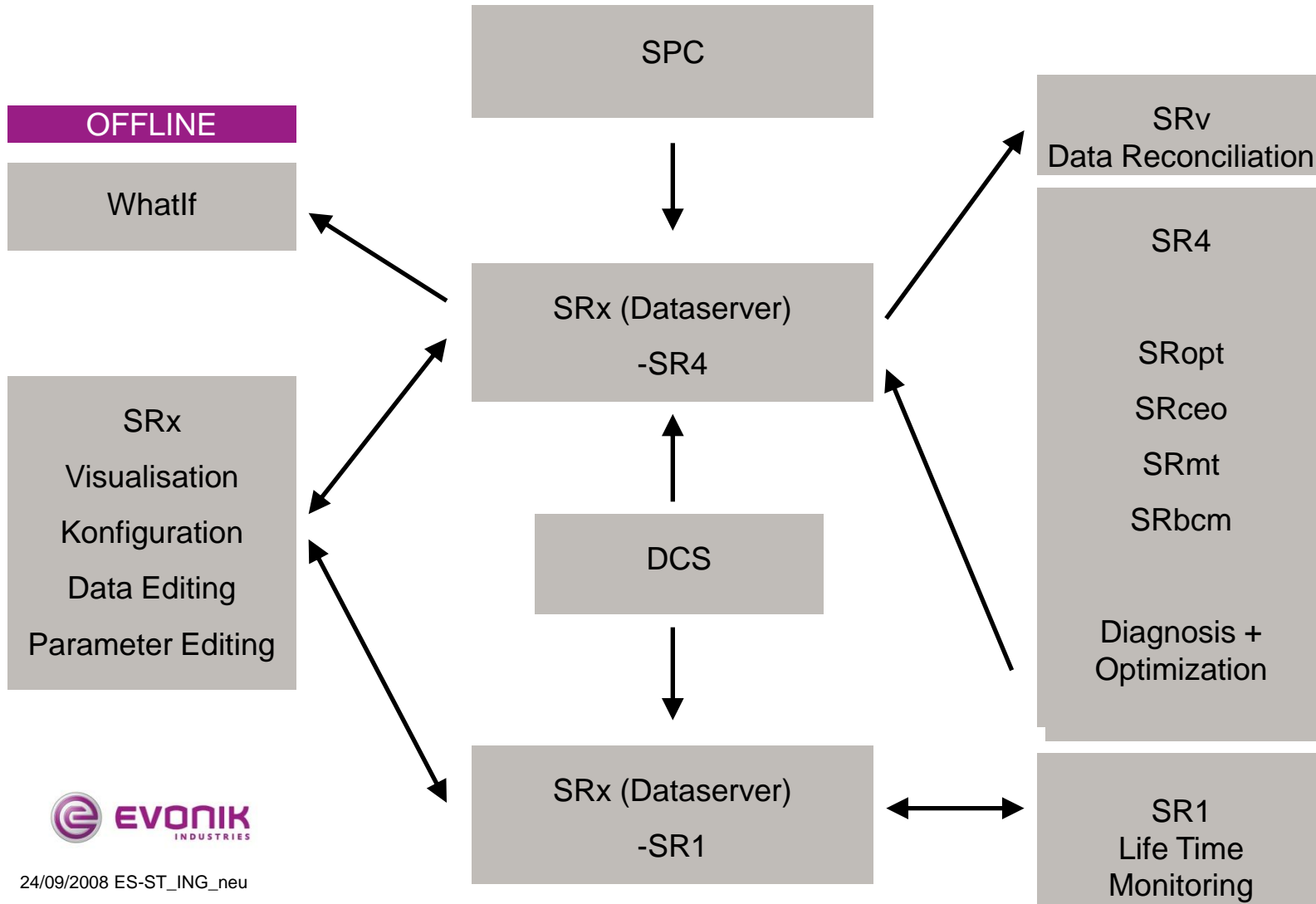
	act value	opt value
O2 at Eco outlet	4.27 %	5.00 %Vol
Burner tilt	9°	9°

Turbine Cycle

MS temperature	538.55 °C	545.00 °C
MS pressure	170.47 kg/cm ²	170.00 kg/cm ²
Reheat temperature	530.45 °C	545.00 °C
Condenser back pressure	-0.87 kg/cm ²	-0.87 kg/cm ²
Windbox Furn. pressure	73.90 mm ² /C	89.74 mm ² /C
PA HDR Pressure	806.55 mm ² /C	800.1
Unit Heat Rate gross	2399.48	2338

**RECOMMENDED
SETPOINTS NOT
SET**

Online Tool: Modules



Advantages of the Online Tool

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 !**



Creativity means:
Developing solutions that no
one expects.

BHEL & Evonik. Power to create

THANK YOU