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National Aeronautics and Space Administration
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Work performed for
U.S. DEPARTMENT OF ENERGY
Conservation and Renewable Energy
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STIRLING ENGINE TECHNOLOGY

FINAL REPORT FOR THE DEPARTMENT OF ENERGY

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RE-1000 FREE-PISTON STIRLING ENGINE

SENSITIVITY TEST RESULTS

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SUMMARY

The NASA Lewis Research Center has been testing a 1 kW (1.33 hp) free-piston Stirling engine at the NASA Lewis test facilities. The tests performed over the past several years have been on a single cylinder machine known as the RE-1000. The data recorded were to aid in the investigation of the dynamics and thermodynamics of the free-piston Stirling engine. The data are intended to be used primarily for computer code validation. NASA reports TM-82999, TM-83407, and TM-87126 give initial results of the engine tests.

The tests were designed to investigate the sensitivity of the engine performance to variations on the mean pressure of the working space, the working fluid used, heater and cooler temperatures, regenerator porosity, power piston mass and displacer dynamics. These tests have now been completed at NASA Lewis.

This report presents some of the detailed data collected in the sensitivity tests. In all, 781 data points were recorded. A complete description of the engine and test facility is given. Many of the data can be found in tabular form, while a microfiche containing all of the data points can be requested from NASA Lewis.

INTRODUCTION

A free-piston Stirling engine has been under test at NASA Lewis as part of the Stirling engine technology program. The engine was intended to be used for basic research of specific thermodynamic processes involved in the Stirling engine cycle. The engine, known as the model RE-1000 was designed and built by Sunpower Inc., of Athens, Ohio in 1979 for NASA Lewis. The name RE-1000 indicates that the device is a research engine producing approximately 1000 W of brake power.

The RE-1000 engine, as tested at NASA Lewis, does not represent an engine design optimized as a total system. The goal used during the initial stages of the design was to produce an engine with maximum efficiency at the design condition of 1 kW brake power output. The starting point of the design task, however, was to use an existing design of a cooler that was intended to be used on an engine with 3 kW brake power output. The size of the regenerator cavity was also taken from the existing 3 kW design. With these constraints, along with the heater tube temperature fixed at 600 °C, cooler temperature of 25 °C, mean working space pressure of 7.0 MPa, and Helium as the working fluid, the Sunpower optimization code was used to maximize the efficiency. The engine is described in references 1 and 2.

Since the design of the engine research was aimed at the need for basic Stirling cycle research, consideration was given to the ability to measure key thermodynamic characteristics. Many instrumentation ports were incorporated in the hardware during the fabrication of the engine. Also considered at the time of fabrication was the requirement for reliable operation, short teardown and rebuild times, and flexibility of configurations. Because the research to be carried out was not intended to be on the heat input system, an electric resistance heater was developed. This heater will be discussed in detail in a later section. For similar reasons, a dashpot load was installed to absorb the power generated by the engine. This load will also be discussed in a later section. Figure 1 is a cutaway view of the RE-1000 showing the internal parts with some of the key components labeled. Figure 2 shows the engine installed in the NASA Lewis test facility.

The purpose of the tests performed with the RE-1000 was to collect data throughout a test matrix and to use these data to validate computer simulations of the Stirling cycle. The test matrix developed was intended to exercise the engine over a wide range of operating conditions to find the parameters to which the engine has a great amount of sensitivity, and also to find parameters to which the engine has little sensitivity. The matrix not only varied the operating conditions of the engine, but also varied the configuration of the engine hardware. Changes in the operating condition were accomplished by varying the working fluid, the mean pressure level, the heater and cooler temperatures, and the power piston stroke. Changes in the configuration of the engine were accomplished by varying the power piston mass, the regenerator porosity, and the displacer dynamics.

At the end of the sensitivity testing, a total of 781 data points were accumulated. During some of the testing, a measurement of the dynamic pressure drops of the heat exchangers was recorded. The measurement of steady-state pressure drops for each of the engine configurations was also recorded. A discussion of the measurement of the dynamic pressure drops of the heat exchangers will be presented in a later section.

This report presents a complete description of the RE-1000 engine suitable for computer modeling of the test hardware. A description of the test methods and the instrumentation is given. The 781 data points recorded during the sensitivity tests are presented in detail along with suggestions on how some of the data should be used. Some of the data are given in the form of graphs to show the general trends of the engine performance. A sample of the detailed data readings is presented in tabular form but the entire collection of data on a microfiche card can be requested from NASA Lewis.

DESCRIPTION OF THE SENSITIVITY

Test Program

During the initial stages of the NASA Lewis free-piston Stirling test program, a need was recognized for data recorded over a wide range of operating conditions for the purpose of computer code validation. Little free-piston Stirling engine data had been published and none of it was in enough detail to be used for code validation. With the ability to change the configuration of the RE-1000 engine and the wide range of operating conditions at which the

engine could be run, a test program was designed to exercise the engine over many configurations and operating conditions.

The sensitivity tests were developed to provide this much needed data with the use of the RE-1000. The term sensitivity was used to describe these tests because the engine would be exercised throughout a matrix of operating conditions with eight parameters being varied. The data could then be studied to better understand how the engine responds not only to changes in the operating conditions, but also to changes in the configuration of the hardware. Three of the varied parameters were configurational changes of the hardware. These changes include variations in the power piston mass, regenerator porosity, and the displacer dynamics. A description of each of these configurational changes is given later in this report. The other parameters varied include the power piston stroke, the mean operating pressure in the working space, the working fluid, the heater temperature and the cooler temperature.

With the data collected in these tests, it would be possible to see which parameters strongly influence the performance of the engine and which parameters have little if any effect on the engine performance. Because these tests cover a wide range of operating conditions it would be possible to see the trends of the engine on a macro basis rather than on a small, local basis. This feature is helpful in the validation of computer simulations since a computer code should be able to predict engine performance over a wide range of conditions. Descriptions of the NASA Lewis Stirling engine simulation and the calibration of it are given in references 3, 4, 5, and 6.

Figure 3 shows a segment of the sensitivity test matrix. The parameters varied in this matrix were mean engine pressure level, heater head temperature, and cooler temperature. Inside each of the elements of this matrix the stroke of the power piston was varied. The stroke was varied in increments of 0.2 cm from 1.8 cm up to an upper limit determined by the operating conditions of the engine. In some cases, the upper limit of the stroke was determined by the presence of system instability causing the engine to operate with a low frequency beat imposed on the engine operating frequency. Other times the stroke was limited by either the condition of no load being applied to the piston or by the increased risk to the engine instrumentation. In all cases, the stroke was kept below a limit of 3.6 cm because of physical limits in the engine.

The matrix depicted in figure 4 shows the variations in the configuration of the test hardware. The configuration matrix shows that the engine was tested with all four possible combinations of the two regenerators and two displacers. In addition to these four configurations, the tests were run with the regenerator 1 and displacer 1, but the working fluid was changed to nitrogen for one series of tests and to argon for another series. A series was also run with a power piston with a mass less than the design mass. It should be noted that the matrix shown in figure 3 exists once inside of each of the elements of the matrix shown in figure 4. Table I gives a listing of the number of data points recorded for each of the elements of the configuration matrix.

The test matrix was designed to provide a method to detect the potential weakness of a Stirling engine computer simulation. When a computer simulation is calibrated against too few data points, the code may be very accurate when simulating a point near the conditions it was calibrated against, but may have significant errors when it tries to predict engine performance at an operating

point far from the calibration conditions. This may be caused by the adjustment of calibration factors that tend to counteract one another in some respect. The idea that it is desirable to calibrate a computer code over a wide range of data conditions led to the detail design of the sensitivity test program.

The data can be used to study the sensitivity of the RE-1000 to variations in any one parameter with all other parameters held constant. While this is done in most engine test programs to some degree, (i.e., the engine speed is usually varied as the pressure level is held constant in most kinematic Stirling engines as shown in ref. 7), it is possible to use data from the current sensitivity tests to look at the variation in engine performance with respect to any of the controlled parameters used as a test variable. With this in mind, the significance of some of the tests becomes more clear. If data points are used for code validation where the test parameter varied is the working fluid while all other parameters are held constant, some of the deficiencies of a code that are a function of the gas properties can be found. By using the data points recorded when the mass of the power piston was the test variable, the deficiencies of a code that are frequency dependent can be found. This can be very helpful in the calibration of a Stirling simulation since the configuration of the engine and the gas properties are held constant and the operating frequency of the engine is changed.

DESCRIPTION OF THE ENGINE

Along with the cutaway drawing of the RE-1000 free-piston Stirling engine shown in figure 1, a photograph of the engine in the test cell is shown in figure 2. The engine is relatively large and massive for its power level for several reasons. The engine as built for NASA Lewis, was intended to be a rugged test engine to be used for many hours of research. Since there was no interest in demonstrating the feasibility of commercialization or production features of the engine, no consideration was given to make the engine light or compact. A design requirement was to make the engine reliable and provide ease of maintenance. Consideration was also given to the ability to get instrumentation into key locations to enable the measurement of some thermodynamic characteristics. Generally, ports were incorporated at the connecting ducts between the heat exchangers for gas property measurements.

As can be seen in figure 1, the RE-1000 is a single cylinder free-piston Stirling engine with a posted displacer, annular regenerator and cooler, electric resistance heater head, and a dashpot load device built inside of the bounce space. The significance of the posted displacer configuration is that the displacer dynamics are coupled to the engine housing by the displacer gas spring. (The other possible configuration is to couple the displacer dynamics to a gas spring inside of the power piston.) Since the engine housing of the RE-1000 is very massive relative to any other engine component, the driving force that the displacer responds to during operation is the pressure variation of the working space. The response of the displacer generally follows the classical linear vibration theory as described in reference 8. Some nonlinearity does exist in the engine however and the linear theory does not yield a perfect representation of the dynamics.

The sliding surfaces of the engine use wear couples. The power piston is coated with a fluorocarbon material and the cylinder is coated with chrome

oxide. The displacer rods are coated with chrome oxide while the bores of the displacers are hardened stainless steel. Advances in Stirling engine technology include the use of hydrostatic and hydrodynamic gas bearings as described in references 9 and 10.

A complete list of engine parameters and dimensions is given in table II. It is intended that this list should be a complete description of the RE-1000 for its modeling on a computer. In the event of any conflict, the data presented in this table supersedes any previously published data with respect to the dimensions and configuration of the NASA Lewis RE-1000 since some alterations and more accurate measurements have occurred.

Heater. - The RE-1000 heater head is shown in figure 5. The heater was made with 34 tubes of Inconel 718. The tubes are used to form an electric resistance heater. As can be seen in figure 5, 17 of the tubes are connected at their midpoints to a semicircular electric bus bar. The other 17 tubes are connected at their midpoints to another electric bus bar. Each of the electric bus bars has two power tabs extending radially from the center of the heater. The flow of current from the one bus bar, through 17 of the tubes to the cylinder produces heat in those 17 tubes. The cylinder of the engine is at electric ground. Heat is likewise generated in the other 17 tubes as the current flows away from the head, through the tubes to the other bus bar and its power tabs, back to the electric power supply. The heat is generated by the high current, low voltage system.

The four power tabs that extend radially from the two bus bars were sized to generate heat in an attempt to minimize the heat loss from the heater tubes. With the proper amount of heat generated in each power tab, the temperature gradient in each tab would be zero at a point where the power tabs connect to the semicircular bus bars. A cross section of one power tab and its connection to the bus bar is shown in the exploded section of figure 5. The diagram shown in the exploded view illustrates how the power tab becomes neither a heat sink nor a heat source to the heater tubes. In this case, the heat conducted from the bus bars to the power tabs would be zero and the power tabs. The heat calculated in the data system as PWRIN, however, includes some of the heat generated in the power tabs that is lost to the surrounding air. This has an effect on any attempt to develop an energy balance or to calculate the engine efficiency based on the power input.

Each heater tube connects the expansion space to the hot end of the regenerator. The 34 tubes flow gas in parallel from the expansion space to a small plenum chamber at the hot end of the regenerator. As the tubes pass through the two semicircular bus bars, there is no mixing of the hot gas from one tube to another. The bus bars are brazed to the heater tubes only as a conductor for the electric current.

The heater head was fabricated with two semicircular bus bars attached to the midpoint of each of the 34 heater tubes. Since all of the heater tubes were fabricated from the same supply of tubing and therefore should be identical, every tube should be at the same temperature level during operation. The data always indicated that there was a tube to tube variation in temperature of as much as 20 °C. The variation was interpreted as misalignment of the thermocouples on the heater tubes and not a true variation of the heater tube temperatures. Since there is a voltage gradient along the length of the tube during operation, any misalignment of the thermocouple on the heater tube would cause

the thermocouple output to be the summation of the temperature induced output and the voltage gradient over the length of the thermocouple. This thought was substantiated by the fact that with each new installation of thermocouples, the highest heater tube temperature measured was on a different tube than on the previous tests.

Regenerator. - The regenerator cavity is an annular volume between the outside surface of the displacer cylinder wall and the inside surface of the gas-pressure containing wall. The regenerator matrix is a knitted 304 stainless steel material produced by Metex Corporation of Edison, New Jersey. Regenerator material is inserted into the regenerator cavity from the cold end of the heater head and becomes compressed when the cooler is attached to the heater head. The matrix structure is much like a metallic rope with a square cross section. The regenerator matrix is shown in figure 6.

The engine was tested with two different regenerators. The regenerators were similar with the exception that they had different porosities. When the engine was purchased at the beginning of the program it was built with a regenerator and a displacer that shall be referred to as regenerator 1 and displacer 1. These parts were produced as a result of the design goal of high engine efficiency within the original design constraints. At a later time in the testing of the RE-1000, NASA Lewis purchased a regenerator and displacer from Sunpower that were optimized for high power output with all other parameters of the engine held constant. These high power parts shall be referred to as regenerator 2 and displacer 2. Regenerator 1 had a porosity of 75.9 percent while regenerator 2 had a porosity of 81.2 percent. As a standard test procedure, the heat exchangers were flow tested after each rebuild. The results of the steady-state flow tests are given in figures 7 and 8.

Cooler. - The cooler of the RE-1000 is shown in figures 9 and 10. The cooler is of an annular design. The gas flow path consists of 135 rectangular passages spaced evenly around the displacer cylinder. The cooling water flows through passages in the cooler housing, parallel to the gas passages. The water flow direction during the tests was from the regenerator end of the cooler to the compression space end of the cooler. All of the parts of the cooler assembly are made of aluminum for low thermal resistance. The stainless steel displacer cylinder required a light press fit into the aluminum finned unit.

Displacer. - Tests on the RE-1000 were run with two different displacers. As discussed earlier, displacer 1 was designed for high efficiency and displacer 2 was designed for high power. The two displacers are shown in figures 11 and 12. Both of the displacers are similar in construction. The gas spring of the displacer is contained inside of the displacer body. The cold end of the displacer provides mounts for the antirotation rod and the displacer position measurement rod. The displacer position measurement rod extends into a linear voltage differential transformer (LVDT) built inside the power piston. This measures the position of the displacer relative to the power piston position since no easy method exists in the RE-1000 to measure the absolute displacer position. The antirotation rod prevents the LVDT core mounted on the displacer from becoming rotationally misaligned with respect to the LVDT windings built into the power piston.

The displacer rods are coated with chrome oxide for wear resistance. The rod is supported by the mounting spider located at the end of the rod. A small

bushing of Rulon is built into one of the legs of the spider to guide the displacer antirotation rod. The bore of the displacer, into which the displacer rod fits, is made of hardened stainless steel. On the end of the sleeve, inside of the displacer, an enclosed volume is attached to form the displacer gas spring. The volume was sized in each displacer gas spring to achieve a predetermined spring rate. Leakage of gas between the displacer gas spring and the working space is minimized by the close fit of the displacer rod in the displacer bore.

There must also be a seal to minimize leakage of the gas of the expansion and compression spaces from leaking between one another without flowing through the heat exchangers. This seal is a single ring of Teflon impregnated with molybdenum-disulfide. There was no backup ring used to provide a preload. The ring had a cross section of 3.00 mm (0.118 in.) by 2.82 mm (0.111 in.). Since little differential pressure across the displacer exists during engine operation a high drag piston ring similar to the ones used in kinematic engines is not necessary.

The two displacers and displacer rods differ in design. Displacer 1 was intended to operate with a phase angle of about 45° with respect to the power piston. Displacer 2 was designed to operate with a phase angle of approximately 80°. Displacer rod 1 was 1.663 cm (0.6548 in.) in diameter while the bore of the displacer was 1.666 cm (0.6558 in.). Displacer rod 2 was 1.808 cm (0.7120 in.) in diameter while the bore of the displacer was 1.811 cm (0.7130 in.). The combination of the gas spring stiffness, the displacer mass, and the damping to which the displacer was subject determined the dynamic response of the displacer to the pressure wave in the working space. Critical dimensions of the two displacers are given in figures 13 and 14.

One major difference between the two displacer rods was the instrumentation port provided in displacer rod 2 that could not be fit into displacer rod 1. This instrumentation port allowed the measurement of the pressure variation in the displacer gas spring as the engine was operating. Figure 12 shows the displacer rod with the instrumentation port labeled. The passage in the displacer rod caused a slight phase shift of the pressure reading but a negligible amount of attenuation. Because of this, the data reported contains a measurement of pressure amplitude but does not try to integrate the pressure-volume diagram of the gas spring. The error in the calculated loss would be too large relative to the actual value of the loss.

Power Piston. - The power piston of the RE-1000 is shown in figure 15. The main body of the piston is made of aluminum with the outer surface having a coating of a fluorocarbon anti-friction material. The larger diameter section of the piston was made of steel to increase the piston mass to the level required to make the engine resonant frequency become 30 Hz. For the tests conducted at the higher operating frequency this steel mass was replaced by a mass of the same dimensions but made of aluminum. This had the effect of making the oscillating mass of the piston lighter and therefore raised the resonant frequency to approximately 37 Hz.

A slot was machined in the side of the large mass to hold a Rulon bushing. This bushing would ride on a stationary rod during operation of the engine to prevent the piston from rotating. The bushing was made of Rulon to minimize friction. Misalignment of the power piston could cause damage to the instrumentation in the engine or the power piston itself. A new technology being

applied to free-piston Stirling engines involves the use of induced rotation to cause the displacer and the power piston to ride on hydrodynamic gas bearings. Some of the work on these bearings can be found in reference 9.

Three protrusions are on the end of the power piston toward the compression space. These three protrusions extend through the three openings of the displacer rod spider when the piston is at the inward end of its stroke. This feature was incorporated with the intent of reducing the dead volume of the engine.

The power piston uses a clearance seal to reduce gas leakage. The cylinder in which the piston rides is coated with chrome oxide. The inside diameter of the power piston cylinder is 5.722 mm (2.2528 in.), and the outside diameter of the piston is 5.718 mm (2.2514 in.).

The power piston of the RE-1000 with its original steel mass weighed 5.47 kg (12.06 lb). Other hardware attached to the power piston weighed 504 g (1.11 lb). This caused the total oscillating mass to be 5.97 kg (13.2 lb). Since this mass is nearly 15 times as large as the mass of a displacer, the dynamics of the engine are dictated by the inertia of the power piston. The operating frequency of the engine was approximately equal to the natural frequency of the piston mass rebounding against the gas spring formed by the working space. The bounce space in the large pressure vessel had a negligible effect on the frequency since its volume is about 100 times as large as the working space volume.

Centering ports. - Since a free-piston Stirling engine has no kinematic linkage to constrain the motions of the power piston or the displacer, a system is required to insure that the midpoint of the stroke of each oscillating part stays at some fixed location in the engine. This is necessary to insure that the piston and displacer do not collide with one another or with some physical limitation inside of the engine. This system is needed even if the hardware were able to be produced with perfect dimensions because the leakage past most of the seals in the engine is not symmetrical. A power piston will generally tend to drift into the working space, and in the configuration of the RE-1000, the displacer will drift toward the compression space.

Leakage in the engine is not symmetrical due to the variation of the density of the working fluid. As an example, the leakage of gas between the working space and the bounce space will be discussed. Since the bounce space undergoes no heating or cooling and the change in volume is very small compared to the total volume of the bounce space, the pressure in this space will be assumed to be constant. The pressure in the working space however undergoes a sizeable pressure variation. The equations describing the leakage between the two spaces indicate that the volumetric flow of gas will be equal in both directions. This flow rate is proportional to the square of the differential pressure across the leak path. The density of the gas flowing from the working space to the bounce space will be higher than the flow from the bounce space to the working space. There will be a net mass flow rate from the working space to the bounce space when the two volumetric flow rates are equal.

When the piston is at midstroke, a small port on the surface of the piston is aligned with a small port in the cylinder wall. The alignment of these ports allows the working space to communicate with the bounce space. This has the effect of forcing the engine to have no difference between the mean working

space pressure and the mean bounce space pressure when the engine is operating. This centering port system has been very effective and trouble free throughout the testing.

A similar system exists for the centering of the displacer stroke. In the case of the displacer, ports are aligned at midstroke that lets the small internal gas spring communicate with the large bounce space of the engine. This forces the pressure of the displacer gas spring to have its pressure equal to the mean pressure of the engine when it is at the center of its stroke. Figure 16 shows a cross section of the displacer centering port system.

When the engine is running, the centers of the piston and displacer strokes will not be at the exact same positions as when their respective centering ports are aligned. The distance between the center of the stroke and the centering port position will vary from one data point to another depending on the operating conditions. If the centering port system was made strong enough to force the center of the stroke to be at the same position as the centering port, a large loss may be incurred. This loss will be discussed later. The power piston of the RE-1000 has a maximum stroke of 4.35 cm (1.713 in.). The centering port for the power piston is aligned when the piston is 2.05 cm (0.807 in.) from the bumpers that limit its movement into the working space. Even though the piston does not touch the bumper during operation, the positions of the centering ports and of the center of the piston stroke were measured relative to these bumpers.

Displacer number 1 has a maximum stroke of 4.04 cm (1.591 in.). Its movement is limited by the end of the cylinder at the expansion space end of its stroke and by the spider that supports the displacer rod at the compression space end of its stroke. The centering port for displacer number 1 becomes aligned when the displacer is 1.90 cm (0.75 in.) from the expansion space limit of its movement. The dimensions for displacer number 2 are 5.18 cm (2.039 in.) for the maximum stroke and 2.64 cm (1.04 in.) from the end of its possible movement to the centering port position. Table III lists the volumes in the engine with both the power piston and the displacer at their respective center port positions. Locations of the different volumes are shown in figure 17.

Each of these centering port systems has some loss associated with it. This loss occurs in the form of gas flowing from the higher pressure side of the port to the low pressure side of the port each time the port opens. For the displacer centering port system this loss should not be too great. The reason for this is that the pressure in the gas spring of the displacer should be the same at both times the port opens during a cycle if there is no leakage and the spring has little hysteresis. The centering port of the displacer should only flow enough gas to correct for some slight leakage and a slight hysteresis in the spring. The power piston centering port, on the other hand, may have a great amount of loss associated with it. The reason for the loss is that the pressure in the working space at the two times during an engine cycle that the ports open is not nearly equal. One opening occurs when the power piston is in the process of compressing the working fluid and the other opening occurs when the power piston is expanding the working fluid. During the compression stroke most of the working fluid is in the relatively cool compression space while during the expansion stroke most of the working fluid is in the relatively hot expansion space. At one opening of the centering ports the working space pressure will be much greater than the bounce space

pressure, while at the other opening of the centering ports the pressure in the working space will be much less than the pressure in the bounce space. The result is that there is gas flowing from the working space to the bounce space at one opening of the ports and gas flowing in the opposite direction at the other opening of the ports. These two situations are diagramed in figure 18. For these reasons it is important to have the centering port systems of an engine no bigger than is needed to maintain proper operation.

In the RE-1000 tests were done to determine the best strength of the centering port system for the power piston. The piston originally had four centering ports. Each port was a 1.14 mm (0.045 in.) hole. Data was recorded with from one to four of the ports operational. When only one port was working, the power piston tended to operate far in toward the working space and would almost not open the centering ports at all. As the number of ports was increased, the piston ran more centered around the centering ports but the losses increased. The best combination found was with two of the four original centering ports in operation.

Leak paths. - There are several leak paths in the RE-1000 that should be included in any model to insure proper simulation. Leak paths that allow the gas in the working space to leak to and from the bounce space will be discussed. Not only are these leak paths not obvious at first look at the engine, but the number of paths that are leaking actually changes during the engine cycle.

Figure 19 shows the leak paths that involve the power piston and its cylinder. In the position that the piston is shown in figure 19(a) there are three different leak paths for the gas to use. The shortest path and therefore the path that probably allows the most leakage, is the path that connects the port in the piston to the port in the cylinder wall. This path is designated as path 1 in figure 19(a). The length of this path changes as the piston moves during operation of the engine. Path 2 connects the working space to the centering port in the cylinder wall. This port in the cylinder wall is always at the bounce space pressure level. The length of this leak path also changes during the engine cycle as the piston moves. Leak path 3 connects the centering port of the piston to the bounce space without going through the centering port in the cylinder wall. Care must be taken to realize that while the piston is on the outer half of its stroke as is shown in figure 19(a), there are three separate leak paths, but when the piston is on the inner half of its stroke there is only one leak path. Leak paths 2 and 3 do not leak because the centering port of the piston is on the working space side of the centering port of the cylinder wall. There will be no leakage between the working space and the piston centering port because they are both at the working space pressure. Similarly there will be no leakage between the bounce space and the cylinder centering port because they are both at the same pressure. A two dimensional description of the leak paths past the power piston is given in figure 20. The paths are shown for both halves of the engine cycle.

A similar situation exists for the displacer centering port system. In this case, there is leakage that involves three different gas volumes. When the displacer is on the half of its stroke toward the compression space, there are three leak paths as shown in figure 16(a). Leak path 1 connects the centering port in the displacer bore to the centering port in the displacer rod. This allows gas to leak between the displacer gas spring and the main

bounce space. Leak path 2 connects the working space to the centering port in the displacer bore. This allows leakage of gas between the working space and the displacer gas spring. Leak path 3 connects the displacer gas spring to the ports in the displacer rod. This leak path allows leakage in a parallel path to leak path 1. As was the case with the power piston, the number of leak paths in existence changes during the engine cycle. Leak path 2 changes to leak between the compression space and the main engine bounce space when the displacer has moved to the expansion space as shown in figure 16(b). Both ends of leak path 3 connect the same volume when the displacer has moved to the expansion space and therefore has no leakage.

Dashpot load. - The RE-1000 was built with a small dashpot as a load for the engine. Since the purpose of the testing was not to do research on power output conversion devices, the dashpot load system was well suited. The dashpot load device can be seen in figures 1 and 21 near the top of the engine. The dashpot was made with a carbon piston inside of a cylinder that would pump gas in the bounce space back and forth through an orifice. The orifice size was adjusted during each test to change the level of the load. The adjustment was accomplished by rotating a valve stem that had a 3° taper. The valve stem was rotated by means of an electric motor that can be call out at the top of the engine in figure 21. This load, being a damping device, produced a force resisting the piston motion that was nearly proportional to the square of the piston velocity. A water jacket was formed around the dashpot cylinder to cool the load device.

DESCRIPTION OF THE FACILITY

The RE-1000 test facility was built to supply all of the support systems needed to carry out the research program. The facility had a high pressure, 15.5 MPa, (2250 psi) gas system to supply the working fluid to the engine, a water system to cool the engine, and a dc electric power supply system to heat the engine. Along with these systems, a high speed data system was built to help in the data gathering process. Each of these systems will be described in detail. A simple schematic of the facility systems and some of the instrumentation built into the systems is shown in figure 21.

The gas system was designed with the ability to charge the engine with helium, hydrogen, nitrogen, or argon. The supply pressure to the engine was set with a remote control pressure regulator. The flow of gas into or out of the engine was controlled by motorized needle valves in the supply and vent lines respectively. To start the engine, a pair of solenoid valves alternatively connected the high pressure supply line or the low pressure vent line directly to the working space. The gas pulses would start the displacer and power piston in motion. If the motion was great enough, the engine cycle would continue to operate.

The water cooling system consisted of two separate systems. An open loop system was used to cool the dashpot load device. This system had no temperature control. A closed loop water system was used to cool the engine compression space. This water system was filled with distilled water. A heat exchanger with a feedback system controlled the temperature of this water loop. Water temperature varied during the tests from 25 to 55 °C. Temperatures and flow rates were measured in both systems to allow the calculation of heat rejection rates of the engine.

The engine heater power supply system consisted of two Sorensen electric power supplies connected in parallel. Each power supply unit had the capability of delivering 1000 A of direct current to the engine. The two power supplies were regulated by an automatic controller which used a thermocouple on one of the engine heater tubes as feedback. The heater temperature was varied from 450 to 600 °C during the engine tests. The control room for these systems is shown in figure 22.

DESCRIPTION OF THE INSTRUMENTATION

Since the purpose of these tests was to collect detailed data on the dynamics and thermodynamics of the free-piston Stirling engine, a variety of diagnostic instrumentation was installed. In all cases, the instrumentation was designed to have as little impact on the operation of the engine as possible.

All of the temperatures were measured with type K (Chromel-Alumel) thermocouples. Twelve heater tube temperatures were recorded for data use; their average was used to set the desired test conditions. Six of the heater tube temperatures were measured at the quarter-length point at the expansion space end of the heater tube, while the other six temperatures were measured at the quarter-length point of the heater tube near the regenerator end of the tube. The thermocouples attached to the heater tubes were closed ball and unsheathed. Thermocouples were added on the outer wall of the regenerator to aid in the calculation of conduction losses. The locations of the thermocouples installed on the heater head are shown in figure 23. These regenerator wall thermocouples were closed ball and sheathed.

Thermocouples used to measure the temperature rise of the water as it passed through the engine cooler or through the dashpot cooler were installed in a differential temperature configuration. This produced a signal proportional to the temperature rise of the water. The thermocouples were matched pairs to insure accuracy. These thermocouples were used in addition to the ones used to measure the water inlet temperature and the water outlet temperature because they give a more accurate reading of the differential temperature. Both the inlet and outlet temperatures were estimated to have a probable error of 1 °C compared to 0.2 °C for the temperature differential measurement.

A dynamic pressure measurement was made in the compression space. This measurement was used along with a measurement of power piston motion to calculate the indicated power of the engine. A dynamic pressure measurement was also made of the gas spring inside of displacer 2. As was mentioned earlier, the path that the gas pressure wave traveled caused a slight phase shift of the signal but a negligible amount of attenuation.

A great amount of work was done to develop techniques for accurate measurement of the dynamic pressure drop across each of the heat exchangers. Due to physical limitations in the installation of the instrumentation, measurements across the cooler, the regenerator, and across the entire heat exchanger circuit were made. Special attention was given to the response characteristics of the tubes that connected the transducers to the engine. Each tube was sized to provide the same acustic response on both sides of the transducers. Corrections in the length of the lines were made to compensate for differences in the tube diameters and the gas temperatures. Tests

performed at NASA Lewis indicated that the transducers had insignificant sensitivity to mean pressure level but were affected by the temperature of operation. The transducer bodies were therefore water cooled so that the transducer would maintain a constant operating temperature.

The transducers installed to measure the dynamic pressure drops during engine operation were also used to measure steady-state pressure drops. Because these tests were run at steady-state conditions, the data is reported in the form of cooler pressure drop, regenerator pressure drop, and heater pressure drop. The heater pressure drop was calculated from the measurement of the total pressure drop minus the regenerator and cooler pressure drops. This same calculation was not done for the measurements of the dynamic pressure drops during operation of the engine. The reason is that while great care was taken to insure that the response was equal for both lines feeding any individual transducer, this does not guarantee that the response of the two lines feeding one transducer is the same as the response of the two lines feeding another transducer. Although any two transducers may in fact measure the pressure drop properly, there was no attempt made to synchronize one transducer with another. The reasons not to subtract one pressure drop measurement from another becomes even more apparent when it is realized that the actual pressure drops in the heat exchangers are not necessarily in phase with one another.

The displacer and power piston positions and the power piston velocity were measured. The power piston position and velocity were measured directly by a LVDT, and LVT (linear velocity transducer), respectively. The displacer position cannot be measured directly, since the displacer is completely enclosed in the working space. The displacer position was measured relative to the power piston position with the core of the LVDT attached to the displacer and the windings of the LVDT built inside of the power piston. The signal from the windings inside of the power piston was carried along wires from the moving piston that had to flex as the piston moved. These wires were supported by a piece of music wire 0.254 mm (0.010 in.) in diameter.

To obtain the absolute displacer position signal, the power piston position had to be subtracted from the displacer signal. An electric analog circuit performed the subtraction of the signals from the LVDTs. The circuit also measured the peak values of the signals to produce a measurement of the piston and displacer strokes.

A crystal-type force transducer was mounted in the link that connected the power piston to the dashpot load. Since the force transducer moves with the power piston, a wire system similar to the one used for the displacer signal had to be incorporated to relay the force transducer output signal to the data system. This dynamic measurement of the resistance force being applied to the power piston by the dashpot was used in an analog circuit along with the power piston velocity to calculate the brake power output of the engine. The equation used to calculate the power output was

$$\text{brake power} = \frac{FV \cos \theta}{2}$$

where

F amplitude of the force signal
V amplitude of the piston velocity signal
θ phase angle between F and V signals

An error analysis method outlined in reference 11 was applied to this calculation of power. The resultant probable error was found to be 3 percent at the engine design conditions, assuming that all of the input signals maintained their individual accuracies. The indicated power output of the engine was calculated in a similar manner to that used for the brake power output. The dynamic compression space pressure was measured with a crystal type fast response pressure transducer. The equation used was

$$\text{indicated power} = \frac{PAV \cos \theta}{2}$$

where

P amplitude of the compression space pressure signal
A area of the power piston
V amplitude of the piston velocity signal
θ phase angle between P and V

The same error analysis method was applied to this calculation and the resultant probable error was found to be 3 percent. Once again, this assumes that all of the input signals maintained their individual accuracies. Both the indicated power calculation and the brake power calculation were recorded by the data system.

Two phase angle meters were utilized in the data system. One of the meters measured the phase angle between the power piston and the displacer positions. The other phase angle meter measured the phase angle between the power piston position and the compression space pressure wave. The motions of the power piston and the displacer were not pure sine waves, and the pressure variation in the compression space also had some higher harmonic content. By strict definition, there can be no measurement of a phase angle between two signals that are not pure sine waves. By describing the measured motion of the power piston in a Fourier series it was found that approximately 97 percent of the piston motion is due to the 30 Hz fundamental frequency of the engine. The other 3 percent of the motion was contained in the higher harmonics. In the case of the displacer motion, 95 percent of the motion is in the fundamental frequency term and the remaining 5 percent is in the higher harmonics. The phase angles presented in these data represent the time interval between the positive going zero crossings of the two signals. The outputs from both of these meters were checked against other methods of measuring the phase angles and found to be accurate. The outputs from these meters were fed into the data system and appear on the data output.

A diagram showing the location of most of the instrumentation on the engine is presented in figure 24. A listing of all of the instrumentation used in the tests is given in table IV. The number located near each piece of instrumentation represented in figure 24 is an item number that can be used to identify the instrumentation listing in table IV.

Data was recorded by two different systems during the sensitivity tests. The NASA Lewis Escort system was used for the steady-state data and a separate

system was installed in the control room for recording the dynamic data. Most of the data signals were transmitted to the Escort data system. The Escort system is a microcomputer-based digital data recording and display system intended for steady-state use. The sampling rate of approximately 5000 samples per second permits the use of multiple scans, which are averaged for each data point recorded. The data system uses five scans of data recorded over a 15 sec period. Calculations are performed to indicate the statistical variation of each channel recorded over the total number of scans.

The Escort system has the ability to convert millivolt signals to engineering units with preprogrammed calibrations. The system can do any predefined calculations with the parameters and display the results on either a set of light emitting diodes (LED) or on a preprogrammed cathode ray tube (CRT) display. There were 15 LEDs available for these tests. The CRT could be programmed to have many different displays, or pages, that could be viewed during the test sessions. An important feature of the Escort system was its ability to do limit checking during the tests. The system could check for high or low limits of any of the data channels or calculated parameters, and then provide either a warning of limits violation or perform some predefined action, such as the initiation of a shutdown procedure. Both the LEDs and the two CRTs can be seen in the control room in figure 22. More information on the Escort system may be found in reference 12.

While the Escort system was able to handle the steady-state data channels, it did not fulfill the sample time requirements to record dynamic data channels. The dynamic data were handled by several different methods. Phase angles were measured with phase angle meters. The inputs to these meters were the dynamic engine parameters from the LVDTs and the compression space pressure transducer. The output from these meters was used as an input to the Escort data system. The measurements of the piston stroke, the displacer stroke, and the calculations of the indicated and brake power levels were performed by analog electronic circuits. The analog electronic circuits were checked for accuracy by comparing their measurements to measurements made by other methods and were found to be accurate. These analog circuits were recalibrated regularly to insure accuracy was maintained.

All of the dynamic signals were recorded for each data point on a Honeywell Visicorder. The parameters recorded on the Visicorder are indicated as such in table IV. Some data reduction was performed with the output from the recorder after each test run. The measurements resulting from this output include the amplitudes of the three differential pressure transducers, the amplitude of the compression space pressure wave, the center position of both the displacer and power piston strokes, and the amplitude of the pressure wave in the displacer gas spring for displacer 2. These parameters were later merged with the steady-state data and appear on the output of the steady-state data system.

Table V provides a list of the calculations performed in the data reduction process. The exact form of each calculation is presented in appendix B. This appendix also gives a calculated error for each of the calculations based on the probable error of the inputs for the calculation.

DESCRIPTION OF THE TEST PROCEDURE

The RE-1000 engine installed in the test facility is shown in figure 2. Before any test session was initiated a calibration of all pressure transducers was performed automatically by the Escort data system. The engine was purged of air by a pressure-vent cycle of the working and bounce spaces. The engine was then pressurized with the desired working fluid to some pressure level between 5.5 MPa (800 psig) and 7.0 MPa (1015 psig) depending on the test conditions to run on that particular day. Since the engine would usually start to run after fewer than five impulses from the starter system, regardless of pressure level, it was not important to be at any particular pressure level to start the engine. On most test runs the engine would become self sustaining after two impulses.

After the engine was purged of air and pressurized with the desired working fluid, the electric heat input was started and the cooling water flows were set to their proper levels. The dashpot load was set to give little or no resistance to the power piston motion. When the heater tube temperature reached 600 °C, the engine was given pressure pulses from the starter system until self sustaining operation was achieved. The dashpot needle valve orifice was then adjusted to give the proper load to the engine for the piston stroke desired.

After typically 2 min of operation, all measured temperatures had reached their steady-state values. (The shortness of the transient period is due to the very low thermal inertia, including the absence of an oil lubrication system that kinematic engines have.) Although steady-state temperature readings were obtained in about 2 min, the engine would typically be allowed to operate at the initial test conditions for 15 min or more.

When recording data, the points were recorded in order of increasing stroke. The engine would be held at the desired operating conditions, (i.e., temperature and pressure) with the power piston stroke at 1.8 cm. After this point was recorded, the dashpot setting was adjusted to allow the power piston stroke to reach 2.0 cm. The piston stroke was increased in increments of 0.2 cm and data was recorded until the stroke reached 3.6 cm or until the engine operation started to become erratic. The engine was allowed to operate at each new condition for 5 min before this new data point was recorded.

It must be noted that the test conditions were traversed in a rather orderly fashion. For example, the first series of data points recorded may have been with the conditions of 450 °C heater temperature, 25 °C cooler temperature and 5.5 MPa mean pressure level. The next three series taken would then be at the same conditions with the heater temperature set to 500, 550, and 600 °C respectively. Similar data points would then be recorded for these same operating points with the mean pressure level set at 7.0 MPa. This test procedure, although convenient, can result in misleading data. The reason is that if there were any changes in the instrumentation characteristics that were a function of time, these changes would mistakenly be interpreted as being a result of the changed engine operating conditions. If, on the other hand, the data points are traversed in a random fashion the changes in the instrumentation characteristics will show as scatter in the data. This is also true for changes in the engine as it accumulates run time if there are any parts that are susceptible to wear. This is discussed here to indicate that although it

was recognized that the data matrix should be traversed in a completely random fashion, it was felt that it was not possible within the time frame of the sensitivity tests.

SAMPLE TEST DATA POINT

Some sample data points will be discussed in this section to provide a better understanding of the format used to present the data output. Table VI contains all of the data points that have only one of the set conditions varied from the design conditions. Within this set, data points 1006 to 1012 will be examined. The mean pressure reading of the engine was set at 7000 kPa. This can be seen by the mnemonics MEANCP and MEANBP. These are the mean compression space and bounce space pressure readings respectively. The average value of the 12 heater tube temperatures was set at 600 °C which can be seen by the mnemonic TAVHTR. The cooling water inlet temperature was set at 25 °C as shown by TWINCL. The piston stroke was set at 1.8 cm on data point 1006 as indicated by the parameter PISTST and then increased by 0.2 cm on each successive data point. These parameters are specified by the sensitivity test matrix. All other values on the data sheet are a result of the engine operating at these set conditions.

In the column on the left side of the data sheet there are two sections. These sections are labeled "HEAT TO DASHPOT COOLING" and "HEAT TO COOLER". The calculation used in each of these measurements is based on the water mass flow rates and the differential temperature measurements of the respective cooling loops. The parameters TDLDP and TDLCL are the differential temperatures. Note that these measurements are not equal to the outlet temperature minus the inlet temperature in either case. This results from the locations of the thermocouples used for the inlet and outlet temperature measurements versus the locations of the thermocouples used for the differential temperature measurements. It also results from the improved accuracy of the differential temperature measurement versus the subtraction of two absolute temperature measurements. As previously stated, both the inlet and outlet temperatures were estimated to have a probable error of 1 °C while the differential temperature measure has an estimated probable error of 0.2 °C. Subtracting one temperature from another to calculate the differential temperature can lead to substantial errors when the differential temperature and the probable errors are of the same order of magnitude.

In the second column appear the measurements of the electric power input to the heater head and the calculations performed by the Escort data system. The parameter VOLTG is the voltage across the resistance of the heater head and was measured from a point on the electrically positive power tab near the semicircular bus bar to a similar point on the electrically negative power tab. This measurement therefore was not the true voltage that existed across the heater tubes alone.

The calculated parameters Pressure Factor of the Piston (PFP), and Pressure Factor of the Displacer (PFD), are shown in graphic form in figure 25. The phasor diagram represents the operating condition at the design point. The format of the diagram follows the vector notation outlined in reference 13. The pressure wave of the engine is divided into two components, one in phase with the piston motion and one in phase with the displacer motion. In general, the component of the pressure wave in phase with the piston motion has been

caused by the piston motion. Similarly, the component of the pressure wave in phase with the displacer motion has been caused by the displacer motion. The vector PFP is the pressure variation in the working space that is the result of the piston motion, divided by the amplitude of the piston. The vector PFD is the pressure variation in the working space that is the result of the displacer motion, divided by the amplitude of the displacer. This provides an easy check on the effectiveness of the piston and displacer motions although care must be taken since it is not an exact measurement of the performance of the piston or displacer. By definition, the PFP vector is parallel to the power piston vector and the PFD vector is parallel to the displacer position vector.

A calculation of the Beale number is included in this column. The Beale number, as outlined in reference 13, gives an indication of how well the engine makes use of its swept volume and pressure level for the conversion of energy. All of the calculations are presented in appendix B.

The third column of the data sheet has several different types of measurements. The parameter PRESUP is the supply pressure to the engine. MEANBP and MEANCP are the average pressure levels of the bounce space and the working space respectively. Vibration transducers were mounted on the large base plate of the engine. The measurement represents the vibration level of the entire engine housing, measured in terms of peak velocity (cm/sec). This measurement, along with the frequency of the engine, can be used to calculate the motion of the engine housing.

The fourth column presents measurements of the mean temperatures of the gas inside the engine housing. Below these readings is a section labeled "REMOTE CALCULATIONS". The four parameters represent calculations executed by the analog circuits. All of the parameters listed under the title "DYNAMIC CALCULATIONS" were measured from the Visicorder traces. PAMPC is the amplitude of the pressure variation in the compression space. PISTCP and DISPCP give the center position of the power piston and the displacer: i.e., the distance from inward limit of the possible movement to the center of the oscillatory movement. As an example, for data point 1010 the center positions measured were 2.33 cm for the power piston and 2.37 cm for the displacer. It was stated in the "Centering Port" subsection of the section "Description of the Engine", that the centering port of the power piston opened when the power piston was 2.05 cm from the inward limit of its motion and the displacer 1 centering port opened when its position was 1.81 cm from its inward limit. This indicates that for data point 1010, the center of the center power piston stroke was 2.33 - 2.05 = 0.28 cm from the center port location. Similarly, the displacer was operating 2.37 - 1.90 = 0.47 cm from the center port location.

Measurements presented in this column also include the pressure amplitude inside the gas spring of displacer number 2, PDYNDB. The last three parameters listed give the amplitudes of the dynamic pressure drop measurements. PDLCLR and PDLREG are the pressure drop amplitudes across the cooler and the regenerator respectively. PDLDIS is the pressure drop across the total heat exchanger system as measured between the expansion and compression spaces.

The last column gives the individual heater tube temperature readings. From these individual readings, the average heater tube temperature was calculated and the heater temperature was set. There is some scatter in the readings of the tube temperatures. There are two effects causing this scatter.

First, there is some variation in the temperatures of the heater tubes due to the slight tube to tube variation in electrical resistance. Second, the voltage gradient along the length of the heater tube may effect the accuracy of the temperature measurement. The voltage gradient can be either added to or subtracted from the voltage signal of the thermocouple if the thermocouple is not either electrically insulated from the heater tube or known to be mounted perpendicular to the voltage gradient. Both of these effects probably contributed to the variation in the measurements, but since there were 12 thermocouples, the average of all the heater temperatures should still represent the operating temperature of the heater. Another indication that misalignment of thermocouples was responsible for some of the scatter in the heater temperatures was that a heater tube that indicated the highest temperature with one set of thermocouples was not always the same tube that indicated the highest temperature with the next set of thermocouples. Typically the thermocouples were replaced during each rebuild.

The temperatures in the lower part of the last column are the outer wall temperatures of the regenerator. The locations of these measurements are shown in figure 23. The equation used to determine the axial conduction losses of the regenerator wall from these measurements are listed in appendix B.

When any measurement is made, there is some amount of error associated with each reading. In the case of the RE-1000, being a free-piston Stirling engine (FPSE), the measurement errors are important and in some instances highly significant when calculations are performed. This must be considered when the data is being used to validate computer simulations of the engine cycle. If a code is being validated to produce good agreement in the prediction of indicated power with test data, the validation work can go no further when the code predicts a value of indicated power that is within the error band of the data. For a FPSE, the error band on the indicated power measurement is at times significant. The reason is that there are errors associated with: (1) the volume measurement, (2) the dynamic pressure measurement, and (3) matching the time scales of the two measurements. While it is possible to measure each of these parameters with acceptable accuracy, the size of the error of each signal relative to the size of the signal must be considered. When synchronizing time scales, any phase shift of the two signals relative to one another can lead to a sizeable error in the calculated value of indicated power since the phase angle between the pressure and volume signals is small. Any error in the synchronizing of signals will have a large effect when added to this relatively small phase angle.

With proper technique, measurement errors can be kept to a minimum. An example of minimizing measurement error can be seen in the calculation of heat rejected by the engine cooler. The thermocouples used measuring the temperature rise of the water as it passed through the engine cooler were connected in a differential temperature configuration. If the differential thermocouple configuration has a maximum error of 1.0 percent then the reading will indeed be very accurate. If on the other hand the differential temperatures were measured using two separate thermocouples, there will be an error associated with each of the two temperature measurements. The summation of these two errors will most likely be quite large when compared to the temperature rise intended to be measured.

Estimated probable errors associated with each of the parameters measured in this test program are listed in table IV. The error associated with each of

the calculations is presented in appendix B. In cases where the exact value of the probable error of an individual parameter was not known an estimate was made based on experience with that particular type of instrumentation.

DESCRIPTION OF THE TEST MATRIX

The test matrix was devised to generate the data necessary to characterize the sensitivity of the RE-1000 with respect to each of the parameters that define the test point, plus several configuration related parameters. The attempt was made to optimize the matrix to minimize the number of test conditions and data points. While the engine was designed to operate at temperature levels up to 650 °C, for the reasons of reliability the test matrix was limited to values of 600, 550, 500, and 450 °C. Since power and efficiency are also dependent on the cooler temperature, three levels were chosen: 25, 40, and 55 °C. The engine was designed to operate with helium as the working fluid at a mean pressure level of 7.0 MPa (1015 psig). The test matrix used pressures of 7.0 MPa (1015 psig), 5.5 MPa (798 psig), and 4.0 MPa (580 psig). Testing the engine at four heater temperatures, three cooler temperatures, and three pressure levels, would generate 36 different test conditions for each configuration. To maintain the size of the test matrix at a reasonable level, it was decided that the 14 conditions shown in dashed lines in figure 3 were eliminated. The conditions remaining in figure 3 were used for all four combinations of the two displacers and two regenerators. Figure 4 shows that only displacer 1 and regenerator 1 were used when running tests with either the light weight power piston or an alternate working fluid.

Figure 4 shows the number of data points recorded for each of the configurations. The seven versions of the test condition matrix shown in figure 26 give the data point reading numbers for each of the conditions. With this figure, the reading number for any desired condition can be found. The lower of the two numbers that appear in an element is the reading number of the data point recorded at the shortest power piston stroke tested. In all cases, this value was 1.8 cm. Each successive data reading had the power piston stroke increased by 0.2 cm. As an example, if an element has only four data readings listed in it, the engine was tested with power piston stroke settings of 1.8, 2.0, 2.2, and 2.4 cm.

All 781 data points are not needed to validate a computer code, so the test matrix was divided into two smaller subsets. These two matrixes are called the "Single Variable Data Set" (SVDS) and the "Double Variable Data Set" (DVDS). A list of the data points in the SVDS is given in table VII and a list of the data points in the DVDS is given in table VIII. The remainder of the data can be obtained on microfiche from NASA Lewis by request.

The RE-1000 was designed for high efficiency at the set conditions of 600 °C heater head temperature, 25 °C cooling water inlet temperature, 7.0 MPa mean working pressure with helium and a power piston stroke setting of 2.6 cm. The configuration used included the standard power piston, regenerator 1 and displacer 1. This test condition was recorded on data reading number 1010. Since there were eight test parameters varied during the sensitivity tests, there should be eight different curves that can be plotted showing the sensitivity of the engine to any one of the eight parameters, while the other seven parameters are kept at their respective design conditions. If these plots were generated, every one would contain data reading 1010. The collection of all of

the data points needed to produce these plots is called the SVDS. The title Single Variable Data Set indicates that only one of the eight variable parameters was allowed to deviate from the design condition. Table VII gives the data point reading numbers for all of these points, and also shows which data points are needed to generate each of the eight curves. Table VII shows that the SVDS contains only 18 data points and is therefore an easier data set to work with for computer code validation. This data set can be used to check the sensitivity of a computer code prediction against the sensitivity of the engine for any of the eight test parameters varied.

Figure 27 shows some plots generated from the SVDS. These plots indicate that performance of the RE-1000 obeys the general trends attributed to free-piston Stirling engines. As the power piston stroke is increased, the indicated power produced increased. The displacer stroke also grew as the power piston stroke increased. The displacer stroke growing can be attributed to the larger pressure wave in the working space when the piston is sweeping more volume. The larger pressure wave provides more driving force for the displacer to respond to during operation. It can also be seen in figure 27 that both the indicated power and the efficiency increase as the heater temperature increases.

In some cases the plots generated from the SVDS contain only two points. This is true for any plot of the engine performance with the power piston mass as the independent variable. The engine was tested with only two different levels of power piston mass. This is also true for the variations of the displacer dynamics, the regenerator porosity, and even with the working fluid. The reason this is true for the working fluid is that even though the engine was tested with three different working fluids, the design conditions for the other seven variables could not be reached when tests were being conducted with argon as the working fluid. In an attempt to expand the collection of data points in the SVDS, the DVDS was formed. The DVDS was generated from the SVDS by taking each data point in the SVDS and allowing the power piston stroke to be varied over its entire range. By doing this, a collection of 79 data points was formulated. The list of the data points in this collection is shown in table VIII with the lowest value number of each set being the reading number for the set point condition indicated and the power piston stroke set at 1.8 cm. Each successive reading number had the power piston stroke increased by 0.2 cm. Appendix C contains the data of the DVDS printed out in the same format as described earlier. Figure 28 shows some plots of engine performance using data from the DVDS. Unlike the SVDS, the DVDS can be used to generate plots that show families of curves. Once again it can be seen that the RE-1000 obeys the general laws of FPSE operation.

Some data not included in the SVDS or in the DVDS but that still may be of importance are presented in appendix D. These data points were recorded with both the high power displacer and the high power regenerator installed in the engine. A description of the data points can be found in appendix D.

USE OF THE TEST DATA

There are some important characteristics of the test data that must be understood when the data is being used to validate a computer simulation. These areas will be discussed to provide better insight into the interpretation

of the test data. In all cases the data will be shown to be completely valid, but it will also be shown that the data must be used in the proper manner.

As was described in the section on the sample data output, the motions of the displacer and the power piston were measured in terms of their strokes and their phase relationship to one another. The compression space pressure wave was also characterized by its amplitude and its phase angle relative to the power piston. This assumes that all three of these parameters can be characterized as sinusoidal in nature, without any higher harmonics. A study was performed to test the validity of this approach with the NASA Lewis Stirling engine simulation used in the constrained mode. More information on the details of the NASA Lewis simulation can be found in references 3, 4, 5, and 6. Some of the data points from the SVDS were chosen for this test, and the measured piston motion and displacer motion were digitized. These digitized wave forms were analyzed and their respective Fourier series were generated. Both the power piston and the displacer motion are dominated by the fundamental frequency with only a small part of the motion attributed to the harmonics. Higher harmonics of the fundamental frequency accounted for 1.4 percent of the piston motion and 3.5 percent of the displacer motion. The series solution for each of these wave forms, up to the third harmonic of the fundamental frequency were used as inputs to the NASA Lewis computer code. The results of these simulations were compared to the results of the simulations run with the inputs being in the same form as the data presented in this report. The difference in the code predictions with the two different forms of inputs was negligible. This comparison was made between the two different methods of inputting the data without looking at how well any of the code predictions compared to the test results. It was a test of how similar the two input methods were to one another, not a test of how well the simulation predicted the true engine performance. In the case of the simulations run at the design point of the engine, the results differed by less than 4 percent from one another in the prediction of indicated power. It was felt that this was smaller that the experimental error incurred in the measurement of indicated power and was therefore valid.

This style of data presentation may not be valid for other FPSE engines. The reason that it works well for the RE-1000 is due to the power piston being quite massive and therefore tending to have a sinusoidal motion with little of any higher harmonics. This is reinforced by the load being a pure damper unit which has sinusoidal load characteristics. The same would most likely not be true for a load like the hydraulic pump being tested at NASA Lewis, since the force exerted on the engine is far from sinusoidal. More about the hydraulic load can be found in reference 14. The hydraulic load can cause the engine motions to become highly nonsinusoidal in nature.

Another topic that warrants discussion is the use of the heater tube temperature measurements. The heater tubes of the RE-1000 are heated by resistance heating. The heat is generated inside the heater tube walls. An insulation blanket was placed around the heater head to help prevent heat losses from the head to the surroundings. The thermocouples used to measure the heater tube temperatures were mounted on the outside surface of the tubes indicated in figure 23 and can be seen installed on the heater head in figure 5. If the insulation around the heater head was perfect and with no loss of heat from the head, the temperature gradient through the wall of the heater tube would be flat at the outer surface of the tube. This is very different from the situation that normally exists in Stirling engines where the

heat input is from a combustion source. Since the insulation around the heater head was not perfect, there was some loss of heat from the heater tubes to the atmosphere around the engine. Therefore a temperature gradient exists at the outer surface of the tube that conducts heat toward the outer surface. This creates a point at some distance inside the tube material with a higher temperature than the measured outer wall temperature. The temperature at the inner surface of the heater tube would, as expected, be at some lower temperature because the working fluid is absorbing heat. Figure 29 shows the temperature gradients in these cases discussed.

It would increase the accuracy of a simulation if a correction method was implemented for inputting the measured outer wall temperature. The correction should account for the temperature gradient in a resistance heated tube being different than the gradient in a combustion heated tube. A comparison of the measured expansion space mean gas temperature to the calculated values may provide a means of assuring a correct simulation of the heater temperature.

It was found during these tests that even the measurement of the mean pressure level of the engine needs to be interpreted properly for best results. These measurements were made with strain gauge pressure transducers connected to the engine by means of stainless steel tubing. A small orifice was inserted into each of the stainless steel tubes used for the two mean pressure measurements. In the case of the mean working space measurement, the orifice was a micrometer needle valve with a taper of 1° on the needle. This orifice size could therefore be adjusted as the engine was running. It was found that the reading of the mean pressure could be distorted by changing the size of the orifice. If the orifice was too big, some of the pressure wave present in the engine would get to the transducer and make the output of the transducer fluctuate at the operating frequency of the engine. If the orifice size became too small, the reading of the mean pressure would become higher without the actual engine pressure being raised.

This phenomenon was caused by the change in the density of the working fluid during an engine cycle. If the mean pressure in the engine and the pressure in the transducer were at the exact same level at the initiation of a cycle, there would be the same volumetric flow of gas from the engine to the transducer during the high pressure half of the cycle as the volumetric flow from the transducer to the engine during the low pressure half of the cycle. Due to the change in the density of the gas in the working space during the cycle, the mass flow would not be the same in both directions. This causes a net mass flow of gas toward the transducer which continues until the mean pressure in the transducer is above the mean pressure in the engine to force the net mass flow to become zero.

To prove that this actually did effect the pressure readings of the engine, the output signals of the mean pressure transducers were connected to a strip chart recorder to record the pressure readings versus time. With the engine running at a steady-state condition, the orifice size of the mean compression space transducer (MEANCP), was varied. As the orifice size was reduced, the output signal of the transducer increased. As the orifice size was increased, the output signal was lowered until a point was reached where the pressure wave of the engine started to show in the output signal of the transducer. During this test the output of the mean bounce space pressure transducer (MEANBP), was observed to remain constant.

Because of these results, it may be more accurate to use the value of MEANBP as a representation of the true mean pressure level of the engine. This transducer is less susceptible to this sort of error because the pressure wave in the bounce space is extremely small in the RE-1000. The true mean pressure of the working space should be higher than that of the bounce space only by the amount needed to support the weight of the power piston. The pressure required is about 20.9 kPa (3.03 psi) for the standard power piston.

During the recording of some data points, 1020 to 1025, a failure in the thermocouples that measured the temperature differential of the water used to cool the engine resulted in erroneous calculations of the heat rejection from the engine cooler. These readings were for a series of points with the average heater tube temperature set at 500 °C. Figure 30 shows the recorded values of cooler heat rejection versus the power piston stroke. The 500 °C curve clearly does not follow the trends of the other curves. By using a curve fitting technique applied to the data points with the heater tube average temperature set at 450, 550, and 600 °C, values for the heat rejected during the 500 °C run were predicted. The predicted values of heat rejection are also plotted. In addition, figure 30 shows the measured and predicted values of the engine efficiency plotted as a function of heater temperature and piston stroke. From the closeness of the curve fitting technique used, it is felt that these analytical values are valid when coupled with the experimental data.

On some data points, the instrumentation used to measure QCOOLR proved to be correct while the trends of the internal efficiency were opposite to the expected classical Stirling engine trends. It was noted that as the cooling water inlet temperature was raised the calculation of INTEFF diverted from the calculation of EXTEFF. The only difference between the two methods used to calculate the engine brake efficiency was the representation of the heat input to the engine system. EXTEFF was based on the electric power supplied to the heater head while INTEFF was based on the summation of the power and heat flowing out of the engine system. The calculated values of efficiency agreed well with one another for data with the cooling water inlet temperature at 25 °C, however, their values diverged as the cooling water inlet temperature was raised to the values of 40 and 55 °C .

It was found that when the cooling water inlet temperature was at 25 °C, there was little heat transferred between the cooler housing and the atmosphere around the engine. At elevated cooling water temperatures some heat was lost directly from the cooler housing to the atmosphere without being detected as an increase in the cooling water temperature as it passed through the cooler. To derive a correction for this measurement would require an assumption to be made so that the heat transfer from the cooler housing to the atmosphere could be calculated. It is best to exclude the use of data points having elevated cooling water inlet temperatures when accurate energy balances are required.

CONCLUDING REMARKS

The effort to complete the sensitivity tests at the NASA Lewis test facility has been completed. A matrix with 8 parameters varied was used to determine the test conditions. The RE-1000 provided a reliable test bed for the investigation of the thermodynamics of the Stirling cycle along with the dynamics of a free-piston engine. Throughout the test program the engine

demonstrated high reliability. Most of the problems encountered involved the instrumentation used to measure the engine performance.

A complete characterization of the engine performance has been recorded and is presented in this report for the purpose of Stirling cycle computer code validation. Some of the measurements made can be of great help in understanding the losses of the Stirling cycle. For some of the data points recorded, the amplitude of the dynamic pressure drop through the heat exchangers was recorded. The measurement technique used for the dynamic pressure drop had to be perfected and therefore was not made during the initial stages of the test program. However, steady-state flow tests were performed on all of the heat exchangers used in the program. During tests utilizing one of the two displacers, the amplitude of the gas pressure inside of the displacer gas spring was recorded. Due to the nonlinearity of a gas spring, this parameter can be of great use in the computer simulation validation process.

SUMMARY OF RESULTS

The data are generally quite accurate and lend themselves well to validation purposes, especially when used as per the recommendations outlined in this report. Because there is some error associated with the measurement of any experimental parameter, care must be used when validating a computer simulation. A rough indication of the error of each measurement and calculation is given in this report.

The RE-1000 was designed to be a reliable, research engine intended to provide easy access to key areas for measurements of critical parameters. This engine was not optimized as a complete engine for high power or for high efficiency. The sensitivity test program did however obtain the following results:

1. The trends contained in the data agree well with the theoretical rules of Stirling engine performance. Power output and efficiencies measured act in accordance with previous engine tests.

2. The test program investigated many characteristics of the engine.

a. Tests were completed over a test matrix which varied the mean operating pressure to three levels, the heater temperature to four levels, the cooler temperature to three levels, both the regenerator porosity and the displacer dynamics to two different values, the power piston mass to two values and used three different working fluids. In addition, the power piston stroke was varied over its range for each of the operating conditions.

b. In the nearly 200 hr of operation accumulated during the sensitivity tests, the engine proved itself to be a reliable test bed for research. The engine was usually found to be more reliable than the instrumentation and supporting data system.

c. During the course of the testing, some novel instrumentation was added to provide a better insight into the operation of the free-piston engine. These measurements included the dynamic pressure drop transducers and the dynamic pressure reading of the displacer gas spring.

d. Steady-state flow tests were performed to enable a correlation between these measurements and the dynamic pressure drop measurements to be made. Although the dynamic pressure drop transducers were working only for the tests performed with one of the two regenerators used, this should still prove to be of great benefit in the validation of computer codes.

APPENDIX A

Heat Exchanger Steady-State Flow Tests

Steady-state flow tests were performed on the RE-1000 heat exchanger assembly. These tests were done for the engine with both of the regenerators used in the sensitivity tests. The two regenerators tested were of 75.9 percent porosity and of 81.2 percent porosity. The tests were run with nitrogen at mass flow rates that gave approximately the Reynolds numbers that occur in the engine during operation.

The pressure drops were measured with the Validyne differential pressure transducers that were installed on the engine for the dynamic pressure drop measurements. The cooler pressure drop and the regenerator pressure drop were measured directly with the transducers installed. The heater pressure drop was calculated from a measurement of the total pressure drop across the heat exchanger assembly, minus the regenerator and cooler pressure drops. The tests were run from zero flow rate, up to the maximum flow desired and back down to zero flow again. If the transducers did not return to zero pressure drop at zero flow, the transducers were adjusted and the tests were rerun.

Tests were run with the mean pressure at either 1380 kPa (200 psi) or at 2070 kPa (300 psi) depending on the requirements of the flow meters being used for the particular test. The mass flow rates were measured with venturi-type flow meters. The measurements of flow rate were corrected for the variations in the temperature of the nitrogen.

The results of these flow tests are presented in the form of graphs of the pressure drops measured versus the mass flow rate. These plots are shown in figure 7 for the tests with regenerator 1 (75.9 percent porosity) and in figure 8 for regenerator 2 (81.2 percent porosity).

APPENDIX B

Data System Calculations

All of the calculations used in the data system are presented in this appendix. For each of the calculations, the parameters used as inputs are listed, the calculation is shown, and an estimate of the error of the calculation is given. The error is based on the estimated errors of the input parameters and was calculated by methods outlined in reference 11. The error of the calculation corresponds to the design point of the engine, data point 1010. A second error calculation is presented that corresponds to data point 1099. This shows the error in the calculations at a low power operating condition. The inputs to the calculations are listed in terms of their mnemonics and can be found in the list of instrumentation in table IV.

CALCULATION 1

ELECTRICAL POWER INPUT (WATTS)

power = voltage x current

PWRIN = voltg x amps

VOLTG heater head voltage (volts)
AMPS calculation 8 (amps)

$$ERROR = [(0.01)^2 + (0.02)^2]^{1/2}$$

ERROR = 2% (73 W)

(ERROR = 4% @ POINT 1099)

CALCULATION 2

HEAT TO THE COOLING WATER BY THE COOLER (WATTS)

heat = (mass flow) (specific heat) (delta temp)

$$QCOOLR = \frac{(FLOCLR)\ (RHOH2O)\ (CPH2O)\ (TDLCLR)}{60}$$

FLOCLR cooling water volumetric flow rate (l/min)
$RHOH_2O$ water density sub-routine (gm/l)
CPH_2O water specific heat sub-routine (joules/gm °C)
TDLHTR cooling water delta temperature (°C)

$$ERROR = [(0.1/4.22)^2 + (0.2/9.34)^2]^{1/2}$$

ERROR = 3% (82 W)

(ERROR = 6% @ POINT 1099)

CALCULATION 3

HEAT TO THE COOLING WATER BY THE DASHPOT (WATTS)

heat = (mass flow) (specific heat) (delta temp)

$$QDSHPT = \frac{(FLODP)\ (RHOH2O)\ (CPH2O)\ (TDLDP)}{60}$$

FLODP dashpot water volumetric flow rate (l/min)
$RHOH_2O$ water density sub-routine (gm/l)
CPH_2O water specific heat sub-routine (joules/gm °C)
TDLDP dashpot water delta temperature (°C)

$$ERROR = [(0.1/3.96)^2 + (0.2/2.21)^2]^{1/2}$$

$$ERROR = [(0.1/3.96)^2 + (0.2/2.21)^2]^{1/2}$$

ERROR = 9% (55 W)

(ERROR = 51% @ 1099)

CALCULATION 4

BRAKE ENGINE EFFICIENCY, EXTERNAL (%)

$$\text{efficiency} = \frac{\text{brake power output}}{\text{electric power input}}$$

$$EXTEFF = \frac{PWROUT}{PWRIN}$$

PWROUT brake power output, analog circuit (W)
PWRIN electric heater power input (W)

$$ERROR = [(0.03)^2 + (0.02)^2]^{1/2}$$

ERROR = 4%

(ERROR = 6% @ POINT 1099)

CALCULATION 5

AVERAGE HEATER TUBE TEMPERATURE (°C)

$$\text{temperature} = \frac{\text{summation of 12 tube temps}}{12}$$

$$TAVHTR = \frac{\text{summation T01HTR to T12HTR}}{12}$$

TxxHTR heater tube outside wall temperature (°C)

$$ERROR = [12(10/600)^2]^{1/2}$$

ERROR = 6% (36 °C)

(ERROR = 8% @ POINT 1099)

CALCULATION 6

BRAKE ENGINE EFFICIENCY, INTERNAL (%)

$$\text{efficiency} = \frac{\text{brake power output}}{\text{brake power + heat rejected}}$$

$$INTEFF = \frac{PWROUT}{PWROUT + QCOOLR}$$

PWROUT brake power output, analog circuit (W)
QCOOLR heat rejected by the engine cooler (W)

$$ERROR = [(0.03)^2 + (0.03)^2 + (0.03)^2]^{1/2}$$

$$ERROR = 5\%$$

(ERROR = 9% @ POINT 1099)

CALCULATION 8

HEATER AMPERAGE (°C)

amperage = amperage 1 + amperage 2

AMPS = AMPS1 + AMPS2

AMPS1 amperage from power supply 1 (A)
AMPS2 amperage from power supply 2 (A)

$$ERROR = [(10/673)^2 + (10/618)^2]^{1/2}$$

ERROR = 2% (28 A)

(ERROR = 4% @ POINT 1099)

CALCULATION 9

DISPLACER GAS CONDUCTION (WATTS)

heat = (gas conductivity) (conduction area) (delta temp)

QDISPG = (Kg) (2.76) (TGEXP-TGCOMP)

Kg gas conductivity (W/cm °C)
2.76 cross section of gas (cm^2)
TGEXP expansion space gas temperature (°C)
TGCOMP compression space gas temperature (°C)

$$ERROR = \frac{10 + 1}{(557-56)}$$

ERROR = 2% (0.06 W)

(ERROR = 3% @ POINT 1099)

CALCULATION 10

DISPLACER SHELL CONDUCTION (WATTS)

heat = (shell conductivity) (conduction area) (delta temp)

QDISP = (Km) (0.0284) (TGEXP-TGCOMP)

Km	displacer metal conductivity (W/cm °C)
0.00284	conduction area (cm^2)
TGEXP	expansion space gas temperature (°C)
TGCOMP	compression space gas temperature (°C)

$$\text{ERROR} = \frac{10 + 1}{(557-56)}$$

ERROR = 2% (0.28 W)

(ERROR = 3% @ POINT 1099)

CALCULATION 11

REGENERATOR WALL CONDUCTION, COOL END (WATTS)

heat = (Km) (conduction area) (delta temp)

QREG1 = 0.811 (T18REG-T19REG)

0.811	metal conductivity times conduction area (W cm/°C)
T18REG	regenerator wall temperature, midpoint (°C)
T19REG	regenerator wall temperature, cool and (°C)

$$\text{ERROR} = \frac{5 + 5}{(339-221)}$$

ERROR = 8% (7.7 W)

(ERROR = 9% @ POINT 1099)

CALCULATION 12

REGENERATOR WALL CONDUCTION, COOL END (WATTS)

heat = (Km) (conduction area) (delta temp)

QREG2 = 0.811 (T14REG-T18REG)

0.811	metal conductivity times conduction area (W/cm °C)
T14REG	regenerator wall temperature, hot end (°C)
T18REG	regenerator wall temperature, midpoint (°C)

$$\text{ERROR} = \frac{10 + 5}{(339-221)}$$

ERROR = 9% (12.5 W)

(ERROR = 13% @ POINT 1099)

CALCULATION 13

INNER REGENERATOR WALL CONDUCTION (WATTS)

heat = (Km) (conduction area) (delta temp)

$$QREG3 = 0.0774\ (TGREGH - TGREGC)$$

0.0774	metal conductivity times conduction area (W cm/°C)
TREGH	regenerator hot end gas temperature (°C)
TREGC	regenerator cold end gas temperature (°C)

$$ERROR = \frac{10 + 1}{(549-91)}$$

ERROR = 2% (0.7 W)

(ERROR = 3% @ POINT 1099)

CALCULATION 14

PRESSURE FACTOR OF THE POWER PISTON (kPa/cm)

$$\text{factor} = \frac{\text{(compression space pressure amplitude)}}{\text{(piston amplitude)}}\ \text{(trig term)}$$

$$PFP = \frac{2(PAMPC)\ (\cos \theta p + (\sin \theta p / \tan \theta d))}{(PISTST)}$$

PAMPC	pressure amplitude in the compression space (kPa)
θp	phase angle, pressure to power piston (deg)
PISTST	power piston stroke (cm)

ERROR = 3%

(ERROR = 5% @ POINT 1099)

CALCULATION 15

PRESSURE FACTOR OF THE DISPLACER (kPa/cm)

$$\text{factor} = \frac{\text{(compression space pressure amplitude)}}{\text{(displacer amplitude)}}\ \text{(trig term)}$$

$$PFD = \frac{(PAMPC)\ (\sin \theta p)2}{(DISPST)\ (\sin \theta d)}$$

PAMPC	pressure amplitude in the compression space (kPa)
θp	phase angle, pressure to power piston (deg)
DISPST	displacer stroke (cm)
θd	phase angle, displacer to power piston (deg)

ERROR = 2%

(ERROR = 4% @ POINT 1099)

CALCULATION 16

BEALE NUMBER

$$\text{number} = \frac{\text{brake power output}}{(\text{mean pressure})\ (\text{swept volume})\ (\text{frequency})}$$

$$\text{NBEALE} = \frac{(100)\ \text{PWROUT}}{(\text{MEANBP})\ (\text{PISTST})\ (\text{AREA})\ (\text{FREQ})}$$

PWROUT	brake power output, analog circuit (W)
MEANBP	mean bounce space pressure (kPa)
PISTST	power piston stroke (cm)
AREA	cross section area of the power piston (cm^2)
FREQ	operating frequency of the engine (Hz)

ERROR = 3%

(ERROR = 5% @ POINT 1099)

APPENDIX C

Double Variable Data Set, (DVDS)

Listing of the DVDS are presented in this appendix. These data points were determined by letting the stroke of the power piston be varied over its range for each one of the data points of the Single Variable Data Set (SVDS). The format of the listing is the same as used for the SVDS.

APPENDIX C. - DOUBLE VARIABLE DATA SET, (DVDS)

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/17/83 09:56:39.76 RDG 598

FLUID HELIUM BAROM 14.268 PSI REGENERATOR 2 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.17 L/MIN
TWINDP 16.5 DEG.C
TDLDP 1.55 DEG.C
TWODPR 18.6 DEG.C

POWER IN
AMPS1 606. AMPS
AMPS2 535. AMPS
VOLTG 2.50 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7411. KPA
MEANBP 7003. KPA
MEANCP 7026. KPA

GAS TEMPERATURES
TGEXP 566.0 DEG.C
TGREGH 547.6 DEG.C
TGREGC 96.2 DEG.C
TGCOMP 45.7 DEG.C
TGBOUN 28.7 DEG.C

SURFACE TEMPERATURE
T01HTR 591.2 DEG.C
T02HTR 617.6 DEG.C
T03HTR 610.5 DEG.C
T04HTR 602.9 DEG.C
T05HTR 609.2 DEG.C
T06HTR 586.2 DEG.C
T07HTR 586.5 DEG.C
T08HTR 604.9 DEG.C
T09HTR 621.1 DEG.C
T10HTR 552.6 DEG.C
T11HTR 601.0 DEG.C
T12HTR 609.9 DEG.C
T13REG 566.3 DEG.C
T14REG 532.1 DEG.C
T15REG 406.3 DEG.C
T16REG****** DEG.C
T17REG 357.7 DEG.C
T18REG 381.5 DEG.C
T19REG 254.3 DEG.C
T03HED 221.0 DEG.C

HEAT TO COOLER
FLOCLR 4.02 L/MIN
TWINCL 24.8 DEG.C
TDLCL 6.42 DEG.C
TWOCLR 31.19 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2848. WATTS
2 QCOOLR 1789. WATTS
3 QDSHPT 450. WATTS
4 EXTEFF 24.9 %
5 TAVHTR 599.5 DEG.C
6 INTEFF 28.4 %
8 AMPS 1140. AMPS
9 QDISPG 3. WATTS
10 QDISP 15. WATTS
11 QREG1 103. WATTS
12 QREG2 122. WATTS
13 QREG3 35. WATTS
14 PFP 1024.5 KPA/CM
15 PFD 385.1 KPA/CM
16 NBEALE 0.00741

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 5.7 CM/S

PHASE ANGLES
PADISP 54.7 DEG.
PAPRES -27.1 DEG.

ENGINE SPEED
FREQ 29.9 HZ

REMOTE CALCULATIONS
PWROUT 709. WATTS
INDPWR 739. WATTS
PISTST 1.78 CM
DISPST 2.18 CM

DYNAMIC CALCULATIONS
PAMPC 753. KPA
DISPCP 1.89 CM
PISTCP 2.50 CM
PDYNDB****** KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/17/83 10:01:48.78 RDG 599

FLUID HELIUM BAROM 14.268 PSI REGENERATOR 2 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.16 L/MIN
TWINDP 16.7 DEG.C
TDLDP 1.83 DEG.C
TWODPR 19.1 DEG.C

POWER IN
AMPS1 643. AMPS
AMPS2 568. AMPS
VOLTG 2.65 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7147. KPA
MEANBP 6996. KPA
MEANCP 7019. KPA

GAS TEMPERATURES
TGEXP 563.3 DEG.C
TGREGH 547.3 DEG.C
TGREGC 99.6 DEG.C
TGCOMP 49.4 DEG.C
TGBOUN 30.1 DEG.C

SURFACE TEMPERATURE
T01HTR 594.8 DEG.C
T02HTR 614.9 DEG.C
T03HTR 612.3 DEG.C
T04HTR 601.6 DEG.C
T05HTR 607.2 DEG.C
T06HTR 589.3 DEG.C
T07HTR 583.0 DEG.C
T08HTR 604.1 DEG.C
T09HTR 622.0 DEG.C
T10HTR 550.5 DEG.C
T11HTR 601.0 DEG.C
T12HTR 607.2 DEG.C
T13REG 563.8 DEG.C
T14REG 529.8 DEG.C
T15REG 404.5 DEG.C
T16REG****** DEG.C
T17REG 364.9 DEG.C
T18REG 378.5 DEG.C
T19REG 254.0 DEG.C
T03HED 248.6 DEG.C

HEAT TO COOLER
FLOCLR 4.06 L/MIN
TWINCL 24.9 DEG.C
TDLCL 7.14 DEG.C
TWOCLR 32.02 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3214. WATTS
2 QCOOLR 2010. WATTS
3 QDSHPT 531. WATTS
4 EXTEFF 26.1 %
5 TAVHTR 599.0 DEG.C
6 INTEFF 29.4 %
8 AMPS 1212. AMPS
9 QDISPG 3. WATTS
10 QDISP 15. WATTS
11 QREG1 101. WATTS
12 QREG2 123. WATTS
13 QREG3 35. WATTS
14 PFP 1015.6 KPA/CM
15 PFD 376.6 KPA/CM
16 NBEALE 0.00783

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 6.4 CM/S

PHASE ANGLES
PADISP 55.4 DEG.
PAPRES -25.6 DEG.

ENGINE SPEED
FREQ 29.8 HZ

REMOTE CALCULATIONS
PWROUT 839. WATTS
INDPWR 878. WATTS
PISTST 2.00 CM
DISPST 2.36 CM

DYNAMIC CALCULATIONS
PAMPC 846. KPA
DISPCP 1.99 CM
PISTCP 2.58 CM
PDYNDB****** KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/17/83 10:06:54.78 RDG 600

FLUID HELIUM BAROM 14.268 PSI REGENERATOR 2 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.13 L/MIN
TWINDP 16.8 DEG.C
TDLDP 2.16 DEG.C
TWODPR 19.7 DEG.C

POWER IN
AMPS1 692. AMPS
AMPS2 607. AMPS
VOLTG 2.84 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7428. KPA
MEANBP 7001. KPA
MEANCP 7031. KPA

GAS TEMPERATURES
TGEXP 562.2 DEG.C
TGREGH 547.8 DEG.C
TGREGC 103.0 DEG.C
TGCOMP 53.5 DEG.C
TGBOUN 32.1 DEG.C

SURFACE TEMPERATURE
T01HTR 599.6 DEG.C
T02HTR 617.4 DEG.C
T03HTR 617.2 DEG.C
T04HTR 603.1 DEG.C
T05HTR 610.3 DEG.C
T06HTR 592.9 DEG.C
T07HTR 584.0 DEG.C
T08HTR 606.1 DEG.C
T09HTR 625.6 DEG.C
T10HTR 550.1 DEG.C
T11HTR 603.6 DEG.C
T12HTR 609.4 DEG.C
T13REG 564.7 DEG.C
T14REG 530.9 DEG.C
T15REG 405.9 DEG.C
T16REG****** DEG.C
T17REG 368.4 DEG.C
T18REG 381.4 DEG.C
T19REG 256.9 DEG.C
T03HED 276.8 DEG.C

HEAT TO COOLER
FLOCLR 4.09 L/MIN
TWINCL 25.0 DEG.C
TDLCL 8.09 DEG.C
TWOCLR 33.11 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3684. WATTS
2 QCOOLR 2296. WATTS
3 QDSHPT 622. WATTS
4 EXTEFF 26.5 %
5 TAVHTR 601.6 DEG.C
6 INTEFF 29.8 %
8 AMPS 1299. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 101. WATTS
12 QREG2 121. WATTS
13 QREG3 34. WATTS
14 PFP 1027.1 KPA/CM
15 PFD 372.6 KPA/CM
16 NBEALE 0.00823

VIBRATION
VX1HOR 0.5 CM/S
VY1VER 7.2 CM/S

PHASE ANGLES
PADISP 56.1 DEG.
PAPRES -24.1 DEG.

ENGINE SPEED
FREQ 29.9 HZ

REMOTE CALCULATIONS
PWROUT 976. WATTS
INDPWR 1021. WATTS
PISTST 2.21 CM
DISPST 2.52 CM

DYNAMIC CALCULATIONS
PAMPC 955. KPA
DISPCP 2.01 CM
PISTCP 2.58 CM
PDYNDB****** KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/17/83 10:12:06.78 RDG 601

FLUID HELIUM BAROM 14.268 PSI REGENERATOR 2 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.12 L/MIN	AMPS1	742. AMPS	PRESUP	7134. KPA	TGEXP	557.6 DEG.C	T01HTR	598.3 DEG.C
		AMPS2	627. AMPS					T02HTR	615.7 DEG.C
TWINDP	17.1 DEG.C	VOLTG	2.98 VOLTS	MEANBP	6983. KPA	TGREGH	543.3 DEG.C	T03HTR	616.6 DEG.C
TDLDP	2.55 DEG.C			MEANCP	7021. KPA	TGREGC	101.9 DEG.C	T04HTR	599.0 DEG.C
TWODPR	20.2 DEG.C					TGCOMP	57.1 DEG.C	T05HTR	609.3 DEG.C
						TGBOUN	34.1 DEG.C	T06HTR	590.2 DEG.C
								T07HTR	580.9 DEG.C
								T08HTR	603.6 DEG.C
								T09HTR	622.6 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	545.0 DEG.C
FLOCLR	4.13 L/MIN	1 PWRIN	4080. WATTS	VX1HOR	0.5 CM/S	PWROUT	1077. WATTS	T11HTR	601.4 DEG.C
TWINCL	25.1 DEG.C	2 QCOOLR	2589. WATTS	VY1VER	7.8 CM/S	INDPWR	1125. WATTS	T12HTR	607.7 DEG.C
TDLCL	9.03 DEG.C	3 QDSHPT	730. WATTS			PISTST	2.38 CM		
TWOCLR	34.11 DEG.C	4 EXTEFF	26.4 %	PHASE ANGLES		DISPST	2.65 CM		
		5 TAVHTR	599.2 DEG.C	PADISP	57.1 DEG.			T13REG	561.0 DEG.C
		6 INTEFF	29.4 %	PAPRES	-22.5 DEG.	DYNAMIC CALCULATIONS		T14REG	525.9 DEG.C
		8 AMPS	1369. AMPS			PAMPC	546. KPA	T15REG	397.9 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.05 CM	T16REG	****** DEG.C
		10 QDISP	14. WATTS	FREQ	29.9 HZ	PISTCP	2.56 CM	T17REG	357.2 DEG.C
		11 QREG1	102. WATTS			PDYNDB	****** KPA	T18REG	378.2 DEG.C
		12 QREG2	120. WATTS			PDLCLR	****** KPA	T19REG	252.1 DEG.C
		13 QREG3	34. WATTS			PDLREG	****** KPA		
		14 PFP	537.5 KPA/CM			PDLDIS	****** KPA	T03HED	285.9 DEG.C
		15 PFD	188.0 KPA/CM						
		16 NBEALE	0.00843						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/17/83 10:17:21.80 RDG 602

FLUID HELIUM BAROM 14.268 PSI REGENERATOR 2 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.10 L/MIN	AMPS1	776. AMPS	PRESUP	7482. KPA	TGEXP	554.8 DEG.C	T01HTR	609.3 DEG.C
		AMPS2	651. AMPS					T02HTR	609.9 DEG.C
TWINDP	17.3 DEG.C	VOLTG	3.11 VOLTS	MEANBP	7013. KPA	TGREGH	547.0 DEG.C	T03HTR	619.7 DEG.C
TDLDP	2.94 DEG.C			MEANCP	7056. KPA	TGREGC	101.9 DEG.C	T04HTR	594.8 DEG.C
TWODPR	20.9 DEG.C					TGCOMP	61.6 DEG.C	T05HTR	604.4 DEG.C
						TGBOUN	36.9 DEG.C	T06HTR	602.3 DEG.C
								T07HTR	573.2 DEG.C
								T08HTR	605.9 DEG.C
								T09HTR	619.2 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	546.2 DEG.C
FLOCLR	4.17 L/MIN	1 PWRIN	4433. WATTS	VX1HOR	0.5 CM/S	PWROUT	1216. WATTS	T11HTR	603.4 DEG.C
TWINCL	25.2 DEG.C	2 QCOOLR	2789. WATTS	VY1VER	8.5 CM/S	INDPWR	1262. WATTS	T12HTR	603.9 DEG.C
TDLCL	9.94 DEG.C	3 QDSHPT	840. WATTS			PISTST	2.58 CM		
TWOCLR	34.80 DEG.C	4 EXTEFF	27.4 %	PHASE ANGLES		DISPST	2.72 CM		
		5 TAVHTR	599.3 DEG.C	PADISP	57.1 DEG.			T13REG	553.7 DEG.C
		6 INTEFF	30.4 %	PAPRES	-21.6 DEG.	DYNAMIC CALCULATIONS		T14REG	514.8 DEG.C
		8 AMPS	1427. AMPS			PAMPC	1127. KPA	T15REG	376.7 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.11 CM	T16REG	****** DEG.C
		10 QDISP	14. WATTS	FREQ	29.9 HZ	PISTCP	2.64 CM	T17REG	355.8 DEG.C
		11 QREG1	106. WATTS			PDYNDB	****** KPA	T18REG	366.0 DEG.C
		12 QREG2	121. WATTS			PDLCLR	****** KPA	T19REG	235.5 DEG.C
		13 QREG3	34. WATTS			PDLREG	****** KPA		
		14 PFP	1019.5 KPA/CM			PDLDIS	****** KPA	T03HED	293.5 DEG.C
		15 PFD	362.7 KPA/CM						
		16 NBEALE	0.00875						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:35:55.03 RDG 1006

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	3.96 L/MIN	AMPS1	534. AMPS	PRESUP	7365. KPA	TGEXP	567.8 DEG.C	T01HTR	601.6 DEG.C
		AMPS2	503. AMPS					T02HTR	605.5 DEG.C
TWINDP	17.7 DEG.C	VOLTG	2.25 VOLTS	MEANBP	7011. KPA	TGREGH	564.5 DEG.C	T03HTR	612.6 DEG.C
TDLDP	1.15 DEG.C			MEANCP	7040. KPA	TGREGC	90.7 DEG.C	T04HTR	606.4 DEG.C
TWODPR	19.6 DEG.C					TGCOMP	39.9 DEG.C	T05HTR	614.3 DEG.C
						TGBOUN	27.9 DEG.C	T06HTR	606.3 DEG.C
								T07HTR	604.5 DEG.C
								T08HTR	584.1 DEG.C
								T09HTR	608.8 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	591.8 DEG.C
FLOCLR	4.22 L/MIN	1 PWRIN	2338. WATTS	VX1HOR	0.2 CM/S	PWROUT	532. WATTS	T11HTR	578.7 DEG.C
TWINCL	24.7 DEG.C	2 QCOOLR	1892. WATTS	VY1VER	5.9 CM/S	INDPWR	570. WATTS	T12HTR	580.2 DEG.C
TDLCL	6.47 DEG.C	3 QDSHPT	317. WATTS			PISTST	1.80 CM		
TWOCLR	29.47 DEG.C	4 EXTEFF	22.7 %	PHASE ANGLES		DISPST	1.83 CM		
		5 TAVHTR	599.6 DEG.C	PADISP	56.0 DEG.			T13REG	****** DEG.C
		6 INTEFF	21.9 %	PAPRES	-19.8 DEG.	DYNAMIC CALCULATIONS		T14REG	518.3 DEG.C
		8 AMPS	1037. AMPS			PAMPC	792. KPA	T15REG	384.4 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.13 CM	T16REG	386.7 DEG.C
		10 QDISP	15. WATTS	FREQ	30.2 HZ	PISTCP	2.31 CM	T17REG	376.6 DEG.C
		11 QREG1	119. WATTS			PDYNDB	****** KPA	T18REG	372.8 DEG.C
		12 QREG2	118. WATTS			PDLCLR	3.22 KPA	T19REG	225.5 DEG.C
		13 QREG3	37. WATTS			PDLREG	37.33 KPA		
		14 PFP	1029.1 KPA/CM			PDLDIS	65.16 KPA	T03HED	****** DEG.C
		15 PFD	353.7 KPA/CM						
		16 NBEALE	0.00544						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:40:22.06 RDG 1007

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES
FLODP	3.94 L/MIN	AMPS1	571. AMPS	PRESUP	7469. KPA	TGEXP	564.8 DEG.C	T01HTR 602.6 DEG.C
		AMPS2	533. AMPS					T02HTR 605.0 DEG.C
TWINDP	17.8 DEG.C	VOLTG	2.40 VOLTS	MEANBP	6982. KPA	TGREGH	563.7 DEG.C	T03HTR 613.7 DEG.C
TDLDP	1.42 DEG.C			MEANCP	7013. KPA	TGREGC	92.6 DEG.C	T04HTR 605.5 DEG.C
TWODPR	19.8 DEG.C					TGCOMP	42.0 DEG.C	T05HTR 615.7 DEG.C
						TGBOUN	29.0 DEG.C	T06HTR 607.1 DEG.C
								T07HTR 605.4 DEG.C
								T08HTR 583.8 DEG.C
								T09HTR 609.7 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS			VIBRATION		REMOTE CALCULATIONS		
FLOCLR	4.24 L/MIN	1	PWRIN	2648. WATTS	VX1HOR	0.3 CM/S	PWROUT	622. WATTS	T10HTR 590.4 DEG.C
TWINCL	24.7 DEG.C	2	QCOOLR	2004. WATTS	VY1VER	6.6 CM/S	INDPWR	665. WATTS	T11HTR 577.8 DEG.C
TDLCL	6.82 DEG.C	3	QDSHPT	390. WATTS			PISTST	2.01 CM	T12HTR 577.7 DEG.C
TWOCLR	29.95 DEG.C	4	EXTEFF	23.5 %	PHASE ANGLES		DISPST	1.97 CM	
		5	TAVHTR	599.5 DEG.C	PADISP	56.6 DEG.			T13REG****** DEG.C
		6	INTEFF	23.7 %	PAPRES	-18.9 DEG.	DYNAMIC CALCULATIONS		T14REG 517.9 DEG.C
		8	AMPS	1104. AMPS			PAMPC	881. KPA	T15REG 385.7 DEG.C
		9	QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.24 CM	T16REG 388.3 DEG.C
		10	QDISP	15. WATTS	FREQ	30.2 HZ	PISTCP	2.34 CM	T17REG 377.9 DEG.C
		11	QREG1	118. WATTS			PDYNDB****** KPA		T18REG 373.3 DEG.C
		12	QREG2	117. WATTS			PDLCLR	3.73 KPA	T19REG 228.0 DEG.C
		13	QREG3	36. WATTS			PDLREG	42.43 KPA	
		14	PFP	1018.7 KPA/CM			PDLDIS	73.65 KPA	T03HED****** DEG.C
		15	PFD	345.8 KPA/CM					
		16	NBEALE	0.00573					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:46:40.06 RDG 1008

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES
FLODP	3.94 L/MIN	AMPS1	604. AMPS	PRESUP	7055. KPA	TGEXP	562.6 DEG.C	T01HTR 603.8 DEG.C
		AMPS2	557. AMPS					T02HTR 604.7 DEG.C
TWINDP	17.8 DEG.C	VOLTG	2.53 VOLTS	MEANBP	6988. KPA	TGREGH	563.2 DEG.C	T03HTR 615.3 DEG.C
TDLDP	1.72 DEG.C			MEANCP	7023. KPA	TGREGC	94.9 DEG.C	T04HTR 605.1 DEG.C
TWODPR	20.2 DEG.C					TGCOMP	45.4 DEG.C	T05HTR 617.5 DEG.C
						TGBOUN	30.6 DEG.C	T06HTR 608.2 DEG.C
								T07HTR 606.3 DEG.C
								T08HTR 584.0 DEG.C
								T09HTR 610.7 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS			VIBRATION		REMOTE CALCULATIONS		
FLOCLR	4.23 L/MIN	1	PWRIN	2930. WATTS	VX1HOR	0.3 CM/S	PWROUT	703. WATTS	T10HTR 589.5 DEG.C
TWINCL	24.7 DEG.C	2	QCOOLR	2233. WATTS	VY1VER	7.2 CM/S	INDPWR	753. WATTS	T11HTR 577.5 DEG.C
TDLCL	7.61 DEG.C	3	QDSHPT	470. WATTS			PISTST	2.20 CM	T12HTR 576.1 DEG.C
TWOCLR	30.73 DEG.C	4	EXTEFF	24.0 %	PHASE ANGLES		DISPST	2.09 CM	
		5	TAVHTR	599.9 DEG.C	PADISP	56.7 DEG.			T13REG****** DEG.C
		6	INTEFF	23.9 %	PAPRES	-17.7 DEG.	DYNAMIC CALCULATIONS		T14REG 518.7 DEG.C
		8	AMPS	1160. AMPS			PAMPC	979. KPA	T15REG 388.8 DEG.C
		9	QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.27 CM	T16REG 389.2 DEG.C
		10	QDISP	15. WATTS	FREQ	30.2 HZ	PISTCP	2.34 CM	T17REG 380.1 DEG.C
		11	QREG1	117. WATTS			PDYNDB****** KPA		T18REG 376.6 DEG.C
		12	QREG2	115. WATTS			PDLCLR	4.07 KPA	T19REG 232.8 DEG.C
		13	QREG3	36. WATTS			PDLREG	47.86 KPA	
		14	PFP	1025.2 KPA/CM			PDLDIS	82.13 KPA	T03HED****** DEG.C
		15	PFD	339.6 KPA/CM					
		16	NBEALE	0.00589					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:50:22.06 RDG 1009

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES
FLODP	3.97 L/MIN	AMPS1	637. AMPS	PRESUP	7339. KPA	TGEXP	561.2 DEG.C	T01HTR 602.1 DEG.C
		AMPS2	585. AMPS					T02HTR 608.6 DEG.C
TWINDP	17.8 DEG.C	VOLTG	2.66 VOLTS	MEANBP	6999. KPA	TGREGH	558.0 DEG.C	T03HTR 616.2 DEG.C
TDLDP	1.97 DEG.C			MEANCP	7036. KPA	TGREGC	94.3 DEG.C	T04HTR 604.3 DEG.C
TWODPR	20.5 DEG.C					TGCOMP	48.5 DEG.C	T05HTR 620.1 DEG.C
						TGBOUN	32.1 DEG.C	T06HTR 611.6 DEG.C
								T07HTR 610.2 DEG.C
								T08HTR 581.4 DEG.C
								T09HTR 609.4 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS			VIBRATION		REMOTE CALCULATIONS		
FLOCLR	4.23 L/MIN	1	PWRIN	3253. WATTS	VX1HOR	0.3 CM/S	PWROUT	794. WATTS	T10HTR 588.8 DEG.C
TWINCL	24.7 DEG.C	2	QCOOLR	2505. WATTS	VY1VER	7.9 CM/S	INDPWR	856. WATTS	T11HTR 573.6 DEG.C
TDLCL	8.53 DEG.C	3	QDSHPT	545. WATTS			PISTST	2.40 CM	T12HTR 577.0 DEG.C
TWOCLR	31.51 DEG.C	4	EXTEFF	24.4 %	PHASE ANGLES		DISPST	2.22 CM	
		5	TAVHTR	600.3 DEG.C	PADISP	57.1 DEG.			T13REG****** DEG.C
		6	INTEFF	24.1 %	PAPRES	-16.5 DEG.	DYNAMIC CALCULATIONS		T14REG 517.8 DEG.C
		8	AMPS	1222. AMPS			PAMPC	1063. KPA	T15REG 384.9 DEG.C
		9	QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.37 CM	T16REG 378.4 DEG.C
		10	QDISP	15. WATTS	FREQ	30.2 HZ	PISTCP	2.38 CM	T17REG 364.0 DEG.C
		11	QREG1	108. WATTS			PDYNDB****** KPA		T18REG 364.0 DEG.C
		12	QREG2	125. WATTS			PDLCLR	5.43 KPA	T19REG 231.2 DEG.C
		13	QREG3	36. WATTS			PDLREG	52.95 KPA	
		14	PFP	1012.0 KPA/CM			PDLDIS	90.28 KPA	T03HED****** DEG.C
		15	PFD	324.2 KPA/CM					
		16	NBEALE	0.00609					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:55:25.06 RDG 1010

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	3.96 L/MIN	AMPS1	673. AMPS	PRESUP	7464. KPA	TGEXP	557.5 DEG.C	T01HTR	598.1 DEG.C
		AMPS2	619. AMPS					T02HTR	610.5 DEG.C
TWINDP	17.8 DEG.C	VOLTG	2.82 VOLTS	MEANBP	6988. KPA	TGREGH	548.5 DEG.C	T03HTR	614.9 DEG.C
TDLDP	2.21 DEG.C			MEANCP	7032. KPA	TGREGC	90.7 DEG.C	T04HTR	601.4 DEG.C
TWODPR	20.8 DEG.C					TGCOMP	55.7 DEG.C	T05HTR	621.1 DEG.C
						TGBOUN	33.4 DEG.C	T06HTR	613.0 DEG.C
								T07HTR	611.9 DEG.C
								T08HTR	576.7 DEG.C
								T09HTR	605.4 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	586.4 DEG.C
FLOCLR	4.22 L/MIN	1 PWRIN	3643. WATTS	VX1HOR	0.4 CM/S	PWROUT	866. WATTS	T11HTR	567.1 DEG.C
TWINCL	24.8 DEG.C	2 QCOOLR	2736. WATTS	VY1VER	8.5 CM/S	INDPWR	939. WATTS	T12HTR	576.9 DEG.C
TDLCL	9.34 DEG.C	3 QDSHPT	607. WATTS			PISTST	2.60 CM		
TWOCLR	32.52 DEG.C	4 EXTEFF	23.8 %	PHASE ANGLES		DISPST	2.34 CM		
		5 TAVHTR	598.6 DEG.C	PADISP	57.5 DEG.			T13REG	****** DEG.C
		6 INTEFF	24.0 %	PAPRES	-15.7 DEG.	DYNAMIC CALCULATIONS		T14REG	510.3 DEG.C
		8 AMPS	1292. AMPS			PAMPC	1147. KPA	T15REG	368.0 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.37 CM	T16REG	350.7 DEG.C
		10 QDISP	14. WATTS	FREQ	30.1 HZ	PISTCP	2.33 CM	T17REG	331.5 DEG.C
		11 QREG1	96. WATTS			PDYNDB	****** KPA	T18REG	338.9 DEG.C
		12 QREG2	139. WATTS			PDLCLR	6.79 KPA	T19REG	221.0 DEG.C
		13 QREG3	35. WATTS			PDLREG	55.66 KPA		
		14 PFP	1002.8 KPA/CM			PDLDIS	95.71 KPA	T03HED	****** DEG.C
		15 PFD	314.1 KPA/CM						
		16 NBEALE	0.00617						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:00:55.09 RDG 1011

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	3.93 L/MIN	AMPS1	702. AMPS	PRESUP	7063. KPA	TGEXP	555.5 DEG.C	T01HTR	598.9 DEG.C
		AMPS2	653. AMPS					T02HTR	612.9 DEG.C
TWINDP	17.8 DEG.C	VOLTG	2.98 VOLTS	MEANBP	6987. KPA	TGREGH	545.4 DEG.C	T03HTR	617.1 DEG.C
TDLDP	2.67 DEG.C			MEANCP	7034. KPA	TGREGC	92.1 DEG.C	T04HTR	602.4 DEG.C
TWODPR	21.2 DEG.C					TGCOMP	61.1 DEG.C	T05HTR	624.1 DEG.C
						TGBOUN	35.8 DEG.C	T06HTR	616.0 DEG.C
								T07HTR	614.9 DEG.C
								T08HTR	576.4 DEG.C
								T09HTR	606.9 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	586.4 DEG.C
FLOCLR	4.23 L/MIN	1 PWRIN	4038. WATTS	VX1HOR	0.4 CM/S	PWROUT	955. WATTS	T11HTR	566.2 DEG.C
TWINCL	24.9 DEG.C	2 QCOOLR	3032. WATTS	VY1VER	9.2 CM/S	INDPWR	1030. WATTS	T12HTR	577.3 DEG.C
TDLCL	10.32 DEG.C	3 QDSHPT	732. WATTS			PISTST	2.80 CM		
TWOCLR	33.65 DEG.C	4 EXTEFF	23.7 %	PHASE ANGLES		DISPST	2.45 CM		
		5 TAVHTR	600.0 DEG.C	PADISP	57.5 LEG.			T13REG	****** DEG.C
		6 INTEFF	24.0 %	PAPRES	-15.2 DEG.	DYNAMIC CALCULATIONS		T14REG	506.8 DEG.C
		8 AMPS	1355. AMPS			PAMPC	1250. KPA	T15REG	359.0 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.36 CM	T16REG	339.8 DEG.C
		10 QDISP	14. WATTS	FREQ	30.1 HZ	PISTCP	2.29 CM	T17REG	317.8 DEG.C
		11 QREG1	90. WATTS			PDYNDB	****** KPA	T18REG	326.8 DEG.C
		12 QREG2	146. WATTS			PDLCLR	8.82 KPA	T19REG	216.2 DEG.C
		13 QREG3	35. WATTS			PDLREG	60.41 KPA		
		14 PFP	1010.0 KPA/CM			PDLDIS	103.52 KPA	T03HED	****** DEG.C
		15 PFD	317.9 KPA/CM						
		16 NBEALE	0.00631						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:03:22.09 RDG 1012

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	3.93 L/MIN	AMPS1	742. AMPS	PRESUP	7066. KPA	TGEXP	552.5 DEG.C	T01HTR	598.1 DEG.C
		AMPS2	683. AMPS					T02HTR	613.6 DEG.C
TWINDP	17.9 DEG.C	VOLTG	3.13 VOLTS	MEANBP	7000. KPA	TGREGH	540.3 DEG.C	T03HTR	617.4 DEG.C
TDLDP	2.89 DEG.C			MEANCP	7049. KPA	TGREGC	92.6 DEG.C	T04HTR	601.2 DEG.C
TWODPR	21.4 DEG.C					TGCOMP	65.4 DEG.C	T05HTR	625.1 DEG.C
						TGBOUN	37.2 DEG.C	T06HTR	616.7 DEG.C
								T07HTR	615.6 DEG.C
								T08HTR	574.6 DEG.C
								T09HTR	606.0 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	585.4 DEG.C
FLOCLR	4.24 L/MIN	1 PWRIN	4467. WATTS	VX1HOR	0.4 CM/S	PWROUT	1026. WATTS	T11HTR	563.2 DEG.C
TWINCL	24.9 DEG.C	2 QCOOLR	3265. WATTS	VY1VER	9.8 CM/S	INDPWR	1100. WATTS	T12HTR	576.1 DEG.C
TDLCL	11.10 DEG.C	3 QDSHPT	791. WATTS			PISTST	3.00 CM		
TWOCLR	34.54 DEG.C	4 EXTEFF	23.0 %	PHASE ANGLES		DISPST	2.51 CM		
		5 TAVHTR	599.4 DEG.C	PADISP	57.6 DEG.			T13REG	****** DEG.C
		6 INTEFF	23.9 %	PAPRES	-14.0 DEG.	DYNAMIC CALCULATIONS		T14REG	500.1 DEG.C
		8 AMPS	1426. AMPS			PAMPC	1344. KPA	T15REG	346.2 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.35 CM	T16REG	326.9 DEG.C
		10 QDISP	14. WATTS	FREQ	30.2 HZ	PISTCP	2.26 CM	T17REG	303.8 DEG.C
		11 QREG1	85. WATTS			PDYNDB	****** KPA	T18REG	313.6 DEG.C
		12 QREG2	151. WATTS			PDLCLR	11.20 KPA	T19REG	208.9 DEG.C
		13 QREG3	35. WATTS			PDLREG	63.81 KPA		
		14 PFP	1007.4 KPA/CM			PDLDIS	109.97 KPA	T03HED	****** DEG.C
		15 PFD	306.5 KPA/CM						
		16 NBEALE	0.00631						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:10:31.09 RDG 1013

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 3.91 L/MIN
TWINDP 17.9 DEG.C
TDLDP 1.65 DEG.C
TWODPR 20.2 DEG.C

POWER IN
AMPS1 494. AMPS
AMPS2 487. AMPS
VOLTG 2.14 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7273. KPA
MEANBP 7014. KPA
MEANCP 7048. KPA

GAS TEMPERATURES
TGEXP 521.6 DEG.C
TGREGH 517.7 DEG.C
TGREGC 88.2 DEG.C
TGCOMP 43.2 DEG.C
TGBOUN 34.1 DEG.C

SURFACE TEMPERATURES
T01HTR 551.8 DEG.C
T02HTR 556.2 DEG.C
T03HTR 562.5 DEG.C
T04HTR 556.3 DEG.C
T05HTR 565.1 DEG.C
T06HTR 557.6 DEG.C
T07HTR 555.8 DEG.C
T08HTR 535.2 DEG.C
T09HTR 559.3 DEG.C
T10HTR 543.0 DEG.C
T11HTR 530.5 DEG.C
T12HTR 532.3 DEG.C
T13REG****** DEG.C
T14REG 477.8 DEG.C
T15REG 357.7 DEG.C
T16REG 359.1 DEG.C
T17REG 348.7 DEG.C
T18REG 346.4 DEG.C
T19REG 213.1 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.23 L/MIN
TWINCL 24.8 DEG.C
TDLCL 6.73 DEG.C
TWOCLR 29.88 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2100. WATTS
2 QCOOLR 1978. WATTS
3 QDSHPT 449. WATTS
4 EXTEFF 22.8 %
5 TAVHTR 550.5 DEG.C
6 INTEFF 19.5 %
8 AMPS 981. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 108. WATTS
12 QREG2 107. WATTS
13 QREG3 33. WATTS
14 PFP 1004.7 KPA/CM
15 PFD 312.6 KPA/CM
16 NBEALE 0.00489

VIBRATION
VX1HOR 0.2 CM/S
VY1VER 6.0 CM/S

PHASE ANGLES
PADISP 57.8 DEG.
PAPRES -17.6 DEG.

ENGINE SPEED
FREQ 30.2 HZ

REMOTE CALCULATIONS
PWROUT 479. WATTS
INDPWR 514. WATTS
PISTST 1.80 CM
DISPST 1.81 CM

DYNAMIC CALCULATIONS
PAMPC 792. KPA
DISPCP 2.16 CM
PISTCP 2.31 CM
PDYNDB****** KPA
PDLCLR 3.05 KPA
PDLREG 37.33 KPA
PDLDIS 68.56 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:15:40.12 RDG 1014

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 3.94 L/MIN
TWINDP 17.9 DEG.C
TDLDP 1.82 DEG.C
TWODPR 20.4 DEG.C

POWER IN
AMPS1 537. AMPS
AMPS2 518. AMPS
VOLTG 2.30 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7176. KPA
MEANBP 6998. KPA
MEANCP 7034. KPA

GAS TEMPERATURES
TGEXP 518.2 DEG.C
TGREGH 517.7 DEG.C
TGREGC 89.4 DEG.C
TGCOMP 44.9 DEG.C
TGBOUN 34.7 DEG.C

SURFACE TEMPERATURES
T01HTR 553.9 DEG.C
T02HTR 555.2 DEG.C
T03HTR 564.7 DEG.C
T04HTR 556.1 DEG.C
T05HTR 566.8 DEG.C
T06HTR 557.4 DEG.C
T07HTR 555.6 DEG.C
T08HTR 536.2 DEG.C
T09HTR 560.4 DEG.C
T10HTR 542.4 DEG.C
T11HTR 530.3 DEG.C
T12HTR 529.9 DEG.C
T13REG****** DEG.C
T14REG 476.5 DEG.C
T15REG 358.2 DEG.C
T16REG 359.3 DEG.C
T17REG 351.5 DEG.C
T18REG 348.9 DEG.C
T19REG 215.1 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.22 L/MIN
TWINCL 24.5 DEG.C
TDLCL 7.07 DEG.C
TWOCLR 30.05 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2423. WATTS
2 QCOOLR 2073. WATTS
3 QDSHPT 498. WATTS
4 EXTEFF 22.4 %
5 TAVHTR 550.8 DEG.C
6 INTEFF 20.8 %
8 AMPS 1054. AMPS
9 QDISPG 3. WATTS
10 QDISP 13. WATTS
11 QREG1 109. WATTS
12 QREG2 103. WATTS
13 QREG3 33. WATTS
14 PFP 993.7 KPA/CM
15 PFD 305.2 KPA/CM
16 NBEALE 0.00505

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 6.6 CM/S

PHASE ANGLES
PADISP 58.1 DEG.
PAPRES -16.7 DEG.

ENGINE SPEED
FREQ 30.1 HZ

REMOTE CALCULATIONS
PWROUT 544. WATTS
INDPWR 582. WATTS
PISTST 1.99 CM
DISPST 1.93 CM

DYNAMIC CALCULATIONS
PAMPC 871. KPA
DISPCP 2.33 CM
PISTCP 2.31 CM
PDYNDB****** KPA
PDLCLR 3.56 KPA
PDLREG 42.76 KPA
PDLDIS 74.33 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:20:22.12 RDG 1015

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.10 L/MIN
TWINDP 18.0 DEG.C
TDLDP 1.87 DEG.C
TWODPR 20.5 DEG.C

POWER IN
AMPS1 573. AMPS
AMPS2 552. AMPS
VOLTG 2.45 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7276. KPA
MEANBP 6994. KPA
MEANCP 7035. KPA

GAS TEMPERATURES
TGEXP 515.3 DEG.C
TGREGH 516.9 DEG.C
TGREGC 91.7 DEG.C
TGCOMP 46.8 DEG.C
TGBOUN 34.8 DEG.C

SURFACE TEMPERATURES
T01HTR 555.3 DEG.C
T02HTR 554.2 DEG.C
T03HTR 566.5 DEG.C
T04HTR 555.3 DEG.C
T05HTR 568.3 DEG.C
T06HTR 557.5 DEG.C
T07HTR 555.6 DEG.C
T08HTR 536.4 DEG.C
T09HTR 561.0 DEG.C
T10HTR 541.8 DEG.C
T11HTR 529.2 DEG.C
T12HTR 527.7 DEG.C
T13REG****** DEG.C
T14REG 475.3 DEG.C
T15REG 357.1 DEG.C
T16REG 358.8 DEG.C
T17REG 352.5 DEG.C
T18REG 349.0 DEG.C
T19REG 215.6 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.21 L/MIN
TWINCL 24.4 DEG.C
TDLCL 7.82 DEG.C
TWOCLR 30.61 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2761. WATTS
2 QCOOLR 2285. WATTS
3 QDSHPT 534. WATTS
4 EXTEFF 22.7 %
5 TAVHTR 550.7 DEG.C
6 INTEFF 21.5 %
8 AMPS 1125. AMPS
9 QDISPG 3. WATTS
10 QDISP 13. WATTS
11 QREG1 108. WATTS
12 QREG2 102. WATTS
13 QREG3 33. WATTS
14 PFP 1003.4 KPA/CM
15 PFD 304.9 KPA/CM
16 NBEALE 0.00527

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 7.2 CM/S

PHASE ANGLES
PADISP 58.1 DEG.
PAPRES -15.9 DEG.

ENGINE SPEED
FREQ 30.1 HZ

REMOTE CALCULATIONS
PWROUT 627. WATTS
INDPWR 673. WATTS
PISTST 2.20 CM
DISPST 2.06 CM

DYNAMIC CALCULATIONS
PAMPC 974. KPA
DISPCP 2.26 CM
PISTCP 2.31 CM
PDYNDB****** KPA
PDLCLR 4.41 KPA
PDLREG 47.86 KPA
PDLDIS 82.13 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:25:22.12 RDG 1016

FLUID HELIUM BAROM 14.298 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES
FLODP	4.11 L/MIN	AMPS1	612. AMPS	PRESUP	7122. KPA	TGEXP	511.8 DEG.C	T01HTR 551.1 DEG.C
		AMPS2	577. AMPS					T02HTR 555.6 DEG.C
TWINDP	18.0 DEG.C	VOLTG	2.59 VOLTS	MEANBP	6992. KPA	TGREGH	510.2 DEG.C	T03HTR 564.6 DEG.C
TDLDP	2.00 DEG.C			MEANCP	7037. KPA	TGREGC	92.2 DEG.C	T04HTR 552.4 DEG.C
TWODPR	20.7 DEG.C					TGCOMP	49.6 DEG.C	T05HTR 568.3 DEG.C
						TGBOUN	35.4 DEG.C	T06HTR 558.7 DEG.C
								T07HTR 557.3 DEG.C
								T08HTR 531.3 DEG.C
								T09HTR 557.6 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS			VIBRATION		REMOTE CALCULATIONS			
FLOCLR	4.21 L/MIN	1	PWRIN	3086. WATTS	VX1HOR	0.4 CM/S	PWROUT	706. WATTS	T10HTR	538.2 DEG.C
TWINCL	24.4 DEG.C	2	QCOOLR	2470. WATTS	VY1VER	7.9 CM/S	INDPWR	764. WATTS	T11HTR	523.3 DEG.C
TDLCL	8.46 DEG.C	3	QDSHPT	572. WATTS			PISTST	2.41 CM	T12HTR	526.2 DEG.C
TWOCLR	31.32 DEG.C	4	EXTEFF	22.9 %	PHASE ANGLES		DISPST	2.20 CM		
		5	TAVHTR	548.7 DEG.C	PADISP	58.4 DEG.			T13REG******	DEG.C
		6	INTEFF	22.2 %	PAPRES	-14.7 DEG.	DYNAMIC CALCULATIONS		T14REG	473.9 DEG.C
		8	AMPS	1189. AMPS			PAMPC	1068. KPA	T15REG	355.5 DEG.C
		9	QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.40 CM	T16REG	351.6 DEG.C
		10	QDISP	13. WATTS	FREQ	30.1 HZ	PISTCP	2.38 CM	T17REG	340.8 DEG.C
		11	QREG1	100. WATTS			PDYNDB******	KPA	T18REG	339.3 DEG.C
		12	QREG2	109. WATTS			PDLCLR	5.60 KPA	T19REG	216.2 DEG.C
		13	QREG3	32. WATTS			PDLREG	52.95 KPA		
		14	PFP	996.6 KPA/CM			PDLDIS	91.98 KPA	T03HED******	DEG.C
		15	PFD	289.2 KPA/CM						
		16	NBEALE	0.00542						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:30:25.12 RDG 1017

FLUID HELIUM BAROM 14.298 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES
FLODP	4.08 L/MIN	AMPS1	645. AMPS	PRESUP	7187. KPA	TGEXP	510.7 DEG.C	T01HTR 550.9 DEG.C
		AMPS2	608. AMPS					T02HTR 558.5 DEG.C
TWINDP	18.0 DEG.C	VOLTG	2.73 VOLTS	MEANBP	7011. KPA	TGREGH	507.3 DEG.C	T03HTR 565.8 DEG.C
TDLDP	2.30 DEG.C			MEANCP	7062. KPA	TGREGC	92.3 DEG.C	T04HTR 553.1 DEG.C
TWODPR	21.0 DEG.C					TGCOMP	53.4 DEG.C	T05HTR 570.6 DEG.C
						TGBOUN	36.2 DEG.C	T06HTR 561.8 DEG.C
								T07HTR 560.5 DEG.C
								T08HTR 530.1 DEG.C
								T09HTR 558.1 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS			VIBRATION		REMOTE CALCULATIONS			
FLOCLR	4.22 L/MIN	1	PWRIN	3424. WATTS	VX1HOR	0.4 CM/S	PWROUT	776. WATTS	T10HTR	537.8 DEG.C
TWINCL	24.5 DEG.C	2	QCOOLR	2713. WATTS	VY1VER	8.5 CM/S	INDPWR	846. WATTS	T11HTR	521.5 DEG.C
TDLCL	9.27 DEG.C	3	QDSHPT	651. WATTS			PISTST	2.60 CM	T12HTR	526.8 DEG.C
TWOCLR	32.09 DEG.C	4	EXTEFF	22.7 %	PHASE ANGLES		DISPST	2.30 CM		
		5	TAVHTR	549.6 DEG.C	PADISP	58.8 DEG.			T13REG******	DEG.C
		6	INTEFF	22.2 %	PAPRES	-14.1 DEG.	DYNAMIC CALCULATIONS		T14REG	473.2 DEG.C
		8	AMPS	1253. AMPS			PAMPC	1166. KPA	T15REG	352.3 DEG.C
		9	QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.35 CM	T16REG	343.8 DEG.C
		10	QDISP	13. WATTS	FREQ	30.2 HZ	PISTCP	2.35 CM	T17REG	330.4 DEG.C
		11	QREG1	93. WATTS			PDYNDB******	KPA	T18REG	330.0 DEG.C
		12	QREG2	116. WATTS			PDLCLR	6.79 KPA	T19REG	215.2 DEG.C
		13	QREG3	32. WATTS			PDLREG	57.70 KPA		
		14	PFP	1003.3 KPA/CM			PDLDIS	98.77 KPA	T03HED******	DEG.C
		15	PFD	289.5 KPA/CM						
		16	NBEALE	0.00549						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:35:25.12 RDG 1018

FLUID HELIUM BAROM 14.298 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES
FLODP	4.06 L/MIN	AMPS1	695. AMPS	PRESUP	7360. KPA	TGEXP	507.8 DEG.C	T01HTR 548.6 DEG.C
		AMPS2	646. AMPS					T02HTR 561.7 DEG.C
TWINDP	18.1 DEG.C	VOLTG	2.93 VOLTS	MEANBP	7004. KPA	TGREGH	498.0 DEG.C	T03HTR 566.1 DEG.C
TDLDP	2.50 DEG.C			MEANCP	7057. KPA	TGREGC	88.8 DEG.C	T04HTR 551.9 DEG.C
TWODPR	21.3 DEG.C					TGCOMP	62.1 DEG.C	T05HTR 573.0 DEG.C
						TGBOUN	37.6 DEG.C	T06HTR 564.2 DEG.C
								T07HTR 563.3 DEG.C
								T08HTR 526.9 DEG.C
								T09HTR 555.9 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS			VIBRATION		REMOTE CALCULATIONS			
FLOCLR	4.21 L/MIN	1	PWRIN	3924. WATTS	VX1HOR	0.4 CM/S	PWROUT	849. WATTS	T10HTR	536.9 DEG.C
TWINCL	24.7 DEG.C	2	QCOOLR	3092. WATTS	VY1VER	9.2 CM/S	INDPWR	917. WATTS	T11HTR	516.2 DEG.C
TDLCL	10.57 DEG.C	3	QDSHPT	707. WATTS			PISTST	2.81 CM	T12HTR	527.6 DEG.C
TWOCLR	33.52 DEG.C	4	EXTEFF	21.6 %	PHASE ANGLES		DISPST	2.41 CM		
		5	TAVHTR	549.4 DEG.C	PADISP	58.8 DEG.			T13REG******	DEG.C
		6	INTEFF	21.5 %	PAPRES	-13.4 DEG.	DYNAMIC CALCULATIONS		T14REG	462.5 DEG.C
		8	AMPS	1341. AMPS			PAMPC	1255. KPA	T15REG	327.1 DEG.C
		9	QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.37 CM	T16REG	310.0 DEG.C
		10	QDISP	13. WATTS	FREQ	30.1 HZ	PISTCP	2.27 CM	T17REG	291.2 DEG.C
		11	QREG1	81. WATTS			PDYNDB******	KPA	T18REG	299.0 DEG.C
		12	QREG2	133. WATTS			PDLCLR	9.33 KPA	T19REG	199.2 DEG.C
		13	QREG3	32. WATTS			PDLREG	61.43 KPA		
		14	PFP	996.2 KPA/CM			PDLDIS	105.89 KPA	T03HED******	DEG.C
		15	PFD	282.7 KPA/CM						
		16	NBEALE	0.00559						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:40:04.12 RDG 1019

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.05 L/MIN
TWINDP 18.1 DEG.C
TDLDP 2.77 DEG.C
TWODPR 21.5 DEG.C

POWER IN
AMPS1 736. AMPS
AMPS2 683. AMPS
VOLTG 3.10 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7090. KPA
MEANBP 6994. KPA
MEANCP 7048. KPA

GAS TEMPERATURES
TGEXP 503.9 DEG.C
TGREGH 489.9 DEG.C
TGREGC 89.2 DEG.C
TGCOMP 68.3 DEG.C
TGBOUN 38.9 DEG.C

SURFACE TEMPERATURES
T01HTR 547.6 DEG.C
T02HTR 564.3 DEG.C
T03HTR 566.9 DEG.C
T04HTR 551.2 DEG.C
T05HTR 575.0 DEG.C
T06HTR 566.1 DEG.C
T07HTR 565.2 DEG.C
T08HTR 525.0 DEG.C
T09HTR 554.6 DEG.C
T10HTR 536.6 DEG.C
T11HTR 512.7 DEG.C
T12HTR 528.0 DEG.C
T13REG****** DEG.C
T14REG 451.1 DEG.C
T15REG 305.2 DEG.C
T16REG 286.6 DEG.C
T17REG 265.2 DEG.C
T18REG 275.5 DEG.C
T19REG 186.9 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.26 L/MIN
TWINCL 24.9 DEG.C
TDLCL 11.64 DEG.C
TWOCLR 34.96 DEG.C

CALCULATED PARAMETERS
1 PWRIN 4402. WATTS
2 QCOOLR 3442. WATTS
3 QDSHPT 781. WATTS
4 EXTEFF 19.6 %
5 TAVHTR 549.4 DEG.C
6 INTEFF 20.1 %
8 AMPS 1419. AMPS
9 QDISPG 3. WATTS
10 QDISP 12. WATTS
11 QREG1 72. WATTS
12 QREG2 142. WATTS
13 QREG3 31. WATTS
14 PFP 979.1 KPA/CM
15 PFD 264.0 KPA/CM
16 NBEALE 0.00536

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 9.8 CM/S

PHASE ANGLES
PADISP 58.5 DEG.
PAPRES -11.9 DEG.

ENGINE SPEED
FREQ 30.1 HZ

REMOTE CALCULATIONS
PWROUT 864. WATTS
INDPWR 927. WATTS
PISTST 2.99 CM
DISPST 2.42 CM

DYNAMIC CALCULATIONS
PAMPC 1323. KPA
DISPCP 2.64 CM
PISTCP 2.26 CM
PDYNDB****** KPA
PDLCLR 12.22 KPA
PDLREG 62.45 KPA
PDLDIS109.97 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 10:37:22.48 RDG 1020

FLUID HELIUM BAROM 14.327 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.78 L/MIN
TWINDP 16.6 DEG.C
TDLDP 0.82 DEG.C
TWODPR 18.0 DEG.C

POWER IN
AMPS1 522. AMPS
AMPS2 485. AMPS
VOLTG 2.16 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7382. KPA
MEANBP 7010. KPA
MEANCP 7045. KPA

GAS TEMPERATURES
TGEXP 472.1 DEG.C
TGREGH 468.4 DEG.C
TGREGC 83.7 DEG.C
TGCOMP 40.0 DEG.C
TGBOUN 27.2 DEG.C

SURFACE TEMPERATURES
T01HTR 501.1 DEG.C
T02HTR 506.4 DEG.C
T03HTR 512.4 DEG.C
T04HTR 506.2 DEG.C
T05HTR 514.6 DEG.C
T06HTR 506.6 DEG.C
T07HTR 505.1 DEG.C
T08HTR 484.9 DEG.C
T09HTR 507.6 DEG.C
T10HTR 493.2 DEG.C
T11HTR 478.8 DEG.C
T12HTR 482.1 DEG.C
T13REG****** DEG.C
T14REG 433.2 DEG.C
T15REG 326.1 DEG.C
T16REG 325.7 DEG.C
T17REG 317.1 DEG.C
T18REG 315.9 DEG.C
T19REG 196.0 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.20 L/MIN
TWINCL 25.1 DEG.C
TDLCL ****** DEG.C
TWOCLR 29.47 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2178. WATTS
2 QCOOLR 1961. WATTS
3 QDSHPT 271. WATTS
4 EXTEFF 20.6 %
5 TAVHTR 499.9 DEG.C
6 INTEFF 18.6 %
8 AMPS 1007. AMPS
9 QDISPG 2. WATTS
10 QDISP 12. WATTS
11 QREG1 97. WATTS
12 QREG2 95. WATTS
13 QREG3 30. WATTS
14 PFP 1022.1 KPA/CM
15 PFD 297.2 KPA/CM
16 NBEALE 0.00460

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 5.9 CM/S

PHASE ANGLES
PADISP 59.5 DEG.
PAPRES -16.5 DEG.

ENGINE SPEED
FREQ 30.2 HZ

REMOTE CALCULATIONS
PWROUT 449. WATTS
INDPWR 483. WATTS
PISTST 1.80 CM
DISPST 1.81 CM

DYNAMIC CALCULATIONS
PAMPC 817. KPA
DISPCP 2.15 CM
PISTCP 2.26 CM
PDYNDB****** KPA
PDLCLR 3.39 KPA
PDLREG 37.67 KPA
PDLDIS 67.20 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 10:42:25.54 RDG 1021

FLUID HELIUM BAROM 14.327 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.53 L/MIN
TWINDP 16.4 DEG.C
TDLDP 1.07 DEG.C
TWODPR 18.1 DEG.C

POWER IN
AMPS1 549. AMPS
AMPS2 515. AMPS
VOLTG 2.28 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7585. KPA
MEANBP 6991. KPA
MEANCP 7030. KPA

GAS TEMPERATURES
TGEXP 470.0 DEG.C
TGREGH 468.6 DEG.C
TGREGC 85.3 DEG.C
TGCOMP 42.2 DEG.C
TGBOUN 28.3 DEG.C

SURFACE TEMPERATURES
T01HTR 503.1 DEG.C
T02HTR 506.0 DEG.C
T03HTR 514.3 DEG.C
T04HTR 506.0 DEG.C
T05HTR 516.5 DEG.C
T06HTR 507.3 DEG.C
T07HTR 506.0 DEG.C
T08HTR 485.9 DEG.C
T09HTR 509.0 DEG.C
T10HTR 492.7 DEG.C
T11HTR 478.9 DEG.C
T12HTR 480.6 DEG.C
T13REG****** DEG.C
T14REG 433.3 DEG.C
T15REG 327.0 DEG.C
T16REG 325.6 DEG.C
T17REG 318.4 DEG.C
T18REG 317.7 DEG.C
T19REG 198.6 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.20 L/MIN
TWINCL 25.0 DEG.C
TDLCL ****** DEG.C
TWOCLR 30.07 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2432. WATTS
2 QCOOLR 2047. WATTS
3 QDSHPT 339. WATTS
4 EXTEFF 21.0 %
5 TAVHTR 500.5 DEG.C
6 INTEFF 20.0 %
8 AMPS 1065. AMPS
9 QDISPG 2. WATTS
10 QDISP 12. WATTS
11 QREG1 97. WATTS
12 QREG2 94. WATTS
13 QREG3 30. WATTS
14 PFP 1006.9 KPA/CM
15 PFD 284.8 KPA/CM
16 NBEALE 0.00471

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 6.6 CM/S

PHASE ANGLES
PADISP 59.3 DEG.
PAPRES -15.3 DEG.

ENGINE SPEED
FREQ 30.1 HZ

REMOTE CALCULATIONS
PWROUT 510. WATTS
INDPWR 551. WATTS
PISTST 2.01 CM
DISPST 1.94 CM

DYNAMIC CALCULATIONS
PAMPC 901. KPA
DISPCP 2.22 CM
PISTCP 2.26 CM
PDYNDB****** KPA
PDLCLR 4.07 KPA
PDLREG 42.76 KPA
PDLDIS 74.67 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 10:47:31.54 RDG 1022

FLUID HELIUM BAROM 14.327 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.51 L/MIN
TWINDP 16.3 DEG.C
TDLDP 1.27 DEG.C
TWODPR 18.2 DEG.C

POWER IN
AMPS1 581. AMPS
AMPS2 547. AMPS
VOLTG 2.42 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7245. KPA
MEANBP 7015. KPA
MEANCP 7055. KPA

GAS TEMPERATURES
TGEXP 467.9 DEG.C
TGREGH 468.2 DEG.C
TGREGC 87.5 DEG.C
TGCOMP 45.5 DEG.C
TGBOUN 29.1 DEG.C

SURFACE TEMPERATURES
T01HTR 504.6 DEG.C
T02HTR 505.8 DEG.C
T03HTR 516.3 DEG.C
T04HTR 505.6 DEG.C
T05HTR 518.7 DEG.C
T06HTR 508.3 DEG.C
T07HTR 506.9 DEG.C
T08HTR 486.3 DEG.C
T09HTR 510.1 DEG.C
T10HTR 492.5 DEG.C
T11HTR 478.4 DEG.C
T12HTR 479.5 DEG.C
T13REG****** DEG.C
T14REG 433.8 DEG.C
T15REG 329.0 DEG.C
T16REG 326.0 DEG.C
T17REG 319.6 DEG.C
T18REG 319.3 DEG.C
T19REG 201.8 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.20 L/MIN
TWINCL 24.8 DEG.C
TDLCL ****** DEG.C
TWOCLR 30.71 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2730. WATTS
2 QCOOLR 2216. WATTS
3 QDSHPT 398. WATTS
4 EXTEFF 21.3 %
5 TAVHTR 501.1 DEG.C
6 INTEFF 20.8 %
8 AMPS 1128. AMPS
9 QDISPG 2. WATTS
10 QDISP 12. WATTS
11 QREG1 95. WATTS
12 QREG2 93. WATTS
13 QREG3 29. WATTS
14 PFP 1007.7 KPA/CM
15 PFD 278.8 KPA/CM
16 NBEALE 0.00488

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 7.3 CM/S

PHASE ANGLES
PADISP 59.8 DEG.
PAPRES -14.5 DEG.

ENGINE SPEED
FREQ 30.2 HZ

REMOTE CALCULATIONS
PWROUT 583. WATTS
INDPWR 630. WATTS
PISTST 2.20 CM
DISPST 2.07 CM

DYNAMIC CALCULATIONS
PAMPC 994. KPA
DISPCP 2.24 CM
PISTCP 2.29 CM
PDYNDB****** KPA
PDLCLR 4.58 KPA
PDLREG 47.86 KPA
PDLDIS 83.15 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 10:52:22.54 RDG 1023

FLUID HELIUM BAROM 14.327 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.49 L/MIN
TWINDP 16.2 DEG.C
TDLDP 1.53 DEG.C
TWODPR 18.3 DEG.C

POWER IN
AMPS1 618. AMPS
AMPS2 576. AMPS
VOLTG 2.56 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7584. KPA
MEANBP 7014. KPA
MEANCP 7061. KPA

GAS TEMPERATURES
TGEXP 465.3 DEG.C
TGREGH 466.0 DEG.C
TGREGC 90.2 DEG.C
TGCOMP 50.5 DEG.C
TGBOUN 30.5 DEG.C

SURFACE TEMPERATURES
T01HTR 504.1 DEG.C
T02HTR 505.9 DEG.C
T03HTR 516.7 DEG.C
T04HTR 504.4 DEG.C
T05HTR 519.7 DEG.C
T06HTR 509.5 DEG.C
T07HTR 508.0 DEG.C
T08HTR 484.7 DEG.C
T09HTR 509.9 DEG.C
T10HTR 490.7 DEG.C
T11HTR 476.3 DEG.C
T12HTR 477.6 DEG.C
T13REG****** DEG.C
T14REG 433.5 DEG.C
T15REG 330.0 DEG.C
T16REG 325.2 DEG.C
T17REG 318.4 DEG.C
T18REG 318.7 DEG.C
T19REG 204.5 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.20 L/MIN
TWINCL 24.8 DEG.C
TDLCL ****** DEG.C
TWOCLR 31.45 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3062. WATTS
2 QCOOLR 2456. WATTS
3 QDSHPT 478. WATTS
4 EXTEFF 21.5 %
5 TAVHTR 500.6 DEG.C
6 INTEFF 21.1 %
8 AMPS 1194. AMPS
9 QDISPG 2. WATTS
10 QDISP 12. WATTS
11 QREG1 93. WATTS
12 QREG2 93. WATTS
13 QREG3 29. WATTS
14 PFP 1005.0 KPA/CM
15 PFD 268.6 KPA/CM
16 NBEALE 0.00502

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 8.0 CM/S

PHASE ANGLES
PADISP 60.1 DEG.
PAPRES -13.6 DEG.

ENGINE SPEED
FREQ 30.2 HZ

REMOTE CALCULATIONS
PWROUT 658. WATTS
INDPWR 712. WATTS
PISTST 2.41 CM
DISPST 2.21 CM

DYNAMIC CALCULATIONS
PAMPC 1093. KPA
DISPCP 2.27 CM
PISTCP 2.27 CM
PDYNDB****** KPA
PDLCLR 5.60 KPA
PDLREG 54.30 KPA
PDLDIS 93.00 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 10:57:22.54 RDG 1024

FLUID HELIUM BAROM 14.327 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.47 L/MIN
TWINDP 16.2 DEG.C
TDLDP 1.71 DEG.C
TWODPR 18.6 DEG.C

POWER IN
AMPS1 646. AMPS
AMPS2 602. AMPS
VOLTG 2.68 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7572. KPA
MEANBP 7000. KPA
MEANCP 7048. KPA

GAS TEMPERATURES
TGEXP 462.4 DEG.C
TGREGH 460.8 DEG.C
TGREGC 90.5 DEG.C
TGCOMP 53.8 DEG.C
TGBOUN 31.8 DEG.C

SURFACE TEMPERATURES
T01HTR 501.0 DEG.C
T02HTR 507.9 DEG.C
T03HTR 515.5 DEG.C
T04HTR 503.0 DEG.C
T05HTR 519.9 DEG.C
T06HTR 511.0 DEG.C
T07HTR 510.1 DEG.C
T08HTR 481.0 DEG.C
T09HTR 507.7 DEG.C
T10HTR 488.1 DEG.C
T11HTR 471.9 DEG.C
T12HTR 476.6 DEG.C
T13REG****** DEG.C
T14REG 431.6 DEG.C
T15REG 326.4 DEG.C
T16REG 317.8 DEG.C
T17REG 307.7 DEG.C
T18REG 308.1 DEG.C
T19REG 203.0 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.21 L/MIN
TWINCL 24.7 DEG.C
TDLCL ****** DEG.C
TWOCLR 32.15 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3348. WATTS
2 QCOOLR 2681. WATTS
3 QDSHPT 531. WATTS
4 EXTEFF 21.1 %
5 TAVHTR 499.5 DEG.C
6 INTEFF 20.9 %
8 AMPS 1248. AMPS
9 QDISPG 2. WATTS
10 QDISP 12. WATTS
11 QREG1 85. WATTS
12 QREG2 100. WATTS
13 QREG3 29. WATTS
14 PFP 995.1 KPA/CM
15 PFD 254.7 KPA/CM
16 NBEALE 0.00501

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 8.6 CM/S

PHASE ANGLES
PADISP 60.4 DEG.
PAPRES -12.5 DEG.

ENGINE SPEED
FREQ 30.2 HZ

REMOTE CALCULATIONS
PWROUT 707. WATTS
INDPWR 765. WATTS
PISTST 2.60 CM
DISPST 2.30 CM

DYNAMIC CALCULATIONS
PAMPC 1176. KPA
DISPCP 2.32 CM
PISTCP 2.28 CM
PDYNDB****** KPA
PDLCLR 6.96 KPA
PDLREG 58.04 KPA
PDLDIS 99.10 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 11:02:49.54 RDG 1025

FLUID HELIUM BAROM 14.327 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.46 L/MIN	AMPS1	686. AMPS	PRESUP	7561. KPA	TGEXP	460.4 DEG.C	T01HTR	498.6 DEG.C
		AMPS2	636. AMPS					T02HTR	510.9 DEG.C
TWINDP	16.1 DEG.C	VOLTG	2.85 VOLTS	MEANBP	6987. KPA	TGREGH	453.1 DEG.C	T03HTR	515.5 DEG.C
TDLDP	2.01 DEG.C			MEANCP	7037. KPA	TGREGC	87.7 DEG.C	T04HTR	501.4 DEG.C
TWODPR	18.7 DEG.C					TGCOMP	59.7 DEG.C	T05HTR	522.1 DEG.C
						TGBOUN	33.4 DEG.C	T06HTR	513.0 DEG.C
								T07HTR	512.4 DEG.C
								T08HTR	477.6 DEG.C
								T09HTR	505.3 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	487.3 DEG.C
FLOCLR	4.20 L/MIN	1 PWRIN	3764. WATTS	VX1HOR	0.4 CM/S	PWROUT	767. WATTS	T11HTR	466.9 DEG.C
TWINCL	24.7 DEG.C	2 QCOOLR	2994. WATTS	VY1VER	9.2 CM/S	INDPWR	827. WATTS	T12HTR	478.1 DEG.C
TDLCL	****** DEG.C	3 QDSHPT	623. WATTS			PISTST	2.80 CM		
TWOCLR	33.24 DEG.C	4 EXTEFF	20.4 %	PHASE ANGLES		DISPST	2.41 CM		
		5 TAVHTR	499.1 DEG.C	PADISP	60.8 DEG.			T13REG	****** DEG.C
		6 INTEFF	20.4 %	PAPRES	-11.8 DEG.	DYNAMIC CALCULATIONS		T14REG	423.8 DEG.C
		8 AMPS	1322. AMPS			PAMPC	1265. KPA	T15REG	306.7 DEG.C
		9 QDISPG	2. WATTS	ENGINE SPEED		DISPCP	2.36 CM	T16REG	290.7 DEG.C
		10 QDISP	11. WATTS	FREQ	30.2 HZ	PISTCP	2.26 CM	T17REG	277.3 DEG.C
		11 QREG1	75. WATTS			PDYNDB	****** KPA	T18REG	282.5 DEG.C
		12 QREG2	115. WATTS			PDLCLR	9.33 KPA	T19REG	189.9 DEG.C
		13 QREG3	28. WATTS			PDLREG	61.77 KPA		
		14 PFP	987.7 KPA/CM			PDLDIS	106.23 KPA	T03HED	****** DEG.C
		15 PFD	245.8 KPA/CM						
		16 NBEALE	0.00506						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 11:13:22.54 RDG 1026

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.24 L/MIN	AMPS1	482. AMPS	PRESUP	7565. KPA	TGEXP	425.8 DEG.C	T01HTR	451.6 DEG.C
		AMPS2	481. AMPS					T02HTR	457.0 DEG.C
TWINDP	16.0 DEG.C	VOLTG	2.06 VOLTS	MEANBP	7011. KPA	TGREGH	421.4 DEG.C	T03HTR	462.9 DEG.C
TDLDP	1.29 DEG.C			MEANCP	7050. KPA	TGREGC	79.6 DEG.C	T04HTR	456.2 DEG.C
TWODPR	18.0 DEG.C					TGCOMP	41.8 DEG.C	T05HTR	465.8 DEG.C
						TGBOUN	31.8 DEG.C	T06HTR	457.1 DEG.C
								T07HTR	455.9 DEG.C
								T08HTR	436.2 DEG.C
								T09HTR	457.9 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	444.7 DEG.C
FLOCLR	4.20 L/MIN	1 PWRIN	1983. WATTS	VX1HOR	0.3 CM/S	PWROUT	396. WATTS	T11HTR	430.2 DEG.C
TWINCL	24.4 DEG.C	2 QCOOLR	2012. WATTS	VY1VER	6.0 CM/S	INDPWR	426. WATTS	T12HTR	434.7 DEG.C
TDLCL	6.90 DEG.C	3 QDSHPT	380. WATTS			PISTST	1.82 CM		
TWOCLR	29.24 DEG.C	4 EXTEFF	20.0 %	PHASE ANGLES		DISPST	1.80 CM		
		5 TAVHTR	450.9 DEG.C	PADISP	61.3 DEG.			T13REG	****** DEG.C
		6 INTEFF	16.5 %	PAPRES	-14.4 DEG.	DYNAMIC CALCULATIONS		T14REG	391.1 DEG.C
		8 AMPS	964. AMPS			PAMPC	807. KPA	T15REG	295.0 DEG.C
		9 QDISPG	2. WATTS	ENGINE SPEED		DISPCP	2.19 CM	T16REG	294.0 DEG.C
		10 QDISP	11. WATTS	FREQ	30.1 HZ	PISTCP	2.29 CM	T17REG	286.6 DEG.C
		11 QREG1	87. WATTS			PDYNDB	****** KPA	T18REG	286.7 DEG.C
		12 QREG2	85. WATTS			PDLCLR	3.56 KPA	T19REG	179.3 DEG.C
		13 QREG3	26. WATTS			PDLREG	39.71 KPA		
		14 PFP	981.6 KPA/CM			PDLDIS	70.93 KPA	T03HED	****** DEG.C
		15 PFD	255.1 KPA/CM						
		16 NBEALE	0.00403						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 11:18:28.54 RDG 1027

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.16 L/MIN	AMPS1	516. AMPS	PRESUP	7195. KPA	TGEXP	423.6 DEG.C	T01HTR	452.5 DEG.C
		AMPS2	507. AMPS					T02HTR	456.6 DEG.C
TWINDP	16.1 DEG.C	VOLTG	2.18 VOLTS	MEANBP	7001. KPA	TGREGH	420.7 DEG.C	T03HTR	464.1 DEG.C
TDLDP	1.34 DEG.C			MEANCP	7045. KPA	TGREGC	80.6 DEG.C	T04HTR	455.8 DEG.C
TWODPR	18.1 DEG.C					TGCOMP	43.0 DEG.C	T05HTR	467.0 DEG.C
						TGBOUN	31.8 DEG.C	T06HTR	457.5 DEG.C
								T07HTR	456.3 DEG.C
								T08HTR	436.2 DEG.C
								T09HTR	458.4 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	444.0 DEG.C
FLOCLR	4.19 L/MIN	1 PWRIN	2233. WATTS	VX1HOR	0.3 CM/S	PWROUT	444. WATTS	T11HTR	429.2 DEG.C
TWINCL	24.2 DEG.C	2 QCOOLR	2064. WATTS	VY1VER	6.6 CM/S	INDPWR	474. WATTS	T12HTR	433.1 DEG.C
TDLCL	7.10 DEG.C	3 QDSHPT	387. WATTS			PISTST	2.00 CM		
TWOCLR	29.47 DEG.C	4 EXTEFF	19.9 %	PHASE ANGLES		DISPST	1.91 CM		
		5 TAVHTR	450.9 DEG.C	PADISP	60.8 DEG.			T13REG	****** DEG.C
		6 INTEFF	17.7 %	PAPRES	-13.1 DEG.	DYNAMIC CALCULATIONS		T14REG	390.5 DEG.C
		8 AMPS	1022. AMPS			PAMPC	891. KPA	T15REG	295.4 DEG.C
		9 QDISPG	2. WATTS	ENGINE SPEED		DISPCP	2.20 CM	T16REG	293.0 DEG.C
		10 QDISP	11. WATTS	FREQ	30.1 HZ	PISTCP	2.26 CM	T17REG	286.8 DEG.C
		11 QREG1	86. WATTS			PDYNDB	****** KPA	T18REG	287.6 DEG.C
		12 QREG2	83. WATTS			PDLCLR	4.07 KPA	T19REG	181.0 DEG.C
		13 QREG3	26. WATTS			PDLREG	45.48 KPA		
		14 PFP	979.5 KPA/CM			PDLDIS	75.35 KPA	T03HED	****** DEG.C
		15 PFD	242.6 KPA/CM						
		16 NBEALE	0.00410						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 11:23:22.54 RDG 1028

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.11 L/MIN	AMPS1 554. AMPS	PRESUP 7567. KPA	TGEXP 421.0 DEG.C	T01HTR 453.0 DEG.C
	AMPS2 537. AMPS			T02HTR 456.5 DEG.C
TWINDP 16.0 DEG.C	VOLTG 2.33 VOLTS	MEANBP 6994. KPA	TGREGH 419.4 DEG.C	T03HTR 465.3 DEG.C
TDLDP 1.49 DEG.C		MEANCP 7040. KPA	TGREGC 83.4 DEG.C	T04HTR 455.2 DEG.C
TWODPR 18.2 DEG.C			TGCOMP 45.7 DEG.C	T05HTR 468.5 DEG.C
			TGBOUN 31.6 DEG.C	T06HTR 458.2 DEG.C
				T07HTR 457.1 DEG.C
				T08HTR 435.6 DEG.C
				T09HTR 458.6 DEG.C

HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR 4.24 L/MIN	1 PWRIN 2544. WATTS	VX1HOR 0.3 CM/S	PWROUT 503. WATTS	T10HTR 443.1 DEG.C
TWINCL 25.4 DEG.C	2 QCOOLR 2129. WATTS	VY1VER 7.3 CM/S	INDPWR 536. WATTS	T11HTR 427.7 DEG.C
TDLCL 7.24 DEG.C	3 QDSHPT 428. WATTS		PISTST 2.20 CM	T12HTR 431.3 DEG.C
TWOCLR 31.11 DEG.C	4 EXTEFF 19.8 %	PHASE ANGLES	DISPST 2.04 CM	
	5 TAVHTR 450.8 DEG.C	PADISP 61.5 DEG.		T13REG****** DEG.C
	6 INTEFF 19.1 %	PAPRES -12.2 DEG.	DYNAMIC CALCULATIONS	T14REG 390.4 DEG.C
	8 AMPS 1091. AMPS		PAMPC 994. KPA	T15REG 297.0 DEG.C
	9 QDISPG 2. WATTS	ENGINE SPEED	DISPCP 2.21 CM	T16REG 293.1 DEG.C
	10 QDISP 11. WATTS	FREQ 30.1 HZ	PISTCP 2.26 CM	T17REG 287.3 DEG.C
	11 QREG1 84. WATTS		PDYNDB****** KPA	T18REG 288.6 DEG.C
	12 QREG2 83. WATTS		PDLCLR 4.75 KPA	T19REG 184.4 DEG.C
	13 QREG3 26. WATTS		PDLREG 47.52 KPA	
	14 PFP 986.2 KPA/CM		PDLDIS 83.83 KPA	T03HED****** DEG.C
	15 PFD 234.4 KPA/CM			
	16 NBEALE 0.00423			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 11:29:31.54 RDG 1029

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.05 L/MIN	AMPS1 594. AMPS	PRESUP 7241. KPA	TGEXP 418.4 DEG.C	T01HTR 453.2 DEG.C
	AMPS2 565. AMPS			T02HTR 456.4 DEG.C
TWINDP 16.0 DEG.C	VOLTG 2.48 VOLTS	MEANBP 7000. KPA	TGREGH 418.1 DEG.C	T03HTR 466.4 DEG.C
TDLDP 1.78 DEG.C		MEANCP 7009. KPA	TGREGC 85.9 DEG.C	T04HTR 454.4 DEG.C
TWODPR 18.4 DEG.C			TGCOMP 48.6 DEG.C	T05HTR 469.6 DEG.C
			TGBOUN 32.5 DEG.C	T06HTR 458.9 DEG.C
				T07HTR 457.8 DEG.C
				T08HTR 434.7 DEG.C
				T09HTR 459.1 DEG.C

HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR 4.22 L/MIN	1 PWRIN 2871. WATTS	VX1HOR 0.4 CM/S	PWROUT 566. WATTS	T10HTR 441.8 DEG.C
TWINCL 24.5 DEG.C	2 QCOOLR 2392. WATTS	VY1VER 8.0 CM/S	INDPWR 600. WATTS	T11HTR 426.2 DEG.C
TDLCL 8.17 DEG.C	3 QDSHPT 501. WATTS		PISTST 2.41 CM	T12HTR 429.3 DEG.C
TWOCLR 31.28 DEG.C	4 EXTEFF 19.7 %	PHASE ANGLES	DISPST 2.17 CM	
	5 TAVHTR 450.7 DEG.C	PADISP 61.8 DEG.		T13REG****** DEG.C
	6 INTEFF 19.1 %	PAPRES -11.3 DEG.	DYNAMIC CALCULATIONS	T14REG 390.4 DEG.C
	8 AMPS 1159. AMPS		PAMPC 1083. KPA	T15REG 298.9 DEG.C
	9 QDISPG 2. WATTS	ENGINE SPEED	DISPCP 2.24 CM	T16REG 294.0 DEG.C
	10 QDISP 11. WATTS	FREQ 30.2 HZ	PISTCP 2.27 CM	T17REG 288.5 DEG.C
	11 QREG1 83. WATTS		PDYNDB****** KPA	T18REG 289.7 DEG.C
	12 QREG2 82. WATTS		PDLCLR 5.60 KPA	T19REG 187.8 DEG.C
	13 QREG3 26. WATTS		PDLREG 53.96 KPA	
	14 PFP 975.0 KPA/CM		PDLDIS 94.35 KPA	T03HED****** DEG.C
	15 PFD 223.1 KPA/CM			
	16 NBEALE 0.00432			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 11:35:10.54 RDG 1030

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.11 L/MIN	AMPS1 626. AMPS	PRESUP 7562. KPA	TGEXP 415.3 DEG.C	T01HTR 452.3 DEG.C
	AMPS2 589. AMPS			T02HTR 456.8 DEG.C
TWINDP 16.0 DEG.C	VOLTG 2.60 VOLTS	MEANBP 7007. KPA	TGREGH 415.9 DEG.C	T03HTR 465.5 DEG.C
TDLDP 1.90 DEG.C		MEANCP 7061. KPA	TGREGC 88.9 DEG.C	T04HTR 453.6 DEG.C
TWODPR 18.6 DEG.C			TGCOMP 54.6 DEG.C	T05HTR 469.0 DEG.C
			TGBOUN 33.1 DEG.C	T06HTR 459.9 DEG.C
				T07HTR 458.8 DEG.C
				T08HTR 432.9 DEG.C
				T09HTR 458.6 DEG.C

HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR 4.21 L/MIN	1 PWRIN 3159. WATTS	VX1HOR 0.4 CM/S	PWROUT 605. WATTS	T10HTR 439.4 DEG.C
TWINCL 24.3 DEG.C	2 QCOOLR 2595. WATTS	VY1VER 8.6 CM/S	INDPWR 643. WATTS	T11HTR 424.0 DEG.C
TDLCL 8.88 DEG.C	3 QDSHPT 542. WATTS		PISTST 2.60 CM	T12HTR 426.7 DEG.C
TWOCLR 31.77 DEG.C	4 EXTEFF 19.2 %	PHASE ANGLES	DISPST 2.26 CM	
	5 TAVHTR 449.8 DEG.C	PADISP 61.8 DEG.		T13REG****** DEG.C
	6 INTEFF 18.9 %	PAPRES -10.3 DEG.	DYNAMIC CALCULATIONS	T14REG 389.2 DEG.C
	8 AMPS 1215. AMPS		PAMPC 1181. KPA	T15REG 299.6 DEG.C
	9 QDISPG 2. WATTS	ENGINE SPEED	DISPCP 2.30 CM	T16REG 294.9 DEG.C
	10 QDISP 10. WATTS	FREQ 30.2 HZ	PISTCP 2.25 CM	T17REG 288.2 DEG.C
	11 QREG1 79. WATTS		PDYNDB****** KPA	T18REG 286.8 DEG.C
	12 QREG2 83. WATTS		PDLCLR 6.79 KPA	T19REG 190.0 DEG.C
	13 QREG3 25. WATTS		PDLREG 58.38 KPA	
	14 PFP 980.6 KPA/CM		PDLDIS100.49 KPA	T03HED****** DEG.C
	15 PFD 212.3 KPA/CM			
	16 NBEALE 0.00428			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 11:40:31.54 RDG 1031

FLUID HELIUM BAROM 14.337 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.11 L/MIN
TWINDP 16.1 DEG.C
TDLLP 2.10 DEG.C
TWODPR 18.9 DEG.C

POWER IN
AMPS1 664. AMPS
AMPS2 617. AMPS
VOLTG 2.74 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7552. KPA
MEANBP 6987. KPA
MEANCP 7045. KPA

GAS TEMPERATURES
TGEXP 413.6 DEG.C
TGREGH 409.5 DEG.C
TGREGC 86.7 DEG.C
TGCOMP 59.0 DEG.C
TGBOUN 34.2 DEG.C

SURFACE TEMPERATURES
T01HTR 449.7 DEG.C
T02HTR 459.5 DEG.C
T03HTR 464.8 DEG.C
T04HTR 452.0 DEG.C
T05HTR 470.5 DEG.C
T06HTR 461.8 DEG.C
T07HTR 461.1 DEG.C
T08HTR 429.5 DEG.C
T09HTR 456.1 DEG.C
T10HTR 438.0 DEG.C
T11HTR 419.2 DEG.C
T12HTR 428.0 DEG.C
T13REG****** DEG.C
T14REG 384.5 DEG.C
T15REG 286.4 DEG.C
T16REG 274.9 DEG.C
T17REG 265.6 DEG.C
T18REG 267.3 DEG.C
T19REG 181.0 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.21 L/MIN
TWINCL 24.3 DEG.C
TDLCL 9.79 DEG.C
TWOCLR 32.66 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3509. WATTS
2 QCOOLR 2859. WATTS
3 QDSHPT 601. WATTS
4 EXTEFF 19.1 %
5 TAVHTR 449.2 DEG.C
6 INTEFF 19.0 %
8 AMPS 1281. AMPS
9 QDISPG 2. WATTS
10 QDISP 10. WATTS
11 QREG1 70. WATTS
12 QREG2 95. WATTS
13 QREG3 25. WATTS
14 PFP 978.5 KPA/CM
15 PFD 205.0 KPA/CM
16 NBEALE 0.00441

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 9.2 CM/S

PHASE ANGLES
PADISP 61.9 DEG.
PAPRES -9.8 DEG.

ENGINE SPEED
FREQ 30.2 HZ

REMOTE CALCULATIONS
PWROUT 670. WATTS
INDPWR 687. WATTS
PISTST 2.80 CM
DISPST 2.39 CM

DYNAMIC CALCULATIONS
PAMPC 1275. KPA
DISPCP 2.35 CM
PISTCP 2.22 CM
PDYNDB****** KPA
PDLCLR 9.16 KPA
PDLREG 63.13 KPA
PDLDIS108.27 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 11:43:10.54 RDG 1032

FLUID HELIUM BAROM 14.337 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.12 L/MIN
TWINDP 16.0 DEG.C
TDLDP 2.20 DEG.C
TWODPR 18.9 DEG.C

POWER IN
AMPS1 724. AMPS
AMPS2 663. AMPS
VOLTG 2.97 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7237. KPA
MEANBP 6955. KPA
MEANCP 7054. KPA

GAS TEMPERATURES
TGEXP 411.8 DEG.C
TGREGH 398.5 DEG.C
TGREGC 83.5 DEG.C
TGCOMP 67.8 DEG.C
TGBOUN 34.6 DEG.C

SURFACE TEMPERATURES
T01HTR 447.8 DEG.C
T02HTR 464.2 DEG.C
T03HTR 465.5 DEG.C
T04HTR 452.3 DEG.C
T05HTR 473.3 DEG.C
T06HTR 464.8 DEG.C
T07HTR 463.9 DEG.C
T08HTR 426.4 DEG.C
T09HTR 454.4 DEG.C
T10HTR 438.6 DEG.C
T11HTR 414.1 DEG.C
T12HTR 430.1 DEG.C
T13REG****** DEG.C
T14REG 368.1 DEG.C
T15REG 251.0 DEG.C
T16REG 236.0 DEG.C
T17REG 222.4 DEG.C
T18REG 230.0 DEG.C
T19REG 159.6 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.21 L/MIN
TWINCL 24.3 DEG.C
TDLCL 11.13 DEG.C
TWOCLR 34.14 DEG.C

CALCULATED PARAMETERS
1 PWRIN 4116. WATTS
2 QCOOLR 3252. WATTS
3 QDSHPT 632. WATTS
4 EXTEFF 16.7 %
5 TAVHTR 449.6 DEG.C
6 INTEFF 17.5 %
8 AMPS 1387. AMPS
9 QDISPG 2. WATTS
10 QDISP 10. WATTS
11 QREG1 57. WATTS
12 QREG2 112. WATTS
13 QREG3 24. WATTS
14 PFP 961.9 KPA/CM
15 PFD 185.2 KPA/CM
16 NBEALE 0.00426

VIBRATION
VX1HOR 0.5 CM/S
VY1VER 9.8 CM/S

PHASE ANGLES
PADISP 61.6 DEG.
PAPRES -8.4 DEG.

ENGINE SPEED
FREQ 30.1 HZ

REMOTE CALCULATIONS
PWROUT 688. WATTS
INDPWR 692. WATTS
PISTST 2.98 CM
DISPST 2.40 CM

DYNAMIC CALCULATIONS
PAMPC 1344. KPA
DISPCP 2.46 CM
PISTCP 2.15 CM
PDYNDB****** KPA
PDLCLR 14.42 KPA
PDLREG 67.20 KPA
PDLDIS116.41 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/03/84 14:38:38.30 RDG 1066

FLUID HELIUM BAROM 14.342 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.21 L/MIN
TWINDP 22.3 DEG.C
TDLDP 0.96 DEG.C
TWODPR 23.9 DEG.C

POWER IN
AMPS1 512. AMPS
AMPS2 429. AMPS
VOLTG 2.02 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 5570. KPA
MEANBP 5503. KPA
MEANCP 5532. KPA

GAS TEMPERATURES
TGEXP 566.1 DEG.C
TGREGH 561.3 DEG.C
TGREGC 74.3 DEG.C
TGCOMP 40.2 DEG.C
TGBOUN 34.4 DEG.C

SURFACE TEMPERATURES
T01HTR 598.8 DEG.C
T02HTR 607.5 DEG.C
T03HTR 612.9 DEG.C
T04HTR 606.0 DEG.C
T05HTR 616.0 DEG.C
T06HTR 606.1 DEG.C
T07HTR 605.4 DEG.C
T08HTR 583.7 DEG.C
T09HTR 606.5 DEG.C
T10HTR 594.1 DEG.C
T11HTR 579.1 DEG.C
T12HTR 586.0 DEG.C
T13REG****** DEG.C
T14REG 519.7 DEG.C
T15REG 384.2 DEG.C
T16REG 376.7 DEG.C
T17REG 363.9 DEG.C
T18REG 369.8 DEG.C
T19REG 220.3 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.41 L/MIN
TWINCL 25.1 DEG.C
TDLCL 5.09 DEG.C
TWOCLR 28.93 DEG.C

CALCULATED PARAMETERS
1 PWRIN 1904. WATTS
2 QCOOLR 1559. WATTS
3 QDSHPT 280. WATTS
4 EXTEFF 21.9 %
5 TAVHTR 600.2 DEG.C
6 INTEFF 21.1 %
8 AMPS 941. AMPS
9 QDISPG 3. WATTS
10 QDISP 15. WATTS
11 QREG1 121. WATTS
12 QREG2 122. WATTS
13 QREG3 38. WATTS
14 PFP 649.2 KPA/CM
15 PFD 232.3 KPA/CM
16 NBEALE 0.00608

VIBRATION
VX1HOR 0.2 CM/S
VY1VER 4.7 CM/S

PHASE ANGLES
PADISP 56.5 DEG.
PAPRES -22.1 DEG.

ENGINE SPEED
FREQ 26.7 HZ

REMOTE CALCULATIONS
PWROUT 418. WATTS
INDPWR 443. WATTS
PISTST 1.82 CM
DISPST 1.95 CM

DYNAMIC CALCULATIONS
PAMPC 502. KPA
DISPCP 2.07 CM
PISTCP 2.40 CM
PDYNDB****** KPA
PDLCLR 2.04 KPA
PDLREG 28.17 KPA
PDLDIS 48.87 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/03/84 14:42:44.30 RDG 1067

FLUID HELIUM BAROM 14.342 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.21 L/MIN	AMPS1	543. AMPS	PRESUP	5562. KPA	TGEXP	563.3 DEG.C	T01HTR	599.9 DEG.C
		AMPS2	455. AMPS					T02HTR	606.4 DEG.C
TWINDP	22.4 DEG.C	VOLTG	2.15 VOLTS	MEANBP	5482. KPA	TGREGH	561.9 DEG.C	T03HTR	612.9 DEG.C
TDLDP	1.14 DEG.C			MEANCP	5513. KPA	TGREGC	76.6 DEG.C	T04HTR	605.8 DEG.C
TWODPR	24.0 DEG.C					TGCOMP	42.0 DEG.C	T05HTR	615.8 DEG.C
						TGBOUN	34.5 DEG.C	T06HTR	606.4 DEG.C
								T07HTR	605.5 DEG.C
								T08HTR	583.5 DEG.C
								T09HTR	608.0 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS			VIBRATION		REMOTE CALCULATIONS			SURFACE TEMPERATURES	
FLOCLR	4.40 L/MIN	1	PWRIN	2142. WATTS	VX1HOR	0.2 CM/S	PWROUT	495.	WATTS	T10HTR	591.7 DEG.C
TWINCL	25.0 DEG.C	2	QCOOLR	1692. WATTS	VY1VER	5.2 CM/S	INDPWR	524.	WATTS	T11HTR	579.4 DEG.C
TDLCL	5.54 DEG.C	3	QDSHPT	335. WATTS			PISTST	2.01	CM	T12HTR	582.5 DEG.C
TWOCLR	29.30 DEG.C	4	EXTEFF	23.1 %	PHASE ANGLES		DISPST	2.07	CM		
		5	TAVHTR	599.8 DEG.C	PADISP	57.8 DEG.				T13REG******	DEG.C
		6	INTEFF	22.6 %	PAPRES	-20.9 DEG.	DYNAMIC CALCULATIONS			T14REG	518.5 DEG.C
		8	AMPS	998. AMPS			PAMPC	699.	KPA	T15REG	384.1 DEG.C
		9	QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.13	CM	T16REG	379.5 DEG.C
		10	QDISP	15. WATTS	FREQ	26.9 HZ	PISTCP	2.45	CM	T17REG	368.1 DEG.C
		11	QREG1	119. WATTS			PDYNDB******		KPA	T18REG	368.6 DEG.C
		12	QREG2	122. WATTS			PDLCLR	2.55	KPA	T19REG	221.5 DEG.C
		13	QREG3	38. WATTS			PDLREG	31.90	KPA		
		14	PFP	805.9 KPA/CM			PDLDIS	54.30	KPA	T03HED******	DEG.C
		15	PFD	284.8 KPA/CM							
		16	NBEALE	0.00652							

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/03/84 14:47:26.35 RDG 1068

FLUID HELIUM BAROM 14.342 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.21 L/MIN	AMPS1	575. AMPS	PRESUP	5565. KPA	TGEXP	560.8 DEG.C	T01HTR	602.3 DEG.C
		AMPS2	478. AMPS					T02HTR	605.2 DEG.C
TWINDP	22.4 DEG.C	VOLTG	2.27 VOLTS	MEANBP	5503. KPA	TGREGH	562.5 DEG.C	T03HTR	614.6 DEG.C
TDLDP	1.31 DEG.C			MEANCP	5536. KPA	TGREGC	78.9 DEG.C	T04HTR	605.5 DEG.C
TWODPR	24.3 DEG.C					TGCOMP	43.5 DEG.C	T05HTR	616.9 DEG.C
						TGBOUN	35.0 DEG.C	T06HTR	606.9 DEG.C
								T07HTR	605.7 DEG.C
								T08HTR	584.7 DEG.C
								T09HTR	610.2 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS			VIBRATION		REMOTE CALCULATIONS			SURFACE TEMPERATURES	
FLOCLR	4.41 L/MIN	1	PWRIN	2387. WATTS	VX1HOR	0.2 CM/S	PWROUT	570.	WATTS	T10HTR	590.8 DEG.C
TWINCL	25.1 DEG.C	2	QCOOLR	1833. WATTS	VY1VER	5.8 CM/S	INDPWR	602.	WATTS	T11HTR	580.2 DEG.C
TDLCL	5.99 DEG.C	3	QDSHPT	383. WATTS			PISTST	2.20	CM	T12HTR	579.9 DEG.C
TWOCLR	29.80 DEG.C	4	EXTEFF	23.9 %	PHASE ANGLES		DISPST	2.19	CM		
		5	TAVHTR	600.2 DEG.C	PADISP	58.1 DEG.				T13REG******	DEG.C
		6	INTEFF	23.7 %	PAPRES	-19.8 DEG.	DYNAMIC CALCULATIONS			T14REG	517.8 DEG.C
		8	AMPS	1053. AMPS			PAMPC	768.	KPA	T15REG	385.2 DEG.C
		9	QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.16	CM	T16REG	381.9 DEG.C
		10	QDISP	15. WATTS	FREQ	27.0 HZ	PISTCP	2.44	CM	T17REG	371.8 DEG.C
		11	QREG1	118. WATTS			PDYNDB******		KPA	T18REG	369.8 DEG.C
		12	QREG2	120. WATTS			PDLCLR	2.72	KPA	T19REG	223.8 DEG.C
		13	QREG3	37. WATTS			PDLREG	35.98	KPA		
		14	PFP	804.1 KPA/CM			PDLDIS	60.75	KPA	T03HED******	DEG.C
		15	PFD	279.2 KPA/CM							
		16	NBEALE	0.00680							

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/03/84 14:52:23.35 RDG 1069

FLUID HELIUM BAROM 14.342 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.22 L/MIN	AMPS1	607. AMPS	PRESUP	5561. KPA	TGEXP	558.0 DEG.C	T01HTR	603.6 DEG.C
		AMPS2	500. AMPS					T02HTR	604.9 DEG.C
TWINDP	22.4 DEG.C	VOLTG	2.39 VOLTS	MEANBP	55[illegible]. KPA	TGREGH	562.2 DEG.C	T03HTR	615.8 DEG.C
TDLDP	1.51 DEG.C			MEANCP	55[illegible]. KPA	TGREGC	81.1 DEG.C	T04HTR	604.8 DEG.C
TWODPR	24.5 DEG.C					TGCOMP	45.8 DEG.C	T05HTR	618.0 DEG.C
						TGBOUN	36.3 DEG.C	T06HTR	608.0 DEG.C
								T07HTR	606.6 DEG.C
								T08HTR	585.1 DEG.C
								T09HTR	611.2 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS			VIBRATION		REMOTE CALCULATIONS			SURFACE TEMPERATURES	
FLOCLR	4.41 L/MIN	1	PWRIN	2642. WATTS	VX1HOR	0.3 CM/S	PWROUT	646.	WATTS	T10HTR	589.3 DEG.C
TWINCL	25.1 DEG.C	2	QCOOLR	1979. WATTS	VY1VER	6.5 CM/S	INDPWR	681.	WATTS	T11HTR	579.9 DEG.C
TDLCL	6.46 DEG.C	3	QDSHPT	441. WATTS			PISTST	2.41	CM	T12HTR	577.8 DEG.C
TWOCLR	30.43 DEG.C	4	EXTEFF	24.5 %	PHASE ANGLES		DISPST	2.32	CM		
		5	TAVHTR	600.4 DEG.C	PADISP	58.5 DEG.				T13REG******	DEG.C
		6	INTEFF	24.6 %	PAPRES	-18.6 DEG.	DYNAMIC CALCULATIONS			T14REG	517.7 DEG.C
		8	AMPS	1107. AMPS			PAMPC	827.	KPA	T15REG	386.7 DEG.C
		9	QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.19	CM	T16REG	383.2 DEG.C
		10	QDISP	15. WATTS	FREQ	27.0 HZ	PISTCP	2.44	CM	T17REG	373.7 DEG.C
		11	QREG1	117. WATTS			PDYNDB******		KPA	T18REG	370.7 DEG.C
		12	QREG2	119. WATTS			PDLCLR	3.56	KPA	T19REG	226.8 DEG.C
		13	QREG3	37. WATTS			PDLREG	40.05	KPA		
		14	PFP	785.9 KPA/CM			PDLDIS	67.20	KPA	T03HED******	DEG.C
		15	PFD	266.8 KPA/CM							
		16	NBEALE	0.00704							

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/03/84 14:58:23.35 RDG 1070

FLUID HELIUM BAROM 14.342 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.20 L/MIN
TWINDP 22.4 DEG.C
TDLDP 1.70 DEG.C
TWODPR 24.7 DEG.C

POWER IN
AMPS1 635. AMPS
AMPS2 521. AMPS
VOLTG 2.49 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 5553. KPA
MEANBP 5494. KPA
MEANCP 5531. KPA

GAS TEMPERATURES
TGEXP 555.0 DEG.C
TGREGH 554.7 DEG.C
TGREGC 79.7 DEG.C
TGCOMP 49.4 DEG.C
TGBOUN 37.7 DEG.C

SURFACE TEMPERATURES
T01HTR 599.7 DEG.C
T02HTR 606.6 DEG.C
T03HTR 614.7 DEG.C
T04HTR 601.3 DEG.C
T05HTR 619.1 DEG.C
T06HTR 609.4 DEG.C
T07HTR 608.6 DEG.C
T08HTR 580.8 DEG.C
T09HTR 607.0 DEG.C
T10HTR 586.7 DEG.C
T11HTR 573.8 DEG.C
T12HTR 577.7 DEG.C
T13REG****** DEG.C
T14REG 515.2 DEG.C
T15REG 379.5 DEG.C
T16REG 367.6 DEG.C
T17REG 352.7 DEG.C
T18REG 355.3 DEG.C
T19REG 222.0 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.40 L/MIN
TWINCL 25.2 DEG.C
TDLCL 7.00 DEG.C
TWOCLR 30.99 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2879. WATTS
2 QCOOLR 2137. WATTS
3 QDSHPT 495. WATTS
4 EXTEFF 25.0 %
5 TAVHTR 598.8 DEG.C
6 INTEFF 25.2 %
8 AMPS 1156. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 108. WATTS
12 QREG2 130. WATTS
13 QREG3 37. WATTS
14 PFP 795.4 KPA/CM
15 PFD 267.8 KPA/CM
16 NBEALE 0.00729

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 7.1 CM/S

PHASE ANGLES
PADISP 58.7 DEG.
PAPRES -18.0 DEG.

ENGINE SPEED
FREQ 26.9 HZ

REMOTE CALCULATIONS
PWROUT 720. WATTS
INDPWR 759. WATTS
PISTST 2.61 CM
DISPST 2.46 CM

DYNAMIC CALCULATIONS
PAMPC 910. KPA
DISPCP 2.25 CM
PISTCP 2.46 CM
PDYNDB****** KPA
PDLCLR 4.41 KPA
PDLREG 42.43 KPA
PDLDIS 71.95 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/03/84 15:03:44.35 RDG 1071

FLUID HELIUM BAROM 14.342 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.18 L/MIN
TWINDP 22.4 DEG.C
TDLDP 1.91 DEG.C
TWODPR 24.9 DEG.C

POWER IN
AMPS1 680. AMPS
AMPS2 558. AMPS
VOLTG 2.68 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 5546. KPA
MEANBP 5489. KPA
MEANCP 5530. KPA

GAS TEMPERATURES
TGEXP 550.9 DEG.C
TGREGH 541.6 DEG.C
TGREGC 74.2 DEG.C
TGCOMP 55.2 DEG.C
TGBOUN 38.7 DEG.C

SURFACE TEMPERATURES
T01HTR 596.8 DEG.C
T02HTR 610.6 DEG.C
T03HTR 614.7 DEG.C
T04HTR 598.6 DEG.C
T05HTR 621.7 DEG.C
T06HTR 611.7 DEG.C
T07HTR 611.3 DEG.C
T08HTR 577.1 DEG.C
T09HTR 602.4 DEG.C
T10HTR 586.1 DEG.C
T11HTR 567.0 DEG.C
T12HTR 579.7 DEG.C
T13REG****** DEG.C
T14REG 499.2 DEG.C
T15REG 343.6 DEG.C
T16REG 321.0 DEG.C
T17REG 298.4 DEG.C
T18REG 311.2 DEG.C
T19REG 198.0 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.41 L/MIN
TWINCL 25.3 DEG.C
TDLCL 7.97 DEG.C
TWOCLR 32.10 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3315. WATTS
2 QCOOLR 2441. WATTS
3 QDSHPT 554. WATTS
4 EXTEFF 23.7 %
5 TAVHTR 598.1 DEG.C
6 INTEFF 24.3 %
8 AMPS 1238. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 92. WATTS
12 QREG2 152. WATTS
13 QREG3 36. WATTS
14 PFP 780.6 KPA/CM
15 PFD 261.2 KPA/CM
16 NBEALE 0.00744

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 7.6 CM/S

PHASE ANGLES
PADISP 59.5 DEG.
PAPRES -17.3 DEG.

ENGINE SPEED
FREQ 26.8 HZ

REMOTE CALCULATIONS
PWROUT 785. WATTS
INDPWR 833. WATTS
PISTST 2.79 CM
DISPST 2.55 CM

DYNAMIC CALCULATIONS
PAMPC 965. KPA
DISPCP 2.31 CM
PISTCP 2.44 CM
PDYNDB****** KPA
PDLCLR 6.28 KPA
PDLREG 44.80 KPA
PDLDIS 77.38 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/03/84 15:07:17.40 RDG 1072

FLUID HELIUM BAROM 14.342 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.17 L/MIN
TWINDP 22.5 DEG.C
TDLDP 1.96 DEG.C
TWODPR 25.0 DEG.C

POWER IN
AMPS1 696. AMPS
AMPS2 573. AMPS
VOLTG 2.75 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 5558. KPA
MEANBP 5494. KPA
MEANCP 5536. KPA

GAS TEMPERATURES
TGEXP 548.3 DEG.C
TGREGH 532.0 DEG.C
TGREGC 72.3 DEG.C
TGCOMP 59.7 DEG.C
TGBOUN 39.4 DEG.C

SURFACE TEMPERATURES
T01HTR 594.4 DEG.C
T02HTR 613.1 DEG.C
T03HTR 614.0 DEG.C
T04HTR 597.7 DEG.C
T05HTR 622.3 DEG.C
T06HTR 612.6 DEG.C
T07HTR 612.1 DEG.C
T08HTR 574.5 DEG.C
T09HTR 599.4 DEG.C
T10HTR 586.0 DEG.C
T11HTR 562.9 DEG.C
T12HTR 581.6 DEG.C
T13REG****** DEG.C
T14REG 487.4 DEG.C
T15REG 321.4 DEG.C
T16REG 296.8 DEG.C
T17REG 270.4 DEG.C
T18REG 288.0 DEG.C
T19REG 184.7 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.42 L/MIN
TWINCL 25.5 DEG.C
TDLCL 8.35 DEG.C
TWOCLR 32.86 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3489. WATTS
2 QCOOLR 2559. WATTS
3 QDSHPT 566. WATTS
4 EXTEFF 21.7 %
5 TAVHTR 597.5 DEG.C
6 INTEFF 22.8 %
8 AMPS 1269. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 84. WATTS
12 QREG2 162. WATTS
13 QREG3 36. WATTS
14 PFP 794.0 KPA/CM
15 PFD 265.6 KPA/CM
16 NBEALE 0.00709

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 7.7 CM/S

PHASE ANGLES
PADISP 59.2 DEG.
PAPRES -16.2 DEG.

ENGINE SPEED
FREQ 26.7 HZ

REMOTE CALCULATIONS
PWROUT 756. WATTS
INDPWR 806. WATTS
PISTST 2.83 CM
DISPST 2.44 CM

DYNAMIC CALCULATIONS
PAMPC 999. KPA
DISPCP 2.34 CM
PISTCP 2.43 CM
PDYNDB****** KPA
PDLCLR****** KPA
PDLREG 26.13 KPA
PDLDIS 74.67 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/06/84 14:31:24.59 RDG 1075

FLUID HELIUM BAROM 14.288 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	3.84 L/MIN	AMPS1	448. AMPS	PRESUP	4145. KPA	TGEXP	562.2 DEG.C	T01HTR	606.5 DEG.C
		AMPS2	382. AMPS					T02HTR	598.6 DEG.C
TWINDP	22.8 DEG.C	VOLTG	1.78 VOLTS	MEANBP	4011. KPA	TGREGH	562.2 DEG.C	T03HTR	613.7 DEG.C
TDLDP	0.32 DEG.C			MEANCP	4028. KPA	TGREGC	66.0 DEG.C	T04HTR	607.6 DEG.C
TWODPR	23.8 DEG.C					TGCOMP	33.8 DEG.C	T05HTR	611.9 DEG.C
						TGBOUN	28.7 DEG.C	T06HTR	596.9 DEG.C
								T07HTR	598.3 DEG.C
								T08HTR	593.9 DEG.C
								T09HTR	606.9 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		SURFACE TEMPERATURES	
FLOCLR	4.31 L/MIN	1 PWRIN	1481. WATTS	VX1HOR	0.2 CM/S	PWROUT	280. WATTS	T10HTR	598.1 DEG.C
TWINCL	25.2 DEG.C	2 QCOOLR	890. WATTS	VY1VER	4.1 CM/S	INDPWR	290. WATTS	T11HTR	585.3 DEG.C
TDLCL	2.97 DEG.C	3 QDSHPT	86. WATTS			PISTST	1.82 CM	T12HTR	584.7 DEG.C
TWOCLR	27.79 DEG.C	4 EXTEFF	18.9 %	PHASE ANGLES		DISPST	1.97 CM		
		5 TAVHTR	600.2 DEG.C	PADISP	55.9 DEG.			T13REG******	DEG.C
		6 INTEFF	23.9 %	PAPRES	-23.8 DEG.	DYNAMIC CALCULATIONS		T14REG	507.9 DEG.C
		8 AMPS	830. AMPS			PAMPC	438. KPA	T15REG	366.8 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	1.76 CM	T16REG	363.4 DEG.C
		10 QDISP	15. WATTS	FREQ	22.8 HZ	PISTCP	2.34 CM	T17REG	360.7 DEG.C
		11 QREG1	129. WATTS			PDYNDB******	KPA	T18REG	361.9 DEG.C
		12 QREG2	118. WATTS			PDLCLR	1.19 KPA	T19REG	203.1 DEG.C
		13 QREG3	38. WATTS			PDLREG	17.65 KPA		
		14 PFP	573.1 KPA/CM			PDLDIS	31.90 KPA	T03HED******	DEG.C
		15 PFD	216.8 KPA/CM						
		16 NBEALE	0.00656						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/06/84 14:37:54.59 RDG 1076

FLUID HELIUM BAROM 14.288 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	3.85 L/MIN	AMPS1	464. AMPS	PRESUP	4155. KPA	TGEXP	560.4 DEG.C	T01HTR	605.6 DEG.C
		AMPS2	396. AMPS					T02HTR	600.3 DEG.C
TWINDP	22.8 DEG.C	VOLTG	1.85 VOLTS	MEANBP	4008. KPA	TGREGH	562.3 DEG.C	T03HTR	614.9 DEG.C
TDLDP	0.45 DEG.C			MEANCP	4025. KPA	TGREGC	67.6 DEG.C	T04HTR	605.9 DEG.C
TWODPR	23.9 DEG.C					TGCOMP	36.1 DEG.C	T05HTR	614.6 DEG.C
						TGBOUN	29.0 DEG.C	T06HTR	597.9 DEG.C
								T07HTR	599.1 DEG.C
								T08HTR	592.2 DEG.C
								T09HTR	606.3 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		SURFACE TEMPERATURES	
FLOCLR	4.31 L/MIN	1 PWRIN	1589. WATTS	VX1HOR	0.2 CM/S	PWROUT	327. WATTS	T10HTR	597.4 DEG.C
TWINCL	25.2 DEG.C	2 QCOOLR	968. WATTS	VY1VER	4.4 CM/S	INDPWR	345. WATTS	T11HTR	584.1 DEG.C
TDLCL	3.24 DEG.C	3 QDSHPT	119. WATTS			PISTST	1.99 CM	T12HTR	586.1 DEG.C
TWOCLR	28.07 DEG.C	4 EXTEFF	20.6 %	PHASE ANGLES		DISPST	2.13 CM		
		5 TAVHTR	600.4 DEG.C	PADISP	55.7 DEG.			T13REG******	DEG.C
		6 INTEFF	25.3 %	PAPRES	-22.8 DEG.	DYNAMIC CALCULATIONS		T14REG	511.9 DEG.C
		8 AMPS	860. AMPS			PAMPC	472. KPA	T15REG	373.5 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.05 CM	T16REG	365.9 DEG.C
		10 QDISP	15. WATTS	FREQ	22.8 HZ	PISTCP	2.36 CM	T17REG	362.8 DEG.C
		11 QREG1	127. WATTS			PDYNDB******	KPA	T18REG	366.2 DEG.C
		12 QREG2	118. WATTS			PDLCLR	1.36 KPA	T19REG	209.5 DEG.C
		13 QREG3	38. WATTS			PDLREG	21.72 KPA		
		14 PFP	562.5 KPA/CM			PDLDIS	36.66 KPA	T03HED******	DEG.C
		15 PFD	208.3 KPA/CM						
		16 NBEALE	0.00700						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/06/84 14:42:21.59 RDG 1077

FLUID HELIUM BAROM 14.288 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	3.83 L/MIN	AMPS1	501. AMPS	PRESUP	4150. KPA	TGEXP	556.6 DEG.C	T01HTR	603.9 DEG.C
		AMPS2	420. AMPS					T02HTR	599.1 DEG.C
TWINDP	22.9 DEG.C	VOLTG	1.98 VOLTS	MEANBP	4000. KPA	TGREGH	560.5 DEG.C	T03HTR	613.3 DEG.C
TDLDP	0.57 DEG.C			MEANCP	4020. KPA	TGREGC	69.3 DEG.C	T04HTR	605.2 DEG.C
TWODPR	24.1 DEG.C					TGCOMP	38.1 DEG.C	T05HTR	613.6 DEG.C
						TGBOUN	29.9 DEG.C	T06HTR	599.1 DEG.C
								T07HTR	599.9 DEG.C
								T08HTR	589.4 DEG.C
								T09HTR	606.7 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		SURFACE TEMPERATURES	
FLOCLR	4.29 L/MIN	1 PWRIN	1824. WATTS	VX1HOR	0.2 CM/S	PWROUT	387. WATTS	T10HTR	593.7 DEG.C
TWINCL	25.2 DEG.C	2 QCOOLR	1071. WATTS	VY1VER	4.9 CM/S	INDPWR	407. WATTS	T11HTR	582.2 DEG.C
TDLCL	3.59 DEG.C	3 QDSHPT	151. WATTS			PISTST	2.20 CM	T12HTR	583.3 DEG.C
TWOCLR	28.42 DEG.C	4 EXTEFF	21.2 %	PHASE ANGLES		DISPST	2.27 CM		
		5 TAVHTR	599.1 DEG.C	PADISP	57.1 DEG.			T13REG******	DEG.C
		6 INTEFF	26.5 %	PAPRES	-21.7 DEG.	DYNAMIC CALCULATIONS		T14REG	512.1 DEG.C
		8 AMPS	921. AMPS			PAMPC	541. KPA	T15REG	376.4 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.06 CM	T16REG	369.4 DEG.C
		10 QDISP	15. WATTS	FREQ	23.0 HZ	PISTCP	2.39 CM	T17REG	363.7 DEG.C
		11 QREG1	123. WATTS			PDYNDB******	KPA	T18REG	364.3 DEG.C
		12 QREG2	120. WATTS			PDLCLR	1.87 KPA	T19REG	212.9 DEG.C
		13 QREG3	38. WATTS			PDLREG	24.44 KPA		
		14 PFP	574.3 KPA/CM			PDLDIS	40.73 KPA	T03HED******	DEG.C
		15 PFD	209.8 KPA/CM						
		16 NBEALE	0.00746						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/06/84 14:47:21.59 RDG 1078

FLUID HELIUM BAROM 14.288 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 3.82 L/MIN
TWINDP 22.9 DEG.C
TDLDP 0.80 DEG.C
TWODPR 24.3 DEG.C

POWER IN
AMPS1 516. AMPS
AMPS2 434. AMPS
VOLTG 2.04 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 4146. KPA
MEANBP 3995. KPA
MEANCP 4018. KPA

GAS TEMPERATURES
TGEXP 555.0 DEG.C
TGREGH 561.3 DEG.C
TGREGC 71.0 DEG.C
TGCOMP 40.2 DEG.C
TGBOUN 30.9 DEG.C

SURFACE TEMPERATURES
T01HTR 605.0 DEG.C
T02HTR 600.1 DEG.C
T03HTR 613.7 DEG.C
T04HTR 604.9 DEG.C
T05HTR 614.0 DEG.C
T06HTR 600.5 DEG.C
T07HTR 600.9 DEG.C
T08HTR 589.6 DEG.C
T09HTR 607.9 DEG.C
T10HTR 592.2 DEG.C
T11HTR 582.9 DEG.C
T12HTR 582.0 DEG.C
T13REG****** DEG.C
T14REG 512.8 DEG.C
T15REG 378.0 DEG.C
T16REG 371.9 DEG.C
T17REG 367.3 DEG.C
T18REG 365.8 DEG.C
T19REG 215.0 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.30 L/MIN
TWINCL 25.2 DEG.C
TDLCL 3.94 DEG.C
TWOCLR 28.82 DEG.C

CALCULATED PARAMETERS
1 PWRIN 1939. WATTS
2 QCOOLR 1176. WATTS
3 QDSHPT 212. WATTS
4 EXTEFF 23.0 %
5 TAVHTR 599.5 DEG.C
6 INTEFF 27.5 %
8 AMPS 950. AMPS
9 QDISPG 3. WATTS
10 QDISP 15. WATTS
11 QREG1 122. WATTS
12 QREG2 119. WATTS
13 QREG3 38. WATTS
14 PFP 551.3 KPA/CM
15 PFD 197.3 KPA/CM
16 NBEALE 0.00784

VIBRATION
VX1HOR 0.2 CM/S
VY1VER 5.4 CM/S

PHASE ANGLES
PADISP 58.1 DEG.
PAPRES -20.3 DEG.

ENGINE SPEED
FREQ 23.0 HZ

REMOTE CALCULATIONS
PWROUT 446. WATTS
INDPWR 466. WATTS
PISTST 2.41 CM
DISPST 2.39 CM

DYNAMIC CALCULATIONS
PAMPC 576. KPA
DISPCP 2.13 CM
PISTCP 2.37 CM
PDYNDB****** KPA
PDLCLR 2.04 KPA
PDLREG 27.15 KPA
PDLDIS 45.48 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/06/84 14:52:24.59 RDG 1079

FLUID HELIUM BAROM 14.288 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.08 L/MIN
TWINDP 23.0 DEG.C
TDLDP 0.81 DEG.C
TWODPR 24.4 DEG.C

POWER IN
AMPS1 539. AMPS
AMPS2 451. AMPS
VOLTG 2.13 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 4143. KPA
MEANBP 3988. KPA
MEANCP 4012. KPA

GAS TEMPERATURES
TGEXP 553.1 DEG.C
TGREGH 560.1 DEG.C
TGREGC 70.5 DEG.C
TGCOMP 41.6 DEG.C
TGBOUN 32.0 DEG.C

SURFACE TEMPERATURES
T01HTR 605.6 DEG.C
T02HTR 599.1 DEG.C
T03HTR 614.7 DEG.C
T04HTR 603.7 DEG.C
T05HTR 615.3 DEG.C
T06HTR 600.7 DEG.C
T07HTR 601.4 DEG.C
T08HTR 589.7 DEG.C
T09HTR 607.8 DEG.C
T10HTR 591.6 DEG.C
T11HTR 581.8 DEG.C
T12HTR 581.3 DEG.C
T13REG****** DEG.C
T14REG 512.2 DEG.C
T15REG 376.1 DEG.C
T16REG 367.6 DEG.C
T17REG 363.5 DEG.C
T18REG 363.0 DEG.C
T19REG 213.7 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.31 L/MIN
TWINCL 25.2 DEG.C
TDLCL 4.15 DEG.C
TWOCLR 29.17 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2109. WATTS
2 QCOOLR 1242. WATTS
3 QDSHPT 228. WATTS
4 EXTEFF 23.7 %
5 TAVHTR 599.4 DEG.C
6 INTEFF 28.7 %
8 AMPS 990. AMPS
9 QDISPG 3. WATTS
10 QDISP 15. WATTS
11 QREG1 121. WATTS
12 QREG2 121. WATTS
13 QREG3 38. WATTS
14 PFP 568.8 KPA/CM
15 PFD 200.5 KPA/CM
16 NBEALE 0.00815

VIBRATION
VX1HOR 0.2 CM/S
VY1VER 5.8 CM/S

PHASE ANGLES
PADISP 58.4 DEG.
PAPRES -19.7 DEG.

ENGINE SPEED
FREQ 23.0 HZ

REMOTE CALCULATIONS
PWROUT 500. WATTS
INDPWR 520. WATTS
PISTST 2.61 CM
DISPST 2.55 CM

DYNAMIC CALCULATIONS
PAMPC 645. KPA
DISPCP 2.18 CM
PISTCP 2.40 CM
PDYNDB****** KPA
PDLCLR 2.72 KPA
PDLREG 29.53 KPA
PDLDIS 49.21 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/06/84 14:58:30.59 RDG 1080

FLUID HELIUM BAROM 14.288 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.11 L/MIN
TWINDP 23.1 DEG.C
TDLDP 0.93 DEG.C
TWODPR 24.7 DEG.C

POWER IN
AMPS1 568. AMPS
AMPS2 475. AMPS
VOLTG 2.25 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 4141. KPA
MEANBP 3986. KPA
MEANCP 4010. KPA

GAS TEMPERATURES
TGEXP 551.4 DEG.C
TGREGH 552.6 DEG.C
TGREGC 65.5 DEG.C
TGCOMP 45.0 DEG.C
TGBOUN 33.3 DEG.C

SURFACE TEMPERATURES
T01HTR 606.1 DEG.C
T02HTR 602.6 DEG.C
T03HTR 618.9 DEG.C
T04HTR 600.0 DEG.C
T05HTR 621.4 DEG.C
T06HTR 602.5 DEG.C
T07HTR 604.1 DEG.C
T08HTR 590.2 DEG.C
T09HTR 603.7 DEG.C
T10HTR 594.6 DEG.C
T11HTR 577.3 DEG.C
T12HTR 585.2 DEG.C
T13REG****** DEG.C
T14REG 506.8 DEG.C
T15REG 358.9 DEG.C
T16REG 335.6 DEG.C
T17REG 331.6 DEG.C
T18REG 342.7 DEG.C
T19REG 201.7 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.33 L/MIN
TWINCL 25.3 DEG.C
TDLCL 4.67 DEG.C
TWOCLR 29.62 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2342. WATTS
2 QCOOLR 1402. WATTS
3 QDSHPT 266. WATTS
4 EXTEFF 24.2 %
5 TAVHTR 600.6 DEG.C
6 INTEFF 28.8 %
8 AMPS 1043. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 114. WATTS
12 QREG2 133. WATTS
13 QREG3 38. WATTS
14 PFP 568.0 KPA/CM
15 PFD 202.2 KPA/CM
16 NBEALE 0.00860

VIBRATION
VX1HOR 0.2 CM/S
VY1VER 6.3 CM/S

PHASE ANGLES
PADISP 58.6 DEG.
PAPRES -19.5 DEG.

ENGINE SPEED
FREQ 22.8 HZ

REMOTE CALCULATIONS
PWROUT 567. WATTS
INDPWR 592. WATTS
PISTST 2.82 CM
DISPST 2.71 CM

DYNAMIC CALCULATIONS
PAMPC 699. KPA
DISPCP 2.21 CM
PISTCP 2.50 CM
PDYNDB****** KPA
PDLCLR 3.53 KPA
PDLREG 31.22 KPA
PDLDIS 51.93 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/06/84 15:02:18.59 RDG 1081

FLUID HELIUM BAROM 14.288 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.10 L/MIN	AMPS1	588. AMPS	PRESUP	4139. KPA	TGEXP	548.9 DEG.C	T01HTR	605.2 DEG.C
		AMPS2	491. AMPS					T02HTR	603.1 DEG.C
TWINDP	23.1 DEG.C	VOLTG	2.32 VOLTS					T03HTR	619.5 DEG.C
TDLDP	1.06 DEG.C			MEANBP	3983. KPA	TGREGH	549.8 DEG.C	T04HTR	597.7 DEG.C
TWODPR	24.8 DEG.C			MEANCP	4011. KPA	TGREGC	65.1 DEG.C	T05HTR	622.8 DEG.C
						TGCOMP	47.0 DEG.C	T06HTR	603.2 DEG.C
						TGBOUN	33.9 DEG.C	T07HTR	604.6 DEG.C
								T08HTR	588.7 DEG.C
								T09HTR	602.6 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	593.1 DEG.C
FLOCLR	4.34 L/MIN	1 PWRIN	2507. WATTS	VX1HOR	0.3 CM/S	PWROUT	622. WATTS	T11HTR	575.1 DEG.C
TWINCL	25.3 DEG.C	2 QCOOLR	1500. WATTS	VY1VER	6.7 CM/S	INDPWR	647. WATTS	T12HTR	584.3 DEG.C
TDLCL	4.99 DEG.C	3 QDSHPT	302. WATTS			PISTST	3.01 CM		
TWOCLR	29.90 DEG.C	4 EXTEFF	24.8 %	PHASE ANGLES		DISPST	2.86 CM		
		5 TAVHTR	600.0 DEG.C	PADISP	58.9 DEG.			T13REG	****** DEG.C
		6 INTEFF	29.3 %	PAPRES	-19.3 DEG.	DYNAMIC CALCULATIONS		T14REG	505.5 DEG.C
		8 AMPS	1079. AMPS			PAMPC	733. KPA	T15REG	354.8 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.11 CM	T16REG	328.7 DEG.C
		10 QDISP	14. WATTS	FREQ	22.7 HZ	PISTCP	2.56 CM	T17REG	324.6 DEG.C
		11 QREG1	113. WATTS			PDYNDB	****** KPA	T18REG	338.1 DEG.C
		12 QREG2	136. WATTS			PDLCLR	3.39 KPA	T19REG	198.9 DEG.C
		13 QREG3	38. WATTS			PDLREG	33.26 KPA		
		14 PFP	557.0 KPA/CM			PDLDIS	56.68 KPA	T03HED	****** DEG.C
		15 PFD	197.2 KPA/CM						
		16 NBEALE	0.00890						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/08/84 13:16:33.40 RDG 1117

FLUID HELIUM BAROM 14.239 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.40 L/MIN	AMPS1	560. AMPS	PRESUP	7088. KPA	TGEXP	568.8 DEG.C	T01HTR	600.0 DEG.C
		AMPS2	479. AMPS					T02HTR	605.4 DEG.C
TWINDP	25.0 DEG.C	VOLTG	2.22 VOLTS					T03HTR	611.6 DEG.C
TDLDP	1.19 DEG.C			MEANBP	7007. KPA	TGREGH	563.8 DEG.C	T04HTR	606.7 DEG.C
TWODPR	26.7 DEG.C			MEANCP	7047. KPA	TGREGC	100.3 DEG.C	T05HTR	615.9 DEG.C
						TGCOMP	52.1 DEG.C	T06HTR	605.5 DEG.C
						TGBOUN	39.5 DEG.C	T07HTR	604.2 DEG.C
								T08HTR	582.6 DEG.C
								T09HTR	609.2 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	591.2 DEG.C
FLOCLR	4.36 L/MIN	1 PWRIN	2303. WATTS	VX1HOR	0.3 CM/S	PWROUT	503. WATTS	T11HTR	579.1 DEG.C
TWINCL	39.6 DEG.C	2 QCOOLR	1710. WATTS	VY1VER	6.0 CM/S	INDPWR	544. WATTS	T12HTR	582.9 DEG.C
TDLCL	5.69 DEG.C	3 QDSHPT	363. WATTS			PISTST	1.81 CM		
TWOCLR	44.13 DEG.C	4 EXTEFF	21.9 %	PHASE ANGLES		DISPST	1.86 CM		
		5 TAVHTR	599.5 DEG.C	PADISP	57.9 DEG.			T13REG	****** DEG.C
		6 INTEFF	22.7 %	PAPRES	-18.7 DEG.	DYNAMIC CALCULATIONS		T14REG	521.2 DEG.C
		8 AMPS	1039. AMPS			PAMPC	797. KPA	T15REG	389.1 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.02 CM	T16REG	392.1 DEG.C
		10 QDISP	15. WATTS	FREQ	30.1 HZ	PISTCP	2.36 CM	T17REG	384.9 DEG.C
		11 QREG1	118. WATTS			PDYNDB	****** KPA	T18REG	389.6 DEG.C
		12 QREG2	115. WATTS			PDLCLR	3.05 KPA	T19REG	232.9 DEG.C
		13 QREG3	36. WATTS			PDLREG	35.30 KPA		
		14 PFP	1009.7 KPA/CM			PDLDIS	65.16 KPA	T03HED	****** DEG.C
		15 PFD	324.6 KPA/CM						
		16 NBEALE	0.00512						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/08/84 13:21:24.40 RDG 1118

FLUID HELIUM BAROM 14.239 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.39 L/MIN	AMPS1	597. AMPS	PRESUP	7085. KPA	TGEXP	565.3 DEG.C	T01HTR	601.1 DEG.C
		AMPS2	508. AMPS					T02HTR	604.4 DEG.C
TWINDP	25.1 DEG.C	VOLTG	2.36 VOLTS					T03HTR	612.7 DEG.C
TDLDP	1.45 DEG.C			MEANBP	7005. KPA	TGREGH	563.9 DEG.C	T04HTR	605.5 DEG.C
TWODPR	27.0 DEG.C			MEANCP	7047. KPA	TGREGC	103.2 DEG.C	T05HTR	616.6 DEG.C
						TGCOMP	54.8 DEG.C	T06HTR	606.3 DEG.C
						TGBOUN	40.7 DEG.C	T07HTR	604.7 DEG.C
								T08HTR	582.5 DEG.C
								T09HTR	610.0 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	588.9 DEG.C
FLOCLR	4.37 L/MIN	1 PWRIN	2608. WATTS	VX1HOR	0.3 CM/S	PWROUT	587. WATTS	T11HTR	578.6 DEG.C
TWINCL	39.7 DEG.C	2 QCOOLR	1842. WATTS	VY1VER	6.7 CM/S	INDPWR	631. WATTS	T12HTR	579.5 DEG.C
TDLCL	6.10 DEG.C	3 QDSHPT	442. WATTS			PISTST	2.01 CM		
TWOCLR	44.66 DEG.C	4 EXTEFF	22.5 %	PHASE ANGLES		DISPST	1.97 CM		
		5 TAVHTR	599.2 DEG.C	PADISP	57.9 DEG.			T13REG	****** DEG.C
		6 INTEFF	24.2 %	PAPRES	-18.0 DEG.	DYNAMIC CALCULATIONS		T14REG	521.3 DEG.C
		8 AMPS	1105. AMPS			PAMPC	886. KPA	T15REG	392.8 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.23 CM	T16REG	396.2 DEG.C
		10 QDISP	14. WATTS	FREQ	30.2 HZ	PISTCP	2.37 CM	T17REG	389.8 DEG.C
		11 QREG1	118. WATTS			PDYNDB	****** KPA	T18REG	382.9 DEG.C
		12 QREG2	112. WATTS			PDLCLR	3.73 KPA	T19REG	237.7 DEG.C
		13 QREG3	36. WATTS			PDLREG	41.07 KPA		
		14 PFP	1009.5 KPA/CM			PDLDIS	80.10 KPA	T03HED	****** DEG.C
		15 PFD	327.9 KPA/CM						
		16 NBEALE	0.00538						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/08/84 13:26:36.40 RDG 1119

FLUID HELIUM BAROM 14.234 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.38 L/MIN
TWINDP 25.2 DEG.C
TDLDP 1.63 DEG.C
TWODPR 27.4 DEG.C

POWER IN
AMPS1 629. AMPS
AMPS2 536. AMPS
VOLTG 2.49 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7086. KPA
MEANBP 7009. KPA
MEANCP 7053. KPA

GAS TEMPERATURES
TGEXP 562.9 DEG.C
TGREGH 563.0 DEG.C
TGREGC 105.7 DEG.C
TGCOMP 57.4 DEG.C
TGBOUN 41.6 DEG.C

SURFACE TEMPERATURES
T01HTR 602.1 DEG.C
T02HTR 604.2 DEG.C
T03HTR 614.5 DEG.C
T04HTR 605.0 DEG.C
T05HTR 618.6 DEG.C
T06HTR 607.2 DEG.C
T07HTR 605.7 DEG.C
T08HTR 582.5 DEG.C
T09HTR 611.1 DEG.C
T10HTR 588.5 DEG.C
T11HTR 578.0 DEG.C
T12HTR 578.3 DEG.C

HEAT TO COOLER
FLOCLR 4.36 L/MIN
TWINCL 39.7 DEG.C
TDLCL 6.88 DEG.C
TWOCLR 45.37 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2900. WATTS
2 QCOOLR 2073. WATTS
3 QDSHPT 496. WATTS
4 EXTEFF 23.0 %
5 TAVHTR 599.6 DEG.C
6 INTEFF 24.3 %
8 AMPS 1165. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 116. WATTS
12 QREG2 111. WATTS
13 QREG3 35. WATTS
14 PFP 1003.3 KPA/CM
15 PFD 314.8 KPA/CM
16 NBEALE 0.00558

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 7.3 CM/S

PHASE ANGLES
PADISP 58.4 DEG.
PAPRES -16.8 DEG.

ENGINE SPEED
FREQ 30.2 HZ

REMOTE CALCULATIONS
PWROUT 667. WATTS
INDPWR 718. WATTS
PISTST 2.19 CM
DISPST 2.09 CM

DYNAMIC CALCULATIONS
PAMPC 970. KPA
DISPCP 2.26 CM
PISTCP 2.39 CM
PDYNDB****** KPA
PDLCLR 4.24 KPA
PDLREG 45.48 KPA
PDLDIS 80.78 KPA

T13REG****** DEG.C
T14REG 521.9 DEG.C
T15REG 395.2 DEG.C
T16REG 397.0 DEG.C
T17REG 390.9 DEG.C
T18REG 384.7 DEG.C
T19REG 241.6 DEG.C
T03HED****** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/08/84 13:31:27.40 RDG 1120

FLUID HELIUM BAROM 14.234 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.38 L/MIN
TWINDP 25.3 DEG.C
TDLDP 1.97 DEG.C
TWODPR 27.7 DEG.C

POWER IN
AMPS1 667. AMPS
AMPS2 568. AMPS
VOLTG 2.64 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7089. KPA
MEANBP 7011. KPA
MEANCP 7061. KPA

GAS TEMPERATURES
TGEXP 559.6 DEG.C
TGREGH 561.7 DEG.C
TGREGC 108.4 DEG.C
TGCOMP 60.5 DEG.C
TGBOUN 42.9 DEG.C

SURFACE TEMPERATURES
T01HTR 602.7 DEG.C
T02HTR 604.0 DEG.C
T03HTR 616.3 DEG.C
T04HTR 603.9 DEG.C
T05HTR 620.6 DEG.C
T06HTR 608.3 DEG.C
T07HTR 606.7 DEG.C
T08HTR 582.1 DEG.C
T09HTR 611.5 DEG.C
T10HTR 587.4 DEG.C
T11HTR 576.6 DEG.C
T12HTR 576.3 DEG.C

HEAT TO COOLER
FLOCLR 4.39 L/MIN
TWINCL 39.8 DEG.C
TDLCL 7.74 DEG.C
TWOCLR 46.23 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3258. WATTS
2 QCOOLR 2345. WATTS
3 QDSHPT 598. WATTS
4 EXTEFF 23.2 %
5 TAVHTR 599.7 DEG.C
6 INTEFF 24.4 %
8 AMPS 1234. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 114. WATTS
12 QREG2 110. WATTS
13 QREG3 35. WATTS
14 PFP 1010.9 KPA/CM
15 PFD 309.5 KPA/CM
16 NBEALE 0.00575

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 8.0 CM/S

PHASE ANGLES
PADISP 58.4 DEG.
PAPRES -15.7 DEG.

ENGINE SPEED
FREQ 30.2 HZ

REMOTE CALCULATIONS
PWROUT 757. WATTS
INDPWR 814. WATTS
PISTST 2.42 CM
DISPST 2.22 CM

DYNAMIC CALCULATIONS
PAMPC 1083. KPA
DISPCP 2.27 CM
PISTCP 2.38 CM
PDYNDB****** KPA
PDLCLR 5.09 KPA
PDLREG 51.25 KPA
PDLDIS 89.26 KPA

T13REG****** DEG.C
T14REG 522.0 DEG.C
T15REG 397.2 DEG.C
T16REG 397.8 DEG.C
T17REG 391.7 DEG.C
T18REG 386.3 DEG.C
T19REG 245.2 DEG.C
T03HED****** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/08/84 13:36:21.40 RDG 1121

FLUID HELIUM BAROM 14.234 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.37 L/MIN
TWINDP 25.4 DEG.C
TDLDP 2.18 DEG.C
TWODPR 28.0 DEG.C

POWER IN
AMPS1 702. AMPS
AMPS2 595. AMPS
VOLTG 2.78 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7093. KPA
MEANBP 7012. KPA
MEANCP 7066. KPA

GAS TEMPERATURES
TGEXP 557.0 DEG.C
TGREGH 559.4 DEG.C
TGREGC 109.0 DEG.C
TGCOMP 64.0 DEG.C
TGBOUN 44.0 DEG.C

SURFACE TEMPERATURES
T01HTR 602.6 DEG.C
T02HTR 604.7 DEG.C
T03HTR 616.7 DEG.C
T04HTR 603.0 DEG.C
T05HTR 621.4 DEG.C
T06HTR 609.5 DEG.C
T07HTR 608.0 DEG.C
T08HTR 580.9 DEG.C
T09HTR 611.3 DEG.C
T10HTR 586.0 DEG.C
T11HTR 574.7 DEG.C
T12HIR 574.8 DEG.C

HEAT TO COOLER
FLOCLR 4.36 L/MIN
TWINCL 39.9 DEG.C
TDLCL 8.42 DEG.C
TWOCLR 46.99 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3599. WATTS
2 QCOOLR 2532. WATTS
3 QDSHPT 662. WATTS
4 EXTEFF 23.5 %
5 TAVHTR 599.5 DEG.C
6 INTEFF 25.0 %
8 AMPS 1296. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 111. WATTS
12 QREG2 114. WATTS
13 QREG3 35. WATTS
14 PFP 1007.1 KPA/CM
15 PFD 300.9 KPA/CM
16 NBEALE 0.00593

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 8.6 CM/S

PHASE ANGLES
PADISP 58.5 DEG.
PAPRES -14.9 DEG.

ENGINE SPEED
FREQ 30.3 HZ

REMOTE CALCULATIONS
PWROUT 845. WATTS
INDPWR 907. WATTS
PISTST 2.61 CM
DISPST 2.35 CM

DYNAMIC CALCULATIONS
PAMPC 1171. KPA
DISPCP 2.29 CM
PISTCP 2.34 CM
PDYNDB****** KPA
PDLCLR 6.11 KPA
PDLREG 56.34 KPA
PDLDIS 96.73 KPA

T13REG****** DEG.C
T14REG 519.6 DEG.C
T15REG 391.9 DEG.C
T16REG 391.7 DEG.C
T17REG 386.0 DEG.C
T18REG 378.7 DEG.C
T19REG 241.7 DEG.C
T03HED****** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/08/84 13:41:21.40 RDG 1122

FLUID HELIUM BAROM 14.234 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.37 L/MIN	AMPS1	744. AMPS	PRESUP	7093. KPA	TGEXP	553.0 DEG.C	T01HTR	600.3 DEG.C
		AMPS2	627. AMPS					T02HTR	606.8 DEG.C
TWINDP	25.6 DEG.C	VOLTG	2.91 VOLTS	MEANBP	7014. KPA	TGREGH	550.7 DEG.C	T03HTR	614.7 DEG.C
TDLDP	2.52 DEG.C			MEANCP	7072. KPA	TGREGC	104.8 DEG.C	T04HTR	601.2 DEG.C
TWODPR	28.5 DEG.C					TGCOMP	70.5 DEG.C	T05HTR	621.1 DEG.C
						TGBOUN	45.8 DEG.C	T06HTR	610.5 DEG.C
								T07HTR	608.9 DEG.C
								T08HTR	577.5 DEG.C
								T09HTR	608.8 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	583.8 DEG.C
FLOCLR	4.35 L/MIN	1 PWRIN	3994. WATTS	VX1HOR	0.4 CM/S	PWROUT	912. WATTS	T11HTR	569.9 DEG.C
TWINCL	39.9 DEG.C	2 QCOOLR	2889. WATTS	VY1VER	9.1 CM/S	INDPWR	976. WATTS	T12HTR	574.2 DEG.C
TDLCL	9.62 DEG.C	3 QDSHPT	765. WATTS			PISTST	2.77 CM		
TWOCLR	48.16 DEG.C	4 EXTEFF	22.8 %	PHASE ANGLES		DISPST	2.44 CM		
		5 TAVHTR	598.1 DEG.C	PADISP	58.5 DEG.			T13REG******	DEG.C
		6 INTEFF	24.0 %	PAPRES	-14.4 DEG.	DYNAMIC CALCULATIONS		T14REG	505.1 DEG.C
		8 AMPS	1371. AMPS			PAMPC	1196. KPA	T15REG	358.4 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.39 CM	T16REG	355.7 DEG.C
		10 QDISP	14. WATTS	FREQ	30.1 HZ	PISTCP	2.38 CM	T17REG	348.0 DEG.C
		11 QREG1	99. WATTS			PDYNDB******	KPA	T18REG	338.4 DEG.C
		12 QREG2	135. WATTS			PDLCLR	6.28 KPA	T19REG	216.9 DEG.C
		13 QREG3	35. WATTS			PDLREG	55.66 KPA		
		14 PFP	967.1 KPA/CM			PDLDIS	97.07 KPA	T03HED******	DEG.C
		15 PFD	285.6 KPA/CM						
		16 NBEALE	0.00606						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/27/84 13:46:04.27 RDG 1196

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.00 L/MIN	AMPS1	557. AMPS	PRESUP	7217. KPA	TGEXP	570.3 DEG.C	T01HTR	599.5 DEG.C
		AMPS2	461. AMPS					T02HTR	607.4 DEG.C
TWINDP	18.2 DEG.C	VOLTG	2.22 VOLTS	MEANBP	6995. KPA	TGREGH	563.9 DEG.C	T03HTR	611.0 DEG.C
TDLDP	1.58 DEG.C			MEANCP	7025. KPA	TGREGC	113.1 DEG.C	T04HTR	608.2 DEG.C
TWODPR	20.5 DEG.C					TGCOMP	61.3 DEG.C	T05HTR	615.2 DEG.C
						TGBOUN	37.7 DEG.C	T06HTR	607.0 DEG.C
								T07HTR	605.8 DEG.C
								T08HTR	582.1 DEG.C
								T09HTR	610.2 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	591.5 DEG.C
FLOCLR	4.15 L/MIN	1 PWRIN	2263. WATTS	VX1HOR	0.4 CM/S	PWROUT	473. WATTS	T11HTR	579.7 DEG.C
TWINCL	53.9 DEG.C	2 QCOOLR	1278. WATTS	VY1VER	5.8 CM/S	INDPWR	512. WATTS	T12HTR	584.1 DEG.C
TDLCL	4.48 DEG.C	3 QDSHPT	439. WATTS			PISTST	1.80 CM		
TWOCLR	57.49 DEG.C	4 EXTEFF	20.9 %	PHASE ANGLES		DISPST	1.82 CM		
		5 TAVHTR	600.1 DEG.C	PADISP	58.3 DEG.			T13REG******	DEG.C
		6 INTEFF	27.0 %	PAPRES	-17.8 DEG.	DYNAMIC CALCULATIONS		T14REG	522.9 DEG.C
		8 AMPS	1018. AMPS			PAMPC	787. KPA	T15REG	394.2 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.06 CM	T16REG	396.6 DEG.C
		10 QDISP	14. WATTS	FREQ	30.1 HZ	PISTCP	2.36 CM	T17REG	385.4 DEG.C
		11 QREG1	113. WATTS			PDYNDB******	KPA	T18REG	380.3 DEG.C
		12 QREG2	116. WATTS			PDLCLR	3.05 KPA	T19REG	241.3 DEG.C
		13 QREG3	35. WATTS			PDLREG	34.28 KPA		
		14 PFP	997.0 KPA/CM			PDLDIS	61.43 KPA	T03HED******	DEG.C
		15 PFD	311.0 KPA/CM						
		16 NBEALE	0.00486						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/27/84 13:50:19.27 RDG 1197

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.02 L/MIN	AMPS1	598. AMPS	PRESUP	7260. KPA	TGEXP	567.2 DEG.C	T01HTR	600.1 DEG.C
		AMPS2	490. AMPS					T02HTR	606.6 DEG.C
TWINDP	18.3 DEG.C	VOLTG	2.37 VOLTS	MEANBP	6995. KPA	TGREGH	562.6 DEG.C	T03HTR	612.9 DEG.C
TDLDP	1.80 DEG.C			MEANCP	7027. KPA	TGREGC	116.1 DEG.C	T04HTR	607.5 DEG.C
TWODPR	20.8 DEG.C					TGCOMP	63.2 DEG.C	T05HTR	617.2 DEG.C
						TGBOUN	38.8 DEG.C	T06HTR	607.8 DEG.C
								T07HTR	606.6 DEG.C
								T08HTR	581.6 DEG.C
								T09HTR	611.3 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	590.3 DEG.C
FLOCLR	4.15 L/MIN	1 PWRIN	2582. WATTS	VX1HOR	0.5 CM/S	PWROUT	557. WATTS	T11HTR	578.8 DEG.C
TWINCL	54.0 DEG.C	2 QCOOLR	1444. WATTS	VY1VER	6.5 CM/S	INDPWR	602. WATTS	T12HTR	582.1 DEG.C
TDLCL	5.06 DEG.C	3 QDSHPT	504. WATTS			PISTST	2.01 CM		
TWOCLR	58.16 DEG.C	4 EXTEFF	21.6 %	PHASE ANGLES		DISPST	1.96 CM		
		5 TAVHTR	600.2 DEG.C	PADISP	58.7 DEG.			T13REG******	DEG.C
		6 INTEFF	27.8 %	PAPRES	-16.7 DEG.	DYNAMIC CALCULATIONS		T14REG	523.7 DEG.C
		8 AMPS	1088. AMPS			PAMPC	886. KPA	T15REG	397.9 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.15 CM	T16REG	399.7 DEG.C
		10 QDISP	14. WATTS	FREQ	30.1 HZ	PISTCP	2.37 CM	T17REG	387.7 DEG.C
		11 QREG1	111. WATTS			PDYNDB******	KPA	T18REG	382.7 DEG.C
		12 QREG2	114. WATTS			PDLCLR	3.90 KPA	T19REG	246.2 DEG.C
		13 QREG3	35. WATTS			PDLREG	39.37 KPA		
		14 PFP	998.3 KPA/CM			PDLDIS	71.29 KPA	T03HED******	DEG.C
		15 PFD	303.3 KPA/CM						
		16 NBEALE	0.00512						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/27/84 13:55:22.27 RDG 1198

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.01 L/MIN
TWINDP 18.5 DEG.C
TDLDP 2.06 DEG.C
TWODPR 21.2 DEG.C

POWER IN
AMPS1 633. AMPS
AMPS2 516. AMPS
VOLTG 2.51 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7273. KPA
MEANBP 6991. KPA
MEANCP 7027. KPA

GAS TEMPERATURES
TGEXP 564.3 DEG.C
TGREGH 561.6 DEG.C
TGREGC 118.7 DEG.C
TGCOMP 66.2 DEG.C
TGBOUN 39.9 DEG.C

SURFACE TEMPERATURES
T01HTR 600.3 DEG.C
T02HTR 607.0 DEG.C
T03HTR 613.9 DEG.C
T04HTR 607.0 DEG.C
T05HTR 618.5 DEG.C
T06HTR 609.5 DEG.C
T07HTR 608.2 DEG.C
T08HTR 580.8 DEG.C
T09HTR 612.3 DEG.C
T10HTR 588.8 DEG.C
T11HTR 577.9 DEG.C
T12HTR 580.4 DEG.C
T13REG****** DEG.C
T14REG 524.2 DEG.C
T15REG 400.3 DEG.C
T16REG 401.8 DEG.C
T17REG 389.2 DEG.C
T18REG 382.9 DEG.C
T19REG 249.6 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.14 L/MIN
TWINCL 53.8 DEG.C
TDLCL 5.79 DEG.C
TWOCLR 58.75 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2882. WATTS
2 QCOOLR 1646. WATTS
3 QDSHPT 575. WATTS
4 EXTEFF 22.0 %
5 TAVHTR 600.4 DEG.C
6 INTEFF 27.9 %
8 AMPS 1149. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 108. WATTS
12 QREG2 115. WATTS
13 QREG3 34. WATTS
14 PFP 993.0 KPA/CM
15 PFD 297.3 KPA/CM
16 NBEALE 0.00531

VIBRATION
VX1HOR 0.5 CM/S
VY1VER 7.2 CM/S

PHASE ANGLES
PADISP 58.8 DEG.
PAPRES -15.8 DEG.

ENGINE SPEED
FREQ 30.1 HZ

REMOTE CALCULATIONS
PWROUT 635. WATTS
INDPWR 687. WATTS
PISTST 2.21 CM
DISPST 2.08 CM

DYNAMIC CALCULATIONS
PAMPC 974. KPA
DISPCP 2.15 CM
PISTCP 2.39 CM
PDYNDB****** KPA
PDLCLR 4.41 KPA
PDLREG 44.12 KPA
PDLDIS 78.06 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/27/84 14:00:22.27 RDG 1199

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.01 L/MIN
TWINDP 18.6 DEG.C
TDLDP 2.39 DEG.C
TWODPR 21.7 DEG.C

POWER IN
AMPS1 663. AMPS
AMPS2 545. AMPS
VOLTG 2.64 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7294. KPA
MEANBP 6992. KPA
MEANCP 7033. KPA

GAS TEMPERATURES
TGEXP 561.2 DEG.C
TGREGH 561.0 DEG.C
TGREGC 121.9 DEG.C
TGCOMP 69.7 DEG.C
TGBOUN 41.7 DEG.C

SURFACE TEMPERATURES
T01HTR 601.4 DEG.C
T02HTR 607.2 DEG.C
T03HTR 614.5 DEG.C
T04HTR 606.8 DEG.C
T05HTR 619.1 DEG.C
T06HTR 610.8 DEG.C
T07HTR 609.4 DEG.C
T08HTR 580.6 DEG.C
T09HTR 613.5 DEG.C
T10HTR 586.9 DEG.C
T11HTR 577.6 DEG.C
T12HTR 577.9 DEG.C
T13REG****** DEG.C
T14REG 523.7 DEG.C
T15REG 402.1 DEG.C
T16REG 405.0 DEG.C
T17REG 392.3 DEG.C
T18REG 383.3 DEG.C
T19REG 252.8 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.15 L/MIN
TWINCL 53.9 DEG.C
TDLCL 6.70 DEG.C
TWOCLR 59.60 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3188. WATTS
2 QCOOLR 1911. WATTS
3 QDSHPT 667. WATTS
4 EXTEFF 22.0 %
5 TAVHTR 600.5 DEG.C
6 INTEFF 26.9 %
8 AMPS 1208. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 106. WATTS
12 QREG2 114. WATTS
13 QREG3 34. WATTS
14 PFP 1001.2 KPA/CM
15 PFD 291.6 KPA/CM
16 NBEALE 0.00540

VIBRATION
VX1HOR 0.5 CM/S
VY1VER 7.8 CM/S

PHASE ANGLES
PADISP 58.9 DEG.
PAPRES -14.6 DEG.

ENGINE SPEED
FREQ 30.2 HZ

REMOTE CALCULATIONS
PWROUT 702. WATTS
INDPWR 759. WATTS
PISTST 2.40 CM
DISPST 2.17 CM

DYNAMIC CALCULATIONS
PAMPC 1073. KPA
DISPCP 2.22 CM
PISTCP 2.38 CM
PDYNDB****** KPA
PDLCLR 5.09 KPA
PDLREG 48.53 KPA
PDLDIS 84.51 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/27/84 14:05:40.27 RDG 1200

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.01 L/MIN
TWINDP 18.7 DEG.C
TDLDP 2.63 DEG.C
TWODPR 22.1 DEG.C

POWER IN
AMPS1 694. AMPS
AMPS2 569. AMPS
VOLTG 2.77 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7311. KPA
MEANBP 6986. KPA
MEANCP 7031. KPA

GAS TEMPERATURES
TGEXP 558.0 DEG.C
TGREGH 558.6 DEG.C
TGREGC 123.0 DEG.C
TGCOMP 74.7 DEG.C
TGBOUN 43.1 DEG.C

SURFACE TEMPERATURES
T01HTR 600.3 DEG.C
T02HTR 607.1 DEG.C
T03HTR 614.6 DEG.C
T04HTR 605.0 DEG.C
T05HTR 619.5 DEG.C
T06HTR 611.7 DEG.C
T07HTR 610.3 DEG.C
T08HTR 578.4 DEG.C
T09HTR 612.6 DEG.C
T10HTR 584.7 DEG.C
T11HTR 575.1 DEG.C
T12HTR 575.6 DEG.C
T13REG****** DEG.C
T14REG 522.7 DEG.C
T15REG 402.6 DEG.C
T16REG 402.4 DEG.C
T17REG 388.9 DEG.C
T18REG 382.4 DEG.C
T19REG 255.2 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.15 L/MIN
TWINCL 54.0 DEG.C
TDLCL 7.39 DEG.C
TWOCLR 60.48 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3493. WATTS
2 QCOOLR 2108. WATTS
3 QDSHPT 734. WATTS
4 EXTEFF 22.2 %
5 TAVHTR 599.6 DEG.C
6 INTEFF 26.9 %
8 AMPS 1263. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 103. WATTS
12 QREG2 114. WATTS
13 QREG3 34. WATTS
14 PFP 994.2 KPA/CM
15 PFD 280.7 KPA/CM
16 NBEALE 0.00551

VIBRATION
VX1HOR 0.6 CM/S
VY1VER 8.4 CM/S

PHASE ANGLES
PADISP 59.1 DEG.
PAPRES -13.7 DEG.

ENGINE SPEED
FREQ 30.2 HZ

REMOTE CALCULATIONS
PWROUT 777. WATTS
INDPWR 837. WATTS
PISTST 2.60 CM
DISPST 2.29 CM

DYNAMIC CALCULATIONS
PAMPC 1161. KPA
DISPCP 2.25 CM
PISTCP 2.34 CM
PDYNDB****** KPA
PDLCLR 6.11 KPA
PDLREG 53.29 KPA
PDLDIS 91.98 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/27/84 14:10:19.27 RDG 1201

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

T TO DASHPOT COOLING
LODP 4.01 L/MIN
WINDP 18.9 DEG.C
DLDP 2.99 DEG.C
WODPR 22.5 DEG.C

POWER IN
AMPS1 723. AMPS
AMPS2 598. AMPS
VOLTG 2.89 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7305. KPA
MEANBP 6991. KPA
MEANCP 7039. KPA

GAS TEMPERATURES
TGEXP 556.4 DEG.C
TGREGH 557.1 DEG.C
TGREGC 120.6 DEG.C
TGCOMP 76.3 DEG.C
TGBOUN 44.5 DEG.C

SURFACE TEMPERATURES
T01HTR 602.6 DEG.C
T02HTR 608.4 DEG.C
T03HTR 617.3 DEG.C
T04HTR 604.0 DEG.C
T05HTR 623.0 DEG.C
T06HTR 612.7 DEG.C
T07HTR 611.5 DEG.C
T08HTR 579.8 DEG.C
T09HTR 612.4 DEG.C
T10HTR 585.8 DEG.C
T11HTR 574.0 DEG.C
T12HTR 576.0 DEG.C

T TO COOLER
LOCLR 4.14 L/MIN
WINCL 53.9 DEG.C
DLCL 8.53 DEG.C
WOCLR 61.33 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3821. WATTS
2 QCOOLR 2429. WATTS
3 QDSHPT 835. WATTS
4 EXTEFF 22.7 %
5 TAVHTR 600.6 DEG.C
6 INTEFF 26.3 %
8 AMPS 1321. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 103. WATTS
12 QREG2 119. WATTS
13 QREG3 34. WATTS
14 PFP 1001.2 KPA/CM
15 PFD 274.5 KPA/CM
16 NBEALE 0.00571

VIBRATION
VX1HOR 0.6 CM/S
VY1VER 9.1 CM/S

PHASE ANGLES
PADISP 59.0 DEG.
PAPRES -13.1 DEG.

ENGINE SPEED
FREQ 30.3 HZ

REMOTE CALCULATIONS
PWROUT 867. WATTS
INDPWR 926. WATTS
PISTST 2.79 CM
DISPST 2.42 CM

DYNAMIC CALCULATIONS
PAMPC 1260. KPA
DISPCP 2.30 CM
PISTCP 2.27 CM
PDYNDB****** KPA
PDLCLR 7.13 KPA
PDLREG 58.38 KPA
PDLDIS100.12 KPA

T13REG****** DEG.C
T14REG 518.9 DEG.C
T15REG 389.9 DEG.C
T16REG 385.9 DEG.C
T17REG 377.6 DEG.C
T18REG 372.5 DEG.C
T19REG 245.5 DEG.C
T03HED****** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/27/84 14:15:34.27 RDG 1202

FLUID HELIUM BAROM 14.327 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

T TO DASHPOT COOLING
LODP 4.02 L/MIN
WINDP 19.0 DEG.C
DLDP 3.29 DEG.C
WODPR 22.9 DEG.C

POWER IN
AMPS1 783. AMPS
AMPS2 647. AMPS
VOLTG 3.13 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7280. KPA
MEANBP 6995. KPA
MEANCP 7050. KPA

GAS TEMPERATURES
TGEXP 552.0 DEG.C
TGREGH 546.6 DEG.C
TGREGC 115.6 DEG.C
TGCOMP 88.7 DEG.C
TGBOUN 46.0 DEG.C

SURFACE TEMPERATURES
T01HTR 602.5 DEG.C
T02HTR 612.2 DEG.C
T03HTR 617.6 DEG.C
T04HTR 603.5 DEG.C
T05HTR 624.6 DEG.C
T06HTR 614.3 DEG.C
T07HTR 612.8 DEG.C
T08HTR 578.2 DEG.C
T09HTR 610.6 DEG.C
T10HTR 586.3 DEG.C
T11HTR 569.6 DEG.C
T12HTR 577.0 DEG.C

T TO COOLER
LOCLR 4.16 L/MIN
WINCL 54.1 DEG.C
DLCL 10.06 DEG.C
WOCLR 63.05 DEG.C

CALCULATED PARAMETERS
1 PWRIN 4480. WATTS
2 QCOOLR 2878. WATTS
3 QDSHPT 920. WATTS
4 EXTEFF 21.0 %
5 TAVHTR 600.8 DEG.C
6 INTEFF 24.6 %
8 AMPS 1430. AMPS
9 QDISPG 3. WATTS
10 QDISP 13. WATTS
11 QREG1 90. WATTS
12 QREG2 141. WATTS
13 QREG3 33. WATTS
14 PFP 995.9 KPA/CM
15 PFD 262.4 KPA/CM
16 NBEALE 0.00576

VIBRATION
VX1HOR 0.6 CM/S
VY1VER 9.7 CM/S

PHASE ANGLES
PADISP 59.5 DEG.
PAPRES -11.6 DEG.

ENGINE SPEED
FREQ 30.3 HZ

REMOTE CALCULATIONS
PWROUT 939. WATTS
INDPWR 978. WATTS
PISTST 2.99 CM
DISPST 2.41 CM

DYNAMIC CALCULATIONS
PAMPC 1358. KPA
DISPCP 2.40 CM
PISTCP 2.16 CM
PDYNDB****** KPA
PDLCLR****** KPA
PDLREG 59.73 KPA
PDLDIS104.87 KPA

T13REG****** DEG.C
T14REG 496.1 DEG.C
T15REG 341.2 DEG.C
T16REG 338.3 DEG.C
T17REG 331.2 DEG.C
T18REG 322.7 DEG.C
T19REG 211.5 DEG.C
T03HED****** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 09/26/84 10:34:29.52 RDG 1353

FLUID HELIUM BAROM 14.474 PSI REGENERATOR 1 DISPLACER 2 STANDARD PISTON

T TO DASHPOT COOLING
LODP 4.44 L/MIN
WINDP 18.9 DEG.C
DLDP 1.14 DEG.C
WODPR 20.7 DEG.C

POWER IN
AMPS1 553. AMPS
AMPS2 485. AMPS
VOLTG 2.24 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7180. KPA
MEANBP 7016. KPA
MEANCP 7044. KPA

GAS TEMPERATURES
TGEXP 570.0 DEG.C
TGREGH 554.2 DEG.C
TGREGC 90.3 DEG.C
TGCOMP 41.5 DEG.C
TGBOUN 33.6 DEG.C

SURFACE TEMPERATURES
T01HTR 595.9 DEG.C
T02HTR 614.9 DEG.C
T03HTR 605.8 DEG.C
T04HTR 611.3 DEG.C
T05HTR 611.4 DEG.C
T06HTR 607.4 DEG.C
T07HTR 606.7 DEG.C
T08HTR 577.0 DEG.C
T09HTR 607.6 DEG.C
T10HTR 592.4 DEG.C
T11HTR 576.1 DEG.C
T12HTR 588.5 DEG.C

T TO COOLER
LOCLR 4.20 L/MIN
WINCL 25.1 DEG.C
DLCL 6.16 DEG.C
WOCLR 30.00 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2329. WATTS
2 QCOOLR 1795. WATTS
3 QDSHPT 352. WATTS
4 EXTEFF 20.9 %
5 TAVHTR 599.6 DEG.C
6 INTEFF 21.3 %
8 AMPS 1038. AMPS
9 QDISPG 3. WATTS
10 QDISP 15. WATTS
11 QREG1 108. WATTS
12 QREG2 128. WATTS
13 QREG3 36. WATTS
14 PFP 1024.5 KPA/CM
15 PFD 318.6 KPA/CM
16 NBEALE 0.00476

VIBRATION
VX1HOR 0.5 CM/S
VY1VER 6.3 CM/S

PHASE ANGLES
PADISP 75.8 DEG.
PAPRES -14.6 DEG.

ENGINE SPEED
FREQ 31.4 HZ

REMOTE CALCULATIONS
PWROUT 486. WATTS
INDPWR 504. WATTS
PISTST 1.80 CM
DISPST 1.46 CM

DYNAMIC CALCULATIONS
PAMPC 896. KPA
DISPCP 2.54 CM
PISTCP 2.28 CM
PDYNDB 863. KPA
PDLCLR 4.24 KPA
PDLREG 33.60 KPA
PDLDIS 61.09 KPA

T13REG****** DEG.C
T14REG 512.8 DEG.C
T15REG 379.1 DEG.C
T16REG 384.1 DEG.C
T17REG 369.9 DEG.C
T18REG 354.5 DEG.C
T19REG 221.1 DEG.C
T03HED****** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 09/26/84 10:39:20.52 RDG 1354

FLUID HELIUM BAROM 14.474 PSI REGENERATOR 1 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.42 L/MIN	AMPS1	589. AMPS	PRESUP	7176. KPA	TGEXP	567.5 DEG.C	T01HTR	599.0 DEG.C
		AMPS2	517. AMPS					T02HTR	614.7 DEG.C
TWINDP	18.8 DEG.C	VOLTG	2.39 VOLTS	MEANBP	7013. KPA	TGREGH	555.3 DEG.C	T03HTR	608.7 DEG.C
TDLDP	1.29 DEG.C			MEANCP	7046. KPA	TGREGC	92.9 DEG.C	T04HTR	610.9 DEG.C
TWODPR	20.9 DEG.C					TGCOMP	44.3 DEG.C	T05HTR	613.6 DEG.C
						TGBOUN	33.8 DEG.C	T06HTR	608.5 DEG.C
								T07HTR	607.7 DEG.C
								T08HTR	578.9 DEG.C
								T09HTR	609.5 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	592.5 DEG.C
FLOCLR	4.19 L/MIN	1 PWRIN	2649. WATTS	VX1HOR	0.5 CM/S	PWROUT	570. WATTS	T11HTR	576.9 DEG.C
TWINCL	25.0 DEG.C	2 QCOOLR	1999. WATTS	VY1VER	7.0 CM/S	INDPWR	590. WATTS	T12HTR	586.7 DEG.C
TDLCL	6.88 DEG.C	3 QDSHPT	396. WATTS			PISTST	2.00 CM		
TWOCLR	30.79 DEG.C	4 EXTEFF	21.5 %	PHASE ANGLES		DISPST	1.58 CM		
		5 TAVHTR	600.6 DEG.C	PADISP	76.9 DEG.			T13REG******	DEG.C
		6 INTEFF	22.2 %	PAPRES	-13.8 DEG.	DYNAMIC CALCULATIONS		T14REG	513.0 DEG.C
		8 AMPS	1106. AMPS			PAMPC	994. KPA	T15REG	381.2 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.56 CM	T16REG	385.9 DEG.C
		10 QDISP	15. WATTS	FREQ	31.5 HZ	PISTCP	2.29 CM	T17REG	375.8 DEG.C
		11 QREG1	109. WATTS			PDYNDB	938. KPA	T18REG	359.7 DEG.C
		12 QREG2	124. WATTS			PDLCLR	5.09 KPA	T19REG	224.8 DEG.C
		13 QREG3	36. WATTS			PDLREG	39.03 KPA		
		14 PFP	1020.2 KPA/CM			PDLDIS	70.26 KPA	T03HED******	DEG.C
		15 PFD	309.4 KPA/CM						
		16 NBEALE	0.00503						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 09/26/84 10:44:41.52 RDG 1355

FLUID HELIUM BAROM 14.474 PSI REGENERATOR 1 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.42 L/MIN	AMPS1	630. AMPS	PRESUP	7179. KPA	TGEXP	565.0 DEG.C	T01HTR	599.9 DEG.C
		AMPS2	546. AMPS					T02HTR	614.3 DEG.C
TWINDP	18.8 DEG.C	VOLTG	2.54 VOLTS	MEANBP	7002. KPA	TGREGH	554.0 DEG.C	T03HTR	610.2 DEG.C
TDLDP	1.56 DEG.C			MEANCP	7038. KPA	TGREGC	94.7 DEG.C	T04HTR	609.3 DEG.C
TWODPR	21.1 DEG.C					TGCOMP	46.4 DEG.C	T05HTR	615.5 DEG.C
						TGBOUN	34.4 DEG.C	T06HTR	609.3 DEG.C
								T07HTR	608.5 DEG.C
								T08HTR	578.5 DEG.C
								T09HTR	609.6 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	591.2 DEG.C
FLOCLR	4.21 L/MIN	1 PWRIN	2988. WATTS	VX1HOR	0.6 CM/S	PWROUT	665. WATTS	T11HTR	575.1 DEG.C
TWINCL	25.0 DEG.C	2 QCOOLR	2231. WATTS	VY1VER	7.6 CM/S	INDPWR	688. WATTS	T12HTR	584.7 DEG.C
TDLCL	7.64 DEG.C	3 QDSHPT	478. WATTS			PISTST	2.20 CM		
TWOCLR	31.41 DEG.C	4 EXTEFF	22.2 %	PHASE ANGLES		DISPST	1.70 CM		
		5 TAVHTR	600.5 DEG.C	PADISP	78.3 DEG.			T13REG******	DEG.C
		6 INTEFF	23.0 %	PAPRES	-13.3 DEG.	DYNAMIC CALCULATIONS		T14REG	514.0 DEG.C
		8 AMPS	1175. AMPS			PAMPC	1107. KPA	T15REG	385.7 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.66 CM	T16REG	386.1 DEG.C
		10 QDISP	15. WATTS	FREQ	31.5 HZ	PISTCP	2.31 CM	T17REG	377.2 DEG.C
		11 QREG1	108. WATTS			PDYNDB	1013. KPA	T18REG	362.9 DEG.C
		12 QREG2	123. WATTS			PDLCLR	6.11 KPA	T19REG	230.2 DEG.C
		13 QREG3	36. WATTS			PDLREG	47.52 KPA		
		14 PFP	1026.0 KPA/CM			PDLDIS	84.17 KPA	T03HED******	DEG.C
		15 PFD	306.8 KPA/CM						
		16 NBEALE	0.00532						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 09/26/84 10:49:20.52 RDG 1356

FLUID HELIUM BAROM 14.474 PSI REGENERATOR 1 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.41 L/MIN	AMPS1	651. AMPS	PRESUP	7174. KPA	TGEXP	562.0 DEG.C	T01HTR	600.8 DEG.C
		AMPS2	578. AMPS					T02HTR	613.9 DEG.C
TWINDP	18.8 DEG.C	VOLTG	2.66 VOLTS	MEANBP	6993. KPA	TGREGH	552.7 DEG.C	T03HTR	611.7 DEG.C
TDLDP	1.83 DEG.C			MEANCP	7034. KPA	TGREGC	96.7 DEG.C	T04HTR	608.2 DEG.C
TWODPR	21.2 DEG.C					TGCOMP	49.0 DEG.C	T05HTR	617.1 DEG.C
						TGBOUN	35.1 DEG.C	T06HTR	610.3 DEG.C
								T07HTR	609.5 DEG.C
								T08HTR	578.6 DEG.C
								T09HTR	610.0 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	590.1 DEG.C
FLOCLR	4.20 L/MIN	1 PWRIN	3269. WATTS	VX1HOR	0.6 CM/S	PWROUT	737. WATTS	T11HTR	574.1 DEG.C
TWINCL	25.1 DEG.C	2 QCOOLR	2347. WATTS	VY1VER	8.3 CM/S	INDPWR	758. WATTS	T12HTR	583.3 DEG.C
TDLCL	8.05 DEG.C	3 QDSHPT	562. WATTS			PISTST	2.41 CM		
TWOCLR	32.04 DEG.C	4 EXTEFF	22.5 %	PHASE ANGLES		DISPST	1.79 CM		
		5 TAVHTR	600.6 DEG.C	PADISP	77.6 DEG.			T13REG******	DEG.C
		6 INTEFF	23.9 %	PAPRES	-12.3 DEG.	DYNAMIC CALCULATIONS		T14REG	513.8 DEG.C
		8 AMPS	1229. AMPS			PAMPC	1191. KPA	T15REG	386.6 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.70 CM	T16REG	386.8 DEG.C
		10 QDISP	15. WATTS	FREQ	31.3 HZ	PISTCP	2.32 CM	T17REG	378.8 DEG.C
		11 QREG1	108. WATTS			PDYNDB	1113. KPA	T18REG	364.8 DEG.C
		12 QREG2	121. WATTS			PDLCLR	6.96 KPA	T19REG	232.2 DEG.C
		13 QREG3	35. WATTS			PDLREG	50.57 KPA		
		14 PFP	1013.0 KPA/CM			PDLDIS	88.92 KPA	T03HED******	DEG.C
		15 PFD	289.6 KPA/CM						
		16 NBEALE	0.00544						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 09/26/84 10:54:20.52 RDG 1357

FLUID HELIUM BAROM 14.474 PSI REGENERATOR 1 DISPLACER 2 STANDARD PISTON

AT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.38 L/MIN	AMPS1 680. AMPS	PRESUP 7163. KPA	TGEXP 559.5 DEG.C	T01HTR 601.7 DEG.C
	AMPS2 605. AMPS			T02HTR 614.3 DEG.C
TWINDP 18.8 DEG.C	VOLTG 2.78 VOLTS	MEANBP 6992. KPA	TGREGH 551.9 DEG.C	T03HTR 612.7 DEG.C
TDLDP 1.99 DEG.C		MEANCP 7033. KPA	TGREGC 98.6 DEG.C	T04HTR 608.1 DEG.C
TWODPR 21.4 DEG.C			TGCOMP 51.6 DEG.C	T05HTR 618.4 DEG.C
			TGBOUN 35.8 DEG.C	T06HTR 611.3 DEG.C
				T07HTR 610.5 DEG.C
				T08HTR 578.3 DEG.C
				T09HTR 610.9 DEG.C

AT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 589.1 DEG.C
FLOCLR 4.22 L/MIN	1 PWRIN 3575. WATTS	VX1HOR 0.7 CM/S	PWROUT 798. WATTS	T11HTR 573.5 DEG.C
TWINCL 25.0 DEG.C	2 QCOOLR 2563. WATTS	VY1VER 8.9 CM/S	INDPWR 818. WATTS	T12HTR 582.0 DEG.C
TDLCL 8.75 DEG.C	3 QDSHPT 605. WATTS		PISTST 2.61 CM	
TWOCLR 32.75 DEG.C	4 EXTEFF 22.3 %	PHASE ANGLES	DISPST 1.88 CM	
	5 TAVHTR 600.9 DEG.C	PADISP 77.7 DEG.		T13REG****** DEG.C
	6 INTEFF 23.7 %	PAPRES -11.3 DEG.	DYNAMIC CALCULATIONS	T14REG 514.2 DEG.C
	8 AMPS 1285. AMPS		PAMPC 1299. KPA	T15REG 390.1 DEG.C
	9 QDISPG 3. WATTS	ENGINE SPEED	DISPCP 2.65 CM	T16REG 386.3 DEG.C
	10 QDISP 14. WATTS	FREQ 31.3 HZ	PISTCP 2.36 CM	T17REG 378.5 DEG.C
	11 QREG1 103. WATTS		PDYNDB 1163. KPA	T18REG 364.0 DEG.C
	12 QREG2 122. WATTS		PDLCLR 7.81 KPA	T19REG 237.4 DEG.C
	13 QREG3 35. WATTS		PDLREG 57.36 KPA	
	14 PFP 1020.3 KPA/CM		PDLDIS 99.10 KPA	T03HED****** DEG.C
	15 PFD 277.8 KPA/CM			
	16 NBEALE 0.00545			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 09/26/84 10:59:38.52 RDG 1358

FLUID HELIUM BAROM 14.474 PSI REGENERATOR 1 DISPLACER 2 STANDARD PISTON

AT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.36 L/MIN	AMPS1 711. AMPS	PRESUP 7175. KPA	TGEXP 556.8 DEG.C	T01HTR 601.8 DEG.C
	AMPS2 630. AMPS			T02HTR 614.1 DEG.C
TWINDP 18.7 DEG.C	VOLTG 2.90 VOLTS	MEANBP 7019. KPA	TGREGH 550.4 DEG.C	T03HTR 613.3 DEG.C
TDLDP 2.25 DEG.C		MEANCP 7064. KPA	TGREGC 101.1 DEG.C	T04HTR 607.2 DEG.C
TWODPR 21.6 DEG.C			TGCOMP 55.2 DEG.C	T05HTR 619.1 DEG.C
			TGBOUN 37.0 DEG.C	T06HTR 612.3 DEG.C
				T07HTR 611.6 DEG.C
				T08HTR 577.5 DEG.C
				T09HTR 611.3 DEG.C

AT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 587.4 DEG.C
FLOCLR 4.22 L/MIN	1 PWRIN 3891. WATTS	VX1HOR 0.7 CM/S	PWROUT 870. WATTS	T11HTR 572.3 DEG.C
TWINCL 25.0 DEG.C	2 QCOOLR 2795. WATTS	VY1VER 9.5 CM/S	INDPWR 887. WATTS	T12HTR 579.8 DEG.C
TDLCL 9.55 DEG.C	3 QDSHPT 684. WATTS		PISTST 2.79 CM	
TWOCLR 33.62 DEG.C	4 EXTEFF 22.4 %	PHASE ANGLES	DISPST 1.96 CM	
	5 TAVHTR 600.6 DEG.C	PADISP 78.1 DEG.		T13REG****** DEG.C
	6 INTEFF 23.7 %	PAPRES -10.9 DEG.	DYNAMIC CALCULATIONS	T14REG 513.4 DEG.C
	8 AMPS 1341. AMPS		PAMPC 1383. KPA	T15REG 390.1 DEG.C
	9 QDISPG 3. WATTS	ENGINE SPEED	DISPCP 2.74 CM	T16REG 387.2 DEG.C
	10 QDISP 14. WATTS	FREQ 31.3 HZ	PISTCP 2.33 CM	T17REG 378.5 DEG.C
	11 QREG1 101. WATTS		PDYNDB 1250. KPA	T18REG 363.7 DEG.C
	12 QREG2 121. WATTS		PDLCLR 8.65 KPA	T19REG 239.1 DEG.C
	13 QREG3 35. WATTS		PDLREG 61.43 KPA	
	14 PFP 1011.9 KPA/CM		PDLDIS104.87 KPA	T03HED****** DEG.C
	15 PFD 271.3 KPA/CM			
	16 NBEALE 0.00553			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 09/26/84 13:52:29.52 RDG 1359

FLUID HELIUM BAROM 14.489 PSI REGENERATOR 1 DISPLACER 2 STANDARD PISTON

T TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
LODP 4.04 L/MIN	AMPS1 765. AMPS	PRESUP 7172. KPA	TGEXP 552.7 DEG.C	T01HTR 602.9 DEG.C
	AMPS2 648. AMPS			T02HTR 612.8 DEG.C
WINDP 18.8 DEG.C	VOLTG 3.05 VOLTS	MEANBP 7019. KPA	TGREGH 548.5 DEG.C	T03HTR 615.7 DEG.C
DLDP 2.33 DEG.C		MEANCP 7072. KPA	TGREGC 98.1 DEG.C	T04HTR 604.7 DEG.C
WODPR 21.7 DEG.C			TGCOMP 56.8 DEG.C	T05HTR 621.4 DEG.C
			TGBOUN 34.0 DEG.C	T06HTR 611.1 DEG.C
				T07HTR 610.6 DEG.C
				T08HTR 577.6 DEG.C
				T09HTR 609.8 DEG.C

T TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 587.0 DEG.C
LOCLR 4.22 L/MIN	1 PWRIN 4315. WATTS	VX1HOR 0.8 CM/S	PWROUT 928. WATTS	T11HTR 570.0 DEG.C
WINCL 24.8 DEG.C	2 QCOOLR 3040. WATTS	VY1VER10.3 CM/S	INDPWR 945. WATTS	T12HTR 577.7 DEG.C
DLCL 10.38 DEG.C	3 QDSHPT 656. WATTS		PISTST 3.00 CM	
WOCLR 34.04 DEG.C	4 EXTEFF 21.5 %	PHASE ANGLES	DISPST 2.05 CM	
	5 TAVHTR 600.1 DEG.C	PADISP 78.0 DEG.		T13REG****** DEG.C
	6 INTEFF 23.4 %	PAPRES -10.0 DEG.	DYNAMIC CALCULATIONS	T14REG 511.7 DEG.C
	8 AMPS 1413. AMPS		PAMPC 1506. KPA	T15REG 389.4 DEG.C
	9 QDISPG 3. WATTS	ENGINE SPEED	DISPCP 2.82 CM	T16REG 383.5 DEG.C
	10 QDISP 14. WATTS	FREQ 31.2 HZ	PISTCP 2.34 CM	T17REG 380.1 DEG.C
	11 QREG1 106. WATTS		PDYNDB 1313. KPA	T18REG 371.1 DEG.C
	12 QREG2 114. WATTS		PDLCLR 11.20 KPA	T19REG 240.3 DEG.C
	13 QREG3 35. WATTS		PDLREG 69.58 KPA	
	14 PFP 1026.1 KPA/CM		PDLDIS117.77 KPA	T03HED****** DEG.C
	15 PFD 260.8 KPA/CM			
	16 NBEALE 0.00550			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 09/26/84 13:58:08.52 RDG 1360

FLUID HELIUM BAROM 14.489 PSI REGENERATOR 1 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.06 L/MIN
TWINDP 18.8 DEG.C
TDLDP 2.74 DEG.C
TWODPR 22.0 DEG.C

POWER IN
AMPS1 785. AMPS
AMPS2 675. AMPS
VOLTG 3.16 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7033. KPA
MEANBP 6982. KPA
MEANCP 7038. KPA

GAS TEMPERATURES
TGEXP 551.0 DEG.C
TGREGH 547.3 DEG.C
TGREGC 100.3 DEG.C
TGCOMP 60.3 DEG.C
TGBOUN 36.7 DEG.C

SURFACE TEMPERATURES
T01HTR 603.1 DEG.C
T02HTR 612.7 DEG.C
T03HTR 616.4 DEG.C
T04HTR 603.8 DEG.C
T05HTR 622.6 DEG.C
T06HTR 612.2 DEG.C
T07HTR 611.7 DEG.C
T08HTR 576.9 DEG.C
T09HTR 610.3 DEG.C
T10HTR 585.6 DEG.C
T11HTR 569.1 DEG.C
T12HTR 576.1 DEG.C
T13REG****** DEG.C
T14REG 511.8 DEG.C
T15REG 390.4 DEG.C
T16REG 383.8 DEG.C
T17REG 380.3 DEG.C
T18REG 371.0 DEG.C
T19REG 242.4 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.22 L/MIN
TWINCL 24.7 DEG.C
TDLCL 11.22 DEG.C
TWOCLR 34.76 DEG.C

CALCULATED PARAMETERS
1 PWRIN 4609. WATTS
2 QCOOLR 3285. WATTS
3 QDSHPT 774. WATTS
4 EXTEFF 21.4 %
5 TAVHTR 600.0 DEG.C
6 INTEFF 23.1 %
8 AMPS 1460. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 104. WATTS
12 QREG2 114. WATTS
13 QREG3 35. WATTS
14 PFP 1024.3 KPA/CM
15 PFD 247.1 KPA/CM
16 NBEALE 0.00552

VIBRATION
VX1HOR 0.8 CM/S
VY1VER11.0 CM/S

PHASE ANGLES
PADISP 77.9 DEG.
PAPRES -9.2 DEG.

ENGINE SPEED
FREQ 31.1 HZ

REMOTE CALCULATIONS
PWROUT 987. WATTS
INDPWR 1000. WATTS
PISTST 3.21 CM
DISPST 2.13 CM

DYNAMIC CALCULATIONS
PAMPC 1609. KPA
DISPCP 2.91 CM
PISTCP 2.36 CM
PDYNDB 1350. KPA
PDLCLR 11.71 KPA
PDLREG 77.04 KPA
PDLDIS128.29 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/27/84 10:36:18.08 RDG 1548

FLUID NITROGEN BAROM 14.362 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.01 L/MIN
TWINDP 19.7 DEG.C
TDLDP 0.73 DEG.C
TWODPR 20.6 DEG.C

POWER IN
AMPS1 477. AMPS
AMPS2 373. AMPS
VOLTG 1.88 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7146. KPA
MEANBP 7003. KPA
MEANCP 7041. KPA

GAS TEMPERATURES
TGEXP 569.6 DEG.C
TGREGH 552.4 DEG.C
TGREGC 103.0 DEG.C
TGCOMP 35.5 DEG.C
TGBOUN 25.2 DEG.C

SURFACE TEMPERATURES
T01HTR 600.9 DEG.C
T02HTR 615.3 DEG.C
T03HTR 601.6 DEG.C
T04HTR 619.8 DEG.C
T05HTR 599.1 DEG.C
T06HTR 602.4 DEG.C
T07HTR 601.6 DEG.C
T08HTR 585.8 DEG.C
T09HTR 606.8 DEG.C
T10HTR 600.9 DEG.C
T11HTR 582.9 DEG.C
T12HTR 586.5 DEG.C
T13REG****** DEG.C
T14REG 489.5 DEG.C
T15REG 372.9 DEG.C
T16REG 384.9 DEG.C
T17REG 385.7 DEG.C
T18REG 369.5 DEG.C
T19REG 223.2 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.32 L/MIN
TWINCL 25.0 DEG.C
TDLCL 4.76 DEG.C
TWOCLR 28.40 DEG.C

CALCULATED PARAMETERS
1 PWRIN 1600. WATTS
2 QCOOLR 1426. WATTS
3 QDSHPT 203. WATTS
4 EXTEFF 11.3 %
5 TAVHTR 600.3 DEG.C
6 INTEFF 11.2 %
8 AMPS 850. AMPS
9 QDISPG 0. WATTS
10 QDISP 15. WATTS
11 QREG1 119. WATTS
12 QREG2 97. WATTS
13 QREG3 35. WATTS
14 PFP 965.8 KPA/CM
15 PFD 245.8 KPA/CM
16 NBEALE 0.00202

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 4.8 CM/S

PHASE ANGLES
PADISP 39.3 DEG.
PAPRES -7.0 DEG.

ENGINE SPEED
FREQ 27.9 HZ

REMOTE CALCULATIONS
PWROUT 180. WATTS
INDPWR 194. WATTS
PISTST 1.78 CM
DISPST 1.19 CM

DYNAMIC CALCULATIONS
PAMPC 753. KPA
DISPCP 2.18 CM
PISTCP 2.28 CM
PDYNDB****** KPA
PDLCLR 8.49 KPA
PDLREG 40.73 KPA
PDLDIS109.29 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/27/84 10:41:21.08 RDG 1549

FLUID NITROGEN BAROM 14.357 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.01 L/MIN
TWINDP 19.5 DEG.C
TDLDP 0.83 DEG.C
TWODPR 20.5 DEG.C

POWER IN
AMPS1 502. AMPS
AMPS2 389. AMPS
VOLTG 1.96 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7143. KPA
MEANBP 7008. KPA
MEANCP 7047. KPA

GAS TEMPERATURES
TGEXP 570.0 DEG.C
TGREGH 552.4 DEG.C
TGREGC 104.2 DEG.C
TGCOMP 36.7 DEG.C
TGBOUN 25.7 DEG.C

SURFACE TEMPERATURES
T01HTR 600.6 DEG.C
T02HTR 615.5 DEG.C
T03HTR 600.8 DEG.C
T04HTR 619.1 DEG.C
T05HTR 599.2 DEG.C
T06HTR 602.7 DEG.C
T07HTR 602.1 DEG.C
T08HTR 584.5 DEG.C
T09HTR 606.7 DEG.C
T10HTR 598.8 DEG.C
T11HTR 581.4 DEG.C
T12HTR 586.3 DEG.C
T13REG****** DEG.C
T14REG 492.6 DEG.C
T15REG 376.7 DEG.C
T16REG 386.5 DEG.C
T17REG 386.5 DEG.C
T18REG 370.2 DEG.C
T19REG 226.9 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.31 L/MIN
TWINCL 25.0 DEG.C
TDLCL 5.16 DEG.C
TWOCLR 28.78 DEG.C

CALCULATED PARAMETERS
1 PWRIN 1749. WATTS
2 QCOOLR 1545. WATTS
3 QDSHPT 232. WATTS
4 EXTEFF 12.1 %
5 TAVHTR 599.8 DEG.C
6 INTEFF 12.1 %
8 AMPS 891. AMPS
9 QDISPG 0. WATTS
10 QDISP 15. WATTS
11 QREG1 116. WATTS
12 QREG2 99. WATTS
13 QREG3 35. WATTS
14 PFP 958.7 KPA/CM
15 PFD 238.3 KPA/CM
16 NBEALE 0.00213

VIBRATION
VX1HOR 0.5 CM/S
VY1VER 5.4 CM/S

PHASE ANGLES
PADISP 38.6 DEG.
PAPRES -6.6 DEG.

ENGINE SPEED
FREQ 27.9 HZ

REMOTE CALCULATIONS
PWROUT 212. WATTS
INDPWR 228. WATTS
PISTST 1.99 CM
DISPST 1.29 CM

DYNAMIC CALCULATIONS
PAMPC 837. KPA
DISPCP 2.22 CM
PISTCP 2.32 CM
PDYNDB****** KPA
PDLCLR 9.84 KPA
PDLREG 46.16 KPA
PDLDIS121.51 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/27/84 10:46:18.08 RDG 1550

FLUID NITROGEN BAROM 14.357 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

AT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.03 L/MIN	AMPS1 528. AMPS	PRESUP 7157. KPA	TGEXP 569.4 DEG.C	T01HTR 601.3 DEG.C
	AMPS2 406. AMPS			T02HTR 615.8 DEG.C
TWINDP 19.3 DEG.C	VOLTG 2.05 VOLTS	MEANBP 7012. KPA	TGREGH 553.1 DEG.C	T03HTR 601.5 DEG.C
TDLDP 0.91 DEG.C		MEANCP 7052. KPA	TGREGC 106.5 DEG.C	T04HTR 618.7 DEG.C
TWODPR 20.4 DEG.C			TGCOMP 38.2 DEG.C	T05HTR 600.1 DEG.C
			TGBOUN 26.1 DEG.C	T06HTR 603.8 DEG.C
				T07HTR 603.2 DEG.C
				T08HTR 584.4 DEG.C
				T09HTR 607.5 DEG.C

AT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 597.6 DEG.C
FLOCLR 4.33 L/MIN	1 PWRIN 1916. WATTS	VX1HOR 0.5 CM/S	PWROUT 240. WATTS	T11HTR 581.0 DEG.C
TWINCL 25.0 DEG.C	2 QCOOLR 1714. WATTS	VY1VER 6.1 CM/S	INDPWR 258. WATTS	T12HTR 585.4 DEG.C
TDLCL 5.70 DEG.C	3 QDSHPT 256. WATTS		PISTST 2.18 CM	
TWOCLR 29.17 DEG.C	4 EXTEFF 12.5 %	PHASE ANGLES	DISPST 1.39 CM	
	5 TAVHTR 600.0 DEG.C	PADISP 37.9 DEG.		T13REG****** DEG.C
	6 INTEFF 12.3 %	PAPRES -6.3 DEG.	DYNAMIC CALCULATIONS	T14REG 494.9 DEG.C
	8 AMPS 934. AMPS		PAMPC 925. KPA	T15REG 380.4 DEG.C
	9 QDISPG 0. WATTS	ENGINE SPEED	DISPCP 2.31 CM	T16REG 389.0 DEG.C
	10 QDISP 15. WATTS	FREQ 27.9 HZ	PISTCP 2.40 CM	T17REG 389.0 DEG.C
	11 QREG1 115. WATTS		PDYNDB****** KPA	T18REG 372.2 DEG.C
	12 QREG2 100. WATTS		PDLCLR 11.54 KPA	T19REG 230.5 DEG.C
	13 QREG3 35. WATTS		PDLREG 52.27 KPA	
	14 PFP 962.8 KPA/CM		PDLDIS134.06 KPA	T03HED****** DEG.C
	15 PFD 239.0 KPA/CM			
	16 NBEALE 0.00219			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/27/84 10:51:18.08 RDG 1551

FLUID NITROGEN BAROM 14.357 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

AT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.01 L/MIN	AMPS1 546. AMPS	PRESUP 7160. KPA	TGEXP 568.4 DEG.C	T01HTR 601.8 DEG.C
	AMPS2 422. AMPS			T02HTR 615.0 DEG.C
TWINDP 19.2 DEG.C	VOLTG 2.13 VOLTS	MEANBP 7010. KPA	TGREGH 552.9 DEG.C	T03HTR 602.6 DEG.C
TDLDP 0.99 DEG.C		MEANCP 7049. KPA	TGREGC 108.3 DEG.C	T04HTR 617.5 DEG.C
TWODPR 20.4 DEG.C			TGCOMP 39.6 DEG.C	T05HTR 601.1 DEG.C
			TGBOUN 26.6 DEG.C	T06HTR 603.6 DEG.C
				T07HTR 603.0 DEG.C
				T08HTR 584.4 DEG.C
				T09HTR 607.4 DEG.C

AT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 597.0 DEG.C
FLOCLR 4.34 L/MIN	1 PWRIN 2061. WATTS	VX1HOR 0.6 CM/S	PWROUT 268. WATTS	T11HTR 580.0 DEG.C
TWINCL 25.1 DEG.C	2 QCOOLR 1781. WATTS	VY1VER 6.8 CM/S	INDPWR 289. WATTS	T12HTR 584.0 DEG.C
TDLCL 5.92 DEG.C	3 QDSHPT 277. WATTS		PISTST 2.38 CM	
TWOCLR 29.56 DEG.C	4 EXTEFF 13.0 %	PHASE ANGLES	DISPST 1.48 CM	
	5 TAVHTR 599.8 DEG.C	PADISP 37.4 DEG.		T13REG****** DEG.C
	6 INTEFF 13.1 %	PAPRES -6.0 DEG.	DYNAMIC CALCULATIONS	T14REG 496.1 DEG.C
	8 AMPS 968. AMPS		PAMPC 1009. KPA	T15REG 382.5 DEG.C
	9 QDISPG 0. WATTS	ENGINE SPEED	DISPCP 2.37 CM	T16REG 390.0 DEG.C
	10 QDISP 15. WATTS	FREQ 28.0 HZ	PISTCP 2.42 CM	T17REG 390.3 DEG.C
	11 QREG1 114. WATTS		PDYNDB****** KPA	T18REG 374.1 DEG.C
	12 QREG2 99. WATTS		PDLCLR 12.90 KPA	T19REG 233.1 DEG.C
	13 QREG3 34. WATTS		PDLREG 57.02 KPA	
	14 PFP 957.7 KPA/CM		PDLDIS140.51 KPA	T03HED****** DEG.C
	15 PFD 232.4 KPA/CM			
	16 NBEALE 0.00224			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/27/84 10:56:18.08 RDG 1552

FLUID NITROGEN BAROM 14.357 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

T TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
LODP 4.00 L/MIN	AMPS1 565. AMPS	PRESUP 7160. KPA	TGEXP 566.9 DEG.C	T01HTR 602.2 DEG.C
	AMPS2 437. AMPS			T02HTR 615.1 DEG.C
WINDP 19.2 DEG.C	VOLTG 2.20 VOLTS	MEANBP 7010. KPA	TGREGH 552.1 DEG.C	T03HTR 604.1 DEG.C
DLDP 1.10 DEG.C		MEANCP 7058. KPA	TGREGC 109.5 DEG.C	T04HTR 616.8 DEG.C
WODPR 20.4 DEG.C			TGCOMP 40.9 DEG.C	T05HTR 602.7 DEG.C
			TGBOUN 27.3 DEG.C	T06HTR 604.2 DEG.C
				T07HTR 603.7 DEG.C
				T08HTR 584.2 DEG.C
				T09HTR 607.4 DEG.C

T TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 596.9 DEG.C
LOCLR 4.35 L/MIN	1 PWRIN 2210. WATTS	VX1HOR 0.6 CM/S	PWROUT 292. WATTS	T11HTR 579.0 DEG.C
WINCL 25.2 DEG.C	2 QCOOLR 1948. WATTS	VY1VER 7.5 CM/S	INDPWR 314. WATTS	T12HTR 583.9 DEG.C
DLCL 6.46 DEG.C	3 QDSHPT 306. WATTS		PISTST 2.56 CM	
WOCLR 29.99 DEG.C	4 EXTEFF 13.2 %	PHASE ANGLES	DISPST 1.56 CM	
	5 TAVHTR 600.0 DEG.C	PADISP 36.5 DEG.		T13REG****** DEG.C
	6 INTEFF 13.0 %	PAPRES -5.5 DEG.	DYNAMIC CALCULATIONS	T14REG 497.4 DEG.C
	8 AMPS 1002. AMPS		PAMPC 1102. KPA	T15REG 385.4 DEG.C
	9 QDISPG 0. WATTS	ENGINE SPEED	DISPCP 2.47 CM	T16REG 391.0 DEG.C
	10 QDISP 15. WATTS	FREQ 28.0 HZ	PISTCP 2.41 CM	T17REG 391.1 DEG.C
	11 QREG1 112. WATTS		PDYNDB****** KPA	T18REG 375.3 DEG.C
	12 QREG2 99. WATTS		PDLCLR 14.93 KPA	T19REG 236.7 DEG.C
	13 QREG3 34. WATTS		PDLREG 61.09 KPA	
	14 PFP 967.5 KPA/CM		PDLDIS154.77 KPA	T03HED****** DEG.C
	15 PFD 226.5 KPA/CM			
	16 NBEALE 0.00226			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/07/84 10:54:18.64 RDG 1604

FLUID HELIUM BAROM 14.386 PSI REGENERATOR 1 DISPLACER 1 LIGHT PISTON

HEAT TO DASHPOT COOLING
FLODP 4.58 L/MIN
TWINDP 20.6 DEG.C
TDLDP 1.22 DEG.C
TWODPR 21.7 DEG.C

POWER IN
AMPS1 531. AMPS
AMPS2 399. AMPS
VOLTG 2.05 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7243. KPA
MEANBP 6994. KPA
MEANCP 7024. KPA

GAS TEMPERATURES
TGEXP 568.2 DEG.C
TGREGH 565.8 DEG.C
TGREGC 92.5 DEG.C
TGCOMP 36.2 DEG.C
TGBOUN 27.3 DEG.C

SURFACE TEMPERATURES
T01HTR 599.2 DEG.C
T02HTR 609.4 DEG.C
T03HTR 606.0 DEG.C
T04HTR 608.2 DEG.C
T05HTR 609.2 DEG.C
T06HTR 608.3 DEG.C
T07HTR 607.5 DEG.C
T08HTR 581.7 DEG.C
T09HTR 609.0 DEG.C
T10HTR 586.6 DEG.C
T11HTR 582.4 DEG.C
T12HTR 581.5 DEG.C
T13REG****** DEG.C
T14REG 519.1 DEG.C
T15REG 387.9 DEG.C
T16REG 394.2 DEG.C
T17REG 391.1 DEG.C
T18REG 375.7 DEG.C
T19REG 227.8 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.20 L/MIN
TWINCL 24.6 DEG.C
TDLCL 6.10 DEG.C
TWOCLR 28.53 DEG.C

CALCULATED PARAMETERS
1 PWRIN 1902. WATTS
2 QCOOLR 1779. WATTS
3 QDSHPT 387. WATTS
4 EXTEFF 16.5 %
5 TAVHTR 599.1 DEG.C
6 INTEFF 15.0 %
8 AMPS 930. AMPS
9 QDISPG 3. WATTS
10 QDISP 15. WATTS
11 QREG1 120. WATTS
12 QREG2 116. WATTS
13 QREG3 37. WATTS
14 PFP 980.4 KPA/CM
15 PFD 277.1 KPA/CM
16 NBEALE 0.00268

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 4.1 CM/S

PHASE ANGLES
PADISP 40.8 DEG.
PAPRES -10.1 DEG.

ENGINE SPEED
FREQ 36.8 HZ

REMOTE CALCULATIONS
PWROUT 315. WATTS
INDPWR 327. WATTS
PISTST 1.78 CM
DISPST 1.42 CM

DYNAMIC CALCULATIONS
PAMPC 733. KPA
DISPCP 2.05 CM
PISTCP 2.30 CM
PDYNDB****** KPA
PDLCLR 2.21 KPA
PDLREG 24.44 KPA
PDLDIS 48.19 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/07/84 11:00:27.64 RDG 1605

FLUID HELIUM BAROM 14.386 PSI REGENERATOR 1 DISPLACER 1 LIGHT PISTON

HEAT TO DASHPOT COOLING
FLODP 4.54 L/MIN
TWINDP 20.1 DEG.C
TDLDP 1.38 DEG.C
TWODPR 21.4 DEG.C

POWER IN
AMPS1 574. AMPS
AMPS2 423. AMPS
VOLTG 2.20 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7312. KPA
MEANBP 7009. KPA
MEANCP 7045. KPA

GAS TEMPERATURES
TGEXP 565.5 DEG.C
TGREGH 565.7 DEG.C
TGREGC 96.4 DEG.C
TGCOMP 38.4 DEG.C
TGBOUN 28.3 DEG.C

SURFACE TEMPERATURES
T01HTR 600.4 DEG.C
T02HTR 608.3 DEG.C
T03HTR 607.8 DEG.C
T04HTR 608.0 DEG.C
T05HTR 611.3 DEG.C
T06HTR 609.0 DEG.C
T07HTR 608.3 DEG.C
T08HTR 581.6 DEG.C
T09HTR 610.9 DEG.C
T10HTR 584.8 DEG.C
T11HTR 581.9 DEG.C
T12HTR 579.0 DEG.C
T13REG****** DEG.C
T14REG 520.7 DEG.C
T15REG 393.0 DEG.C
T16REG 399.2 DEG.C
T17REG 395.0 DEG.C
T18REG 380.8 DEG.C
T19REG 234.1 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.23 L/MIN
TWINCL 25.2 DEG.C
TDLCL 6.67 DEG.C
TWOCLR 29.74 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2189. WATTS
2 QCOOLR 1957. WATTS
3 QDSHPT 436. WATTS
4 EXTEFF 17.4 %
5 TAVHTR 599.3 DEG.C
6 INTEFF 16.3 %
8 AMPS 997. AMPS
9 QDISPG 3. WATTS
10 QDISP 15. WATTS
11 QREG1 119. WATTS
12 QREG2 114. WATTS
13 QREG3 36. WATTS
14 PFP 989.2 KPA/CM
15 PFD 273.5 KPA/CM
16 NBEALE 0.00287

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 4.6 CM/S

PHASE ANGLES
PADISP 40.4 DEG.
PAPRES -9.4 DEG.

ENGINE SPEED
FREQ 37.0 HZ

REMOTE CALCULATIONS
PWROUT 381. WATTS
INDPWR 392. WATTS
PISTST 1.99 CM
DISPST 1.54 CM

DYNAMIC CALCULATIONS
PAMPC 837. KPA
DISPCP 2.16 CM
PISTCP 2.37 CM
PDYNDB****** KPA
PDLCLR 3.05 KPA
PDLREG 29.19 KPA
PDLDIS 57.70 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/07/84 11:04:30.64 RDG 1606

FLUID HELIUM BAROM 14.381 PSI REGENERATOR 1 DISPLACER 1 LIGHT PISTON

HEAT TO DASHPOT COOLING
FLODP 4.50 L/MIN
TWINDP 19.7 DEG.C
TDLDP 1.57 DEG.C
TWODPR 21.2 DEG.C

POWER IN
AMPS1 599. AMPS
AMPS2 448. AMPS
VOLTG 2.30 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7318. KPA
MEANBP 6998. KPA
MEANCP 7035. KPA

GAS TEMPERATURES
TGEXP 563.8 DEG.C
TGREGH 567.7 DEG.C
TGREGC 98.2 DEG.C
TGCOMP 40.2 DEG.C
TGBOUN 29.1 DEG.C

SURFACE TEMPERATURES
T01HTR 604.0 DEG.C
T02HTR 607.5 DEG.C
T03HTR 610.3 DEG.C
T04HTR 608.3 DEG.C
T05HTR 613.3 DEG.C
T06HTR 609.6 DEG.C
T07HTR 608.9 DEG.C
T08HTR 584.1 DEG.C
T09HTR 613.5 DEG.C
T10HTR 584.4 DEG.C
T11HTR 583.4 DEG.C
T12HTR 576.9 DEG.C
T13REG****** DEG.C
T14REG 521.0 DEG.C
T15REG 394.3 DEG.C
T16REG 401.6 DEG.C
T17REG 400.4 DEG.C
T18REG 386.0 DEG.C
T19REG 236.3 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.24 L/MIN
TWINCL 25.3 DEG.C
TDLCL 7.41 DEG.C
TWOCLR 30.29 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2411. WATTS
2 QCOOLR 2182. WATTS
3 QDSHPT 490. WATTS
4 EXTEFF 17.6 %
5 TAVHTR 600.3 DEG.C
6 INTEFF 16.3 %
8 AMPS 1047. AMPS
9 QDISPG 3. WATTS
10 QDISP 15. WATTS
11 QREG1 121. WATTS
12 QREG2 109. WATTS
13 QREG3 36. WATTS
14 PFP 1003.4 KPA/CM
15 PFD 275.1 KPA/CM
16 NBEALE 0.00294

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 5.0 CM/S

PHASE ANGLES
PADISP 40.2 DEG.
PAPRES -9.1 DEG.

ENGINE SPEED
FREQ 37.0 HZ

REMOTE CALCULATIONS
PWROUT 424. WATTS
INDPWR 432. WATTS
PISTST 2.16 CM
DISPST 1.64 CM

DYNAMIC CALCULATIONS
PAMPC 925. KPA
DISPCP 2.23 CM
PISTCP 2.36 CM
PDYNDB****** KPA
PDLCLR 3.39 KPA
PDLREG 31.90 KPA
PDLDIS 62.45 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/07/84 11:09:27.64 RDG 1607

FLUID HELIUM BAROM 14.381 PSI REGENERATOR 1 DISPLACER 1 LIGHT PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.33 L/MIN	AMPS1	632. AMPS	PRESUP	7309. KPA	TGEXP	561.1 DEG.C	T01HTR	605.5 DEG.C
		AMPS2	480. AMPS					T02HTR	606.9 DEG.C
TWINDP	19.4 DEG.C	VOLTG	2.45 VOLTS	MEANBP	6991. KPA	TGREGH	567.0 DEG.C	T03HTR	612.8 DEG.C
TDLDP	1.81 DEG.C			MEANCP	7031. KPA	TGREGC	100.5 DEG.C	T04HTR	607.3 DEG.C
TWODPR	21.2 DEG.C					TGCOMP	42.8 DEG.C	T05HTR	615.8 DEG.C
						TGBOUN	29.7 DEG.C	T06HTR	610.6 DEG.C
								T07HTR	609.8 DEG.C
								T08HTR	584.3 DEG.C
								T09HTR	614.4 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	583.7 DEG.C
FLOCLR	4.26 L/MIN	1 PWRIN	2721. WATTS	VX1HOR	0.4 CM/S	PWROUT	498. WATTS	T11HTR	582.5 DEG.C
TWINCL	25.4 DEG.C	2 QCOOLR	2338. WATTS	VY1VER	6.0 CM/S	INDPWR	504. WATTS	T12HTR	575.3 DEG.C
TDLCL	7.91 DEG.C	3 QDSHPT	546. WATTS			PISTST	2.39 CM		
TWOCLR	31.12 DEG.C	4 EXTEFF	18.3 %	PHASE ANGLES		DISPST	1.78 CM		
		5 TAVHTR	600.7 DEG.C	PADISP	40.5 DEG.			T13REG******	DEG.C
		6 INTEFF	17.5 %	PAPRES	-8.7 DEG.	DYNAMIC CALCULATIONS		T14REG	521.6 DEG.C
		8 AMPS	1112. AMPS			PAMPC	1024. KPA	T15REG	395.8 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.27 CM	T16REG	401.9 DEG.C
		10 QDISP	15. WATTS	FREQ	37.1 HZ	PISTCP	2.39 CM	T17REG	401.2 DEG.C
		11 QREG1	121. WATTS			PDYNDB******	KPA	T18REG	388.8 DEG.C
		12 QREG2	108. WATTS			PDLCLR	3.90 KPA	T19REG	239.4 DEG.C
		13 QREG3	36. WATTS			PDLREG	36.66 KPA		
		14 PFP	997.3 KPA/CM			PDLDIS	71.27 KPA	T03HED******	DEG.C
		15 PFD	267.4 KPA/CM						
		16 NBEALE	0.00312						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/07/84 14:42:20.19 RDG 1608

FLUID HELIUM BAROM 14.322 PSI REGENERATOR 1 DISPLACER 1 LIGHT PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.12 L/MIN	AMPS1	653. AMPS	PRESUP	7070. KPA	TGEXP	558.4 DEG.C	T01HTR	606.1 DEG.C
		AMPS2	517. AMPS					T02HTR	606.3 DEG.C
TWINDP	18.0 DEG.C	VOLTG	2.58 VOLTS	MEANBP	7016. KPA	TGREGH	566.1 DEG.C	T03HTR	614.3 DEG.C
TDLDP	2.44 DEG.C			MEANCP	7063. KPA	TGREGC	102.3 DEG.C	T04HTR	606.5 DEG.C
TWODPR	20.5 DEG.C					TGCOMP	46.1 DEG.C	T05HTR	617.5 DEG.C
						TGBOUN	32.6 DEG.C	T06HTR	611.5 DEG.C
								T07HTR	610.5 DEG.C
								T08HTR	584.0 DEG.C
								T09HTR	615.3 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	582.2 DEG.C
FLOCLR	4.26 L/MIN	1 PWRIN	3018. WATTS	VX1HOR	0.4 CM/S	PWROUT	572. WATTS	T11HTR	581.7 DEG.C
TWINCL	25.3 DEG.C	2 QCOOLR	2618. WATTS	VY1VER	6.0 CM/S	INDPWR	571. WATTS	T12HTR	573.3 DEG.C
TDLCL	8.86 DEG.C	3 QDSHPT	701. WATTS			PISTST	2.56 CM		
TWOCLR	31.88 DEG.C	4 EXTEFF	19.0 %	PHASE ANGLES		DISPST	1.90 CM		
		5 TAVHTR	600.8 DEG.C	PADISP	41.6 DEG.			T13REG******	DEG.C
		6 INTEFF	17.9 %	PAPRES	-8.1 DEG.	DYNAMIC CALCULATIONS		T14REG	522.1 DEG.C
		8 AMPS	1170. AMPS			PAMPC	1102. KPA	T15REG	398.0 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.28 CM	T16REG	402.5 DEG.C
		10 QDISP	15. WATTS	FREQ	37.4 HZ	PISTCP	2.37 CM	T17REG	402.6 DEG.C
		11 QREG1	119. WATTS			PDYNDB******	KPA	T18REG	390.7 DEG.C
		12 QREG2	107. WATTS			PDLCLR	4.41 KPA	T19REG	243.5 DEG.C
		13 QREG3	36. WATTS			PDLREG	40.05 KPA		
		14 PFP	987.2 KPA/CM			PDLDIS	75.69 KPA	T03HED******	DEG.C
		15 PFD	245.5 KPA/CM						
		16 NBEALE	0.00331						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/07/84 14:47:50.19 RDG 1609

FLUID HELIUM BAROM 14.317 PSI REGENERATOR 1 DISPLACER 1 LIGHT PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.11 L/MIN	AMPS1	685. AMPS	PRESUP	7072. KPA	TGEXP	555.2 DEG.C	T01HTR	606.3 DEG.C
		AMPS2	546. AMPS					T02HTR	606.0 DEG.C
TWINDP	18.0 DEG.C	VOLTG	2.71 VOLTS	MEANBP	7017. KPA	TGREGH	563.8 DEG.C	T03HTR	615.3 DEG.C
TDLDP	2.62 DEG.C			MEANCP	7068. KPA	TGREGC	104.2 DEG.C	T04HTR	605.2 DEG.C
TWODPR	20.6 DEG.C					TGCOMP	48.4 DEG.C	T05HTR	619.0 DEG.C
						TGBOUN	33.2 DEG.C	T06HTR	612.0 DEG.C
								T07HTR	611.2 DEG.C
								T08HTR	583.1 DEG.C
								T09HTR	615.3 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	580.5 DEG.C
FLOCLR	4.26 L/MIN	1 PWRIN	3342. WATTS	VX1HOR	0.4 CM/S	PWROUT	639. WATTS	T11HTR	579.8 DEG.C
TWINCL	25.3 DEG.C	2 QCOOLR	2826. WATTS	VY1VER	6.5 CM/S	INDPWR	633. WATTS	T12HTR	571.8 DEG.C
TDLCL	9.57 DEG.C	3 QDSHPT	749. WATTS			PISTST	2.77 CM		
TWOCLR	32.66 DEG.C	4 EXTEFF	19.1 %	PHASE ANGLES		DISPST	2.00 CM		
		5 TAVHTR	600.5 DEG.C	PADISP	42.0 DEG.			T13REG******	DEG.C
		6 INTEFF	18.4 %	PAPRES	-7.6 DEG.	DYNAMIC CALCULATIONS		T14REG	521.9 DEG.C
		8 AMPS	1231. AMPS			PAMPC	1201. KPA	T15REG	399.0 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.34 CM	T16REG	401.8 DEG.C
		10 QDISP	14. WATTS	FREQ	37.6 HZ	PISTCP	2.37 CM	T17REG	402.7 DEG.C
		11 QREG1	118. WATTS			PDYNDB******	KPA	T18REG	391.1 DEG.C
		12 QREG2	106. WATTS			PDLCLR	5.26 KPA	T19REG	245.7 DEG.C
		13 QREG3	36. WATTS			PDLREG	44.12 KPA		
		14 PFP	987.4 KPA/CM			PDLDIS	82.47 KPA	T03HED******	DEG.C
		15 PFD	238.4 KPA/CM						
		16 NBEALE	0.00341						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/07/84 14:52:20.19 RDG 1610

FLUID HELIUM BAROM 14.317 PSI REGENERATOR 1 DISPLACER 1 LIGHT PISTON

HEAT TO DASHPOT COOLING

FLODP	4.10	L/MIN
TWINDP	18.0	DEG.C
TDLDP	2.88	DEG.C
TWODPR	20.8	DEG.C

POWER IN

AMPS1	714.	AMPS
AMPS2	574.	AMPS
VOLTG	2.84	VOLTS

ENGINE CHARGE PRESSURE

PRESUP	7077.	KPA
MEANBP	7018.	KPA
MEANCP	7075.	KPA

GAS TEMPERATURES

TGEXP	552.3	DEG.C
TGREGH	561.9	DEG.C
TGREGC	105.4	DEG.C
TGCOMP	51.3	DEG.C
TGBOUN	33.9	DEG.C

SURFACE TEMPERATURES

T01HTR	607.1	DEG.C
T02HTR	605.6	DEG.C
T03HTR	617.6	DEG.C
T04HTR	603.8	DEG.C
T05HTR	621.5	DEG.C
T06HTR	612.5	DEG.C
T07HTR	611.9	DEG.C
T08HTR	582.9	DEG.C
T09HTR	615.1	DEG.C
T10HTR	580.3	DEG.C
T11HTR	578.2	DEG.C
T12HTR	570.8	DEG.C
T13REG	******	DEG.C
T14REG	521.6	DEG.C
T15REG	398.3	DEG.C
T16REG	398.9	DEG.C
T17REG	401.3	DEG.C
T18REG	391.4	DEG.C
T19REG	246.8	DEG.C
T03HED	******	DEG.C

HEAT TO COOLER

FLOCLR	4.27	L/MIN
TWINCL	25.3	DEG.C
TDLCL	10.44	DEG.C
TWOCLR	33.54	DEG.C

CALCULATED PARAMETERS

1	PWRIN	3664.	WATTS
2	QCOOLR	3090.	WATTS
3	QDSHPT	823.	WATTS
4	EXTEFF	19.2	%
5	TAVHTR	600.6	DEG.C
6	INTEFF	18.6	%
8	AMPS	1289.	AMPS
9	QDISPG	3.	WATTS
10	QDISP	14.	WATTS
11	QREG1	117.	WATTS
12	QREG2	106.	WATTS
13	QREG3	35.	WATTS
14	PFP	992.5	KPA/CM
15	PFD	230.9	KPA/CM
16	NBEALE	0.00347	

VIBRATION

VX1HOR	0.4	CM/S
VY1VER	7.0	CM/S

PHASE ANGLES

PADISP	42.4	DEG.
PAPRES	-7.2	DEG.

ENGINE SPEED

FREQ	37.7	HZ

REMOTE CALCULATIONS

PWROUT	705.	WATTS
INDPWR	691.	WATTS
PISTST	2.99	CM
DISPST	2.10	CM

DYNAMIC CALCULATIONS

PAMPC	1314.	KPA
DISPCP	2.33	CM
PISTCP	2.34	CM
PDYNDB	******	KPA
PDLCLR	6.45	KPA
PDLREG	48.19	KPA
PDLDIS	89.60	KPA

APPENDIX D

Other Data Points of Interest

By the definition of the SVDS and the DVDS, data points with both the high power regenerator and the high power displacer were eliminated. Since these data points may be of great interest for computer code validation, they were presented in this appendix. Although all of the data points are available on a microfiche card that may be obtained from NASA Lewis, it was felt that it would be easier to access the data from an appendix.

The 69 data points included in this appendix are those that have any combination of two of the following three set conditions: 7.0 MPa pressure 25 °C cooler temperature, and 600 °C heater temperature. If viewed from the format of figure 27, these include the row of 25 °C and 7.0 MPa, 25 °C, and 600 °C, and also the pair of 600 °C and 7.0 MPa.

APPENDIX D. - OTHER DATA POINTS OF INTEREST.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/21/83 15:42:22.48 RDG 774

FLUID HELIUM BAROM 14.411 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.02 L/MIN
TWINDP 17.0 DEG.C
TDLDP 2.06 DEG.C
TWODPR 19.9 DEG.C

POWER IN
AMPS1 634. AMPS
AMPS2 499. AMPS
VOLTG 2.50 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7345. KPA
MEANBP 6998. KPA
MEANCP 7049. KPA

GAS TEMPERATURES
TGEXP 563.9 DEG.C
TGREGH 542.4 DEG.C
TGREGC 115.9 DEG.C
TGCOMP 68.4 DEG.C
TGBOUN 44.1 DEG.C

SURFACE TEMPERATURE
T01HTR 599.0 DEG.C
T02HTR 609.0 DEG.C
T03HTR 606.6 DEG.C
T04HTR 597.5 DEG.C
T05HTR 596.7 DEG.C
T06HTR 600.7 DEG.C
T07HTR 572.7 DEG.C
T08HTR 605.0 DEG.C
T09HTR 610.4 DEG.C
T10HTR 597.6 DEG.C
T11HTR 596.0 DEG.C
T12HTR 604.5 DEG.C
T13REG 548.3 DEG.C
T14REG 510.8 DEG.C
T15REG 385.7 DEG.C
T16REG****** DEG.C
T17REG 369.5 DEG.C
T18REG 371.4 DEG.C
T19REG 247.4 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 3.94 L/MIN
TWINCL 53.7 DEG.C
TDLCL 6.59 DEG.C
TWOCLR 58.57 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2831. WATTS
2 QCOOLR 1783. WATTS
3 QDSHPT 577. WATTS
4 EXTEFF 21.4 %
5 TAVHTR 599.6 DEG.C
6 INTEFF 25.4 %
8 AMPS 1133. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 101. WATTS
12 QREG2 113. WATTS
13 QREG3 33. WATTS
14 PFP 995.8 KPA/CM
15 PFD 306.5 KPA/CM
16 NBEALE 0.00576

VIBRATION
VX1HOR 0.2 CM/S
VY1VER 6.5 CM/S

PHASE ANGLES
PADISP 84.4 DEG.
PAPRES -17.5 DEG.

ENGINE SPEED
FREQ 32.4 HZ

REMOTE CALCULATIONS
PWROUT 606. WATTS
INDPWR 644. WATTS
PISTST 1.81 CM
DISPST 1.80 CM

DYNAMIC CALCULATIONS
PAMPC 915. KPA
DISPCP 2.54 CM
PISTCP 2.38 CM
PDYNDB 1138. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/21/83 15:48:10.48 RDG 775

FLUID HELIUM BAROM 14.416 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.00 L/MIN
TWINDP 17.1 DEG.C
TDLDP 2.18 DEG.C
TWODPR 19.9 DEG.C

POWER IN
AMPS1 668. AMPS
AMPS2 527. AMPS
VOLTG 2.63 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7249. KPA
MEANBP 6996. KPA
MEANCP 7052. KPA

GAS TEMPERATURES
TGEXP 561.9 DEG.C
TGREGH 540.6 DEG.C
TGREGC 118.4 DEG.C
TGCOMP 71.4 DEG.C
TGBOUN 43.5 DEG.C

SURFACE TEMPERATURE
T01HTR 599.7 DEG.C
T02HTR 609.0 DEG.C
T03HTR 607.8 DEG.C
T04HTR 596.9 DEG.C
T05HTR 596.9 DEG.C
T06HTR 600.5 DEG.C
T07HTR 571.9 DEG.C
T08HTR 604.3 DEG.C
T09HTR 611.4 DEG.C
T10HTR 598.4 DEG.C
T11HTR 595.8 DEG.C
T12HTR 604.2 DEG.C
T13REG 547.6 DEG.C
T14REG 510.0 DEG.C
T15REG 385.6 DEG.C
T16REG****** DEG.C
T17REG 369.9 DEG.C
T18REG 372.0 DEG.C
T19REG 249.1 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 3.99 L/MIN
TWINCL 54.5 DEG.C
TDLCL 6.49 DEG.C
TWOCLR 59.87 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3148. WATTS
2 QCOOLR 1781. WATTS
3 QDSHPT 608. WATTS
4 EXTEFF 21.7 %
5 TAVHTR 599.7 DEG.C
6 INTEFF 27.7 %
8 AMPS 1196. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 100. WATTS
12 QREG2 112. WATTS
13 QREG3 33. WATTS
14 PFP 991.8 KPA/CM
15 PFD 296.7 KPA/CM
16 NBEALE 0.00592

VIBRATION
VX1HOR 0.2 CM/S
VY1VER 7.1 CM/S

PHASE ANGLES
PADISP 84.5 DEG.
PAPRES -16.5 DEG.

ENGINE SPEED
FREQ 32.2 HZ

REMOTE CALCULATIONS
PWROUT 684. WATTS
INDPWR 729. WATTS
PISTST 2.00 CM
DISPST 1.93 CM

DYNAMIC CALCULATIONS
PAMPC 1004. KPA
DISPCP 2.51 CM
PISTCP 2.42 CM
PDYNDB 1188. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/21/83 15:52:31.48 RDG 776

FLUID HELIUM BAROM 14.416 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.00 L/MIN
TWINDP 17.0 DEG.C
TDLDP 2.40 DEG.C
TWODPR 20.2 DEG.C

POWER IN
AMPS1 707. AMPS
AMPS2 556. AMPS
VOLTG 2.78 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7356. KPA
MEANBP 7008. KPA
MEANCP 7066. KPA

GAS TEMPERATURES
TGEXP 558.7 DEG.C
TGREGH 537.8 DEG.C
TGREGC 121.3 DEG.C
TGCOMP 74.3 DEG.C
TGBOUN 43.7 DEG.C

SURFACE TEMPERATURE
T01HTR 599.5 DEG.C
T02HTR 608.7 DEG.C
T03HTR 608.2 DEG.C
T04HTR 595.7 DEG.C
T05HTR 596.3 DEG.C
T06HTR 599.4 DEG.C
T07HTR 570.2 DEG.C
T08HTR 603.3 DEG.C
T09HTR 611.7 DEG.C
T10HTR 598.4 DEG.C
T11HTR 595.0 DEG.C
T12HTR 603.5 DEG.C
T13REG 546.0 DEG.C
T14REG 508.9 DEG.C
T15REG 386.0 DEG.C
T16REG****** DEG.C
T17REG 369.2 DEG.C
T18REG 371.2 DEG.C
T19REG 251.4 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.03 L/MIN
TWINCL 54.6 DEG.C
TDLCL 7.29 DEG.C
TWOCLR 60.81 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3513. WATTS
2 QCOOLR 2021. WATTS
3 QDSHPT 669. WATTS
4 EXTEFF 22.0 %
5 TAVHTR 599.2 DEG.C
6 INTEFF 27.6 %
8 AMPS 1263. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 97. WATTS
12 QREG2 112. WATTS
13 QREG3 32. WATTS
14 PFP 973.2 KPA/CM
15 PFD 283.3 KPA/CM
16 NBEALE 0.00608

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 7.8 CM/S

PHASE ANGLES
PADISP 85.0 DEG.
PAPRES -15.5 DEG.

ENGINE SPEED
FREQ 32.1 HZ

REMOTE CALCULATIONS
PWROUT 772. WATTS
INDPWR 816. WATTS
PISTST 2.20 CM
DISPST 2.05 CM

DYNAMIC CALCULATIONS
PAMPC 1083. KPA
DISPCP 2.52 CM
PISTCP 2.43 CM
PDYNDB 1263. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/21/83 15:57:19.48 RDG 777

FLUID HELIUM BAROM 14.416 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	3.98 L/MIN	AMPS1	748. AMPS	PRESUP	7351. KPA	TGEXP	555.7 DEG.C	T01HTR	599.5 DEG.C
		AMPS2	592. AMPS					T02HTR	609.0 DEG.C
TWINDP	17.0 DEG.C	VOLTG	2.95 VOLTS	MEANBP	6998. KPA	TGREGH	534.7 DEG.C	T03HTR	609.3 DEG.C
TDLDP	2.78 DEG.C			MEANCP	7062. KPA	TGREGC	124.6 DEG.C	T04HTR	595.4 DEG.C
TWODPR	20.5 DEG.C					TGCOMP	78.3 DEG.C	T05HTR	597.1 DEG.C
						TGBOUN	44.0 DEG.C	T06HTR	598.4 DEG.C
								T07HTR	569.4 DEG.C
								T08HTR	602.2 DEG.C
								T09HTR	613.3 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	598.6 DEG.C
FLOCLR	4.05 L/MIN	1 PWRIN	3951. WATTS	VX1HOR	0.3 CM/S	PWROUT	886. WATTS	T11HTR	594.7 DEG.C
TWINCL	54.6 DEG.C	2 QCOOLR	2261. WATTS	VY1VER	8.5 CM/S	INDPWR	911. WATTS	T12HTR	603.3 DEG.C
TDLCL	8.13 DEG.C	3 QDSHPT	771. WATTS			PISTST	2.40 CM		
TWOCLR	61.75 DEG.C	4 EXTEFF	22.4 %	PHASE ANGLES		DISPST	2.20 CM		
		5 TAVHTR	599.2 DEG.C	PADISP	84.9 DEG.			T13REG	545.2 DEG.C
		6 INTEFF	28.1 %	PAPRES	-14.7 DEG.	DYNAMIC CALCULATIONS		T14REG	508.7 DEG.C
		8 AMPS	1340. AMPS			PAMPC	1196. KPA	T15REG	387.7 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.55 CM	T16REG	****** DEG.C
		10 QDISP	14. WATTS	FREQ	32.0 HZ	PISTCP	2.38 CM	T17REG	368.9 DEG.C
		11 QREG1	95. WATTS			PDYNDB	1350. KPA	T18REG	372.3 DEG.C
		12 QREG2	111. WATTS			PDLCLR	****** KPA	T19REG	254.6 DEG.C
		13 QREG3	32. WATTS			PDLREG	****** KPA		
		14 PFP	986.6 KPA/CM			PDLDIS	****** KPA	T03HED	****** DEG.C
		15 PFD	277.1 KPA/CM						
		16 NBEALE	0.00641						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/21/83 16:02:16.48 RDG 778

FLUID HELIUM BAROM 14.411 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	3.97 L/MIN	AMPS1	792. AMPS	PRESUP	7349. KPA	TGEXP	553.7 DEG.C	T01HTR	600.1 DEG.C
		AMPS2	619. AMPS					T02HTR	611.1 DEG.C
TWINDP	17.0 DEG.C	VOLTG	3.11 VOLTS	MEANBP	6998. KPA	TGREGH	532.1 DEG.C	T03HTR	611.9 DEG.C
TDLDP	3.13 DEG.C			MEANCP	7066. KPA	TGREGC	127.1 DEG.C	T04HTR	596.2 DEG.C
TWODPR	20.9 DEG.C					TGCOMP	82.4 DEG.C	T05HTR	599.5 DEG.C
						TGBOUN	44.7 DEG.C	T06HTR	597.9 DEG.C
								T07HTR	570.3 DEG.C
								T08HTR	602.1 DEG.C
								T09HTR	616.0 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	599.2 DEG.C
FLOCLR	4.07 L/MIN	1 PWRIN	4387. WATTS	VX1HOR	0.4 CM/S	PWROUT	1000. WATTS	T11HTR	595.2 DEG.C
TWINCL	54.6 DEG.C	2 QCOOLR	2428. WATTS	VY1VER	9.1 CM/S	INDPWR	1005. WATTS	T12HTR	605.1 DEG.C
TDLCL	8.69 DEG.C	3 QDSHPT	865. WATTS			PISTST	2.61 CM		
TWOCLR	62.74 DEG.C	4 EXTEFF	22.8 %	PHASE ANGLES		DISPST	2.30 CM		
		5 TAVHTR	600.4 DEG.C	PADISP	83.6 DEG.			T13REG	545.5 DEG.C
		6 INTEFF	29.2 %	PAPRES	-13.7 DEG.	DYNAMIC CALCULATIONS		T14REG	509.1 DEG.C
		8 AMPS	1410. AMPS			PAMPC	1294. KPA	T15REG	389.4 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.77 CM	T16REG	****** DEG.C
		10 QDISP	13. WATTS	FREQ	32.0 HZ	PISTCP	2.51 CM	T17REG	363.3 DEG.C
		11 QREG1	93. WATTS			PDYNDB	1450. KPA	T18REG	372.4 DEG.C
		12 QREG2	111. WATTS			PDLCLR	****** KPA	T19REG	258.0 DEG.C
		13 QREG3	31. WATTS			PDLREG	****** KPA		
		14 PFP	989.0 KPA/CM			PDLDIS	****** KPA	T03HED	****** DEG.C
		15 PFD	267.2 KPA/CM						
		16 NBEALE	0.00666						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/21/83 16:06:19.48 RDG 779

FLUID HELIUM BAROM 14.411 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	3.97 L/MIN	AMPS1	834. AMPS	PRESUP	7347. KPA	TGEXP	549.9 DEG.C	T01HTR	599.5 DEG.C
		AMPS2	644. AMPS					T02HTR	610.0 DEG.C
TWINDP	17.1 DEG.C	VOLTG	3.26 VOLTS	MEANBP	6998. KPA	TGREGH	529.2 DEG.C	T03HTR	612.1 DEG.C
TDLDP	3.37 DEG.C			MEANCP	7070. KPA	TGREGC	129.9 DEG.C	T04HTR	594.4 DEG.C
TWODPR	21.2 DEG.C					TGCOMP	86.5 DEG.C	T05HTR	599.4 DEG.C
						TGBOUN	45.1 DEG.C	T06HTR	596.6 DEG.C
								T07HTR	568.1 DEG.C
								T08HTR	600.7 DEG.C
								T09HTR	616.0 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	599.0 DEG.C
FLOCLR	4.08 L/MIN	1 PWRIN	4815. WATTS	VX1HOR	0.4 CM/S	PWROUT	1075. WATTS	T11HTR	593.9 DEG.C
TWINCL	54.7 DEG.C	2 QCOOLR	2570. WATTS	VY1VER	9.7 CM/S	INDPWR	1093. WATTS	T12HTR	603.8 DEG.C
TDLCL	9.17 DEG.C	3 QDSHPT	932. WATTS			PISTST	2.80 CM		
TWOCLR	63.87 DEG.C	4 EXTEFF	22.3 %	PHASE ANGLES		DISPST	2.41 CM		
		5 TAVHTR	599.5 DEG.C	PADISP	83.8 DEG.			T13REG	543.8 DEG.C
		6 INTEFF	29.5 %	PAPRES	-13.1 DEG.	DYNAMIC CALCULATIONS		T14REG	508.4 DEG.C
		8 AMPS	1477. AMPS			PAMPC	1393. KPA	T15REG	391.2 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.82 CM	T16REG	****** DEG.C
		10 QDISP	13. WATTS	FREQ	31.9 HZ	PISTCP	2.48 CM	T17REG	362.5 DEG.C
		11 QREG1	90. WATTS			PDYNDB	1525. KPA	T18REG	372.8 DEG.C
		12 QREG2	110. WATTS			PDLCLR	****** KPA	T19REG	262.0 DEG.C
		13 QREG3	31. WATTS			PDLREG	****** KPA		
		14 PFP	993.6 KPA/CM			PDLDIS	****** KPA	T03HED	****** DEG.C
		15 PFD	263.2 KPA/CM						
		16 NBEALE	0.00669						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/21/83 16:10:19.48 RDG 780

FLUID HELIUM BAROM 14.411 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 3.99 L/MIN
TWINDP 17.0 DEG.C
TDLDP 3.67 DEG.C
TWODPR 21.6 DEG.C

POWER IN
AMPS1 876. AMPS
AMPS2 681. AMPS
VOLTG 3.44 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7350. KPA
MEANBP 7008. KPA
MEANCP 7087. KPA

GAS TEMPERATURES
TGEXP 547.1 DEG.C
TGREGH 528.7 DEG.C
TGREGC 132.8 DEG.C
TGCOMP 90.3 DEG.C
TGBOUN 46.2 DEG.C

SURFACE TEMPERATUR
T01HTR 601.4 DEG.
T02HTR 609.4 DEG.
T03HTR 613.8 DEG.
T04HTR 593.1 DEG.
T05HTR 599.5 DEG.
T06HTR 597.6 DEG.
T07HTR 565.5 DEG.
T08HTR 600.9 DEG.
T09HTR 616.2 DEG.
T10HTR 600.7 DEG.
T11HTR 594.6 DEG.
T12HTR 603.6 DEG.
T13REG 542.0 DEG.
T14REG 507.0 DEG.
T15REG 391.8 DEG.
T16REG****** DEG.
T17REG 366.9 DEG.
T18REG 376.1 DEG.
T19REG 265.2 DEG.
T03HED****** DEG.

HEAT TO COOLER
FLOCLR 4.05 L/MIN
TWINCL 54.0 DEG.C
TDLCL 10.48 DEG.C
TWOCLR 64.54 DEG.C

CALCULATED PARAMETERS
1 PWRIN 5355. WATTS
2 QCOOLR 2919. WATTS
3 QDSHPT 1018. WATTS
4 EXTEFF 21.9 %
5 TAVHTR 599.7 DEG.C
6 INTEFF 28.7 %
8 AMPS 1557. AMPS
9 QDISPG 3. WATTS
10 QDISP 13. WATTS
11 QREG1 90. WATTS
12 QREG2 106. WATTS
13 QREG3 31. WATTS
14 PFP 1008.2 KPA/CM
15 PFD 264.5 KPA/CM
16 NBEALE 0.00678

VIBRATION
VX1HOR 0.5 CM/S
VY1VER10.4 CM/S

PHASE ANGLES
PADISP 84.3 DEG.
PAPRES -12.0 DEG.

ENGINE SPEED
FREQ 32.1 HZ

REMOTE CALCULATIONS
PWROUT 1175. WATTS
INDPWR 1186. WATTS
PISTST 3.00 CM
DISPST 2.39 CM

DYNAMIC CALCULATIONS
PAMPC 1516. KPA
DISPCP 2.89 CM
PISTCP 2.35 CM
PDYNDB 1625. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/06/84 13:00:19.43 RDG 804

FLUID HELIUM BAROM 14.136 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.12 L/MIN
TWINDP 20.3 DEG.C
TDLDP 1.54 DEG.C
TWODPR 22.4 DEG.C

POWER IN
AMPS1 623. AMPS
AMPS2 515. AMPS
VOLTG 2.50 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7076. KPA
MEANBP 7010. KPA
MEANCP 7051. KPA

GAS TEMPERATURES
TGEXP 562.6 DEG.C
TGREGH 540.1 DEG.C
TGREGC 102.3 DEG.C
TGCOMP 56.2 DEG.C
TGBOUN 36.6 DEG.C

SURFACE TEMPERATURE
T01HTR 599.6 DEG.C
T02HTR 610.4 DEG.C
T03HTR 609.8 DEG.C
T04HTR 595.3 DEG.C
T05HTR 600.9 DEG.C
T06HTR 601.1 DEG.C
T07HTR 574.0 DEG.C
T08HTR 602.8 DEG.C
T09HTR 607.4 DEG.C
T10HTR 598.8 DEG.C
T11HTR 593.9 DEG.C
T12HTR 607.6 DEG.C
T13REG 552.8 DEG.C
T14REG 515.4 DEG.C
T15REG 389.0 DEG.C
T16REG****** DEG.C
T17REG 364.8 DEG.C
T18REG 376.4 DEG.C
T19REG 246.1 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.37 L/MIN
TWINCL 39.4 DEG.C
TDLCL 5.40 DEG.C
TWOCLR 44.66 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2844. WATTS
2 QCOOLR 1629. WATTS
3 QDSHPT 441. WATTS
4 EXTEFF 22.4 %
5 TAVHTR 600.1 DEG.C
6 INTEFF 28.1 %
8 AMPS 1139. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 106. WATTS
12 QREG2 113. WATTS
13 QREG3 34. WATTS
14 PFP 1019.6 KPA/CM
15 PFD 332.1 KPA/CM
16 NBEALE 0.00608

VIBRATION
VX1HOR 0.2 CM/S
VY1VER 6.5 CM/S

PHASE ANGLES
PADISP 83.6 DEG.
PAPRES -18.4 DEG.

ENGINE SPEED
FREQ 32.4 HZ

REMOTE CALCULATIONS
PWROUT 638. WATTS
INDPWR 669. WATTS
PISTST 1.80 CM
DISPST 1.78 CM

DYNAMIC CALCULATIONS
PAMPC 930. KPA
DISPCP 2.52 CM
PISTCP 2.44 CM
PDYNDB 1075. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/06/84 13:06:16.43 RDG 805

FLUID HELIUM BAROM 14.140 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.13 L/MIN
TWINDP 20.3 DEG.C
TDLDP 1.80 DEG.C
TWODPR 22.7 DEG.C

POWER IN
AMPS1 661. AMPS
AMPS2 541. AMPS
VOLTG 2.64 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7084. KPA
MEANBP 6997. KPA
MEANCP 7043. KPA

GAS TEMPERATURES
TGEXP 560.4 DEG.C
TGREGH 537.7 DEG.C
TGREGC 105.7 DEG.C
TGCOMP 59.6 DEG.C
TGBOUN 38.0 DEG.C

SURFACE TEMPERATURE
T01HTR 599.2 DEG.C
T02HTR 610.0 DEG.C
T03HTR 609.8 DEG.C
T04HTR 595.5 DEG.C
T05HTR 600.5 DEG.C
T06HTR 599.8 DEG.C
T07HTR 572.6 DEG.C
T08HTR 602.4 DEG.C
T09HTR 609.4 DEG.C
T10HTR 598.6 DEG.C
T11HTR 594.0 DEG.C
T12HTR 606.5 DEG.C
T13REG 550.8 DEG.C
T14REG 513.6 DEG.C
T15REG 388.1 DEG.C
T16REG****** DEG.C
T17REG 363.4 DEG.C
T18REG 376.2 DEG.C
T19REG 247.4 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.37 L/MIN
TWINCL 39.5 DEG.C
TDLCL 6.25 DEG.C
TWOCLR 45.58 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3173. WATTS
2 QCOOLR 1886. WATTS
3 QDSHPT 516. WATTS
4 EXTEFF 22.9 %
5 TAVHTR 599.9 DEG.C
6 INTEFF 27.8 %
8 AMPS 1202. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 105. WATTS
12 QREG2 111. WATTS
13 QREG3 33. WATTS
14 PFP 1012.1 KPA/CM
15 PFD 323.8 KPA/CM
16 NBEALE 0.00632

VIBRATION
VX1HOR 0.2 CM/S
VY1VER 7.1 CM/S

PHASE ANGLES
PADISP 84.2 DEG.
PAPRES -17.5 DEG.

ENGINE SPEED
FREQ 32.3 HZ

REMOTE CALCULATIONS
PWROUT 727. WATTS
INDPWR 765. WATTS
PISTST 1.98 CM
DISPST 1.91 CM

DYNAMIC CALCULATIONS
PAMPC 1019. KPA
DISPCP 2.54 CM
PISTCP 2.45 CM
PDYNDB 1175. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/06/84 13:10:34.48 RDG 806

FLUID HELIUM BAROM 14.140 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.12 L/MIN
TWINDP 20.2 DEG.C
TDLDP 2.13 DEG.C
TWODPR 23.0 DEG.C

POWER IN
AMPS1 702. AMPS
AMPS2 574. AMPS
VOLTG 2.80 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7058. KPA
MEANBP 6989. KPA
MEANCP 7036. KPA

GAS TEMPERATURES
TGEXP 556.9 DEG.C
TGREGH 535.3 DEG.C
TGREGC 108.4 DEG.C
TGCOMP 62.1 DEG.C
TGBOUN 38.8 DEG.C

SURFACE TEMPERATURES
T01HTR 599.3 DEG.C
T02HTR 609.0 DEG.C
T03HTR 610.3 DEG.C
T04HTR 594.1 DEG.C
T05HTR 599.8 DEG.C
T06HTR 598.9 DEG.C
T07HTR 570.4 DEG.C
T08HTR 601.5 DEG.C
T09HTR 609.8 DEG.C
T10HTR 598.7 DEG.C
T11HTR 593.4 DEG.C
T12HTR 605.2 DEG.C

HEAT TO COOLER
FLOCLR 4.37 L/MIN
TWINCL 39.6 DEG.C
TDLCL 7.12 DEG.C
TWOCLR 46.49 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3568. WATTS
2 QCOOLR 2145. WATTS
3 QDSHPT 612. WATTS
4 EXTEFF 23.2 %
5 TAVHTR 599.2 DEG.C
6 INTEFF 27.8 %
8 AMPS 1276. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 104. WATTS
12 QREG2 110. WATTS
13 QREG3 33. WATTS
14 PFP 1012.9 KPA/CM
15 PFD 315.8 KPA/CM
16 NBEALE 0.00652

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 7.8 CM/S

PHASE ANGLES
PADISP 84.5 DEG.
PAPRES -16.6 DEG.

ENGINE SPEED
FREQ 32.2 HZ

REMOTE CALCULATIONS
PWROUT 827. WATTS
INDPWR 868. WATTS
PISTST 2.19 CM
DISPST 2.04 CM

DYNAMIC CALCULATIONS
PAMPC 1127. KPA
DISPCP 2.58 CM
PISTCP 2.46 CM
PDYNDB 1263. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

T13REG 548.0 DEG.C
T14REG 511.3 DEG.C
T15REG 386.5 DEG.C
T16REG****** DEG.C
T17REG 363.4 DEG.C
T18REG 376.1 DEG.C
T19REG 248.0 DEG.C
T03HED****** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/06/84 13:15:19.48 RDG 807

FLUID HELIUM BAROM 14.140 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.12 L/MIN
TWINDP 20.3 DEG.C
TDLDP 2.47 DEG.C
TWODPR 23.3 DEG.C

POWER IN
AMPS1 745. AMPS
AMPS2 602. AMPS
VOLTG 2.95 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7098. KPA
MEANBP 7009. KPA
MEANCP 7065. KPA

GAS TEMPERATURES
TGEXP 554.4 DEG.C
TGREGH 534.3 DEG.C
TGREGC 113.3 DEG.C
TGCOMP 65.8 DEG.C
TGBOUN 40.1 DEG.C

SURFACE TEMPERATURES
T01HTR 600.7 DEG.C
T02HTR 607.8 DEG.C
T03HTR 611.5 DEG.C
T04HTR 593.6 DEG.C
T05HTR 598.8 DEG.C
T06HTR 599.5 DEG.C
T07HTR 567.7 DEG.C
T08HTR 601.9 DEG.C
T09HTR 611.4 DEG.C
T10HTR 600.1 DEG.C
T11HTR 594.3 DEG.C
T12HTR 603.9 DEG.C

HEAT TO COOLER
FLOCLR 4.38 L/MIN
TWINCL 39.7 DEG.C
TDLCL 8.08 DEG.C
TWOCLR 47.47 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3977. WATTS
2 QCOOLR 2443. WATTS
3 QDSHPT 708. WATTS
4 EXTEFF 23.4 %
5 TAVHTR 599.3 DEG.C
6 INTEFF 27.6 %
8 AMPS 1347. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 104. WATTS
12 QREG2 108. WATTS
13 QREG3 33. WATTS
14 PFP 1018.6 KPA/CM
15 PFD 308.2 KPA/CM
16 NBEALE 0.00670

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 8.4 CM/S

PHASE ANGLES
PADISP 84.6 DEG.
PAPRES -15.7 DEG.

ENGINE SPEED
FREQ 32.2 HZ

REMOTE CALCULATIONS
PWROUT 930. WATTS
INDPWR 973. WATTS
PISTST 2.40 CM
DISPST 2.18 CM

DYNAMIC CALCULATIONS
PAMPC 1235. KPA
DISPCP 2.62 CM
PISTCP 2.46 CM
PDYNDB 1363. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

T13REG 545.5 DEG.C
T14REG 509.0 DEG.C
T15REG 384.4 DEG.C
T16REG****** DEG.C
T17REG 366.0 DEG.C
T18REG 376.0 DEG.C
T19REG 247.9 DEG.C
T03HED****** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/06/84 13:21:04.48 RDG 808

FLUID HELIUM BAROM 14.140 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.12 L/MIN
TWINDP 20.3 DEG.C
TDLDP 2.83 DEG.C
TWODPR 23.6 DEG.C

POWER IN
AMPS1 772. AMPS
AMPS2 627. AMPS
VOLTG 3.08 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7092. KPA
MEANBP 6987. KPA
MEANCP 7051. KPA

GAS TEMPERATURES
TGEXP 551.3 DEG.C
TGREGH 533.7 DEG.C
TGREGC 116.6 DEG.C
TGCOMP 69.6 DEG.C
TGBOUN 41.5 DEG.C

SURFACE TEMPERATURES
T01HTR 602.3 DEG.C
T02HTR 606.0 DEG.C
T03HTR 612.4 DEG.C
T04HTR 592.6 DEG.C
T05HTR 596.3 DEG.C
T06HTR 599.9 DEG.C
T07HTR 564.9 DEG.C
T08HTR 602.1 DEG.C
T09HTR 612.0 DEG.C
T10HTR 601.6 DEG.C
T11HTR 595.1 DEG.C
T12HTR 602.3 DEG.C

HEAT TO COOLER
FLOCLR 4.37 L/MIN
TWINCL 39.7 DEG.C
TDLCL 8.90 DEG.C
TWOCLR 48.29 DEG.C

CALCULATED PARAMETERS
1 PWRIN 4307. WATTS
2 QCOOLR 2686. WATTS
3 QDSHPT 811. WATTS
4 EXTEFF 23.4 %
5 TAVHTR 599.0 DEG.C
6 INTEFF 27.2 %
8 AMPS 1399. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 107. WATTS
12 QREG2 104. WATTS
13 QREG3 32. WATTS
14 PFP 1012.5 KPA/CM
15 PFD 296.8 KPA/CM
16 NBEALE 0.00676

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 9.0 CM/S

PHASE ANGLES
PADISP 84.4 DEG.
PAPRES -14.7 DEG.

ENGINE SPEED
FREQ 32.0 HZ

REMOTE CALCULATIONS
PWROUT 1006. WATTS
INDPWR 1051. WATTS
PISTST 2.59 CM
DISPST 2.28 CM

DYNAMIC CALCULATIONS
PAMPC 1324. KPA
DISPCP 2.64 CM
PISTCP 2.44 CM
PDYNDB 1438. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

T13REG 542.2 DEG.C
T14REG 504.7 DEG.C
T15REG 379.1 DEG.C
T16REG****** DEG.C
T17REG 368.6 DEG.C
T18REG 376.3 DEG.C
T19REG 244.8 DEG.C
T03HED****** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/06/84 13:25:19.48 RDG 809

FLUID HELIUM BAROM 14.140 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.11 L/MIN
TWINDP 20.3 DEG.C
TDLDP 3.06 DEG.C
TWODPR 23.9 DEG.C

POWER IN
AMPS1 807. AMPS
AMPS2 657. AMPS
VOLTG 3.23 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7071. KPA
MEANBP 6995. KPA
MEANCP 7063. KPA

GAS TEMPERATURES
TGEXP 548.0 DEG.C
TGREGH 531.8 DEG.C
TGREGC 119.2 DEG.C
TGCOMP 73.6 DEG.C
TGBOUN 43.2 DEG.C

SURFACE TEMPERATURE
T01HTR 602.0 DEG.C
T02HTR 605.5 DEG.C
T03HTR 612.7 DEG.C
T04HTR 591.3 DEG.C
T05HTR 596.1 DEG.C
T06HTR 599.0 DEG.C
T07HTR 563.2 DEG.C
T08HTR 601.3 DEG.C
T09HTR 612.4 DEG.C
T10HTR 601.5 DEG.C
T11HTR 594.8 DEG.C
T12HTR 601.4 DEG.C
T13REG 540.6 DEG.C
T14REG 503.7 DEG.C
T15REG 380.7 DEG.C
T16REG****** DEG.C
T17REG 368.5 DEG.C
T18REG 376.1 DEG.C
T19REG 248.8 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.39 L/MIN
TWINCL 39.7 DEG.C
TDLCL 10.00 DEG.C
TWOCLR 49.39 DEG.C

CALCULATED PARAMETERS
1 PWRIN 4736. WATTS
2 QCOOLR 3031. WATTS
3 QDSHPT 874. WATTS
4 EXTEFF 23.0 %
5 TAVHTR 598.4 DEG.C
6 INTEFF 26.4 %
8 AMPS 1464. AMPS
9 QDISPG 3. WATTS
10 QDISP 13. WATTS
11 QREG1 103. WATTS
12 QREG2 104. WATTS
13 QREG3 32. WATTS
14 PFP 1014.3 KPA/CM
15 PFD 284.2 KPA/CM
16 NBEALE 0.00680

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 9.6 CM/S

PHASE ANGLES
PADISP 84.9 DEG.
PAPRES -13.8 DEG.

ENGINE SPEED
FREQ 31.9 HZ

REMOTE CALCULATIONS
PWROUT 1089. WATTS
INDPWR 1138. WATTS
PISTST 2.79 CM
DISPST 2.40 CM

DYNAMIC CALCULATIONS
PAMPC 1427. KPA
DISPCP 2.67 CM
PISTCP 2.39 CM
PDYNDB 1494. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/11/84 13:59:30.48 RDG 810

FLUID HELIUM BAROM 14.489 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.04 L/MIN
TWINDP 17.7 DEG.C
TDLDP 3.08 DEG.C
TWODPR 21.4 DEG.C

POWER IN
AMPS1 838. AMPS
AMPS2 709. AMPS
VOLTG 3.40 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7493. KPA
MEANBP 6998. KPA
MEANCP 7065. KPA

GAS TEMPERATURES
TGEXP 545.2 DEG.C
TGREGH 529.9 DEG.C
TGREGC 116.5 DEG.C
TGCOMP 75.0 DEG.C
TGBOUN 38.1 DEG.C

SURFACE TEMPERATURE
T01HTR 604.3 DEG.C
T02HTR 606.4 DEG.C
T03HTR 614.7 DEG.C
T04HTR 591.2 DEG.C
T05HTR 595.7 DEG.C
T06HTR 600.3 DEG.C
T07HTR 561.9 DEG.C
T08HTR 601.4 DEG.C
T09HTR 613.5 DEG.C
T10HTR 603.2 DEG.C
T11HTR 595.0 DEG.C
T12HTR 601.5 DEG.C
T13REG****** DEG.C
T14REG 501.8 DEG.C
T15REG 380.7 DEG.C
T16REG****** DEG.C
T17REG 369.1 DEG.C
T18REG 378.4 DEG.C
T19REG 250.2 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.59 L/MIN
TWINCL 39.3 DEG.C
TDLCL 10.03 DEG.C
TWOCLR 48.65 DEG.C

CALCULATED PARAMETERS
1 PWRIN 5261. WATTS
2 QCOOLR 3181. WATTS
3 QDSHPT 866. WATTS
4 EXTEFF 23.2 %
5 TAVHTR 599.1 DEG.C
6 INTEFF 27.7 %
8 AMPS 1547. AMPS
9 QDISPG 3. WATTS
10 QDISP 13. WATTS
11 QREG1 104. WATTS
12 QREG2 100. WATTS
13 QREG3 32. WATTS
14 PFP 1025.8 KPA/CM
15 PFD 275.7 KPA/CM
16 NBEALE 0.00710

VIBRATION
VX1HOR 0.6 CM/S
VY1VER10.2 CM/S

PHASE ANGLES
PADISP 84.7 DEG.
PAPRES -12.8 DEG.

ENGINE SPEED
FREQ 32.1 HZ

REMOTE CALCULATIONS
PWROUT 1219. WATTS
INDPWR 1240. WATTS
PISTST 2.98 CM
DISPST 2.48 CM

DYNAMIC CALCULATIONS
PAMPC 1536. KPA
DISPCP 2.81 CM
PISTCP 2.28 CM
PDYNDB 1588. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/11/84 14:04:09.48 RDG 811

FLUID HELIUM BAROM 14.489 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.03 L/MIN
TWINDP 17.7 DEG.C
TDLDP 3.45 DEG.C
TWODPR 21.8 DEG.C

POWER IN
AMPS1 868. AMPS
AMPS2 734. AMPS
VOLTG 3.54 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7503. KPA
MEANBP 6988. KPA
MEANCP 7061. KPA

GAS TEMPERATURES
TGEXP 542.6 DEG.C
TGREGH 530.1 DEG.C
TGREGC 122.5 DEG.C
TGCOMP 79.2 DEG.C
TGBOUN 41.0 DEG.C

SURFACE TEMPERATURE
T01HTR 606.1 DEG.C
T02HTR 605.2 DEG.C
T03HTR 616.0 DEG.C
T04HTR 590.4 DEG.C
T05HTR 596.1 DEG.C
T06HTR 601.2 DEG.C
T07HTR 559.9 DEG.C
T08HTR 602.7 DEG.C
T09HTR 614.0 DEG.C
T10HTR 605.1 DEG.C
T11HTR 596.9 DEG.C
T12HTR 601.2 DEG.C
T13REG****** DEG.C
T14REG 499.9 DEG.C
T15REG 377.8 DEG.C
T16REG****** DEG.C
T17REG 371.7 DEG.C
T18REG 378.2 DEG.C
T19REG 250.0 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.51 L/MIN
TWINCL 39.8 DEG.C
TDLCL 11.15 DEG.C
TWOCLR 50.71 DEG.C

CALCULATED PARAMETERS
1 PWRIN 5666. WATTS
2 QCOOLR 3468. WATTS
3 QDSHPT 969. WATTS
4 EXTEFF 22.8 %
5 TAVHTR 599.6 DEG.C
6 INTEFF 27.1 %
8 AMPS 1601. AMPS
9 QDISPG 3. WATTS
10 QDISP 13. WATTS
11 QREG1 104. WATTS
12 QREG2 99. WATTS
13 QREG3 32. WATTS
14 PFP 1025.1 KPA/CM
15 PFD 265.2 KPA/CM
16 NBEALE 0.00703

VIBRATION
VX1HOR 0.6 CM/S
VY1VER10.9 CM/S

PHASE ANGLES
PADISP 84.2 DEG.
PAPRES -12.0 DEG.

ENGINE SPEED
FREQ 32.0 HZ

REMOTE CALCULATIONS
PWROUT 1290. WATTS
INDPWR 1299. WATTS
PISTST 3.20 CM
DISPST 2.59 CM

DYNAMIC CALCULATIONS
PAMPC 1639. KPA
DISPCP 2.81 CM
PISTCP 2.17 CM
PDYNDB 1650. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/11/84 14:07:18.48 RDG 812

FLUID HELIUM BAROM 14.494 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.03 L/MIN	AMPS1 895. AMPS	PRESUP 7427. KPA	TGEXP 541.0 DEG.C	T01HTR 607.2 DEG.C
	AMPS2 791. AMPS			T02HTR 606.2 DEG.C
TWINDP 17.7 DEG.C	VOLTG 3.70 VOLTS	MEANBP 7014. KPA	TGREGH 530.6 DEG.C	T03HTR 617.1 DEG.C
TDLDP 3.69 DEG.C		MEANCP 7097. KPA	TGREGC 127.5 DEG.C	T04HTR 591.2 DEG.C
TWODPR 22.2 DEG.C			TGCOMP 83.6 DEG.C	T05HTR 596.3 DEG.C
			TGBOUN 42.8 DEG.C	T06HTR 601.3 DEG.C
				T07HTR 559.4 DEG.C
				T08HTR 604.2 DEG.C
				T09HTR 616.8 DEG.C

HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 606.1 DEG.C
FLOCLR 4.51 L/MIN	1 PWRIN 6242. WATTS	VX1HOR 0.7 CM/S	PWROUT 1377. WATTS	T11HTR 598.7 DEG.C
TWINCL 39.9 DEG.C	2 QCOOLR 3840. WATTS	VY1VER11.6 CM/S	INDPWR 1378. WATTS	T12HTR 601.1 DEG.C
TDLCL 12.34 DEG.C	3 QDSHPT 1035. WATTS		PISTST 3.39 CM	
TWOCLR 52.00 DEG.C	4 EXTEFF 22.1 %	PHASE ANGLES	DISPST 2.70 CM	
	5 TAVHTR 600.5 DEG.C	PADISP 83.9 DEG.		T13REG****** DEG.C
	6 INTEFF 26.4 %	PAPRES -11.0 DEG.	DYNAMIC CALCULATIONS	T14REG 499.6 DEG.C
	8 AMPS 1686. AMPS		PAMPC 1762. KPA	T15REG 379.5 DEG.C
	9 QDISPG 3. WATTS	ENGINE SPEED	DISPCP 2.84 CM	T16REG****** DEG.C
	10 QDISP 13. WATTS	FREQ 32.1 HZ	PISTCP 2.04 CM	T17REG 374.0 DEG.C
	11 QREG1 101. WATTS		PDYNDB 1750. KPA	T18REG 378.3 DEG.C
	12 QREG2 98. WATTS		PDLCLR****** KPA	T19REG 253.4 DEG.C
	13 QREG3 31. WATTS		PDLREG****** KPA	
	14 PFP 1040.7 KPA/CM		PDLDIS****** KPA	T03HED****** DEG.C
	15 PFD 251.4 KPA/CM			
	16 NBEALE 0.00702			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 13:57:19.44 RDG 862

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.32 L/MIN	AMPS1 401. AMPS	PRESUP 4030. KPA	TGEXP 557.6 DEG.C	T01HTR 599.7 DEG.C
	AMPS2 468. AMPS			T02HTR 606.4 DEG.C
TWINDP 17.9 DEG.C	VOLTG 1.91 VOLTS	MEANBP 3998. KPA	TGREGH 545.1 DEG.C	T03HTR 603.2 DEG.C
TDLDP 0.85 DEG.C		MEANCP 4026. KPA	TGREGC 79.1 DEG.C	T04HTR 599.0 DEG.C
TWODPR 19.4 DEG.C			TGCOMP 36.8 DEG.C	T05HTR 597.5 DEG.C
			TGBOUN 33.8 DEG.C	T06HTR 602.2 DEG.C
				T07HTR 578.8 DEG.C
				T08HTR 606.1 DEG.C
				T09HTR 607.3 DEG.C

HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 598.6 DEG.C
FLOCLR 4.17 L/MIN	1 PWRIN 1663. WATTS	VX1HOR 0.2 CM/S	PWROUT 355. WATTS	T11HTR 598.4 DEG.C
TWINCL 25.0 DEG.C	2 QCOOLR 915. WATTS	VY1VER 4.4 CM/S	INDPWR 369. WATTS	T12HTR 602.8 DEG.C
TDLCL 3.16 DEG.C	3 QDSHPT 256. WATTS		PISTST 1.82 CM	
TWOCLR 28.66 DEG.C	4 EXTEFF 21.4 %	PHASE ANGLES	DISPST 1.89 CM	
	5 TAVHTR 600.0 DEG.C	PADISP 80.0 DEG.		T13REG****** DEG.C
	6 INTEFF 28.0 %	PAPRES -21.7 DEG.	DYNAMIC CALCULATIONS	T14REG 508.6 DEG.C
	8 AMPS 869. AMPS		PAMPC 541. KPA	T15REG 375.0 DEG.C
	9 QDISPG 3. WATTS	ENGINE SPEED	DISPCP 2.63 CM	T16REG****** DEG.C
	10 QDISP 15. WATTS	FREQ 24.9 HZ	PISTCP 2.50 CM	T17REG 358.6 DEG.C
	11 QREG1 108. WATTS		PDYNDB 625. KPA	T18REG 352.8 DEG.C
	12 QREG2 126. WATTS		PDLCLR****** KPA	T19REG 219.7 DEG.C
	13 QREG3 36. WATTS		PDLREG****** KPA	
	14 PFP 591.7 KPA/CM		PDLDIS****** KPA	T03HED****** DEG.C
	15 PFD 214.5 KPA/CM			
	16 NBEALE 0.00764			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:02:19.44 RDG 863

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.34 L/MIN	AMPS1 424. AMPS	PRESUP 4033. KPA	TGEXP 554.9 DEG.C	T01HTR 599.6 DEG.C
	AMPS2 486. AMPS			T02HTR 605.6 DEG.C
TWINDP 17.9 DEG.C	VOLTG 2.00 VOLTS	MEANBP 4004. KPA	TGREGH 543.1 DEG.C	T03HTR 602.9 DEG.C
TDLDP 0.90 DEG.C		MEANCP 4036. KPA	TGREGC 79.7 DEG.C	T04HTR 597.2 DEG.C
TWODPR 19.4 DEG.C			TGCOMP 37.6 DEG.C	T05HTR 597.4 DEG.C
			TGBOUN 33.4 DEG.C	T06HTR 601.3 DEG.C
				T07HTR 577.5 DEG.C
				T08HTR 604.4 DEG.C
				T09HTR 606.8 DEG.C

HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 598.5 DEG.C
FLOCLR 4.16 L/MIN	1 PWRIN 1821. WATTS	VX1HOR 0.2 CM/S	PWROUT 405. WATTS	T11HTR 597.4 DEG.C
TWINCL 24.8 DEG.C	2 QCOOLR 987. WATTS	VY1VER 4.7 CM/S	INDPWR 424. WATTS	T12HTR 601.8 DEG.C
TDLCL 3.42 DEG.C	3 QDSHPT 272. WATTS		PISTST 1.99 CM	
TWOCLR 28.77 DEG.C	4 EXTEFF 22.3 %	PHASE ANGLES	DISPST 2.01 CM	
	5 TAVHTR 599.2 DEG.C	PADISP 80.8 DEG.		T13REG****** DEG.C
	6 INTEFF 29.1 %	PAPRES -20.9 DEG.	DYNAMIC CALCULATIONS	T14REG 509.0 DEG.C
	8 AMPS 910. AMPS		PAMPC 600. KPA	T15REG 377.1 DEG.C
	9 QDISPG 3. WATTS	ENGINE SPEED	DISPCP 2.64 CM	T16REG****** DEG.C
	10 QDISP 15. WATTS	FREQ 24.8 HZ	PISTCP 2.56 CM	T17REG 357.9 DEG.C
	11 QREG1 107. WATTS		PDYNDB 664. KPA	T18REG 352.6 DEG.C
	12 QREG2 127. WATTS		PDLCLR****** KPA	T19REG 220.9 DEG.C
	13 QREG3 36. WATTS		PDLREG****** KPA	
	14 PFP 599.7 KPA/CM		PDLDIS****** KPA	T03HED****** DEG.C
	15 PFD 215.8 KPA/CM			
	16 NBEALE 0.00800			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:07:19.44 RDG 864

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.33 L/MIN
TWINDP 17.9 DEG.C
TDLDP 0.99 DEG.C
TWODPR 19.6 DEG.C

POWER IN
AMPS1 448. AMPS
AMPS2 504. AMPS
VOLTG 2.10 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 4036. KPA
MEANBP 4009. KPA
MEANCP 4044. KPA

GAS TEMPERATURES
TGEXP 551.9 DEG.C
TGREGH 541.5 DEG.C
TGREGC 81.1 DEG.C
TGCOMP 39.2 DEG.C
TGBOUN 33.5 DEG.C

SURFACE TEMPERATURE
T01HTR 600.5 DEG.C
T02HTR 605.3 DEG.C
T03HTR 604.0 DEG.C
T04HTR 596.5 DEG.C
T05HTR 597.8 DEG.C
T06HTR 601.2 DEG.C
T07HTR 576.8 DEG.C
T08HTR 603.4 DEG.C
T09HTR 607.4 DEG.C
T10HTR 599.3 DEG.C
T11HTR 597.1 DEG.C
T12HTR 601.3 DEG.C
T13REG****** DEG.C
T14REG 508.2 DEG.C
T15REG 376.7 DEG.C
T16REG****** DEG.C
T17REG 358.4 DEG.C
T18REG 353.4 DEG.C
T19REG 221.9 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.17 L/MIN
TWINCL 24.8 DEG.C
TDLCL 3.84 DEG.C
TWOCLR 29.15 DEG.C

CALCULATED PARAMETERS
1 PWRIN 1999. WATTS
2 QCOOLR 1111. WATTS
3 QDSHPT 299. WATTS
4 EXTEFF 22.5 %
5 TAVHTR 599.2 DEG.C
6 INTEFF 28.8 %
8 AMPS 953. AMPS
9 QDISPG 3. WATTS
10 QDISP 15. WATTS
11 QREG1 107. WATTS
12 QREG2 126. WATTS
13 QREG3 36. WATTS
14 PFP 592.3 KPA/CM
15 PFD 209.2 KPA/CM
16 NBEALE 0.00821

VIBRATION
VX1HOR 0.2 CM/S
VY1VER 5.1 CM/S

PHASE ANGLES
PADISP 81.0 DEG.
PAPRES -20.0 DEG.

ENGINE SPEED
FREQ 24.7 HZ

REMOTE CALCULATIONS
PWROUT 449. WATTS
INDPWR 471. WATTS
PISTST 2.15 CM
DISPST 2.12 CM

DYNAMIC CALCULATIONS
PAMPC 640. KPA
DISPCP 2.67 CM
PISTCP 2.58 CM
PDYNDB 738. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:12:19.44 RDG 865

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.34 L/MIN
TWINDP 17.9 DEG.C
TDLDP 1.20 DEG.C
TWODPR 19.7 DEG.C

POWER IN
AMPS1 479. AMPS
AMPS2 526. AMPS
VOLTG 2.21 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 4040. KPA
MEANBP 4014. KPA
MEANCP 4053. KPA

GAS TEMPERATURES
TGEXP 550.7 DEG.C
TGREGH 540.3 DEG.C
TGREGC 82.5 DEG.C
TGCOMP 41.1 DEG.C
TGBOUN 33.7 DEG.C

SURFACE TEMPERATURE
T01HTR 601.4 DEG.C
T02HTR 605.3 DEG.C
T03HTR 604.8 DEG.C
T04HTR 596.0 DEG.C
T05HTR 598.4 DEG.C
T06HTR 600.9 DEG.C
T07HTR 576.5 DEG.C
T08HTR 602.3 DEG.C
T09HTR 608.6 DEG.C
T10HTR 600.2 DEG.C
T11HTR 597.2 DEG.C
T12HTR 600.7 DEG.C
T13REG****** DEG.C
T14REG 508.3 DEG.C
T15REG 376.6 DEG.C
T16REG****** DEG.C
T17REG 357.3 DEG.C
T18REG 351.2 DEG.C
T19REG 222.8 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.16 L/MIN
TWINCL 24.7 DEG.C
TDLCL 4.25 DEG.C
TWOCLR 29.61 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2225. WATTS
2 QCOOLR 1228. WATTS
3 QDSHPT 363. WATTS
4 EXTEFF 23.2 %
5 TAVHTR 599.4 DEG.C
6 INTEFF 29.6 %
8 AMPS 1005. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 104. WATTS
12 QREG2 127. WATTS
13 QREG3 35. WATTS
14 PFP 583.6 KPA/CM
15 PFD 199.7 KPA/CM
16 NBEALE 0.00849

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 5.6 CM/S

PHASE ANGLES
PADISP 81.9 DEG.
PAPRES -18.8 DEG.

ENGINE SPEED
FREQ 24.6 HZ

REMOTE CALCULATIONS
PWROUT 516. WATTS
INDPWR 547. WATTS
PISTST 2.39 CM
DISPST 2.30 CM

DYNAMIC CALCULATIONS
PAMPC 704. KPA
DISPCP 2.63 CM
PISTCP 2.61 CM
PDYNDB 807. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:17:19.44 RDG 866

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.33 L/MIN
TWINDP 17.9 DEG.C
TDLDP 1.27 DEG.C
TWODPR 19.8 DEG.C

POWER IN
AMPS1 500. AMPS
AMPS2 545. AMPS
VOLTG 2.30 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 4055. KPA
MEANBP 4008. KPA
MEANCP 4049. KPA

GAS TEMPERATURES
TGEXP 549.3 DEG.C
TGREGH 539.7 DEG.C
TGREGC 84.1 DEG.C
TGCOMP 42.9 DEG.C
TGBOUN 34.1 DEG.C

SURFACE TEMPERATURE
T01HTR 602.6 DEG.C
T02HTR 606.2 DEG.C
T03HTR 606.7 DEG.C
T04HTR 596.4 DEG.C
T05HTR 600.2 DEG.C
T06HTR 601.0 DEG.C
T07HTR 577.2 DEG.C
T08HTR 602.1 DEG.C
T09HTR 610.3 DEG.C
T10HTR 601.5 DEG.C
T11HTR 598.0 DEG.C
T12HTR 601.3 DEG.C
T13REG****** DEG.C
T14REG 508.9 DEG.C
T15REG 377.5 DEG.C
T16REG****** DEG.C
T17REG 357.0 DEG.C
T18REG 350.7 DEG.C
T19REG 224.4 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.18 L/MIN
TWINCL 24.9 DEG.C
TDLCL 4.70 DEG.C
TWOCLR 30.07 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2408. WATTS
2 QCOOLR 1362. WATTS
3 QDSHPT 383. WATTS
4 EXTEFF 23.8 %
5 TAVHTR 600.3 DEG.C
6 INTEFF 29.6 %
8 AMPS 1045. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 102. WATTS
12 QREG2 128. WATTS
13 QREG3 35. WATTS
14 PFP 579.0 KPA/CM
15 PFD 196.5 KPA/CM
16 NBEALE 0.00877

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 6.0 CM/S

PHASE ANGLES
PADISP 81.4 DEG.
PAPRES -18.3 DEG.

ENGINE SPEED
FREQ 24.4 HZ

REMOTE CALCULATIONS
PWROUT 572. WATTS
INDPWR 607. WATTS
PISTST 2.59 CM
DISPST 2.43 CM

DYNAMIC CALCULATIONS
PAMPC 753. KPA
DISPCP 2.64 CM
PISTCP 2.63 CM
PDYNDB 850. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:22:19.44 RDG 867

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES
FLODP	4.34 L/MIN	AMPS1	526. AMPS	PRESUP	4050. KPA	TGEXP	545.6 DEG.C	T01HTR 602.7 DEG.C
		AMPS2	563. AMPS					T02HTR 604.9 DEG.C
TWINDP	17.9 DEG.C	VOLTG	2.40 VOLTS	MEANBP	3997. KPA	TGREGH	537.7 DEG.C	T03HTR 606.9 DEG.C
TDLDP	1.39 DEG.C			MEANCP	4045. KPA	TGREGC	85.7 DEG.C	T04HTR 595.0 DEG.C
TWODPR	20.0 DEG.C					TGCOMP	45.2 DEG.C	T05HTR 599.7 DEG.C
						TGBOUN	34.8 DEG.C	T06HTR 599.9 DEG.C
								T07HTR 575.8 DEG.C
								T08HTR 600.1 DEG.C
								T09HTR 610.4 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR 601.5 DEG.C
FLOCLR	4.17 L/MIN	1 PWRIN	2617. WATTS	VX1HOR	0.3 CM/S	PWROUT	629. WATTS	T11HTR 596.9 DEG.C
TWINCL	24.9 DEG.C	2 QCOOLR	1507. WATTS	VY1VER	6.5 CM/S	INDPWR	668. WATTS	T12HTR 599.7 DEG.C
TDLCL	5.21 DEG.C	3 QDSHPT	420. WATTS			PISTST	2.80 CM	
TWOCLR	30.65 DEG.C	4 EXTEFF	24.0 %	PHASE ANGLES		DISPST	2.57 CM	
		5 TAVHTR	599.5 DEG.C	PADISP	81.5 DEG.			T13REG****** DEG.C
		6 INTEFF	29.4 %	PAPRES	-17.4 DEG.	DYNAMIC CALCULATIONS		T14REG 507.4 DEG.C
		8 AMPS	1090. AMPS			PAMPC	817. KPA	T15REG 376.9 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.67 CM	T16REG****** DEG.C
		10 QDISP	14. WATTS	FREQ	24.3 HZ	PISTCP	2.68 CM	T17REG 356.9 DEG.C
		11 QREG1	102. WATTS			PDYNDB	888. KPA	T18REG 350.4 DEG.C
		12 QREG2	127. WATTS			PDLCLR****** KPA		T19REG 225.2 DEG.C
		13 QREG3	35. WATTS			PDLREG****** KPA		
		14 PFP	583.2 KPA/CM			PDLDIS****** KPA		T03HED****** DEG.C
		15 PFD	192.6 KPA/CM					
		16 NBEALE	0.00900					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:27:19.44 RDG 868

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES
FLODP	4.34 L/MIN	AMPS1	552. AMPS	PRESUP	4050. KPA	TGEXP	542.4 DEG.C	T01HTR 602.9 DEG.C
		AMPS2	582. AMPS					T02HTR 603.4 DEG.C
TWINDP	17.9 DEG.C	VOLTG	2.50 VOLTS	MEANBP	3993. KPA	TGREGH	536.1 DEG.C	T03HTR 607.4 DEG.C
TDLDP	1.59 DEG.C			MEANCP	4043. KPA	TGREGC	87.5 DEG.C	T04HTR 593.6 DEG.C
TWODPR	20.2 DEG.C					TGCOMP	47.4 DEG.C	T05HTR 598.9 DEG.C
						TGBOUN	35.6 DEG.C	T06HTR 599.2 DEG.C
								T07HTR 574.0 DEG.C
								T08HTR 598.7 DEG.C
								T09HTR 610.4 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR 601.8 DEG.C
FLOCLR	4.17 L/MIN	1 PWRIN	2836. WATTS	VX1HOR	0.3 CM/S	PWROUT	683. WATTS	T11HTR 596.2 DEG.C
TWINCL	25.0 DEG.C	2 QCOOLR	1631. WATTS	VY1VER	6.9 CM/S	INDPWR	727. WATTS	T12HTR 597.9 DEG.C
TDLCL	5.64 DEG.C	3 QDSHPT	480. WATTS			PISTST	2.99 CM	
TWOCLR	31.16 DEG.C	4 EXTEFF	24.1 %	PHASE ANGLES		DISPST	2.70 CM	
		5 TAVHTR	598.7 DEG.C	PADISP	82.0 DEG.			T13REG****** DEG.C
		6 INTEFF	29.5 %	PAPRES	-16.6 DEG.	DYNAMIC CALCULATIONS		T14REG 504.7 DEG.C
		8 AMPS	1134. AMPS			PAMPC	866. KPA	T15REG 375.3 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.73 CM	T16REG****** DEG.C
		10 QDISP	14. WATTS	FREQ	24.2 HZ	PISTCP	2.69 CM	T17REG 356.8 DEG.C
		11 QREG1	101. WATTS			PDYNDB	938. KPA	T18REG 350.9 DEG.C
		12 QREG2	125. WATTS			PDLCLR****** KPA		T19REG 225.8 DEG.C
		13 QREG3	35. WATTS			PDLREG****** KPA		
		14 PFP	577.9 KPA/CM			PDLDIS****** KPA		T03HED****** DEG.C
		15 PFD	184.9 KPA/CM					
		16 NBEALE	0.00918					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:32:19.46 RDG 869

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES
FLODP	4.33 L/MIN	AMPS1	580. AMPS	PRESUP	4043. KPA	TGEXP	539.8 DEG.C	T01HTR 604.4 DEG.C
		AMPS2	603. AMPS					T02HTR 601.7 DEG.C
TWINDP	17.9 DEG.C	VOLTG	2.61 VOLTS	MEANBP	4004. KPA	TGREGH	535.1 DEG.C	T03HTR 608.6 DEG.C
TDLDP	1.73 DEG.C			MEANCP	4058. KPA	TGREGC	89.0 DEG.C	T04HTR 591.6 DEG.C
TWODPR	20.3 DEG.C					TGCOMP	50.1 DEG.C	T05HTR 597.9 DEG.C
						TGBOUN	36.7 DEG.C	T06HTR 599.1 DEG.C
								T07HTR 571.7 DEG.C
								T08HTR 597.1 DEG.C
								T09HTR 610.2 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR 603.4 DEG.C
FLOCLR	4.18 L/MIN	1 PWRIN	3088. WATTS	VX1HOR	0.3 CM/S	PWROUT	749. WATTS	T11HTR 595.8 DEG.C
TWINCL	25.1 DEG.C	2 QCOOLR	1814. WATTS	VY1VER	7.3 CM/S	INDPWR	797. WATTS	T12HTR 595.9 DEG.C
TDLCL	6.25 DEG.C	3 QDSHPT	522. WATTS			PISTST	3.17 CM	
TWOCLR	31.89 DEG.C	4 EXTEFF	24.3 %	PHASE ANGLES		DISPST	2.74 CM	
		5 TAVHTR	598.1 DEG.C	PADISP	83.1 DEG.			T13REG****** DEG.C
		6 INTEFF	29.2 %	PAPRES	-15.9 DEG.	DYNAMIC CALCULATIONS		T14REG 502.7 DEG.C
		8 AMPS	1183. AMPS			PAMPC	930. KPA	T15REG 374.4 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.80 CM	T16REG****** DEG.C
		10 QDISP	14. WATTS	FREQ	24.3 HZ	PISTCP	2.75 CM	T17REG 359.6 DEG.C
		11 QREG1	104. WATTS			PDYNDB	1013. KPA	T18REG 355.3 DEG.C
		12 QREG2	120. WATTS			PDLCLR****** KPA		T19REG 226.8 DEG.C
		13 QREG3	35. WATTS			PDLREG****** KPA		
		14 PFP	583.7 KPA/CM			PDLDIS****** KPA		T03HED****** DEG.C
		15 PFD	187.4 KPA/CM					
		16 NBEALE	0.00947					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:42:19.46 RDG 870

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.31 L/MIN
TWINDP 17.9 DEG.C
TDLDP 1.23 DEG.C
TWODPR 19.8 DEG.C

POWER IN
AMPS1 470. AMPS
AMPS2 519. AMPS
VOLTG 2.18 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 5524. KPA
MEANBP 5492. KPA
MEANCP 5529. KPA

GAS TEMPERATURES
TGEXP 560.7 DEG.C
TGREGH 542.5 DEG.C
TGREGC 88.0 DEG.C
TGCOMP 40.3 DEG.C
TGBOUN 35.2 DEG.C

SURFACE TEMPERATUR
T01HTR 598.8 DEG.
T02HTR 607.4 DEG.
T03HTR 603.2 DEG.
T04HTR 597.9 DEG.
T05HTR 597.0 DEG.
T06HTR 600.3 DEG.
T07HTR 576.4 DEG.
T08HTR 604.5 DEG.
T09HTR 608.9 DEG.
T10HTR 597.6 DEG.
T11HTR 596.7 DEG.
T12HTR 602.5 DEG.
T13REG****** DEG.
T14REG 508.9 DEG.
T15REG 376.9 DEG.
T16REG****** DEG.
T17REG 357.0 DEG.
T18REG 353.7 DEG.
T19REG 226.2 DEG.
T03HED****** DEG.

HEAT TO COOLER
FLOCLR 4.18 L/MIN
TWINCL 25.0 DEG.C
TDLCL 4.37 DEG.C
TWOCLR 29.94 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2152. WATTS
2 QCOOLR 1268. WATTS
3 QDSHPT 368. WATTS
4 EXTEFF 22.3 %
5 TAVHTR 599.3 DEG.C
6 INTEFF 27.4 %
8 AMPS 989. AMPS
9 QDISPG 3. WATTS
10 QDISP 15. WATTS
11 QREG1 103. WATTS
12 QREG2 126. WATTS
13 QREG3 35. WATTS
14 PFP 819.1 KPA/CM
15 PFD 286.5 KPA/CM
16 NBEALE 0.00662

VIBRATION
VX1HOR 0.2 CM/S
VY1VER 5.2 CM/S

PHASE ANGLES
PADISP 80.8 DEG.
PAPRES -19.9 DEG.

ENGINE SPEED
FREQ 28.8 HZ

REMOTE CALCULATIONS
PWROUT 479. WATTS
INDPWR 513. WATTS
PISTST 1.78 CM
DISPST 1.77 CM

DYNAMIC CALCULATIONS
PAMPC 733. KPA
DISPCP 2.60 CM
PISTCP 2.48 CM
PDYNDB 825. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:47:25.51 RDG 871

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.30 L/MIN
TWINDP 18.0 DEG.C
TDLDP 1.42 DEG.C
TWODPR 20.0 DEG.C

POWER IN
AMPS1 508. AMPS
AMPS2 548. AMPS
VOLTG 2.33 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 5533. KPA
MEANBP 5503. KPA
MEANCP 5543. KPA

GAS TEMPERATURES
TGEXP 557.4 DEG.C
TGREGH 540.7 DEG.C
TGREGC 90.0 DEG.C
TGCOMP 42.5 DEG.C
TGBOUN 35.2 DEG.C

SURFACE TEMPERATUR
T01HTR 599.0 DEG.
T02HTR 606.3 DEG.
T03HTR 603.6 DEG.
T04HTR 596.4 DEG.
T05HTR 596.6 DEG.
T06HTR 599.5 DEG.
T07HTR 574.2 DEG.
T08HTR 603.6 DEG.
T09HTR 609.2 DEG.
T10HTR 597.7 DEG.
T11HTR 596.6 DEG.
T12HTR 600.9 DEG.
T13REG****** DEG.
T14REG 506.5 DEG.
T15REG 375.4 DEG.
T16REG****** DEG.
T17REG 357.0 DEG.
T18REG 352.1 DEG.
T19REG 226.3 DEG.
T03HED****** DEG.

HEAT TO COOLER
FLOCLR 4.17 L/MIN
TWINCL 24.9 DEG.C
TDLCL 4.93 DEG.C
TWOCLR 30.43 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2455. WATTS
2 QCOOLR 1427. WATTS
3 QDSHPT 425. WATTS
4 EXTEFF 23.0 %
5 TAVHTR 598.6 DEG.C
6 INTEFF 28.4 %
8 AMPS 1056. AMPS
9 QDISPG 3. WATTS
10 QDISP 15. WATTS
11 QREG1 102. WATTS
12 QREG2 125. WATTS
13 QREG3 35. WATTS
14 PFP 805.7 KPA/CM
15 PFD 276.0 KPA/CM
16 NBEALE 0.00699

VIBRATION
VX1HOR 0.2 CM/S
VY1VER 5.9 CM/S

PHASE ANGLES
PADISP 82.0 DEG.
PAPRES -18.9 DEG.

ENGINE SPEED
FREQ 28.8 HZ

REMOTE CALCULATIONS
PWROUT 566. WATTS
INDPWR 604. WATTS
PISTST 1.99 CM
DISPST 1.91 CM

DYNAMIC CALCULATIONS
PAMPC 807. KPA
DISPCP 2.61 CM
PISTCP 2.51 CM
PDYNDB 913. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:52:19.51 RDG 872

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.33 L/MIN
TWINDP 18.0 DEG.C
TDLDP 1.54 DEG.C
TWODPR 20.2 DEG.C

POWER IN
AMPS1 544. AMPS
AMPS2 576. AMPS
VOLTG 2.47 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 5918. KPA
MEANBP 5502. KPA
MEANCP 5549. KPA

GAS TEMPERATURES
TGEXP 555.5 DEG.C
TGREGH 539.7 DEG.C
TGREGC 91.9 DEG.C
TGCOMP 45.1 DEG.C
TGBOUN 35.5 DEG.C

SURFACE TEMPERATUR
T01HTR 600.6 DEG.
T02HTR 606.9 DEG.
T03HTR 606.2 DEG.
T04HTR 596.3 DEG.
T05HTR 597.6 DEG.
T06HTR 599.9 DEG.
T07HTR 573.6 DEG.
T08HTR 603.6 DEG.
T09HTR 610.7 DEG.
T10HTR 599.5 DEG.
T11HTR 597.3 DEG.
T12HTR 601.3 DEG.
T13REG****** DEG.
T14REG 506.2 DEG.
T15REG 375.3 DEG.
T16REG****** DEG.
T17REG 358.2 DEG.
T18REG 354.7 DEG.
T19REG 228.1 DEG.
T03HED****** DEG.

HEAT TO COOLER
FLOCLR 4.16 L/MIN
TWINCL 24.9 DEG.C
TDLCL 5.63 DEG.C
TWOCLR 31.12 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2767. WATTS
2 QCOOLR 1625. WATTS
3 QDSHPT 465. WATTS
4 EXTEFF 23.6 %
5 TAVHTR 599.4 DEG.C
6 INTEFF 28.7 %
8 AMPS 1120. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 103. WATTS
12 QREG2 123. WATTS
13 QREG3 35. WATTS
14 PFP 813.2 KPA/CM
15 PFD 272.7 KPA/CM
16 NBEALE 0.00733

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 6.6 CM/S

PHASE ANGLES
PADISP 83.0 DEG.
PAPRES -17.9 DEG.

ENGINE SPEED
FREQ 28.8 HZ

REMOTE CALCULATIONS
PWROUT 654. WATTS
INDPWR 694. WATTS
PISTST 2.19 CM
DISPST 2.05 CM

DYNAMIC CALCULATIONS
PAMPC 901. KPA
DISPCP 2.65 CM
PISTCP 2.53 CM
PDYNDB 1000. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:57:19.51 RDG 873

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

T TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
LODP 4.32 L/MIN	AMPS1 579. AMPS	PRESUP 5700. KPA	TGEXP 553.0 DEG.C	T01HTR 601.3 DEG.C
	AMPS2 601. AMPS			T02HTR 606.6 DEG.C
WINDP 18.0 DEG.C	VOLTG 2.60 VOLTS	MEANBP 5504. KPA	TGREGH 538.3 DEG.C	T03HTR 607.7 DEG.C
DLDP 1.74 DEG.C		MEANCP 5553. KPA	TGREGC 93.4 DEG.C	T04HTR 595.5 DEG.C
WODPR 20.4 DEG.C			TGCOMP 47.8 DEG.C	T05HTR 597.8 DEG.C
			TGBOUN 36.2 DEG.C	T06HTR 599.6 DEG.C
				T07HTR 572.5 DEG.C
				T08HTR 603.0 DEG.C
				T09HTR 611.2 DEG.C

T TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 600.4 DEG.C
LOCLR 4.20 L/MIN	1 PWRIN 3068. WATTS	VX1HOR 0.3 CM/S	PWROUT 735. WATTS	T11HTR 597.3 DEG.C
WINCL 25.1 DEG.C	2 QCOOLR 1834. WATTS	VY1VER 7.2 CM/S	INDPWR 780. WATTS	T12HTR 601.1 DEG.C
DLCL 6.30 DEG.C	3 QDSHPT 522. WATTS		PISTST 2.39 CM	
WOCLR 31.83 DEG.C	4 EXTEFF 24.0 %	PHASE ANGLES	DISPST 2.17 CM	
	5 TAVHTR 599.5 DEG.C	PADISP 83.7 DEG.		T13REG****** DEG.C
	6 INTEFF 28.6 %	PAPRES -16.9 DEG.	DYNAMIC CALCULATIONS	T14REG 505.8 DEG.C
	8 AMPS 1180. AMPS		PAMPC 974. KPA	T15REG 373.5 DEG.C
	9 QDISPG 3. WATTS	ENGINE SPEED	DISPCP 2.69 CM	T16REG****** DEG.C
	10 QDISP 14. WATTS	FREQ 28.7 HZ	PISTCP 2.57 CM	T17REG 359.0 DEG.C
	11 QREG1 103. WATTS		PDYNDB 1088. KPA	T18REG 356.5 DEG.C
	12 QREG2 121. WATTS		PDLCLR****** KPA	T19REG 229.0 DEG.C
	13 QREG3 34. WATTS		PDLREG****** KPA	
	14 PFP 805.5 KPA/CM		PDLDIS****** KPA	T03HED****** DEG.C
	15 PFD 262.4 KPA/CM			
	16 NBEALE 0.00756			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 15:02:19.51 RDG 874

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

T TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
LODP 4.29 L/MIN	AMPS1 615. AMPS	PRESUP 5643. KPA	TGEXP 549.9 DEG.C	T01HTR 601.5 DEG.C
	AMPS2 629. AMPS			T02HTR 605.9 DEG.C
WINDP 18.0 DEG.C	VOLTG 2.74 VOLTS	MEANBP 5508. KPA	TGREGH 535.7 DEG.C	T03HTR 608.8 DEG.C
DLDP 1.97 DEG.C		MEANCP 5565. KPA	TGREGC 96.1 DEG.C	T04HTR 594.5 DEG.C
WODPR 20.6 DEG.C			TGCOMP 50.8 DEG.C	T05HTR 598.1 DEG.C
			TGBOUN 37.1 DEG.C	T06HTR 598.8 DEG.C
				T07HTR 571.0 DEG.C
				T08HTR 601.4 DEG.C
				T09HTR 611.9 DEG.C

T TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 600.8 DEG.C
LOCLR 4.20 L/MIN	1 PWRIN 3407. WATTS	VX1HOR 0.3 CM/S	PWROUT 817. WATTS	T11HTR 596.3 DEG.C
WINCL 25.1 DEG.C	2 QCOOLR 2041. WATTS	VY1VER 7.9 CM/S	INDPWR 868. WATTS	T12HTR 600.1 DEG.C
DLCL 7.01 DEG.C	3 QDSHPT 588. WATTS		PISTST 2.61 CM	
WOCLR 32.72 DEG.C	4 EXTEFF 24.0 %	PHASE ANGLES	DISPST 2.31 CM	
	5 TAVHTR 599.1 DEG.C	PADISP 84.2 DEG.		T13REG****** DEG.C
	6 INTEFF 28.6 %	PAPRES -15.9 DEG.	DYNAMIC CALCULATIONS	T14REG 505.0 DEG.C
	8 AMPS 1243. AMPS		PAMPC 1063. KPA	T15REG 374.9 DEG.C
	9 QDISPG 3. WATTS	ENGINE SPEED	DISPCP 2.71 CM	T16REG****** DEG.C
	10 QDISP 14. WATTS	FREQ 28.7 HZ	PISTCP 2.58 CM	T17REG 359.3 DEG.C
	11 QREG1 102. WATTS		PDYNDB 1138. KPA	T18REG 357.7 DEG.C
	12 QREG2 119. WATTS		PDLCLR****** KPA	T19REG 232.3 DEG.C
	13 QREG3 34. WATTS		PDLREG****** KPA	
	14 PFP 807.0 KPA/CM		PDLDIS****** KPA	T03HED****** DEG.C
	15 PFD 253.5 KPA/CM			
	16 NBEALE 0.00773			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 15:07:19.52 RDG 875

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

T TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
LODP 4.30 L/MIN	AMPS1 649. AMPS	PRESUP 5623. KPA	TGEXP 547.9 DEG.C	T01HTR 602.4 DEG.C
	AMPS2 651. AMPS			T02HTR 606.0 DEG.C
WINDP 18.0 DEG.C	VOLTG 2.86 VOLTS	MEANBP 5500. KPA	TGREGH 535.2 DEG.C	T03HTR 610.2 DEG.C
DLDP 2.18 DEG.C		MEANCP 5562. KPA	TGREGC 98.1 DEG.C	T04HTR 594.5 DEG.C
WODPR 20.8 DEG.C			TGCOMP 54.0 DEG.C	T05HTR 599.1 DEG.C
			TGBOUN 38.5 DEG.C	T06HTR 599.1 DEG.C
				T07HTR 570.5 DEG.C
				T08HTR 601.9 DEG.C
				T09HTR 613.4 DEG.C

T TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 601.8 DEG.C
LOCLR 4.19 L/MIN	1 PWRIN 3721. WATTS	VX1HOR 0.3 CM/S	PWROUT 893. WATTS	T11HTR 597.3 DEG.C
WINCL 25.2 DEG.C	2 QCOOLR 2244. WATTS	VY1VER 8.5 CM/S	INDPWR 947. WATTS	T12HTR 600.4 DEG.C
DLCL 7.72 DEG.C	3 QDSHPT 652. WATTS		PISTST 2.79 CM	
WOCLR 33.35 DEG.C	4 EXTEFF 24.0 %	PHASE ANGLES	DISPST 2.43 CM	
	5 TAVHTR 599.7 DEG.C	PADISP 84.1 DEG.		T13REG****** DEG.C
	6 INTEFF 28.5 %	PAPRES -15.3 DEG.	DYNAMIC CALCULATIONS	T14REG 505.3 DEG.C
	8 AMPS 1301. AMPS		PAMPC 1142. KPA	T15REG 376.4 DEG.C
	9 QDISPG 3. WATTS	ENGINE SPEED	DISPCP 2.74 CM	T16REG****** DEG.C
	10 QDISP 14. WATTS	FREQ 28.6 HZ	PISTCP 2.59 CM	T17REG 359.4 DEG.C
	11 QREG1 100. WATTS		PDYNDB 1225. KPA	T18REG 357.9 DEG.C
	12 QREG2 120. WATTS		PDLCLR****** KPA	T19REG 234.3 DEG.C
	13 QREG3 34. WATTS		PDLREG****** KPA	
	14 PFP 811.8 KPA/CM		PDLDIS****** KPA	T03HED****** DEG.C
	15 PFD 249.2 KPA/CM			
	16 NBEALE 0.00793			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 15:12:19.57 RDG 876

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.29 L/MIN
TWINDP 18.0 DEG.C
TDLDP 2.44 DEG.C
TWODPR 21.1 DEG.C

POWER IN
AMPS1 678. AMPS
AMPS2 673. AMPS
VOLTG 2.97 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 5655. KPA
MEANBP 5515. KPA
MEANCP 5587. KPA

GAS TEMPERATURES
TGEXP 544.3 DEG.C
TGREGH 534.2 DEG.C
TGREGC 101.1 DEG.C
TGCOMP 57.5 DEG.C
TGBOUN 39.8 DEG.C

SURFACE TEMPERATURES
T01HTR 603.1 DEG.C
T02HTR 604.9 DEG.C
T03HTR 610.5 DEG.C
T04HTR 593.5 DEG.C
T05HTR 598.7 DEG.C
T06HTR 598.3 DEG.C
T07HTR 569.2 DEG.C
T08HTR 601.1 DEG.C
T09HTR 614.2 DEG.C
T10HTR 602.4 DEG.C
T11HTR 597.6 DEG.C
T12HTR 598.7 DEG.C
T13REG****** DEG.C
T14REG 503.6 DEG.C
T15REG 375.5 DEG.C
T16REG****** DEG.C
T17REG 363.4 DEG.C
T18REG 359.0 DEG.C
T19REG 235.8 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.20 L/MIN
TWINCL 25.2 DEG.C
TDLCL 8.49 DEG.C
TWOCLR 34.20 DEG.C

CALCULATED PARAMETERS
1 PWRIN 4017. WATTS
2 QCOOLR 2473. WATTS
3 QDSHPT 729. WATTS
4 EXTEFF 24.0 %
5 TAVHTR 599.3 DEG.C
6 INTEFF 28.1 %
8 AMPS 1351. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 100. WATTS
12 QREG2 117. WATTS
13 QREG3 34. WATTS
14 PFP 809.8 KPA/CM
15 PFD 240.9 KPA/CM
16 NBEALE 0.00802

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 9.0 CM/S

PHASE ANGLES
PADISP 82.7 DEG.
PAPRES -14.6 DEG.

ENGINE SPEED
FREQ 28.4 HZ

REMOTE CALCULATIONS
PWROUT 965. WATTS
INDPWR 1019. WATTS
PISTST 2.99 CM
DISPST 2.55 CM

DYNAMIC CALCULATIONS
PAMPC 1211. KPA
DISPCP 2.79 CM
PISTCP 2.56 CM
PDYNDB 1263. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 15:17:19.57 RDG 877

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.27 L/MIN
TWINDP 18.0 DEG.C
TDLDP 2.67 DEG.C
TWODPR 21.4 DEG.C

POWER IN
AMPS1 710. AMPS
AMPS2 698. AMPS
VOLTG 3.10 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 5643. KPA
MEANBP 5502. KPA
MEANCP 5583. KPA

GAS TEMPERATURES
TGEXP 541.6 DEG.C
TGREGH 534.2 DEG.C
TGREGC 104.1 DEG.C
TGCOMP 60.3 DEG.C
TGBOUN 41.3 DEG.C

SURFACE TEMPERATURES
T01HTR 605.2 DEG.C
T02HTR 602.6 DEG.C
T03HTR 611.6 DEG.C
T04HTR 591.6 DEG.C
T05HTR 596.5 DEG.C
T06HTR 599.2 DEG.C
T07HTR 565.8 DEG.C
T08HTR 601.7 DEG.C
T09HTR 613.7 DEG.C
T10HTR 604.1 DEG.C
T11HTR 598.4 DEG.C
T12HTR 596.9 DEG.C
T13REG****** DEG.C
T14REG 499.6 DEG.C
T15REG 371.9 DEG.C
T16REG****** DEG.C
T17REG 367.7 DEG.C
T18REG 363.3 DEG.C
T19REG 235.4 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.21 L/MIN
TWINCL 25.3 DEG.C
TDLCL 9.38 DEG.C
TWOCLR 35.17 DEG.C

CALCULATED PARAMETERS
1 PWRIN 4369. WATTS
2 QCOOLR 2740. WATTS
3 QDSHPT 792. WATTS
4 EXTEFF 24.0 %
5 TAVHTR 598.9 DEG.C
6 INTEFF 27.7 %
8 AMPS 1408. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 104. WATTS
12 QREG2 111. WATTS
13 QREG3 33. WATTS
14 PFP 811.9 KPA/CM
15 PFD 240.9 KPA/CM
16 NBEALE 0.00817

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 9.7 CM/S

PHASE ANGLES
PADISP 84.0 DEG.
PAPRES -13.7 DEG.

ENGINE SPEED
FREQ 28.4 HZ

REMOTE CALCULATIONS
PWROUT 1049. WATTS
INDPWR 1101. WATTS
PISTST 3.20 CM
DISPST 2.58 CM

DYNAMIC CALCULATIONS
PAMPC 1304. KPA
DISPCP 2.83 CM
PISTCP 2.53 CM
PDYNDB 1338. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 15:22:19.57 RDG 878

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.26 L/MIN
TWINDP 17.9 DEG.C
TDLDP 2.93 DEG.C
TWODPR 21.6 DEG.C

POWER IN
AMPS1 739. AMPS
AMPS2 720. AMPS
VOLTG 3.22 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 5619. KPA
MEANBP 5511. KPA
MEANCP 5595. KPA

GAS TEMPERATURES
TGEXP 540.1 DEG.C
TGREGH 533.9 DEG.C
TGREGC 106.2 DEG.C
TGCOMP 63.7 DEG.C
TGBOUN 42.5 DEG.C

SURFACE TEMPERATURES
T01HTR 606.6 DEG.C
T02HTR 603.3 DEG.C
T03HTR 613.5 DEG.C
T04HTR 591.7 DEG.C
T05HTR 598.5 DEG.C
T06HTR 599.9 DEG.C
T07HTR 565.4 DEG.C
T08HTR 602.5 DEG.C
T09HTR 615.0 DEG.C
T10HTR 605.5 DEG.C
T11HTR 599.4 DEG.C
T12HTR 597.7 DEG.C
T13REG****** DEG.C
T14REG 501.2 DEG.C
T15REG 374.4 DEG.C
T16REG****** DEG.C
T17REG 368.3 DEG.C
T18REG 364.4 DEG.C
T19REG 238.5 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.23 L/MIN
TWINCL 25.2 DEG.C
TDLCL 10.22 DEG.C
TWOCLR 35.97 DEG.C

CALCULATED PARAMETERS
1 PWRIN 4694. WATTS
2 QCOOLR 3002. WATTS
3 QDSHPT 869. WATTS
4 EXTEFF 23.7 %
5 TAVHTR 599.9 DEG.C
6 INTEFF 27.0 %
8 AMPS 1458. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 102. WATTS
12 QREG2 111. WATTS
13 QREG3 33. WATTS
14 PFP 817.9 KPA/CM
15 PFD 240.5 KPA/CM
16 NBEALE 0.00817

VIBRATION
VX1HOR 0.3 CM/S
VY1VER10.2 CM/S

PHASE ANGLES
PADISP 84.6 DEG.
PAPRES -13.0 DEG.

ENGINE SPEED
FREQ 28.3 HZ

REMOTE CALCULATIONS
PWROUT 1112. WATTS
INDPWR 1165. WATTS
PISTST 3.39 CM
DISPST 2.62 CM

DYNAMIC CALCULATIONS
PAMPC 1393. KPA
DISPCP 2.81 CM
PISTCP 2.58 CM
PDYNDB 1425. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/19/84 12:35:29.83 RDG 909

FLUID HELIUM BAROM 14.450 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.11 L/MIN
TWINDP 17.4 DEG.C
TDLDP 1.22 DEG.C
TWODPR 19.2 DEG.C

POWER IN
AMPS1 520. AMPS
AMPS2 521. AMPS
VOLTG 2.25 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7093. KPA
MEANBP 7011. KPA
MEANCP 7039. KPA

GAS TEMPERATURES
TGEXP 420.9 DEG.C
TGREGH 402.3 DEG.C
TGREGC 80.3 DEG.C
TGCOMP 43.3 DEG.C
TGBOUN 32.5 DEG.C

SURFACE TEMPERATURES
T01HTR 450.9 DEG.C
T02HTR 456.7 DEG.C
T03HTR 458.1 DEG.C
T04HTR 448.1 DEG.C
T05HTR 445.7 DEG.C
T06HTR 452.8 DEG.C
T07HTR 423.7 DEG.C
T08HTR 455.8 DEG.C
T09HTR 459.0 DEG.C
T10HTR 450.0 DEG.C
T11HTR 447.1 DEG.C
T12HTR 454.2 DEG.C
T13REG****** DEG.C
T14REG 377.6 DEG.C
T15REG 281.7 DEG.C
T16REG****** DEG.C
T17REG 273.9 DEG.C
T18REG 283.1 DEG.C
T19REG 179.1 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.14 L/MIN
TWINCL 25.1 DEG.C
TDLCL 5.28 DEG.C
TWOCLR 30.71 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2338. WATTS
2 QCOOLR 1518. WATTS
3 QDSHPT 350. WATTS
4 EXTEFF 19.8 %
5 TAVHTR 450.2 DEG.C
6 INTEFF 23.4 %
8 AMPS 1041. AMPS
9 QDISPG 2. WATTS
10 QDISP 11. WATTS
11 QREG1 84. WATTS
12 QREG2 77. WATTS
13 QREG3 25. WATTS
14 PFP 993.5 KPA/CM
15 PFD 245.7 KPA/CM
16 NBEALE 0.00452

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 6.2 CM/S

PHASE ANGLES
PADISP 87.6 DEG.
PAPRES -13.1 DEG.

ENGINE SPEED
FREQ 31.6 HZ

REMOTE CALCULATIONS
PWROUT 463. WATTS
INDPWR 461. WATTS
PISTST 1.80 CM
DISPST 1.68 CM

DYNAMIC CALCULATIONS
PAMPC 910. KPA
DISPCP 2.60 CM
PISTCP 2.36 CM
PDYNDB 1063. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/19/84 12:40:20.83 RDG 910

FLUID HELIUM BAROM 14.445 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.10 L/MIN
TWINDP 17.3 DEG.C
TDLDP 1.41 DEG.C
TWODPR 19.4 DEG.C

POWER IN
AMPS1 556. AMPS
AMPS2 547. AMPS
VOLTG 2.38 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7096. KPA
MEANBP 6998. KPA
MEANCP 7032. KPA

GAS TEMPERATURES
TGEXP 418.9 DEG.C
TGREGH 399.9 DEG.C
TGREGC 82.9 DEG.C
TGCOMP 45.9 DEG.C
TGBOUN 32.9 DEG.C

SURFACE TEMPERATURES
T01HTR 450.2 DEG.C
T02HTR 456.6 DEG.C
T03HTR 457.9 DEG.C
T04HTR 447.5 DEG.C
T05HTR 445.7 DEG.C
T06HTR 451.7 DEG.C
T07HTR 422.6 DEG.C
T08HTR 454.9 DEG.C
T09HTR 459.7 DEG.C
T10HTR 449.3 DEG.C
T11HTR 446.4 DEG.C
T12HTR 453.6 DEG.C
T13REG****** DEG.C
T14REG 377.0 DEG.C
T15REG 282.7 DEG.C
T16REG****** DEG.C
T17REG 273.5 DEG.C
T18REG 282.3 DEG.C
T19REG 181.6 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.16 L/MIN
TWINCL 25.2 DEG.C
TDLCL 5.97 DEG.C
TWOCLR 31.38 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2625. WATTS
2 QCOOLR 1723. WATTS
3 QDSHPT 402. WATTS
4 EXTEFF 19.8 %
5 TAVHTR 449.7 DEG.C
6 INTEFF 23.2 %
8 AMPS 1103. AMPS
9 QDISPG 2. WATTS
10 QDISP 11. WATTS
11 QREG1 82. WATTS
12 QREG2 77. WATTS
13 QREG3 25. WATTS
14 PFP 993.8 KPA/CM
15 PFD 235.5 KPA/CM
16 NBEALE 0.00460

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 6.9 CM/S

PHASE ANGLES
PADISP 88.3 DEG.
PAPRES -12.0 DEG.

ENGINE SPEED
FREQ 31.5 HZ

REMOTE CALCULATIONS
PWROUT 520. WATTS
INDPWR 517. WATTS
PISTST 2.00 CM
DISPST 1.78 CM

DYNAMIC CALCULATIONS
PAMPC 1009. KPA
DISPCP 2.60 CM
PISTCP 2.38 CM
PDYNDB 1125. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/19/84 12:45:23.83 RDG 911

FLUID HELIUM BAROM 14.445 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.09 L/MIN
TWINDP 17.0 DEG.C
TDLDP 1.59 DEG.C
TWODPR 19.2 DEG.C

POWER IN
AMPS1 591. AMPS
AMPS2 574. AMPS
VOLTG 2.51 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7094. KPA
MEANBP 6999. KPA
MEANCP 7031. KPA

GAS TEMPERATURES
TGEXP 417.1 DEG.C
TGREGH 398.5 DEG.C
TGREGC 85.7 DEG.C
TGCOMP 49.0 DEG.C
TGBOUN 33.5 DEG.C

SURFACE TEMPERATURES
T01HTR 450.9 DEG.C
T02HTR 457.2 DEG.C
T03HTR 458.6 DEG.C
T04HTR 447.3 DEG.C
T05HTR 447.2 DEG.C
T06HTR 451.7 DEG.C
T07HTR 421.8 DEG.C
T08HTR 455.0 DEG.C
T09HTR 461.0 DEG.C
T10HTR 449.9 DEG.C
T11HTR 446.7 DEG.C
T12HTR 453.8 DEG.C
T13REG****** DEG.C
T14REG 377.4 DEG.C
T15REG 284.3 DEG.C
T16REG****** DEG.C
T17REG 274.7 DEG.C
T18REG 281.6 DEG.C
T19REG 184.2 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.16 L/MIN
TWINCL 25.2 DEG.C
TDLCL 6.70 DEG.C
TWOCLR 32.22 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2928. WATTS
2 QCOOLR 1933. WATTS
3 QDSHPT 452. WATTS
4 EXTEFF 19.6 %
5 TAVHTR 450.1 DEG.C
6 INTEFF 22.9 %
8 AMPS 1164. AMPS
9 QDISPG 2. WATTS
10 QDISP 10. WATTS
11 QREG1 79. WATTS
12 QREG2 78. WATTS
13 QREG3 24. WATTS
14 PFP 990.0 KPA/CM
15 PFD 224.5 KPA/CM
16 NBEALE 0.00462

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 7.6 CM/S

PHASE ANGLES
PADISP 88.6 DEG.
PAPRES -11.1 DEG.

ENGINE SPEED
FREQ 31.4 HZ

REMOTE CALCULATIONS
PWROUT 573. WATTS
INDPWR 567. WATTS
PISTST 2.20 CM
DISPST 1.89 CM

DYNAMIC CALCULATIONS
PAMPC 1102. KPA
DISPCP 2.60 CM
PISTCP 2.38 CM
PDYNDB 1213. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/19/84 12:50:20.83 RDG 912

FLUID HELIUM BAROM 14.445 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURE	
FLODP	4.08 L/MIN	AMPS1	625. AMPS	PRESUP	7102. KPA	TGEXP	414.5 DEG.C	T01HTR	450.9 DEG.C
		AMPS2	603. AMPS					T02HTR	456.8 DEG.C
TWINDP	16.9 DEG.C	VOLTG	2.65 VOLTS	MEANBP	7012. KPA	TGREGH	396.7 DEG.C	T03HTR	458.8 DEG.C
TDLDP	1.73 DEG.C			MEANCP	7050. KPA	TGREGC	88.6 DEG.C	T04HTR	446.5 DEG.C
TWODPR	19.4 DEG.C					TGCOMP	52.4 DEG.C	T05HTR	446.9 DEG.C
						TGBOUN	34.1 DEG.C	T06HTR	451.1 DEG.C
								T07HTR	420.2 DEG.C
								T08HTR	454.5 DEG.C
								T09HTR	461.6 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	450.1 DEG.C
FLOCLR	4.15 L/MIN	1 PWRIN	3251. WATTS	VX1HOR	0.4 CM/S	PWROUT	618. WATTS	T11HTR	446.4 DEG.C
TWINCL	25.4 DEG.C	2 QCOOLR	2181. WATTS	VY1VER	8.2 CM/S	INDPWR	619. WATTS	T12HTR	453.1 DEG.C
TDLCL	7.57 DEG.C	3 QDSHPT	491. WATTS			PISTST	2.40 CM		
TWOCLR	33.08 DEG.C	4 EXTEFF	19.0 %	PHASE ANGLES		DISPST	2.00 CM		
		5 TAVHTR	449.7 DEG.C	PADISP	88.7 DEG.			T13REG******	DEG.C
		6 INTEFF	22.1 %	PAPRES	-10.3 DEG.	DYNAMIC CALCULATIONS		T14REG	376.0 DEG.C
		8 AMPS	1227. AMPS			PAMPC	1153. KPA	T15REG	284.5 DEG.C
		9 QDISPG	2. WATTS	ENGINE SPEED		DISPCP	2.61 CM	T16REG******	DEG.C
		10 QDISP	10. WATTS	FREQ	31.3 HZ	PISTCP	2.39 CM	T17REG	273.5 DEG.C
		11 QREG1	78. WATTS			PDYNDB	1300. KPA	T18REG	281.9 DEG.C
		12 QREG2	76. WATTS			PDLCLR******	KPA	T19REG	185.8 DEG.C
		13 QREG3	24. WATTS			PDLREG******	KPA		
		14 PFP	949.7 KPA/CM			PDLDIS******	KPA	T03HED******	DEG.C
		15 PFD	206.1 KPA/CM						
		16 NBEALE	0.00457						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/19/84 12:55:26.94 RDG 913

FLUID HELIUM BAROM 14.445 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURE	
FLODP	4.09 L/MIN	AMPS1	658. AMPS	PRESUP	7106. KPA	TGEXP	411.3 DEG.C	T01HTR	451.7 DEG.C
		AMPS2	630. AMPS					T02HTR	455.0 DEG.C
TWINDP	16.9 DEG.C	VOLTG	2.78 VOLTS	MEANBP	6994. KPA	TGREGH	396.4 DEG.C	T03HTR	458.7 DEG.C
TDLDP	1.92 DEG.C			MEANCP	7034. KPA	TGREGC	92.0 DEG.C	T04HTR	445.0 DEG.C
TWODPR	19.5 DEG.C					TGCOMP	56.7 DEG.C	T05HTR	445.5 DEG.C
						TGBOUN	35.0 DEG.C	T06HTR	451.1 DEG.C
								T07HTR	417.4 DEG.C
								T08HTR	454.4 DEG.C
								T09HTR	461.7 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	450.6 DEG.C
FLOCLR	4.18 L/MIN	1 PWRIN	3583. WATTS	VX1HOR	0.4 CM/S	PWROUT	663. WATTS	T11HTR	447.0 DEG.C
TWINCL	25.4 DEG.C	2 QCOOLR	2427. WATTS	VY1VER	8.8 CM/S	INDPWR	662. WATTS	T12HTR	451.3 DEG.C
TDLCL	8.37 DEG.C	3 QDSHPT	546. WATTS			PISTST	2.60 CM		
TWOCLR	34.05 DEG.C	4 EXTEFF	18.5 %	PHASE ANGLES		DISPST	2.11 CM		
		5 TAVHTR	449.1 DEG.C	PADISP	87.4 DEG.			T13REG******	DEG.C
		6 INTEFF	21.5 %	PAPRES	-9.6 DEG.	DYNAMIC CALCULATIONS		T14REG	373.1 DEG.C
		8 AMPS	1288. AMPS			PAMPC	1206. KPA	T15REG	281.1 DEG.C
		9 QDISPG	2. WATTS	ENGINE SPEED		DISPCP	2.62 CM	T16REG******	DEG.C
		10 QDISP	10. WATTS	FREQ	31.1 HZ	PISTCP	2.39 CM	T17REG	276.3 DEG.C
		11 QREG1	78. WATTS			PDYNDB	1363. KPA	T18REG	280.5 DEG.C
		12 QREG2	75. WATTS			PDLCLR******	KPA	T19REG	184.5 DEG.C
		13 QREG3	24. WATTS			PDLREG******	KPA		
		14 PFP	922.8 KPA/CM			PDLDIS******	KPA	T03HED******	DEG.C
		15 PFD	191.0 KPA/CM						
		16 NBEALE	0.00456						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/19/84 13:00:20.94 RDG 914

FLUID HELIUM BAROM 14.445 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURE	
FLODP	4.09 L/MIN	AMPS1	690. AMPS	PRESUP	7103. KPA	TGEXP	409.9 DEG.C	T01HTR	452.2 DEG.C
		AMPS2	659. AMPS					T02HTR	455.1 DEG.C
TWINDP	17.0 DEG.C	VOLTG	2.92 VOLTS	MEANBP	7012. KPA	TGREGH	395.8 DEG.C	T03HTR	459.6 DEG.C
TDLDP	2.15 DEG.C			MEANCP	7054. KPA	TGREGC	95.1 DEG.C	T04HTR	444.5 DEG.C
TWODPR	19.8 DEG.C					TGCOMP	60.7 DEG.C	T05HTR	446.0 DEG.C
						TGBOUN	35.9 DEG.C	T06HTR	451.0 DEG.C
								T07HTR	416.4 DEG.C
								T08HTR	454.3 DEG.C
								T09HTR	462.6 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	451.2 DEG.C
FLOCLR	4.18 L/MIN	1 PWRIN	3934. WATTS	VX1HOR	0.4 CM/S	PWROUT	706. WATTS	T11HTR	447.2 DEG.C
TWINCL	25.5 DEG.C	2 QCOOLR	2718. WATTS	VY1VER	9.4 CM/S	INDPWR	702. WATTS	T12HTR	451.3 DEG.C
TDLCL	9.38 DEG.C	3 QDSHPT	612. WATTS			PISTST	2.80 CM		
TWOCLR	35.03 DEG.C	4 EXTEFF	18.0 %	PHASE ANGLES		DISPST	2.22 CM		
		5 TAVHTR	449.3 DEG.C	PADISP	87.5 DEG.			T13REG******	DEG.C
		6 INTEFF	20.6 %	PAPRES	-8.9 DEG.	DYNAMIC CALCULATIONS		T14REG	373.5 DEG.C
		8 AMPS	1349. AMPS			PAMPC	1285. KPA	T15REG	282.5 DEG.C
		9 QDISPG	2. WATTS	ENGINE SPEED		DISPCP	2.69 CM	T16REG******	DEG.C
		10 QDISP	10. WATTS	FREQ	31.1 HZ	PISTCP	2.38 CM	T17REG	278.3 DEG.C
		11 QREG1	76. WATTS			PDYNDB	1488. KPA	T18REG	281.6 DEG.C
		12 QREG2	75. WATTS			PDLCLR******	KPA	T19REG	187.5 DEG.C
		13 QREG3	23. WATTS			PDLREG******	KPA		
		14 PFP	914.1 KPA/CM			PDLDIS******	KPA	T03HED******	DEG.C
		15 PFD	179.3 KPA/CM						
		16 NBEALE	0.00451						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/19/84 13:05:21.01 RDG 915

FLUID HELIUM BAROM 14.445 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
QDASHP	4.06 L/MIN	AMPS1	737. AMPS	PRESUP	7106. KPA	TGEXP	405.7 DEG.C	T01HTR	454.4 DEG.C
		AMPS2	695. AMPS					T02HTR	456.2 DEG.C
TWINDP	17.0 DEG.C	VOLTG	3.11 VOLTS	MEANBP	6998. KPA	TGREGH	394.6 DEG.C	T03HTR	461.7 DEG.C
TDLDP	2.30 DEG.C			MEANCP	7043. KPA	TGREGC	98.1 DEG.C	T04HTR	445.3 DEG.C
TWODPR	19.9 DEG.C					TGCOMP	64.5 DEG.C	T05HTR	446.3 DEG.C
						TGBOUN	36.9 DEG.C	T06HTR	452.6 DEG.C
								T07HTR	415.5 DEG.C
								T08HTR	455.7 DEG.C
								T09HTR	465.3 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	453.1 DEG.C
QLOCLR	4.20 L/MIN	1 PWRIN	4448. WATTS	VX1HOR	0.5 CM/S	PWROUT	743. WATTS	T11HTR	448.9 DEG.C
TWINCL	25.5 DEG.C	2 QCOOLR	2998. WATTS	VY1VER	10.0 CM/S	INDPWR	732. WATTS	T12HTR	452.0 DEG.C
TDLCL	10.29 DEG.C	3 QDSHPT	651. WATTS			PISTST	2.99 CM		
TWOCLR	35.91 DEG.C	4 EXTEFF	16.7 %	PHASE ANGLES		DISPST	2.32 CM		
		5 TAVHTR	450.6 DEG.C	PADISP	87.4 DEG.			T13REG******	DEG.C
		6 INTEFF	19.9 %	PAPRES	-8.1 DEG.	DYNAMIC CALCULATIONS		T14REG	370.1 DEG.C
		8 AMPS	1432. AMPS			PAMPC	1388. KPA	T15REG	280.8 DEG.C
		9 QDISPG	2. WATTS	ENGINE SPEED		DISPCP	2.71 CM	T16REG******	DEG.C
		10 QDISP	10. WATTS	FREQ	31.0 HZ	PISTCP	2.35 CM	T17REG	278.1 DEG.C
		11 QREG1	74. WATTS			PDYNDB	1538. KPA	T18REG	279.1 DEG.C
		12 QREG2	74. WATTS			PDLCLR******	KPA	T19REG	188.4 DEG.C
		13 QREG3	23. WATTS			PDLREG******	KPA		
		14 PFP	923.9 KPA/CM			PDLDIS******	KPA	T03HED******	DEG.C
		15 PFD	168.2 KPA/CM						
		16 NBEALE	0.00445						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/19/84 13:17:24.01 RDG 916

FLUID HELIUM BAROM 14.445 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
QDASHP	4.03 L/MIN	AMPS1	742. AMPS	PRESUP	7110. KPA	TGEXP	406.1 DEG.C	T01HTR	455.6 DEG.C
		AMPS2	717. AMPS					T02HTR	456.5 DEG.C
TWINDP	17.1 DEG.C	VOLTG	3.19 VOLTS	MEANBP	7016. KPA	TGREGH	395.8 DEG.C	T03HTR	462.7 DEG.C
TDLDP	2.60 DEG.C			MEANCP	7059. KPA	TGREGC	102.3 DEG.C	T04HTR	445.1 DEG.C
TWODPR	20.5 DEG.C					TGCOMP	69.4 DEG.C	T05HTR	447.9 DEG.C
						TGBOUN	39.1 DEG.C	T06HTR	453.1 DEG.C
								T07HTR	415.3 DEG.C
								T08HTR	456.4 DEG.C
								T09HTR	466.4 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	454.2 DEG.C
QLOCLR	4.20 L/MIN	1 PWRIN	4657. WATTS	VX1HOR	0.4 CM/S	PWROUT	764. WATTS	T11HTR	449.9 DEG.C
TWINCL	25.6 DEG.C	2 QCOOLR	3372. WATTS	VY1VER	10.5 CM/S	INDPWR	754. WATTS	T12HTR	452.4 DEG.C
TDLCL	11.58 DEG.C	3 QDSHPT	730. WATTS			PISTST	3.19 CM		
TWOCLR	37.42 DEG.C	4 EXTEFF	16.4 %	PHASE ANGLES		DISPST	2.43 CM		
		5 TAVHTR	451.3 DEG.C	PADISP	87.0 DEG.			T13REG******	DEG.C
		6 INTEFF	18.5 %	PAPRES	-7.5 DEG.	DYNAMIC CALCULATIONS		T14REG	374.1 DEG.C
		8 AMPS	1459. AMPS			PAMPC	1585. KPA	T15REG	284.6 DEG.C
		9 QDISPG	2. WATTS	ENGINE SPEED		DISPCP	2.72 CM	T16REG******	DEG.C
		10 QDISP	10. WATTS	FREQ	31.0 HZ	PISTCP	2.23 CM	T17REG	282.5 DEG.C
		11 QREG1	72. WATTS			PDYNDB	1600. KPA	T18REG	281.8 DEG.C
		12 QREG2	75. WATTS			PDLCLR******	KPA	T19REG	193.1 DEG.C
		13 QREG3	23. WATTS			PDLREG******	KPA		
		14 PFP	990.6 KPA/CM			PDLDIS******	KPA	T03HED******	DEG.C
		15 PFD	171.3 KPA/CM						
		16 NBEALE	0.00428						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 14:25:18.80 RDG 921

FLUID HELIUM BAROM 14.268 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
QDASHP	4.17 L/MIN	AMPS1	519. AMPS	PRESUP	7379. KPA	TGEXP	466.3 DEG.C	T01HTR	501.8 DEG.C
		AMPS2	549. AMPS					T02HTR	506.5 DEG.C
TWINDP	17.0 DEG.C	VOLTG	2.35 VOLTS	MEANBP	7012. KPA	TGREGH	449.3 DEG.C	T03HTR	508.2 DEG.C
TDLDP	1.33 DEG.C			MEANCP	7027. KPA	TGREGC	85.6 DEG.C	T04HTR	498.0 DEG.C
TWODPR	18.9 DEG.C					TGCOMP	43.1 DEG.C	T05HTR	496.5 DEG.C
						TGBOUN	30.7 DEG.C	T06HTR	504.1 DEG.C
								T07HTR	471.9 DEG.C
								T08HTR	506.7 DEG.C
								T09HTR	509.8 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	501.2 DEG.C
QLOCLR	4.23 L/MIN	1 PWRIN	2513. WATTS	VX1HOR	0.3 CM/S	PWROUT	531. WATTS	T11HTR	497.9 DEG.C
TWINCL	25.0 DEG.C	2 QCOOLR	1598. WATTS	VY1VER	6.5 CM/S	INDPWR	567. WATTS	T12HTR	504.1 DEG.C
TDLCL	5.45 DEG.C	3 QDSHPT	385. WATTS			PISTST	1.80 CM		
TWOCLR	30.63 DEG.C	4 EXTEFF	21.1 %	PHASE ANGLES		DISPST	1.69 CM		
		5 TAVHTR	500.6 DEG.C	PADISP	85.9 DEG.			T13REG******	DEG.C
		6 INTEFF	25.0 %	PAPRES	-15.1 DEG.	DYNAMIC CALCULATIONS		T14REG	420.1 DEG.C
		8 AMPS	1069. AMPS			PAMPC	935. KPA	T15REG	310.7 DEG.C
		9 QDISPG	2. WATTS	ENGINE SPEED		DISPCP	2.59 CM	T16REG******	DEG.C
		10 QDISP	12. WATTS	FREQ	31.9 HZ	PISTCP	2.34 CM	T17REG	304.2 DEG.C
		11 QREG1	95. WATTS			PDYNDB	1075. KPA	T18REG	310.4 DEG.C
		12 QREG2	89. WATTS			PDLCLR******	KPA	T19REG	193.8 DEG.C
		13 QREG3	28. WATTS			PDLREG******	KPA		
		14 PFP	1025.4 KPA/CM			PDLDIS******	KPA	T03HED******	DEG.C
		15 PFD	288.3 KPA/CM						
		16 NBEALE	0.00515						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 14:30:18.80 RDG 922

FLUID HELIUM BAROM 14.268 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.19 L/MIN
TWINDP 16.8 DEG.C
TDLDP 1.45 DEG.C
TWODPR 18.9 DEG.C

POWER IN
AMPS1 557. AMPS
AMPS2 574. AMPS
VOLTG 2.50 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7173. KPA
MEANBP 7012. KPA
MEANCP 7028. KPA

GAS TEMPERATURES
TGEXP 460.7 DEG.C
TGREGH 446.4 DEG.C
TGREGC 88.0 DEG.C
TGCOMP 45.7 DEG.C
TGBOUN 31.4 DEG.C

SURFACE TEMPERATURES
T01HTR 500.9 DEG.C
T02HTR 507.4 DEG.C
T03HTR 508.3 DEG.C
T04HTR 498.0 DEG.C
T05HTR 496.7 DEG.C
T06HTR 502.2 DEG.C
T07HTR 471.6 DEG.C
T08HTR 505.8 DEG.C
T09HTR 511.2 DEG.C
T10HTR 500.4 DEG.C
T11HTR 497.4 DEG.C
T12HTR 503.9 DEG.C
T13REG****** DEG.C
T14REG 419.2 DEG.C
T15REG 311.2 DEG.C
T16REG****** DEG.C
T17REG 303.3 DEG.C
T18REG 309.8 DEG.C
T19REG 197.1 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.25 L/MIN
TWINCL 25.0 DEG.C
TDLCL 6.22 DEG.C
TWOCLR 31.31 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2826. WATTS
2 QCOOLR 1832. WATTS
3 QDSHPT 424. WATTS
4 EXTEFF 21.2 %
5 TAVHTR 500.3 DEG.C
6 INTEFF 24.6 %
8 AMPS 1130. AMPS
9 QDISPG 2. WATTS
10 QDISP 12. WATTS
11 QREG1 91. WATTS
12 QREG2 89. WATTS
13 QREG3 28. WATTS
14 PFP 1026.1 KPA/CM
15 PFD 280.3 KPA/CM
16 NBEALE 0.00525

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 7.1 CM/S

PHASE ANGLES
PADISP 86.3 DEG.
PAPRES -14.1 DEG.

ENGINE SPEED
FREQ 31.8 HZ

REMOTE CALCULATIONS
PWROUT 599. WATTS
INDPWR 642. WATTS
PISTST 1.99 CM
DISPST 1.81 CM

DYNAMIC CALCULATIONS
PAMPC 1038. KPA
DISPCP 2.62 CM
PISTCP 2.35 CM
PDYNDB 1175. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 14:35:30.80 RDG 923

FLUID HELIUM BAROM 14.263 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.18 L/MIN
TWINDP 16.7 DEG.C
TDLDP 1.69 DEG.C
TWODPR 19.0 DEG.C

POWER IN
AMPS1 602. AMPS
AMPS2 603. AMPS
VOLTG 2.65 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7149. KPA
MEANBP 6989. KPA
MEANCP 7008. KPA

GAS TEMPERATURES
TGEXP 459.8 DEG.C
TGREGH 444.4 DEG.C
TGREGC 90.2 DEG.C
TGCOMP 49.2 DEG.C
TGBOUN 32.3 DEG.C

SURFACE TEMPERATURES
T01HTR 501.9 DEG.C
T02HTR 507.2 DEG.C
T03HTR 509.9 DEG.C
T04HTR 496.9 DEG.C
T05HTR 495.7 DEG.C
T06HTR 502.2 DEG.C
T07HTR 470.1 DEG.C
T08HTR 505.4 DEG.C
T09HTR 511.7 DEG.C
T10HTR 501.2 DEG.C
T11HTR 497.1 DEG.C
T12HTR 503.4 DEG.C
T13REG****** DEG.C
T14REG 418.0 DEG.C
T15REG 312.1 DEG.C
T16REG****** DEG.C
T17REG 302.8 DEG.C
T18REG 312.0 DEG.C
T19REG 199.8 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.24 L/MIN
TWINCL 25.0 DEG.C
TDLCL 7.04 DEG.C
TWOCLR 32.19 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3188. WATTS
2 QCOOLR 2073. WATTS
3 QDSHPT 492. WATTS
4 EXTEFF 20.9 %
5 TAVHTR 500.2 DEG.C
6 INTEFF 24.3 %
8 AMPS 1205. AMPS
9 QDISPG 2. WATTS
10 QDISP 12. WATTS
11 QREG1 91. WATTS
12 QREG2 86. WATTS
13 QREG3 27. WATTS
14 PFP 1019.9 KPA/CM
15 PFD 264.1 KPA/CM
16 NBEALE 0.00533

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 7.8 CM/S

PHASE ANGLES
PADISP 86.8 DEG.
PAPRES -12.9 DEG.

ENGINE SPEED
FREQ 31.7 HZ

REMOTE CALCULATIONS
PWROUT 667. WATTS
INDPWR 712. WATTS
PISTST 2.20 CM
DISPST 1.92 CM

DYNAMIC CALCULATIONS
PAMPC 1137. KPA
DISPCP 2.61 CM
PISTCP 2.35 CM
PDYNDB 1238. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 14:40:18.80 RDG 924

FLUID HELIUM BAROM 14.263 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.18 L/MIN
TWINDP 16.6 DEG.C
TDLDP 1.95 DEG.C
TWODPR 19.2 DEG.C

POWER IN
AMPS1 641. AMPS
AMPS2 628. AMPS
VOLTG 2.79 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7385. KPA
MEANBP 7004. KPA
MEANCP 7023. KPA

GAS TEMPERATURES
TGEXP 458.2 DEG.C
TGREGH 442.1 DEG.C
TGREGC 93.2 DEG.C
TGCOMP 52.8 DEG.C
TGBOUN 33.4 DEG.C

SURFACE TEMPERATURES
T01HTR 501.5 DEG.C
T02HTR 506.9 DEG.C
T03HTR 509.9 DEG.C
T04HTR 496.1 DEG.C
T05HTR 495.7 DEG.C
T06HTR 500.8 DEG.C
T07HTR 468.9 DEG.C
T08HTR 504.3 DEG.C
T09HTR 512.5 DEG.C
T10HTR 500.7 DEG.C
T11HTR 496.6 DEG.C
T12HTR 502.6 DEG.C
T13REG****** DEG.C
T14REG 417.8 DEG.C
T15REG 313.1 DEG.C
T16REG****** DEG.C
T17REG 302.5 DEG.C
T18REG 311.4 DEG.C
T19REG 202.6 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.25 L/MIN
TWINCL 25.1 DEG.C
TDLCL 7.85 DEG.C
TWOCLR 33.12 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3536. WATTS
2 QCOOLR 2313. WATTS
3 QDSHPT 566. WATTS
4 EXTEFF 20.5 %
5 TAVHTR 499.7 DEG.C
6 INTEFF 23.9 %
8 AMPS 1269. AMPS
9 QDISPG 2. WATTS
10 QDISP 12. WATTS
11 QREG1 88. WATTS
12 QREG2 86. WATTS
13 QREG3 27. WATTS
14 PFP 1022.3 KPA/CM
15 PFD 251.0 KPA/CM
16 NBEALE 0.00531

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 8.4 CM/S

PHASE ANGLES
PADISP 87.0 DEG.
PAPRES -11.8 DEG.

ENGINE SPEED
FREQ 31.6 HZ

REMOTE CALCULATIONS
PWROUT 725. WATTS
INDPWR 774. WATTS
PISTST 2.40 CM
DISPST 2.03 CM

DYNAMIC CALCULATIONS
PAMPC 1240. KPA
DISPCP 2.61 CM
PISTCP 2.38 CM
PDYNDB 1325. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 14:45:18.80 RDG 925

FLUID HELIUM BAROM 14.263 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

AT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.17 L/MIN	AMPS1 680. AMPS	PRESUP 7177. KPA	TGEXP 456.9 DEG.C	T01HTR 502.9 DEG.C
	AMPS2 653. AMPS			T02HTR 505.9 DEG.C
TWINDP 16.6 DEG.C	VOLTG 2.92 VOLTS	MEANBP 7005. KPA	TGREGH 442.7 DEG.C	T03HTR 510.5 DEG.C
TDLDP 2.22 DEG.C		MEANCP 7024. KPA	TGREGC 96.4 DEG.C	T04HTR 495.3 DEG.C
TWODPR 19.4 DEG.C			TGCOMP 57.0 DEG.C	T05HTR 495.7 DEG.C
			TGBOUN 34.6 DEG.C	T06HTR 501.7 DEG.C
				T07HTR 467.0 DEG.C
				T08HTR 505.0 DEG.C
				T09HTR 513.5 DEG.C

AT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR 4.25 L/MIN	1 PWRIN 3888. WATTS	VX1HOR 0.4 CM/S	PWROUT 794. WATTS	T10HTR 501.9 DEG.C
TWINCL 25.2 DEG.C	2 QCOOLR 2566. WATTS	VY1VER 9.0 CM/S	INDPWR 841. WATTS	T11HTR 497.7 DEG.C
TDLCL 8.69 DEG.C	3 QDSHPT 644. WATTS		PISTST 2.60 CM	T12HTR 501.4 DEG.C
TWOCLR 33.98 DEG.C	4 EXTEFF 20.4 %	PHASE ANGLES	DISPST 2.15 CM	
	5 TAVHTR 499.9 DEG.C	PADISP 85.4 DEG.		T13REG****** DEG.C
	6 INTEFF 23.6 %	PAPRES -11.4 DEG.	DYNAMIC CALCULATIONS	T14REG 416.5 DEG.C
	8 AMPS 1333. AMPS		PAMPC 1319. KPA	T15REG 311.5 DEG.C
	9 QDISPG 2. WATTS	ENGINE SPEED	DISPCP 2.71 CM	T16REG****** DEG.C
	10 QDISP 11. WATTS	FREQ 31.4 HZ	PISTCP 2.35 CM	T17REG 305.9 DEG.C
	11 QREG1 89. WATTS		PDYNDB 1450. KPA	T18REG 311.5 DEG.C
	12 QREG2 85. WATTS		PDLCLR****** KPA	T19REG 201.5 DEG.C
	13 QREG3 27. WATTS		PDLREG****** KPA	
	14 PFP 1012.7 KPA/CM		PDLDIS****** KPA	T03HED****** DEG.C
	15 PFD 242.5 KPA/CM			
	16 NBEALE 0.00542			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 14:50:21.80 RDG 926

FLUID HELIUM BAROM 14.263 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

T TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
LODP 4.15 L/MIN	AMPS1 715. AMPS	PRESUP 7167. KPA	TGEXP 455.9 DEG.C	T01HTR 504.7 DEG.C
	AMPS2 684. AMPS			T02HTR 506.3 DEG.C
WINDP 16.6 DEG.C	VOLTG 3.07 VOLTS	MEANBP 6996. KPA	TGREGH 442.1 DEG.C	T03HTR 512.2 DEG.C
DLDP 2.53 DEG.C		MEANCP 7021. KPA	TGREGC 99.9 DEG.C	T04HTR 495.1 DEG.C
WODPR 19.7 DEG.C			TGCOMP 61.3 DEG.C	T05HTR 496.8 DEG.C
			TGBOUN 36.1 DEG.C	T06HTR 502.3 DEG.C
				T07HTR 466.1 DEG.C
				T08HTR 505.6 DEG.C
				T09HTR 515.0 DEG.C

T TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
LOCLR 4.25 L/MIN	1 PWRIN 4293. WATTS	VX1HOR 0.4 CM/S	PWROUT 853. WATTS	T10HTR 503.6 DEG.C
WINCL 25.2 DEG.C	2 QCOOLR 2895. WATTS	VY1VER 9.7 CM/S	INDPWR 901. WATTS	T11HTR 498.8 DEG.C
DLCL 9.82 DEG.C	3 QDSHPT 730. WATTS		PISTST 2.80 CM	T12HTR 501.8 DEG.C
WOCLR 35.08 DEG.C	4 EXTEFF 19.9 %	PHASE ANGLES	DISPST 2.27 CM	
	5 TAVHTR 500.7 DEG.C	PADISP 85.4 DEG.		T13REG****** DEG.C
	6 INTEFF 22.8 %	PAPRES -10.6 DEG.	DYNAMIC CALCULATIONS	T14REG 415.8 DEG.C
	8 AMPS 1398. AMPS		PAMPC 1383. KPA	T15REG 311.0 DEG.C
	9 QDISPG 2. WATTS	ENGINE SPEED	DISPCP 2.71 CM	T16REG****** DEG.C
	10 QDISP 11. WATTS	FREQ 31.3 HZ	PISTCP 2.31 CM	T17REG 305.9 DEG.C
	11 QREG1 87. WATTS		PDYNDB 1525. KPA	T18REG 310.3 DEG.C
	12 QREG2 86. WATTS		PDLCLR****** KPA	T19REG 202.5 DEG.C
	13 QREG3 26. WATTS		PDLREG****** KPA	
	14 PFP 985.0 KPA/CM		PDLDIS****** KPA	T03HED****** DEG.C
	15 PFD 224.7 KPA/CM			
	16 NBEALE 0.00541			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 14:55:18.80 RDG 927

FLUID HELIUM BAROM 14.263 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

T TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
LODP 4.14 L/MIN	AMPS1 747. AMPS	PRESUP 7398. KPA	TGEXP 455.3 DEG.C	T01HTR 504.7 DEG.C
	AMPS2 710. AMPS			T02HTR 505.4 DEG.C
WINDP 16.7 DEG.C	VOLTG 3.20 VOLTS	MEANBP 7009. KPA	TGREGH 440.8 DEG.C	T03HTR 512.5 DEG.C
DLDP 2.77 DEG.C		MEANCP 7037. KPA	TGREGC 103.2 DEG.C	T04HTR 494.0 DEG.C
WODPR 19.9 DEG.C			TGCOMP 65.1 DEG.C	T05HTR 496.1 DEG.C
			TGBOUN 37.6 DEG.C	T06HTR 501.8 DEG.C
				T07HTR 464.1 DEG.C
				T08HTR 505.1 DEG.C
				T09HTR 515.2 DEG.C

T TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
LOCLR 4.27 L/MIN	1 PWRIN 4664. WATTS	VX1HOR 0.4 CM/S	PWROUT 897. WATTS	T10HTR 503.9 DEG.C
WINCL 25.2 DEG.C	2 QCOOLR 3188. WATTS	VY1VER10.3 CM/S	INDPWR 945. WATTS	T11HTR 498.7 DEG.C
DLCL 10.76 DEG.C	3 QDSHPT 798. WATTS		PISTST 2.99 CM	T12HTR 500.9 DEG.C
WOCLR 36.07 DEG.C	4 EXTEFF 19.2 %	PHASE ANGLES	DISPST 2.36 CM	
	5 TAVHTR 500.2 DEG.C	PADISP 85.2 DEG.		T13REG****** DEG.C
	6 INTEFF 22.0 %	PAPRES -9.8 DEG.	DYNAMIC CALCULATIONS	T14REG 414.4 DEG.C
	8 AMPS 1457. AMPS		PAMPC 1516. KPA	T15REG 310.7 DEG.C
	9 QDISPG 2. WATTS	ENGINE SPEED	DISPCP 2.72 CM	T16REG****** DEG.C
	10 QDISP 11. WATTS	FREQ 31.3 HZ	PISTCP 2.25 CM	T17REG 308.2 DEG.C
	11 QREG1 85. WATTS		PDYNDB 1588. KPA	T18REG 309.9 DEG.C
	12 QREG2 85. WATTS		PDLCLR****** KPA	T19REG 204.6 DEG.C
	13 QREG3 26. WATTS		PDLREG****** KPA	
	14 PFP 1014.4 KPA/CM		PDLDIS****** KPA	T03HED****** DEG.C
	15 PFD 218.5 KPA/CM			
	16 NBEALE 0.00533			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:00:18.80 RDG 928

FLUID HELIUM BAROM 14.263 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.14 L/MIN
TWINDP 16.6 DEG.C
TDLDP 3.02 DEG.C
TWODPR 20.2 DEG.C

POWER IN
AMPS1 775. AMPS
AMPS2 738. AMPS
VOLTG 3.34 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7387. KPA
MEANBP 7007. KPA
MEANCP 7044. KPA

GAS TEMPERATURES
TGEXP 454.0 DEG.C
TGREGH 439.9 DEG.C
TGREGC 107.4 DEG.C
TGCOMP 70.1 DEG.C
TGBOUN 39.0 DEG.C

SURFACE TEMPERATURES
T01HTR 505.2 DEG.C
T02HTR 504.5 DEG.C
T03HTR 513.0 DEG.C
T04HTR 493.0 DEG.C
T05HTR 495.4 DEG.C
T06HTR 501.6 DEG.C
T07HTR 462.0 DEG.C
T08HTR 505.0 DEG.C
T09HTR 515.9 DEG.C
T10HTR 504.0 DEG.C
T11HTR 499.0 DEG.C
T12HTR 500.0 DEG.C
T13REG****** DEG.C
T14REG 412.3 DEG.C
T15REG 309.5 DEG.C
T16REG****** DEG.C
T17REG 310.4 DEG.C
T18REG 309.5 DEG.C
T19REG 206.6 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.28 L/MIN
TWINCL 25.3 DEG.C
TDLCL 11.95 DEG.C
TWOCLR 37.41 DEG.C

CALCULATED PARAMETERS
1 PWRIN 5062. WATTS
2 QCOOLR 3545. WATTS
3 QDSHPT 869. WATTS
4 EXTEFF 18.9 %
5 TAVHTR 499.9 DEG.C
6 INTEFF 21.2 %
8 AMPS 1514. AMPS
9 QDISPG 2. WATTS
10 QDISP 11. WATTS
11 QREG1 83. WATTS
12 QREG2 83. WATTS
13 QREG3 26. WATTS
14 PFP 1018.2 KPA/CM
15 PFD 207.8 KPA/CM
16 NBEALE 0.00533

VIBRATION
VX1HOR 0.4 CM/S
VY1VER10.9 CM/S

PHASE ANGLES
PADISP 84.9 DEG.
PAPRES -9.1 DEG.

ENGINE SPEED
FREQ 31.2 HZ

REMOTE CALCULATIONS
PWROUT 956. WATTS
INDPWR 985. WATTS
PISTST 3.20 CM
DISPST 2.47 CM

DYNAMIC CALCULATIONS
PAMPC 1624. KPA
DISPCP 2.74 CM
PISTCP 2.19 CM
PDYNDB 1638. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:02:57.83 RDG 929

FLUID HELIUM BAROM 14.268 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.14 L/MIN
TWINDP 16.6 DEG.C
TDLDP 3.14 DEG.C
TWODPR 20.3 DEG.C

POWER IN
AMPS1 811. AMPS
AMPS2 767. AMPS
VOLTG 3.49 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7383. KPA
MEANBP 7005. KPA
MEANCP 7040. KPA

GAS TEMPERATURES
TGEXP 452.2 DEG.C
TGREGH 437.7 DEG.C
TGREGC 111.0 DEG.C
TGCOMP 74.4 DEG.C
TGBOUN 39.8 DEG.C

SURFACE TEMPERATURES
T01HTR 504.4 DEG.C
T02HTR 503.5 DEG.C
T03HTR 512.8 DEG.C
T04HTR 491.5 DEG.C
T05HTR 495.2 DEG.C
T06HTR 500.3 DEG.C
T07HTR 459.6 DEG.C
T08HTR 504.0 DEG.C
T09HTR 515.9 DEG.C
T10HTR 503.5 DEG.C
T11HTR 498.1 DEG.C
T12HTR 499.0 DEG.C
T13REG****** DEG.C
T14REG 410.6 DEG.C
T15REG 310.2 DEG.C
T16REG****** DEG.C
T17REG 311.1 DEG.C
T18REG 310.3 DEG.C
T19REG 209.5 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.28 L/MIN
TWINCL 25.3 DEG.C
TDLCL 12.99 DEG.C
TWOCLR 38.37 DEG.C

CALCULATED PARAMETERS
1 PWRIN 5505. WATTS
2 QCOOLR 3855. WATTS
3 QDSHPT 903. WATTS
4 EXTEFF 17.3 %
5 TAVHTR 499.0 DEG.C
6 INTEFF 19.8 %
8 AMPS 1578. AMPS
9 QDISPG 2. WATTS
10 QDISP 11. WATTS
11 QREG1 82. WATTS
12 QREG2 81. WATTS
13 QREG3 25. WATTS
14 PFP 1023.6 KPA/CM
15 PFD 189.9 KPA/CM
16 NBEALE 0.00501

VIBRATION
VX1HOR 0.4 CM/S
VY1VER11.5 CM/S

PHASE ANGLES
PADISP 84.7 DEG.
PAPRES -8.2 DEG.

ENGINE SPEED
FREQ 31.2 HZ

REMOTE CALCULATIONS
PWROUT 955. WATTS
INDPWR 998. WATTS
PISTST 3.39 CM
DISPST 2.61 CM

DYNAMIC CALCULATIONS
PAMPC 1732. KPA
DISPCP 2.75 CM
PISTCP 2.07 CM
PDYNDB 1813. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:13:21.83 RDG 930

FLUID HELIUM BAROM 14.268 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.16 L/MIN
TWINDP 16.6 DEG.C
TDLDP 1.96 DEG.C
TWODPR 19.0 DEG.C

POWER IN
AMPS1 543. AMPS
AMPS2 549. AMPS
VOLTG 2.42 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7173. KPA
MEANBP 7011. KPA
MEANCP 7026. KPA

GAS TEMPERATURES
TGEXP 654.3 DEG.C
TGREGH 495.7 DEG.C
TGREGC 89.6 DEG.C
TGCOMP 45.3 DEG.C
TGBOUN 37.5 DEG.C

SURFACE TEMPERATURES
T01HTR 551.4 DEG.C
T02HTR 555.6 DEG.C
T03HTR 558.4 DEG.C
T04HTR 546.3 DEG.C
T05HTR 545.8 DEG.C
T06HTR 553.3 DEG.C
T07HTR 520.2 DEG.C
T08HTR 556.0 DEG.C
T09HTR 558.5 DEG.C
T10HTR 550.9 DEG.C
T11HTR 547.3 DEG.C
T12HTR 553.1 DEG.C
T13REG****** DEG.C
T14REG 462.4 DEG.C
T15REG 340.6 DEG.C
T16REG****** DEG.C
T17REG 332.7 DEG.C
T18REG 339.2 DEG.C
T19REG 210.2 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.26 L/MIN
TWINCL 24.9 DEG.C
TDLCL 5.89 DEG.C
TWOCLR 31.05 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2637. WATTS
2 QCOOLR 1742. WATTS
3 QDSHPT 566. WATTS
4 EXTEFF 22.4 %
5 TAVHTR 549.7 DEG.C
6 INTEFF 25.3 %
8 AMPS 1092. AMPS
9 QDISPG 3. WATTS
10 QDISP 17. WATTS
11 QREG1 105. WATTS
12 QREG2 100. WATTS
13 QREG3 31. WATTS
14 PFP 1171.7 KPA/CM
15 PFD 357.9 KPA/CM
16 NBEALE 0.00571

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 6.5 CM/S

PHASE ANGLES
PADISP 83.9 DEG.
PAPRES -16.7 DEG.

ENGINE SPEED
FREQ 32.2 HZ

REMOTE CALCULATIONS
PWROUT 590. WATTS
INDPWR 630. WATTS
PISTST 1.79 CM
DISPST 1.70 CM

DYNAMIC CALCULATIONS
PAMPC 1058. KPA
DISPCP 2.68 CM
PISTCP 2.40 CM
PDYNDB 1075. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:18:18.83 RDG 931

FLUID HELIUM BAROM 14.263 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

AT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.17 L/MIN	AMPS1 588. AMPS	PRESUP 7404. KPA	TGEXP 695.6 DEG.C	T01HTR 551.1 DEG.C
	AMPS2 587. AMPS			T02HTR 557.4 DEG.C
TWINDP 16.6 DEG.C	VOLTG 2.60 VOLTS	MEANBP 7005. KPA	TGREGH 492.7 DEG.C	T03HTR 559.3 DEG.C
TDLDP 2.11 DEG.C		MEANCP 7032. KPA	TGREGC 92.4 DEG.C	T04HTR 546.8 DEG.C
TWODPR 19.3 DEG.C			TGCOMP 47.9 DEG.C	T05HTR 547.3 DEG.C
			TGBOUN 37.2 DEG.C	T06HTR 551.9 DEG.C
				T07HTR 521.0 DEG.C
				T08HTR 555.5 DEG.C
				T09HTR 561.3 DEG.C

AT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 550.7 DEG.C
FLOCLR 4.24 L/MIN	1 PWRIN 3053. WATTS	VX1HOR 0.3 CM/S	PWROUT 690. WATTS	T11HTR 547.2 DEG.C
TWINCL 24.8 DEG.C	2 QCOOLR 1981. WATTS	VY1VER 7.2 CM/S	INDPWR 734. WATTS	T12HTR 553.6 DEG.C
TDLCL 6.73 DEG.C	3 QDSHPT 612. WATTS		PISTST 2.01 CM	
TWOCLR 31.75 DEG.C	4 EXTEFF 22.6 %	PHASE ANGLES	DISPST 1.86 CM	
	5 TAVHTR 550.3 DEG.C	PADISP 84.5 DEG.		T13REG****** DEG.C
	6 INTEFF 25.8 %	PAPRES -15.7 DEG.	DYNAMIC CALCULATIONS	T14REG 463.5 DEG.C
	8 AMPS 1174. AMPS		PAMPC 1043. KPA	T15REG 344.0 DEG.C
	9 QDISPG 4. WATTS	ENGINE SPEED	DISPCP 2.66 CM	T16REG****** DEG.C
	10 QDISP 18. WATTS	FREQ 32.0 HZ	PISTCP 2.41 CM	T17REG 331.1 DEG.C
	11 QREG1 100. WATTS		PDYNDB 1200. KPA	T18REG 339.3 DEG.C
	12 QREG2 101. WATTS		PDLCLR****** KPA	T19REG 215.5 DEG.C
	13 QREG3 31. WATTS		PDLREG****** KPA	
	14 PFP 1028.5 KPA/CM		PDLDIS****** KPA	T03HED****** DEG.C
	15 PFD 305.5 KPA/CM			
	16 NBEALE 0.00597			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:23:18.86 RDG 932

FLUID HELIUM BAROM 14.263 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

AT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.18 L/MIN	AMPS1 623. AMPS	PRESUP 7308. KPA	TGEXP 713.1 DEG.C	T01HTR 551.6 DEG.C
	AMPS2 613. AMPS			T02HTR 556.6 DEG.C
TWINDP 16.6 DEG.C	VOLTG 2.74 VOLTS	MEANBP 7019. KPA	TGREGH 490.5 DEG.C	T03HTR 559.8 DEG.C
TDLDP 2.28 DEG.C		MEANCP 7059. KPA	TGREGC 95.4 DEG.C	T04HTR 545.7 DEG.C
TWODPR 19.5 DEG.C			TGCOMP 51.2 DEG.C	T05HTR 546.2 DEG.C
			TGBOUN 37.7 DEG.C	T06HTR 551.0 DEG.C
				T07HTR 519.0 DEG.C
				T08HTR 554.7 DEG.C
				T09HTR 561.9 DEG.C

AT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 550.6 DEG.C
FLOCLR 4.23 L/MIN	1 PWRIN 3388. WATTS	VX1HOR 0.4 CM/S	PWROUT 764. WATTS	T11HTR 546.7 DEG.C
TWINCL 24.9 DEG.C	2 QCOOLR 2200. WATTS	VY1VER 7.8 CM/S	INDPWR 813. WATTS	T12HTR 552.3 DEG.C
TDLCL 7.49 DEG.C	3 QDSHPT 663. WATTS		PISTST 2.20 CM	
TWOCLR 32.54 DEG.C	4 EXTEFF 22.5 %	PHASE ANGLES	DISPST 1.97 CM	
	5 TAVHTR 549.7 DEG.C	PADISP 84.5 DEG.		T13REG****** DEG.C
	6 INTEFF 25.8 %	PAPRES -14.8 DEG.	DYNAMIC CALCULATIONS	T14REG 461.0 DEG.C
	8 AMPS 1236. AMPS		PAMPC 1142. KPA	T15REG 342.3 DEG.C
	9 QDISPG 4. WATTS	ENGINE SPEED	DISPCP 2.62 CM	T16REG****** DEG.C
	10 QDISP 19. WATTS	FREQ 31.9 HZ	PISTCP 2.38 CM	T17REG 331.0 DEG.C
	11 QREG1 101. WATTS		PDYNDB 1263. KPA	T18REG 340.8 DEG.C
	12 QREG2 98. WATTS		PDLCLR****** KPA	T19REG 216.0 DEG.C
	13 QREG3 31. WATTS		PDLREG****** KPA	
	14 PFP 1030.8 KPA/CM		PDLDIS****** KPA	T03HED****** DEG.C
	15 PFD 297.0 KPA/CM			
	16 NBEALE 0.00604			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:28:21.86 RDG 933

FLUID HELIUM BAROM 14.263 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

AT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.19 L/MIN	AMPS1 654. AMPS	PRESUP 7129. KPA	TGEXP 722.9 DEG.C	T01HTR 551.2 DEG.C
	AMPS2 639. AMPS			T02HTR 556.2 DEG.C
TWINDP 16.7 DEG.C	VOLTG 2.87 VOLTS	MEANBP 6996. KPA	TGREGH 487.8 DEG.C	T03HTR 560.1 DEG.C
TDLDP 2.53 DEG.C		MEANCP 7028. KPA	TGREGC 97.4 DEG.C	T04HTR 544.6 DEG.C
TWODPR 19.7 DEG.C			TGCOMP 54.1 DEG.C	T05HTR 546.6 DEG.C
			TGBOUN 38.2 DEG.C	T06HTR 550.1 DEG.C
				T07HTR 517.5 DEG.C
				T08HTR 553.5 DEG.C
				T09HTR 561.9 DEG.C

AT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 550.3 DEG.C
FLOCLR 4.23 L/MIN	1 PWRIN 3706. WATTS	VX1HOR 0.4 CM/S	PWROUT 831. WATTS	T11HTR 545.7 DEG.C
TWINCL 24.9 DEG.C	2 QCOOLR 2440. WATTS	VY1VER 8.4 CM/S	INDPWR 883. WATTS	T12HTR 551.9 DEG.C
TDLCL 8.30 DEG.C	3 QDSHPT 737. WATTS		PISTST 2.39 CM	
TWOCLR 33.38 DEG.C	4 EXTEFF 22.4 %	PHASE ANGLES	DISPST 2.06 CM	
	5 TAVHTR 549.1 DEG.C	PADISP 85.3 DEG.		T13REG****** DEG.C
	6 INTEFF 25.4 %	PAPRES -13.5 DEG.	DYNAMIC CALCULATIONS	T14REG 460.6 DEG.C
	8 AMPS 1293. AMPS		PAMPC 1240. KPA	T15REG 343.1 DEG.C
	9 QDISPG 4. WATTS	ENGINE SPEED	DISPCP 2.66 CM	T16REG****** DEG.C
	10 QDISP 19. WATTS	FREQ 31.8 HZ	PISTCP 2.39 CM	T17REG 329.5 DEG.C
	11 QREG1 98. WATTS		PDYNDB 1300. KPA	T18REG 339.7 DEG.C
	12 QREG2 98. WATTS		PDLCLR****** KPA	T19REG 218.5 DEG.C
	13 QREG3 30. WATTS		PDLREG****** KPA	
	14 PFP 1027.4 KPA/CM		PDLDIS****** KPA	T03HED****** DEG.C
	15 PFD 280.9 KPA/CM			
	16 NBEALE 0.00607			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:33:18.88 RDG 934

FLUID HELIUM BAROM 14.263 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.20 L/MIN
TWINDP 16.7 DEG.C
TDLDP 2.81 DEG.C
TWODPR 20.0 DEG.C

POWER IN
AMPS1 692. AMPS
AMPS2 669. AMPS
VOLTG 3.02 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7454. KPA
MEANBP 7000. KPA
MEANCP 7034. KPA

GAS TEMPERATURES
TGEXP 733.3 DEG.C
TGREGH 488.0 DEG.C
TGREGC 101.2 DEG.C
TGCOMP 59.0 DEG.C
TGBOUN 38.9 DEG.C

SURFACE TEMPERATU
T01HTR 553.2 DEG.
T02HTR 555.6 DEG.
T03HTR 561.1 DEG.
T04HTR 543.9 DEG.
T05HTR 545.9 DEG.
T06HTR 551.0 DEG.
T07HTR 515.5 DEG.
T08HTR 554.1 DEG.
T09HTR 563.0 DEG.
T10HTR 552.3 DEG.
T11HTR 547.2 DEG.
T12HTR 550.8 DEG.
T13REG****** DEG.
T14REG 458.6 DEG.
T15REG 340.1 DEG.
T16REG****** DEG.
T17REG 332.7 DEG.
T18REG 338.4 DEG.
T19REG 216.6 DEG.
T03HED****** DEG.

HEAT TO COOLER
FLOCLR 4.23 L/MIN
TWINCL 25.1 DEG.C
TDLCL 9.24 DEG.C
TWOCLR 34.47 DEG.C

CALCULATED PARAMETERS
1 PWRIN 4107. WATTS
2 QCOOLR 2715. WATTS
3 QDSHPT 822. WATTS
4 EXTEFF 22.4 %
5 TAVHTR 549.5 DEG.C
6 INTEFF 25.3 %
8 AMPS 1361. AMPS
9 QDISPG 4. WATTS
10 QDISP 19. WATTS
11 QREG1 99. WATTS
12 QREG2 97. WATTS
13 QREG3 30. WATTS
14 PFP 1028.0 KPA/CM
15 PFD 276.9 KPA/CM
16 NBEALE 0.00621

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 9.1 CM/S

PHASE ANGLES
PADISP 83.9 DEG.
PAPRES -13.0 DEG.

ENGINE SPEED
FREQ 31.7 HZ

REMOTE CALCULATIONS
PWROUT 919. WATTS
INDPWR 977. WATTS
PISTST 2.60 CM
DISPST 2.19 CM

DYNAMIC CALCULATIONS
PAMPC 1339. KPA
DISPCP 2.70 CM
PISTCP 2.36 CM
PDYNDB 1425. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:38:18.88 RDG 935

FLUID HELIUM BAROM 14.263 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.17 L/MIN
TWINDP 16.7 DEG.C
TDLDP 2.99 DEG.C
TWODPR 20.3 DEG.C

POWER IN
AMPS1 724. AMPS
AMPS2 694. AMPS
VOLTG 3.15 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7132. KPA
MEANBP 6990. KPA
MEANCP 7027. KPA

GAS TEMPERATURES
TGEXP 746.2 DEG.C
TGREGH 487.6 DEG.C
TGREGC 104.2 DEG.C
TGCOMP 62.8 DEG.C
TGBOUN 40.0 DEG.C

SURFACE TEMPERATUR
T01HTR 554.5 DEG.
T02HTR 555.4 DEG.
T03HTR 562.4 DEG.
T04HTR 543.8 DEG.
T05HTR 546.5 DEG.
T06HTR 551.5 DEG.
T07HTR 514.7 DEG.
T08HTR 554.7 DEG.
T09HTR 564.6 DEG.
T10HTR 553.5 DEG.
T11HTR 548.3 DEG.
T12HTR 550.7 DEG.
T13REG****** DEG.
T14REG 457.8 DEG.
T15REG 339.7 DEG.
T16REG****** DEG.
T17REG 335.1 DEG.
T18REG 338.7 DEG.
T19REG 218.3 DEG.
T03HED****** DEG.

HEAT TO COOLER
FLOCLR 4.24 L/MIN
TWINCL 25.2 DEG.C
TDLCL 10.08 DEG.C
TWOCLR 35.43 DEG.C

CALCULATED PARAMETERS
1 PWRIN 4467. WATTS
2 QCOOLR 2967. WATTS
3 QDSHPT 869. WATTS
4 EXTEFF 22.0 %
5 TAVHTR 550.1 DEG.C
6 INTEFF 24.9 %
8 AMPS 1418. AMPS
9 QDISPG 4. WATTS
10 QDISP 19. WATTS
11 QREG1 98. WATTS
12 QREG2 97. WATTS
13 QREG3 30. WATTS
14 PFP 1020.0 KPA/CM
15 PFD 263.5 KPA/CM
16 NBEALE 0.00621

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 9.7 CM/S

PHASE ANGLES
PADISP 83.7 DEG.
PAPRES -12.2 DEG.

ENGINE SPEED
FREQ 31.5 HZ

REMOTE CALCULATIONS
PWROUT 981. WATTS
INDPWR 1042. WATTS
PISTST 2.79 CM
DISPST 2.30 CM

DYNAMIC CALCULATIONS
PAMPC 1422. KPA
DISPCP 2.71 CM
PISTCP 2.35 CM
PDYNDB 1519. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:43:18.91 RDG 936

FLUID HELIUM BAROM 14.263 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.17 L/MIN
TWINDP 16.7 DEG.C
TDLDP 3.27 DEG.C
TWODPR 20.5 DEG.C

POWER IN
AMPS1 762. AMPS
AMPS2 723. AMPS
VOLTG 3.30 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7470. KPA
MEANBP 7007. KPA
MEANCP 7036. KPA

GAS TEMPERATURES
TGEXP 766.9 DEG.C
TGREGH 486.6 DEG.C
TGREGC 107.3 DEG.C
TGCOMP 67.0 DEG.C
TGBOUN 41.2 DEG.C

SURFACE TEMPERATUR
T01HTR 555.6 DEG.
T02HTR 555.1 DEG.
T03HTR 563.9 DEG.
T04HTR 542.8 DEG.
T05HTR 546.7 DEG.
T06HTR 551.8 DEG.
T07HTR 513.0 DEG.
T08HTR 554.7 DEG.
T09HTR 565.1 DEG.
T10HTR 554.8 DEG.
T11HTR 548.9 DEG.
T12HTR 550.4 DEG.
T13REG****** DEG.
T14REG 457.2 DEG.
T15REG 339.7 DEG.
T16REG****** DEG.
T17REG 337.7 DEG.
T18REG 338.1 DEG.
T19REG 220.3 DEG.
T03HED****** DEG.

HEAT TO COOLER
FLOCLR 4.29 L/MIN
TWINCL 25.2 DEG.C
TDLCL 11.07 DEG.C
TWOCLR 36.46 DEG.C

CALCULATED PARAMETERS
1 PWRIN 4898. WATTS
2 QCOOLR 3294. WATTS
3 QDSHPT 949. WATTS
4 EXTEFF 21.5 %
5 TAVHTR 550.2 DEG.C
6 INTEFF 24.2 %
8 AMPS 1485. AMPS
9 QDISPG 4. WATTS
10 QDISP 20. WATTS
11 QREG1 95. WATTS
12 QREG2 97. WATTS
13 QREG3 29. WATTS
14 PFP 1027.2 KPA/CM
15 PFD 256.0 KPA/CM
16 NBEALE 0.00621

VIBRATION
VX1HOR 0.4 CM/S
VY1VER10.3 CM/S

PHASE ANGLES
PADISP 83.6 DEG.
PAPRES -11.5 DEG.

ENGINE SPEED
FREQ 31.5 HZ

REMOTE CALCULATIONS
PWROUT 1051. WATTS
INDPWR 1113. WATTS
PISTST 2.99 CM
DISPST 2.40 CM

DYNAMIC CALCULATIONS
PAMPC 1531. KPA
DISPCP 2.73 CM
PISTCP 2.32 CM
PDYNDB 1613. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:48:18.91 RDG 937

FLUID HELIUM BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

AT TO DASHPOT COOLING	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES
FLODP 4.16 L/MIN	AMPS1 796. AMPS		PRESUP 7263. KPA		TGEXP 794.8 DEG.C		T01HTR 555.3 DEG.C
	AMPS2 745. AMPS						T02HTR 553.4 DEG.C
TWINDP 16.8 DEG.C	VOLTG 3.43 VOLTS		MEANBP 6991. KPA		TGREGH 484.9 DEG.C		T03HTR 563.6 DEG.C
TDLDP 3.41 DEG.C			MEANCP 7052. KPA		TGREGC 109.6 DEG.C		T04HTR 540.9 DEG.C
TWODPR 20.9 DEG.C					TGCOMP 70.9 DEG.C		T05HTR 545.2 DEG.C
					TGBOUN 42.3 DEG.C		T06HTR 550.7 DEG.C
							T07HTR 510.3 DEG.C
							T08HTR 553.8 DEG.C
							T09HTR 564.8 DEG.C
AT TO COOLER	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR 554.3 DEG.C
FLOCLR 4.29 L/MIN	1 PWRIN 5287. WATTS		VX1HOR 0.4 CM/S		PWROUT 1119. WATTS		T11HTR 548.3 DEG.C
TWINCL 25.3 DEG.C	2 QCOOLR 3592. WATTS		VY1VER10.9 CM/S		INDPWR 1168. WATTS		T12HTR 548.8 DEG.C
TDLCL 12.07 DEG.C	3 QDSHPT 987. WATTS				PISTST 3.19 CM		
TWOCLR 37.61 DEG.C	4 EXTEFF 21.2 %		PHASE ANGLES		DISPST 2.50 CM		
	5 TAVHTR 549.1 DEG.C		PADISP 83.3 DEG.				T13REG****** DEG.C
	6 INTEFF 23.7 %		PAPRES -10.6 DEG.		DYNAMIC CALCULATIONS		T14REG 453.6 DEG.C
	8 AMPS 1541. AMPS				PAMPC 1629. KPA		T15REG 337.9 DEG.C
	9 QDISPG 4. WATTS		ENGINE SPEED		DISPCP 2.78 CM		T16REG****** DEG.C
	10 QDISP 21. WATTS		FREQ 31.4 HZ		PISTCP 2.26 CM		T17REG 338.8 DEG.C
	11 QREG1 94. WATTS				PDYNDB 1675. KPA		T18REG 337.9 DEG.C
	12 QREG2 94. WATTS				PDLCLR****** KPA		T19REG 222.1 DEG.C
	13 QREG3 29. WATTS				PDLREG****** KPA		
	14 PFP 1024.9 KPA/CM				PDLDIS****** KPA		T03HED****** DEG.C
	15 PFD 240.9 KPA/CM						
	16 NBEALE 0.00622						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:51:21.91 RDG 938

FLUID HELIUM BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

T TO DASHPOT COOLING	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES
LODP 4.16 L/MIN	AMPS1 836. AMPS		PRESUP 7132. KPA		TGEXP 811.7 DEG.C		T01HTR 556.4 DEG.C
	AMPS2 783. AMPS						T02HTR 554.2 DEG.C
WINDP 16.9 DEG.C	VOLTG 3.60 VOLTS		MEANBP 7008. KPA		TGREGH 484.0 DEG.C		T03HTR 565.6 DEG.C
DLDP 3.60 DEG.C			MEANCP 7069. KPA		TGREGC 113.0 DEG.C		T04HTR 540.9 DEG.C
WODPR 21.1 DEG.C					TGCOMP 75.4 DEG.C		T05HTR 546.1 DEG.C
					TGBOUN 43.1 DEG.C		T06HTR 551.1 DEG.C
							T07HTR 509.1 DEG.C
							T08HTR 555.1 DEG.C
							T09HTR 566.5 DEG.C
T TO COOLER	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR 555.6 DEG.C
LOCLR 4.27 L/MIN	1 PWRIN 5831. WATTS		VX1HOR 0.5 CM/S		PWROUT 1144. WATTS		T11HTR 549.8 DEG.C
WINCL 25.4 DEG.C	2 QCOOLR 3944. WATTS		VY1VER11.6 CM/S		INDPWR 1191. WATTS		T12HTR 549.4 DEG.C
DLCL 13.30 DEG.C	3 QDSHPT 1042. WATTS				PISTST 3.39 CM		
WOCLR 38.73 DEG.C	4 EXTEFF 19.6 %		PHASE ANGLES		DISPST 2.53 CM		
	5 TAVHTR 550.0 DEG.C		PADISP 84.5 DEG.				T13REG****** DEG.C
	6 INTEFF 22.5 %		PAPRES -9.7 DEG.		DYNAMIC CALCULATIONS		T14REG 453.3 DEG.C
	8 AMPS 1618. AMPS				PAMPC 1747. KPA		T15REG 339.9 DEG.C
	9 QDISPG 4. WATTS		ENGINE SPEED		DISPCP 2.82 CM		T16REG****** DEG.C
	10 QDISP 21. WATTS		FREQ 31.4 HZ		PISTCP 2.19 CM		T17REG 340.2 DEG.C
	11 QREG1 92. WATTS				PDYNDB 1763. KPA		T18REG 339.7 DEG.C
	12 QREG2 92. WATTS				PDLCLR****** KPA		T19REG 226.3 DEG.C
	13 QREG3 29. WATTS				PDLREG****** KPA		
	14 PFP 1032.2 KPA/CM				PDLDIS****** KPA		T03HED****** DEG.C
	15 PFD 234.0 KPA/CM						
	16 NBEALE 0.00597						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:00:18.91 RDG 939

FLUID HELIUM BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

AT TO DASHPOT COOLING	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES
FLODP 4.20 L/MIN	AMPS1 564. AMPS		PRESUP 7105. KPA		TGEXP****** DEG.C		T01HTR 601.8 DEG.C
	AMPS2 560. AMPS						T02HTR 606.0 DEG.C
TWINDP 16.9 DEG.C	VOLTG 2.50 VOLTS		MEANBP 6989. KPA		TGREGH 542.8 DEG.C		T03HTR 609.0 DEG.C
TDLDP 2.18 DEG.C			MEANCP 7025. KPA		TGREGC 93.8 DEG.C		T04HTR 595.9 DEG.C
TWODPR 19.5 DEG.C					TGCOMP 46.4 DEG.C		T05HTR 596.1 DEG.C
					TGBOUN 39.9 DEG.C		T06HTR 603.7 DEG.C
							T07HTR 569.5 DEG.C
							T08HTR 606.4 DEG.C
							T09HTR 609.0 DEG.C
AT TO COOLER	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR 601.4 DEG.C
FLOCLR 4.24 L/MIN	1 PWRIN 2812. WATTS		VX1HOR 0.3 CM/S		PWROUT 640. WATTS		T11HTR 597.6 DEG.C
TWINCL 24.9 DEG.C	2 QCOOLR 1842. WATTS		VY1VER 6.6 CM/S		INDPWR 695. WATTS		T12HTR 603.2 DEG.C
TDLCL 6.26 DEG.C	3 QDSHPT 637. WATTS				PISTST 1.79 CM		
TWOCLR 31.39 DEG.C	4 EXTEFF 22.8 %		PHASE ANGLES		DISPST 1.73 CM		
	5 TAVHTR 600.0 DEG.C		PADISP 82.5 DEG.				T13REG****** DEG.C
	6 INTEFF 25.8 %		PAPRES -18.2 DEG.		DYNAMIC CALCULATIONS		T14REG 505.8 DEG.C
	8 AMPS 1124. AMPS				PAMPC 945. KPA		T15REG 371.1 DEG.C
	9 QDISPG****** WATTS		ENGINE SPEED		DISPCP 2.60 CM		T16REG****** DEG.C
	10 QDISP ****** WATTS		FREQ 32.3 HZ		PISTCP 2.38 CM		T17REG 363.5 DEG.C
	11 QREG1 115. WATTS				PDYNDB 1088. KPA		T18REG 369.2 DEG.C
	12 QREG2 111. WATTS				PDLCLR****** KPA		T19REG 227.3 DEG.C
	13 QREG3 35. WATTS				PDLREG****** KPA		
	14 PFP 1044.0 KPA/CM				PDLDIS****** KPA		T03HED****** DEG.C
	15 PFD 343.2 KPA/CM						
	16 NBEALE 0.00615						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:05:21.91 RDG 940

FLUID HELIUM BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.25 L/MIN
TWINDP 16.9 DEG.C
TDLDP 2.15 DEG.C
TWODPR 19.7 DEG.C

POWER IN
AMPS1 619. AMPS
AMPS2 577. AMPS
VOLTG 2.67 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7476. KPA
MEANBP 7007. KPA
MEANCP 7052. KPA

GAS TEMPERATURES
TGEXP1030.6 DEG.C
TGREGH 537.5 DEG.C
TGREGC 95.6 DEG.C
TGCOMP 48.3 DEG.C
TGBOUN 39.3 DEG.C

SURFACE TEMPERATURES
T01HTR 599.3 DEG.C
T02HTR 604.9 DEG.C
T03HTR 607.6 DEG.C
T04HTR 593.1 DEG.C
T05HTR 594.6 DEG.C
T06HTR 599.8 DEG.C
T07HTR 567.2 DEG.C
T08HTR 603.1 DEG.C
T09HTR 607.8 DEG.C
T10HTR 599.0 DEG.C
T11HTR 594.7 DEG.C
T12HTR 600.9 DEG.C
T13REG****** DEG.C
T14REG 503.9 DEG.C
T15REG 372.4 DEG.C
T16REG****** DEG.C
T17REG 360.5 DEG.C
T18REG 367.8 DEG.C
T19REG 230.4 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.24 L/MIN
TWINCL 24.8 DEG.C
TDLCL 6.71 DEG.C
TWOCLR 31.85 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3189. WATTS
2 QCOOLR 1976. WATTS
3 QDSHPT 635. WATTS
4 EXTEFF 23.1 %
5 TAVHTR 597.7 DEG.C
6 INTEFF 27.2 %
8 AMPS 1196. AMPS
9 QDISPG 6. WATTS
10 QDISP 28. WATTS
11 QREG1 111. WATTS
12 QREG2 110. WATTS
13 QREG3 34. WATTS
14 PFP 1036.2 KPA/CM
15 PFD 332.4 KPA/CM
16 NBEALE 0.00638

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 7.3 CM/S

PHASE ANGLES
PADISP 83.1 DEG.
PAPRES -17.1 DEG.

ENGINE SPEED
FREQ 32.2 HZ

REMOTE CALCULATIONS
PWROUT 738. WATTS
INDPWR 802. WATTS
PISTST 2.00 CM
DISPST 1.86 CM

DYNAMIC CALCULATIONS
PAMPC 1043. KPA
DISPCP 2.62 CM
PISTCP 2.43 CM
PDYNDB 1163. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:10:18.91 RDG 941

FLUID HELIUM BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.35 L/MIN
TWINDP 16.9 DEG.C
TDLDP 2.28 DEG.C
TWODPR 19.8 DEG.C

POWER IN
AMPS1 660. AMPS
AMPS2 601. AMPS
VOLTG 2.81 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7124. KPA
MEANBP 6999. KPA
MEANCP 7045. KPA

GAS TEMPERATURES
TGEXP 986.8 DEG.C
TGREGH 536.7 DEG.C
TGREGC 97.4 DEG.C
TGCOMP 51.3 DEG.C
TGBOUN 39.0 DEG.C

SURFACE TEMPERATURES
T01HTR 601.7 DEG.C
T02HTR 606.8 DEG.C
T03HTR 610.6 DEG.C
T04HTR 594.1 DEG.C
T05HTR 597.2 DEG.C
T06HTR 601.5 DEG.C
T07HTR 567.6 DEG.C
T08HTR 604.3 DEG.C
T09HTR 610.3 DEG.C
T10HTR 601.3 DEG.C
T11HTR 596.1 DEG.C
T12HTR 602.9 DEG.C
T13REG****** DEG.C
T14REG 505.4 DEG.C
T15REG 374.0 DEG.C
T16REG****** DEG.C
T17REG 360.6 DEG.C
T18REG 369.3 DEG.C
T19REG 233.3 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.22 L/MIN
TWINCL 24.8 DEG.C
TDLCL 7.51 DEG.C
TWOCLR 32.55 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3547. WATTS
2 QCOOLR 2199. WATTS
3 QDSHPT 690. WATTS
4 EXTEFF 23.2 %
5 TAVHTR 599.5 DEG.C
6 INTEFF 27.2 %
8 AMPS 1261. AMPS
9 QDISPG 5. WATTS
10 QDISP 27. WATTS
11 QREG1 110. WATTS
12 QREG2 110. WATTS
13 QREG3 34. WATTS
14 PFP 1025.3 KPA/CM
15 PFD 315.8 KPA/CM
16 NBEALE 0.00649

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 7.9 CM/S

PHASE ANGLES
PADISP 83.9 DEG.
PAPRES -15.8 DEG.

ENGINE SPEED
FREQ 32.2 HZ

REMOTE CALCULATIONS
PWROUT 822. WATTS
INDPWR 892. WATTS
PISTST 2.19 CM
DISPST 1.97 CM

DYNAMIC CALCULATIONS
PAMPC 1132. KPA
DISPCP 2.64 CM
PISTCP 2.44 CM
PDYNDB 1288. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:15:18.94 RDG 942

FLUID HELIUM BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.34 L/MIN
TWINDP 16.9 DEG.C
TDLDP 2.48 DEG.C
TWODPR 20.0 DEG.C

POWER IN
AMPS1 696. AMPS
AMPS2 631. AMPS
VOLTG 2.96 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7458. KPA
MEANBP 6996. KPA
MEANCP 7047. KPA

GAS TEMPERATURES
TGEXP 951.3 DEG.C
TGREGH 535.0 DEG.C
TGREGC 100.2 DEG.C
TGCOMP 54.6 DEG.C
TGBOUN 39.4 DEG.C

SURFACE TEMPERATURES
T01HTR 602.5 DEG.C
T02HTR 607.0 DEG.C
T03HTR 612.0 DEG.C
T04HTR 593.9 DEG.C
T05HTR 597.7 DEG.C
T06HTR 601.2 DEG.C
T07HTR 566.7 DEG.C
T08HTR 604.3 DEG.C
T09HTR 611.7 DEG.C
T10HTR 601.9 DEG.C
T11HTR 596.4 DEG.C
T12HTR 602.7 DEG.C
T13REG****** DEG.C
T14REG 504.3 DEG.C
T15REG 373.6 DEG.C
T16REG****** DEG.C
T17REG 360.1 DEG.C
T18REG 370.5 DEG.C
T19REG 234.8 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.24 L/MIN
TWINCL 24.9 DEG.C
TDLCL 8.39 DEG.C
TWOCLR 33.45 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3929. WATTS
2 QCOOLR 2471. WATTS
3 QDSHPT 750. WATTS
4 EXTEFF 23.1 %
5 TAVHTR 599.8 DEG.C
6 INTEFF 26.9 %
8 AMPS 1327. AMPS
9 QDISPG 5. WATTS
10 QDISP 25. WATTS
11 QREG1 110. WATTS
12 QREG2 108. WATTS
13 QREG3 34. WATTS
14 PFP 1033.5 KPA/CM
15 PFD 308.4 KPA/CM
16 NBEALE 0.00659

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 8.6 CM/S

PHASE ANGLES
PADISP 83.8 DEG.
PAPRES -14.9 DEG.

ENGINE SPEED
FREQ 32.0 HZ

REMOTE CALCULATIONS
PWROUT 908. WATTS
INDPWR 988. WATTS
PISTST 2.40 CM
DISPST 2.09 CM

DYNAMIC CALCULATIONS
PAMPC 1245. KPA
DISPCP 2.61 CM
PISTCP 2.45 CM
PDYNDB 1375. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:24:31.06 RDG 943

FLUID HELIUM BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES
FLODP	4.34 L/MIN	AMPS1	730. AMPS	PRESUP	7459. KPA	TGEXP	900.7 DEG.C	T01HTR 602.5 DEG.C
		AMPS2	660. AMPS					T02HTR 605.8 DEG.C
TWINDP	16.9 DEG.C	VOLTG	3.10 VOLTS					T03HTR 612.3 DEG.C
TDLDP	2.75 DEG.C			MEANBP	7007. KPA	TGREGH	532.2 DEG.C	T04HTR 592.2 DEG.C
TWODPR	20.3 DEG.C			MEANCP	7059. KPA	TGREGC	103.1 DEG.C	T05HTR 597.3 DEG.C
						TGCOMP	58.6 DEG.C	T06HTR 600.1 DEG.C
						TGBOUN	40.2 DEG.C	T07HTR 564.5 DEG.C
								T08HTR 602.7 DEG.C
								T09HTR 611.6 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR 601.8 DEG.C
FLOCLR	4.26 L/MIN	1 PWRIN	4314. WATTS	VX1HOR	0.5 CM/S	PWROUT	1001. WATTS	T11HTR 595.6 DEG.C
TWINCL	25.0 DEG.C	2 QCOOLR	2723. WATTS	VY1VER	9.2 CM/S	INDPWR	1078. WATTS	T12HTR 601.5 DEG.C
TDLCL	34.45 DEG.C	3 QDSHPT	831. WATTS			PISTST	2.59 CM	
TWOCLR		4 EXTEFF	23.2 %	PHASE ANGLES		DISPST	2.20 CM	T13REG****** DEG.C
		5 TAVHTR	599.0 DEG.C	PADISP	83.7 DEG.			T14REG 502.8 DEG.C
		6 INTEFF	26.9 %	PAPRES	-14.3 DEG.	DYNAMIC CALCULATIONS		T15REG 373.7 DEG.C
		8 AMPS	1390. AMPS			PAMPC	1339. KPA	T16REG****** DEG.C
		9 QDISPG	5. WATTS	ENGINE SPEED		DISPCP	2.68 CM	T17REG 359.9 DEG.C
		10 QDISP	24. WATTS	FREQ	31.9 HZ	PISTCP	2.48 CM	T18REG 370.5 DEG.C
		11 QREG1	108. WATTS			PDYNDB	1450. KPA	T19REG 237.4 DEG.C
		12 QREG2	107. WATTS			PDLCLR******	KPA	
		13 QREG3	33. WATTS			PDLREG******	KPA	T03HED****** DEG.C
		14 PFP	1029.1 KPA/CM			PDLDIS******	KPA	
		15 PFD	301.7 KPA/CM					
		16 NBEALE	0.00674					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:28:19.08 RDG 944

FLUID HELIUM BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURE
FLODP	4.33 L/MIN	AMPS1	765. AMPS	PRESUP	7439. KPA	TGEXP	898.6 DEG.C	T01HTR 603.5 DEG.C
		AMPS2	689. AMPS					T02HTR 604.9 DEG.C
TWINLP	16.9 DEG.C	VOLTG	3.25 VOLTS					T03HTR 612.9 DEG.C
TDLDP	2.97 DEG.C			MEANBP	6982. KPA	TGREGH	532.0 DEG.C	T04HTR 591.7 DEG.C
TWODPR	20.5 DEG.C			MEANCP	7031. KPA	TGREGC	106.5 DEG.C	T05HTR 596.8 DEG.C
						TGCOMP	62.7 DEG.C	T06HTR 599.9 DEG.C
						TGBOUN	40.7 DEG.C	T07HTR 563.0 DEG.C
								T08HTR 603.2 DEG.C
								T09HTR 613.2 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR 602.7 DEG.C
FLOCLR	4.27 L/MIN	1 PWRIN	4725. WATTS	VX1HOR	0.5 CM/S	PWROUT	1095. WATTS	T11HTR 597.1 DEG.C
TWINCL	25.1 DEG.C	2 QCOOLR	2991. WATTS	VY1VER	9.9 CM/S	INDPWR	1171. WATTS	T12HTR 600.1 DEG.C
TDLCL	10.10 DEG.C	3 QDSHPT	895. WATTS			PISTST	2.81 CM	
TWOCLR	35.40 DEG.C	4 EXTEFF	23.2 %	PHASE ANGLES		DISPST	2.32 CM	T13REG****** DEG.C
		5 TAVHTR	599.1 DEG.C	PADISP	82.5 DEG.			T14REG 501.0 DEG.C
		6 INTEFF	26.8 %	PAPRES	-13.6 DEG.	DYNAMIC CALCULATIONS		T15REG 371.8 DEG.C
		8 AMPS	1455. AMPS			PAMPC	1437. KPA	T16REG****** DEG.C
		9 QDISPG	5. WATTS	ENGINE SPEED		DISPCP	2.70 CM	T17REG 362.9 DEG.C
		10 QDISP	24. WATTS	FREQ	31.6 HZ	PISTCP	2.46 CM	T18REG 367.9 DEG.C
		11 QREG1	106. WATTS			PDYNDB	1500. KPA	T19REG 237.5 DEG.C
		12 QREG2	108. WATTS			PDLCLR******	KPA	
		13 QREG3	33. WATTS			PDLREG******	KPA	T03HED****** DEG.C
		14 PFP	1026.6 KPA/CM			PDLDIS******	KPA	
		15 PFD	294.4 KPA/CM					
		16 NBEALE	0.00688					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:32:22.08 RDG 945

FLUID HELIUM BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

EAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES
FLODP	4.32 L/MIN	AMPS1	803. AMPS	PRESUP	7141. KPA	TGEXP	921.7 DEG.C	T01HTR 604.3 DEG.C
		AMPS2	721. AMPS					T02HTR 604.0 DEG.C
TWINDP	17.0 DEG.C	VOLTG	3.40 VOLTS					T03HTR 613.6 DEG.C
TDLDP	3.24 DEG.C			MEANBP	7036. KPA	TGREGH	531.0 DEG.C	T04HTR 590.8 DEG.C
TWODPR	20.8 DEG.C			MEANCP	7105. KPA	TGREGC	110.4 DEG.C	T05HTR 596.2 DEG.C
						TGCOMP	67.4 DEG.C	T06HTR 599.8 DEG.C
						TGBOUN	42.1 DEG.C	T07HTR 560.6 DEG.C
								T08HTR 603.5 DEG.C
								T09HTR 614.0 DEG.C
EAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR 603.4 DEG.C
FLOCLR	4.25 L/MIN	1 PWRIN	5185. WATTS	VX1HOR	0.5 CM/S	PWROUT	1187. WATTS	T11HTR 597.8 DEG.C
TWINCL	25.1 DEG.C	2 QCOOLR	3303. WATTS	VY1VER	10.5 CM/S	INDPWR	1260. WATTS	T12HTR 599.2 DEG.C
TDLCL	11.19 DEG.C	3 QDSHPT	975. WATTS			PISTST	2.99 CM	
TWOCLR	36.56 DEG.C	4 EXTEFF	22.9 %	PHASE ANGLES		DISPST	2.42 CM	T13REG****** DEG.C
		5 TAVHTR	598.9 DEG.C	PADISP	82.9 DEG.			T14REG 499.3 DEG.C
		6 INTEFF	26.4 %	PAPRES	-12.8 DEG.	DYNAMIC CALCULATIONS		T15REG 370.6 DEG.C
		8 AMPS	1524. AMPS			PAMPC	1540. KPA	T16REG****** DEG.C
		9 QDISPG	5. WATTS	ENGINE SPEED		DISPCP	2.72 CM	T17REG 365.1 DEG.C
		10 QDISP	24. WATTS	FREQ	31.7 HZ	PISTCP	2.41 CM	T18REG 367.9 DEG.C
		11 QREG1	105. WATTS			PDYNDB	1588. KPA	T19REG 238.3 DEG.C
		12 QREG2	107. WATTS			PDLCLR******	KPA	
		13 QREG3	33. WATTS			PDLREG******	KPA	T03HED****** DEG.C
		14 PFP	1032.1 KPA/CM			PDLDIS******	KPA	
		15 PFD	284.2 KPA/CM					
		16 NBEALE	0.00693					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:35:28.08 RDG 946

FLUID HELIUM BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.30 L/MIN
TWINDP 17.1 DEG.C
TDLDP 3.45 DEG.C
TWODPR 21.1 DEG.C

POWER IN
AMPS1 829. AMPS
AMPS2 758. AMPS
VOLTG 3.54 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7448. KPA
MEANBP 7005. KPA
MEANCP 7072. KPA

GAS TEMPERATURES
TGEXP 969.6 DEG.C
TGREGH 531.8 DEG.C
TGREGC 113.5 DEG.C
TGCOMP 70.9 DEG.C
TGBOUN 42.9 DEG.C

SURFACE TEMPERATURE
T01HTR 607.8 DEG.C
T02HTR 603.5 DEG.C
T03HTR 616.3 DEG.C
T04HTR 590.5 DEG.C
T05HTR 596.4 DEG.C
T06HTR 602.2 DEG.C
T07HTR 558.9 DEG.C
T08HTR 604.7 DEG.C
T09HTR 615.1 DEG.C
T10HTR 606.8 DEG.C
T11HTR 599.6 DEG.C
T12HTR 599.0 DEG.C
T13REG****** DEG.C
T14REG 497.7 DEG.C
T15REG 368.7 DEG.C
T16REG****** DEG.C
T17REG 370.2 DEG.C
T18REG 369.9 DEG.C
T19REG 238.2 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.27 L/MIN
TWINCL 25.2 DEG.C
TDLCL 12.10 DEG.C
TWOCLR 37.42 DEG.C

CALCULATED PARAMETERS
1 PWRIN 5619. WATTS
2 QCOOLR 3587. WATTS
3 QDSHPT 1034. WATTS
4 EXTEFF 22.7 %
5 TAVHTR 600.1 DEG.C
6 INTEFF 26.2 %
8 AMPS 1587. AMPS
9 QDISPG 5. WATTS
10 QDISP 26. WATTS
11 QREG1 107. WATTS
12 QREG2 104. WATTS
13 QREG3 32. WATTS
14 PFP 1036.2 KPA/CM
15 PFD 278.1 KPA/CM
16 NBEALE 0.00702

VIBRATION
VX1HOR 0.6 CM/S
VY1VER11.2 CM/S

PHASE ANGLES
PADISP 82.1 DEG.
PAPRES -12.2 DEG.

ENGINE SPEED
FREQ 31.6 HZ

REMOTE CALCULATIONS
PWROUT 1274. WATTS
INDPWR 1348. WATTS
PISTST 3.19 CM
DISPST 2.53 CM

DYNAMIC CALCULATIONS
PAMPC 1644. KPA
DISPCP 2.80 CM
PISTCP 2.30 CM
PDYNDB 1700. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:37:28.08 RDG 947

FLUID HELIUM BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.33 L/MIN
TWINDP 17.1 DEG.C
TDLDP 3.67 DEG.C
TWODPR 21.4 DEG.C

POWER IN
AMPS1 844. AMPS
AMPS2 805. AMPS
VOLTG 3.68 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7445. KPA
MEANBP 6998. KPA
MEANCP 7074. KPA

GAS TEMPERATURES
TGEXP1005.3 DEG.C
TGREGH 531.1 DEG.C
TGREGC 117.2 DEG.C
TGCOMP 75.3 DEG.C
TGBOUN 43.5 DEG.C

SURFACE TEMPERATURE
T01HTR 608.8 DEG.C
T02HTR 603.4 DEG.C
T03HTR 617.5 DEG.C
T04HTR 589.7 DEG.C
T05HTR 596.9 DEG.C
T06HTR 602.3 DEG.C
T07HTR 557.6 DEG.C
T08HTR 604.9 DEG.C
T09HTR 616.2 DEG.C
T10HTR 607.7 DEG.C
T11HTR 600.4 DEG.C
T12HTR 599.0 DEG.C
T13REG****** DEG.C
T14REG 498.2 DEG.C
T15REG 371.0 DEG.C
T16REG****** DEG.C
T17REG 372.2 DEG.C
T18REG 371.5 DEG.C
T19REG 242.1 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.27 L/MIN
TWINCL 25.2 DEG.C
TDLCL 13.21 DEG.C
TWOCLR 38.48 DEG.C

CALCULATED PARAMETERS
1 PWRIN 6067. WATTS
2 QCOOLR 3910. WATTS
3 QDSHPT 1106. WATTS
4 EXTEFF 22.1 %
5 TAVHTR 600.4 DEG.C
6 INTEFF 25.5 %
8 AMPS 1649. AMPS
9 QDISPG 5. WATTS
10 QDISP 26. WATTS
11 QREG1 105. WATTS
12 QREG2 103. WATTS
13 QREG3 32. WATTS
14 PFP 1046.3 KPA/CM
15 PFD 272.4 KPA/CM
16 NBEALE 0.00697

VIBRATION
VX1HOR 0.6 CM/S
VY1VER11.8 CM/S

PHASE ANGLES
PADISP 82.4 DEG.
PAPRES -11.4 DEG.

ENGINE SPEED
FREQ 31.6 HZ

REMOTE CALCULATIONS
PWROUT 1340. WATTS
INDPWR 1410. WATTS
PISTST 3.38 CM
DISPST 2.57 CM

DYNAMIC CALCULATIONS
PAMPC 1757. KPA
DISPCP 2.82 CM
PISTCP 2.19 CM
PDYNDB 1763. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:40:31.08 RDG 948

FLUID HELIUM BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.31 L/MIN
TWINDP 17.2 DEG.C
TDLDP 3.92 DEG.C
TWODPR 21.7 DEG.C

POWER IN
AMPS1 859. AMPS
AMPS2 865. AMPS
VOLTG 3.86 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7112. KPA
MEANBP 6998. KPA
MEANCP 7094. KPA

GAS TEMPERATURES
TGEXP 605.1 DEG.C
TGREGH 532.2 DEG.C
TGREGC 121.7 DEG.C
TGCOMP 80.3 DEG.C
TGBOUN 44.7 DEG.C

SURFACE TEMPERATURE
T01HTR 612.9 DEG.C
T02HTR 607.0 DEG.C
T03HTR 622.4 DEG.C
T04HTR 592.7 DEG.C
T05HTR 601.0 DEG.C
T06HTR 605.5 DEG.C
T07HTR 559.8 DEG.C
T08HTR 608.5 DEG.C
T09HTR 621.0 DEG.C
T10HTR 612.1 DEG.C
T11HTR 604.4 DEG.C
T12HTR 602.3 DEG.C
T13REG****** DEG.C
T14REG 499.2 DEG.C
T15REG 372.6 DEG.C
T16REG****** DEG.C
T17REG 373.7 DEG.C
T18REG 372.0 DEG.C
T19REG 246.0 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.28 L/MIN
TWINCL 25.2 DEG.C
TDLCL 14.69 DEG.C
TWOCLR 39.99 DEG.C

CALCULATED PARAMETERS
1 PWRIN 6649. WATTS
2 QCOOLR 4363. WATTS
3 QDSHPT 1176. WATTS
4 EXTEFF 21.1 %
5 TAVHTR 604.1 DEG.C
6 INTEFF 24.3 %
8 AMPS 1724. AMPS
9 QDISPG 3. WATTS
10 QDISP 15. WATTS
11 QREG1 102. WATTS
12 QREG2 103. WATTS
13 QREG3 32. WATTS
14 PFP 1077.5 KPA/CM
15 PFD 279.5 KPA/CM
16 NBEALE 0.00683

VIBRATION
VX1HOR 0.6 CM/S
VY1VER12.5 CM/S

PHASE ANGLES
PADISP 81.6 DEG.
PAPRES -10.7 DEG.

ENGINE SPEED
FREQ 31.7 HZ

REMOTE CALCULATIONS
PWROUT 1400. WATTS
INDPWR 1495. WATTS
PISTST 3.60 CM
DISPST 2.58 CM

DYNAMIC CALCULATIONS
PAMPC 1919. KPA
DISPCP 2.89 CM
PISTCP 2.04 CM
PDYNDB 1888. KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

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TABLE I. - NUMBER OF DATA POINTS PER CONFIGURATION

[Regenerator and displacer 1 were designed for high efficiency. Regenerator and displacer 2 were designed for high power.]

Regenerator	Displacer	Power piston	Working fluid	Number of data points
No. 1	No. 1	Std	Helium	150
No. 1	No. 2	↓	↓	174
No. 2	No. 2	↓	↓	189
No. 2	No. 1	↓	↓	108
No. 1	↓	↓	Argon	12
No. 1	↓	↓	Nitrogen	64
No. 1	↓	Light	Helium	84

TABLE II. - DESCRIPTION OF THE GEOMETRY OF THE RE-1000

Number of cylinders	1
Housing weight, Kg (lb)	416 (917)
Type	free-piston with dashpot
Design working fluid	helium
Design frequency, Hz	30
Design pressure, Mpa	7.0
Bounce space volume, cm^3 ($in.^3$)	20,500 (1250)
Design power, W	1000
Design displacer phase angle	45
Cylinder bore, cm (in.)	5.722 (2.2527)
Maximum displacer 1 stroke, cm (in.)	4.01 (1.579)
Displacer 1 length, cm (in.)	15.21 (5.99)
Maximum displacer 2 stroke, cm (in.)	5.18 (2.039)
Displacer 2 length, cm (in.)	14.05 (5.53)
Maximum power piston stroke, cm (in.)	4.35 (1.713)
Cooler	
Description	135 rectangular gas passages
Passage width, cm (in.)	0.0508 (0.020)
Passage depth, cm (in.)	0.376 (0.148)
Length, cm (in.)	7.92 (3.118)
Flow area, cm^2 ($in.^2$)	2.58 (0.400)
Wetted perimeter, cm (in.)	115.2 (45.354)
Volume, cm3 (in.3)	20.42 (1.246)
Heater	
Description	tubular
Tube material	Inconel 718
Number of tubes	34
Tube length, cm (in.)	18.34 (7.220)
Tube inside diameter, mm (in.)	2.362 (0.093)
Tube outside diameter, mm (in.)	3.175 (0.125)
Design maximum wall temperature, °C (°F)	650 (1202)
Regenerator	
Length containing wire mesh, cm (in.)	6.446 (2.538)
Outside diameter, cm (in.)	7.18 (2.825)
Inside diameter, cm (in.)	6.07 (2.391)
Inner wall thickness, cm (in.)	0.13 (0.05)
Matrix material	304SS Metex
Wire diameter, mm (in.)	0.0889 (0.0035)
Porosity, regenerator 1, percent	75.9
Porosity, regenerator 2, percent	81.2
Weight of matrix, regenerator 1, g (lb)	139 (0.31)
Weight of matrix, regenerator 2, g (lb)	108 (0.24)
Pistons	
Standard power piston oscillating mass, kg (lb)	5.97 (13.17)
Light power piston oscillating mass, kg (lb)	3.48 (7.67)
Power piston diameter, cm (in.)	5.718 (2.2514)

TABLE II. - Continued

Displacer 1 mass, kg (lb)	0.426 (0.939)
Displacer 1 diameter, cm (in.)	5.67 (2.232)
Displacer 1 rod diameter, cm (in.)	1.663 (0.6548)
Displacer 1 bore, cm (in.)	1.666 (0.6560)
Displacer 2 mass, kg (lb)	0.381 (0.840)
Displacer 2 diameter, cm (in.)	5.67 (2.232)
Displacer 2 rod diameter, cm (in.)	1.806 (0.7110)
Displacer 2 bore, cm (in.)	1.808 (0.7118)
Dead volumes	
Displacer 1/cylinder annular gap, cm^3 ($in.^3$)	9.83 (0.60)
Displacer 2/cylinder annular gap, cm^3 ($in.^3$)	8.36 (0.51)
Expansion space instrumentation ports, cm^3 ($in.^3$)	1.64 (0.10)
Expansion space to heater tube junction, cm^3 ($in.^3$)	3.80 (0.23)
Heater tubes, cm^3 ($in.^3$)	27.4 (1.67)
Heater tube to regenerator plenum junction, cm^3 ($in.^3$)	5.90 (0.36)
Regenerator hot end plenum, cm^3 ($in.^3$)	4.10 (0.25)
Regenerator plenum ring, cm^3 ($in.^3$)	0.83 (0.05)
Instrumentation ports (heater/regenerator), cm^3 ($in.^3$)	1.64 (0.10)
Regenerator 1, cm^3 ($in.^3$)	56.1 (3.42)
Regenerator 2, cm^3 ($in.^3$)	69.1 (3.67)
Regenerator cold end plenum, cm^3 ($in.^3$)	4.23 (0.26)
Instrumentation ports (regenerator/cooler), cm^3 ($in.^3$)	3.41 (0.21)
Cooler, cm^3 ($in.^3$)	20.42 (1.25)
Cooler plenum at the compression space, cm^3 ($in.^3$)	7.15 (0.44)
Compression space instrumentation ports, cm^3 ($in.^3$)	3.15 (0.19)
Cylinder ports, cm^3 ($in.^3$)	1.21 (0.07)
Piston/spider clearance, cm^3 ($in.^3$)	18.4 (1.21)
Annular ring around the spider, cm^3 ($in.^3$)	3.82 (0.23)
Displacer LVDT core, cm^3 ($in.^3$)	2.95 (0.18)
Power piston center port, cm^3 ($in.^3$)	5.90 (0.36)
Materials	
Heater head	
Regenerator outer cylinder	316SS
Expansion space dome	316SS
Regenerator inner cylinder wall	316SS
Displacer	321SS
Cooler	6061-T6 Al
Cylinder	
Power piston	6061-T6 Al with chrome oxide coating
Displacer	304SS with chrome oxide coating
Standard power piston	6061-T6 Al body with Xylan Coating and mild steel mass
Light power piston	6061-T6 Al body with Xylan coating and Al mass
Diametral clearances	
Displacer 1 rod/rod cylinder, mm (in.)	0.030 (0.0012)
Displacer 1 body/displacer cylinder, mm (in.)	0.381 (0.015)
Displacer 2 rod/rod cylinder, mm (in.)	0.020 (0.0008)
Displacer 2 body/displacer cylinder, mm (in.)	0.381 (0.015)
Power piston/piston cylinder, mm (in.)	0.033 (0.001)

TABLE II. - Concluded

Displacer gas spring	
No. 1 design mean volume, cm^3 ($in.^3$)	31.79 (1.94)
No. 1 rod diameter, cm (in.)	1.663 (0.655)
No. 2 design mean volume, cm^3 ($in.^3$)	18.8 (1.147)
No. 2 rod diameter, cm (in.)	1.806 (0.711)
Center ports	
Power piston port location, distance from inward limit to center port opening position, cm (in.)	2.05 (0.81)
Displacer 1, distance from expansion space limit to position where the center port opens, cm (in.)	1.90 (0.75)
Displacer 2, distance from expansion space limit to position where the center port opens, cm (in.)	2.64 (1.04)
Center port diameter, power piston, mm (in.)	1.1 (0.042)
Center port diameter, displacers, mm (in.)	1.0 (0.040)

TABLE III. - RE-1000 ENGINE VOLUMES WHEN THE PISTON AND DISPLACER AT THEIR CENTER PORT POSITIONS

	cm^3 ($in.^3$)
Expansion space	
Clearance around displacer 1	9.83 (0.60)
Clearance around displacer 2	8.36 (0.51)
Between the displacer and the end of the cylinder	50.1 (3.06)
Instrumentation ports	1.64 (0.10)
Total with D1	61.6 (3.76)
Expansion-heater connecting duct	
Expansion to heater tube junction	3.80 (0.232)
Heater assembly	
Heated portion of the tubes	27.4 (1.67)
Heater-regenerator duct	
Heater tube to regenerator plenum junction	5.90 (0.360)
Regenerator hot end plenum	4.10 (0.250)
Regenerator plenum ring	0.83 (0.051)
Instrumentation ports	1.64 (0.10)
Total	12.47 (0.761)
Regenerator	
Regenerator dead volume R1	56.1 (3.42)
Regenerator dead volume R2	60.1 (3.67)
Regenerator-cooler duct	
Regenerator cold end plenum ring	0.84 (0.051)
Regenerator cold end plenum	4.23 (0.258)
Instrumentation ports	0.93 (0.057)
Heater flange fittings	3.41 (0.208)
Total	9.41 (0.574)
Cooler	
Cooler passages	20.4 (1.25)
Cooler-compression space duct	
Cooler plenum at compression space	7.14 (0.436)
Cylinder ports	1.21 (0.074)
Total	8.36 (0.510)
Compression space	
Between displacer and spider with D1	49.0 (2.99)
Between displacer and spider with D2	58.5 (3.57)
From piston to spider passages	16.06 (0.98)
Annular space around spider	3.82 (0.23)
Between power piston and spider	18.4 (1.12)
Power piston centering port passage	5.90 (0.36)
Displacer LVDT inside of piston	2.95 (0.18)
Anti rotation rod clearance holes	5.16 (0.32)
Instrumentation ports	3.15 (0.19)
Total with D1	104.4 (6.37)

TABLE IV. - RE-1000 INSTRUMENTATION

	Mnemonic	Parameter	Range	Type	SS	V	E±
1	MEANCP	Mean comp space pressure, kPa	0-13800	Strain gauge	X		20
2	MEANBP	Mean bounce pressure, kPa	0-1380	Strain gauge			20
3	PRESUP	Gas supply pressure, kPa	0-13800	Strain gauge			20
4	T01HTR	Heater tube metal temp, °C	400-825	Thermocouple			10
5	T02HTR						
6	T03HTR						
7	T04HTR						
8	T05HTR						
9	T06HTR						
10	T07HTR						
11	T08HTR						
12	T09HTR						
13	T10HTR						
14	T11HTR						
15	T12HTR						
16	T03HED	Head metal temp, °C					
17	T13REG	Regen. vert. profile, °C					
18	T14REG	Regen. vert. profile, °C					
19	T15REG	Regen. circular profile, °C	250-825				5
20	T16REG						
21	T17REG						
22	T18REG						
23	T19REG	Regen. vert. profile, °C	20-250				1
24	TGBOUN	Regen. vert. profile, °C	20-80				
25	TGCOMP	Comp. space gas temp, °C	20-250				
26	TGREGC	Regen.-cooler gas temp, °C	20-250				
27	TGREGH	Regen.-heater gas temp, °C	400-825				10
28	TGEXP	Expansion space gas temp, °C	400-825				10
29	TWINDP	Dashpot water inlet temp, °C	10-70				1
30	TDLDP	Dashpot water delta temp, °C	0-20				0.2
31	TWODP	Dashpot water outlet temp, °C	10-70				1
32	TWINCL	Cooler water inlet temp, °C	10-70				1
33	IDLCL	Cooler water delta temp, °C	0-20				0.2
34	TWOCL	Cooler outlet temp, °C	10-70				0.2
35	AMPS1	Heater amps, supply 1, A	0-1000	Ammeter			10
36	AMPS2	Heater amps, supply 2, A	0-1000	Ammeter			10
37	VOLTG	Heater voltage, V	0-20	Voltmeter			0.01
38	FLODP	Dashpot water flow, l/min	0-10	Turbine meter			0.1
39	FLOCLR	Cooler water flow, l/min	0-10	Turbine meter			
40	VX1HOR	Horiz. vibration, cm/sec	0-3.8	Accelerometer			
41	VY1VER	Vert. vibration, cm/sec	0-3.8	Accelerometer			
42	PISTST	Piston stroke, cm	0-4	Stroke meter			0.02
43	DISPST	Displacer stroke, cm	0-4	Stroke meter			0.02
44	INDPWR	Indicated power, W	0-3000	Analog circ.			40
45	PWROUT	Brake power, kW	0-3.0	Analog circ.			40
46	FPIST	Load force on piston, N	0-1600	F transducer		X	20
47	XPIST	Piston position, cm	±2.0	LVDT		X	0.02

TABLE IV. - Concluded

	Mnemonic	Parameter	Range	Type	SS	V	E±
48	XDOTP	Piston velocity, m/sec	±8.0	LVT		X	0.1
49	XDISP	Displacer position, cm	±2.0	LVDT		↓	0.04
50	PDYNC	Comp. space pressure, kPa	±2000	Crystal		↓	10
51	PDLCLR	Cooler delta pressure, kPa	68.9	Diff. P xducer		↓	2.5
52	PDLREG	Regen. delta pressure, kPa	138	Diff. P xducer		X	5
53	PDLDIS	Displacer delta pressure, kPa	138	Diff. P xducer		↓	5
54	PDYNDB	Disp. gas spring press., MPa	10.0	Strain gauge		↓	0.1
55	PAPRES	Phase angle of pressure, deg	0-360	Phase meter	X		1
56	PADISP	Phase angle of displacer, deg	0-360	Phase meter	X		1
57	FREQ	Engine frequency, Hz	0-50	Freq. to dc	X		0.05
58	PAMPC	Comp. pressure ampl., kPa	0-2000	Crystal		X	20

TABLE V. - RE-1000 CALCULATIONS

Mnemonic	Description of the calculation
PWRIN	Electric power input to the heater head
QCOOLR	Heat rejected by the engine cooler
QDSHPT	Heat rejected by the dashpot
EXTEFF	Engine efficiency based on the brake power output and the heater power input
TAVHTR	Average heater tube outside temperature
INTEFF	Engine efficiency based on the brake power output and brake power plus QCOOLR used as the input
AMPS	Total amperage to the heater head
QDISPG	Heat conduction through the gas in the displacer
QDISP	Heat conduction through the displacer body
QREG1	Outer regenerator wall conduction
QREG2	Outer regenerator wall conduction
QREG3	Inner regenerator wall conduction
PWROUT	Brake power output, analog calculation
INDPWR	Indicated power output, analog calculation
PISTST	Power piston stroke
DISPST	Displacer stroke

TABLE VI. - RE-1000 SAMPLE DATA POINTS SINGLE VARIABLE DATA SET

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/17/83 10:17:21.80 RDG 602

FLUID HELIUM BAROM 14.268 PSI REGENERATOR 2 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 4.10 L/MIN
TWINDP 17.3 DEG.C
TDLDP 2.94 DEG.C
TWODPR 20.9 DEG.C

POWER IN
AMPS1 776. AMPS
AMPS2 651. AMPS
VOLTG 3.11 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7482. KPA
MEANBP 7013. KPA
MEANCP 7056. KPA

GAS TEMPERATURES
TGEXP 554.8 DEG.C
TGREGH 547.0 DEG.C
TGREGC 101.9 DEG.C
TGCOMP 61.6 DEG.C
TGBOUN 36.9 DEG.C

SURFACE TEMPERATURES
T01HTR 609.3 DEG.C
T02HTR 609.9 DEG.C
T03HTR 619.7 DEG.C
T04HTR 594.8 DEG.C
T05HTR 604.4 DEG.C
T06HTR 602.3 DEG.C
T07HTR 573.2 DEG.C
T08HTR 605.9 DEG.C
T09HTR 619.2 DEG.C
T10HTR 546.2 DEG.C
T11HTR 603.4 DEG.C
T12HTR 603.9 DEG.C
T13REG 553.7 DEG.C
T14REG 514.8 DEG.C
T15REG 376.7 DEG.C
T16REG****** DEG.C
T17REG 355.8 DEG.C
T18REG 366.0 DEG.C
T19REG 235.5 DEG.C
T03HED 293.5 DEG.C

HEAT TO COOLER
FLOCLR 4.17 L/MIN
TWINCL 25.2 DEG.C
TDLCL 9.63 DEG.C
TWOCLR 34.80 DEG.C

CALCULATED PARAMETERS
1 PWRIN 4433. WATTS
2 QCOOLR 2789. WATTS
3 QDSHPT 840. WATTS
4 EXTEFF 27.4 %
5 TAVHTR 599.3 DEG.C
6 INTEFF 30.4 %
8 AMPS 1427. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 106. WATTS
12 QREG2 121. WATTS
13 QREG3 34. WATTS
14 PFP 1019.5 KPA/CM
15 PFD 362.7 KPA/CM
16 NBEALE 0.00875

VIBRATION
VX1HOR 0.5 CM/S
VY1VER 8.5 CM/S

PHASE ANGLES
PADISP 57.1 DEG.
PAPRES -21.6 DEG.

ENGINE SPEED
FREQ 29.9 HZ

REMOTE CALCULATIONS
PWROUT 1216. WATTS
INDPWR 1262. WATTS
PISTST 2.58 CM
DISPST 2.72 CM

DYNAMIC CALCULATIONS
PAMPC 1127. KPA
DISPCP 2.11 CM
PISTCP 2.64 CM
PDYNDB****** KPA
PDLCLR****** KPA
PDLREG****** KPA
PDLDIS****** KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:35:55.03 RDG 1006

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 3.96 L/MIN
TWINDP 17.7 DEG.C
TDLDP 1.15 DEG.C
TWODPR 19.6 DEG.C

POWER IN
AMPS1 534. AMPS
AMPS2 503. AMPS
VOLTG 2.25 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7365. KPA
MEANBP 7011. KPA
MEANCP 7040. KPA

GAS TEMPERATURES
TGEXP 567.8 DEG.C
TGREGH 564.5 DEG.C
TGREGC 90.7 DEG.C
TGCOMP 39.9 DEG.C
TGBOUN 27.9 DEG.C

SURFACE TEMPERATURES
T01HTR 601.6 DEG.C
T02HTR 605.5 DEG.C
T03HTR 612.6 DEG.C
T04HTR 606.4 DEG.C
T05HTR 61[illegible].3 DEG.C
T06HTR 60[illegible].3 DEG.C
T07HTR 604.5 DEG.C
T08HTR 584.1 DEG.C
T09HTR 608.8 DEG.C
T10HTR 591.8 DEG.C
T11HTR 578.7 DEG.C
T12HTR 580.2 DEG.C
T13REG****** DEG.C
T14REG 518.3 DEG.C
T15REG 384.4 DEG.C
T16REG 386.7 DEG.C
T17REG 376.6 DEG.C
T18REG 372.8 DEG.C
T19REG 225.5 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.22 L/MIN
TWINCL 24.7 DEG.C
TDLCL 6.47 DEG.C
TWOCLR 29.47 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2338. WATTS
2 QCOOLR 1892. WATTS
3 QDSHPT 317. WATTS
4 EXTEFF 22.7 %
5 TAVHTR 599.6 DEG.C
6 INTEFF 21.9 %
8 AMPS 1037. AMPS
9 QDISPG 3. WATTS
10 QDISP 15. WATTS
11 QREG1 119. WATTS
12 QREG2 118. WATTS
13 QREG3 37. WATTS
14 PFP 1029.1 KPA/CM
15 PFD 353.7 KPA/CM
16 NBEALE 0.00544

VIBRATION
VX1HOR 0.2 CM/S
VY1VER 5.9 CM/S

PHASE ANGLES
PADISP 56.0 DEG.
PAPRES -19.8 DEG.

ENGINE SPEED
FREQ 30.2 HZ

REMOTE CALCULATIONS
PWROUT 532. WATTS
INDPWR 570. WATTS
PISTST 1.80 CM
DISPST 1.83 CM

DYNAMIC CALCULATIONS
PAMPC 792. KPA
DISPCP 2.13 CM
PISTCP 2.31 CM
PDYNDB****** KPA
PDLCLR 3.22 KPA
PDLREG 37.33 KPA
PDLDIS 65.16 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:40:22.06 RDG 1007

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 3.94 L/MIN
TWINDP 17.8 DEG.C
TDLDP 1.42 DEG.C
TWODPR 19.8 DEG.C

POWER IN
AMPS1 571. AMPS
AMPS2 533. AMPS
VOLTG 2.40 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7469. KPA
MEANBP 6982. KPA
MEANCP 7013. KPA

GAS TEMPERATURES
TGEXP 564.8 DEG.C
TGREGH 563.7 DEG.C
TGREGC 92.6 DEG.C
TGCOMP 42.0 DEG.C
TGBOUN 29.0 DEG.C

SURFACE TEMPERATURES
T01HTR 602.6 DEG.C
T02HTR 605.0 DEG.C
T03HTR 613.7 DEG.C
T04HTR 605.5 DEG.C
T05HTR 615.7 DEG.C
T06HTR 607.1 DEG.C
T07HTR 605.4 DEG.C
T08HTR 583.8 DEG.C
T09HTR 609.7 DEG.C
T10HTR 590.4 DEG.C
T11HTR 577.8 DEG.C
T12HTR 577.7 DEG.C
T13REG****** DEG.C
T14REG 517.9 DEG.C
T15REG 385.7 DEG.C
T16REG 388.3 DEG.C
T17REG 377.9 DEG.C
T18REG 373.3 DEG.C
T19REG 228.0 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.24 L/MIN
TWINCL 24.7 DEG.C
TDLCL 6.82 DEG.C
TWOCLR 29.95 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2648. WATTS
2 QCOOLR 2004. WATTS
3 QDSHPT 390. WATTS
4 EXTEFF 23.5 %
5 TAVHTR 599.5 DEG.C
6 INTEFF 23.7 %
8 AMPS 1104. AMPS
9 QDISPG 3. WATTS
10 QDISP 15. WATTS
11 QREG1 118. WATTS
12 QREG2 117. WATTS
13 QREG3 36. WATTS
14 PFP 1018.7 KPA/CM
15 PFD 345.8 KPA/CM
16 NBEALE 0.00573

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 6.6 CM/S

PHASE ANGLES
PADISP 56.6 DEG.
PAPRES -18.9 DEG.

ENGINE SPEED
FREQ 30.2 HZ

REMOTE CALCULATIONS
PWROUT 622. WATTS
INDPWR 665. WATTS
PISTST 2.01 CM
DISPST 1.97 CM

DYNAMIC CALCULATIONS
PAMPC 881. KPA
DISPCP 2.24 CM
PISTCP 2.34 CM
PDYNDB****** KPA
PDLCLR 3.73 KPA
PDLREG 42.43 KPA
PDLDIS 73.65 KPA

TABLE VI. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:46:40.06 RDG 1008

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 3.94 L/MIN
TWINDP 17.8 DEG.C
TDLDP 1.72 DEG.C
TWODPR 20.2 DEG.C

POWER IN
AMPS1 604. AMPS
AMPS2 557. AMPS
VOLTG 2.53 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7055. KPA
MEANBP 6988. KPA
MEANCP 7023. KPA

GAS TEMPERATURES
TGEXP 562.6 DEG.C
TGREGH 563.2 DEG.C
TGREGC 94.9 DEG.C
TGCOMP 45.4 DEG.C
TGBOUN 30.6 DEG.C

SURFACE TEMPERATURES
T01HTR 603.8 DEG.C
T02HTR 604.7 DEG.C
T03HTR 615.3 DEG.C
T04HTR 605.1 DEG.C
T05HTR 617.5 DEG.C
T06HTR 608.2 DEG.C
T07HTR 606.3 DEG.C
T08HTR 584.0 DEG.C
T09HTR 610.7 DEG.C
T10HTR 589.5 DEG.C
T11HTR 577.5 DEG.C
T12HTR 576.1 DEG.C
T13REG****** DEG.C
T14REG 518.7 DEG.C
T15REG 388.8 DEG.C
T16REG 389.2 DEG.C
T17REG 380.1 DEG.C
T18REG 376.6 DEG.C
T19REG 232.8 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.23 L/MIN
TWINCL 24.7 DEG.C
TDLCL 7.61 DEG.C
TWOCLR 30.73 DEG.C

CALCULATED PARAMETERS
1 PWRIN 2930. WATTS
2 QCOOLR 2233. WATTS
3 QDSHPT 470. WATTS
4 EXTEFF 24.0 %
5 TAVHTR 599.9 DEG.C
6 INTEFF 23.9 %
8 AMPS 1160. AMPS
9 QDISPG 3. WATTS
10 QDISP 15. WATTS
11 QREG1 117. WATTS
12 QREG2 115. WATTS
13 QREG3 36. WATTS
14 PFP 1025.2 KPA/CM
15 PFD 339.6 KPA/CM
16 NBEALE 0.00589

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 7.2 CM/S

PHASE ANGLES
PADISP 56.7 DEG.
PAPRES -17.7 DEG.

ENGINE SPEED
FREQ 30.2 HZ

REMOTE CALCULATIONS
PWROUT 703. WATTS
INDPWR 753. WATTS
PISTST 2.20 CM
DISPST 2.09 CM

DYNAMIC CALCULATIONS
PAMPC 979. KPA
DISPCP 2.27 CM
PISTCP 2.34 CM
PDYNDB****** KPA
PDLCLR 4.07 KPA
PDLREG 47.86 KPA
PDLDIS 82.13 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:50:22.06 RDG 1009

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 3.97 L/MIN
TWINDP 17.8 DEG.C
TDLDP 1.97 DEG.C
TWODPR 20.5 DEG.C

POWER IN
AMPS1 637. AMPS
AMPS2 585. AMPS
VOLTG 2.66 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7339. KPA
MEANBP 6999. KPA
MEANCP 7036. KPA

GAS TEMPERATURES
TGEXP 561.2 DEG.C
TGREGH 558.0 DEG.C
TGREGC 94.3 DEG.C
TGCOMP 48.5 DEG.C
TGBOUN 32.1 DEG.C

SURFACE TEMPERATURES
T01HTR 602.1 DEG.C
T02HTR 608.6 DEG.C
T03HTR 61[illegible].2 DEG.C
T04HTR 60[illegible].3 DEG.C
T05HTR 620.1 DEG.C
T06HTR 611.6 DEG.C
T07HTR 610.2 DEG.C
T08HTR 581.4 DEG.C
T09HTR 609.4 DEG.C
T10HTR 588.8 DEG.C
T11HTR 573.6 DEG.C
T12HTR 577.0 DEG.C
T13REG****** DEG.C
T14REG 517.8 DEG.C
T15REG 384.9 DEG.C
T16REG 378.4 DEG.C
T17REG 364.0 DEG.C
T18REG 364.0 DEG.C
T19REG 231.2 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.23 L/MIN
TWINCL 24.7 DEG.C
TDLCL 8.53 DEG.C
TWOCLR 31.51 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3253. WATTS
2 QCOOLR 2505. WATTS
3 QDSHPT 545. WATTS
4 EXTEFF 24.4 %
5 TAVHTR 600.3 DEG.C
6 INTEFF 24.1 %
8 AMPS 1222. AMPS
9 QDISPG 3. WATTS
10 QDISP 15. WATTS
11 QREG1 108. WATTS
12 QREG2 125. WATTS
13 QREG3 36. WATTS
14 PFP 1012.0 KPA/CM
15 PFD 324.2 KPA/CM
16 NBEALE 0.00609

VIBRATION
VX1HOR 0.3 CM/S
VY1VER 7.9 CM/S

PHASE ANGLES
PADISP 57.1 DEG.
PAPRES -16.5 DEG.

ENGINE SPEED
FREQ 30.2 HZ

REMOTE CALCULATIONS
PWROUT 794. WATTS
INDPWR 856. WATTS
PISTST 2.40 CM
DISPST 2.22 CM

DYNAMIC CALCULATIONS
PAMPC 1063. KPA
DISPCP 2.37 CM
PISTCP 2.38 CM
PDYNDB****** KPA
PDLCLR 5.43 KPA
PDLREG 52.95 KPA
PDLDIS 90.28 KPA

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:55:25.06 RDG 1010

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING
FLODP 3.96 L/MIN
TWINDP 17.8 DEG.C
TDLDP 2.21 DEG.C
TWODPR 20.8 DEG.C

POWER IN
AMPS1 673. AMPS
AMPS2 619. AMPS
VOLTG 2.82 VOLTS

ENGINE CHARGE PRESSURE
PRESUP 7464. KPA
MEANBP 6988. KPA
MEANCP 7032. KPA

GAS TEMPERATURES
TGEXP 557.5 DEG.C
TGREGH 548.5 DEG.C
TGREGC 90.7 DEG.C
TGCOMP 55.7 DEG.C
TGBOUN 33.4 DEG.C

SURFACE TEMPERATURES
T01HTR 598.1 DEG.C
T02HTR 610.5 DEG.C
T03HTR 614.9 DEG.C
T04HTR 601.4 DEG.C
T05HTR 621.1 DEG.C
T06HTR 613.0 DEG.C
T07HTR 611.9 DEG.C
T08HTR 576.7 DEG.C
T09HTR 605.4 DEG.C
T10HTR 586.4 DEG.C
T11HTR 567.1 DEG.C
T12HTR 576.9 DEG.C
T13REG****** DEG.C
T14REG 510.3 DEG.C
T15REG 368.0 DEG.C
T16REG 350.7 DEG.C
T17REG 331.5 DEG.C
T18REG 338.9 DEG.C
T19REG 221.0 DEG.C
T03HED****** DEG.C

HEAT TO COOLER
FLOCLR 4.22 L/MIN
TWINCL 24.8 DEG.C
TDLCL 9.34 DEG.C
TWOCLR 32.52 DEG.C

CALCULATED PARAMETERS
1 PWRIN 3643. WATTS
2 QCOOLR 2736. WATTS
3 QDSHPT 607. WATTS
4 EXTEFF 23.8 %
5 TAVHTR 598.6 DEG.C
6 INTEFF 24.0 %
8 AMPS 1292. AMPS
9 QDISPG 3. WATTS
10 QDISP 14. WATTS
11 QREG1 96. WATTS
12 QREG2 139. WATTS
13 QREG3 35. WATTS
14 PFP 1002.8 KPA/CM
15 PFD 314.1 KPA/CM
16 NBEALE 0.00617

VIBRATION
VX1HOR 0.4 CM/S
VY1VER 8.5 CM/S

PHASE ANGLES
PADISP 57.5 DEG.
PAPRES -15.7 DEG.

ENGINE SPEED
FREQ 30.1 HZ

REMOTE CALCULATIONS
PWROUT 866. WATTS
INDPWR 939. WATTS
PISTST 2.60 CM
DISPST 2.34 CM

DYNAMIC CALCULATIONS
PAMPC 1147. KPA
DISPCP 2.37 CM
PISTCP 2.33 CM
PDYNDB****** KPA
PDLCLR 6.79 KPA
PDLREG 55.66 KPA
PDLDIS 95.71 KPA

TABLE VI. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:00:55.09 RDG 1011

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	3.93 L/MIN	AMPS1	702. AMPS	PRESUP	7063. KPA	TGEXP	555.5 DEG.C	T01HTR	598.9 DEG.C
		AMPS2	653. AMPS					T02HTR	612.9 DEG.C
TWINDP	17.8 DEG.C	VOLTG	2.98 VOLTS	MEANBP	6987. KPA	TGREGH	545.4 DEG.C	T03HTR	617.1 DEG.C
TDLDP	2.67 DEG.C			MEANCP	7034. KPA	TGREGC	92.1 DEG.C	T04HTR	602.4 DEG.C
TWODPR	21.2 DEG.C					TGCOMP	61.1 DEG.C	T05HTR	624.1 DEG.C
						TGBOUN	35.8 DEG.C	T06HTR	616.0 DEG.C
								T07HTR	614.9 DEG.C
								T08HTR	576.4 DEG.C
								T09HTR	606.9 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	586.4 DEG.C
FLOCLR	4.23 L/MIN	1 PWRIN	4038. WATTS	VX1HOR	0.4 CM/S	PWROUT	955. WATTS	T11HTR	566.2 DEG.C
TWINCL	24.9 DEG.C	2 QCOOLR	3032. WATTS	VY1VER	9.2 CM/S	INDPWR	1030. WATTS	T12HTR	577.3 DEG.C
TDLCL	10.32 DEG.C	3 QDSHPT	732. WATTS			PISTST	2.80 CM		
TWOCLR	33.65 DEG.C	4 EXTEFF	23.7 %	PHASE ANGLES		DISPST	2.45 CM		
		5 TAVHTR	600.0 DEG.C	PADISP	57.5 DEG.			T13REG******	DEG.C
		6 INTEFF	24.0 %	PAPRES	-15.2 DEG.	DYNAMIC CALCULATIONS		T14REG	506.8 DEG.C
		8 AMPS	1355. AMPS			PAMPC	1250. KPA	T15REG	359.0 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.36 CM	T16REG	339.8 DEG.C
		10 QDISP	14. WATTS	FREQ	30.1 HZ	PISTCP	2.29 CM	T17REG	317.8 DEG.C
		11 QREG1	90. WATTS			PDYNDB******	KPA	T18REG	326.8 DEG.C
		12 QREG2	146. WATTS			PDLCLR	8.82 KPA	T19REG	216.2 DEG.C
		13 QREG3	35. WATTS			PDLREG	60.41 KPA		
		14 PFP	1010.0 KPA/CM			PDLDIS	103.52 KPA	T03HED******	DEG.C
		15 PFD	317.9 KPA/CM						
		16 NBEALE	0.00631						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:03:22.09 RDG 1012

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	3.93 L/MIN	AMPS1	742. AMPS	PRESUP	7063. KPA	TGEXP	552.5 DEG.C	T01HTR	598.1 DEG.C
		AMPS2	683. AMPS					T02HTR	613.6 DEG.C
TWINDP	17.9 DEG.C	VOLTG	3.13 VOLTS	MEANBP	7000. KPA	TGREGH	540.3 DEG.C	T03HTR	617.4 DEG.C
TDLDP	2.89 DEG.C			MEANCP	7049. KPA	TGREGC	92.6 DEG.C	T04HTR	601.2 DEG.C
TWODPR	21.4 DEG.C					TGCOMP	65.4 DEG.C	T05HTR	625.1 DEG.C
						TGBOUN	37.2 DEG.C	T06HTR	616.7 DEG.C
								T07HTR	615.6 DEG.C
								T08HTR	574.6 DEG.C
								T09HTR	606.0 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	585.4 DEG.C
FLOCLR	4.24 L/MIN	1 PWRIN	4467. WATTS	VX1HOR	0.4 CM/S	PWROUT	1026. WATTS	T11HTR	563.2 DEG.C
TWINCL	24.9 DEG.C	2 QCOOLR	3265. WATTS	VY1VER	9.8 CM/S	INDPWR	1100. WATTS	T12HTR	576.1 DEG.C
TDLCL	11.10 DEG.C	3 QDSHPT	791. WATTS			PISTST	3.00 CM		
TWOCLR	34.54 DEG.C	4 EXTEFF	23.0 %	PHASE ANGLES		DISPST	2.51 CM		
		5 TAVHTR	599.4 DEG.C	PADISP	57.6 DEG.			T13REG******	DEG.C
		6 INTEFF	23.9 %	PAPRES	-14.0 DEG.	DYNAMIC CALCULATIONS		T14REG	500.1 DEG.C
		8 AMPS	1426. AMPS			PAMPC	1344. KPA	T15REG	346.2 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.35 CM	T16REG	326.9 DEG.C
		10 QDISP	14. WATTS	FREQ	30.2 HZ	PISTCP	2.26 CM	T17REG	303.8 DEG.C
		11 QREG1	85. WATTS			PDYNDB******	KPA	T18REG	313.6 DEG.C
		12 QREG2	151. WATTS			PDLCLR	11.20 KPA	T19REG	208.9 DEG.C
		13 QREG3	35. WATTS			PDLREG	63.81 KPA		
		14 PFP	1007.4 KPA/CM			PDLDIS	109.97 KPA	T03HED******	DEG.C
		15 PFD	306.5 KPA/CM						
		16 NBEALE	0.00631						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:30:25.12 RDG 1017

FLUID HELIUM BAROM 14.298 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.08 L/MIN	AMPS1	645. AMPS	PRESUP	7187. KPA	TGEXP	510.7 DEG.C	T01HTR	550.9 DEG.C
		AMPS2	608. AMPS					T02HTR	558.5 DEG.C
TWINDP	18.0 DEG.C	VOLTG	2.73 VOLTS	MEANBP	7011. KPA	TGREGH	507.3 DEG.C	T03HTR	565.8 DEG.C
TDLDP	2.30 DEG.C			MEANCP	7062. KPA	TGREGC	92.3 DEG.C	T04HTR	553.1 DEG.C
TWODPR	21.0 DEG.C					TGCOMP	53.4 DEG.C	T05HTR	570.6 DEG.C
						TGBOUN	36.2 DEG.C	T06HTR	561.8 DEG.C
								T07HTR	560.5 DEG.C
								T08HTR	530.1 DEG.C
								T09HTR	558.1 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	537.8 DEG.C
FLOCLR	4.22 L/MIN	1 PWRIN	3424. WATTS	VX1HOR	0.4 CM/S	PWROUT	776. WATTS	T11HTR	521.5 DEG.C
TWINCL	24.5 DEG.C	2 QCOOLR	2713. WATTS	VY1VER	8.5 CM/S	INDPWR	846. WATTS	T12HTR	526.8 DEG.C
TDLCL	9.27 DEG.C	3 QDSHPT	651. WATTS			PISTST	2.60 CM		
TWOCLR	32.09 DEG.C	4 EXTEFF	22.7 %	PHASE ANGLES		DISPST	2.30 CM		
		5 TAVHTR	549.6 DEG.C	PADISP	58.8 DEG.			T13REG******	DEG.C
		6 INTEFF	22.2 %	PAPRES	-14.1 DEG.	DYNAMIC CALCULATIONS		T14REG	473.2 DEG.C
		8 AMPS	1253. AMPS			PAMPC	1166. KPA	T15REG	352.3 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.35 CM	T16REG	343.8 DEG.C
		10 QDISP	13. WATTS	FREQ	30.2 HZ	PISTCP	2.35 CM	T17REG	330.4 DEG.C
		11 QREG1	93. WATTS			PDYNDB******	KPA	T18REG	330.0 DEG.C
		12 QREG2	116. WATTS			PDLCLR	6.79 KPA	T19REG	215.2 DEG.C
		13 QREG3	32. WATTS			PDLREG	57.70 KPA		
		14 PFP	1003.3 KPA/CM			PDLDIS	98.77 KPA	T03HED******	DEG.C
		15 PFD	289.5 KPA/CM						
		16 NBEALE	0.00549						

TABLE VI. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 10:57:22.54 RDG 1024

FLUID HELIUM BAROM 14.327 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.47 L/MIN	AMPS1 646. AMPS	PRESUP 7572. KPA	TGEXP 462.4 DEG.C	T01HTR 501.0 DEG.C
	AMPS2 602. AMPS			T02HTR 507.9 DEG.C
TWINDP 16.2 DEG.C	VOLTG 2.68 VOLTS	MEANBP 7000. KPA	TGREGH 460.8 DEG.C	T03HTR 515.5 DEG.C
TDLDP 1.71 DEG.C		MEANCP 7048. KPA	TGREGC 90.5 DEG.C	T04HTR 503.0 DEG.C
TWODPR 18.6 DEG.C			TGCOMP 53.8 DEG.C	T05HTR 519.9 DEG.C
			TGBOUN 31.8 DEG.C	T06HTR 511.0 DEG.C
				T07HTR 510.1 DEG.C
				T08HTR 481.0 DEG.C
				T09HTR 507.7 DEG.C

HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 488.1 DEG.C
FLOCLR 4.21 L/MIN	1 PWRIN 3348. WATTS	VX1HOR 0.4 CM/S	PWROUT 707. WATTS	T11HTR 471.9 DEG.C
TWINCL 24.7 DEG.C	2 QCOOLR 2681. WATTS	VY1VER 8.6 CM/S	INDPWR 765. WATTS	T12HTR 476.6 DEG.C
TDLCL ****** DEG.C	3 QDSHPT 531. WATTS		PISTST 2.60 CM	
TWOCLR 32.15 DEG.C	4 EXTEFF 21.1 %	PHASE ANGLES	DISPST 2.30 CM	
	5 TAVHTR 499.5 DEG.C	PADISP 60.4 DEG.		T13REG****** DEG.C
	6 INTEFF 20.9 %	PAPRES -12.5 DEG.	DYNAMIC CALCULATIONS	T14REG 431.6 DEG.C
	8 AMPS 1248. AMPS		PAMPC 1176. KPA	T15REG 326.4 DEG.C
	9 QDISPG 2. WATTS	ENGINE SPEED	DISPCP 2.32 CM	T16REG 317.8 DEG.C
	10 QDISP 12. WATTS	FREQ 30.2 HZ	PISTCP 2.28 CM	T17REG 307.7 DEG.C
	11 QREG1 85. WATTS		PDYNDB****** KPA	T18REG 308.1 DEG.C
	12 QREG2 100. WATTS		PDLCLR 6.96 KPA	T19REG 203.0 DEG.C
	13 QREG3 29. WATTS		PDLREG 58.04 KPA	
	14 PFP 995.1 KPA/CM		PDLDIS 99.10 KPA	T03HED****** DEG.C
	15 PFD 254.7 KPA/CM			
	16 NBEALE 0.00501			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 11:35:10.54 RDG 1030

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.11 L/MIN	AMPS1 626. AMPS	PRESUP 7562. KPA	TGEXP 415.3 DEG.C	T01HTR 452.3 DEG.C
	AMPS2 589. AMPS			T02HTR 456.8 DEG.C
TWINDP 16.0 DEG.C	VOLTG 2.60 VOLTS	MEANBP 7007. KPA	TGREGH 415.9 DEG.C	T03HTR 465.5 DEG.C
TDLDP 1.90 DEG.C		MEANCP 7061. KPA	TGREGC 88.9 DEG.C	T04HTR 453.6 DEG.C
TWODPR 18.6 DEG.C			TGCOMP 54.6 DEG.C	T05HTR 469.0 DEG.C
			TGBOUN 33.1 DEG.C	T06HTR 459.9 DEG.C
				T07HTR 458.8 DEG.C
				T08HTR 432.9 DEG.C
				T09HTR 458.6 DEG.C

HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 439.4 DEG.C
FLOCLR 4.21 L/MIN	1 PWRIN 3159. WATTS	VX1HOR 0.4 CM/S	PWROUT 605. WATTS	T11HTR 424.0 DEG.C
TWINCL 24.3 DEG.C	2 QCOOLR 2595. WATTS	VY1VER 8.6 CM/S	INDPWR 643. WATTS	T12HTR 426.7 DEG.C
TDLCL 8.88 DEG.C	3 QDSHPT 542. WATTS		PISTST 2.60 CM	
TWOCLR 31.77 DEG.C	4 EXTEFF 19.2 %	PHASE ANGLES	DISPST 2.26 CM	
	5 TAVHTR 449.8 DEG.C	PADISP 61.8 DEG.		T13REG****** DEG.C
	6 INTEFF 18.9 %	PAPRES -10.3 DEG.	DYNAMIC CALCULATIONS	T14REG 389.2 DEG.C
	8 AMPS 1215. AMPS		PAMPC 1181. KPA	T15REG 299.6 DEG.C
	9 QDISPG 2. WATTS	ENGINE SPEED	DISPCP 2.30 CM	T16REG 294.9 DEG.C
	10 QDISP 10. WATTS	FREQ 30.2 HZ	PISTCP 2.25 CM	T17REG 288.2 DEG.C
	11 QREG1 79. WATTS		PDYNDB****** KPA	T18REG 286.8 DEG.C
	12 QREG2 83. WATTS		PDLCLR 6.79 KPA	T19REG 190.0 DEG.C
	13 QREG3 25. WATTS		PDLREG 58.38 KPA	
	14 PFP 980.6 KPA/CM		PDLDIS100.49 KPA	T03HED****** DEG.C
	15 PFD 212.3 KPA/CM			
	16 NBEALE 0.00428			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/03/84 14:58:23.35 RDG 1070

FLUID HELIUM BAROM 14.342 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.20 L/MIN	AMPS1 635. AMPS	PRESUP 5553. KPA	TGEXP 555.0 DEG.C	T01HTR 599.7 DEG.C
	AMPS2 521. AMPS			T02HTR 606.6 DEG.C
TWINDP 22.4 DEG.C	VOLTG 2.49 VOLTS	MEANBP 5494. KPA	TGREGH 554.7 DEG.C	T03HTR 614.7 DEG.C
TDLDP 1.70 DEG.C		MEANCP 5531. KPA	TGREGC 79.7 DEG.C	T04HTR 601.3 DEG.C
TWODPR 24.7 DEG.C			TGCOMP 49.4 DEG.C	T05HTR 619.1 DEG.C
			TGBOUN 37.7 DEG.C	T06HTR 609.4 DEG.C
				T07HTR 608.6 DEG.C
				T08HTR 580.8 DEG.C
				T09HTR 607.0 DEG.C

HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 586.7 DEG.C
FLOCLR 4.40 L/MIN	1 PWRIN 2879. WATTS	VX1HOR 0.3 CM/S	PWROUT 720. WATTS	T11HTR 573.8 DEG.C
TWINCL 25.2 DEG.C	2 QCOOLR 2137. WATTS	VY1VER 7.1 CM/S	INDPWR 759. WATTS	T12HTR 577.7 DEG.C
TDLCL 7.00 DEG.C	3 QDSHPT 495. WATTS		PISTST 2.61 CM	
TWOCLR 30.99 DEG.C	4 EXTEFF 25.0 %	PHASE ANGLES	DISPST 2.46 CM	
	5 TAVHTR 598.8 DEG.C	PADISP 58.7 DEG.		T13REG****** DEG.C
	6 INTEFF 25.2 %	PAPRES -18.0 DEG.	DYNAMIC CALCULATIONS	T14REG 515.2 DEG.C
	8 AMPS 1156. AMPS		PAMPC 910. KPA	T15REG 379.5 DEG.C
	9 QDISPG 3. WATTS	ENGINE SPEED	DISPCP 2.25 CM	T16REG 367.6 DEG.C
	10 QDISP 14. WATTS	FREQ 26.9 HZ	PISTCP 2.46 CM	T17REG 352.7 DEG.C
	11 QREG1 108. WATTS		PDYNDB****** KPA	T18REG 355.3 DEG.C
	12 QREG2 130. WATTS		PDLCLR 4.41 KPA	T19REG 222.0 DEG.C
	13 QREG3 37. WATTS		PDLREG 42.43 KPA	
	14 PFP 795.4 KPA/CM		PDLDIS 71.95 KPA	T03HED****** DEG.C
	15 PFD 267.8 KPA/CM			
	16 NBEALE 0.00729			

TABLE VI. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/06/84 14:52:24.59 RDG 1079

FLUID HELIUM BAROM 14.288 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.08 L/MIN	AMPS1	539. AMPS	PRESUP	4143. KPA	TGEXP	553.1 DEG.C	T01HTR	605.6 DEG.C
		AMPS2	451. AMPS					T02HTR	599.1 DEG.C
TWINDP	23.0 DEG.C	VOLTG	2.13 VOLTS	MEANBP	3988. KPA	TGREGH	560.1 DEG.C	T03HTR	614.7 DEG.C
TDLDP	0.81 DEG.C			MEANCP	4012. KPA	TGREGC	70.5 DEG.C	T04HTR	603.7 DEG.C
TWODPR	24.4 DEG.C					TGCOMP	41.6 DEG.C	T05HTR	615.3 DEG.C
						TGBOUN	32.0 DEG.C	T06HTR	600.7 DEG.C
								T07HTR	601.4 DEG.C
								T08HTR	589.7 DEG.C
								T09HTR	607.8 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	591.6 DEG.C
FLOCLR	4.31 L/MIN	1 PWRIN	2109. WATTS	VX1HOR	0.2 CM/S	PWROUT	500. WATTS	T11HTR	581.8 DEG.C
TWINCL	25.2 DEG.C	2 QCOOLR	1242. WATTS	VY1VER	5.8 CM/S	INDPWR	520. WATTS	T12HTR	581.3 DEG.C
TDLCL	4.15 DEG.C	3 QDSHPT	228. WATTS			PISTST	2.61 CM		
TWOCLR	29.17 DEG.C	4 EXTEFF	23.7 %	PHASE ANGLES		DISPST	2.55 CM		
		5 TAVHTR	599.4 DEG.C	PADISP	58.4 DEG.			T13REG******	DEG.C
		6 INTEFF	28.7 %	PAPRES	-19.7 DEG.	DYNAMIC CALCULATIONS		T14REG	512.2 DEG.C
		8 AMPS	990. AMPS			PAMPC	645. KPA	T15REG	376.1 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.18 CM	T16REG	367.6 DEG.C
		10 QDISP	15. WATTS	FREQ	23.0 HZ	PISTCP	2.40 CM	T17REG	363.5 DEG.C
		11 QREG1	121. WATTS			PDYNDB******	KPA	T18REG	363.0 DEG.C
		12 QREG2	121. WATTS			PDLCLR	2.72 KPA	T19REG	213.7 DEG.C
		13 QREG3	38. WATTS			PDLREG	29.53 KPA		
		14 PFP	568.8 KPA/CM			PDLDIS	49.21 KPA	T03HED******	DEG.C
		15 PFD	200.5 KPA/CM						
		16 NBEALE	0.00815						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/08/84 13:36:21.40 RDG 1121

FLUID HELIUM BAROM 14.234 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.37 L/MIN	AMPS1	702. AMPS	PRESUP	7093. KPA	TGEXP	557.0 DEG.C	T01HTR	602.6 DEG.C
		AMPS2	595. AMPS					T02HTR	604.7 DEG.C
TWINDP	25.4 DEG.C	VOLTG	2.78 VOLTS	MEANBP	7012. KPA	TGREGH	559.4 DEG.C	T03HTR	616.7 DEG.C
TDLDP	2.18 DEG.C			MEANCP	7066. KPA	TGREGC	109.0 DEG.C	T04HTR	603.0 DEG.C
TWODPR	28.0 DEG.C					TGCOMP	64.0 DEG.C	T05HTR	621.4 DEG.C
						TGBOUN	44.0 DEG.C	T06HTR	609.5 DEG.C
								T07HTR	608.0 DEG.C
								T08HTR	580.9 DEG.C
								T09HTR	611.3 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	586.0 DEG.C
FLOCLR	4.36 L/MIN	1 PWRIN	3599. WATTS	VX1HOR	0.4 CM/S	PWROUT	845. WATTS	T11HTR	574.7 DEG.C
TWINCL	39.9 DEG.C	2 QCOOLR	2532. WATTS	VY1VER	8.6 CM/S	INDPWR	907. WATTS	T12HTR	574.8 DEG.C
TDLCL	8.42 DEG.C	3 QDSHPT	662. WATTS			PISTST	2.61 CM		
TWOCLR	46.99 DEG.C	4 EXTEFF	23.5 %	PHASE ANGLES		DISPST	2.35 CM		
		5 TAVHTR	599.5 DEG.C	PADISP	58.5 DEG.			T13REG******	DEG.C
		6 INTEFF	25.0 %	PAPRES	-14.9 DEG.	DYNAMIC CALCULATIONS		T14REG	519.6 DEG.C
		8 AMPS	1296. AMPS			PAMPC	1171. KPA	T15REG	391.9 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.29 CM	T16REG	391.7 DEG.C
		10 QDISP	14. WATTS	FREQ	30.3 HZ	PISTCP	2.34 CM	T17REG	386.0 DEG.C
		11 QREG1	111. WATTS			PDYNDB******	KPA	T18REG	378.7 DEG.C
		12 QREG2	114. WATTS			PDLCLR	6.11 KPA	T19REG	241.7 DEG.C
		13 QREG3	35. WATTS			PDLREG	56.34 KPA		
		14 PFP	1007.1 KPA/CM			PDLDIS	96.73 KPA	T03HED******	DEG.C
		15 PFD	300.9 KPA/CM						
		16 NBEALE	0.00593						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/27/84 14:05:40.27 RDG 1200

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.01 L/MIN	AMPS1	694. AMPS	PRESUP	7311. KPA	TGEXP	558.0 DEG.C	T01HTR	600.3 DEG.C
		AMPS2	569. AMPS					T02HTR	607.1 DEG.C
TWINDP	18.7 DEG.C	VOLTG	2.77 VOLTS	MEANBP	6986. KPA	TGREGH	558.6 DEG.C	T03HTR	614.6 DEG.C
TDLDP	2.63 DEG.C			MEANCP	7031. KPA	TGREGC	123.0 DEG.C	T04HTR	605.0 DEG.C
TWODPR	22.1 DEG.C					TGCOMP	74.7 DEG.C	T05HTR	619.5 DEG.C
						TGBOUN	43.1 DEG.C	T06HTR	611.7 DEG.C
								T07HTR	610.3 DEG.C
								T08HTR	578.4 DEG.C
								T09HTR	612.6 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T10HTR	584.7 DEG.C
FLOCLR	4.15 L/MIN	1 PWRIN	3493. WATTS	VX1HOR	0.6 CM/S	PWROUT	777. WATTS	T11HTR	575.1 DEG.C
TWINCL	54.0 DEG.C	2 QCOOLR	2108. WATTS	VY1VER	8.4 CM/S	INDPWR	837. WATTS	T12HTR	575.6 DEG.C
TDLCL	7.39 DEG.C	3 QDSHPT	734. WATTS			PISTST	2.60 CM		
TWOCLR	60.48 DEG.C	4 EXTEFF	22.2 %	PHASE ANGLES		DISPST	2.29 CM		
		5 TAVHTR	599.6 DEG.C	PADISP	59.1 DEG.			T13REG******	DEG.C
		6 INTEFF	26.9 %	PAPRES	-13.7 DEG.	DYNAMIC CALCULATIONS		T14REG	522.7 DEG.C
		8 AMPS	1263. AMPS			PAMPC	1161. KPA	T15REG	402.6 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.25 CM	T16REG	402.4 DEG.C
		10 QDISP	14. WATTS	FREQ	30.2 HZ	PISTCP	2.34 CM	T17REG	388.9 DEG.C
		11 QREG1	103. WATTS			PDYNDB******	KPA	T18REG	382.4 DEG.C
		12 QREG2	114. WATTS			PDLCLR	6.11 KPA	T19REG	255.2 DEG.C
		13 QREG3	34. WATTS			PDLREG	53.29 KPA		
		14 PFP	994.2 KPA/CM			PDLDIS	91.98 KPA	T03HED******	DEG.C
		15 PFD	280.7 KPA/CM						
		16 NBEALE	0.00551						

TABLE VI. - CONCLUDED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 09/26/84 10:54:20.52 RDG 1357

FLUID HELIUM BAROM 14.474 PSI REGENERATOR 1 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.38 L/MIN	AMPS1	680. AMPS	PRESUP	7163. KPA	TGEXP	559.5 DEG.C	T01HTR	601.7 DEG.C
		AMPS2	605. AMPS					T02HTR	614.3 DEG.C
TWINDP	18.8 DEG.C	VOLTG	2.78 VOLTS	MEANBP	6992. KPA	TGREGH	551.9 DEG.C	T03HTR	612.7 DEG.C
TDLDP	1.99 DEG.C			MEANCP	7033. KPA	TGREGC	98.6 DEG.C	T04HTR	608.1 DEG.C
TWODPR	21.4 DEG.C					TGCOMP	51.6 DEG.C	T05HTR	618.4 DEG.C
						TGBOUN	35.8 DEG.C	T06HTR	611.3 DEG.C
								T07HTR	610.5 DEG.C
								T08HTR	578.3 DEG.C
								T09HTR	610.9 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS			VIBRATION		REMOTE CALCULATIONS			
FLOCLR	4.22 L/MIN	1	PWRIN	3575. WATTS	VX1HOR	0.7 CM/S	PWROUT	798. WATTS	T10HTR	589.1 DEG.C
TWINCL	25.0 DEG.C	2	QCOOLR	2563. WATTS	VY1VER	8.9 CM/S	INDPWR	818. WATTS	T11HTR	573.5 DEG.C
TDLCL	8.75 DEG.C	3	QDSHPT	605. WATTS			PISTST	2.61 CM	T12HTR	582.0 DEG.C
TWOCLR	32.75 DEG.C	4	EXTEFF	22.3 %	PHASE ANGLES		DISPST	1.88 CM		
		5	TAVHTR	600.9 DEG.C	PADISP	77.7 DEG.			T13REG******	DEG.C
		6	INTEFF	23.7 %	PAPRES	-11.3 DEG.	DYNAMIC CALCULATIONS		T14REG	514.2 DEG.C
		8	AMPS	1285. AMPS			PAMPC	1299. KPA	T15REG	390.1 DEG.C
		9	QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.65 CM	T16REG	386.3 DEG.C
		10	QDISP	14. WATTS	FREQ	31.3 HZ	PISTCP	2.36 CM	T17REG	378.5 DEG.C
		11	QREG1	103. WATTS			PDYNDB	1163. KPA	T18REG	364.0 DEG.C
		12	QREG2	122. WATTS			PDLCLR	7.81 KPA	T19REG	237.4 DEG.C
		13	QREG3	35. WATTS			PDLREG	57.36 KPA		
		14	PFP	1020.3 KPA/CM			PDLDIS	99.10 KPA	T03HED******	DEG.C
		15	PFD	277.8 KPA/CM						
		16	NBEALE	0.00545						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/27/84 10:56:18.08 RDG 1552

FLUID NITROGEN BAROM 14.357 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.00 L/MIN	AMPS1	565. AMPS	PRESUP	7160. KPA	TGEXP	566.9 DEG.C	T01HTR	602.2 DEG.C
		AMPS2	437. AMPS					T02HTR	615.1 DEG.C
TWINDP	19.2 DEG.C	VOLTG	2.20 VOLTS	MEANBP	7010. KPA	TGREGH	552.1 DEG.C	T03HTR	604.1 DEG.C
TDLDP	1.10 DEG.C			MEANCP	7058. KPA	TGREGC	109.5 DEG.C	T04HTR	616.8 DEG.C
TWODPR	20.4 DEG.C					TGCOMP	40.9 DEG.C	T05HTR	602.7 DEG.C
						TGBOUN	27.3 DEG.C	T06HTR	604.2 DEG.C
								T07HTR	603.7 DEG.C
								T08HTR	584.2 DEG.C
								T09HTR	607.4 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS			VIBRATION		REMOTE CALCULATIONS			
FLOCLR	4.35 L/MIN	1	PWRIN	2210. WATTS	VX1HOR	0.6 CM/S	PWROUT	292. WATTS	T10HTR	596.9 DEG.C
TWINCL	25.2 DEG.C	2	QCOOLR	1948. WATTS	VY1VER	7.5 CM/S	INDPWR	314. WATTS	T11HTR	579.0 DEG.C
TDLCL	6.46 DEG.C	3	QDSHPT	306. WATTS			PISTST	2.56 CM	T12HTR	583.9 DEG.C
TWOCLR	29.99 DEG.C	4	EXTEFF	13.2 %	PHASE ANGLES		DISPST	1.56 CM		
		5	TAVHTR	600.0 DEG.C	PADISP	36.5 DEG.			T13REG******	DEG.C
		6	INTEFF	13.0 %	PAPRES	-5.5 DEG.	DYNAMIC CALCULATIONS		T14REG	497.4 DEG.C
		8	AMPS	1002. AMPS			PAMPC	1102. KPA	T15REG	385.4 DEG.C
		9	QDISPG	0. WATTS	ENGINE SPEED		DISPCP	2.47 CM	T16REG	391.0 DEG.C
		10	QDISP	15. WATTS	FREQ	28.0 HZ	PISTCP	2.41 CM	T17REG	391.1 DEG.C
		11	QREG1	112. WATTS			PDYNDB******	KPA	T18REG	375.3 DEG.C
		12	QREG2	99. WATTS			PDLCLR	14.93 KPA	T19REG	236.7 DEG.C
		13	QREG3	34. WATTS			PDLREG	61.09 KPA		
		14	PFP	967.5 KPA/CM			PDLDIS	154.77 KPA	T03HED******	DEG.C
		15	PFD	226.5 KPA/CM						
		16	NBEALE	0.00226						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/07/84 14:42:20.19 RDG 1608

FLUID HELIUM BAROM 14.322 PSI REGENERATOR 1 DISPLACER 1 LIGHT PISTON

HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES		SURFACE TEMPERATURES	
FLODP	4.12 L/MIN	AMPS1	653. AMPS	PRESUP	7070. KPA	TGEXP	558.4 DEG.C	T01HTR	606.1 DEG.C
		AMPS2	517. AMPS					T02HTR	606.3 DEG.C
TWINDP	18.0 DEG.C	VOLTG	2.58 VOLTS	MEANBP	7016. KPA	TGREGH	566.1 DEG.C	T03HTR	614.3 DEG.C
TDLDP	2.44 DEG.C			MEANCP	7063. KPA	TGREGC	102.3 DEG.C	T04HTR	606.5 DEG.C
TWODPR	20.5 DEG.C					TGCOMP	46.1 DEG.C	T05HTR	617.5 DEG.C
						TGBOUN	32.6 DEG.C	T06HTR	611.5 DEG.C
								T07HTR	610.5 DEG.C
								T08HTR	584.0 DEG.C
								T09HTR	615.3 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS			VIBRATION		REMOTE CALCULATIONS			
FLOCLR	4.26 L/MIN	1	PWRIN	3018. WATTS	VX1HOR	0.4 CM/S	PWROUT	572. WATTS	T10HTR	582.2 DEG.C
TWINCL	25.3 DEG.C	2	QCOOLR	2618. WATTS	VY1VER	6.0 CM/S	INDPWR	571. WATTS	T11HTR	581.7 DEG.C
TDLCL	8.86 DEG.C	3	QDSHPT	701. WATTS			PISTST	2.56 CM	T12HTR	573.3 DEG.C
TWOCLR	31.88 DEG.C	4	EXTEFF	19.0 %	PHASE ANGLES		DISPST	1.90 CM		
		5	TAVHTR	600.8 DEG.C	PADISP	41.6 DEG.			T13REG******	DEG.C
		6	INTEFF	17.9 %	PAPRES	-8.1 DEG.	DYNAMIC CALCULATIONS		T14REG	522.1 DEG.C
		8	AMPS	1170. AMPS			PAMPC	1102. KPA	T15REG	398.0 DEG.C
		9	QDISPG	3. WATTS	ENGINE SPEED		DISPCP	2.28 CM	T16REG	402.5 DEG.C
		10	QDISP	15. WATTS	FREQ	37.4 HZ	PISTCP	2.37 CM	T17REG	402.6 DEG.C
		11	QREG1	119. WATTS			PDYNDB******	KPA	T18REG	390.7 DEG.C
		12	QREG2	107. WATTS			PDLCLR	4.41 KPA	T19REG	243.5 DEG.C
		13	QREG3	36. WATTS			PDLREG	40.05 KPA		
		14	PFP	987.2 KPA/CM			PDLDIS	75.69 KPA	T03HED******	DEG.C
		15	PFD	245.5 KPA/CM						
		16	NBEALE	0.00331						

TABLE VII. - LIST OF SINGLE VARIABLE DATA POINTS

[Regenerator and displacer 1 were designed for high efficiency. Regenerator and displacer 2 were designed for high power.]

Nominal Values								
Reading Number	Gas	Heater, °C	Cooler, °C	Pressure, MPa	Stroke, cm	Disp.	Regen.	Pist.
1006-1012	He	600	25	7.0	Var 1.8, 2.0, ...	1	1	Std
1010, 1070, 1079	He	600	25	Var 7.0, 5.5, 4.0	2.6	1	1	Std
1010, 1017, 1024, 1030	He	Var 600, 550 500, 450	25	7.0	2.6	1	1	Std
1010, 1121, 1200	He	600	Var 25, 40, 55	7.0	2.6	1	1	Std
1010, 1357	He	600	25	7.0	2.6	Var 1, 2	1	Std
1010, 602	He	600	25	7.0	2.6	1	Var 1, 2	Std
1010, 1608	He	600	25	7.0	2.6	1	1	Var Std and Light
1010, 1552	Var He, N_2	600	25	7.0	2.6	1	1	Std

TABLE VIII. - LIST OF DOUBLE VARIABLE DATA POINTS

SVDS reading numbers	DVDS reading numbers (stroke varied starting at 1.8 cm)	
602	598-602	(1.8-2.6 cm)
1006	1006-1012	(1.8-3.0 cm)
1007	↓	↓
1008		
1009		
1010		
1011		
1012		
1017	1013-1019	↓
1024	1020-1025	(1.8-2.8 cm)
1030	1026-1032	(1.8-3.0 cm)
1070	1066-1072	↓
1079	1075-1081	
1121	1117-1122	(1.8-2.8 cm)
1200	1196-1202	(1.8-3.0 cm)
1357	1353-1360	(1.8-3.2 cm)
1552	1548-1552	(1.8-2.6 cm)
1608	1604-1610	(1.8-3.0 cm)

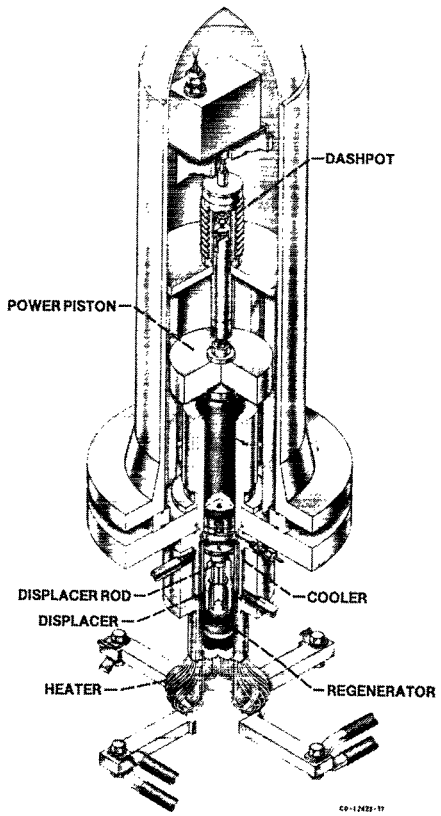


FIGURE 1. - COMPONENT LAYOUT OF RE-1000 FREE PISTON STIRLING ENGINE.

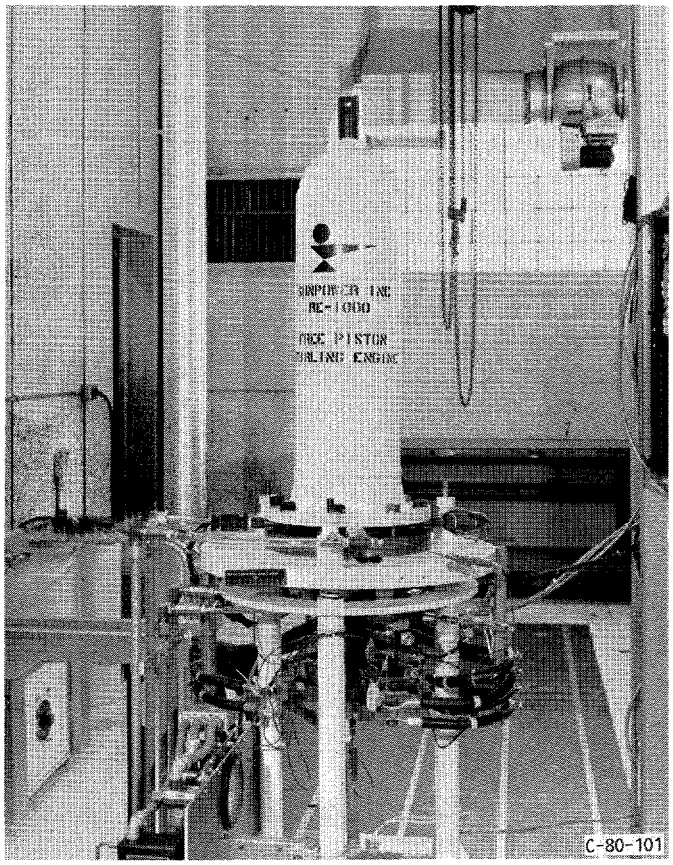


FIGURE 2. - RE-1000 FREE-PISTON STRILING ENGINE IN TEST CELL.

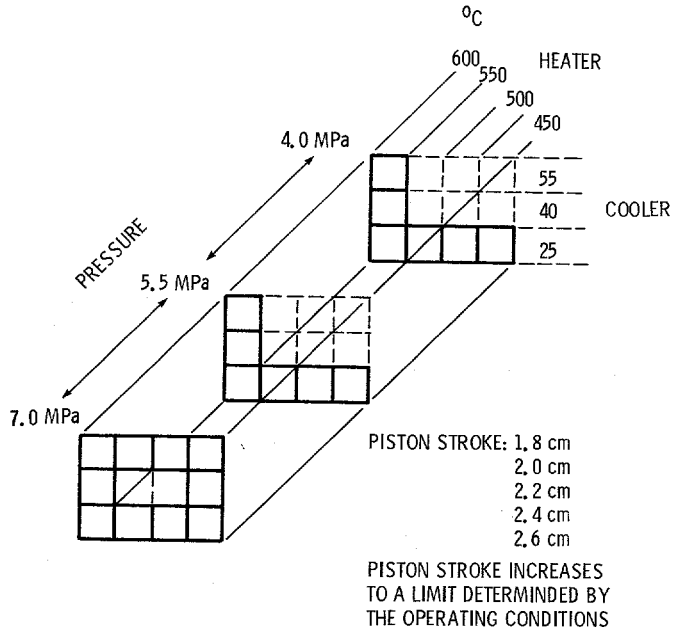


FIGURE 3.- RE-1000 TEST MATRIX.

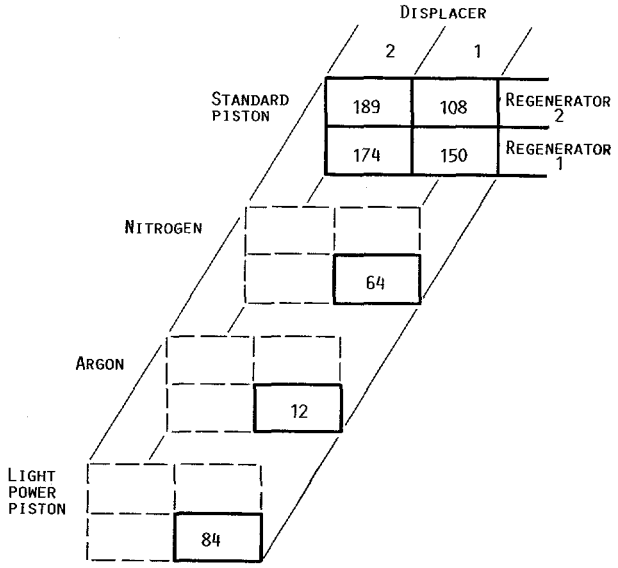


FIGURE 4.- CONFIGURATION MATRIX WITH NUMBER OF READINGS.

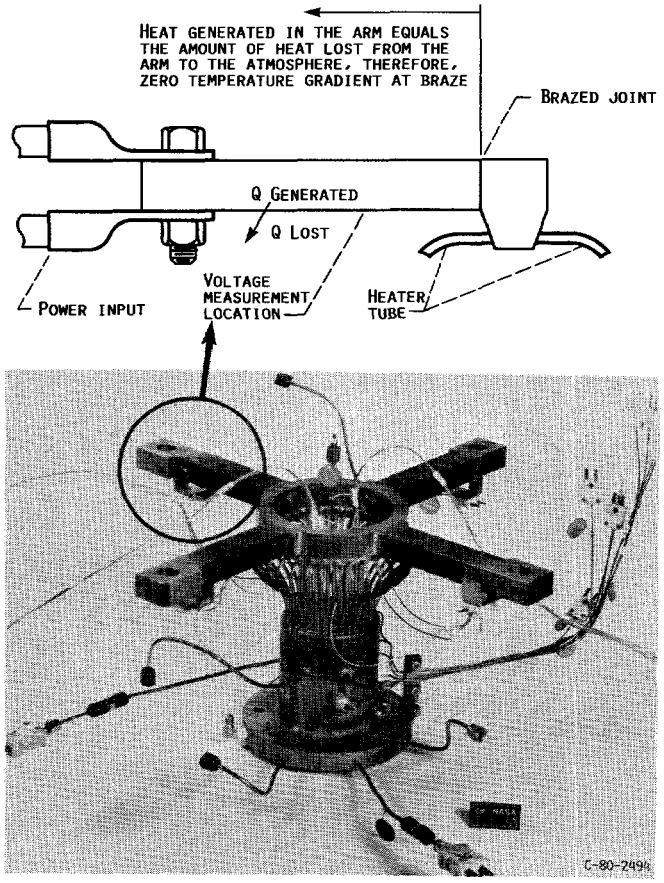


FIGURE 5.- RE-1000 HEATER HEAD.

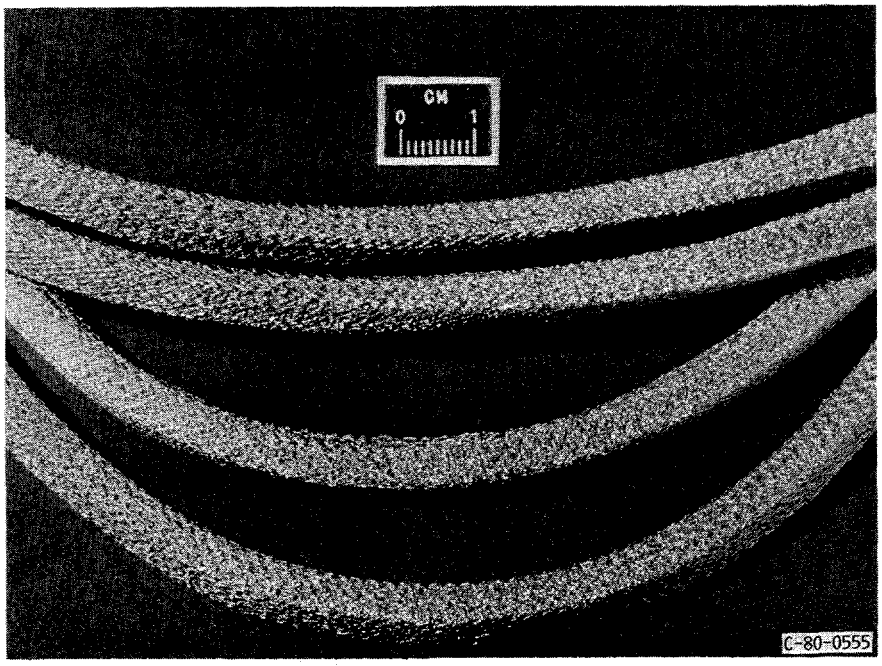


FIGURE 6. - METEX KNITTED REGENERATOR MATRIX.

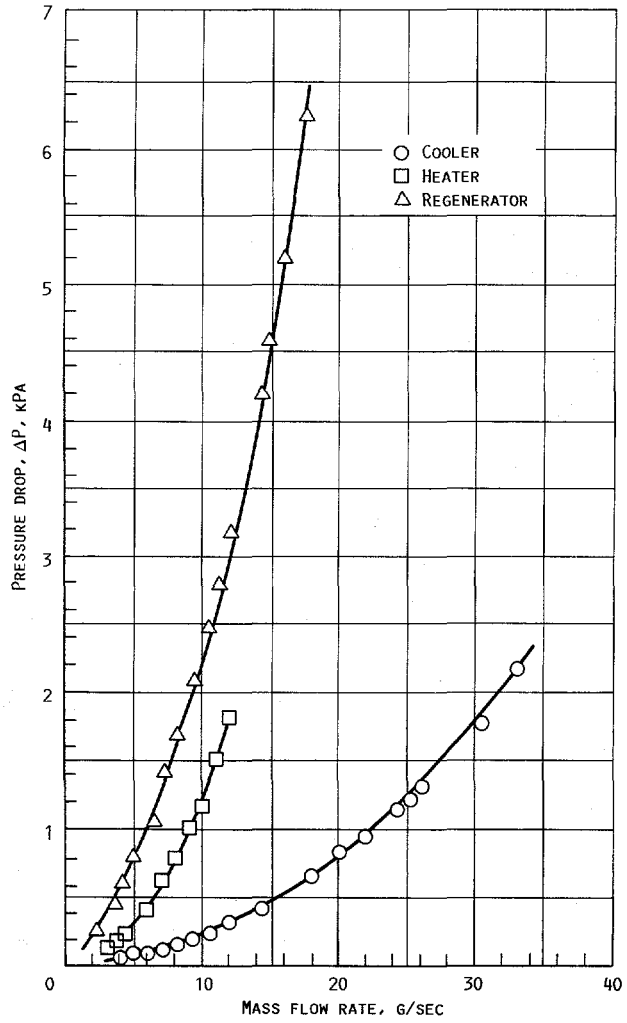


FIGURE 7.- PRESSURE DROP AS A FUNCTION OF MASS FLOW RATE WITH REGENERATOR 1. TESTED WITH NITROGEN AT 2070 KPA FOR THE COOLER AND REGENERATOR, AND 1380 KPA FOR THE HEATER. NITROGEN TEMPERATURE WAS 15 °C.

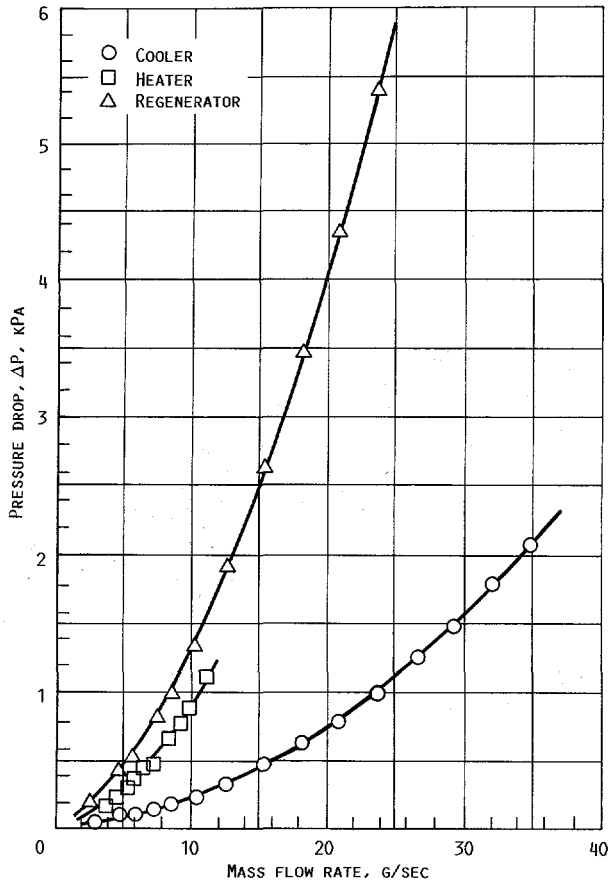


FIGURE 8.- PRESSURE DROP AS A FUNCTION OF MASS FLOW RATE WITH REGENERATOR 2. TESTED WITH NIGROGEN AT 2070 kPA FOR THE COOLER AND REGENERATOR, AND 1380 kPA FOR THE HEATER. NITROGEN TEMPERATURE WAS 10 °C.

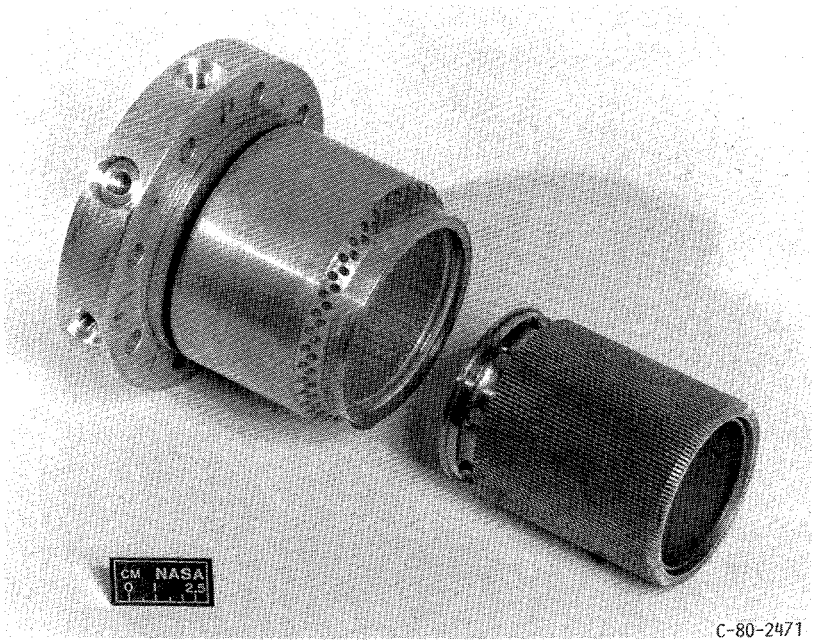


FIGURE 9. - RE-1000 COOLER AND HOUSING.

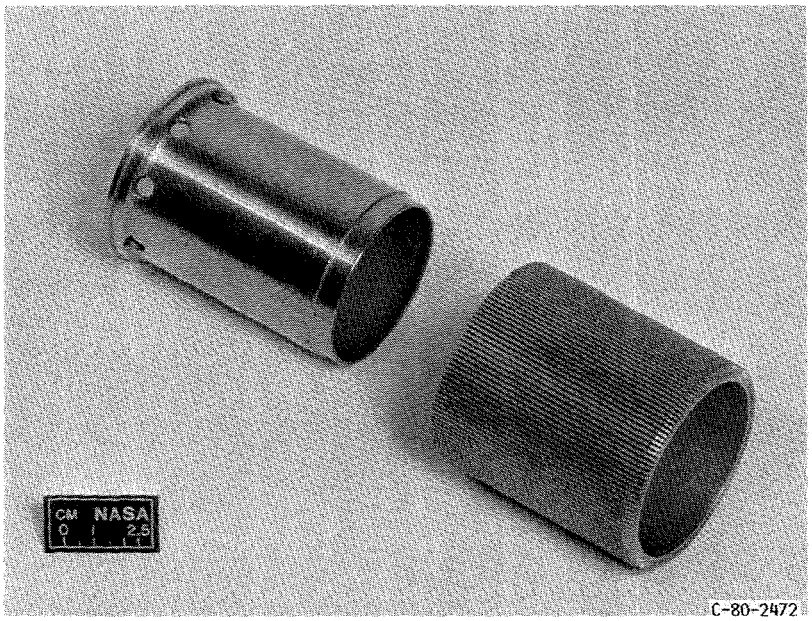


FIGURE 10. - DISPLACER CYLINDER AND COOLER GAS PASSAGES.

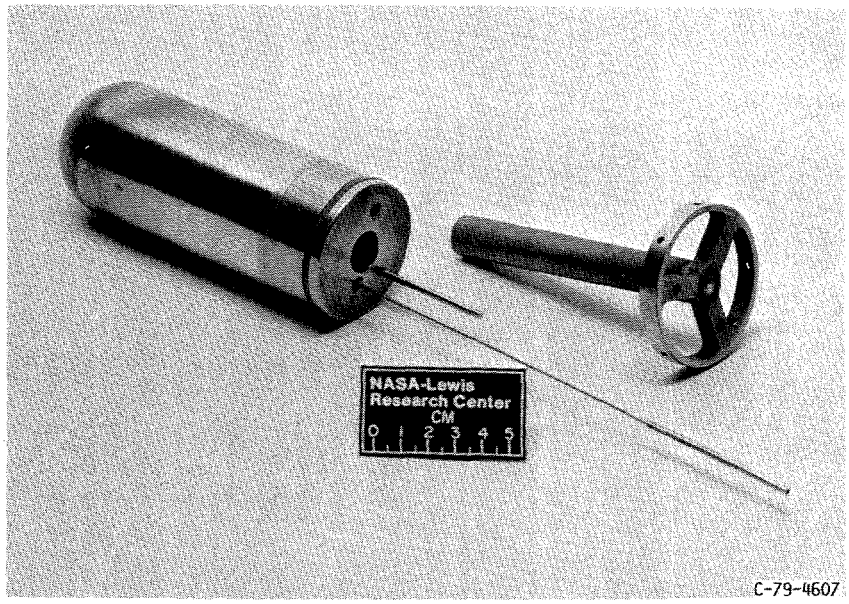


FIGURE 11. - DISPLACER AND DISPLACER ROD 1.

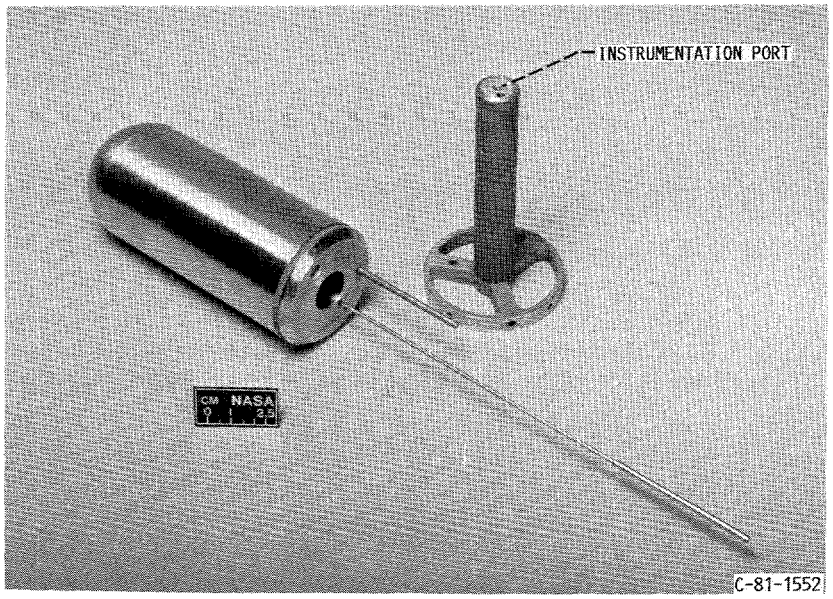


FIGURE 12. - DISPLACER AND DISPLACER ROD 2.

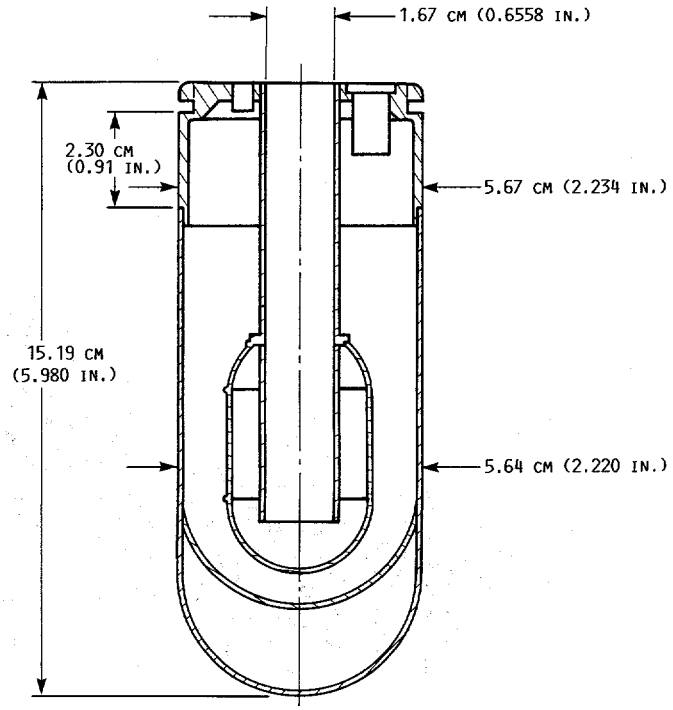


FIGURE 13.- DISPLACER 1 CROSS-SECTION. DISPLACER WEIGHT, 426 G (0.94 LB); GAS SPRING MEAN VOLUME, 31.79 CM^3 (1.94 $IN.^3$).

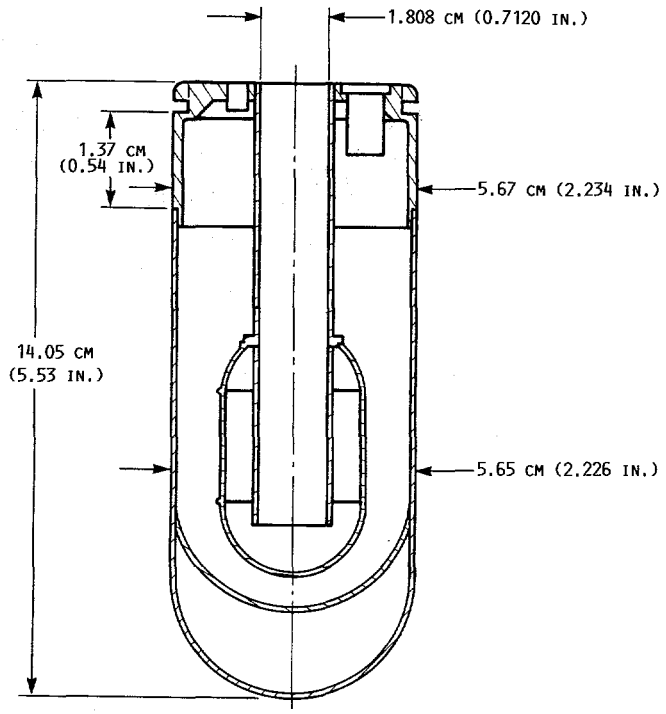


FIGURE 14.- DISPLACER 2 CROSS-SECTION. DISPLACER WEIGHT 381.3G (0.84 LB), GAS SPRING MEAN VOLUME, 18.80 CM^3(1.147 $IN.^3$).

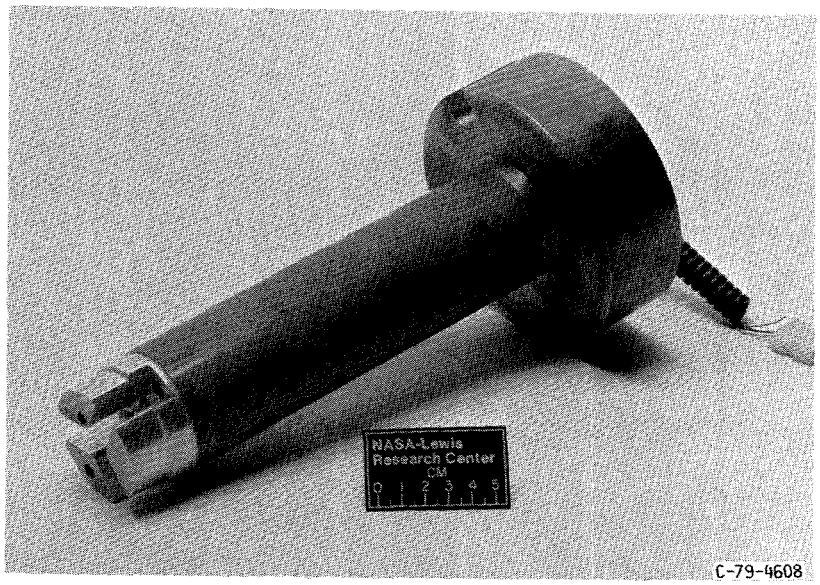
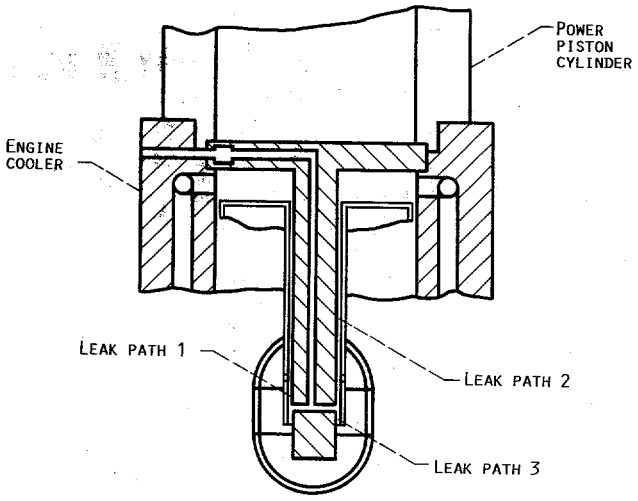
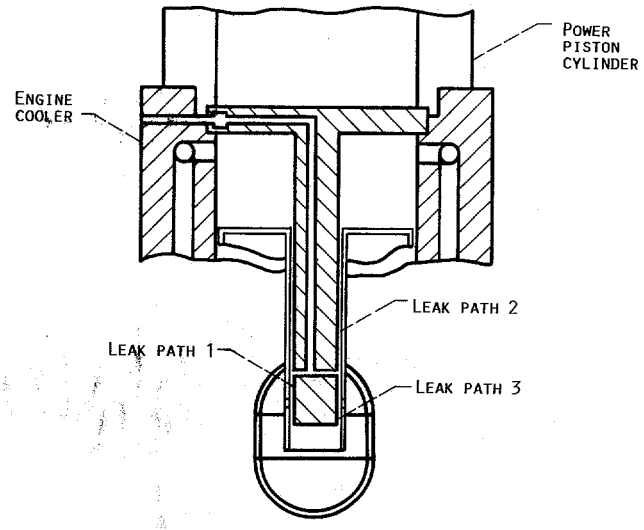


FIGURE 15. - RE-1000 FREE-PISTON STRILING ENGINE POWER PISTON.



(A) WHEN DISPLACER IS AT COMPRESSION SPACE.



(B) WHEN DISPLACER IS AT EXPANSION SPACE.

FIGURE 16. - DISPLACER ROD MOUNTING WITH CENTER PORTS AND LEAK PATHS SHOW.

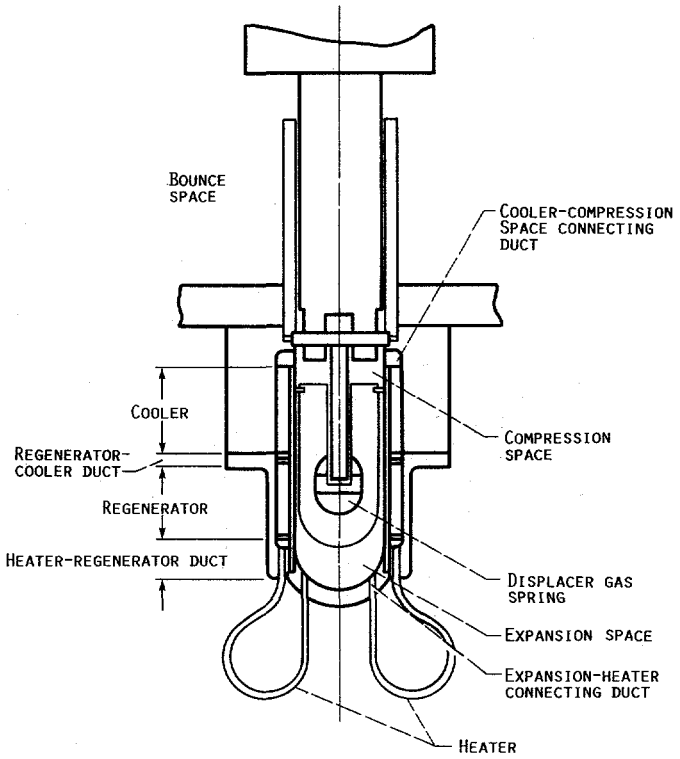


FIGURE 17.- DEFINITIONS OF VOLUMES IN THE ENGINE.

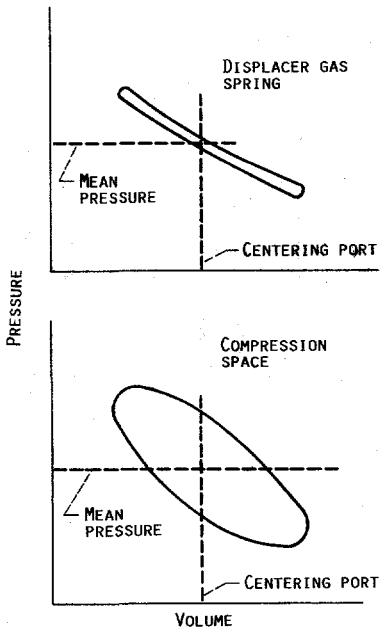
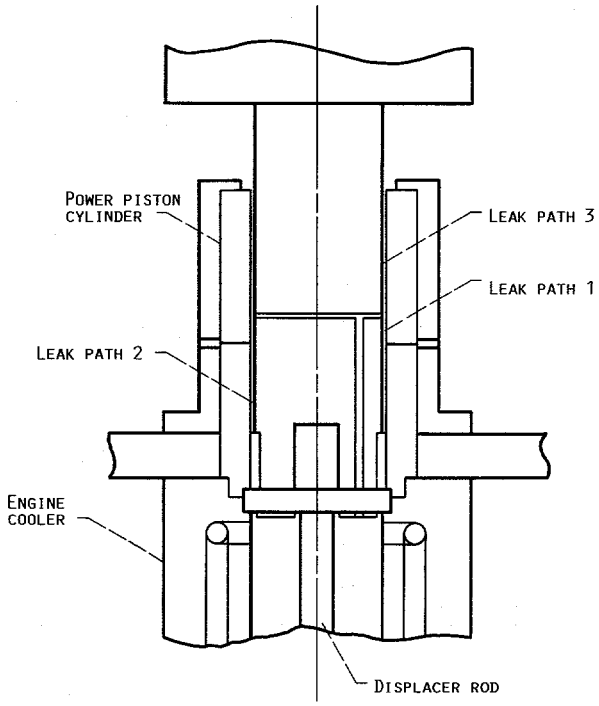
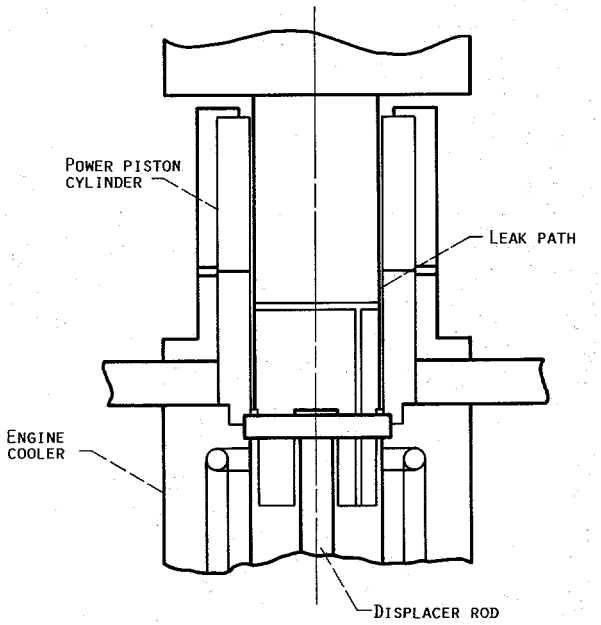


FIGURE 18.- RE-1000 ENGINE CENTERING PORT PRESSURE DROP FOR DISPLACER GAS SPRING AND COMPRESION SPACE.

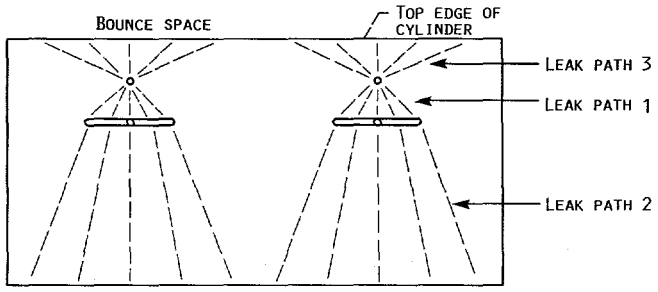


(A) WHEN POWER PISTON IS ABOVE CENTER PORTS.

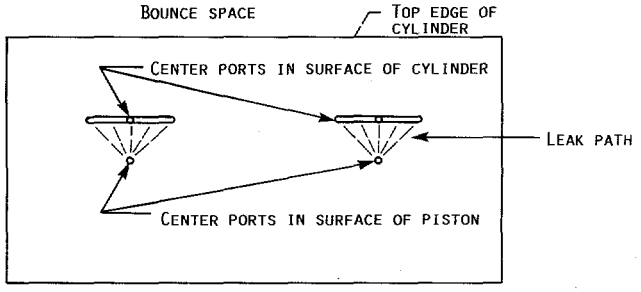


(B) WHEN POWER PISTON IS BELOW CENTER PORTS.

FIGURE 19.- SCHEMATIC OF LEAK PATHS PAST POWER PISTON.



(A) WHEN POWER PISTON IS ABOVE CENTER PORTS.



(B) WHEN POWER PISTON IS BELOW CENTER PORTS.

FIGURE 20. - GEOMETRY OF LEAK PATHS PAST POWER PISTON. THE CENTER PORT IN THE POWER PISTON CYLINDER IS A 1.1-MM-DIAMETER HOLE WITHIN A GROOVE 30 MM LONG, 1.25 MM WIDE, AND 0.75 MM DEEP.

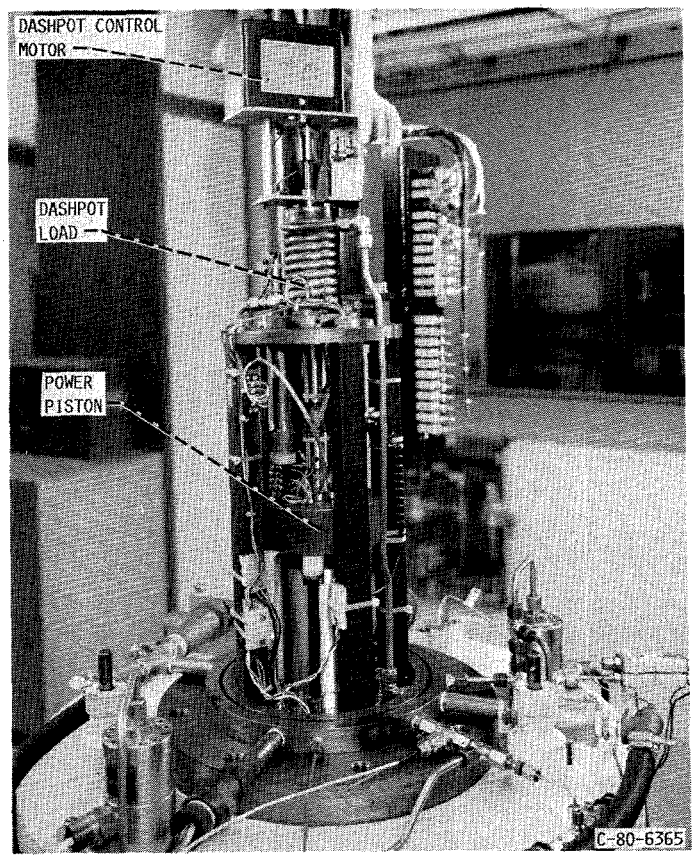


FIGURE 21. - RE-1000 IN TEST CELL WITH PRESSURE VESSEL REMOVED.

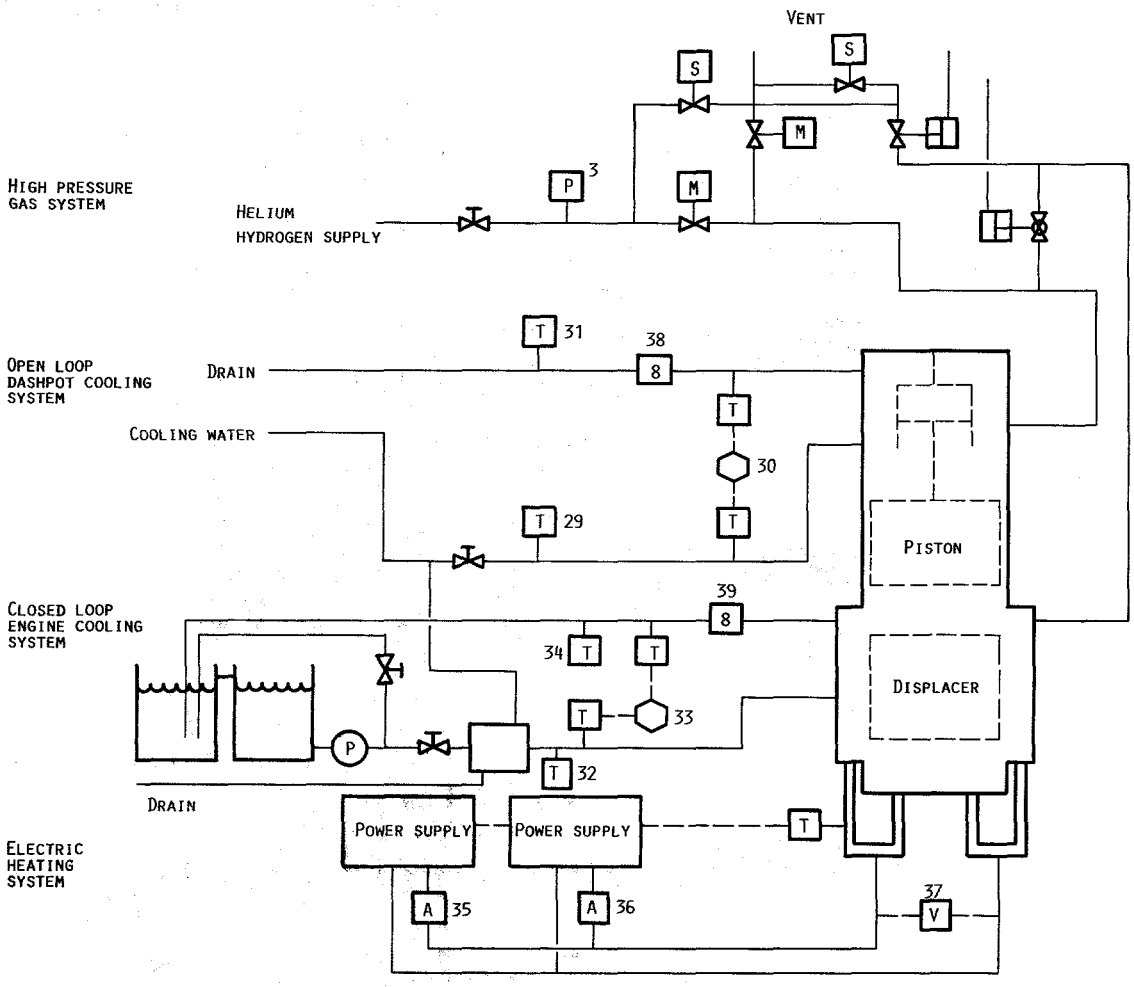


FIGURE 22.- RE-1000 TEST SCHEMATIC.

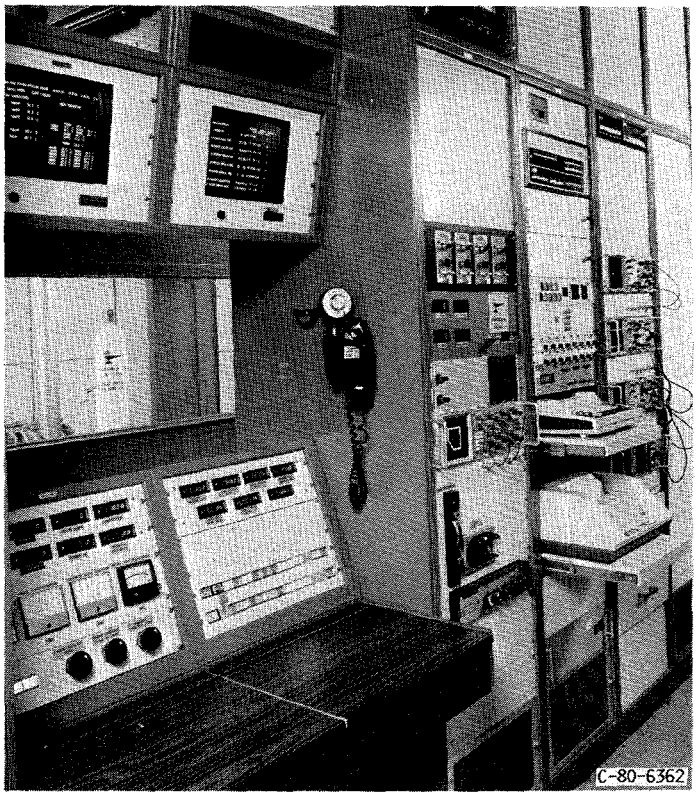


FIGURE 23. - CONTROL ROOM.

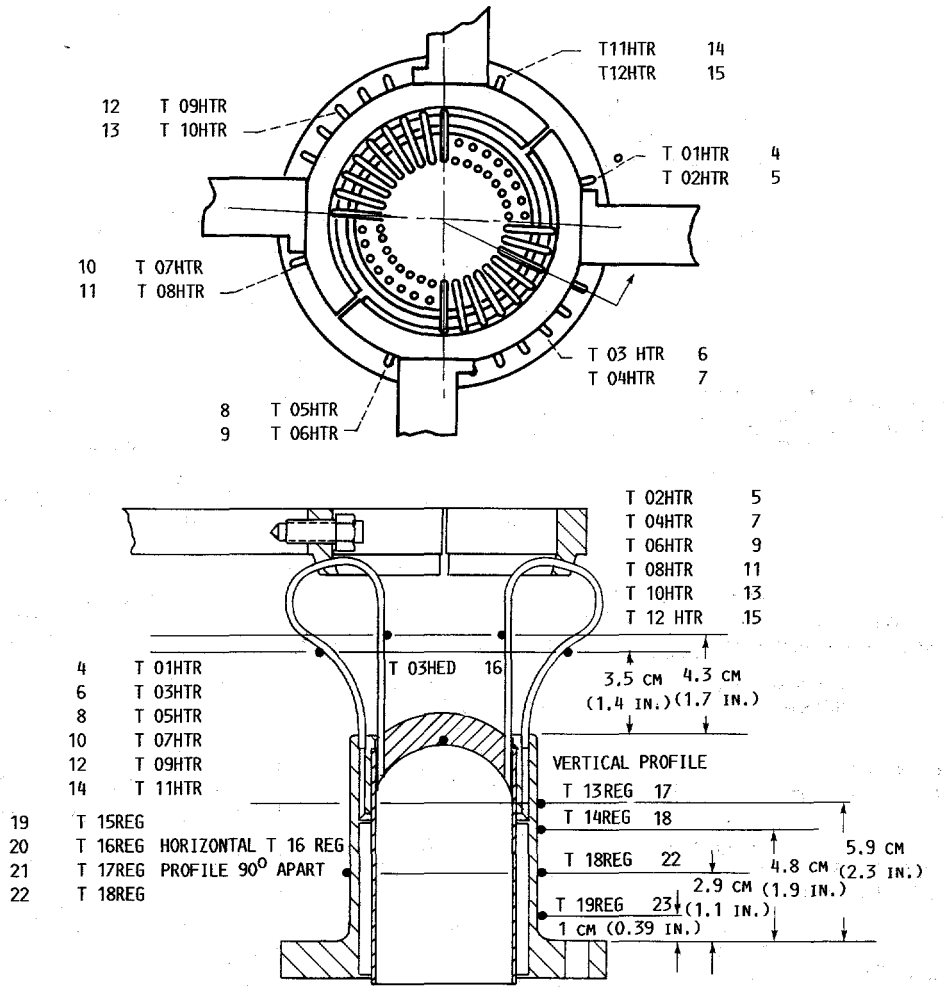


FIGURE 24.- RE-1000 HEATER HEAD THERMOCOUPLE LOCATIONS.

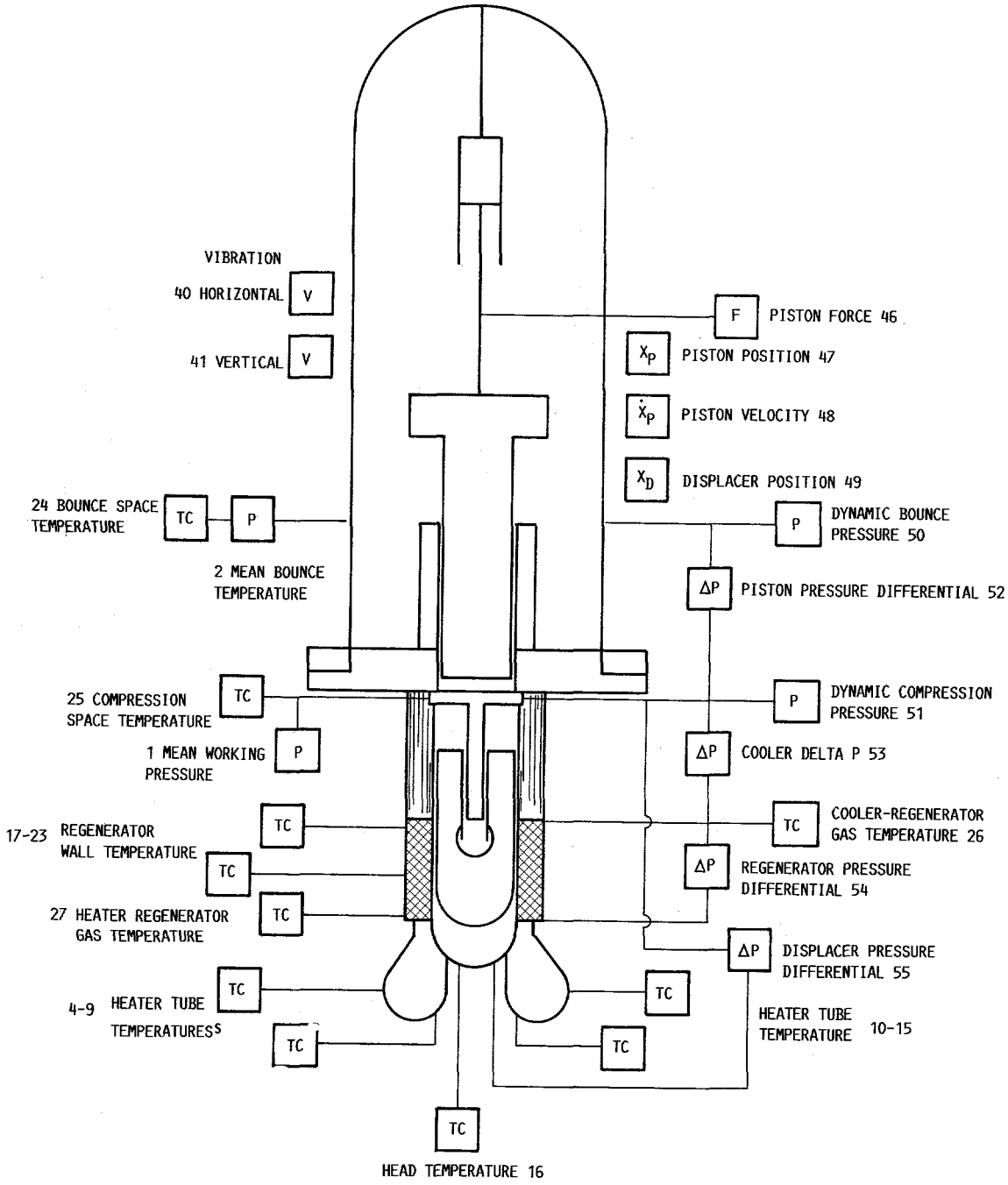
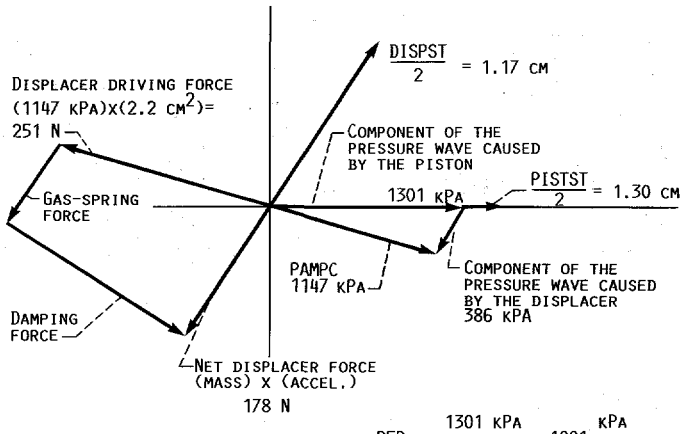


FIGURE 25.- INSTRUMENTATION LAYOUT OF RE-1000.



$$PFP \quad \frac{1301 \text{ KPA}}{1.30 \text{ CM}} = 1001 \frac{\text{KPA}}{\text{CM}}$$

$$PFD \quad \frac{386 \text{ KPA}}{1.17 \text{ CM}} = 329.9 \frac{\text{KPA}}{\text{CM}}$$

FIGURE 26.- PHASOR DIAGRAM OF THE RE-1000 AT DATA POINT 1010, DESIGN CONDITION.

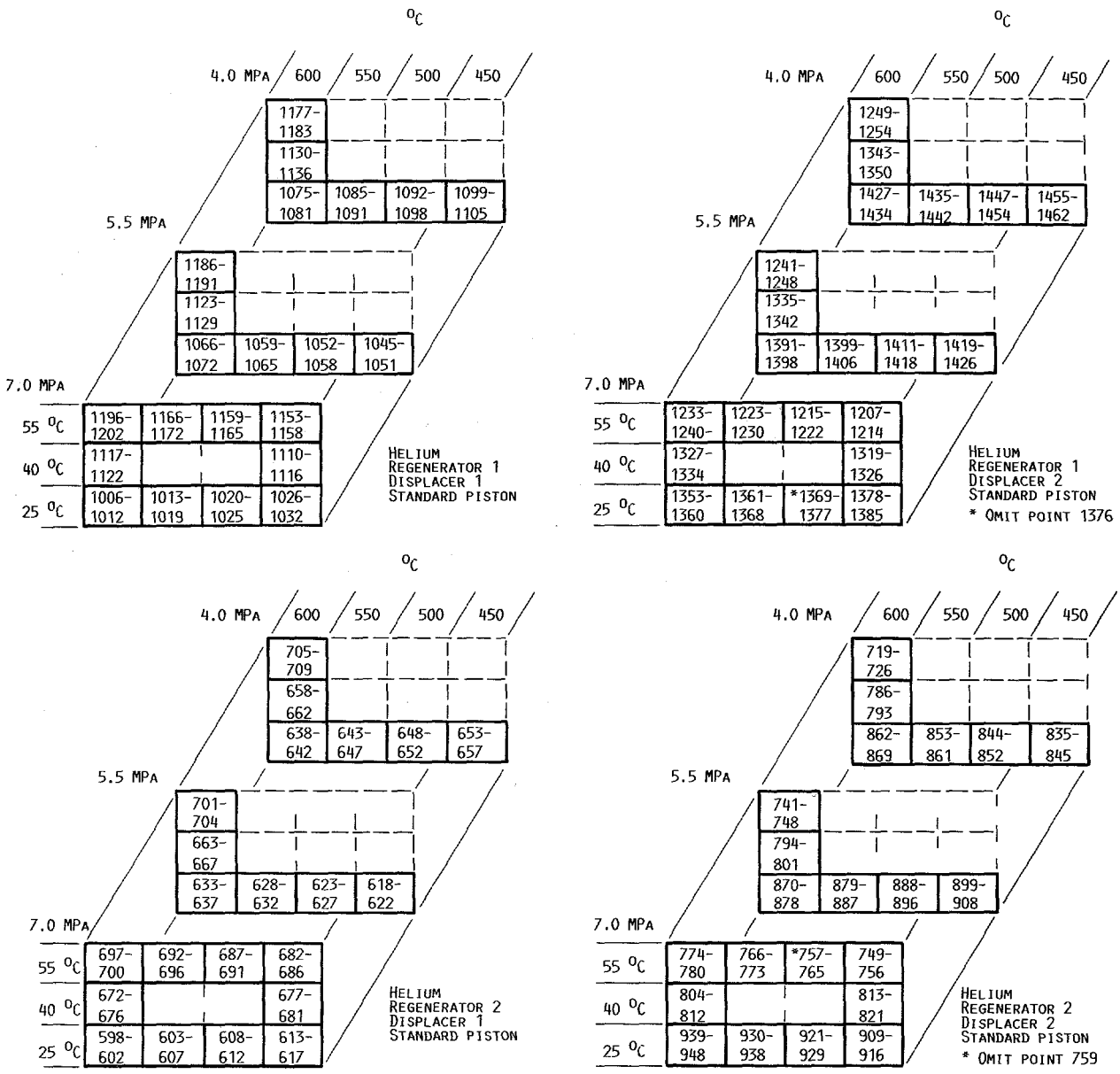


FIGURE 27.- TEST MATRIX WITH READING NUMBERS.

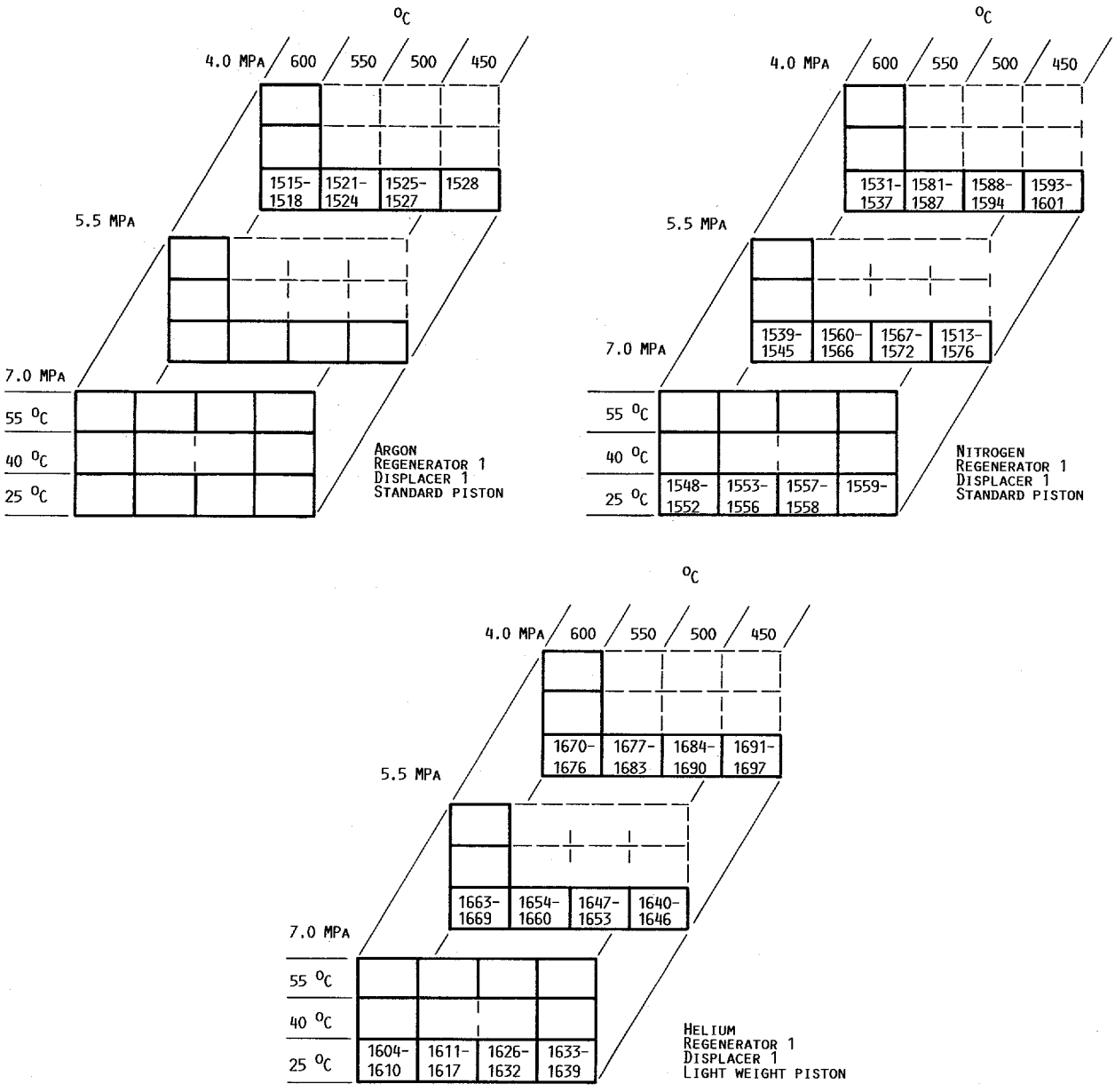


FIGURE 27.- CONCLUDED.

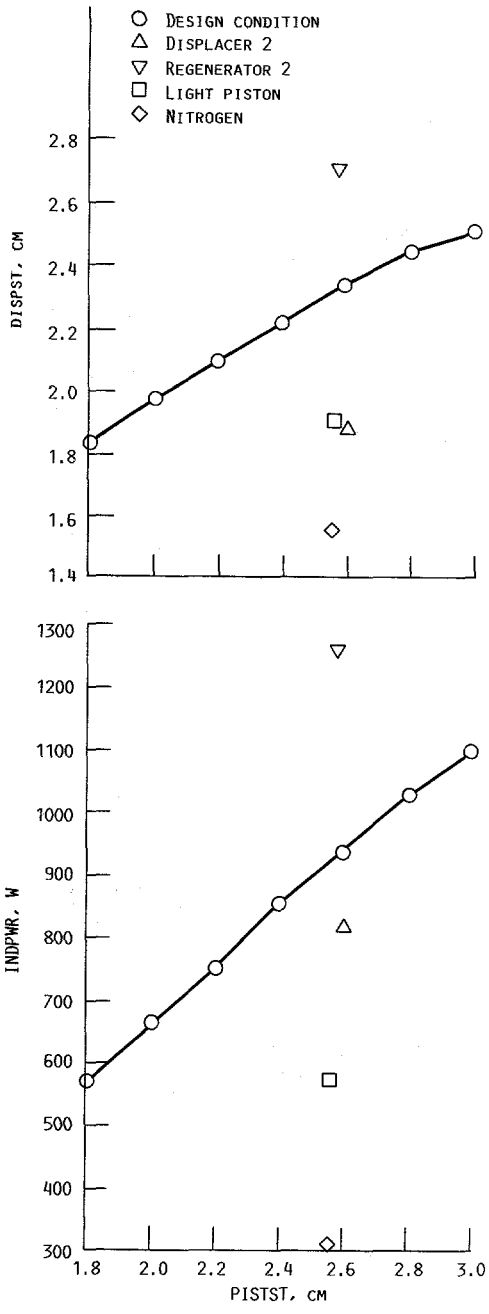


FIGURE 28.- DATA PLOTTED FROM THE SINGLE VARIABLE DATA SET (SVDS).

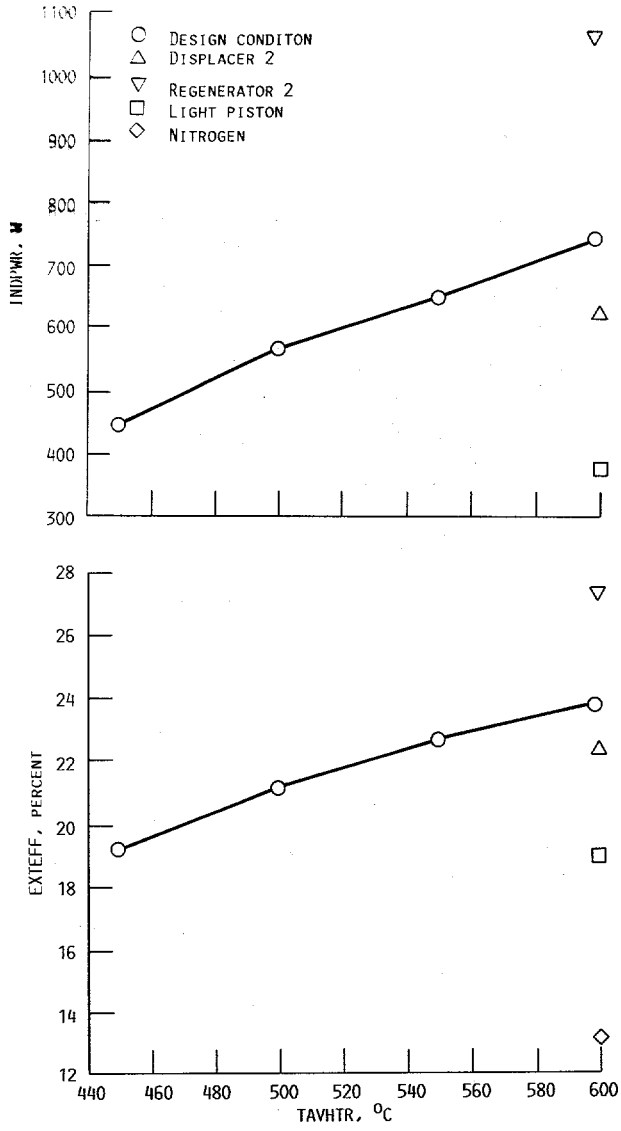


FIGURE 28.- CONCLUDED.

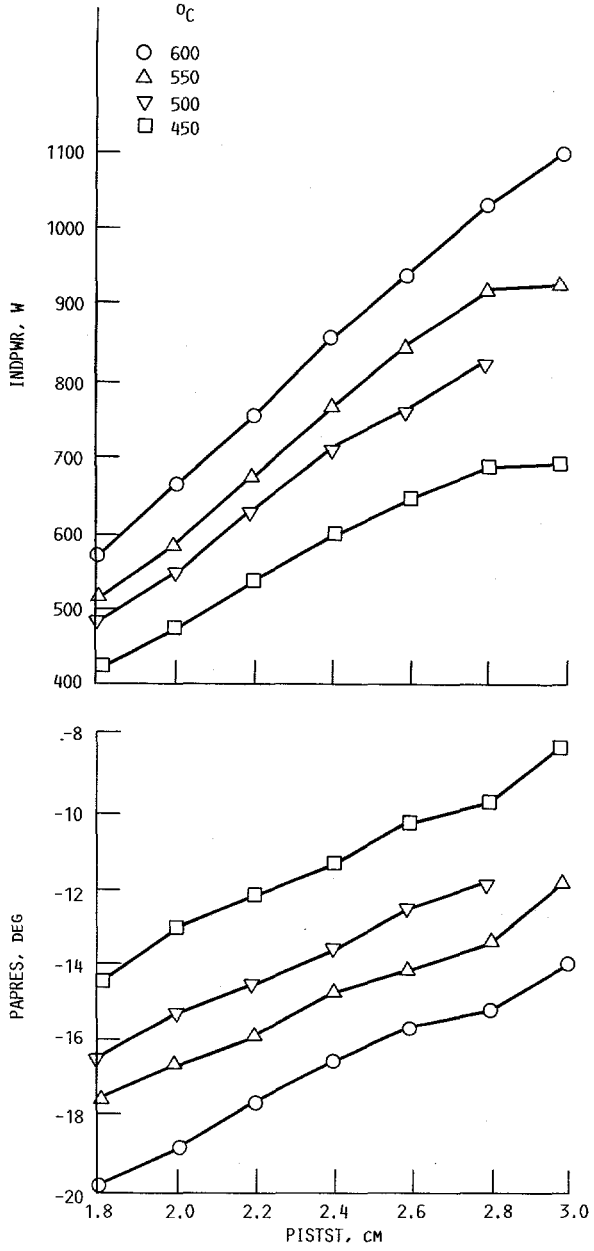


FIGURE 29.- DATA PLOTTED FROM THE DOUBLE VARIABLE DATA SET (DVDS).

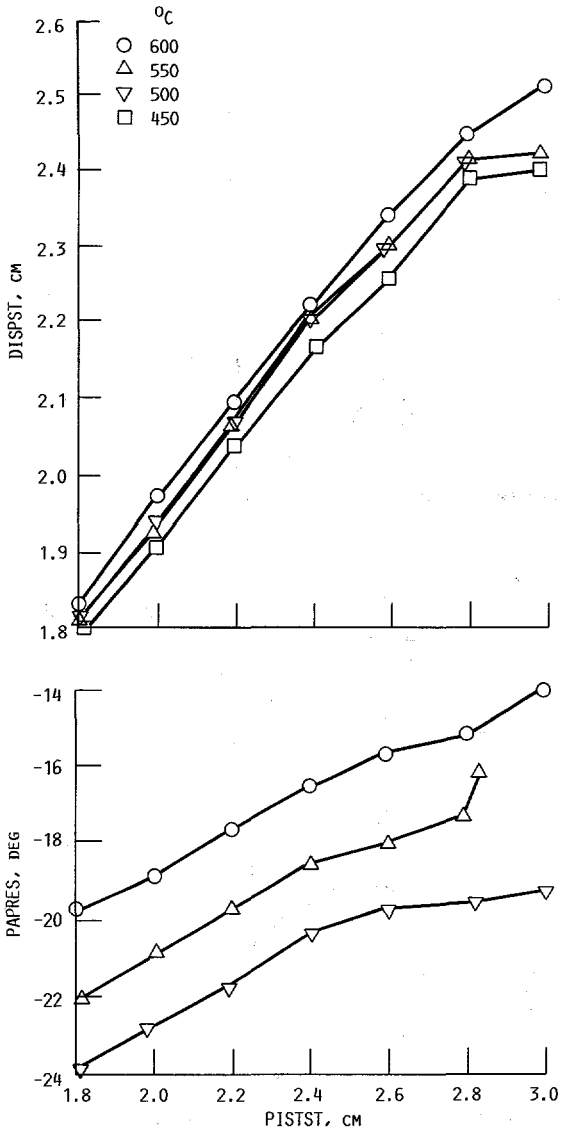


FIGURE 29.- CONCLUDED.

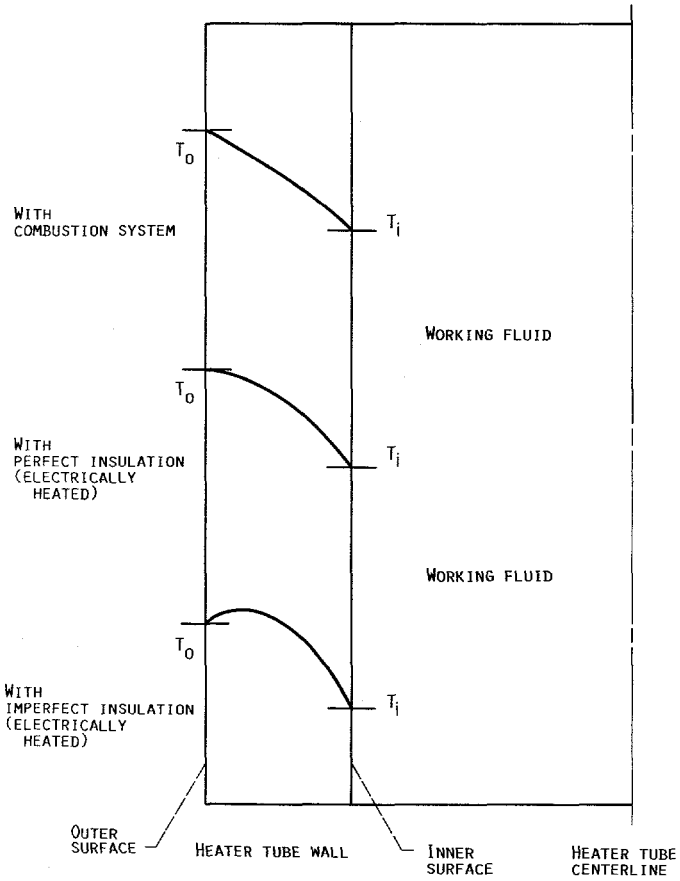


FIGURE 30.- HEATER TUBE TEMPERATURE PROFILES.

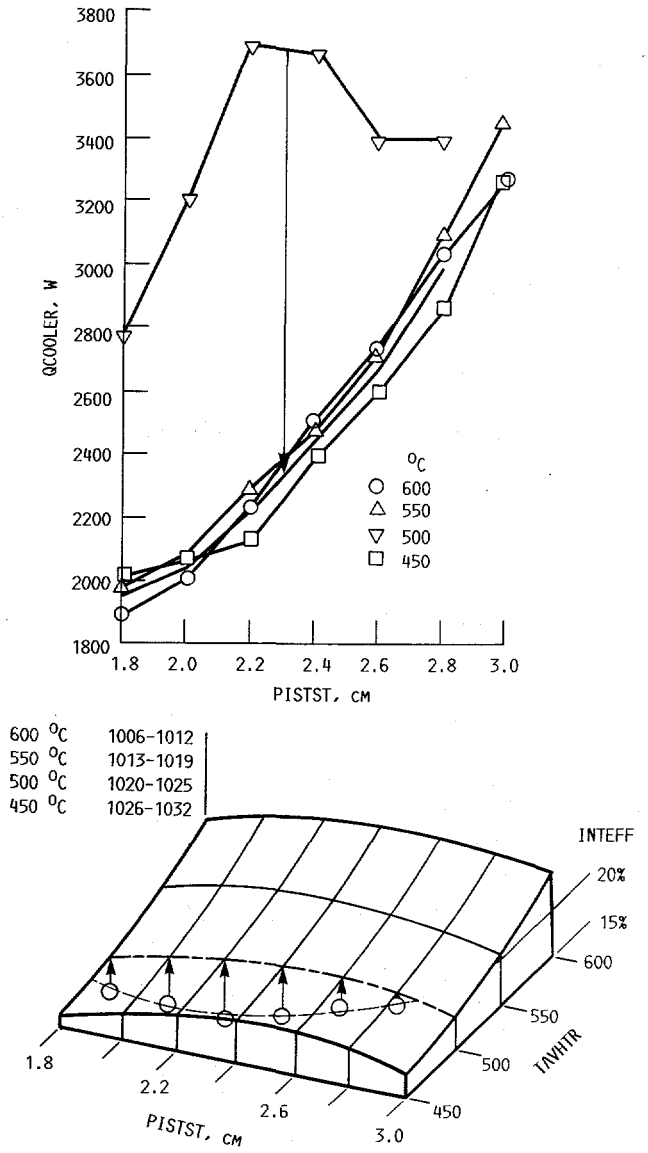


FIGURE 31.- CORRECTION OF FAULTY QCOOLER READING FOR DATA POINTS 1020-1025.

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16. Abstract

The NASA Lewis Research Center has been testing a 1 kW (1.33 hp) free-piston Stirling engine at the NASA Lewis test facilities. The tests performed over the past several years have been on a single cylinder machine known as the RE-1000. The data recorded were to aid in the investigation of the dynamics and thermodynamics of the free-piston Stirling engine. The data are intended to be used primarily for computer code validation. NASA reports TM-82999, TM-83407, and TM-87126 give initial results of the engine tests. The tests were designed to investigate the sensitivity of the engine performance to variations on the mean pressure of the working space, the working fluid used, heater and cooler temperatures, regenerator porosity, power piston mass and displacer dynamics. These tests have now been completed at NASA Lewis. This report presents some of the detailed data collected in the sensitivity tests. In all, 781 data points were recorded. A complete description of the engine and test facility is given. Many of the data can be found in tabular form, while a microfiche containing all of the data points can be requested from the NASA Lewis.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Stirling engine; Heat engine; Stirling cycle; Free-piston engine	Foreign distribution excluded. Available from NASA Industrial Applications Centers.

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