## System Description

### Reheat Steam System

<table>
<thead>
<tr>
<th>Submitted for:</th>
<th>Customer reference:</th>
<th>Other information:</th>
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1 GENERAL

The boiler is furnished with reheaters, where the steam is reheated to improve cycle efficiency after high pressure part of the steam turbine. Reheater system increase boiler LP – steam, which is turbine’s IP-steam (IP = Intermediate Pressure), temperature after turbine HP-casing. After reheater steam is lead to turbine IP-casing. Steam from the pressure reduction valve after superheater IV is taken to the inlet of the reheater I.

The valves are arranged so that the pressure reduction station (S1 LBH10/20 AA201) controls boiler HP –steam pressure, but functioning also as a safety valves of the HP –steam system (in the cold reheater line).

Hot reheat steam system has two safety valves, which functions also as pressure controlling device’s. Hot reheat system valves blow first and therefore in some operation situations HP –pressure station valves can be maintain closed. These valves are used for regulating the boiler pressure especially during start ups (or shut down). The start-up steam line is led to atmosphere trough a silencer.

The reheat steam enters to reheater IA, which is of similar construction to superheater I and located in the back pass of the boiler after SH II. Reheater IB is after SH I. Reheat steam temperature is maintained at design value typically over load range 60 –100 % of MCR. Compared with feed water spray control by-pass control gives higher plant efficiency.

Final reheating takes place in reheater II, which is similar in construction to Intrex superheaters and is located in the return leg.

All superheaters and reheaters are fully drainable.

2 DESIGN DATA

2.1 Reheat steam values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>bar(g)</td>
<td>33</td>
</tr>
<tr>
<td>Flow</td>
<td>kg/s</td>
<td>98.5</td>
</tr>
<tr>
<td>Temperature</td>
<td>°C</td>
<td>563</td>
</tr>
</tbody>
</table>
2.2 Pressure drops

Low pressure side

Turbine to hot reheat pipe bar 4.4

2.3 Steam temp. control range

Steam temperature is controlled to 563°C boiler load range at 67 – 113 kg/s.

3 EQUIPMENT DATA

3.1 Reheater tube bundles

The boiler is equipped with two reheaters where RH I is divided to two and RH II is Intrex type. Reheater I is counter current flow type located in back pass. Reheater II is located in return leg. Reheaters are connected according to the Reheat Steam P&I-diagram.

Reheater I A
- Tube type bare tube
- Arrangement in line
- Tube size mm 44,5 x 4,0
- Materials 13CrMo44 (50 %)
  7CrMoVTiB1010 (50 %)

Reheater I B
- Tube type bare tube
- Arrangement in line
- Tube size mm 38,0 x 4,0
- Materials 7CrMoVTiB1010

Reheater II
- Tube type Intrex
- Arrangement in line
- Tube size mm 63,5 x 8,0
- Materials SA213TP347HFG
3.2 Reheater headers

**Reheater I A**
Inlet header
- Size \( \text{mm} \) 610,0 x 30,0
- Material 15Mo3

Outlet header
- Size \( \text{mm} \) 660,0 x 25,0
- Material X10CrMoVNB91

**Reheater I B**
Inlet header
- Size \( \text{mm} \) 711,0 x 30,0
- Material 13CrMo44

Soot blower Nozzle
- Size \( \text{mm} \) 114,3 x 10,0
- Material 10CrMo910

Outlet header
- Size \( \text{mm} \) 813,0 x 36,0
- Material X10CrMoVNB91

**Reheater II**
Inlet header
- Size \( \text{mm} \) 711,0 x 30,0
- Material X10CrMoVNB91

Outlet header
- Size \( \text{mm} \) 813,0 x 65,0
- Material X10CrMoVNB91

3.3 Reheater IA by-pass valve

Manufacturer KSB
Type CV
Size DN 500
Actuator Automatic
3.4 Desuperheaters

System have three spray type desuperheaters for controlling of the steam temperature. Feed water is used for spraying.

Dereheater I / Spray water I
- Size  mm  610,0 x 20,0
- Material  X10CrMoVNb91

Dereheater II / Spray water II
- Size  mm  610 x 20,0
- Material  X10CrMoVNb91

3.5 Valves for desuperheaters

Main line close valve  S1 LAE09 AA101
Manuacturer  KSB
Type  GT
Size  DN  80
Actuator  Automatic

Dereheater I / II spray water hand valves  S1 LAF05/10 AA001
Manuacturer  KSB
Type  GL
Size  DN  40

Dereheater I / II spray water motor valves  S1 LAF05/10 AA101
Manuacturer  KSB
Type  GL
Size  DN  40
Actuator  Automatic
3.6 Safety/Start up valves

The function of the Reheater safety valves is to protect the reheater against overpressure. The capacity of the Reheater safety valves is equal to the outlet capacity of the HP bypass stations. The pressure impulses are taken from the cold reheat pipe (1pc.) and hot reheat pipe (2pcs.). The HP bypass stations are equipped with a control function acting at lower pressure than the safety function.

Number of units: % 2 x 50
Capacity: kg/s 2 x 57.5

Pressure set values:
Mechanical design pressure (cold and hot reheat) bar(g) 50

Cold reheat:
Safety function bar(g) 50
Normal operating pressure bar(g) 37

Hot reheat:
Safety function bar(g) 43
Safety valve closing* bar(g) 40.8
Control set pressure** bar(g) 40
LP bypass station opening bar(g) 36 (see: LP bypass station)
Normal operating pressure bar(g) 33

*) Safety valve closing to be checked with valve manufacturer (assumed 95% of opening pressure).
**) LP-bypass opening pressure set value + 4…6 bar. To be checked during commissioning.
3.7 **LP-by-pass valve**

Number of units: 1
Capacity kg/s 1 x 50.6

Pressure set value:

- Design pressure bar(g) 50
- Control set pressure*) bar(g) 36
- Normal operating pressure bar(g) 33
- Safety function close bar(g) 0.39
  (condenser pressure)**)

*) To be checked during commissioning.
**) The LP bypass station will also be closed if the maximum allowable temperature in the condenser 80°C is exceeded.

3.8 **Silencers**

Manufacturer Foster Wheeler
Material Stainless steel
4 AUTOMATION AND INSTRUMENTATION

In this section automation is explained only basic level and more detailed descriptions can be found in Automation Descriptions.

4.1 Reheater pressure control

Normal operation function of the LP bypass station is to bypass the IP/LP-turbine. The LP bypass station is used in start-up and house load operation of the power plant and during a steam turbine trip. The LP bypass station also controls the reheater pressure so, that the maximum allowed pressure or rate of pressure increase 2 bar/min is not exceeded.

Reheater steam pressure is managed by turbine IP-steam system and LP-bypass valve is closed. If LP-by-pass is not capable to maintain pressure, start-up/safety valves will open. Before safety action, valves work as pressure controlled start-up valves.

4.2 Reheater temperature control

Reheating is controlled by a RH IA by-pass valve, this means that at full load part of steam bypasses reheater IA and regulates the outlet steam temperature after reheater IB.

Reheaters are equipped two spray desuperheaters one after RH IA and one after RH IB, so the end temperature after reheat II is controlled with desuperheater after RH IB.
5 OPERATION

5.1 Preliminary checks prior to start up

Action by Control room operator and Auxiliary Operator

Verify that:
- Reheater drain valves are open
  Reheater IA, IB, II inlet and II outlet motor operated drain valve are available
- Reheater vent valves are open
- Reheated steam line drain valves are open
- HP bypass drain line steam traps is open
- Start up isolation/check valve is open
  Start up valve is open 30…100 %, if boiler has no pressure. If boiler has a pressure, set start up valve(s) to position of a minimum steam flow required to cool superheaters.
- Open desuperheating line check valves
- Desuperheating control valves are operative
- All safety valve plugs are removed
- Safety valves are in proper operating conditions
- Hydraulic units for safety and HP bypass valves are available

Action by Auxiliary Operator

Walk down the boiler to verify that:
- Silencers are operative (free from foreign parts or covers and drains are in operation)
- Reheater doors are closed
- Check for any leaks before proceeding
- All auxiliary equipment must be in first-class operating condition and operated according to manufacturer's recommendations and instructions.
- All pressure indicator valves are open.
- Ensure locally, that safety / start up valves are in proper condition for operation
5.2 Boiler start up

Starting a boiler with no pressure and a turbine with metal temperatures below 200 °C is considered a cold start up.

Action by Control Room Operator and Auxiliary Operator

- Start hydraulic units for safety and HP bypass valves
- Set standby pumps of hydraulic units in sequence-mode
- When igniting the first burner, open HP bypass valves and the start up valves to 30...100 % to maintain a flow through the reheaters
- During boiler warm up, reheater flue gas temperatures must be limited to the maximum allowable reheater metal temperature
  
  **Note:** Avoid increasing fuel flow at too fast a rate, since any excess steam is exhausted to waste through the start up valve.
- When boiler pressure reaches 1.5 – 2.0 bar, close the boiler drum, superheater, reheater and main steam line vent valves
- Close superheater and reheater drain valves open until boiler pressure reaches 8 – 12 bar (when it can be ensured that steam is at least 20 °C superheated).
- Monitor feed-, boiler water and steam chemistry continuously
- Steam temperature after the HP bypass valves is controlled according start up curve
- As the LP bypass valve opens (when condenser has vacuum), the start up valve closes.

5.3 Normal operation

- Monitor reheat’ superheater material temperatures. See also superheaters temp. diagram.
- Check, that spray water controlling works proper.
- Monitor the steam temp.
- Monitor the steam pressure.
- Reheater steam pressure will vary with turbine load
- In normal operation the boiler fuel control can be operated in one of two modes:
  a) The control set point is main steam pressure. Fuel flow is varied to maintain the set point, set by operator, operating the controller in Auto-mode or
  b) The control set point is the electrical load supplied to the grid. Fuel flow is varied to anticipate a change in steam flow resulting from a change in demand of the grid. As the boiler pressure starts to change as a result of the change in fuel flow, the turbine loads varies to keep the boiler pressure steady. Steam pressure control is in Sequence-mode
- In the case of reheater pressure surges, in order to limit reheater pressure, check the reheater pressure controller mode and set pressure and also function of safety valves.
5.4 Shut down

Shut down the boiler and check that spray water valves are not leaking.

5.5 Operating Disturbances

5.5.1 High Steam Temperatures

High steam temperatures can be caused by insufficient spray water due to a faulty control valve or plugging due to poor feed water quality. The cause should be traced and rectified.

It is possible to use the manual bypass valve until the control valve is fixed.

5.5.2 Tube leakage

- If a major leak occurs - burst of a tube - during operation, the combustion chamber pressure may rise due to the increase in flow caused by the sudden evaporation to steam. Operator judgement must be used to assess the seriousness of the failure and to decide whether an emergency or normal shut down should be performed.

- Should such a burst occur the ID fan flow should be increased and fuel flow stopped. At the same time steps should be taken to reduce the boiler pressure immediately with the start-up (or turbine by-pass) valve.

- Feed water should be brought to the boiler so, that the boiler parts do not overheat and only stopped when the flue gas temperatures have dropped below 400 °C. Keep the drum level at minimum.

- If the water level has been completely lost, do not bring cold feed water to a hot drum max. allowed difference ~ 50 °C. Check the feed water temperature after economiser.

- Secondary air flow can be reduced but not completely stopped, while there is still combustible material in the gases.

- Primary air for fluidising should be stopped, if the leakage is big. This will stop the burning at once in the bed. Otherwise primary air for fluidising can be kept at minimum flow until all the remaining fuel in the bed has burnt completely, and it helps also to get the rest of the bed ash away from the grid.

- Remove bed material via the ash cooler, if the leakage is entering the bed. Check, that (small amounts of) unburned fuel will not start to burn at the ash conveyors causing a fire.
For smaller leakages follow normal shut down procedures.

- Secondary air flow can be reduced but not completely stopped, while there is still combustible material in the gases.
- Primary air for fluidising can be kept at minimum flow until all the remaining fuel in the bed has burnt completely.
- Remove bed material via the ash cooler, if the leakage is entering the bed.
- Try to determine the approximate location of the leakage by walking round the boiler.
- An economiser leak may be detectable by sound or by an increase in make-up water requirements.
- Note, that water leaks can lead to erosion of adjacent tubes and may cause plugging of ash hoppers and air heaters.
- Steam leaks in superheaters can cause considerable damage to adjacent tubes due to steam cutting.
- Operator judgement must be used to assess the seriousness of the failure and to decide whether an emergency or normal shut down should be performed.
- Monitor the leakage rate and cooling down rate.

5.6 Power failure

When a power failure occurs, the boiler shuts down. Most important devices to control the boiler to secured situation are secured by the emergency electricity supply.

6 CONNECTED SYSTEMS

Superheater steam system S1 HAH_-MFB0001
Feed water system S1 LA___-MFB1001
HP-steam system S1 LB___-MFB1001
Soot blower system S1 HCB_-MFB0001
Drains S1 HAN_-MFB0002
Vents S1 HAN_-MFB0003
Sampling S1 QU__-MFB1001
Blow down system S1 HAN_-MFB0001

7 APPENDICES

Control- and logic diagrams
Pressure raising diagram.