
METTUR THERMAL POWER STATION-I
MTPS TANGEDCO IGEN IMPLEMENTATION REPORT
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ELECTRICAL SYSTEM/ MTPS 1
METTUR DAM

Brief Introduction of the Plant

Capacity – 840 MW   Unit Size – 4 X 210 MW

Unit No.	Unit Capacity (MW)	Year of commissioning	Boiler / Turbine make
1	210	1987	BHEL/LMW
2	210	1987	BHEL/LMW
3	210	1989	BHEL/LMW
4	210	1990	BHEL/LMW

Location of power plant : METTUR THERMAL POWER STATION.

Owner : TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED.

PLF for the station : 92.70 % (IN THE SILVER JUBILEY YEAR 2011-12)

UNIT CONTINUOUS RUN :

UNIT 1	UNIT 2	UNIT 3	UNIT 4
227	205	272	311

STATION CONTIN. RUN : 71 days

IGEN Programme and MTPS - I

- Under IGEN Phase 2 MTPS Unit 1 was selected as model unit
- With the help of M/s STEAG detailed model of unit 1 was developed.
- Extensive training was imported to the engineers
- Field studies were conducted by M/s STEAG
- Under the programme, exchange of best O&M practices, valuable knowledges were shared.

Works carried out in Unit – 1 of MTPS

- Boiler
  - CFD analysis
  - R & M of Air Pre Heater (with double sealing)
  - Pent house sealing
  - High pressure Jet cleaning
- Turbine
  - Condenser tube replacement (top portion only)
  - Condenser tube bullet cleaning
  - Tip Seal Replacement in the HP, IP Turbine diaphragms
  - Monitoring of HP Drains (using Thermal imager)

MTPS-I General Arrangements

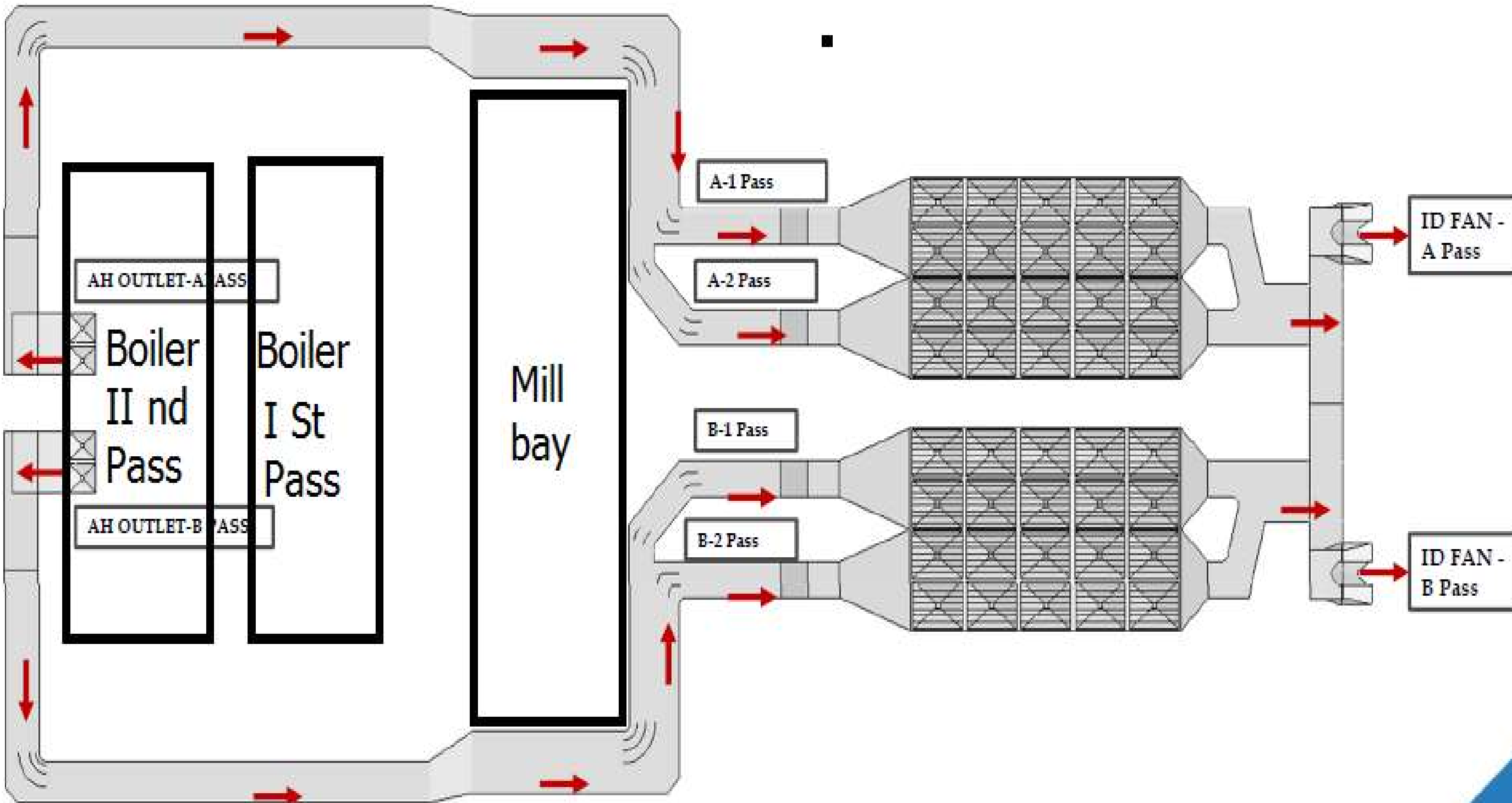


Figure illustrates Top View of model

Problems Faced in Unit – I of MTPS

- Very high erosion in the flue gas ducts.
- High APH outlet temperature
- Low outlet temperature of secondary and primary air of APH outlet
- Full ID fan Loading
- Low condenser vacuum during summer
- Higher steam consumption

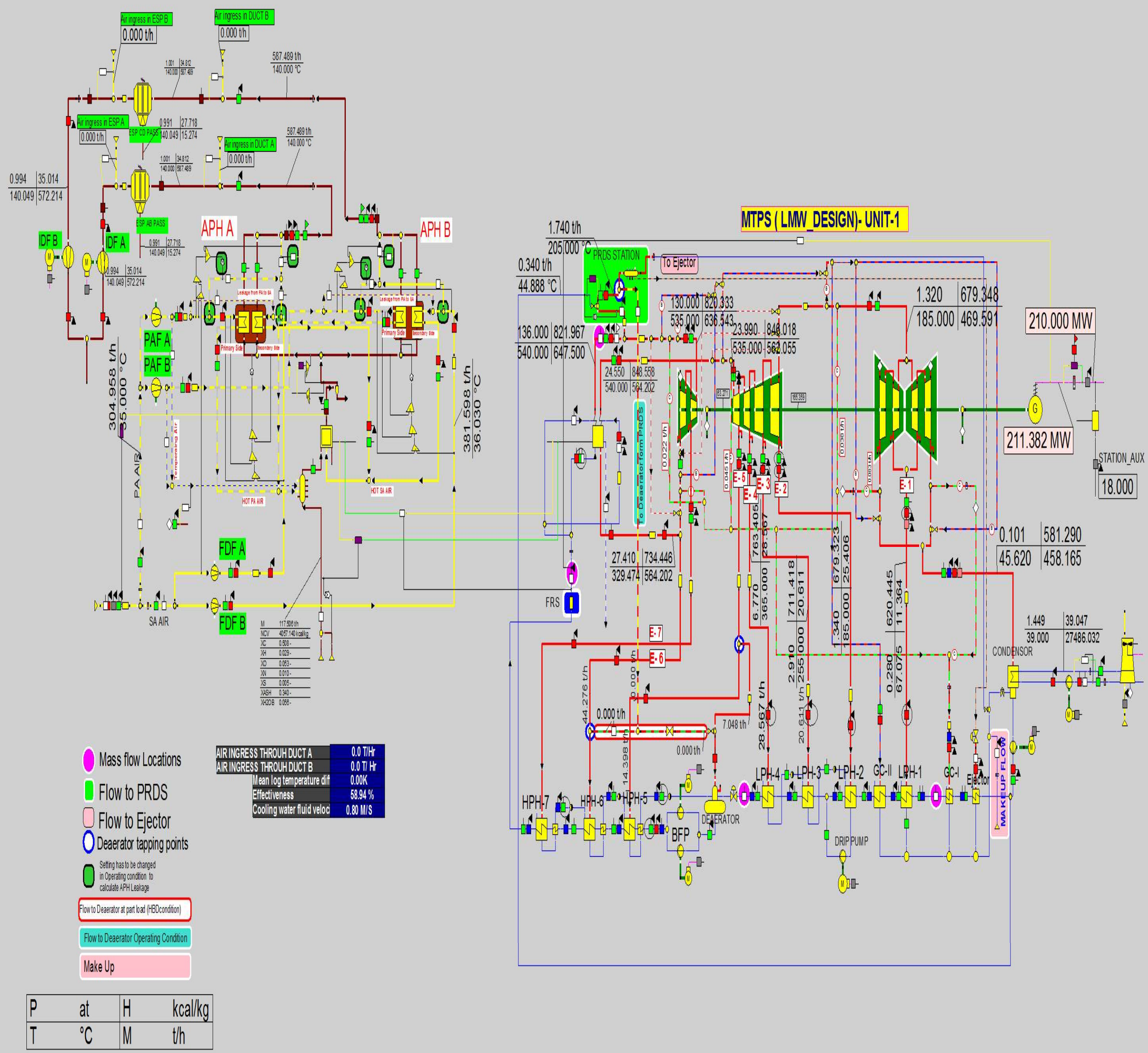
Almost all the problems have been solved after implementation of IGEN programme.

All the above works except Air Pre- Heater Replacement were carried out in the remaining Three units.

Studies made using EBSILON software

Following studies were made

- Air ingress in the flue gas system
  - by measuring the O_2 value at different locations in the flue gas path. Using This model the above study can be done by measuring temp at different locations of flue gas duct.
- Air pre heater Performance study
- Heaters Performance Study
- Condenser performance study.
- Total cycle analysis. (operating Model analysis)



P	at	H	kcal/kg
T	°C	M	t/h

TURBINE HEAT RATE= 2047.2 kcal/kWh

UNIT GROSS HEAT RATE = 2381.0 kcal/kWh

Plant Economy	Power	Efficiency	Unit Heat Rate
Gross	210.0 MW	36.16 %	2381.0 kcal/kWh
Net	192.0 MW	33.06%	2604.3 kcal/kWh
Boiler Efficiency		85.98 %	TG Heat Rate
Coal Consumption		117.51 t/h	2047.2 kcal/kWh
Main Steam Flow(HPT Inlet)		646.10 t/h	2239.1 kcal/kWh
Specific Coal Consumption		0.56	
Specific Steam Consumption		3.08	

Turbine Economy

Turbine	Efficiency	Power
HPT	80.79 %	63.27 MW
IPT	89.38 %	102.09 MW
LPT	97.57 %	48.76 MW

Condenser

KA	28409.8KW/K
TTD	6.6 K
Mean log temperature dif	10.10K
Effectiveness	58.94 %
Cooling water fluid veloci	0.80 M/S
Effective cooling tube len	3.92 M

Pump Economy

Pump	Efficiency	Power
BFP A	66.27 %	2.63 MW
BFP B	66.27 %	2.63 MW
CEP	70.00 %	0.37 MW

Cooling Tower

Approach	4.01 °C
Range	9.00 °C
Wet bulb Temp	26.00°C
Effectiveness	69.20%

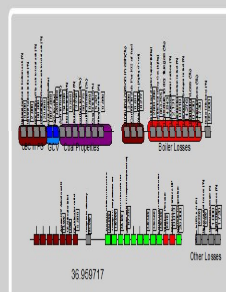
Heater Economy

HEATER	TTD	DCA
HPH 7	2.35 K	9.75 K
HPH 6	4.26 K	9.58 K
HPH 5	2.81 K	15.88 K
LPH 4	5.18 K	-
LPH 3	5.29 K	-
LPH 2	5.18 K	-
LPH 1	5.23 K	-

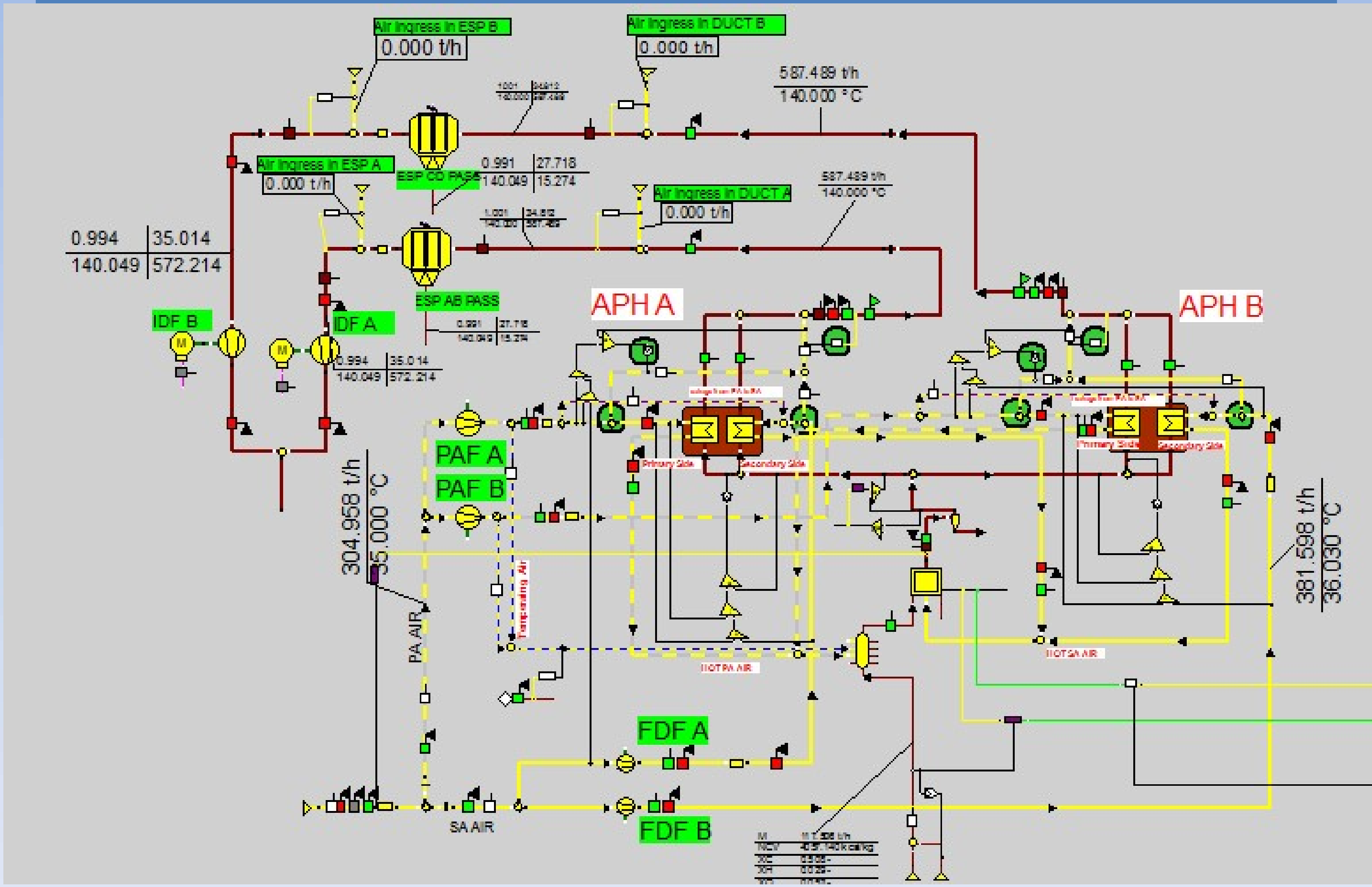
AIR HEATER	APH A	APH B
Seal Leakage	7.20 %	7.20 %
Corrected Gas Out Temp	147.34 °C	147.34 °C
Efficiency	66.49 %	66.49 %
XRATIO	0.72	0.72
Exess Air	23.905 %	23.905 %
Combustion Eff.	97.71 %	97.71 %

7.20 %
147.34 °C
66.49 %
0.72

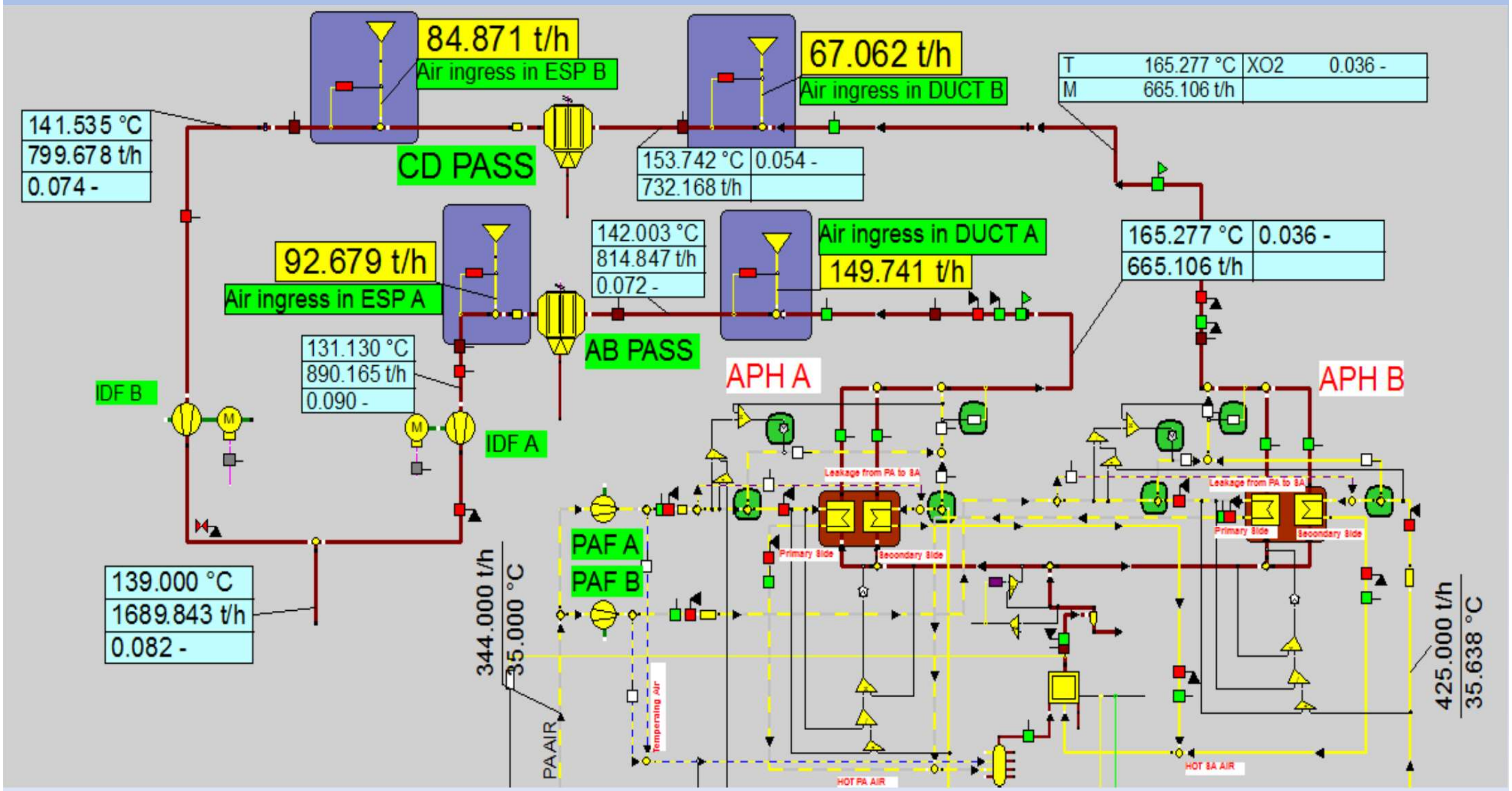
97.71 %
23.905 %



Air ingress in the flue gas system



Air ingress in the flue gas system



Outcome of Air ingress study in the flue gas system

- High Air ingress noticed in the APH system.
- Air ingress in the Flue gas duct is also more.

Action Taken

Based on the IGEN knowledge exchange program the following improvement works was carried out

- Modification of APH from 27VIT2000mm to 27.5VITM2300mm with double sealing arrangement and increase the heating surface area by 29%.
- Computational Fluid dynamics (CFD) modelling was carried out in the Flue gas path and guide vanes were erected in the Duct based on the CFD results.
- Penthouse sealing was carried out.

AIR PRE-HEATER

EXISTING - Make : BHEL

- TYPE:27 V I T 2000mm
- 27 - FEET DIAMETER
- V - VERTICAL
- I -INVERTED GAS FLOW
- T - TRISECTOR
- 2000mm -HEATING ELEMENT HEIGHT
- 72° PRIMARY AIR FLOW OPENING
- Single sealing
- 12 sector


12 SECTOR APH CENTER SHAFT
10 06 2015


12 SECTOR AIR PRE-HEATER

Baskets of APH (old)

Modified APH Model

27.5 V I T 2300mm – Make GEECO

27.5	- FEET DIAMETER
V	- VERTICAL
I	- INVERTED GAS FLOW
T	- TRISECTOR
2300mm	- HEATING ELEMENT HEIGHT
72°C	- PRIMARY AIR FLOW OPENING
24 Nos	- Sector
sealing	- Double sealing

AIR PRE-HEATER WORK CARRIED OUT

Air pre-heater "A & B" replaced with new one

- Double sealing
- Increase in Height by 300mm from 2000mm to 2300mm.
- Increase in Diameter by 344mm from 8676mm to 9030mm.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LHS
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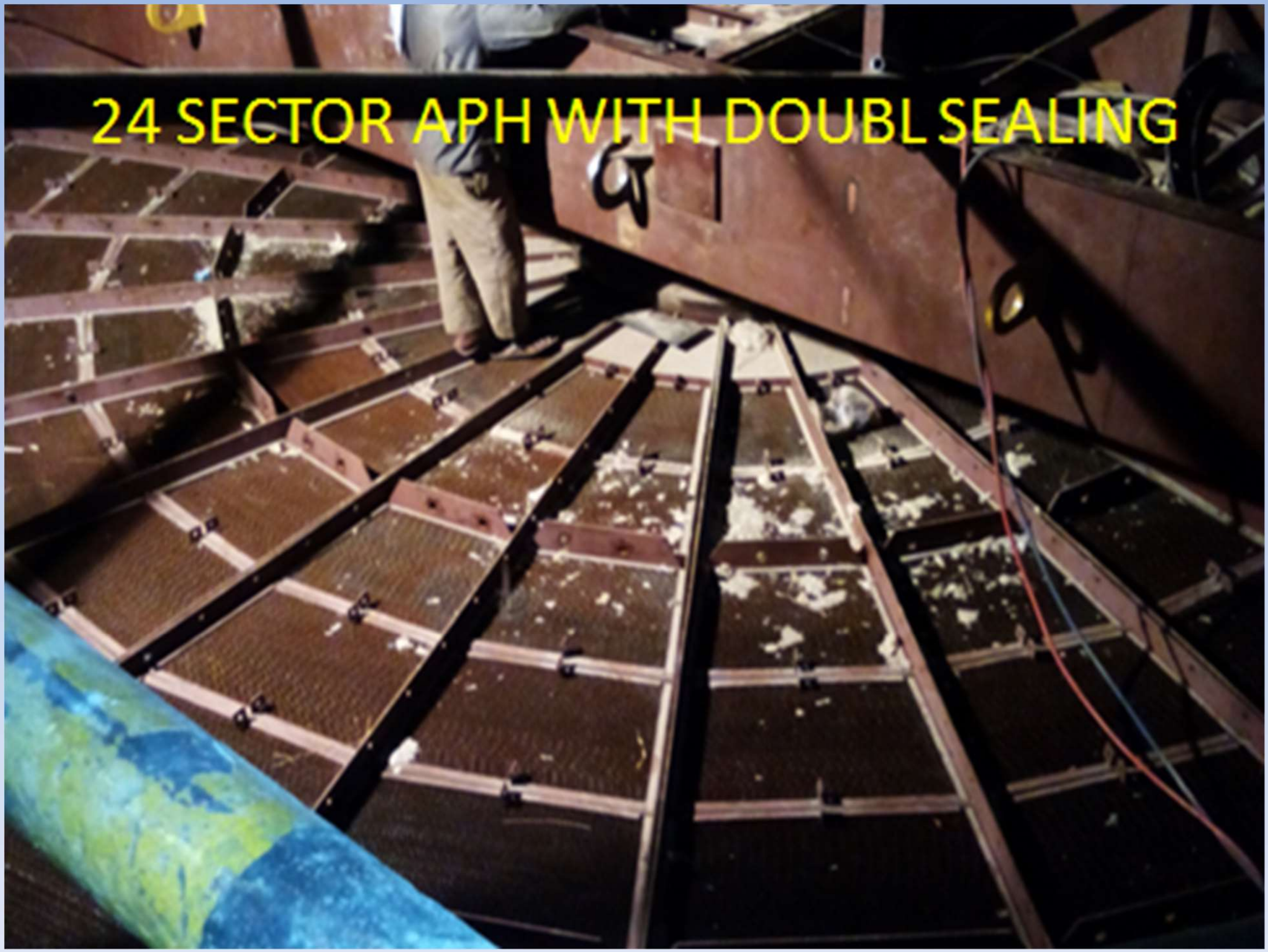
APH 'A'
Rotor alignment
30.6.15


24 SECTOR APH WITH DOUBL SEALING


APH BOTTOM VIEW

PERFORMANCE IMPROVEMENTS

SL.NO	Description	Units	Before COH	After COH
1)	Air pre-heater Inlet primary air temperature	°C	45/46	43/44 ↓
2)	Air pre-heater Outlet primary air temperature	°C	308/307	332/330 ↑
3)	Air pre-heater Inlet secondary air temperature	°C	37/37	34/35 ↓
4)	Air pre-heater Outlet secondary air temperature	°C	295/292	322/327 ↑
5)	Air pre-heater Outlet Flue gastemperature	°C	167/176	164/153 ↓

AIM OF CFD ANALYSIS

- » To find out flow separation and recirculation as well as flow concentration zone in existing duct arrangement using CFD.

- » Pressure drop prediction in the existing system.

- » To find the mass imbalance in each pass of the ESP.

AIM OF CFD ANALYSIS

» Iterative analysis to modify the duct by CFD technique to reduce problematic areas.

» To optimize turbulence (eddy function and formation of recirculation zones)by designing the guide plate to reduced pressure drop.

» To achieve equal flow distribution at each ESP inlet by CFD technique.

» Pressure drop reduction across the system.

CFD Modelling

3D CAD MODEL

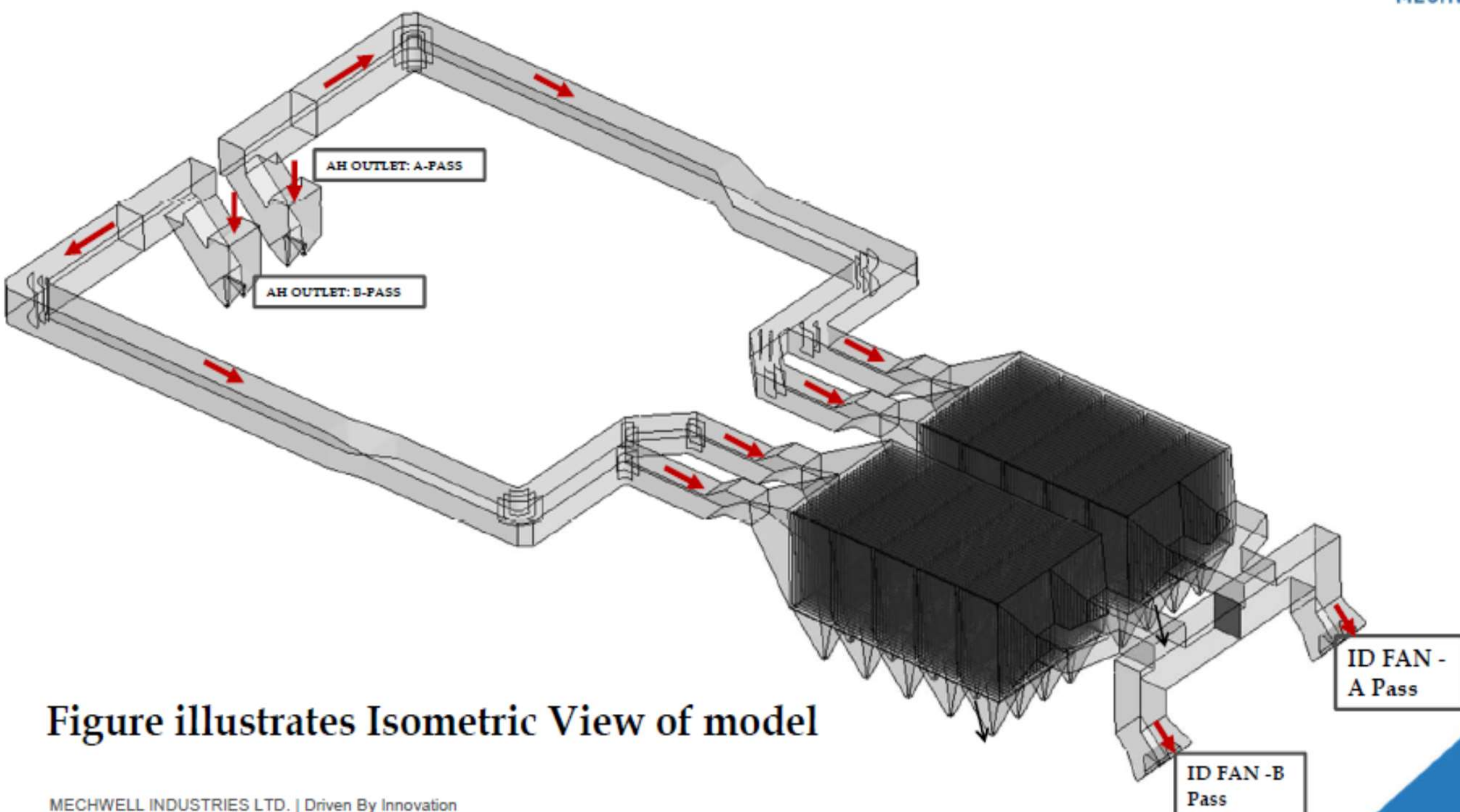


Figure illustrates Isometric View of model

MODIFICATIONS

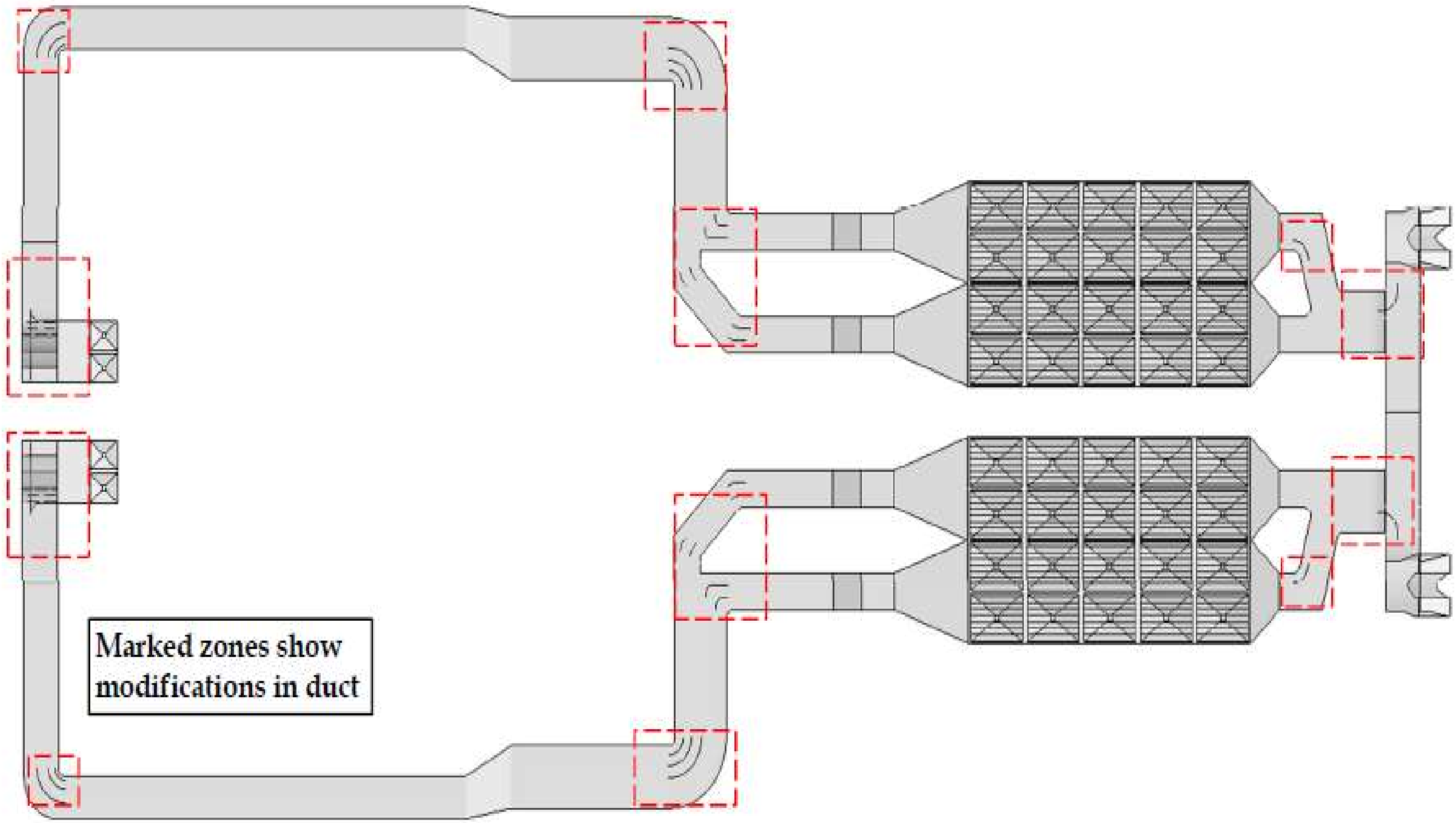
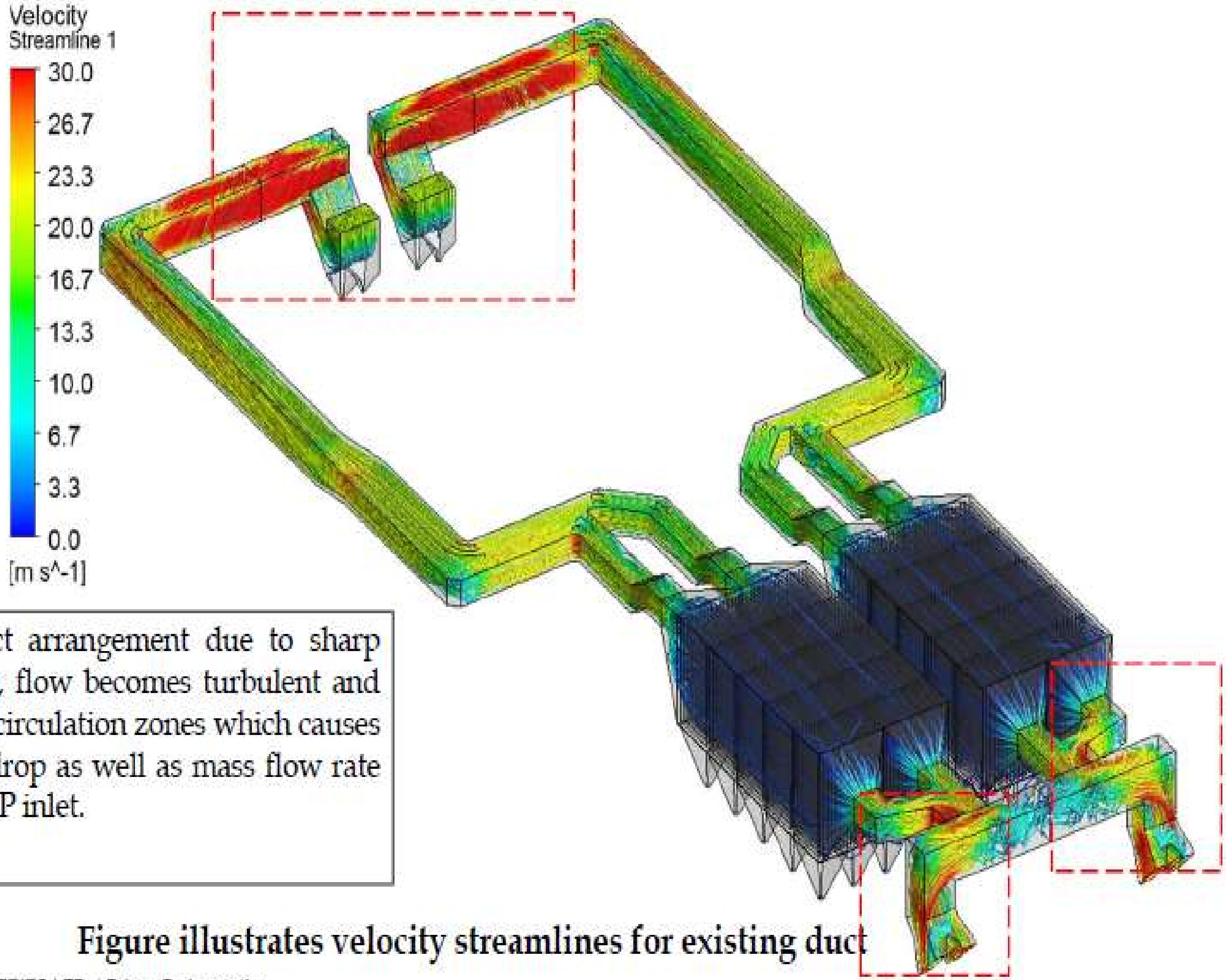


Figure illustrates Top View of modified model

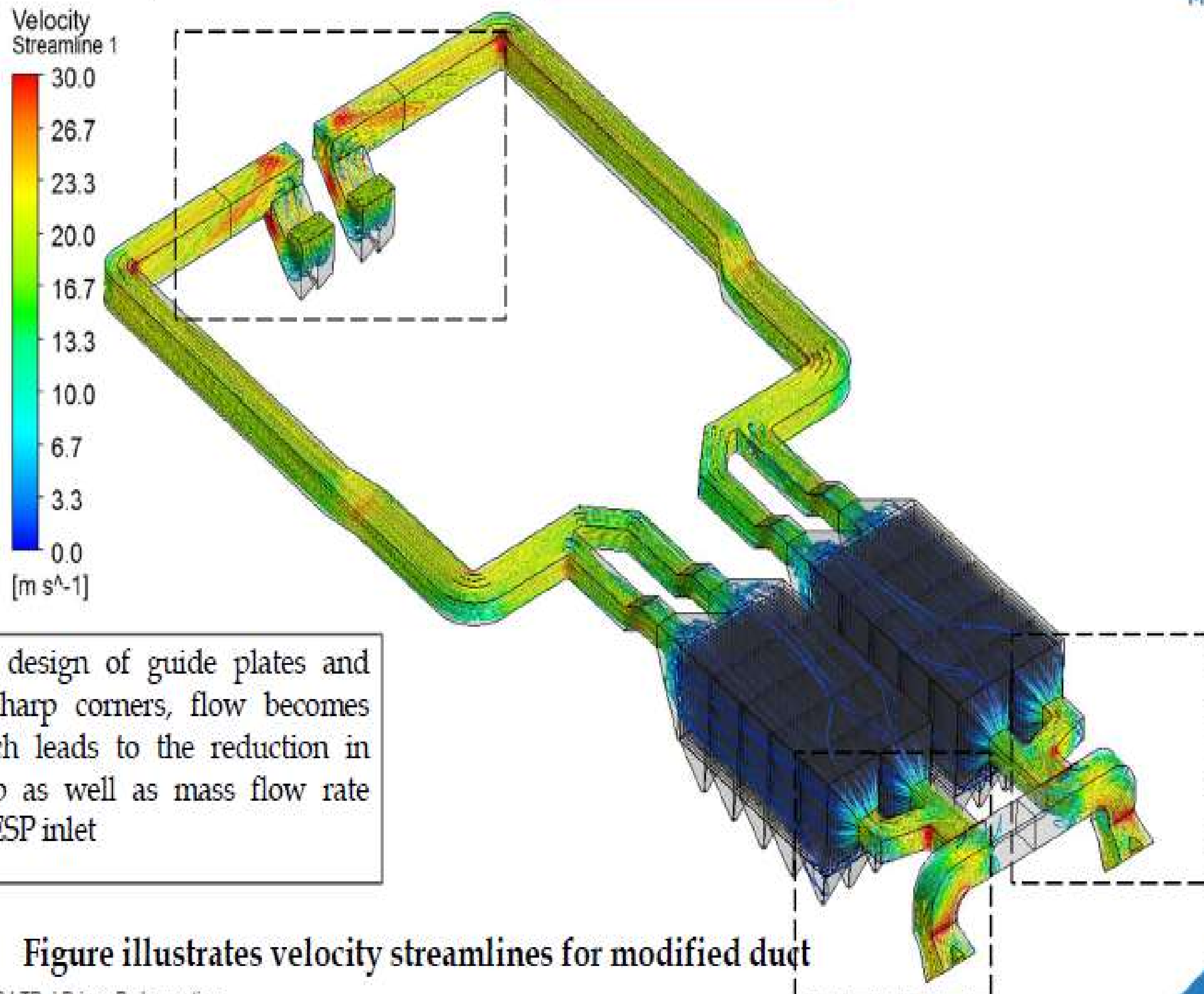
CFD RESULTS-EXISTING



In existing duct arrangement due to sharp corners in duct, flow becomes turbulent and having more recirculation zones which causes high pressure drop as well as mass flow rate imbalance at ESP inlet.

Figure illustrates velocity streamlines for existing duct

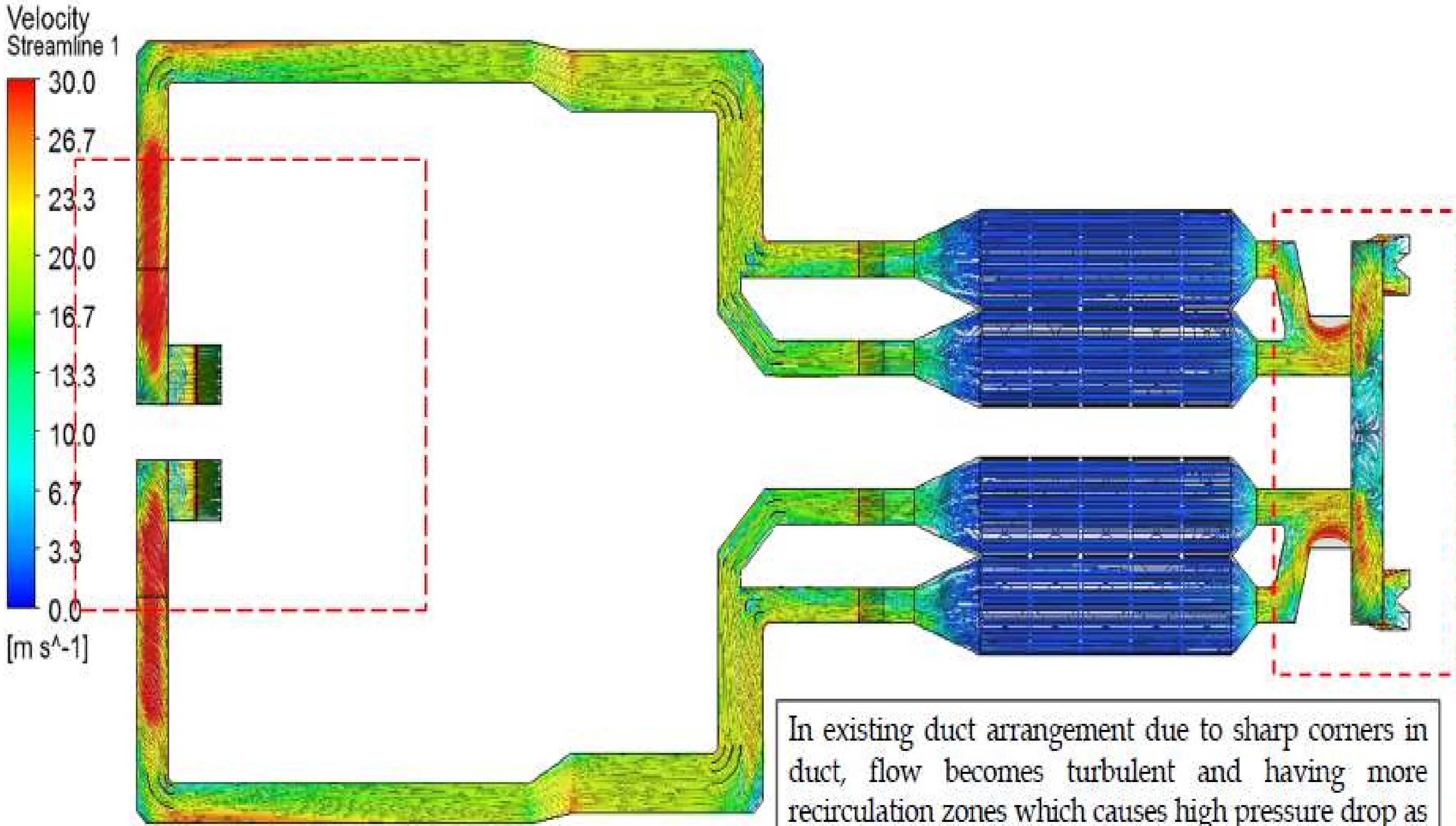
CFD RESULTS-MODIFIED



After proper design of guide plates and removal of sharp corners, flow becomes uniform which leads to the reduction in pressure drop as well as mass flow rate imbalance at ESP inlet

Figure illustrates velocity streamlines for modified duct

CFD RESULTS-EXISTING

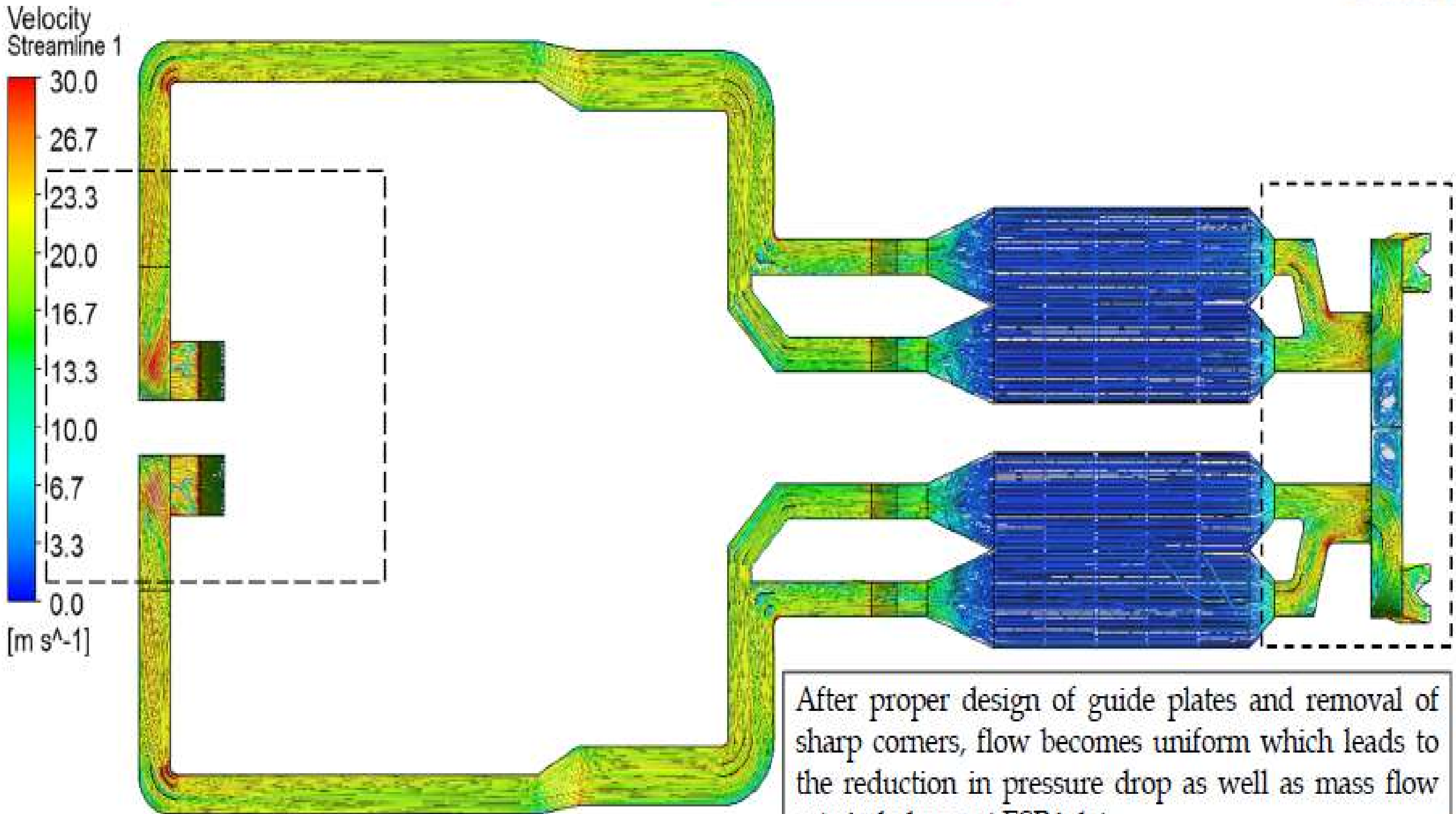


In existing duct arrangement due to sharp corners in duct, flow becomes turbulent and having more recirculation zones which causes high pressure drop as well as mass flow rate imbalance at ESP inlet

Figure illustrates velocity streamlines for existing duct

CFD RESULTS-MODIFIED

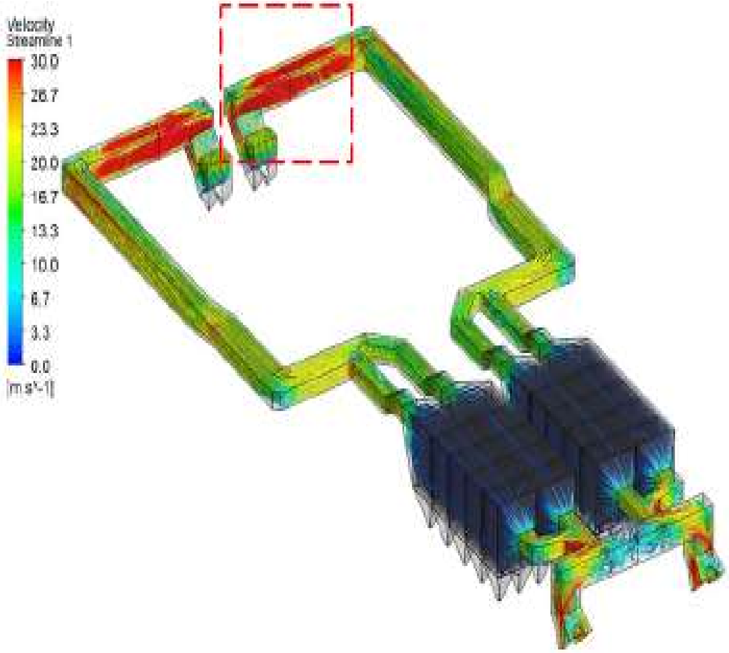
MECHWELL

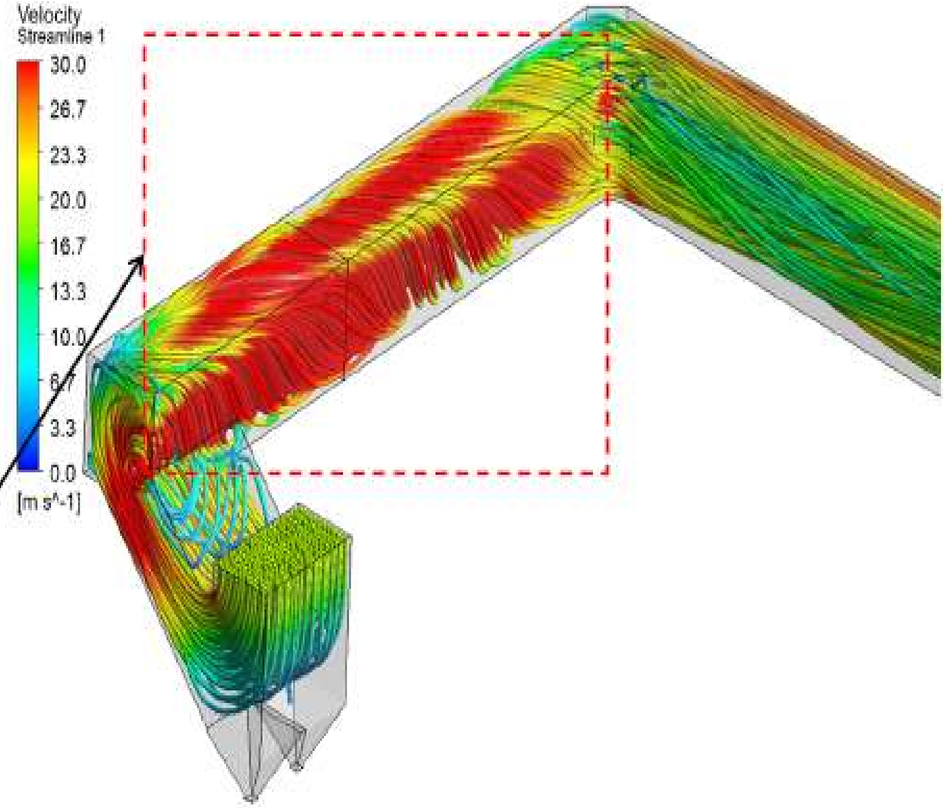


After proper design of guide plates and removal of sharp corners, flow becomes uniform which leads to the reduction in pressure drop as well as mass flow rate imbalance at ESP inlet

Figure illustrates velocity streamlines for modified duct

CFD RESULTS-EXISTING

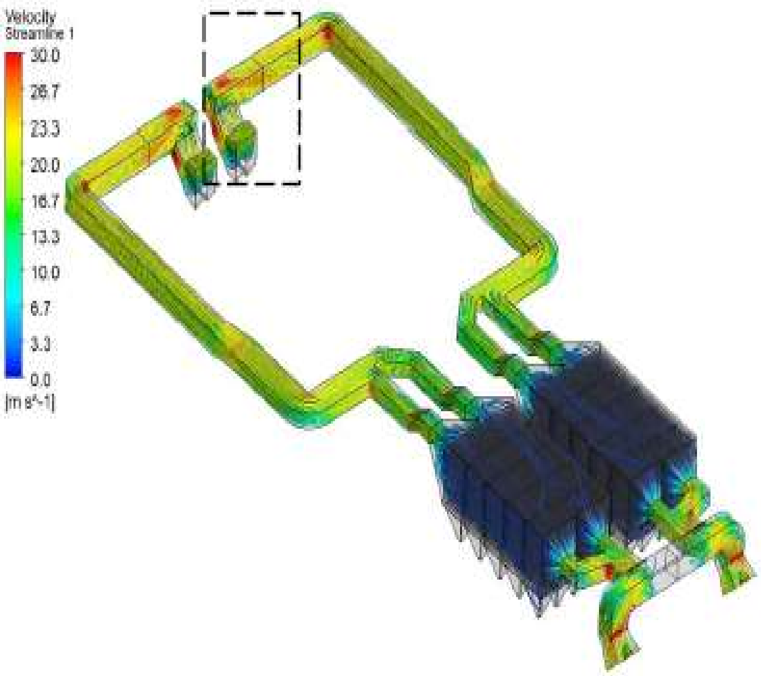


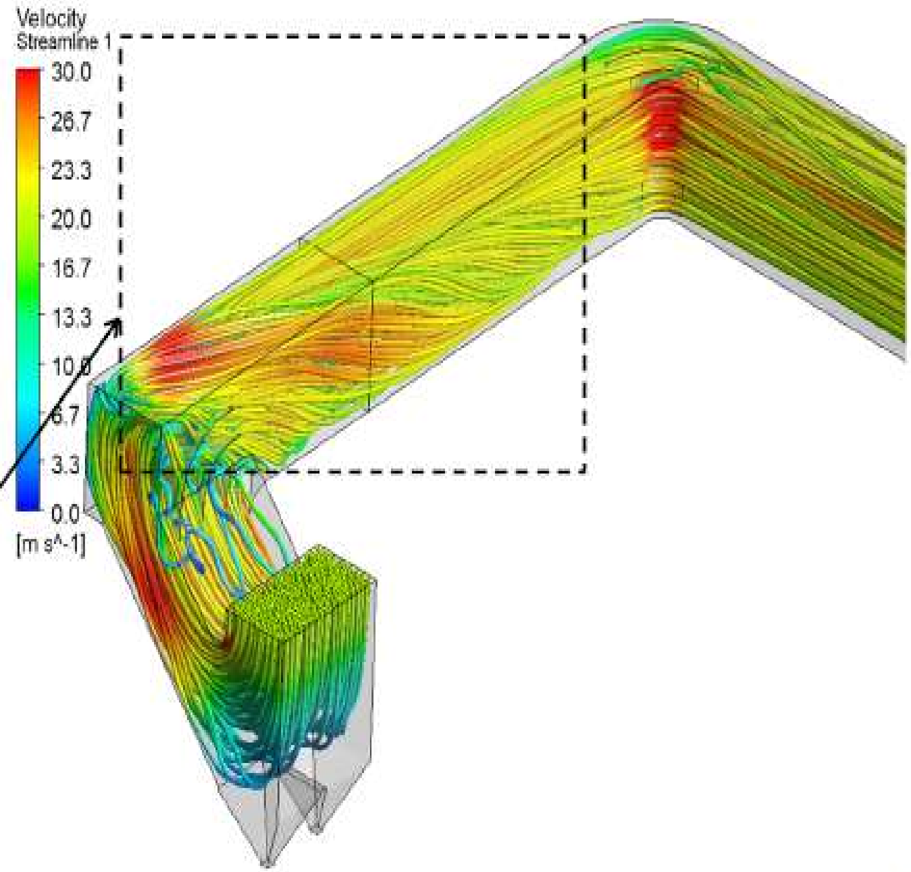


In existing duct arrangement due to sharp corners in duct, flow becomes turbulent and having more recirculation zones which causes high pressure drop as well as mass flow rate imbalance at ESP inlet

Figure illustrates velocity streamlines in AH outlet ducting for existing arrangement

CFD RESULTS-MODIFIED





After proper design of guide plates and removal of sharp corners, flow becomes uniform which leads to the reduction in pressure drop.

Figure illustrates velocity streamlines in AH outlet ducting for modified arrangement

Flue Gas Duct Photos

Flue Gas Duct Photos

Flue Gas Duct Photos

Flue Gas Duct Photos

New deflector plates erection works in the ESP outlet side FG ducts

Flue Gas Duct Photos

- NEW DEFLETOR PLATE IN APH OUTLET

PRESENT DUCT CONDITION

PRESENT DUCT CONDITION

PRESENT DUCT CONDITION

PRESENT DUCT CONDITION

PERFORMANCE IMPROVEMENTS

- From CFD analysis of existing duct it can be concluded that there was flow separation, re-circulation & dead zone in the common duct which creates the high pressure drop &mass flow imbalance problem. These problems were optimized by design of proper guide vanes.
- In existing duct there is flow imbalance of ESP A-1 & A-2 and B-1 & B-2 duct pass

PERFORMANCE IMPROVEMENTS

» By designing the optimized guide vane and duct plates using CFD, the flow is nearly uniform with optimum turbulence & completely avoiding recirculation zone, which result in reduction in pressure drop.

» After modification in ESP inlet & outlet duct ,the flow in A-1 & A-2 and B-1 & B-2 pass of ESP has been balanced within 5% of the average flow rate.

» After modification, the pressure drop reduction from APH outlet to ESP Inlet & ESP outlet to ID Fan inlet is 40 mmWC across the system

❖ FLUE GAS LEAKAGES ARRESTING IN PENT HOUSE WORK CARRIED OUT

» Huge quantity of fly ash dumped in pent house area was cleaned totally.

» The pent house was completely water washes.

PENT HOUSE SEALING

» The area of leakages were identified & arrested by seal plates with proper welding and providing flexible membrane consist of

- ❑ Ceramic wool matters,
- ❑ Asbestos blanket
- ❑ Accplazt 55 (Chemical component)
- ❑ SS wire mesh

PENT HOUSE SEALING WORK

PENT HOUSE SEALING WORK

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PENT HOUSE SEALING WORK

❖PERFORMANCE IMPROVEMENTS

- » Since the leakage of flue gas has been totally arrested
- » Effective turbulence inside the boiler has been enabled
- » Clean environment in pent house area was ensured
- » Loading of ID fans got reduced considerably

OVERALL PERFOMANCE IMPROVMENT

SL.NO	Description	Before COH	After COH
1)	Induced draft fan scoop	99/100 %	67/67 % ↓
2)	Induced draft fan current	141/134 A	102/102 A↓
3)	Primary air fan current	100/97 A	95/94 A↓
4)	Forced draft fan current	45/42 A	43/44 A↔

HIGH PRESSURE JET CLEANING IN BOILER PRESSURE PARTS WORK CARRIED OUT.

» High pressure water jet cleaning was carried out in boiler pressure parts area using water jet pump with 200 Ksc.

PERFORMANCE IMPROVEMENTS

- Heat pickup got increased in water wall and super heater area .
- Hence the attemperation got reduced appreciably there by increasing the boiler efficiency .

PARTIAL REPLACEMENT OF CONDENSER TUBES

Total No. of tubes available: 15620 Nos

Replaced tubes : 3763 Nos

% of tube replacement : 24%

Benefit achieved : Around 10 mm of Hg

Replacement Area : Top portion of condenser on both left and right

Reason for replacement : Scaling

PERFORMANCE IMPROVEMENTS

- Condenser vacuum improved from 670mmHg to 680mmHg at cooling water temperature of 30°C.

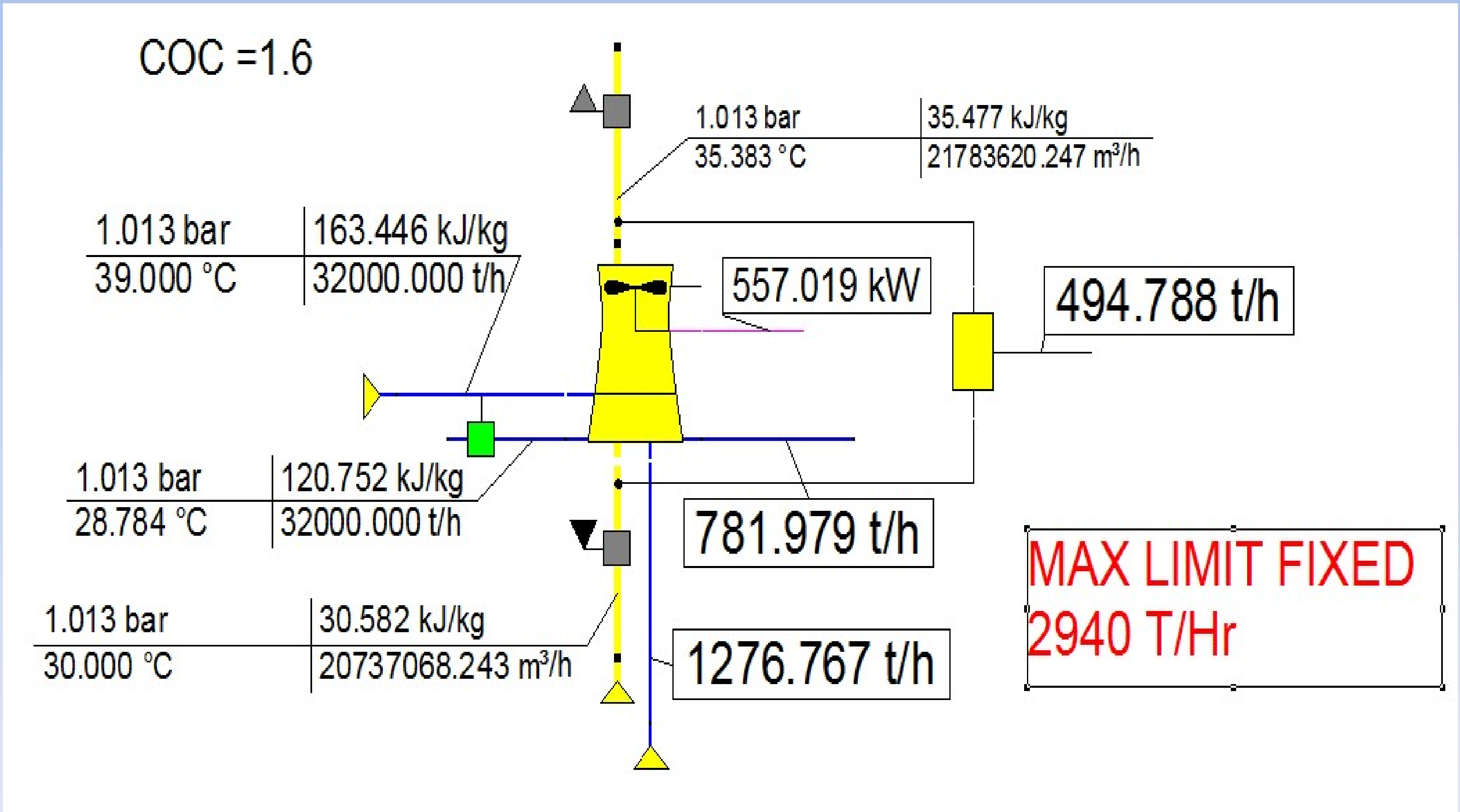
Over all Improvements Achieved

- APH Leakage reduced to less than 8%.
- APH outlet flue gas temperature reduced by around 15^0C.
- Around 20^0C to 25^0C temperature improvement achieved in Primary and Secondary Air of APH.
- ID fan loading reduced to around 20% to 25% and maintains the same state till date.
- After optimization of flue gas flow in the duct, around 40mmWc pressure drop reduction achieved from APH outlet to ID fan.
- Appreciable improvement in the condenser vacuum.

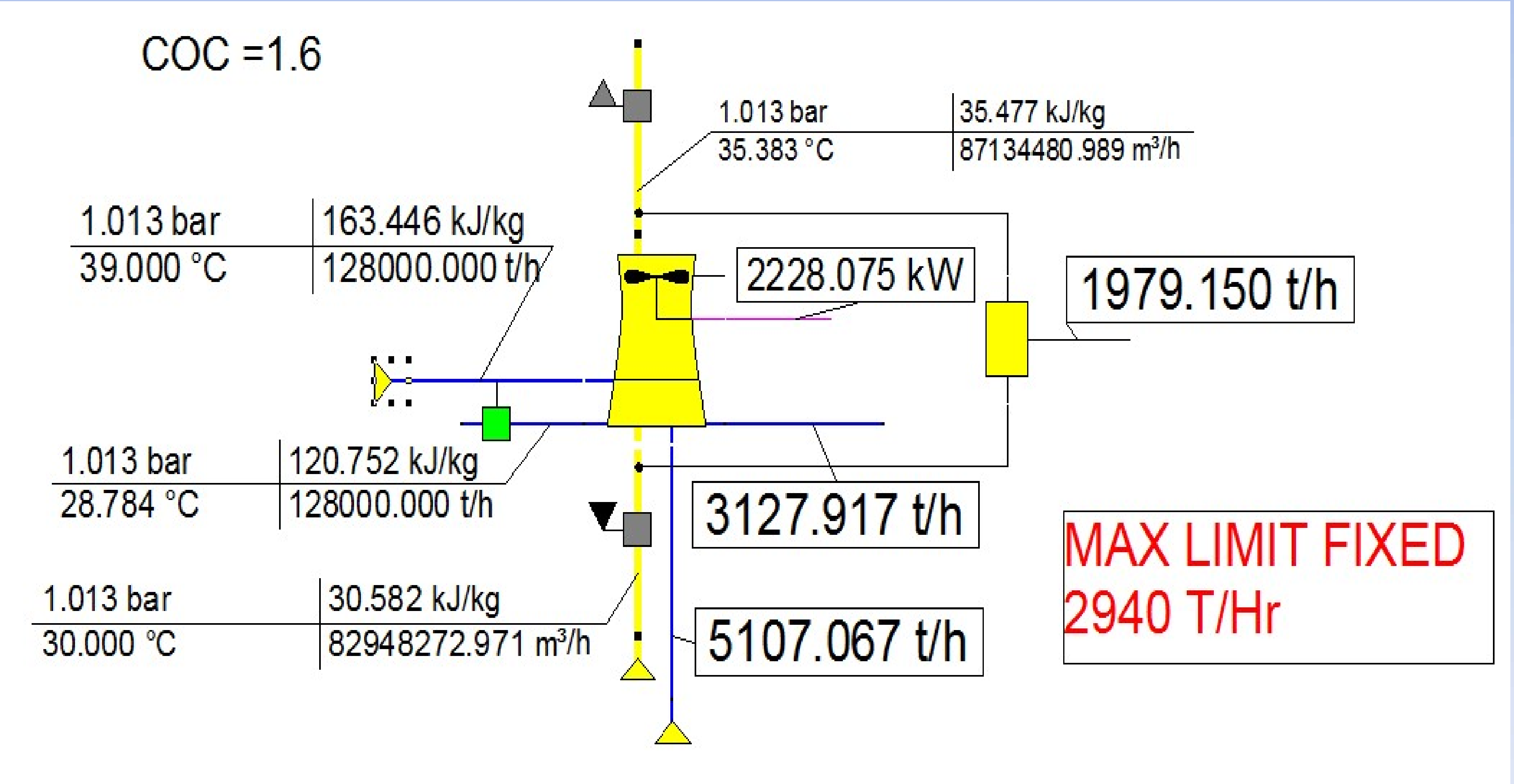
Study on reduction of Raw water Consumption

- MTPS has induced draft cooling tower system for cooling water system.
- At present Cycle of concentration is 1.6.
- Condenser tube material is cupro-nickel 90/10.
- At present Raw water consumption of MTPS for all the four units is around 5200 M^3 per hour.
- This corresponds to 6.19 M^3 / MW.
- Present specific water consumption norms is 3.5 M^3/ MW.
- To fix the Required COC study was carried out using EBSILON .

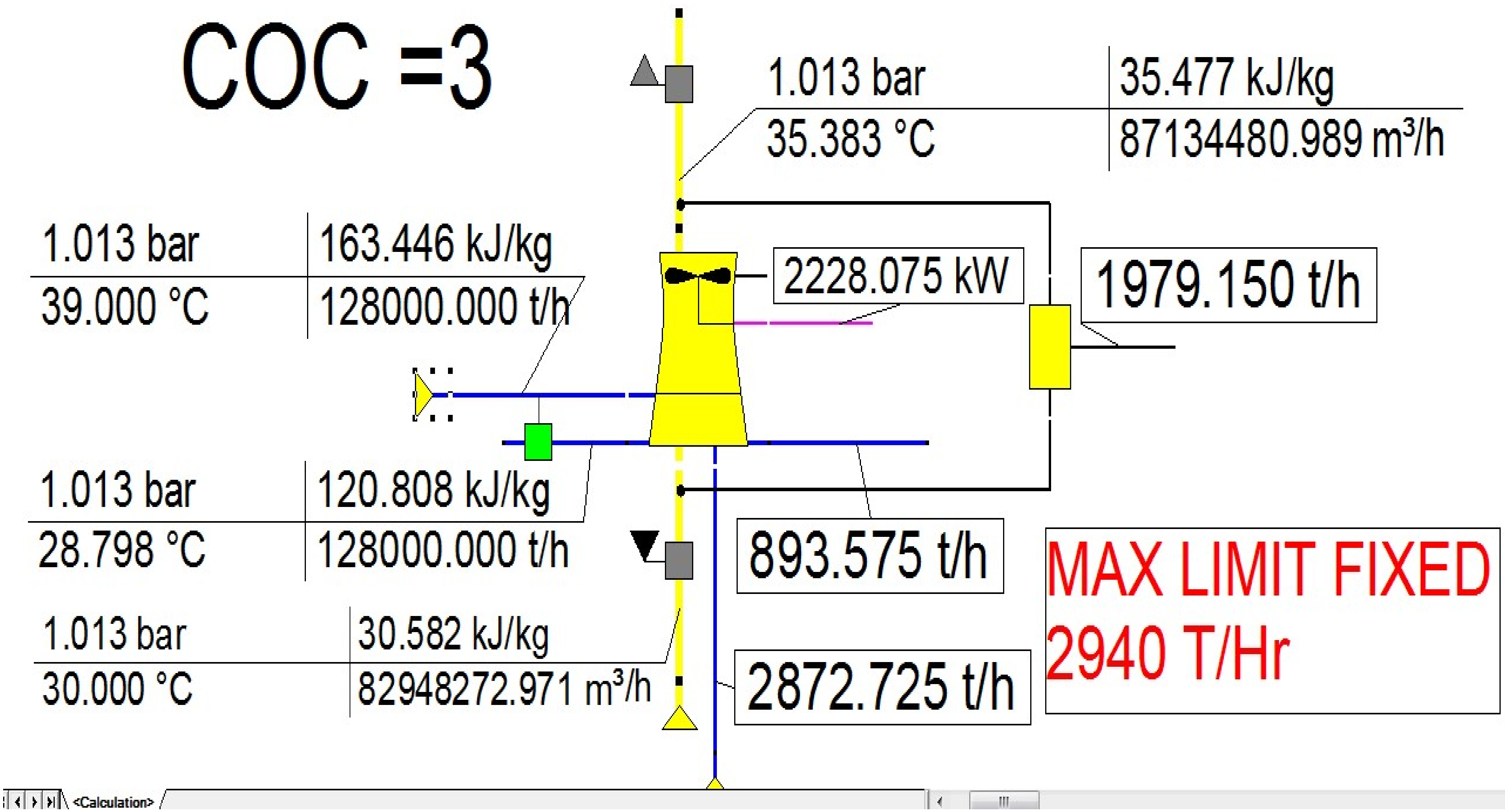
UNIT WISE CONSUMPTION OF COOLING WATER



FOR ALL THE FOUR UNITS
2940/5200



BY CHANGING COC TO 3
2940/5200



Study on reduction of Raw water Consumption

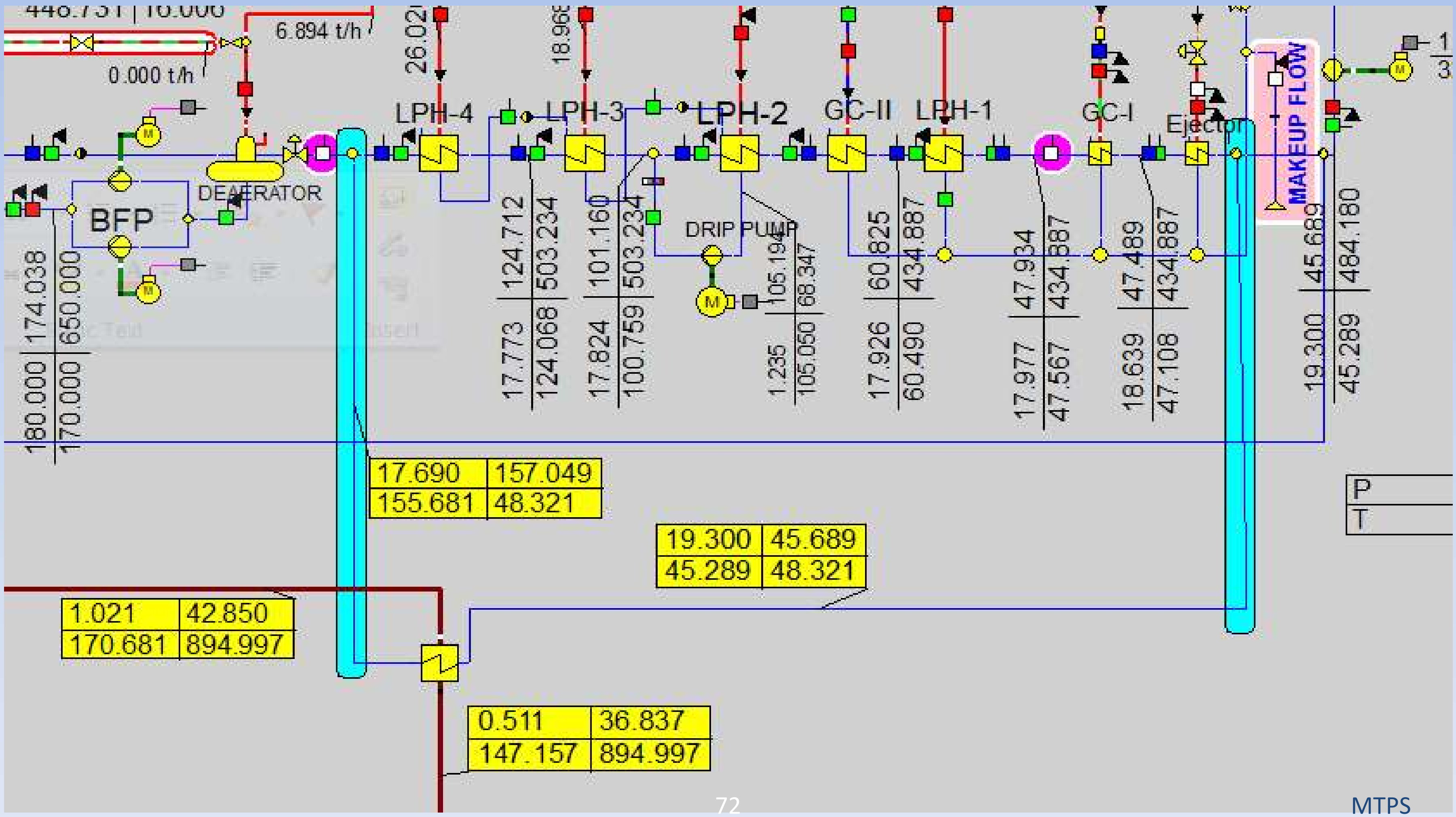
- Now based on the above results, discussions are going on with the suppliers to raise the COC of the system to 3.5 by admitting Sulphuric acid in the cooling water system.

- All calculations such as Sulphuric acid requirement per day, Tank storage capacity Etc. are corresponds to 3.5 COC.

STUDY ON HEATING OF CONDENSATE WATER IN THE FLUE GAS DUCT FOR HEAT RECOVERY

- In MTPS long flue gas ducts are available .
- APH outlet temperature is high in the order of 170°c
- It is proposed to heat 10 % of condensate water in the flue gas duct
- Improvements observed is around 10 kcal/kwhr

AFTER DIVERSION OF 10 % CONDENSATE TO HEAT AT FLUE GAS DUCT



BEFORE AND AFTER DIVERSION OF 10 % CONDENSATE TO HEAT AT FLUE GAS DUCT

TURBINE HEAT RATE= 2052.3 kcal/kWh

UNIT GROSS HEAT RATE = 2228.5 kcal/kWh

Plant Economy

	Power	Efficiency	Unit Heat Rate
Gross	209.0 MW	38.44 %	2228.5 kcal/kWh
Net	191.0 MW	35.13%	2438.5 kcal/kWh
Boiler Efficiency		92.10 %	TG Heat Rate
Coal Consumption		93.01 t/h	2052.3 kcal/kWh
Main Steam Flow(HPT Inlet)		646.00 t/h	2245.7 kcal/kWh
Specific Coal Consumption		0.44	
Specific Steam Consumption		3.09	

TURBINE HEAT RATE= 2041.7 kcal/kWh

UNIT GROSS HEAT RATE = 2216.9 kcal/kWh

Plant Economy

	Power	Efficiency	Unit Heat Rate
Gross	210.1 MW	38.64 %	2216.9 kcal/kWh
Net	192.1 MW	35.33%	2424.7 kcal/kWh
Boiler Efficiency		92.10 %	TG Heat Rate
Coal Consumption		93.01 t/h	2041.7 kcal/kWh
Main Steam Flow(HPT Inlet)		646.00 t/h	2233.0 kcal/kWh
Specific Coal Consumption		0.44	
Specific Steam Consumption		3.07	

Area of attention needed to improve the Heat Rate

Coal yard Management system

Problem faced

- FIFO system not followed due to coal demand, Long travel time of SCR etc.,
- Spontaneous combustion in coal yard
- Very long period of storage of coal in the coal yard.
- Coal received for MTPS-I through wagon from long distance. Hence deterioration in coal quality is more.

The Targeted Heat rate in the PAT scheme unable to be achieved due to above reasons even though the machines are in good condition.

THANKS

- My sincere thanks to:
  - » Er. Chandrasekaran, CEA
  - » Er.Vikas Ranjan, BEE
  - » M/s GEZ Germany
  - » Er.Bobin Anto, STEAG
  - » Er. Patnayak, STEAG

»To all the participants of the session.

THANKYOU.

M.RAMACHANDRAN
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METTUR THERMAL POWER STATION-1

Thank You