Boiler Controls & Instrumentation

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PART I - BOILER BASICS

PART 2 - INSTRUMENTATION

PART 3 - CONTROLS

BOILER BASICS

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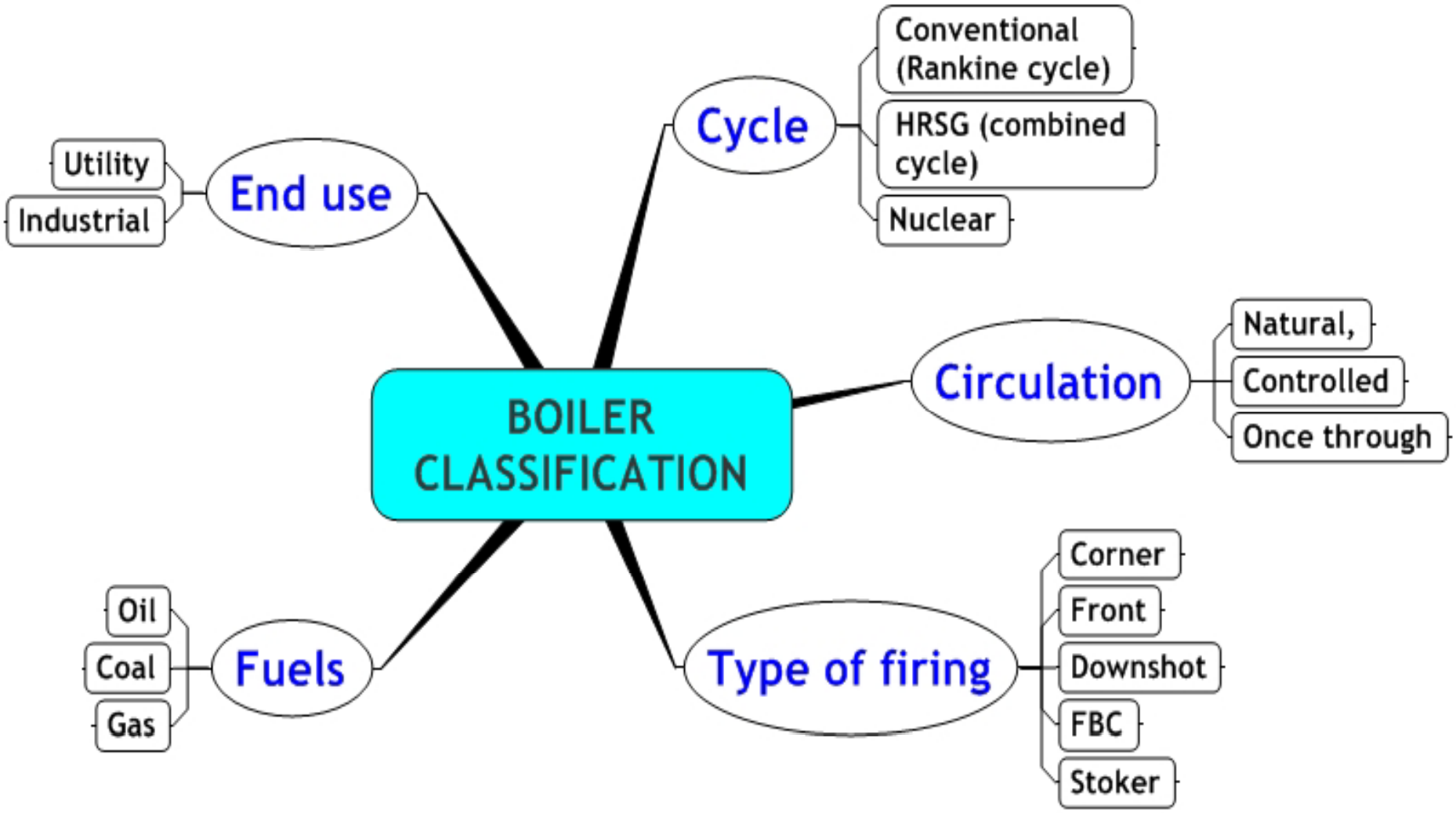
BOILER CLASSIFICATION

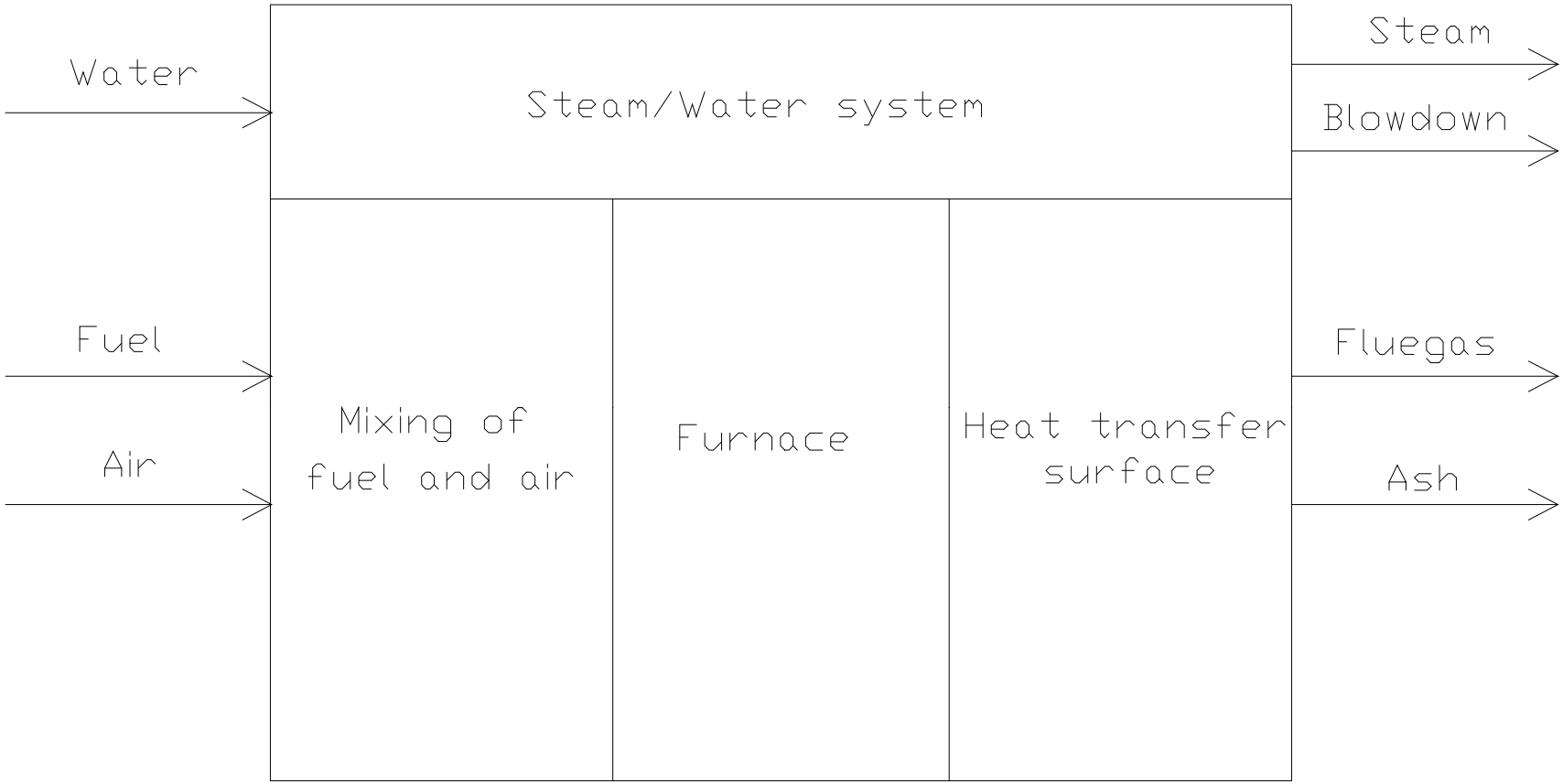


BHEL BOILERS

- **Power Boilers**
  - *Up to 600 MW rating(Coal, oil and gas fired - Subcritical)*
  - *Up to 800 MW - Supercritical*

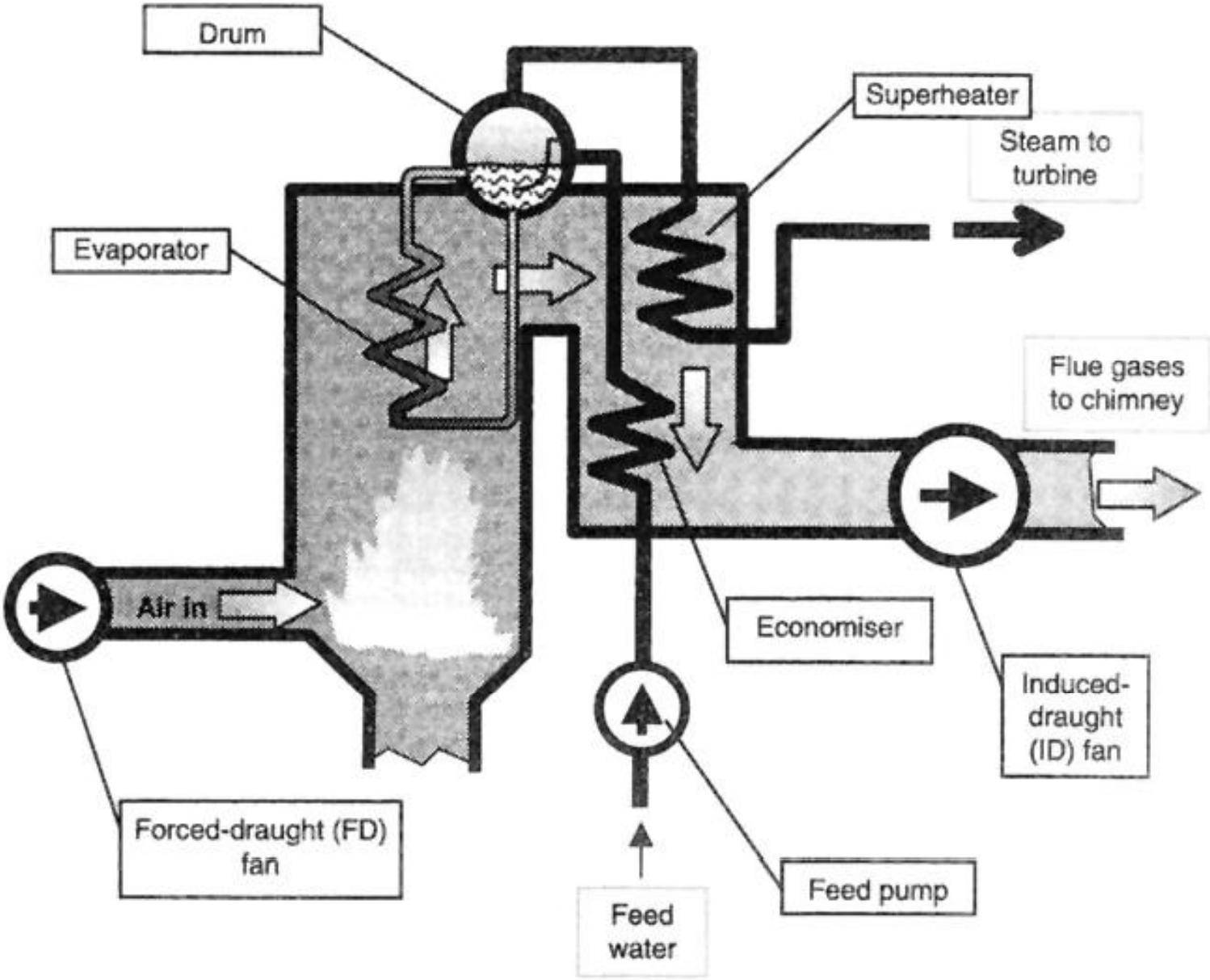
- **Nuclear steam generators**
  - *Up to 235 MW rating*

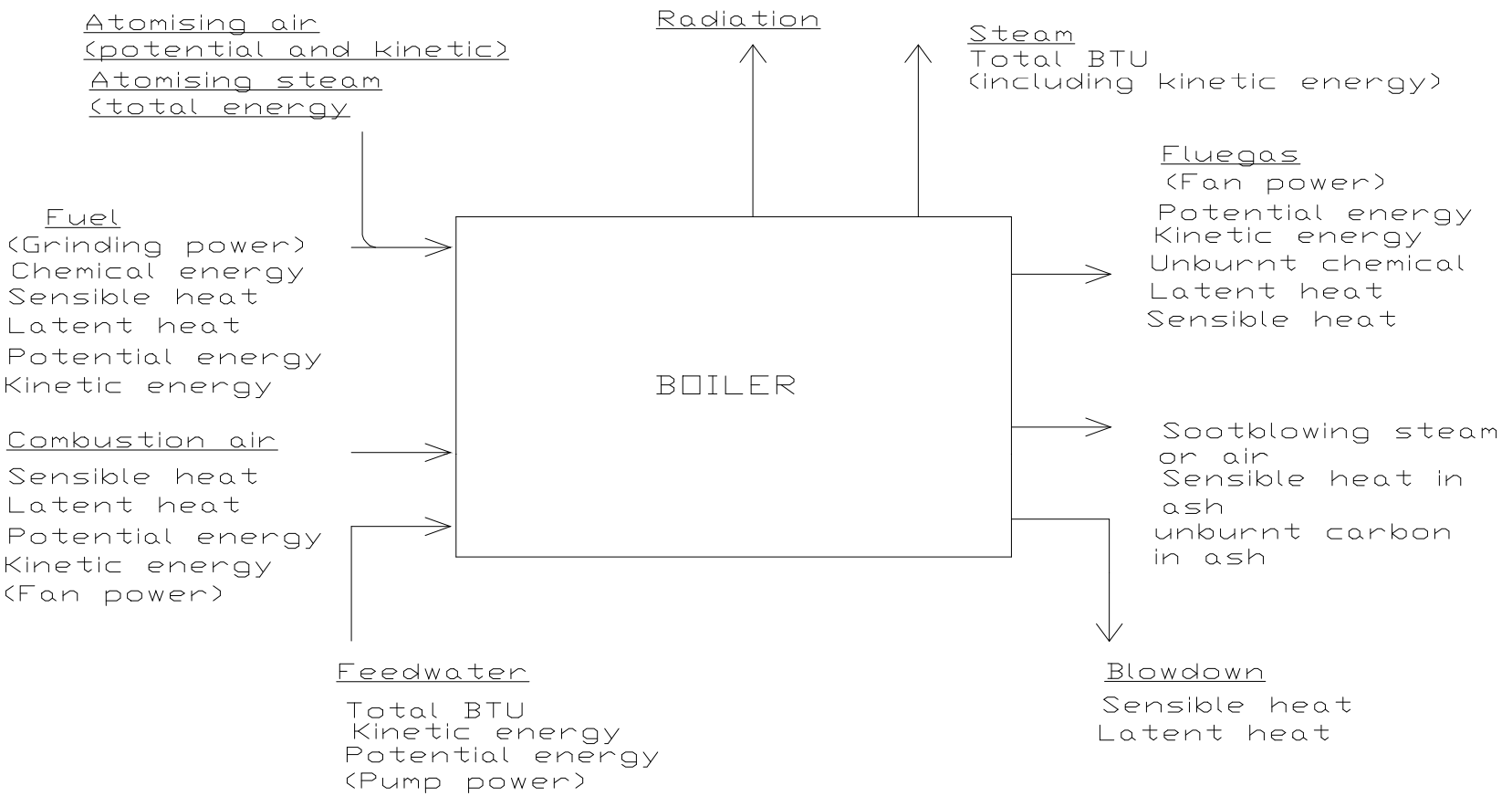
- **Industrial boilers**
  - *Up to 450 Tonnes/hour rating*
  - *Fertilisers, Petrochemical, Steel & Paper industries*
  - *Wide range of fuels- Oil, Gas, BFG, Bagasse, Black liquor.*



Basic diagram of a boiler

Schematic of a boiler





- Input ± Change in stored energy = output
- Stored energy increases as firing rate increases
- Sootblowing loss is periodic

Energy balance – Heat balance

UTILITY BOILERS - ESSENTIAL COMPONENTS

- Furnace & Circulation system
- Superheaters
- Reheaters
- Economiser
- Airheaters
- Fans
- Pulverisers
- Raw coal feeders
- Fuel firing system
- Sootblowers

CIRCULATION SYSTEMS

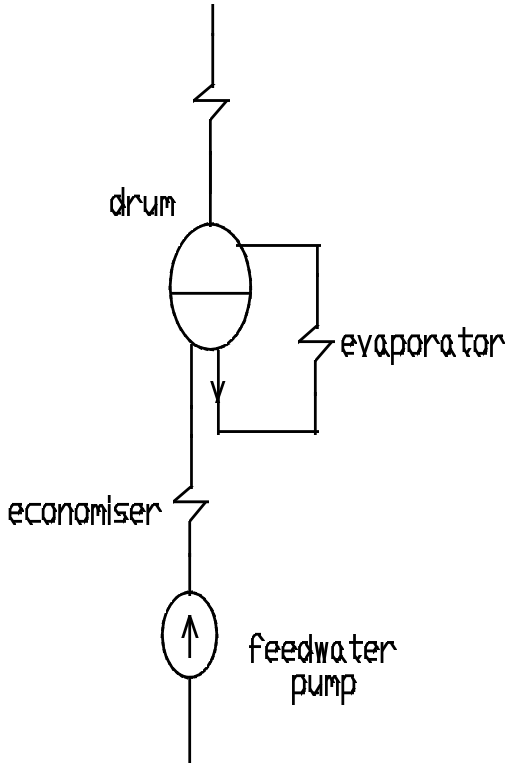
- Natural circulation
- Controlled circulation
- Once through

Circulation ratio :

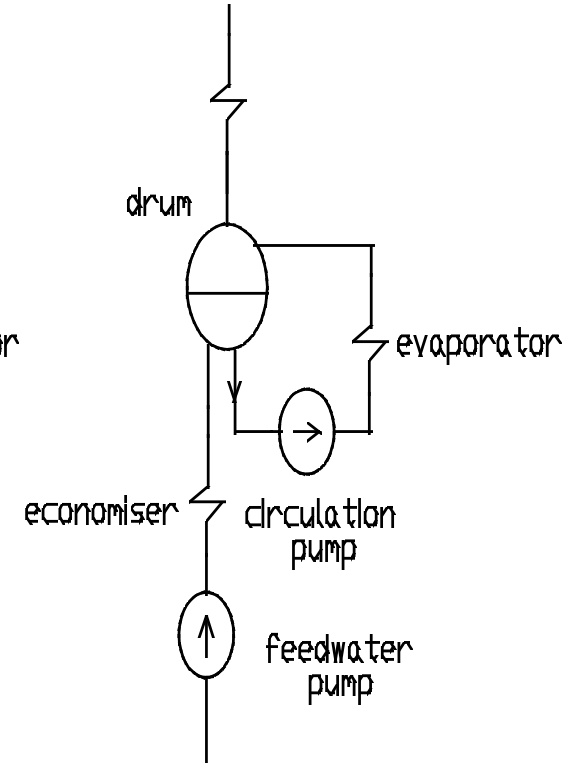
Mass rate of water fed to the steam generating tubes to the mass rate of steam generated.

Natural circulation	6
Controlled circ	4
Once through	1

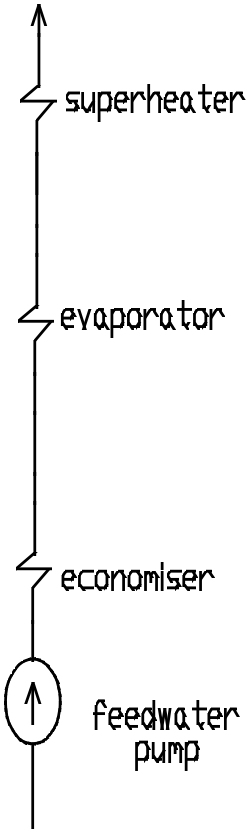
BOILER CIRCULATION SYSTEMS



Basic scheme of a
natural circulation boiler



Basic scheme of a
forced circulation boiler



Basic scheme of a
Once through boiler

Fans

Types

- **Centrifugal fans** (Radial Flow fans)

  Air enters parallel to axis and leaves perpendicular to axis

- **Axial flow fans**

  Air enters parallel to axis and leaves parallel to axis

Fans

1. **Axial**
   - ***Impulse type - IGV Control.***
   - ***Reaction type - Blade pitch Control*.**

2. **Radial**

Inlet damper control, Variable speed control;
Variable speed control by two speed motor,
Hydraulic coupling or Variable frequency drive.

RADIAL FANS - SPEED CONTROL

- Flow proportional to Speed
- Flow proportional to cube of (Impeller Dia)

- Head proportional to Square (Speed)
- Head proportional to Square (Impeller Dia)

Hence Variation in speed alters the performance

FANS IN BOILER - SCOPE

- **Primary air fans - Dries & transports Pulverised coal**
- **Forced draft fans - Supplies Combustion air**
- **Induced draft fans - Sucks Flue gas out of furnace**

MILL - GRINDS COAL

- **Slow speed** mills (Tube mills - 15 to 25 RPM)
- **Medium speed** mills (Bowl mill, Ball and race mill etc.- 50 to 100 RPM)
- **High speed** mills (hammer mills directly coupled to motor - 750 to 1000 RPM)

RAW COAL FEEDERS

Scope : **CONVEY RAW COAL TO MILL**

Types :

- **Volumetric - Rotary and drag link,**
- **Gravimetric – Endless belt type**

AIRHEATER

Heat recovery equipment

Extract heat from Flue gas to heat primary & secy. Air

Types :

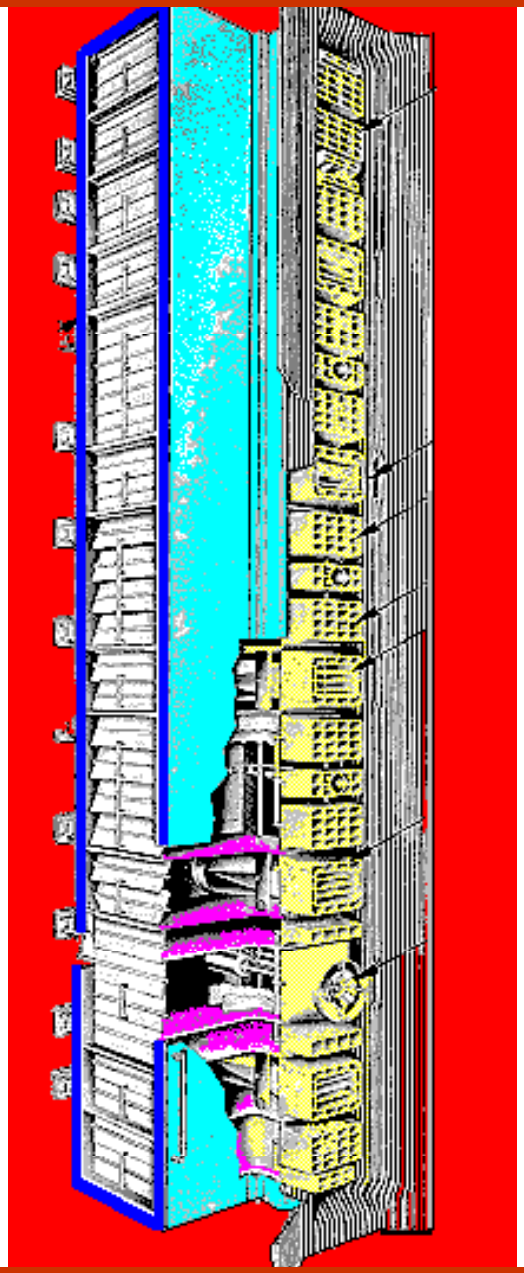
- ***Regenerative type*** **(Rotating drive)**
- ***Tubular type***

SOOTBLOWERS

Remove ash & slag from pressure part tubes

Types

- **Long retractable sootblowers - traverse & rotary motors**
- **Half retractable sootblowers- traverse & rotary motors**
- **Rotary blowers - rotary motor**
- **Wall blowers - traverse & rotary motors**
- **Furnace temperature probe - Used during boiler start up**

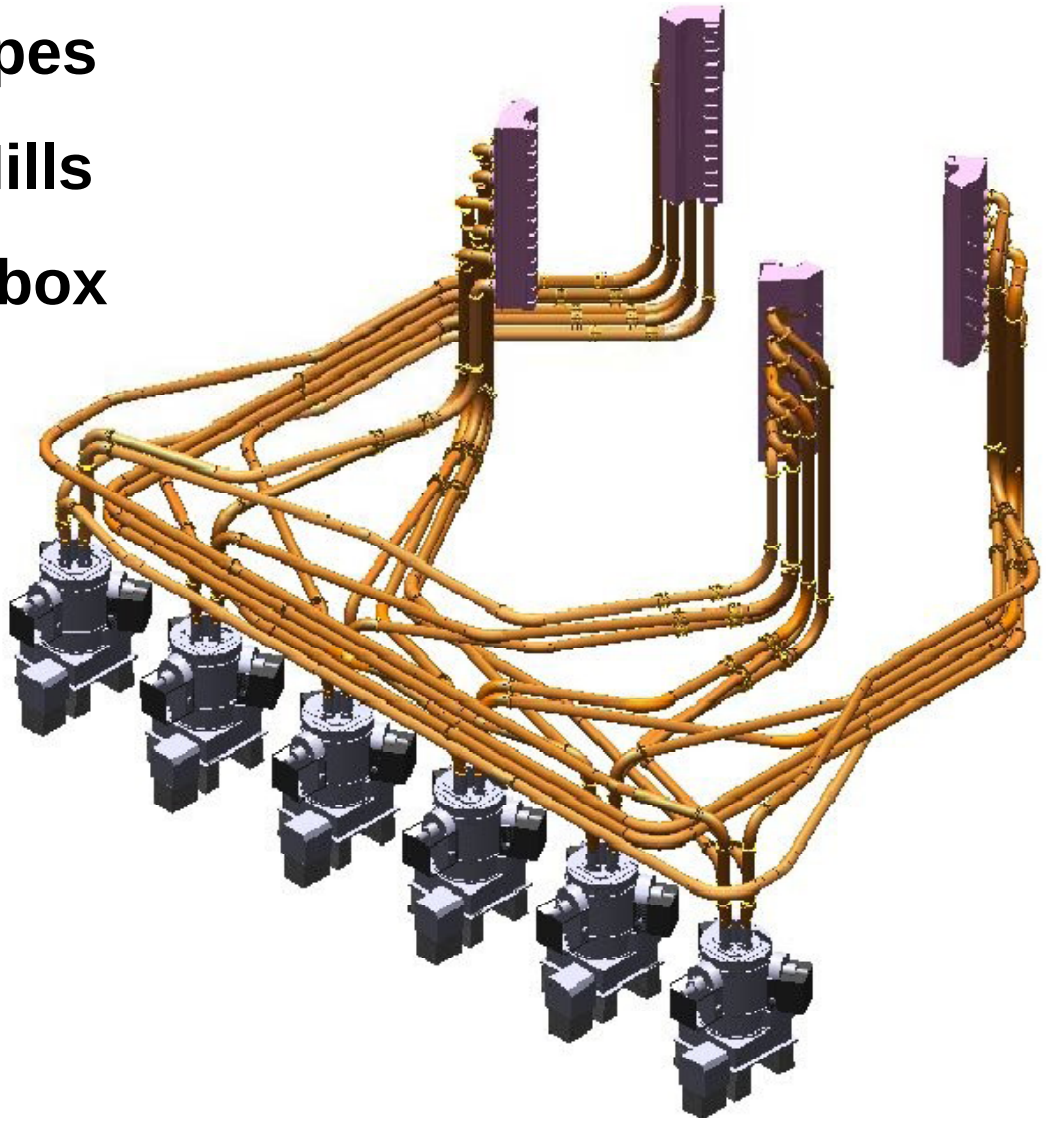


Tangential Firing Assembly ‘Windbox

Coal Pipes

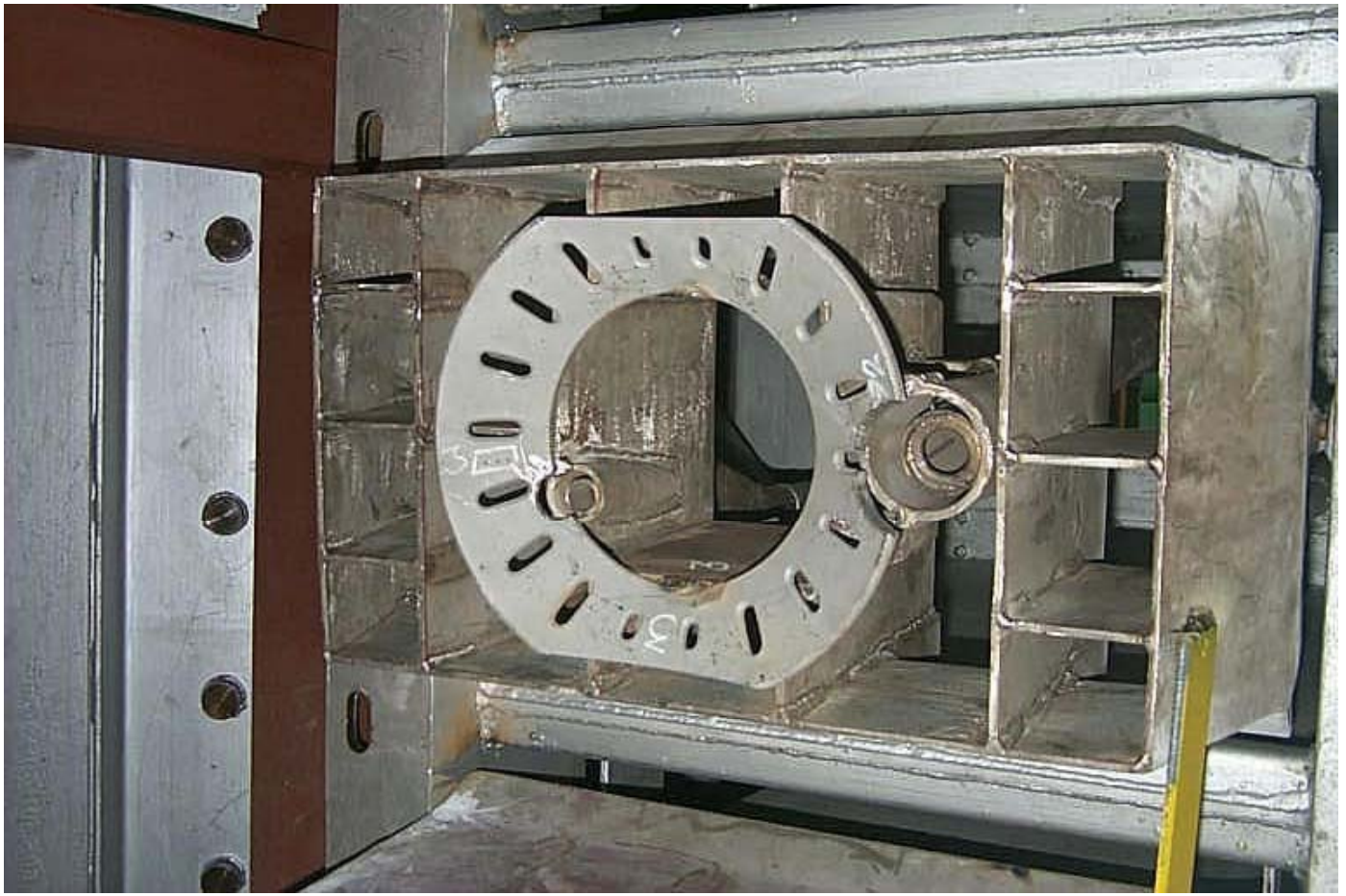
From Mills

to Windbox



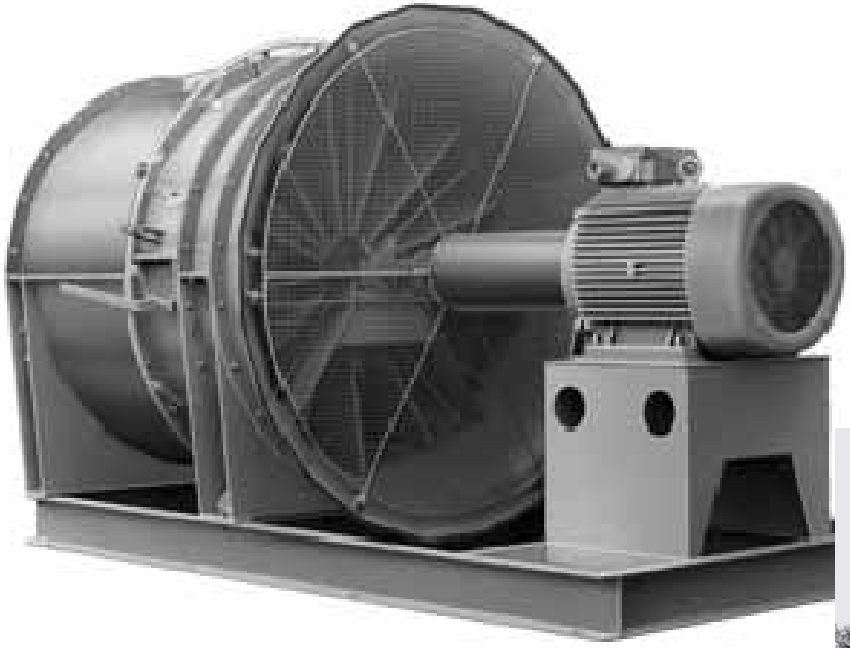
Coal burner

Oil burner



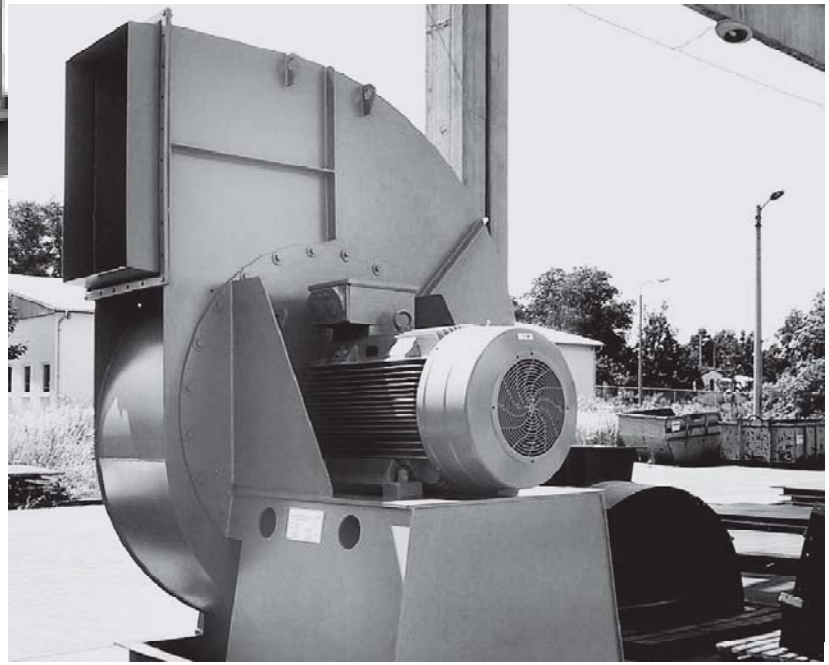
Windbox in shop

Burner tilt lever



Axial Fan

Radial Fan



Pulveriser

Pulveriser

Gravimetric coal feeder

BOILER CONTROLS

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BOILER CONTROLS

Continuous control :

Objective

Enabling Automatic Operation.

Optimising operating performance.

On-Off control :

Objective

Supervise process operation for safety

Prevent process from entering hazardous region.

BOILER CONTROLS

- Auto control system
- Boiler Auxiliaries interlocks & protection system
- Furnace safeguard supervisory system (FSSS)

Auto control system.

- Master demand
- Combustion and draft control
- Feed-water control
- Steam-temperature control

Master demand

- 'Master demand' controls the boiler operation.

- Steam is generated by burning fuel.

- ‘Master demand’ sets burners firing at a rate required for steam production.

- Firing rate requires FD fans to deliver adequate air for combusting the fuel.

Master demand

- Air input requires products of combustion to be expelled from furnace (by ID fans).

- Water must be fed into boiler to match steam production.

Master demand

- Air input requires products of combustion to be expelled from furnace (by ID fans).

- Water must be fed into boiler to match steam production.

- Boiler is a complex, multivariable, interactive process.

- Each of the above parameters affects/ is affected by all of the others.

Master demand

Functions of 'Master demand' :

- Sets the firing rate
- Regulates quantity of combustion air to match fuel input
- Regulates quantity of feed water to match steam production

Master demand

Design of the master system :

***Power Demand*….**

…..Fed primarily to turbine (Boiler-following control)

…..Fed directly to boiler (Turbine-following control)

……Fed to both (Co-ordinated unit control).

Combustion and draft control

- Air Flow Control
- Fuel Flow control
- Coal mill control

Objective :

Fuel is consumed at a rate that exactly matches the Steam demand.

Fuel is consumed safely, so that the energy is released without risk to plant, personnel or environment

Combustion and draft control

Boiler Master demand provides the common demand for both fuel and air control.

Total unit fuel demand is obtained with lesser of the actual air flow or the Boiler master demand as set value

Unit air flow demand is obtained with greater of the actual fuelflow or the boiler master demand as set value

Unit air flow demand is adjusted in response to measured flue gas 02 and CO

Total corrected Fuel flow signal is obtained by summing up individual fuel flow signals

Combustion and draft control

Coal mill control

Objective :

To maintain adequate Primary Air velocity while transporting coal from mill to furnace.

To regulate PA temperature to "dry" coal as it is transported to furnace.

Feedwater control

Objective :

To supply enough water to the boiler to match the evaporation rate.

Water level in the drum provides an immediate indication of water contained by the boiler

Actual Steam Flow is a useful feedback to correct for required feedwater during transient conditions when level may not be accurate.

Difference between Actual steam flow and Actual Feedwater Flow is added to the level error to form the 'Feedwater demand'.

Steam temperature control

As the steam flow increases, steam temperature in radiant zone decreases where as steam temperature in convection zone increases.

Radiant zone tubes

The increasing fluid flow takes away more heat that falls on the metal.

So steam-temperature/steam-flow profile for radiant zone shows a decline as steam flow increases.

Steam temperature control

Convection pass tubes:

Steam temperature in convection pass increases with steam flow increase.

Higher heat transfer by increased flow of gases increases the steam temperature.

Steam temperature/ Steam-flow profile for convection pass shows a rise in temperature as the flow increases.

Steam temperature control

Attemperation is to pump a fine spray of comparatively cool water droplets into the vapour to reduce steam temperature.

Intermixing of hot steam and cold water causes the coolant to evaporate.

Final mixture is an increased volume of steam at a temperature lower than that prior to the water injection point.

This cooling function is achieved in the attemperator.

Steam temperature control

Fireball can be moved to a higher or lower level in the furnace.

This is achieved by tilting burners upwards or downwards with respect to a midpoint.

Fireball repositioning changes the heat transfer pattern in tube banks.

Controlling steam temperature by use of tilt is predominantly used for RH Steam temp control.

BOILER AUXILIARIES INTERLOCKS AND PROTECTION SYSTEM

Scope :

Sequence control of starting and Protection & interlocking of boiler auxiliaries like

- **FD fans,**
- **ID fans,**
- **PA fans,**
- **Airheaters,**
- **Dampers,**
- **Valves, etc.**

CONDITIONS EXISTING WHEN THE UNIT IS SHUT DOWN AND PRIOR TO STARTING OF ID FANS.

- ID fan 'A' and ID fan 'B' off.
- Regulating vanes of fans A & B fully open
- Inlet dampers of ID fans A & B open
- Outlet dampers of ID fans A & B open
- The regulating vanes will be on manual control during shutdown, and signal from furnace draft control to regulating vanes of ID fans disconnected.
- Lube oil pumps off(if applicable)

Starting ID Fan 'A' (ID fan 'B' off)
ID fan 'A' shall be prohibited from starting till the following conditions are satisfied:

- Regulating vanes of ID Fan-A in minimum position.
- Outlet damper of ID Fan-A closed.
- Inlet damper of ID Fan-A closed
- Lube oil pressure to the ID fan-A bearing adequate (lube oil pressure adequate lamp indication shall be provided on the control on the control desk) if FOLS is applicable.
- ID Fan and Fan motor bearing temperature not very high.
- One of the airpreheaters running.
- Motor winding temperature not very high.

When ID fan 'A' is started (ID Fan B is off), impulses shall be given for:

- Opening the inlet damper and outlet damper of ID fan A after the motor reaches rated speed.
- Connecting the regulating vanes/scoop tube control of ID fan A to the auto control.
- Opening the interconnecting dampers (if applicable)
- Closing the inlet gate and the outlet gate of ID fan B and bringing the regulating vanes/scoop tube control to minimum position.
- Permission to start either FD Fan A or FD Fan B.

Tripping of ID Fan A (ID Fan B is off)- ID fan 'A' shall trip automatically under following conditions.

- ID fan A bearing temperature too high (prior to this, ID fan A bearing temperature high shall be annunciated in UCB)
- ID fan A motor bearing/winding temp. too high (prior to this, ID fan 'A' motor bearing/winding temperature high shall be annunciated in UCB)
- Lube oil pressure is very low and very low condition remain for certain fixed time 10 secs (if FOLS is applicable)
- Post purge fan trip from FSSS
- Vibration level of fan or motor very high (high to be alarmed)
- ID fan A motor protection acted.

When ID fan A trips (ID fan B is off) impulses shall be given for:

- **Opening the outlet damper of ID fan B**
- **Opening the inlet damper of ID fan B to wide open position.**
- **Disconnecting the impulse from auto control system (output from A/M station)**
- **Opening the regulating vanes/scoop control of ID fan A to wide open position.**
- **Tripping the working FD fans.**
- **Boiler tripping.**
- **To keep the inlet gate and outlet gate of ID fan A open**

Tripping of FD fan A (FD fan B is off)- FD fan A shall trip automatically under the following conditions:

- FD fan A bearing temperature too high (prior to this, FD fan A bearing temperature high will be annunciated in UCB)
- FD fan A motor bearing/winding temperature too high (prior to this, FD fan A motor temperature high will be annunciated in UCB)
- Both ID fans trip
- Vibration level of fan or motor very high (high to be alarmed)

When FD Fan A trips (FD fan B is off) impulses shall be given for:

- Disconnecting the impeller control drive from auto control system (output signal from A/M station)
- Bringing the impeller of Fan A to the maximum position
- Bringing the impeller of FD fan B to the maximum position
- Opening the outlet damper of FD fan B
- To open the emergency scanner air damper
- Boiler tripping
- The outlet damper of FD fan A shall remain open

Starting PA fan A (PA fan B off)- PA fan A shall be prohibited from starting until the following conditions are satisfied:

- **Regulating vanes of PA Fan A in the minimum position**
- **Outlet damper of PA fan A in closed position**
- **Anyone FD fan is on**
- **Purge complete**
- **PA fan and fan motor bearing temperature not very high**

When PA fan A is started (PA fan B is off), impulses shall be given for:

- Opening the outlet damper of PA Fan A after the motor reaches rated speed
- Connecting the regulating vanes of PA fan A to auto control
- Bringing the regulating vanes of PA fan B to the minimum position
- Closing the outlet damper of PA fan B
- Permission to start any three mills through FSSS.

PA fan A shall trip (PA fan B is off) under the following conditions:

- PA fan A bearing temperature too high (prior to this bearing temperature high shall be annunciated in UCB)
- PA fan A motor bearing/winding temperature too high (prior to s, this motor bearing/winding temperature high shall be annunciated in UCB)
- Boiler trips
- Vibration level of fan or motor very high (high to be alarmed)

When PA fan A trips (PA fan B is off), impulses shall be given for:

- Disconnecting the regulating vanes of PA fan A from auto control
- Bringing the regulating vanes of PA fan A to minimum position
- Closing the outlet damper of PA fan A
- Bringing the regulating vane PA fan B to minimum position
- Closing the outlet damper of PA fan B
- Tripping all the operating mills (done through FSSS)

When PA fan B trips (PA fan A is on), impulses shall be given for:

- Disconnecting the regulating vanes of PA fan B from auto control
- Bringing the regulating vanes of PA fan B to minimum position
- Closing the outlet damper of PA fan B
- Energisation of partial load relay (load to be limited to 60%)
- Tripping mills in excess of three through FSSS

Starting AH A (AH B is off):

- AH A electric motor is started if the sump oil temperature of the bearings measured through RTD is less than 70
- Whenever AH A electric motor trips impulses shall be given for starting AH A air motor by de-energising the solenoid provided the sump oil temperature of support/guide bearing of AH A is less than 70
- Impulse shall be given for closing of the inlet and outlet dampers of AH B which is off

Tripping of AH A (AH B is off)

- Whenever the sump oil temperature of support/guide bearing is greater than 70 c an alarm shall be initiated through RTD to alert the operator. The operator shall check the circulation pump operation and the coolant flow at local to bring down the sump oil temperature. In case if the temperature of sump oil is unable to be brought down AH electric motor/air motor shall be tripped manually.
- Air motor shall trip automatically when AH A electric motor starts.

Both AHs are working when AH A trips & AH B continues to run:

The gas inlet damper, the secondary air outlet damper and primary air outlet damper of the tripped AH shall automatically closed. The gas outlet damper, the secondary air inlet damper and PA fan inlet damper (if provided) of the tripped AH need not be closed. However, if the operator wants to manually close these dampers they can be closed.

BOTH AHS ARE TRIPPED:

If both AHs A & B trip the operator may try for restarting the AHs.

If anyone of the AH is not started within 5 minutes the operator shall manually trip the boiler. Conditions before start up of AH

INTERLOCKS FOR OIL CIRCULATION PUMPS OF SUPPORT BEARING OF AIR HEATER: FOLLOWING INTERLOCKS SHALL BE PROVIDED FOR OIL CIRCULATION PUMPS.

- Whenever the sump oil temperature of support bearing of air heater A is high (40) impulse shall be given to start the main oil circulation
- The standby oil circulation pump shall start when the main oil circulation pump fails to start or trips (This is applicable where 2 x 100% oil circulation pumps are provided)
- The main oil circulation pump/stand-by oil circulation pump shall trip when the temperature of the support bearing falls below a preset value (40 ^{o} C).
- Manual operation of the lube oil pumps shall be prohibited when the ambient temperature is too low. Since viscosity of the oil will be high so that the pump couldn't be started

BLOW DOWN VALVE INTERLOCKS

- When drum water level rises to 125mm above normal water level an annunciation 'Drum level high shall be given in UCB.
- When drum level rises to 125mm above normal water level, blow down valves BD-8 and BD-9 shall open and this condition shall be annunciated.
- Blow down valves shall close automatically when the water level falls down to NWL. One de-interlock switch shall be provided for both the valves for manual operation.

FD fan lube oil/control oil system interlocks:

- Pump A will start automatically if pump B trips provided A/M switch is in auto position
- Pump A will start automatically with a time delay of 0-60 seconds if lube oil pressure falls below a set value and the pump B is working provided A/M switch is in auto position.
- Pump B will start automatically if pump A trips/has not started provided A/M switch is in auto position.
- Pump B will start automatically with a time delay of 0-60 seconds if lube oil pressure falls below a set value and the pump A is working provided A/M
- Pump A or pump B can be started/tripped by pressing the respective push button provided on LCP(local panel) only when A/M switch is in manual position.
- FD fan A shall be prohibited from starting until the control oil pressure is adequate.

REHEATER PROTECTION LOGIC

Boiler shall be tripped after 10 seconds, when any of the following conditions occur:

1) When Boiler is working and if

(i) Both generator circuit breakers open and

(ii) HP Bypass or LP Bypass valves remain closed less than 2%

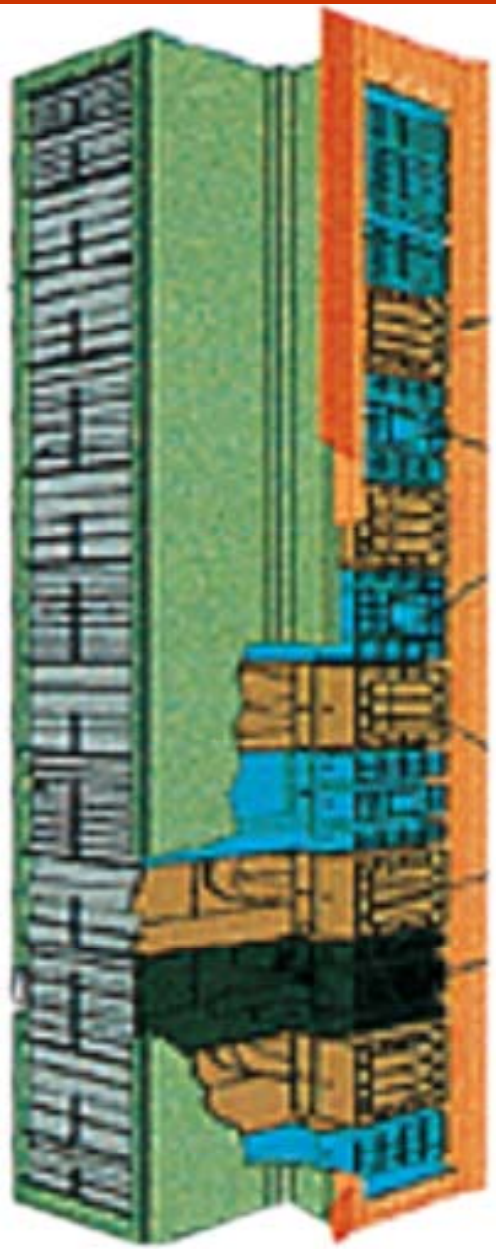
2) When Boiler is working and if

(i) Turbine trips and

(ii) HP Bypass or LP Bypass valves remain closed less than 2%

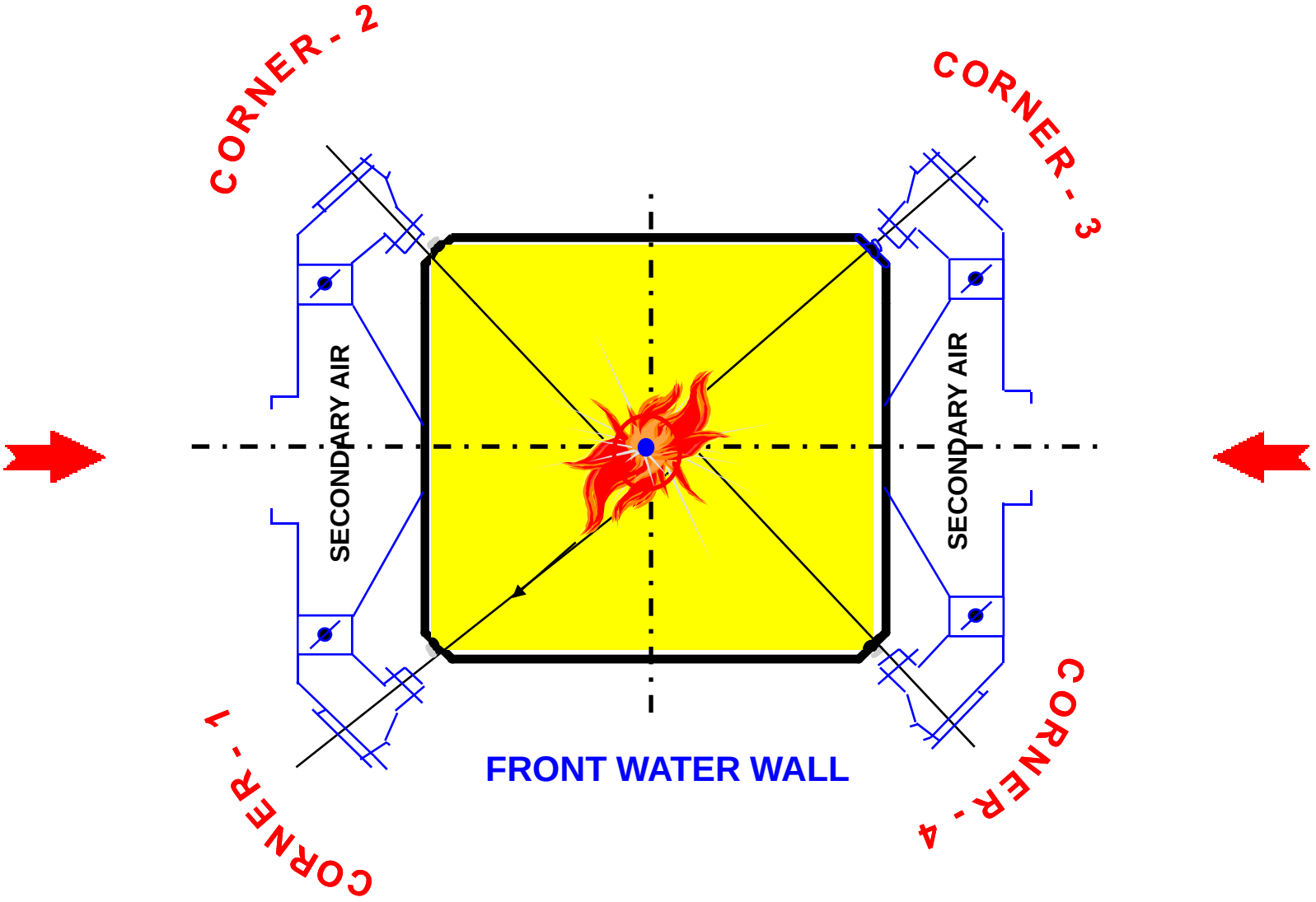
FURNACE SAFEGUARD SUPERVISORY SYSTEM
(FSSS)

This system takes care of interlocks required for starting, supervising the operating and safe shut down of the equipments connected with fuel firing system.



Tangential Windbox

FURNACE PLAN CORNER DESIGNATION



Fireball –Tangential Firing

CAUSES OF FURNACE EXPLOSIONS

- An interruption of the fuel or air supply or ignition energy to the burners, sufficient to result in momentary loss of flames, followed by restoration and delayed reignition of an accumulation.
- Fuel leakage in to an idle furnace and the ignition of the accumulation by a spark or other source of ignition.
- Repeated unsuccessful attempts to light-off without appropriate purging, resulting in the accumulation of an explosive mixture.
- The accumulation of an explosive mixture of fuel and air as a result of loss of flame or incomplete combustion at one or more burners in the presence of other burners operating normally or during lighting of additional burners.
- The accumulation of an explosive mixture of fuel and air as a result of a complete furnace flameout and the ignition of the accumulation by a spark or other ignition source, such as could occur where attempting to light a burner(s).
- Purging with an airflow that is too high, which stirs up combustibles smoldering in hoppers.

CAUSES OF FURNACE IMPLOSIONS

- A mal-operation of the equipment regulating the boiler gas flow, including air supply and flue gas removal, resulting in furnace exposure to excessive induced draft fan head assembly.

- The rapid decay of furnace gas temperatures and pressure resulting from either a rapid reduction in fuel input or a master fuel trip.

- A combination of the two conditions indicated in a, b above has resulted in the most severe furnace implosion incidents.

FUNCTIONS OF FSSS

- A prefiring purge of furnace
- Establishment of appropriate permissives for firing the ignition fuel.(i.e. purge complete, fuel pressure within limits)
- Establishment of the appropriate permissives including ignition permissives, for the main fuel.
- Continuous monitoring of firing conditions and other key operating parameters.
- Emergency shutdown of portions or all of the firing equipment when required.
- A post firing purge of the steam generator.

F S S S

F - FURNACE

S - SAFEGUARD

S - SUPERVISORY

S - -SYSTEM

FSSS ENSURES SAFE FURNACE OPERATING CONDITIONS DURING

- ★ START UP
- ★ LOW LOAD OPERATION
- ★ SHUT DOWN.

FSSS

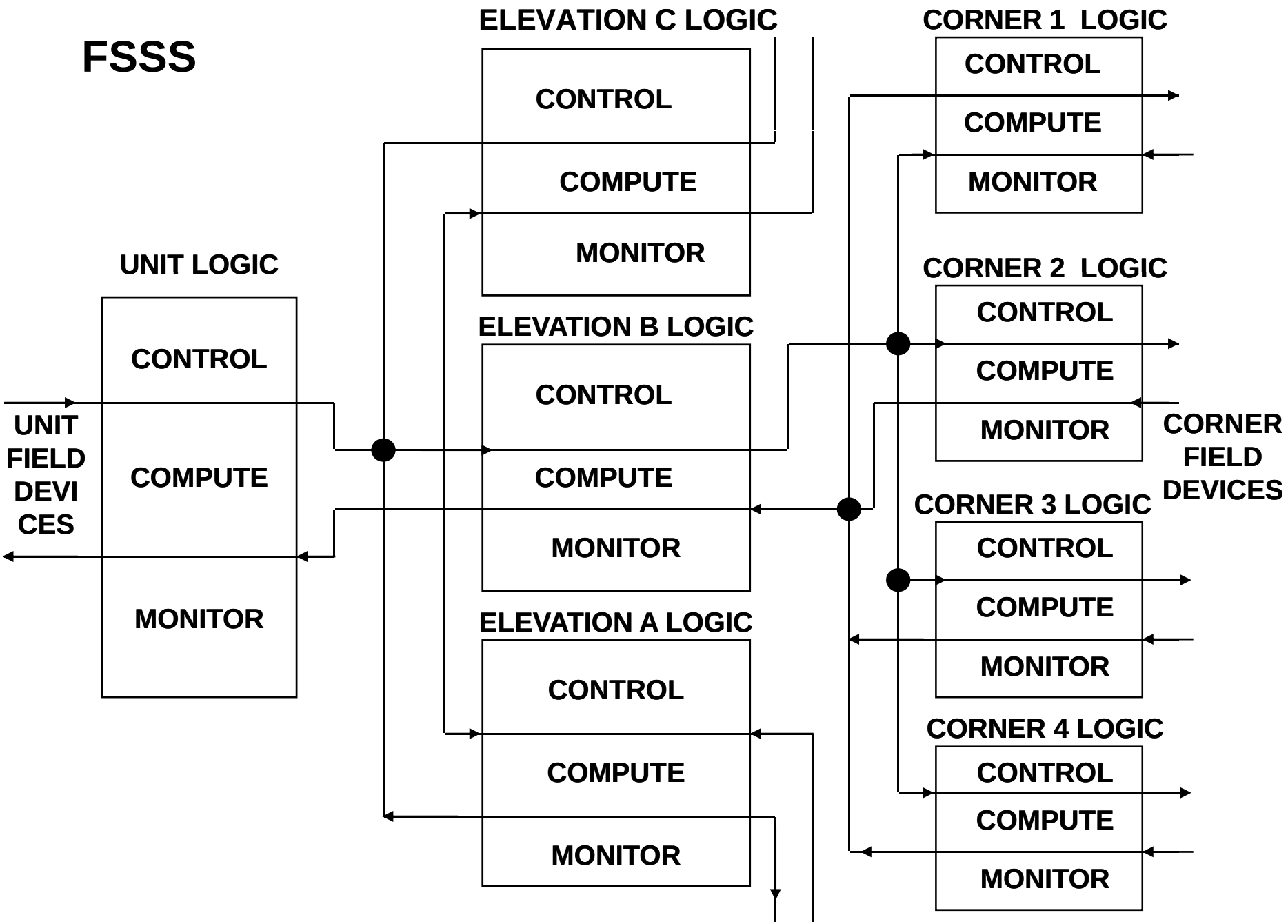
SOME OF THE PRECAUTIONARY MEASURES TO ACHIEVE SAFE AND RELIABLE OPERATION

- ★ FURNACE SHOULD BE PURGED BEFORE LIGHT UP
- ★ ADEQUATE IGNITION ENERGY TO EACH BURNER
- ★ ADEQUATE AIR SUPPLY TO EACH BURNER TO AVOID FLAME OUT
- ★ OPTIMUM FURNACE PRESSURE
- ★ CORRECT AIR TO FUEL RATIO

FSSS

FUNCTIONAL DIVISION OF LOGICS

- ★ UNIT LOGIC
- ★ ELEVATION LOGIC
- ★ CORNER LOGIC



ORGANIZATION OF FSSS LOGIC FIG. - 1

FSSS

UNIT LOGIC

Scope :

★ SUPERVISION OF OVERALL FURNACE CONDITIONS

★ MONITORING CRITICAL PARAMETERS OF FUEL FIRING SYSTEM

★ SUPERVISION OF FURNACE PURGE OPERATION

★ CONTINUOUS MONITORING CRITICAL FEED BACK TO ENSURE MAXIMUM SAFETY DURING OPERATION

★ TRIPPING ALL FUEL IF DANGEROUS CONDITIONS BUILD UP

FSSS

ELEVATION LOGIC

★ RECEIVES COMMAND FROM UNIT LOGIC OR OPERATOR FOR START, SHUTDOWN, OR TRIP THE ELEVATION .

★ ISSUES FEEDBACK TO UNIT LOGIC ON ACTION TAKEN BY ELEVATION LOGIC

FSSS

CORNER LOGIC

★ RECIEVES ELEVATION LOGIC COMMANDS FOR INITIATION OF ACTION APPLICABLE TO CORNER

★ EMERGENCY TRIP SIGNALS ORIGINATING IN UNIT LOGIC AND TRANSMITTED VIA ELEVATION LOGIC BYPASS CORNER LOGIC PERMISSIVES AND CAUSE IMMEDIATE CLOSURE OF FUEL VALVES

★ CORNER LOGIC IS NOT APPLICABLE TO COAL ELEVATIONS SINCE STARTING ONE MILL WILL SHUTDOWN PARTICULAR ELEVATION AS NO INDIVIDUAL CORNER SHUT OFF DEVICES ARE PROVIDED.

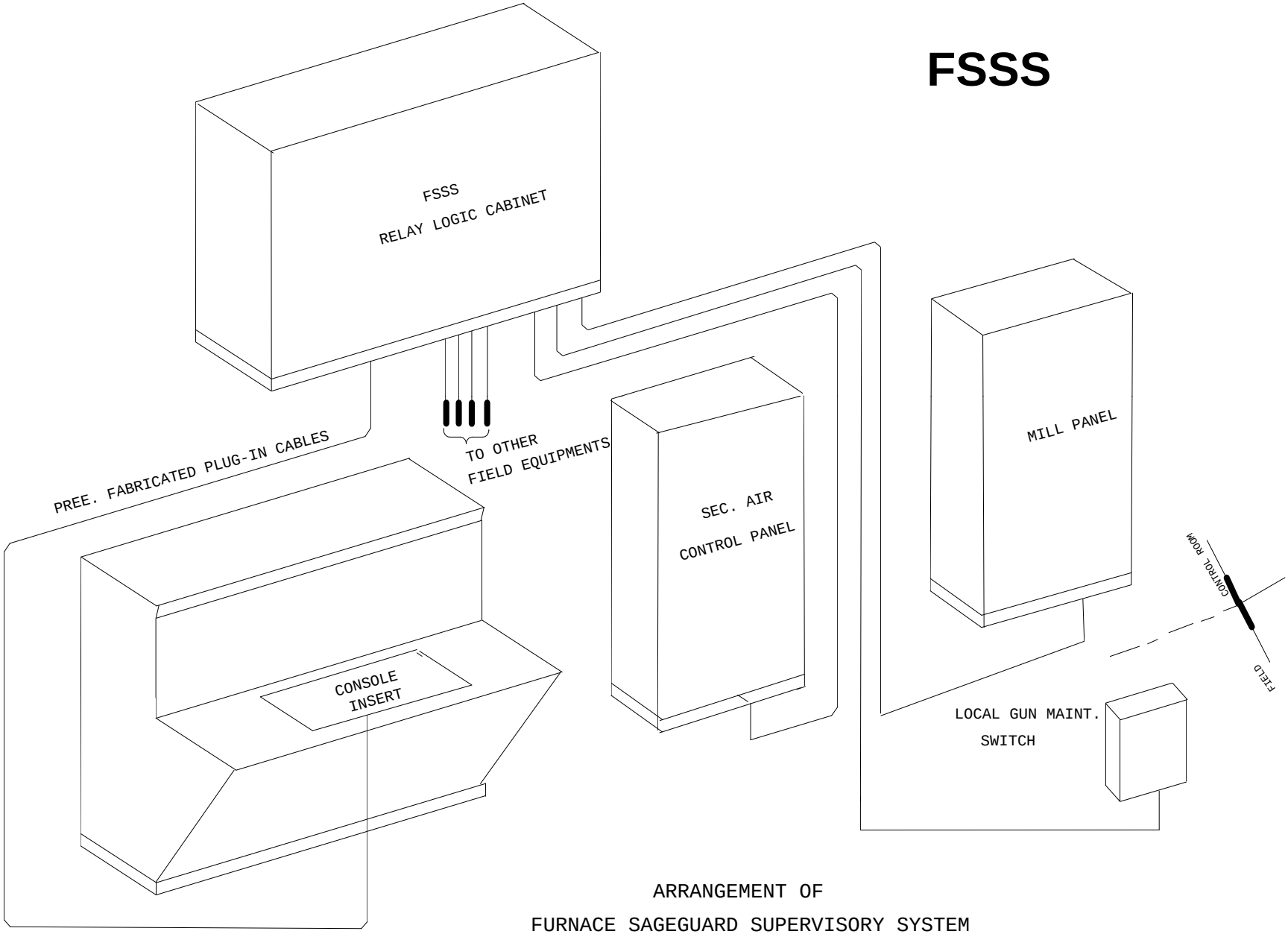
FSSS

ARRANGEMENT OF SYSTEM

FSSS - MAJOR PARTS

- ★ LOGIC CABINET
- ★ CONSOLE INSERT
- ★ SECONDARY AIR DAMPER PANEL
- ★ MILL PANEL
- ★ FIELD EQUIPMENTS
- ★ CUSTOMER SUPPLIED INTERFACE EQUIPMENT.

FSSS



ARRANGEMENT OF

FURNACE SAGEGUARD SUPERVISORY SYSTEM

FSSS

BOILER TRIP COMMAND IS INITIATED BY

- ★ LOW OR HIGH DRUM WATER LEVEL
- ★ BOTH I.D OR F.D ARE OFF
- ★ LOW OR HIGH FURNACE PRESSURE
- ★ REHEATER PROTECTION TRIP
- ★ TURBINE
- ★ LOSS OF ALL FUEL TRIP
- ★ LOSS OF UNIT D.C POWER
- ★ LESS THAN FIRE BALL AND LOSS OF AC AT ANY ELEVATION
- ★ MANUAL TRIP
- ★ UNIT FLAME FAILURE TRIP
- ★ INSUFFICIENT PRIMARY AIR

FSSS

BOILER TRIP COMMAND RESULTS IN

STOPPAGE OF ALL FUEL INPUTS BY TRIPPING

1. **ALL PULVERIZERS**
2. **ALL FEEDERS**
3. **ALL OIL GUNS**
4. **ALL IGNITORS**

IT CLOSES

1. **IGNITOR**
2. **LIGHT OIL**
3. **HEAVY OIL**

TRIP VALVES

FSSS

PULVERIZER SHUT DOWN SEQUENCE

- ○ START ASSOCIATED OIL ELEVATION
- ○ REDUCE FEEDER SPEED TO MINIMUM
- ○ CLOSE HOT AIR GATE
- ◁ PULVERIZER OUTLET TEMPERATURE IS 120°F
- ○ STOP FEEDER
- ◁ WAIT FOR 2 MINUTES
- ○ STOP PULVERIZER
- ◁ FURNACE STABILIZES
- ○ ASSOCIATED OIL LEVEL SHUT DOWN.

FSSS

MILL OUTLET TEMPERATURE CONTROL

A HIGH PULVERIZER OUTLET TEMPERATURE

(ABOVE 200°F) WILL OPEN COLD AIR DAMPER

AND CLOSE THE HOT AIR GATE.

FSSS

FEEDER CONTROL

A. FEEDER RUNS AT MINIMUM SPEED UNTIL INITIATING CONDITION IS CORRECTED, AT WHICH TIME THE FEEDER WILL BE RETURNED TO CONTROL.

   A. PULVERIZER BOWL DIFFERENTIAL HIGH.
   B. PULVERIZER AMPS. ABOVE MAXIMUM SET POINT.

B. LOSS OF COAL FLOW AND LOW PULVERIZER CURRENT WILL TRIP THE FEEDER, OPEN COLD AIR DAMPER AND CLOSE HOT AIR GATE.

   AFTER CORRECTIVE ACTION THE HOT AIR GATE IS OPENED AND FEEDER IS RESTARTED.

FSSS

CONDITIONS FOR A PULVERIZER TRIP

- ★ PULVERIZER DISCHARGE VALVE NOT OPEN
- ★ LOSS OF UNIT DC POWER (FOR MORE THAN 2 SECONDS)
- ★ PULVERIZER IGNITION PERMIT NOT SATISFIED AND SUPPORT IGNITION IS REQUIRED.
- ★ BOILER TRIP
- ★ PRIMARY AIR FAN TRIP

FSSS

PULVERIZER STARTING PROCEDURE

- START
- “PULVERIZER ON” LIGHT
- OPEN HOT AIR GATE
- WAIT TILL PULVERIZER COMES TO TEMPERATURE (140°F)
- START FEEDER (AT MINIMUM FEEDER SPEED)
- COAL FLOW INDICATOR OR PULVERIZER AMPERE ((WITH IN 5 SECONDS)
- FIFTY SECONDS
- FEEDER SPEED RELEASED TO AUTOMATIC CONTROL

FUEL AIR DAMPER OPENED

FUEL AIR DAMPER MODULATED TO AUTOMATIC CONTROL.

FSSS

PULVERIZER START REQUIREMENTS

A IGNITION ENERGY AVAILABLE

B. ADEQUATE PRIMARY AIR

C. D.C POWER AVAILABLE

D. LOCAL PULVERIZER CONDITION SATISFACTORY

E. IF NO OTHER FEEDER IS WORKING FUEL AND AIR NOZZLE TILTS PLACED IN HORIZONDAL CONDITION.

FSSS

CONDITIONS (LOCAL) TO BE SATISFIED TO START RESPECTIVE PULVERIZER

A. DISCHARGE VALVE OPEN

B. SEAL AIR VALVE OPEN

C. COLD AIR DAMPER OPEN

D. PULVERIZER DAMPER OUTLET LESS THAN 200°F

E. FEEDER INLET GATE OPEN

F. TRAMP IRON HOPPER VALVE OPEN.

FSSS

AIR REQUIREMENTS FOR PULVERIZER STARTING

- ★ AIR FLOW ADJUSTED BETWEEN 30% AND 40% FULL LOAD
- ★ AIR FLOW ADEQUATE PRIMARY AIR WITH ONE P.A FAN WORKING ONLY HALF OF THE MILLS CAN BE OPERATED
- ★ FOR ADDITIONS MILLS BOTH P.A FANS SHOULD WORK.

FSSS

PULVERIZER IGNITION ENERGY AVAILABLE

A MINIMUM OF 3 OF THE 4 LIGHT OIL OR HEAVY OIL NOZZLE VALVE OF THE ELEVATION JUST ABOVE OR BELOW, ARE OPEN

OR

BOILER LOADING IS GREATER THAN 30% AND PULVERIZER JUST ABOVE OR BELOW IS IN SERVICE AT GREATER THAN 50% LOADING.

FSSS

FUNCTIONS OF FURNACE SAFEGUARD SUPERVISORY SYSTEMS

1. FURNACE PURGE SUPERVISION
2. SECONDARY AIR DAMPER MODULATION AND ON-OFF CONTROL AND SUPERVISION
3. IGNITOR ON-OFF CONTROL AND SUPERVISION
4. LIGHT OIL ON-OFF CONTROL AND SUPERVISION
5. HEAVY OIL ON-OFF CONTROL AND SUPERVISION
6. PULVERIZER AND FEEDER ON-OFF CONTROL AND SUPERVISION
7. FLAME SCANNER INTELLIGENCE AND CHECKING
8. BOILER TRIP PROTECTION.

FSSS

NO COAL FLOW ALARM SYSTEM

1. PICKUP UNIT
    a) SOUNDING ROD
    b) RUBBER MOUNTING
    c) MICRO PHONE

2. SOLID STATE SIGNAL EVALUATION UNIT
    a) AMPLIFIER
    b) SIGNAL CONDITIONER
    c) SOLID STATE TIMER
    d) OUTPUT RELAY.

FSSS

PULVERIZER SHUT DOWN

- START ASSOCIATED OIL ELEVATION
- REDUCE FEEDER SPEED TO MINIMUM
- CLOSE HOT AIR GATE
  - PULVERIZER TEMPERATURE IS 120°F
- STOP FEEDER
  - TWO MINUTES
- STOP PULVERIZER
  - FURNACE STABILIZES
- SHUT OFF ASSOCIATED OIL ELEVATION.

FSSS Oil system

HFO RECIRCULATION :

- HEAVY FUEL OIL (HFO) RECIRCULATION DONE TO HEAT HFO TO REQUIRED TEMPERATURE BEFORE FIRING IN BOILER.
- HFO RECIRC. VALVE CAN BE OPENED WHEN ALL HFO NOZZLE VALVES ARE CLOSED.
- HFO RECIRC. VALVE AUTOMATICALLY CLOSES IF ANY HFO NOZZLE VALVE IS OPENED.

HFO TRIP VALVE

OPEN PERMISSIVES

- PURGE COMPLETE (NO MFT)
- HFO SUPPLY TEMPERATURE ADEQUATE.
- HFO SUPPLY PRESSURE ADEQUATE
- ALL HONV CLOSED.

OR HFO RECIRC. VALVE OPEN.

CLOSE CONDITION

1. HFO HEADER PRESSURE VERY LOW >2 SEC. & ANY HFO NOZZLE VALVE IS OPEN.
2. HFO HEADER TEMPERATURE VERY LOW >2 SEC. & ANY HFO NOZZLE VALVE IS OPEN.
3. ATOMISING STEAM HEADER PRESSURE V.LOW >2 SEC. AFTER ANY PAIR START/STOP COMMAND.
4. MASTER FUEL TRIP.
5. LOSS OF UNIT 220V DC POWER OR LOSS OF UNIT CRITICAL POWER.

HFO ELEVATION START (PAIR MODE)

(A)PAIR 1-3 START COMMAND INITIATES FOLLOWING :

1. A 70 SEC. TIMER STARTS MONITORING PAIR START SEQUENCE.
2. CORNER-1 GETS START COMMAND IMMEDIATELY.
3. CORNER-3 GETS START COMMAND AFTER 15 SECS.

NOTE : THIS DELAY IS APPROVED TO AVOID TOO MUCH OF HFO HEADER PR. FLUCTUATION. (PAIR 2-4 STARTING IS SIMILAR TO PAIR 1-3.)

(B). WHEN CORNER-1 GETS START COMMAND, FOLLOWING EVENTS TAKEPLACE PROVIDED THERE IS NO CORNER TRIP COMMAND.

1. ATOMISING STEAM NOZZLE VALVE GETS OPEN COMMAND.
2. HEA IGNITOR GETS ADVANCE COMMAND.

WHEN ATOM. NOZZLE VALVE IS FULLY OPEN.

3. HFO NOZZLE VALVE GETS OPEN COMMAND.
4. HEA IGNITOR GETS COMMAND TO SPARK.

(C). HEA GIVE SPARKS FOR 10 SECS. WITHIN THIS TIME FLAME HAS TO BE DETECTED BY THE RESPECTIVE SCANNER. OTHERWISE, HFO NOZZLE VALVE WILL CLOSE AUTOMATICALLY. IF FLAME IS DETECTED THE BURNER WILL CONTINUE TO BE IN SERVICE.

CORNER TRIP

THE BURNER IN SERVICE TRIPS IF ANY ONE OF THE CONDITION EXISTS.

1. OIL GUN NOT ENGAGED.
2. HFO MANUAL ISOLATION VALVE CLOSED.
3. STEAM MANUAL ISOLATION VALVE CLOSED.
4. NO FLAME.
5. LOCAL MAINTENANCE SWITCH NOT IN REMOTE POSITION.

ELEVATION TRIP :

FOLLOWING CONDITIONS TRIPS THE ENTIRE ELEVATION IN SERVICE.

1. MFT.
2. HFO TRIP VALVE CLOSED.

HFO ELEVATION START (ELEVATION MODE)

ELEV. MODE OPERATION IS AUTOMATICALLY SELECTED
IF ANY FEEDER ADJACENT TO THE OIL ELEV. IS IN
SERVICE FOR >50 SECS.
START COMMAND OF ANY ONE PAIR OF BURNERS CAUSES

1. STARTING OF CORNER-1.
2. STARTING OF CORNER-3 AFTER 15 SECS. DELAY.
3. STARTING OF CORNER-2 AFTER 25 SECS. DELAY.
4. STARTING OF CORNER-4 AFTER 40 SECS. DELAY.

AN UNSUCCESSFULL START ALARM IS GIVEN AND THE BURNERS IN SERVICE WILL BE SHUT DOWN IF AFTER THE EXPIRY OF START TIME IS ATLEAST 3 BURNERS ARE NOT IN SERVICE.

HFO ELEV. SHUT DOWN

PAIR 1-3 SHUT DOWN

PAIR 1-3 STOP COMMAND INITIATES THE FOLLOWING

1. A 355 SECS. STOP TIME MONITORING TIMER IS STARTED.
2. CORNER-1 RECEIVES STOP COMMAND.

3. CORNER-3 RECEIVES STOP COMMAND 15 SECS. LATER.

PAIR 2-4 SHUT DOWN SEQUENCE IS SIMILAR TO PAIR 1-3 SHUT DOWN SEQUENCE.

CORNER-1 SHUT DOWN\

CORNER-1 STOP COMMAND INITIATES FOLLOWING.

1. HFO NOZZLE VALVE GETS CLOSE COMMAND.
2. WHEN HFO NOZZLE VALVE FULLY CLOSES,

   SCAVENGE VALVE GETS OPEN COMMAND &

   HEA IGNITOR GETS ADVANCE COMMAND.
3. HEA IGNITOR ADVANCES,SPARKS FOR 15 SECS & THEN RETRACTS
4. AFTER 300 SECS. OF SCAVENGING SCAVENGE VALVE & ATOM . VALVE GET CLOSE COMMAND.

   A BACK UP TRIP IS GENERATED 340 SECS. AFTER BOTH THE PAIRS ARE STOPPED. THIS SIGNAL WILL GENERATE A CORNER TRIP. AFTER 355 SECS. STOP TIME IF ANY HFO NOZZLE VALVE IS STILL OPEN, ELEV. UNSUCCESSFUL SHUT DOWN ALARM IS GENERATED.

HFO ELEV. SHUT DOWN

HFO ELEV. MODE SHUT DOWN IS AUTOMATICALLY SELECTED IF ANY FEEDER IS IN SERVICE FOR >70 SECS.

THIS IS DONE IN SIMILAR LINE TO HFO ELEV. START UP (ELEV. MODE) DESCRIBED EARLIER.

HFO ELEV. PAIR MODE IS AUTOMATICALLY SELECTED WHEN ALL FEEDERS ARE OFF.

TYPICAL CONDITIONS FOR FURNACE PURGE ARE AS FOLLOWS:

- Heavy fuel oil trip valve closed.
- Heavy fuel oil nozzle valves closed.
- Light fuel oil trip valve closed.
- Light fuel oil nozzle valves closed.
- Flame scanners on each elevation indicate no flame.
- Air flow greater than 30% and less than 40%
- All pulverisers off.
- All feeders off.
- Pulveriser outlet gates closed.
- All hot air gates closed.
- All cold air dampers not greater than 5° open.
- Both PA fans off.
- No boiler trip existing.
- All auxiliary air dampers modulating.

TYPICAL CONDITIONS THAT WOULD CAUSE AN EMERGENCY SHUTDOWN ARE AS FOLLOWS:

- Loss of all FD fans.
- Loss of all ID fans.
- Loss of all fuel.
- Reheater Protection acted.
- Air flow less than 30%
- Loss of flame.
- Furnace pressure very high.
- Furnace pressure very low.
- Drum level very high.
- Drum level very low.
- Air flow greater than 30% and less than 40%
- Loss of AC at any elevation in service and less than fire ball.
- Loss of DC.
- Both emergency trip push buttons pushed.
- Heavy fuel oil trip valve closed.
- Heavy fuel oil nozzle valves closed.
- Light fuel oil trip valve closed.
- Light fuel oil nozzle valves closed.
- Flame scanners on each elevation indicate no flame.

BOILER INSTRUMENTATION

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BHEL Trichy

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Why Instruments?

- To measure the actual values of different parameters for which the boiler is designed.
- Safe working range of the different parameters are maintained.
- To monitor one or more variables at a time and provide input for automatic control.

Why Instruments?

- In case of operator failure to take remedial action for an upset condition, it protects the boiler by alarms and trippings.
- To provide data on operating conditions before failure of the equipment for analysing the failure.

Boiler measurements

- Pressure
- Differential pressure
- Temperature
- Differential temperature(heat flux)
- Flow
- Level
- Vibration (rotating device)
- Speed (rotating device)
- Position
- Weight
- Flue gas analysis(O2, CO, SOx, NOx, Opacity)
- SWAS(Conductivity, pH, Silica, Dissilved O2, Hydazine)
- Image sensing(CCTV)
- Sound(steam leak)
- Viscosity (fuel oil)
- Calorific value

Instrumentation representation- ISA

First letter

- P-Pressure
- T-temperature
- F- Flow
- A- Analytical

Succeeding letters

- A- Alarm
- I- Indicate
- R- Record
- Q- Integrate
- C- Control
- S- Switch
- T- tansmitter
- E- Element
- P- Pocket
- W- Well

Kraftwerk Kennzeichen system(KKS)

HA – Pressure system

- **HAC- economiser**
- **HAD- evaporator**
- **HAG- circulation**
- **HAH- HP superheater**
- **HAJ- reheater**
- **HCB- Steam sootblowing**

HF- Bunker, feeder and pulveriser

- **HFA- Bunker**
- **HFB- Feeder**
- **HFC- pulveriser including classifier**
- **HFD- Fluegas return**
- **HFE- Mill air**
- **HFG- temp storage(indirect firing)**
- **HFW- sealing fluid**

Kraftwerk Kennzeichen system(KKS)

HH- Main firing system

- HHA main burners
- HHB- Retarded combustion grate
- HHE- PC bin forwarding and distribution system
- HHL- Combustion air supply system
- HHM- Atomising steam
- HHN- Atomising air

Kraftwerk Kennzeichen system(KKS)

HJ- Ignition firing system

- **HJA – Ignition burners**
- **HJF- Oil temp storage-pump and distribution system**
- **HJL- Combustion air supply system**
- **HJM- Atomising steam**
- **HJN- Altomising air**
- **HJQ- Cooling air**
- **HJT- Heating steam**

Kraftwerk Kennzeichen system(KKS)

HL- Combustion air system)PY, SY and Ducting)

- HLA- ducting
- HLB- fan system- FD
- HLC- extermnal air heating
- HLD- AH flue gas heated

HN- Flue gas

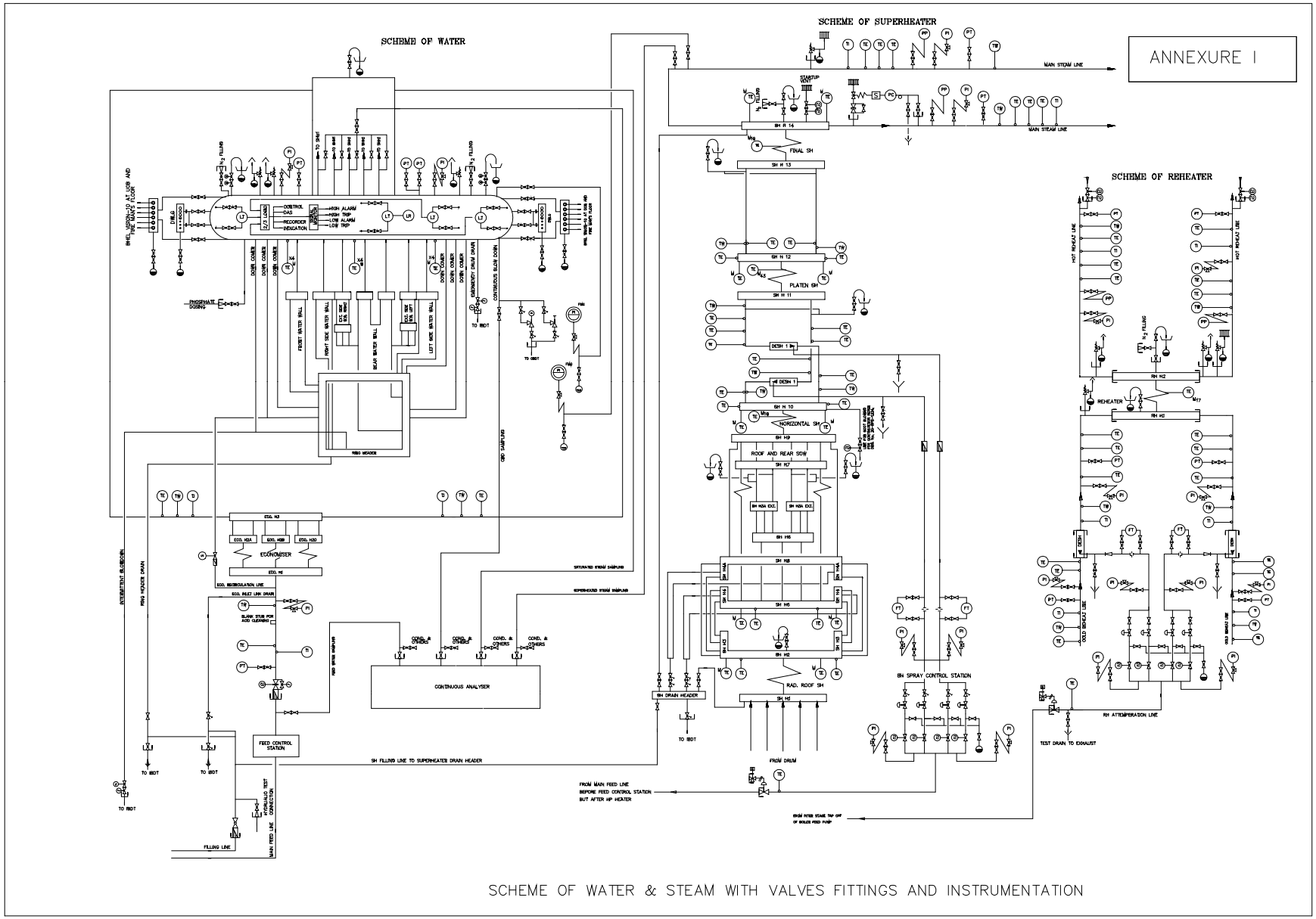
- HNA- ducting
- HNC- ID Fan
- HNE- Stack
- HNF- Fluegas recirculation

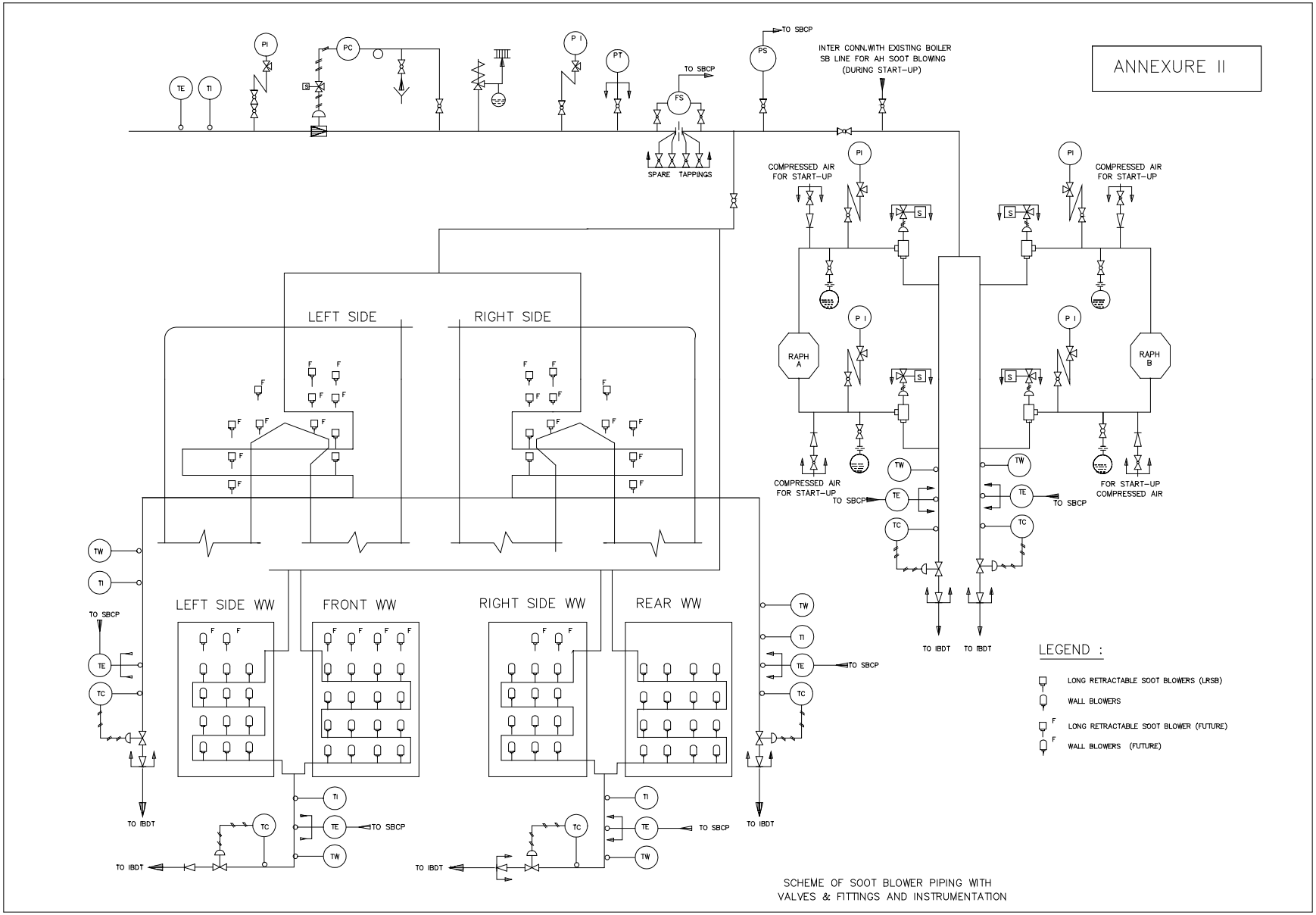
HQ- ESP

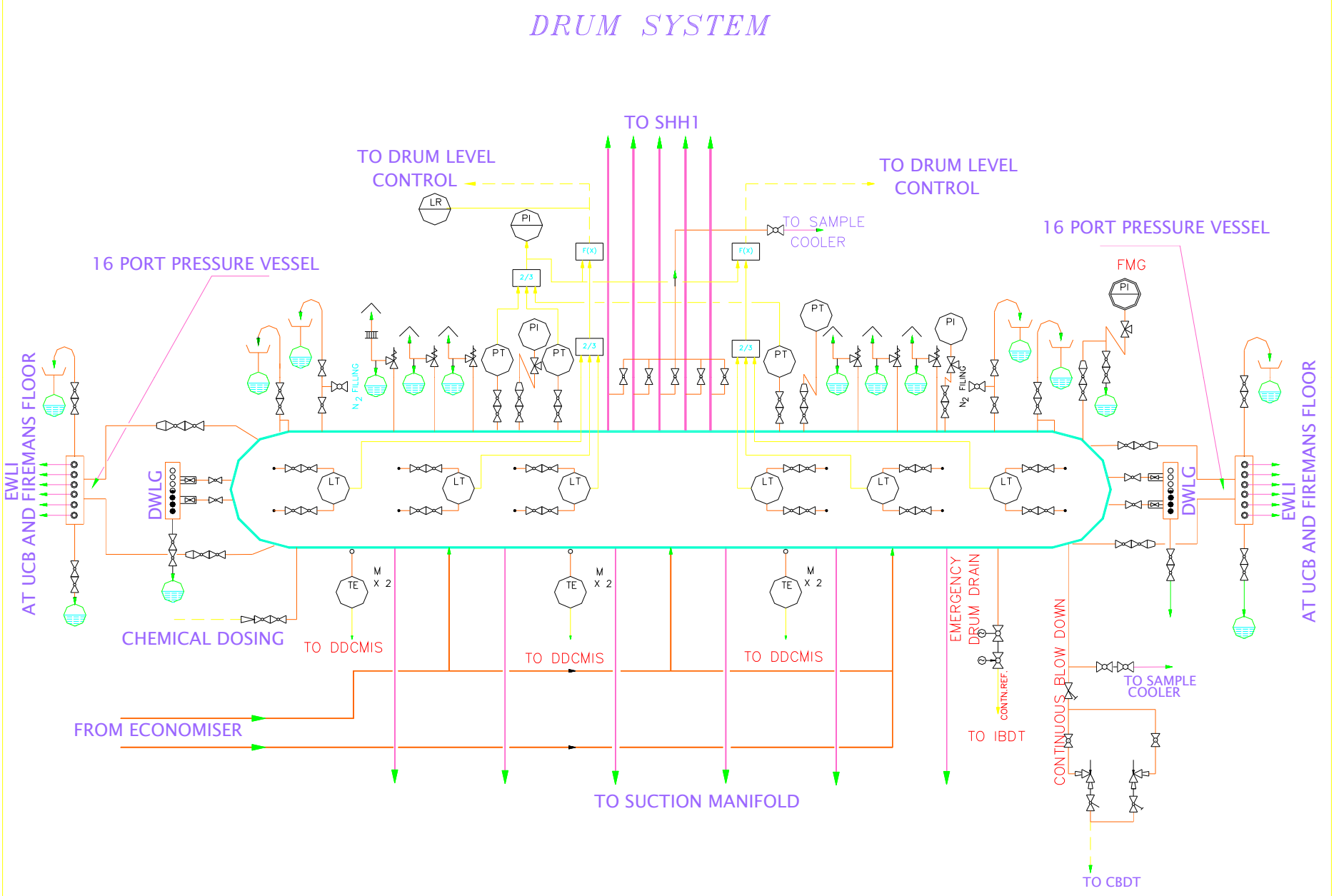
- HQA- ESP system

Kraftwerk Kennzeichen system(KKS)

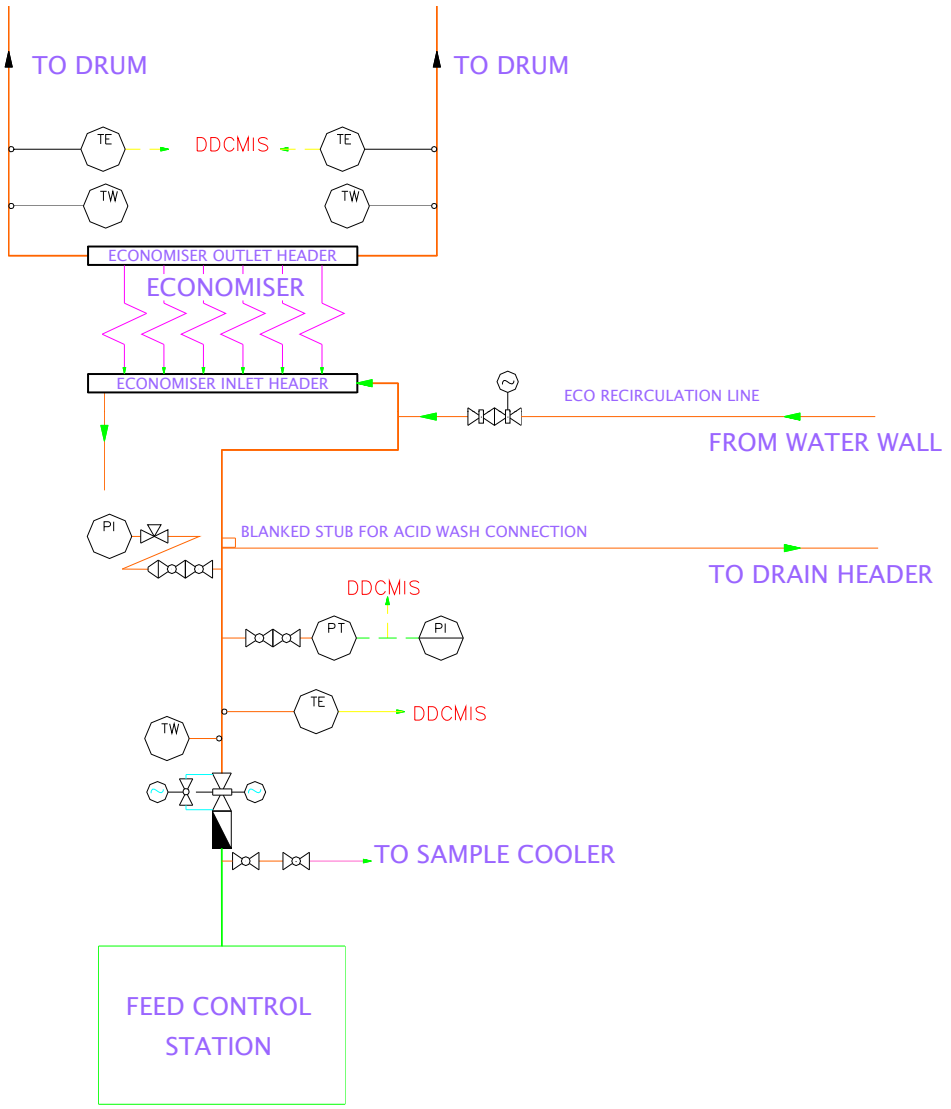
- LAB- FW piping
- LAC-BFP
- LAD- HP heater
- LAE- HP DESH spray
- LAF- IP DESH spray
- LBA- MS piping
- LBB-HRH piping
- LBC-CRH Piping


SCHEME OF WATER
SCHEME OF SUPERHEATER
SCHEME OF REHEATER
ANNEXURE I
MAIN STEAM LINE
FINAL SH
PLATEN SH
HORIZONTAL SH
ROOF AND REAR SDW
RAD. ROOF SH
REHEATER
ECONOMISER
CONTINUOUS ANALYSER
FEED CONTROL STATION
SH SPRAY CONTROL STATION
RH ATTEMPERATION LINE
SCHEME OF WATER & STEAM WITH VALVES FITTINGS AND INSTRUMENTATION

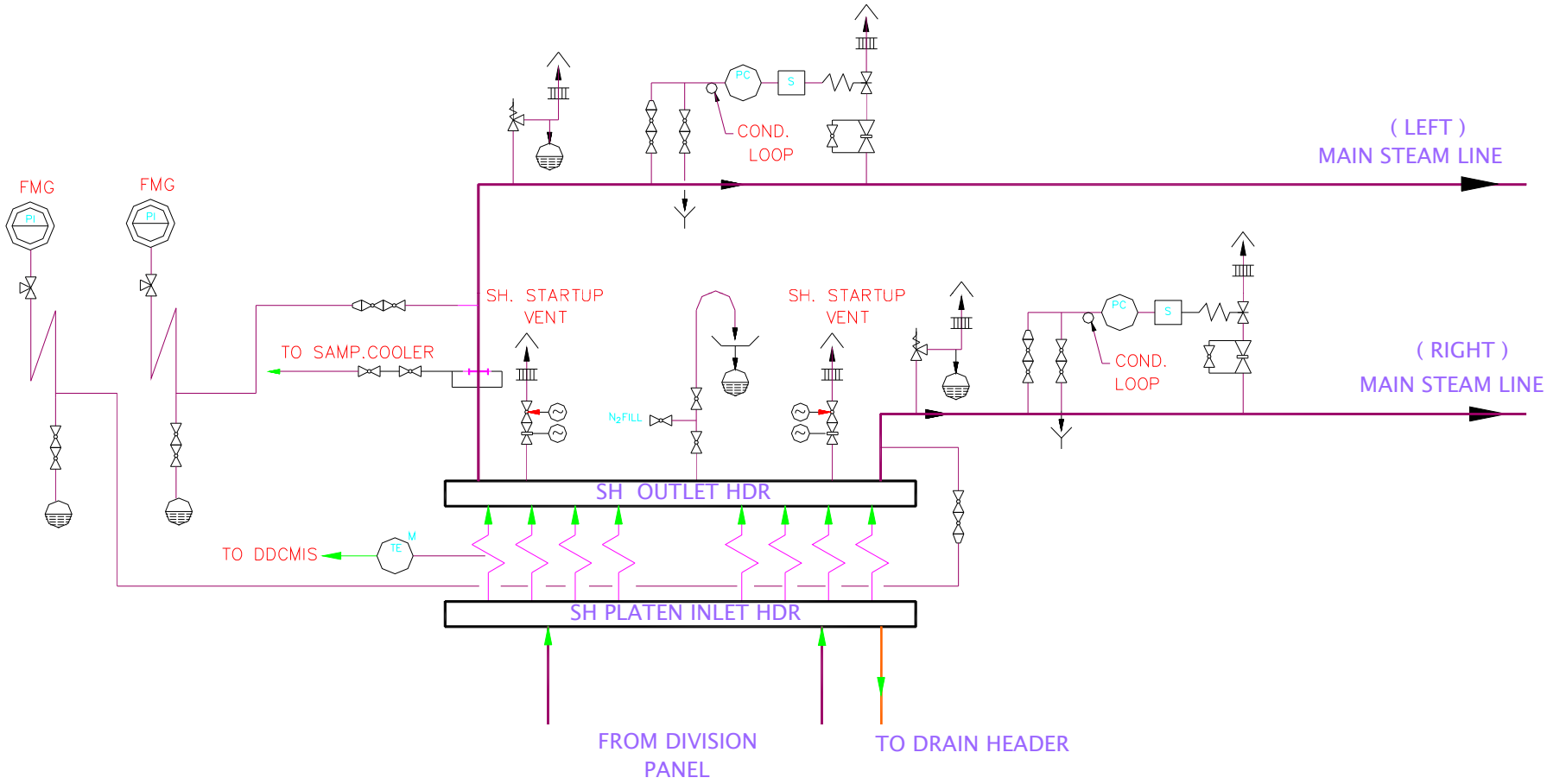

ANNEXURE II
INTER CONN.WITH EXISTING BOILER SB LINE FOR AH SOOT BLOWING (DURING START-UP)
TO SBCP
SPARE TAPPINGS
COMPRESSED AIR FOR START-UP
LEFT SIDE
RIGHT SIDE
RAPH A
RAPH B
LEFT SIDE WW
FRONT WW
RIGHT SIDE WW
REAR WW
TO IBDT
LEGEND :
LONG RETRACTABLE SOOT BLOWERS (LRSB)
WALL BLOWERS
LONG RETRACTABLE SOOT BLOWER (FUTURE)
WALL BLOWERS (FUTURE)
SCHEME OF SOOT BLOWER PIPING WITH VALVES & FITTINGS AND INSTRUMENTATION

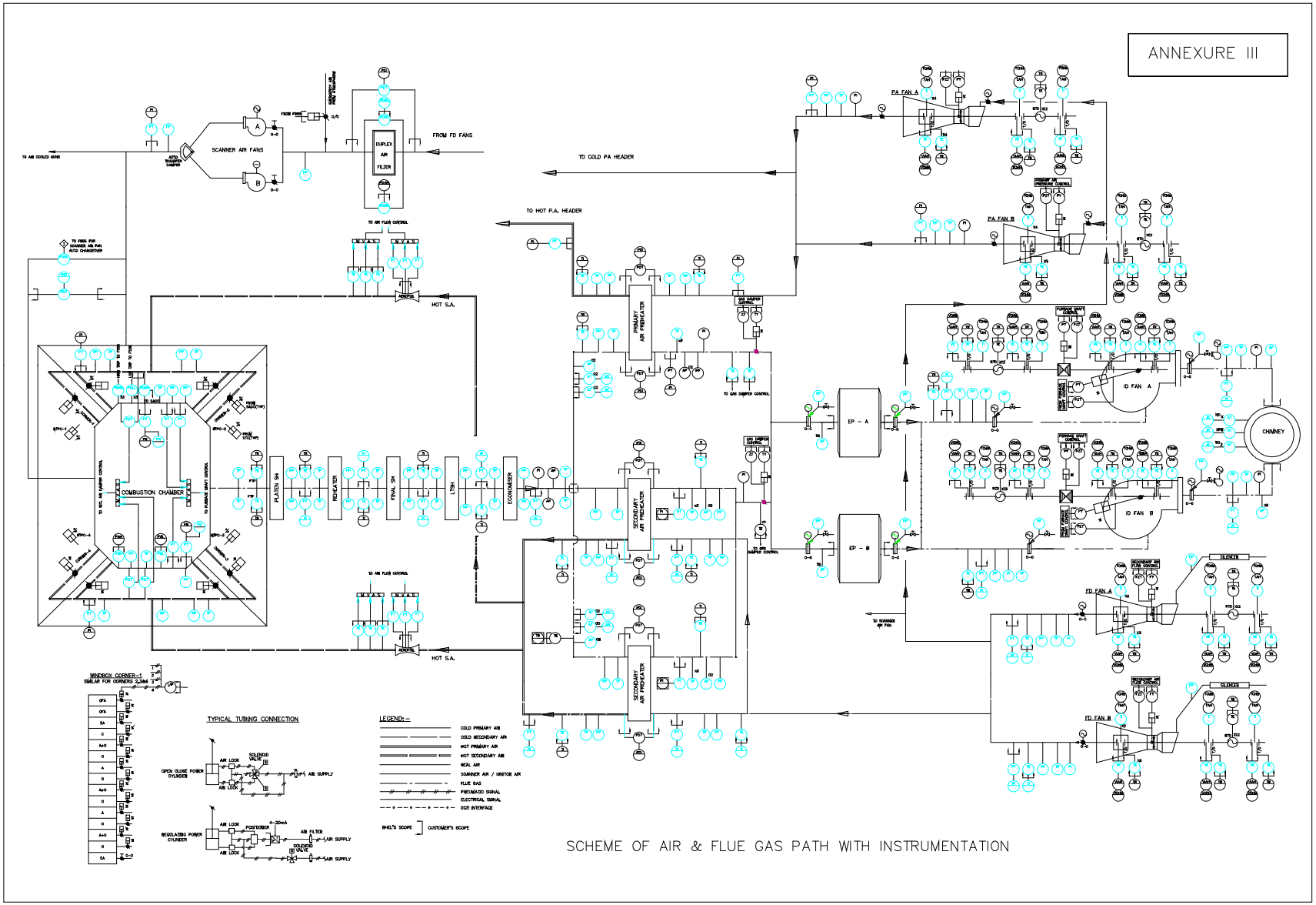

DRUM SYSTEM
TO SHH1
TO DRUM LEVEL CONTROL
TO DRUM LEVEL CONTROL
TO SAMPLE COOLER
16 PORT PRESSURE VESSEL
16 PORT PRESSURE VESSEL
FMG
EWLI AT UCB AND FIREMANS FLOOR
DWLG
LR
PI
PT
LT
F(X)
2/3
TE
M X 2
CHEMICAL DOSING
TO DDCMIS
TO DDCMIS
TO DDCMIS
EMERGENCY DRUM DRAIN
CONTN.REF.
TO IBDT
CONTINUOUS BLOW DOWN
TO SAMPLE COOLER
FROM ECONOMISER
TO SUCTION MANIFOLD
TO CBDT
N2 FILLING

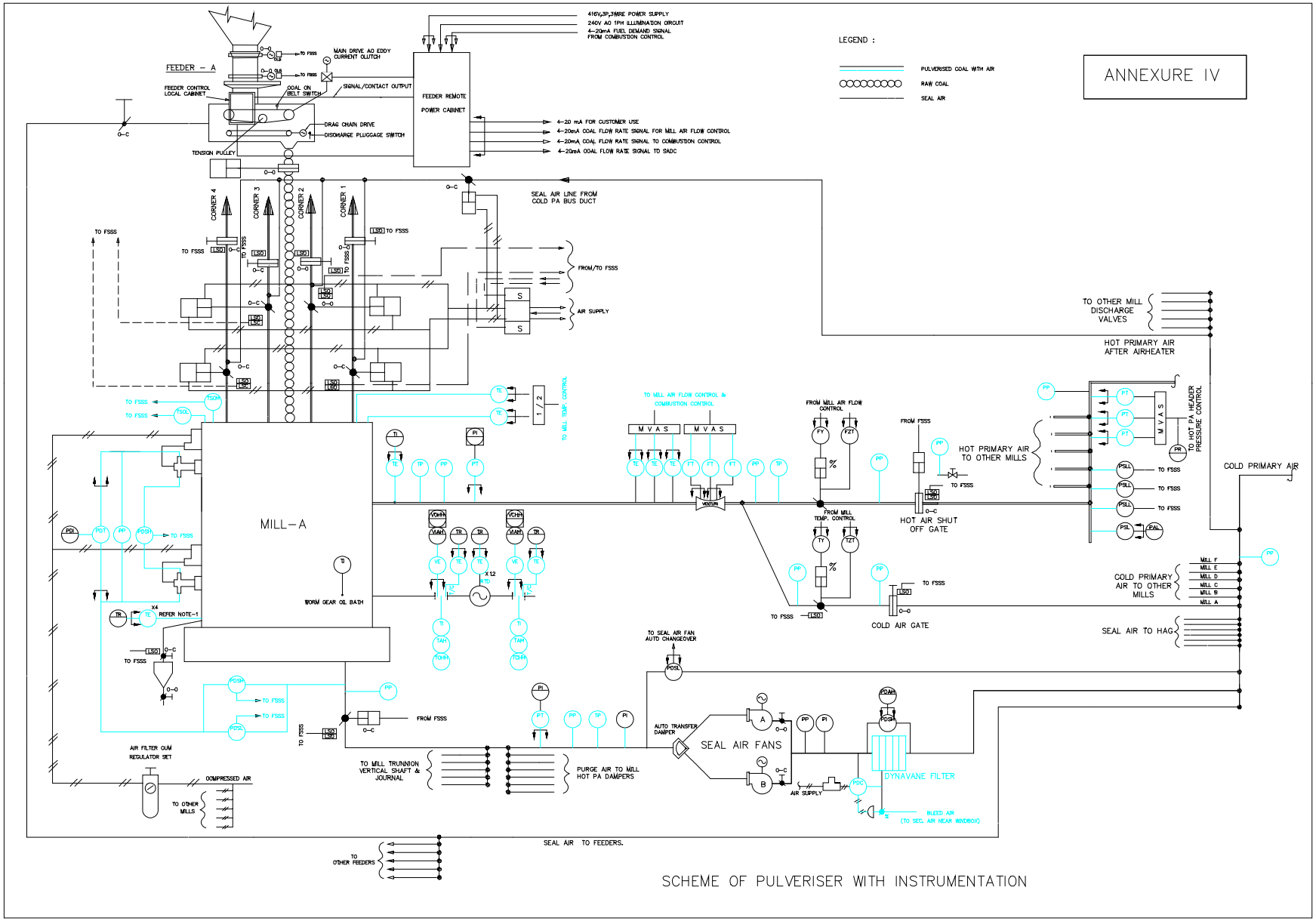
ECONOMISER SYSTEM

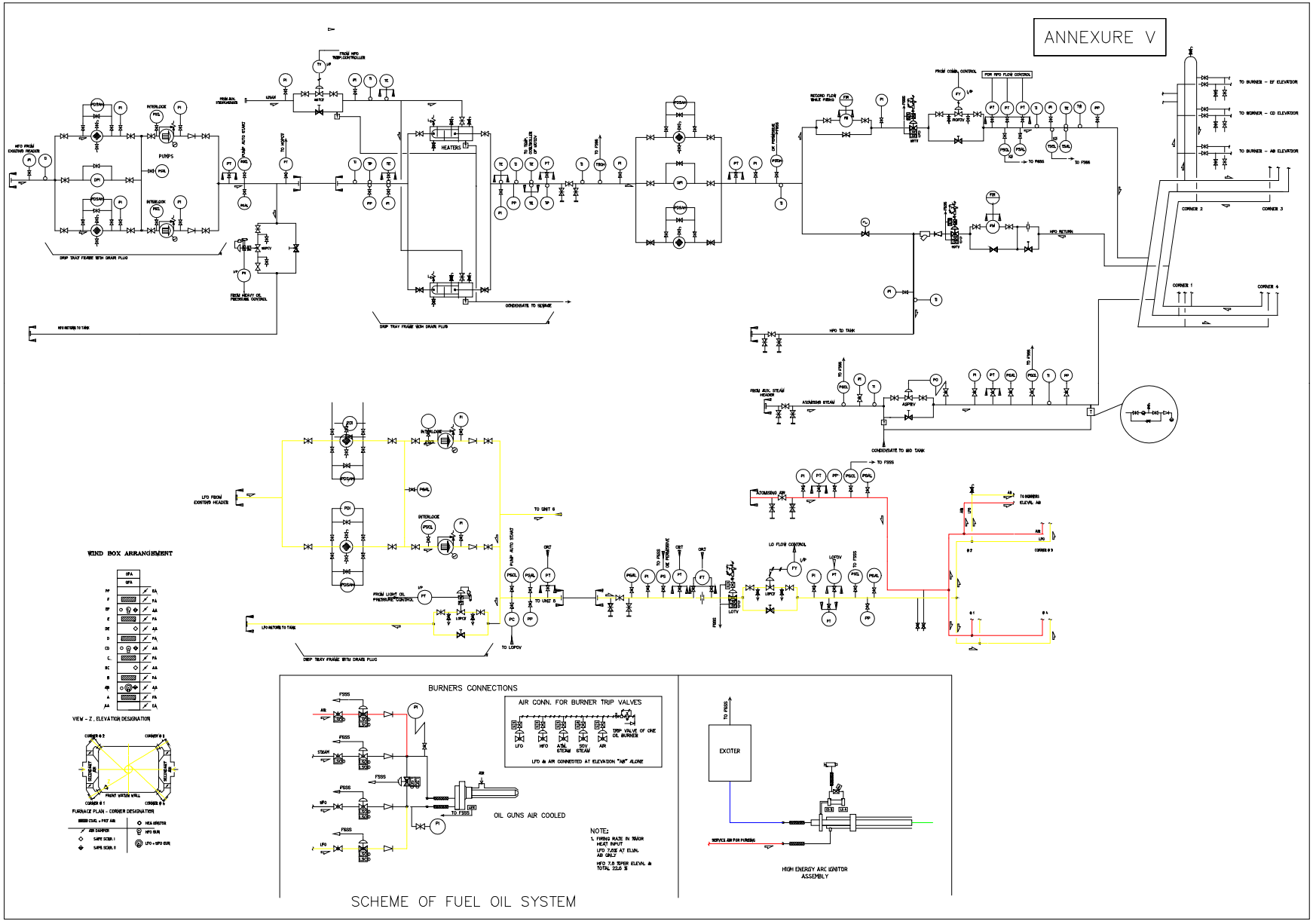


FINAL SUPERHEATER SYSTEM




ANNEXURE III
SCANNER AIR FANS
DUPLEX AIR FILTER
FROM FD FANS
TO COLD PA HEADER
TO HOT P.A. HEADER
PA FAN A
PA FAN B
HOT S.A.
COMBUSTION CHAMBER
PLATEN SH
REHEATER
FINAL SH
LTSH
ECONOMISER
PRIMARY AIR PREHEATER
SECONDARY AIR PREHEATER
EP - A
EP - B
ID FAN A
ID FAN B
CHIMNEY
FD FAN A
FD FAN B
SILENCER
WINDBOX CORNER-1
TYPICAL TUBING CONNECTION
LEGEND:-
COLD PRIMARY AIR
COLD SECONDARY AIR
HOT PRIMARY AIR
HOT SECONDARY AIR
SEAL AIR
SCANNER AIR / IGNITOR AIR
FLUE GAS
PNEUMATIC SIGNAL
ELECTRICAL SIGNAL
DCS INTERFACE
BHEL'S SCOPE
CUSTOMER'S SCOPE
SCHEME OF AIR & FLUE GAS PATH WITH INSTRUMENTATION


ANNEXURE IV
LEGEND :
PULVERISED COAL WITH AIR
RAW COAL
SEAL AIR
FEEDER – A
FEEDER REMOTE POWER CABINET
MILL–A
SEAL AIR FANS
DYNAVANE FILTER
HOT PRIMARY AIR AFTER AIRHEATER
HOT PRIMARY AIR TO OTHER MILLS
HOT AIR SHUT OFF GATE
COLD AIR GATE
COLD PRIMARY AIR
COLD PRIMARY AIR TO OTHER MILLS
SEAL AIR TO HAG
SEAL AIR TO FEEDERS.
SCHEME OF PULVERISER WITH INSTRUMENTATION


ANNEXURE V
WIND BOX ARRANGEMENT
VIEW - Z , ELEVATION DESIGNATION
FURNACE PLAN - CORNER DESIGNATION
BURNERS CONNECTIONS
AIR CONN. FOR BURNER TRIP VALVES
OIL GUNS AIR COOLED
NOTE:
EXCITER
HIGH ENERGY ARC IGNITOR ASSEMBLY
SCHEME OF FUEL OIL SYSTEM


THANK YOU