

# Gas turbine gas path diagnostics

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## Audience

Engineers, researchers and engineering student working or wish to work in the area of gas turbine engine operation, maintenance and overhaul

## Training Description

The performance of gas turbine engines may degrade during operations and failure may happen unexpectedly. This may result in reduced availability and increased maintenance costs. The tutorial intends to provide fundamental knowledge about gas turbine gas path diagnostics that are important technology in gas turbine operations, maintenance, and overhaul. The technology has the potential to provide crucial information of engine health based on gas turbine gas path measurements, support the move from time-scheduled maintenance to condition-based maintenance, and improve gas turbine availability and reduce maintenance costs.

To move from time-scheduled maintenance to condition-based maintenance, condition monitoring has become increasingly important and will play a crucial role. Gas path diagnostics is a technology to predict the degradation or faults of major gas path components of gas turbine engines, such as compressors, combustors and turbines using gas path measurements, such as pressures, temperatures, shaft rotational speeds, fuel flow rate, etc. This tutorial aims to provide the fundamental knowledge of major aspects of gas path diagnostics, such as measurement data pre-processing, measurement selection, fault detection, fault isolation, and fault quantification with a Gas Path Analysis (GPA) approach. A case study to demonstrate the application of the methods is also provided.

## Training Learning Objectives

The participants completing the training will be able to:

- Understand gas turbine degradation phenomenon and the mathematical representation of the degradations.
- Understand the fundamental knowledge of gas turbine gas path diagnostic methods, such as Gas Path Analysis (GPA), data corrections, measurement selection, sensor fault diagnostics, etc.
- Understand the application of the gas path condition monitoring technology in gas turbines through a simulated demonstration using software Pythia developed at Cranfield University.

## Content and Outline

- Degradation and degradation representation – to explain the phenomena of gas turbine performance

degradations and the mathematical representation of the degradation of major gas path components, including compressors, combustors, and turbines.

- Gas Path Analysis (GPA) method – it provides the details of a Gas Path Analysis (GPA) methods, including linear and non-linear GPA, GPA Index, fault isolation, etc.
- Measurement selection – three criteria are introduced to support the measurement selection for GPA analysis, including sensitivity, correlation and sensor sub-sets.
- Data pre-processing – it covers the reduction of measurement noise and correction of measurement data to specified normal condition for diagnostic purpose.
- Demonstration of GPA to predict gas turbine degradations.
- Case demonstration with Pythia software

### Sources and useful links:

1. Blinstrub J., Li Y.G., Newby M., Zhou Q., Stigant G., Pilidis, P. and Honen H., “**Application of Gas Path Analysis to Compressor Diagnosis of an Industrial Gas Turbine Using Field Data**”, GT2014-25330, ASME TURBO EXPO 2014, Dusseldorf, Germany, June 2014.
2. Li Y.G. and Singh R., “**An Advanced Gas Turbine Gas Path Diagnostic System - PYTHIA**”, ISABE-2005-1284, the Seventeenth International Symposium on Airbreathing Engines (17<sup>th</sup> ISABE), Munich, Germany, September 2005.