ROTOR LIFETIME ASSESSMENT (LTA) AND LIFETIME EXTENSION (LTE)

Company Introduction

EthosEnergy's Italia SpA business is a manufacturer, installer and service provider for gas turbine power generation plants and components. The company has turnkey capabilities, its own design and engineering department, a production factory capable of producing complete gas turbines, an in-house repair workshop qualified for all types of Gas Turbine part repairs including complete rotor overhauls and in-house experienced commissioning and service resources.

Founded in Torino (Italy) in 1952 by Fiat group, the company started manufacturing gas turbines under Westinghouse license agreement and became a leading force in the construction of power plants achieving more than 350 plants in over 40 countries.

In 2000, the company became part of Siemens Group and was then re-branded as Gas Turbine Technologies and afterward to TurboCare.

In 2014, EthosEnergy Group was created as joint venture between TurboCare/Siemens and Wood Group to establish a leading independent service provider of rotating equipment, services and solutions to the power, oil & gas, and industrial markets.

At present EthosEnergy Italia SpA is structured around its core OEM and Other OEM business activities of construction of gas turbines and manufacturing of their components, repairs of parts, complete rotors overhauls, relocations, plant upgrades and improvements.

Rotor LTA/LTE Program Definition

For Gas Turbine (GT) Rotors, the LTA (Lifetime Assessment) / LTE (Lifetime Extension) is a program developed by the EthosEnergy Engineering Department with the purpose of assessing rotors' condition after service and extending their operating life. The life of heavy frame gas turbines components is limited. Experience indicates that age-related risks, including forced outages, increases exponentially when gas turbine components are operated beyond their design life. Rotor LTA/LTE is intended for Rotors approaching or exceeding their design life.

The LTA/LTE Program ensures Gas Turbine assets can safely operate beyond the recommended life cycle. EthosEnergy's LTA/LTE Program identifies GT Rotor life limiting factors and provides service solutions to eliminate or mitigate such risks. Life limiting components are replaced with new ones designed and manufactured by EthosEnergy.

Adopting LTA/LTE helps avoid the costly replacement of complete rotors with new ones and allows operators to economically and safely run aged assets well beyond their recommended Rotor life cycle.

The main phases of a LTA/LTE program are described below:

Phase 1: Rotor Components Design Analysis

- New rotor components complete geometrical design and validation.
- Material characterization (chemical composition, mechanical properties, and metallographic properties).
- Main Operational data and design operating conditions gained through direct experience on maintenance service within our LTSAs contracts.
- Predictive Model creations able to output Thermo-Mechanical stresses.
- Determination of critical components and critical areas.

Phase 2: Specific Unit Evaluation

- Gather Operation Data and Maintenance History.
- Tune the Predictive Model on the specific unit.
- Define specific NDE Inspection plan on critical areas.

Phase 3: Overhaul and Manufacture

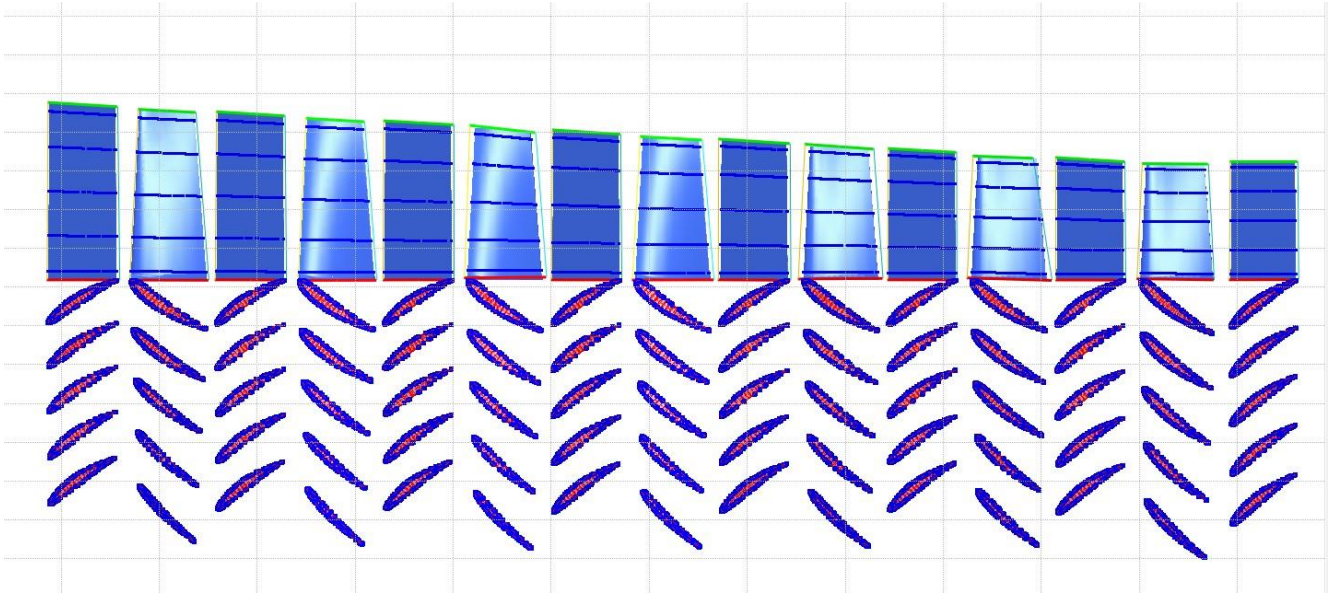
- Rotor standard overhaul plus dedicated NDE inspection and metallurgical evaluation on critical components (include: Magnetic Particles technique, Liquid Penetrant, Phased Array UT, Eddy Current, Replica Test, Hardness Test).
- Manufacture new critical replacement parts (include main rotor components like turbine or compressor discs, stub-shafts, distance piece, spacers etc.).
- Critical parts replacement and Rotor Reassembly.

AxSTREAM Software Application

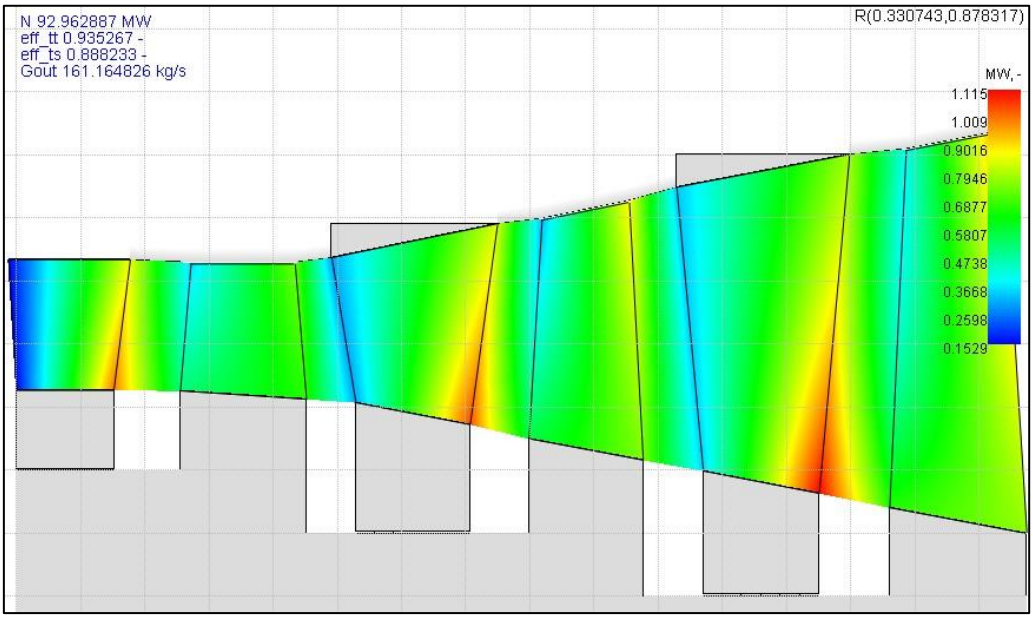
AxSTREAM was purchased by EthosEnergy Italia SpA in 2017 from SoftInWay with the specific purpose of supporting the design phase of the Rotors LTE/LTA program. In particular, it is a meanline/streamline software conceived to create the thermal and aerodynamic boundary condition for the thermomechanical analysis performed through another FEM software.

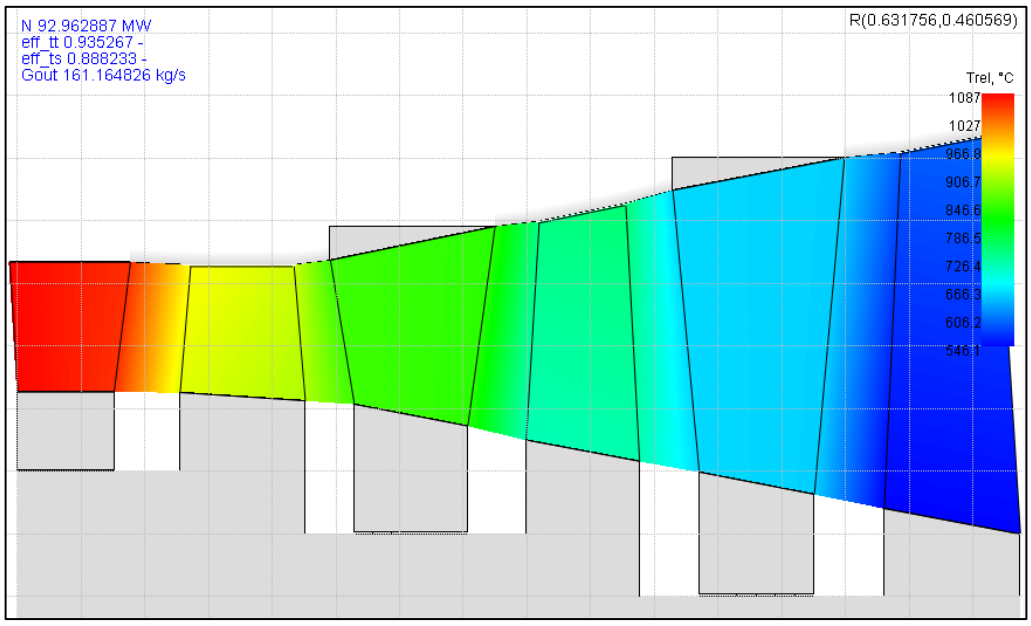
AxSTREAM, with the addition of AxSLICE module, is able to capture the geometry directly from any 3D CAD, recognize the flow path, slice the airfoils automatically on many sections (depending on the specific need) and generate the distribution of all the static and total physical properties upstream and downstream each stator and rotor stage.

This represents a real advantage with respect to the previous streamline software generation, which was not able to dialogue directly with the 3D CADs and all airfoils geometries had to be input numerically, requiring a huge effort in terms of man-hours.



After a delicate but quick tuning phase, which is aimed to match software output with specific design and site data, AxSTREAM is able to perform a 2D simulation of compressor and turbine modules in any operation conditions generating trends of Mach Number (absolute and relative), velocity triangles, temperature (total and static), pressure (total and static), aerodynamic loads (axial and tangential), enthalpy (total and static), stage work, mechanical power output, isentropic and pneumatic efficiency and many other physical parameters.





Furthermore, AxSLICE allows us to modify each single airfoil slice geometry directly without going back to the 3D CAD optimizing stator and rotor blades profile on the row-by-row results.

Going back to the rotor LTA/LTA process, knowing in advance the design criteria to apply in terms of environmental conditions (hot and cold day ambient temperatures, ambient pressure, inlet and outlet pressure loss, turbine Inlet temperature, compressor pressure ratio), it is possible to obtain for each set of design data the row-by-row distribution of the main physical properties that is then used by the engineering team to evaluate:

- the temperature distribution on rotating blades and discs after a post heat transfer analysis.
- the aerodynamic and pressure load on the rotating blades and their effect on the discs through the serrations.

AxSTREAM compressor and turbine modules, with the addition of AxSLICE, are really powerful 2D tools, and very user-friendly both in terms of model creation and output presenting.

A word of thanks goes also to the SoftInWay technical team who is very well prepared and provides invaluable support to the users.