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# Renovation of Boilers during Life Extension Programme of Power Plants

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## ABSTRACT

*Fossil utility boilers are increasingly required to provide service beyond originally anticipated commercial life. Life extension of old power plants is the theme of power industries in the near future to obtain optimum plant availability and load factor. Life extension of old power plants is preferred for the reasons of low cost per MW of power generation as compared to installation of new unit of similar capacity and also very less gestation period. In Life extension program, the pressure parts like super heater and main steam line are replaced completely due to setting in of creep and metallurgical changes taken place during long service at elevated temperatures. The other pressure parts like water walls, economizers, down corners, riser tubes subjected to corrosion and erosion are replaced to extend the life of the power plant for another 15 years. All the problems encountered in pressure parts during operation and maintenance and the extent of repair or replacement works carried out during LEP are discussed in this paper.*

## KEYWORDS:

*Power Plants, Life extension program, LEP*

## INTRODUCTION:

Generally when Thermal Power Plants have served for 100000 hours which is the designed service life of a Thermal unit, it is necessary to decide retirement of the unit or extend the life suitably by resorting to renovation. Therefore, in residual life assessment, studies are to be carried out in all the old units. The Remaining Life Assessment (RLA) study comprises of three stages for conditions assessment as given below.

1. The initial assessment utilizes the original design data of components, unit's historical data, and visual inspection.
2. The second level of assessment involves detailed non-destructive testing to further refine the estimate of remaining life. These are relatively more expensive and time consuming than the initial assessment. The NDT includes Radiographic test, ultrasonic test, Magnetic particle inspection and Die penetration test etc.
3. The third level of assessment involves more detailed techniques including material sampling and testing and sophisticated stress and fracture mechanics analysis. Visual inspection helps in identifying the component conditions and in deciding the location for sampling and also the areas requiring critical examination. NDT examination is carried out to identify the surface and subsurface defects. Thick walled components are analyzed by taking replication at specific locations.

## LIFE EXTENSION PROGRAMME:

The remaining life assessment studies are to be carried out and these experiments have shown that the high pressure parts like main steam line will be showing signs of deterioration and need replacement as these parts have undergone metallurgical changes resulting in reduction in strength, creep etc. and are not safe to operate.

The choices are either to go for renovation of the power station or replacements by completely new units. Renovation is chosen as a better alternative for the following reasons.

1. The gestation period for a new station would be as long as 4-5 years. By renovation, the unit is down only for about 8 months.
2. The cost per kW installation for the LEP is only 20% of that of a new one.
3. The selling price of power in the case of LEP is 70% less than the new plant.

### **OBJECTIVES OF LEP:**

The main objective of LEP works in Boiler is to ensure a substantial additional life at a considerably low cost as compared to that of installing new units. The pressure parts like super heaters, Main Steam Line, water wall, Economizers, Down-comers, and riser tubes which contribute to substantial weight of the boiler become weak due to creep, erosion and corrosion. Also, the MSL pipes and super-heaters which operate at high temperature are likely to suffer creep failure over prolonged usage. (Creep: Average stress to produce 1 % longitudinal deformation in 1 lakhs hours at the design temperature.)

A good part of the structural components of the boilers like main supporting structures, Staircase and platforms which contribute to the weight of the boiler substantially can be considered as having permanent life and only repair work need to be carried out. The air duct and gas ducts are repaired or replaced to the extent necessary. Also, this opportunity is utilized for carrying out modification works in pressure parts as well as in non-pressure parts, thus improving the performance of the equipment.

### **ERECTION OF PRESSURE PARTS**

The boiler consists of two prismatic shafts connected at the top by a horizontal gas duct. The first and larger shaft serves as the boiler furnace. The furnace water walls are arranged around the entire perimeter and along the full height of the furnace chamber. Water walls are heated directly by radiant heat of the flame. The other shaft is for accommodating heating surfaces which receive heat by convection and are called respectively the convective shaft and the convective duct.

### **ERECTION OF ECONOMISERS:**

Visual inspection, OD and thickness measurement and tube sample testing are to be carried out. If No material degradation was found in samples there is no need to replace. But if the excessive thinning and all the bend pipes shows severe material wastage, then the entire damaged portions are completely to be replaced.

### **ERECTION OF MAINSTEAM LINE:**

In MSL ovality and thickness are to be measured, magnetic particle test on welds, Ultrasonic Test on butt welds and replication test are to be carried out. Replication is to be carried out on Main Steam Line. If indication of micro structural to class 4L level, then the transfer pipes between emergency stop valve and turbine control valves shows any reduction in thickness. Considering the hours of operation and from the assessment made out of RLA study, it is recommended to replace Main Steam Line and transfer pipes.

The Emergency Stop Valve, transfer pipes were subjected to acid cleaning before erection, if these pipes were not included in the steam blowing process. The flow nozzle and thermo wells are erected only after steam blowing the main steam line pipe.

### **ERECTION OF DOWN COMERS AND RISER TUBES:**

Ovality measurement and thickness measurement are to be carried out. Also, NDT examination is to be conducted on fillet welds and butt welds. If down comer failure started occurring due to continuous operation of the boilers, considerable erosion has taken place in the fluid flow area, it is necessary to replace the down-comers and up-risers.

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### **ERECTION OF SUPER HEATERS:**

Super-heaters consist of four sections namely, the Radiant SH, Ceiling SH, Semi radiant or Screen SH and Convection SH. It is to be noticed that screen super heater, if the alignment bands were found to have disturbed or warped and damaged, erosion, Replication carried out on the headers is indicated by spheroidization to a level of class 4L.

It is to be checked for Radiant, Semi Radiant, Ceiling and Convective super heater for bowed condition and reduction in thickness. The inlet and outlet header replication test will indicate micro structural degradation. Tube sample analysis indicates polygonal ferrite and fully spheroidized carbides.

In De-super heater, LPI examination of the fillet weld at the inspection cover pipe indicated transverse and longitudinal cracks. Also, Cracks are to be checked in the diffuser pipe inside Desuperheater. Replication of steam cross over pipes will indicate spheroidisation level. Hence, the complete super heater coils, headers, de-superheaters and cross over pipes are to be replaced depending upon the test condition.

### **ERECTION OF WATER WALLS:**

Boiler furnace is lined with water wall tubes and stretches from bottom ash hopper to roof between headers connecting down comers and up riser with the drum. In water wall, visual inspection, OD and thickness survey, deposit analysis and testing of sample are to be carried out. In rear water wall if most of the tubes were found distorted and moved into the furnace, the mid portion at the ignition belt zone on either sides of the water wall tubes are found disturbed, then the previous records are to be checked for failure of tubes for number of times. Then it is advisable to replace water wall tubes to avoid direct impingement of fuel or flame. From the internal deposit analysis of the samples taken from high heat zone, very high deposit contents are seen and the deposits were adherent in nature calling for multi stack cleaning of water wall.

### **FEED WATER LINE AND CONTROL STATION:**

Based on NDT, ovality measurement at bends, thickness measurements and the extent of replacement will be decided and carried out accordingly. All the HP valves are to be replaced according to the percentage of ovality.

$$\text{percentage of ovality} = 2 \left( \frac{D_{\max} - D_{\min}}{D_{\max} + D_{\min}} \right) 100$$

### **DRUM:**

LPI tests are to be carried out on the circumferential seam welds and longitudinal seam welds inside the drum. If some welds indicate surface pore, then grind the surface. After grinding many may disappear and other pores on the surface may be acceptable. Overlap in one of the joints is noticed, which has disappeared after grinding. Ultrasonic Test (UT) to be carried out on these welds, it indicates that they are free from defects. LPI and MPI tests are to be carried out on the circumferential and longitudinal seams at outside surfaces, it indicates that the welds are in good condition except for an under cut. UT is to be carried out at some selected locations of drum plates to check the presence of laminations and no lamination was found, LPI and NPI to be carried out at all the fillet welds of all the DC, UR and other stubs. If no defect was found, then micro structural degradation is to be seen on the replica taken from boiler drum. The examinations that are carried out indicate the possibility for continued operation with the present condition. Hence drum need not to be replaced.

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## COMMISSIONING ACTIVITIES:

**AIR LEAK TEST:** After completion of erection works in pressure parts air leak test is to be conducted before doing hydraulic test. This process helps in identifying the weld defects and the defects can be attended immediately without the need of draining the boiler contour.

**HYDRAULIC TEST:** Hydraulic test is an important milestone activity in the erection of pressure parts. Hydraulic test is to be conducted at a pressure of 1.5 times the working pressure.

**ACID CLEANING OF PRESSURE PARTS:** The aim of acid cleaning is to remove mill scale, oil, paint, preservatives, rust and welding slags that would have entered during manufacture and assembly of new tubes and also to remove the oxides of iron and silica from the old tubes

### Acidcleaning involves the following operation

- a) Cold water and hot water flushing.
- b) Degreasing
- c) Inhibited acid pickling
- d) Citric acid rinsing
- e) Neutralization
- f) Passivation.

Samples of old pipes and new pipes are to be placed inside the drum and dissolving tank. After the process, the samples are physically verified for cleanliness.

**BALL DRIFT TEST:** After acid cleaning operation, the boiler is restored from acid cleaning schemes and down comer thoroughness test is to be conducted to avoid starvation of water walls. Iron ball may be dropped from inside the drum into the down comer opening, and the ball is to be collected in the bottom water wall headers. By ball test method, the blockages found should be rectified.

**REFRACTORY DRY OUT:** The purpose of boiler refractory drying is the removal of moisture from the boiler setting as the presence of moisture substantially affects the thermal and mechanical properties of the refractory and insulation material. It takes about 72-300 hours approximately, depending upon the capacity of the boiler for the completion of refractory dry out process.

**STEAM BLOWING OPERATION:** Steam blow out process is carried out to remove mill scale welding slags and other dirt particles from superheaters and main steam line. For evaluating cleanliness and termination point of the steam blowing, target plate of alloy steel are to be used. In the initial stage, mild steel can be used. The result of blowing operation can be judged by the absolute number of pitting on the target plate in the central zone. The piping is considered clean if there are not more than 5 pitting and shall not have any deformed edges. Besides there shall be no pitting zone

**SAFETY VALVES FLOATING:** Safety valve floating is carried out to check the functioning by opening and closing mechanically. After completing the safety valves floating successfully, the boiler is declared, ready to supply steam for turbine rolling and synchronization with the grid.

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