D.O. 113
NAS8-36955

TEST EQUIPMENT DATA PACKAGE FOR THE KC-135 FIBER PULLING APPARATUS

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Submitted to:

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Lyndon B. Johnson Space Center
Houston, Texas, 77058

KC-135 Reduced Gravity Operations
Ellington Air Field
Building 993

July 1991

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TEST EQUIPMENT DATA PACKAGE

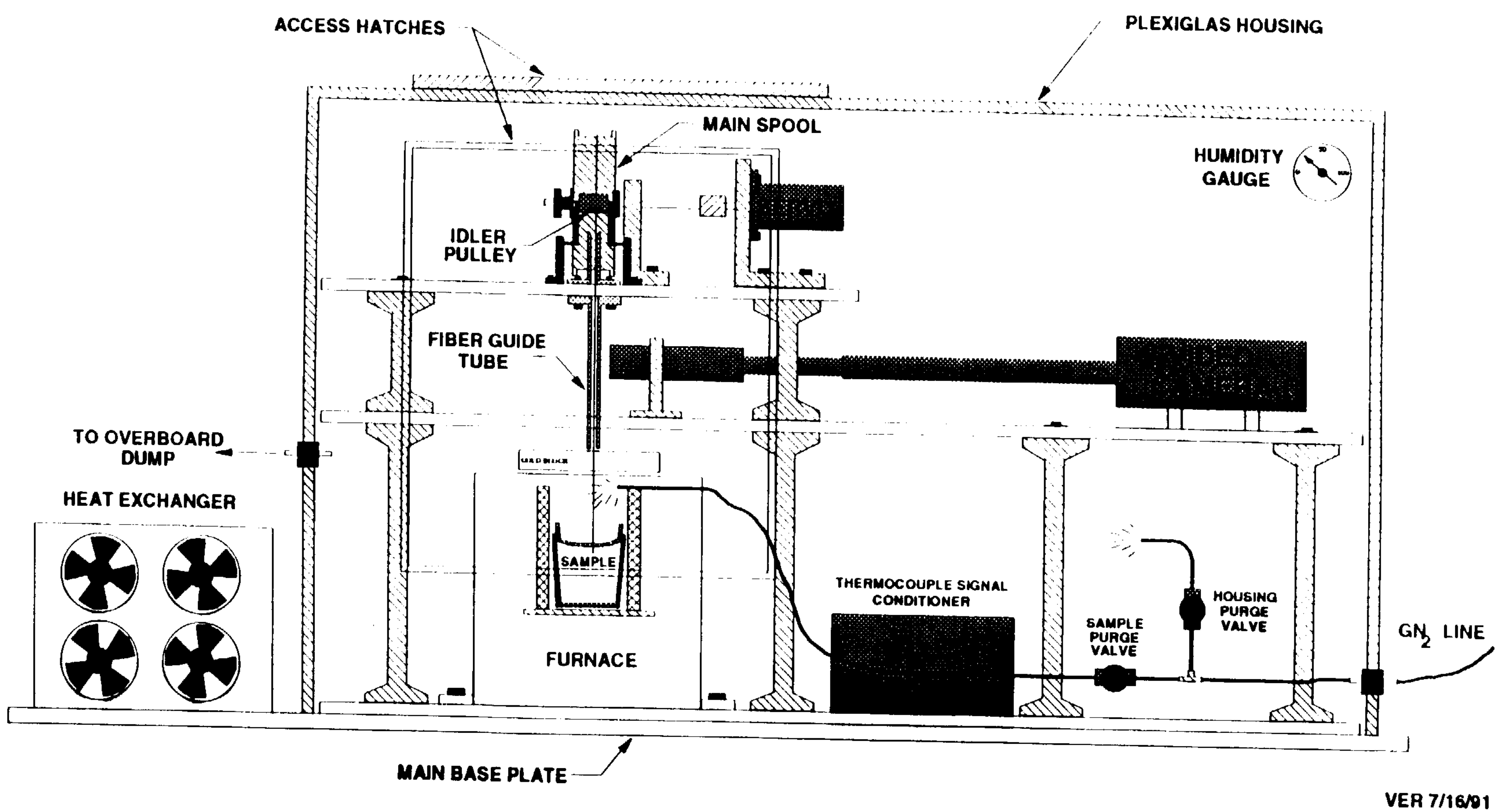
Section A. SYNOPSIS OF THE FIBER PULLING APPARATUS

The Fiber Pulling Apparatus (FPA) is a device designed to produce continuous glass fibers from simulated lunar soil, and to determine the effects of reduced gravity, specifically 1/6 g on fiber formation and resultant properties. Briefly, pre-melt simulated lunar soil will be placed in a pint crucible and heated to 1200C or higher, up to a maximum temperature of 1400C. At a given temperature a quartz fiber will be immersed into the melt and then pulled through a chill block and wound onto a cylindrical bobbin using a servo motor control. A high resolution video camera will record the fiber as it is being pulled. This assembly will be enclosed in Plexiglas. Before fiber pulling commences, the apparatus will be backfilled with dry nitrogen. A separate data acquisition system will support this apparatus. This system will contain a personal computer, video recorder, and monitor. Temperature, acceleration, winding speed, and video images will be controlled and recorded using the data acquisition system. Thus, the FPA will consist of two hardware packages, the fiber production assembly and the data acquisition rack (Figures 1 & 2).

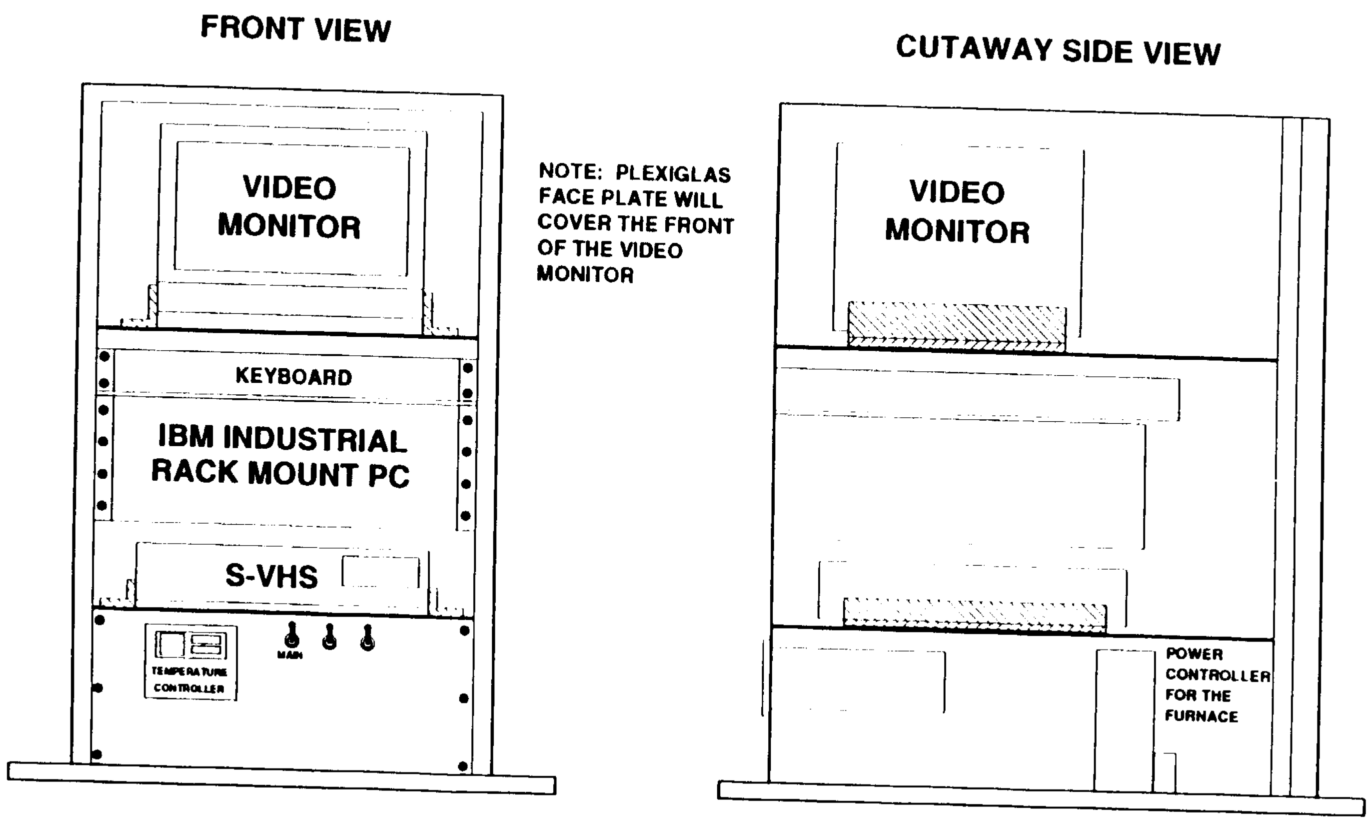
Section B. TEST OBJECTIVES

The primary objective of this test is to determine the effects of 1/6 g on the formation of continuous glass fiber made from simulated lunar soil. Baseline studies using the FPA on the ground will provide a reference for the 1/6 g studies. Of particular interest will be the effect of 1/6 g on the free fluid zone where the fiber exists the crucible. In the fiber spinning parlance this zone is known as the upper jet region, where the boundary slope is greater than one tenth. The properties of the resulting glass fiber will depend on the jet shape as well as distributions of velocity, temperature and tension within the jet. It is unknown at this time how 1/6 g will effect these parameters.

KC-135 LUNAR G FIBER PULLER CONCEPT DESIGN



CONTROL AND DATA ACQUISITION RACK



A second objective is to determine the mechanical properties of the spun glass fibers. The mechanical strength will depend on the above discussed parameters, as well as the previous history of the lunar glass derived from simulant. Another factor in glass strength is the amount of water vapor present while the fiber is being formed and wound onto the package. It is well known that water vapor induces strength loss in glass which manifests itself as static and dynamic fatigue. Thus in this experiment the dry nitrogen will serve to keep the relative humidity as low as possible.

Section C. TEST DESCRIPTION

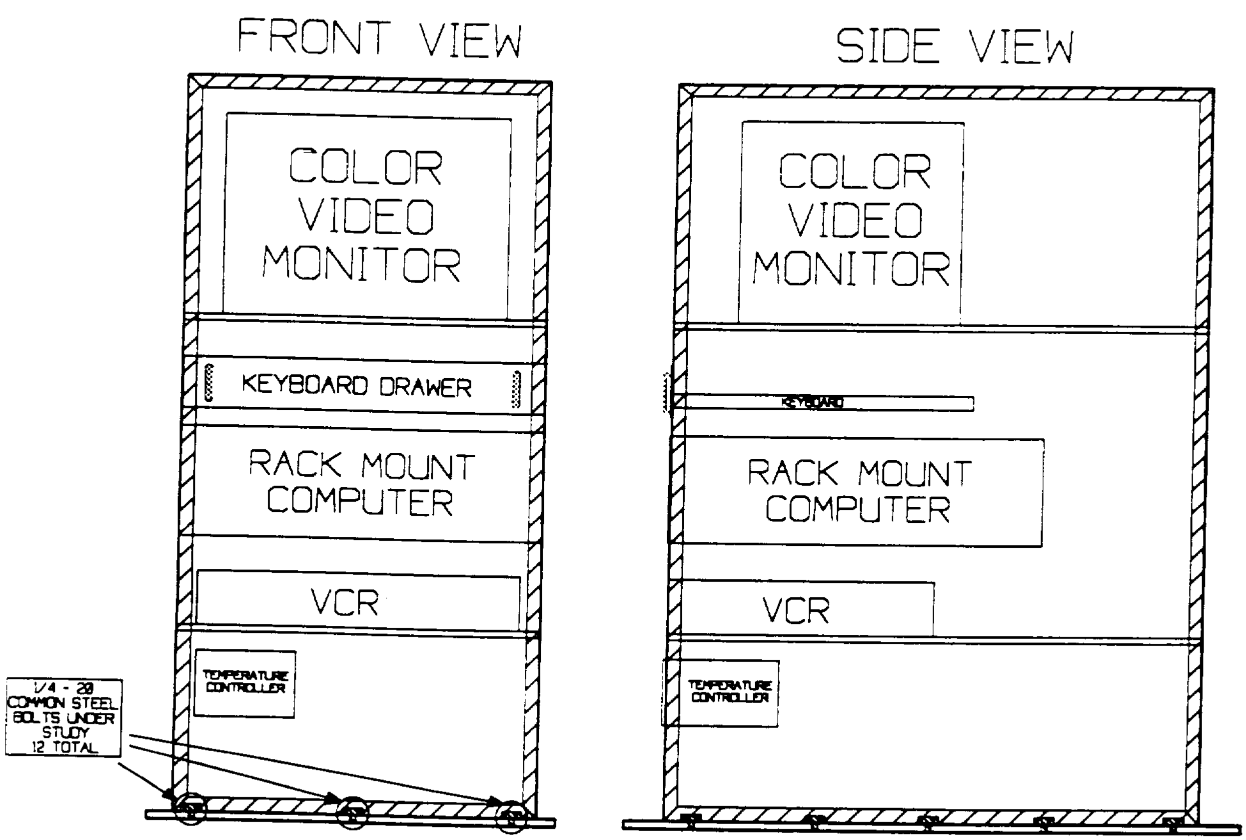
Before the glass is heated, the Plexiglas housing will be purged with dry nitrogen. The glass will then be heated to a suitable pulling temperature which will have been identified during ground studies. This temperature will be in the range of 1200 degrees C. Fiber pulling will commence with the aircraft maneuver and continue for as many as 10 parabolas. During fiber pulling the acceleration will be monitored and recorded, and a high resolution video will record the fiber as it is being pulled. The fiber winding rate will be constant during the first set of parabolas. Fiber shape and diameter will be observed and recorded. Temperature and winding rate will be adjusted in subsequent parabolas to determine their effects on fiber shape and final diameter. Nitrogen purging and over board dump will be used to maintain low humidity and remove any free glass fibers.

Section D. STRUCTURAL LOAD ANALYSIS

Three case studies are presented dealing with the heaviest objects and their associated mounting points. Case 1 deals with the electronics rack housing attachment points to the base plate. Case 2 deals the what we believe to be the weakest link in the FPA production assembly, the mounting of the production assembly to the base plate. The third case deals with the mounting points of the top plate of the FPA production assembly to the middle plate. It is our contention that these studies represent the worst case conditions with this hardware. All other objects such as motors, equipment inside the electronics rack and inside the production package will be contained during crash loads.

Case 1: FPA Data Acquisition System to the Base Plate Mounting Bolts

Note: All calculations are based on the assumption that all stress will be either pure tension or pure shear. The calculations will be based on 9 g's eyeballs in, out, left or right. Calculations for 2 g's eyeballs up and 6 g's eyeballs down will also be presented. Total weight of the data acquisition system is 400 pounds. The weight of the electronics rack alone without the base plate is 375 pounds so the g forces calculated will be on the 375 pound mass that has a center of gravity 21 inches from the base plate, 16.25 inches from the front and 11 inches from the side. Locations of the bolts under study are identified in the figure below.



Electronics Rack to the Base Plate Mounting Points

TENSILE:

No reactive moment arm is calculated therefore the total tensile created is distributed by the 12 1/4-20 common steel bolts that attach the electronics rack to the 1/2 inch thick base plate.

Tensile force for the free standing structure seeing 2 g's eyeballs up pulling apart from the 1/2 inch thick base plate will be:

T = Tension

T = Force/Area

T = (375 lbs * 2 g's)/(3.14/4)*(0.25" dia.)^2 * 12 bolts

T = 750/0.58875

T = 1273.885 psi force at 2 g's eyeballs up.

T = 1273.89/12 bolts

T = 106.16 pounds per bolt at 2 g's eyeballs up.

The bolts used are rated to 68,000 psi or 2150 pounds force each. The force seen at 2 g's eyeballs up is 106.16 pounds per bolt. Therefore, **each bolt** is 2150/106.16 = **20.3 times stronger** than required for a pure tensile force of 2 g's eyeballs up.

SHEAR:

For this case, primary shear is considered for all bolts that attach the equipment rack to its base plate. Shear stress seen across the mounting bolts at 9 g's eyeballs in, out, left or right will be:

F = The Force Seen By One Bolt

F = 375 lbs/12 bolts

F = 31.25 lbs/bolt

S = Shear Force for one Bolt

S = Force/Area

S = (31.25 lbs * 9 g's)/(3.14 * (0.125)^2

S = 281.25 lbf/0.04909 in^2

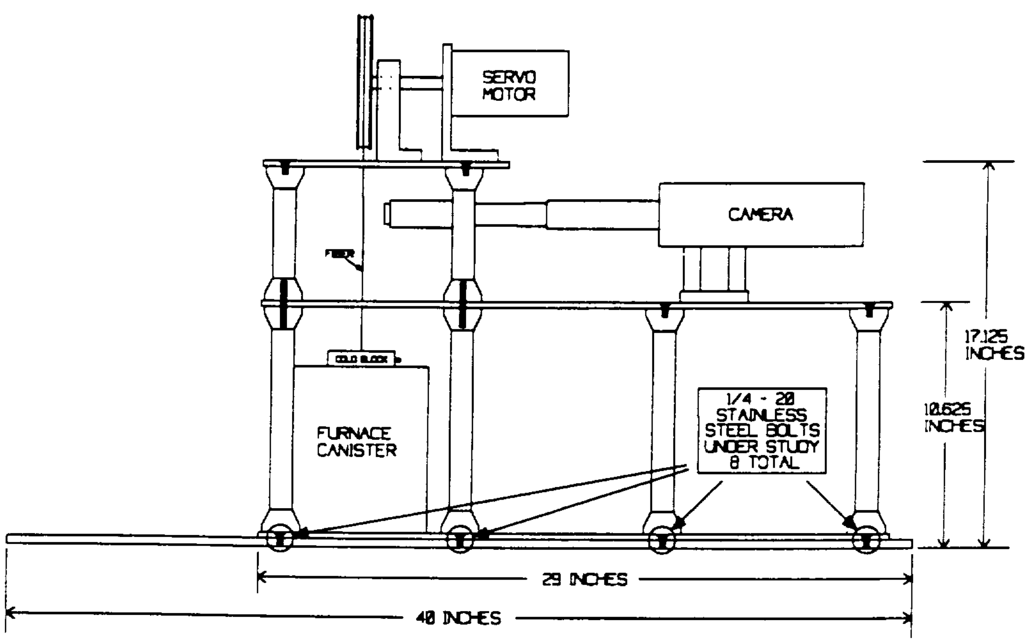
S = 5729.27 psi

S = 477.44 pounds per bolt at 9 g's.

Each bolt sees 477.44 pounds shear force. The bolts used are rated to a shear strength of 40,800 psi (60% of the tensile strength) or 1290 pounds each. Therefore, **each bolt** is 1290/477.44 = **2.7 times stronger** than the shear forces expected at 9 g's eyeballs in, out, right or left.

Case 2: FPA Production Assembly to the Base Plate Mounting Bolts

Note: All calculations are based on the assumption that all stress will be either pure tension or pure shear. The calculations will be based on 9 g's eyeballs in, out, left, or right. Calculations for 2 g's eyeballs up and 6 g's eyeballs down will also be presented. Total weight of the production assembly, the mounting plate and protective Plexiglas covering is 225 pounds. The weight of the production assembly alone is 75 pounds so the g forces calculated will be on the 75 pound mass that has a center of gravity 10.63 inches from the base plate, 20 inches from the side and 12 inches from the front of the base plate. Locations of the bolts under study are identified in the figure below.



Fiber Production Assembly to the Base Plate Mounting Bolts

TENSILE:

No reactive moment arm is calculated therefore the total tensile created is distributed by the eight 1/4-20 stainless steel bolts that attach the production assembly to the 3/8 inch thick base plate.

Tensile force for the free standing structure seeing 2 g's eyeballs up pulling apart from the 3/8 inch thick base plate will be:

T = Tension

T = Force/Area

$T = (75 \text{ lbs} * 2 \text{ g's})/(3.14/4)*(0.25\text{" dia.})^2 * 8 \text{ bolts}$

T = 150/0.3925

T = 382.166 psi force at 2 g's eyeballs up.

T = 382.166 psi/8 bolts

T = 47.77 pounds per bolt at 2 g's eyeballs up.

The bolts used are rated to 80,000 psi or 2550 pounds force each. The force seen at 2 g's eyeballs up is 47.77 pounds per bolt. Therefore, **each bolt** is 2550 lbf/47.77 lbf = **53.4 times stronger** than required for a pure tensile force of 2 g's eyeballs up.

SHEAR:

For this case, primary shear is considered for all bolts that attach the production assembly to its base plate. Shear stresses seen across the mounting bolts at 9 g's eyeballs in, out, left or right will be:

F = The Force Seen By One Bolt

F = 75 lbs/8 bolts

F = 9.375 lbs/bolt

S = Shear Force for one Bolt

S = Force/Area

$S = (9.375 \text{ lbs} * 9 \text{ g's})/(3.14 * (0.125)^2$

$$S = 84.375 \text{ lbf}/0.04909 \text{ in}^2$$

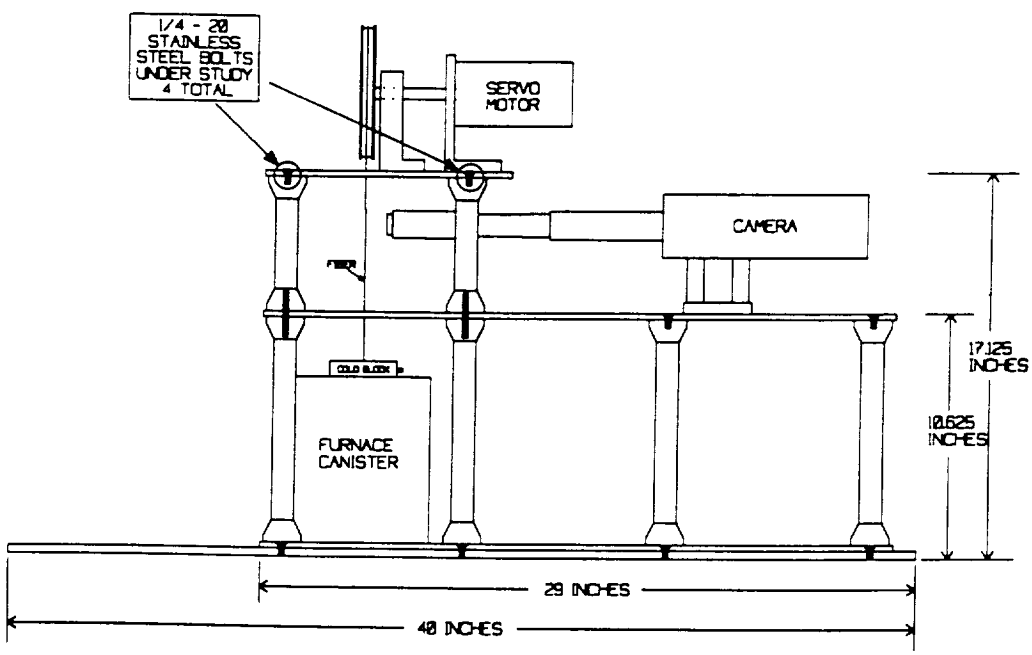
$$S = 1718.782 \text{ psi}$$

$$S = 214.85 \text{ pounds per bolt at 9 g's.}$$

Each bolt sees 214.85 pounds shear force. The bolts used are rated to a shear strength of 40,800 psi (60% of the tensile strength) or 1290 pounds each. Therefore, **each bolt** is 1290/214.85 = **6.0 times stronger** than the shear forces expected at 9 g's eyeballs in, out, right or left.

Case 3: Attachment of the Top Plate to the FPA Production Assembly

Note: All calculations are based on the assumption that all stress will be either pure tension or pure shear. The calculations will be based on 9 g's eyeballs in, out, left or right. Calculations for 2 g's eyeballs up, and 6 g's eyeballs down will also be presented. Total weight of the experiment package, mounting plate and protective Plexiglas covering is 225 pounds. The weight of the top plate and hardware mounted to this plate is 15 pounds. So the g force calculated will be on the 15 pound mass. Locations of the bolts under study are identified in the figure below.



Top Shelf Mounting Points to the Experiment Package

TENSILE:

No reactive moment arm is calculated, therefore the total tensile created is distributed by the 4 1/4-20 stainless steel bolts that attach the plate to the package. Tensile force for the top plate seeing 2 g's eyeballs up pulling apart from the 4 spindles will be:

T = Tension

T = Force/Area

$T = (15 \text{ lbs} * 2 \text{ g's})/(3.14/4) * (0.25 \text{ dia.})^2 * 4 \text{ bolts}$

T = 30/0.19625 psi

T = 152.866 psi force at 2 g's eyeballs up.

T = 152.866 psi/4 bolts

T = 38.217 pounds/bolt at 2 g's eyeballs up

The bolts used are rated to 80,000 psi or 2550 pounds force each. The force seen at 2 g's eyeballs up is 38.217 pounds per bolt. Therefore, **each bolt** is 2550/38.217 = **66.7 times stronger** than required for a pure tensile force.

SHEAR:

For this case, primary shear is considered for all bolts that attach the top shelf to the production assembly. Shear stress seen across the mounting bolts at 9 g's eyeballs in, out, left or right will be:

F = The Force Seen By One Bolt

F = 15 lbs/4 bolts

F = 3.75 lbs/bolt

S = Shear Force for one Bolt

S = Force/Area

$S = (3.75 \text{ lbs} * 9 \text{ g's})/(3.14 * (0.125)^2$

$S = 33.75 \text{ lbf}/0.04909 \text{ in}^2$

S = 687.51 psi

S = 171.88 pounds per bolt at 9 g's.

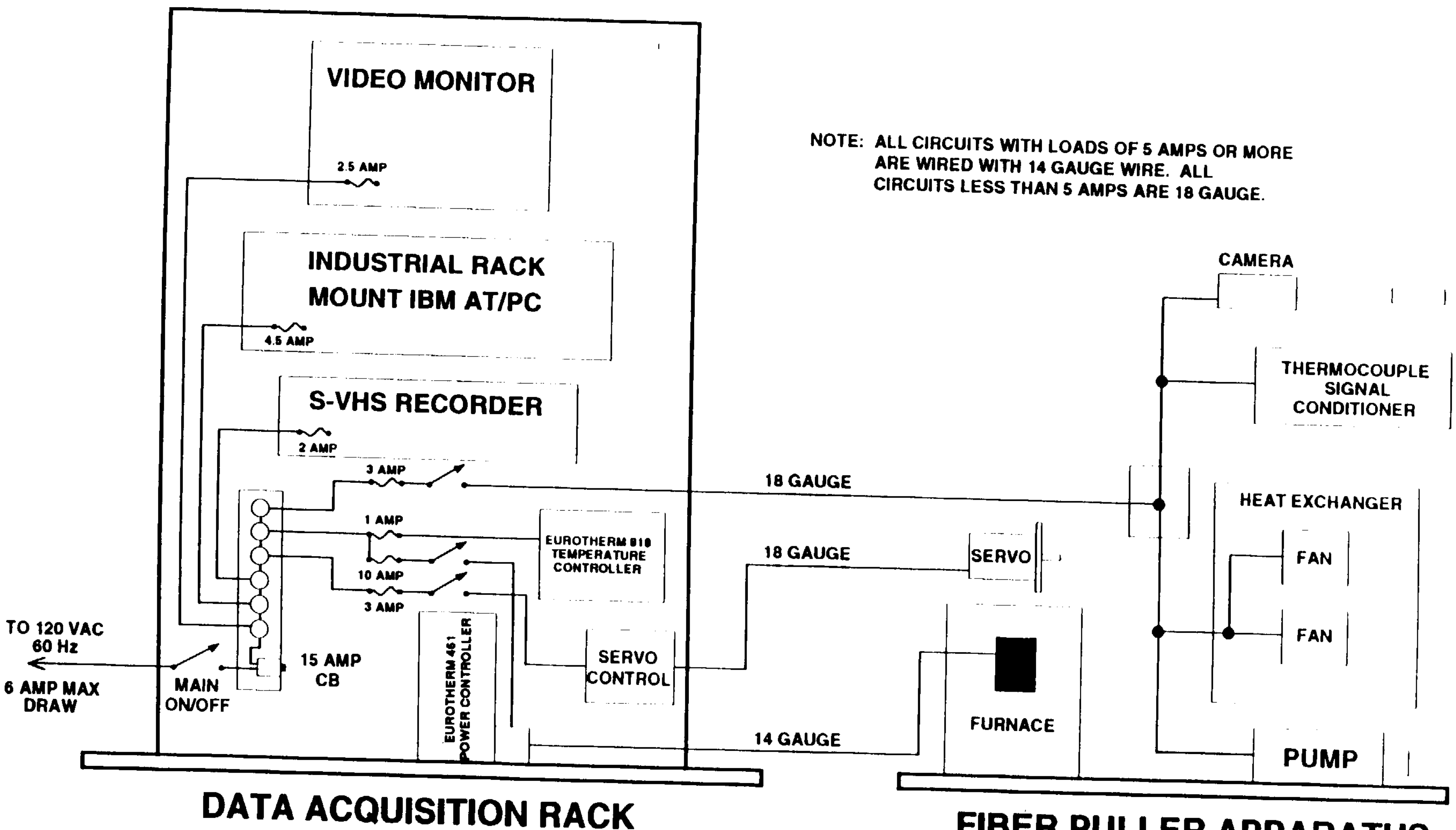
Each bolt sees 171.88 pounds shear force. The bolts used are rated to a shear strength of 40,800 psi (60% of the tensile strength) or 1290 pounds each. Therefore, **each bolt** is 1290/171.88 = **7.5 times stronger** than the shear forces expected at 9 g's eyeballs in, out, right or left.

Section E. ELECTRICAL LOAD ANALYSIS

This system uses 120 volts 60 Hz AC only. A single 20 foot long 12 gauge power cord provides the AC power interface to the experiment. Total load for the experiment will be 8.0 amps maximum during furnace heat up and will subsequently taper down to 5.0 amps once the furnace has reached temperature.

On the following page is Figure 3 which identifies the AC power circuits, circuit breakers, fuses, control switches and wire gauges.

120 VAC 60 Hz POWER DISTRIBUTION



Section F. PRESSURE VESSEL CERTIFICATION

No true pressure vessels are contained within the system. However, there will be a pressure relief valve rated to 5 psi on the regulator located outside the package on an external K-bottle of Nitrogen. Refer to Figure 4. This will protect the down stream tygon tubing and Nitrogen purge system from over pressurization. Pressure gauges located on the regulator will be calibration checked and certified. Purge rates of 0.5 liters at STP per second are anticipated to maintain a low humidity level within the Plexiglas housing. It might appear that the Plexiglas housing is a pressure vessel however it will be connected to the aircraft's overboard dump system and is not 100% air tight.

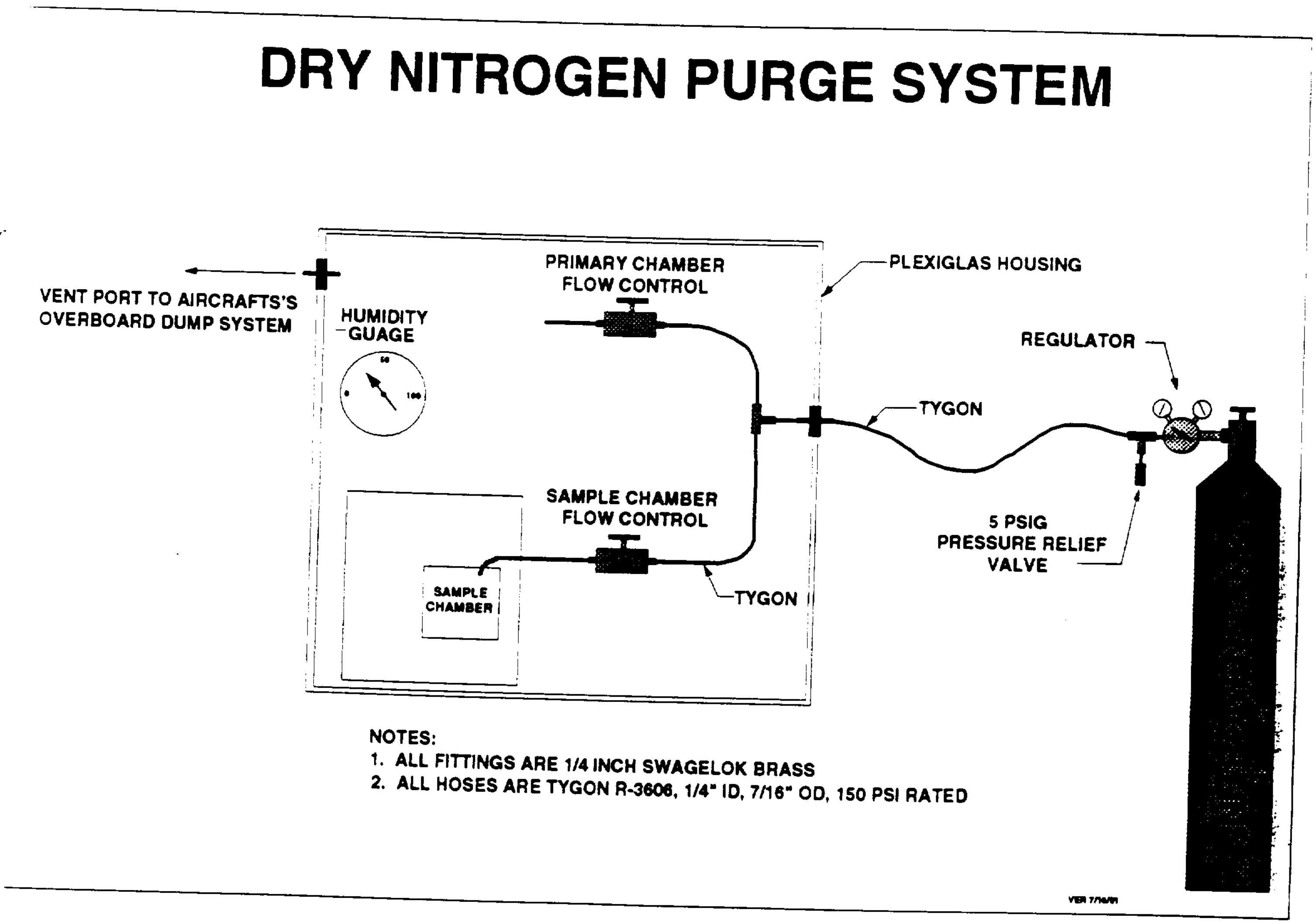


Figure 4

Section G. IN FLIGHT TEST PROCEDURES

1. One hour prior to takeoff load approximately 30 grams of the lunar simulated material along with the Platinum crucible into the furnace core.
2. Install the fiber winding spool along with the quartz fiber stringer and position stinger as required.
3. Close access doors on the Plexiglas housing.
4. Begin purging the Plexiglas housing with Nitrogen at a flow rate of approximately 0.5 liters per second.
5. Thirty minutes prior to take off begin heat up procedure for the furnace.
6. After take off activate the data acquisition system and set up software to begin taking data. Also power up the video recording system.
7. Upon starting parabolas command the servo motor to insert the quartz fiber stinger into the melted lunar simulated material.
8. During the first lunar or (low) g period command servo motor to begin drawing the lunar glass fiber onto the winding spool.
9. Continue winding the glass fiber until the end of the first set of parabolas.
10. During the break period, open tne top access door and remove the spool containing the processed glass fiber and place it into the air tight container.
11. Install a new spool and quartz fiber stinger into the system.
12. Upon completion close the access door.
13. Set up the data acquisition system with the required parameters.

CONTINGENCY PLANS

1. If processed fiber breaks during the set of parabolas suspend winding operations until the following break period and reset the system.
2. If molten lunar simulated material should clog up the hole running through the cold block power down the system and perform no action until on the ground and the furnace is cool.

3. If intermittent power failure occurs during the parabola set, terminate the run and reset the system during the break period.

4. If the cooling system should fail for what ever reason power down the complete system and perform no action until the plane is on the ground.

5. If the nitrogen source runs out power down the system and perform no further operations. Replace tank when on the ground.

Section H. PARABOLA REQUIREMENTS

The experiment will require five to ten lunar or low g maneuvers per set. It is intended to operate the experiment during the entire flight with a minimum of five minutes between sets.

Section I. TEST SUPPORT REQUIREMENTS, GROUND AND FLIGHT

Two K bottle size tanks of pure dry Nitrogen gas will be required for four days of flight. 110 Volt AC, 60 Hz. aircraft power is required at least 30 minutes prior to take off to allow the furnace to heat up. The project is unclassified and has no security restrictions.

Section J. DATA ACQUISITION SYSTEM

No data acquisition connections are required to be made to JSC equipment. The system will have its own data acquisition system.

Section K. TEST OPERATING LIMITS OR RESTRICTIONS

An overboard dump system must be available for venting.

Section L. PROPOSED MANIFEST FOR EACH FLIGHT

Two people are required to operate this experiment per mission. No JSC personnel are required.

Section M. PHOTOGRAPHIC REQUIREMENTS

No photographic requirements.

Section N. HAZARD ANALYSIS IN ACCORDANCE WITH JSC 17773

Part A: GENERAL DESCRIPTION OF THE EXPERIMENT

See Sections A through K of this document.

Part B: EXPERIMENT HAZARD EVALUATION

In considering the possible safety hazards associated with the FPA there are several areas to address. They include extreme temperatures, cooling system failure, free floating glass fibers, injury due to shape corners, hot surfaces, electrical shock or rotating devices, rupture due to over pressurization, fire due to escaping molten sample, or loss of structural integrity. There are no pressure vessels contained inside the experiment package so this will not be a problem.

In the heating assembly of the FPA the hazard of extreme temperatures will be addressed. This hazard will be controlled by a temperature controller and a visual readout. The heating element is enclosed in an aluminum canister filled with insulation thus keeping all outside canister surfaces cool to warm.

If there is a problem in the cooling system such as loss of coolant or a failure in the pumps operations the hazards that could be created are electrical shorting or pressure build up in the cooling system. To prevent electrical shorting from occurring all electrical connections and electronics have been protected from water spray. A pressure relief valve has been included in the cooling system to prevent excessive pressure build up due to heat flux from the furnace core reaching the cold block.

To prevent the escapability of the molten sample the opening for the fiber to be pulled from has been kept to 0.062 inches in diameter. Also tests were run to prove that the molten sample would resolidify if it contacted the cold block.

that the molten sample would resolidify if it contacted the cold block.

In the event that the optical fiber was to break precautions have been taken such that the fiber would not be inhaled by personnel aboard the aircraft. These precautions include enclosing the pulling assembly in a Plexiglas housing and venting to the overboard dump thus preventing the fiber from escaping the package.

Prevention of personal injury has been kept to a minimum by rounding all exposed corners to a 0.25" radius. All rotating devices have been shielded. Exterior surface temperatures have all been measured to be below 30 C to prevent burns to personnel.

Another hazard to be considered is the fact the experiment package will be purged with dry nitrogen. This will be done by means of an external K-bottle of nitrogen placed outside of the package. The pressure inside of the experiment package will be kept at ambient $\pm$ 1 psi. There will be a pressure relief valve set to 5 psi located on the regulator for the nitrogen thus preventing the nitrogen purge system from over pressurization. Also the overboard dump will be connected to the Plexiglas housing.

Loss of structural integrity during takeoff, flight, landing and/or crash loads could injure personnel and/or impact the aircraft and other equipment. A structural design has been made such that based on a worse case mission the package would have no negative margins of safety. Safety factors are no less than 2.0 ultimate and 1.25 yield.

Part C: HAZARD LIST

1. Extreme Temperatures - Exposure of personnel to high temperatures.
2. Loss of Coolant - Electrical shorts due to water on the electronics.
3. Fiber Breakage - Exposure to free floating glass fiber.
4. Sharp Corners, Rotating Devices and Protrusions - Injury to personnel due to sudden aircraft turbulence.
5. Over Pressurization - Rupture of the Plexiglas housing.
6. Escape of the Molten Sample - Fire or smoke if the molten sample lands on

the inside of the Plexiglas housing.

7. Electrical Hazard - Electrical shock to personnel.
8. Structural Failure - Loss of structural integrity during crash loads.
9. Over Pressurization - Rupture of coolant lines.

Part D: HAZARD REPORTS

The following pages are each of the eight hazard reports.

*** HAZARD REPORT NUMBER ONE ***

HAZARD TITLE: Extreme Temperatures - Exposure of personnel to high temperatures.

DESCRIPTION OF HAZARD: First to third degree burn potential to personnel while the furnace assembly is heating up, at temperature or cooling down.

HAZARD CAUSE: Burns caused by contacting high temperature surfaces present on the outside of the furnace assembly canister.

HAZARD CONTROL:

1. Monitoring of the furance assembly temperatures by the temperature controller will provide a visual indication of the conditions. If conditions are deemed excessive the system will be shut down.
2. The heating element is enclosed in an aluminum canister filled with zirconia insulation thus keeping the outside of the cannister cool to warm after two hours of operation.
3. A Plexiglas secondary cover (shield) exists around the entire package thus preventing any contact with the heating assembly.

VERIFICATION METHOD:

1. Visually monitor the temperature readout to insure the display is reading correctly and that the controller behaves properly.
2. Check the temperature of the aluminum canister at various points to make certain that the surface will not burn the operators.
3. Check the temperatures of the Plexiglas housing while the furnace is at its maximum temperature.

VERIFICATION STATUS:

1. Analysis complete - Temperature readout is inherent in the controller design and is providing information any time the system is on.

2. Test complete - The aluminum canister was warm to the touch in all locations.

3. Test Complete - The outside housing was cool to the touch in all locations.

*** HAZARD REPORT NUMBER TWO ***

HAZARD TITLE: Loss of Coolant - Electrical shorts or electrical shock.

DESCRIPTION OF HAZARD: A loss in coolant from the cooling system resulting on electrical shorting to personnel due to the spraying of water.

HAZARD CAUSE: A bad hose or connection in the plumbing for the coolant or hose rupture.

HAZARD CONTROL:

1. Protect all electrical connections from water spray.
2. Keep plumbing to a minimum around electronics.

VERIFICATION METHOD:

1. Visually inspect electrical connections to see if they are shielded from water spray.
2. Visually check placement of cooling system plumbing.

VERIFICATION STATUS:

1. All electrical connections protected from water spray.
2. Cooling system plumbing isolated from electronics where possible.

*** HAZARD REPORT NUMBER THREE ***

HAZARD TITLE: Glass Fiber Breakage - Exposure to free floating glass fiber.

DESCRIPTION OF HAZARD: Breakage of glass fiber causing it to free float and possibly be inhaled during maneuvers.

HAZARD CAUSE: Strong convective flows, sudden vibrations of the winding apparatus, and various other circumstances could cause the breakage of the glass fiber.

HAZARD CONTROL:

1. Completely contain the experiment in Plexiglas so that the fiber can not escape.
2. Keep access doors closed during parabolas.
3. Implement the overboard dump and vent Plexiglas housing continuously.

VERIFICATION METHOD:

1. Visual inspection.
2. Proper procedure during operation.
3. Proper procedure during operation.

VERIFICATION STATUS:

1. Inspection Complete - no means for the fiber to escape with the access doors closed.
2. Real time operational procedures.
3. Real time operational procedures.

*** HAZARD REPORT NUMBER FOUR ***

HAZARD TITLE: Sharp Corners, Rotating Devices, and Protrusions on the Hardware

DESCRIPTION OF HAZARD: Injury to personnel due to contacting sharp corners, rotating devices or protrusions during flight.

HAZARD CONTROL:

1. Insure that all sharp corners that are exposed have been rounded to a radius of no less than a 0.250".
2. Add foam rubber padding as required to satisfy safety requirements at Ellington Air Field, JSC.
3. Cover all rotating devices.

VERIFICATION METHOD:

1. Visual inspection of hardware.
2. None
3. Visual inspection.

VERIFICATION STATUS:

1. Complete - All exposed corners have been rounded to a 0.25" radius.
2. Not complete - To be determined at Ellington Air Field during the TRR.
3. Complete - All rotating devices are shielded.

*** HAZARD REPORT NUMBER FIVE ***

HAZARD TITLE: Over Pressurization - Rupture of the Plexiglas housing.

DESCRIPTION OF HAZARD: Injury to personnel due to Plexiglas fragments caused by over pressurization of the housing.

HAZARD CAUSE:

1. The pressure relief valve fails to open at the correct pressure.
2. The tank pressure regulator gauge reads incorrectly.

HAZARD CONTROL:

1. Pressure relief valve will be calibrated and certified to 5 psig.
2. Calibrate and certify the regulator pressure gauges to read correctly.
3. Insure that the Plexiglas housing is not air tight and thus preclude the possibility of pressure build up.

VERIFICATION METHOD:

1. Certification
2. Certification
3. Inherent to the design.

VERIFICATION STATUS:

1. Tests complete - Certification on following pages.
2. Tests complete - Certification on following pages.
3. Tests complete - There are sufficient air leaks through the Plexiglas access door velcro seals and through the housing vent port to prelude a pressure build up.

FABRICATION DIVISION WORK ORDER REQUEST
ET31

DATE	COST CODE	WORK ORDER NO.:	PROJECT NO.:

PROJECT	PLANNER NAME/TELEPHONE:	PLAN. NO.:

DELIVERY DATE:	OPERATION CODE:	QTY.	DRAWING NO.:	REV.:	PART NO.:

SHOP/HRS.:	NOMENCLATURE:	MATERIAL CERT.:

TO BE USED FOR: FLIGHT | TEST | GSE | FAC | OTHER: X KC-135

QUALITY SENSITIVE/PROGRAM CRITICAL: [X] Yes 2/21/91 [ ] No

IR. REQUIRED: [ ]

USE TEST SET UP

OPER. NO.	WORK STA.	MAN-HOURS	ITEM	QTY.	DESCRIPTION OF WORK
#6			1	1 *	Check and certify calibration of the two pressure guages located on Matheson model 8-350 regulator
#6			2	1 *	Check and certify calibration of the two pressure guages located on Tescom model 44-1012-24 regulator
#3 BK 2-27-91			3	1	Check and certify calibration of NUPRO Pressure relief valve to 1650 psig (1.10 times operation pressure of 1500 psig).
#3 BK 2-27-91			4	1	Check and certify calibration of NUPRO pressure relief valve to 5 psig.
#7 BK 2-27-91			5	1	Proof test CAJON Stainless Steel flex hose (six foot length) to 1500 psig.

REQUESTER USE ONLY

FROM (Name, Telephone No., Organization):	PROJECT:	DATE:	CONTROL NO.:
Dr. Peter Curreri ES74 544-7763	KC-135 ADSF and ICF furnace systems	2/19/91	A50-1779

TO:	COST CODE	NEED DATE:	BOA FUNDS AVAILABLE:
ET32	674 25 08	2/27/91	[ ] Yes [ ] No

DOCUMENTATION PROVIDED: REL. | PRELIM. | RED LINE | SKETCH | OTHER

MATERIAL SUBSTITUTION PERMITTED: [X] Yes [ ] No

REMARKS:
All of the above items are to be used in flight and ground based operations involving NASA's KC-135 aircraft based at JSC, Texas.

TBE 97 2-27-91 NASA 02/27/91

FOR INFORMATION CALL (Name/Phone No.)	APPROVAL SIGNATURE:	DISPOSITION OF END ITEM:
Guy A. Smith or Sue Kosten 895-6086 (UAH)		[X] Pick Up [ ] ET31 Store

"MAKE OR BUY" RATIONALE:
* NASA VERIFIED CALIBRATION ON ALL GAUGES 2-27-91 BK

TEST LABORATORY APPROVAL

SIGNATURE OF LEAD LAB. ENGINEER:	SIGNATURE OF ET01:	SIGNATURE OF ET31:

MSFC - Form 3751 (Rev. August 1982)

SHEET ____ OF ____

FABRICATION DIVISION WORK ORDER REQUEST
ET31

DATE | COST CODE | WORK ORDER NO.: | PROJECT NO.:

PROJECT | PLANNER NAME/TELEPHONE: | PLAN. NO.:

DELIVERY DATE | OPERATION CODE | QTY. | DRAWING NO.: | REV. | PART NO.:

SHOP/HRS.: | NOMENCLATURE: | MATERIAL CERT.:

-

TO BE USED FOR: FLIGHT | TEST | GSE | FAC | OTHER X KC-135

QUALITY, SENSITIVE/PROGRAM CRITICAL: [X] Yes [ ] No

IR. REQUIRED: [ ]

OPER. NO.	WORK STA.	MAN-HOURS	ITEM	QTY.	DESCRIPTION OF WORK
USE TEST SET UP			1	1	Set and certify calibration of NUPRO brand model SS-4CPA2-3
#3 Run					pressure relief valve to 5 psig. GN₂ 2014 7-29-91 (TBE 38) 7-29-91
			2	1	Set and certify calibration of NUPRO brand model ~~SS~~ B-4CPA2-3
					pressure relief valve to 20 psig. H_2O RSH 7-29-91 (TBE 38) 7-29-91
					FREON FLUSH
					TEST GAGE - S-2977 CAL-DATE 7-12-91
					DUE-DATE 7-12-92

REQUESTER USE ONLY

FROM (Name, Telephone No., Organization): Dr. Dennis Tucker EH34 544-2685

PROJECT: KC-135 Glass Fiber Puller Experiment

DATE: 7/22/91

CONTROL NO.: ASC - 2036

TO: ET32

COST CODE:

NEED DATE: 7/31/91

BOA FUNDS AVAILABLE: [ ] Yes [ ] No

DOCUMENTATION PROVIDED: REL. | PRELIM. | RED LINE | SKETCH | OTHER X

MATERIAL SUBSTITUTION PERMITTED: [X] Yes [ ] No

REMARKS:

The above two items are to be used in flight and ground based operations involving NASA's KC-135 aircraft based at JSC, Texas.

FOR INFORMATION CALL (Name/Phone No.): Guy A. Smith or Sue Kosten 895-6086 (UAH)

APPROVAL SIGNATURE: [signature]

DISPOSITION OF END ITEM: [ ] Pick Up [ ] ET31 Store

"MAKE OR BUY" RATIONALE:

TEST LABORATORY APPROVAL

SIGNATURE OF LEAD LAB. ENGINEER: | SIGNATURE OF ET01: | SIGNATURE OF ET31:

MSFC - Form 3751 (Rev. August 1982)

SHEET ____ OF ____

*** HAZARD REPORT NUMBER SIX ***

HAZARD TITLE: Fire or Smoke - Escape of the Molten Sample

DESCRIPTION OF HAZARD: The escaping of the molten sample from the crucible could cause the Plexiglas to smolder or catch fire.

HAZARD CAUSE:

1. A strong negative g spike of 0.3 g's or greater could result in the molten sample ejecting from the crucible if the cold block is removed from the top of the furnace.
2. A large exit hole for the fiber present in the cold block.

HAZARD CONTROL:

1. The cold block will be mounted in place by several screws and will not be removed during flight.
2. The exit hole for the fiber will be only 0.062 inches in diameter through the cold block.
3. Plexiglas housing will be purged with dry nitrogen gas during operation.

VERIFICATION METHODS:

1. Preform test.
2. Inspection
3. Proper procedure during operation.

VERIFICATION STATUS:

1. Test complete - The cold block is securely fastened and the molten sample resolidifies within the cold block when forced to exit the furnace.
2. Inspection complete.
3. Real time operational procedures.

*** HAZARD REPORT NUMBER SEVEN ***

HAZARD TITLE: Electrical Hazard - Electrical shock to personnel.

DESCRIPTION OF HAZARD: Electrical shock to personnel from coming in contact with the 120 VAC, 60 Hz. power.

HAZARD CAUSE: Exposed terminals (connections) carrying voltages in excess of 30 volts 60 Hz. AC or DC.

HAZARD CONTROL:

1. Bonding and grounding is in accordance with MIL-5087B and electrical connections per MIL-5015.
2. Electrical contacts using spade crimp terminals and barrier strips will be covered as to prevent contact with personnel.
3. Fuses and circuit breakers placed on all in coming power to the electronics.

VERIFICATION METHOD:

1. Visual Inspection
2. Visual Inspection
3. Visual Inspection

VERIFICATION STATUS:

1. During final check out of the system Hazard Control 1 was found to be consistent.
2. During final check out of the system Hazard Control 2 was determined to be consistent.
3. During final check out of the system Hazard Control 3 was found to be consistent.

*** HAZARD REPORT NUMBER EIGHT ***

HAZARD TITLE: Structural Failure - Loss of structural integrity during takeoff, flight , landing and/or crash loads.

DESCRIPTION OF HAZARD: Structural failure of the FPA hardware resulting in loose material/objects which could injure personnel and/or impact the aircraft and other equipment.

HAZARD CAUSE: The experiment hardware lacks the structural strength to withstand the environment due to inadequate design strength.

HAZARD CONTROL:

1. Structural design will be based on worse-case mission induced loads with no negative margins of safety. Safety factors will be no less than 2.0 ultimate and 1.25 yield.

VERIFICATION METHOD:

Structural analysis to verify positive margins against specified factors of safety less than 2.0 ultimate.

VERIFICATION STATUS:

Analysis complete - Refer to Section D, page 4 of this document.

***** HAZARD REPORT NUMBER NINE *****

HAZARD TITLE: Over Pressurization of Coolant System.

HAZARD DESCRIPTION: Hydrodynamic pressure buildup of coolant.

HAZARD CAUSE: Due to a failure in the cooling system pump or blocked coolant lines while the furnace is at a maximum temperature of 1400 degrees C the coolant contained within the cold block mounted directly above the furnace core could possibly overheat causing a pressure buildup in the cooling system.

HAZARD CONTROL: Install a pressure relief valve set to 20 psi inline with the coolant system and vent to the aircraft's overboard dump line.

VERIFICATION METHOD:

1. Visual inspection
2. Test - simulate failure and monitor pressure in coolant lines.

VERIFICATION STATUS:

1. Pressure relief valve has been certified and is integrated into the cooling system. Copy of certification on following page.
2. Test complete: With the furnace at a temperature of 1400 C cooling system pump was turned off to simulate a failure or complete line blockage. Temperature of coolant contained within the cold block was monitored as well as coolant line pressure. After 18 minutes line pressure reached 23 psi and the relief valve opened reducing line pressure to below 20 psi. Temperature of coolant inside cold block reached a maximum temperature of 87 degrees C.

FABRICATION DIVISION WORK ORDER REQUEST
ET31

DATE	COST CODE	WORK ORDER NO.:	PROJECT NO.:

PROJECT	PLANNER NAME/TELEPHONE	PLAN. NO.:

DELIVERY DATE	OPERATION CODE:	QTY.	DRAWING NO.:	REV.:	PART NO.:

SHOP/HRS.:	NOMENCLATURE:	MATERIAL CERT.:

TO BE USED FOR: FLIGHT | TEST | GSE | FAC | OTHER: X KC-135

QUALITY SENSITIVE/PROGRAM CRITICAL: [X] Yes [ ] No

IR. REQUIRED: [ ]

OPER. NO.	WORK STA.	MAN-HOURS	ITEM	QTY.	DESCRIPTION OF WORK
USE TEST SET UP			1	1	Set and certify calibration of NUPRO brand model SS-4CPA2-3
#3					pressure relief valve to 5 psig. GN_2 2014 7-29-91 TBE 7-29-91
			2	1	Set and certify calibration of NUPRO brand model B-4CPA2-3
					pressure relief valve to 20 psig. H_2O RSH 7-29-91 TBE 7-29-91
					FREON FLUSH
					TEST GAGE · S-2977 CAL-DATE 7-12-91
					DUE-DATE 7-12-92

REQUESTER USE ONLY

FROM (Name, Telephone No., Organization):	PROJECT:	DATE:	CONTROL NO.:
Dr. Dennis Tucker EH34 544-2685	KC-135 Glass Fiber Puller Experiment	7/22/91	ASO - 2036

TO:	COST CODE	NEED DATE	SOA FUNDS AVAILABLE:
ET32		7/31/91	[ ] Yes [ ] No

DOCUMENTATION PROVIDED:	REL.	PRELIM.	REDLINE	SKETCH	OTHER	MATERIAL SUBSTITUTION PERMITTED:
					X	[X] Yes [ ] No

REMARKS:

The above two items are to be used in flight and ground based operations involving NASA's KC-135 aircraft based at JSC, Texas.

FOR INFORMATION CALL (Name/Phone No.):	APPROVAL SIGNATURE:	DISPOSITION OF END ITEM:
Guy A. Smith or Sue Kosten 895-6086 (UAH)	Dennis S. Tucker	[ ] Pick Up [ ] ET31 Store

"MAKE OR BUY" RATIONALE:

TEST LABORATORY APPROVAL

SIGNATURE OF LEAD LAB. ENGINEER:	SIGNATURE OF ET01:	SIGNATURE OF ET31:

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SHEET ____ OF ____

Section P. SAFETY CERTIFICATION

This letter is provided by MSFC Safety, Huntsville, Alabama.