MI-2019
Site: UCH Power Complex
Gas Turbine Frame-9E

UCH Power (Private) Limited

Gas Turbine Major Inspection

by

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Inspection

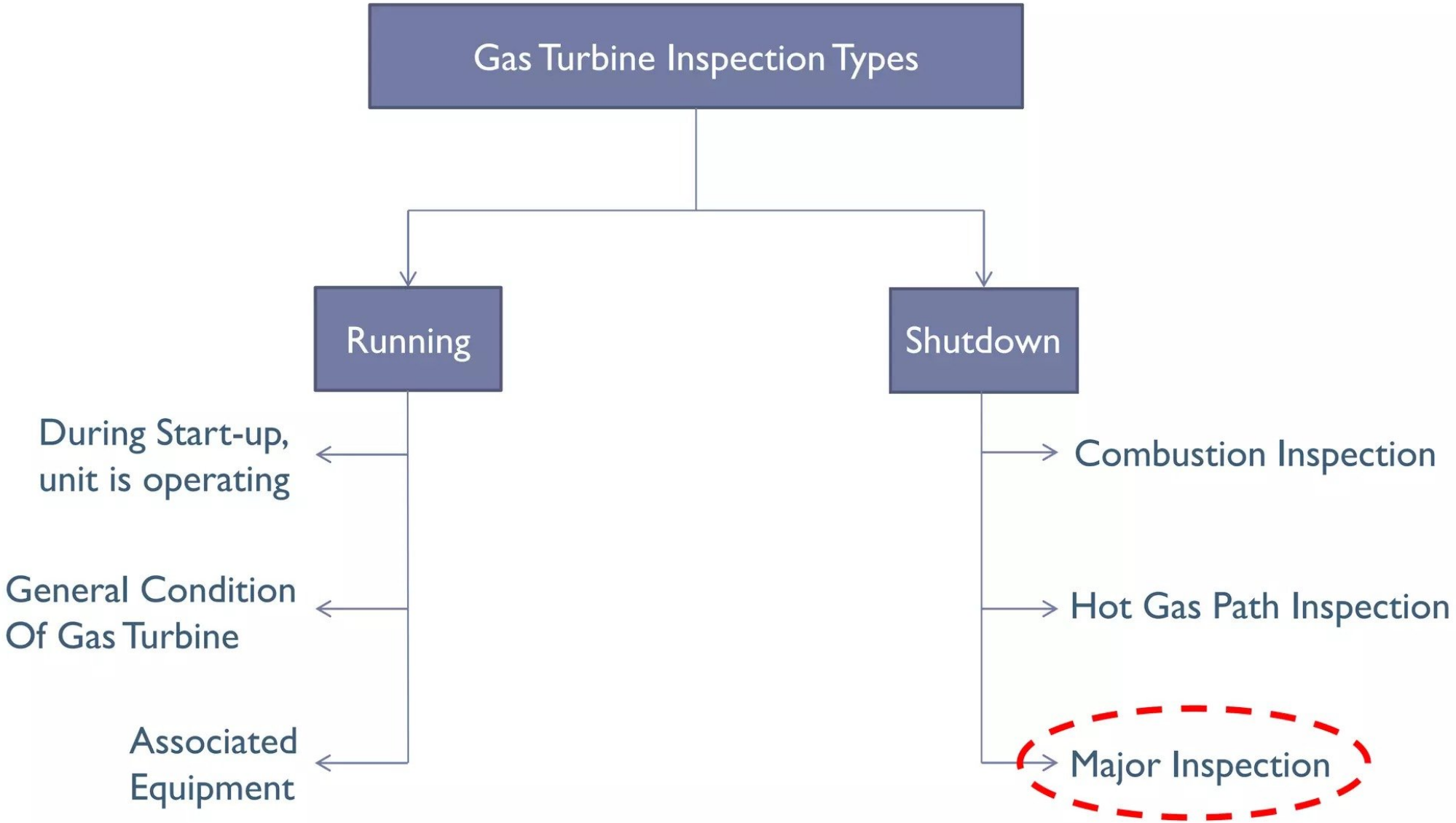
In engineering activities inspection involves the measurements, tests and gauges applied to certain characteristics in regard to an object or activity.



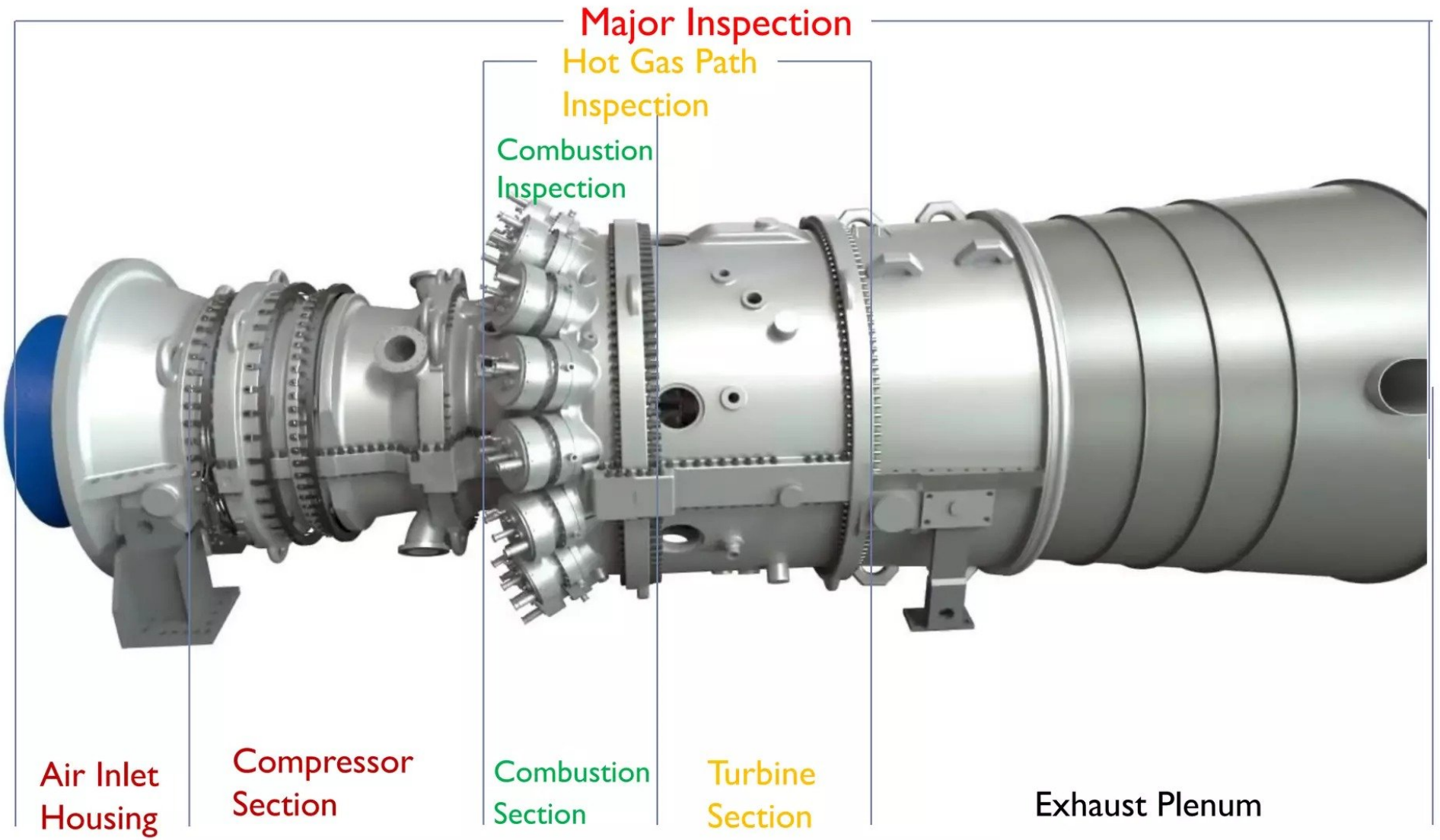
WHY?

Inspection helps to control; quality, reduces downtime costs, eliminate scrap losses and assignable causes of defective work.

Gas Turbine Inspection



Shut Down Inspection



Major Inspection

It involves the inspection of all major flange to flange components of Gas Turbine which are subject to wear during normal operation.

When?

Based on 64000 Running Hours or 2400 Starts.

It includes:

- Combustion Inspection
- Hot Gas Path Inspection
- Inspection of casings (*Cracks, Erosion*)
- Rotor and Stator blades of Compressors *(Tip Clearances, Rubs, Bowing, Cracks)*
- Compressor air inlet housing *(Fouling, Erosion, Corrosion, Leakage)*
- Bearings and Seals *(Measurements against Original Values)*

Pre-checks

Pre-checks are measured for determining the pattern of the machine before dismantling.

Following are the Pre-checks;

A. 6 Points check
B. Load Coupling to Generator Alignment check
C. Bump Test
D. Set Back measurement
E. Compressor Clearances
F. A-set readings
G. Turbine Clearances
H. Bearing Clearances and its labyrinths

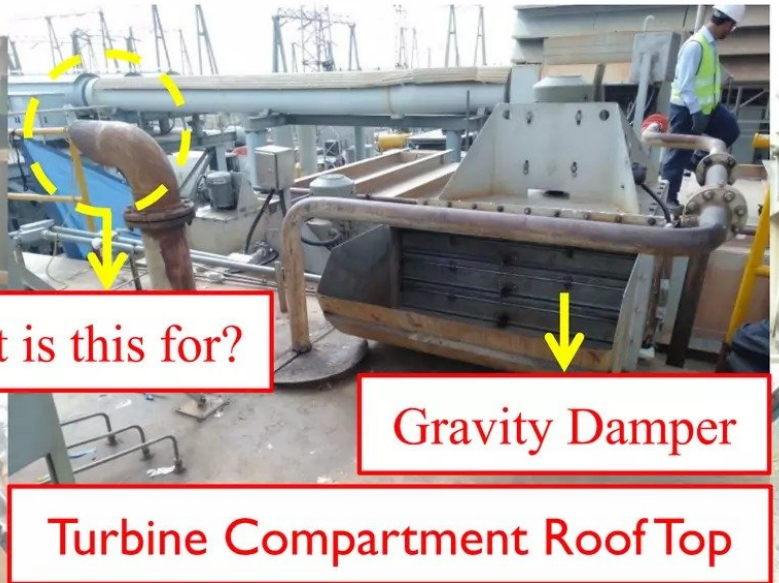


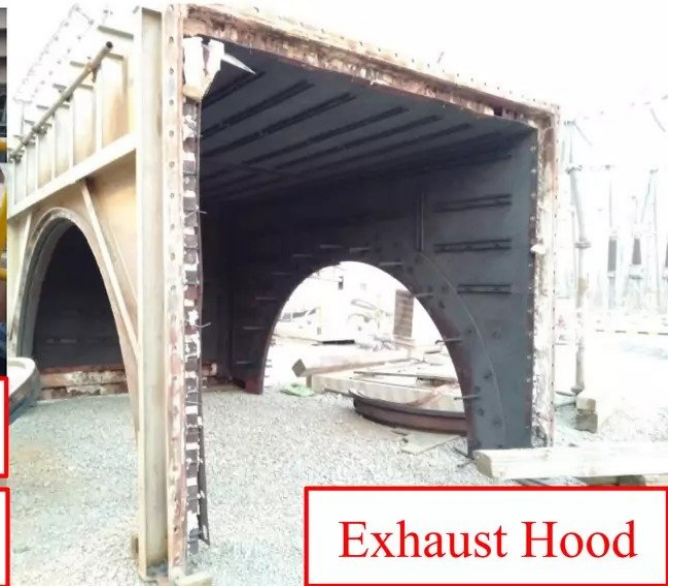
Roof and Walls Removal

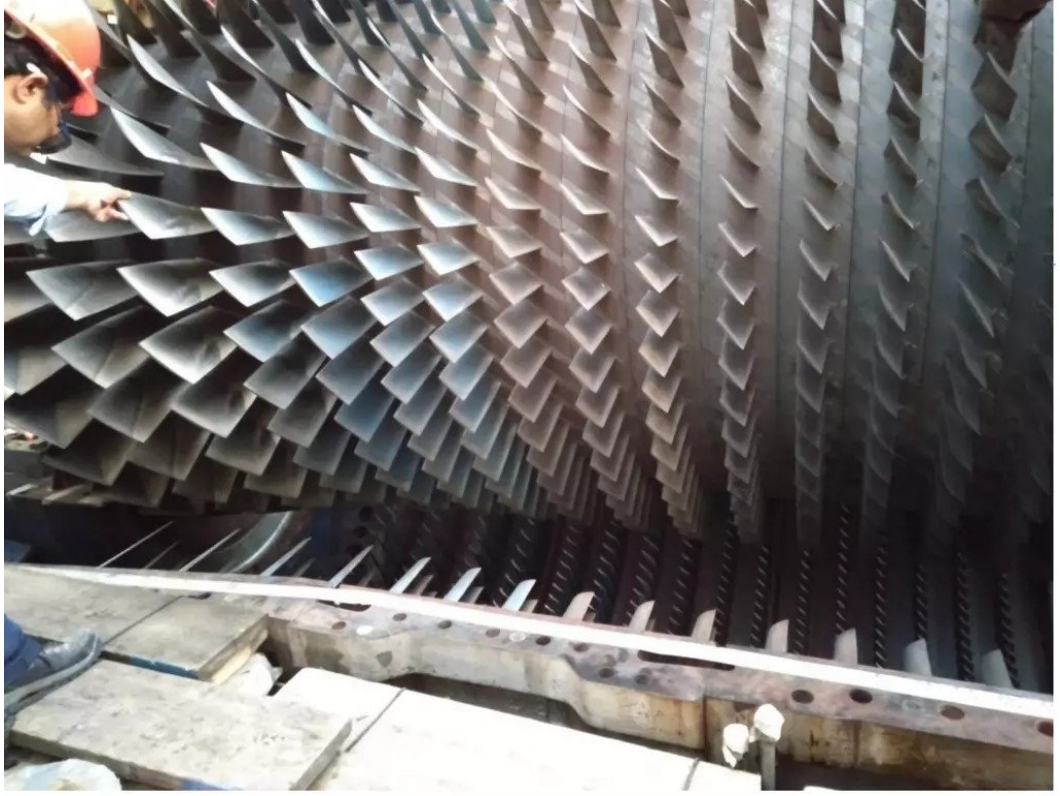
- The activity is performed for facilitating the Gas Turbine casings and parts to lift up by means of crane.
- The roof and walls of turbine and Load Coupling compartments are removed.
- The processes involved in removing the roof and walls are: Cutting, Grinding and Unbolting.
- All of the Flex seals are taken out for the replacement.
- All of the dampers and blowers are removed prior to roof lifting from the Turbine and Load Compartment roofs.














COMPRESSOR
ROTOR STAND
BEARING NO.2
SIDE


ID No. S S 001
S.W.L. 10 T
D.O. INSP. 26 9 ? ?
Due Date 26 9 20


WLL 10T
2933238
EWL 3M
DATE JAN 19

CI Hardware Removal



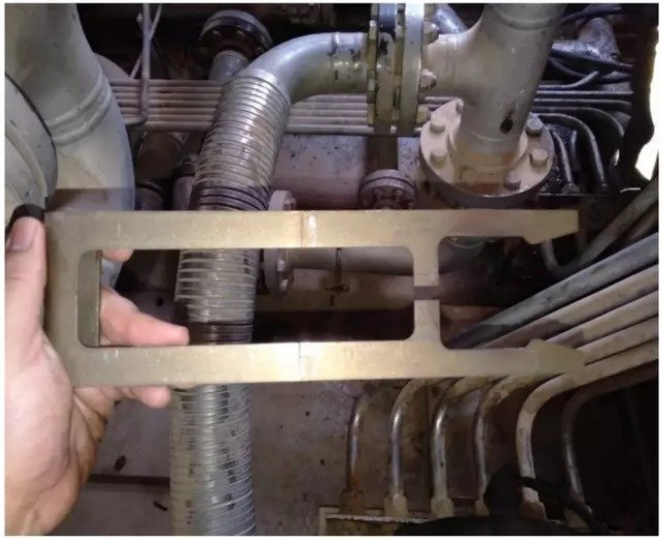


- When all the lines are removed, associated with the nozzle assembly; the nozzle assembly is unbolted. It is hanged with the crane boom by means of chain block, lifted up as recessed from bolts.

What does the white mark on can cover indicate?

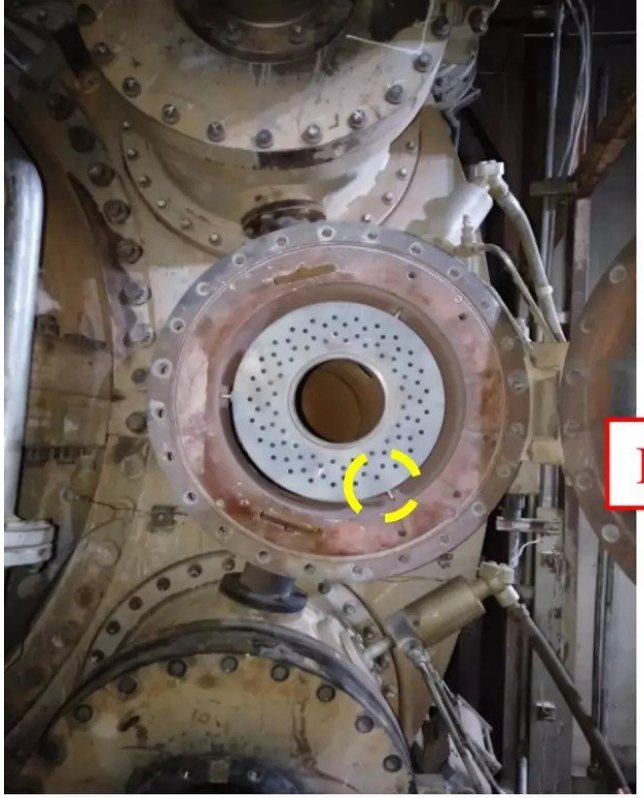
CI Hardware removal







- Can cover, when unbolted, crossfire tube retainers are subjected to remove. Two retainers are associated with each can. Crossfire tubes are in male and female part, the assembly pushed in the crossfire tube cover to make free the liner and flow sleeve. The retainers are removed by inserting a screw driver/ crowbar's flat head into the retainer and pulling it outside the flow sleeve.





Hola Seal

- Flow sleeve is bolted with the combustion can face flange by means of 4 allen key head bolts. When unbolted, it is extracted by a lever hoist. The hook is arranged into the holes configured into the flow sleeve, and pulled out.

What is the indication?



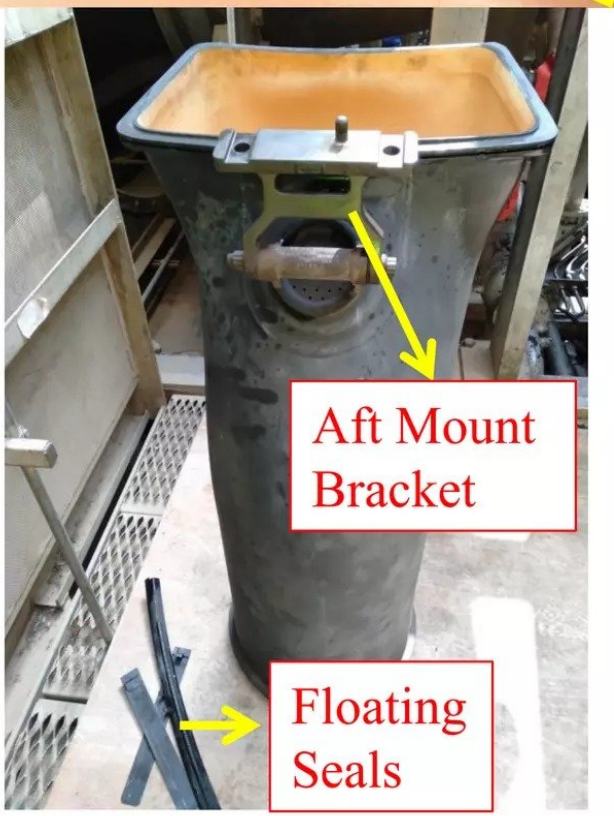
- Liner is stuck by Hola seal at aft end into the Transition Piece, and from the fwd end, supported by three lugs into the flow sleeve grooves. It is extracted by pushing the liner outside from the sleeve.

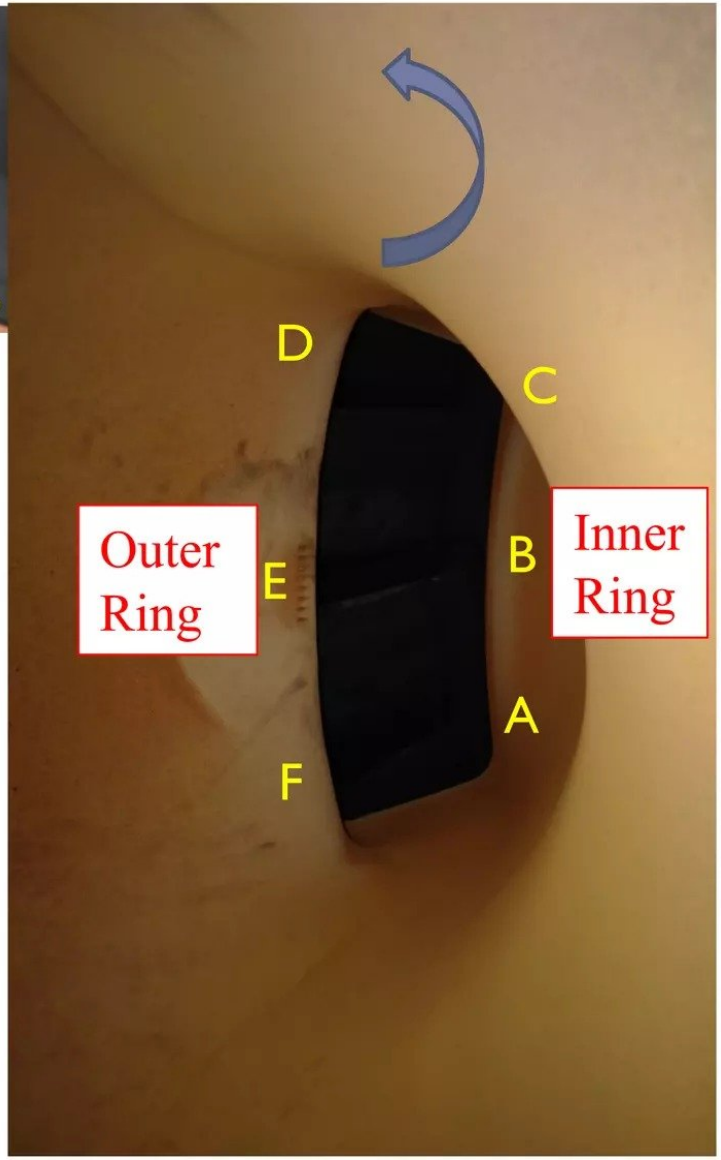


- Cans 5&11 are removed, for getting into the wrapper, for unbolting the transition pieces. The cans, aforementioned, are also exist at the horizontal joint of combustion wrapper casing.

Set Back Measurement ✓



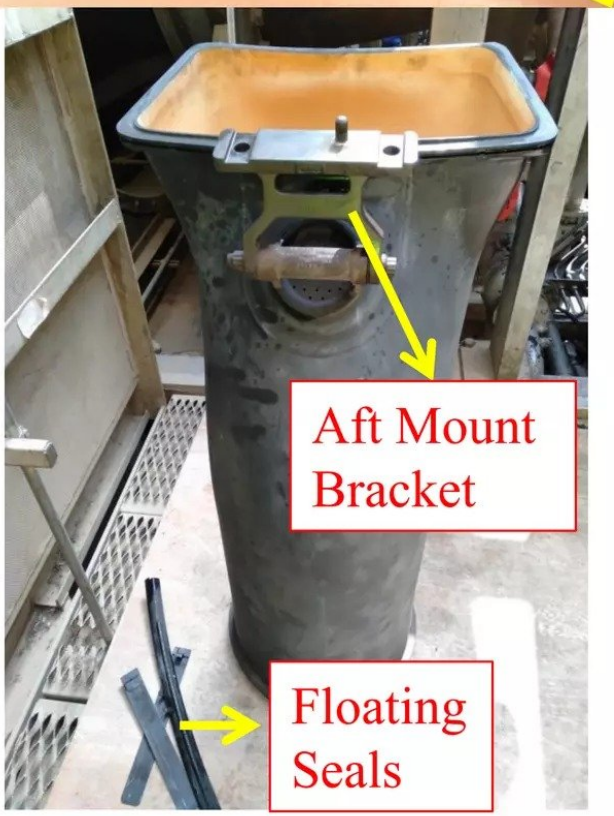


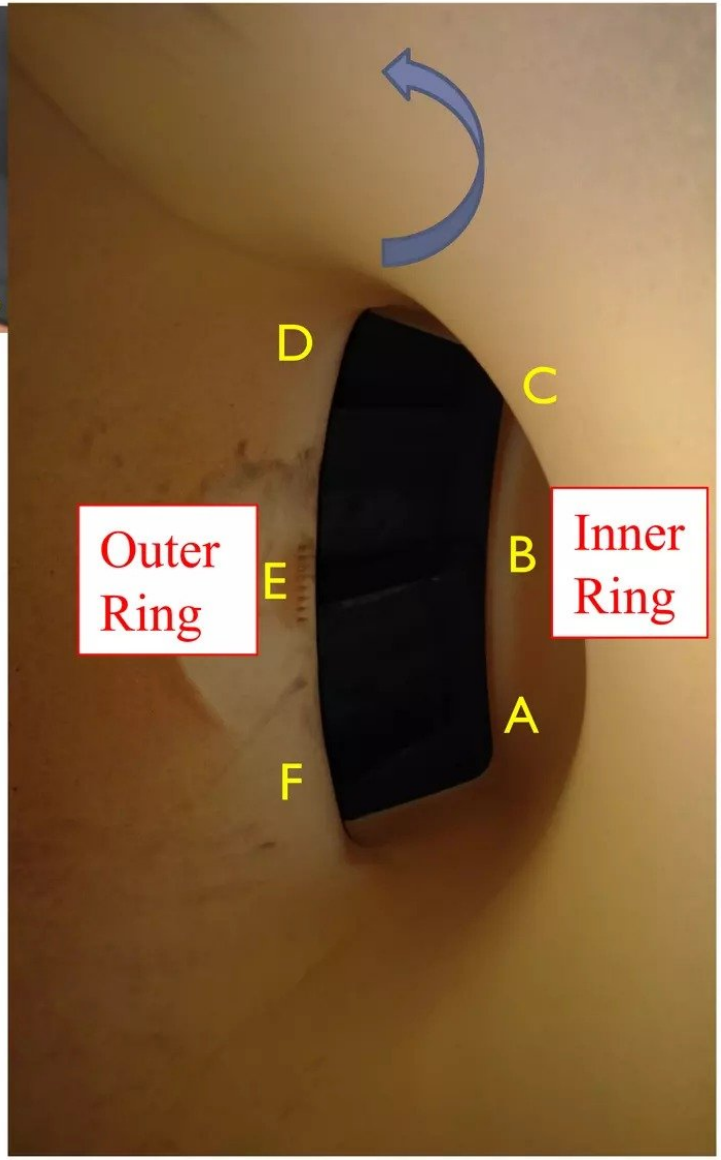


- Transition Piece is engaged with floating seals from fwd end into the 1st stage nozzle outer and inner ring groove.
- Side seals are used for sealing the transition pieces from sides.
- The fwd face of transition piece has the ways for introducing the seals.
- The measurement is taken by vernier caliper for measuring the inner distance between the collar of the transition face and 1st stage nozzle ring collar.
- Range: 250±50 thou

Set Back Measurement ✓





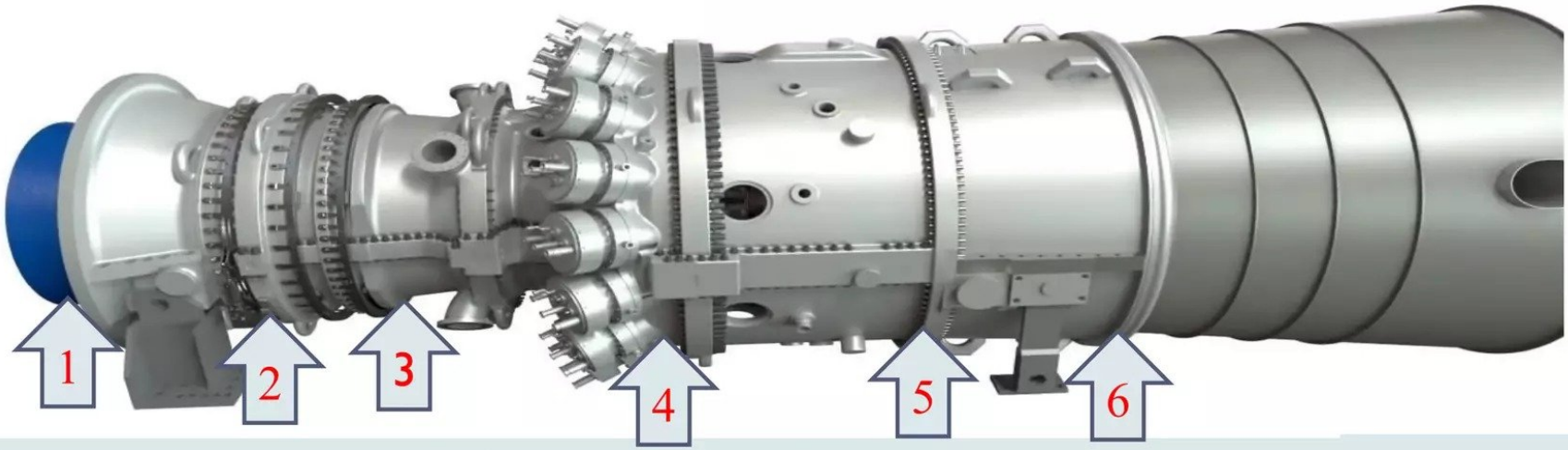


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Jacks Placement

Mechanical jacks are placed before unbolting the upper half casings. These jacks are lifted to metered value after appointing at the lower half casings.

Why do we need jacks to place?



1- 2 jacks are placed under the Bellmouth support and lifted to 3 thou
2- 1 jack is placed under the forward compressor casing and lifted to 2 thou
3- 1 jack is placed under the after compressor casing and lifted to 6 thou
4- 1 jack is placed under the combustion wrapper forward side and lifted to 2 thou
5- 1 jack is placed under the combustion wrapper after side and lifted to 6 thou
6- 1 jack is placed under the turbine aft side and lifted to 4 thou

Note: *The lifting values should consider as per standard and may vary on TA commands.*

Unbolting of the Casing Bolts

- Bolts of casings are classified as Horizontal and Vertical Bolts. Horizontal bolts are fastened at horizontal axis where vertical are radial ones.
- 2 Dowels are fastened at either sides of each casing. Remaining are the bolts, fastened with nuts.
- Dowels are removed first than the remaining bolts.

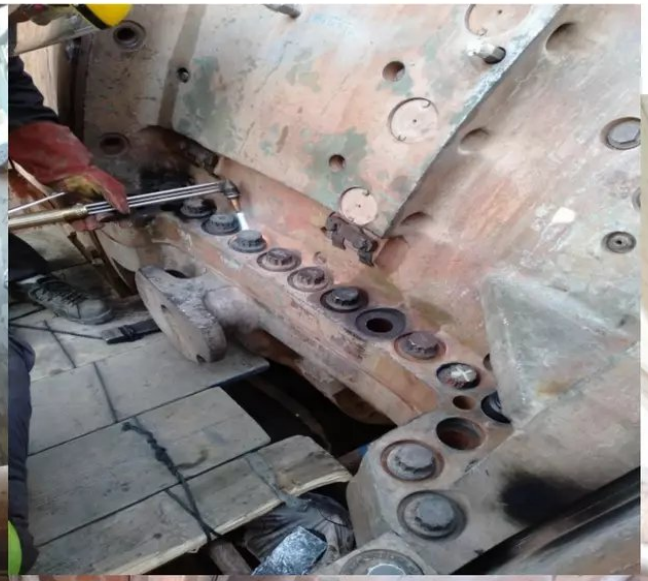
Methods for unbolting the casing bolts are:

- Heating and Hammering (Heated until the bolt becomes red hot)
- Pressure Source

Which bolts are first subjected to remove and why?

Unbolting of the Casings







Dowel

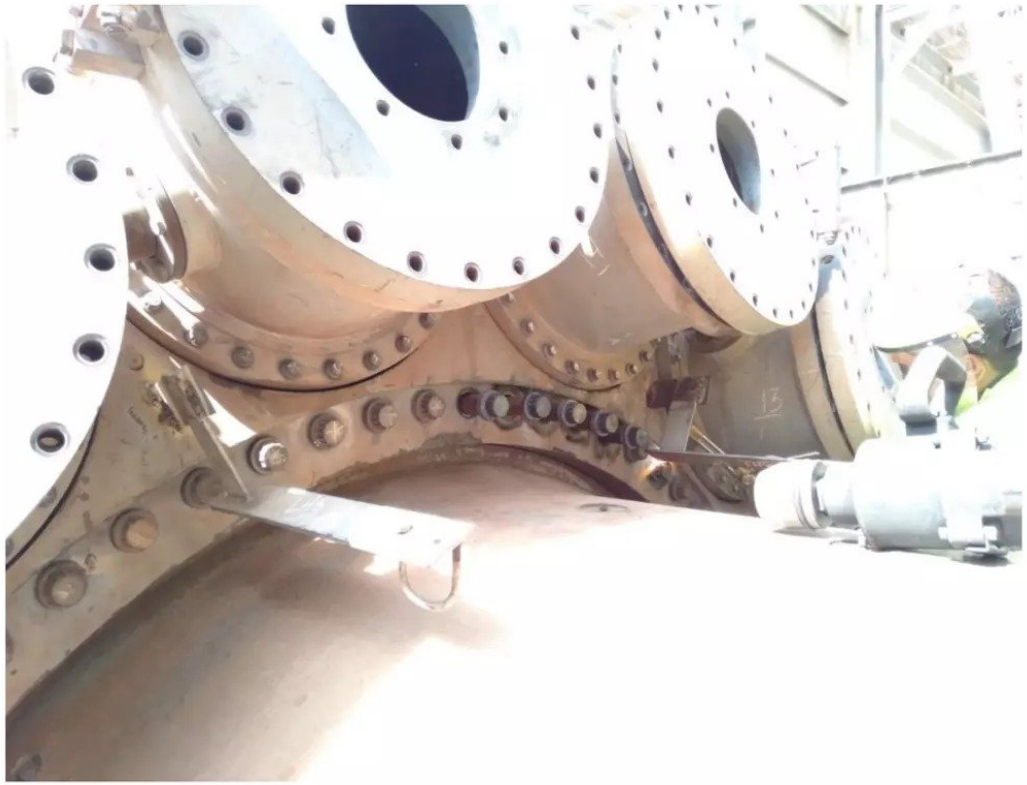


Difference b/w Dowel and Bolt?

Uplifting of Casing Upper Halves

- Jacking Bolts are used for splitting the casings. Jacking bolts are torqued; they are accessed through their provisions from upper half casing to the lower casing surface.
- The Crane radius and boom length should be under consideration, while lifting; a proper Lifting Procedure should be given for each casing and rotor.
- When the casing split up, the upward travelling is constantly monitored by metering. That assures the uniform travelling of the casing half from both sides.
- In case of Compressor and turbine upper halves, jacking is done until the blades of stator and rotor are freed.
- The crane boom remains on load during the jacking, and boom goes up if the upper half is freed from the lower one.
- Guide pins, one each side of the casing, are installed into the bolt access holes for consolidating the concentricity of the casing's halves.
- Weight is also an other important factor to consider while lifting; if it goes beyond limit, should the casing be hinged. That's why the weight should be noticed consistently while booming up the casing.

Combustion Wrapper Casing Uplifting





- Lines, tapped from the combustion wrapper, should be removed, before lifting the wrapper casing.
- One bolt of all can covers, opposite to the can cover joint, should be engaged, while lifting.

Compressor Section

- Compressor section is composed of four horizontal split casings. They are: inlet casing, forward casing, after casing and compressor discharge casing.
- Lines (upper half), cooling and sealing lines (5^{th} stage extraction), surge control lines (11^{th} stage extraction), associated with the compressor section; should be removed for casings dis-assembly. The manifolds: Atomizing air, Purge air and Gas Fuel; upper halves should also be removed.
- First, the CDC (compressor discharge casing) is removed, forward and after casings are removed together afterwards, and may or not be the Bellmouth attached with. For removing the Bellmouth, its housing should be removed first. The sequence of removing the casings may vary as per TA command.

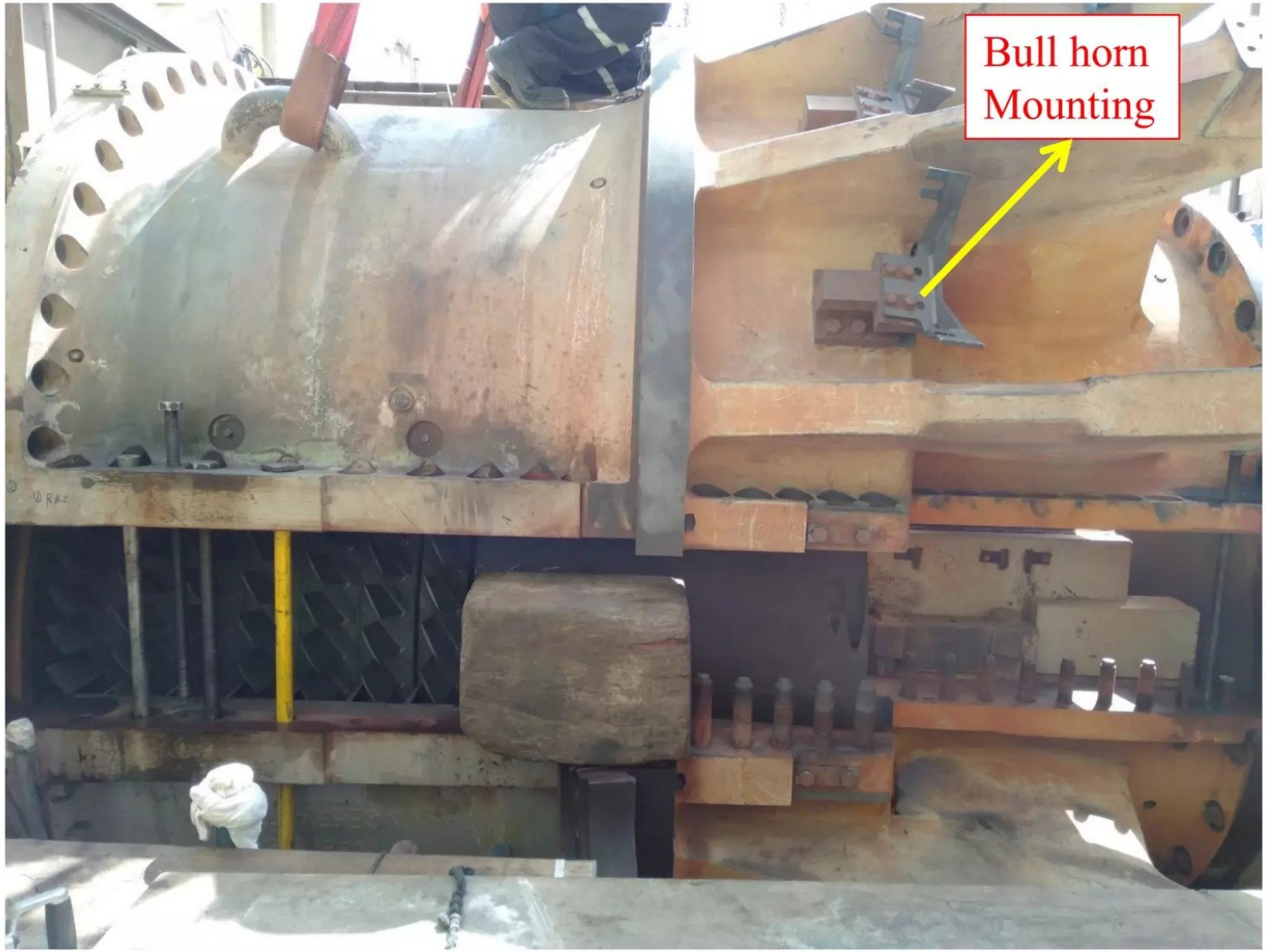
6 Points Check ✓

- 6 points check are recorded before compressor casing upper halves removal. 16 access holes are located on compressor casings, 4 at each top and bottom, and 4 at each left and right. Where, 8 access holes are located at turbine, in the same manner as the compressor.
- These holes are covered with the locking plugs. From these holes, the vernier depth is accessed. The vernier depth goes deep and touches the blade tip, total reading of vernier is than subtracted from the casing thickness, which is punched on the casing. Turning of the rotor may needed, if any rotor blade doesn't exist at the location to the access hole. For turning, ROSH Permit is required.
- The plugs are located on compressor rotor wheels: 1st, 7th, 13th and 17th. Whereas, in the turbine case, on turbine 2nd and 3rd wheel.

Why 6 points?



Compressor Discharge Casing (CDC)



Compressor Discharge Casing (CDC)

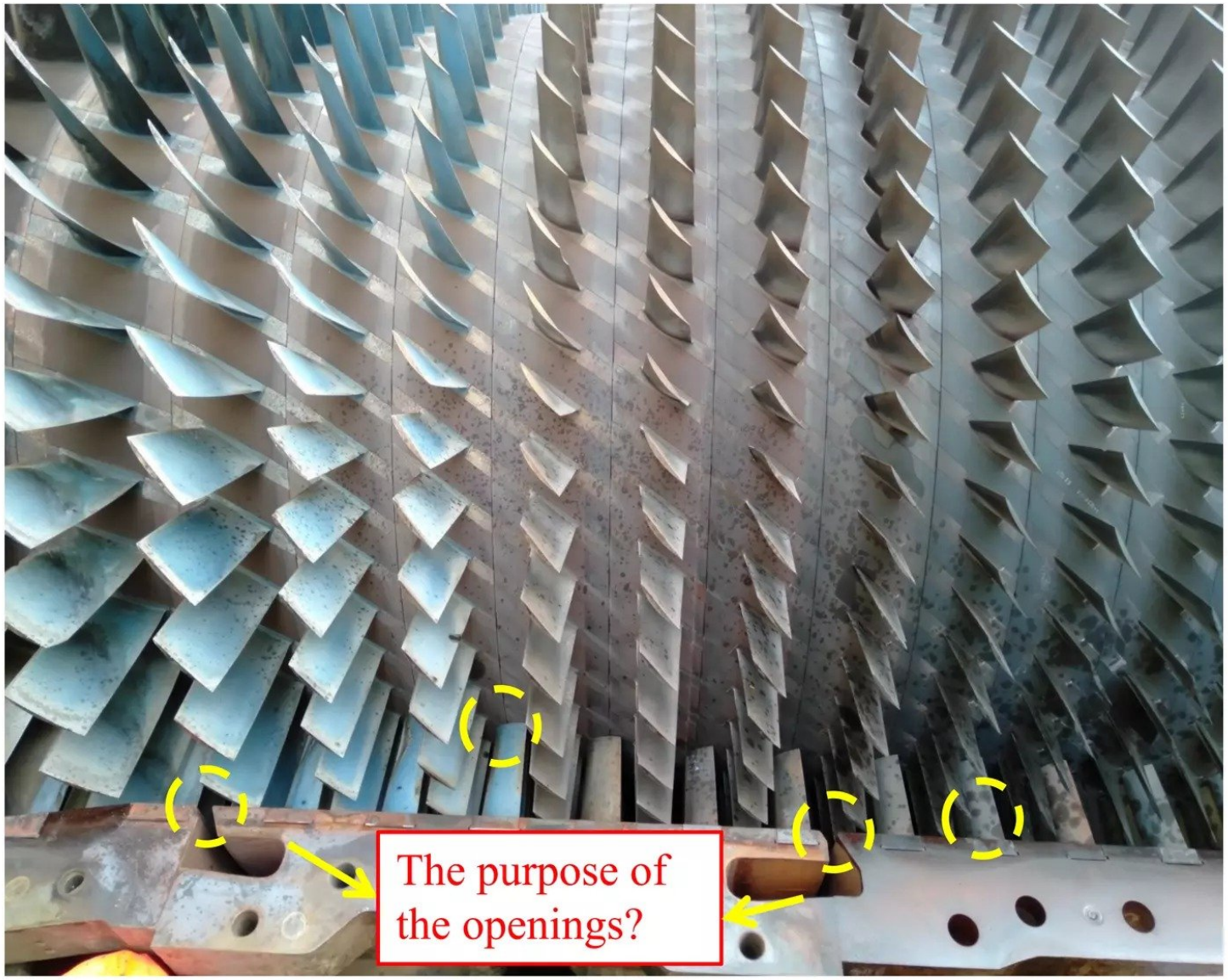


Bellmouth + Forward + After Compressor Casings





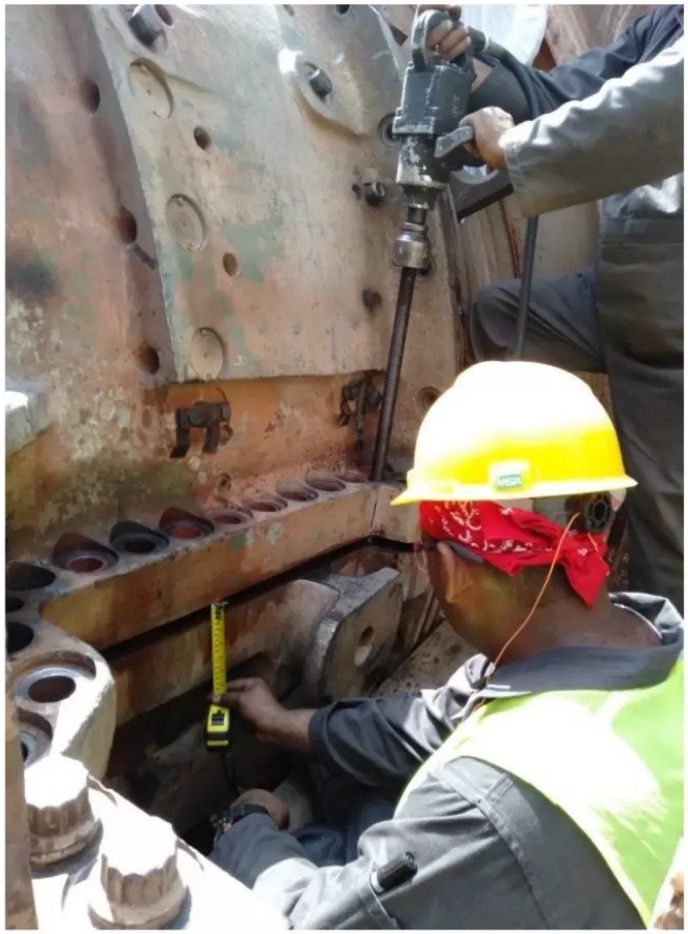
Compressor Clearances ✓



- The radial clearances are measured between, rotor blades and casing, and casing blades and rotor surface, at the horizontal axis.
- The readings are recorded, from left and right sides, at each compressor stage composed of one stationary and rotary blade. Feeler gauge is used for measuring.

Turbine Section (Turbine Shell Lifting)



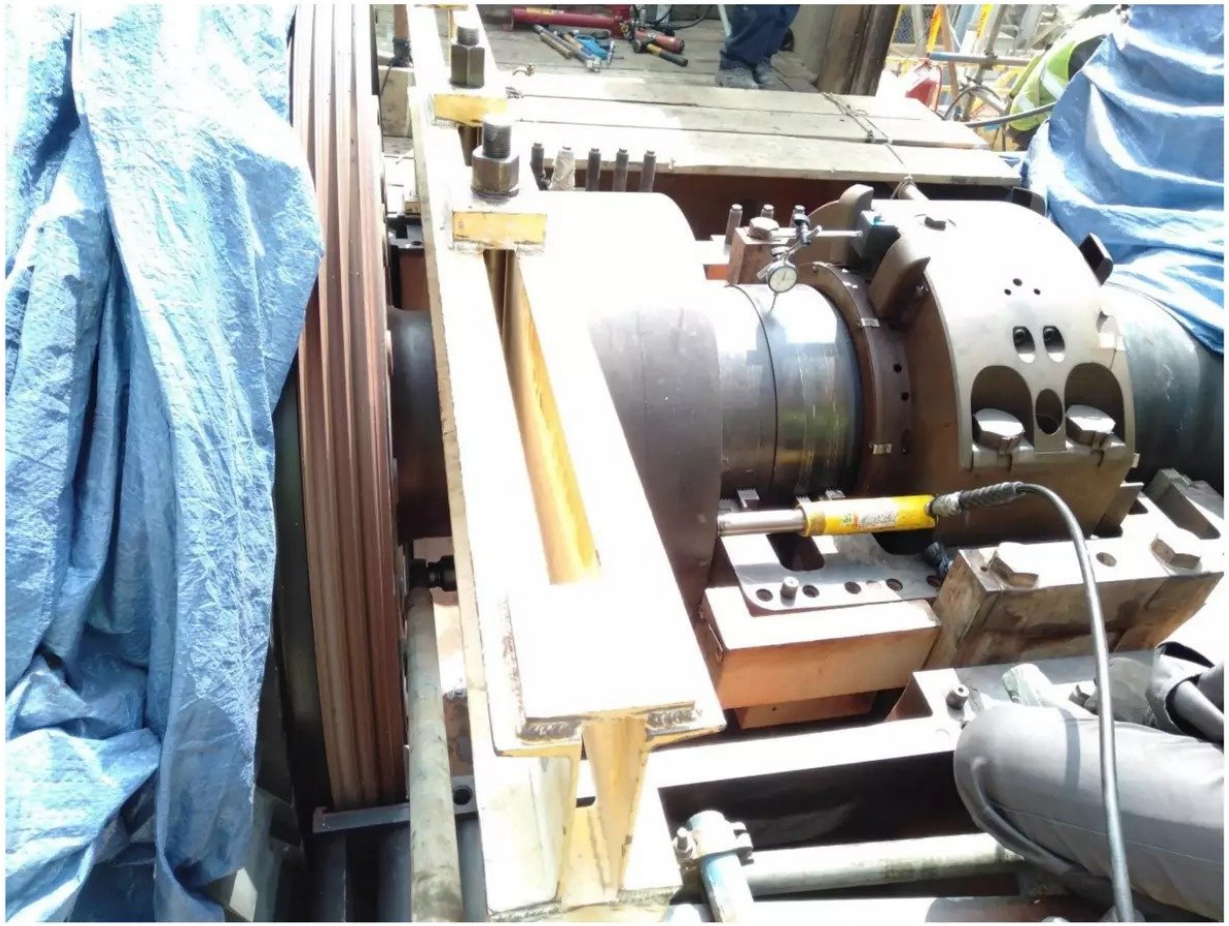


- All the radial and horizontal bolts, of the turbine upper half, are removed.
- The first stage nozzle ring locking pin is removed prior lifting the turbine shell.

Bump Test ✓

- Bump test is performed for checking out the maximum displacement/float of the compressor by keeping the rotor on bearings. The jacking can be done either from fwd or aft side of the compressor rotor.
- 2 hydraulic jacks are used to push the rotor uniformly, placed on horizontal axis on rotor wheel face. Packing is introduced for making the require length of hydraulic jack, If require.
- A dial gauge is introduced with the magnet fixture, mounted on the solid surface free from the rotor, for checking out the maximum displacement indication.
- As, the jacks push the rotor, the rotor will be displaced as per allowable limit provided by the thrust housing.
- The limits range between 13 to 17 thou, if the brush seal exists in the pressure packing. Rather than that, the range falls between 21 to 27 thou.

Bump Test ✓



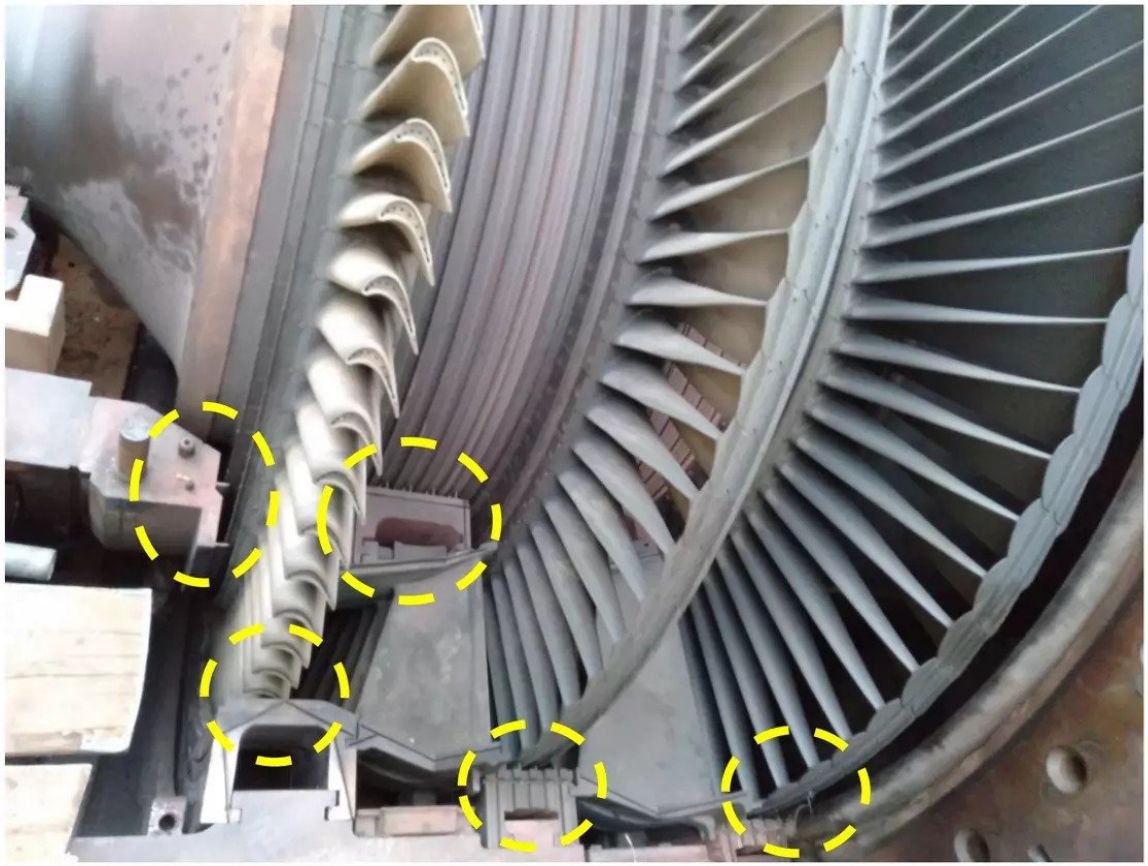


A-set Reading ✓



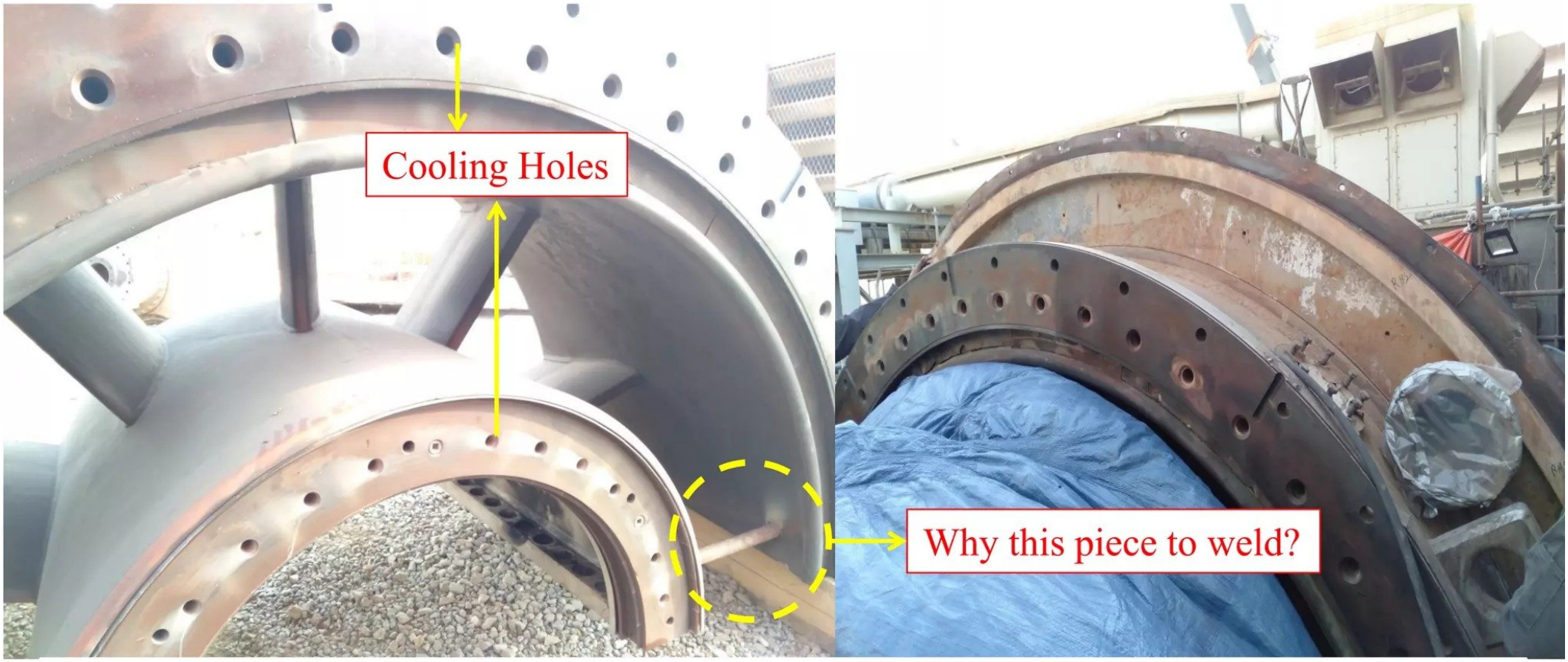
- The reading is measured between the CDC outer cylinder aft surface and first stage rotor wheel of turbine, from both sides, left and right.. A-set reading, if disturbed, will affect the turbine clearances.
- For recording the reading, the rotor should be displaced at active side thrust bearing. The nominal reading is the 10.250”, measured by the Inside Micrometer.

Turbine Clearances ✓



- Turbine clearances are radial and the axial ones. They are recorded by Feeler gauge, Telescopic gauge and vernier calliper.
- The clearances, close to the reference values, will increase the unit performance.
- They are recorded when the rotor is at active thrust bearing side.
- The clearances are categorized as fwd and aft sides clearances, and recorded between, the buckets and shrouds, and the diaphragms and rotor land.
- Shrouds of 2^{nd} and 3^{rd} stage are equipped with the labyrinths and honeycomb seal. Which minimizes the bucket's tip leakage. Whereas, the 1^{st} stage shrouds are plain and thermal barrier coated.

Exhaust Shell Removal



- Exhaust shell is connected with the turbine shell and is composed of inner and outer cylinders. The cylinders are separated by radial struts, which have internal cooling passages. Passive cooling air also gets the provision to flow to inner cylinder and to the turbine shell outer cooling. 88tk lines are first removed before uplifting.

Bearings

- Three Journal bearings are responsible for bearing the radial load of the combined rotor. Whereas, a couple of thrust bearings are compensating the axial thrust of the rotor.
- The journal bearings are in-housed, horizontally split type housings and bearing liners, packed with the labyrinths for sealing. Air is introduced for cooling and sealing purpose.
- For extracting the bearings, their housings are first subjected to remove. Then, the upper bearing liners are removed. Upper labyrinths packing are keyed into the upper housing; whereas, lower ones are freely inserted into the lower housing.

2nd Bearing Housing



- 2nd bearing housing rests inside the CDC inner cylinder. The vent and supply line, for cooling and sealing air, is accessed from the Combustion wrapper.
- The marriage coupling is housed inside the inner barrel. The inner barrel is first removed for recessing the 2nd bearing housing.

Air vent is only introduced to the 2nd bearing??

2nd Bearing Housing

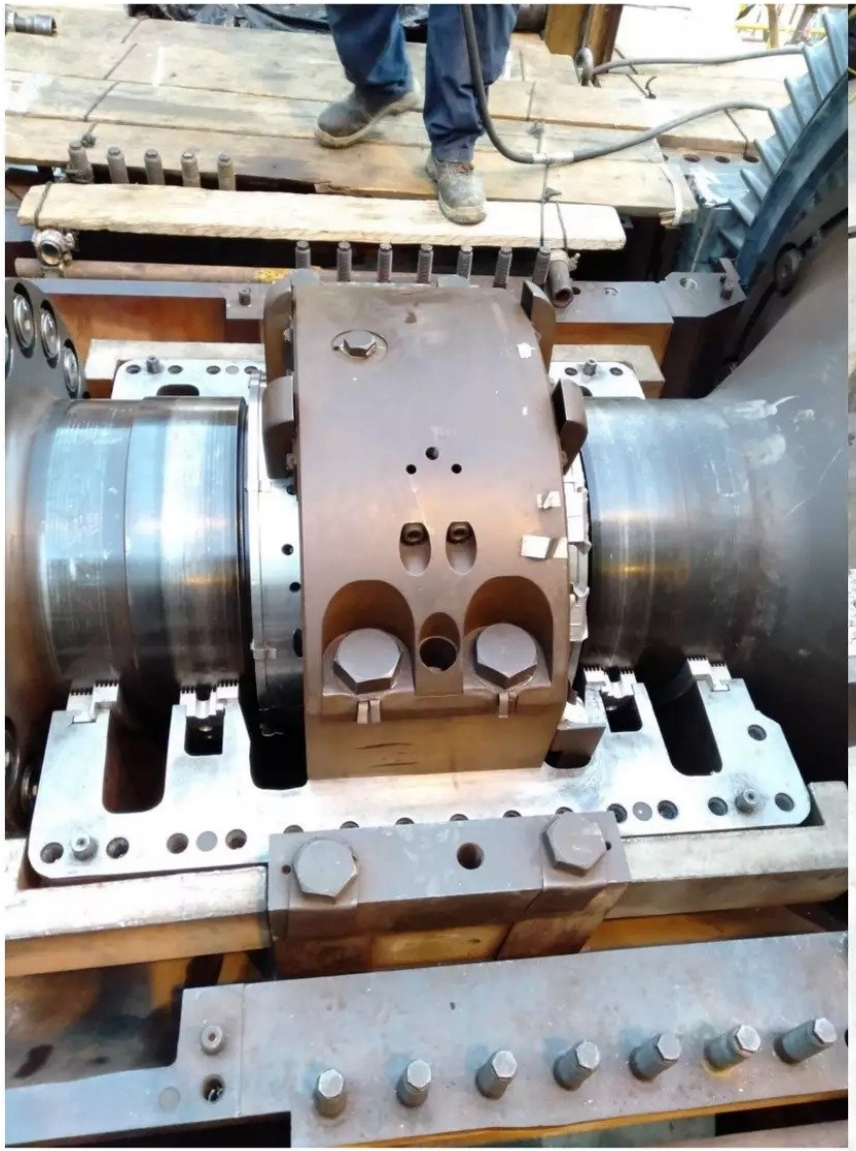






- The inner barrel is bolted from four locations, two at either side. Whereas, the pin lock adjacent to the bolt position, gives the provision to the jacking bolt for lifting up the upper half of the inner barrel. Similarly, the bearing housing is unbolted and lifted up by tying eyebolts and shackle.

2nd Bearing Housing

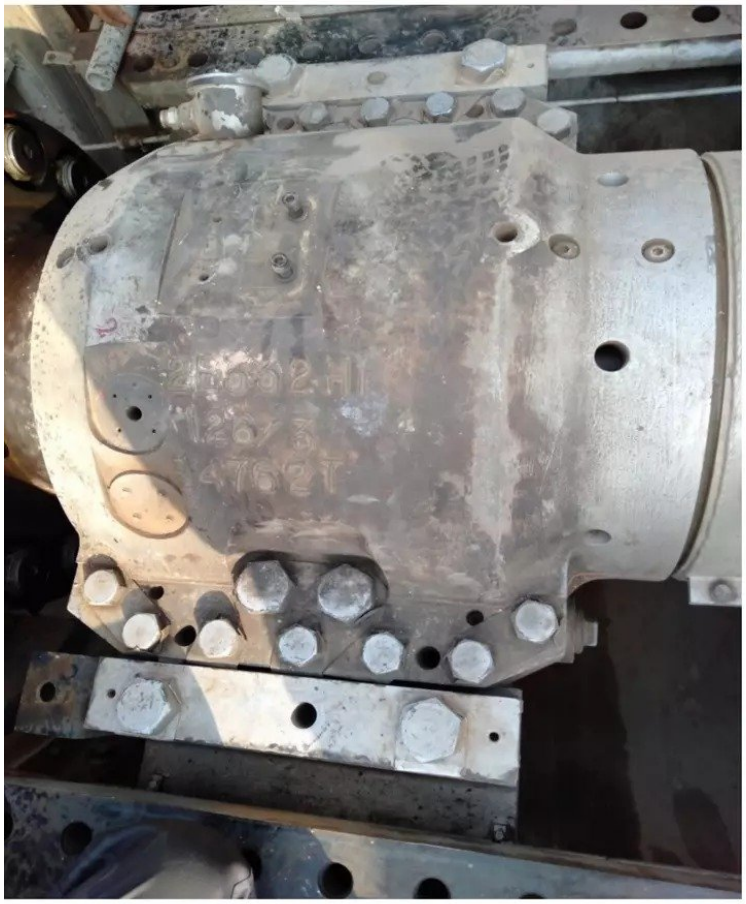






- The 2nd bearing liner strap and bearing liner upper half are unbolted and lifted up through eyebolts and shackle, by means of crane.

3rd Bearing Housing

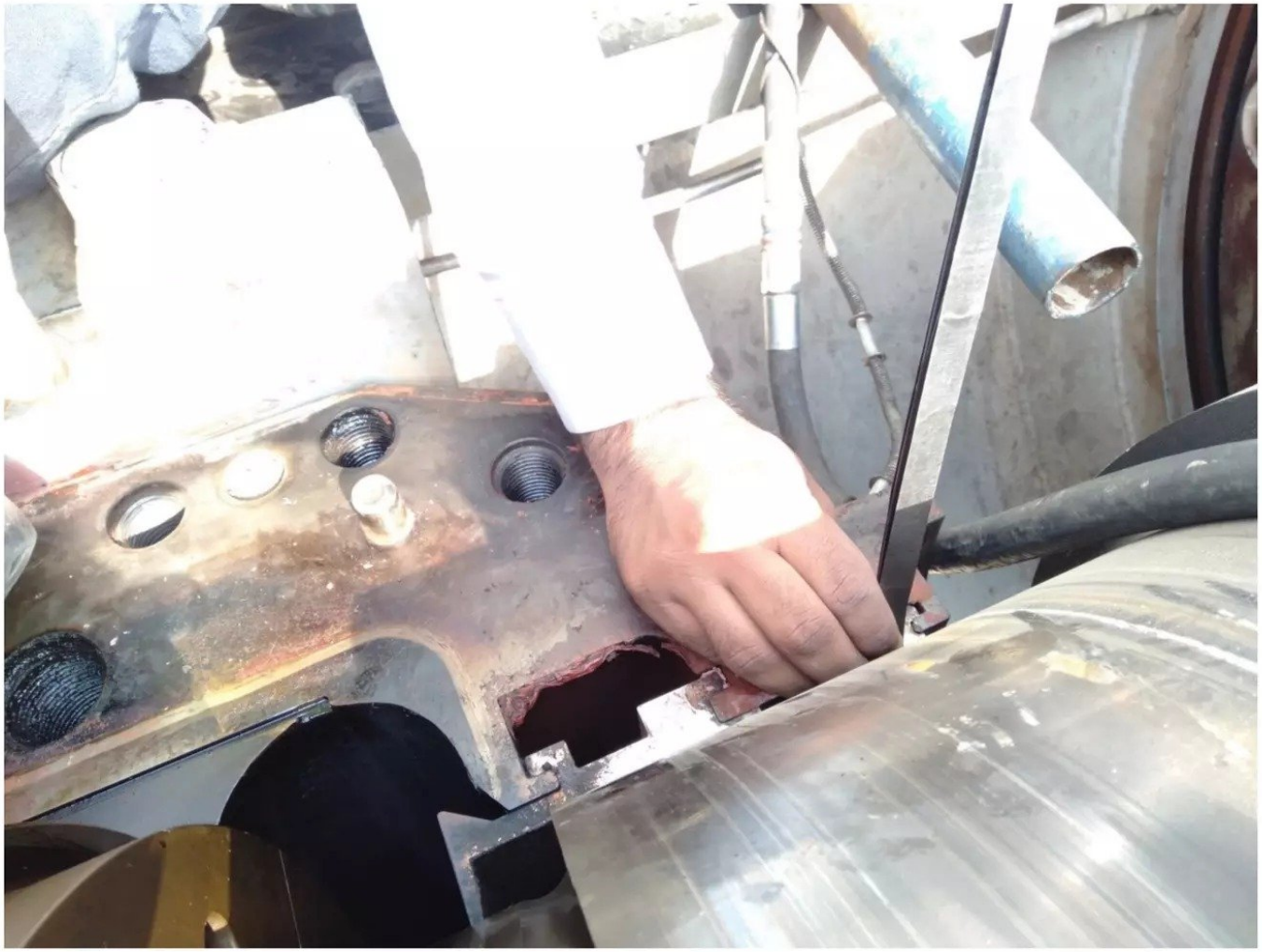






- 3rd bearing is housed inside the exhaust frame inner cylinder. The housing is unbolted and then uplifted through eyebolts and shackle, powered by the crane. 3rd bearing liner, is also bolted through casing bolts to the lower liner, removed when unbolted.

Labyrinths Clearances ✓



- After removing all bearing upper liners, labyrinths clearances w.r.t rotor surface are taken, by means of feeler gauge.
- The labyrinths are air labyrinth and the oil resisting labyrinth.

First Stage Nozzle and Inner Support Ring





- The first stage nozzle is in two halves, bolted together, and supported with the side supporting blocks. The blocks are removed first, then the nozzle rings bolting is removed. The upper half of the nozzle ring is lifted up, whereas, the lower one slides from one end to remove from the housing. Nozzle ring rests on the inner support ring which is bolted with the CDC inner cylinder aft end.

Couplings Unbolting

- Before unbolting the marriage coupling, U-clamp along the bearing stand is attached prior, at the aft end of the compressor rotor.
- Similarly, while unbolting the load shaft coupling, the fwd flange of the load shaft coupling is hanged by the chain block or lever hoist.

Why U-clamp to mount at the Compressor Aft end?

Methods for unbolting the coupling bolts are:

- Hammering with the Striking Spanner
- Pressure Source (Avanti-350 to 400bars)
- Gouging

Disengaging the Marriage Coupling



- After the unbolting, the jacking bolts are used for pushing the turbine rotor for getting free the rabbit of compressor rotor.
- Jacking bolts are accessed from the opening holes of the compressor rotor aft flange to the surface of fwd flange of the turbine rotor.
- The bolts are jacked uniformly from both end, so that, turbine rotor travels smoothly.
- The compressor rotor should be at active side of thrust bearing. The turbine clearances should also be under consideration while pushing the rotor.
- Thrust bearing should be removed after the disengagement of the marriage coupling.

Thrust Bearing Removal





Guess the Active and Inactive bearing?

- The base rings of thrust bearings are composed of lower and upper halves, which are connected to each other by male and female fittings. Pads are pivoted inside the base rings and can be inserted by sliding into each pad housing.

Uplifting of the Compressor Rotor

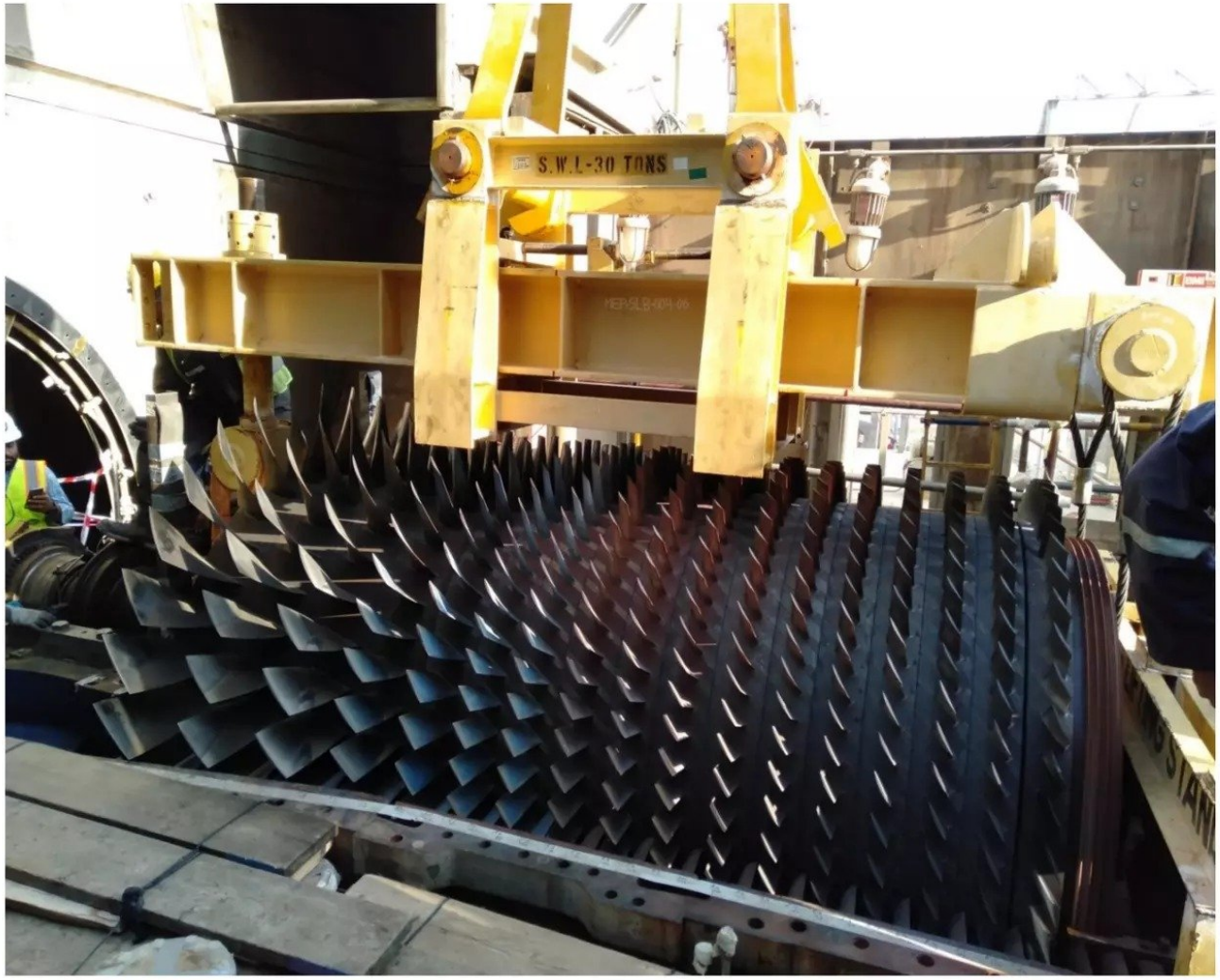




- The guides are placed at the fwd and aft flanges of the rotor.
- Dial indicators are appointed at the rotor surface by keeping their mountings on surface free from the rotor.
- As, the crane booms up, the dial indicators indicate the readings of lifting.
- The lifting beam is used for lifting the rotor.

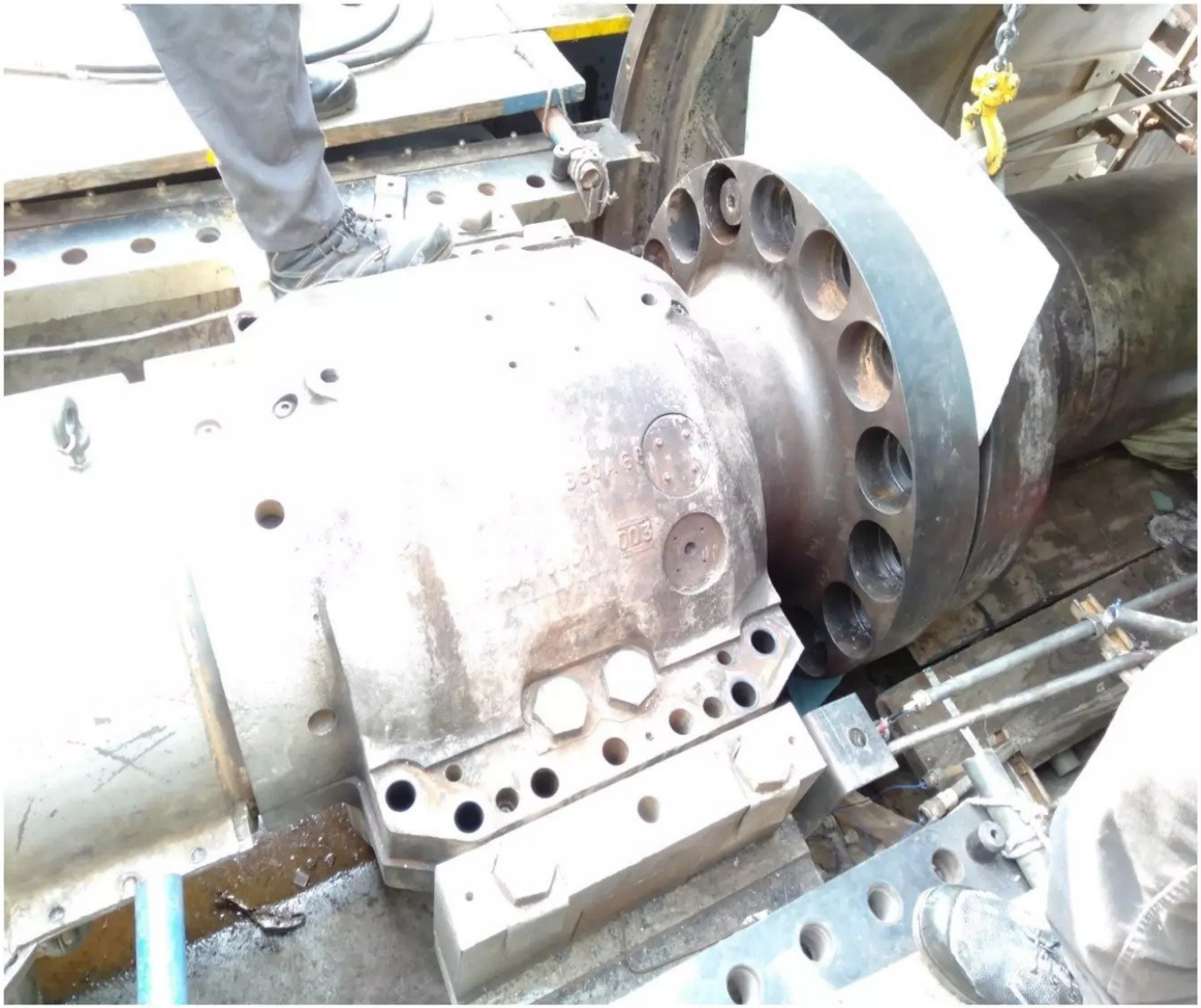
- A turn buckle is introduced at the fwd end of the beam, whereas, the aft end only has the trunnion on both sides. Slings/polyester belts are used for lifting as per lifting plan. The equilibrium is maintained by varying the length of fwd end of beam through turn buckle.

Uplifting of the Compressor Rotor



- Equilibrium, while lifting, achieved, if both dial gauges assures the equal readings.
- Weight factor should also consider while booming up the rotor, and it shouldn't exceed from the S.W.L as per lifting procedure. If it does, should the rotor be resisted at any end. Stop the lifting, and check for any abnormality.
- The blade clearances should continuously be monitored, while lifting.

Load Shaft Coupling Disengagement



- The load coupling forward flange should be disengaged prior to the turbine rotor lifting.
- The load shaft should be hanged with the lever hoist and pushed with the jacking bolts towards the Generator end. So that, rabbit of the turbine rotor flange will be free.
- The travelling of the turbine rotor can be resisted while putting hydraulic jacks at first rotor wheel fwd end.

Uplifting of the Turbine Rotor

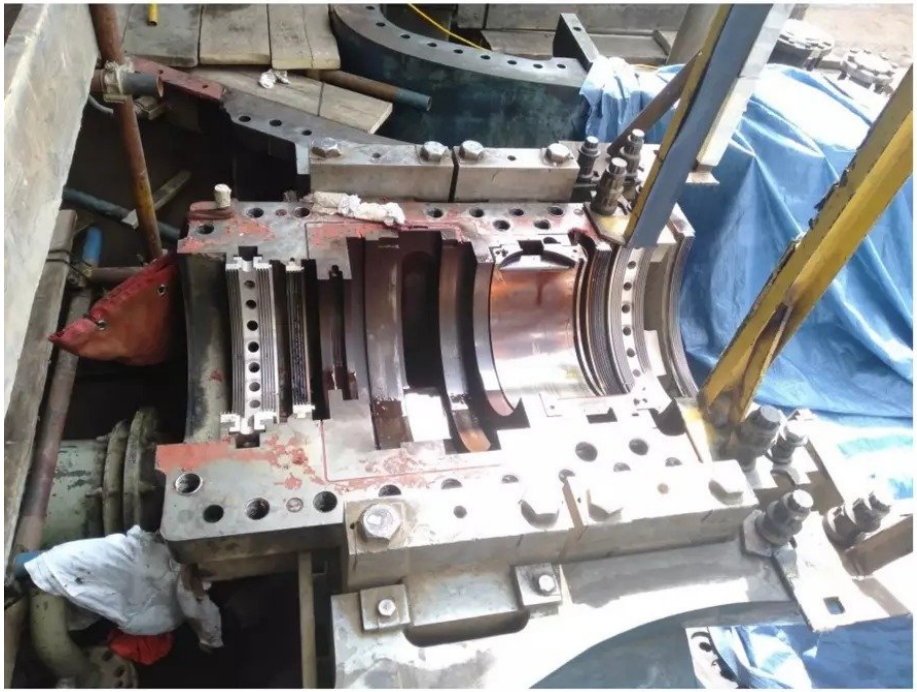


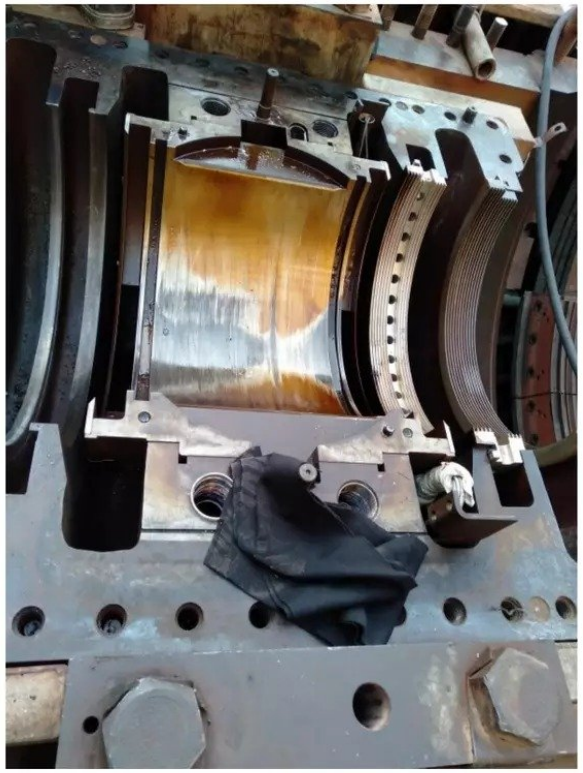




- The lifting of the turbine rotor is identical to the compressor rotor. The turn buckle of the lifting beam is adjustable for maintaining the equilibrium, while lifting. The clearances of the nozzle and buckets are important to be considered.

Lower Bearing Liners Replacement



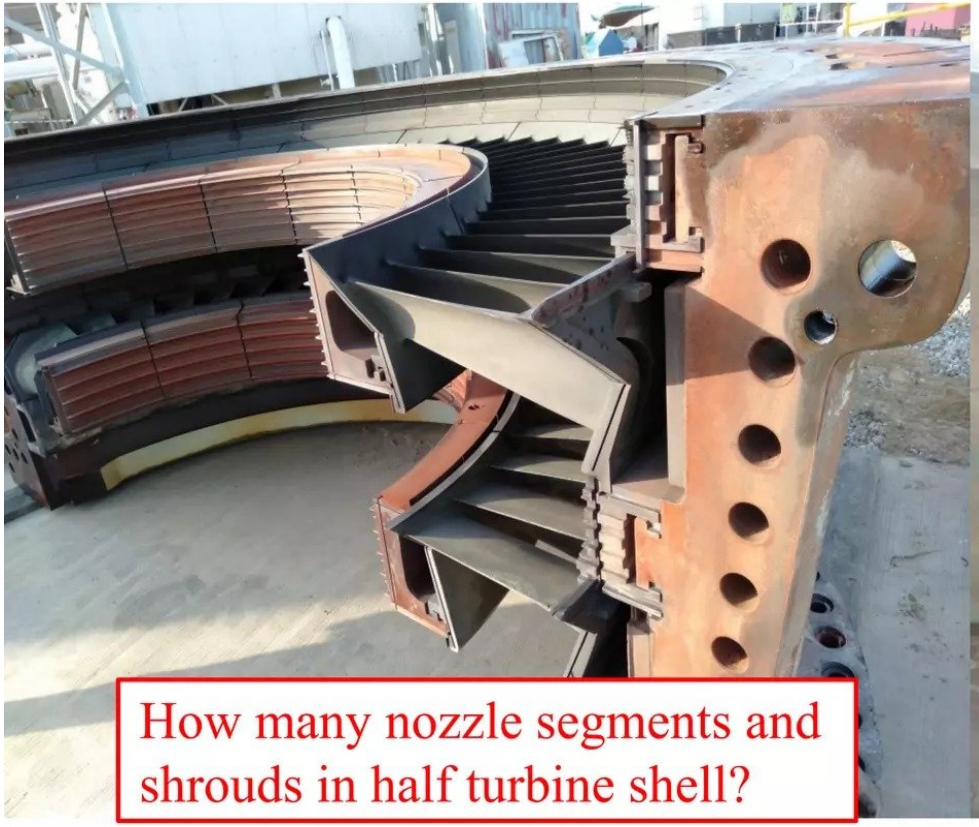




How can you identify which one is the lower liner?

- After lifting the Rotors, all the lower liners of bearings are removed, lower housings are cleaned. Lower housings then equipped with the new labyrinth and the bearing liners.

Turbine Shell Dismantling



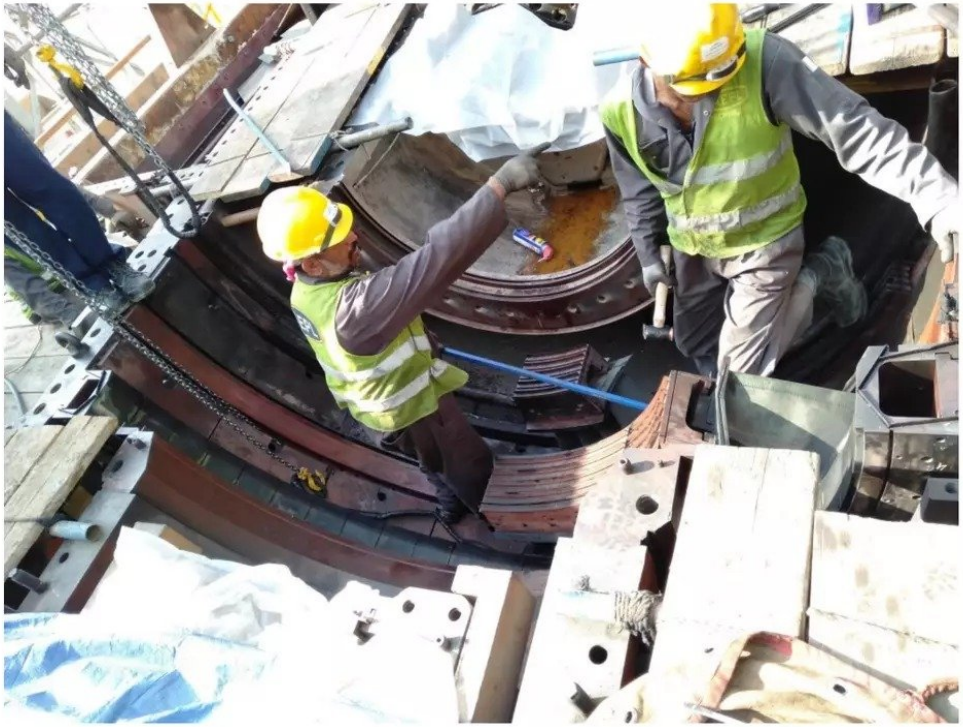
How many nozzle segments and shrouds in half turbine shell?

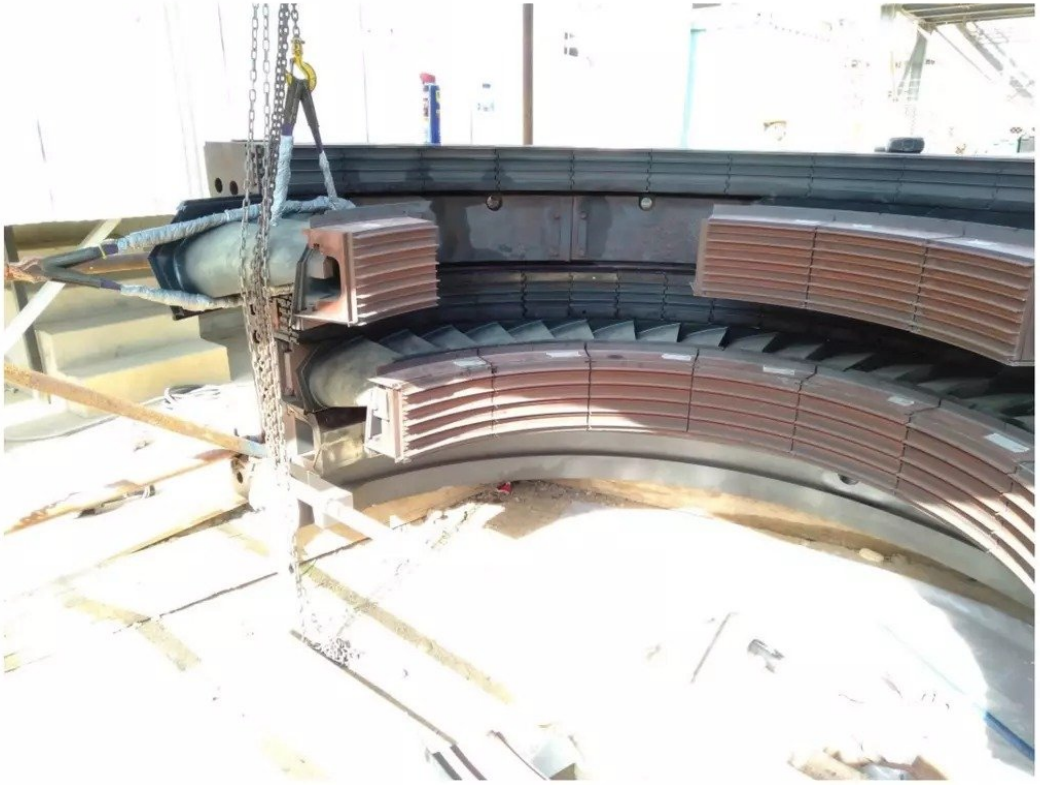


- For dismantling the turbine shell, all the locking bolts are removed.
- All the shrouds and nozzle segments are pinned with the turbine shell. For getting access to the pins, bolts are first removed.
- Pins are internally threaded and removed by a threaded bar, by tying the threads, and pulled it out from the shell.

- The 2nd and 3rd nozzle segments slide into the shrouds. The nozzle segments are integrated with the seals, however, in case of shrouds, seals are inserted on site. Cloth seal for the 1st stage shroud, and for the 2nd and 3rd stage shrouds, key seal is introduced.

Turbine Shell Dismantling

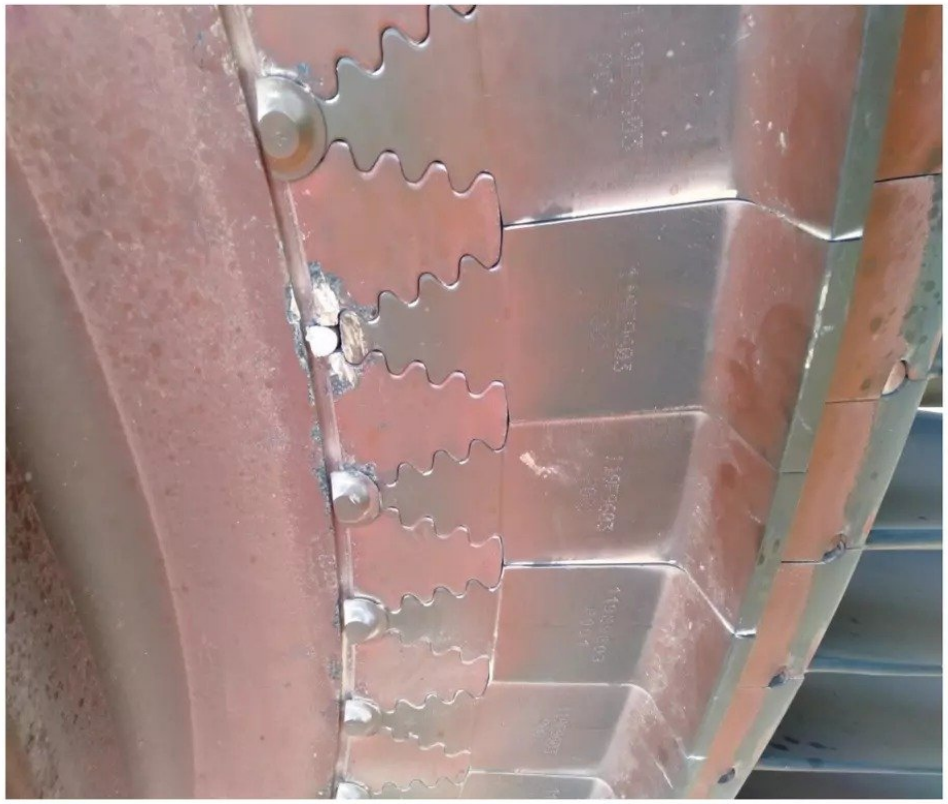




- Lower half of the turbine shell is dismantled by keep mounted on the turbine. For removing the 1st stage nozzle ring lower half, the locking pin is removed first. The shrouds and segments are removed in the same manner as done in the upper half turbine shell.

Turbine Rotor Dismantling





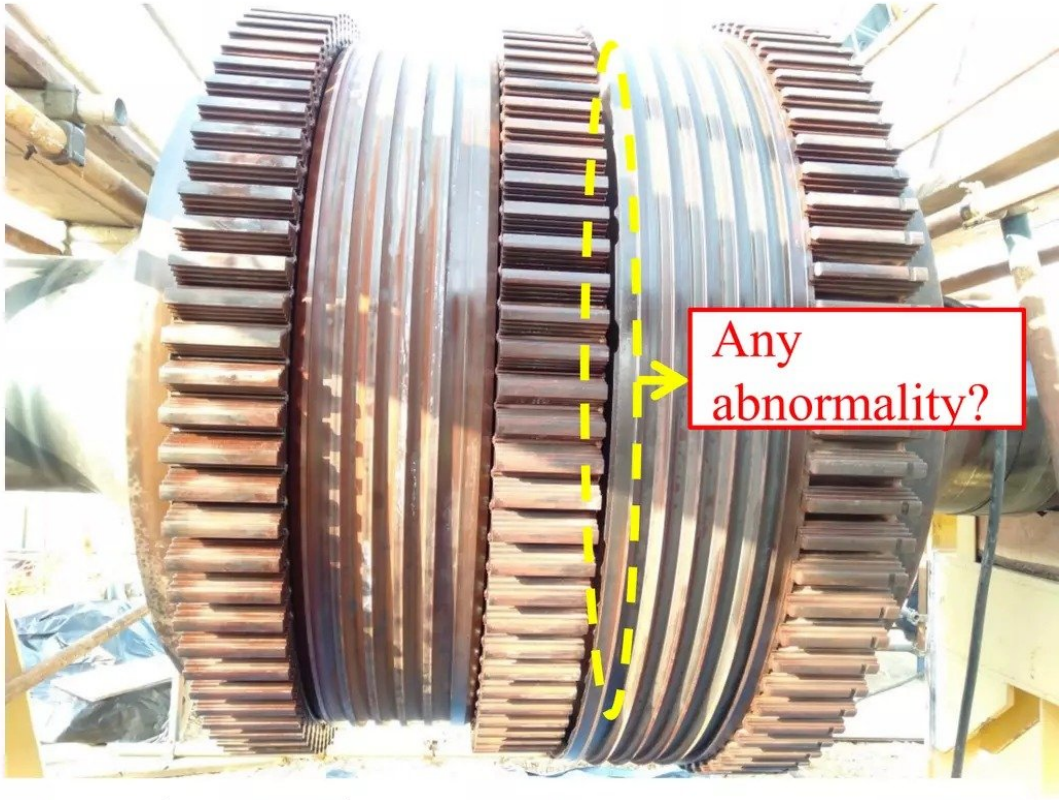
- The turbine rotor buckets are first numbered before removal. The first rotor wheel buckets have the D-key arrangement, whereas, the 1st bucket has the axial and radial pins for locking. The 2nd and 3rd rotor wheel buckets have the twist lock arrangement. For removing the 1st stage buckets, the locking pins are removed first.

1st stage rotor wheel buckets locking arrangement!

How do we number the buckets?

Turbine Rotor Dismantling





- The 2nd and 3rd rotor wheel buckets are first unlocked by twisting the locks, then soft hammering is made uniformly on the periphery of the bucket shanks, so that, they travel uniformly. As, the buckets leave dovetail arrangement, they are extracted.

Compressor Rotor Blades inspection



What is Blade Blending?

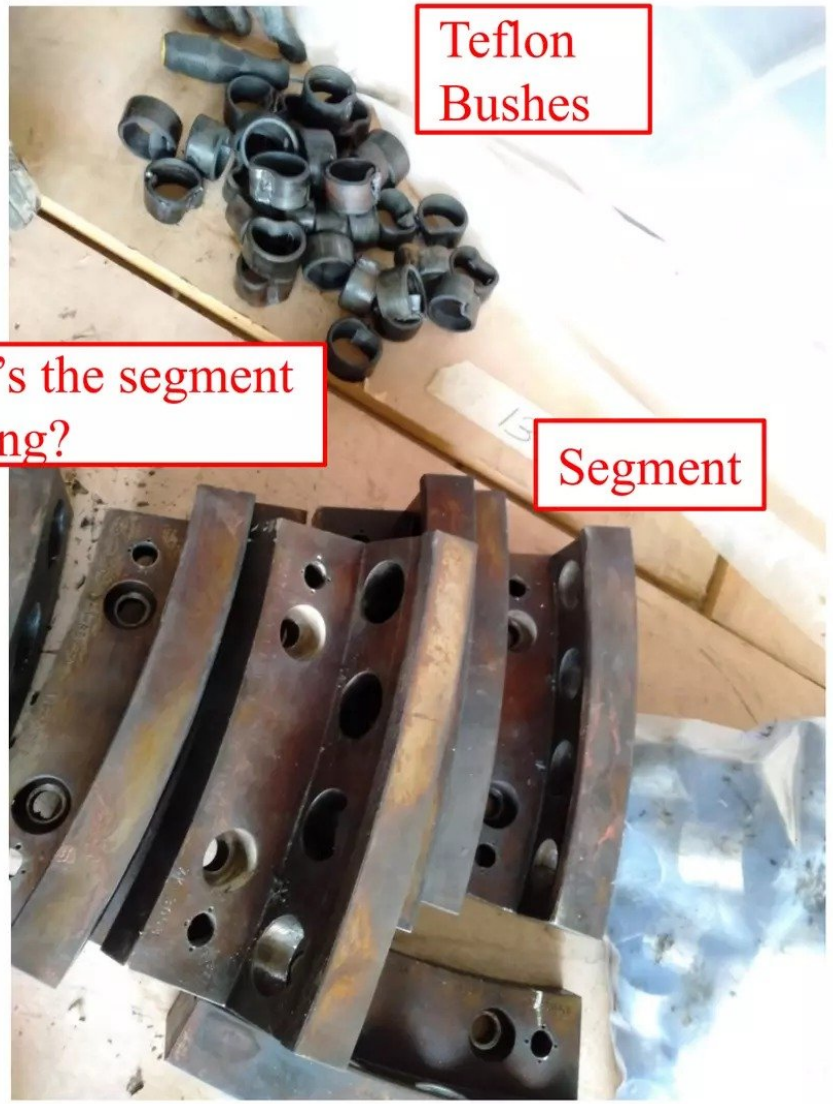


- All the compressor rotor blades are visually inspected. Blades are marked, should any damage, crack and wearing found on blade.
- Blades are then labeled with the row and number. If the blending is required.

How do we number the Rotor blades?

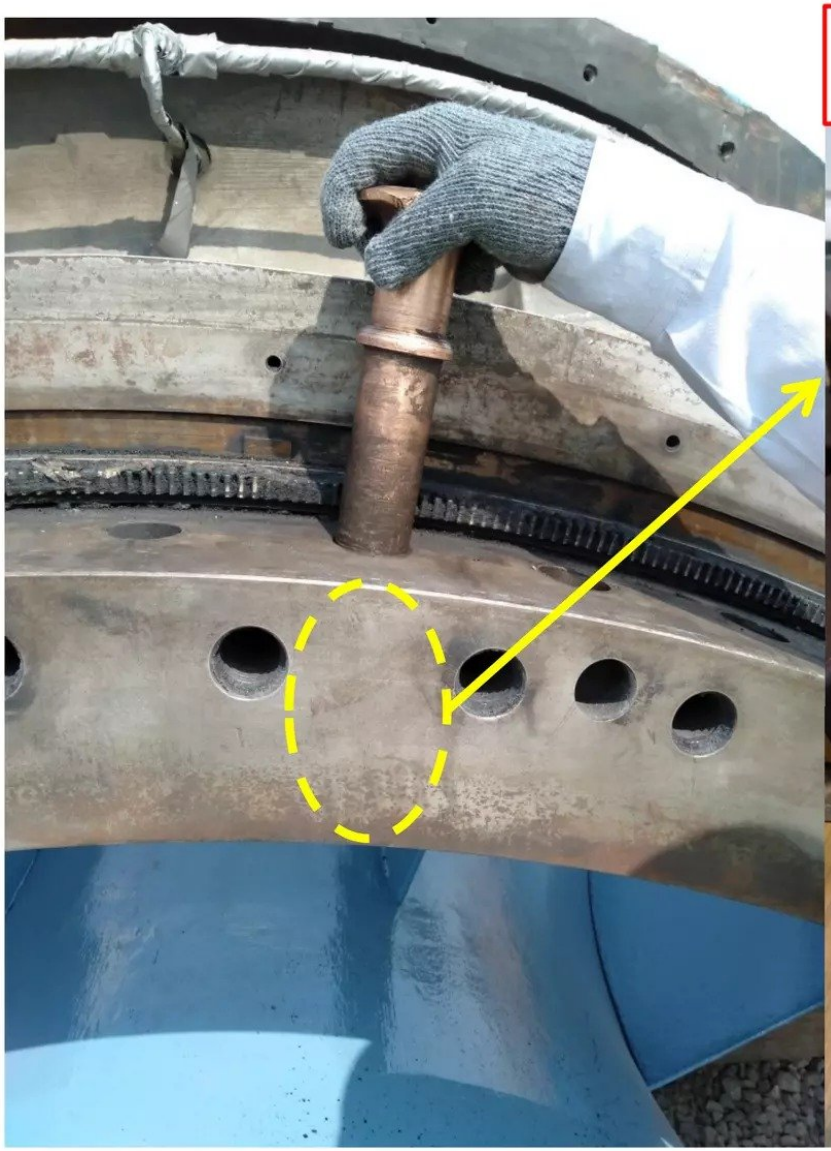
Bellmouth IGVs Dismantling

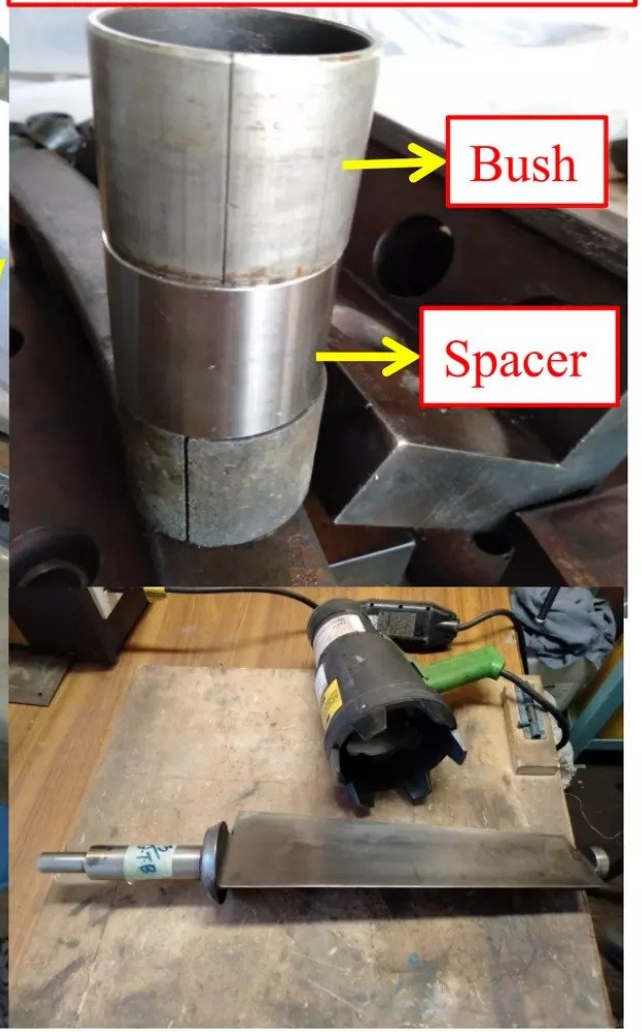




- IGVs are segmented, each stem goes independently to the bellmouth opening hole, where the pinion is attached. The pinion is fastened by means of screw and key. A spring washer is introduced beneath the each pinion.

Bellmouth IGVs Dismantling





- The IGV stem surrounds by the bush and spacer arrangement, as shown. These bushes are lubricated by greasing.
- A rubber washer is placed at the aft side of the stem.
- The lower part of IGV rests in the segment and surrounds by teflon bush.
- All the IGVs are subjected to FPI test, for checking out any pitting, crack and wearing.

Bearing Clearances ✓

Old

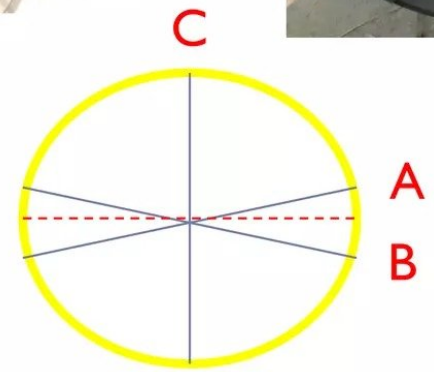


New



- Bearing clearances are taken of old and new one.
- Methods used are: ID/OD method and Lead Wire method.
- External micrometer for measuring the Journal outer diameter .
- Ranges between 10-15 thou

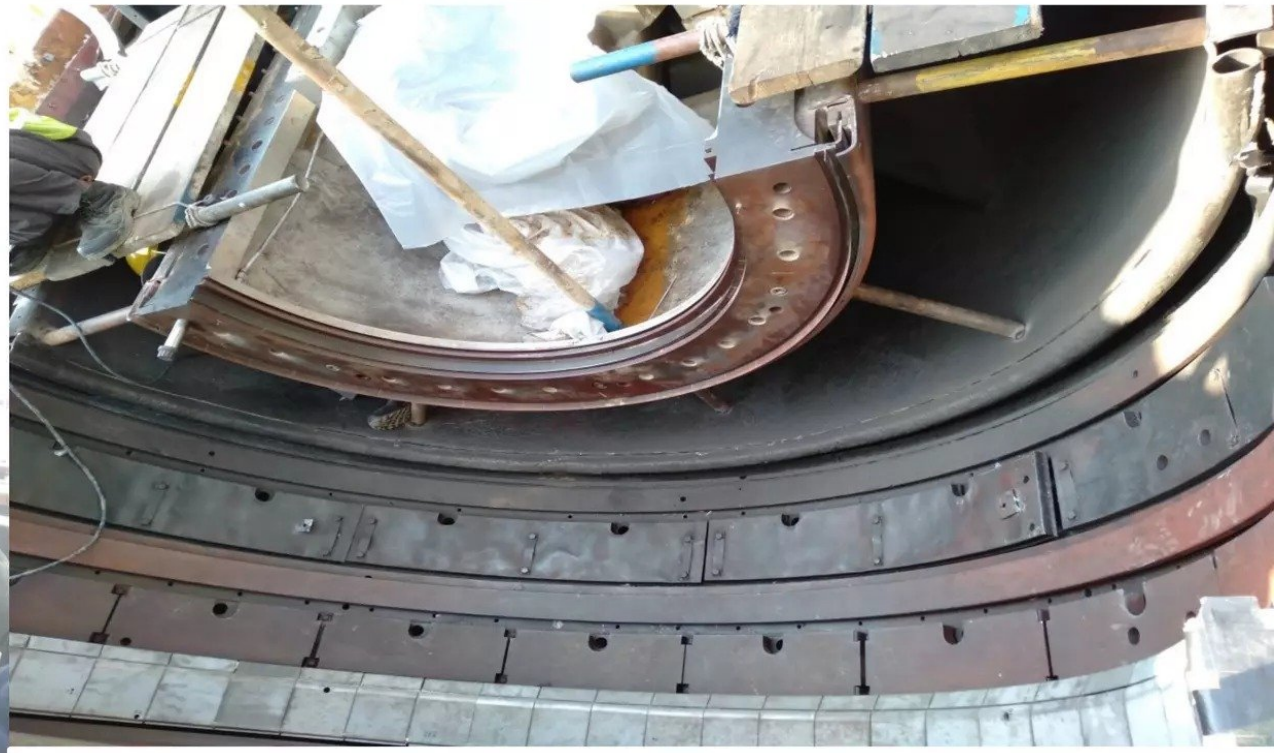
Are the bearings round shaped?





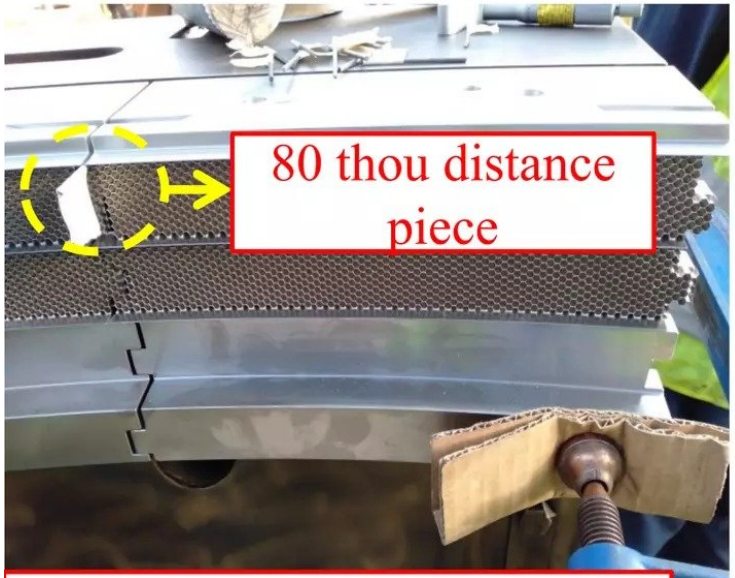
Make-up of the Turbine Shell



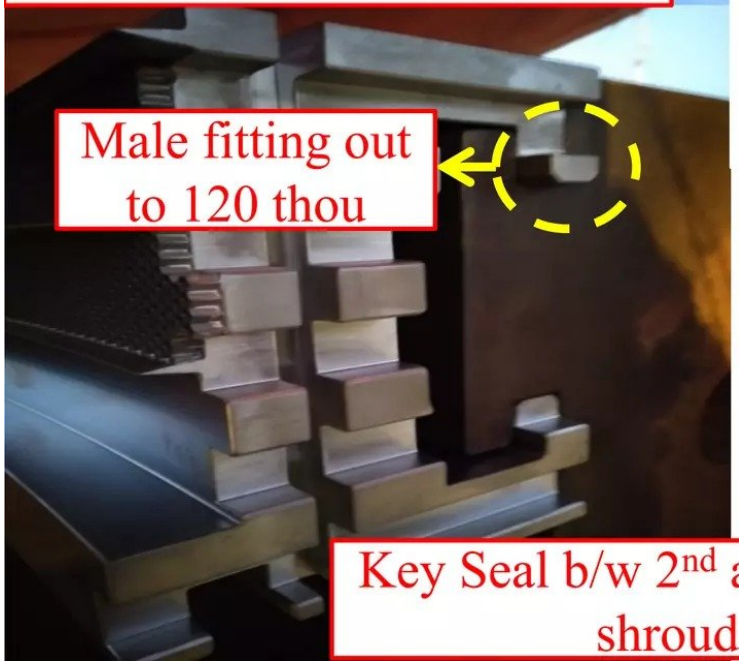


- Turbine lower half is boxed up while kept on turbine base. All the shrouds are first mounted onto the shell. New shrouds are first positioned according to the number and punched from the pinhole, through the shell, for drilling. Where drilling, on the shrouds, is made on site. After shrouds mounting, nozzle segments are installed by sliding, between the shrouds, of two consecutive rows.

Make-up of the Turbine Shell



Why drop check is required?



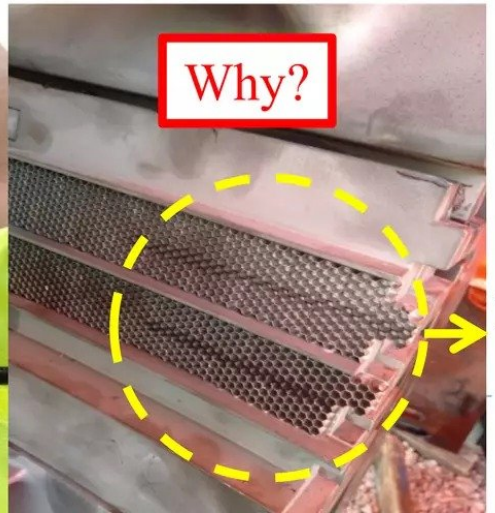
- For drilling, all the shrouds are first installed by number configuration. The first and last shroud in the turbine half shell is clamped by keeping the male fitting out to 120 ± 20 thou and rest of shrouds are arranged by keeping the distance of 60 ± 20 thou, in each. This is known as **Drop Check Reading.**



Cloth Seal Arrangement b/w 1st stage shrouds

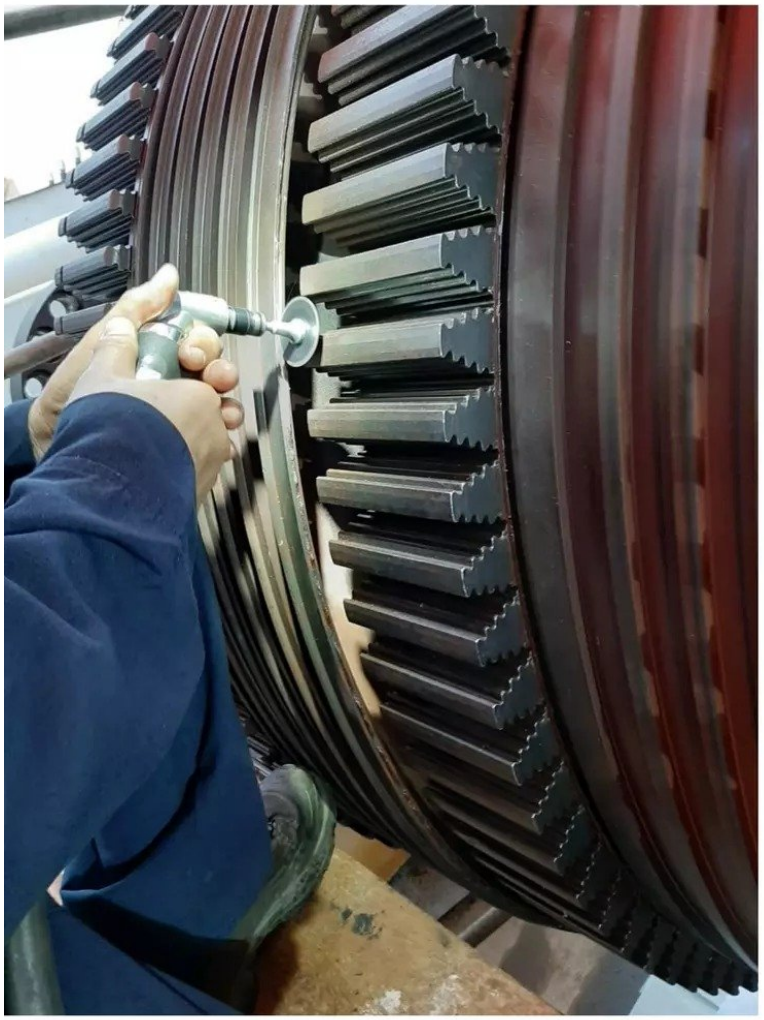


Key Seal b/w 2nd and 3rd stage shrouds



1mm central deep cut into the shrouds honeycomb located at the horizontal joints.

Make-up of the Turbine Rotor

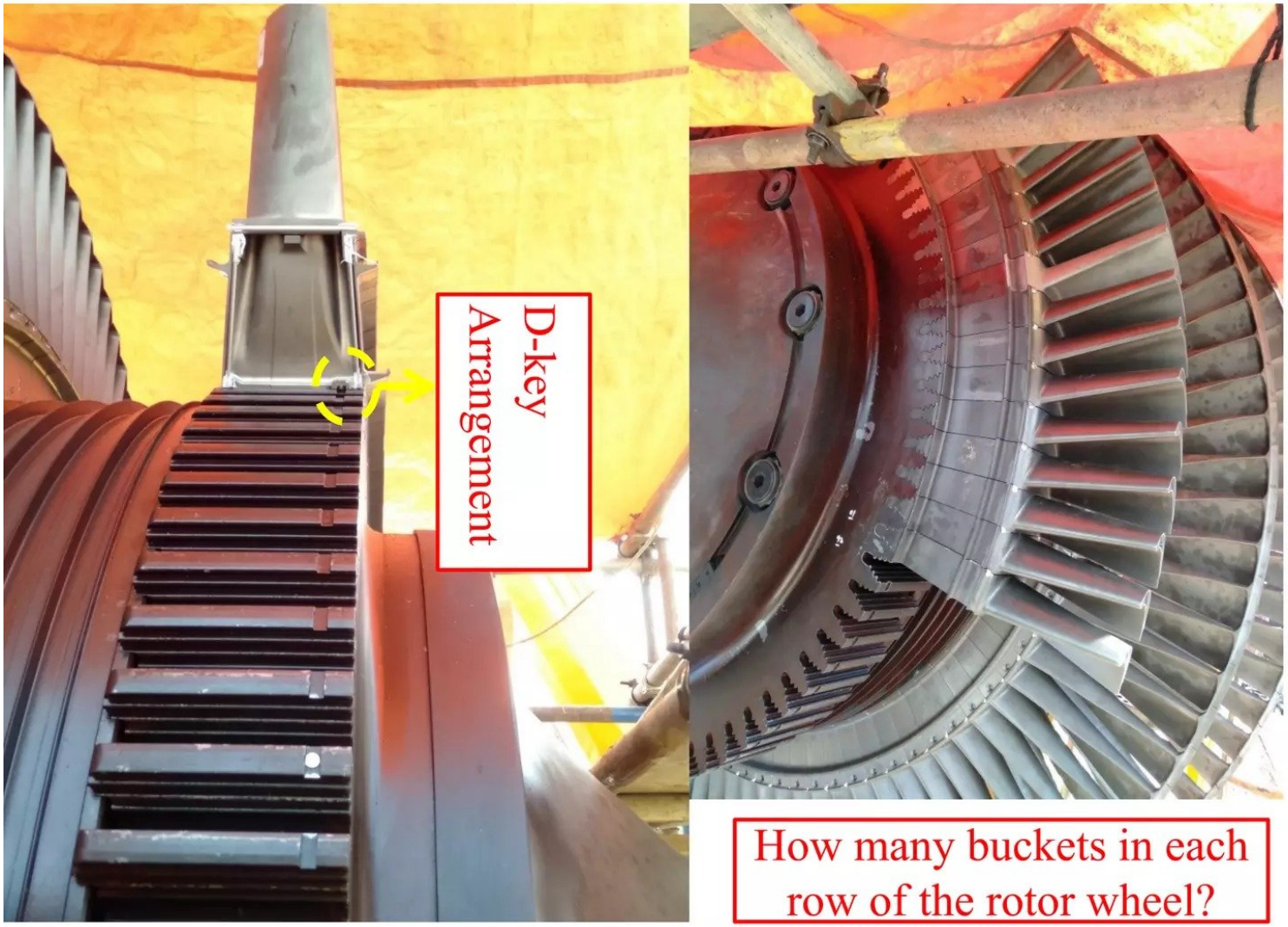




- Repairing of the discourager seal, if found damaged.
- The groove is first cleaned by means of small disc grinder and chiseling. Then a seal, in four pieces, is inserted into the groove.
- The collar of the seal out of the groove and central distance of pieces must be uniform from all the periphery.
- At the end, it is pinched for locking from different locations.
- Cleaning of the dovetails.

Purpose of the Discourager Seal?

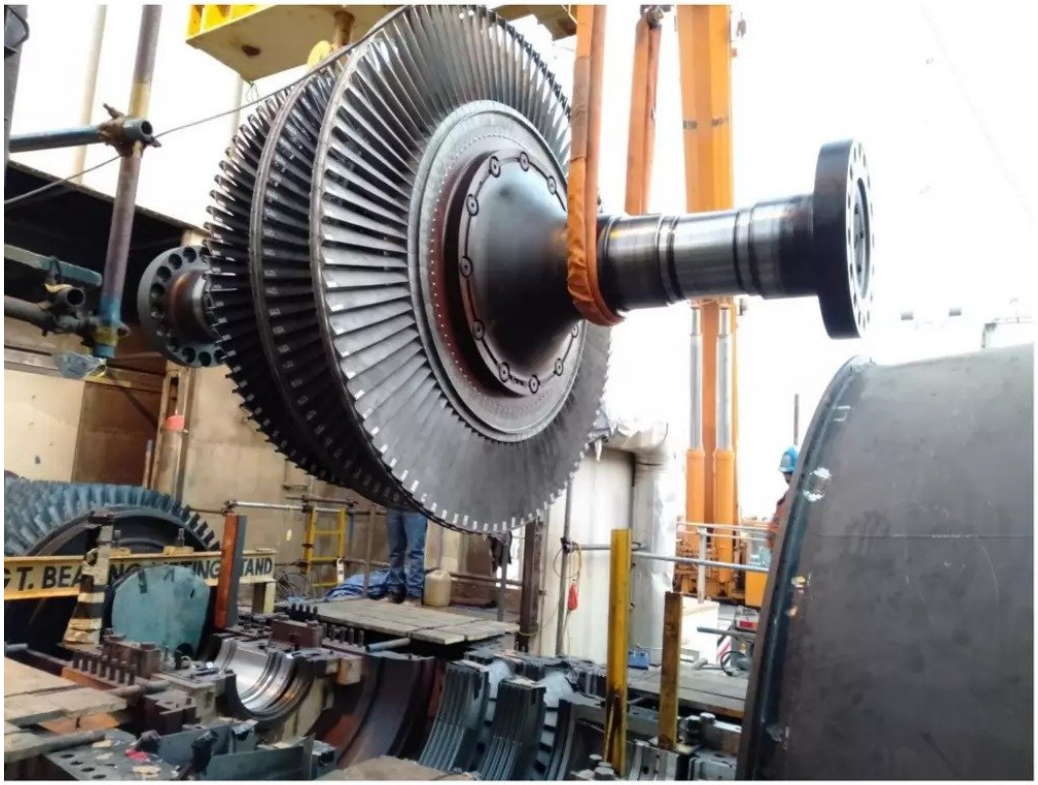
Make-up of the Turbine Rotor



How many buckets in each row of the rotor wheel?

- All the buckets are arranged into the dovetail arrangement.
- After installation, all the buckets are locked.
- The position of the 1st bucket at the 1st rotor wheel can be changed, in parallel to the previous one. For sake of repositioning, a hole for axial pin, is drilled.

Turbine Rotor Installation





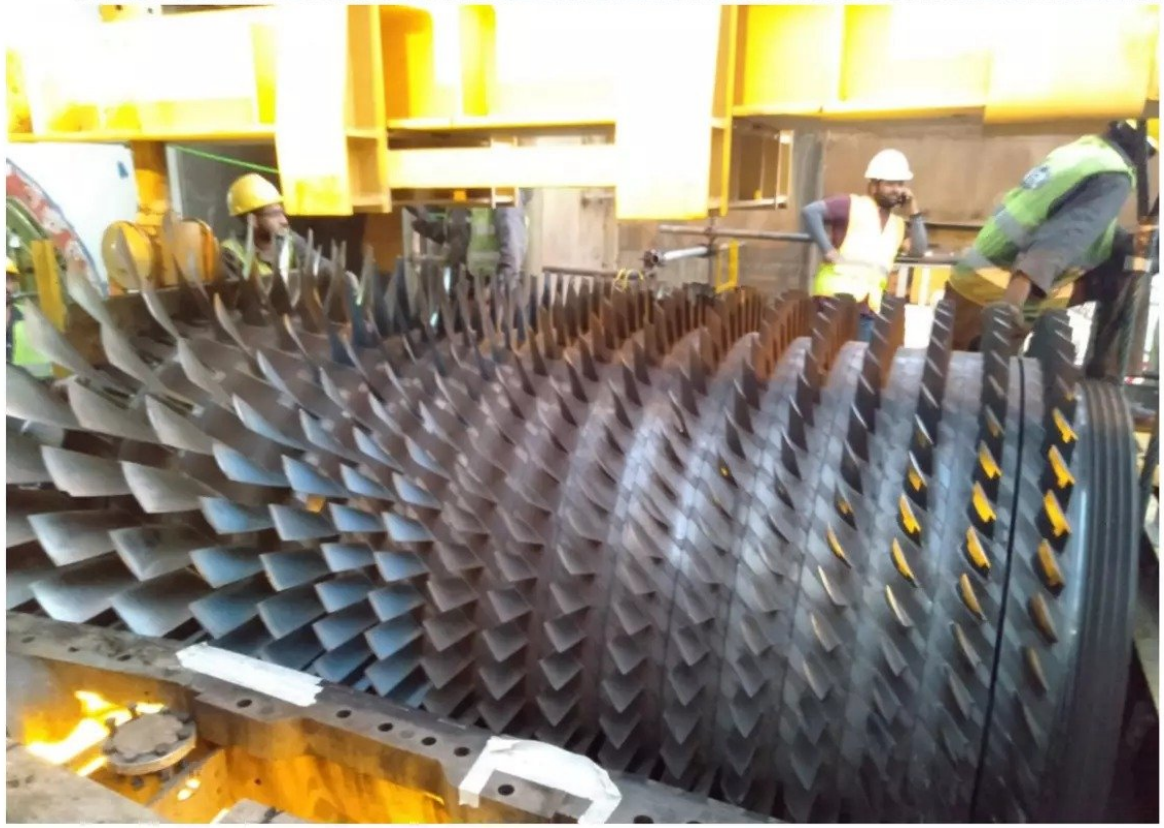
- Load coupling shaft should be at the Generator side before installation of the turbine rotor. This will make a sufficient room for the female rabbit at the turbine rotor aft flange. Moreover, a soft piece should be attached, to any one of the flange, for preventing the rubbing of the flanges, while rotor placement. Some of the lube oil should be poured into bearing lower halves before placement of the journals.

Compressor Rotor Installation





Compressor Rotor Installation





- The bearing stand should be mounted on rotor prior to installation. The rubbing ring for supporting the IGV segments should also install before, this will help in adjusting the compressor rotor . Compressor clearances should be important to consider, and keep checking during compressor rotor landing. As, the journal rests on 1st bearing and thrust collar is inserted into the thrust housing, the U-clamp at bearing stand should be tightened in proportion to 1st journal resting. The clearance at aft side of rotor is to be attained for assuring the rotor blades are not in contact with casing.

High Pressure Packing



Honey Comb Seal





What is the purpose of the High Pressure Packing?

- High pressure packing is composed of brush seal and honey comb seal, inserted into the casing. Compressor rotor aft labyrinth rotates against the honey comb seal.

Coupling Engagement



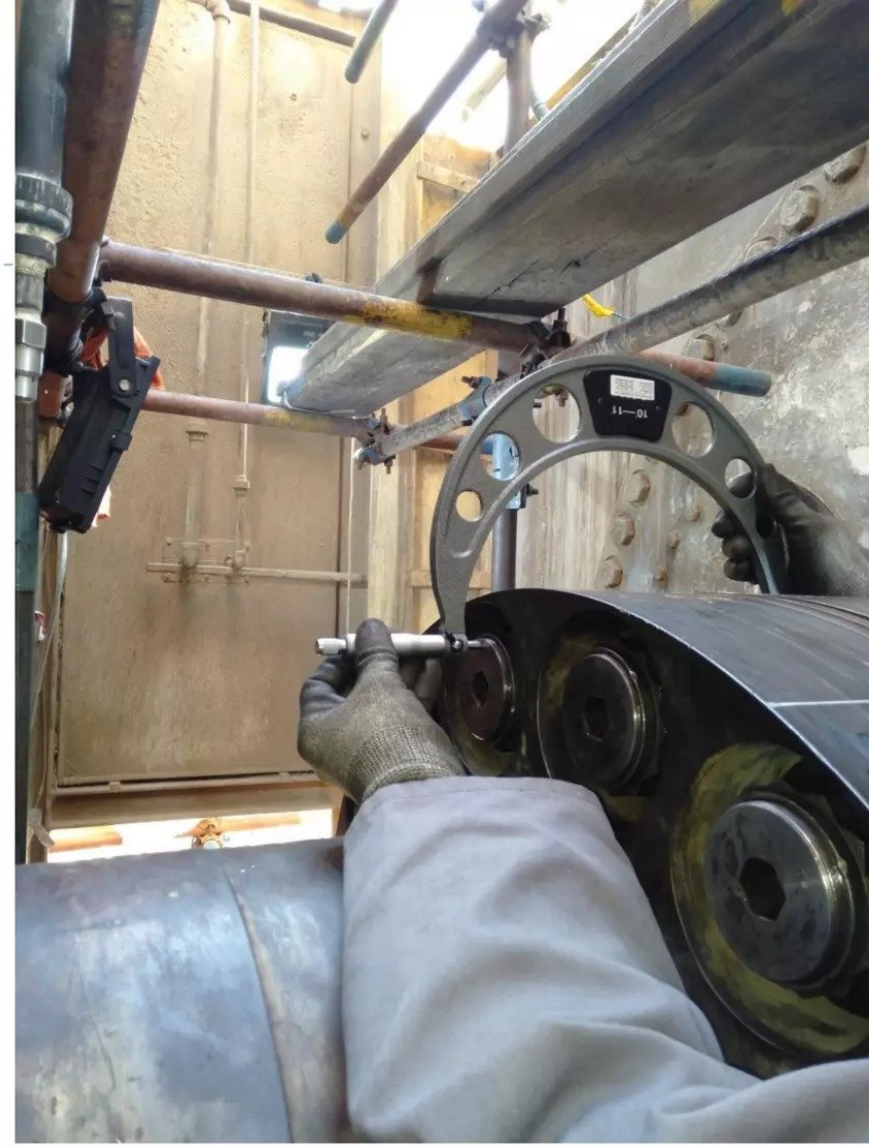


Why coupling bolts are inserted in pairs?



- All the coupling bolts are brought in pairs, contain equal mass. Length of each pair is first recorded by means of outside micrometer. The access holes in the coupling are first numbered according the bolts wheel pattern. Then, bolts in pair are inserted parallel into the access holes of couplings.





- For the engagement of the marriage coupling, the compressor rotor should be at active side. The thrust bearings (old or new) should be introduce before coupling engagement. So that, the clearances of compressor and turbine are adjusted. The U-clamp at aft side of the compressor rotor should be adjusted for making the compressor coupling hub aligned with the turbine coupling hub. As, they are centric, bolts are inserted and tightened in parallel fashion.
- Source of Tightening the bolts;
  - Hydraulic Pressure (Avanti)
  - Hammering

Marriage Coupling- 18 bolts
Load Shaft Couplings- 16 bolts

- The bolts are torqued to metered elongation of 10 to 12 thou. The bolts in pair should be elongated to same value. Turning may require for the lower half coupling bolts tightening.

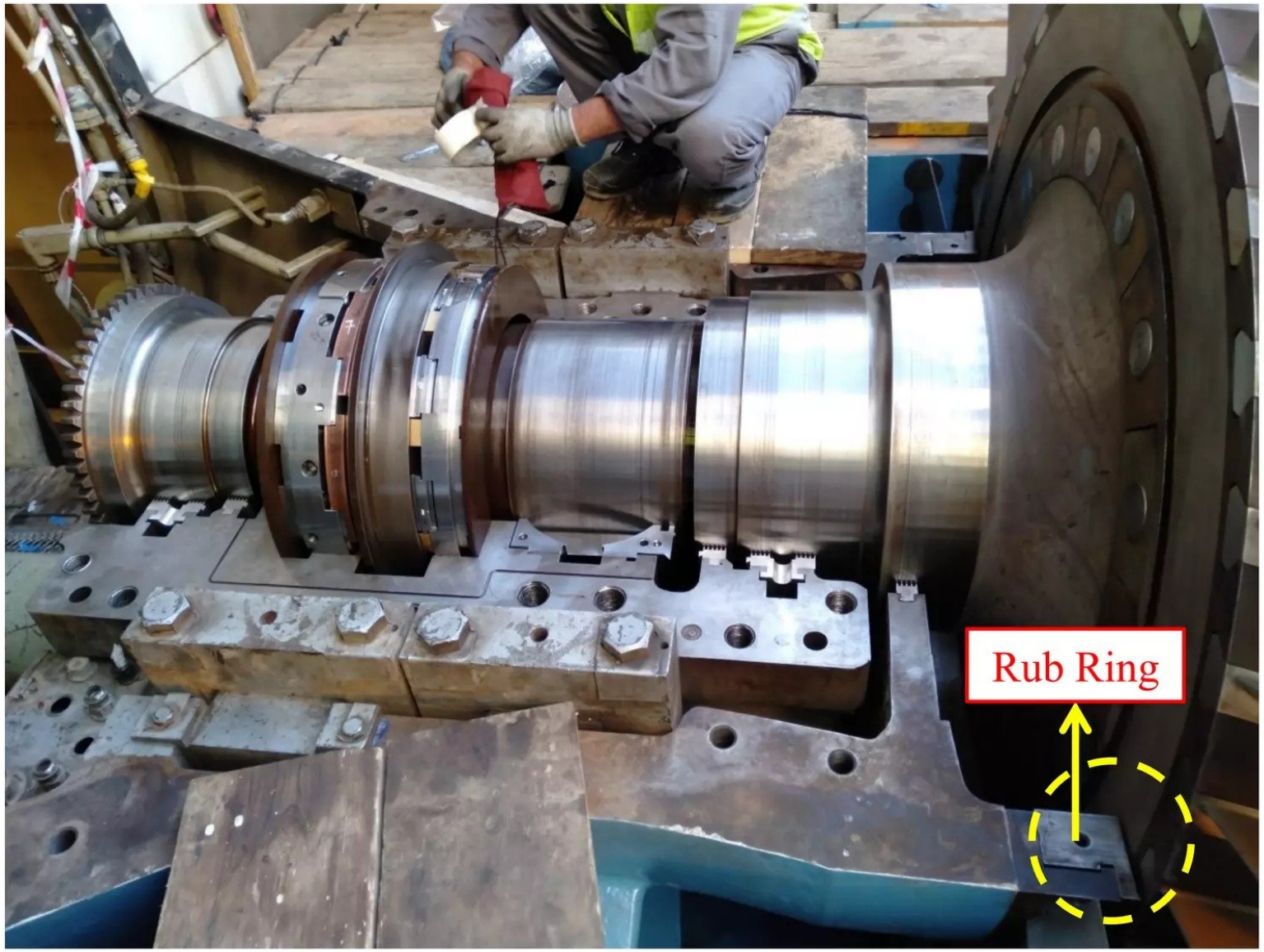
Rotor Position Check

Following readings are recorded for checking out the rotor axial position after marriage coupling engagement.

- Bump Test ✓
- Compressor Clearances ✓
- A-set Reading ✓
- Turbine Clearances ✓
- Rub Ring Clearances ✓

Note: *If, any of the reading falls out of the range, corrective action may be needed to perform, as per standard.*

Rub Ring Clearances ✓



- The axial clearance is measured between the rub ring and the 1st compressor rotor wheel forward side. The reading is recorded from both left and right sides.
- The reading should range to 115 thou.
- The rub rings also plays the role for compensating the active thrust and incorporated with the active thrust bearing.

Casings Installation

- All the casings are installed in the similar fashion, as they were removed. The sequence of casings placement is made on TA's command.
- The sequence may be followed as given below;
  - Exhaust Frame
  - CDC
  - Turbine Shell
  - Compressor Bellmouth
  - Compressor Inlet and Aft casings
  - Combustion Wrapper

Why horizontal bolts are first tightened while casing installation?

- While landing the casings upper halves, as the upper half approaches the lower half horizontal joints, dowels are installed. Dowels help in aligning the casing's halves.
- As, the casing's halves matched up, horizontal bolts are first installed and tightened, then, the radial bolts.
- Bolts are tightened by hammering.

Make-up of the Compressor Bellmouth







- New Bushes arrangement in the bellmouth and segment bushes are installed. Each segment is then locked and gears are installed on IGVs stem.
- Whilst, lower half make-up is exercised as being mounted on turbine base.



IGVs Angle Adjustment

- After all the IGVs are installed, the angle adjustment is required. The pinion is attached on IGV's stem by means of a locking (allen-key head) bolt and cotter. First, all the IGV blades are set at deg. 90 by a bevel protector; at that position, pinions are screwed on each IGV's stem. This is the primary locking. Backlash is then recorded for each of the pinion. If backlash found normal; then, a keyway is drilled in such a way, half in the pinion and half in the IGV stem. A pin is pushed into that keyway for secondary locking.





Backlash ≤ 40 thou

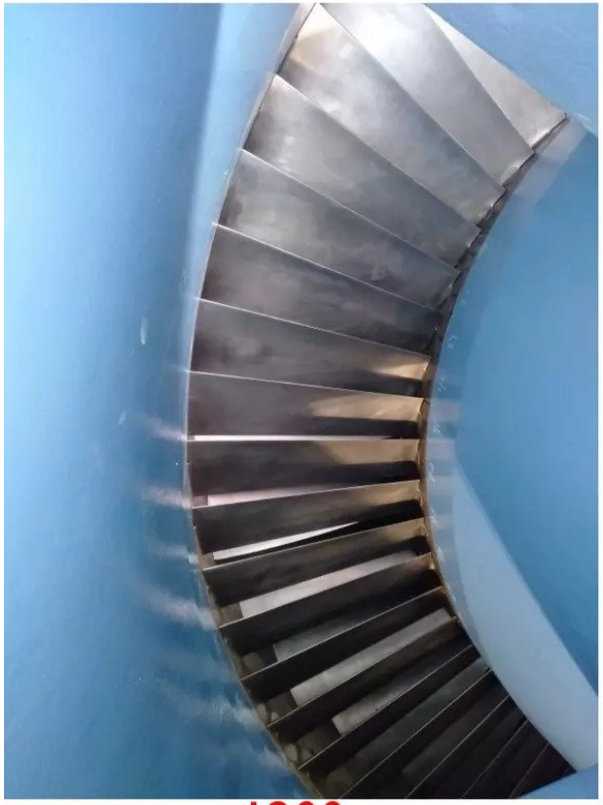


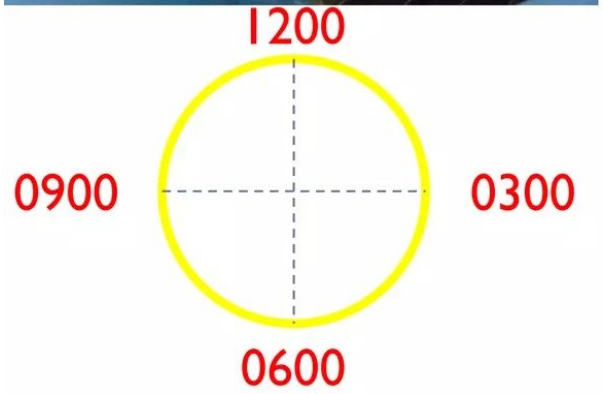
Angle Adjustment



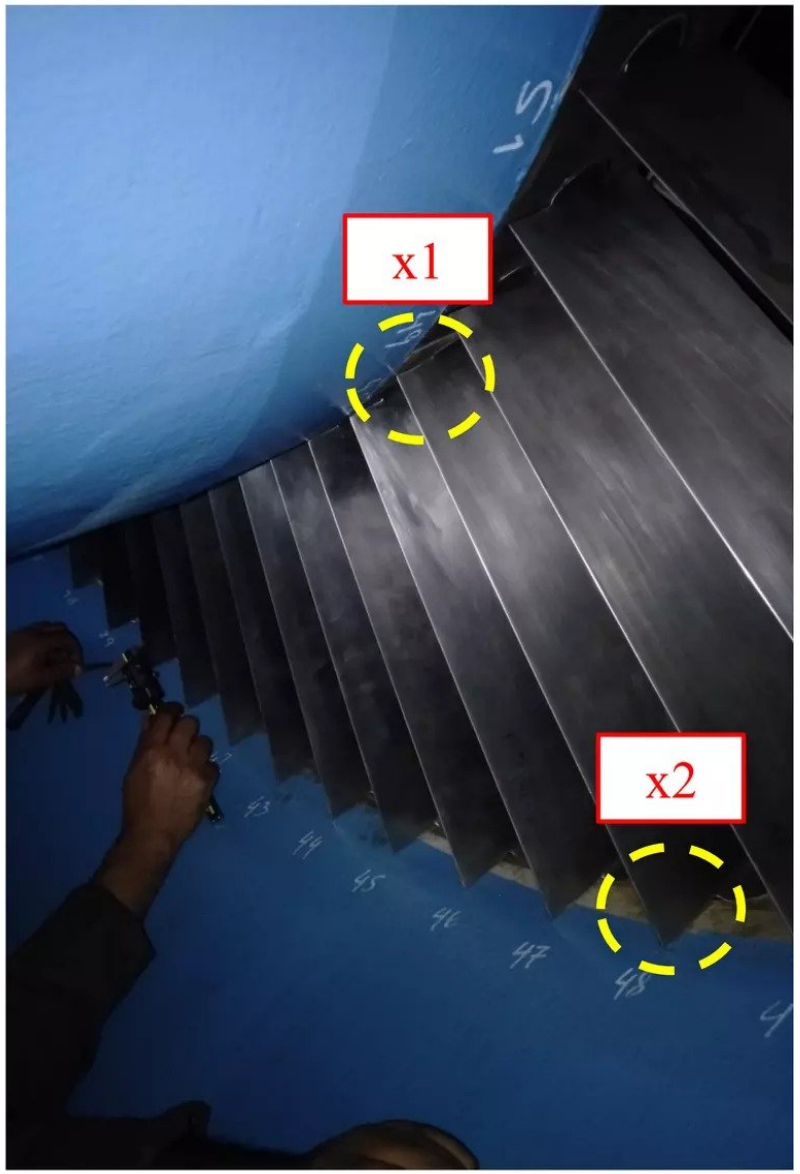
Drilling the keyway

IGV Calibration and Clearances





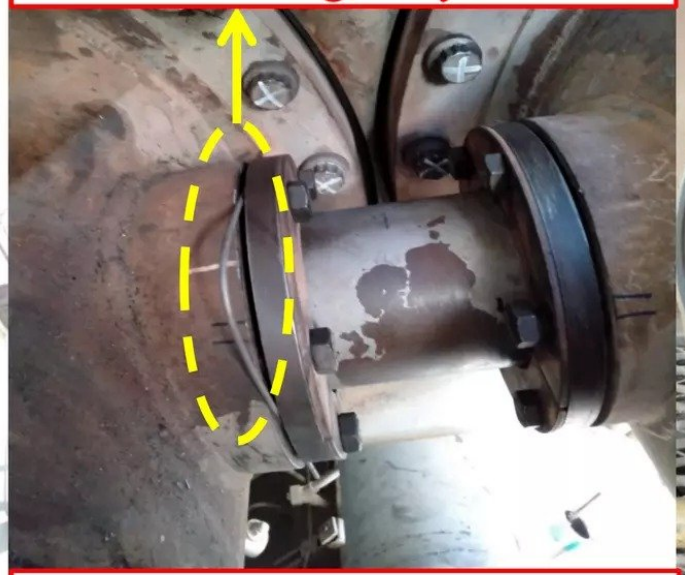
- After all the IGVs angle adjustment, calibration test is performed.
- The test is performed with the collaboration of I&C and Mechanical Dept. A soft command is given, to the IGVs actuator, by means of hydraulic system, to any of the random angle. The mechanical team checks the degree of the blade by bevel protector. 4 blades are inspected, locations describe in the picture. The degree checked by Mechanical Dept., is verified by I&C.
- Blades radial clearances, x1 and x2, are recorded.



Make-up of the Combustion Wrapper



A gap of 2mm is made while bolting, why?



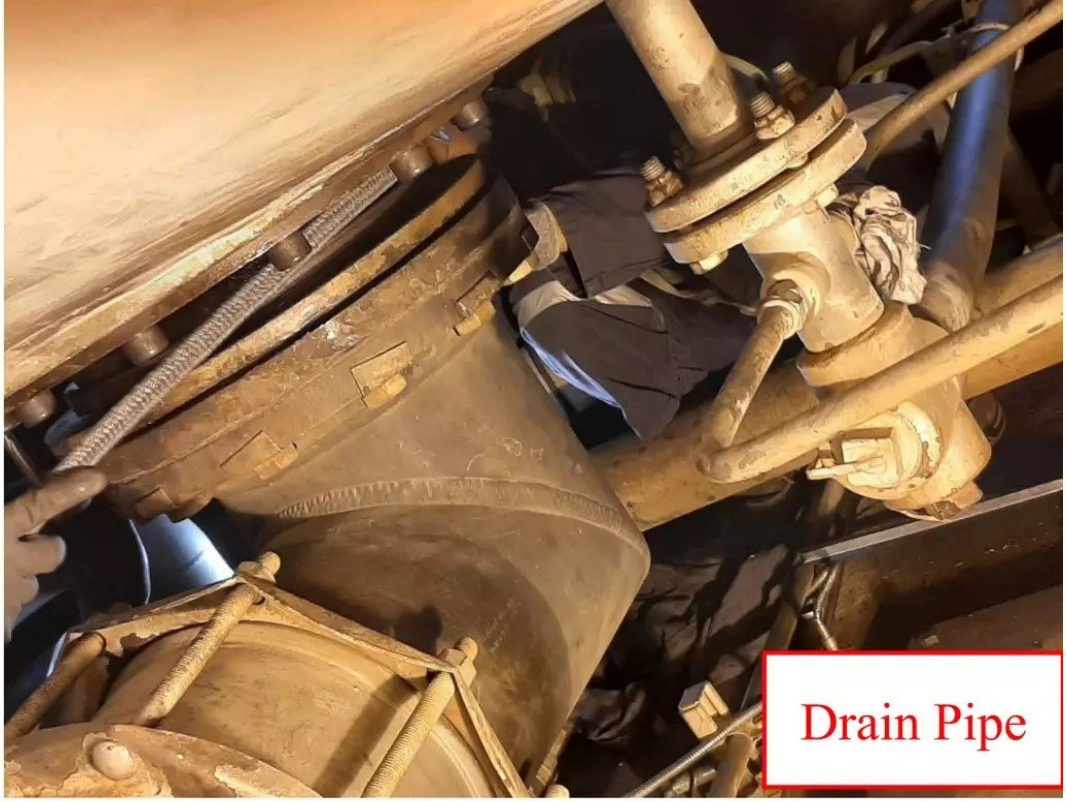
Can Bolts Torque @ 230ft-lb
Can Cover Bolts Torque @160ft-lb
Nozzle Assembly Torque @ 100ft-lb



Crossfire tube Cover Flange

- The gaskets of the combustion cans, can covers and the fuel nozzle assemblies are replaced. 2 Glands of almost 10mm inside the crossfire tube cover are replaced.

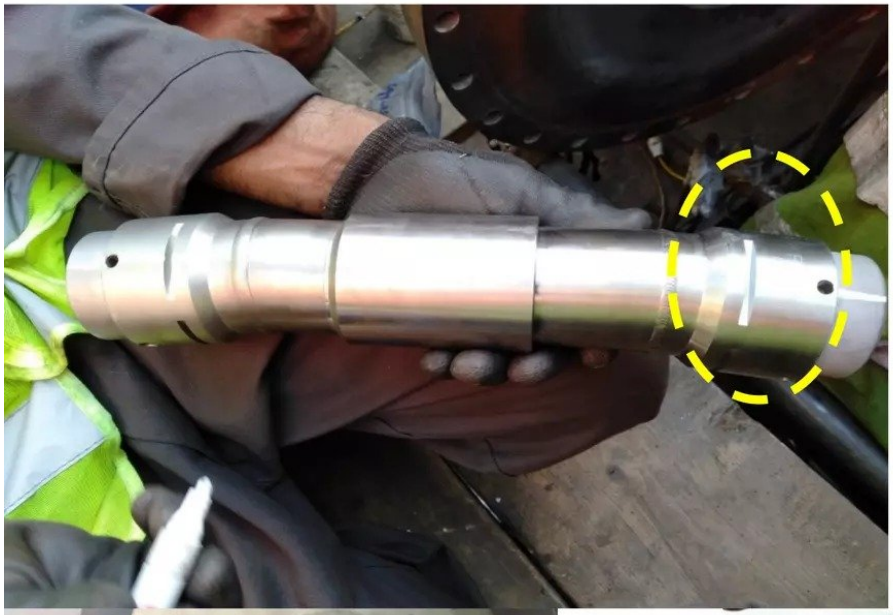




- Sealing is provided to the vent and drain piping of the 2nd bearing. At the drain pipe, gland is inserted by opening the flange plate, bolted with the hexagonal bolts. This flange plate has a collar fabricated, used as gland pusher. Whereas, allen-key head bolted flange plate has a crinkle gasket inside it.



CI Hardware Installation



- Crossfire tubes are in male and female part, each part has three cuts, the one at center is below the hole. A mark is indicated on central cut for accurate positioning the crossfire tube inside the liners, so that, retainers sit on the other two cuts perfectly. While putting this composition of crossfire tubes, the mark indicated on central cut, should face you. The crossfire tubes composition start with the 14th can (Female) and 1st (Male) and carry on to next cans in the same manner.





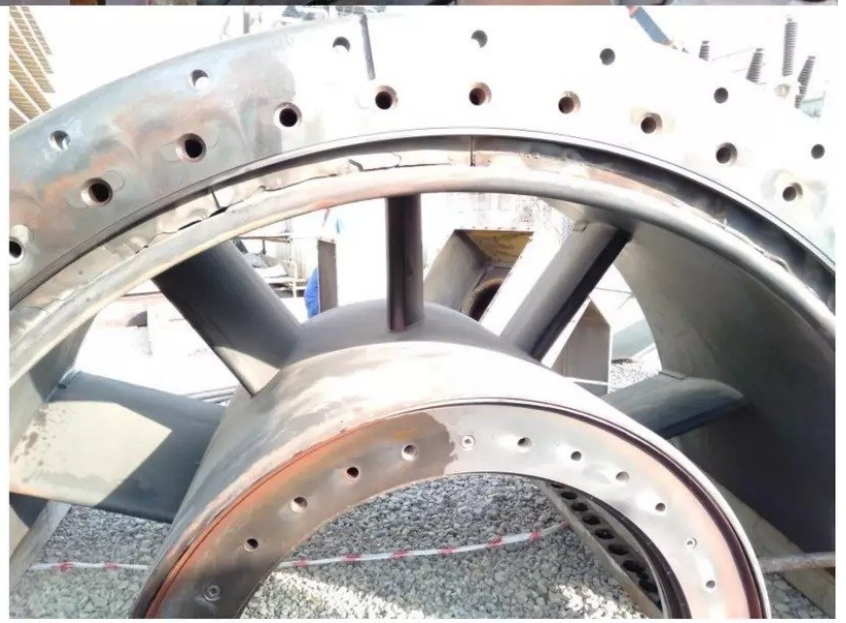


Make-up of the Exhaust Frame









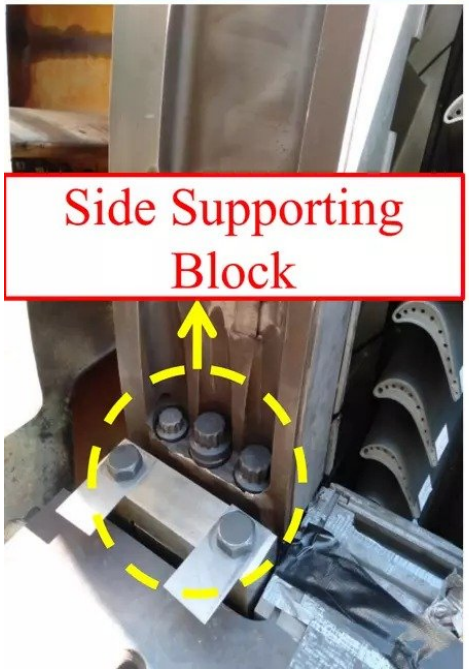
- Removing the cover plate of the exhaust frame, cleaning of the old insulation.
- Re-insulation and attachment of new cover plate.
- Flex Seal installation; a sealing between the exhaust frame and turbine shell.

Support Ring and 1st Stage Nozzle Ring Installation









- Support ring, based on two halves, is bolted with the CDC inner cylinder. After Installation of CDC, Support ring is introduced, when bolted, 1st stage nozzle ring is mounted on it. 1st stage nozzle ring is bolted with three bolts on either sides, connected both halves of the ring. 2 side supporting blocks are also used for holding the nozzle ring with the casing.

1st Stage Nozzle Ring Checks ✓

Ellipticity Check



- Ellipticity check is measured from OD of outer ring, as method followed for bearing ID measurement. This is to assure that nozzle ring is perfectly cylindrical.

Concentricity Check



Why concentricity is required?

- Concentricity is checked between 1st nozzle inner ring to the support ring, measured from 4 points: top, bottom, left and right.

Combustion Wrapper Casing Installation





- It is more convenient to install the transition pieces before installing the wrapper casing. Set back readings are recorded for each of the transition piece. If any reading falls out of the range, should the aft mount bracket bolts be tightened properly.

Float and Turbine Clearances Adjustment



Active Shim Thickness= A
In-active Shim Thickness= B
A-Set Reading (actual)= Ca
A-Set Reading (required)= Cr

Note#1: *For the adjustment of the float, we play with the thickness of in-active shim without consideration of active shim. For the adjustment of the turbine clearances, we treat both shims and their thickness variation is inversely proportional to each other. The active shim is first to consider while adjusting the turbine clearances.*

Float Setting: B ± y (y-thickness variation)
Turbine Clearance Setting: If, A + x; then, B - x
(Ca-Cr = x) or
If, A – x; then, B + x

Note#2: *In such cases, where both corrective actions are to be preformed. We can first correct the Float, then, the adjustment of the turbine clearances; or, by combination of both by numerical configuration.*

Float and Turbine Clearances Adjustment (Case Study)

Active Shim Thickness= A= 0.562”

In-active Shim Thickness= B= 0.384”

A-Set Reading (actual)= Ca= 10.174”

A-Set Reading (required)= Cr= 10.250”

Ca-Cr= x= 0.076”
Fa-Fr= y= 0.010”

Float Actual=Fa= 0.026”

Float Required=Fr= 0.016”

What should be the desired thicknesses of both active and inactive shims in account of float and turbine clearance adjustment?



Alignment ✓

- The alignment is an important exercise to perform in the Major Inspection.

Pre-Alignment

- The pre-check alignment reading is encountered, from the Turbine to Generator side, for getting a reference value.
- The activity is parallel to CI hardware removal work. The load coupling aft side bolts are first open for alignment reading.

Post Alignment

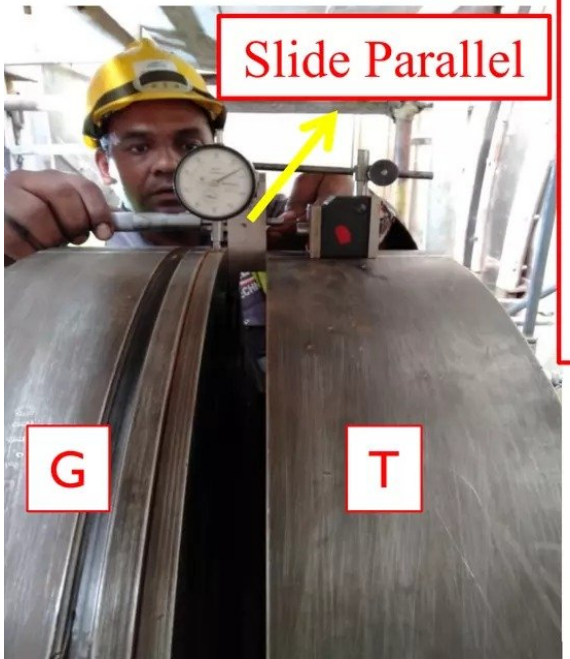
- The Post Alignment after positioning the turbine rotor on turbine base.
- This is the final check of the major inspection.
- The alignment is performed from Accessory Base to Turbine and from Turbine to Generator.

Alignment Method: Rim and Face

Alignment Tools: Christmas Tree, Dial Gauge, Slide Parallel, Vernier Caliper, Inside Micrometer

Turbine to Generator Alignment

- Gib-keys are first removed from fwd and aft sides of the Generator Compartment. All the Generator leg bolts are should be unbolted.
- For performing the alignment Turbine to Generator, the Generator rotor is slightly pushed back for making a room for measuring the face readings, which is recorded by means of a slide parallel.
- Slide parallel where transition fits into coupling faces, the width is measured by the inside micrometer. This is known as axial reading; it is recorded, at each quarter turn, from four positions top, bottom, left and right. Final axial readings are the average of four readings at a point.



Note: *After alignment correction, new housings for gib-keys are emerged and gib-keys undergo engineering for exact fitting into that housings; by addition of shims, or thickness reduction.*

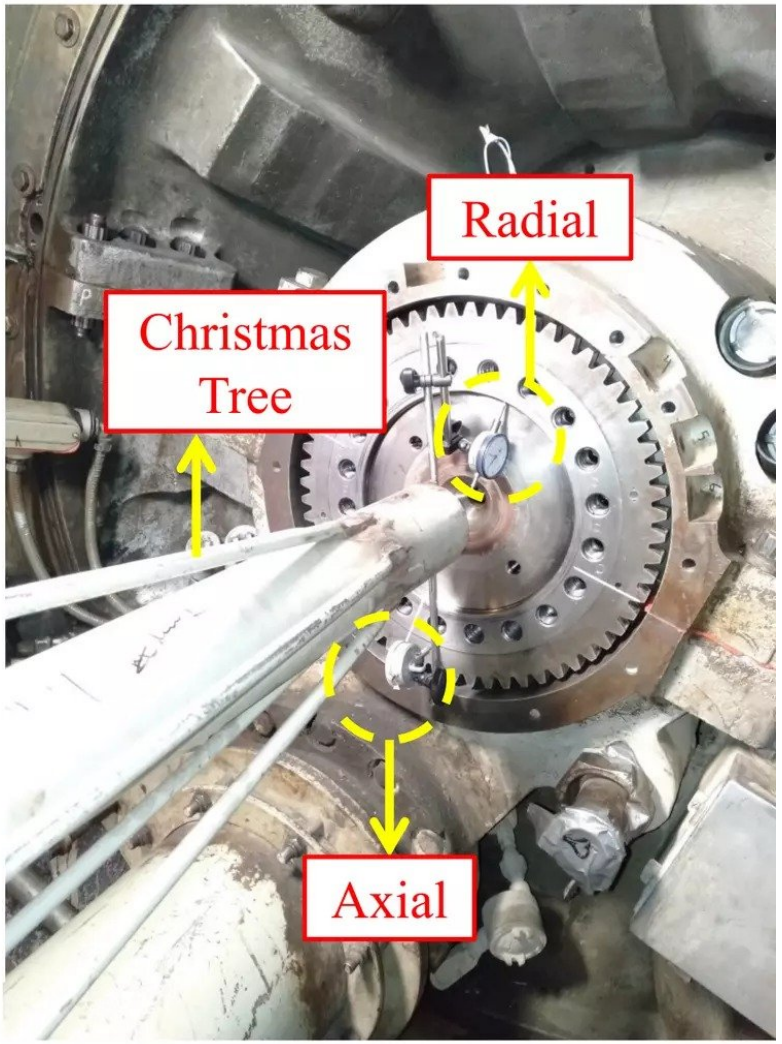


- The turning is performed on turbine, whereas, generator rotor remains stationary.
- The dial gauge indicates the radial reading; noted from four points top, bottom, left and right.



Accessory Base to Turbine Alignment

- Christmas tree is a supporting structure that replaces the accessory shaft for sake of alignment. Its one end connects with the accessory gear box, and other one is used as dial indicator mountings, which interfaces with the Turbine Speed Gear.
- Two Dial Indicators are attached, one for radial reading and other one is for face reading.
- Before recording the readings; all accessory base legs bolts are loosened, gib keys and radial pin are removed.
- The radial pin is located at turbine side, and grounded into the accessory base.
- Gib keys are machined or shim addition is performed, after repositioning the accessory base, for fitting into the new housing.
- The radial pins is re-introduced for locking the accessory base at new position.





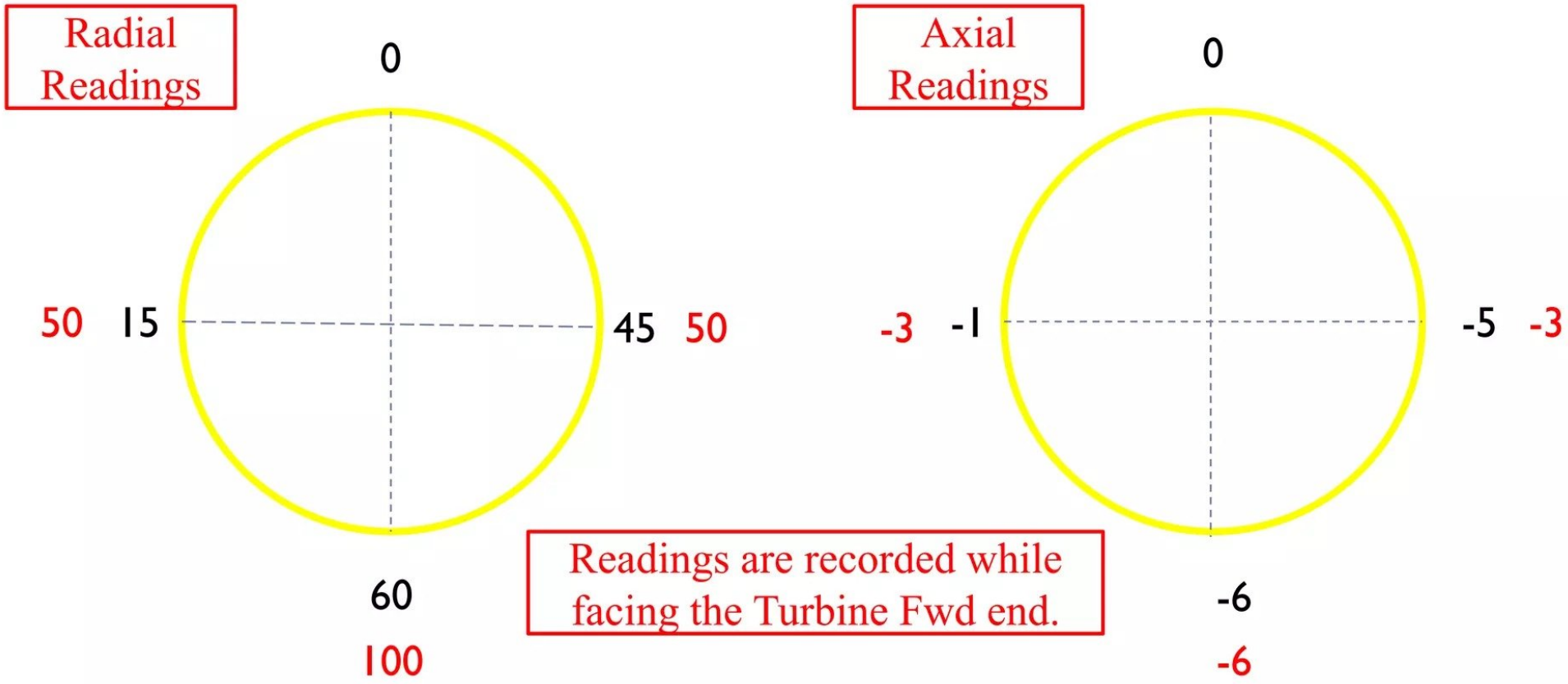
Radial Pin



Gib Key Modification

How many Gib Key housings are associated with Accessory Base and where they exist?

Accessory Base to Turbine Alignment (Case Study)



What corrective actions we need to align both shafts by considering the target values?

Note: *All readings are in thou.*