

A POSSIBILITY FOR ON-BOARD TRAINING FOR MARINE GAS TURBINE PERFORMANCE MONITORING AND DIAGNOSTICS

K. Mathioudakis¹, N. Aretakis¹, E. A. Yfantis²

***¹Laboratory of Thermal Turbomachines
National Technical University of Athens***

***²Department of Naval Sciences
Hellenic Naval Academy***

A POSSIBILITY FOR ON-BOARD TRAINING FOR MARINE GAS TURBINE PERFORMANCE MONITORING AND DIAGNOSTICS

- **Computer models and gas turbine performance training.**
- **The principles of gas turbine engine condition assessment and fault diagnosis.**
- **The visual interface of a model.**
- **A computer model for performance simulation and diagnostics.**
 - **Basics of gas turbine engine operation**
 - **Understanding the effects of malfunctions**
- **Further training aspects-conclusions**

Computer models and gas turbine performance training

- ☞ **Provide a means for effectively training**
 - *Demonstrate behavior of complicated systems*
 - *Effective use of training time*

- ☞ **Cover an extended range of operating conditions**

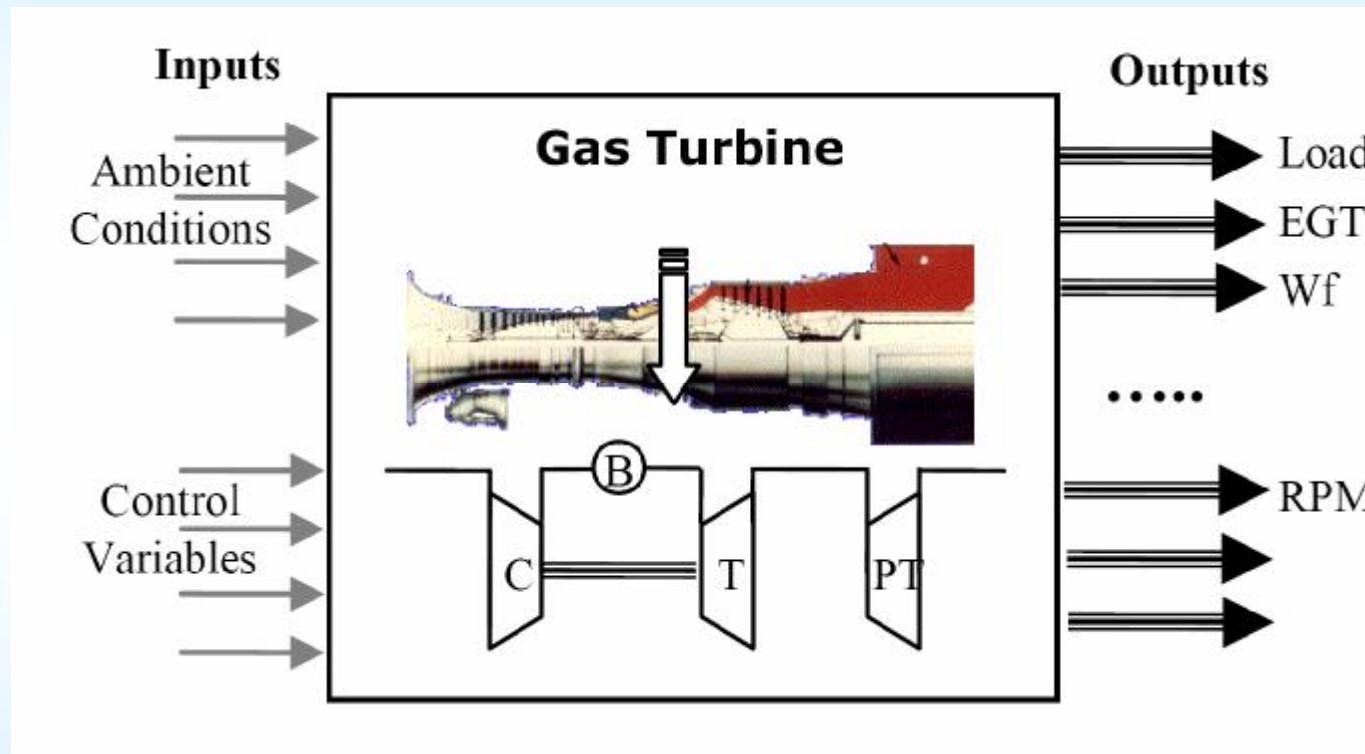
- ☞ **Provide values of physical quantities hard or impossible to observe physically**

- ☞ **Abnormal operation can be studied at no cost**

A POSSIBILITY FOR ON-BOARD TRAINING FOR MARINE GAS TURBINE PERFORMANCE MONITORING AND DIAGNOSTICS

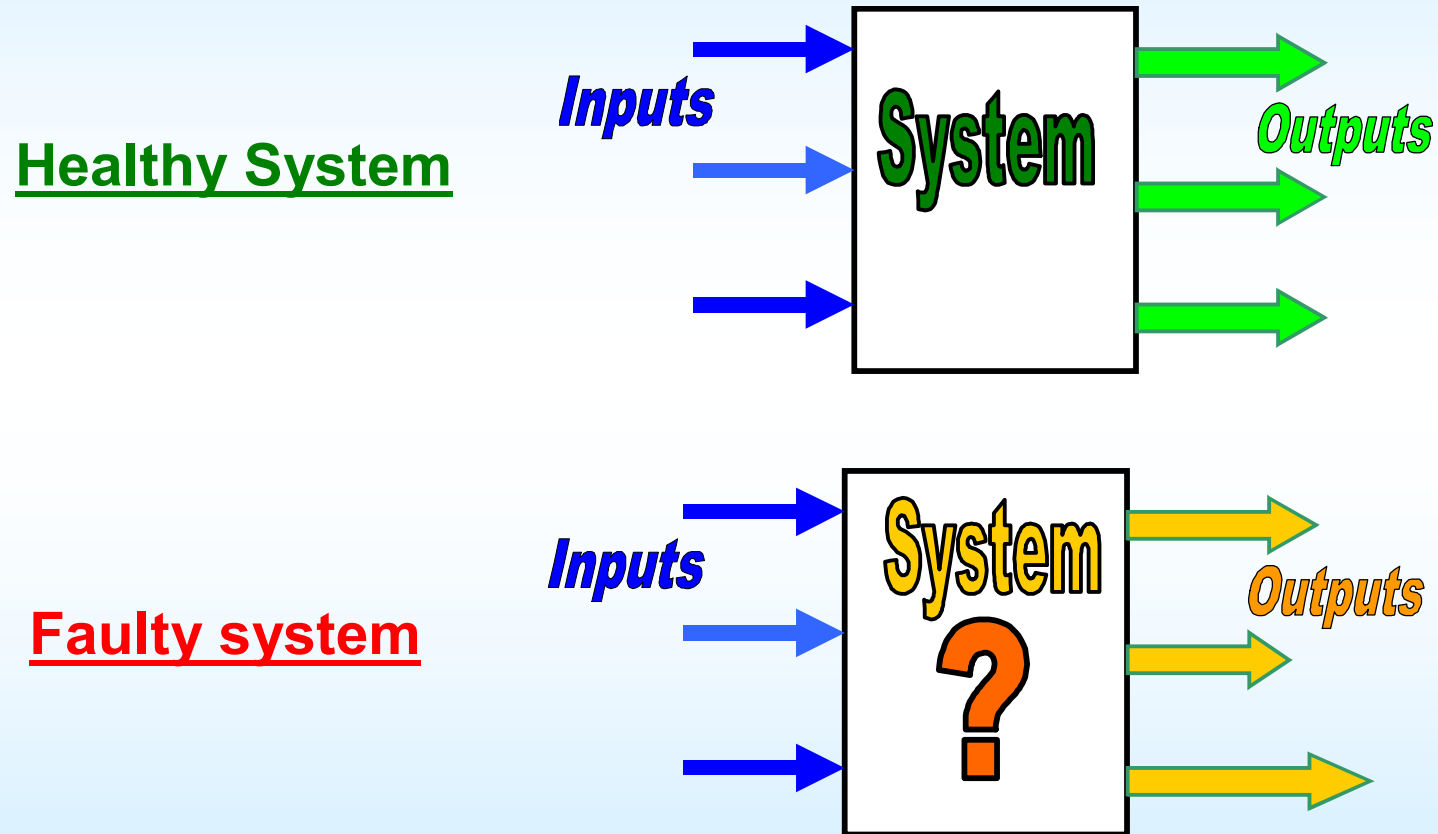
- Computer models and gas turbine performance training.
- The principles of gas turbine engine condition assessment and fault diagnosis.
- The visual interface of a model.
- A computer model for performance simulation and diagnostics.
 - Basics of gas turbine engine operation
 - Understanding the effects of malfunctions
- Further training aspects-conclusions

The principles of gas turbine engine condition assessment and fault diagnosis (1)



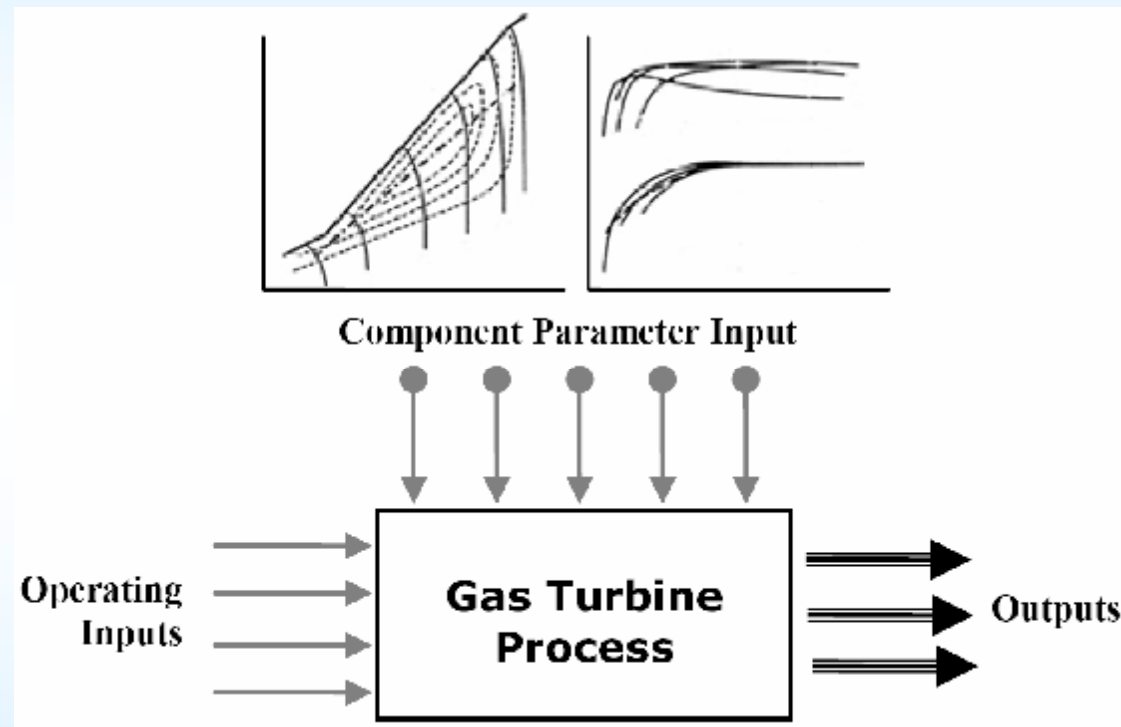
Schematic representation of the gas turbine process

The principles of gas turbine engine condition assessment and fault diagnosis (2)



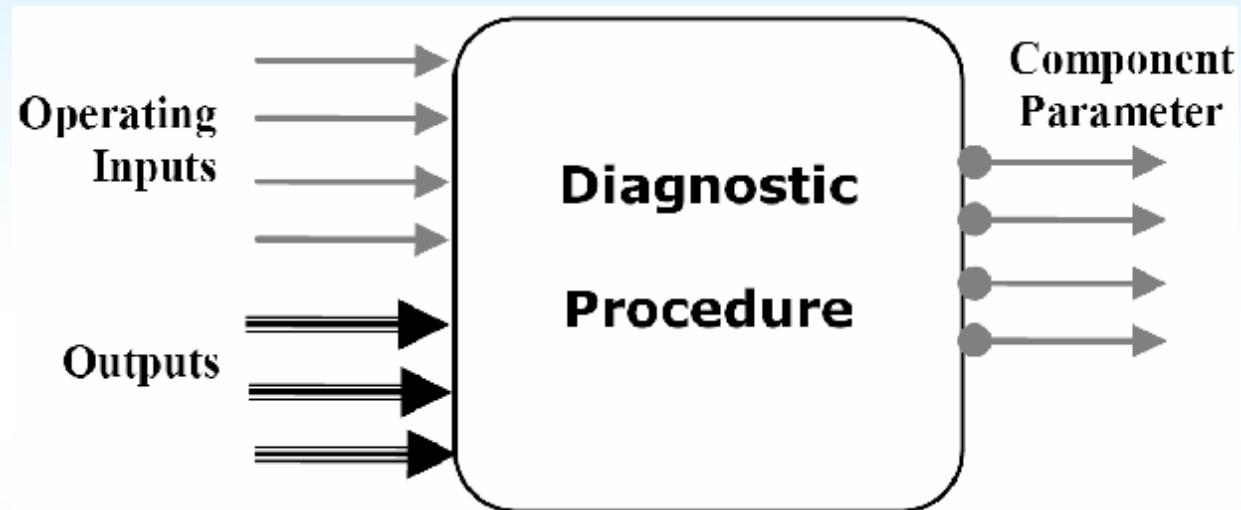
The principles of DIAGNOSTICS

The principles of gas turbine engine condition assessment and fault diagnosis (3)



The gas turbine as an input-output system, for monitoring-diagnostic purposes

The principles of gas turbine engine condition assessment and fault diagnosis (4)



The process of gas turbine engine condition diagnosis

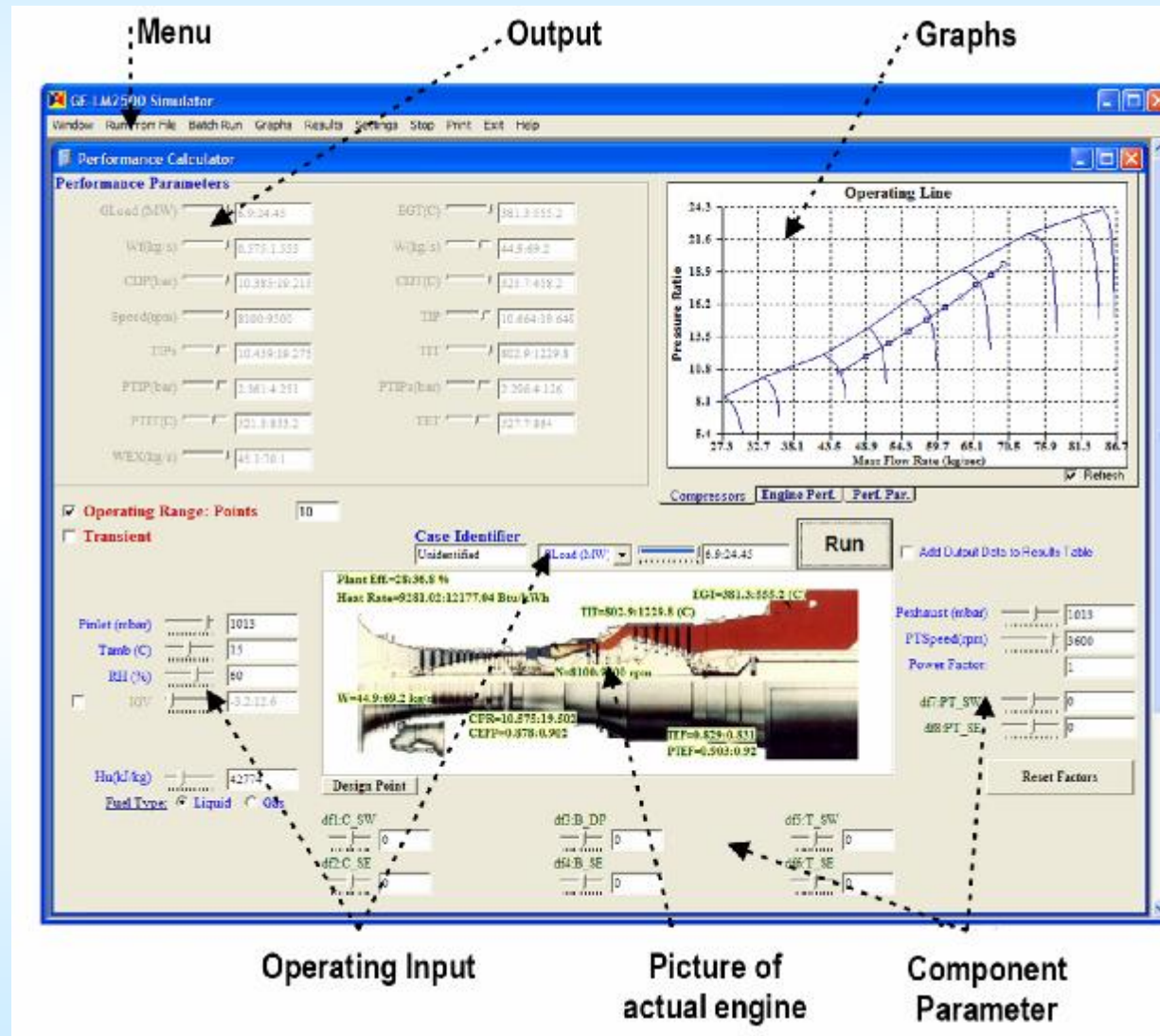
Principles:

- Define “healthy” and “faulty conditions”
- Specify observed variables and observable parameters
- Establish interrelation of condition and variables of parameters

A POSSIBILITY FOR ON-BOARD TRAINING FOR MARINE GAS TURBINE PERFORMANCE MONITORING AND DIAGNOSTICS

- Computer models and gas turbine performance training.
- The principles of gas turbine engine condition assessment and fault diagnosis.
- **The visual interface of a model.**
- A computer model for performance simulation and diagnostics.
 - Basics of gas turbine engine operation
 - Understanding the effects of malfunctions
- Further training aspects-conclusions

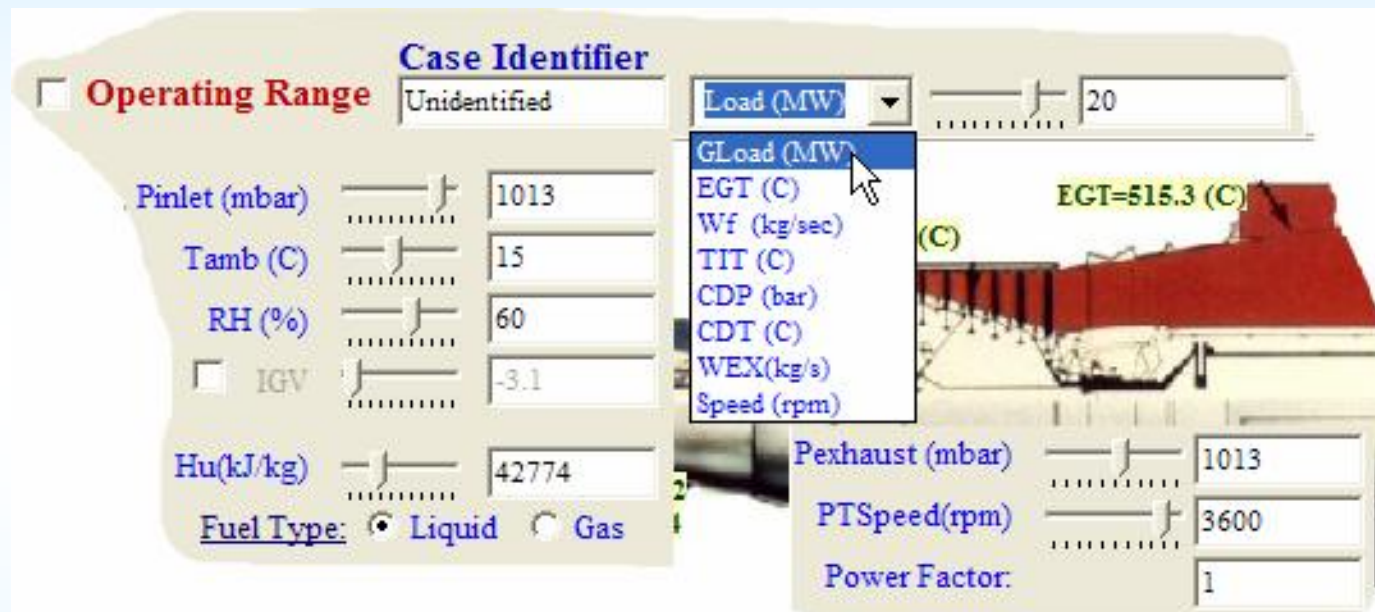
The visual interface of a model



A POSSIBILITY FOR ON-BOARD TRAINING FOR MARINE GAS TURBINE PERFORMANCE MONITORING AND DIAGNOSTICS

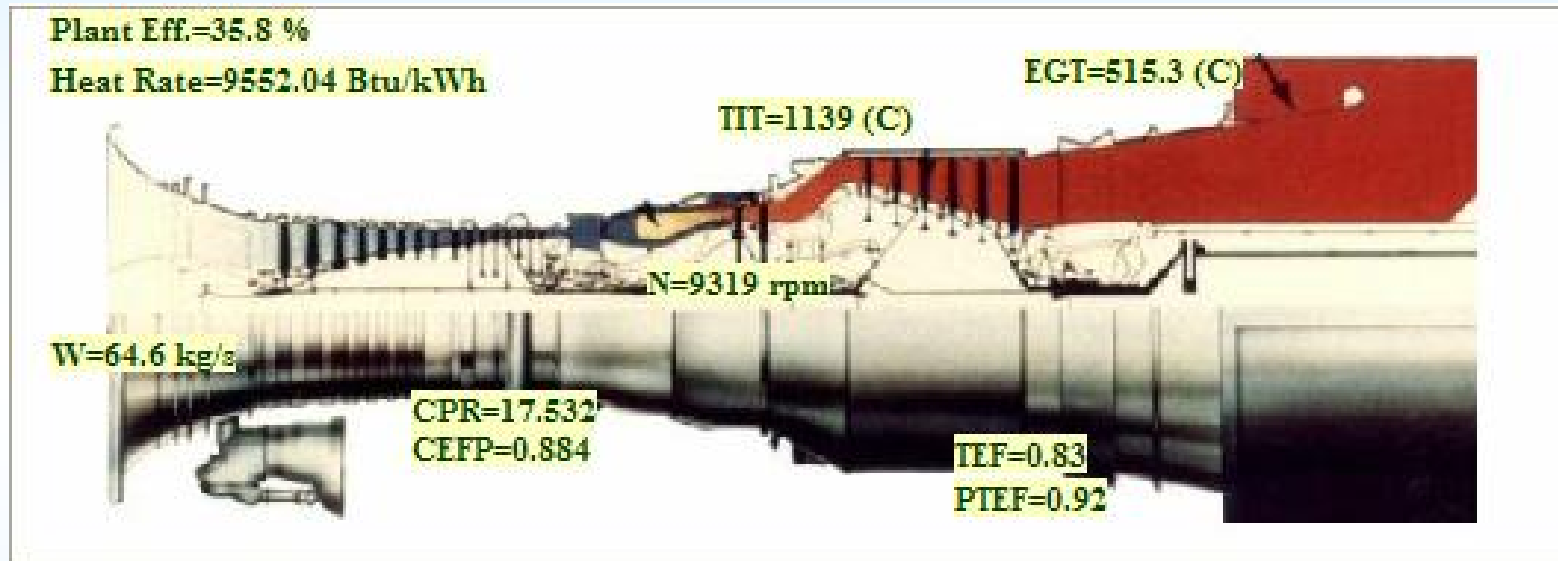
- Computer models and gas turbine performance training.
- The principles of gas turbine engine condition assessment and fault diagnosis.
- The visual interface of a model.
- A computer model for performance simulation and diagnostics.
 - Basics of gas turbine engine operation
 - Understanding the effects of malfunctions
- Further training aspects-conclusions

Basics of gas turbine engine operation (1)



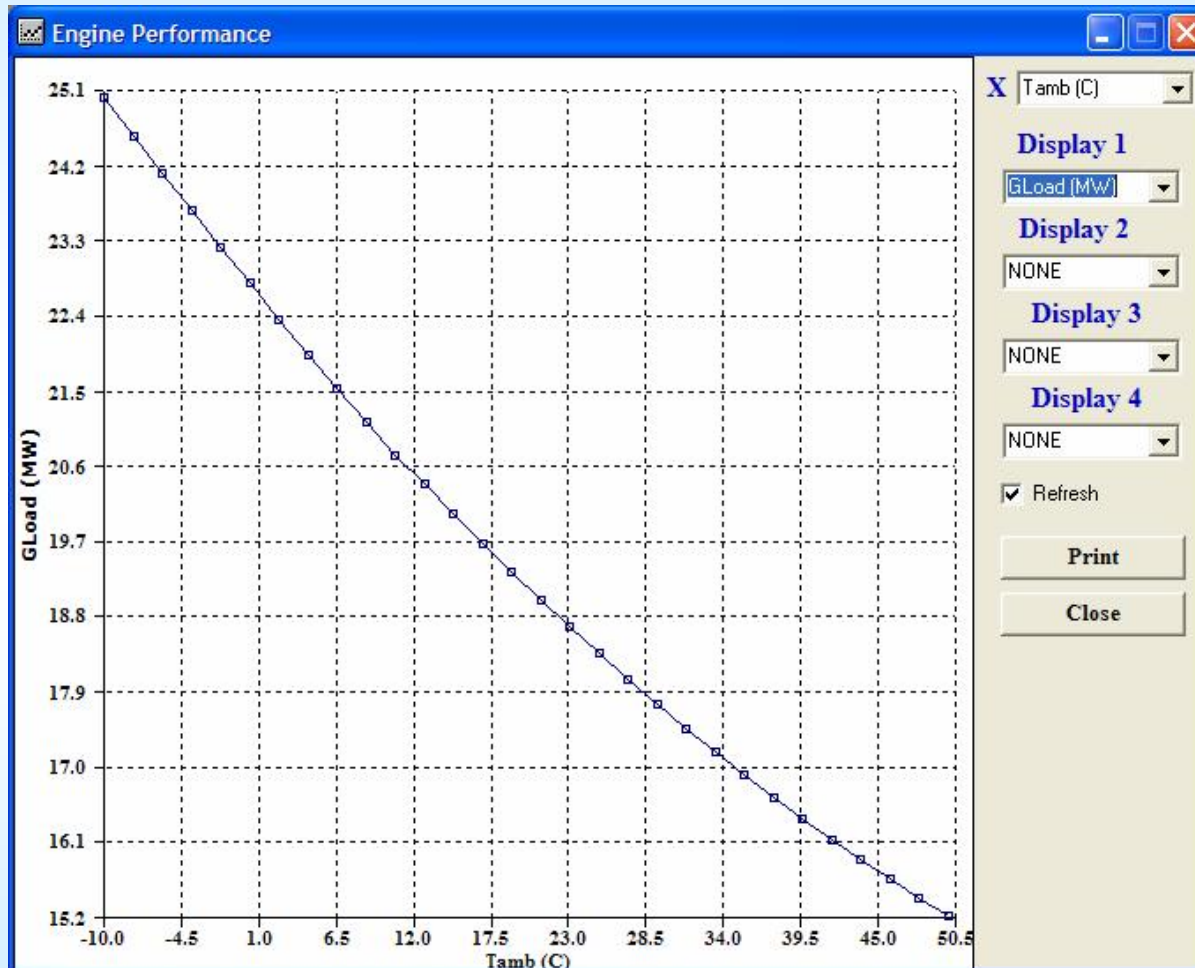
Input for operational parameters

Basics of gas turbine engine operation (2)



Display of performance variables and parameters on
an engine cut-out

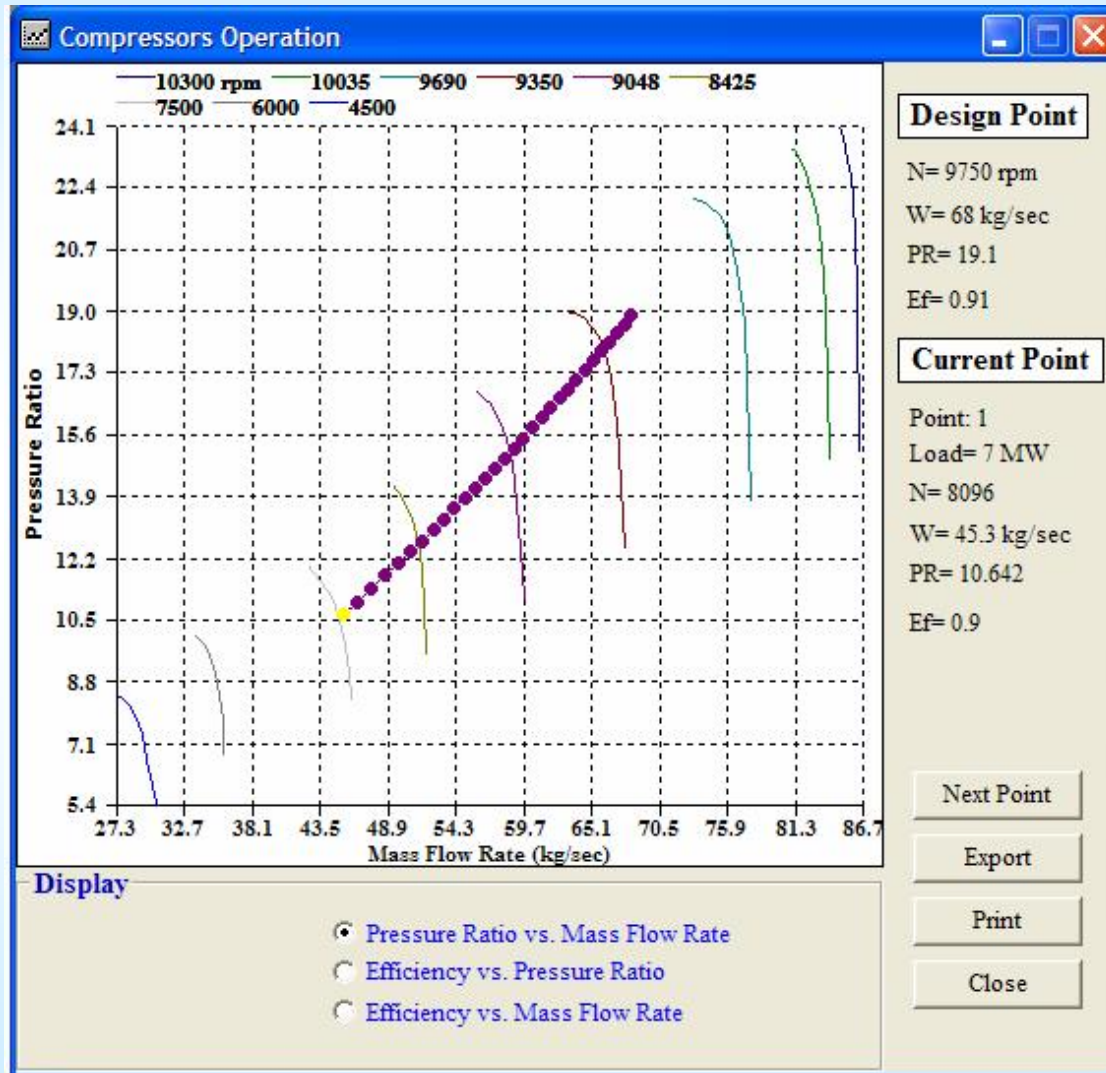
Basics of gas turbine engine operation (3)



Interrelation of
performance
parameters

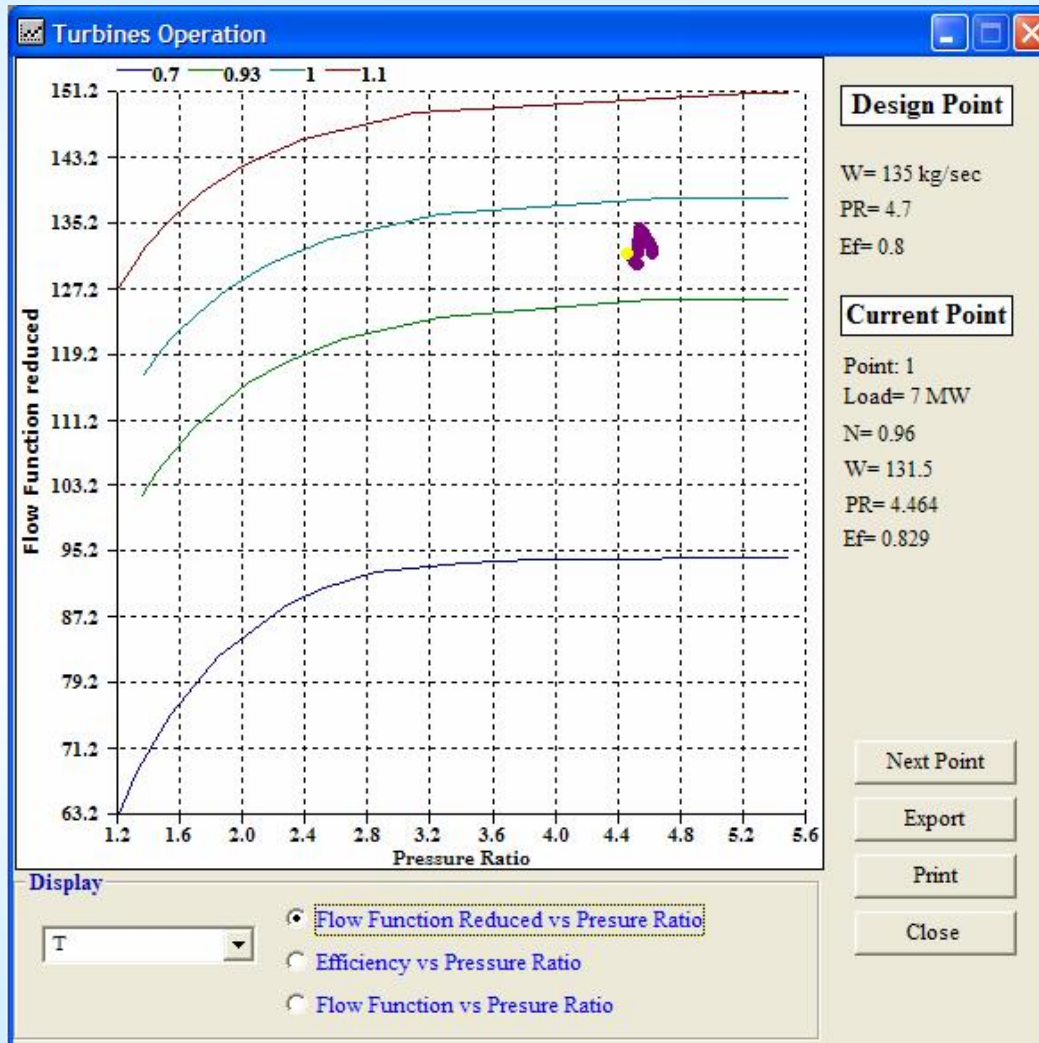
Output power versus
ambient temperature for
constant turbine inlet
temperature (TIT)

Basics of gas turbine engine operation (4)



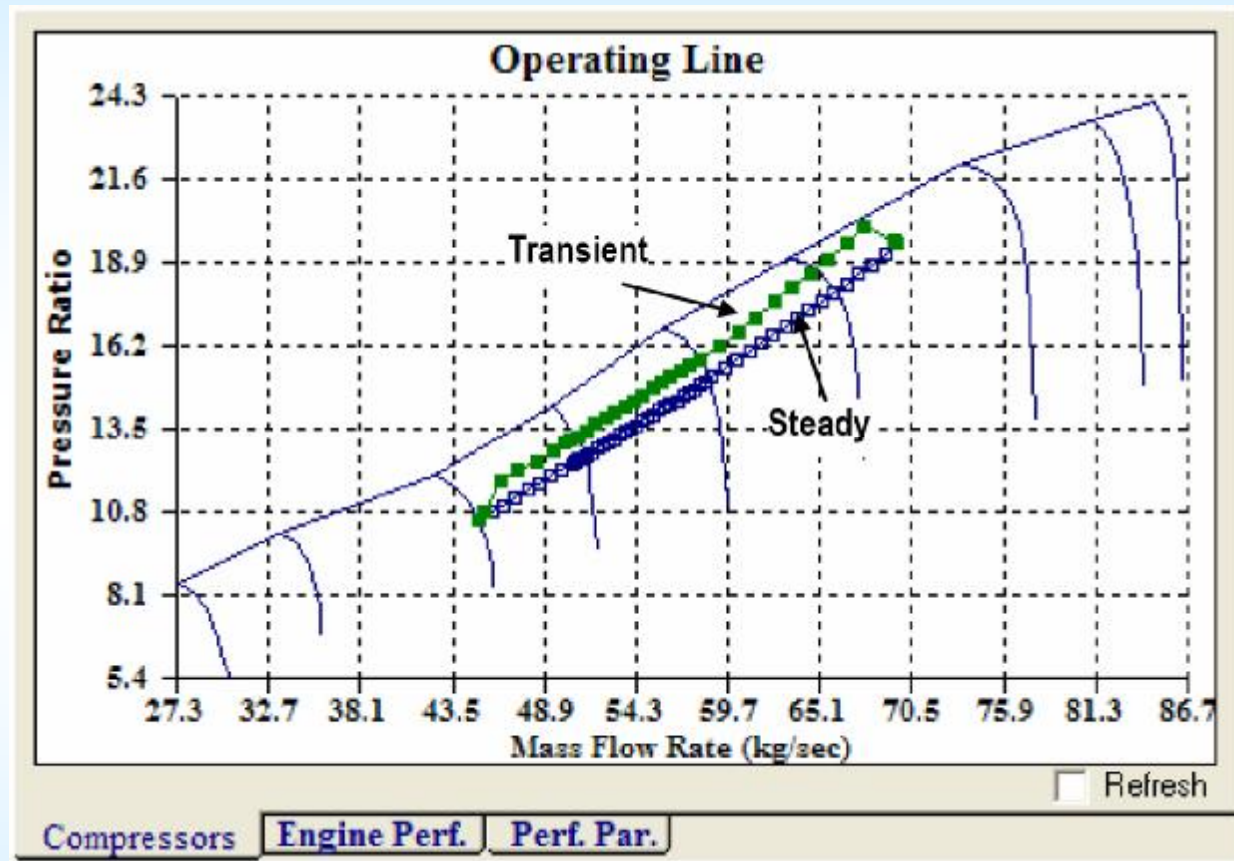
Operating points on compressor maps for twin spool marine gas turbine: a range of power outputs.

Basics of gas turbine engine operation (5)



Operating points on turbine maps for twin spool marine gas turbine: a range of power outputs.

Basics of gas turbine engine operation (6)



Operating line on compressor map for steady and transient operation

A POSSIBILITY FOR ON-BOARD TRAINING FOR MARINE GAS TURBINE PERFORMANCE MONITORING AND DIAGNOSTICS

- Computer models and gas turbine performance training.
- The principles of gas turbine engine condition assessment and fault diagnosis.
- The visual interface of a model.
- A computer model for performance simulation and diagnostics.
 - Basics of gas turbine engine operation
 - **Understanding the effects of malfunctions**
- Further training aspects-conclusions

Understanding the effects of malfunctions (1)

☞ Choice of main components condition parameters

☞ Introducing diagnostic quantities

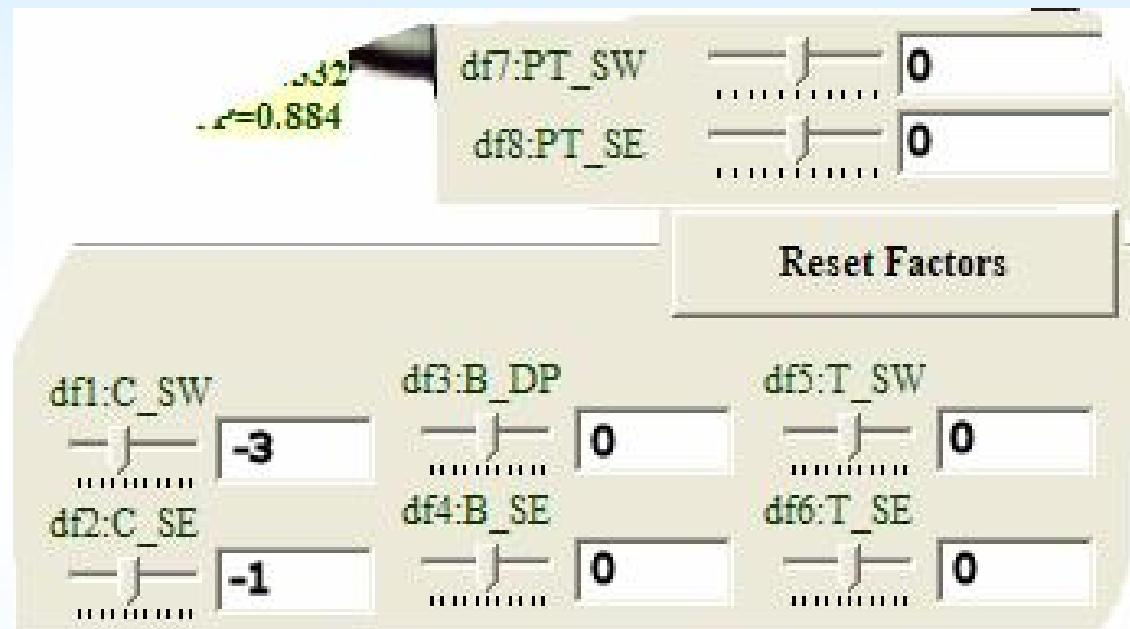
☞ Modification Factors $MF = \frac{X}{X_{act}}$

☞ Use them for

➤ *Simulating Faults*

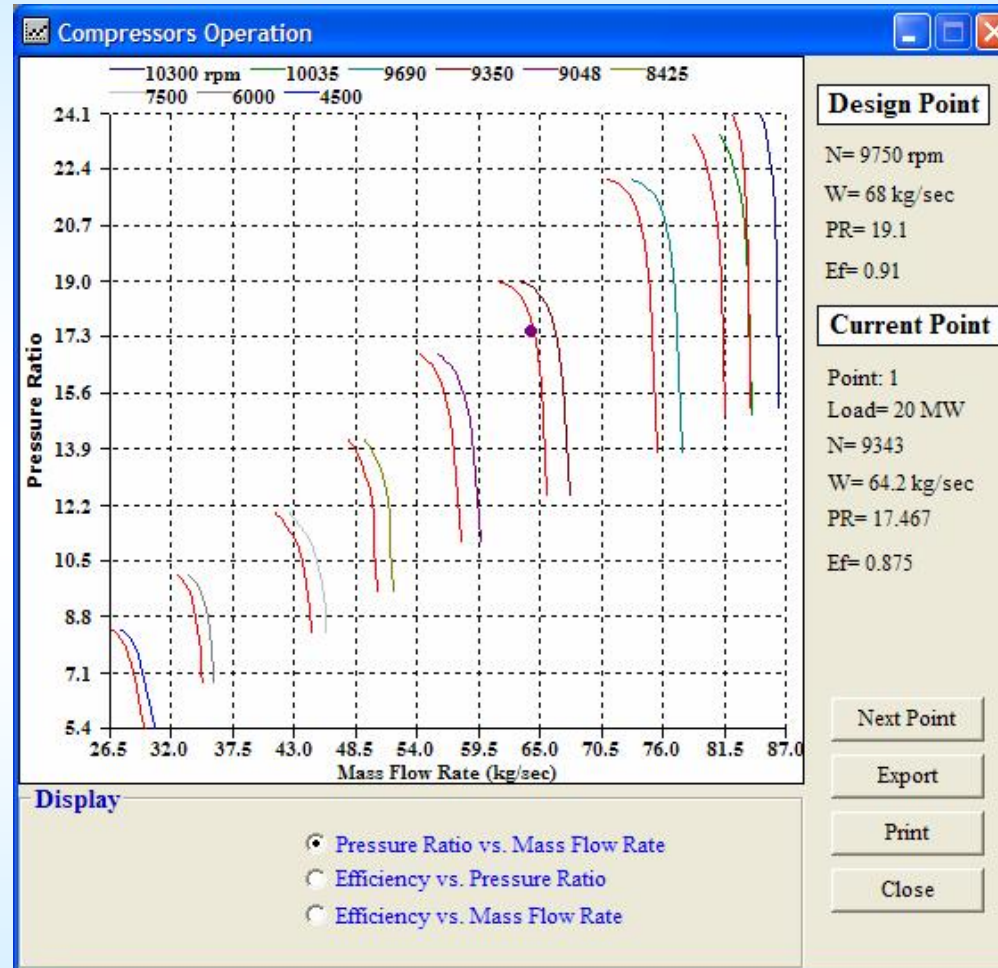
➤ *Diagnostic Faults*

Understanding the effects of malfunctions (2)



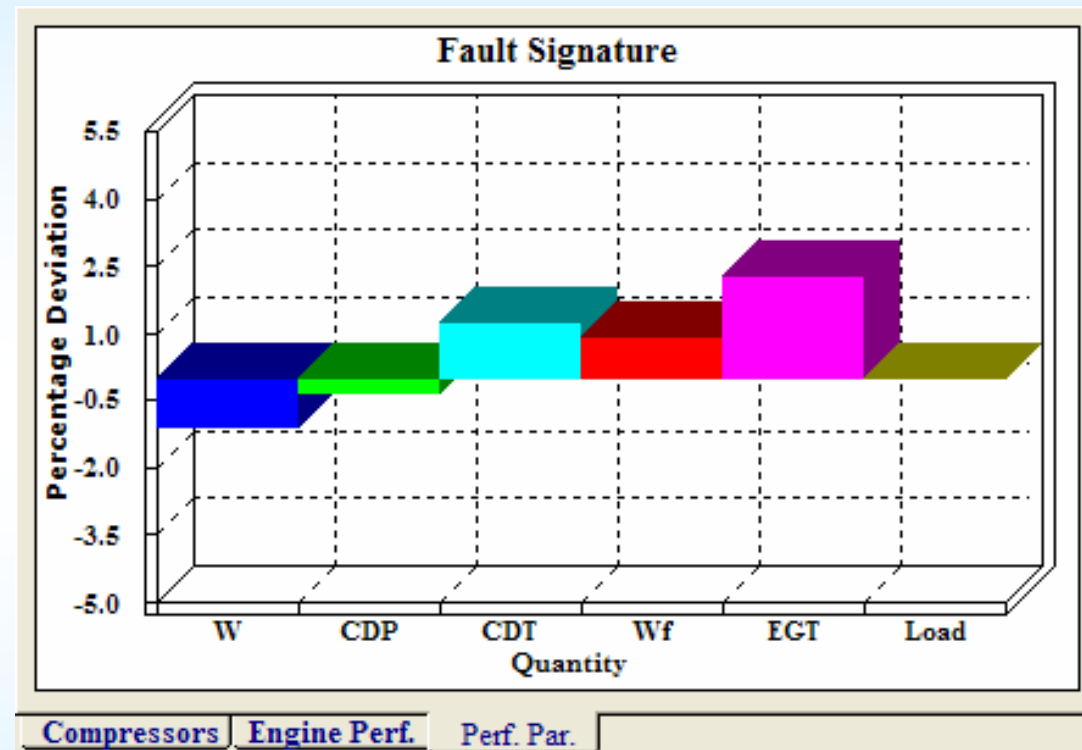
Introducing Component Condition Parameters

Understanding the effects of malfunctions (3)



Modification of compressor performance map for a 3% reduction in flow capacity.

Understanding the effects of malfunctions (4)



Example of fault signature

A POSSIBILITY FOR ON-BOARD TRAINING FOR MARINE GAS TURBINE PERFORMANCE MONITORING AND DIAGNOSTICS

- Computer models and gas turbine performance training.
- The principles of gas turbine engine condition assessment and fault diagnosis.
- The visual interface of a model.
- A computer model for performance simulation and diagnostics.
 - Basics of gas turbine engine operation
 - Understanding the effects of malfunctions
- Further training aspects-conclusions

Further Training Aspects

☞ **Self sufficiency of software**

- *Self understood interface*
- *Interactivity*
- *on-line help*
- *batch processing*
- *exporting capability, interaction with other widespread tools*

☞ **Address people of difference backgrounds**

- *Information provided is complete*

☞ **Accuracy sufficient for practiced use**

Conclusion

Gas Turbine Computer Models Offer great possibilities for training on all aspects of Gas Turbine operation, with particular usefulness when referring to operation with altered (deteriorated, faulty, damaged) components.