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Internal Thermal Control System Hose Heat Transfer Fluid Thermal Expansion Evaluation Test Report

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October 2001

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National Aeronautics and
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Marshall Space Flight Center • MSFC, Alabama 35812

October 2001

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Daniell Hawk participated in this project via the Summer High School Apprenticeship Research Program and assisted in collecting and evaluating test data, preparing plots, and assembling this Technical Memorandum. Bill Barnett, FD21, Marshall Space Flight Center, prepared the test article and test preparation sheet, and John Lowery and Amos Glenn, ASRI, operated the environmental chamber during the test. Jamie Miernik, Boeing, obtained the hose and end cap that were tested.

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TABLE OF CONTENTS

1. INTRODUCTION 1

2. TEST OBJECTIVE AND PURPOSE 1

3. APPLICABLE DOCUMENTS 2

4. TESTING 2

4.1 Test Method 2
4.2 Test Article 2
4.3 Test Facility 3

5. PRETEST PREPARATION AND MEASUREMENTS 4

6. TEST RESULTS AND DISCUSSION 4

7. CONCLUSIONS 6

APPENDIX A—ITCS HOSE HEAT TRANSFER FLUID THERMAL EXPANSION EVALUATION TEST PLAN 9

APPENDIX B—ITCS INTEGRATED HOSE ASSEMBLY COOLANT EXPANSION TEST PREPARATION SHEET 17

LIST OF FIGURES

1. IHA test article 3

2. Test article pressure 4

3. Test article pressure profiles 5

4. Estimated temperature to reach the maximum pressure 7

LIST OF ACRONYMS

HTF	heat transfer fluid
IHA	integrated hose assembly
ISS	*International Space Station*
ITCS	Internal Thermal Control System
MSFC	Marshall Space Flight Center
PACRATS	Payloads and Components Real-Time Automated Test System
PTFE	polytetrafluoroethylene
QD	quick disconnect
RFCA	rack flow control assembly
TPS	test preparation sheet

TECHNICAL MEMORANDUM

INTERNAL THERMAL CONTROL SYSTEM HOSE HEAT TRANSFER FLUID THERMAL EXPANSION EVALUATION TEST REPORT

1. INTRODUCTION

The Internal Thermal Control System (ITCS) of the *International Space Station* (*ISS*) is designed to transfer heat to maintain optimum temperatures for the crew and equipment inside the modules. Excess heat is removed and cool locations are warmed as needed. During assembly of the *ISS*, jumper hoses are used by the astronauts on board to connect the ITCS loops in adjacent modules. A jumper hose with quick disconnects (QDs) and end caps attached is referred to as an integrated hose assembly (IHA). It would be preferable to launch the IHAs prefilled with heat transfer fluid (HTF), but there is a concern that in the event of high temperature during storage or transportation, the IHAs may leak or become damaged due to excessive pressure. To address this concern, a test was requested by the *ISS* Program Thermal Control Lead, Joe Chambliss, to evaluate the ability of an IHA to be launched "wet" and safely accommodate the increased pressure of the HTF if the temperature increased to the worst-case condition of 60 °C (140 °F). This testing was performed at Marshall Space Flight Center (MSFC) in June 2000 on a flightlike hose with a flight end cap to evaluate the maximum pressure that would occur under the worst-case temperature condition. Four cases were run with test conditions subjecting the test article up to 71 °C (160 °F), and results show that the pressure at this temperature reached ≈228 kPa (33 psia), well below the design maximum of 689 kPa (100 psia). The test conditions and results are described in this Technical Memorandum.

2. TEST OBJECTIVE AND PURPOSE

The objective of this test is to simulate the conditions that may be experienced by an isolated IHA, filled with HTF and capped on both ends. The purpose is to determine whether the IHA can accommodate the increased pressure due to HTF expansion when heated from room temperature to 60 °C (140 °F) without exceeding the design maximum pressure of 689 kPa (100 psia), leaking, or being damaged. In addition, measurement of the bend radius of the hose and of the mass of HTF in the filled hose are needed for designing the transportation containers.

3. APPLICABLE DOCUMENTS

The following documents are applicable to this test:

- "ITCS Rack Flow Control Assembly Fill Procedure," SK683–53379, 21 April 1999
- "ITCS Hose HTF Thermal Expansion Evaluation Test Plan," May 2000 (revised June 21, 2000) (app. A)
- "Test Preparation Sheet," FD21TST–TPS–ITCS–00–001 (app. B).

4. TESTING

The test was performed from June 27–30, 2000. The test method, article, and facility are described in sections 4.1 through 4.3.

4.1 Test Method

A flightlike IHA was tested by simulating the worst-case condition plus 11 °C (20 °F); i.e., 71 °C (160 °F). The pressure was monitored and the hose was regularly checked for any signs of leakage or other damage. Four cases were run with increasing temperature profiles: two cases at 60 °C (140 °F), one case at 66 °C (150 °F), and one case at 71 °C (160 °F). The rate of temperature change, increasing and decreasing, for each case was ≤17 °C/hr (30 °F/hr).

The test plan is in appendix A and the test preparation sheet (TPS) is in appendix B.

4.2 Test Article

The test article consisted of an IHA, plus an aluminum adapter block fabricated to attach a pressure transducer and a three-way valve for connecting a vacuum source and a pressurized tank containing HTF. The serial number of the IHA is 683-56836-385. This had been a flight IHA but was rejected due to a change in materials. A flight-qualified end cap covered the QD at the other end of the hose. The hose is made of convoluted teflon (polytetrafluoroethylene (PTFE)) with a nominal diameter of 12.7 mm (0.5 in) and a length of 762 mm (30 in), including fittings. The assembled test article is shown schematically in figure 1.

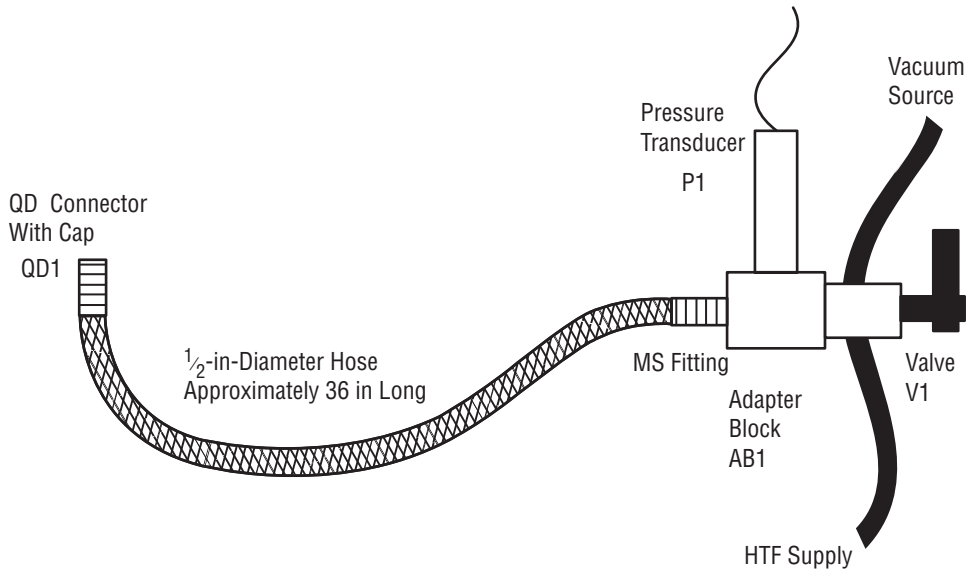

Figure 1. IHA test article.

4.3 Test Facility

The environmental chamber used for this test is an Ecosphere thermal/humidity chamber by Despatch (model 16664) located in Building 4619 at MSFC. This chamber, designated as TH3, is capable of maintaining the temperature anywhere in the range of –70 to 180 ºC (–94 to 356 °F). The chamber allows an unobstructed, usable internal volume that is cube shaped, measuring 1,219 mm (48 in) deep, 1,118 mm (44 in) high, and 1,168 mm (46 in) wide. The chamber has a front opening door with a 610-mm (24-in) square view window located in the center of the door.

A Watlow multiloop process controller manages the operation of the chamber and enables the user to maintain the temperature at a constant value or to continuously vary the temperature according to a predefined program. The Watlow controller allows the operator to manually enter up to 256 temperature steps, with segment times up to 100 h. Temperatures within the allowable range can be maintained to ±2 °C (3.6 °F), dry bulb or wet bulb, of the nominal value.

Temperature and pressure data were recorded by the Payloads and Components Real-Time Automated Test System (PACRATS) every 20 s.

The IHA was filled with HTF in Building 4755, using the same equipment as was used to fill the ITCS simulator facility.

5. PRETEST PREPARATION AND MEASUREMENTS

The empty test article was weighed and the mass was 1403.6 g (3.07 lb). The bend radius of the empty hose was measured as ≈76 mm (3 in). The test article was filled with HTF per procedure SK683–53379, which involves evacuating the IHA to <50 milliTorr before filling with HTF to 207 kPa (30 psia). The filling procedure was designed to ensure that no air bubbles were present in the IHA. (The presence of air bubbles would likely result in higher pressures due to the greater thermal expansion of air compared to water.) After filling with HTF, the bend radius was again measured and found to be ≈76 mm (3 in), and the mass was measured as 1532.5 g (3.35 lb). The mass of HTF in the hose was therefore 128.9 g (0.28 lb), or 4.3 g (0.01 lb) for each inch of hose length. At 101 kPa (14.7 psia) and 25 °C (77 °F), the volume of HTF in the hose is 0.129 L (0.034 gal), or 0.0043 L (0.0011 gal) for each inch of hose length.

6. TEST RESULTS AND DISCUSSION

During pretest preparation on Friday, June 23, 2000, the test article was pressurized to 207 kPa (30 psia) during filling with HTF. Over the weekend, the pressure dropped to <117 kPa (17 psia) with no indication that any leakage had occurred. On Monday, June 26, 2000, the test article was repressurized to 207 kPa (30 psia) in Building 4755, then transported to Building 4619 and connected to the data recording equipment. By the time data recording was initiated, the pressure had dropped to 186 kPa (27 psia). By Tuesday morning, the pressure had dropped to 162 kPa (23.5 psia), again, with no indication of leakage (fig. 2). These pressures were all recorded at ambient temperatures. The pressure was holding at 162 kPa (23.5 psia), indicating that the pressure drop was not due to leakage, and it was decided to proceed with test case 1 on Tuesday. (The drops in pressure shortly before the beginning of case 1 are likely due to temperature drops as air conditioning equipment in the building was activated.)

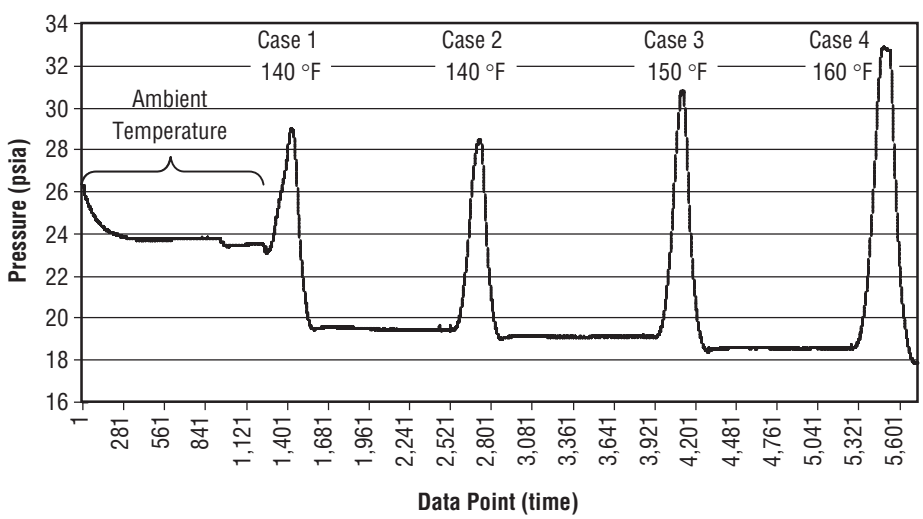

Figure 2. Test article pressure.

As expected, the data clearly show that the pressure increases as the temperature rises, for all cases. However, as shown in figure 3, for case 1, the pressure profile is significantly different from the following cases.

For case 1, the curve has a much shallower slope and is almost linear. The pressure increase is significantly less than for the following cases, including case 2 that followed the same temperature profile. This is thought to be related to expansion of the hose due to the above-ambient pressure, which would result in decreasing pressure, mitigating the pressure increase due to increasing temperature. However, as the temperature nears 60 °C (140 °F), the slope changes to match the slope of case 2 above 57.2 °C (135 °F). This indicates that expansion of the hose had essentially ceased, so the final part of the curve parallels the later cases, where, it is assumed, additional expansion of the hose is minimal. At 60 °C (140 °F) the pressure reached just over 200 kPa (29 psia). When the temperature was reduced to ambient, the pressure decreased to 134 kPa (19.5 psia).

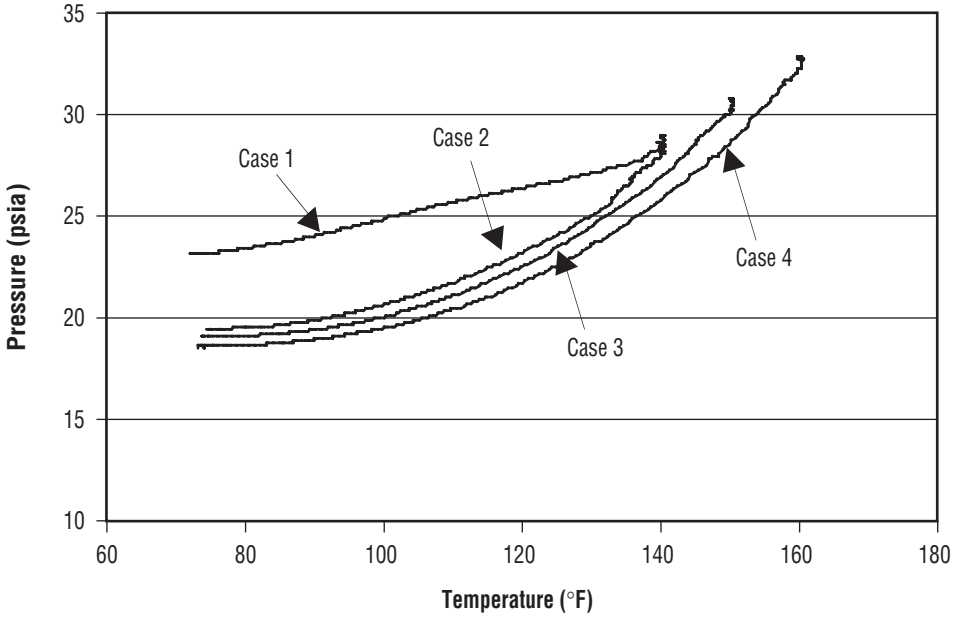

Figure 3. Test article pressure profiles.

Cases 2, 3, and 4 show closely parallel pressure profiles, successively peaking at somewhat higher pressures due to the higher successive temperatures. With each successive case, there is also a slight decrease in pressure (3.4 to 9 kPa (0.5 to 1.3 psia)) at a given temperature. This decrease is partly or totally related to effusion of the HTF through the PTFE hose material. The reported effusion rates, provided by Ahmad Sleiman of Boeing, are 1.74×10^{-7} g/min/in^2 at 18.3 °C (65 °F) and 7.68×10^{-7} g/min/in^2 at 48.9 °C (120 °F). (Precise measurement of the mass before and after the test would provide some insight into the mass of HTF lost during the test related to effusion, but the mass measurements taken for this test were not sufficiently precise for this purpose.)

At the target temperature of each case, a short, vertical portion indicates a pressure increase at those temperatures. This is due to thermal equalization of the test article, which has an aluminum block on one end and a metal QD with a cap on the other. The thermal lag of the masses of these items contributes to this pressure increase.

7. CONCLUSIONS

The test article was initially pressurized to 207 kPa (30 psia) with HTF, per the Boeing procedure for filling the rack flow control assembly (RFCA). As demonstrated during this test, the pressure will decrease to near ambient within a few days, due primarily to expansion of the flexible hose. For this test, the test article was repressurized, which will make the test results conservative; i.e., without the repressurization, which is not called for in the procedure, the maximum pressures would have been lower. The following conclusions can be drawn from the test results:

1. The initial drop in pressure at ambient temperatures before case 1 is related to expansion of the flexible hose.

   This conclusion is supported by the pressure drop leveling out prior to case 1, indicating that expansion had ceased, as well as the behavior after case 1, when the pressure curves are essentially parallel and the low pressure points are very close, indicating that expansion of the hose had essentially stopped.

2. The shape of the case 1 pressure profile is due to expansion of the hose as well as expansion of the HTF while heating is occurring.

   Simultaneous influence of the two opposing effects caused the resulting shape for case 1. Expansion of the hose leads to decreased pressure while increased temperature leads to increased pressure of the HTF. It is thought that the higher temperatures allowed additional hose expansion after the expansion had stabilized at ambient temperature. Without additional hose expansion, the maximum pressure would have been ≈241 kPa (35 psia) for case 1.

3. The slight drop in pressures at the same temperatures with succeeding cases is due to effusion of the HTF through the PTFE hose.

   While continued expansion of the hose might also cause such a result, the even spacing and smooth curves of the profiles are more consistent with gradual fluid loss, which could occur by effusion. The increase in effusion rate as the temperature increases is reflected in the slightly broadening spacing between the curves as the temperature increases.

4. Under the expected worst-case thermal conditions, the pressure in a filled IHA will remain well below the maximum design pressure (689 kPa (100 psia)).

   Extrapolating from the test data to estimate the maximum allowable temperature, figure 4 shows that 689 kPa (100 psia) would not be reached until ≈115 °C (240 °F).

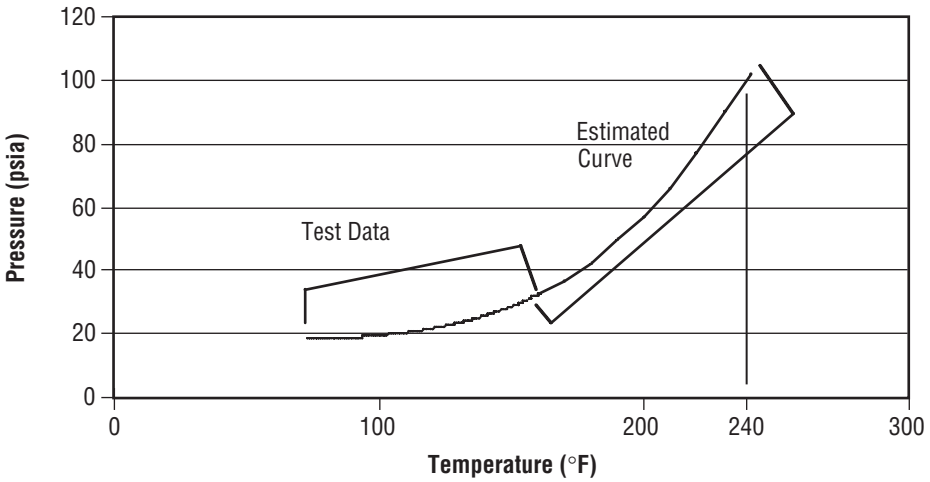

Figure 4. Estimated temperature to reach the maximum pressure.

5. Based on the given thermal conditions and the IHA characteristics, the IHAs can safely be filled with HTF prior to launch.

   Even if the hoses are repressurized to 207 kPa (30 psia) after expansion has ceased, the estimated maximum pressure at 40 °C (140 °F) is 276 kPa (40 psia), assuming the same pressure curve but starting at 207 kPa (30 psia).

6. The bend radius of the IHA when filled with HTF is very close to the bend radius of an empty IHA.

   This measurement was made by loosely, but firmly, coiling the IHA, then allowing it to relax in an unconstrained manner, with the masses of the QD with cap and adapter block with valve attached at the ends. If necessary, it could be coiled tighter than a 76-mm (3-in) radius, but that would induce a higher level of stresses.

APPENDIX A—ITCS HOSE HEAT TRANSFER FLUID THERMAL EXPANSION EVALUATION TEST PLAN

ITCS Hose
HTF Thermal Expansion
Evaluation Test Plan

Paul Wieland
NASA/MSFC/FD21
256-544-7215

May 2000

(Revised June 21, 2000)

Contents

1.0 Introduction 3
2.0 Test Objective 3
3.0 Test Approach 3
4.0 Applicable Documents 3
5.0 Test Method 3
6.0 Test Requirements 4
6.1 Materials/Equipment Required 4
6.2 Facility Requirements 4
6.3 Personnel Requirements 5
7.0 Test Procedure 5
7.1 Pretest Preparation 6
7.2 Test Steps 6
7.3 Post Test 6
8.0 Evaluation Criteria and Risks 6
9.0 Cost and Schedule 7
10.0 Documentation 7

Figures

Figure 6.1-1. IHA Test Assembly 4
Figure 6.2-1. IHA Coolant Expansion Test Setup 5

1.0 Introduction

Internal Thermal Control System (ITCS) jumper hoses will be used by the astronauts on-board the International Space Station (ISS) to connect the ITCS loops in adjacent modules. A jumper hose with quick disconnects (QD) and end caps attached is referred to as an Integrated Hose Assembly (IHA). It would be preferable to launch the IHAs already filled with heat transfer fluid (HTF), but there is a concern that in the event of high temperature during storage or transportation the IHAs may leak or become damaged due to excessive pressure. To address this concern, a test was requested by the ISS Program Thermal Control Lead (Joe Chambliss) to evaluate the ability of an IHA to be launched "wet" and safely accommodate the increased pressure of the HTF if the temperature increased to the worst-case condition of 140°F. This test plan describes the equipment and facility requirements for performing this test, general test procedures, and the evaluation criteria.

2.0 Test Objective

The objective of this test is to simulate the conditions which may be experienced by an isolated IHA, capped on both ends, and to determine whether the IHA can accommodate the increased pressure due to HTF expansion when heated from room temperature to 140°F, without exceeding the design maximum pressure of 100 psia, leaking, or being damaged.

3.0 Test Approach

A flight-like IHA (serial number 683-56836-385) will be tested by simulating the worst-case condition plus 20°F, i.e., 160°F. The pressure will be monitored and the hose will also be checked for any signs of leakage or other damage.

Note: The hose was originally flight hardware but is now obsolete due to a change in materials, however, the cap for the hose is flight hardware and appropriate procedures must be followed.

4.0 Applicable Documents

Internal Thermal Control System Rack Flow Control Assembly Fill Procedure, SK683-53379, 21 April 1999

5.0 Test Method

The test IHA will be filled with coolant per procedure SK683-53379, which involves evacuating the IHA to <50 milliTorr before filling with HTF. The worst-case conditions will be duplicated by heating a coolant-filled, sealed IHA in an environmental chamber, located in Building 4619 at the Marshall Space Flight Center (MSFC). Four cases will be run: two with a target temperature of 140°F, one with a target of 150°F, and one with a target of 160°F.

6.0 Test Requirements

Controlled conditions are needed as well as the means to monitor the pressure in the IHA. The IHA, and equipment that directly connects to the IHA fittings, must be cleaned to cleanliness level 300. Appropriate safety precautions must also be taken. The materials and equipment that are required and the facility support requirements are described below.
The hose will be filled with HTF according to procedure SK683-53379.

6.1 Materials/Equipment Required

A suitable flight-like IHA (undamaged), fittings and connectors, a pressure transducer compatible with operation at 160°F, and HTF are required. The IHA to be provided by Boeing has a QD connector on one end and a threaded MS fitting on the other. A connector block is required for attaching the pressure transducer, and vacuum and fill valve to the IHA. This configuration is shown in Figure 6.1-1. The pressure transducer must have current calibration for the test.

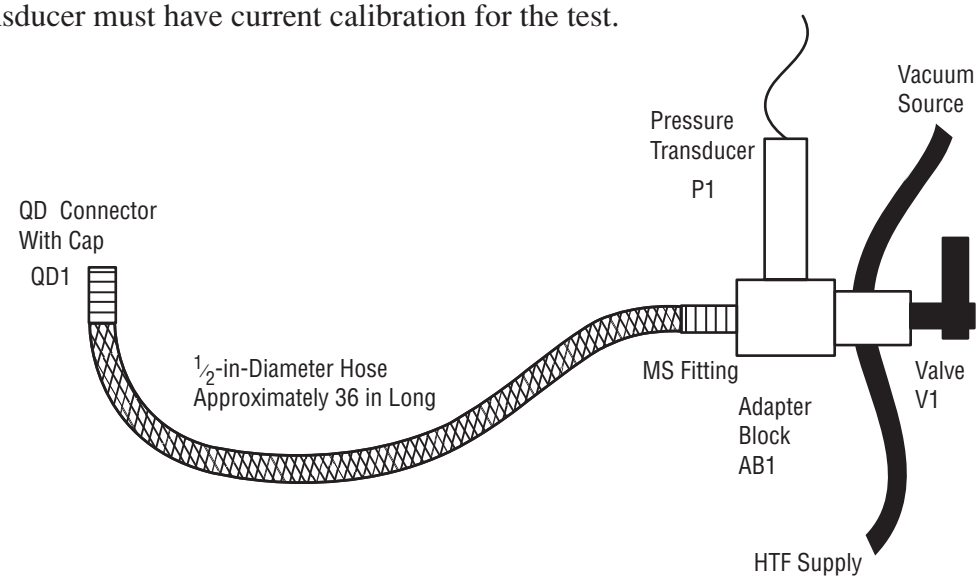

Figure 6.1-1. IHA Test Assembly

6.2 Facility Requirements

Facility support requirements include:
1. A suitable test preparation area to prepare the IHA test article for testing,
2. The means to evacuate the IHA test article and fill it with HTF,
3. An environmental chamber capable of cycling between ambient conditions and the test target temperatures and capable of maintaining the target temperatures for the required durations (sufficient to ensure thermal equilibrium with the IHA test article),
4. A means to record the data (pressure, temperature, time), and
5. Suitable precautions in the event of leakage of the IHA test article or other safety-related concerns.

The IHA test article will be installed in the environmental chamber as indicated in figure 6.2-1. The pressure transducer will have data lines which connect to recording equipment outside the chamber.

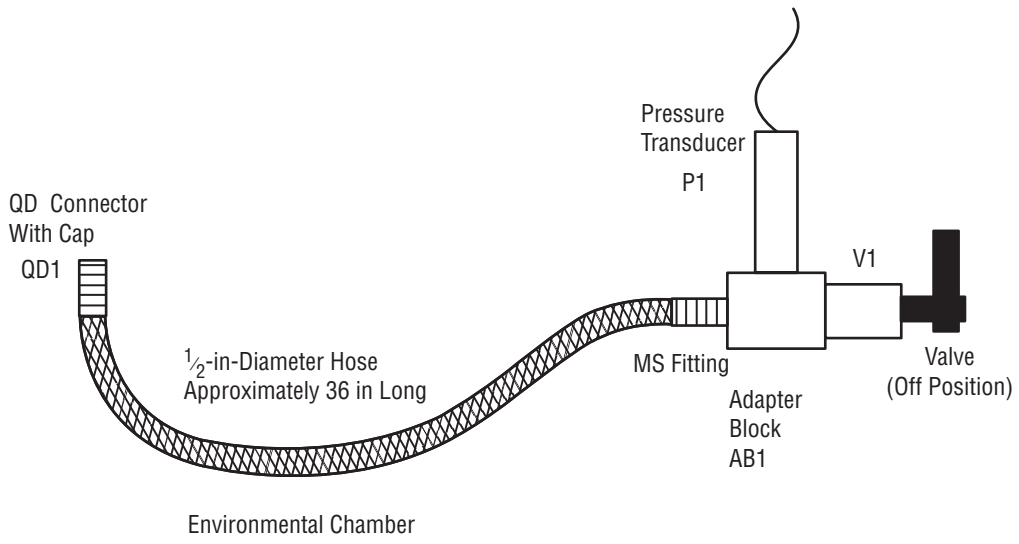

Figure 6.2-1. IHA Coolant Expansion Test Setup

6.3 Personnel Requirements

In addition to test personnel from FD21 and ED26, quality assurance personnel from QS10 will need to approve the test due to the use of a flight hardware end cap.

7.0 Test Procedure

The test procedure should include the following steps.

7.1 Pretest Preparation

1. Connect the required fittings to the IHA, including valve and hoses required for filling the IHA test article with HTF.
2. Attach a pressure gauge and ensure proper tightness of all fittings.
3. Fill the test article with HTF by procedure SK683-53379. (Evacuate the test article to <50 millitorr prior to ensure complete fill with HTF).
4. Place the test article in the environmental chamber and connect to the monitoring equipment.
5. Place paper (or other means to readily detect leakage) under the test article.

7.2 Test Steps

6. Record the initial pressure (~ 15 psig) and temperature. Increase the temperature in the chamber at a maximum rate of 30°F/hour. Record the temperature and pressure every 10 minutes (or more frequently).
7. If the pressure reaches 100 psia during temperature ramp-up, STOP the test immediately and reduce the temperature.

8. If the pressure < 100 psia when the target temperature is reached (140°F, 140°F, 150°F, and 160°F) hold the temperature long enough to ensure thorough heating and to check through the chamber window for signs of leakage. Note any leakage in the test log.
9. Reduce the temperature at a maximum rate of 30°F/hour until near-ambient temperature is reached.
10. Open the chamber and check the test article for indications of leakage or damage.
11. Return to step 7 for the next target temperature.
12. Upon completion of the last target temperature cycle, remove the test article from the chamber and inspect for indications of leakage or damage.

7.3 Post Test

Following completion of the test cycles, the test article is to be disassembled and the cap and hose cleaned to specification level 300 for return to Boeing.
A report on the results of the testing will be prepared.

8.0 Evaluation Criteria and Risks

The purpose of the testing is to determine whether the IHA can accommodate the worst-case scenario of 140°F. To ensure this, the testing will reach a high temperature of 160°F. To demonstrate that the hose can successfully do this, the pressure must remain below the 100 psia limit while at this temperature, no leakage should occur, and the hose should remain undamaged.

Potential risks to performing this test relate to acquisition of materials and availability of facilities and personnel. Presently, the need for funding has not been identified, though it may be necessary to purchase items such as fittings for attaching the pressure gauge.

9.0 Cost and Schedule

It is expected that the test will utilize existing equipment and materials, and therefore require minimal cost and time. No requirements for purchasing items have presently been identified. The IHA and cap will be loaned by Boeing. A preliminary schedule is given below. The duration required for acquiring the IHA and cleaning parts is unknown. The test itself is expected to take only a few days.

Activity	Week 1 2 3 4 5 6
Prepare test plan and procedure, paperwork for environmental chamber, QA, etc.	xxxxxxxxxxxxxxxxx
Acquire hose and parts	xxxxx
Assemble test article (including cleaning, as needed)	xxxxxxxxx
Perform test	xxxxx
Post-test activity (including cleaning and return of hose and cap to Boeing)	xxxxxx
Test report	xxxxx

10.0 Documentation

Documentation of this project includes this test project plan, a test procedure, a test plan (TPS) prepared by the test group, test log and raw test results from the test conductor, and a report on the results of the test.

APPENDIX B—ITCS INTEGRATED HOSE ASSEMBLY COOLANT EXPANSION TEST PREPARATION SHEET

TYPE:	TEST PREPARATION SHEET	TPS NUMBER. FD21TST-TPS-ITCS-00-001		
☐ A. CONFIGURATION CHANGE ☒ B. NON-CONFIGURATION CHANGE		S/C:	CATEGORY.	NUMBER:

MOD. SHEET NUMBER: PAGE 1 OF 3

TPS SHORT TITLE:			SAFETY HAZARD	☐ YES ☒ NO
Thermal Expansion Test for ITCS Jumper Hose			LIMITED LIFE EQUIPMENT	☐ YES ☒ NO
EXPERIMENT/MODEL NUMBER:	DATE: 06-21-2000	NEED DATE:	WEIGHT REQUIRED	☐ YES ☒ NO
DRAWING(S) DOCUMENTS, TCP(S) AND PART NUMBER(S):			MATERIAL ENGINEER SIGNATURE	☐ YES ☒ NO
INITIATING ORGANIZATIONS:	SYSTEM:			

REASON FOR WORK: Hose AAG 888 P/N 683-56836-385 S/N 001001
DDH CAP AAG 889 P/N 683-16348-811 S/N 001097
Determine if ITCS jumper hose~~s~~ can be pre-filled with coolant prior to flight

NO.	DESCRIPTION (PRINT OR TYPE)	TECH	INSPECTION CONT.	INSPECTION NASA
	Assembly (refer to figure 6.1-1 of ITCS Hose HTF Thermal Expansion Evaluation Test Plan:			
1	Connect the 3-way valve (V1), pressure transducer (P1), and Jumper Hose to adapter block (AB1) per figure 6.1-1. The center port of (V1) connects to (AB1). Install cap on jumper hose. Note: O-ring installed on M's fitting of jumper hose	[signature]		6/22/00 M NASA 93Q
2	Weigh the assembly and measure the bend radius of the jumper hose. (1403.6 grams) Scale cal due date 03-30-01 ID no → M631618	[signature]		6/22/00 M NASA 93Q
3	Connect end port of (V1) to vacuum pump/vacuum gauge line. M643171 cal due date 25 Apr 01	[signature]		6/22/00 M NASA 93Q
6 ~~4~~	Connect other end port of (V1) to water fill line.	[signature]		6/23/00
4 ~~5~~	Rotate handle on (V1) to center position. This is the closed position.	[signature]		M NASA 93Q
7 ~~6~~	Refer to figure 6.1-1 of the Test Plan. Fill water vessel with ITCS coolant. Connect N2 purge line to vessel. Pressurize to 30 PSIA M645950 0-60psi Cal due 3-14-01	[signature]		6/23/00 M NASA 94Q
8 ~~7~~	To remove any trapped air, loosen the fitting on the coolant side of (V1) to purge. Re-tighten fitting.	[signature]		6-23-00 M NASA 94Q

SPECIAL NOTES:

PREPARED BY:	PHONE EXT.:	FINAL ACCEPTANCE:	DATE:
Bill Barnett	4-8546	Shirley R [signature] M NASA 94Q	8-22-00

REFER TO LOCAL PROCEDURES FOR SPECIFIC APPROVALS	REFER TO LOCAL PROCEDURES FOR SPECIFIC APPROVALS
1. Paul Wieland FD21 6/21/00	1.
2. Joel M. Anderson, QS30, 6/21/00	2.
3. Darlene Hill QS10 6/22/00	3.
4.	4.

MSFC Form 248 (December 1971) Informed 2.6

TPS NUMBER:	MOD. NUMBER:	TEST PREPARATION SHEET (Continuation)	PAGE 2 OF 3	DATE:

STEP	DESCRIPTION (PRINT OR TYPE)	TECH	INSPECTED CONT.	INSPECTED NASA
	Vacuum/Fill			
5	Rotate handle on (V1) to vacuum pump side. Evacuate assembly to < 50 millitorr. Rotate handle on (V1) to center. ~~Disconnect vacuum line from (V1).~~			6-23-00 M NASA 940
9	To fill with coolant, rotate handle on (V1) to water vessel side.			
10	Once jumper hose is filled with coolant, rotate handle on (V1) to center position.			
11	Loosen the set screw on (V1) and remove the handle to prev ent accidental movement.			
12	Disconnect coolant line and vacuum line from end ports of (V1). Install Swagelok caps on end ports.			6-23-00 M NASA 940
13	Weigh the assembly and measure the bend radius of the jumper hose 1532.5 grams 3" unrestrained (same as unfilled)			
		8-22-00 M NASA 940		

PREPARED BY:	CONTRACTOR APPROVAL:	NASA APPROVAL:	FINAL ACCEPTANCE DATE:
Bill Barnett			

MSFC Form 248-1 (Rev. November 1994) Informed 2.6

TPS NUMBER:	MOD. NUMBER:	TEST PREPARATION SHEET (Continuation)	PAGE 3 OF 3	DATE:

STEP	DESCRIPTION (PRINT OR TYPE)	TECH	INSPECTED CONT.	INSPECTED NASA
	Testing	RW/SRB	6-23-00	
	Transport the test article to the ETF. Place the assembly in the environmental chamber and connect to the monitoring equipment.	JL/SRB	6-26-00	
	Place paper under the test article to readily detect leakage.	JL/SRB	6-27-00	
	Test Steps: Ref. TPS ED26-2000-45 / ED26-5617		11:56 SRB 6-27-00	
1	Record the initial pressure and temperature. Increase the temperature in the chamber at a maximum rate of 30 degrees F/hour. 11:56am 23.30 psia, 73.8F hose, 74.4F chamber			
2	If the pressure reaches 100 psia during temperature ramp-up, stop the test immediately and reduce the temperature. never went above 100 psia 7-6-00			
3	If the pressure is < 100 psia when the target temperature (140, 140, 150, and 160 degrees F) is reached, hold the temperature long enough to ensure thorough heating. Note any signs of leakage in the test log. (32.75) no dampness or puddles noted 7-6-00			
4	Reduce the temperature at a maximum rate of 30 degrees F/hour until near-ambient temperature is reached.			
5	Open the chamber and check the test article for indications of leakage or damage		SRB	
6	Return to step 2 for the next target temperature.			
7	Upon completion of the last target temperature cycle, remove the test article from the chamber and inspect for indications of leakage or damage. none noted.		7-6-00	
	Post Test Following completion of the test cycles, the test article is to be disassembled and the cap ~~and hose~~ cleaned to MIL-STD-1246, level 200A for return to Boeing.			

Noted: Shop cleaned and certified as LOX clean per MSFC-SPEC-164 not MIL-STD-1246, level 200A as per request. Shipment is delayed pending resolution.

Ref WO. 01616/1

SRB 8-22-00

Correct tag per 1246, level 200A provided by ASRI QA.

SRB 8-22-00

8-22-00

PREPARED BY:	CONTRACTOR APPROVAL:	NASA APPROVAL:	FINAL ACCEPTANCE DATE:

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5. FUNDING NUMBERS

6. AUTHORS

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13. ABSTRACT *(Maximum 200 words)*

During assembly of the *International Space Station*, the Internal Thermal Control Systems in adjacent modules are connected by jumper hoses referred to as integrated hose assemblies (IHAs). A test of an IHA has been performed at the Marshall Space Flight Center to determine whether the pressure in an IHA filled with heat transfer fluid would exceed the maximum design pressure when subjected to elevated temperatures (up to 60 °C (140 °F)) that may be experienced during storage or transportation. The results of the test show that the pressure in the IHA remains below 227 kPa (33 psia) (well below the 689 kPa (100 psia) maximum design pressure) even at a temperature of 71 °C (160 °F), with no indication of leakage or damage to the hose. Therefore, based on the results of this test, the IHA can safely be filled with coolant prior to launch. The test and results are documented in this Technical Memorandum.

14. SUBJECT TERMS

ITCS, jumper hose, thermal control system

15. NUMBER OF PAGES

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