W. W. Hansen Experimental Physics Laboratory
STANFORD UNIVERSITY
STANFORD, CALIFORNIA 94305 - 4085

Gravity Probe B Relativity Mission

Limitations of the P9 Gauge
(for measuring Probe internal pressure)

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Prepared by:
Richard Whelan 10-8-2001
Richard Whelan Date

Checked by:
Robert Farley 10/10/01
Bob Farley Date

Approved by:
M. Keiser 10/15/01
M Keiser Date

Approved by:
R. Brumley 10/16/01
~~M. Taber~~ Date

Approved by:
Barry Muhlfelder 10/15/01
B. Muhlfelder Date

ITAR Assessment Performed
Tom Langenstein 10/21/01

ITAR Control Req'd? ☐ Yes ☒ No

Purpose:

This document clarifies the limitation of the flight P9 gauge (PN 200402) related to calibration data and pressure ranges.

Discussion:

For pressures below 1x 10^-3 torr, the P9 accuracy drops significantly as a function of the P9 temperature. Since there is no thermometry on or around the P9 gauge, one option available is to add temperature sensors at the P9 gauge. This option would involve new hardware (the sensors), modification to a cable harness, use of spare channels within the ECU, and a potential software change to telemeter the appropriate data back to earth.

Instead of pursuing the option stated above, it is important to determine how this data will be used. On orbit, prior to gyro spin up, the spin up line valves will be opened, then the Vatterfly valves will be opened to allow the spin up gas to escape. When spin up starts, the pressure in the probe will rise. The P9 may detect this, but there is no utility for this data. One failure scenario is that the Vatterfly valves fail to open (although there are redundant valves, redundant switches, redundant motor windings, and the valve position is verified prior to start of spin up). In this case, the P9 would see the increase in probe internal pressure, indicating that the spin up gas is not venting to space.

Stanford supplied a quantity of He3 to Sentran to perform the He3 measurements (Figure 3) , and Sentran supplied the more common He4 gas (see Figures 1 & 2). A third calibration of each of the gauges was made using nitrogen, which is of little interest to GP-B.

It is of interest to note that the greatest sensitivity to operating temperature exists at the low end of the pressure range, where most of the measured pressures are likely to occur. Comparison of the low range plots for the He3 and He4 indicates that the uncertainty due to temperature is much greater than the uncertainty due to type of gas. When the pressure is high enough to cause the gauges to operate in the high range there is little sensitivity to temperature.

Conclusion:

Instead of pursuing a Program Control Board (PCB) change to add temperature sensors to the 9 gauge, this Sdoc defines the limitations in the utility of P9 and closes the issues of P9 accuracy problems at low pressure.

Figure 1: P9-103 Voltage vs Pressure

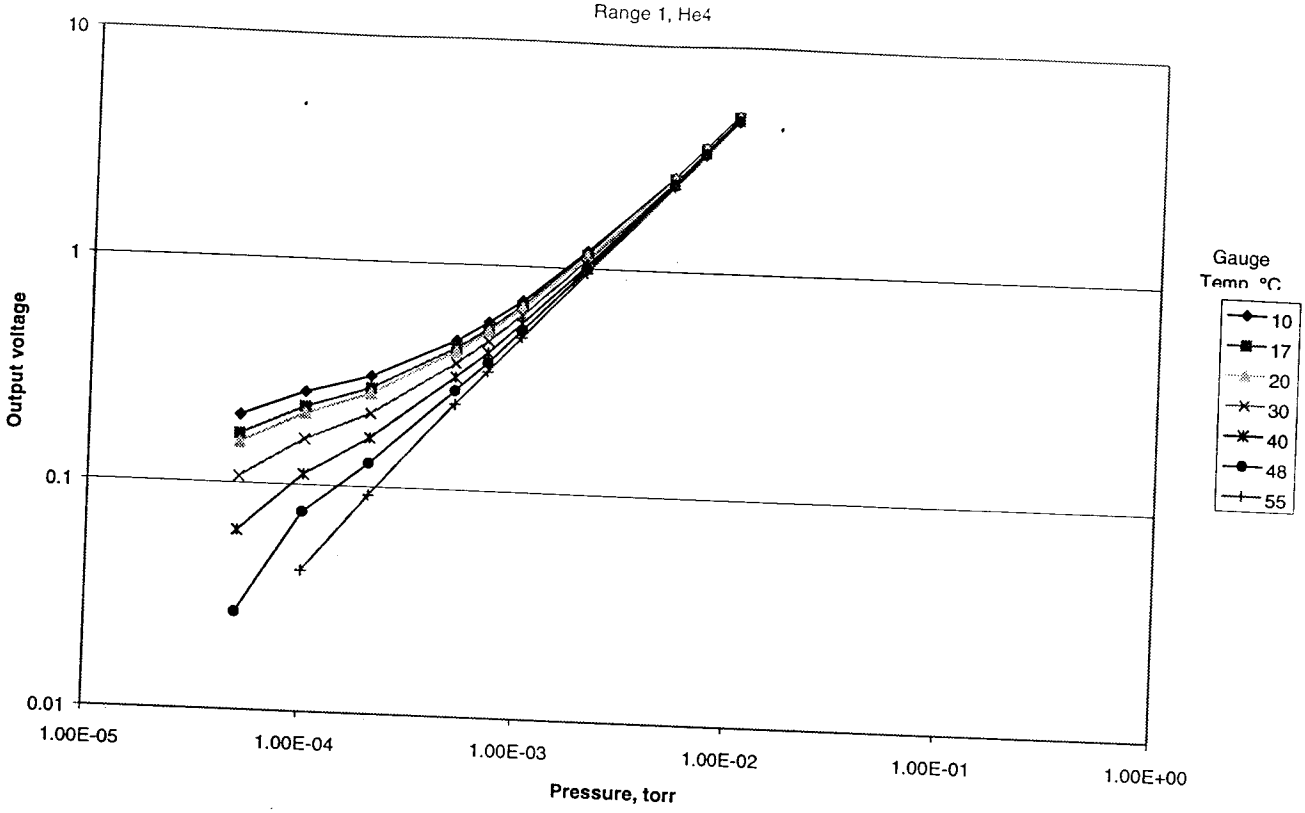

Figure 2: P9-103 Voltage vs Pressure

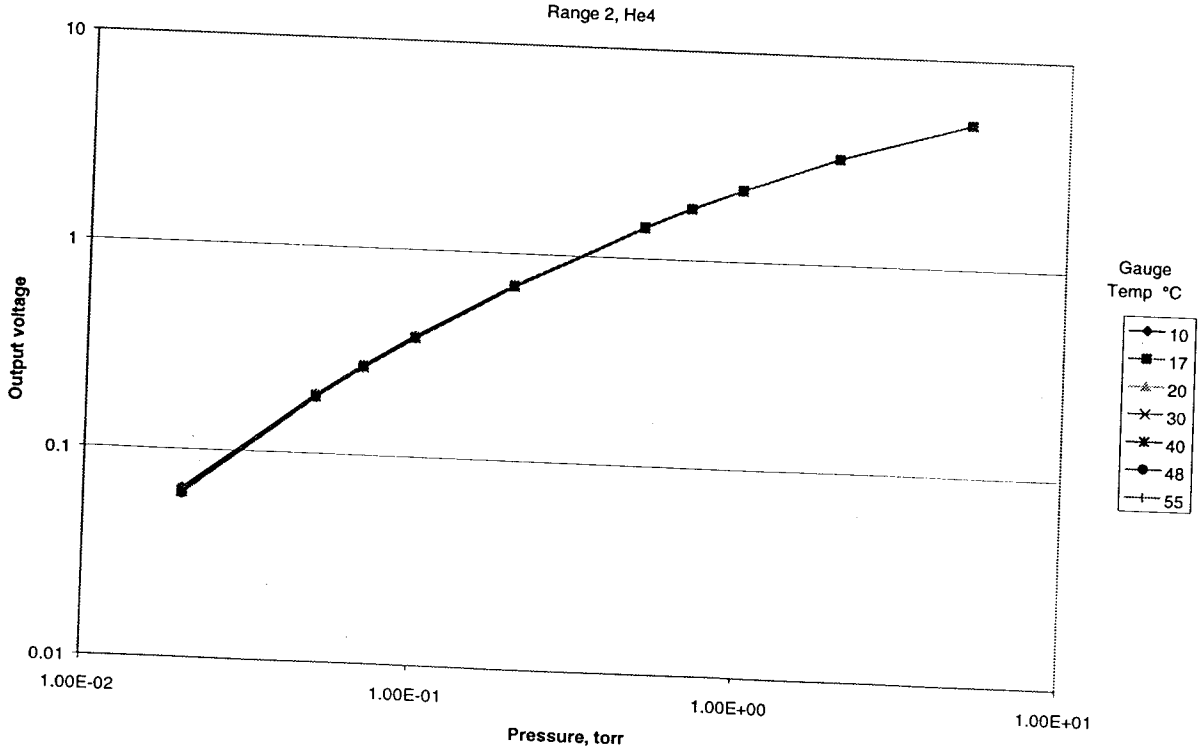

Figure 3: P9-103 He3 Voltage vs Pressure