

Reliance Infrastructure Ltd

220 MW Samalkot Combined Cycle Power Plant



Success in
Aux Power Reduction



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13-05-2010

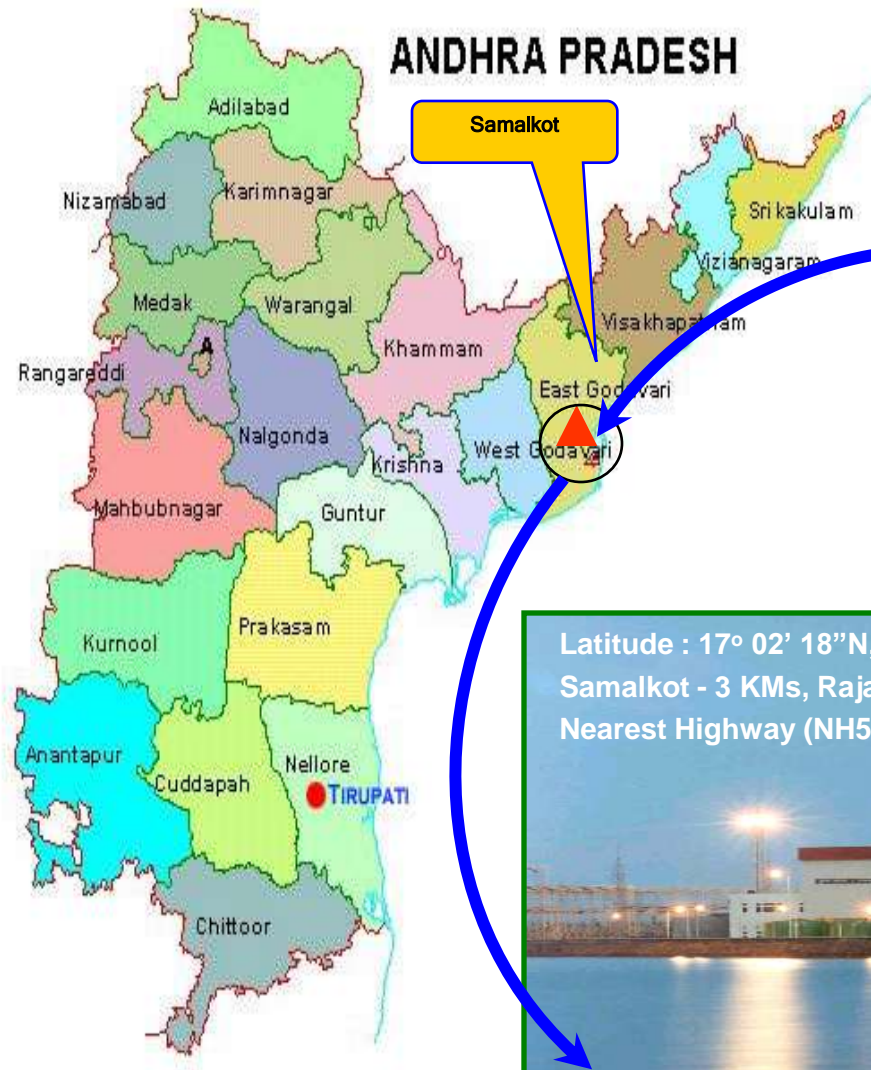
220 MW Samalkot Combined Cycle Power Plant

SAMALKOT POWER STATION



220 MW Samalkot Combined Cycle Power Plant

Location Map:



Latitude : 17° 02' 18"N, Longitude : 82° 08' 15"E, MSL : 27 Mts
Samalkot - 3 KMS, Rajahmundry Airport - 50 KMS, Kakinada Port - 20 KMS
Nearest Highway (NH5) - 15 KMS, Samalkot Rly Station - 2.5 KMS



An integrated Management Systems Certified Plant

RInfra- SPS Management systems Certification

Standards Certified under ONE

- ISO 14001:2004
- OHSAS 18001:2007
- ISO 9001:2008
- ISO 27001: 2005
- SA 8000:2001

Integrated Management System (IMS)



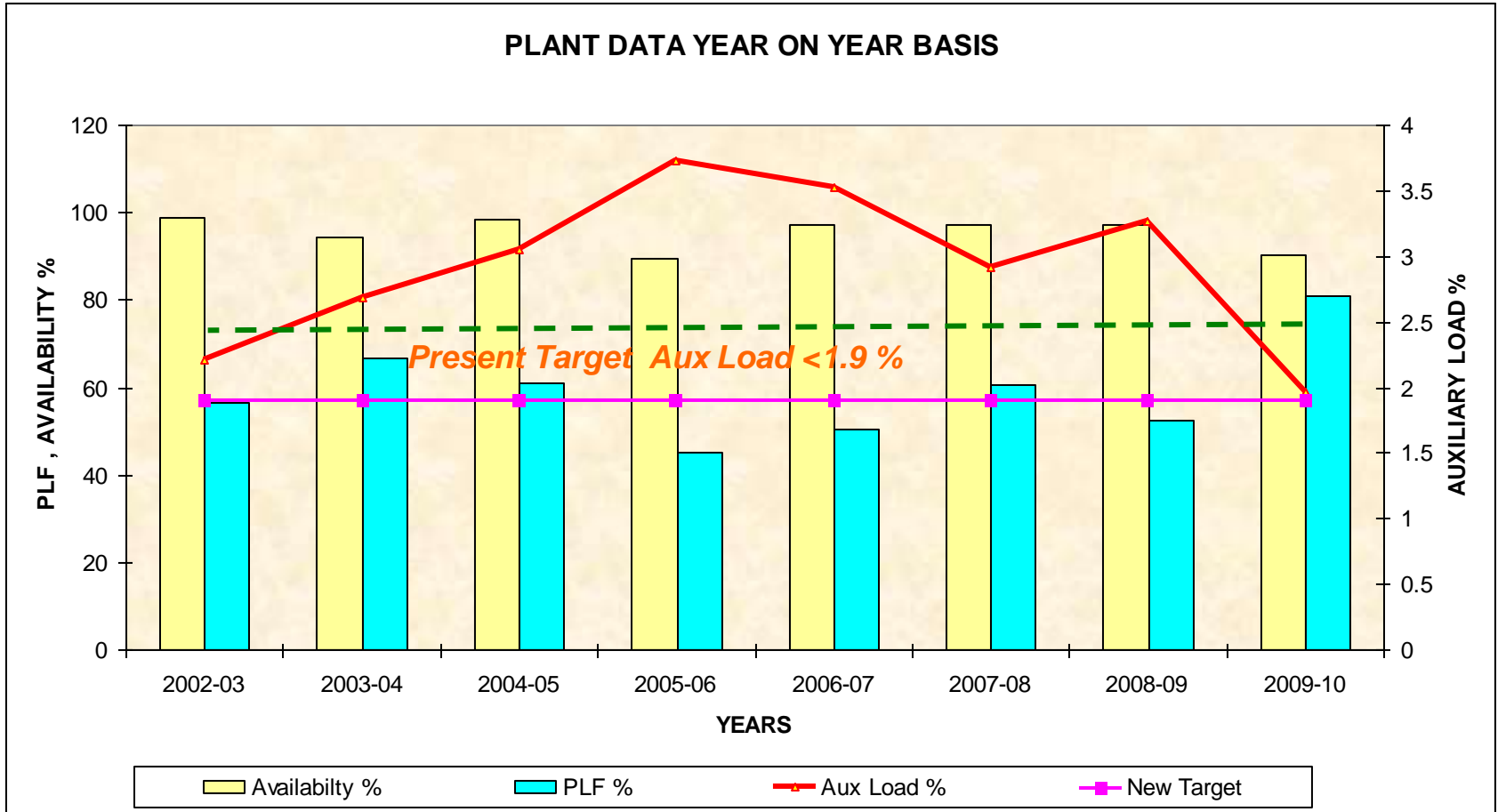
Year wise Operating Data

S.No.	Year	Station PLF %	Availability %	Aux Load %	LESS Natural Gas
1	2002-03	56.56	98.83	2.21	
2	2003-04	66.55	94.34	2.69	
3	2004-05	61.10	98.3	3.05	
4	2005-06	45.28	89.39**	3.73	
5	2006-07	50.55	97.4	3.53	
6	2007-08	60.61	97.4	2.92	
7	2008-09	52.50	97.08	3.27	
8	2009-10	80.86	90.24**	1.97	

** PLANT MAJOR OVERHAUL DONE



Plant Data



FACTORS Affecting Aux power consumption

- ❑ **Plant load factor**
- ❑ **Operation of plant Auxiliaries**
- ❑ **Service auxiliaries like illumination**
- ❑ **Unit Start up power reduction (BFP's at Lower RPM)**

Methods of Aux power Reduction

- ❑ **Installing energy efficiency equipments**
- ❑ **Optimizing Operation procedures**
- ❑ **Monitoring of Aux power consumption**
- ❑ **Knowledge sharing and bench marking**

Significant Energy Conservation Projects

Energy Efficient Projects Implemented

- Variable Frequency Drive – HP and LP Boiler feed pump and Raw water
- C E P Destaging
- CW Pump Corrocoat application
- Wind Ventilators
- SWAS water recovering as a Boiler Feed.
- Cooling Tower Makeup By Pumping Replaced By Gravity Line
- Cooling tower cell fan – FRP Hollow blade placement
- Energy saver – for Lighting systems



Recent Optimizing Operation Procedures

- ❑ **Deaerator Pressure Reduction from 1.0 to 0.5 bar**
- ❑ **Air compressor Load pattern optimization from 8 to 6.5 bar**
- ❑ **Air dryer optimization of cycle time from 6 to 12 hrs**

Change Env

Print Screen

MENU

COLD

WARM

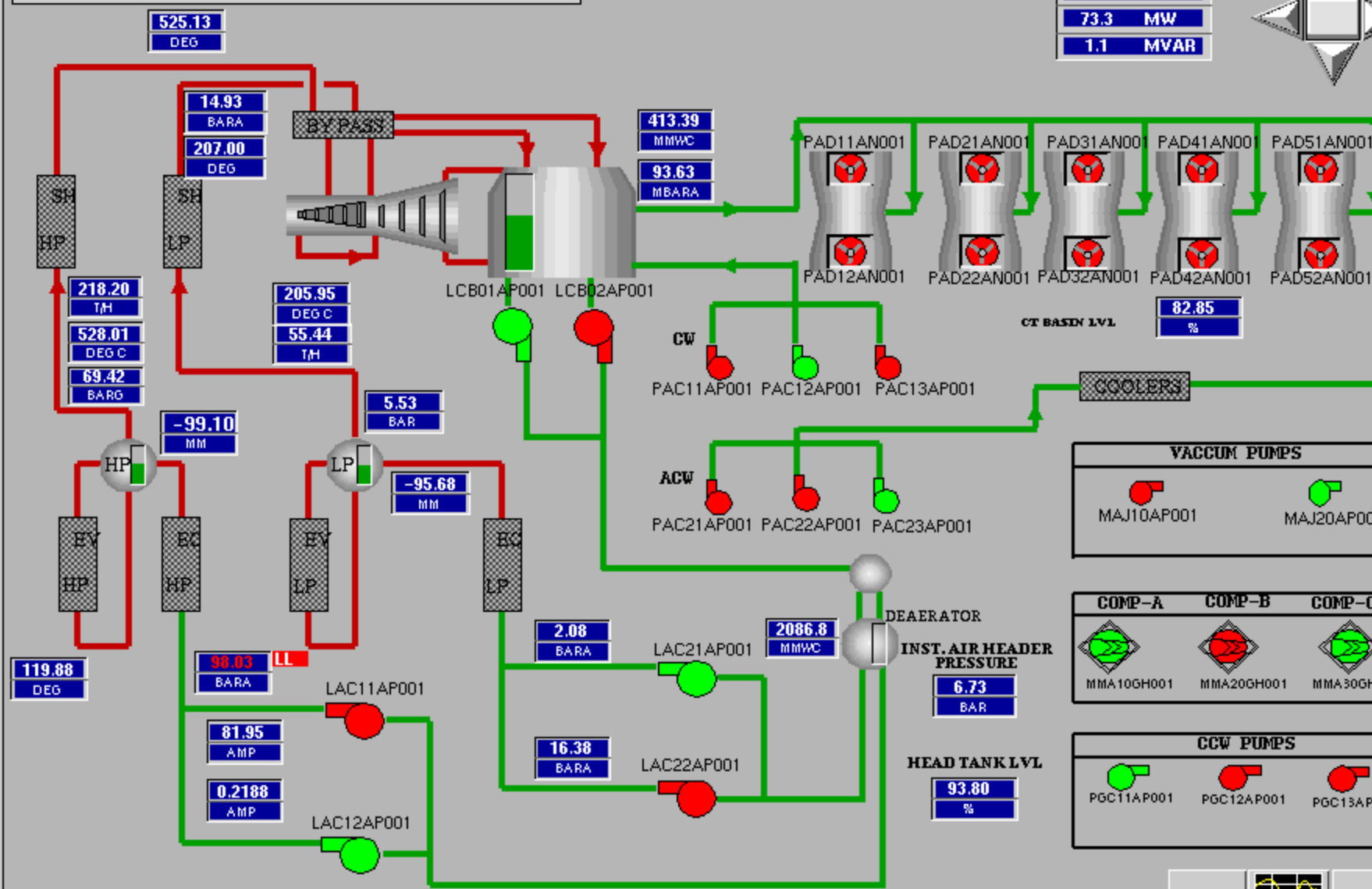
HOT

ACK Page

Prev.Disp

THERMAL CYCLE (OVERVIEW)

2967.6 RPM
73.3 MW
1.1 MVAR



□ HP boiler feed pump- VFD installation

Energy conservation study on the HRSG High Pressure system

- ❑ High Pressure Boiler Feed system –
- ❑ Feed station control valve operating at a throttled position of 35 %.
- ❑ The HP boiler feed water header pressure being 124 bar.
- ❑ Drum pressure of 75 Bar.

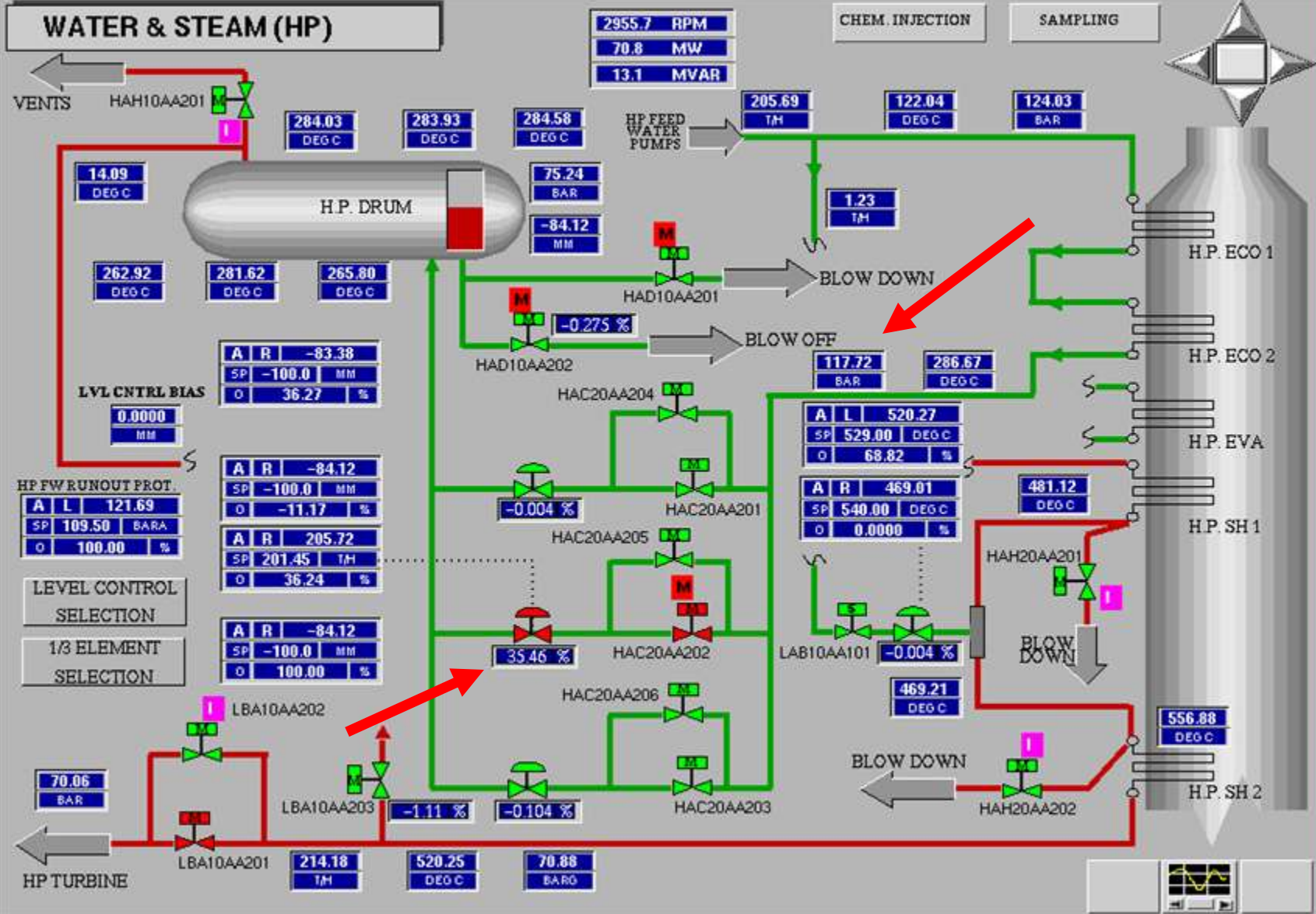


Change Env

MENU

LEVEL CONTROL SELECTION

1/3 ELEMENT SELECTION



- ❑ **Feasibility options for energy conservation study revealed opportunities to select from**
- ✓ **Variable Frequency Drive at Boiler feed pump motor and**
- ✓ **Destaging of the feed Pump.**
- ✓ **Hydraulic fluid Coupling with Scoop control**
- ✓ **Steam turbine driven Boiler feed pump**

Energy Conservation Study of System

- An in house technical study was done and following areas identified.

Equipment	Detailed Study and analysis of existing system
Pump	□ Bearings – Journal and Thrust
	□ Lube oil system, Shaft driven lube MAIN oil pump
	□ Allowable Axial displacement of shaft, balance leak of pressure for water to reach deaerator
	□ Min recirculation - to be maintained per manufacturer and Water conditions
	□ Coupling
	□ Mechanical seals and related cooling system
	□ Vibrations of the pump bearing
	□ Pump Skid as a whole

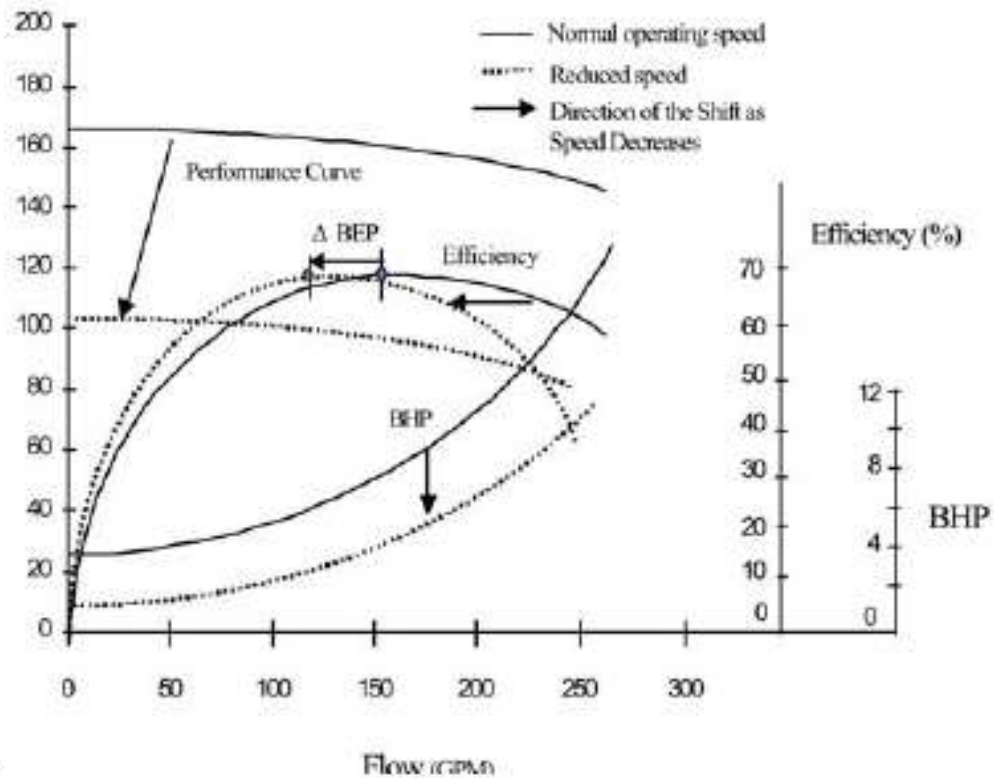
Energy Conservation Study of System

Motor	<input type="checkbox"/> Bearings
	<input type="checkbox"/> Cooling - fan for winding
	<input type="checkbox"/> Vibrations of the Motor bearings
	<input type="checkbox"/> Motor Protections
	<input type="checkbox"/> Harmonics
Feed control Station	<input type="checkbox"/> Control valve type and capacity
	<input type="checkbox"/> Control valve Actuator
	<input type="checkbox"/> Logics of feed water control study with – M/s INVENSYS
Piping	<input type="checkbox"/> Placement of valves at the economizer outlet
	<input type="checkbox"/> Position of Check valves
	<input type="checkbox"/> Position of isolation valves

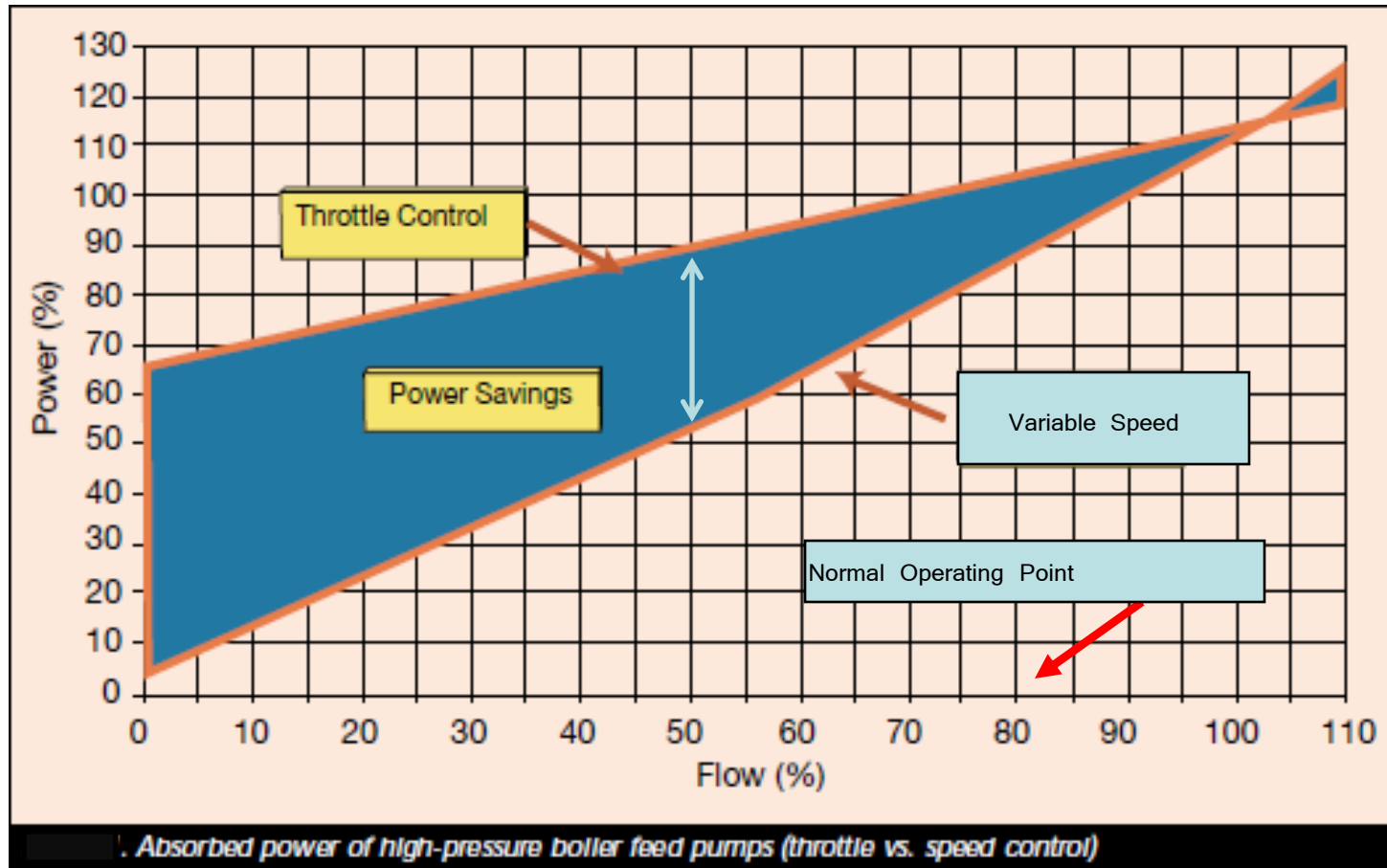
Energy Conservation Study of System

Water and steam cycle	Deaerator
	Temperature and Pressure of water at suction to Pump
	PINCH AND APPROACH at Economizer
	DE SUPERHEATING
	Steaming at the Economizer possibility
	Drum and Deaerator capacity
System	Feed Control system Logics and
	Plant load variation study LDC request
	Study on past Trip history of the plant –Voltage surges and Power / frequency Swing
	Operational Philosophy

Typical Pump Curve with Variable speed



Typical saving in variable speed Application



Due to Regulatory and Guarantee conditions - OEMs design at 125 % of MCR

HP Boiler Feed Pump Technical Data

❑ PUMP:

Make : M/s Sulzer
Head : 1256.5 mwc
Capacity : 276 m³/h
Stages : 11
Lubrication : Forced

❑ Motor:

Make : Kirloskar
Type : 3 Ph AC Induction Motor
Power : 1280 KW
Supply : 3 Ph/6600 V/50 Hz
Speed : 2983 rpm

Reasons for choosing VFD application

Opportunity Type / Technology	Advantage	Disadvantage
Variable Frequency Drive	<ul style="list-style-type: none"> ✓ Highest Efficiency 96% ✓ Variable Load capability ✓ Ease of fitment with existing equipment 	<ul style="list-style-type: none"> ✓ Motor heating and insulation ✓ Harmonics in Input Line side
Hydraulic coupling and Scoop	<ul style="list-style-type: none"> ✓ Existing technology With low Efficiency at part load. 	<ul style="list-style-type: none"> ✓ New Hydraulic system and control to be installed
Pump Destaging	<ul style="list-style-type: none"> ✓ Cost of implementation is lowest. 	<ul style="list-style-type: none"> ✓ Variable load capability to be checked with system installed ✓ Restoration to initial condition

Implementation after study

- ❑ Variable frequency drive came out to be best option
- ❑ As the load varies as per request from load dispatch center.
- ❑ Minimum frequency set at 35 HZ as per OEM
- ❑ Modified Logics configuration with same feed control valve
- ❑ Operation procedure modification.

- HRSG High pressure system **AFTER** VFD application

Change Env

MENU

HP FW RUNOUT PROT.

LEVEL CONTROL SELECTION

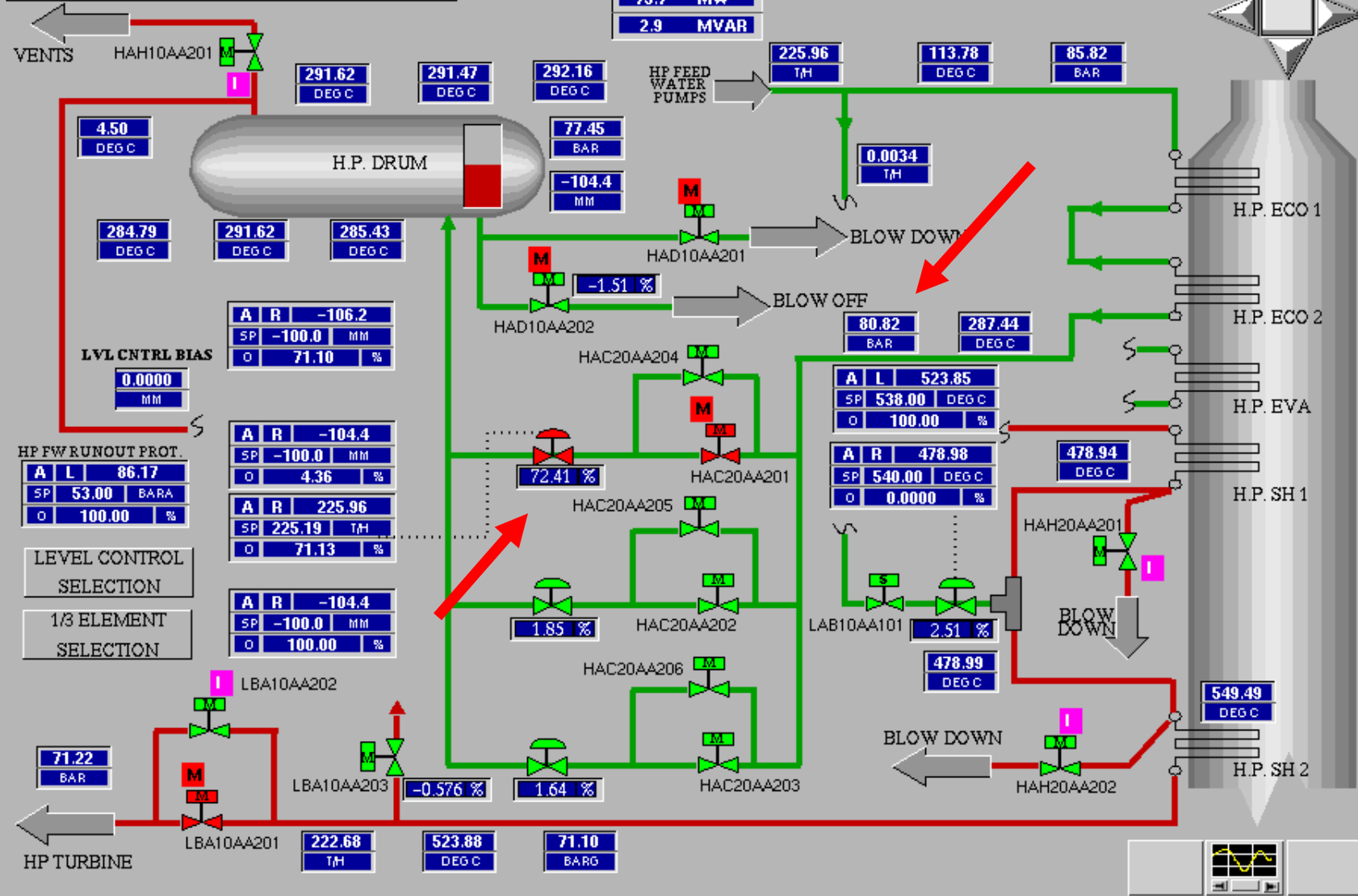
1/3 ELEMENT SELECTION

WATER & STEAM (HP)

2995.6 RPM
75.7 MW
2.9 MVAR

CHEM. INJECTION

SAMPLING



220 MW Samalkot Combined Cycle Power Plant

HP Boiler feed pump V.F.D

Supplier: Yantra Automation Pvt. Ltd





Saving in Load by 51% (Part load) 32% (Base load)

Description	Before Installation Of VFD	After Installation Of VFD <u>42.8</u> Hz
Discharge Pressure	123 bar	87 bar
ECO Outlet Press	118 bar	81 bar
CV Pos	36 %	72 %
Power	1125 kW	770 kW
Power Saving	Part load: 575 KW & Base load: 355 kW	

Saving : 30,17,500 KWH @ 8500 Operating Hours at full load

□ LP boiler feed pump- VFD installation

Energy conservation study on the HRSG Low Pressure system concluded

- ❑ **Low Pressure Boiler Feed system - control valve was operating at a throttled position of 55 %. The LP boiler feed water header pressure being 20 bar with Drum pressure of 5.3 Bar.**

- ❑ **Feasibility options after energy conservation study revealed two opportunities to select from**
- ✓ **Variable Frequency Drive at Boiler feed pump motor and**
- ✓ **Destaging of the feed Pump.**

- ❑ **Variable frequency drive came out to be best option for the plant as load varies as per request from load dispatch center.**

LP Boiler Feed Pump Technical Data

□ Pump

Make	:	Sulzer
Capacity	:	68 m³/h
Head	:	222.5 mwc
Stages	:	05

□ Motor

Make	:	Kirloskar
Type	:	3 Ph Ac Induction Motor
Supply	:	3 Ph, 415 V, 50 Hz
Rating	:	75 kW
Current	:	125 A
Speed	:	2970 rpm

- HRSG LOW pressure system before VFD application

System Process

22-4-10 06:42 PM

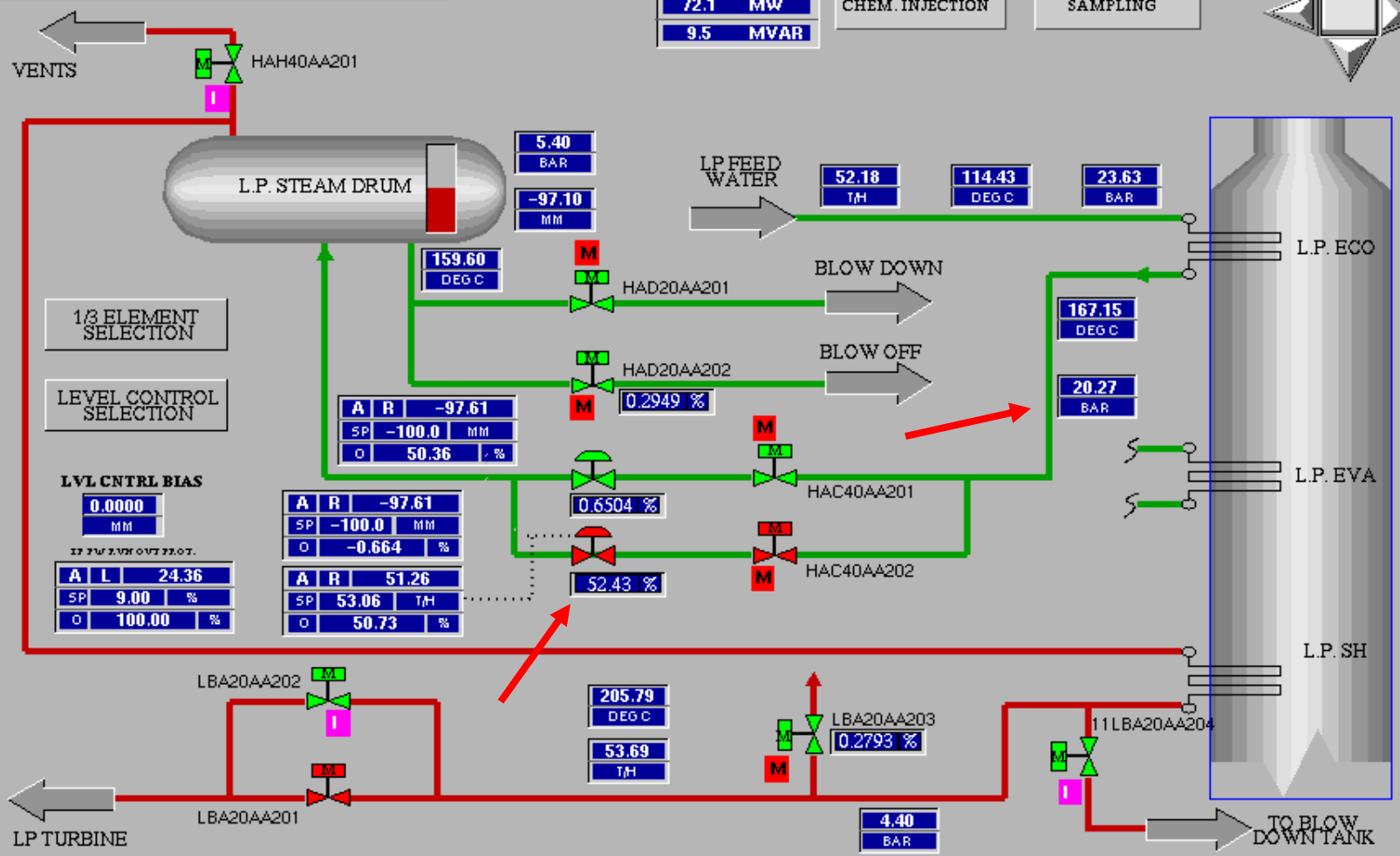
- Change Env
- Print Screen
- MENU
- COLD
- WARM
- HOT
- ACK Page
- Prev.Disp

WATER & STEAM (LP)

2981.7 RPM
72.1 MW
9.5 MVAR

CHEM. INJECTION

SAMPLING



1/3 ELEMENT SELECTION

LEVEL CONTROL SELECTION

LVL CNTRL BIAS

0.0000 MM

A	L	24.36
SP		9.00 %
O		100.00 %

A	R	-97.61
SP		-100.0 MM
O		50.36 %

A	R	-97.61
SP		-100.0 MM
O		-0.664 %

A	R	51.26
SP		53.06 TH
O		50.73 %

205.79 DEG C
53.69 TH

4.40 BAR



- HRSG Low pressure system after VFD application

Change Env

MENU

1/3 ELEMENT SELECTION

LEVEL CONTROL SELECTION

LVL CNTRL BIAS

0.0000 MM

SP L 14.18

SP 10.00 %

O 100.00 %

WATER & STEAM (LP)

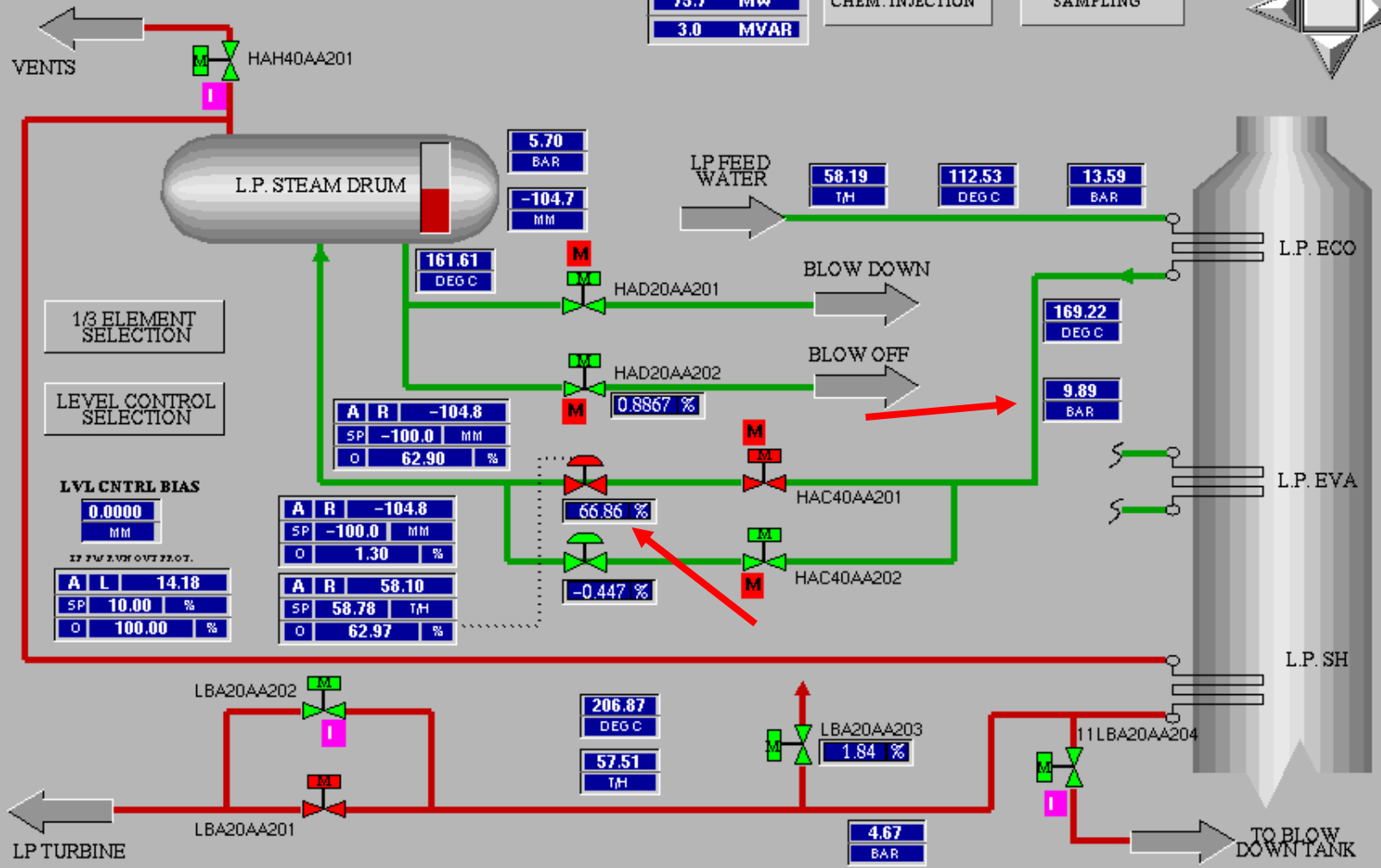
2995.6 RPM

75.7 MW

3.0 MVAR

CHEM. INJECTION

SAMPLING



LP BFP VFD PANEL and Change over Panel





Saving in Load by 36% (at Full load operation)

Description	Before Installation Of VFD	After Installation Of VFD 38 Hz
Discharge Pressure	23.63 bar	13.6bar
ECO Outlet Press	20.27 bar	9.9 bar
CV Pos	55 %	66 %
Power	47.5 kW	30 kW
Power Saving	17.5 kW at Base load	

1,48,750 KWH @ 8500 Operating Hours

- **Raw water PUMP VFD**

Raw Pump Technical Data

Pump

Make	:	Mather and Platt
Capacity	:	470 m³/h
Head	:	20.12 mwc
Stages	:	01

Motor

Make	:	Crompton greaves
Type	:	3 Ph Ac Induction Motor
Supply	:	3 Ph, 415 V, 50 Hz
Rating	:	37 kW
Current	:	63 A
Speed	:	1480 rpm

Saving in Load by 65%

Description	Before Installation Of VFD	After Installation Of VFD <u>28</u> Hz
Power	28 kW	10 kW
Power Saving	18 kW	



▣ C.E.P. Destaging

De staging of Condensate Extraction Pump

Energy conservation study on the **HRSG Condensate system** concluded

- ❑ **Condensate system - control valve was operating at a throttled position of 55 %.**

- ❑ **Feasibility options for energy conservation study revealed three opportunities to select from**
 - ✓ **Variable Frequency Drive**
 - ✓ **Destaging of the Pump.**
 - ✓ **Impeller trimming**

- ❑ **Destaging came out to be best option for the plant as even though the load varies the requirement at the Dearator level control needs to be maintained. Also trimming option doesn't give flexibility to come back to original condition, if required in future.**

Condensate Extraction Pump

□ Pump:

Make	:	Sulzer
Type	:	Vertical
Capacity	:	344 m3/h
Head	:	204.5 MLC
Stages	:	4

□ Motor:

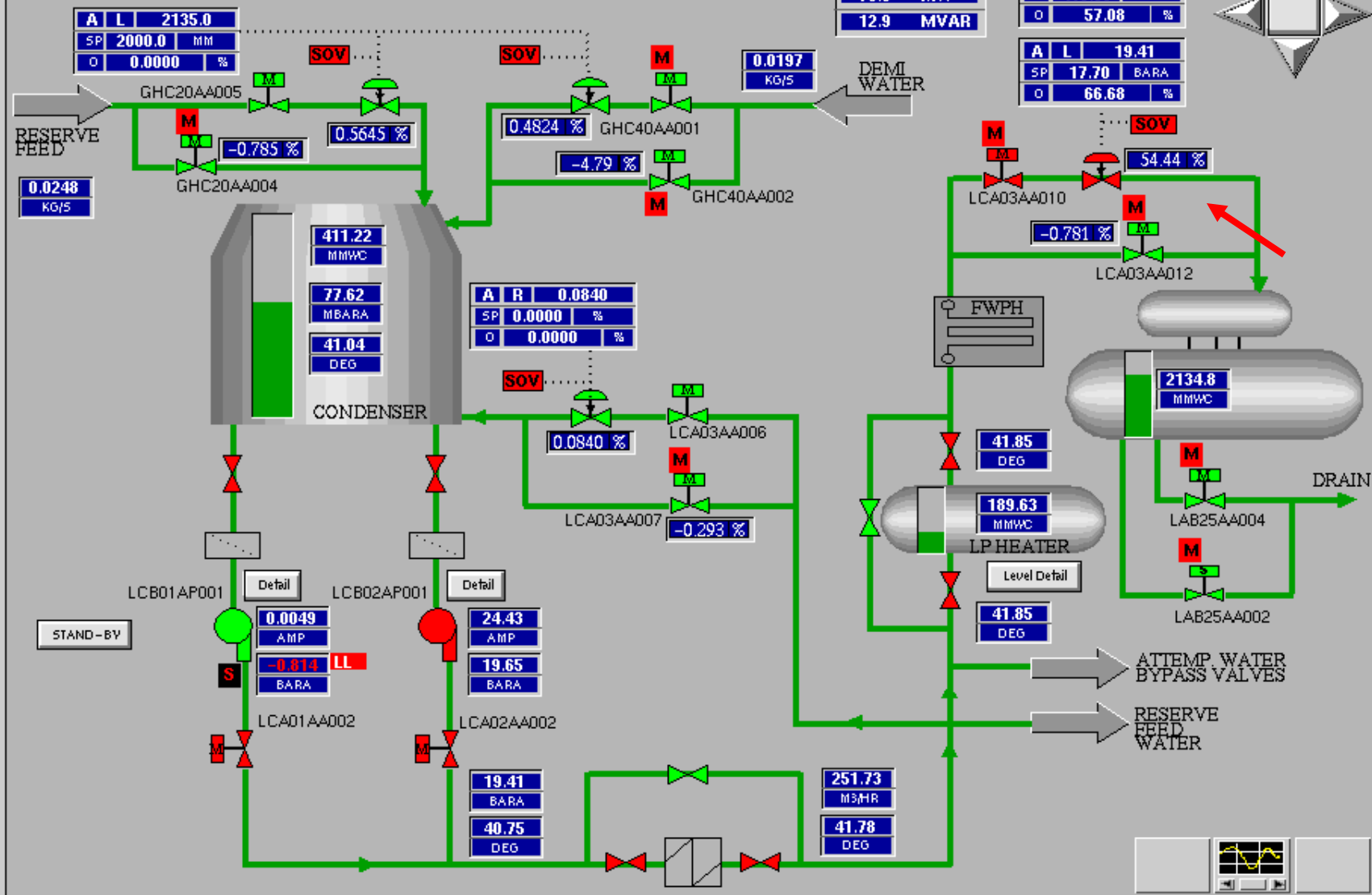
Make	:	Kirloskar
Type	:	3 Ph Ac Induction Motor
Supply	:	3 Ph, 6600 V, 50 Hz
Rating	:	270 kW
Current	:	29 A
Speed	:	1489 rpm

- HRSG Condensate system before Destaging

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MENU

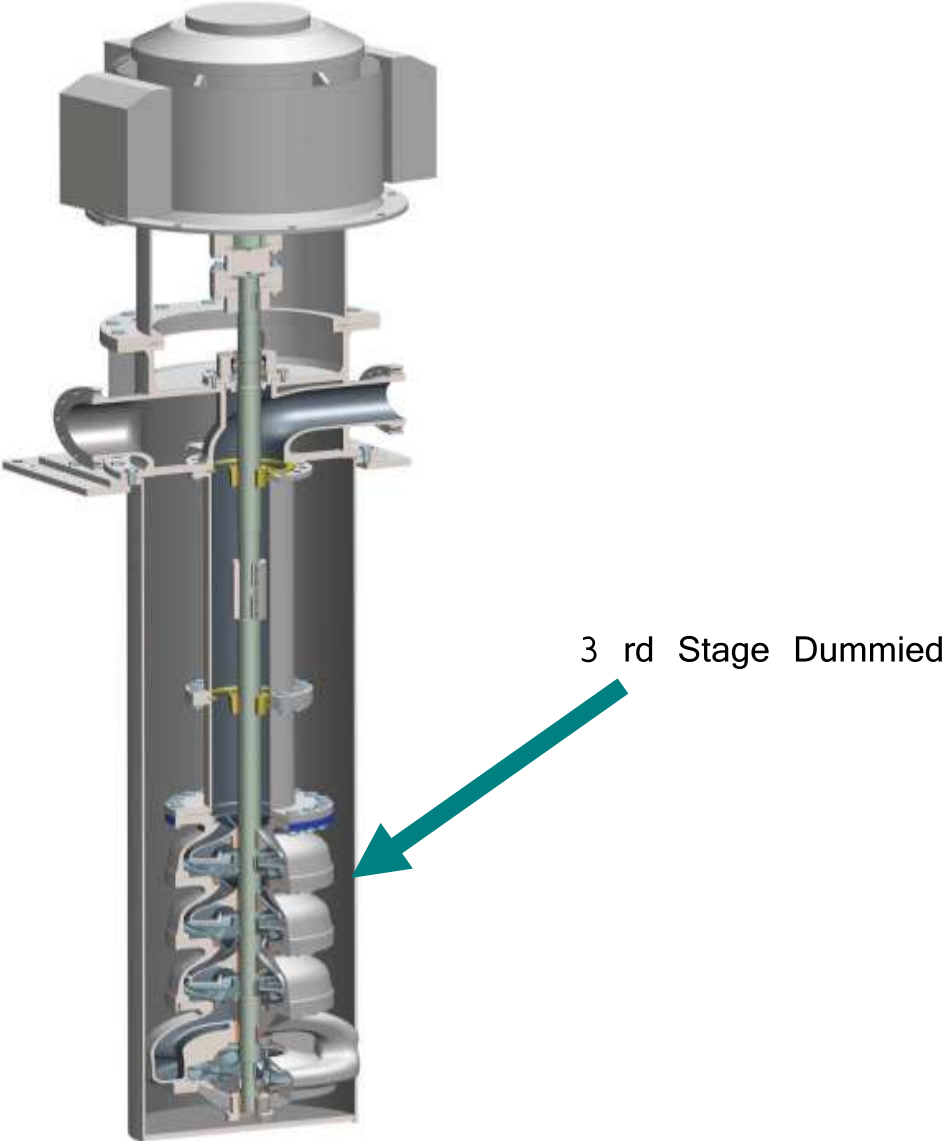
CONDENSATE SYSTEM



CEP Destaging



Sulzer CEP

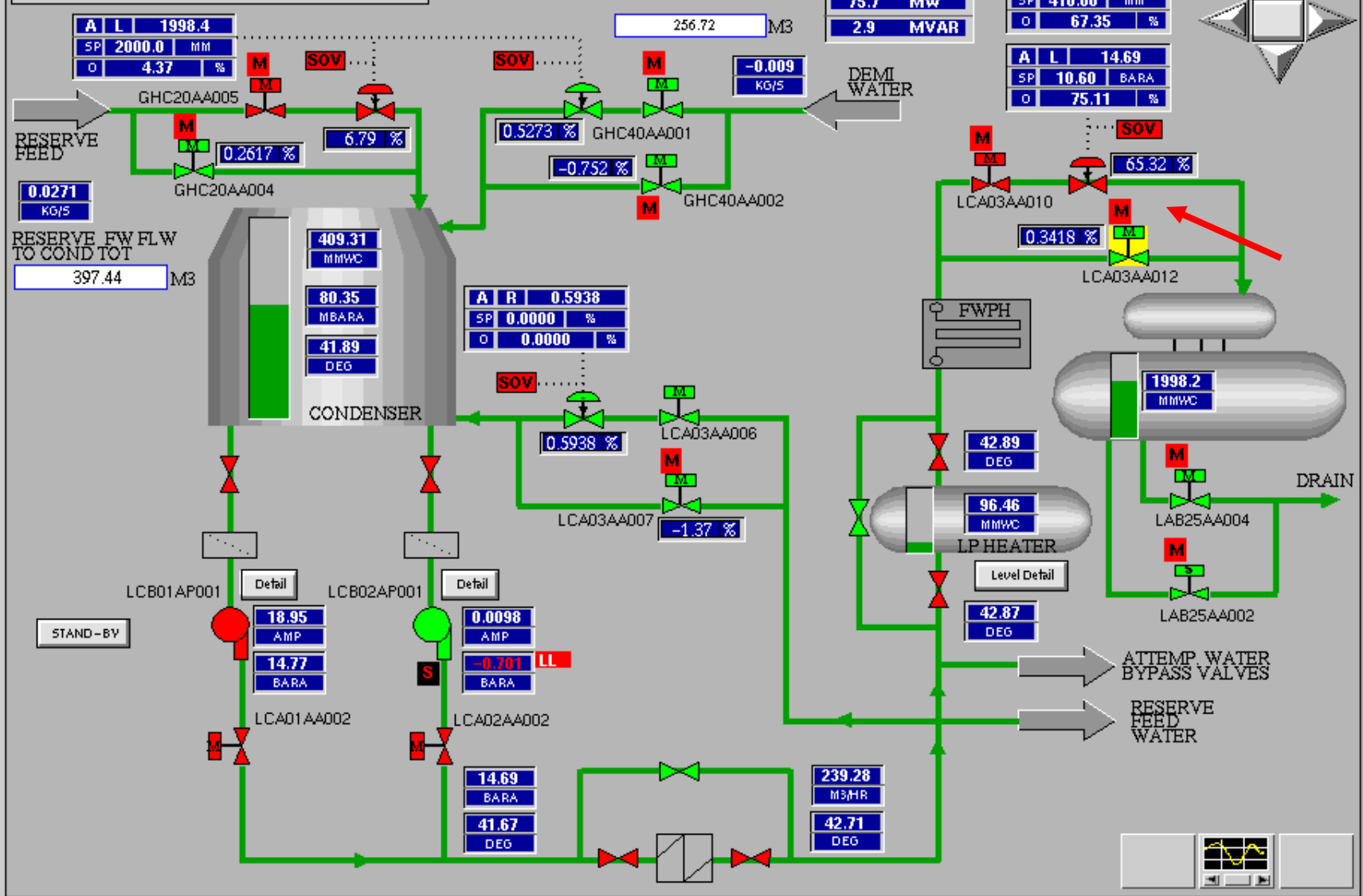


- HRSG condensate system **after** Destaging

Change Env

MENU

CONDENSATE SYSTEM



Saving in Load by 26%

Description	Before De staging	After De staging
Discharge Pressure	19.6 bar	14.7 bar
Power	246 kW	182 kW
Power Saving	Part load: 52 KW & Base load: 64 kW	

5,44,000 KWH @ 8500 Operating Hours

□ CW Pump Corrocoat

Circulating water pump

□ Pump:

Make	:	Mather & Platt (I) Ltd.,
Capacity	:	8872 m³/h
Head	:	19.74 MLC
Stages	:	Single

□ Motor:

Make	:	Crompton Greaves
Type	:	3 Ph Ac Induction Motor
Supply	:	3 Ph, 6600 V, 50 Hz
Rating	:	630 kw
Current	:	71 A
Speed	:	594 rpm

Application Of “Flu Glide” Coating on Circulating Water Pump.

“Flu glide” Coating is the flake glass filled synthetic polymer type coatings and benefits in:

- 1. Reduction in Fluid friction**
- 2. Reduction in micro turbulence**
- 3. Increased Efficiency of the pump due to reduction in hydraulic losses.**
- 4. Reduction in power consumption.**
- 5. Increased protection against Corrosion & Erosion**
- 6. Increased life and reliability of the equipment.**

Corrocoat Application



Saving in Load by 5%

Description	Before Corrocoat	After Corrocoat
Discharge Pressure	1.3bar	1.3 bar
Power	619 kW	583 kW
Power Saving	36 KW	

3,06,000 Kwh @ 8500 Operating Hours

□ Wind Ventilators

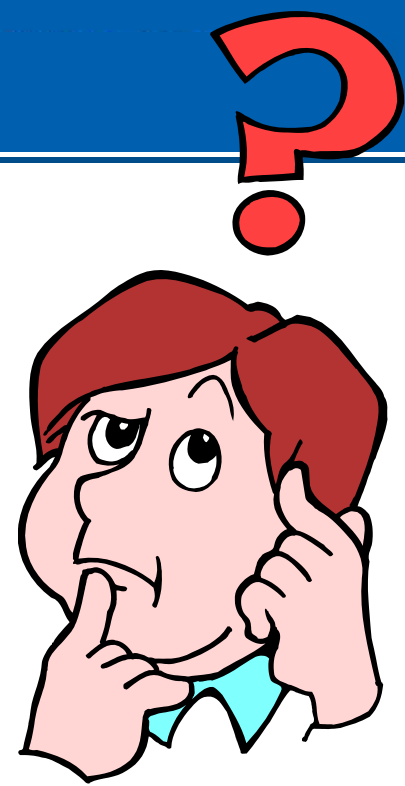
Wind ventilator

- **Electrical driven Exhaust fans power consumption of each fan is 4.27KW.**
- **As part of energy conservation measure one electrical driven exhaust fan was replaced with Wind ventilator which is driven by natural wind.**
- **This has resulted in power saving of 4.27KW.**
- **Total 7 fans were replaced with wind Ventilators.**



Ventilation system

Analysis	
Power Consumption of Exhaust fan	4.27KW
Power Consumption wind ventilators	Nil
Net Power savings	4.27 KW
Annual power Saving (For 7 Fans)	2,54,065 KWHr @ 8500 Operating Hours



- **HRSG – Steam and Water Sample Analysis System –**
water recovery and reuse as feed.

- **Daily Average Consumption of DM Water was 17 Cu meter / Day**

- **Analyzed the SWAS Sampling System outlet water and found the Water quality is meeting the norms of Boiler Feed Water. Therefore the same water was reused in our system.**

- **Over All Achievement**
 - Savings in DM Water make up
 - Cycle Chemical parameters maintained within the requirements.

❑ **COOLING TOWER MAKEUP**

COOLING TOWER MAKEUP

INITIAL OPERATION OF THE SYSTEM.

- ❑ Cooling tower basin level was maintained by using pumps which pumped water from clarified water storage tank to basin. This system also supplied water to the Chlorination plant.
- ❑ CT make up pumps - Two no – Installed since inception – One in service and other stand by. (in summer usage involved two pumps)
- ❑ Design Capacity: : 370 Cu m / Hr
- ❑ Drive Motor Power: 30 KW

MODIFIED SYSTEM

- ❑ After a study on cooling tower make up path.
- ❑ A channel system was suggested which ensured water flow to the basin.
- ❑ A diversion channel and road cutting work was done.
- ❑ The control of water is done via VFD controlled Raw water pump that provides input water to Clarified water system.

Cooling Tower make up



Cooling Tower make up



Savings 22.8 KWH

- ❑ **SAVINGS AND PAYBACK PERIOD**
- ❑ **Project Cost for the implementation: INR 2, 84, 444.00**
- ❑ **Saving : 22.8 Kwh**
- ❑ **Per annum energy saving: 193800 Kwh (@8500 hr)**

□ Illumination Energy saver Panel

Saving in Load by 15%

- ❑ A survey carried out for reduction in Lighting system. The Energy consumption is 1718 KWh/day.
- ❑ Energy Saver has been installed and commissioned for the Power Block MLDB and BOP MLDB.
- ❑ Total investment, Rs.: 285880
- ❑ Units / day reduced : 261.3

Energy saver Panel



- ❑ Cooling tower Fan Hollow blade replacement

Cooling Tower Hollow FRP blade placement

- ❑ A study on cooling tower was done to evaluate the energy saving options in fans.
- ❑ The system consists of ten induced draught fans .
- ❑ The study showed following options
 - ✓ Hollow fan blade
 - ✓ Hub diameter can be reduced as per hollow blade design
 - ✓ Increased flow area for air because of aerofoil profile change.
 - ✓ Cooling tower nozzles replacement with new higher efficiency Nozzles
 - ✓ Blade angle adjusted for the same flow

Saving in Load by 23%

- Average Power Consumption **Before** Hollow Blade placement : 52 KW
- Total consumption for 10 motors : 520 KW
- Average Power consumption **After** Hollow Blade placement : 40 KW
- Total consumption for 10 motors : 400 KW
- 12 KW saving per Fan

□ **Optimizing Operation procedures**

▣ Deaerator Pressure Reduction

Deaerator is maintained at 1.0 bar(g) pressure by steam extraction from Steam Turbine at 171 deg c & 2.592 tph flow rate. The scope for reduction in deaerator pressure was studied by considering the Mechanical deaeration process and NPSH requirement for feed pumps. On experimental basis Deaerator pressure reduced up to 0.5 Bar (g) in steps of 0.1 Bar (g).

With this practice found Dissolved oxygen levels, NPSH of pumps are within limit and observed the increment in Steam Turbine Generation about 200 KW.

Solubility of Air in water

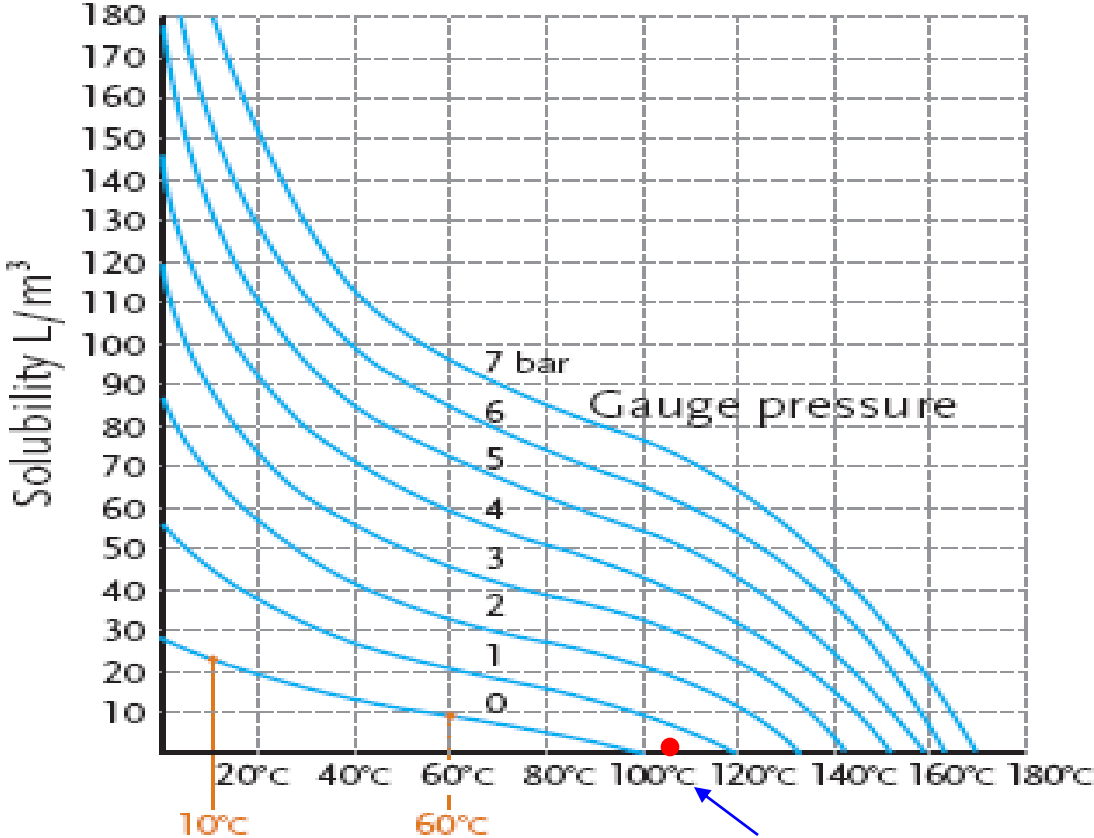


Figure 1: The solubility of air in water

- HRSG deaerator **before** pressure reduction.

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MENU

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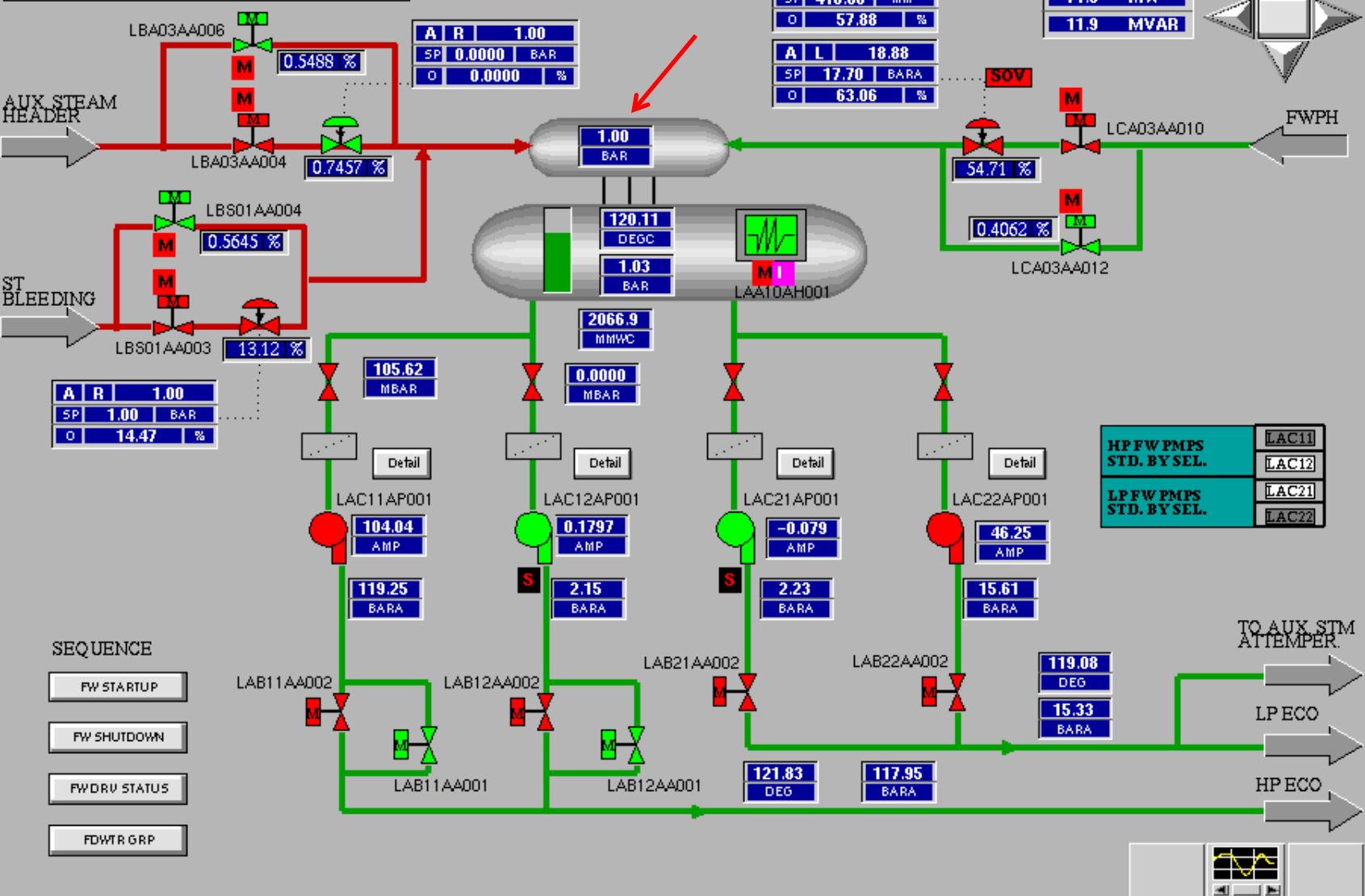
FW STARTUP

FW SHUTDOWN

FWDRU STATUS

FDWTR GRP

FEED WATER SYSTEM



Deaerator pressure reduction

Description	Before Reducing Pressure	After Reducing Pressure
Deaerator Pressure	1.0 bar	0.53 bar
Temp	120 deg c	113 deg c
CV Pos	13.12 %	0.0 %
ECO inlet Hydrazine	26.8 ppb	25.27 ppb
Dissolved O2	3.66 ppb	3.63 ppb
Pump suction press	2.45 bar	2.2 bar
ST generation increased by 200 KW		

- HRSG deaerator **after** pressure reduction.

Change Env

MENU

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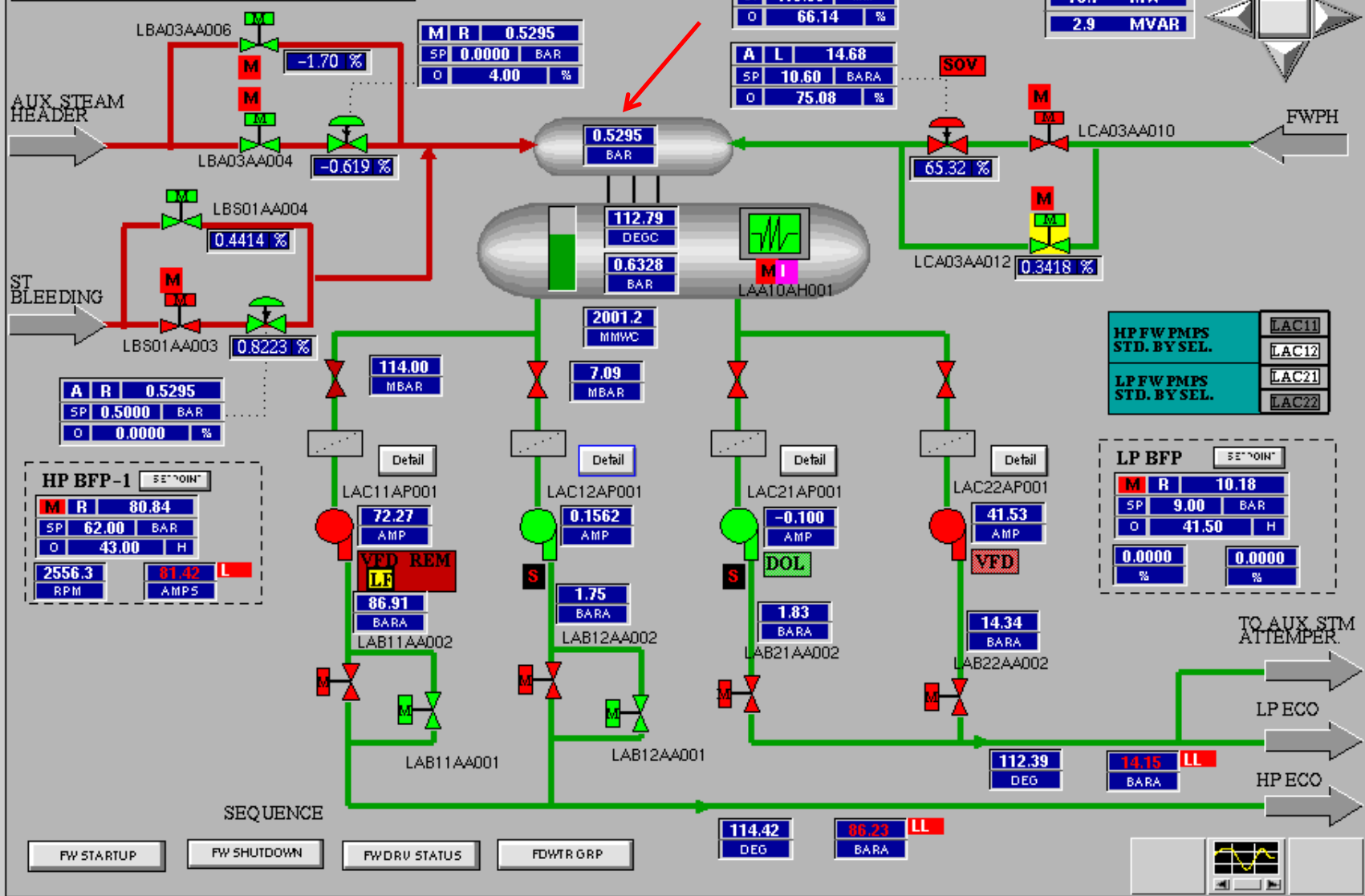
FW STARTUP

FW SHUTDOWN

FWDRV STATUS

FDWTR GRP

FEED WATER SYSTEM



■ Optimization of Compressed air Pressure

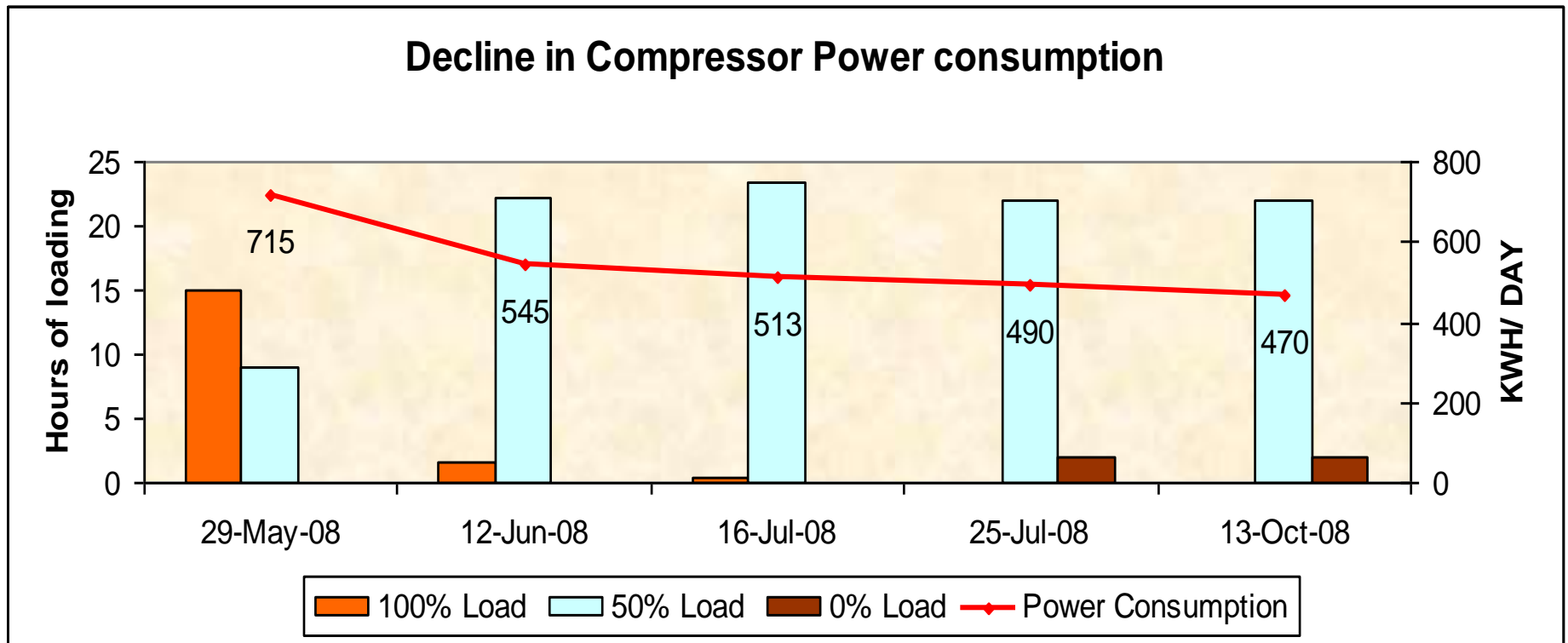
Air Compressors optimization

- **Air Compressors *Installed Capacity***
 - **Make : Chicago Pneumatic**
 - **Type : Horizontal and Non lubricated**
 - **Type of operation : Continuous load (100% and 50%) - unload**
 - **Free air delivery : 5 M3/min at pressure 9 bar.**
 - **Drive Motor Power : 45 KW**

❑ Optimization program

- ❑ Decreased air leakages from valves and other locations.
- ❑ Optimization of consumption in auxiliary areas that are intermittently used. (Fuel oil centrifuge, ETP etc)
- ❑ Decreased pressure set point with out effecting equipment operation.
From 8.0 to 6.5 bar.
- ❑ Load pattern changed from 15 hr full load to 0 hrs full load

Trend Of Compressor Saving



□ Air Dryer System

Air Dryer

DESIGN

- ❑ **Type: Dual tower desiccant,**
- ❑ **Drying mechanism: Blower with Electric heater**
- ❑ **Flow Rate: 300 Nm³/hr.**
- ❑ **Pressure: 9.0 kg/cm²g**
- ❑ **Dew Point Temp. : (-) 40DegC**
- ❑ **Cycle – Every 6 hrs One tower is in service and another tower is in regeneration mode.**

Saving in power 56 %

- ❑ As the Air consumption is optimized to below 50 % of design. (from 300 to 150 M3/Hr).
- ❑ Margin in dew point is available.
- ❑ Cycle time is Optimized to – 12 Hrs of Adsorption for same Regeneration time.
- ❑ Energy consumption per Day : BEFORE optimization 124 kWh/day
- ❑ Energy consumption per Day : AFTER optimization 54 kWh
- ❑ Saving : 70 kWh/day
- ❑ Annual Saving :5,95,000 kWh.

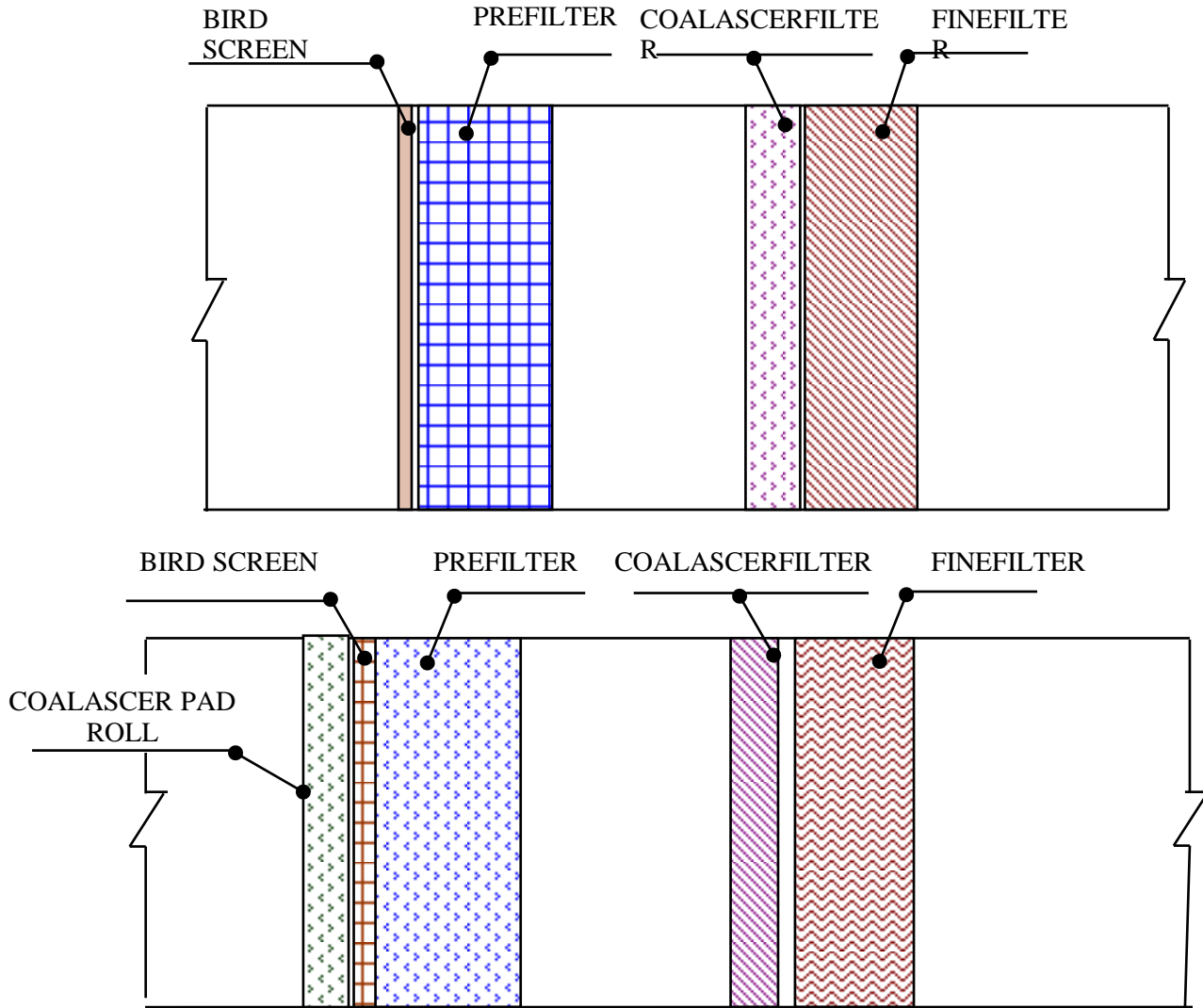
PLANT Auxiliary Power Reduction

Plant Mode of Operation	PLF %	Before Energy Saving	Present Condition	Saving
		MU / Day	MU / Day	%
Base Load Operation	98	0.1030	0.0872	15
Part Load Operation	63	0.1026	0.0773	24

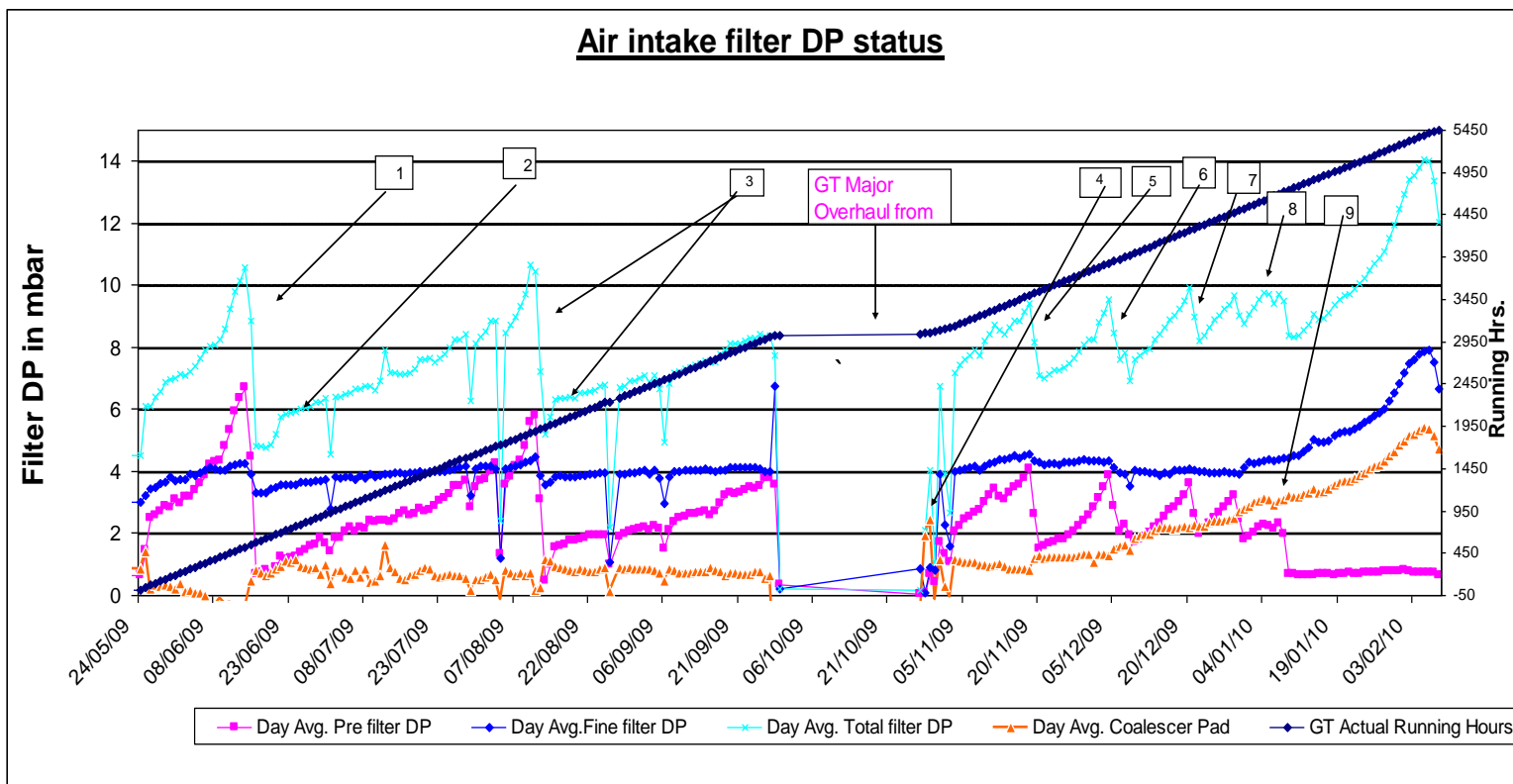


□ Combined Cycle Practices

INTAKE FILTERS



AIR INTAKE FILTERS



**Pre
filter
DP
4.5
mbar**

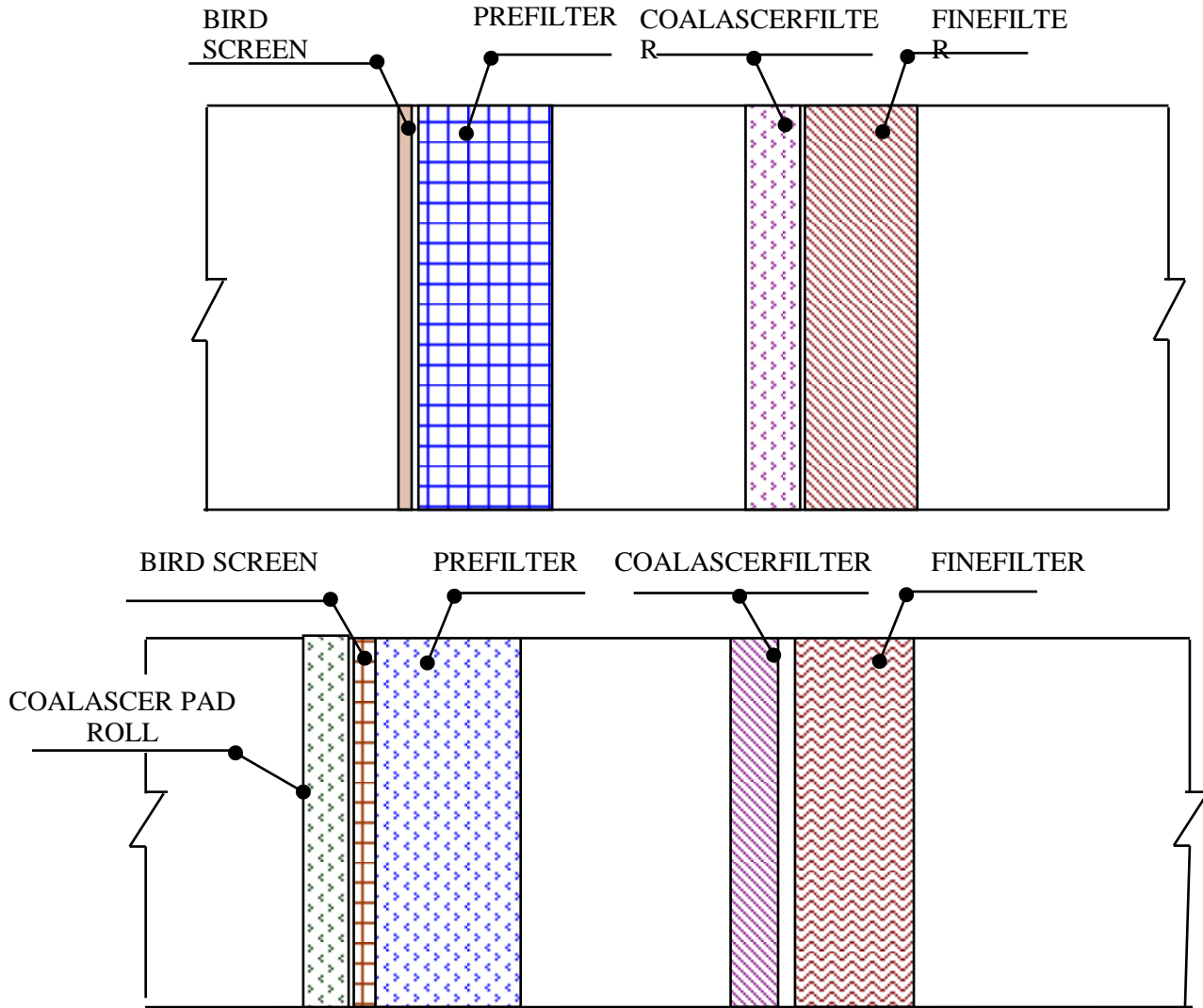
**Fine
filter
DP
7.5 mbar**

**Total filter
DP
14.0 mbar**

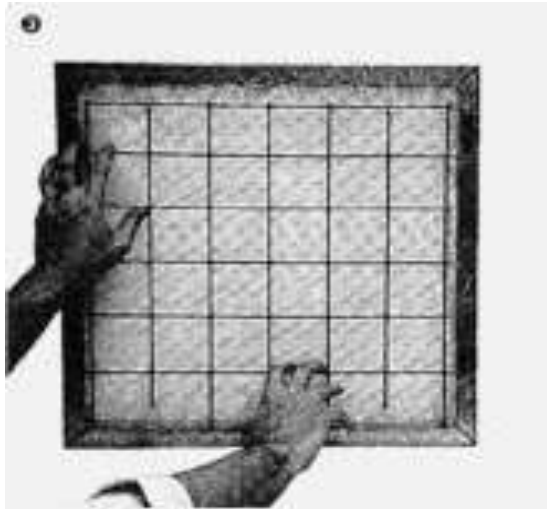
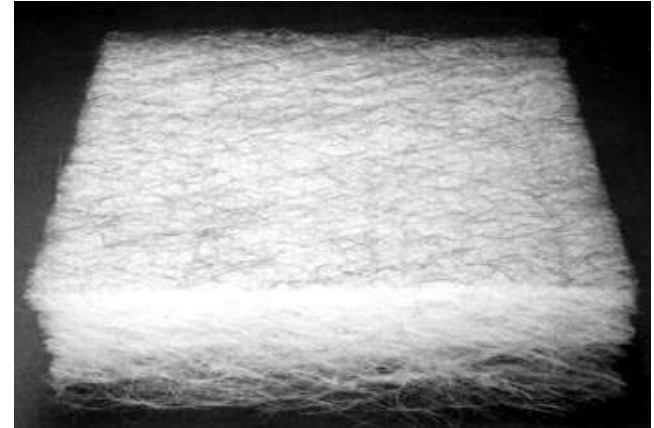
**Coalescer
Pad DP
4.5 mbar**

1. Additional coaleser pads (100 mm) removed on 15.06.09. 2. Additional coaleser pads (50 mm) provided on 20.06.09. 3. Coalescer pads (50 mm) removed on 12.08.09 & fixed back on 14.08.09. 4. New coaleser pads (50 mm) provided on 28.10.09. 5. Coalescer pads removed on 19.11.09 & new one (50 mm) fixed back on 19.11.09. 6. Coalescer pads removed on 05.12.09 & Old cleaned one (50 mm) fixed on 05.12.09. Coalescer pads again removed on 08.12.09 & new (50mm) fixed on 08.12.09. 7. Coalescer pads removed on 21.12.09 & new one (50 mm) fixed back on 21.12.09. 8. Coalescer pads removed on 30.12.09 & new /old one (50 mm) fixed back on 30.12.09. 9. Coalescer pads removed on 05.01.10 & Old cleaned one (50 mm) fixed on 05.01.10. Coalescer pads removed on 08.01.2010 and no coalescer Pad fixed. 10. Max.Avg.total filter DP went upto 14.0407 mbar , so for all filter replacement on 08.02.10 at 6:00 hrs GT shutdown taken.

INTAKE FILTERS



INTAKE FILTERS



▣ MASTER DATA



Thank you