

Commissioning Procedure**Introduction**

Boiler is the heart of plant and hence its safe, reliable & efficient operation decides the entire plant productivity. To have a reliable unit, special care has to be taken during pre commissioning & commissioning, which is the last activity of the project that decides the performance of the product.

Commissioning activity starts from the study of P & I diagrams, CDS and the contract to understand the boiler supplied and contractual obligations.

Commissioning activities divided in different faces.

1. PRE COMMISSIONING ACTIVITY
2. COMMISSIONING ACTIVITIES
 - ◆ HYDROTEST OF PIPING
 - ◆ FLUSHING OF PIPING
 - ◆ TRIALS OF AUXILIARIES
 - ◆ REFRACTORY DRY OUT
 - ◆ ALKALI BOIL OUT
 - ◆ STEAM BLOWING
 - ◆ SAFETY VALVE SETTING
 - ◆ SPECIFIC COMMISSIONING PROCEDURES
3. LOAD TRIAL
4. TUNING AND PERFORMANCE MONITORING
5. CUSTOMER TRAINING

Pre commissioning Checks

Objective

The objective of these checks is to ensure completion of construction, compliance to critical dimensions and tolerances as per the quality assurance requirements.

The following systems are addressed one by one briefly indicating the nature of checks to be carried out:

- ◆ Pressure Parts
- ◆ Flues & Air Ducting
- ◆ Hangers, Expansion Joints and Dampers
- ◆ Rotary Equipments
- ◆ Safety Valves and mountings
- ◆ Piping

Pressure Parts

To be checked for internal cleanliness, proper alignment, tube supports, expansion clearances, gas baffles if any, thermocouple location and installation, proper fixing and closing of all access doors, observation ports, buck stays installation, insulation, orientations of drain valves and vent valves.

Steam Drum to be checked for internal fittings like primary and secondary scrubber, cyclone, steam separator sealing, location and orientation of holes of feed pipe, CBD pipe and Chemical dosing pipe.

Water drum (If provided) to be checked for internal cleanliness, IBD piping and internal attachment.

Expansion tramps fixing for the pressure parts.

Completion of hydro test of boiler and piping.

Temporary supports removal & Loading of spring hangers.

Proper application of refractory over pressure parts as per drawing.

Flues & Ducts

To be inspected for the following:

Completion of ducts as per drawing, Location of supports, direction of expansion joints, proper operation of dampers, hanger location and its load ranges including loading of hangers, tightness of flanged joints, manhole covers, removal of temporary locking on expansion joints.

Access for easy operation of dampers, its lever position, open/close markings, if required servicing of dampers to be done.

Air leak test to be carried out for the entire air and flue gas ducting & furnace.

Fans

To be inspected for completion of construction, foundation as per vendor GA drawing, tightness of foundation bolts, internal clearances, position of fixed and free end bearing, Position of locking ring on bearing, locking of bearings, Cooling arrangements if any, Shaft sealing arrangement, Free movement of rotor, Suction cone & Impeller inside clearances, Overlaps, IGV damper blades orientation w.r.t. impeller direction of rotation, Damper and Actuator linkage arrangement, Alignment of motor and fan, Mechanical completion of fan suction and discharge duct.

Pumps

To be inspected for completion of construction, tightness of foundation bolts, Cooling water arrangements, Impeller free movement, alignment of motor and pump, Completion of pump suction and discharge, balance leak off, Recirculation piping as per drawing, piping hydrotest if required, Support of pumps suction and discharge piping along with spring supports.

Safety Valves

To be inspected for completion of installation, correct location w.r.t. tag numbers as per drawing, Exhaust piping, supports expansion clearances, offsets in drip pan and exhaust piping, tightness of flange bolts, erection of drip pan and its drains, freeness of hand popping lever, exhaust piping silencers (If any) and its supports.

Ensure the availability & suitability of safety gags.

Piping

Feed water, Steam, Drain, Blow down, Chemical dosing, Oil, Service air, Instrument air piping to be checked for construction as per isometry and P & I diagram, valve glands tightness, valve freeness, completion of Hydro / leak test (If required), flushing of piping by substituting control valves with spool pieces, Removal of temporary supports, erection of permanent supports, expansion clearance required as per drawing.

Ensure "Open / Close" positions of control valves, lubrication of spindle/gear box etc. as per supplier's instruction.

Ensure completion of Insulation.

Incorporate color coding for piping/direction marking etc.

Note: Please ensure that all activities are carried out in strict adherence to checklist specification.

Burner**Aim**

To ensure that burner is mechanically ready for firing.

Pre- Requisites

- ◆ For starting the Pre-Commissioning check of the burner following jobs should be completed.
- ◆ PLC/DCS logic hard copy.

Procedure

The logic has to be check along with instrument Engineer as per the logic diagram for timers, valve tag numbers etc.

Burner Management Dry Simulation**Aim**

To check sequence of operation of the valves without actual flame in the furnace.

Pre-Requisites

- ◆ Burner Logic Checking should be completed.
- ◆ All burners Shut-off Valves and Control valves erection and flushing of the piping should be completed.
- ◆ All burner SOVs & CVs loop checking should be completed.
- ◆ All air and flue gas transmitters loop checking should be completed.
- ◆ All steam and water transmitters loop checking should be completed.
- ◆ All air register actuator mounting should be completed.
- ◆ Boiler/HRSG mechanical erection should be completed.
- ◆ Fan erection, Pre-commissioning & commissioning trials are completed.
- ◆ Water in the steam drum should be upto normal water level.
- ◆ Instrument air for all Instruments.
- ◆ Boiler Logic checks should be completed.

Procedure

To start the burner the following condition should be satisfied in sequence

- ◆ Pre-interlocks
- ◆ Purge Interlocks
- ◆ Purging
- ◆ Main Interlocks

Note:

While satisfying the above interlock if some interlock can not be satisfied actually those can be forced through software or by hardwire.

Burner Gas Igniter Testing

Aim

Establishing the gas ignitor flame and set the scanner and make the burner ready for firing pilot Gas.

Pre-Requisites

- ◆ Scanner cabling and loop checking should be completed.
- ◆ Scanner candle test should be completed.
- ◆ Gas line leak test should be completed.
- ◆ Before charging the gas line should be flushed with Nitrogen.
- ◆ Oil line Hydro-testing should be completed.
- ◆ Oil line flushing should be completed.
- ◆ Gas for firing gas lighter should be available at required pressure.
- ◆ Gas lighter cabling and loop checking to be completed.
- ◆ Spark Gap checking to be completed.
- ◆ Gas line cardboard blasting should be completed.
- ◆ Power should be available.
- ◆ Instrument air for all Instruments.
- ◆ Water in the steam drum should be up to normal water level.
- ◆ BMS dry simulation should be completed.
- ◆ Ensure that individual burner manual oil & gas isolation valves are closed.

Procedure

Start the FD fan and adjust the airflow at minimum airflow required for burner light up.

Before going for Actual gas lighter testing all the Pre-Interlock, Purge Interlock, Purging and Main Interlock needs to be satisfied.

Before taking the trials, gas should be vented in to atmosphere through header vent to remove the nitrogen or any incombustible gases present in the piping.

After satisfying the above condition burner is ready for start.

With burner start command spark will be generated in the gas lighter gun and gas SOV will open.

With the above procedure the gas lighter flame can be established.

For proper checking and setting of the scanners the gas lighter timing can be increased temporarily.

Note: Any discrepancies/deviation found during the pre- commissioning checks are to be recorded in the Pre-Commissioning Check / Punch List.

COMMISSIONING ACTIVITIES

✓ PROCEDURE OF HYDRO STATIC TESTING

Objective

This procedure defines the requirement and methodology of hydrostatic testing of pressure parts after assembly of all the components subjected to high pressure / temperature operation.

References

Pressure parts assembly and P&ID drawings may be refer for better understanding.

Pre-Requisites

Ensure the following works are completed before hydrostatic testing.

- ◆ All pressure parts erection.
- ◆ All attachments welded to pressure parts.
- ◆ Radiography and other non-destructive examination for pressure parts.
- ◆ Stress relieving and Repairs (if any)
- ◆ Permanent supports, spring hangers are provided and temporary supports removal
- ◆ Piping for water filling and draining.
- ◆ Isolation valves provided on all drains, vents, and instrument tapping points.
- ◆ Installation of Gags or hydrostatic test plugs for safety valves
- ◆ Drum inside is cleaned and the manholes are boxed up with proper gaskets.
- ◆ Adequate feed water for initial flushing and hydrostatic test/s.

Facilities and Utilities

All facilities required to carry out the hydrostatic testing, like temporary piping, filling pumps and adequate pressure / capacity testing pumps shall be made ready. The test pump discharge shall be connected to any drain of bottom header drain line. Water will be filled through the initial filling line.

Pressure Gauges

Pressure gauges shall be of indicating type and preferably have dials 6" to 10" & to the available range nearest to twice the operating pressure. All gauges used for hydrostatic test shall be calibrated with dead weight tester prior to test and records shall be maintained. Minimum 3 no. Pressure gauges are required for hydrostatic test, one to be connected to steam drum, one steam outlet header and third one on testing pump (before NRV). The pressure gauge used on pump shall preferably be of snubber type.

Test Water Quality

Water used for hydrostatic test shall conform to DM/ Portable / de-aerated water having pH value in between 8.5 to 9.0. The quality should be of / or close to the feed water quality specified in O&M manual.

Test Water Temperature

Test water and the metal temperature should be above the ambient air dew point to prevent condensate formation on the pressure parts being tested, which interferes with the detection of small leaks.

Test water should remain below 50°C for thorough and safe inspection. Water and the metal temperature should be above 21°C to avoid brittle fracture.

Test Pressure

Test pressure is as specified in pressure part assembly Drg. The pressure shall be under proper control, so that the actual pressure is never exceeded by more than six (6) percent of test pressure.

The pressure gauge attached to the steam drum shall be used as official gauge for the test records.

Test Procedure

All valves provided on the drains and instrument isolation valves shall be closed.

Vent valves shall be kept open to purge the air pocket while filling and closed after the air pockets are purged.

Before applying pressure, the unit shall be examined to see that all valves & gasket joints are tight and no leakage is observed.

Application of Pressure

The pressure shall be gradually raised to the test pressure with the help of test pump. The relief valve provided on the leak off line of the pump shall be operated to control the rate of raise of pressure. After raising the boiler pressure to test value, the isolation valve at unit inlet shall be closed.

Duration

The unit shall be held under test pressure for maximum 10 minutes. Quick inspection for leakage /sweating shall be carried out during these 10 minutes. The pressure shall be then reduced to maximum allowable working pressure and maintained at that pressure while the unit is carefully examined for leakage.

Acceptance / Rejection Criteria

Leaks through welds, castings, forging, plate, pipe and tubes excluding gasket joints are not acceptable. Seepage at the test pressure is permitted at gasket joints.

Records

The test data shall be recorded jointly by the parties conducting the test. The records shall include the date / time of testing, the duration of test, the sequence / duration of rise and drop of pressure in the circuit involved in the test, details of pressure gauges and other equipment's used, ambient temperature and any abnormalities observed during the test.

Repairs

Any leaks in the welded connections shall be repaired with approved weld repairs procedure and the applicable boiler and pressure vessel code.

Any unaccepted leaks in gasket joints shall be set right.

After all the repairs have been carried out, hydraulic test shall be repeated in accordance with the above said procedures.

✓ PROCEDURE FOR FLUSHING VESSELS AND PIPING**Objective**

The purpose of carrying out flushing is to remove foreign matter, mill scale dirt etc. Resulting out of manufacturing, storing, fabrication & erection from boiler, vessels & piping. Such deposits in the piping walls sometimes restrict flow through the pipes/tubes causing, over heating, pressure/flow fluctuations and even failures.

Pre-Requisites

In order to commence flushing of piping, following prerequisites/inputs have to be made available:

- ◆ Mechanical completion of piping (including permanent supports) to be flushed.
- ◆ Identify the piping system/circuit to be flushed e.g. flushing is carried out for oil piping, atomizing media piping, pneumatic air piping, steam piping, boiler feed water piping.
- ◆ Check for adequate illumination and personnel safety in and around the flushing area.
- ◆ Check for adequate supports and expansion loops, as per piping drawings. Supports are to be completed, before beginning of flushing activity. If temporary supports are required, they should be provided, as reactive forces resulting from flushing/blowing off media, are more than normal conditions.

Procedure

- Connect flushing media to the starting point of piping.
- Check for flushing media isolating valve in good working condition.
- Remove all strainers, NRV plugs/internals, control valves (provide spool pieces in place Pressure Control Valve/Flow Control Valve, Orifice plate / Flow nozzle).
- Isolate/remove instruments e.g. temperature gauges, pressure switches, flow meters.
- Cordon off the area where flushing is to be done and preferably post a person for vigilance. As a safety measure, install signboards of caution to working personnel.
- Piping will be flushed with DM water with pH of 8.5 containing 0.05% SNID detergent by installing a temporary flushing pump and a closed loop connecting to deaerator.
- Instrument air lines shall be flushed with Air only.
- LDO/ HSD lines shall be flushed with water, then with air and finally with oil circulation.
- After completing the flushing activities, Replace NRV internals/control valves etc., which had been removed during the flushing operation.

Safety Precautions

Clear out / cordon off the area where flushing is being carried out as live pressurized steam/water will flush off through the system end point.

Make available plenty of safety gear e.g. asbestos hand gloves, ear mufflers, transparent eye protective goggles and first aid kit.

Note:

If control valves/isolating valves to be kept in on line position, while steam flushing, keep their position to 100% open to avoid damage to seat of the valves or accumulation of dirt.

✓ TRIAL OF AUXILIARIES**Objective**

Trial of auxiliaries are conducted to ensure mechanical reliability and performance of the equipment and to check whether site parameters matching with its design parameters.

Boiler auxiliaries trials are conducted for equipment like motors, fan, feed water pumps, Soot blowers (If any), Fuel feeders, RAV, Compressors etc.

Pre-Requisites

- ◆ Ensure the availability of instruction manual for different auxiliaries from their respective manufacturers.
- ◆ It is essential that the persons conducting trials of auxiliaries must go through the manufacturers instruction manuals, drawings before starting any work.
- ◆ Complete the pre-commissioning checks as per equipment suppliers' recommendations, quality plan / drawing details.
- ◆ Ensure the driven equipment (if any) is ready for testing/conducting trial run.
- ◆ Ensure that the prime mover/driving (if any) equipment is ready for testing.
- ◆ Ensure that no load test/commissioning has been completed for prime mover / driving equipment and is cleared for auxiliary trial run.
- ◆ Direction of rotation of prime mover is to be ensured.
- ◆ Alignment of prime mover w.r.t. equipment is to be kept within limit as per manufacturer recommendation.
- ◆ Coupling to be done for prime mover and auxiliary and coupling guard to be provided.
- ◆ Lubrication of coupling (If specified)
- ◆ Lubrication of bearing to be done as per manufacturer recommendation.
- ◆ Ensure the availability of concerned inspection authorities.
- ◆ Ensure the availability of calibrated instruments for recording the relevant data.

Note:

As a safety measure before trial run of any auxiliary equipment functioning of Local Emergency Push Button is to be ensured.

Description

Run the equipment/auxiliary at specified conditions for specified number of hours as per equipment supplier's recommendations but not less than 4 hours unless specified and record the parameters.

Check whether actual site parameters, are matching with the design parameters. Note deviations if any, for reference towards corrective action (refer supplier's instruction manual for corrective action)

If no abnormality is found, proceed to normal operating conditions gradually, achieve maximum specified conditions as per equipment suppliers recommendations. Check whether the actual site MCR parameters confirming with the design parameters.

Release the equipment/auxiliary for continuous operation.

During the trial runs record all relevant data in specified formats.

BURNER LIGHT-UP AND STARTUP TRIALS

Aim

Firing the burner and taking different trials to establish the burner firing parameters.

Pre-requisite

- ◆ Boiler/HRSG should be ready mechanically, Instruments & electrically.
- ◆ Fuel gas line leak test should be completed.
- ◆ Fuel gas line flushing should be completed.
- ◆ Fuel gas line all valves should be erected.
- ◆ Fuel gas line vent/drain should be terminated to safe location.
- ◆ Fuel gas line SOVs & CVs loop check should be completed.
- ◆ Fuel gas should be available at required pressure and quantity.
- ◆ Fuel oil hydro-test should be completed.
- ◆ Fuel oil line flushing should be completed.
- ◆ Fuel oil line all valves should be erected.
- ◆ Fuel oil line vent/drain should be terminated to safe location.
- ◆ Fuel oil line SOVs & CVs loop check should be completed.
- ◆ Fuel oil should be available at required pressure and quantity.
- ◆ Water in the steam drum should be up to 'Normal Water Level'.
- ◆ Fire extinguisher should be available at all places.
- ◆ Burner gas lighter trials should be completed.

Procedure

- Start the FD fan and adjust the airflow at minimum airflow required for burner light up.
- Before taking the trials, gas should be vented in to atmosphere through header vent to remove the nitrogen or any incombustible gases present in the piping.
- Before going for burner light up all the Pre-Interlock, Purge Interlock, Purging and Main Interlock needs to be satisfied.
- After satisfying the above condition burner is ready for start.
- Adjust the Gas/oil control valve at minimum position (Just Above turndown) of the burner) to avoid heavy ingress of fuel in the Boiler/HRSG.
- With burner start command spark will be generated in the gas lighter gun and Fuel gas/ Fuel oil SOV will open.
- With the help of pilot flame the Main fuel (Gas/Oil) will ignite.
- With the above procedure the burner flame will be established.
- For proper checking and setting of the flame the burner can be keep in running condition till all trials are complete.
- If it is a multiple-burner boiler/HRSG different burner combination trials to be taken and the start-up parameter shall be established.
- All the above-established parameters should be noted for repeatability for start up of the boiler/HRSG.

Note:

For HRSG/ Aux Unit while taking the first burner in line always the bottom most burner should be taken first.

✓ REFRACTORY DRYOUT**Objective**

The objective of this procedure is to ensure proper drying, curing of refractory applied in the combustor and other components.

The castable usually undergo considerable chemical changes, during initial heating. Controlled heating, through these reactions ensures maximum strength. While heating there must be free airflow over the system to ensure removal of moisture.

Pre-Requisites

- ◆ Ensure the following pre-commissioning checks, for the completion of refractory drying out is over.
- ◆ Ensure the availability of adequate feed water as per recommendations, adequate bed materials, adequate fire wood/ Oil & Oil firing-system, Draft system and instruments required for boiler firing.
- ◆ Make sure that test gags are removed from safety valves.

□ FOR SOLID FUEL FIRED BOILER

- ◆ If the refractory dry-out is to be done through wood firing, fill the start-up compartment and second compartment with refractory bed material 300mm above the bed coil. Remaining compartments can be filled up to 200mm above the bed plate to cover up the bubble caps.
- ◆ If the dry-out is to be done with oil firing, then fill the compartments with refractory bed material 300mm above the bubble.
- ◆ Fill the drum with the specified quality feed water 50mm below the normal water level. Ensure that inbed bed super heaters are filled with water.
- ◆ Ensure the availability of adequate qualified boiler operating staff/ operators.

Procedure Solid Fired/Auxiliary Boiler

Since there is no provision for temperature measurement at various sections, the boiler exit / Economiser Inlet flue gas thermocouple is considered for refractory dry out cycle.

Refractory baking / dry-out cycle requires very slow and controlled heating of refractory as recommended by the refractory manufactures. Please refer a typical heating schedule for refractory baking which are as follows.

For solid fired with wood firing place the firewood in the startup bed of the Combustor and light up the unit.

For Auxiliary boiler/ solid fired boiler where refractory dry out to be done with oil firing ensure the readiness of the boiler for firing i.e. BMS is ready for burner light up, FD fan is ready for service etc. Then light up burner (preferably lower) and control the firing rate as explained below.

Increase the firing rate in such a way that the raise in flue gas temperature at boiler outlet at approximately 25°C/Hr. whenever the temperature reaches 100deg.C hold temperature for 4 to 6 hrs. at 100°C for soaking refractory castable. If the temperature falls, increase the firing rate and maintain the required temperature.

After refractory soaking, raise temperature of flue gas boiler outlet again @ of 25°C/Hr to 125°C and hold the temperature for 4 to 6 Hr for setting of refractory castables.

Once the above heating schedule is over, the boiler may be cooled down with natural cooling with FD, & ID Fans off.

After dry out, before draining the bed material, FD fan to be started to kill the fire in the furnace.

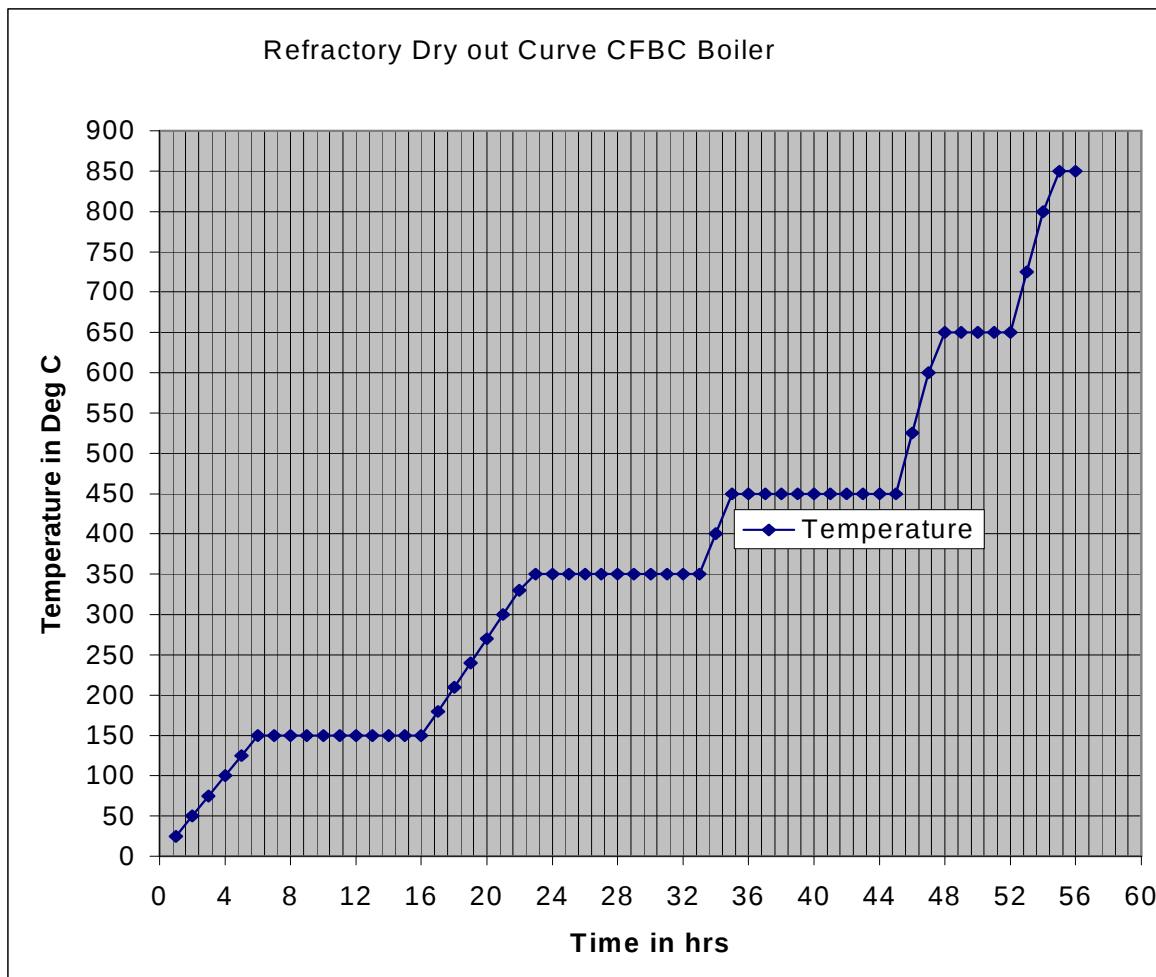
Note:

Keep open the vent lines on boiler drum, super heater headers 100% through out the refractory dry out period.

Maintain Normal water level through out the period.

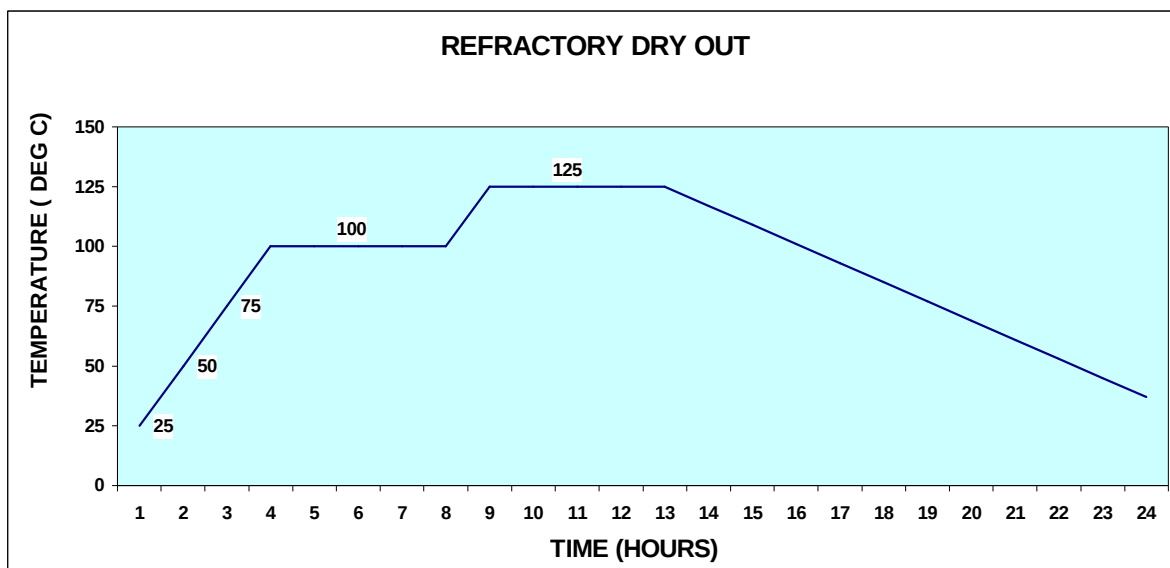
Temperature mentioned are indicative as the rate of raise is depends upon the firing rate, and maintained close to these values with less variation and may be around 5° C.

REFRACTORY DRY OUT CURVE FOR CFBC BOILER



NOTE:

Refractory Dry Out to be done with WOOD upto 350 °C (No fluidisation of bed is required) and after that for achieving 850 °C Oil firing to be done.

REFRACTORY DRY OUT CURVE FOR SOLID FIRED/AUXILIARY BOILERS

✓ ALKALI BOIL - OUT

Objective

Purpose of alkali boil-out is to remove deposits like oil, grease, mill scale etc., resulting out of manufacturing, fabrication and erection procedures from boiler internals. Such deposits in the boiler tube walls restrict heat flow across the tube walls resulting failure due to overheating.

Pre-Requisites

Mechanical

- ◆ Completion of boiler hydro test and other commissioning activities including refractory dry out.
- ◆ Mechanical completion of boiler including auxiliaries and piping.
- ◆ After visual checks, close all access to the boiler unit internals.
- ◆ Safety/relief valves with gags or hydrostatic plugs.
- ◆ Readiness of divertor damper for HRSG / Aux Boiler.

Electrical and Instrumentation

- ◆ Readiness of Electrical, controls and Instrumentation.
- ◆ Adequate illumination in and around the boiler house.
- ◆ Electrical power for motorised valves, gauge glass illuminator, etc.
- ◆ Controls, interlocks and other requirements.
- ◆ Boiler drum pressure gauge. Water level control and associated alarms, Furnace pressure transmitter.
- ◆ Temperature indications for bed, flue gas, feed water and super heater.

Process

- ◆ Alkali boil-out Chemicals as required.
- ◆ Demineralised water through boiler feed water pumps.
- ◆ Readiness of sample collection system.
- ◆ Water testing facilities including pH and oil detection.
- ◆ Readiness of chemical dosing system.
- ◆ Confirm the blow down and drain connections are terminated to safe location.

Note:

For Solid Fuel fired Boiler If the dry-out is to be done with oil firing, then fill the compartments with refractory bed material 300mm above the bubble cap and remaining compartments can be filled up to the height of 200mm above the bed plate to cover up the bubble caps.

If the activity is to be carried out with coal firing, then compartments must be filled up with specified refractory bed material as per normal startup procedure.

Quantity of Chemicals (Considering Water Holding Capacity of boiler)

Hydrous Tri-Sodium Phosphate ($\text{Na}_3\text{PO}_4 \cdot 12 \text{H}_2\text{O}$)	= 4600 ppm
Anhydrous Di-Sodium Phosphate (Na_2HPO_4)	= 1000 ppm
Wetting agent (Surfactant / Detergent)	= 225 ppm

Procedure

Ensure that all dampers are in good working condition and "OPEN" "CLOSE" positions are marked correctly.

Ensure that the feed water pumps operate satisfactorily.

Fill the drum with the specified quality feed water, 200mm below the drum manhole opening.

Exact quantity of chemicals is to be carried in dry form to the drum level platform. Chemicals are to be dissolved in DM water externally in a container near the drum manhole in batches. The concentrated solutions so prepared are to be poured into the drum through the manhole. When the entire quantity of chemical has been charged into the drum, close the manhole.

Then raise the drum level 50mm below the normal water level by viewing the direct level gauges. Fill the drum through normal feed water connections.

Boiler Light Up

After ensuring the above, light up the unit and raise boiler pressure as per the cold start up pressure raising curve.

For HRSG and Aux Boilers start opening the diverter damper with minimum opening and follow-up the pressurizing curve of the HRSG.

Also monitor the thermal expansion of the pressure parts and no case pressure raising should not exceed cold start up pressure raising curve.

Ensure that the normal water level is maintained in the drum through out the boil out operation.

Boil-Out Pressure & Duration

Raise the boiler pressure to 50% of working pressure (Drum) or 40kg/cm^2 whichever is lower. Carry out the boil-out operation by maintaining this pressure for a period of 12 hours. Pressure is to be maintained by controlling the fuel firing and modulation of the start up vent.

Blowdown

On attaining approximately $5\text{kg/cm}^2(\text{g})$ drum pressure, quickly operate the intermittent blow down for 10 sec. Restore drum water level to N.W.L. Allow drum pressure to raise upto a value which is 50% of operating pressure or $40\text{kg/cm}^2(\text{g})$ whichever is lower. Leave the CBD valve slightly open to prevent choking of sample line and sample cooler. Operate the IBD for 10 seconds once every hour. Ensure that water level in the drum is replenished each time.

At the end of 12 hours of boil-out operation, sample of boiler water is tested for oil traces to determine the end point of the process.

If the oil levels are not reducing to the desired limit, even after adequate draining, chemicals may be added to drum through HP dosing system.

Completion of Boil-out

Boiler water sample is analyzed for presence of oil. When analysis confirms that oil present in the sample is within limits (≤ 5 ppm) the boilout operations treated as complete.

For confirmation it is advised to collect 3 samples within 5 minutes span at the end of boilout operation and check for consistency of results

Post Boilout Operation

Box up the boiler and allow the unit to cool by natural cooling. When the drum pressure drops to 2kg/cm^2 open the drum air vent & start up vent.

Rinsing is done until feedwater pH is in close proximity with drain water sample's pH. When the drum pressure drops to atmospheric, start draining the boiler slowly and in the mean time make up the level with feed water. Stop rinsing when the drain water sample pH is in close proximity with the inlet feedwater pH.

After rinsing drain the boiler completely, cut the inspection caps of all the bottom headers for inspection and cleaning of sediments if any.

In case of in-bed evaporator tubes, both inbed coils bottom and top header end caps and inspection caps needs to be cut and inspected. It is to be ensured that all the drain holes in the baffle plates to be clean and free from any blockage from foreign materials like weld slag / welding consumables.

Open the steam drum manholes and remove the sediments (if any).

Back flushing of super heaters and flushing of the drum down comers, supply pipes convection tubes thoroughly.

Re-weld the end caps on headers as per the recommended procedures.

After welding, radiography and post weld heat treatment of the weld joints (if req.) to be carried out prior to hydro test of the boiler.

PROCEDURAL FOR OIL & GREASE DETERMINATION

Reagents

Dilute Hydrochloric acid - 1:1

Light petroleum (petroleum ether) - boiling range 40 to 60 °C.

Apparatus

Separating funnels - of 1.5 to 2 litre capacity. The stopper or stopcock should not be lubricated with matter soluble in petroleum ether.

Details

Outline of the method

The oils and grease are extracted by an organic solvent. The solvent is distilled off and the weight of the extracted matter determined. Some extractable, especially unsaturated fats and fatty acids oxidize rapidly. Hence special precautions regarding temperature and solvent vapour displacement are necessary to minimise the effect.

Storage of sample

Since many oil and hydrocarbons are utilised by bacteria, storage is obviously detrimental. However, if it becomes necessary to store the sample before analysis is taken up, the samples should be acidified with dilute (1:1) sulphuric acid, 5 ml/lit. Of the sample, to inhibit bacterial activity.

Place the sample, usually 1 lt. In a separating funnel of sufficient size to allow the addition of acid and solvent and still have space for proper agitation. Acidify the sample with dilute hydrochloric acid, 5 ml/lt. Rinse the sample bottle carefully with 15 ml of petroleum ether and add the ether washings to the separating funnel. Add an additional 25 ml of ether to the sample bottle, rotate the ether in the sample bottle and add the ether to the separating funnel. Shake vigorously for 2 minutes. Allow the ether layer to separate. Withdraw the aqueous portion of the sample into a clean container, and transfer the solvent layer into the clean tarred distilling flask. If a clear ether layer cannot be obtained, filter the solvent layer into the tarred distilling flask (whatman no. 40 or equivalent).

The filter paper should be washed with petroleum ether after folding to avoid inclusion of skin oils. Use as small as funnel and filter paper as practical.

While transferring the solvent layer from the separating funnel, a small quantity of it remains at the stem of the separating funnel: it is advisable to wash it with a few milliliters of the solvent and to add the washings to the solvent layer.

Return the aqueous portion of the sample to the separating funnel, rinsing the container with 15 ml of the ether. Add the ether washings and an additional 25-ml of ether to separating funnel, and agitate for another 2 minutes. Allow the solvent layer to separate and discard the aqueous phase. Add the ether extract to the tarred distilling flask and rinse the separating funnel with 20 ml of ether. Add the ether washings to the tarred distilling flask. After all the ether from the two extractions and the final rinsing are included, wash down the funnel and filter paper twice with fresh 5 ml increments of petroleum ether.

Distill off or evaporate all but approximately 10 ml of the ether extract on a water bath or an electric heating mantle, observing necessary safety precautions and keeping the heat source at about 70 °C. Disconnect the condenser and boil off the remaining solvent from the tarred flask at the same temperature. Dry on a water bath or steam bath. When dry, lay the flask on its side to facilitate the removal of solvent vapour. Cool in a desiccator for 30 minutes and weight. Using condenser is necessary only if solvent is to be recovered.

Calculation

$$\text{Oils and grease, mg/lit} = \frac{1000 W}{V} = (\text{ppm})$$

Where

W = Weight in mg of the residue in the flask, and

V = Volume in ml of the sample taken for the test

Express the result to the nearest milligram.

✓ STEAM BLOWING**Objective**

Steam blowing is carried out for removing foreign particles like rust, dirt scale and welding burr from the boiler system to prevent any impact damage to steam driven equipment.

Pre-Requisites

- ◆ Before proceeding with steam blowing the following activities need to be completed.
- ◆ Completion of temporary exhaust piping including reaction supports.
- ◆ Removal of internals of NRV & FLOW NOZZLE on main steam line.
- ◆ Operability of boiler stop valve.
- ◆ Readiness of boiler for operation.
- ◆ Readiness of start up vent valve for operation.
- ◆ Readiness of instrumentation namely drum level transmitter, Pressure indicators, pressure transmitters, direct level gauge and necessary instrumentation for safe boiler operation.
- ◆ Readiness of feed water system and feed water pump.
- ◆ Availability of qualified boiler operators and operating staff.
- ◆ Adequate safety equipment's and first aid kit for operating personnel for protection against high noise level and hot surfaces.
- ◆ Equipment's start up in sequence along with all the safety protections for all the equipment's.
- ◆ All the Boiler safety interlocks like drum level very low, furnace pressure high, steam temperature high, equipment's trip interlocks etc.
- ◆ Control valves readiness for boiler level, deaerator level etc.
- ◆ Motorised valves.
- ◆ Temperature gauges and transmitters.
- ◆ Draft gauges and transmitters.
- ◆ Controllers and other panel instruments.
- ◆ Annunciators.

Preparation

The location for releasing the steam will be decided at site by both the parties. Preferably from a flange joint nearer to battery limit or at the process end of the piping. Temporary exhaust pipe with proper support shall be erected to release the steam to a safer area. This temporary exhaust pipe shall be such that it is after the manual isolation valve on line and adequate structural components like beams etc. are available for locking against reaction forces.

To check the extent of removal of foreign particles, target plates are installed near the inlet of the temporary exhaust pipe. Target plates are rectangular plates of soft material like aluminum etc. which would get impingement by articles blowing off with steam. The target plates are mirror finish on one face and fitted on a rigid M.S. mounting with the machined face, facing the blowing steam.

When the impingement noticed on the target plates are within the limits, steam blowing is declared as complete.

Procedure

Fill the boiler with specified quality feed water to NWL

Light up the boiler as per cold start up procedure.

Raise the boiler pressure gradually to 50% of working pressure or 40 Kg/cm² whichever is lower by controlling fuel firing/ modulating the start up vent as required.

Ensure all the pre-requisites are completed.

Ensure the operation of the MSSV in remote mode. And keep the valve in closed condition.

Initially, the steam blowing cycle is done at lower pressure @ 20 kg/cm² to flush pipeline, to remove the foreign particle which may damage the line valve component and also to study the pipe support.

Before blowing ensure there is no condensation in the line & dry steam is coming out through all the drains and from the main steam piping.

Drop the steam drum level to ~ 35 %.

After warming up the steam line throttle the start-up vent valve and simultaneously open the main steam stop valve. Close the MSSV when steam drum pressure drops to 10 kg/cm². Repeat the blowing @ 20 kg/cm² for 3 – 4 times.

Whenever the MSSV is opened the steam drum level will shoot up which happens due to swelling. Hence allow feed water flow gradually to make up the steam relieved and closely watch the steam drum level in the field as well as in DCS during blowing.

Check the condition of main steam piping supports after initial blows and ensure no abnormalities in the support system. Repeat the exercise and confirm integrity.

After ensuring pipe support increase blowing pressure to 40 kg/cm² or 50% of working pressure whichever is lower. Follow the procedure of blowing, drop the drum pressure drops to 20 kg/cm², close MSSV. Maintain drum level at 50% ± 5%.

Leave sufficient interval (Appx. 3 hours) in between steam blowing cycle so that the main steam piping cools down i.e., pipe skin temperature should drop at least by 100°C.

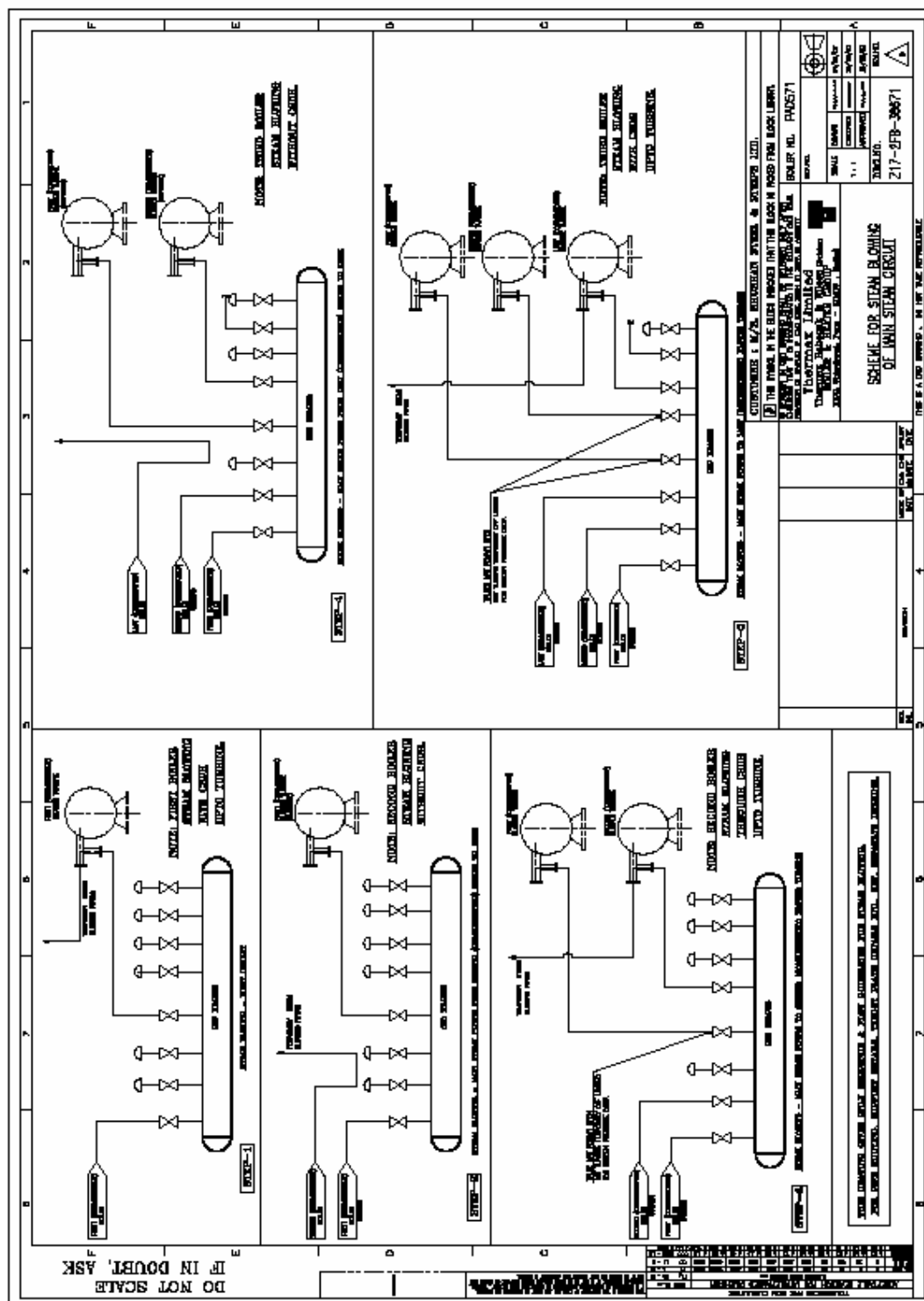
Repeat the above steam blowing exercise several times as long as you could visually observe the steam blowing is clear.

Now, isolate main steam stop valve and insert soft metal target plate in the target plate holder provided for temporary piping. Raise steam drum Pressure to 40 kg/cm². Repeat the blowing one time with the target plate. Close main steam valve and remove target plate. If target plate is not clean, repeat steam-blowing cycle for 4 to 5 times with out target plate. Subsequently, soft metal target plate can be inserted and checked.

Target plate will be checked as per the acceptance criteria and upon acceptance, the steam blowing is said to be completed.

Remove temporary piping and supports provided for steam blowing. Reinststate the main steam piping.

Now the flow nozzle can be installed.



✓ SAFETY VALVE SETTING**Objective**

The objective of this procedure is to outline the procedures involved in setting the safety valves to the designed set pressures before allowing the boiler to go for commercial steaming.

Pre-Requisites

- Ensure proper mounting of the safety valve exhaust pipe, such that no load is coming to the safety valves. Follow instructions of vendor for safety valve exhaust piping support. Check for the proper opening and closing of the start up vent (if provided). Ensure the drain of main steam line is kept open. Close all other vents and drains.
- Normally the highest set pressure valve will be floated first (ex: drum safety valve) while setting this valve the other drum safety valve and the safety valve on the main steam line are gagged.

Procedure

Start the boiler as per cold start up procedure. When the drum pressure reaches about 75% of operating pressure, gently tighten gags on one of the drums and main steam safety valves. Raise pressure slowly by throttling the start up vent valve. When 80% of popping up pressure is reached manually operate the safety valve under test. This will blow off any debris or dust left over in the valve internals. Always maintain water level 50mm below normal level in the drum.

Raise the boiler pressure by continuing to fire burner. When the valve pops, cut off fire and open start up vent valve. When the valve sits back, note down the pressure. Restore drum level.

The set pressure is adjusted by either tightening or loosening the adjusting nut. Tightening of the nut increases the set pressure and vice versa. Blow down which is the difference between set & reset pressure should normally be within 5% of the set pressure.

Adjustments**Popping pressure**

Before proceeding to check the popping pressure, the accuracy of the pressure gages to be used should be ascertained. Otherwise pressure transmitter to be referred while floating the safety valves. To adjust the popping pressure, remove the lifting gear, exposing the adjusting bolt lock nut. Loosen the lock nut and raise the boiler pressure until the valve pops. If the opening pressure is too low, tighten (turn clockwise) the adjusting bolt; if it is too high loosen (turn counter clockwise) the bolt. A very slight adjustment will change the popping pressure several pounds. When the desired pressure is reached - also for each adjustment - the lock nut should be securely tightened to prevent loosening of the bolts.

Caution

The adjusting bolt should never be turned when the boiler pressure is near the set pressure of the valve. Adjustments should be made when the boiler pressure is atleast 5 % below the actual popping pressure of the valve. Unless this precaution is taken, the valve disc may rotate while against the nozzle and damage the seats.

Blowdown adjustment

When the popping pressure is changed a slight adjustment of the blow down may be required. Raising the popping pressure lengthens the blow down, lowering the popping pressure shortens.

Caution

Never make any ring adjustment when the boiler is under pressure without gagging the valve properly.

If the blowdown is not as desired when the set pressure has been obtained, it will be necessary to adjust the rings. The guide (adjusting) ring is the principal blowdown control ring. To change its position, remove the guide set screw on the back of the valve body. Insert a screwdriver or similar tool and engage one of the notches (these can be seen through the set screw hole). The ring can then be turned to the right or left as desired. The guide ring should never be turned more than ten notches either way without re-testing the valve. After each adjustment always replace and tighten the set screw being careful that its point engages a notch and does not rest on the top of the tooth.

Turning the guide (upper) ring to the right raises it and shortens the blowdown. Turning the guide (upper) ring to the left lowers it and lengthens the blowdown.

If the guide ring is raised too high in attempting to shorten the blowdown it will no longer control the valve, and further raising will have no effect. The opening lift may be very low and the closing may be indistinct and dragged out. This can be corrected by lowering the ring.

Every safety valve is fitted with a lower or nozzle ring which permits very close adjustment when operating conditions make this desirable. This ring is carefully set before the valve leaves the factory and rarely needs adjustment, as its main purpose is to do away with "simmer" or "warn" preceding the "pop" without much effect on the blowdown. No attempt should be made to eliminate a short "warn".

The nozzle ring is adjusted by removing the set screw and turning the ring with a screw driver. Turning it counter clockwise to the right raises it and increases the popping power and thereby eliminates "warn". The nozzle ring should be moved only one notch at a time, and the valve action checked after each adjustment.

On high-pressure valve the nozzle ring can be very effective in reducing the blowdown. To reduce blowdown, turn the nozzle ring clockwise to the left (lower it) one notch at a time until the valve begins to warn or simmer before popping. When this notch is reached, raise the ring one notch. Any further adjusting should be done with the guide (adjusting) ring. This method will give the smallest possible blowdown.

Super-heater valve should be set and adjusted on steam, which is superheated nearly to the operating temperature. This is essential, because the ring settings required for good operation with superheated steam are different from those for saturated steam.

Whenever ring adjustments are changed, a record should be kept of the number of notches and the direction in which the ring is moved. This will make it possible to return to the original setting in case of error.

The same procedure shall be followed for floating the other safety valves. While floating a safety valve other safety valves should be gagged.

Note

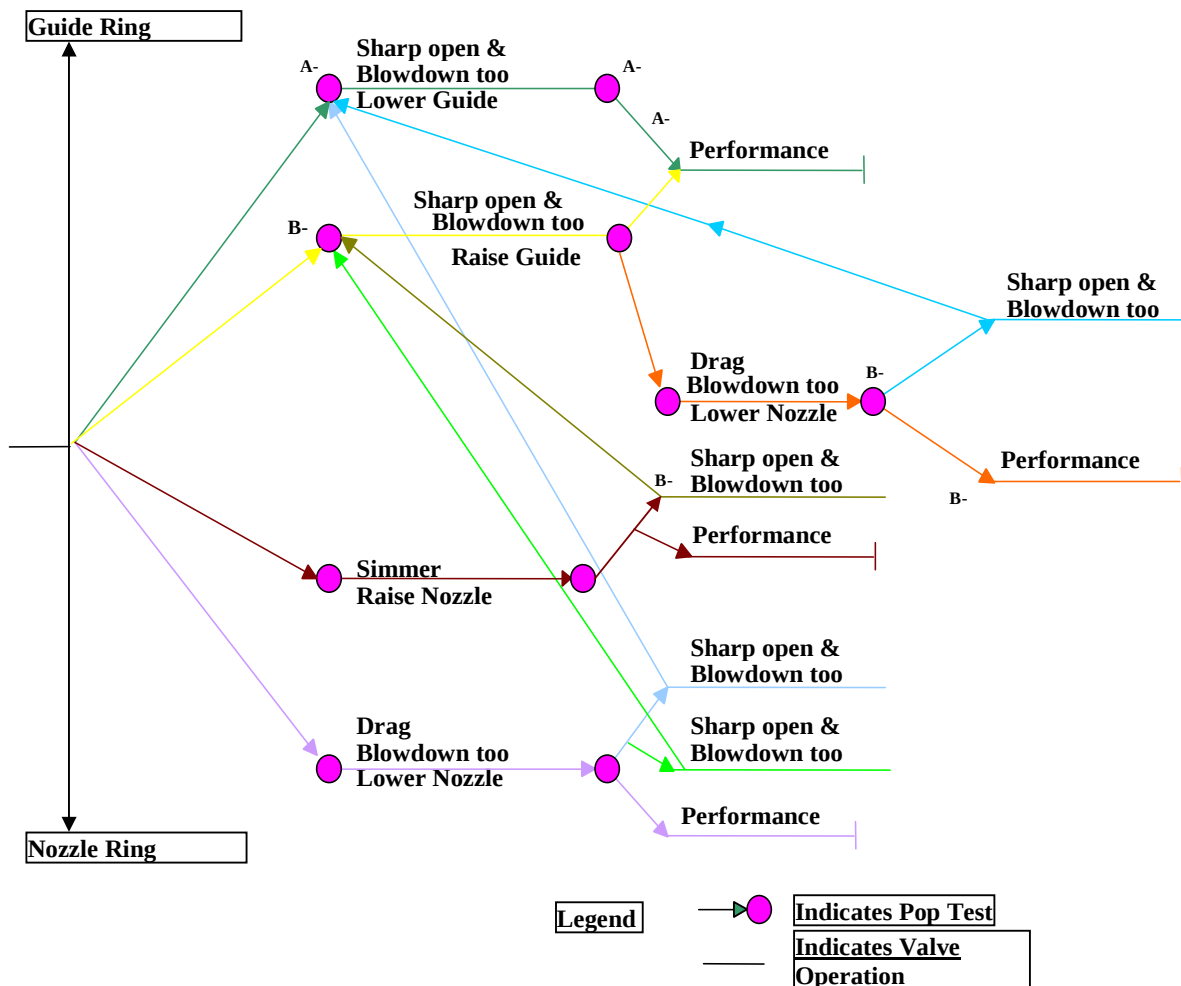
Boiler reaches to the maximum design pressure during safety valve floating. Hence, boiler thermal expansion readings to be noted during this activity. Thermal expansion shall be as per thermal expansion diagram.

Reference

Read carefully the supplier's O & M Manual before starting the activity and familiarize yourself with the components of the equipment

A detailed description of the key features of safety valves is provided in the safety valve manual of operation & maintenance manual.

GRAPHICAL ILLUSTRATION OF SAFETY VALVE



BOILER THERMAL EXPANSION TRAMP DRAWING

Expansion Tramp quantity required – 20 Nos. (approx.) per boiler. Pointer holders to be fixed/ welded on boiler part. Pointer is set move freely inside the holder. Reference plate shall be fixed to a non-moving permanent boiler structure as available nearby. These tramps are preferably fixed in presence of commissioning engineer, just before the commissioning of boilers.

Details of the location of Tramps will be as per Thermal Expansion Diagram

