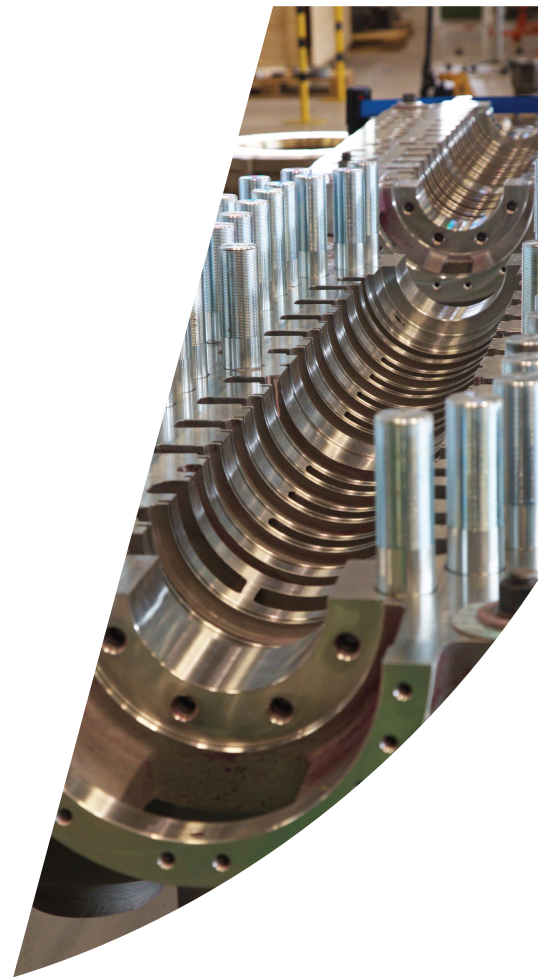


# ALLEN STEAM TURBINES™

## STEAM TURBINE SOLUTIONS

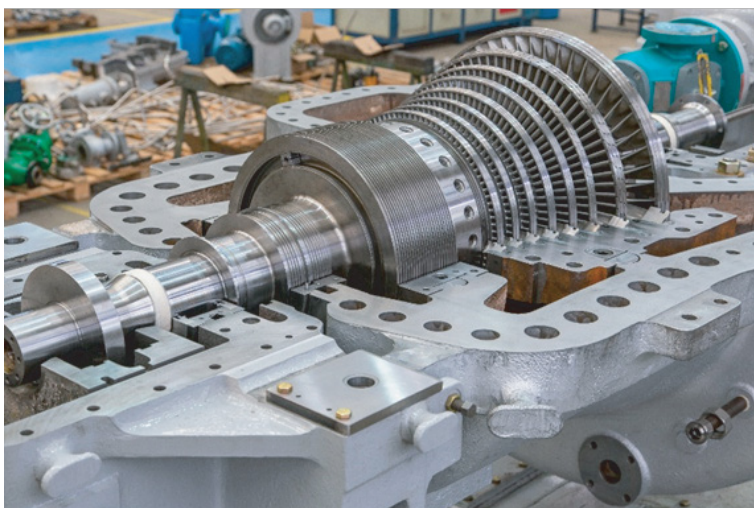
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## YOUR TRUSTED PARTNER IN STEAM TURBINE SOLUTIONS



Allen Steam Turbines™ Facility, Bedford, UK.



Trillium Flow Technologies Legacy Brand Allen Steam Turbines™ was established at the Queen's Engineering Works, Bedford UK in 1894. The company has a long and distinguished history supplying steam turbines including service of the existing OEM fleet together with other manufacturer's machines throughout Europe and the World.

With an extensive knowledge and expertise in steam turbines established from the installed fleet (WH Allen, Allen-KKK & SSK ranges, and NG-Allen) Allen Steam Turbines™ specialises in providing high integrity custom solutions for the maintenance and repair of all industrial steam Turbine manufacturers' products. New machines are provided in collaboration with NG Metalurgica for power generation and mechanical drive.

Allen Steam Turbines supports the current Naval Nuclear Submarine fleet with Steam Turbine Turbo Generator units providing comprehensive aftermarket, support of spares and overhaul work. Aftermarket coverage comprises rotating and stationary components, Combine Stop & Emergency Valves (CSEV's) and associated ancillaries.

The project and engineering solution team ensure a comprehensive range of services from initial site surveys through to long terms service arrangements. Services are carried out in collaboration with customer's existing resources together with other Trillium Flow Technologies facilities as required.



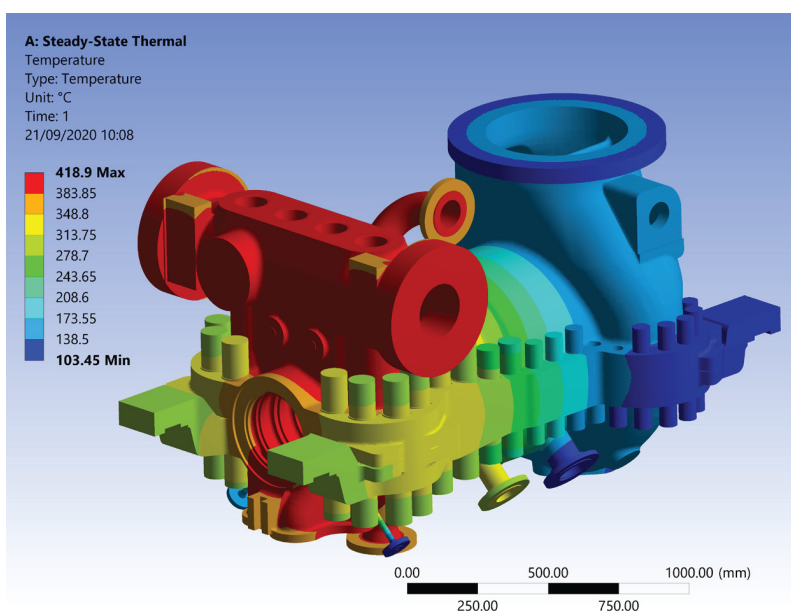


## DESIGN CAPABILITY



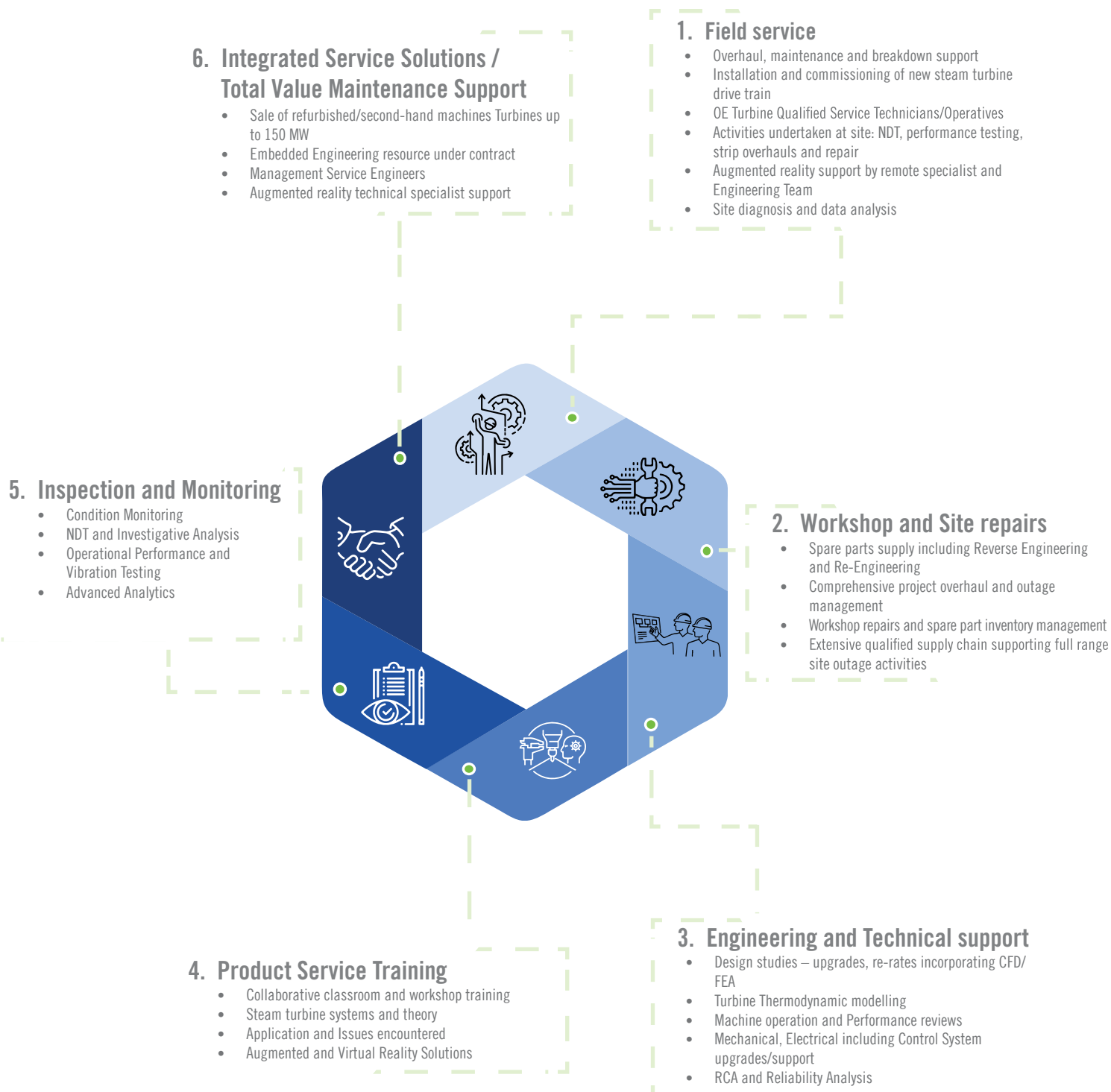
Our complete range of steam turbine services extends into re-rating and upgrading the turbine train in order to meet the revised duty, either to cater for changing process conditions, increased production requirements or to increase the efficiency of the plant or process. With increasing energy costs together with penalties associated with CO2 emissions there is a powerful case for evaluation and adoption of our innovative energy saving techniques.

Re-engineering capability of all rotating and stationary turbine components from complete rotors to individual diaphragms, blade carriers, turbine casings, together with ancillaries and controls. The process we provide includes digital capture of existing parts combined with extensive design expertise ensuring engineered components to suit the original design intent. This is essential when original parts are often too damaged to obtain an accurate profile or when the existing components fail to achieve an acceptable life. This capability enables us to take advantage of developments in manufacturing techniques and upgraded materials.



Modern steam path design and analysis techniques allow us to optimize the steam path of individual machines and recommend a solution to increase the turbine efficiency and the power output.

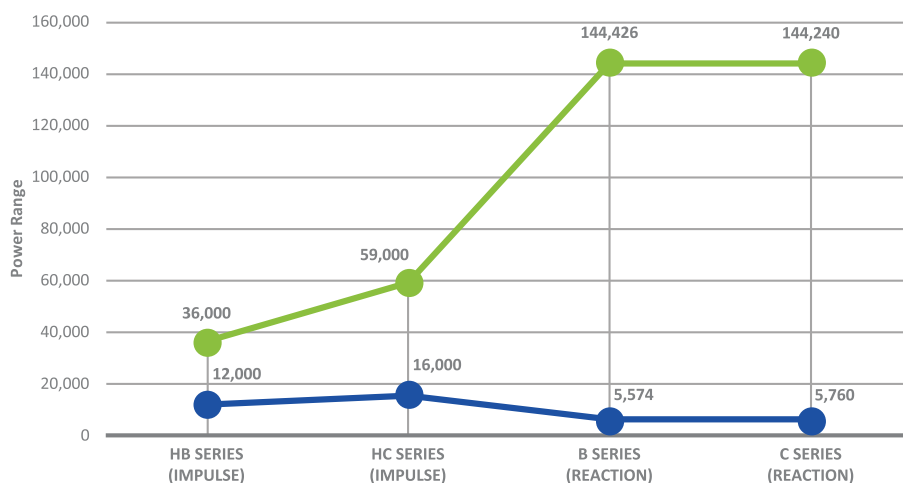
# SERVICE OFFERINGS OF ALLEN STEAM TURBINES





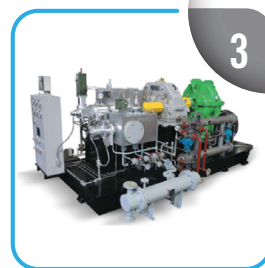
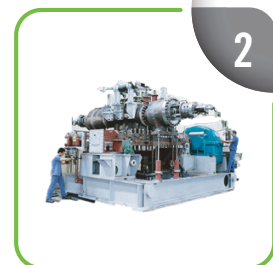
# NG ALLEN TECHNOLOGY

## INDUSTRIAL MULTISTAGE TURBINE RANGE



	CONDENSING; 86 bar(a)/520 °C MAX INLET CONDITIONS	CONDENSING; 86 bar(a)/520 °C MAX INLET CONDITIONS	BACKPRESSURE ; 120 bar(a)/540 °C MAX INLET CONDITIONS	CONDENSING; 120 bar(a)/540 °C MAX INLET CONDITIONS
Min Kw	12,000	16,000	5,574	5,760
Max kW	36,000	59,000	144,426	144,240

NG Metalurgica and Allen Steam Turbines™ have been working together closely as technical partners for several decades. The machines now being brought to the market are a development of the Allen modular range with many improvements and upgrades to comply with international standards.



### 1. B and C Series - Reaction

140 bar / 540 °C / up to 145 MW

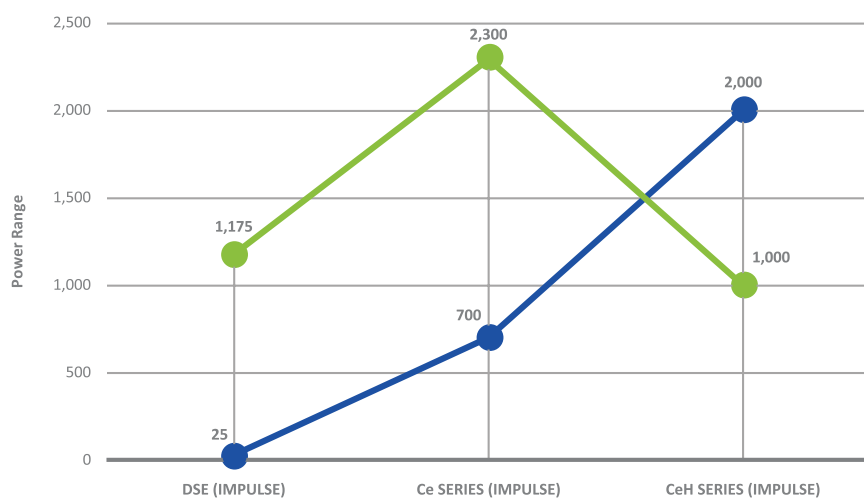
### 2. M and H Series - Impulse

90 bar / 520 °C / 65 MW

### 3. Single Stage

120 bar / 520 °C / 3.000 kW

## INDUSTRIAL SINGLE-STAGE TURBINE RANGE



	BACKPRESSURE; 43 bar(a)/400 °C MAX INLET CONDITIONS	BACKPRESSURE; 50 bar(a)/400 °C MAX INLET CONDITIONS	BACKPRESSURE; 120 bar(a)/520 °C MAX INLET CONDITIONS
Min Kw	25	700	2,000
Max kW	1,175	2,300	1,000

## CASE STUDY

### Turbine Re-Rate and Life Extension

#### Customer Challenge

- New operating conditions
- Risk of mechanical failure
- End of turbine life

#### Customer Benefit

- The critical turbine components have been re-designed for new operating conditions
- New turbine casing, diaphragms, nozzle and turbine rotor have been manufactured
- The turbine performance has been improved

#### Trillium Solution

- Critical components were re-designed
- The steam path has been re-design and optimised best performance
- Project management and Manufacture from design to site commissioning of solution

#### Customer / Site

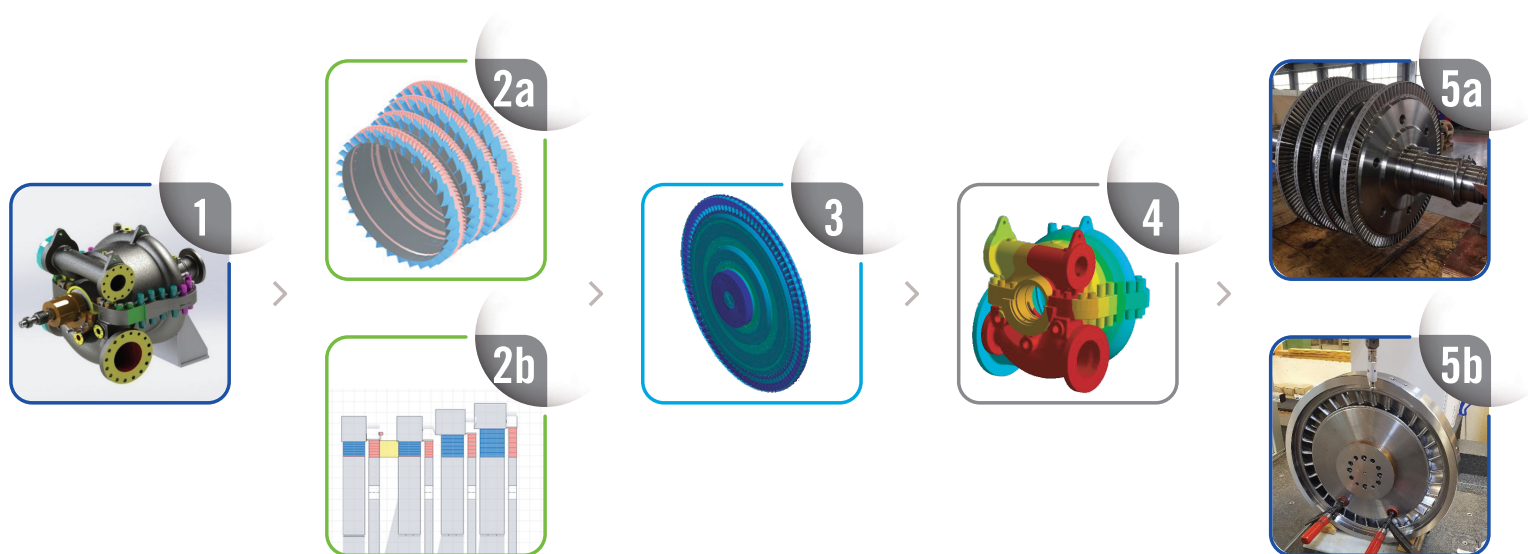
Sugar Mill / Australia

#### Applications

Generator drive

#### Trillium Offering

Turbine Re-Rate  
Life Extension



1. 3D CAD Design
2. Turbine Thermodynamic Model
3. Stress Analysis
4. Thermal Analysis
5. Manufacturing

## CASE STUDY

### Turbine Nozzle Failure – Root Cause Analysis, Performance Improvement.

#### Customer Challenge

- Turbine nozzle was found to have cracks on the vane profiles
- Customer requested Root Cause Analysis to be carried out to find the reason why after two years of operation the nozzle vanes experienced failure
- Customer also requested the nozzle to be redesigned to meet the new operating conditions of the plant

#### Trillium Solution

- Root Cause Analysis to find the solution
- Re-design the turbine nozzle for long time operation and better efficiency
- Project management and Manufacture from design to site commissioning of solution

#### Customer Benefit

- The turbine with re-designed nozzle has been operating without any issues
- The turbine reliability and availability have been improved
- The turbine performance has been improved by circa 4%

#### Customer / Site

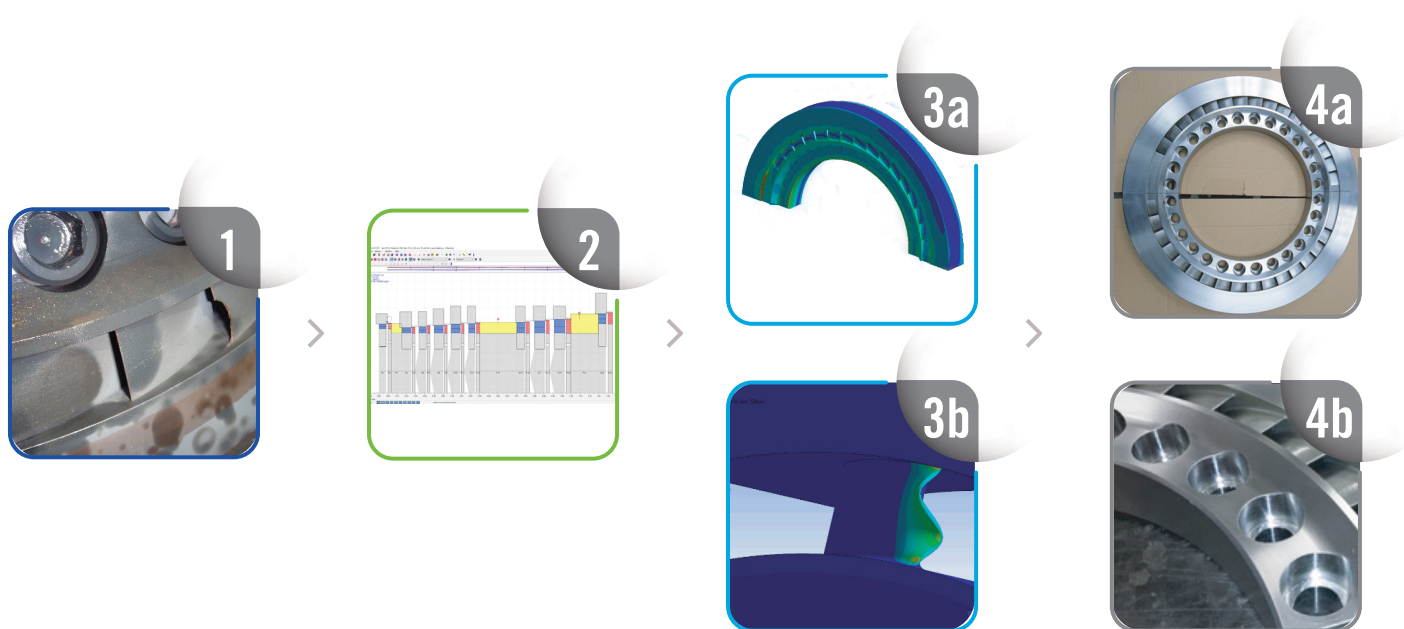
Waste to Energy Plant in Europe

#### Applications

Combine Heat and Power Plan

#### Trillium Offering

- Root Cause Analysis
- Problem Solving
- Turbine Performance Improvement



1. Problem Identification - Cracked
2. Thermodynamic/Aerodynamic Steam Path Design
3. Stress and Modal Analysis
4. Newly Manufactured Nozzle



## CASE STUDY

### Re-engineering & Steam Path Optimisation

#### Customer Challenge

- End of turbine life
- Risk of lack of production
- Risk of mechanical failure
- Poor turbine performance

#### Customer Benefit

- The life of steam path components has been extended for next 20 years
- Significant cost saving
- The turbine reliability and availability have been significantly improved
- New turbine rotor, diaphragms, nozzle, end glands haven been manufactured and fitted

#### Trillium Solution

- Capture critical geometry and design functionality
- Re-engineering of the steam path (third party machine)
- Steam path optimisation for best performance
- Project management and Manufacture from design to site commissioning of solution

#### Customer / Site

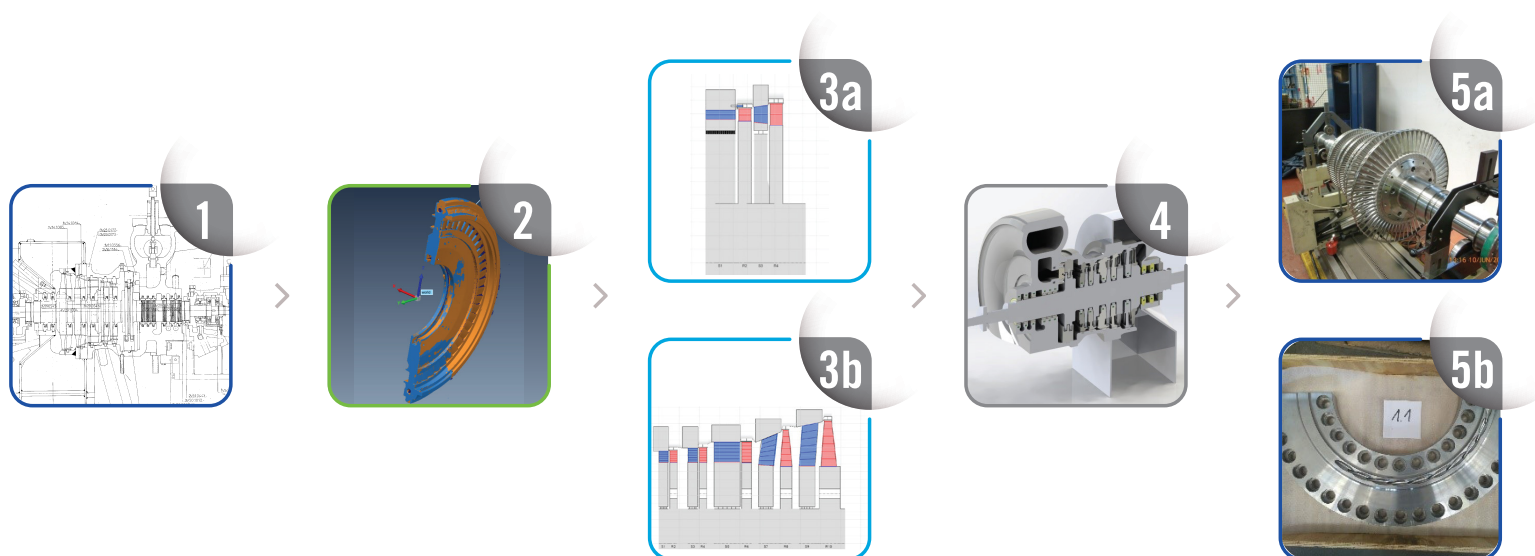
Fertilizer Plant / Egypt

#### Applications

Generator drive

#### Trillium Offering

Turbine Re-Rate  
Life Extension



1. Data capture third party machine
2. Obtaining Geometry by means of 3D scanning
3. Steam Path Optimisation
4. 3D CAD Design
5. Manufacturing

## CASE STUDY

### New Steam Turbine Package Installation

#### Customer Challenge

- Improve plant operational efficiency
- Large volume of low-grade excess steam
- Limited time to show profitability of site

#### Trillium Solution

- Low pressure condensing NG Allen turbine
- Compact well organised installation and commissioning schedule
- High efficiency gearbox and generator
- Design and Installation complete new 11 MW Steam Turbine Drive Train

#### Customer Benefit

- Allowed the site to remain open and become profitable
- Completed ahead of schedule
- Turbine produced additional kWh resulting in further financial benefit

#### Customer / Site

Paper Mill / UK

#### Applications

Power Generation

#### Trillium Offering

New steam turbine, generator, reduction gearbox Condenser, vacuum skid and control system



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- 1 New Turbine delivered to site
- 2 New turbine drive train installed at site

## CASE STUDY

### Replacement 3rd Party Turbine Installation

#### Customer Challenge

- 3rd Party OEM overhaul exceeded economics and delivery of a new NG Allen machine
- Work within the physical constraints of the existing installation
- Execution of the site activities whilst the plant continued to operate in bypass mode

#### Trillium Solution

- Critical execution program including dedicated engineering team
- Customized package to meet the customer expectations
- Experienced team to carry out the site activities

#### Customer Benefit

- Minimal disruption to the plant
- Short effective lines of communication
- Installed and commissioned ahead of schedule

#### Customer / Site

Waste to Energy Plant in Europe

#### Applications

Combine Heat and Power Plant

#### Trillium Offering

Removal and replacement of an existing aged 3rd party turbine



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1. Waste to Energy CHP Plant
2. Turbine to be replaced
3. New NG-Allen Steam Turbine



## CASE STUDY

### Turbine Overhaul / Upgrade

#### Customer Challenge

- LP turbine had suffered severe erosion / corrosion
- Machine was being operated outside the original design parameters
- Control system was no longer supported

#### Trillium Solution

- Performance review of LP turbine
- Supply of a new LP casing in an upgraded material
- Upgrade the control system with digital type devices
- Project management of all onsite activities

#### Customer Benefit

- Extend the life of the machine
- Reliability of the machine
- Reduce future overhaul time and investment

#### Customer / Site

Waste to Energy Plant in Europe

#### Applications

Combine Heat and Power Plant

#### Trillium Offering

- On site overhaul for complete machine train (turbine, gearbox & generator)
- Supply and installation of an upgraded LP cylinder casing
- Upgrade the control system



1. **Control System Upgrade**
2. **Turbine Train**
3. **Half Joint View**
4. **New LP Casing Cylinder at our factory**

## CASE STUDY

The Trillium Flow Technologies Centre Of Excellence is situated in modern premises in Oakley, Bedfordshire, and from this site support customers in varying industries including Biomass, Waste to Energy, Combined Heat & Power (CHP), Chemical, Sugar, Paper and Pulp and Naval Marine in compliance with international Quality and SHE standards. When required the steam turbine business is additionally supported by an extensive global network of Trillium Flow Technologies™ facilities.





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