Triveni TURBINES REFURB

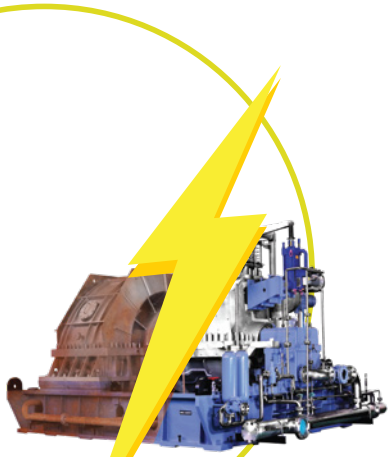
Refurbishing Case Studies

Modernise. Upgrade. Improve.

Case Studies

ANY MAKE AGE OF TURBINE

TRUST US TO REFURBISH IT



Contents

Triveni Turbine Ltd & Triveni Refurbishing 02

Efficieny Improvement

Case Study 1 : Extraction Condensing Turbine to Back Pressure 04

Case Study 2 : Efficiency improvement of a 12MW turbine 05

Case Study 3 : Restoration of Turbine 06

Case Study 4 : Steam Path Redesign : Achieving Higher Efficiency 07

Case Study 5 : Repeated blade failure in the same row 08

Rotor Repair

Case Study 6 : Bend Removal : Rotor Repair 09

Case Study 7 : LP Rotor Repair 10

Case Study 8 : Value Engineering of Damaged Blade Profiles 11

Case Study 9 : Rotor Classified 'Beyond Economic Repair' 12

Rotating Equipment

Case Study 10 : Value Engineering of Damaged Compressor Impeller 13

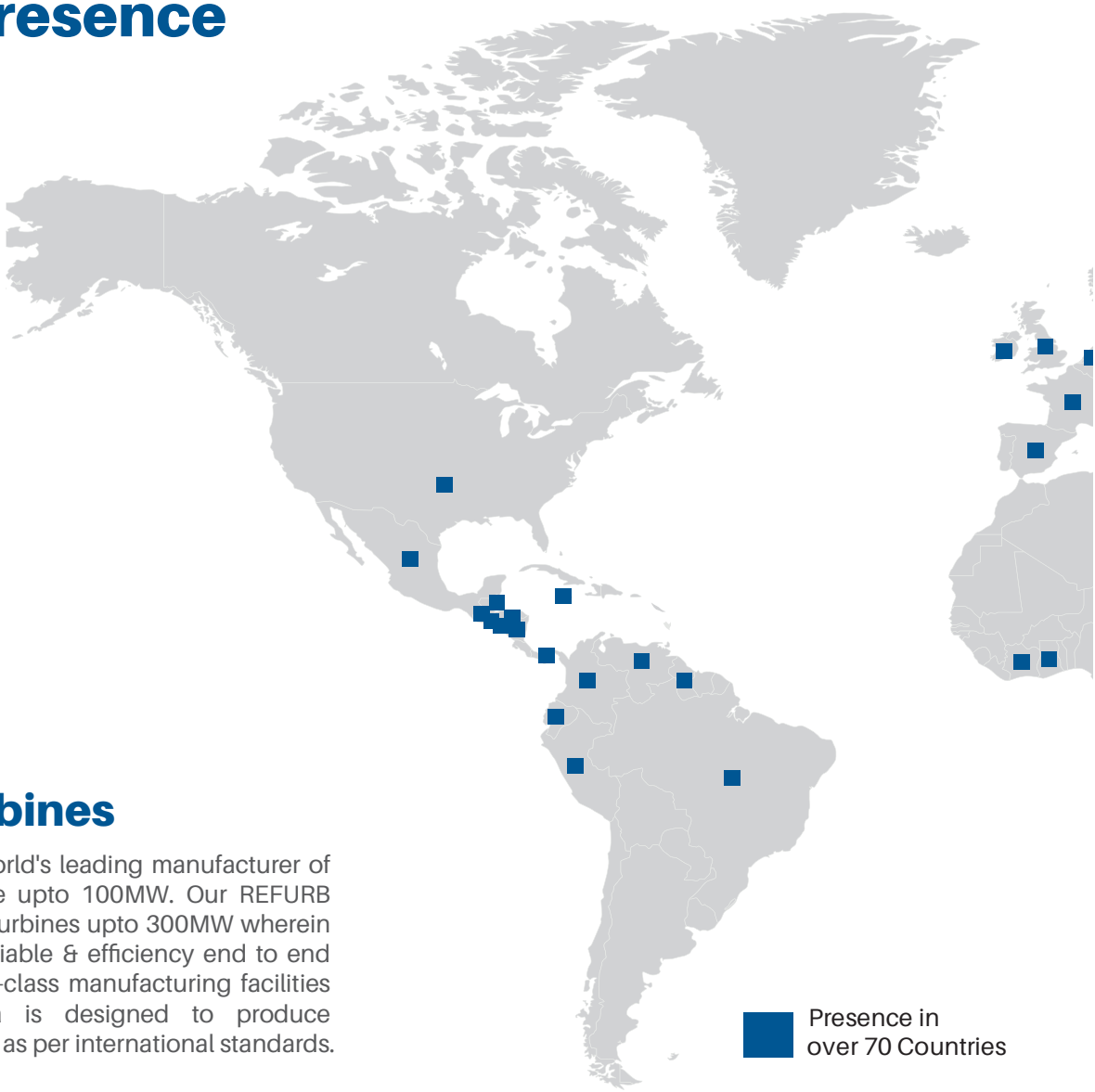
Case Study 11 : Repair & HSB of 35 MW Alternator Rotor 14

Retrofits

Case Study 12 : Conversion of mechanical governing system to electronic governing system 15

Global Network 18

Global **Presence**



Triveni Turbines

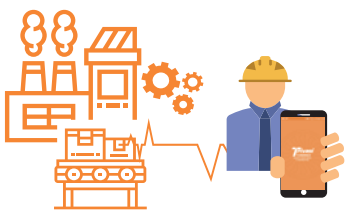
We are one of the world's leading manufacturer of steam turbines range upto 100MW. Our REFURB division, refurbishes turbines upto 300MW wherein we deliver robust, reliable & efficiency end to end solutions. Our world-class manufacturing facilities at Bengaluru, India is designed to produce high-quality products as per international standards.

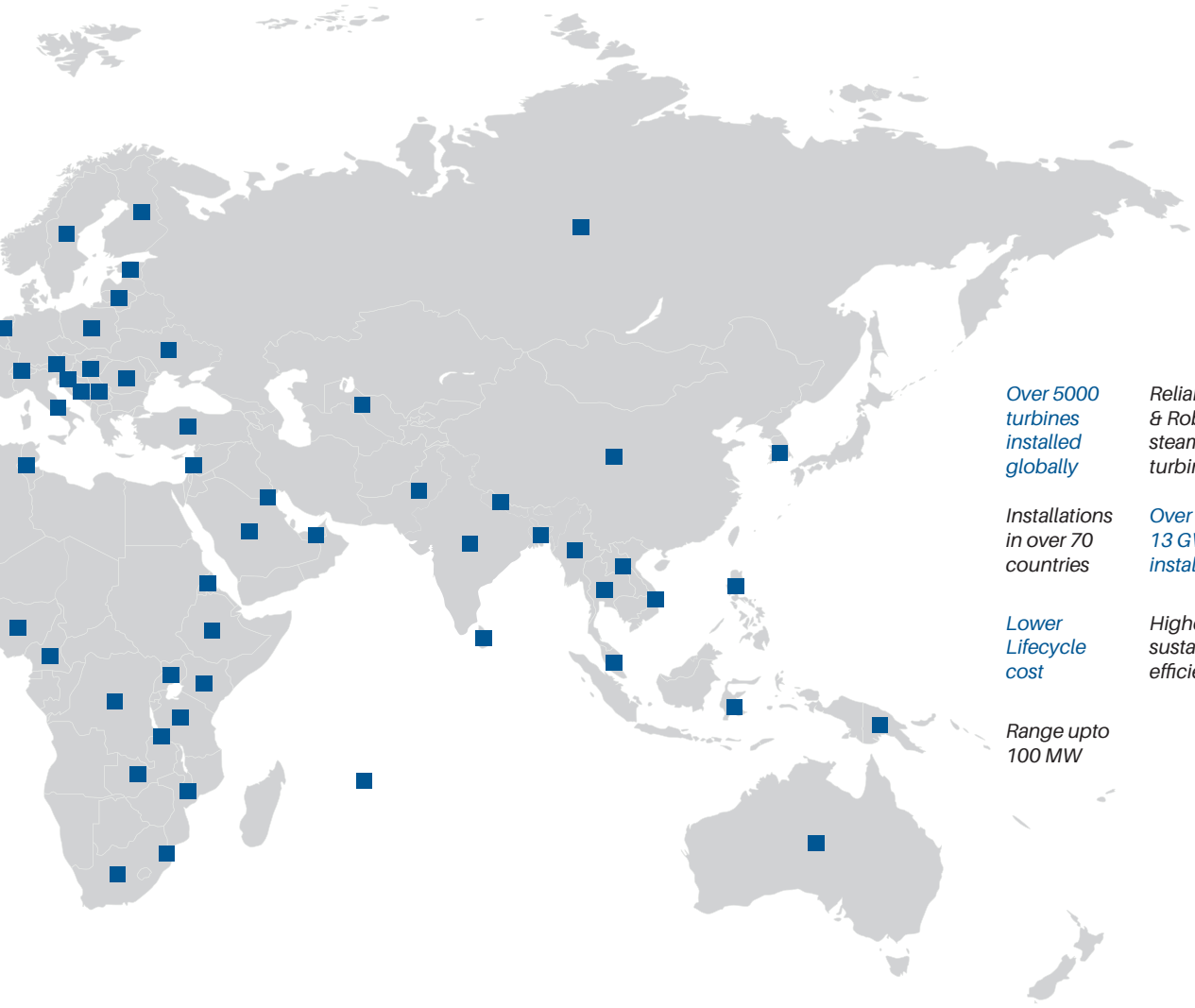
Triveni Spares & Services

Domain expertise intrinsic to an OEM including R&D Capabilities. We offer a quick response in the delivery of spares and Service Support and follow best practices in the industry.

- Predictive, Preventive spares & service plans for long term seamless operations
- Highly trained and multi-skilled field service engineers who can support complete TG Island.
- Robust plans for Efficiency improvements , Restoration of Efficiency, Retrofits and automation solutions to the old STGs
- Partnering with Triveni is an investment in good service experience & access to the latest in power generation technology.

Triveni Touch
Remote monitoring & Diagnostics from Triveni





Over 5000 turbines installed globally

Reliable & Robust steam turbines

Installations in over 70 countries

Over 13 GW of installations

Lower Lifecycle cost

Higher sustained efficiency

Range upto 100 MW

Triveni Refurbishing

Triveni refurbishing team has made its mark in the business and is able to handle any turbine irrespective of age and make and breathe life into it. From a health check to efficiency improvement or process correction, the Triveni team can handle the entire spectrum of business and give the customer the confidence as an OEM of the performance capabilities.

- Renovation & Modernization (R&M)
- Efficiency restoration or improvement
- Re-engineering
- AMCs for all makes of steam turbines
- Overhauling
- Reverse Engineering
- Health survey and condition assessment

Segments we cater to

PETROCHEMICALS · BIOMASS · PULP & PAPER · WASTE TO ENERGY · DISTILLERY · FOOD · CHEMICAL

IRON/STEEL · CEMENT · SUGAR · PALM · TEXTILE · IPP BARGE · DISTRICT HEATING

CASE **STUDY 01**

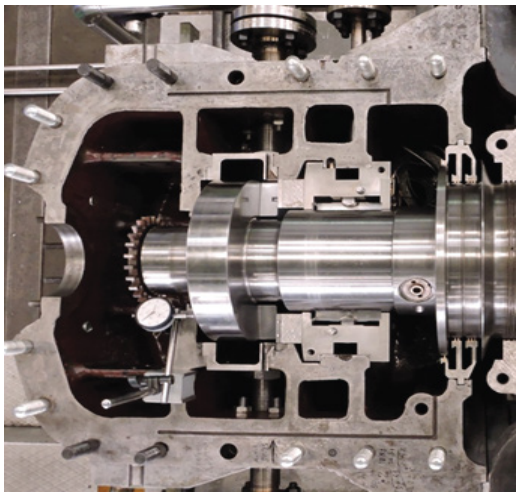
Extraction Condensing Turbine to **Back Pressure**

INTRODUCTION

The customer is a **Refinery in India**.The turbine project was won by Triveni Refurbishing to Convert a **12 MW Russian make** extraction condensing turbine to back pressure turbine ,commissioned in **1964** and sent for **refurbishing in 2018.**

CHALLENGE

The challenge was to redesign the turbine internals within the casing boundary conditions. Convert an extraction condensing turbine to a single extraction back pressure turbine the job also needed additionaly convert existing hydro-mechanical type to electro-hrdraulic type (governor retrofit).

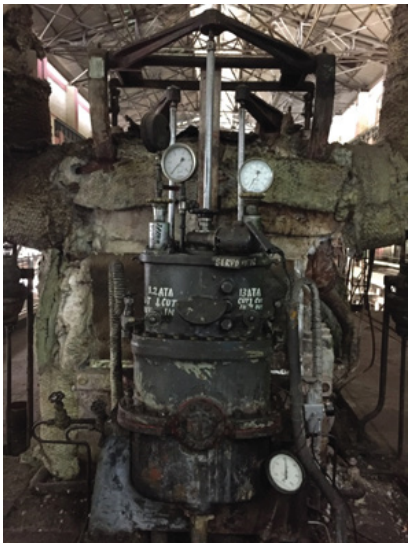


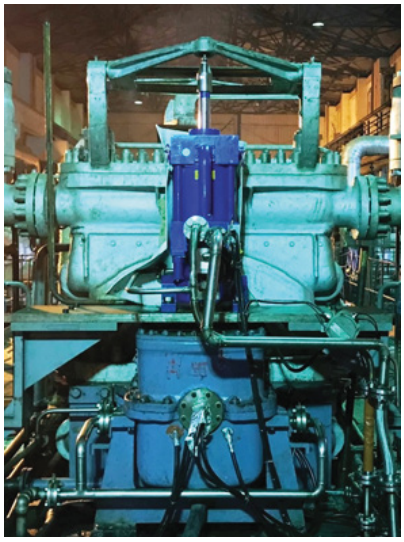
SOLUTION

Triveni Refurbishing Redesigned the turbine to back pressure by reducing the number of stages and the exhaust pressure was changed from 0.1 ata to 5.0 ata. This turbine was successfully commissioned and is running well.

CUSTOMER SPEAK

"Thanks for your Technical support consistently and good job to all your team members who have contributed to this job directly or indirectly."





CASE STUDY 02

Efficiency improvement of a 12MW turbine

INTRODUCTION

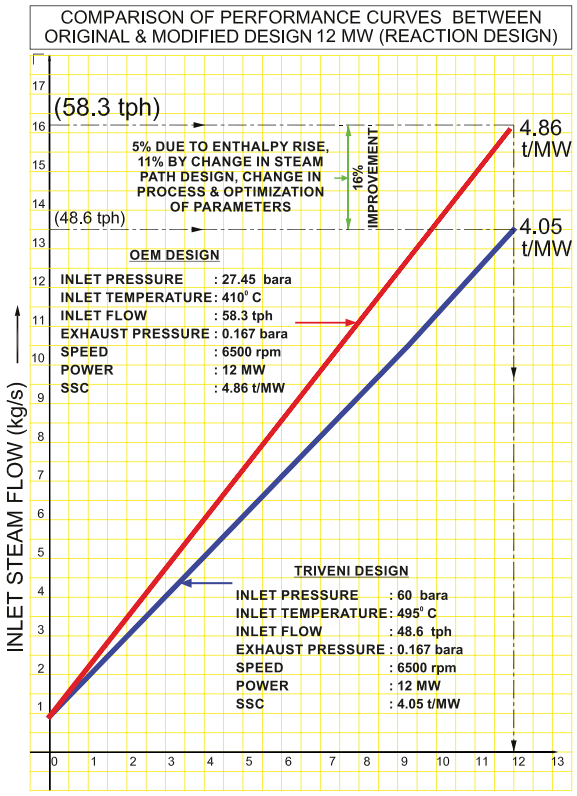
The customer is a **copper manufacturing** Industry in **India**. The turbine was sent to Triveni Refurbishing for repair, modification and **efficiency improvement**. Client's turbine was an old running turbine sourced by them in **1983**, which was sent to us in **2016** for refurbishing.

CHALLENGE

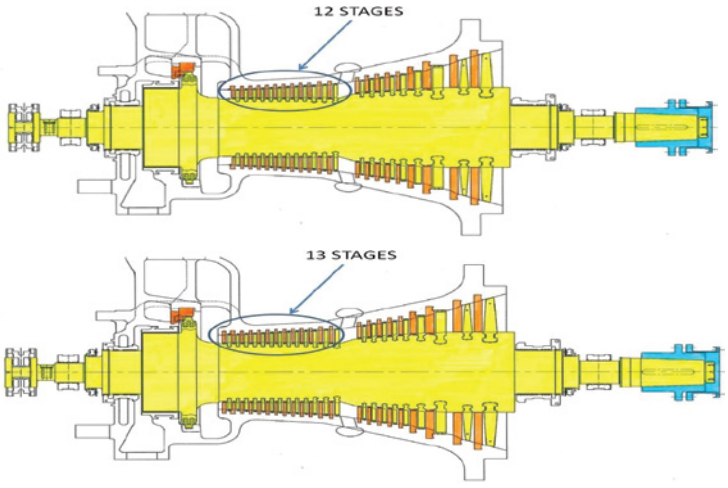
The challenge was to modify the turbine in the existing turbine boundary conditions of the casing by redesigning it for higher efficiency which convert the low inlet steam parameters to high inlet steam parameters.

SOLUTION

Triveni Refurbishing redesigned the steam path within in the existing turbine boundary conditions of the casing. The efficiency of the turbine **improved by 16%** and the **payback period** was just **6 months.**



Parameter	Unit	Without extraction		With extraction	
		Original design	Modified design	Original design	Modified design
Inlet steam pressure	bar (a)	27.45	60	27.45	60
Inlet steam temperature	°C	410	495	410	495
Inlet enthalpy	kJ/kg	3259.5	3410.4	3259.5	3410.4
Exhaust pressure (vacuum)	bar(a)	0.17	0.17	0.17	0.17
Inlet Steam Flow	tph	58.8	49.2	68.4	57.6
Extraction steam pressure (Uncontrolled)	bar (a)	....	....	6.8	6
Extraction steam flow	tph	0	0	20	13
Exhaust steam flow	tph	58.8	49.2	48.4	44.6
Speed	rpm	6500	6500	6500	6500
Power	MW	12	12	12	12
Specific Steam Consumption	t/MW	**4.9**	**4.1**	**5.7**	**4.8**
No. of stages		1+21	1+22	1+21	1+22



CUSTOMER SPEAK

"The TG has been rolled successfully at 12 MW Power & RUNNING SUCCESSFULLY . Thanks to your entire team for relentless efforts."

CASE STUDY 03

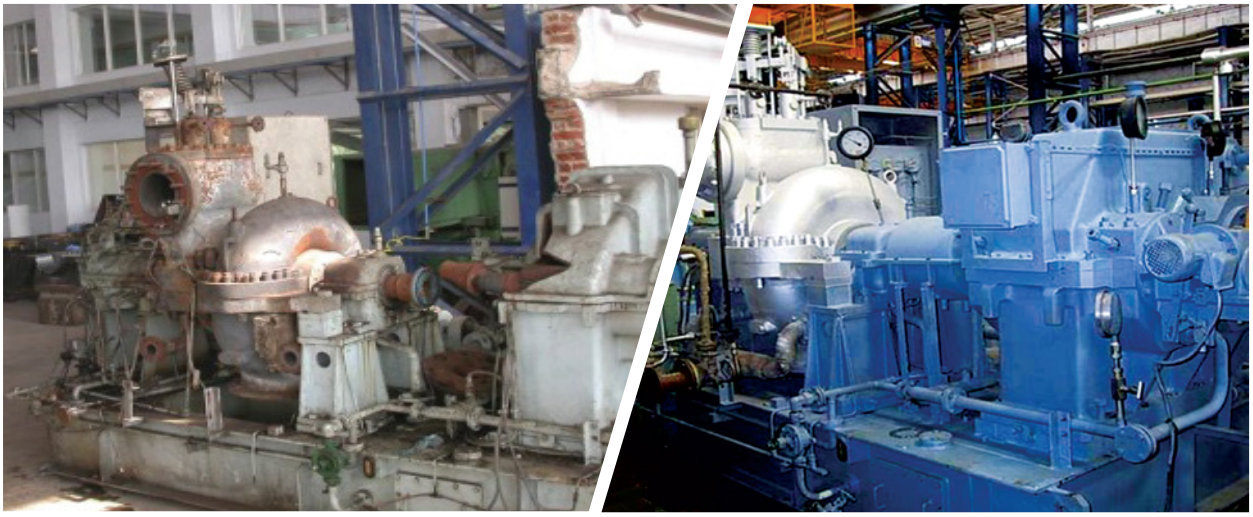
Restoration of Turbine

INTRODUCTION

The customer is a reputed group in the **palm oil** segment from **Malaysia**. The turbine in operation was completely damaged and the rotor shaft was sheared off.

CHALLENGE

The challenge was to **rebuild** the complete turbine **without existing drawings** and replace the broken parts ensuring that it operates at the **designed efficiencies**.



SOLUTION

Triveni Turbines shipped the whole turbine to its factory in Bangalore where the Triveni Refurbishing team rebuilt the whole turbine through reverse engineering.

There was a need to manufacture new blades through reverse engineering and it was found that the old design (root blades) was no longer useable.

The entire project was completed within **4 months**. The turbine is on **full power** for over **3 years now** with no issues since and we have yet another satisfied customer.

CASE STUDY 04

Efficiency Improvement of a 6MW Turbine

INTRODUCTION

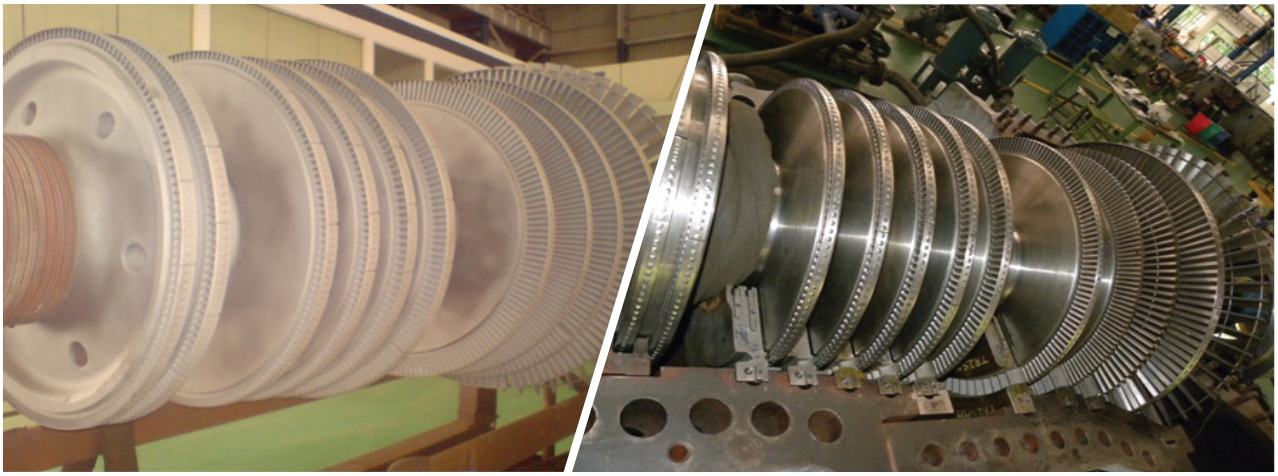
The customer is a large player in the **steel PCG** space in **India**. They imported an old plant manufactured in the year **1972** from **Germany** and wanted the same to be put back in operations with an improved efficiency of **4.8 kg/kw hr to 4.4 kg/kw hr.**

CHALLENGE

The challenge was to establish the new steam path in the absence of any manufacturing data and to be able to give the customer a solution for the turbine to operate at better efficiencies than the original.

SOLUTION

Triveni Turbines took up the challenge and decided to map the existing steam path and interpose on it the new Triveni Turbines design to review if it will work. The new design was a feasible option and would require a full steam path change including introduction of a new row of blades and a new diaphragm.

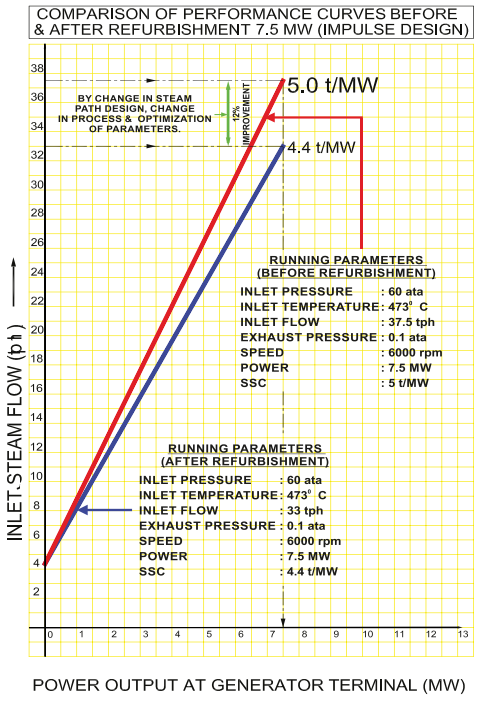


Based on this a **10 stage** rotor was redesigned to a **11 stage** rotor.

We needed to manufacture new blades and found that the old design of root was no longer used and a decision was taken after consulting the customer to replace the same with our new design.

The rotor was rebuilt and assembled in the turbine. The turbine is on full power for over 2 years with no issues since.

On start up achieved a efficiency improvement of **8%.** The turbine with these changes is operational for the past 2 years now and meeting the efficiency requirement of the customer.



CUSTOMER SPEAK

"Triveni Turbines has displayed strong engineering skills to translate our requirement to operational reality. We recommend them to all customers."

CASE STUDY 05

Repeated Blade Failure
in the same row

INTRODUCTION

We have come across several instances of repeated failures of specific row of blade on turbine rotor of various makes and various clients in India and abroad.

CHALLENGE

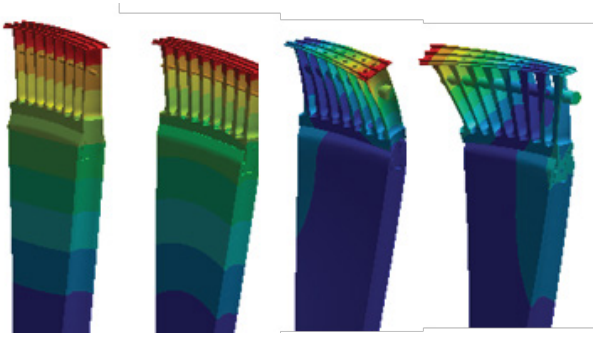
The challenge was to identify the root cause of failures on the specific row of blade, take up necessary design up gradation& incorporate the same during manufacturing of new blades.

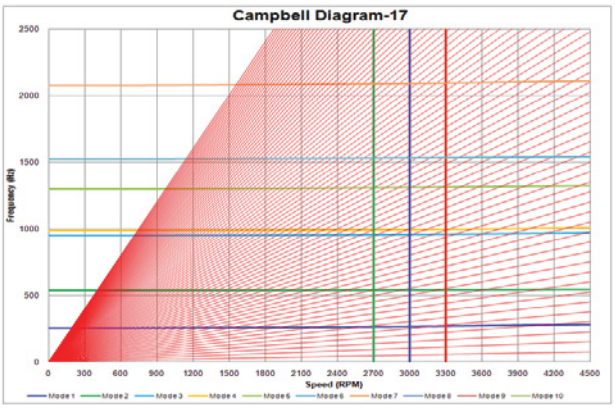
SOLUTION

Existing blade root, profile and nozzles design were analysed individually and together. This is done by analysing LCF, HCF and other analysis as required using the latest software. This enables us to decide the necessary improvements in design to be made whether on root, profile or nozzles to achieve the operating parameters and boundary conditions without undue stresses

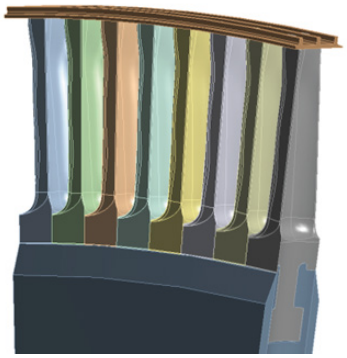
We have corrected a large number of rotors with such issues which need more than just reverse engineering.

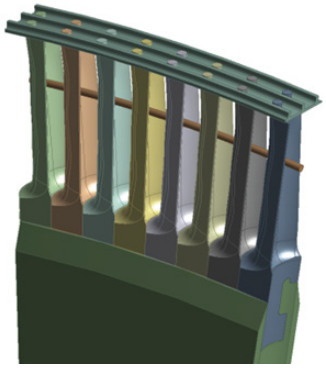
In one Example – Post analysis we decided to include lacing wire as a damping arrangement





Campbell diagram





CASE STUDY 06

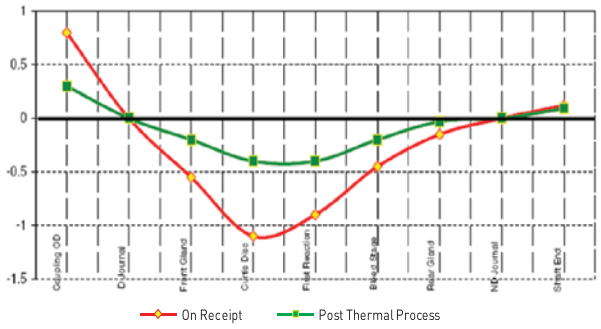
Bend Removal : Rotor Repair

INTRODUCTION

The customer is a leading **sugar manufacturer** in **India** and has a large fleet of turbines.They had a stoppage in power generation due to **break down** of their **30 MW** turbine at their unit. The first information recorded was that the 30 MW was on full power and due to grid fluctuation, high vibration occurred and the turbine tripped. The turbine was over **30 years** old and the customer had no past data on the turbine. The customer put his faith in us to put the turbine back on power.

CHALLENGE

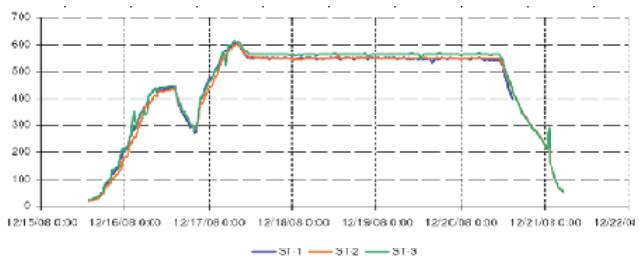
On receipt of the turbine and inspection of run out we found that the turbine had been subjected to a **complex bend** of **1.8 mm across** the length of the shaft and the challenge was to use the same shaft as per instructions of the customer.

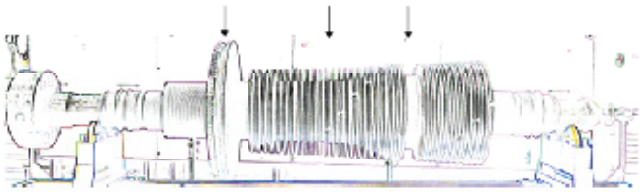


SOLUTION

On review of the possible solutions the best way forward to remove the complex bend was to de-blade the rotor and subject it to a **thermal cycle** to remove all the stresses and enable us to bring the rotor within the desired levels of tolerances of straightness. The thermal cycle is shown below and we achieved the desired results.

We were required to manufacture new blades and found that the old design of root was no longer usable. A decision was taken after consulting the customer to replace them with our **new design**. The rotor was rebuilt and assembled in the turbine. The turbine is on full power for over 2 years with no issues since.





CUSTOMER SPEAK

"Triveni Turbines has displayed a lot of engineering skills in being able to bring our turbine into operation.

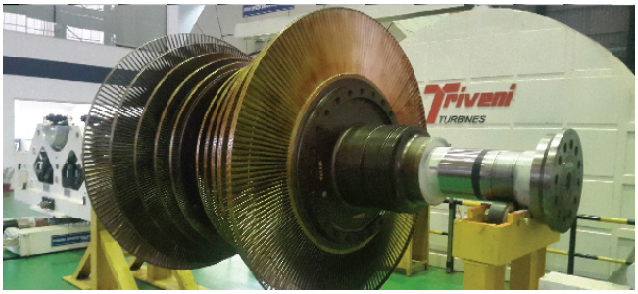
We had complete confidence in Triveni Turbines and hence on the forced stoppage we put our faith in Triveni Turbines to complete the job for us and they have reposed the faith."

CASE STUDY 07

LP Rotor Repair

INTRODUCTION

The customer is an **IPP** from Southern Africa, generating over **500 MW** of power. It was operating a Turbine Generator Set which was commissioned in **1956**. Post overhauling, a new rotor was replaced in the Turbine. The blades of one row of this rotor broke within 2 weeks of operation. This also led to vibration and damage to the adjacent rows.



CHALLENGE

The challenge was to study the reasons of such failure and **redesign the blades** to ensure that this does not recur. Triveni Turbines was given a deadline of 3 months to complete the project.

SOLUTION

The blade design was studied in detail to identify the reasons for the breakage and subsequently necessary design changes were made to ensure that the same does not recur.

The rotor has now been put into operation and is operating trouble free.

CUSTOMER SPEAK

We weren't getting the service we wanted in South Africa. We ship our turbine to Triveni REFUB as they provide fantastic service, get the work done on time and provide good quality. The process is very well managed.

CASE STUDY 08

Value Engineering of **Damaged Blade Profiles**

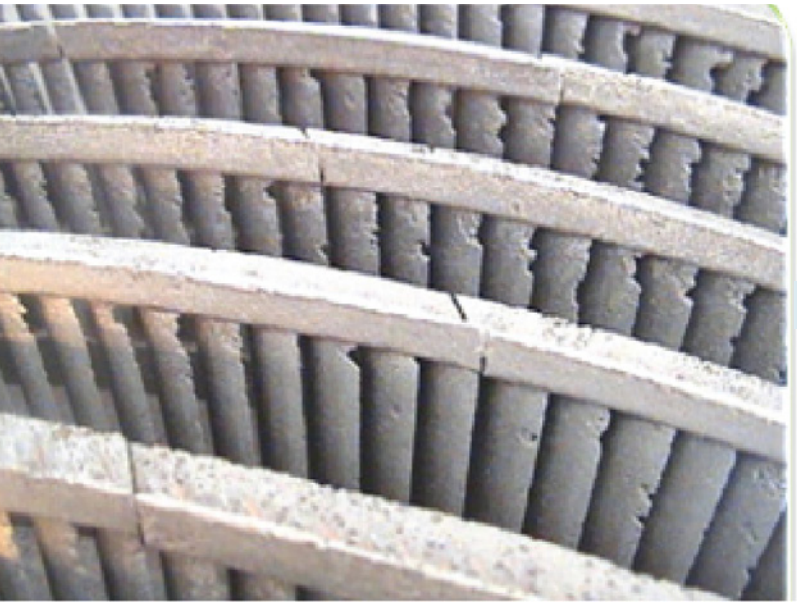
INTRODUCTION

The customer is a large player in the **steel and process PCG space** in **India**.

They imported an old plant manufactured in the year **1940** from **Germany** and wanted to put back the same in operating condition.

CHALLENGE

The challenge was to recreate the blade profiles and the blade packets. 10 blades made one packet and every 3rd blade had a profile angle change which had to be incorporated. Further, the original packet was brazed with gold and silver which was an expensive option to recreate.



SOLUTION

Triveni Turbines took up the challenge and created a new methodology to **weld the blade** packets together and all necessary tests and validations were done to rule out the future possibilities of problems during operations the turbine was put back to operation successfully.

CUSTOMER SPEAK

"Triveni Turbines is a good engineering company in India capable to standing up with global players and we are glad that we took the decision of doing this project with Triveni Turbines." The entire turbine was made operational in 9 months & has been operational for the past 5 years

CASE STUDY 09

Rotor Classified
‘Beyond Economic Repair’

INTRODUCTION

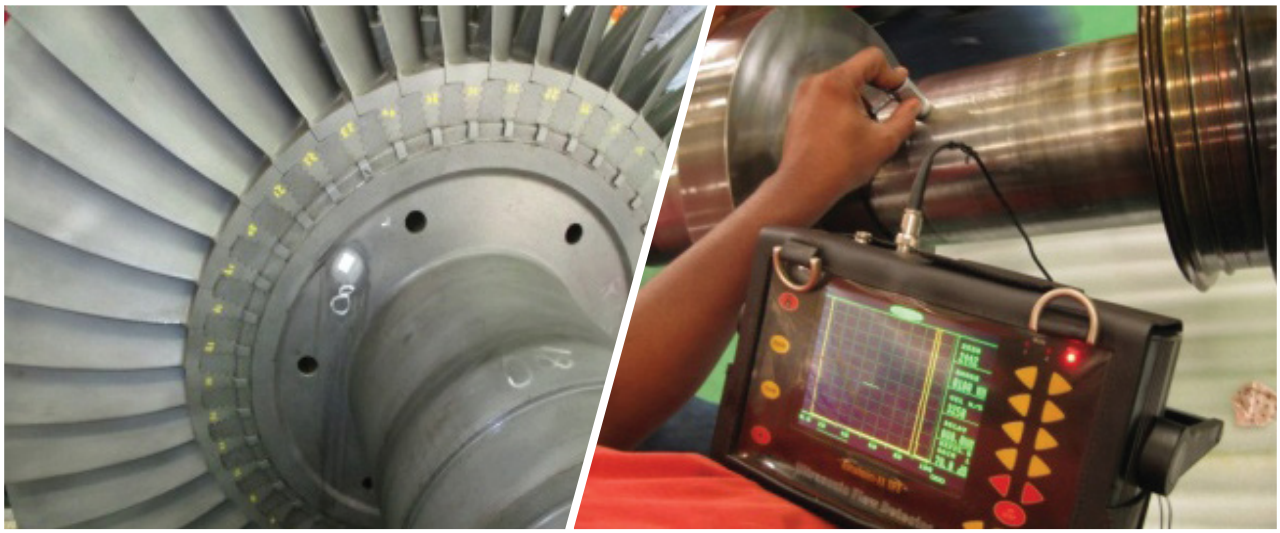
The customer is part of a large **Sugar group** in **Southern Africa.** The problem started with a close down in power generation due to break down of their 30 MW turbine at their unit. This turbine had been **commissioned just 11 months back.** The first information recorded was that the 30 MW was on full power and due to high vibration the turbine had tripped. The customer approached the OEM who reviewed the rotor and classified it as **‘beyond economical repair’.** The customer then decided to explore other options & service providers before taking the final decision and discovered Triveni Refurbishing team. Our Team reassured them that as an OEM ourselves we could support the customer in putting back their turbine to working condition.

CHALLENGE

The visual inspection carried out at the customers place gave us adequate confidence that we could repair the rotor. The confidence was stemming out of the 4000 turbines we have commissioned across the world and knowing the fact that our turbines operate in more difficult conditions. To give the customer confidence in our statement we confirmed we would do the RLA and NDT and establish the integrity and life of the rotor. The rotor was then shipped to India for further analysis.

SOLUTION

All necessary tests were carried out as per the established procedures and we documented that the rotor was fit for use and the life of the rotor was also informed to the customer.



The rotor was then inspected, reverse engineered, necessary corrective actions taken, re-bladed, high speed balanced in the Schenck tunnel and then dispatched to the customer.

CUSTOMER SPEAK

This left just over 3 months to transport our rotor to the Triveni Turbines workshop in Bangalore, affect the repairs, transport the rotor back and commission the turbine successfully. The fact that the team was able to succeed in this very difficult task is testimony to the customer focus and professionalism, not to mention very high levels of competency, that exist in Triveni Turbines.

I will admit that there were times when I doubted whether we could pull this effort off, but we did succeed and I am especially pleased because this validated our decision to award the contract to Triveni Turbines, in the face of some doubts. Triveni Turbines now has a good name and we have not held back extolling the company's virtues to whoever will listen, what Triveni Turbines did in assisting us in a very difficult situation'.

CASE STUDY 10

Value Engineering of **Damaged Compressor Impeller**

INTRODUCTION

The customer is a reputed **Steel group** in the **Middle East.** The compressor impeller was damaged during the operation and required replacement.

CHALLENGE

The challenge was to carry out **reverse engineering** of complete impeller assembly **at site**

SOLUTION

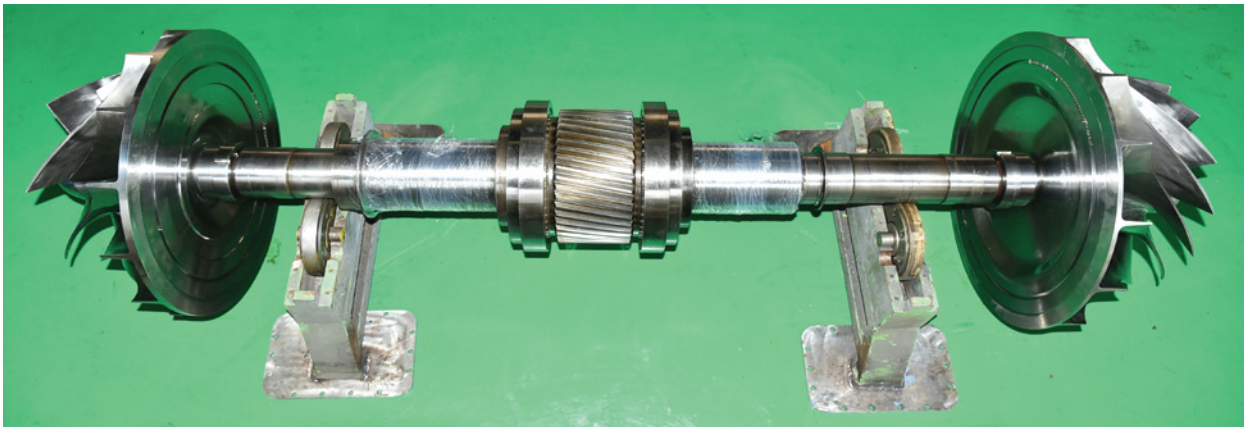
Triveni Turbine deputed design expert along with **3D scanner** at site to complete the reverse engineering **in 2 days.** The equivalent material of impeller was identified and TTL took proactive action for ordering the raw material forgings.

New impeller along with pinion shaft was manufactured & also **High speed balanced** in Vacuum balancing tunnel within **6 months.**

Triveni also supported by deputing **service expert** for installation & commissioning of compressor & this is operational since Dec 2018.

CUSTOMER SPEAK

We found a very successful team , high technical skills, very cooperative team with a very good manufacturing quality. The job was done in high quality & high efficiency



CASE STUDY 11

Repair & High speed balancing of 35 MW Alternator Rotor

INTRODUCTION

Client is a leading **paper & pulp industry**. Their **35 MW** generator rotor experienced heavy vibration during excitation and hence, were unable to load the generator.

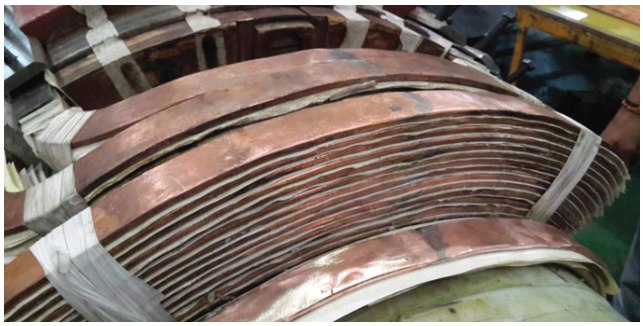
CHALLENGE

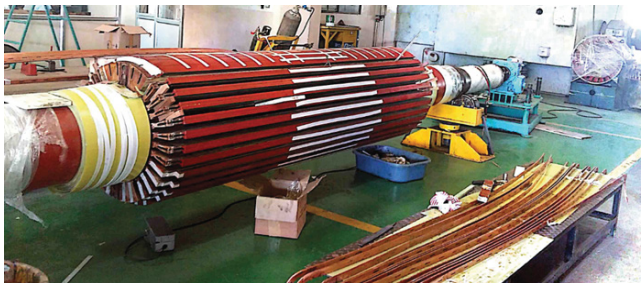
On inspection, the root cause of the issue was improper brazing of rotor windings. This was leading to contact between winding & end rings during rotation and hence, created faults in rotor and distortion on the magnetic flux resulting **vibration** while exciting the **alternator**

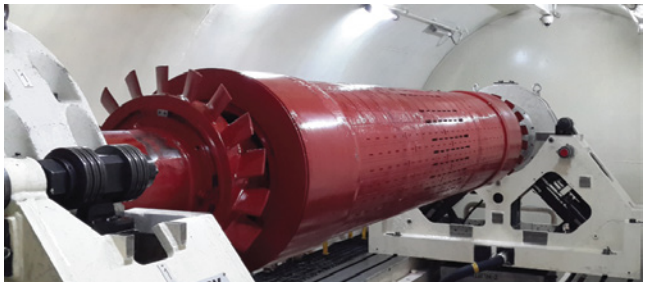
SOLUTION

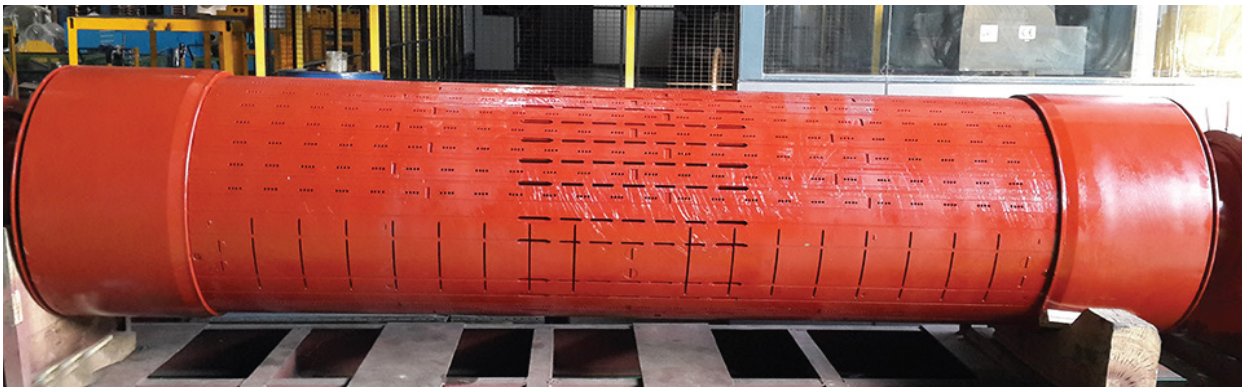
Removing of rotor coils / windings & replacement of faulty windings. Complete **re-insulation,** static tests, before & after **high speed dynamic balancing** in Vacuum tunnel. Rotor has been commissioned and running successfully since May 2016. A series of tests were done in this process which included

- Resistance test,
- High frequency test @ 400HZ,
- Impedance test for the Rotor
- The IR test,
- Resistance test & surge comparision test for the armature
- RSO test was also conducted for the alternator.









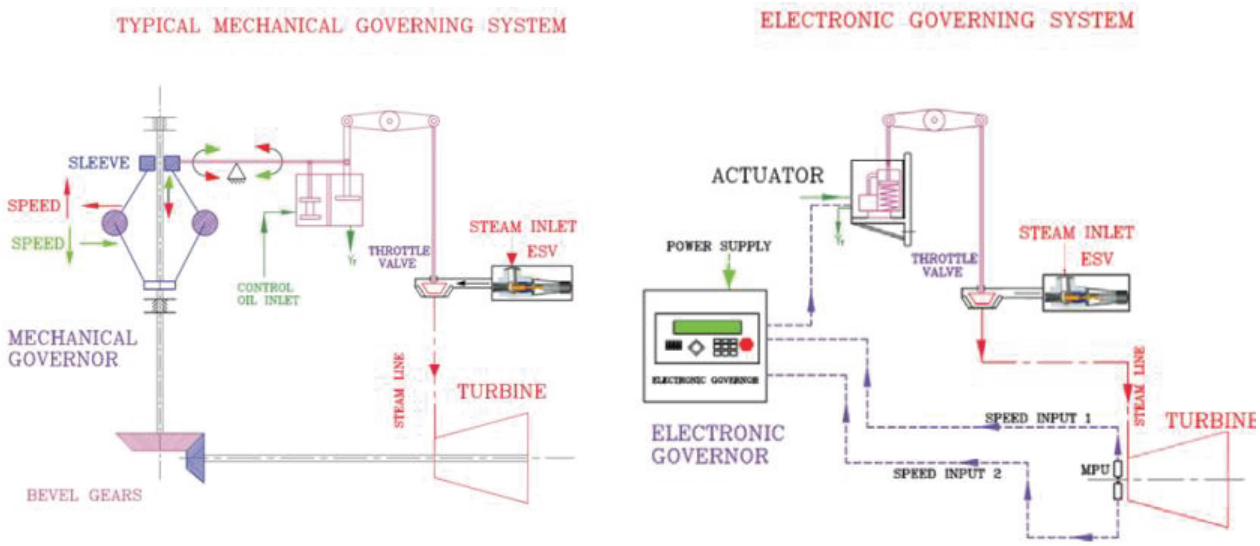
CASE STUDY 12

Retrofits: Conversion of mechanical governing system to **Electronic Governing System**

INTRODUCTION

There are a large number of legacy and older equipment operating with mechanical governing systems which become sluggish over a period of time and require to be adjusted at regular intervals to avoid risk to the turbine.

Triveni refurbishing has a dedicated team that works with customer to convert existing mechanical systems to electronic governing system whether simple non configurable or the high end configurable systems which do away with the need of a standalone PLC depending on customer requirement



CHALLENGE

Understanding the existing mechanical system & integrate the electronic governor & actuator with as few modifications as possible at site.

SOLUTION

Review the existing architecture and build the new one to support the system, implement and commission the project.

Triveni Refurb team has implemented a number of such systems across the world.

CUSTOMER SPEAK

A satisfied Customer stated "The project was extremely complex but Team Triveni executed the job well. The team was very efficient, knowledgeable and quick to act. We thank them for a very successful execution of this project in the given timeline".

NOTES

Triveni TURBINES REFURB

Embracing cultures. Enhancing the future

/TriveniRefurb

/triveni-refurb

SCAN FOR ENQUIRY

VISIT WEBSITE

Global **Network**

INDIA

SALES, SERVICE AND MANUFACTURING FACILITY

Triveni Turbine Limited

12-A, Peenya Industrial Area,
Bengaluru-560 058,
Karnataka, India.
Phone: +91 80 22164000
Fax : +91 80 22164100

SALES, SERVICE AND MANUFACTURING FACILITY

Triveni Turbine Limited

Plot No.491, Sompura
2nd Stage, KIADB Sompura
Industrial Area
Nelamangala Taluk,
Bengaluru Rural - 562 123

THAILAND

MARKETING AND SERVICE OFFICE

Triveni Turbines DMCC

571 RSU Tower,Unit 903,
9th Floor, Sukhumvit
31 Road, Klong Ton Nua,
Wattana, Bangkok 10110,
Thailand
Phone: +66 2 117 9575,
Fax : +66 2 662 3416

INDONESIA

MARKETING AND SERVICE OFFICE

Triveni Turbines DMCC

Suite No. 56, 23rd Floor,
ANZ Tower,Jl. Jend.
Sudirman, Jakarta
Pusat – 10220, Indonesia
Phone : +62-21-29546888
Fax : +62-21-29546889

UAE

SALES AND SERVICE OFFICE

Triveni Turbines DMCC

4502-14 & 4502-15,
45th Floor, Al Mazaya Business
Avenue - Tower BB2,
Jumeirah Lake Towers,
Dubai, United Arab Emirates,
P.O. Box 393509
Phone: +971-4 5670752
Fax : +971-4432 8232

SOUTH AFRICA

MARKETING AND SERVICE OFFICE

Triveni Turbines Africa (Pty) Ltd.

AMR Building,
3 Concorde East Road,
Bedfordview, 2007,
South Africa
Phone: +27 10 007 5245 / 5246

Email: customercare@triveniturbines.com

www.triveniturbines.com/

Sep 2021