'CGPL-Mundra-UMPP Plant – Operational Experience: Issues and challenges'

CGPL
Coastal Gujarat Power Limited

(India's first 830 MW Super Critical Units)

Agility Care Ethics Safety Diligence Respect

Energy Excellence Centre (EEC) Technical Workshop at Mumbai on 02nd September 2015 at Hotel Taj Lands End

Presented by:
Parshuram Mishra Group Head –Operation CGPL-UMPP-Mundra , TATA POWER

TATA POWER
Lighting up Lives!

Agility

Care

Integrity

Excellence

Collaboration

Trust

Respect

Introduction

Tata Power: India's largest Integrated Power Utility

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- **Founded in 1906** to supply power to Mumbai
  - First hydro plant commissioned in 1915
  - Set up thermal power plants in Mumbai in the 1950s
- Expanded in India after private sector reforms in 1990s

Fuel | Fuel Logistics | Generation | Transmission | Distribution | Power Trading

Presence across the entire value chain

- **Thrust on renewable energy sources** including hydro, wind, solar and geothermal
- **Successful Public Private Partnerships** in generation, transmission and distribution




Tata Power- Leading Innovation

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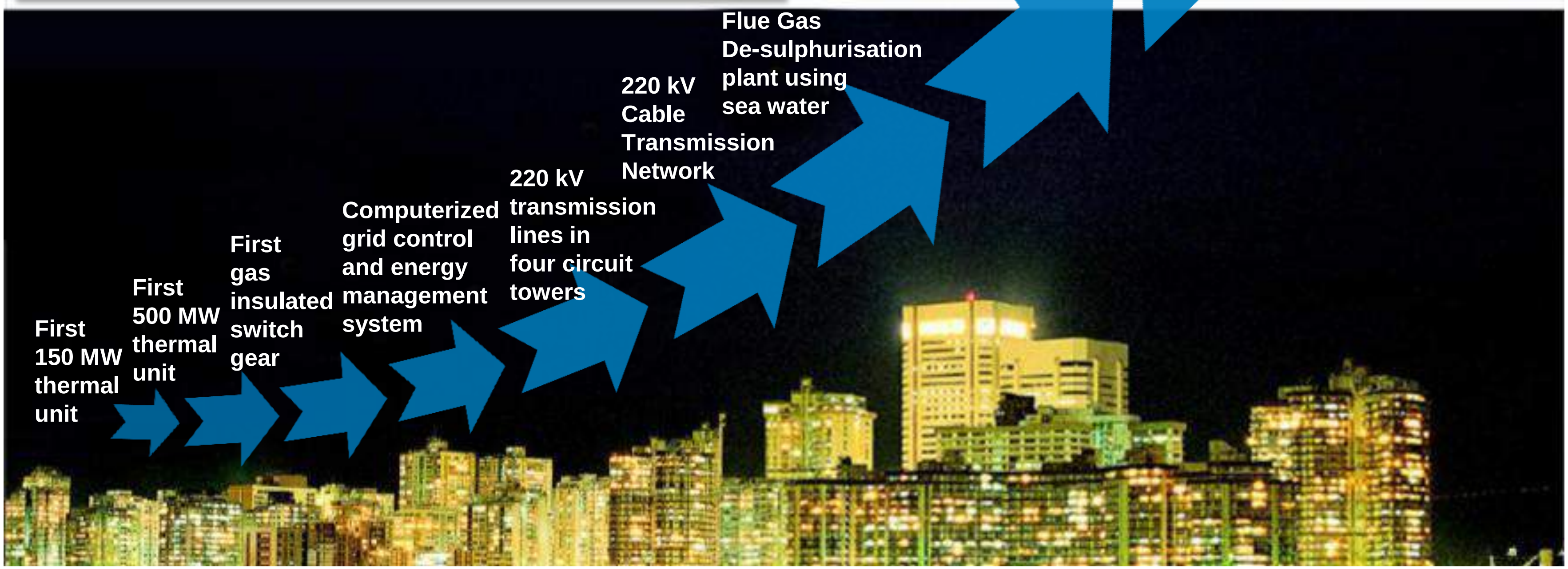
India's first 830MW Steam Turbine Generator (STG)
COD achieved on Mar. 07, 2012

Last Unit COD declared on March 22, 2013



- First 150 MW thermal unit
- First 500 MW thermal unit
- First gas insulated switch gear
- Computerized grid control and energy management system
- 220 kV transmission lines in four circuit towers
- 220 kV Cable Transmission Network
- Flue Gas De-sulphurisation plant using sea water
- First to Introduce SCADA and Fibre Optic ground wire communication
- First pump storage unit in the country of 150 MW Capacity
- **India's First 830 MW Supercritical Unit**

- *Pioneering Technology Adoption….*

UMPP- Ultra Mega Power Project

UMPP SITE December 2006

UMPP Today

Mundra UMPP- Location

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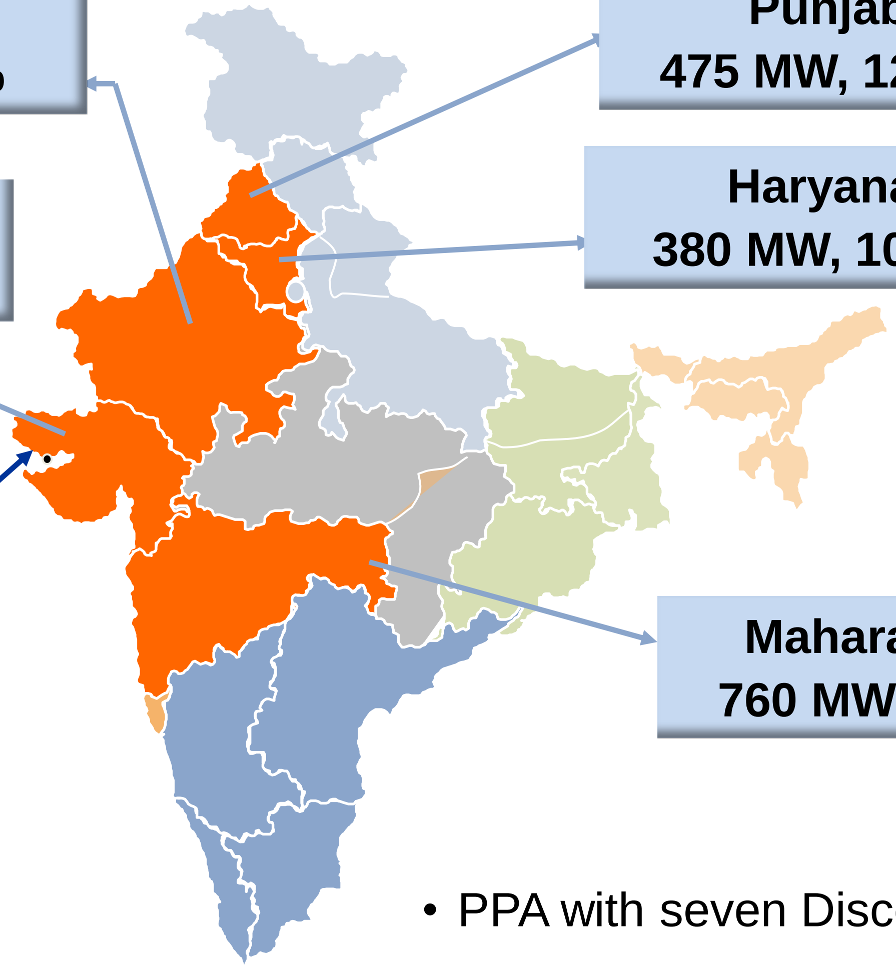
Power Procurers

Rajasthan
380 MW, 10.0%

Punjab
475 MW, 12.5%

Gujarat
1805 MW, 47.5%

Haryana
380 MW, 10.0%



Maharashtra
760 MW, 20.0%

- PPA with seven Discoms of five States
- Lead Procurer - GUVNL

Key Design Parameters

Nos. of Units	Five (830MW x 5)
Steam Generator:	**Type:** Once-thru super-critical, two-pass design, balanced draft. The water wall consists of spiral wound plain tubes with vertical tubes over the spiral water walls. **Make:** M/s. Doosan, Korea Super heater outlet pressure: 250.1 bar (g), at TMCR SH outlet Temp: 568.5°C HRH outlet Temp: 595.6°C Boiler Efficiency: 89.23%
Steam Turbine:	**Type:** Tandem compound **Make:** M/s. Toshiba, Japan Maximum Continuous Rating: 830 MW Throttle Steam Pressure: 242.2 Bar (a) Main Steam Temp: 565°C,HRH Steam Temp: 593°C Design Back Pressure: 0.08 Bar (a) Pressure at IP turbine inlet: 57.4 Bar (a) TMCR/ VWO Steam flow: 2402/ 2498 T/Hr TG Cycle HR :1777Kcal/Kwhr

Key Design Parameters …contd.

Main Generator:	**Type/ Form:** TAKS-LCH 3 Rating (MCR) MVA-960; MW-864 **Make:** Toshiba, Japan, Power Factor: 0.9 (lag) to 0.95 (lead) Rated terminal voltage: 26 KV, Rated armature current: 21318 amps Rotor current at MCR: 5250 amps Rotor voltage at MCR: 570 volts Type of cooling: Stator core - H2 direct, Stator winding - Water direct, Rotor - H2 direct, Rated H2pressure: 5.2 Kg/Cm^2 Excitation System: Static
Nos. of Stacks	Two multi-flue 275 mtr. high stack
Fuels	Coal (12 Million MTPA) with fuel oil (HFO/ LDO) for start-up .
Cooling Water	Sea water (630,000 m^3/hr)
Transmission lines	Three 400 KV double –circuit lines ,(by POWERGRID)

Key consultants and major vendors

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For UMPP Mundra Key Consultants and Major Vendors are as below.

DESIGN	TATA CONSULTING ENGINEERS LIMITED	Engineering Consultant
	KOPEC	Design review Engineers for BTG
SYSTEMS	DUPONT The miracles of science	Consultant for Safety Management
	Solomon Associates	Process Benchmarking
START-UP	KOSEP	Plant Start-Up Consultant

DOOSAN	Boiler & ESP EPC Works
TOSHIBA Leading Innovation	TG & Auxiliaries Supply
LARSEN & TOUBRO It's all about Imagineering	Condensers, LP/HP Heaters & De-aerators EPC
AREVA	GCB and 220 KV Switchyard
WYMAN GORDON	HP Pipes & Fittings
	Main Plant Civil & Strl. Works
Atlas Copco	Compressors & Driers
Aquatech	RO Desal Plant
	Multi Flue Chimney and CW System Civil & Strl. Works
KSB	Boiler Feed Pumps & CEP
	CW Pumps
ABB	**MV Switchgear**
Bopp & Reuther	HP/LP By-Pass Valves
IPS INVENSYS PROCESS SYSTEMS	Distributed Control Sys.
BHEL	GT,UAT,UT,ST, SAT & Bus-Ducts
CCI We Solve Control Valve Problems	Heater group By-pass valves
	Internal Coal Handling System EPC Work
SIEMENS	400 KV Switchyard

UMPP–Ultra Mega Power Project at a glance

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1. GOI initiative to develop coal based power projects each of 4,000 MW capacity to bridge the ever growing power demand- capacity gap.
   - 14 UMPP's planned by GOI
   - Selection of project developer on tariff based competitive bidding
   - Environmentally friendly projects (super-critical technology, 100% fly ash utilization)
   - Tie-up of land acquisitions, water allocation, environmental & other statutory clearances and power purchase
2. Mundra UMPP awarded to Tata Power on 28 Dec. 2006
3. Project being executed thru' CGPL, a 100% subsidiary of Tata Power
4. It is a coastal project using imported coal as primary fuel and sea water for plant use.
5. First Green Field Project to have five similar size supercritical units in single phase.
6. Hi-Fidelity Training Simulator of 830 MW for Operator Training.

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Benchmark Performance (Challenges)

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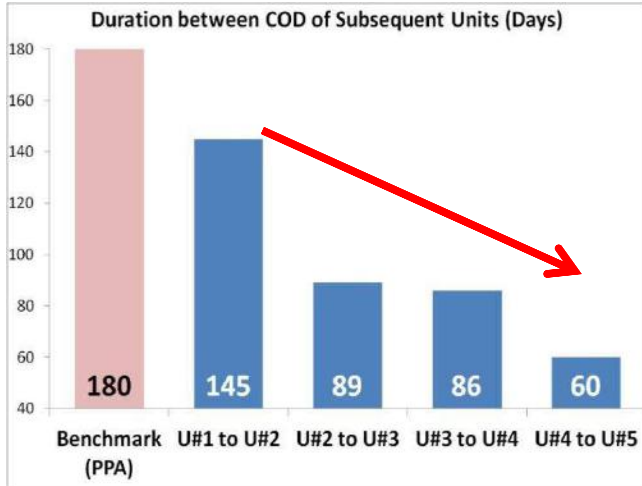
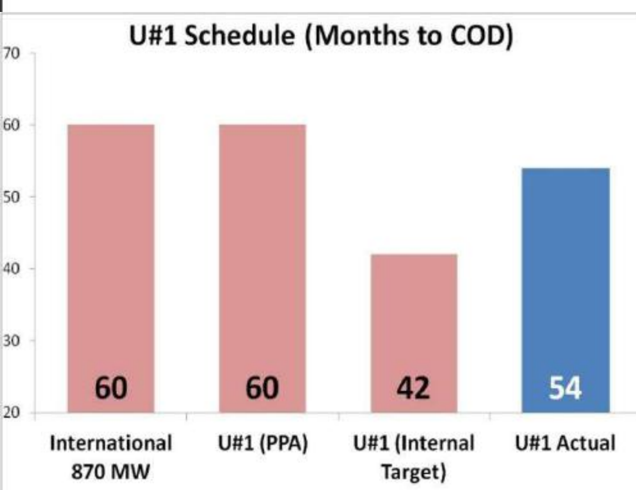
Project duration for Mundra units are among the best in the world for same size and technology.

Among Best in world. New Benchmark of 54 months.



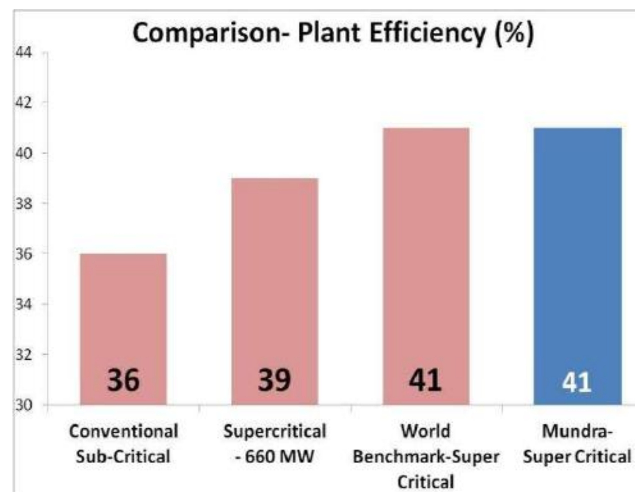
Mundra units among <u>Most Efficient</u> Nationally and Internationally.



<u>Continual Improvement:</u>

Duration between COD of successive units continuously reduced through process improvement.

COD of 4000 MW in just over a Year!



Key Challenges , Approach & Philosophy ➔ Project Management to Commissioning

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Key Challenges

- Larger size of the units
- Lack of experience in supercritical technology
- Numerous interfaces and multiple contractors' involvement
- Challenging timelines
- Active fronts in multiple units and tight resources
- On time and within cost , execution of projects.
- Streamlined business processes, effective controls and transparency.
- Efficient inflow of right technologies and skills.
- Combination of in house and outsource activities.

Approach & Philosophy

Various Philosophies have been adopted for first time Commissioning and Operation of individual Equipments and its System, so as to handle the key challenges of the project and to have a safe, quality commissioning.

Key Challenges , Approach & Philosophy → Project Management to Commissioning

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EQUIPMENT WISE COMPONENT LEVEL STUDY FROM P&ID/ MANUALS

⇩

EQUIPMENT WISE COMPONENT SHEET PREPARATION
(This is made in view of tracking the flow of activities and requirements which are necessary to Culminate into system commissioning)

⇩

PRE START UP SAFETY REVIEW
(Involvement of all concerned Departments:
OPERATION/ COMMISSIONING/ MMD/ IMD/EMD/ CONST)

⇩

COMPONENT LEVEL WALK DOWN and REPORT PREPARATION
(Maintaining the Punch Points in T-Bits software so that the concerned departments will do their job accordingly for system completion)

⇩

CONSTRUCTION SIDE COMPLETION OF THE PUNCH POINTS THAT HAVE BEEN GENERATED FROM THE COMPONENT LEVEL WALK DOWN REPORT

Key Challenges , Approach & Philosophy → Project Management to Commissioning

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REPORT PREPARATION AND SEGREGATION OF PUNCH POINTS IN CATEGORY A/B/C.
Completion of Punch point has been ensured by various Walk down

- EQUIPMENT SOLO TRIAL FOR 4 HOURS.
- ALIGNMENT & COUPLING OF EQUIPMENT ALONG WITH SYSTEM READINESS

- SIGNING OF PROTOCOLS BY ALL THE DEPARTMENTS
- SYSTEM NORMALIZATION FOR EQUIPMENT TRIAL & START UP
- STARTING OF EQUIPMENT WITH ITS ASSOCIATED SYSTEM IN PRESENCE OF OEM AND ALL CONCERNED DEPARTMENTS.

- REPORT PREPARATION

After completion of commissioning of individual system, preparation of Report by the Team Member for Future reference and for Record keeping.

Key Challenges , Approach & Philosophy ➔ Project Management to Commissioning

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Before commissioning of the system **commissioning procedure** has been prepared by the team. Same has been **reviewed by KOSEP and Head operations**. This commissioning procedure has helped a lot during initial commissioning and initial start up of Unit.

Dates Achieved:

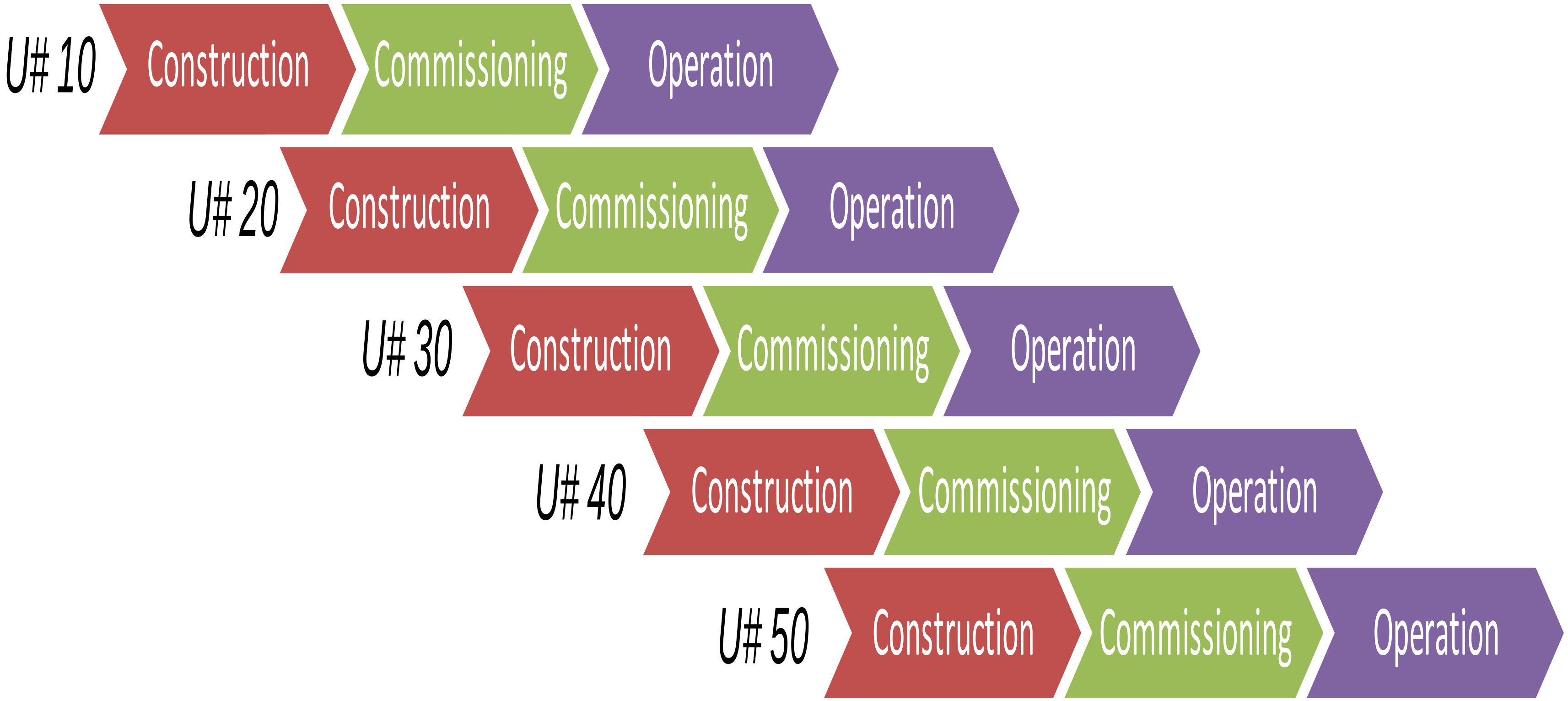
Description	Original Date (PPA)	Duration from NTP	Actual Date	Actual Duration	Difference in Schedule *(PPA-Actual)*
COD U#1	Aug' 2012	60 months	07/03/2012	54 months	6 months
COD U#2	Feb'2013	66 months	30/07/2012	59 months	7 months
COD U#3	Aug'2013	72 months	27/10/2012	62 months	10 months
COD U#4	Feb'2014	78 months	21/01/2013	65 months	13 months
COD U#5	Aug'2014	84 months	21/03/2013	67 months	**17 months**

Average gap between two Units synchronization has been 3.5 months, better than the baseline schedule of 4 months and much better than the 5 months provided in original PPA for CGPL-Mundra.

Key Innovations- O&M

Overcoming the Technology Adoption Challenges

- O&M Team brought in early to Absorb the **Technology, Prepare** and Reduce '**Rework**'.



Key Challenges- Across Value Chain

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Power Production

100 years' presence!

Business Model Innovation **(Mine to Mundra)** and setting Industry precedence by: -

- Transcending from **Owner Mindset to EPC Contractor Outlook**.
- **Stake in mines** for long term security of coal cost & provide a natural hedge.
- Mix of **Own and Chartered** Cape Size **vessels** for coal transportation.

Key Challenges – Contracts Management

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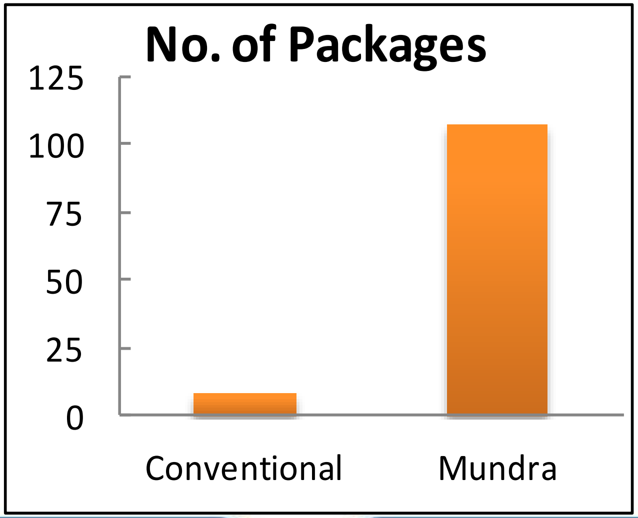
- Build Mundra UMPP through unconventional, <u>**Non-EPC**</u> route.
- **Overall Project Management by Tata Power, the Owner!**
- **100+ packages** to minimise Cost and maintain Time.
- **Multiple Packaging strategies** for different contracts.



Key Challenges- Strategic Alliances

- **Partnering with** Adani, an **industry competitor** for sharing of Sea Port and Cooling Water Channel, leading to substantial savings.

- **Strategic Entry Pricing** from reputed Indian Vendors for critical '**first of its kind**' equipment, by facilitating post-bid comprehensive technology tie-ups: -
  - L&T with Foster Wheeler (Surface Condensers)
  - Kirloskar Brothers with Techmecanicca (Concrete Volute Pump)

- **Gateway to India**: Strategic Alliances with Best in class (Toshiba & Doosan) to secure Technology at prices comparable to *Low Cost Vendors*.

Global Quality with Global Features, at Local Price!!

Key Innovations- Engineering
Step towards Overcoming Environmental Challenges

- 7 km Long Intake Channel with 6,30,000 m^3/hr sea water drawl for Once Through Cooling Water System- among largest in the world.
    - Lower Sea Water Δ Temperature.
    - Better year round operating efficiency.
    - Low Maintenance Cost.

- Adopted 2 + 3 chimneys configuration instead of 2+2+1 (conventional).

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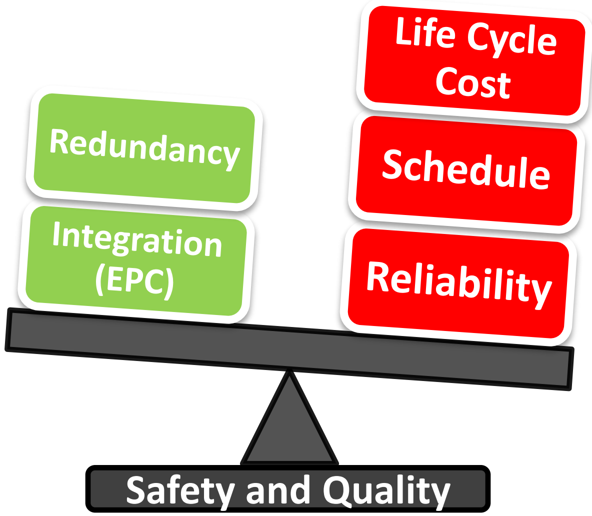
Key Innovations - Design Beyond Convention



- ❑ **2 X 50% Motor Driven BFPs concept against 2 (+1) X 50% Steam Turbine BFP**
  - Reduction in Capital Cost of 5 BFPs.
  - Higher Net Efficiency- Fuel saving, lower Generation Cost.
- ❑ **Most optimized BTG area for units in this class**
  - 580 meter long Turbine Deck housing all auxiliaries for five units of 830MW
- ❑ India's first 800MW Unit with Supercritical Technology
- ❑ Country's biggest Cooling Water Pumps with concrete volute casing. 10 pumps, each with a Capacity of 63000 cubic meter/hr. each. Motor Rating – 5.2 MW
- ❑ Biggest Motor Driven Boiler Feed Pumps in the country. Each rated at 18.1 MW. 10 pumps in total
- ❑ Use of P92 material for the first time in India.
- ❑ One of its kind open CW Pump house

Key Challenges and Improvements during Commissioning

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1. **Steam Blowing**

Various Improvements effected in the Cycle of Steam Blowing and the impact of improvements experienced in successive units during Steam Blowing.

- Modification in Boiler Recirculation Pump Operation during Steam Blowing

- Conventionally, Boiler Recirculation Pump (BRP) is stopped prior to Operation of Martyr Valve, during Steam Blowing. This results in mandatory waiting period of 30 minutes for re-starting the pump, leading to a Steam Blow cycle of approximately 120 minutes. The modified procedure of keeping BRP in operation during the blow cycle reduced the Blow Cycle time to 70 minutes, resulting in increased number of blows per day from 6 to up to 12 blows. Apart from reducing the overall commissioning duration, this has also resulted in lower stresses on BRP Motor caused due to repeated starts.

- Auxiliary power consumption reduced to 50% during the unit #20 steam blowing by running one stream of air path rather than two streams run in unit #10.

- Simultaneous blowing of MS & CRH equalizing lines, aux. steam & de-aerator pegging lines etc.

Key Challenges and Improvements during Commissioning

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- Overnight cooling from 20:00 hrs to morning 06:00 hrs helps in faster cleaning of steam circuit by blowing.

- Modification done in the Steam Blowing Circuit layout to reduce length & bends of temporary pipes. Temporary piping was reduced by 162 m. Also reduced the jumper piping connecting to CRH-NRV.

- Between two successive blows boiler MFT is avoided by which number of blows per day increased and saved costly fuel (LDO, HFO). Boiler minimum fire kept ‘’on’’ during blowout which had reduced time gap between two successive blows.

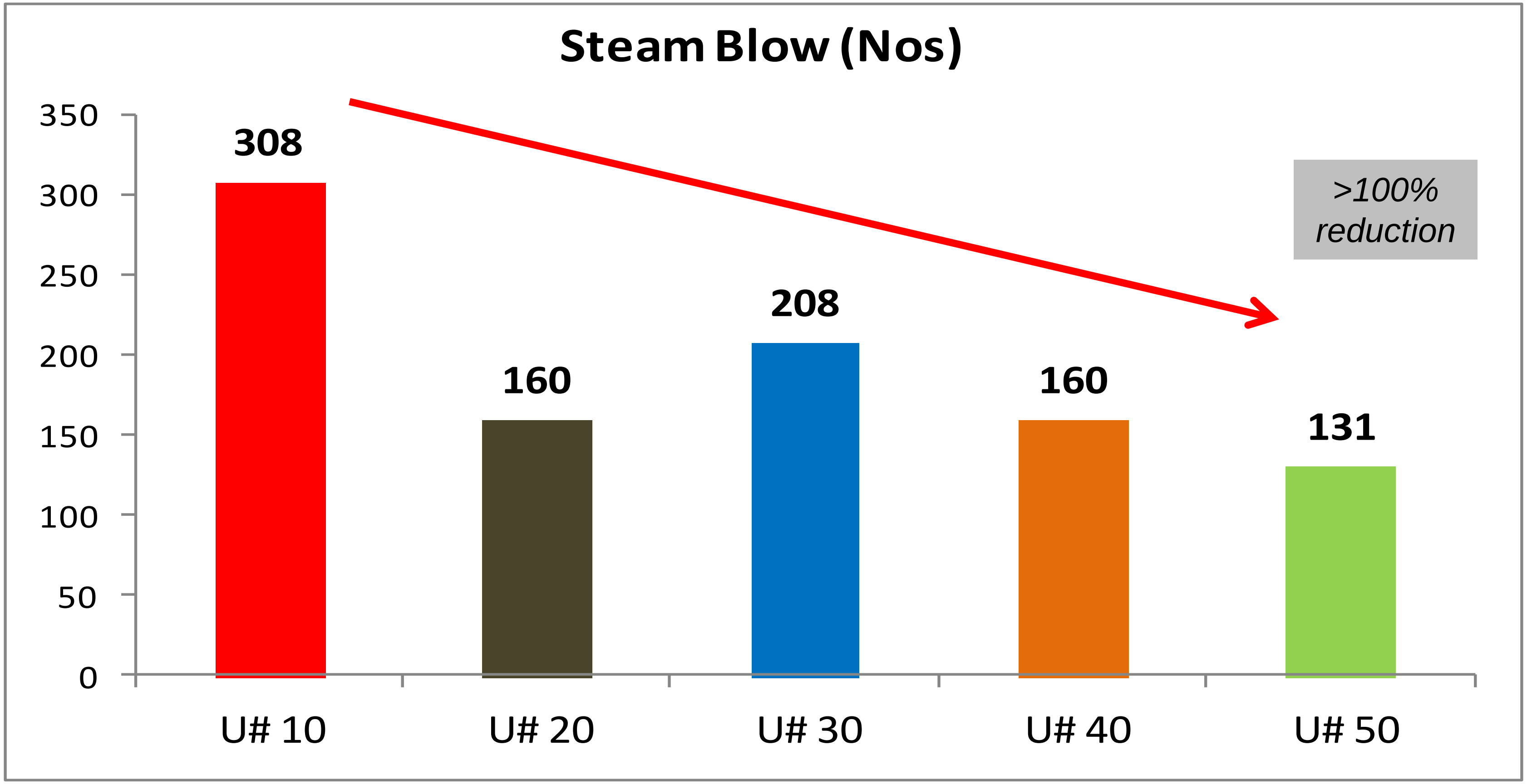
- Clean & preserved temporary pipes of U#10 used for Unit 20/30/40/50. Hence time required to clean the temporary pipes has reduced & subsequently number of blows has reduced.

- Concentration of Hydrazine in hydro test water of HP piping was ensured to avoid post hydro test corrosion, and accordingly reduced number of blows in steam blowing cycle.

- One more target plate assembly was installed on temporary piping header of HRH so that correct analysis of target plate during steam blowing could be established.

Key Challenges and Improvements during Commissioning

As a result of the above improvements, number of blows came down from 308 in unit #10 to 131 in unit # 50. Steam blowing duration came down from 39 days to 22 days.



Key Challenges and Improvements during Commissioning

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2. **<u>CCCW (Close Circuit Cooling Water System) Flushing</u>**

   The CCCW flushing in unit #10 was completed in 29 days & in unit #20 the CCCW flushing completed in 20 days. In unit #10 the flushing was carried out with first service water and then with DM water but in unit #20 the flushing was carried out directly with DM water. Same procedure was adopted in other units. Completion days at unit 30/40/50: U30= 21days U40=:17days U50= 14 days.

3. **<u>Nomenclature and Tagging</u>** of valves and equipments: The naming and tagging of the equipments, electrical panels/system and valves has been done at the time of commissioning.

4. **<u>Adoption and Implementation of Software based LOTO (Lock Out Tag Out) System</u>.** Conventional PTW isolation system is replaced with highly safe LOTO system.

Key Challenges and Improvements during Commissioning /Start up / COD

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5. **Reduction of tripping during COD** and normal operation has been ensured by the following steps/ actions:

- o Thorough logic review and testing on Hi-Fidelity Operator Training Simulator.
- o Trainings by OEM Experts on Equipment/ Systems.
- o Training of personnel in Young-Heung Thermal Power Plant, Korea on Simulator, Unit Start-up and Operation.
- o Operator Training in Simulator.
- o LOTO and Safety Tagging System for Start-up/ Commissioning Phase.
- o HAZOP Study for all Critical Systems.
- o Commissioning Procedure was being prepared well before the starting of commissioning activities.

Other challenges faced during commissioning

1. DM water shortage - As per design, DM water production rate and Consumption pattern during commissioning, initial start up and Construction was not matching.

Proper strategic Planning for start up, commissioning was done considering DM water consumption and production pattern and successfully team Mundra had addressed the problem.

2. Pre-boiler chemical cleaning - Due to long gap between chemical cleaning & plant startup (approx. 6 months) it was noticed that iron pickup tendency was very high in condensate system & feed-water system.

As a result more delay was encountered during flushing cycle. Along with it additional preservation of the system was also required due to long gap in chemical cleaning circuit and plant start up.

For other units acid cleaning step was removed from Pre-Boiler Chemical Cleaning procedure. Due to this iron pickup tendency in condensate system & feed-water system has reduced considerably. Also considerable saving in preservation was also done. Flushing time during start up also reduced.

Other challenges faced during commissioning

3. Boiler clean-up process in U10 was continued for more than 15 days and consumed large quantities of DM water.

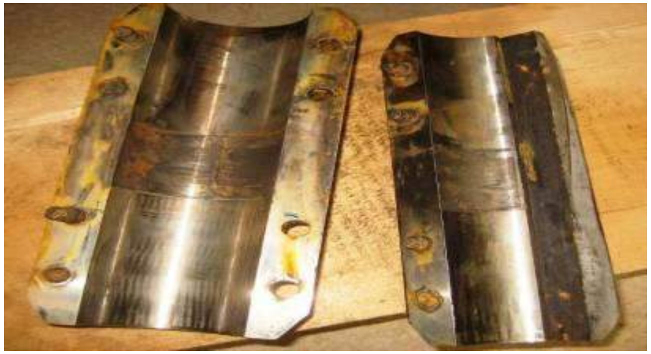
Various steps were implemented in subsequent units to reduce the cycle time of water consumption

- ❑ De-aerated water for boiler clean-up in place of non de aerated water is being used .
- ❑ Continuous boiler filling & draining done instead of complete boiler draining & filling since complete draining of boiler was causing oxygen ingress and is leading to degradation of boiler protective layer.

Issues and Challenges with respect to Equipment Failures during Commissioning

1) During Unit-10 Steam Blowing, Muff coupling of Condensate Extraction pump was decoupled when pump was in running condition. After dismantling the muff coupling between the drive shaft and the first intermediate shaft it was found that, In CEP 10A - four out of eight bolts had sheared and in CEP 10B one bolt out of eight had sheared.

DAMAGED KEY WAY



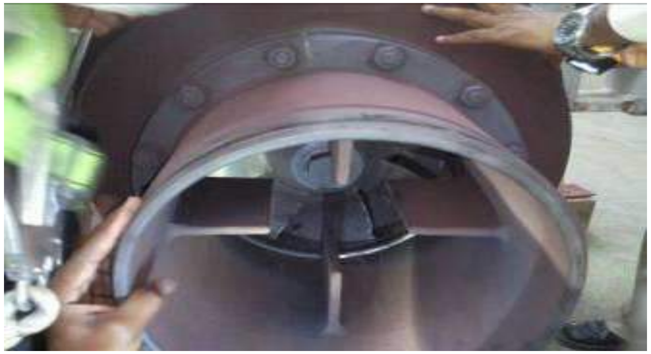
DAMAGED MUFF COUPLING OF CEP

On emergency basis other unit pump was shifted to Unit-10 and necessary rectification of the coupling was carried out by KSB. Later same correction work was carried for all the Condensate Extraction pumps in other Units.

Due to the failure of CEP Unit-10 steam blowing activity was stopped. After due considerations, Steam blowing activity was continued by using the Deaerator cold filling line from Boiler fill pump.

Issues and Challenges with respect to Equipment Failures during Commissioning

2) During commissioning stage BRP supplied by Torishma failed, resulting in delay of commissioning activities.



Torishima have inspected BRP internals and concluded that during BRP operation, a crack might have been developed and grown gradually leading to the damage of safety pipe pieces.

The broken safety pipe pieces have damaged upper coil insulation and caused wear markings on upper rotor end area and also in the lower end of upper bearing sleeve.

Root cause of this incident, as given by the vendor is the inadequate quality of welding, and also faulty assembly of motor. Commissioning activities were carried out by using other BRP. In Later stage, all BRP internal welding defect were rectified by the Supplier.

Issues and Challenges with respect to Equipment Failures during Commissioning

3) Unit#10 Condenser buckled at rated vacuum condition in service. Condenser stress analysis test and checking done. After proper engineering & design analysis extra strengthening work done by installing additional stiffeners inside & outside of condenser.


Twisted structural members of condenser

Condenser wall implosion

4) During initial stage of Unit-10 operation, CRH hangers failed. Hanger and Pipe loading design and Engineering was analyzed.

5) CW motor is supplied by BHEL with IP65, after first monsoon water ingress was found in motor internals. After consulting with vendor, proper sealing arrangements made.

6) During commissioning of CW pumps, concrete lining of conduits dislocated. This has caused delay in CW Pump starting and considerable delay in Unit start up. Concrete lining at the elbow after CW pump discharge was replaced with PU coating but same also got dislocated during the CW pump operation. Later SS lining was provided.

Issues and Challenges with respect to Equipment Failures during Commissioning

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7) Unit-10 BFPs working oil line to Cooler was vibrating heavily during initial start up and commissioning. Vibrations of the line were particularly high at low speed i.e. between 1245RPM to 2000RPM. Failure of BFP 10A /10B bellow on working oil line to cooler and failure of support on the vertical portion was also noticed in this period.

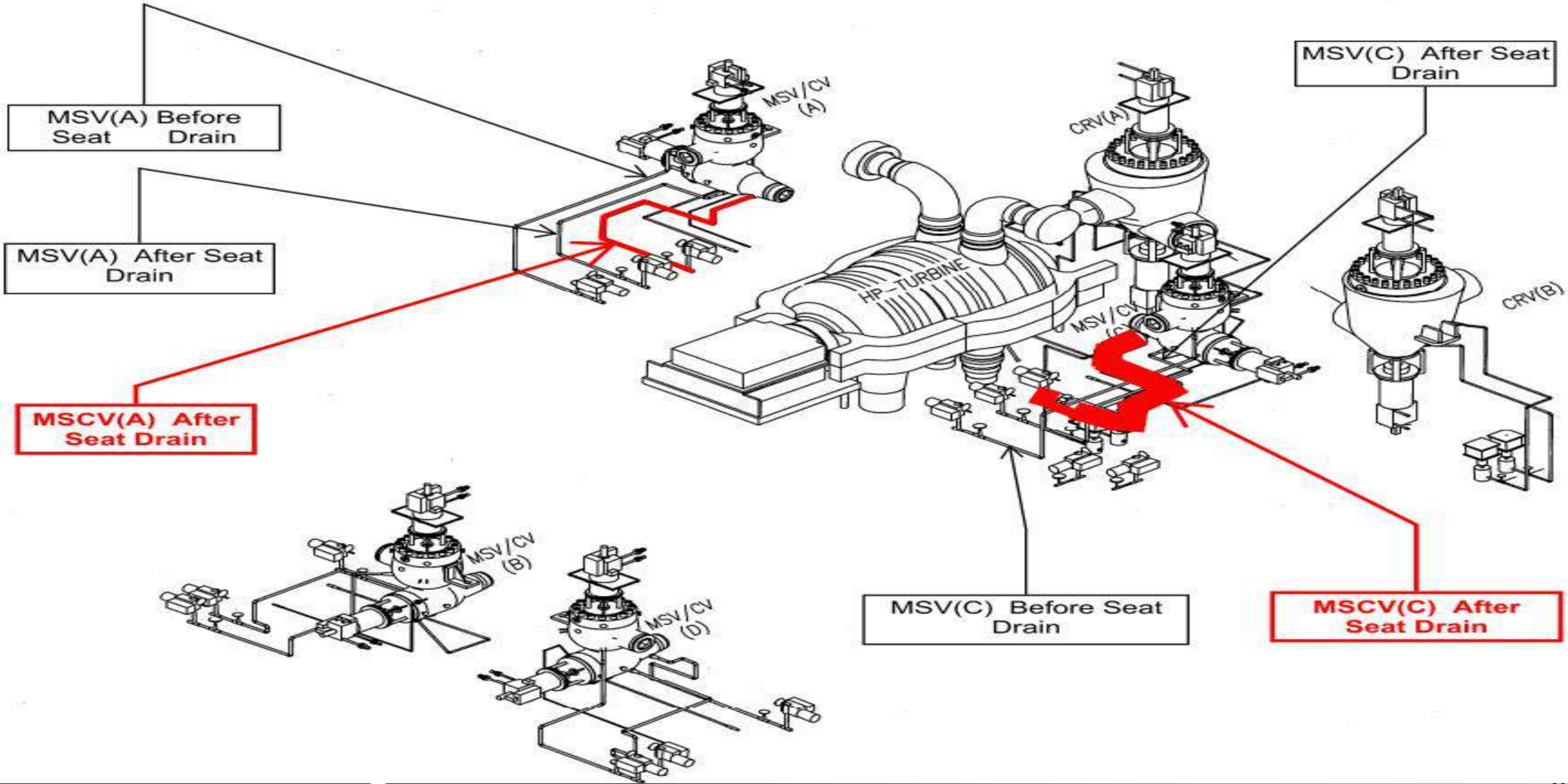
Extensive study was conducted by KSB and Voith. Pipe restraint has been strengthened. Study and rigorous checking of Scoop tube setting, Working oil temperature in line to cooler (TAG Nr. CT007), Working oil temperature in line from cooler (TAG Nr. CT008), Working oil pressure to cooler and Speed of main BFP were done.

As per Voith, a small amount of air has entrained in the working oil line to the cooler, which has lead to the vibration and noise in the piping. The amount of air entrained in the oil is dependent on the variation in scoop tube position, speed, temperature and pressure. As the flow velocity decreases in the coolers, this air expands and is piped back to the coupling housing through the vent line. For solving the problem replacement of Pipe compensators (DN 200 x 500 long) at two points were done.

Major Failures

1) <u>HP Turbine Control Valve After Seat Drain Pipe Failure</u>

Main Turbine has 4 Main Steam Stop and Control Valves which admit steam to the turbine. Stop and Control Valves are located in a common body. 2 valves are located at 17m elevation (A & C) and 2 valves are located at 10.5m elevation (B &D).



Major Failures

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There are 3 drain lines connected to the Main Steam Stop and Control Valves viz.

- Stop Valve Before Seat Drain
- Stop Valve After Seat Drain
- Control Valve After Seat Drain

These are provided for draining the condensate during start up. There are 2 valves provided on the line one Manual Isolating Valve and one Motorized Isolating Valve.

There were **five** incidents of control valve after seat drain pipe (material P91) failure in lines A and C (from Dec'12 to April'13).

M/s. Toshiba came out with the following RCA:

1) Substantial deformation as well as dimple rupture reveal <u>bursting was due to extreme low strength of materials own properties by abnormal heating. The microstructure examination revealed heating to a temperature of about 800 – 850 deg C,</u> though no excursion in steam temp reported.

2) Continuous Low load Operation observed for one hour prior to the incident.

3) In the upper valve (A & C) steam flow is unstable, especially at the lower side of the flow area due to flow separation from piping wall near to drain pipe hole. The reverse flow caused by the interference of down stream elbow is observed. In the upper valve (B&D), steam flow is stable and flow velocity decreases as flow goes to downstream from valve seat area.

Major Failures

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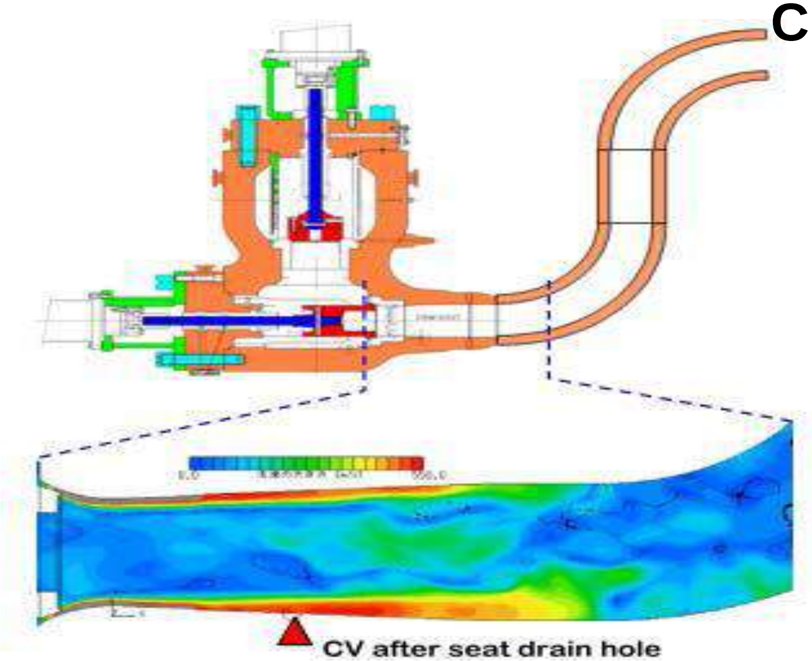
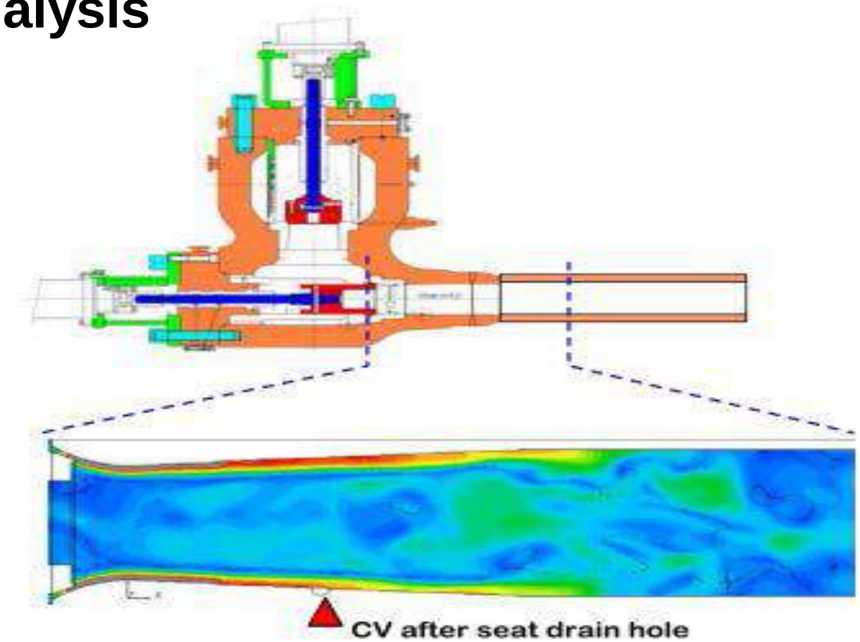
CFD Analysis





UPPER VALVE ARRANGEMENT LOWER VALVE ARRANGEMENT

4) Investigations carried out by Toshiba reveal that only mechanical vibration in piping system cannot produce enough energy to heat up the entire piping system over 800 deg C. <u>Fluid vibration in piping system i.e, acoustic resonance and/or shock wave could be the root cause of the incidence.</u> Toshiba shared about similar incidence reported in Combined Cycle Journal posted on 14th August 2012. It tells that extreme overheating on the isolation valve of steam drain line was observed on several steam turbines.

Major Failures

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2) Turbine Control valve seat dislocation:

During commercial operation on Unit 10, 20 and 30, while testing control valves it was observed that some of them could not be fully closed. It is suspected that CV valve seat came out and shifted from correct holding position. It has been confirmed during visual inspection of CV valve seat by boroscope that CV valve seat's shift had actually happened. As the seats have got dislocated, it reduced the effective valve opening also, leading to partial loading.

M/s. Toshiba suggested installing pins to hold CV valve seat from outside of MSV/CV valve casing as Counter measure in all the units taking a shutdown of the unit. They submitted a detailed procedure covering preparatory works, drilling and reaming holes in the valve body, pin installation and restoration work.

Accordingly, shut down was taken and pin installed in control valve seats. Later on valve operation was found alright.

Major Failures

3) Tube Failures:

There were not many tube failures in these units, but repeated failures were observed on re-heater coils of U#30 super critical boiler. The Boiler was first lit up in August’12. First failure of two tubes occurred on 10th April, 2013. The section of leaky tubes was replaced and the boiler was put to service on 13th April, 2013.

Failures had occurred in tubes with TP 304H metallurgy. Metallurgical analysis showed cracks in some more tubes. In the report submitted by M/s Doosan with respect to the first failure, they have indicated short term creep damage of the subject tubes due to exposure of the tubes beyond the permitted design temperature. However operating parameters didn’t show any excursion beyond permissible limits. The mechanical property of the subject material was found in line with the specification.

Discussions are still on with M/s. Doosan and other metallurgical experts about further corrective actions needed including a review of the material used.

Key Challenges
Grid stability & Unit stabilization

•At CGPL Mundra There was a station Blackout on 12th March 2014 after tripping of the outgoing Lines .(With CGPL Generation was 4089 MW. and Station export was 3772 MW.)
• Non availability of evacuation from CGPL leading all units at CGPL to run on house load, except Unit#40 which tripped on SPS operation. After 5-6 mins of operation of Unit#10/20/30/50 on house load, all these units were hand tripped, except Unit#10 which tripped on HP exhaust hood temp very high.
• The frequency of the islanded system of CGPL Mundra touched to 52.885 Hz (at 19:21:59:200) and the governor action immediately controlled the frequency.
•The frequency in the grid rapidly declined and touched 49.285 Hz within 3 minutes due to sudden deficit of 4050 MW.

Unit No	Total Black out	400kV S/Y charging	GT Back charging	Light up	Synch	Total Duration
20		19.37	20:00	00:46	07:57	07.11
10	19:28:22		21:28	06:57	12:22	05.25
50			02:50	14:04	19:24	05.20
40			02:41	22:40	03:37	04.57
30			20:50	Shut Down taken		

Coal Blending

Operational Experience: Issues and challenges

Blending was tried with varying percentage of HCV /MCV & LCV coal. Initially blending was done in the yard, with the help of stacker/ reclaimers. With this method the exact ratio of blending could not be estimated. Subsequently **Choice bunkering** was adopted, by which feeding elevation of high/ low quality coal could be controlled. It also provided accurate blend ratio. Gradually blend ratio was increased. Though it helped in reducing the fuel cost, it resulted in the following setbacks:

- ❑ Drop in Boiler Efficiency by about 2.5-3% and consequent increase in unit heat rate
- ❑ High auxiliary power consumption due to increased coal flow and 6 mills operation
- ❑ Increased SH/ RH spray levels and metal temp
- ❑ Clinkering in the boiler due to high Fe_2O_3 and bases content leading to furnace disturbances and bottom ash handling issues.
- ❑ Unable to achieve full load at higher blending ratios.

For reducing clinkering and slagging in the furnace, Combustion tuning is done on a continuous basis. In addition, **injection of fuel additive in the furnace** is tried. After injecting fuel additive in the furnace , a reduction in the slagging/ clinkering tendency has been noticed. It seems the chemical is reducing the fusing tendency of the ash particles by making them brittle.

Heat Rate Improvement Initiatives

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Various initiatives have been taken by the team to Heat Rate improvement, which are listed below:

- **Configuration of 'Burner Tilt' auto logic with Reheat Spray levels:** It has helped in reducing reheater spray and to maintain the RH temperature in the design operating range. Continuous monitoring, timely calibration and maintenance of the system are ongoing activities that have been adopted. At present in all the units Burner tilt, HRH temperature control is maintaining in auto mode effectively.

- **Valve replacement/ rectification schedule to reduce make-up/ heat loss:** In all the Units valves passing monitoring and rectification in opportunity is being done continuously. This has helped a lot in reducing the DM water make up to the system and improving heat rate.

- **Steam Turbine Valve (HPCV) Wide Open operation:** This has resulted in considerable reduction in throttling losses at HPT inlet and reduction in BFP discharge pressure and current.

Heat Rate Improvement Initiatives

- **Changeover to Oxygenated Treatment regime from all volatile Treatment:** This has resulted in improvement in chemical parameter of the units. Due to this venting at Deaerator has been stopped and hence considerable amount of makeup loss has been reduced. This has also got an impact on Heat rate improvement.

- **Operation at higher Loading Factor:** It is being decided that during low generation schedule from Grid, reduction of generation will be done in minimum required units, maintaining load constant in other units. Maintaining higher load in the unit results in maintaining design parameters and improved heat rate.

- **Unit Routine Performance Tests**

- **Technical Review Meeting (Monthly),**

- **Projects through Structured Problem Solving,**

- **Projects through CFT , Think tank Projects**

- **Daily Performance Monitoring**

Process Management and Initiatives

Enterprise Process Model

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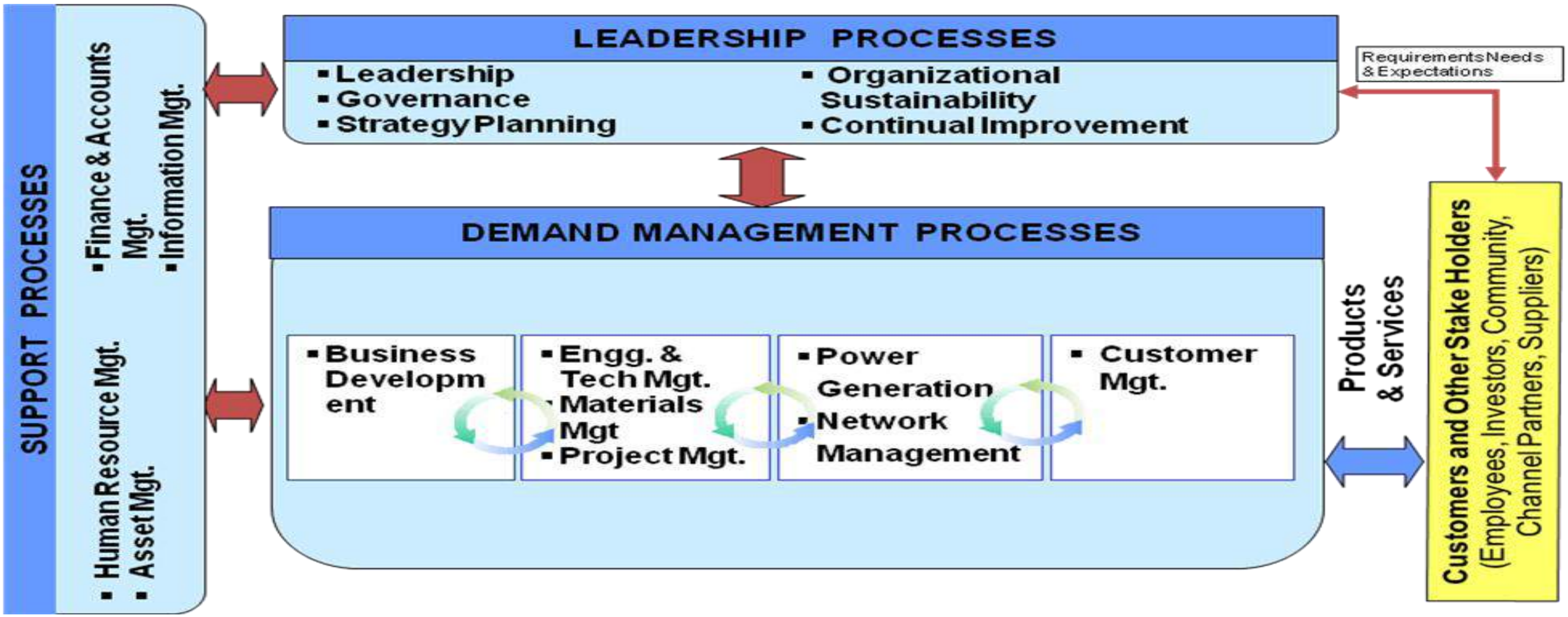

L1	L2	L3 (Opn)	L3 (Main)
• **Operation**	• **Power Generation**	• Thermal Power Plant Operation • Switch yard Operation • Generation Scheduling • Outage Scheduling	• Break down maintenance • Calibration Process • Preventive Maintenance • Major Overhauling

O&M Safety Practices:-

Safety Oath	• **Day starts with Safety Oath.**
CGPL BSC Goals	• Balance Score card / All the Team members KRA linkage with Safety.
Dept SDM	•Individual KRAs are driven from Dept SDM
Mock drill	•Conducted by safety department and participation of all the department
JSA (Job Safety Analysis)	•A systematic safety analysis before starting a job
SCAR (Safety Corrective Action Request)	•Pictorial proof of Safety violation issued to contractors & they reply with pictorial proof of compliance
PSUSR (Pre-startup Safety Review)	•:Safety review before commissioning of equipments / systems (“A” & “B” category actions)
NGO Out-reach Program	•Program by NGO to bring about behavioral change
Safety Flashes	•Learning’s shared with employees across divisions
Safety Pause	•Safety Pause at Localized work areas during violations

O&M Safety Practices:- …contd.

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SIAT (Safety Intervention Audit Team)	**•A cross functional team (CFT) audits specific Site area daily and provides photographs of good & OFI observations during Safety Time-out**
Mutual Aid :-	•Mutual Aid agreement with adjoining industries for handling fire incidents
Competency Mapping	•Competency mapping of specialized trades
Consequence Mgmt Committee (CMC)	•Group nominated by all contractors for deciding penalties for unsafe working
ICU on Wheels	•ICU on wheels ambulance for shifting critical patients.
Safety Time-out	•Unsafe observations are shared among employees everyday

Operation Practices:-

Standardization of all the operational procedures	**•Detailed step by step operation procedures (SOPs) and work instruction is prepared** **•Periodical Review of Operational Procedures** **•Proper Documentation of the Operational procedure at common folder at server. This is to facilitate the entire team member for easy access.**
8D analysis report	• For root cause analysis of occurrences •Prepared by assigned CFT •Availability of 8D analysis report at common server and assess to the team member. • CAPA (Corrective action & Preventive action) is planned.
Scheduled Changeover of equipment	•Ensuring critical equipment availability and trial run. •Record Keeping •Ensuring uniform life cycle of equipments & avoidance of random failures
Improvement	•Various modifications initiatives are done through FCR/Delta /Modification note etc.

Operation Practices:- …contd.

On job training	•On job training to new employee. •Inter and intra departmental Periodic job rotation policy
Outage report	•Preparation of outage report after every outage. •Preparation of strategy to improve the system that has been learned after every outage.
Others	•Regular and effective Plant round for identification and proactive action for abnormality •Cross checking of O2 reading by chemical. •Critical defect identification ,discussion in O & M meeting and finding out the action plan. •Presence of EMD/MMD/IMD personnel in Shift to tackle the emergency immediately. •Monitoring of Metal temperature on regular basis. •Running the equipment close to design parameter.

Start up and Shut down

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Tracking of PTW during Unit Outage	**•During outage of Unit ,every day Outage meeting is conducted and is being co ordinate by Planning department.** **•Every day tracking of PTW system through SAP-PTW System is being done, so as to avoid delay in Unit start up.**
Protocols	•Philosophy of signing of protocols before Unit start up. •All the department representative are signing in the protocol before starting the equipments during start up.
SOP of start up and shutdown	•Adhering to the SOP of start up and shutdown. •Adherence to startup/shutdown curve, recommended by OEM. • Start up analysis report is prepared and analysis of the same is done after every start up in O&M meeting. Accordingly action plan for next start up is done as a part of learning. •Adopted the practice to optimize the start up and shut down time.
Chemical Parameters	•Flushing activity is done as per the guideline of OEM. •In every start up before turbine rolling chemical department is giving clearance via mail about the required chemical parameter suitable for rolling. • Strict adherence to Chemical parameter. •On line monitoring of chemical parameters.

Start up and Shut down …contd.

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Interlock and Protection checking	**•Before Unit start up after long outage interlock and Protection checking is conducted.** **• The protocol is being signed by all the department after the protection check.** **•Interlock and Protection checking policy is line .**
During Unit Start up	•Before start up oil gun cleaning and healthiness is ensured so as to avoid problem during start up. •All the PTW are being closed via E-PTW System and the hard copy is submitted to operation by service dept well in advance before the Unit start up. •Check sheet /SOP is used by all the team members during start up and are documented properly for record keeping. •Check sheet for startup is filled by control desk engineer, duly signed by SCE practice is adopted during turbine rolling. •Regular APH soot blowing is done to prevent APH fire during start up. •Planning of start up and shutdown is being communicated to SCE/CDE/Field Engg/service department via mail well in advance, by head operation.

Various Initiatives in O & M

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Knowledge Sharing Initiatives :

- Provide Assistance to project ADORE : Model Development for Critical Assets
- Provide Technical assistance to Power plants within the group.
- Commercial Simulator Training Program
- Provide refresher simulator training to Operation staff.
- Participative in the knowledge sharing sessions across Division through VC and discussed 8D of different occurrences.
- Tarang Session
- K Hub
- Visit to other Power Station.

New Technology Adaption:

- Implementation of Water Canon
- Intelligent Soot Blowing System for Boilers
- Implementation of ABT monitoring System.
- E-PTW System and LOTO
- Adoption of robotic technology for tube header Inspection
- Implementation of Online plant performance Monitoring (PADO) system.
- PI Soft ware for Plant data collection and for data analysis.
- Migration from E-PTW System to SAP PM Module.

Various Initiatives in O & M …contd.

- **LASER:(Learn/Apply/Share/Enjoy/Reflect)** Inter departmental teams formed with interactive learning and developing projects.
- **SANKALP:** Inter departmental team formed for Improvement of plant performance.
- **SPS (Structured Problem Solving) :** Improvement projects taken by Operation team members linked with KRA.
- **Seminar Presentation:** Encourage team to participate in national level seminar presentation and represent CGPL.
- **Occurrence analysis:** 8D analysis of tripping & failures.
- **FCR & Delta:** Field change requests submitted by O & M engineers and implementing the changes after review.
- **5S**: 5S Projects taken for different areas.

Various Audit Program to strengthen the Process & System:

- Safety Audit
- Fire System Audit
- Protection Check Audit
- PTW Audit
- Performance Related Audit.
- TBEM and Deep Dive Assessment
- Audit by External Agency

Performance Monitoring

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- **Deviation of Operational parameter with respect to design** is being recorded in Daily generation report on daily basis. Same is being discussed and requisite action plan is made in daily O & M Morning meeting.
- Various **losses with respect to kcal** (heat loss) in boiler and TG cycle is being tracked on daily basis in O & M Morning meeting.
- **PADO system is installed in DCS**. On regular basis Operation engineer is monitoring in DCS for the performance of the unit with the help of PADO system.
- Performance audit is being conducted regularly
- Various CFT among O&M team is formed for plant performance improvements. LASER/LEHER/SPS/SANKALP projects are in line for plant performance and other improvements.
- **CTDS** (Core technical and diagnostic Services) is formed to track Plant performance at TATA Power level.
- On monthly basis **ORT (Operation review team**) is being conducted by **CTDS** (Core technical and diagnostic Services) and senior leadership team for addressing various plant performance and technical related issues.
- **Periodic Technical Review Meeting** is conducted by Plant performance cell **.**
- For specific achievement in Plant performance , employees are being rewarded.

O & M Review Process

Input-(Customer-Operation/Other Service Dept)			
PTW	Daily Review Meeting	Technical Review Meeting	ORT

Process (Based on Criticality)					
CFT	SPS	8D	LASER	SAMIKSHA	PTW

Output -Review by SLT			
SAMIKSHA	O & M Review Meeting	DRM	IMPROVEMENTS

Recognition and Laurels

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1. Project financing deal - Asia Pacific deal of the year 2008
2. Listed as one of the three best infrastructure projects by KPMG in 2010 (among top 100 in the world)
3. CNBC India Infrastructure Excellence Awards 2012 – Energy & Power
4. One of the two winning entries in the Modern Power Systems (MPS), UK, Fossil Power Innovation awards, 2012
5. "Special Jury Award" in Thermal Power Generation Category at the 6th "Enertia Awards 2012" (October 2012)

4

1

pfi awards 2008

Asia Pacific deal of the year 2008

3

5

Way Forward

Proactive initiatives are the indispensable and Key attributes for overall improvement to gain expertise in Standardized O&M systems.

- To set up bench mark in the world market CGPL- Mundra
- To accomplish sustainable high level of performance
- Establishment of best practices
- High level targets for Safety, sustainable improvements in Heat rate
- Reduction in auxiliary power
- Enhancement of Equipment efficiency
- Reduction of operating cost and maintaining high standards in O&M practices.
- Enhancement of Knowledge

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Sl. No	Activities	Comparative Study for Steam Blowing completion				
		Unit#10	Unit#20	Unit#30	Unit#40	Unit#50
	Methodology	Puffing with Silencer	Puffing with Silencer	Puffing with Silencer	Puffing with Silencer	Puffing with Silencer
1	MS LINE	141	29	42	31	25
2	MS+HPBP	4	3	3	7	4
3	MS+CRH	11	9	9	9	6
4	MS+CRH+HRH	145	110	141	107	90
5	MS+CRH+LPBP	5	7	9	6	6
6	PRDS+Aux Steam	2	2	3	4	3
No. of Blows (Total)		308	160	207	164	131
Operating Pressure (Bar)		65-75	65-75	65-75	65-75	65-75
Blowing Duration (mins)		2.5	2.5	2.5	2.5	2.5
TOTAL DURATION (DAYS)		39	26	138*	29	22