



Flexibilisation of BHEL supplied sets: The Way Forward

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Presentation Agenda



FLEXIBILISATION : THE CONCEPT

- What? Why? How?

FLEXIBILISATION & BHEL

- Case Study

MITIGATING THE EFFECTS

- The Way Forward





FLEXIBILISATION

WHAT ? WHY ? HOW ?

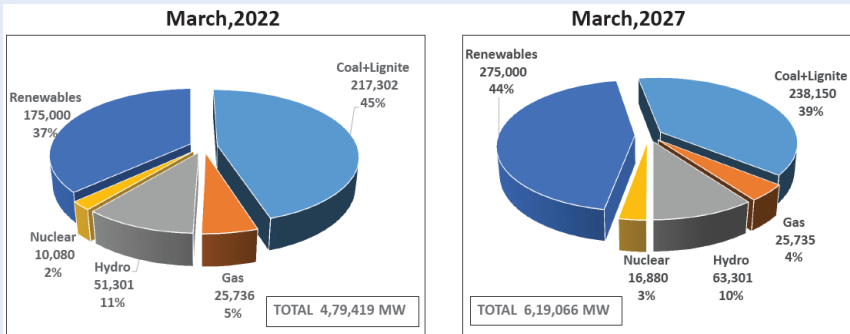


The Rise of Renewable Energy



THE RISE OF RENEWABLE ENERGY GENERATION

- ❏ 105 GW renewable generation addition by 2022. Thereby taking the figure to 175 GW
- ❏ The share will increase from current 20% share to 37% share in 2022 and further 44% share is target by 2027.
- ❏ Solar & wind will have a contribution of 21% & 12.5% respectively of the total generation capacity in 2022



ALL FIGURES IN MW

S. No.	Sector	Installed Capacity (in GW)	
		2017-18	2021-22
1.	Coal + Lignite	197	217
2.	Hydro	45	51
3.	Gas	25	26
4.	Nuclear	6.7	10
5.	Solar	22	100
6.	Wind	34	60
7.	Biomass	9	10
8.	Small Hydro	4	5
	Total	344	479

Source: CEA



Flexibilisation: The Need

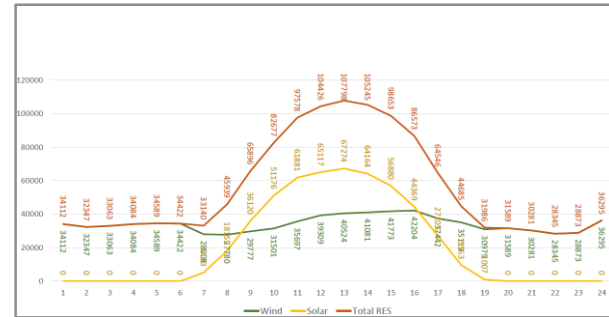
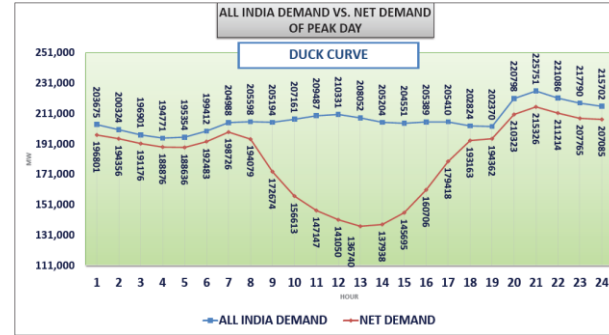


LIMITATIONS WITH RENEWABLE ENERGY SOURCE

- ❑ Intermittent and variable
- ❑ Season and Weather dependent
- ❑ Location and time of day dependent
- ❑ Does not match the load demand curve
- ❑ Wind generation is unpredictable
- ❑ Solar generation is predictable but non controllable

FOR BALANCING THE GRID (LOAD GENERATION BALANCE)

- ❑ Off-peak and peak demand variation
- ❑ Sudden increase of load in the grid
- ❑ Loss of grid connected load
- ❑ Loss of generation in the system
- ❑ Addition or reduction of RE generation



Maximum Solar & Wind Generation
(Predicted on 25.06.2021)



Flexibilisation: The Expectations

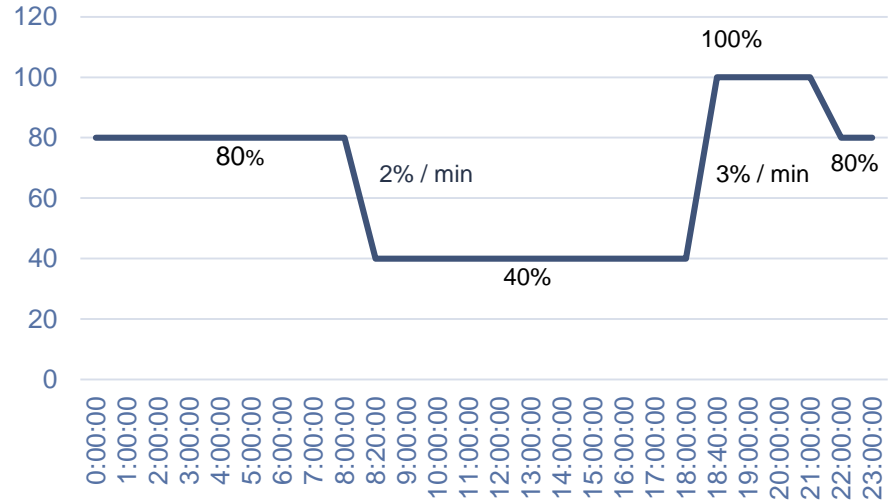


EXPECTATIONS FROM THE THERMAL PLANTS

- ✘ Higher ramping rates during loading and unloading
- ✘ Faster Startup
- ✘ Lower stable minimum load

THE PRACTICAL OPERATIONAL REGIME IN FLEXIBLE OPERATION WILL BE AS:

- ✘ Frequent & increased load cycling
- ✘ Fast load ramp up and ramp down
- ✘ Low load operation
- ✘ Two shift operation
- ✘ Frequent and increased number of unit startup & shutdown cycles





Effect of Load Cycling



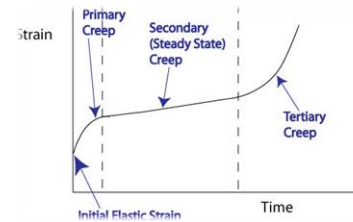
DEPENDING ON THE OPERATIONAL CONDITIONS, TURBINE & BOILER COMPONENTS ARE EXPOSED TO VARIOUS DAMAGE MECHANISMS:

COMPONENTS

- HP/IP rotors
- Blades
- Casings
- Valves
- Header
- Y-Piece
- T-piece
- MS/HRH Pipelines
- Pressure parts

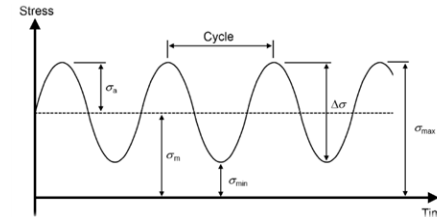
CREEP

Slow and continuous deformation of materials due to high temperature exposure even at constant load



THERMAL FATIGUE

Failure of metal when subjected to repeated or fluctuating stresses due to thermal cycling of components





FLEXIBILISATION & BHEL

THE JOURNEY



Flexibilisation: Journey so far



BHEL's FORAY INTO FLEXIBLISATION INITIATIVE

- ❑ Part of IGEF / EEC
- ❑ Working in close coordination with agencies, such as CEA, for implementing flexibilisation in Indian power sector
- ❑ Closely working with our customer to understand how they perceive flexibilisation & hence their expectations
- ❑ Building flexibilisation portfolio to meet customer's & market's requirements

THE CASE STUDY

- ❑ Capability of BHEL sets for flexible operation (some operational limitations & added life consumption)
- ❑ Dedicated solutions for enhancing plant's reliability & availability
- ❑ Confidence to statutory authorities
- ❑ Avoid furore that flexibility will jeopardize the existing plants
- ❑ Identify required solutions to achieve current/ future level of flexibility requirement



Flexibilisation: Pilot Study



LOAD RAMPING : STUDY

- ❑ Load ramping tests have been carried out at:
 - 1% ramp up & down
 - 2% ramp up & down
 - 3% ramp up & down
- ❑ Load range of 55% to 100% TMCR
- ❑ Unit operation in CMC with slight manual intervention
- ❑ Load change has been done both in coupled blocks of 50-125 MW & in single block of 225 MW.
- ❑ Results have been quite encouraging and as per our expectations

LOAD RAMPING : CHALLENGES

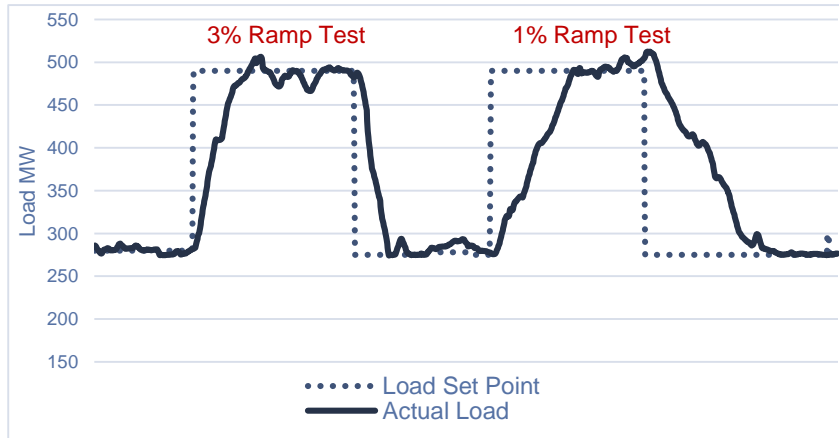
- ❑ Unit stability – furnace stability – flame stability – excess air flow
- ❑ Unit response
- ❑ SHO & RHO temperature deviations
- ❑ Combination & number of mills in service
- ❑ BFP – single stream/ double stream operation
- ❑ AFG path – single stream/ double stream operation
- ❑ FG temperature deviations
- ❑ Emission control equipment (currently ESP only)
- ❑ State of the plant – O & M practices
- ❑ Fuel characteristics



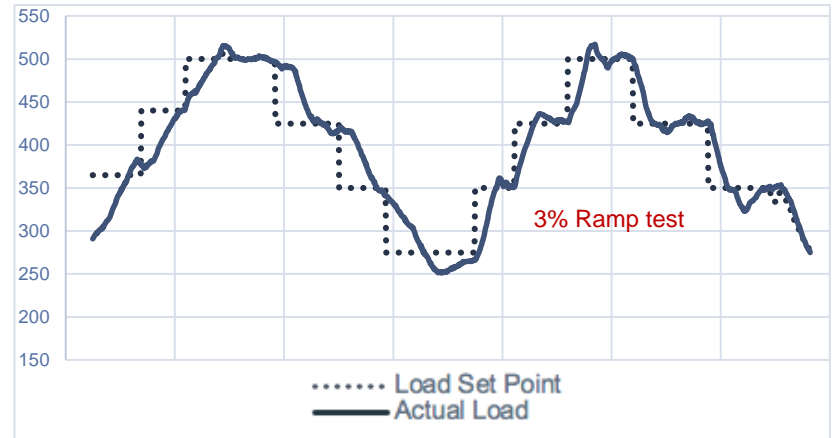
Pilot Study: Load Variation



CASE 1



CASE 2

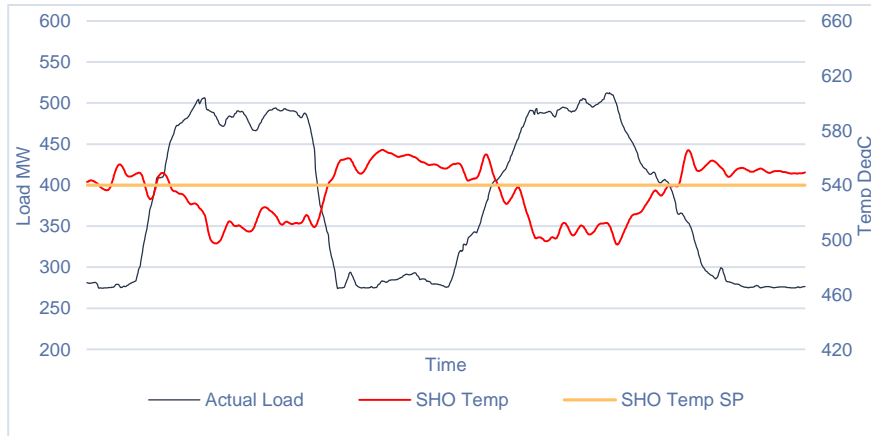




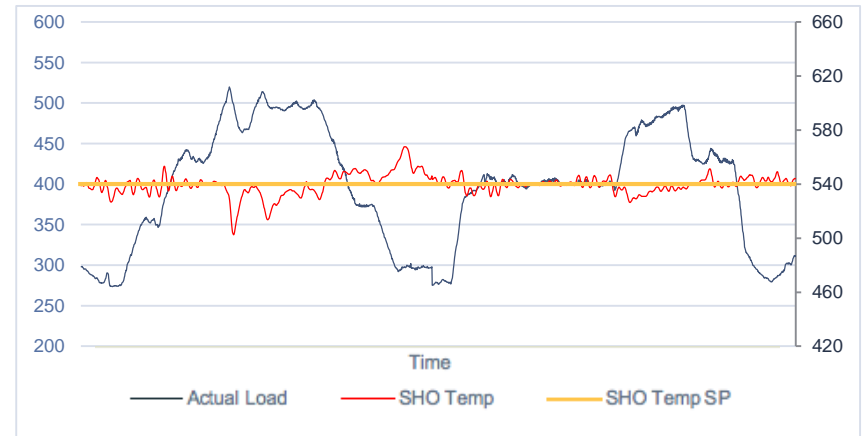
Pilot Study: SHO Temperature Variation



CASE 1



CASE 2

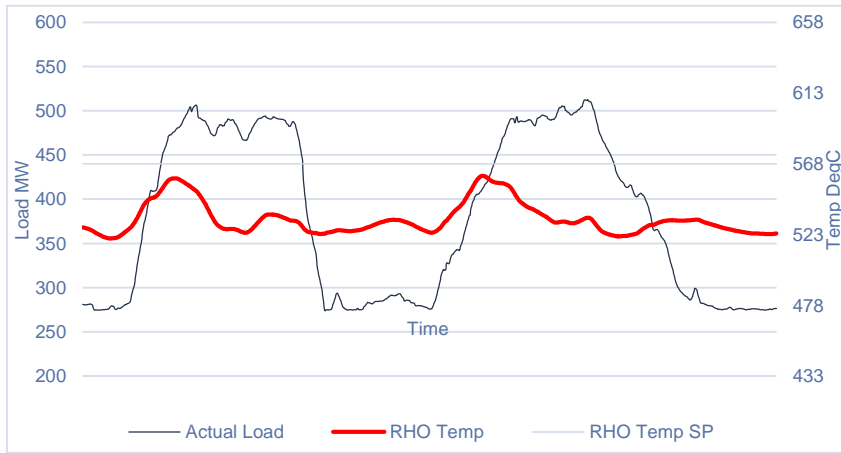




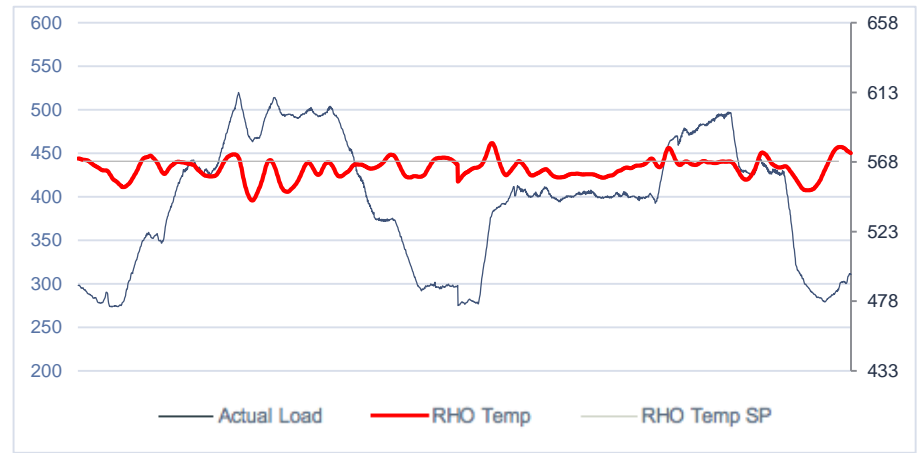
Pilot Study: RHO Temperature Variation



CASE 1



CASE 2

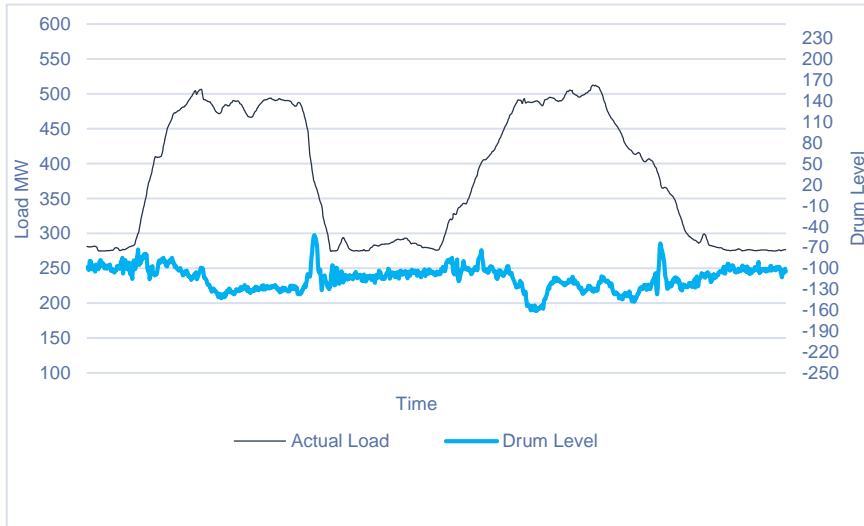




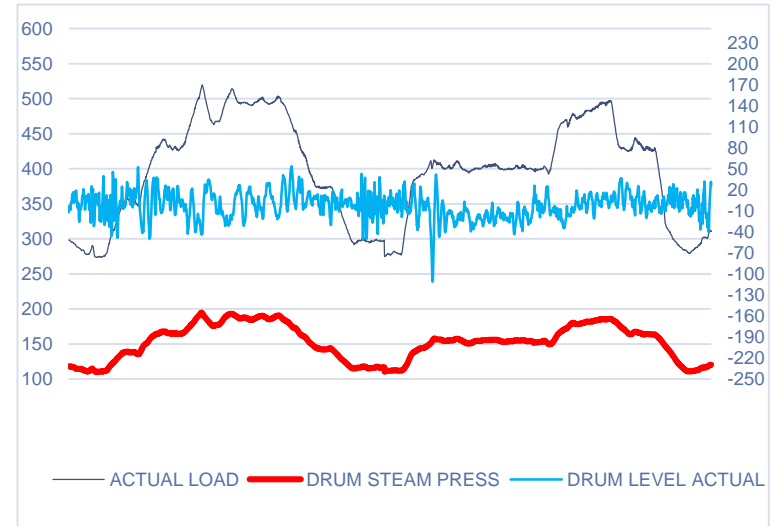
Pilot Study: Variation in Drum Parameters



CASE 1



CASE 2

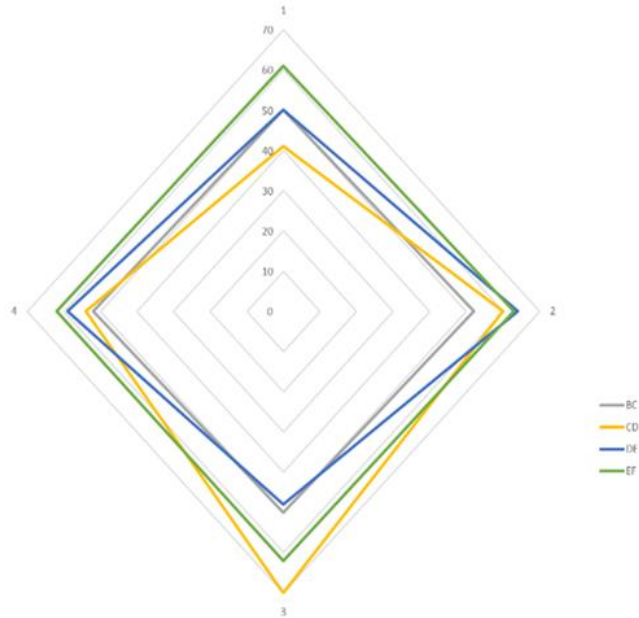




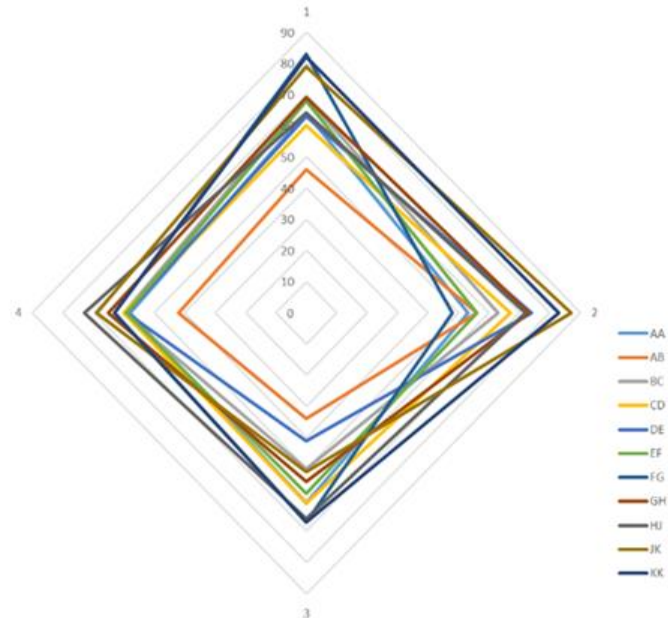
Pilot Study: The Fireball



200 MW



500 MW





FLEXIBILISATION

MITIGATING THE EFFECTS



Cyclic Loading: Mitigating the Effects



- ❑ Customized operating guidelines
- ❑ Thermo-mechanical assessment
- ❑ Condition monitoring systems/ Sensors
- ❑ Controls & Automation Package
- ❑ Model based / Adaptive Control Systems
- ❑ Fuel Firing System Optimization
- ❑ Plant Optimizer
- ❑ Advisory Services for Flexible Operation
- ❑ Improved design of Boiler and Turbine to allow faster ramping and increased number of cycles





Customized Operating Guidelines



- ❑ **Customized operating guidelines**
- ❑ Thermo-mechanical assessment
- ❑ Condition monitoring systems/ Sensors
- ❑ Controls & Automation Package
- ❑ Model based / Adaptive Control Systems
- ❑ Advisory Services for Flexible Operation

CUSTOMIZED OPERATING GUIDELINES

- ❑ Low load operation
- ❑ Load ramping at required ramp rates



Thermo-mechanical Assessment



- ❑ Customized operating guidelines
- ❑ **Thermo-mechanical assessment**
- ❑ Condition monitoring systems/ Sensors
- ❑ Controls & Automation Package
- ❑ Model based / Adaptive Control Systems
- ❑ Advisory Services for Flexible Operation

THERMO-MECHANICAL ASSESSMENT

- ❑ Detailed thermo-mechanical assessment of unit
 - Current state of the equipment
 - Response and capability for flexible operation with a set of proposed fuel



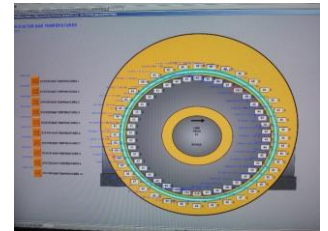
Condition Monitoring Systems



- ❑ Customized operating guidelines
- ❑ Thermo-mechanical assessment
- ❑ **Condition monitoring systems/ Sensors**
- ❑ Controls & Automation Package
- ❑ Model based / Adaptive Control Systems
- ❑ Advisory Services for Flexible Operation

CONDITION MONITORING SYSTEMS

- ❑ Dedicated Packages for stress monitoring in:
 - ❑ Boiler
 - ❑ Turbine
 - ❑ Generator





Controls & Automation



- ❑ Customized operating guidelines
- ❑ Thermo-mechanical assessment
- ❑ Condition monitoring systems/ Sensors
- ❑ **Controls & Automation Package**
- ❑ Model based / Adaptive Control Systems
- ❑ Advisory Services for Flexible Operation

CONTROLS & AUTOMATION PACKAGE

- ❑ Fine tuning of Existing Controls
- ❑ Customised Control Packages for various sub-controls
- ❑ Complete Control Package
- ❑ Upgradation of older control systems either through complete R&M or additional packages

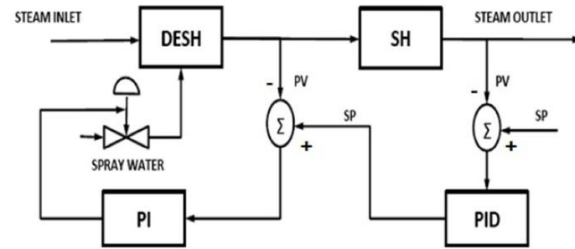


Model based / Adaptive Predictive Control (MPC/APC)

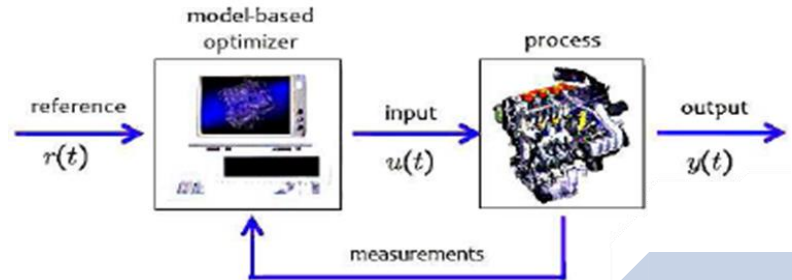


- ❑ Customized operating guidelines
- ❑ Thermo-mechanical assessment
- ❑ Condition monitoring systems/ Sensors
- ❑ Controls & Automation Package
- ❑ **Model based / Adaptive Control Systems**
- ❑ Advisory Services for Flexible Operation

Existing PID Controller Philosophy



MPC Philosophy

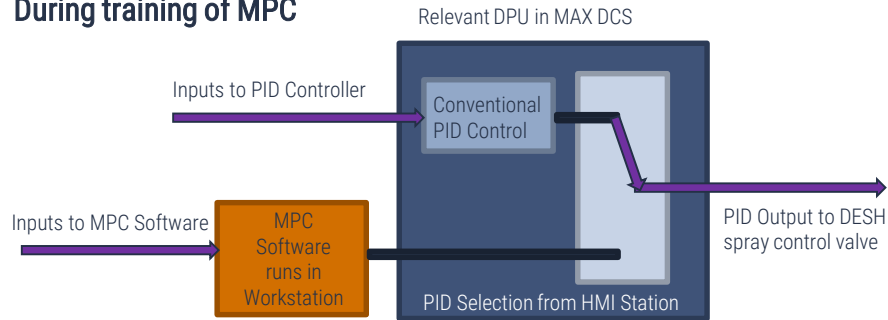




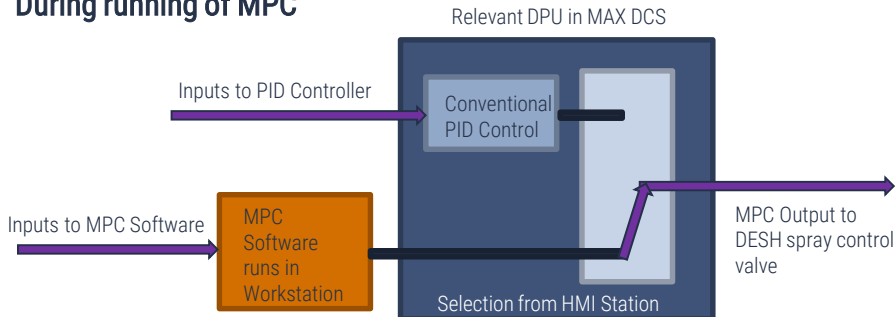
Model based / Adaptive Predictive Control (MPC/APC)



During training of MPC



During running of MPC



ADVANCED TYPE CONTROLLER PRIMARILY FOR STEAM TEMPERATURE CONTROL FOR BOTH SH & RH:

- ❑ Consists of predictor & controller
- ❑ Predictor creates models based on past operating data and then predicts the parameters in future course
- ❑ Based on the prediction, the controller regulates the spray control valves.
- ❑ Continuous communication between MPC & DCS.
- ❑ Automatic updating of models.



Advisory Services



- ❑ Customized operating guidelines
- ❑ Thermo-mechanical assessment
- ❑ Condition monitoring systems/ Sensors
- ❑ Controls & Automation Package
- ❑ Model based / Adaptive Control Systems
- ❑ **Advisory Services for Flexible Operation**

ADVISORY SERVICES FOR FLEXIBLE OPERATION

- ❑ Replacement of fatigued/ worn-out components
- ❑ Shorter inspection period
- ❑ Customized O&M guidelines
- ❑ Customized maintenance schedules



THANK YOU



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