SU/GPB P0415 Rev -

STANFORD UNIVERSITY
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STANFORD, CALIFORNIA 94305-4085

INSTALLATION OF THE SQUID KIT INTO THE GP-B PAYLOAD

P0415 Rev – "As-built"

GP-B SCIENCE MISSION PROCEDURE

24 May 1999

PREPARED	B. Muhlfelder, SQUID Hardware Manager	date
APPROVED	R. Brumley, Gyro Manager	date
APPROVED	D. Bardas, Payload Integration Manager	date
APPROVED	D. Ross, Quality Assurance	date
APPROVED	J. Janicki, Safety	date
APPROVED	S. Buchman, Hwr. Mgr	date

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1 SCOPE

This procedure describes the method for installing the Science Mission SQUID kits, P/N 25132-101 and 25132-102 into the SIA. It assumes that the SIA is integrated with the Probe per P0177, with vacuum can off, and the SQUID brackets and rail kits have been installed per P0432. It assumes that the SIA/Probe is horizontal in the Class 10 cleanroom, with the cold end facing the observation window.

NOTE: THIS IS THE BLACKLINE VERSION OF THE REDLINE REV – SQUID KIT INSTALLATION PROCEDURE. THE REDLINE REV – PROCEDURE IS ALSO AVAILABLE IN THIS FILE. TEXT ADDED TO THE ORIGINAL BLACKLINE REV – PROCEDURE ARE UNDERLINED IN THIS DOCUMENT.

2. APPLICABLE DOCUMENTS

2.1 Plans and Procedures

P0057	Stanford Magnetic Control Plan
P0080	Magnetic Screening Procedure
P0177	SIA to Probe Integration
P0432	Wire Lok QBF Bolts, Install Rails, SQUID Brackets, Plumbing Links
P0476	ESD/EOS Risk Mitigation Procedure
P0419	Operations Manual for the Probe Precision Manipulator

3. GENERAL REQUIREMENTS

3.1 Environmental Requirements

This procedure will be conducted in the Stanford Class 10 Cleanroom in the HEPL facility.

3.1.1. Cleanliness

The Class 10 clean room where this integration takes place shall be maintained at the cleanliness levels per GPB Contamination Control Plan P0059. Certified Class 10 cloth garments shall be worn in the Class 10 clean room.

3.1.2 Particulate Contamination

All parts and tools shall be cleaned at least to the cleanliness levels of the rooms where they are used for assembly or testing. In addition, all flight parts shall be maintained at level 100 cleanliness per GP-B Contamination Control Plan (P0059). Take all necessary precautions to keep tools and handling equipment free of particulate contamination. The cleanroom vacuum shall be used during fastening operations as required to maintain cleanliness.

To the maximum extent possible, personnel shall keep parts of their bodies downstream of the QB/T, relative to the HEPA wall.

3.1.3. Magnetic Contamination

All parts and tools shall be screened per Procedure P0057. Tools to be sprayed with Freon from pressure can (filtered to < 0.2 micron) prior to use, or when contaminated.

3.1.4. Electrostatic Discharge Control

The particle ionizer should always be upstream of the quartz block relative to the fan wall, to prevent electrostatic charge buildup on the quartz block. P0476 shall be read prior to starting this procedure and shall be signed for here. _____ _____
Barry Muhlfelder date

3.2 Integration Personnel

3.2.1 Integration and Test Director

The Integration and Test Director (ITD) shall be Dr. Barry Muhlfelder. He has overall responsibility for the implementation of this procedure and shall sign off the completed procedure.

3.2.2 Personnel

All engineers and technicians participating in this procedure shall work under the direction of the ITD who shall determine whether the person is qualified to participate in this procedure.

3.3 Safety

3.3.1 General

Personnel working in the Class 10 Cleanroom must be cognizant of the base of the Precision Manipulator, and take special care to avoid tripping or bumping into it.

3.3.2 Hardware Safety

Extreme care must be taken to avoid accidentally bumping the QB and other delicate flight hardware.

3.3.3 Maximum Number of People in Cleanroom

Under normal operating conditions, there shall be no more than 5 people in the Class 10 Cleanroom. This is to avoid violating legal make up air requirements, and to provide an efficient workspace. Exceptions must be for short periods only, and be approved by the test director.

3.4 Quality Assurance

Integration shall be conducted on a formal basis to approved and released procedures. The QA program office shall be notified of the start of this procedure. A Quality Assurance Representative, nominally B. Taller, or his designee, shall be present during the procedure and

shall review any discrepancies noted and approve their disposition. Upon completion of this procedure, the QA Program Engineer, B. Taller will certify his 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. Discrepancies will be recorded in a D-log or as a DR per Quality Plan P0108.

The ONR representative shall be notified prior to beginning this procedure.

3.5 Red-line Authority

Authority to red-line (make minor changes during execution) this procedure is given solely to the ITD or his designate, Greg Gutt, and Ming Luo. Additionally, approval by the Integration Manager and Hardware Manager shall be required, if in the judgment of the ITD or QA Representative, experiment functionality or probe integrity may be affected.

3.6 Procedure Computerization Special Requirements

3.6.1 To conveniently record data directly into the procedure thus generating the "as-built" document, the procedure may be handled in a paperless fashion until completed. A Laptop computer containing an electronic version of this procedure may be recorded by typing directly into the electronic file.

3.6.2 Following completion of the procedure, a hard copy of the "as-built" procedure shall be printed *and signed off by all the designated parties*. It shall then be filed, including an electronic copy into the data base.

4. REQUIRED EQUIPMENT

Flight Hardware

Hardware	Part Number	Quantity	Notes
SQUID KIT, negative X	25132-101	1	
SQUID KIT, positive X	25132-102	1	

Note: Serial Numbers and/or Lot Date Code of Flight Hardware are listed in the various tables as the assembly occurs in Section 5.

Ground Support Equipment

Approved non-magnetic tools
Fluke ~~77~~ 87 ohmmeter, Calibration due 3/10/00. S/N 107791.
Keithley 580 ohmmeter, Calibration due 4/15/00. S/N 005157.
Fiberlite Model 190, Dolan-Jenner Industries
LEMO Disassembly tool
LEMO mating connectors
Allen wrenches, various
Cleanroom vacuum cleaner

Non-magnetic cable bending tools

5 INITIAL CHECKS AND SETUP

Record Start Date and Time: 5/1/99; 1545.

- Make sure the Ion Bar Array is positioned between the HEPA wall and the cold end of the probe where the SQUID packages are to be installed
- Raise or lower the probe , if necessary, to a comfortable working height of approximately 4 feet. Use the Probe Precision Manipulator to do this, in accordance with procedure P0419.
- Rotate the probe, if necessary, to position the –X axis toward the ceiling, and slightly rotated toward you.
- Group the flight hardware by SQUID packages, and place on the optical table.

NOTE: For Science Mission, SQUID packages are to be installed in positions 1, 2, 3, and 4 for Gyros 1-4, respectively. Positions are shown below. Note that spaces allocated for other SQUID packages are no longer numbered.

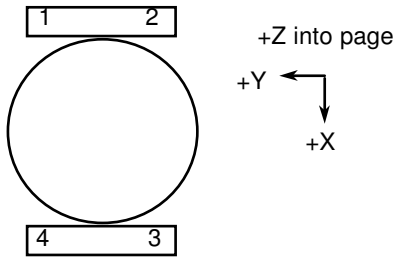


Figure 1. SQUID Positions

- Using the Fluke ohmmeter, measure the round-trip resistance and resistance-to-ground of each pickup loop of each gyro. ~~Record in Table 1.~~

6 INSTALL SQUIDS IN POSITIONS #1 AND #2

- Attach the output cable assembly (25042-101) designated for SQUID position #1 to a SQUID package assembly (25017-201). Record the serial numbers of the output cable and SQUID package in Table 2.
- Install the SQUID package and output cable onto SQUID position #1 of the –X bracket. Use 3 each of socket head screw P/N 25137-111, and shoulder washer P/N 25129-101, and one insulating shim, P/N 25341-101 on each package. Record the lot date codes of the parts in Table 2.

Table 2. SQUID POSITION SERIAL NUMBERS AND LOT DATE CODES

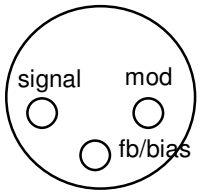
SQUID POSITION	OUTPUT CABLE PART NO.	OUTPUT CABLE SERIAL NO.	SQUID PACKAGE SERIAL NO.	SCREW 25137-111 LOT DATE CODE	WASHER 25129-101 LOT DATE CODE	SHIM, 25341-101 LOT DATE CODE
1	25042-101	1	SM8/43B	092694 qty: 3 ea	51696 qty: 3 ea	51596 qty: 2 ea
2	25042-102	4	SM7/36A	""	""	51596 qty: 2 ea
3	25042-103	5	SM1/31C	""	""	51596 qty: 1 ea
4	25042-104	8	SM6/42C	""	""	51596 qty: 2 ea

Screw, SHC 25054-104 Mag #G345, qty: 16 total
Lemo Retainer, 25642-101, Mag #G387, qty: 4 total

DLOG #1: 25042-10n Rev C, Section C-C, Orientation of cable des not match dwg. Signal and modulation cables are reversed.

- Follow the above procedure to install the SQUID package and output cable onto SQUID position #2 of the –X bracket. Be sure to use output cable part no. 25042-102 for SQUID position #2.

An end-on view of the SQUID package as seen from the outside of the package shows the bias/feedback output cable located adjacent to the notch (which is towards the bottom of the package). The modulation cable is located counterclockwise from the bias/feedback cable and the signal cable is located clockwise from the bias/feedback cable.

Fig 2. 

SQUID Output cables relative locations

- For each SQUID package, measure the resistance at the end of each output cable and record the result in Table 3 below. Verify that the male and female connectors are correctly clocked. Prior to mating

the two connectors, it may be necessary to loosen the back nut of the male connector to correctly clock the jumper cable connector to the probe connector. Mate the SQUID output cables to the Probe Lemo connectors as shown in Table 3. The connectors are keyed, so that they automatically mate correctly. Each lemo has 4 pins; for the signal and modulation cables, only pins 1 and 2 are actively used, while 3 and 4 are spares. For the feedback/bias cable, pins 1 and 2 provide the feedback signal, while pins 3 and 4 provide the bias signal. Bend the output cable as necessary, so that it can be mated. Use only non-magnetic bending tools.

- Use the Fluke ohmmeter to measure resistance to ground and round trip resistance as measured at the top hat for each function. Record results in Table 3. Typical values are 10 ohms for the signal, 9 kohms for the modulation, 400 ohms for the bias, and 3 kohms for the feedback.

Table 3. SQUID Lemo Pinouts and Resistances

SQUID POS.	CABLE FUNCTION	Probe Connect	PROBE LEMO PINS	PROBE TOP HAT PINS	RESISTANCE TO GROUND (> 20 Mohms)	RT RESIST (before hookup)	RT RESIST (after hookup)
1	signal	SS1	1	2	**8.422 Ω**	**8.295 Ω**	**13.00 Ω; 10.9 Ω pin 1 to gnd**
			2	1	**8.496 Ω**	**1 to 3 > 200 kΩ**	**1 to 3 > 200 kΩ**
			3	5	**> 200 kΩ**	**-**	**-**
			4	4	**> 200 kΩ**	**-**	**-**
	modulation	MS1	1	2	**> 200 kΩ**	**9.97 kΩ**	**9.97 kΩ**
			2	1	**> 200 kΩ**	**-**	**1 to 3 > 200 kΩ**
			3	5	**> 200 kΩ**	**> 40 MΩ**	**> 40 MΩ**
			4	4	**> 200 kΩ**	**-**	**-**
	feedback/bias	FB1	1	2	**> 40 MΩ**	**3.87 kΩ**	**3.92 kΩ**
			2	1	**-**	**-**	**1 to 3 > 200 kΩ**
			3	5			
			4	4	**>200 kΩ**	**-**	**-**
2	signal	SS2	1	2	**8.679 Ω**	**9.102 Ω**	**13.76 Ω; 11.21 Ω pin 1 to gnd**
			2	1	**8.633**	**-**	**1 to 3 > 200 kΩ**
			3	5	**> 200 kΩ**	**> 200 kΩ**	**> 40 MΩ**
			4	4	**-**	**-**	**-**
	modulation	MS2	1	2	**> 200 kΩ**	**7.22 kΩ**	**7.19 kΩ**
			2	1	**-**	**-**	**1 to 3 > 200 kΩ**
			3	5	**> 200 kΩ**	**> 200 kΩ**	**> 40 MΩ**
			4	4	**-**	**-**	**-**
	feedback/bias	FB2	1	2	**> 200 kΩ**	**3.49 kΩ**	**3.52 kΩ**
			2	1	**-**	**-**	**1 to 3 > 200 kΩ**
			3	5	**> 200 kΩ**	**.376 kΩ**	**421 Ω**
			4	4	**-**	**-**	**-**

SQUID POS.	CABLE FUNCTION	Probe Connect	PROBE LEMO PINS	PROBE TOP HAT PINS	RESISTANCE TO GROUND (> 20 Mohms)	RT RESIST (before hookup)	RT RESIST (after hookup)
3	signal	SS3	1	2	**9.460 Ω**	**9.352 Ω**	**14.009 Ω; 12.14 Ω pin 1 to gnd**
			2	1	**9.546 Ω**	**-**	**1 to 3 > 200 kΩ**
			3	5	**> 40 MΩ**	**> 40 MΩ**	**> 40 MΩ**
			4	4	**> 40 MΩ**	**> 40 MΩ**	**> 40 MΩ**
	modulation	MSS3	1	2	**> 40 MΩ**	**8.96 kΩ**	**8.975 kΩ**
			2	1	**-**	**-**	**1 to 3 > 200 kΩ**
			3	5	**> 40 MΩ**	**> 40 MΩ**	**> 40 MΩ**
			4	4	**> 40 MΩ**	**> 40 MΩ**	**> 40 MΩ**
	feedback/bias	FB3	1	2	**> 40 MΩ**	**3.233 kΩ**	**3.284 kΩ**
			2	1	**-**	**-**	**1 to 3 > 200 kΩ**
			3	5	**> 40 MΩ**	**385.0 Ω**	**432 Ω**
			4	4	**-**	**-**	**-**
4	signal	SS4	1	2	**9.52 Ω**	**9.425 Ω**	**14.066 Ω; 12.17 Ω pin 1 to gnd**
			2	1	**9.64 Ω**	**-**	**1 to 3 > 200 kΩ**
			3	5	**> 200 kΩ**	**> 200 kΩ**	**> 200 kΩ**
			4	4	**> 200 kΩ**	**> 200 kΩ**	**> 200 kΩ**
	modulation	MS4	1	2	**> 200 kΩ**	**10.64 kΩ**	**10.67 kΩ**
			2	1	**> 200 kΩ**	**-**	**-**
			3	5	**> 200 kΩ**	**> 200 kΩ**	**> 200 kΩ**
			4	4	**> 200 kΩ**	**-**	**-**
	feedback/bias	FB4	1	2	**> 40 MΩ**	**3.054 kΩ**	**3.083 kΩ**
			2	1	**> 40 MΩ**	**> 40 MΩ**	**> 40 MΩ**
			3	5	**> 40 MΩ**	**389.1 Ω**	**432 Ω**
			4	4	**> 40 MΩ**	**> 40 MΩ**	**> 40 MΩ**

Notes: Resistance to ground at tophat of FB1, MS1, FB2, MS2, MSS3, FB3, MS4, and FB4 were all greater than 40 MΩ.

DLOG2: SQUID #4 rt resistance before hookup readings were inconsistent. Modulation and feedback/bias reading open after initially reading OK. Microscopic inspection of SQUID showed no obvious problem. Reassemble and retest ok. Found DMM probably incorrectly set.

7 INSTALL SQUIDS IN POSITIONS #3 AND #4

- Rotate the probe approximately 180 degrees, so that the +X axis is pointing up and slightly toward you.
- Attach the output cable assembly (25042-103) designated for SQUID position #3 to a SQUID package assembly (25017-201). Record the serial numbers of the output cable and SQUID package in Table 2 of Section 6.
- Install the SQUID package and output cable onto SQUID position #3 of the +X bracket. Use 3 each of socket head screw P/N 25137-111, and shoulder washer P/N 25129-101, and one insulating shim, P/N 25341-101 on each package. Record the lot date codes of the parts in Table 2.
- Follow the above procedure to install the SQUID package and output cable onto SQUID position #4 of the –X bracket. Be sure to use output cable part no. 25042-104 for SQUID position #4.
- As before, mate the SQUID output cables to the Probe Lemo connectors as shown in Table 3. The connectors are keyed, so that they automatically mate correctly. Bend the output cable as necessary, so that it can be mated. Use only non-magnetic bending tools.
- As before, measure resistance to ground and input to output round trip resistance for each function both before and after installation onto the probe. Record results in Table 3.

Clasp 25476-101 with nut 23193-101 (LDC 940630): 4 total, 2 on +x, 2 on –x.

Sections 6 and 7 completed:

DLOG #3: Grounding strap not used for installation of SQUID #1 and SQUID #2. Post hookup checks per Table 3.

Approved: _____ date: _____
B. Muhlfelder, ITD

Discrepancies if any:

Approved: _____ Date: _____
QA Representative

8 CONNECT INPUT CABLES TO SQUIDS

- Install probe rails 23557-101, 23557-102, and 23557-103 using screws 25614-101. Install readout cable mount 25606-101 using screws 25614-101. Rotate probe as required to install these parts.
- Using the probe rails, tie down the input readout cables from gyroscopes #3 with 2 thermal ground clip kits (25236-101) and an on/off thermal ground clip kit (25326-101). The on/off

clip kit is located between the 2 ground clip kits.. The on/off clip kit requires the attachment of the gyro's gyro and readout cable heater assy (23550-101). Route the gyro #3 readout cables to SQUID position #3. The probe is rotated as required to allow the routing of the readout cables.

- Remove the cover to the SQUID package in SQUID position #3. Measure the resistances of the input to the SQUID carrier and pickup loop. Record in Table 4.
- Scrape the readout cable to achieve a shiny surface. (DH 5/16/99 for gyros #3 and 4), (DH 5/17/99 for gyros #1 and #2).
- Attach the readout cable to the carrier in the SQUID package. Record the polarity of the readout cable by noting which clamp (right or left) the cable conductor 25003-103 is attached to. Measure the parallel resistance of the SQUID carrier and pickup loop. The resistance to ground of each readout cable is measured and recorded in Table 4 after the cable is attached to the SQUID. For gyro #1, conductor 25003-103 connects to the contact block 25354-101 in the squid package. For gyros #2, #3, and #4 conductor 25003-104 connects to the contact block 25354-101.
- Replace the cover to SQUID package.
- Repeat the above steps for SQUID position #4.
- Rotate the probe approximately 180 degrees, so that – X is up, and repeat the above steps for SQUID positions #1 and #2.

Table 4. SQUID Input Readout Cable Resistances

SQUID POS.	GYRO NO.	PARALLEL RES. OF SQUID AND PICKUP LOOP (Ω)	PICKUP LOOP ROUND-TRIP RESISTANCE BEFORE HOOKUP	Input Filter Cap. (nF), Cap. To gnd (nF)	SQUID CARRIER INPUT RES.	PICKUP LOOP RES. TO GND AFTER HOOKUP (OHMS)
1	1	**107.7 Ω**	**5.79 kΩ, >40 MΩ to gnd**	**5.95, 21.2**	**109.4 Ω**	**1.99 MΩ**
2	2	**107.9 Ω**	**6.33 kΩ, >40 MΩ to gnd**	**6.23, 21.7**	**109.4 Ω**	**1.995 MΩ**
3	3	**108.0 Ω**	**6.27 kΩ, >40 MΩ to gnd**	**5.85, 20**	**109.6 Ω**	**1.992 MΩ**
4	4	**107.9 Ω**	**7.17 kΩ, >40 MΩ to gnd**	**6.08, 20.6**	**109.4 Ω**	**1.999 MΩ**

SQUID positions #1 and 2 used 4 ea of 25053-105. SQUID positions #3 and #4 used 4 ea of 25053-103. SQUID #4 used 2 layers of Kapton tape to isolate 25053-103 from SQUID body. Gyro #3 readout cable has no thermal ground on SQUID side of cable heater. Stray area inside SQUID packages < 1cm^2 for all packages.

Section 8 completed:

Approved: _____ date: _____
B. Muhlfelder, ITD

Discrepancies if any:

Approved: _____ Date: _____
QA Representative

9 CONNECT SQUID GRTS

- Table 6 gives the pinouts and associated functions for the SQUID bracket thermometers, the locations on each bracket for these thermometers, and the serial number for each thermometer. Measure (4 terminal) and record each device's resistance prior to installation. Measure and record each device's resistance at the tophat following installation.

TABLE 6 SQUID GRT CONNECTIONS

SQUID Position	GRT Serial No.	GRT Location	Probe Conn.	Function	Lemo Cold End	Tophat Pinout	Res. device	Res. (top 2 wire)	Res. (Top 4 w.)
1	XS1(27519)	T-9Q	XS3	(I+, I-)	3,4	5,4	**12.2Ω**	**56.7Ω**	**3.51Ω**
1	XS1(27519)	T-9Q	XS3	(V+, V-)	1,2	2, 1	**12.6Ω**	**18.2Ω**	
2	XS3(27504)	T-8Q	XS1	(I+, I-)	3,4	5,4	**12.6Ω**	**56.5Ω**	**3.06Ω**
2	XS3(27504)	T-8Q	XS1	(V+, V-)	1,2	2, 1	**12.2Ω**	**17.0Ω**	
3	X6R(27553)	T-11Q	X6R	(I+, I-)	3,4	5,4	**10.0Ω**	**55.4Ω**	**1.66Ω**
3	X6R(27553)	T-11Q	X6R	(V+, V-)	1,2	2, 1	**9.8Ω**	**55.3Ω**	
4	X5R(27549)	T-10Q	X5R	(I+, I-)	3,4	5,4	**11.5Ω**	**57.0Ω**	**1.55Ω**
4	X5R(27549)	T-10Q	X5R	(V+, V-)	1,2	2, 1	**13.1Ω**	**58.2Ω**	

Note: GRT S/N XS1(27519) SHOULD BE CONNECTED TO XS3 FOR T-9Q AND GRT S/N XS3(27504) SHOULD BE CONNECTED TO X1 FOR T-8Q. **Verified all GRT pins >40 MΩ to gnd.**

10 CONNECT SQUID HEATERS

Table 7 gives the pinouts and associated functions for the SQUID bracket heaters, and locations on each bracket for these heaters. The procedure to connect these heaters are covered in another procedure.

Table 7: SQUID HEATERS

Heater Position and bracket ID	Device Name	Probe C Connector	Lemo Pins at Cold End	Top Hat Pinout
2, -x	H-10Q	I3J10	3,4	5,4
1, -x	H-9Q	I3J10	1,2	2, 1
2, +x	H-12Q	I3J3	3,4	5,4
1, +x	H-11Q	I3J3	1,2	2, 1

11 REPLACEMENT OF CAP. KIT SM-8 WITH SM-2 FOR SQUID #4 (SEE DR 265).

Take SQUID lid off of SQUID #4, loosen readout cable fasteners, R(loop) = 7.16 Kohms, > 40 Mohms to gnd.

D. Hipkins recleans readout cable tips.

Wedge for SM-8 broke on removal. Use new wedge with SM-2.

C (wire to wire) =6.05 nF, each wire to gnd = 20.6 nF.

Intermittant short to gnd found from conductors to shield.

Repaired (conductors where they exit the readout cable using heat shrink P/N 050050CST).

Using HP LCZ meter:

F	C1-gnd	C2-gnd	C1-C2
10 kHz	12.1 nF	12.0 nF	6 nF
100 kHz	12.0 nF	12.0 nF	6 nF
420 kHz	14.0 nF	14.0 nF	6.6 nF

Tighten wedge screws, remeasure with hand held meter
20.6 nF to gnd, 20.5 nF to gnd, 6.5 nF conductor to conductor

While tighening wedge screws, wedge broke. Placed Kapton under screw heads to provide isolation of wedge screws to gnd. Functionality of wedge not affected.

R/O cable to gnd > 40 Mohms prior to SQUID hookup.

R(squid) prior to hookup = 109.4 ohms, R(squid) after hookup = 107.9 ohms.

R(squid) to gnd = 1.993 Mohms.

12 PROCEDURE COMPLETION

The results obtained in the performance of this procedure are acceptable.

ITD: _____ Date _____

Integration Manager: _____ Date_____

The information obtained under this assembly and test procedure is as represented and the documentation is complete and correct.

Quality Assurance: _____ Date _____

13 DATA BASE ENTRY

The following data shall be entered into the GP-B database:

- Name, number and revision of this procedure
- An electronic copy of this document
- A copy of the "as-built" procedure with data when completed.