Gravity Probe B
Procedure for
GSE Certification

CONNECT TM&A TO SMD

To be performed at Vandenberg Air Force Base building 1610

THIS DOCUMENT CONTAINS NON HAZARDOUS OPERATIONS

P1011

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REVISION RECORD

REVISION	ECO	PAGES	DATE

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List of Abbreviations and Acronyms

AG-x	Gauge x of Gas Module auxiliary section
AMI	American Magnetics Inc.
AP-1	Vane Pump in Gas module
APR-x	Pressure regulator x of Gas Module
AV-x	Valve x of Gas Module auxiliary section
CG-x	Gauge x of portable helium pressurization source
CPR-x	Pressure regulator x of portable helium pressurization source
CV-x	Valve x of portable helium pressurization source
CN [xx]	Data acquisition channel number
DAS	Data Acquisition System
EFM-x	Exhaust gas Flow Meters
EG-x	Gauge x of Gas Module exhaust section
EH-x	Vent line heat exchanger in GM
EM	Electrical Module
ERV-x	Relief valve of GM exhaust section
EV-x	Valve number x of Gas Module exhaust section
FCV	Fill Cap Valve
FIST	Full Integrated System Test
GHe	Gaseous Helium
GM	Gas Module
GP-B	Gravity Probe-B
GSE	Ground Support Equipment
GT	Guard Tank
GTVC	Guard Tank Vent Cap
GTVC-G	Guard Tank Vent Cap pressure gauge
GTVC-RV	Guard Tank Vent Cap relief valve
GTV-G	Guard Tank vent pressure gauge
GTV-RV	Guard Tank vent relief valve
GTV-V	Guard Tank vent valve
GTV-Va	Guard Tank Vent line valve for independent pressure regulation
HEX-x	SMD heat exchanger x
KFxx	Quick connect o-ring vacuum flange (xx mm diameter)
LHe	Liquid Helium
LHSD	Liquid Helium Supply Dewar
LHV-x	Liquid Helium Supply Dewar valves
LLS	Liquid level sensor
LM	Lockheed Martin Co.
MT	Main Tank
MTVC	Main Tank Vent Cap
MTVC-G	Main Tank Vent Cap pressure gauge
MTVC-RV	Main Tank Vent Cap relief valve
MTVC-V	Main Tank Vent Cap valve
NBP	Normal boiling point
ONR	Office of Naval Research
PFCG	Fill Cap assembly pressure Gauge
PFM	Pump equipment Flow Meter
PG-x	Gauge x of Pump equipment
PM	Pump Module
psi	pounds per square inch
psig	pounds per square inch gauge
TD	Test Director
PV-x	Valve x of the Pump equipment
QA	Quality Assurance
RAV-x	Remote Actuated Valve-x
RGA	Residual Gas Analyzer
RGA-LV	RGA leak valve (needle valve)
RGA-SOV	RGA shut off valve
SMD	Science Mission Dewar
STV	SMD Thruster vent Valve
SU	Stanford University
SV-x	SMD Valve number x
TG-x	Gauge x of Utility Turbo System
TV-x	Valve x of Utility Turbo System
UTS	Utility Turbo System
Vac	Vacuum
VCP-x	Vent cap pressure gauge
VCRV-x	Vent cap relief valve
VCV-x	Vent cap valve
VDC	Volts Direct Current
VF-x	Liquid helium Fill line valve
VG-x	Gauge x of Vacuum Module
VM	Vacuum Module
VV-x	Valve x of Vacuum Module
VW-x	Valve x of Dewar Adapter

LIST OF SPECIFIC HEADING DEFINITIONS

Each type of alert message will precede the procedural step to which it applies

1. NOTE: Used to indicate an operating procedure of such importance that it must be emphasized
2. CAUTION: Used to identify hazards to equipment
3. WARNING: Used to identify hazards to personnel

A SCOPE

This procedure is used to connect the Temperature Monitor and Alarm system (TM&A) to the Science Mission Dewar (SMD).

B SAFETY

B.1 Potential Hazards

Personal injury and hardware damage can result during normal positioning, assembly and disassembly of hardware.

Liquid helium used in the SMD represents a hazardous material for the personnel involved in the operations. Cryogenic burns can be caused by contact with the cold liquid or gas, high pressures can result if boiling liquid or cold gas is confined without a vent path, and asphyxiation can result if the vent gas is allowed to accumulate.

The SMD Safety Compliance Assessment, document GPB-100153C and the Missile System Prelaunch Safety Package LM/P479945 discuss the safety design, operating requirements and the hazard analysis of the SMD.

B.2 Mitigation of Hazards

B.2.1 Lifting Hazards

There are no lifting operations in this procedure

B.2.2 Cryogenic Hazards

In VAFB building 1610, the GP-B cryogenic team provides an oxygen deficiency monitor that alarms when the oxygen level is reduced to 19.5%. Additional temperature and pressure alarms, provided by the DAS, warn of potential over-pressure conditions. Emergency vent lines are installed over the four burst disks to direct any flow to an outside area.

Only authorized and trained personnel are allowed in VAFB facilities without escort. All personnel working on platforms at a height 30 inches or more off the floor are required to have an approved air tank (emergency breathing apparatus) within easy reach. Note that tank need not be kept available when working from ladder. In the unlikely event of a large LHe spill all employees have been instructed to evacuate the room and contact NASA and VAFB safety.

The following additional requirements apply to all personnel involved directly in cryogenic operations. Gloves that are impervious to liquid helium and liquid nitrogen are to be worn whenever the possibility of splashing or impingement of high-velocity cryogens exists or when handling equipment that has been cooled to cryogenic temperatures. Protective clothing, non-absorbent shoes and full-face shields and glasses/goggles are to be worn whenever the possibility of splashing cryogens exists.

B.2.3 Other Hazards

All tools or other items used with the potential to damage the space vehicle shall be tethered.

B.3 Mishap Notification

B.3.1 Injury

In case of any injury obtain medical treatment as follows
Call 911

B.3.2 Hardware Mishap

In case of an accident, incident, or mishap, notification is to proceed per the procedures outlined in Lockheed Martin Engineering Memorandum EM SYS229 and Stanford University GP-B P0879. Additionally, VAFB NASA Safety and 30th Space Wing Safety will be notified as required.

B.3.3 Contingency Response

Responses to contingencies/emergency (e.g., power failure) are listed in Appendix 3.

C QUALITY ASSURANCE

C.1 QA Notification

The NASA program and the NASA safety representative and SU QA shall be notified 24 hours prior to the start of this procedure. Upon completion of this procedure, the QE Manager will certify his/her concurrence that the effort was performed and accomplished in accordance with the prescribed instructions by signing and dating in the designated place(s) in this document.

C.2 Red-line Authority

Authority to red-line (make minor changes during execution) this procedure is given solely to the TD or his designate and shall be approved by the QA Representative. Additionally, approval by the Payload Technical Manager shall be required, if in the judgement of the TD or QA Representative, experiment functionality may be affected.

C.3 Discrepancies

A Quality Assurance Representative designated by D. Ross shall review any discrepancy noted during this procedure, and approve its disposition. Discrepancies will be recorded in a D-log or a DR per Quality Plan P0108. Any time a procedure calls for verification of a specific configuration and that configuration is not the current configuration, it represents a discrepancy of one of three types. These types are to be dealt with as described below.

1. If the discrepancy has minimal effect on procedure functionality (such as the state of a valve that is irrelevant to performance of the procedure) it shall be documented in the procedure, together with the resolution. Redlines to procedures are included in this category.
2. If the discrepancy is minor and affects procedure functionality but not flight hardware fit or function, it shall be recorded in the D-log. Resolution shall be in consultation with the TD and approved by the QA representative.

3. All critical and major discrepancies, those that effect flight hardware fit or functions, shall be documented in a D-log and also in a Discrepancy Report, per P0108.

D TEST PERSONNEL

D.1 Personnel Responsibilities

The performance of this procedure requires a minimum complement of personnel as determined by the Test Director. The person performing the operations (Test Director or Test Engineer) is to sign the "Completed by" sign-off. Any other qualified person or QA person who can attest to the successful performance of this procedure may sign the "Witnessed by" sign-off. The Test Director will perform Pre-Test and Post-Test Briefings in accordance with P0875 "GP-B Maintenance and Testing at all Facilities." Checklists will be used as directed by P0875.

D.2 Personnel Qualifications

The Test Director must have a detailed understanding of all procedures and facility operations and experience in all of the SMD operations. Test Engineers must have SMD Cryogenic operations experience and an understanding of the operations and procedures used for the cryogenic servicing/maintenance of the Dewar.

D.3 Required Personnel

The following personnel are essential to the accomplishment of this procedure:

FUNCTIONAL TITLE	NUMBER	AFFILIATION
Test Director/Test Engineer	1	Stanford
GP-B Quality Assurance	1	Stanford

E REQUIREMENTS

E.1 Electrostatic Discharge Requirements

When working on the space vehicle, proper ESD protection is required. A properly grounded ESD wrist strap must be worn while mating to or de-mating from payload connectors. Wrist-strap must be checked on an appropriate checker prior to use.

E.2 Lifting Operation Requirements

There are no lifting operations in this procedure

E.3 **Hardware/Software Requirements**

E.3.1 Commercial Test Equipment

No commercial test equipment is required for this operation.

E.3.2 Ground Support Equipment

No GSE is required for this operation other than that described in Section E.3.3.

E.3.3 Computers and Software:

The TM&A together with its associated laptop computer and LabView data acquisition program are required for this operation.

E.4 **Additional Test Equipment**

E.4.1 Additional Hardware

None

E.4.2 Tools

No special tools are required.

E.4.3 Expendables

No expendables are required.

E.5 **Configuration Requirements**

E.5.1 Main Tank

Liquid in the Main Tank may be at its normal boiling point (NBP) or subatmospheric.

E.5.2 Guard Tank

The Guard Tank may contain liquid or be depleted.

E.5.3 Well

The Well is evacuated.

E.5.4 SMD Vacuum Shell

The Vacuum Shell pressure should be less than 5x 10-5 torr, but the actual pressure has no bearing on the performance of this procedure.

E.5.5 Optional Non-flight Configurations.

The following modifications or non-flight arrangement of the basic SMD configuration may also be in place. They are incidental to the performance of this procedure and not required.

1. The SMD may be installed in its transportation and test fixture.
2. The Vacuum shell pump out port at SV-14 may be connected to the Vacuum Module (P/N 5833816) via a 2-in valve and pumping line, with the valve in either the closed position or in the open position. The Vacuum Module pump may be; off, actively pumping the pumping line up to a closed SV-6, or actively pumping the vacuum shell.
3. The ion-pump magnet may be installed.

F REFERENCE DOCUMENTS

F.1 Drawings

Drawing No.	***Title***
LMMS-5833394	Instrumentation Installation

F.2 Supporting documentation

Document No.	***Title***
LMMC-5835031	GP-B Magnetic Control Plan
GPB-100153C	SMD Safety Compliance Assessment
SU/GP-B P0141	FIST Emergency Procedures
LM/P479945	Missile System Prelaunch Safety Package
LMSC-P088357	Science Mission Dewar Critical Design Review
SU/GP-B P0108	Quality Plan
LMMS GPB-100333	Science Mission Dewar Failure Effects and Causes Analysis
SU/GP-B P059	GP-B Contamination Control Plan
EM SYS229	Accident/Mishap/Incident Notification Process
EWR 127-1	Eastern and Western Range Safety Requirements
KHB 1710.2 E	Kennedy Space Center Safety Practices Handbook

F.3 Additional Procedures

Document No.	***Title***
SU/GP-B P0879	Accident/Incident/Mishap Notification Process
SU/GP-B P0775	Certification of the TM&A

Operation Number:_____
Date Initiated:_____
Time Initiated:_____

G OPERATIONS

G.1 Pre-Operations Verifications

- Verify SU QA notified.

  Record: Individual notified _____,

  Date/time _____/_____.
- Verify NASA program representative notified.

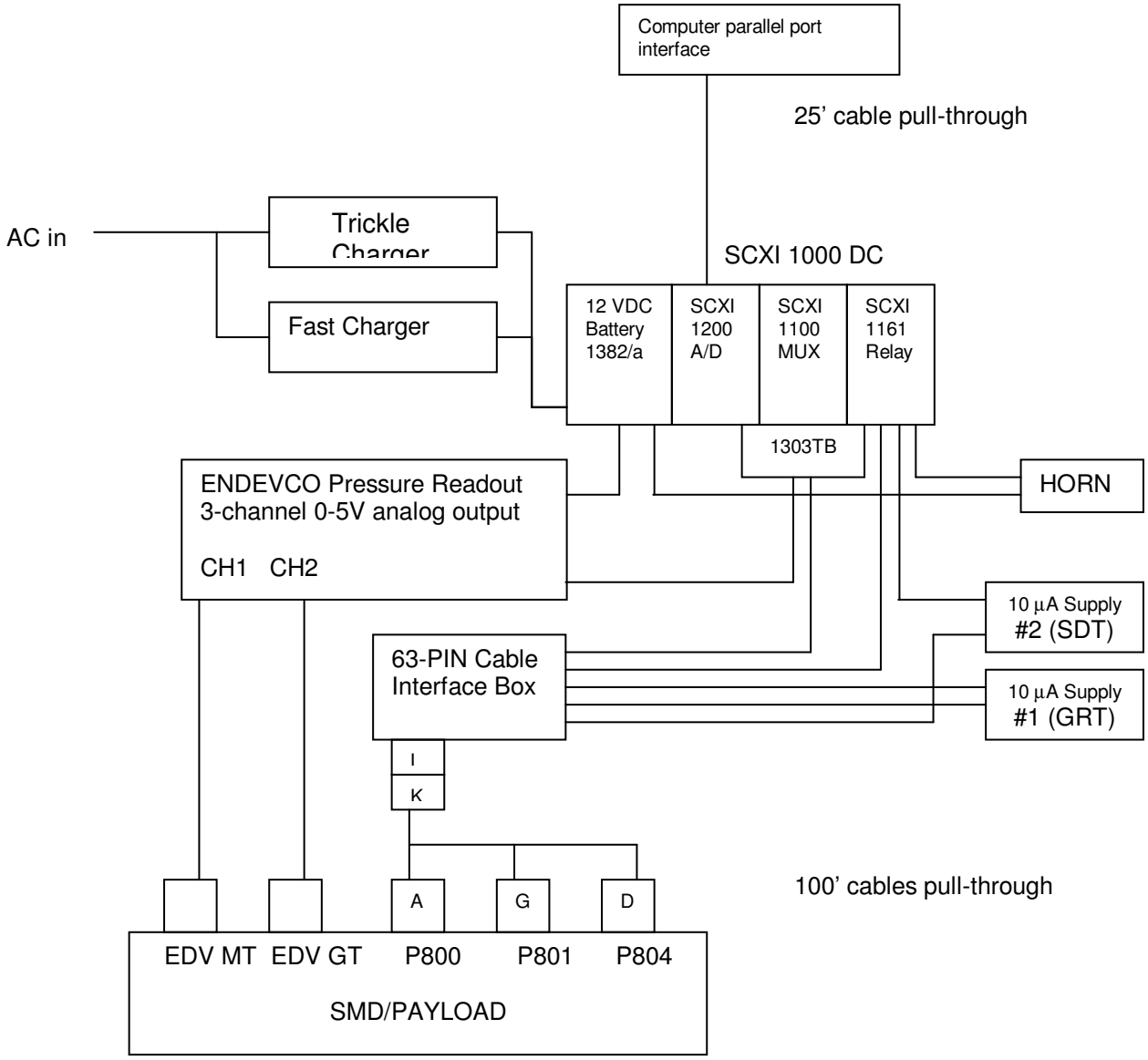
  Record: Individual notified _____,

  Date/time _____/_____.
- Record calibration due dates in Table 1 (Sections. E.3.4, E.4)
- Persons actually performing this procedure should list their names in Sec D.3.
- Verify completion of the pre-operations checklist (Appendix 1).
- Verify proper operation of GP-B Cryogenic Team oxygen monitor
- Verify availability and functioning of emergency shower.

Section Complete QA Witness:_____

G.2 Verify Configuration Requirements

G.2.1 Verify that the TM&A is set up as shown below.. The cable connections to the SMD/PAYLOAD are K/A-D-G (K = 63-pin female, A, D and G = 66-pin female) and two 5-conductor ENDEVCO cables (male/female, 9-pin D-style connector).



G.2.2 Ensure that P1021 – CERTIFICATION OF THE TM&A has been completed successfully within the last 120 hours. Enter the date of completion and Op. Order Number here.

Date_____Op Order Number_____

G.2.3 Ensure that the 1382/a battery has enough charge to run the components of the TM&A. If needed, half an hour on the fast charger should provide enough charge to run this procedure. An overnight charge on the trickle charger will fully charge the battery.

G.2.4 Check that all the TM&A components are powered down and that the horn is switched off.

Item	***Condition***	***Checked***
AC in	Unplugged	
SCXI DC 1000	OFF	
ENDEVCO	OFF	
10 μA #1 (GRT)	OFF	
10 μA #1 (SDT)	OFF	
Laptop Computer	OFF	
Horn Defeat	ON	

Section G.2 completed. QA Witness:_____

G.3 **Connect TM&A to SMD**

Caution
Extreme care must be taken to avoid accidentally bumping the Probe or damaging the connectors. Connectors should be inspected for bent pins and/or debris prior to mating. Connector savers or equivalent adapters shall be used to protect the connector pins from damage during the measurements. A properly grounded ESD wrist strap must be worn. All mate/demates involving flight connectors shall be logged. Failure to comply may result in equipment damage.

G.3.1 Connect the TM&A cables to the SMD and to the ENDEVCO heads. Connect the laptop computer interface to the SCXI chassis.

G.3.2 Cable K/A-D-G connects to the interface box (connector K to L) and to the SMD (A to P800, D to P804).

G.3.3 Connect proper shorting plug to the end of cable G P801

G.3.4 Connect the main tank and guard tank ENDEVCO cables to the ENDEVCO heads using the cables EDV MT and EDV GT.

G.3.5 Connect the parallel port of the laptop computer to the SCXI 1200 using the parallel interface cable.

Section G.4 completed. QA Witness:_____

G.4 **Power Up TM&A**

G.4.1 Power on all the TM&A components in the following order and activate the horn circuit.

Item	***Condition***	***Checked***
AC in	Plugged in	
SCXI DC 1000	ON	
ENDEVCO	ON	
10 μA #1 (GRT)	ON	
10 μA #1 (SDT)	ON	
Laptop Computer	ON	
Horn Defeat	OFF	

G.4.2 Boot the laptop computer and start the 'TM&A' program.

G.4.3 Verify TM&A readings in agreement with expected values

G.4.4 Verify completion of post operations checklist

Section G5 completed. QA Witness:_____

H **PROCEDURE COMPLETION**

Completed by:

Witnessed by:

Date: _____

Time:_____

Quality Manager_____**Date**_____

Payload Test Director_____**Date**_____

TM&A CABLING

		A	K	L		1303	1161	other
Device	**function**	**P800/P1**			**L jumpers**			
T22D	-	-	1	1		GND		
top lead	V+	6	2	2		CH0+		
bag /a	V-	12	3	3		CH0-		
	-	-	4	4	10	GND		
GRT	I+	1	5	5			NO(0)	
	I-	5	6	6	11			
T23D	shield	-	7	7		GND		
top lead	V+	28	8	8		CH1+		
bag /b	V-	29	9	9		CH1-		
	shield	-	10	10	34			
GRT	I+	19	11	11	6			
	I-	20	12	12	35			
T09D	shield	-	13	13		GND		
main tank	V+	16	14	14		CH2+		
bottom	V-	23	15	15		CH2-		
	shield	-	16	16		GND		
SDT	I+	9	17	17			NO(1)	
	I-	15	18	18				10uA(-) SDT
T15D	shield	-	19	19		GND		
guard tank /a	V+	7	20	20		CH3+		
	V-	8	21	21		CH3-		
SDT	shield	-	22	22		GND		
	I+	2	23	23			NO(2)	
	I-	3	24	24				10uA(-) SDT
T24D	shield	-	25	25		GND		
fill valve V13	V+	11	26	26		CH4+		
	V-	18	27	27		CH4-		
SDT	shield	-	28	28		GND		
	I+	4	29	29			NO(3)	
	I-	10	30	30				10uA(-) SDT
		D	**K**	**L**		**1303**	**1161**	**other**
Device	**function**	**P804/P5**			**L jumpers**			
T20D	-	-	31	31		GND		
top lead bag	V+	35	32	32		CH5+		
/c	V-	36	33	33		CH5-		
	-	-	34	34	40			
GRT	I+	26	35	35	12			
	I-	27	36	36	41			
T21D	shield	-	37	37		GND		
top lead bag	V+	16	38	38		CH6+		
/d	V-	23	39	39		CH6-		
	shield	-	40	40	46			
GRT	I+	9	41	41	36			
	I-	15	42	42	47			
		D	**K**	**L**		**1303**	**1161**	**other**
Device	**function**	**P801/P2**			**L jumpers**			
T01D	-	-	43	43		GND		
station 200 /a	V+	16	44	44		CH7+		
	V-	23	45	45		CH7-		
GRT	-	-	46	46	52			
	I+	9	47	47	42			
	I-	15	48	48	53			
T10D	shield	-	49	49		GND		
MT top /a	V+	62	50	50		CH8+		
	V-	63	51	51		CH8-		
GRT	shield	-	52	52	46			
	I+	56	53	53	48			
	I-	57	54	54				10uA(-) GRT
T05D	shield	-	55	55		GND		
VCS-1 Bottom	V+	28	56	56		CH9+		
	V-	29	57	57		CH9-		
SDT	shield	-	58	58		GND		

	I+	19	59	59			NO(4)	
	I-	20	60	60				10uA(-) SDT
T08D	shield	-	61	61		GND		
HEX-4	V+	34	62	62		CH10+	NO(5)	
	V-	43	63	63		CH10-		10uA(-) SDT
SDT	shield	-						
	I+	17						
	I-	25						

ENDEVCO and Spare A/D CHANNELS

		1303			**1303**
spare 63-pin	**ENDEVCO**		**spare 63-pin**	**ENDEVCO**	
	CH1-pin	CH11+	24		GND
	CH1-shield	CH11-	25		CH22+
		GND	26		CH22-
	CH2-pin	CH12+	27		GND
	CH2-shield	CH12-	28		CH23+
		GND	29		CH23-
	CH3-pin	CH13+	30		GND
	CH3-shield	CH13-	31		CH24+
		GND	32		CH24-
1		CH14+	33		GND
2		CH14-	34		CH25+
3		GND	35		CH25-
4		CH15+	36		GND
5		CH15-	37		CH26+
6		GND	38		CH26-
7		CH16+	39		GND
8		CH16-	40		CH27+
9		GND	41		CH27-
10		CH17+	42		GND
11		CH17-	43		CH28+
12		GND	44		CH28-
13		CH18+	45		GND
14		CH18-	46		CH29+
15		GND	47		CH29-
16		CH19+	48		GND
17		CH19-	49		CH30+
18		GND	50		CH30-
19		CH20+	51		GND
20		CH20-	52		CH31+
21		GND	53		CH31-
22		CH21+	54		GND
23		CH21-			

CURRENT SOURCE AND BATTERY TO 1161 RELAY

1161		**10 uA GRT**	**10uA SDT**	**12VDC**
	1161 jumper			
NC(0)				
COM(0)		10 uA (+)		
NO(0)				
NC(1)				
COM(1)	COM(2)		10 uA (+)	
NO(1)				
NC(2)				
COM(2)	COM(3)			
NO(2)				
NC(3)				
COM(3)	COM(4)			
NO(3)				
NC(4)				
COM(4)	COM(5)			
NO(4)				
NC(5)				
COM(5)	COM(4)			
NO(5)				
NC(6)				
COM(6)				
NO(6)				
NC(7)				
COM(7)				12 V (+)
NO(7)				

ENDEVCO CABLES

pin #	function	color
4		white
5		green
7		red
8		black
9	shield	none

Sensor end = female 9-pin D-style
Readout end = male 9=pin D-style

l APPENDIX 1 PRETEST CHECKLIST

DATE	CHECKLIST ITEM	COMPLETED	REMARKS
	1. Verify the test procedure being used is the latest revision.		
	2. Verify all critical items in the test are identified and discussed with the test team.		
	3. Verify all required materials and tools are available in the test area.		
	4. Verify all hazardous materials involved in the test are identified to the test team.		
	5. Verify all hazardous steps to be performed are identified to the test team.		
	6. Verify each team member is certified for the task being performed and knows their responsibilities.		
	7. Confirm that each test team member clearly understands that he/she has the authority to stop the test if an item in the procedure is not clear.		
	8. Confirm that each test team member clearly understands that he/she must stop the test if there is any anomaly or suspected anomaly.		
	9. Notify management of all discrepancy reports or d-log items identified during procedure performance. In the event an incident or major discrepancy occurs during procedure performance management will be notified immediately.		
	10. Perform an Engineering and Safety high bay walk down. Ensure all discrepancies are corrected prior to start of operation.		
	11. Confirm that each test team member understands that there will be a post-test team meeting.		
	Team Lead Signature: _____		

J **APPENDIX 2 POST-TEST CHECKLIST**

DATE	CHECKLIST ITEM	COMPLETED	REMARKS
	1. Verify all steps in the procedure were successfully completed.		
	2. Verify all anomalies discovered during testing are properly documented.		
	3. Ensure management has been notified of all major or minor discrepancies.		
	4. Ensure that all steps that were not required to be performed are properly identified.		
	5. If applicable sign-off test completion.		
	6. Verify all RAV valve operations have been entered in log book		
	7. Verify the as-run copy of procedure has been filed in the appropriate binder		
	Team Lead Signature: _____		

K **APPENDIX 3– CONTINGENCY/EMERGENCY RESPONSES**

Condition	Circumstance	Response
Power Failure	Anytime	Wait for power restoration, and resume procedure
Oxygen monitor alarm	Anytime	Evacuate
Liquid Nitrogen Spill	Anytime	Clear area until spilled liquid has evaporated