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GE Power Systems

Standard Field Performance Testing Philosophy

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes the matter should be referred to the GE Company.

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I. INTRODUCTION

This document provides guidance for conducting a standard performance test of GE heavy duty gas turbines. Station instruments for power and fuel flow are utilized along with a combination of station instruments and special instruments for other parameters that must be determined.

The objective of the test will be to determine performance characteristics of the gas turbine in accordance with requirements of the purchase agreement.

This document is not a procedure for conducting the test. A detailed procedure for conducting the test and evaluating the results must be issued and agreed upon prior to conducting a test. GE will provide the procedure and conduct the test. When the Customer delegates these activities to parties other than GE, then GE approval for the test procedure and test must be obtained.

Proper preparation of the gas turbine for test is essential. This preparation is not considered part of normal commissioning activity. It is required that GE inspect the equipment to be tested and provide instruction as to restorative action that is required prior to conducting the test. A pre-test readiness report that demonstrates the equipment has been properly prepared must be issued to General Electric prior to conducting the test.

Uncertainties in the measurements will be unavoidable. Based on extensive experience in conducting such tests and complete understanding of the equipment and its response to the environment, GE has developed uncertainties for a standard performance test. Depending on specific needs, the Customer and GE may agree to some modifications in the test that may alter the uncertainties.

The estimated uncertainties will be considered tolerance bands for the purpose of equipment acceptance. In the event that the equipment fails to meet acceptance criteria, then post-test uncertainty analysis may be required to determine whether the problem is measurement related. The Customer and GE will then agree as to interpretation of test results.

II. OBJECT AND SCOPE

The Standard Field Performance Test Philosophy is intended for full load testing new and clean gas turbines with generator loads. Performance characteristics of interest would be:

- Generator Electrical Power Output
- Gas Turbine-Generator Heat Rate
- Gas Turbine Exhaust Gas Temperature
- Gas Turbine Exhaust Gas Flow Rate
- Gas Turbine Exhaust Gas Energy

Not all quantities are required for all tests. In the majority of cases, the quantities of interest are power output and heat rate. Testing will be confined to gas turbines that operate on natural gas or light distillate liquid fuels.

The Standard Field Performance Test Philosophy represents a simpler alternative to ASME PTC-22. Testing will be based upon use of existing station instruments for measurement of generator power and gas

turbine fuel flow. The balance of the instrumentation will be a combination of existing gas turbine devices and special devices that are intended to provide measurement accuracy consistent with goals for overall test uncertainty.

Prior to the test, compressor cleaning will be completed as a minimum action to ensure the gas turbine is in a condition suitable for test. In addition, the gas turbine will be inspected, and major control functions that affect full load operation will be verified to be operating correctly.

When completed, the Standard Field Performance Test will be expected to have overall uncertainties of approximately $\pm 2\%$ for corrected power output and $\pm 1.7\%$ for corrected heat rate for the gas turbine operating with natural gas fuel at maximum load.

III. GUIDING PRINCIPLES

The primary purpose of the test shall be the measurement of generator power and gas turbine fuel heat consumption at full load. Sufficient supporting data will be recorded to enable correction of the test results to conditions of rating, as stated in the appropriate sections of the purchase order, so that a comparison may be made between results from testing and rated machine capability at specified operating conditions. Correction factors, most up-to-date versions will be provided by GE prior to the test. The quantity and format of the correction factors applied to a particular project will depend on the contractual basis of the performance guarantee as stated in the purchase contract. The following list presents potential correction factors:

- Inlet Air Temperature
- Inlet Air Humidity
- Barometric Pressure
- Generator Power Factor
- Water/Steam Injection Flow Rate
- Fired Hours
- Rotational Speed
- Fuel Temperature
- Fuel Composition
- Inlet System Pressure Differential, when equipment is outside General Electric scope.
- Exhaust System Pressure Differential, when equipment is outside General Electric scope.

The subject gas turbine shall be capable of reliable operation at full load before conduct of the test. Inlet guide vane position in the full open position will be verified by manual measurement of at least 16 vanes. Exhaust temperature control parameters will be verified to be at specified values, including verification of the exhaust thermocouple signal processor via input of a known millivolt level at the first thermocouple junction closest to the exhaust gas thermocouples.

General Electric will inspect the gas turbine and determine the actions necessary to place it in a new and clean condition. In most cases, the turbine will be considered new if it has operated less than 100 fired hours and in accordance with General Electric instructions. It will be necessary to clean the compressor and/or turbine in almost every case, regardless of the amount of fired hours. Visual inspection of the compressor inlet area, including bellmouth, inlet guide vanes and compressor blades, following water wash will be required to insure cleanliness. In some cases, it may be necessary to conduct more than one wash cycle to achieve the required cleanliness. General Electric may require that the wash process be supplemented by a manual wiping of the inlet surfaces which are readily accessible from the bellmouth area, including the bellmouth surface, support struts, inlet guide vanes, and first stage blades.

If prior to the test, the turbine has accumulated more than 100 fired hours a degradation correction will be applied to the test results to account for the amount of degradation that can not be recovered through off-line washing.

Fuel flow measurement will be made using General Electric recommended devices, or their equivalent. Liquid fuel flow measurement devices will be calibrated prior to test if they have been placed into service during commissioning or their original calibrations do not meet accepted industry standards. When used for gas fuel flow measurement, orifice meters will not be placed in service prior to the test. Verification of orifice plate size and orientation will be done prior to installation. In the event the orifice metering tube has been specially calibrated as a unit, removal of the orifice plate will not be required.

Instruments for the test will consist mostly of those that are used to operate and control the gas turbine provided they meet accuracy requirements for the overall test. Control system sensors that affect direct evaluation of thermal performance must have their calibration verified before the test. The accuracy of the signals from the following control variables will be verified by portable NIST traceable field calibration devices. Loop calibration will be conducted.

- Barometric Pressure
- Air Inlet Pressure Differential
- Compressor Bellmouth Pressure Differential
- Compressor Discharge Pressure
- Exhaust System Pressure Differential
- Gas Fuel Line Pressure at Metering Orifice
- Gas Fuel Metering Orifice Differential Pressure

Special instruments will be required for the test in accordance with overall test uncertainty requirements. A list of measurements to be recorded with precision test instruments is provided as follows:

- Inlet Air Temperature (Multiple sensors mandatory)
- Inlet Air Humidity
- Barometric Pressure
- Air Inlet Pressure Differential

- Compressor Bellmouth Pressure Differential
- Compressor Discharge Pressure
- Exhaust System Pressure Differential

Preparations for test as outlined above are to be completed immediately prior to test. Calibrations and checks made during commissioning normally do not meet the stricter requirements of the performance test.

A log of additional parameters will be required to establish documentation that the gas turbine was operated in accordance with General Electric specifications and in a stable manner throughout the test run. These additional parameters will be identified in the official test procedure.

It is estimated that preparations for test including offline water/detergent wash installation of special instruments will require between one and two days.

The test should commence as soon as possible after the turbine is in a new and clean condition with no more than 24 fired hours of operation having elapsed after cleaning. If compressor fouling is suspected to be a problem during this 24 hour period, it may be necessary to inspect the compressor prior to declaring the test results valid.

The gas turbine should be thermally stable and operating according to control specifications prior to start of test. A test point will consist of a half hour period during which sufficient readings of all instruments will be made to ensure time variations do not result in abnormally large uncertainties. The number of test points will be sufficient to demonstrate performance over the range of operation specified in the purchase order and to demonstrate repeatability of the test set-up.

Samples of fuel from the testing will be taken using recognized standards and submitted to recognized laboratories for analysis. The number of samples will be sufficient to establish fuel variability.

Test results are based on averaged data taken during the test point. The averaged results are corrected to account for differences between test operating conditions and those which are specified in the purchase order. Correction factors will be supplied by General Electric and may consist of curves, tables or computer programs.

Preliminary results from testing will be available to all affected parties within one day of completion of testing. Final results will be available by mutual agreement of the parties to the test.

Exhaust Gas Energy, Gas Fuel Decisions based on test results will recognize the measurement uncertainties inherent in the tests. For testing per these guidelines, these uncertainties are expected to be:

Power Output	+/- 2%
Heat Rate, Gas Fuel	+/- 1.7%
Heat Rate, Oil Fuel	+/- 1.45%
Exhaust Gas Temperature	+/- 11°F
Exhaust Gas Flow	+/- 3.3%

Exhaust Gas Energy, Gas Fuel	+/- 3.35%
Exhaust Gas Energy, Oil Fuel	+/- 3.1%

The test uncertainties will be considered to be minimum tolerance bands in the commercial evaluation of the test.



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