

# HISTORY OF INNOVATION & TECHNICAL SOLUTIONS



## The Beginning

Since 1983, Turbine Technology Services (TTS) has been providing the turbomachinery industry with high quality, cost-effective alternatives to the OEM. With 35+ years in the gas turbine industry, TTS is an experienced innovator in control solutions, equipment modernization and upgrade services.

1983

## Relocation Expertise

During the 1980s and 1990s TTS relocated and modernized over 40 gas turbines across the globe. Many of these projects required cycle conversions along with modernization of gas path and ancillary systems technology. We gave new life to neglected simple cycle gas turbines by relocating and reapplying them in combined cycle and cogen roles.

1987

## Powerlog Digital Data

First company to apply Powerlog digital data acquisition hardware and software to existing electro-pneumatic-hydraulic turbine controls.

1987

## Remote Access and Support

First company to apply remote access systems to support and troubleshoot gas turbine operational failures. Ref. ASME Extending Expertise through State-of-the-Art Monitoring.

1988

## High Speed Electronic Servo Valves

Pioneered application of high speed electronic servo valves to large gas turbine applications.

1989

## Advanced Mechanical Maintenance Methods

In its early history TTS pioneered new maintenance techniques to shave up to 50% off otherwise lengthy procedures.

1994

## Online Reference Library

In the 1990s, TTS pioneered the first comprehensive online relational reference library, known as MasterMind™. It linked the sources of all critical alarms and trips on the control screen to all documented detail and live control data related to that root cause.

1994

## Wearable Process Power Plant Control

First company to create a wearable, wireless Human Machine Interface for wireless Process Power Plant control.

1995

## Dry NOx Control Fuel System

In 1998 TTS, together with a leading combustion hardware designer, created the first non-OEM dry low NOx type combustion system.

1998

## Remote Worldwide Access

First to provide inexpensive integration of control platforms from diverse OEMs to provide for remote worldwide access.

1998

## Bundled Performance Services

DynaFlex™ was introduced to the market as the first comprehensive combustion emissions, dynamics and controls tuning service. Our platform provides operators a wide range of products and services that maximizes gas turbine output and efficiency, optimizes DLN combustor dynamics and emissions, and enhances operational *flexibility*.

2002

## Future Proofing for Sustainability

TTS begins applying its unique experience in gas turbine technology to retrofit hundreds of existing gas turbines to burn HFO, RFO and blends of low BTU gas fuel from coal, petroleum coke and other syngases.

2005

## Frame 7 Modifications

TTS successfully undertakes the modification of Frame 7 units for 50HZ applications.

2008

2011

◆ **Triple Redundancy Introduction**

In response to the demand of gas turbine users to maintain the triple modular redundancy (TMR) functionality provided with their OEM gas turbine control system, TTS developed the first aftermarket Industrial Gas Turbine control system with full TMR functionality utilizing open architecture and non-proprietary, commercially available hardware.

2012

◆ **Combustion Auto Tuning System**

TTS, a pioneer in aftermarket combustion system technology, develops an "auto tuning system" for use on advanced class gas turbines equipped with Dry Low NOx combustion system. The system automatically keeps the gas turbine operating within allowable emissions levels and in compliance with air quality permitting while protecting the combustion system from damage due to excessive wear and tear and combustion system operational excursions.

2014

◆ **Introduction of Replacement HMI for Mark V**

TMOS was designed to provide ease of operation, flexibility and reliability with modern off the shelf hardware. TMOS is a feature-packed, user friendly, robust and multi-connective system that includes NERC cyber security compliance. Today, we have almost 100 installations and over 36 million operating hours.

2014

◆ **RTS is Founded to Address the Midstream O&G Market**

Reciprocating Technology Services (RTS) was formed to open new markets and opportunities in the midstream power generation and gas compression markets. As with TTS, RTS is a company whose distinguishing characteristic in the competitive landscape is the ability to provide innovative solutions.

2016

◆ **Bring to Market Gas Turbine Parts Management Software**

Lodestar is the only parts life cycle management software in the market that can gather unprecedented amounts of data about parts and components and weave systems, data and people together to create solutions that increase performance across many levels. Further development of Lodestar will provide the same robust parts data management for every piece of rotating equipment in your fleet... due in 2019.

2017

◆ **Market Conditions Mandates Fleet Flexibility and Rapid Starts**

Renewables are growing fast but weather can have a negative effect on grid stability. TTS introduces it's Fast Start Program™ to help operators change their output rapidly - start and stop with short notice in as little as 10 minutes.

2018

◆ **RTS partner with Voith Turbo to Develop a New Environmental Friendly Hydraulic Starter System**

EcoStart™ combines reliability, safety and advanced features to meet increasingly stringent environmental regulatory mandates and improve on gas, compressed air and electric starting systems for gas compression engines ranging from 300 to 11,000 HP. EcoStart offers a short starting frequency for greater capacity, and slow roll and soft start capabilities for reduced maintenance and improved safety.

2018

◆ **Cyber Security for Energy Industry**

TTS is teaming with leading universities to harden today's process controls against cyber attack. This innovative application allows uninterrupted process operation despite external intrusion.

To be continued...