

CASE STUDY



STEAM TURBINE RE-ENGINEERING

This study covers the successful bid and execution of a comprehensive revamp on a critical piece of equipment for an industrial food and beverage plant in Louisiana, USA. Blackstone Technical Services America (BTS) in association with Compression Services Technology (CST) was commissioned to overhaul a Turbodyne, Worthington, frame ITS6, 2500kW, steam turbine. The project aimed to increase the power output of an existing unit, while addressing the technical challenges associated with a 60+ year old steam turbine. The turbine underwent extensive refurbishment and re-engineering, focusing on a new steam path which included both rotating and stationary components. The collaboration between the client, partners, and Blackstone Technical Services not only led to the successful revamp of the steam turbine but also showcased the potential for proactive planning in extending equipment life cycles. The upgraded equipment now operates at increased efficiency, demonstrating the positive impact of strategic refurbishment and re-engineering efforts.



Rotor & Shell as received.



OVERVIEW

DATE: 2023

LOCATION: Louisiana, United States

APPLICATION: Food & Beverage Industrial Plant

SERVICE: Power generation and steam

SPECIFICS: Steam Turbine / Size / Scope of Work, entire bundle supplied to customer
7 stages (1 Curtis, 6 Rateau)

POWER: 2500kW, 4475 rpm.
Output increase of 42%

INLET STEAM CONDITIONS: 250 psig 475°F

EQUIPMENT SCOPE OF WORK

01

Valve Rack

- Disassembled, cleaned, and inspected.
- Dimensional checks, runout checks, blue contact checks and non-destructive examination (NDE) performed.
- Replacement of cam shaft end bearings, stem collars, bonnet dowel pins, and other hardware.
- Onsite adjustments completed to repair leaking valve rack.

02

Re-engineered Rotor

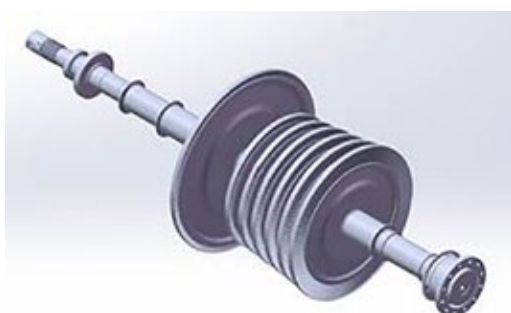
- Assembled a new rotor in accordance with CST drawings and utilizing parts from our manufacturing partner.
- Metrology (3D scan) and data capture was performed. Finite Element Analysis (FEA) was performed for blades and the wheel bore design.
- A mono-dimensional flow path optimization calculation was developed to design blades and nozzles.
- Balanced both a low speed (LSB), at speed (HSB), and overspeed (OST).
- Installed new wheels, blades, shrouds, thrust collar, worm gear, overspeed device, and gear coupling.

03

Casing

- Recorded incoming shell to rotor clearances and axial dimensions.
- Blast cleaned with 220 Aluminum Oxide, NDE, dimensional checks, and set clearances performed.
- Repairs included hand dressing, reaming dowel pin holes, welding, drilling, tapping, and adjusting shims.
- Replaced nozzle caulking, hardware, dowel pins, and upper half diaphragm holding set screws.

Located new diaphragms, machined axial face and outer diameter, painted casing, and cleaned and inspected all hardware.

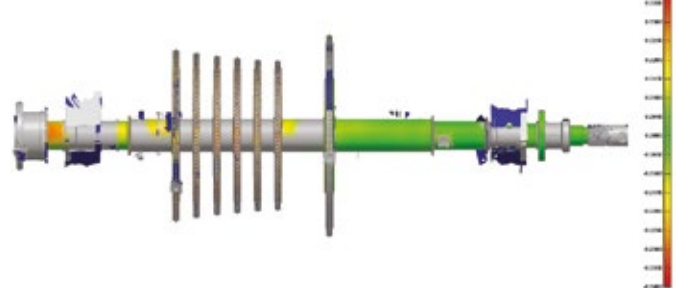


CST re-engineered model

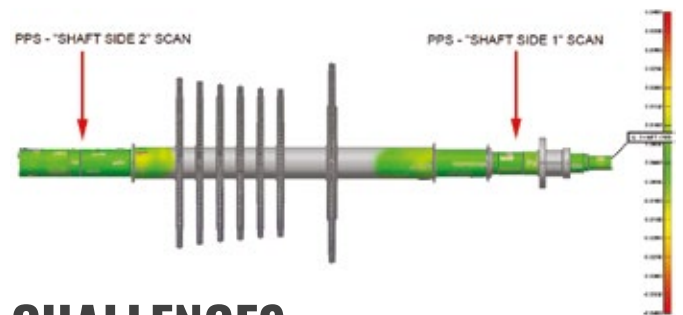
PROJECT BACKGROUND

The Blackstone Technical Services and CST team presented a comprehensive business case emphasizing the feasibility of revamping the existing equipment. The plan involved replacing diaphragms and rotors, instilling confidence in the client that the equipment could be brought back to optimal performance. BTS's history of successful collaboration and proactive maintenance strategies played a crucial role in fostering trust and winning the bid. The original unit, initially designed for 2400kW, fell short, achieving only 1900kW. This performance gap prompted the client to reevaluate and re-rate the equipment for maximum critical power generation. The turbine, underwent extensive repairs and improvements, including rotor re-blading, casing inspections, and valve rack adjustments.

3D scan vs. CST model

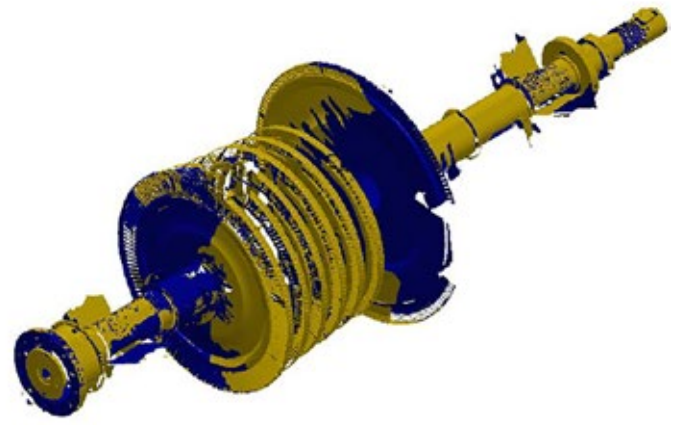
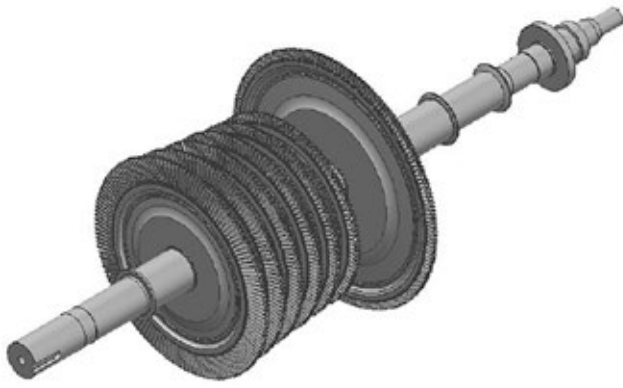


Manufacturing Partner shaft scan vs. CST model



CHALLENGES

The client faced the challenge of maintaining a 60-year-old steam turbine without support from the original manufacture. The large OEM pushed to replace the equipment with new equipment. Blackstone prioritized understanding and addressing the genuine needs and practicalities of the client. Secondly, the metrology process revealed design gaps from years of wear, requiring redesigns by our engineering team at CST.



CST in collaboration with Politecnico di Milano University (POLIMI) Rotor Design

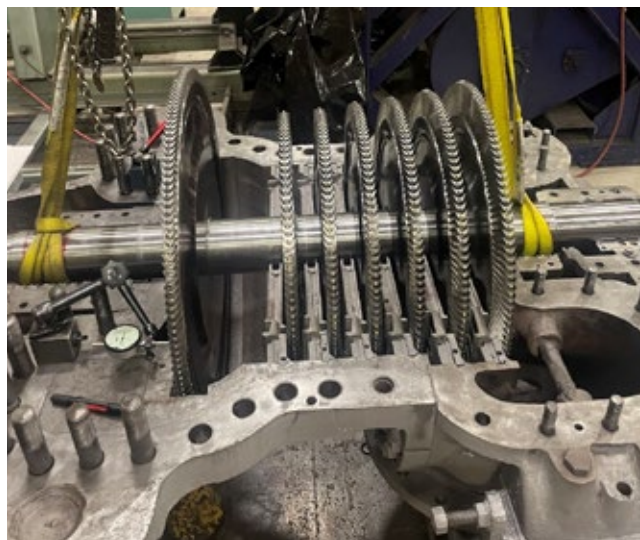
Rotor 3D Scan: Initial 3D scans presented challenges due to gaps in data.

OUR SOLUTION

- Precise Metrology, 3D scanning of components, followed by re-engineering of the rotor.
- CST, in collaboration with Politecnico di Milano University (POLIMI) developed a dedicated software to design the angles of the blades and nozzle to optimise the performance of the steam flow path.
- Assembled a new rotor using Blackstone/CST drawings and partner manufactured parts, factoring in the re-engineered design.
- Components manufactured and quality assurance, quality control, HSB, LSB, NDE, OST, and non-destructive examination completed.
- Overhauled the valve rack and optimized timing/sequencing to minimize observed impacts and wear on startup.

CUSTOMER BENEFITS

- Provided a comprehensive, one-stop solution for the entire project.
- Demonstrated deep knowledge of the machinery and a decade-long history of successful collaboration.
- Power INCREASED by 42%
- Delivered a fully customized solution, increasing power capacity from baseline customer output of 1900 kW to a rating tested 2700 kW (maximum output).
- Ensured an internally refurbished and optimized piece of equipment.
- Addressed safety concerns with a fully repaired valve rack.
- Delivered the solution on time and within budget.



RESULTS

The Steam Turbine Power Upgrade Project achieved its primary goal by increasing the power output of the equipment. The successful revamp not only enhanced the equipment's performance but also extended its operational life by re-engineering internals and providing extended life-cycle on equipment in alignment with the facility's heavy maintenance plan. The collaboration between the client and Blackstone showcased the importance of experience, trust, and proactive communication in addressing complex industrial challenges.

