

Diagnosics Tutorial Guide

Use Pythia Software for Diagnosis

General Description of the Practice

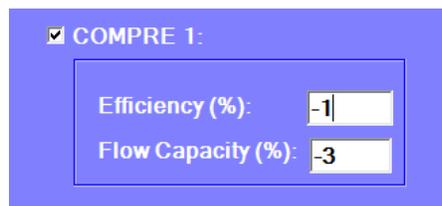
The purpose of the practice is to enhance the understanding of the Gas Path Analysis by using **Pythia** computer software. The basic procedure of the practice is:

- Implant an engine component degradation
- Select measurable parameters
- Simulate clean and degraded engine performance/measurements
- Search potential degraded components with linear and non-linear GPA.
- Fill in the “Work Sheet” with obtained results.
- Analyze the results, find out the degraded component and the level of degradation, and finally explain how the degraded component is found.

Procedure of the Practice

Copy the whole PYTHIA software folder and put it on C drive.

1. Load PYTHIA by double-clicking **PYTHIA** icon in C:/Pythia vs 5.1/.
2. Click on **START** button to activate a login window. Provide password and press **OK** button to access PYTHIA
3. Click on **Diagnosics** button
4. Click on **File** menu and click on **Open Existing Engine Model**
5. Find ‘**Tutorial Model**’ in folder C:/Pythia vs 5.1/My Projects/, double click on the file “tutorial model” to open the engine model.
Click on **Make Engine** button to update the model route.
6. Implant a component degradation in the following steps:
 - Go to menu **Build Simulation** and choose **Degradation**
 - Tick the checkbox for “COMPRE 1”
 - Implant “-1” to **Efficiency** (means -1% drop in efficiency Index)
 - Implant “-3” to **Flow Capacity**: (means -3% drop in flow capacity Index)
 - Go to **File** menu and click on **Save** and then **Return**

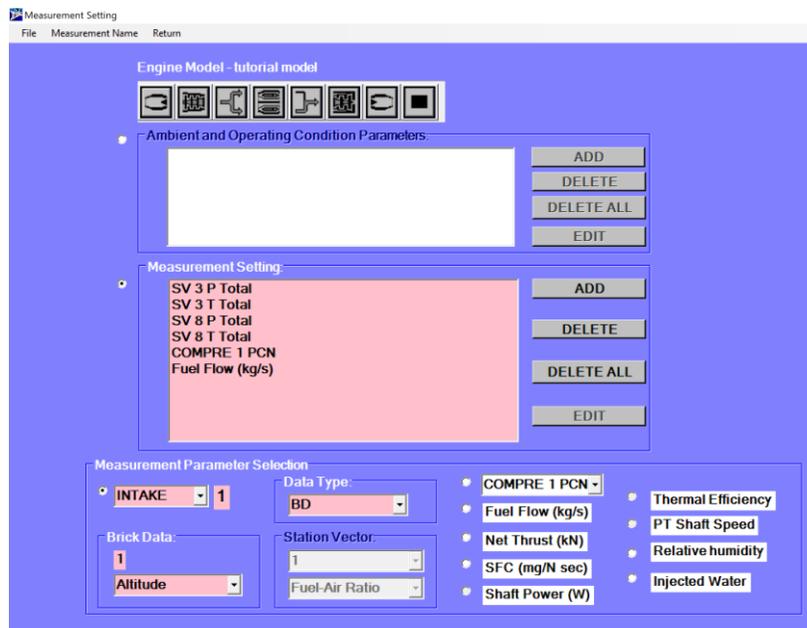


☑ COMPRE 1:

Efficiency (%):	-1
Flow Capacity (%):	-3

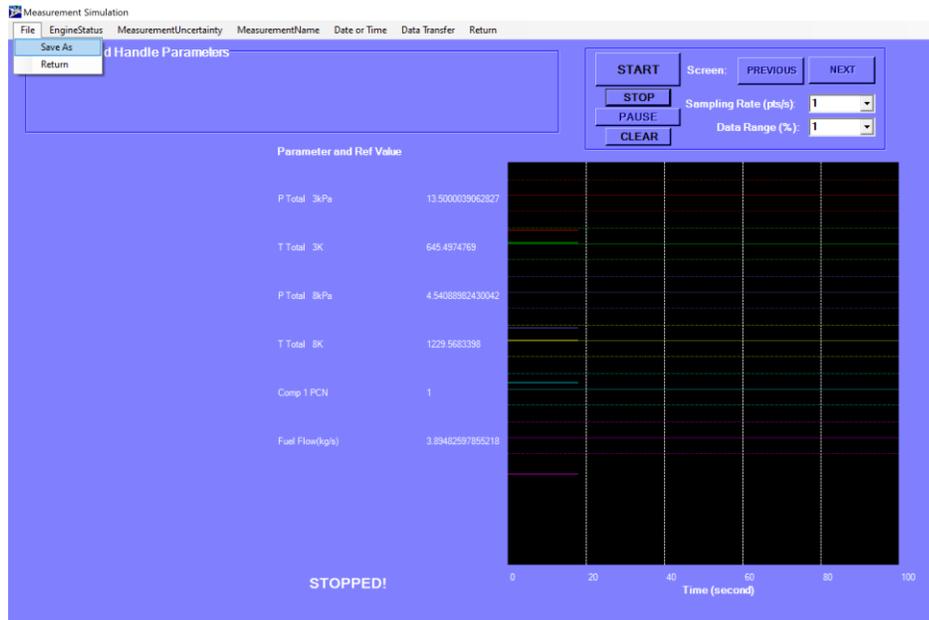
7. Select measurement parameters:

- ❑ Go to menu **Build Simulation** and click on **Measurement** to open measurement setting window
- ❑ Click on the Radio button at the left-hand side of **Measurement Setting** window
- ❑ Choose the measurable parameters:
 - Click on **COMPRE** brick on the engine model bar
 - Select “SV” under *Data Type*
 - Choose station “3” under *Station Vector*
 - Choose “P Total” under *Station Vector*
 - Click on **ADD** button to add P3 to the *Measurement Setting* window
 - In the same way to select *T3, P8 and T8* respectively and click on **ADD** button to add them to the *Measurement Setting* window
 - Click on the Radio button for *COMPRE 1 PCN*, and then click on **ADD** button
 - Click on the Radio button for *Fuel Flow*, and then click on **ADD** button
- ❑ Click **Save** menu to save the setting
- ❑ Click **Return** menu to leave the window

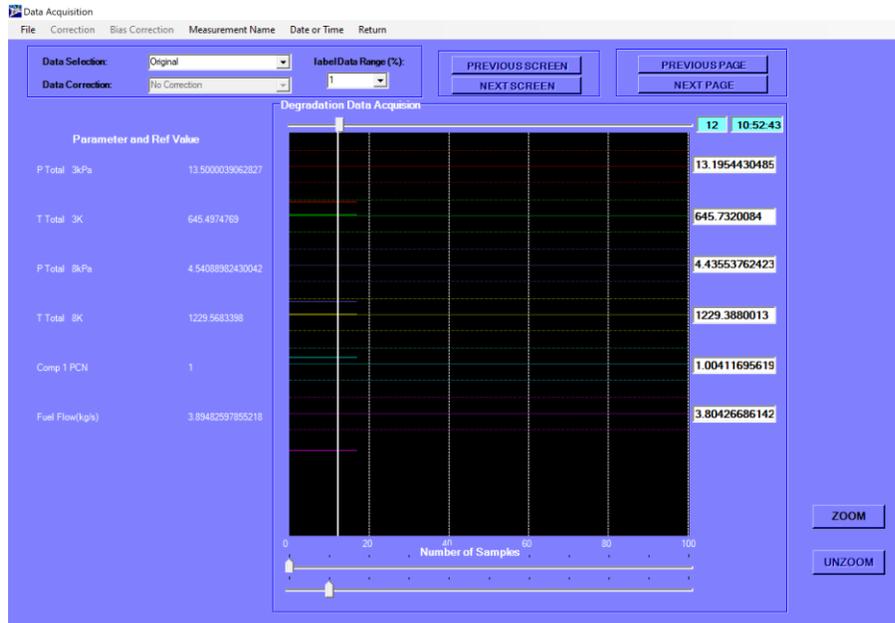


8. Simulate measurement samples of degraded model engine:

- ❑ Click on **Simulate** menu and then choose **Measurement Samples** menu
- ❑ Choose **Degraded** under **Engine Status** menu
- ❑ Choose **Without Noise and Bias** under **Measurement Uncertainty** button
- ❑ Click on **START** button to start the simulation
- ❑ Press **STOP** button to terminate the simulation after several samples are simulated
- ❑ Go to **File** menu and choose **Save As**. Give a user defined file name (such as ‘*degraded*’) and click on **Save** button to save the simulated measurement samples to a data file called “*degraded.dat*” for degraded engine model
- ❑ Click on **Return** menu to leave the window

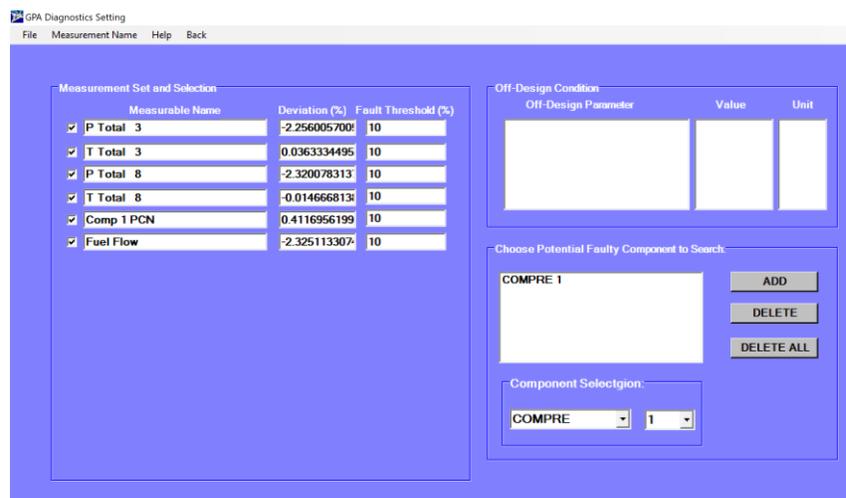


9. Imagine that test data for the degraded engine are available in a data file called “degraded.dat”. You are supposed to upload test data into *Pythia* software to conduct diagnostic analysis as follows.
10. Data acquisition to upload the test data
 - ❑ Go to ***Build Analysis*** menu, choose ***Data Acquisition Preprocessing*** and then click on ***From File***
 - ❑ Go to ***File*** menu and choose ***Open Degraded Data***. Select the data file (*degraded.dat*) and open it. The measurement samples are shown on the screen. As all samples have the same values, they are shown on straight lines.
 - ❑ You may move the Slider under ***Degradation Data Acquisition*** window to choose a particular sample. If you do not move the Slider, the first sample is chosen.
 - ❑ Go to ***File*** menu, choose ***Save*** and then choose ***Selected Sample***
 - ❑ Click ***Return*** to leave the window



11. GPA setting – assuming the *compressor* is the potentially degraded component:

- ❑ Go to **Build Analysis** and choose **Fault Quantification** and then click on **Gas Path Analysis**. The GPA setting window will appear.
- ❑ On this window you have the second chance to re-select measurement parameters for diagnosis if necessary. In this case, the checkboxes on the left-hand side of the measurement parameters should be ticked, which means that all measurements are selected.
- ❑ Select **COMPRE** as the potential faulty component under **Component Selection** and click on **Add** button to add **COMPRE 1** to the **Choose Potential Faulty Component to Search** window.
- ❑ Go to **File** menu and choose **Save**
- ❑ Click on **Back** menu



12. Search compressor degradation with linear and non-linear GPA in the following steps:

- ❑ Go to *Analysis* menu and choose *Fault Quantification* and then choose *Gas Path Analysis*
 - ❑ To start a linear GPA prediction, go to *Run* menu and click on *Linear GPA*. The predicted degradation will be shown on the screen.
 - ❑ Record the predicted results on the *Work Sheet* on the next page.
 - ❑ Go to *View* menu and choose *Linear GPA Result File* to view the details of the prediction
 - ❑ Click on *Show Fault Signature Bar Char* button to view fault signature bar chart
 - ❑ Click on *Show GPA Result Bar Char* button to see result bar chart
 - ❑ Click on *Implanted Fault* menu and choose *Know*
 - ❑ Click on *View* menu and choose *Implant Fault* to view implant degradation

 - ❑ To start a non-linear GPA prediction, go to *Run* menu and choose *Non-Linear GPA*. The predicted degradation will be shown on the screen.
 - ❑ Record the predicted results on the *Work Sheet*.
 - ❑ Go to *View* menu and choose *Non-Linear GPA Result File* to view the details of the prediction.
 - ❑ Press *Show GPA Result Bar Chart* to see result on a bar chart
 - ❑ Press *Back* menu to leave the window.
13. Search burner degradation by assuming that the BURNER as the potentially degraded component in the following steps:
- ❑ Go to *Build Analysis* and choose *Fault Quantification* and then *Gas Path Analysis*
 - ❑ Press *DELETE ALL* button
 - ❑ Select the BURNER as the potential faulty component and press *Add* button to add it to the searching list
 - ❑ Go to *File* menu and choose *Save* and then *Back*
 - ❑ Go to *Analysis* and choose *Fault Quantification* and then *Gas Path Analysis*
 - ❑ Go to *Run* menu and choose *Linear GPA* to get liner GPA results
 - ❑ Record the predicted degradation on the *Work Sheet*
 - ❑ Go to *Run* menu and choose *Non-Linear GPA* to get non-linear GPA results
 - ❑ Record the predicted degradation on the *Work Sheet*.
 - ❑ Click *Back* to leave the window.
14. Search turbine degradation by assuming that the TURBIN as the potentially degraded component as follows:
- ❑ Go to *Build Analysis* and choose *Fault Quantification* and then *Gas Path Analysis*
 - ❑ Press *DELETE ALL* button
 - ❑ Select the TURBIN as potential faulty component and press *Add* button to add it to the searching list
 - ❑ Go to *File* menu and choose *Save* and then *Back*
 - ❑ Go to *Analysis* menu and choose *Fault Quantification* and then *Gas Path Analysis*
 - ❑ Go to *Run* menu and choose *Linear GPA* to start liner GPA prediction
 - ❑ Record the predicted results on the *Work Sheet*
 - ❑ Go to *Run* menu and choose *Non-Linear GPA* to start ono-linear GPA prediction

- ❑ Record the predicted degradation on the *Work Sheet*.
- ❑ Click on *Back* to leave the window

15. **Analyze the results** on the *Work Sheet* and try to answer the following questions:

- ❑ Assume that the actual degradation may be the compressor, the burner or the turbine. Which component is more likely to have degraded and why? Show the evidence to support your answer.
- ❑ Compare the results from the linear and the non-linear GPA and assess which result is better and why?

Work Sheet

Instrumentation Set						
1		Compressor Shaft Speed (PCN 1)				
2		Compressor exit total pressure (P3)				
3		Compressor exit total temperature (T3)				
4		Exhaust total temperature (T8)				
5		Exhaust total pressure (P8)				
6		Fuel flow rate				
Implemented Degradation						
Component:		Compressor				
Efficiency Index drop η_c (%):		-1				
Flow capacity Index drop Γ_c (%):		-3				
GPA Diagnostic Results						
Fault Case	Component		Linear GPA		Non-Linear GPA	
			Degradation (%)	GPA Index	Degradation (%)	GPA Index
1	Compressor	η_c				
		Γ_c				
2	Burner	η_b				
3	Turbine	η_t				
		Γ_t				