AEROSPACE RECOMMENDED PRACTICE

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GAS TURBINE ENGINE TEST CELL CORRELATION

CONTENTS

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1. PURPOSE

1.1 To outline practices and procedures which can lead to better correlation of engine performance test results from test cells used for development and acceptance testing of turbo-prop, turbo-shaft, turbo-jet, and turbo-fan engines; hereafter referred to as gas turbine engines. Specific cases in which the type of information contained herein would be of benefit are:

1.2 As an aid in providing better correlation of test cell data between engine and airframe companies supporting commercial and military requirements.

1.3 For use by the military services in correlating a number of engine test cells at an overhaul depot, or between various depots, or in correlating field test cells that have depot level test capability with those at the engine manufacturer's plant.

1.4 As an aid in establishing correlation practices for new test cells and/or update or modernization of existing military and commercial test facilities.

1.5 Within an engine manufacturer's plant to aid in correlation of test cells used for gas turbine engine development and acceptance tests in accordance with the applicable engine model specification.

2. SCOPE

2.1 This recommended practice considers many facets of testing which have a bearing on obtaining accurate, repeatable engine performance data. These are:

- TEST CELL CONFIGURATIONS
- TEST CELL INSTRUMENTATION
- ENGINE PERFORMANCE CORRECTION FACTORS
- TEST CELL EFFECTS
- INSTRUMENTATION CALIBRATION
- CORRELATION TEST PROGRAM

2.2 Two factors remain paramount in obtaining good test cell correlation:

- Test cell calibration
- Accurate data

3. TEST CELL CONFIGURATIONS

3.1 General: During gas turbine engine development, a wide variety of engine test cell designs have been used successfully in development and production testing. Some are converted reciprocating-engine test cells whereas others were designed specifically for engines being tested.

3.2 Test Cell Design Fundamentals: Test cell design factors which can affect engine performance are:

3.2.1 The path of the primary air flow (mainly engine air flow) into the test cell should be relatively unrestricted and of sufficient size to preclude excessive cell pressure depression. While cell depression values up to 5.0 inches of water (1240 Pa) have been tolerated in some installations, a nominal figure of 1.5 to 2.5 inches of water (370 to 620 Pa) is desirable in order to minimize the magnitude of the inlet air pressure and the ram drag ratio correction factors. Excessive depressions can cause undue structural stresses as well as compressor face air flow distortion causing unstable engine operation. The need for uniform flow at the compressor inlet cannot be over emphasized.

3.2.2 The cooling air flow surrounding the engine (aspirated air) must be adequate to provide cooling of both the turbine and exhaust areas of the test cell. The air flow velocity must not be so high as to cause either friction forces or static pressure variations which are difficult to compensate for or to evaluate accurately. Test cell pressure differential between the inlet and exhaust planes of the engine preferably should not exceed 1 inch of water (250 Pa).

3.2.3 The engine, in most test cell designs, augments secondary air by ejector action thereby cooling the exhaust gases before entry into the exhaust noise suppressor. (Dependent on test cell design, this cooling air may or may not pass through the engine inlet room.) Excessive amounts of secondary air will increase the suppressor size requirements and may, if swept across the engine, result in undue drag forces.

3.2.4 The exhaust gases are mixed with, and cooled by, the augmented secondary air. It may be necessary, primarily in the case of after-burning engines, to further cool the exhaust gases by water sprays located in the augmentor section. It should be noted that, in the case of marginal cross-sectional area in the test cell, the use of water sprays can affect the secondary air pumping influencing the drag on the engine either by friction or localized static pressure effects. During correlation, these conditions must be noted and all subsequent testing preferably conducted under the same conditions.

3.2.5 Either the engine mount configuration or the engine exhaust augmentor tube should be adjustable so that the augmentor-to-jet nozzle distance can be set to a value consistent with augmentor air flow pumping requirements, noise minimization, and effects on localized static pressure at the jet nozzle exit plane. Care must be taken to prevent recirculation of hot air into the engine inlet. The relationship of engine and exhaust augmentor when established shall be maintained for all subsequent tests of the specific engine model.

3.2.6 Test cell inlet stacks and exhaust stacks should be designed to minimize recirculation of exhaust gases under all weather conditions. Ideally, exhaust gases should be ejected down-wind of the air inlet stack and in the same direction as the prevailing wind. In vertical inlet and exhaust configurations, it is desirable that the exhaust stack be at least 25% higher than the primary and secondary air inlets.

3.2.7 Because of high sound pressure levels in the engine test chamber, facility design consideration should be given to using absorption-type acoustic construction of interior walls.

3.2.8 Temperature, pressure, and humidity of the control room should be controlled so as not to affect instrumentation.

4. TEST CELL INSTRUMENTATION

4.1 General: The very best test cell correlation methods cannot overcome shortcomings in test cell calibration procedures. The instrumentation must be certified to meet established metrology performance standards of calibration that can be achieved by the calibration accuracies of primary and secondary standard test equipment.

4.2 Thrust Measurement:

4.2.1 The system most commonly used to measure the thrust of turbojet/turbofan engines utilizes strain gage load cells. Strain gage load cells have the advantage of being readily adapted to high-speed transient recording electronic instrumentation.

4.2.2 The three basic flexure plate designs most commonly used with the thrust platform are compression, tension, and compound with the latter two configurations preferred.

4.2.3 It is recommended that thrust load cells be mounted near the front of the thrust platform to reduce the possibility of errors due to thermal radiation from the high temperatures of the engine exhaust. The thrust measuring system should be designed to minimize false loading of the load cell due to temperature gradients in the structure and/or calibration in a different plane than the thrust loading.

4.3 Power Absorption and Measurement:

4.3.1 Various loading devices, such as electric generators, air compressors, fluid brakes, and propellers are used to absorb the power of turbo-prop and turbo-shaft engines. The type selected for a particular application is usually based on the most economical to operate and the services available. A propeller is generally used for a turbo-prop engine while an electric generator, air compressor, or a fluid brake is used for the turbo-shaft engine.

4.3.2 Power measurement is achieved by adding torque and speed measuring systems to these loading devices to provide a complete dynamometer system.

4.4 Fuel Flow Measurement:

4.4.1 The most commonly used system to measure fuel flow is a volumetric type which employs the turbine-type flow transducer coupled with a variable time base digital electronic instrument. This system is acceptable from an accuracy and reliability standpoint and is readily adaptable for automatic recording. This system also has the capability of compensating for variations in fuel density by inserting the fuel specific gravity and calibration (K) factor into the aforementioned instrumentation. In cases where automated data acquisition is used, compensation for variations in fuel specific gravity and in the calibration of the instrument may be made by the software program. In many instances, the use of turbine-type transducers requires a multi-manifold fuel system to cover a wide flow range. Fuel flow and fuel temperature transducers should be located near the fuel inlet to the engine. The use of flow straighteners is recommended.

4.4.2 Mass flowmeter systems are also used to measure fuel flow. This system automatically compensates for variations in fuel density.

4.5 Temperature Measurement:

4.5.1 Thermocouples are used almost universally for measuring the engine inlet air, exhaust gas, fuel, oil, and metal temperatures. The actual wire used for the thermocouples must be checked carefully to determine that it is of the correct type and meets ANSI (American National Standards Institute) specifications. The wire in the thermocouples and indicating instruments must be compatible in wire type; otherwise, errors will exist. Common thermocouple wire combinations are Iron-Constantan (Type J or Y) thermocouple; Copper-Constantan (Type T) thermocouple; and Chromel-Alumel (Type K) thermocouple. Caution must be exercised to ensure that poor connections do not exist in the installation of thermocouple circuits. A resistance temperature bulb is commonly used where a high degree of accuracy is desired. Increased accuracy can be achieved in computer-based systems by using the individual thermocouple calibration and eliminating all intermediate junctions.

4.5.2 Bent or twisted thermocouples, lead reversals at connections, resistance variations in the leads, corroded connections, etc., are all common troubles associated with temperature measurement. Temperature indicating systems perhaps require more maintenance than any other equipment in the test cell instrumentation.

4.5.3 When measuring inlet air temperature, accurate measurement of test cell ambient temperature with not more than 1° F (0.6° C) error is desired. On outdoor stands, inlet temperature probe reading can be affected by radiation from the sun.

4.5.4 Refer to Figure 1(A) for typical temperature probe.

4.6 Engine Speed Measurement:

4.6.1 Engine speed is generally measured by electronic counters, tachometers, and strobo-tachs.

4.6.2 Errors in speed measurement have often been traced to "human" errors, mistakes in gear ratio computation (use of wrong gears), use of improper strob-o-disc charts, calculating time-base values for digital counters, and selecting the count time. Therefore, special care must be taken to eliminate such errors.

4.6.3 The most commonly used reference for RPM is the ratio of the tachometer pad speed of 4200 RPM to the rated speed of 100% RPM of the rotors. When using the combination of tachometer generator and an analog readout of actual RPM, care must be exercised so that the analog scale is calibrated to the applicable tach-pad drive gear ratio. Additionally, many engine manufacturers are incorporating internally installed magnetic pulse-type transducers to measure shaft speeds precluding the need for mechanical driven tach-generators which are limited to relatively low RPM (i.e., 4200 vs 10-20,000 plus RPM).

4.7 Air Flow Measurement:

4.7.1 Engine air flow measurement is, in most cases, obtained by the use of either a smooth-approach orifice or by a flat-plate orifice. The former is in more universal use for engine test with the latter reserved mainly for calibrations of secondary or auxiliary air flow measurement systems.

4.7.2 Smooth-approach orifices, either attached directly to the engine inlet duct or built into the engine inlet room air supply system, are recommended. Smooth-approach orifices should conform to ASME Standards (Fluid Meters). However, good engineering judgment and application of the intent of the ASME Standards, insofar as practicable, will preclude difficulty from faulty installation practices.

4.7.3 In addition to recording the air velocity head in the orifice throat, readings of inlet air average total temperature and average static pressure must also be obtained to compute the corrected air flow.

4.8 Inlet Air Temperature:

4.8.1 Since many engine performance parameters are corrected for inlet air temperature, it is extremely important to accurately measure that temperature.

4.8.2 To measure the average inlet air temperature, a sufficient number of temperature sensors must be mounted ahead of the engine inlet. The number and location of temperature sensors should be determined by a temperature survey.

4.9 Pressure Measurement:

4.9.1 Gas and liquid pressure measurements are made with conventional Bourdon-type gages, mercury or water columns, as well as various types of transducers utilizing electronic read-out instrumentation. The pressures vary in range from a few inches of water (Pascals) to several thousand psi (several million Pascals). The requirements cover gage and absolute and differential pressure measurements. Among the common varieties of pressure transducers are: force balance, strain gage, variable capacitance, variable reluctance, etc. They are available in many ranges and accuracies.

4.9.2 Refer to Figures 1(B), 1(C) and 1(D) for types of pressure probes.

4.10 Vibration and Oil Flow/Consumption Measurement:

4.10.1 General: Vibration and oil flow/consumption measurements of jet engines are not normally part of a correlation program. However, these parameters are usually monitored during the correlation runs. These parameters may be made part of the correlation program at the discretion of the coordinator (See 8.3.1.3). Once a test set-up has been established, it must be repeated precisely for each subsequent test of a given engine type to obtain comparable data.

4.10.2 Vibration data are measured with velocity transducers, accelerometers, or other types of vibration pick-ups having a variety of shapes, sizes, and features. Some newer engines utilize vibration pick-ups permanently imbedded in the engine at points of interest. Generally, filters are used in the read-out device to restrict the frequency of vibration measured to that of the engine rotational frequencies. Caution should be exercised in mounting the pick-ups on the engine. Insufficient rigidity may lead to unwanted pick-up resonances resulting in false vibration indication. Location and orientation of the vibration pick-ups should be given careful consideration to obtain consistent and meaningful vibration readings. Vibration levels may be affected by changes in the configuration of test hardware and accessories.

4.10.3 Oil consumption is generally measured by a weighing system while oil flow is measured by the volumetric displacement method. The weight flow method is particularly adaptable to the measurement of scavenge oil flows since considerable aeration of the oil may exist. For self-contained oil supply systems within the engine, a method of marking oil level before and after specified runs can be utilized as specified by the engine manufacturer for that model.

5. ENGINE PERFORMANCE CORRECTION FACTORS

5.1 General: All gas turbine engines are affected by the ambient conditions in which they operate. Since the method or values for correcting the performance parameters to a standard day condition often vary between different engine types and models, the procedures to correct these parameters are contained in that particular engine type model specification, Technical Order, or Overhaul Manual. Early studies by NACA, employing dimensional analysis, revealed that the primary operating variables of a gas turbine can be normalized as functions of total temperature and total pressure levels measured at the engine inlet. (Station 1 per ARP 755A) The basic normalizing parameters are:

θ_1 = (observed inlet total absolute temperature)/ (absolute temperature of sea level standard day reference atmosphere).

δ_1 = (observed inlet total absolute pressure)/ (absolute pressure of sea level standard day reference atmosphere).

NOTE: These ratios require the use of consistent units and absolute values i.e., temperatures in degrees Rankine (Kelvin), pressures in psia, in-HgA, (Pascal).

5.1.1 In some cases, for gas turbine engines the referenced condition are values other than the standard day values. Refer to the applicable model specification, Technical Order, or Overhaul Manual.

5.2 Major Engine Parameters: The correction (normalizing) of the major engine parameters requires use of θ_1 and δ_1 as follows:

5.2.1 Rotor speed, N, normalizes when divided by $\sqrt{\theta_1}$ i.e., $N/\sqrt{\theta_1}$

5.2.2 Net thrust, F_n, normalizes when divided by δ_1; i.e., F_n/δ_1

5.2.3 Air Flow rate, W_a normalizes when multiplied by $\sqrt{\theta_1}/\delta_1$; i.e., $W_a\sqrt{\theta_1}/\delta_1$

5.2.4 Shaft horsepower, SHP, normalizes when divided by $\delta_1\sqrt{\theta_1}$ i.e., $SHP/\delta_1\sqrt{\theta_1}$

5.2.5 Fuel flow rate, W_f, normalizes when divided by $\delta_1\sqrt{\theta_1}$, i.e., $W_f/\delta_1\sqrt{\theta_1}$. For correlation tests, fuel flow rate should also be corrected for FHV, if the test fuel FHV differs from that on which the engine specification performance was based or from that of the baseline test. This involves multiplying the normalized W_f by FHV test/FHV model specification or FHV test/FHV baseline test.

5.2.6 Engine cycle total temperatures (T_4, T_5) are normalized when divided by θ_1, i.e., T_4/θ_1. (The absolute value of the total temperature is used). The power of θ_1 to be used will depend on the CP effects of the individual engine model.

5.2.7 Engine cycle total pressures (compressor discharge pressure, turbine discharge, nozzle exit, etc.) are normalized when divided by δ_1, i.e. P_3/δ_1, P_9/δ_1 (Absolute values used).

5.3 Inlet Air Pressure:

5.3.1 Operation of gas turbine engines in test cells involves the use of an inlet nozzle whose contours comply with the ASME Standard for smooth-approach orifices. The total pressure at the engine face (the discharge section of the nozzle) will be the same as the test cell pressure forward of the nozzle lip (in free field testing this is the local atmospheric pressure). If an inlet nozzle screen is used (to prevent foreign object damage during testing), a measurable pressure loss may occur. Accordingly, it will be necessary to either measure the inlet total pressure at the engine face in each test or to predetermine (calibrate) the screen loss and account for it in the data reduction process.

5.3.2 Test cell ambient pressure, i.e., on-site barometric pressure less cell depression, may be used for engine inlet total pressure if (1) a nozzle screen is not installed, and (2) the air velocity in the test cell is less than 30 feet per second (9.0 m/s). If it has been determined that the test cell ambient pressure can be used without error, this measurement is easily made with a water manometer which has one side vented to the atmosphere and the other side vented to the engine inlet room of the test cell. This gives the engine inlet room depression very accurately in inches of water (Pascals). A mercury column barometer or equivalent is recommended to read the atmospheric pressure in the vicinity of the test cell. The barometric reading should be made using the standard procedures recommended by the instrument manufacturer, including mercury column temperature corrections as required.

5.3.3 Inlet pressures, if measured at the engine face, should be obtained with a sufficient number of pressure probes, installed at such locations and depth as to represent the average total pressure determined by a pressure survey procedure approved by the engine manufacturer. Typical probes for this purpose are shown in Figure 1(B), 1(C), 1(D).

5.4 Humidity Correction Factors:

5.4.1 In the dimensional analysis process that derived the engine performance correction factors noted in 5.1, values for CP, γ, MW, and R (specific heat at constant pressure, ratio of specific heat, molecular weight of a gas, and a specific gas constant) are treated as constants. However, the water content of the air has an effect on some of these parameters, particularly at dry bulb temperatures above 60°F (15.6°C); therefore, in areas where the specific humidity is high, a correction for this factor may be required.

5.4.2 The correction factor can be defined by determining the variations in CP, γ, MW, and R with various degrees of moisture and then substituting these variables in a cycle analysis equation.

5.5 Correction for Fuel Heating Value Factor:

5.5.1 Experience has shown that fuel purchased to a particular fuel specification from a single supply source maintains a reasonably uniform heating value. However, the net heating value of fuels used from various sources, even when purchased to the same fuel specification, can vary by several hundred BTU/lb. (several thousand J/kg). In running test cell correlation tests at widely separated geographical locations this factor must be taken into account.

5.5.2 A fuel analysis can be obtained from the supplier. A well established empirical relationship between the net heating value of jet fuels and the aniline-gravity product is generally used. The determination of the aniline point of fuel sample and fuel density in degrees API requires a minimum of laboratory equipment. Fuel lower heating value may be determined in a laboratory by a precision bomb calorimeter.

5.5.3 The fuel flow data from the comparative test runs are corrected to a common FHV base by applying the direct ratio of the heating value of the fuel used to the heating value of the model specification, or of the baseline test fuel.

5.6 Ambient Temperature Effect on Corrected Fuel Flow:

5.6.1 If the inlet air temperature varies drastically from standard day conditions, a variation in corrected engine fuel flow occurs because of the changes in the specific heat of the gases involved in the cycle analysis. The magnitude of the correction factor varies with engine type and must be determined for a particular engine design. The engine manufacturer will provide such data for each engine model.

6. TEST CELL EFFECTS

6.1 General: Test cell influence factors are dependent upon the configuration of the cell, the airflow demand of the engine, and the positioning of the engine in the cell.

6.2 Exhaust Sound Suppressor:

6.2.1 The use of an augmentor duct to carry off engine exhaust gases can affect the local static pressure at the plane of the engine exhaust nozzle. The augmentor entrance is normally sized for minimum airflow consistent with the total cell airflow, the allowable cell depression, and the minimum cell velocity. The total avoidance of static pressure depression at the engine nozzle requires ample spacing between the nozzle and the augmentor inlet. Therefore, location of the engine relative to the augmentor is a compromise to obtain optimum operation with minimal corrections. This particular cell effect must be considered when operating high airflow turbo-fans or turbo-jets in limited capacity cells.

6.3 Ram Pressure Ratio:

6.3.1 Due to cell depression, engine operation in a test cell is equivalent to operation at an altitude slightly higher than the true elevation at the test locale. If the airflow velocity in the cell is significant, the result is equivalent to "flying" the engine at a ram pressure ratio greater than 1.0 and at a slightly higher altitude. The total pressure available at the test locale will be the prevailing barometric pressure. With pressure losses through the cell inlet system, the total pressure inside the cell is below the prevailing barometric pressure. If the velocity is high in the cell due to excessive augmentor (cooling air) pumping or due to a small cell cross section relative to the engine size, the local static pressure will also be depressed.

6.3.2 Since the objective of test cell runs is the determination of performance correctable to sea level static standard day conditions, cell depression should be minimized. However, since cell velocity is required, it is necessary to assess its effect on performance. The engine is the prime mover responsible for accelerating the air from rest to the prevailing cell velocity and the ram drag is properly credited to the engine as a thrust correction to static conditions.

6.3.3 Cell velocities should preferably be less than the 32.2 feet per second (9.81 m/s). An engine rated at 300 pounds per second (136 kg/s) operating in a 400 square foot (37 m^2) cross section cell with 50% secondary air will create a cell velocity of only 15 feet per second (4.57 m/s). This is equal to a ram pressure ratio of 1.00027 and represents a very small correction.

6.4 Buoyancy Effect:

6.4.1 If the test cell is of small cross section in relation to engine size, or if the secondary air flow is unduly large in a given installation, there is a reduction in static pressure along the engine length. These pressures work on the corresponding areas of the engine to cause forces which would not occur in open air testing. Static pressure data along the length of the engine will indicate the magnitude of these corrections and the integration of these pressures times the areas involved will provide the required correction to the observed thrust. The major effect of this force is generally near the exhaust end of the engine where the secondary flow velocities are high. If a test cell baffle wall is included at any point along the length of the engine, it may induce an appreciable pressure-area force which must be considered.

7. INSTRUMENTATION CALIBRATION

7.1 General: It should be reiterated that accurate calibration of test cell instrumentation is a prime requisite to obtaining good test cell correlation and precise, repeatable data. Instrumentation systems, therefore, must be recently calibrated to required accuracies.

7.1.1 Calibration of instruments must be traceable to National Bureau of Standards as agreed on during the pre-test conference (see 8.3.1).

8. CORRELATION TEST PROGRAM

8.1 General: The ultimate use of the engine is to provide a required level of performance when installed in the vehicle for which it was designed. The assurance of the level of performance often requires confidence in the adequacy of the acceptance testing performed prior to the installation. Test facility correlation programs are used to establish the reproducibility of engine test results among different cells which may vary in instrumentation, configuration, size, and location.

8.2 Test Personnel: Test personnel should be familiar with operation and testing of gas turbine engines and should be experienced enough to recognize deviations from stable characteristic engine data. The personnel must be constantly aware of the need for precise and accurate data.

8.3 Pre-Test Conference:

8.3.1 Before undertaking a correlation program, a meeting should be held between responsible personnel from the facilities to be correlated and the engine manufacturer. The participants in the pre-test conference must agree upon the following:

8.3.1.1 The baseline or referee facility. This facility will serve as a standard for the other facilities in the program and will be used to calibrate the correlation engine. This may be one of the engine manufacturer's test cells, an established test cell at a military overhaul depot, or one of several cells at a field activity. If the baseline facility is other than the engine manufacturer's facility, then it must be correlated with the engine manufacturer's facility within 30 days (prior to the start of the correlation test program) if practicable.

8.3.1.2 The overall test plan, including test schedule dates, number of test points, stabilization time, range of power settings, data recording and reduction, acceptable correlation variation from baseline, and report distribution.

8.3.1.3 A coordinator acceptable to all parties to monitor progress and serve as a focal point for the program. Each facility involved should have one person assigned as a contact at his own facility; the coordinator working directly with the designated contact at each facility. Ideally, the coordinator should be a highly qualified individual whose primary assignment is not involved with one of the facilities being correlated. The coordinator may be a representative from the engine manufacturer or a neutral office.

8.3.1.4 The configuration of the engine to be used must be established whether it is a completely bare engine with a flight rated nozzle and no aircraft accessories, a quick engine charge incorporating some aircraft subsystem interfaces, or another variation to be determined. This decision may be largely determined by the nature of the tests normally conducted in the facilities being correlated. Variable geometry features such as compressor stators and/or exhaust nozzles should be operable in a manner consistent with a sea level static test.

8.3.1.5 When a computer or programmable calculator is used for data reduction at a facility, a verification check of the data reduction program must be made to verify the computed output results.

8.4 Referee Engine Selection & Calibration:

8.4.1 The referee or correlation engine should be selected from those available engines which have satisfactorily completed the appropriate acceptance test run. An engine calibrated by the engine manufacturer and used only for correlation purposes may also be used and need not be recalibrated at the start of each program unless it has been determined and documented that depreciation or deterioration has occurred.

8.4.2 To reduce the possibility of early depreciation or deterioration when the program involves numerous stands, it is desirable to obtain an overhaul engine or a serviceable engine with several hours of run time as the referee engine.

8.4.3 The selected engine shall be configured in the manner agreed upon in 8.3.1.4 and installed in the test facility to be used as the baseline.

8.4.4 The calibration run(s) should then be performed, the number of runs to be agreed upon in the pre-test conference. If more than one run is made, the time interval between runs should be as agreed upon in the pre-test conference.

8.4.5 Minor engine adjustments not affecting the baseline may be made after the baseline run is established, but no parts which affect engine performance are to be replaced.

8.4.6 The baseline test results are then plotted in a conventional format, as applicable for that engine model, using those correction factors described in Technical Order or Overhaul Manual or in the manner agreed to by the parties attending the pre-test conference. The variables to be plotted as agreed in pre-test conference will depend on the type of gas turbine engine.

8.4.7 The engine calibration data are made available to the correlation test program participants. The correlation data report will include the final engine calibration data on plot sheets as agreed upon showing the individual data points, faired curves for each parameter, and a tabulated summary of these values (from the plots) at each guarantee point.

8.5 Facility Correlation:

8.5.1 The referee engine is then cycled through the other test facilities involved in the program. The manner of packing and delivering the calibrated engine should be in accordance with the overall test plan agreed upon in 8.3.1.2.

8.5.2 At each facility or test cell, the engine shall be installed in the agreed upon configuration and tested in the same manner, using the same run points, stabilization time, run sequence, method of data reduction, etc., as agreed upon in 8.3.1.2. Insofar as practical, the personnel, type of instrumentation, and test equipment (smooth approach orifice, thrust or shaft horsepower measurement system, fuel system, meters, etc.) should be the same as those intended for use in the post-correlation or production configuration at the facility in question. If parameters do not meet the prescribed baseline values, or the analytically predicted values within the variation allowed, determine the cause, initiate corrective action, and repeat the correlation run.