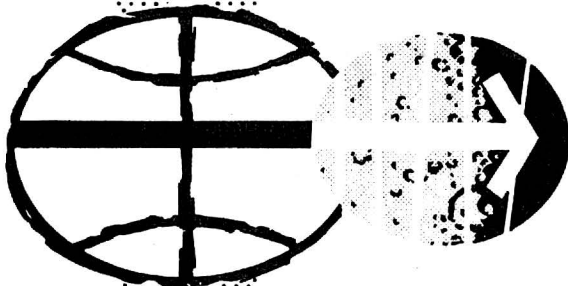




NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

APOLLO 13
30-DAY FAILURE AND ANOMALY LISTING REPORT




MANNED SPACECRAFT CENTER
HOUSTON, TEXAS
MAY 1970

APOLLO 13
30-DAY FAILURE AND ANOMALY LISTING REPORT

PREPARED BY

Mission Evaluation Team

APPROVED BY



for James A. McDivitt
Colonel, USAF
Manager, Apollo Spacecraft Program

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS
MAY 1970

INTRODUCTION

This report contains a discussion of the significant problems or discrepancies noted during the Apollo 13 mission.

COMMAND AND SERVICE MODULES

Loss of Cryogenic Oxygen Tank 2 Pressure

At approximately 55 hours 55 minutes into the Apollo 13 mission, the crew heard and felt a sharp "bang," coincident with a computer restart and a master alarm associated with a main bus B undervoltage condition. Within 20 seconds, a quick check of the electrical parameters was made by the crew and all parameters appeared normal. However, the crew did report the following barberpole indications from the service module reaction control system:

- a. Helium 1 on quads B and D
- b. Helium 2 on quad D
- c. Secondary propellant valves on quads A and C.

About 2-1/2 minutes later, fuel cells 1 and 3 ceased generating electrical power.

The first indication of a problem occurred in cryogenic oxygen tank 2 at 46 hours 40 minutes, when the quantity gage went to a full-scale reading. For the next 9 hours, all systems operations were normal. The next abnormal indication occurred when the fans in cryogenic oxygen tank 2 were turned on at 55:53:18. About 2 seconds after energizing the fan circuit, a short was indicated in the current from fuel cell 3, which was supplying power to cryogenic oxygen tank 2 fans. Within several additional seconds, two other shorted conditions occurred.

Electrical shorts in the fan circuit ignited the wire insulation, causing pressure and temperature increases within cryogenic oxygen tank 2. During the pressure rise period, the fuses blew in both fan circuits in cryogenic oxygen tank 2. A short-circuit conduction in the quantity gaging system cleared itself and then began an open-circuit condition. When the pressure reached the cryogenic oxygen tank 2 relief valve full-flow conditions of 1008 psia, the pressure began decreasing for about 9 seconds, at which time the relief valve probably reseated, causing the pressure to rise again momentarily. About 1/4 second later, a vibration disturbance was noted on the command module accelerometers.

The next series of events occurred within a fraction of a second between the accelerometer disturbances and the data loss. A tank line burst because of heat in the vacuum jacket pressurizing the annulus and, in turn, caused the blow-out plug on the vacuum jacket to rupture. Some mechanism, possibly the burning of insulation, in bay 4 combined with the oxygen buildup in that bay to cause a rapid pressure rise which resulted in separation of the outer panel. Ground tests, however, have not substantiated the burning of the Mylar insulation under the conditions which probably existed just after the tank rupture. The panel struck one of the dishes of the high-gain antenna. The panel separation shock closed the fuel cell 1 and 3 oxygen reactant shut-off valves and several propellant and helium isolation valves in the reaction control system. Data were lost for about 1.8 seconds as the high-gain antenna switched from narrow beam to wide beam, because of the antenna being hit and damaged.

Following recovery of the data, the vehicle had experienced a translation change of about 0.4 ft/sec, primarily in a plane normal to bay 4. Cryogenic oxygen tank 2 pressure indication was at the lower limit read-out value. The cryogenic oxygen tank 1 heaters were on, and the tank 1 pressure was decaying rapidly. A main bus B undervoltage alarm and a computer restart also were present at this time.

Fuel cells 1 and 3 operated for about 2-1/2 minutes after the reactant valves closed. During this period, these fuel cells consumed the oxygen trapped in the plumbing, thereby reducing the pressure below minimum requirements and causing total loss of fuel cell current and voltage output from these two fuel cells. Due to the loss of performance by two of the three fuel cells and the subsequent load switching by the crew, numerous associated master alarms occurred as expected.

Temperature changes were noted in bays 3 and 4 of the service module in response to a high heat pulse. Fuel cell 2 was turned off about 2 hours later because of the loss of pressure from cryogenic oxygen tank 1.

This anomaly will be discussed more thoroughly in a separate Anomaly Report.

Postlanding Vent Valve Malfunction

During postlanding activities, the recovery forces discovered that the postlanding ventilation valve inlet was closed and the exhaust was open.

The ventilation valve is opened by first pulling the postlanding vent valve unlock handle on panel 2 (fig. 1). The handle is attached by a cable to two pins which mechanically lock the ventilation valves closed.

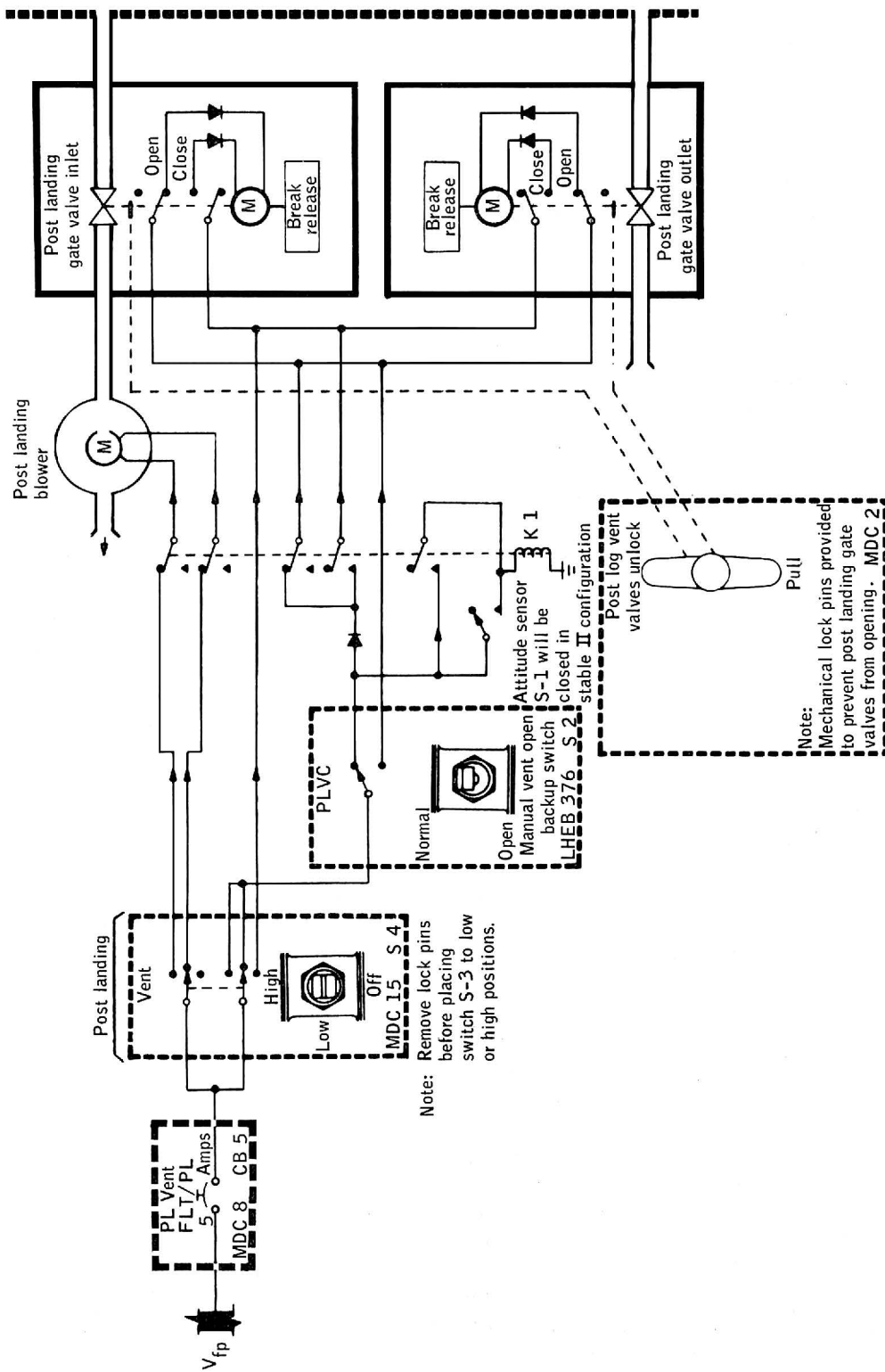


Figure 1.- Post landing vent valve control circuit.

Once the handle is pulled, the postlanding vent switch on panel 15 is placed to either high or low with the postlanding vent valve switch on panel 376 in normal. This operation opens both ventilation valves and actuates the postlanding blower. An attitude sensing circuit is installed to close the valves if the spacecraft is inverted. Switch setting checks by the recovery forces verified that all switch settings were proper but a comment had been made that the handle was "neither completely in or out...[and] appears to be jammed."

The crew reported that postlanding ventilation was adequate, but the chilled cabin could have masked detection of inferior ventilation. The postlanding ventilation valve will be tested to identify the cause.

This anomaly is open.

Shaft Fluctuations in the Zero Optics Mode

Beginning at approximately 40 hours, fluctuations of as much as 0.3 degree were observed in the computer readout of the optics shaft angle. The system had been powered up throughout the flight and had been in the zero optics mode since the star horizon navigation sightings at 31 hours. Crew observation of the manual readout subsequently confirmed that the fluctuation was actually caused by motion of the shaft. The circumstances and time of occurrence were almost identical to a similar situation during the Apollo 12 mission.

A simplified schematic of the optics shaft servo loop mechanization is shown in figure 2. In the zero optics mode, the sine outputs of the half-speed and 16-speed resolvers are routed through a coarse/fine switching network to the motor drive amplifier and are used to null the system. Rate feedback from the motor tachometer is routed to the drive amplifier through a compensation network which removes any bias in the signal. When the zero optics mode is selected, the coupling-data-unit counter and the computer register which contains the shaft angle are zeroed for 15 seconds and then released to follow the 16-speed resolver. The half-speed resolver, the fine/coarse switching network, and the tachometer feedback compensation are used only in the zero optics mode.

An investigation conducted after the Apollo 12 mission did not identify a definite source of the problem, since extreme corrosion from sea water after landing prevented examination of the mechanical drive system and restricted testing to the power and servo assembly which contains the major electronic components. No abnormal indications were found; however, the failure symptoms were reproduced on a breadboard by breaking down the isolation across a transformer in the tachometer feedback compensation network. Although depotting and testing of the actual transformer failed

NASA-S-70-2916

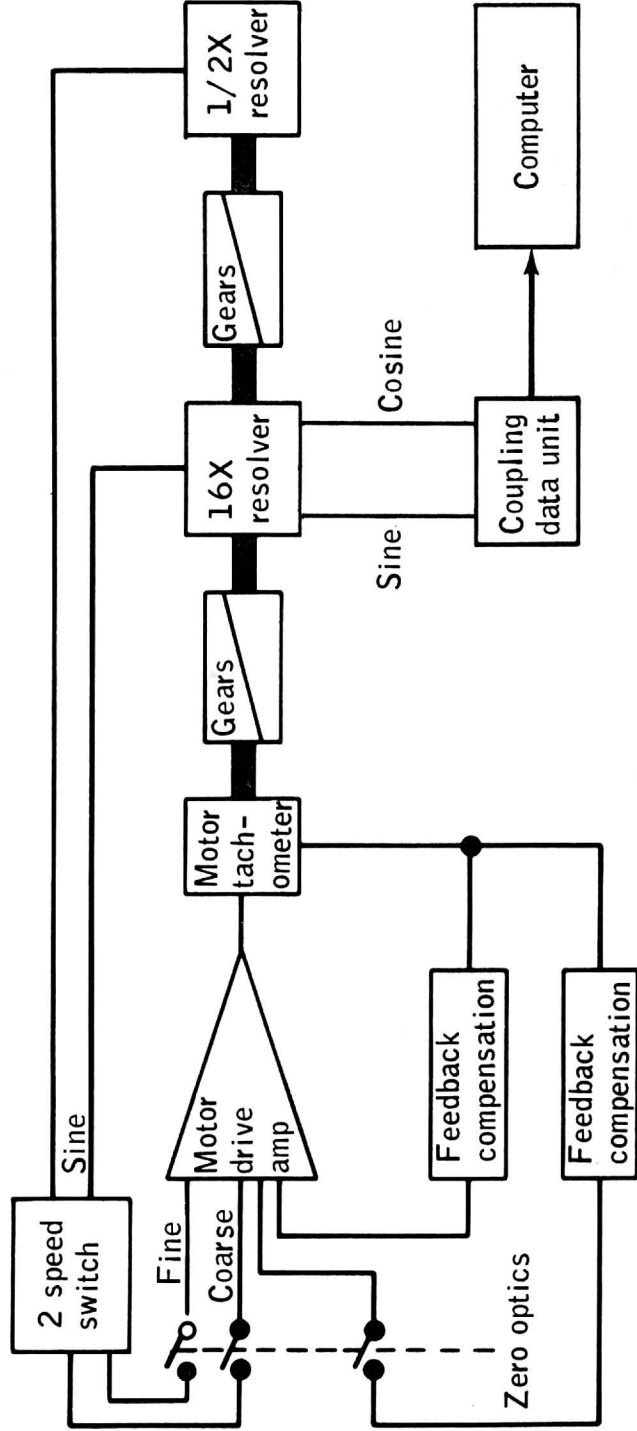


Figure 2.- Zero optics mode circuitry.

to produce any evidence of malfunction, this mechanism was considered a likely candidate for a random failure.

The recurrence of the problem under almost identical circumstances on Apollo 13 indicates that the cause is more likely generic than random and that it is time and/or vacuum dependent. The susceptibility of the shaft rather than the trunnion axis also tends to absolve components common to both axes, such as the electronics and the motor drive amplifier. The shaft loop has been shown to be more sensitive than the trunnion to harmonics of the 800-hertz reference voltage introduced into the forward loop; however, because the level of the required null offset voltage is well above that available by induction, this mechanism is considered unlikely.

The most likely candidate found to date is the half-speed resolver, which is used only in the shaft axis and only to provide an unambiguous zero reference. The reference voltage is applied to the rotor through slip rings connected as shown in figure 3. The cosine winding is not used and is normally shorted out. However, if there is any resistance in the common ground path through the slip ring, then a portion of the reference voltage will appear across the cosine winding and the apparent output null will be offset from zero degrees. Tests indicate that a resistance of 50 ohms will cause an offset of 0.5 degree.

Some evidence of susceptibility to vacuum was exhibited in this class of resolvers when variations of approximately 5 ohms were observed in the slip ring resistance during thermal vacuum testing. The tests were run with the units rotating at 1 rpm, however, and the momentary resistance changes disappeared with the wiping action.

The slip ring resistance mechanism meets all the bounds and constraints on the problem. It is unique to the shaft axis, since none of the other resolvers in the system use slip rings. This resolver is in the optics head which is vented to a vacuum. The rotation of the optics head in a normal operation would wipe the slip rings clean and explain the delay in the fluctuations for some hours after selecting zero optics.

Tests of the system in the spacecraft and after removal are planned to insure that no other abnormalities exist which could have caused the problem. If none are found, however, the half-speed resolver must be considered the most likely cause. No corrective action would be required because accurate zeroing is unaffected and there is no effect in operational modes.

This anomaly is closed.

NASA-S-70-2917

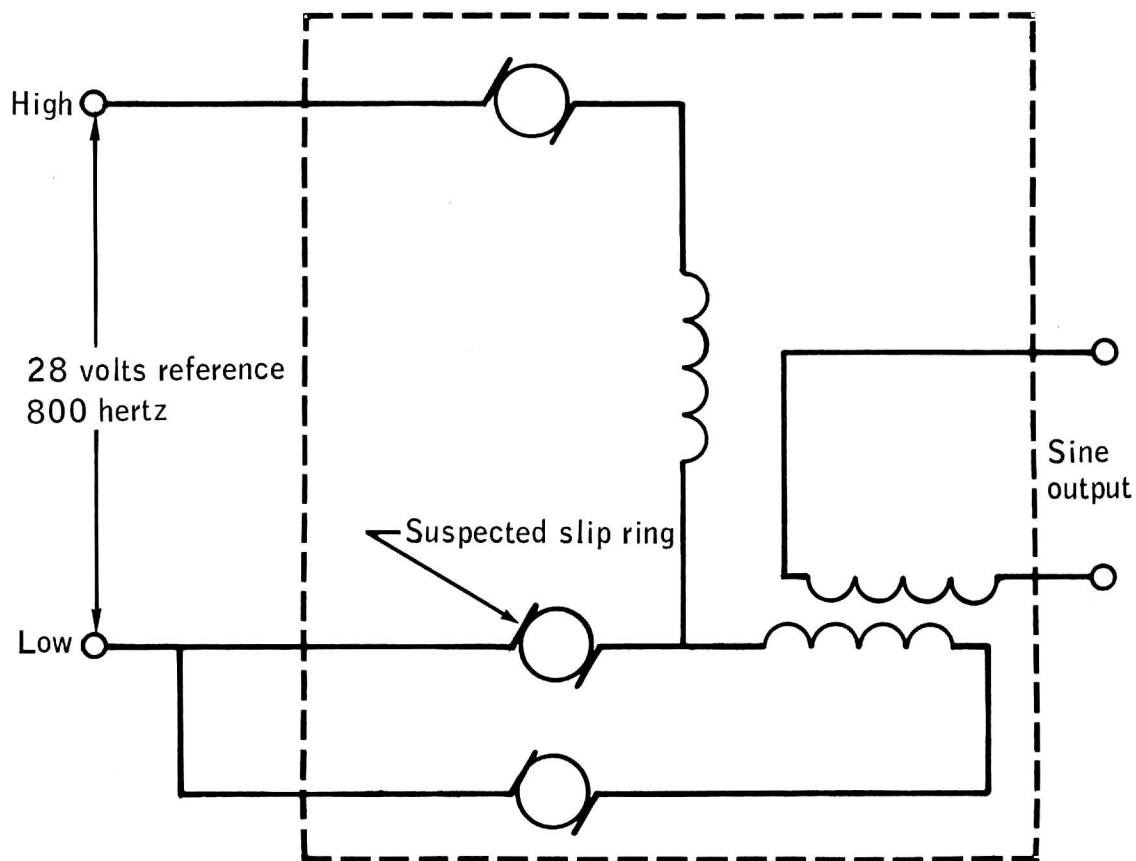


Figure 3.- One-half speed resolver.

High-Gain Antenna Acquisition Problem

Prior to television transmission from the spacecraft near 55 hours, difficulty was experienced in obtaining high-gain antenna acquisition and tracking. The command module pilot had manually adjusted the antenna settings to plus 23 degrees pitch and 267 degrees yaw, as requested by the ground at 47 hours 52 minutes. The most favorable settings for 55 hours were actually plus 5 degrees pitch and 237 degrees yaw. The ground had requested settings which were calculated for the originally scheduled transmission 2 hours later. The difference between these two sets of angles pointed the high-gain antenna boresight approximately 35 degrees away from the line of sight to the ground station (fig. 4).

When the transmission was switched from the omnidirectional antenna to manual mode of the high-gain antenna, there was a 6 dB decrease in uplink signal strength and a 17 dB decrease in downlink signal strength (fig. 5a). With the high-gain antenna in the wide beam mode, on or near boresight, the uplink and downlink signal strengths should have been at least equal to the signal strength obtained with an omnidirectional antenna. A comparison of the wide, medium, and narrow beam transmit and receive antenna patterns indicates that the high-gain antenna mode was medium beam and manual at the time of acquisition and remained there until the reacquisition mode was selected at 55:00:10.

Starting at 55:00:10 and continuing to 55:00:40, deep repetitive transients approximately every 5 seconds were noted on the phase modulated downlink (fig. 5a). The transients were approximately 30 dB for 0.75 second. This type of signature could be caused by the high-gain antenna operating in the auto or reacquisition mode with medium beam selected and a misalignment existing between the boresight of the wide and narrow received beams. This boresight shift could cause the antenna to switch from wide beam to a narrow beam null, off axis. It could also cause tracking in narrow beam at very low levels without switching to wide beam. The misalignment effects can be illustrated with the aid of figure 5a. Starting at A, the antenna was switched in to the reacquisition mode with the medium beam selected and acquisition was normal in wide beam from about 35 degrees away from the earth line of sight (pitch 5 degrees, yaw 237 degrees). At point B, the antenna switched from wide beam track to narrow beam track and the transmitted beam changed from wide to medium. As a result of the wide-to-narrow-beam boresight misalignment, the antenna switched into the first null of the received narrow beam. The decrease in automatic gain control due to the null created a false track signal and started the antenna to track from B to C position. The antenna tracked in narrow beam until a sufficient amplitude modulation level was reached causing it to switch back to wide beam. The antenna tracked away from the earth line of sight while in the null region of the narrow beam, explaining why there was repeated tracking in wide beam from A to B.

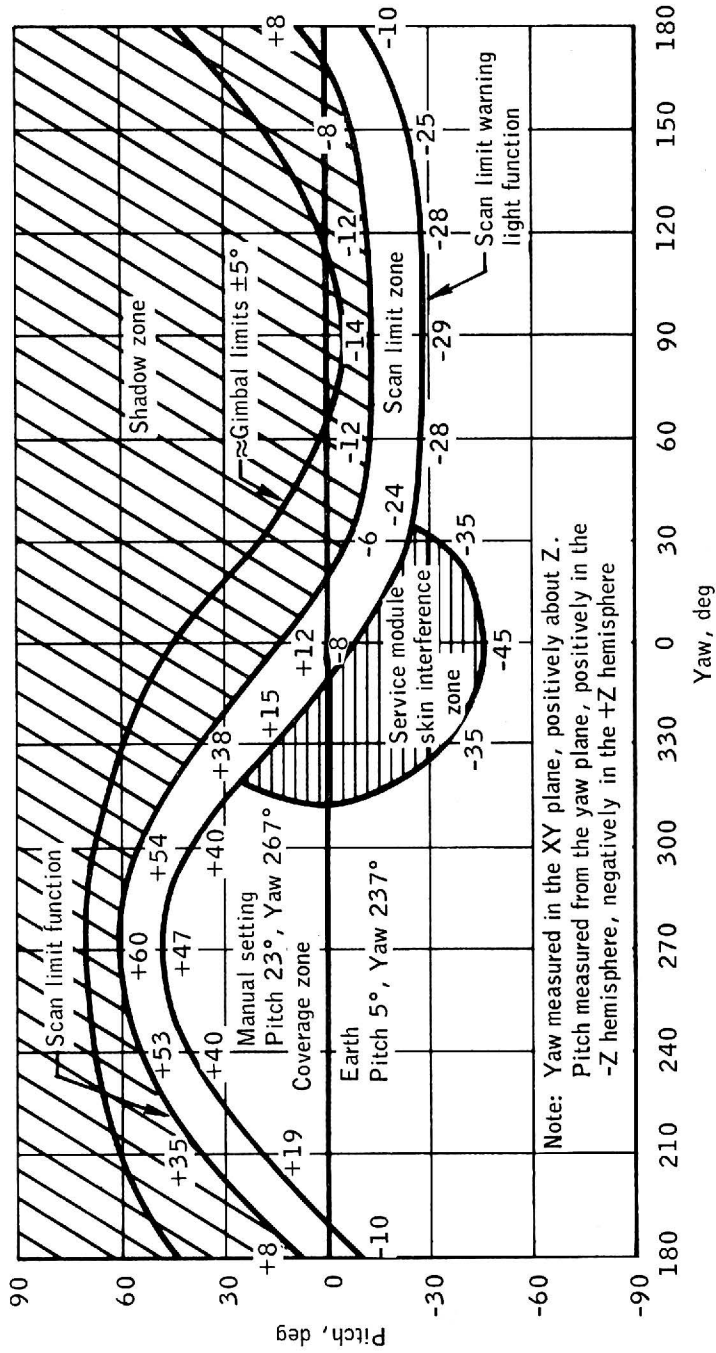
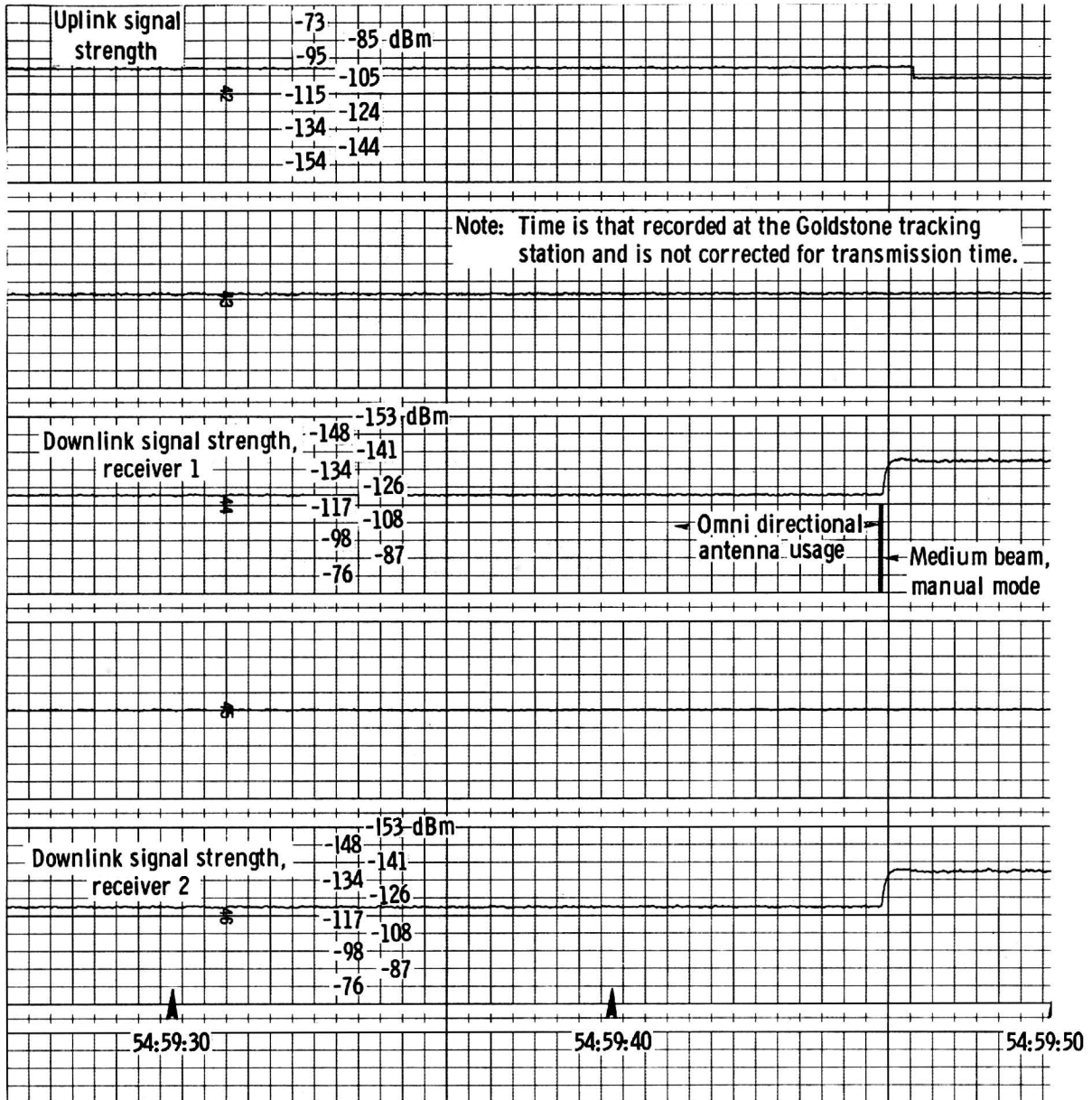


Figure 4.- High gain antenna scan and warning limit.

NASA-S-70-2919



(a) 54:59:30 to 54:59:50 elapsed time

Figure 5. - Recorded signal strengths during high gain antenna operation.

NASA-S-70-2920

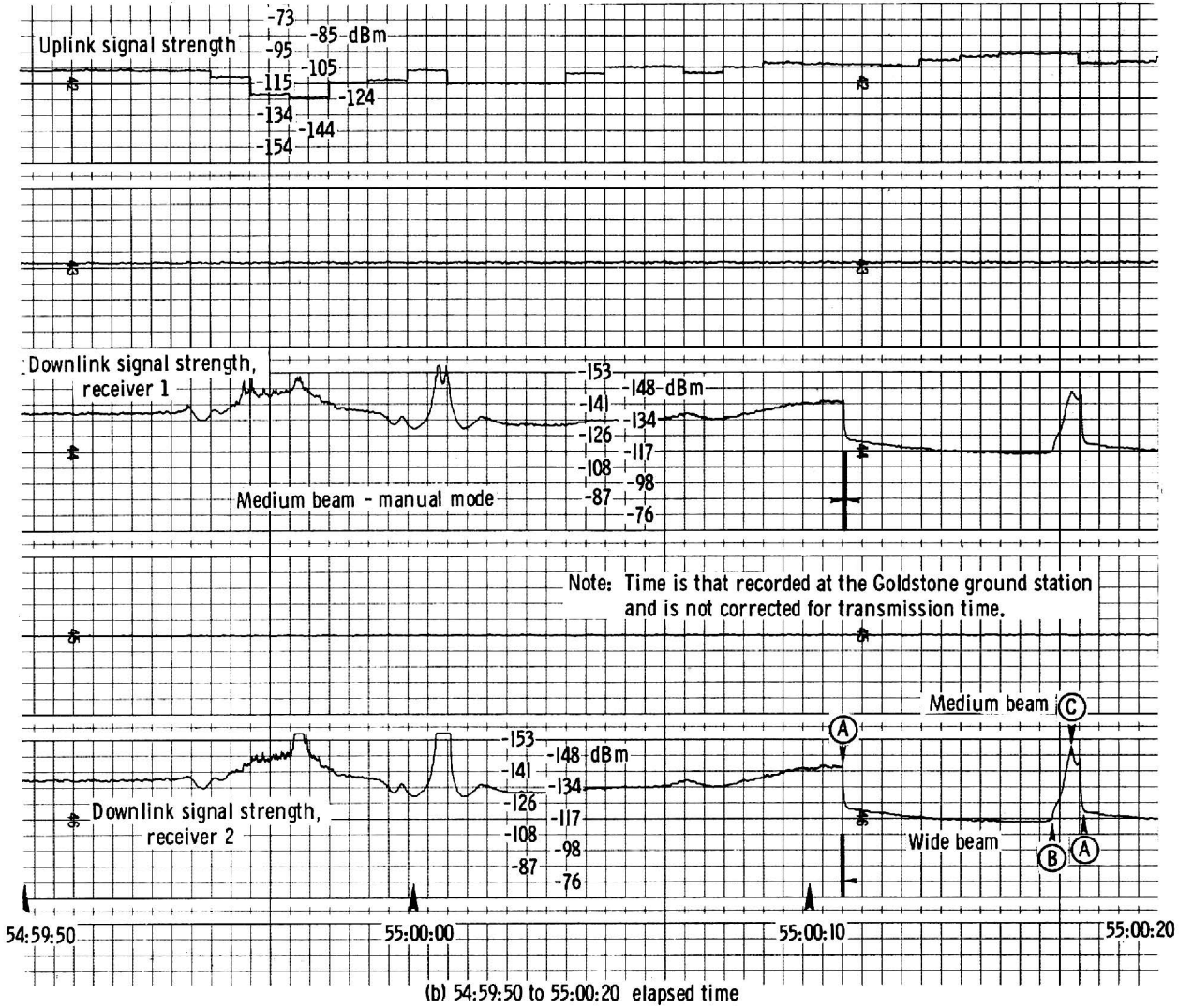


Figure 5. - Continued.

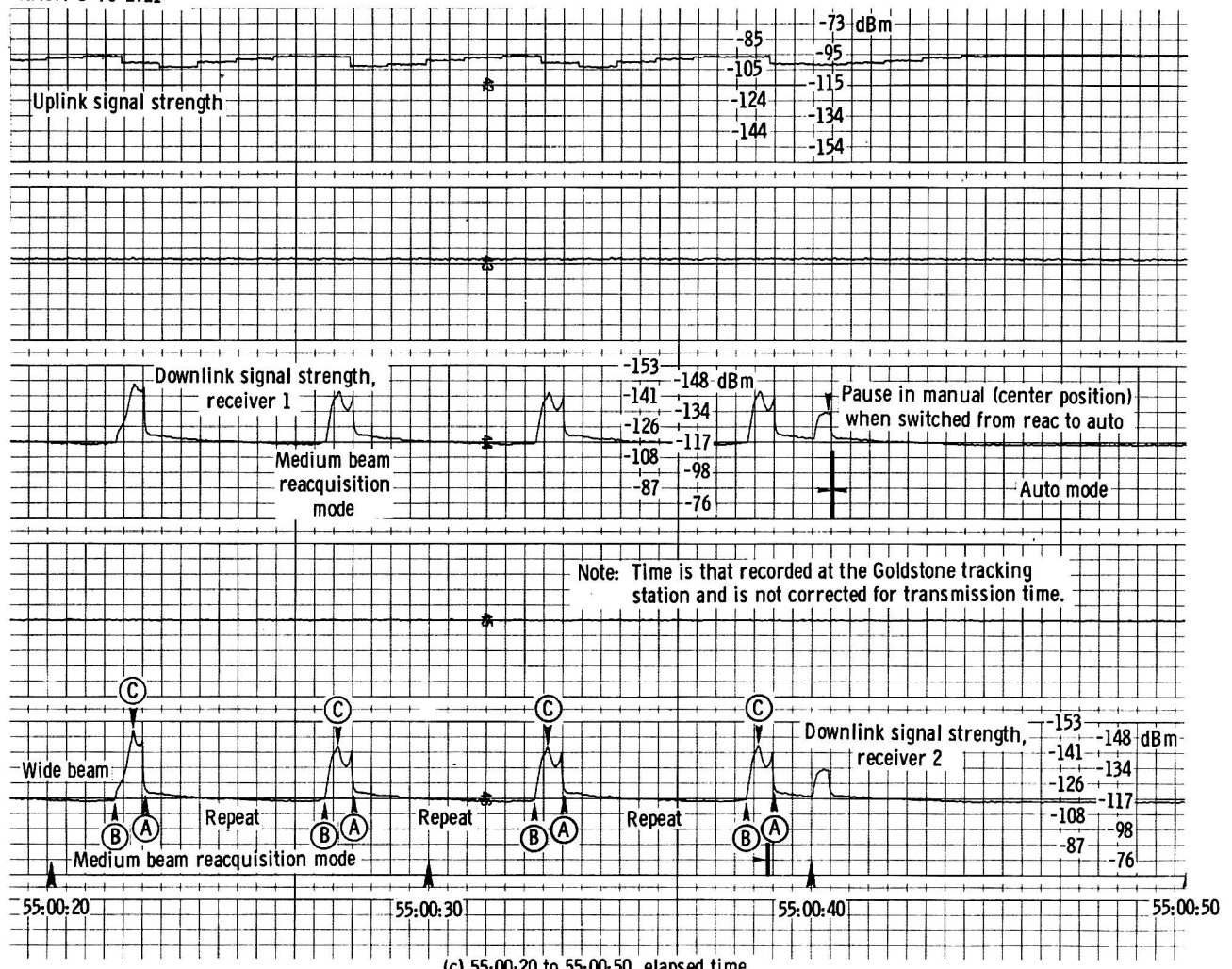


Figure 5. - Continued.

NASA-S-70-2922

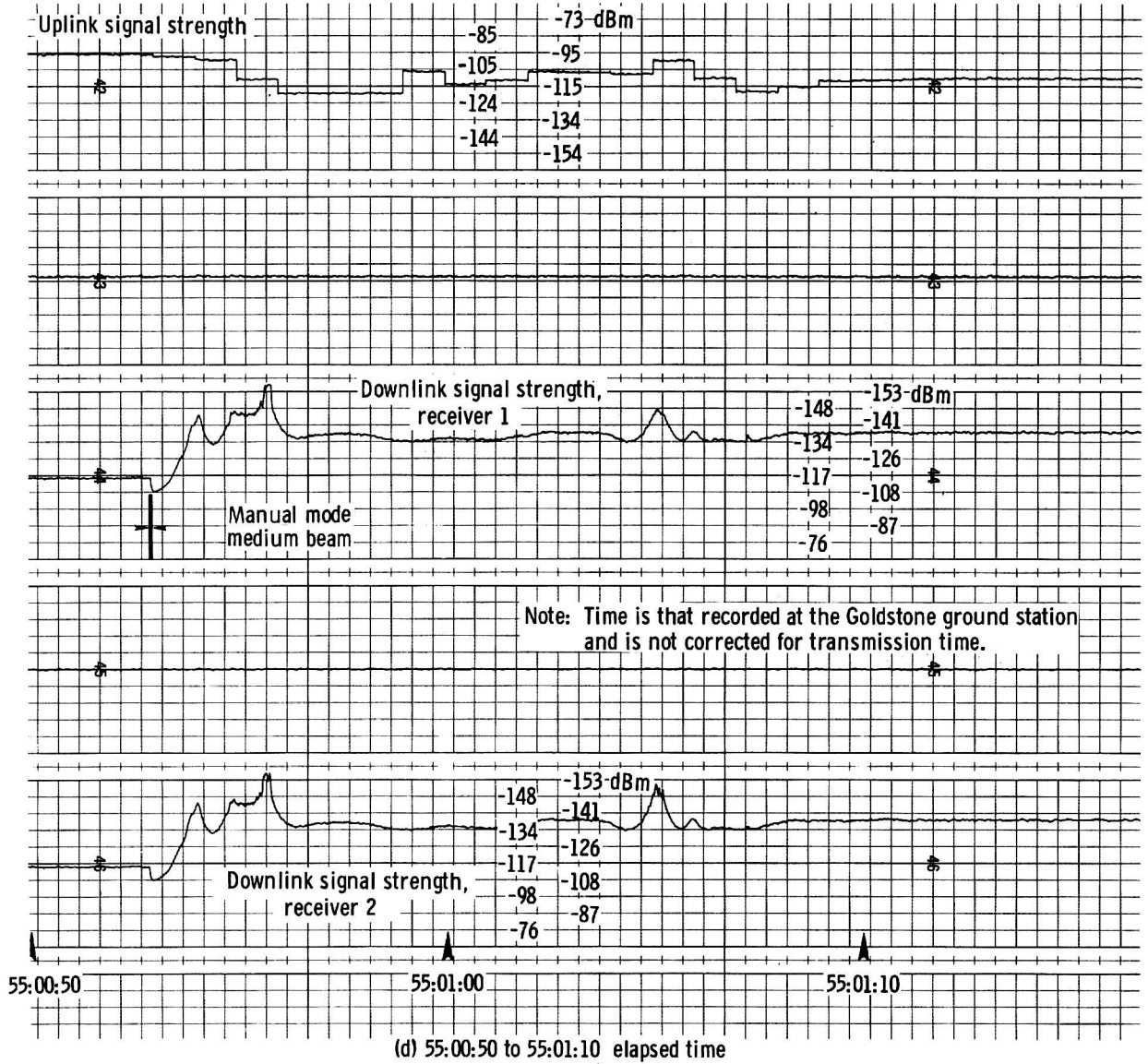


Figure 5. - Concluded.

In summary, the spacecraft and ground radio frequency data, voice transcripts, and crew debriefing notes indicate that a misalignment existed between the boresight of the wide and narrow received beams of the S-band high-gain antenna. This misalignment prevented smooth switch-over from wide beam to narrow beam operation during acquisition in the auto or reacquisition modes. The beam effective misalignment could have been caused by a defective radio frequency stripline coaxial cable, mechanical failure, or radio frequency feedlines. The problem most likely resulted from a quality defect in material or manufacturing assembly, and no hardware changes will be made. Manufacturing and inspection procedures will be reviewed to insure that any necessary assembly and/or inspection instructions be effected.

This anomaly is open.

Entry Monitor System 0.05g Light Malfunction

The entry monitor system 0.05g light did not illuminate within 3 seconds after 0.05g was sensed by the guidance system. The crew started the system manually by switching to standby. It is not definitely known whether the failure was in the light or in the 0.05g sensing and automatic-start circuitry.

The entry monitor system is designed to start automatically when 0.05g is sensed by the entry monitor system accelerometer. When this event occurs, the 0.05g light should illuminate, the scroll should begin to drive, and the range-to-go counter should begin to count down. The crew reported the failure of the light but could not verify whether the scroll or the counter responded before the manual backup was activated.

The system will be removed and tested to determine the cause of the problem.

This anomaly is open.

Potable Water Quantity Fluctuations

The potable water quantity measurement fluctuated briefly on two occasions during the mission. At 22:41:00, the reading decreased from 98 percent to 79 percent for about 5 minutes and then returned to a normal reading of approximately 102 percent. Another fluctuation was noted at 37:38:00, at which time the reading decreased from its upper limit to 83.5 percent, and then returned to the upper limit over a period of 7 seconds.

Preflight fluctuations of from 2 to 6 percent near the full level had been observed once during the countdown demonstration, and a review indicated a possible earlier fluctuation of about 4 percent at the half-full level during the flight readiness test.

This transducer has operated erratically on previous missions. Testing after Apollo 8, traced the failure during that mission to moisture contamination within the transducer. Similar fluctuations were noted during Apollo 12 and postflight testing revealed a minute quantity of undetermined contamination on the surface of the resistance wafer (fig. 6). Tests using aluminum hydroxide as a contaminant reproduced the anomalous transducer operation. Apollo 13 postflight testing is planned.

This anomaly is open.

Suit Pressure Transducer Failure

During launch the suit pressure transducer reading followed cabin pressure until 00:02:45, when it suddenly dropped from 6.7 to 5.7 psia coincident with S-II engine ignition. The difference between the two measurements decreased to only 0.2 psi by 1-1/2 hours, when the cabin reached its nominal regulated pressure of 5.0 psia. For the shirtsleeve mode, the suit and cabin pressure readings should be nearly equal. During the normal changes in the command module cabin pressure, associated with the initial lunar module pressurization from about 3 to 4 hours, the suit pressure measurement responded sluggishly and indicated as much as 1 psi low while moving in a narrow band. Subsequently, the measurement output decayed and remained in the 4.1 to 4.3 psia range until deactivation at 58-1/2 hours. During periods when the spacecraft cabins were interconnected, the corresponding cabin pressure readings were approximately equal.

The suit measurement indicated correctly during the brief instrumentation power-up periods at 102 and 123 hours. However, the suit indication was approximately 0.3 psi lower than cabin pressure just prior to entry and increased to only 7.7 psia just prior to landing, when the cabin pressure was reading 13.9 psia (fig. 7).

The suit transducer also indicated low and showed a similarly erratic operation during the Apollo 12 mission. Postflight testing determined the cause to be internal contamination from particles which either remained in the transducer from improper cleaning after electroless nickel plating or were self-generated.

Postflight testing will be conducted to determine the exact cause of the Apollo 13 failure.

This anomaly is open.

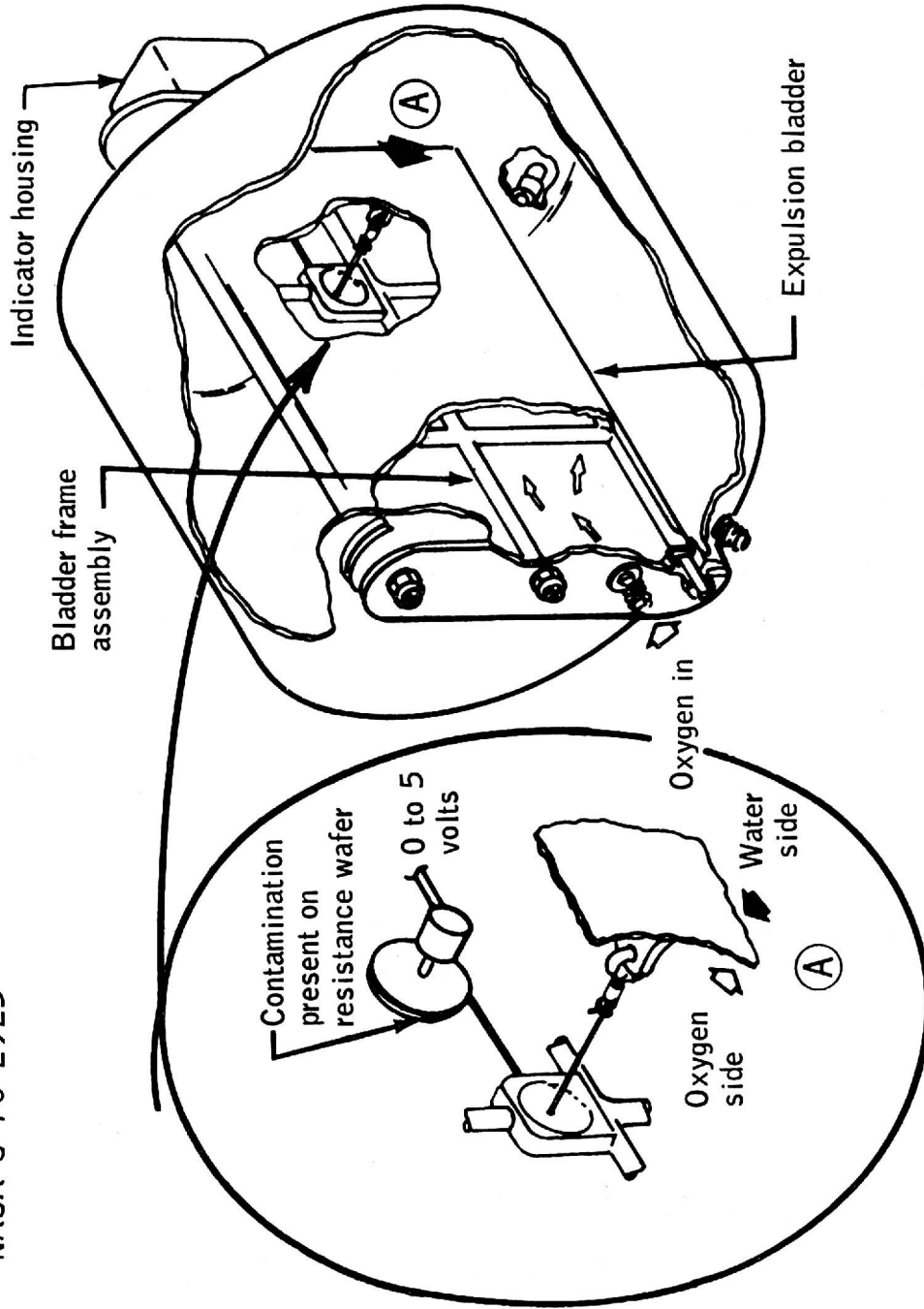
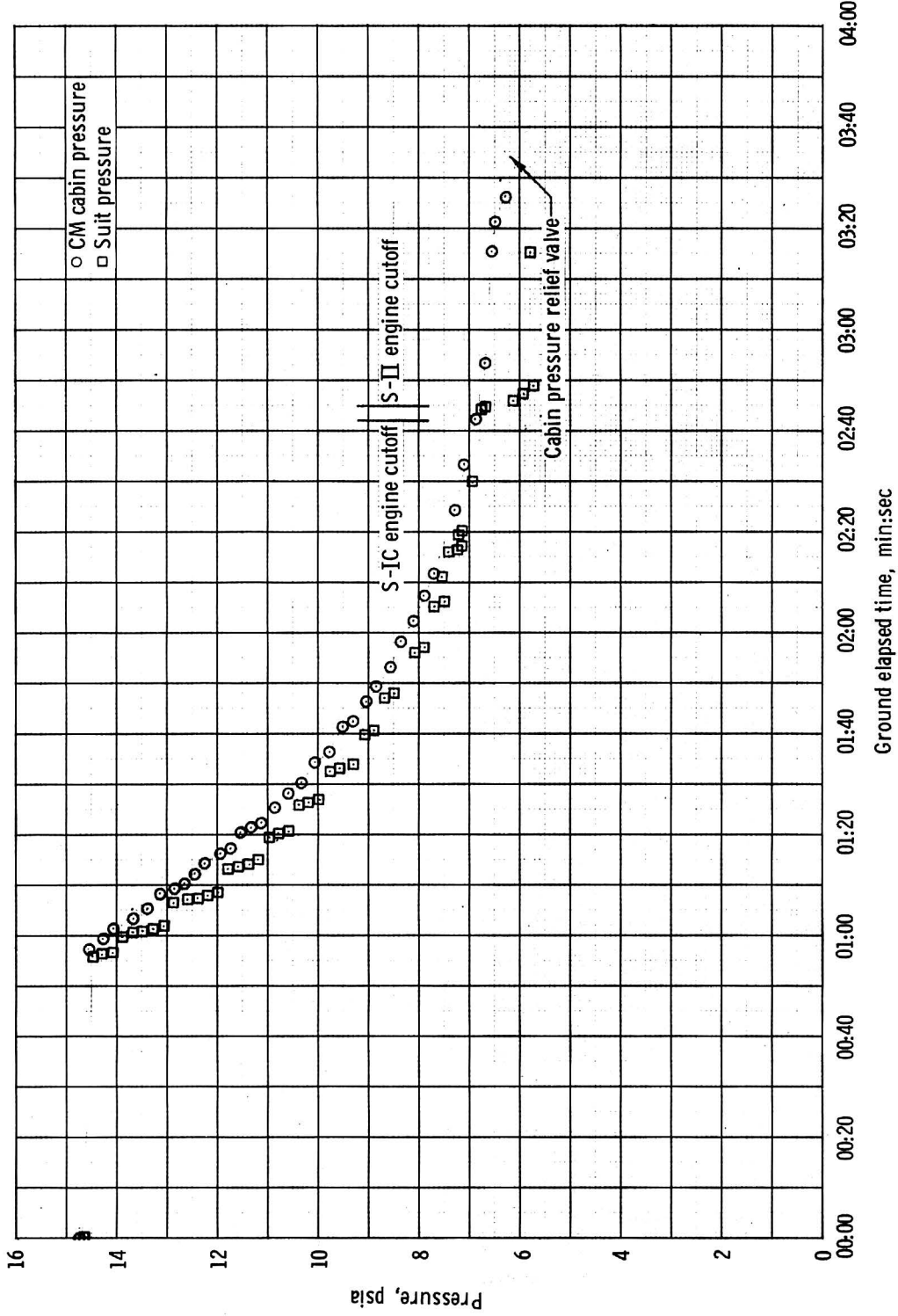
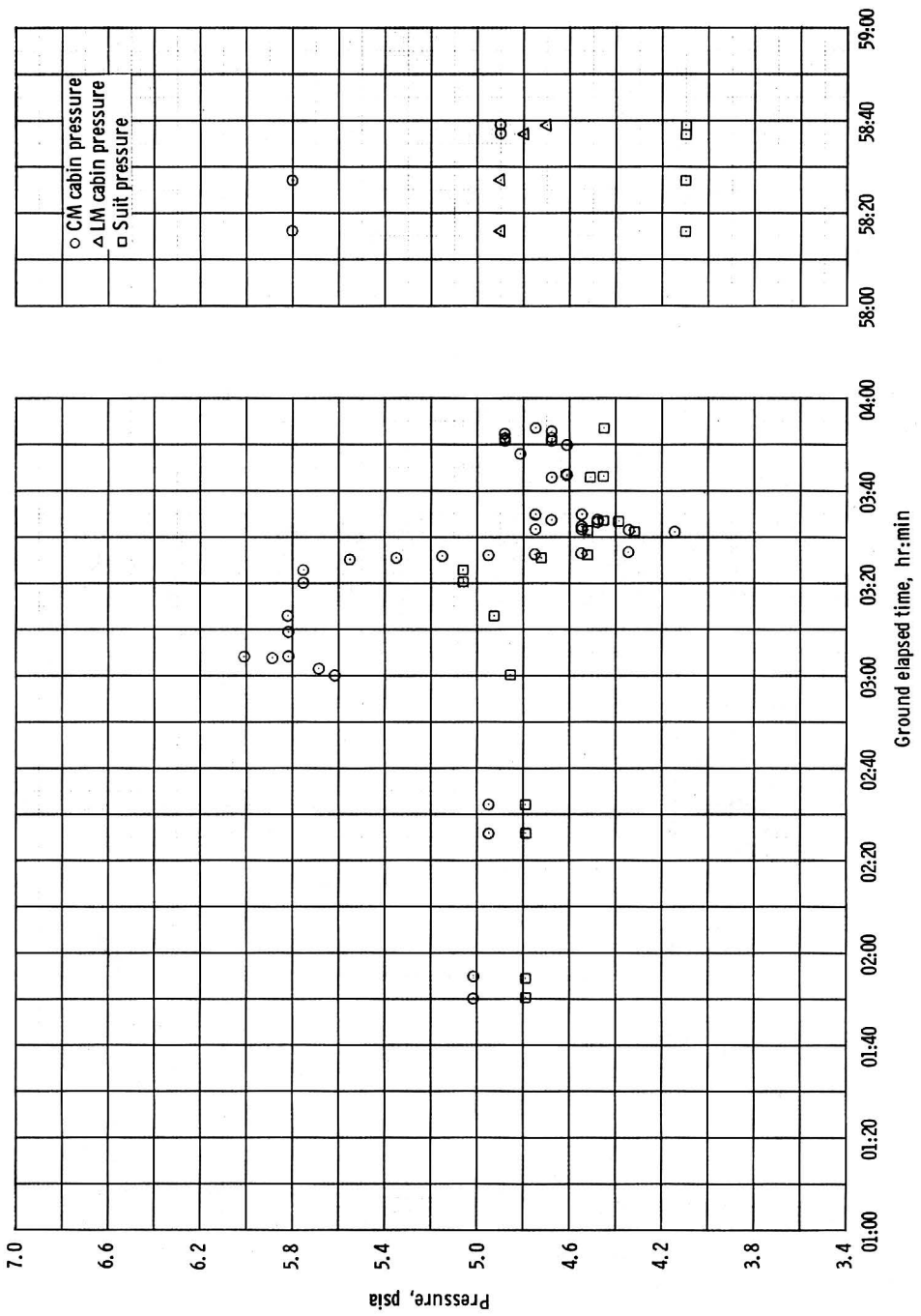


Figure 6.- Area of failure in erratic water transducer.



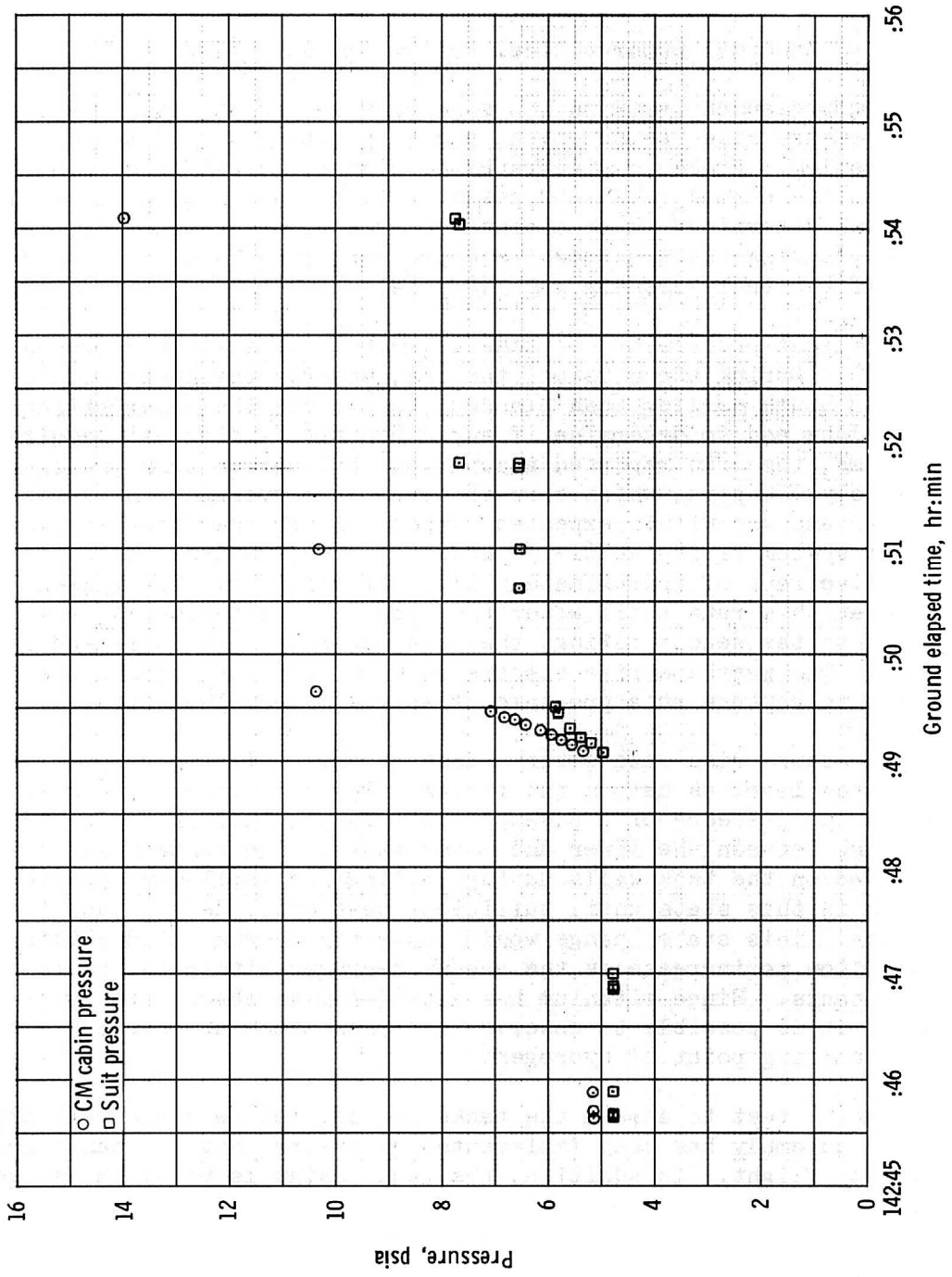
(a) Lift-off through 4 minutes.
Figure 7. - Suit and cabin pressure.



(b) One through 4 hours, and 58 through 59 hours.

Figure 7. - Continued.

NASA-S-70-2926



(c) 142:45 through 142:56 hours.

Figure 7. - Concluded.

LUNAR MODULE

Abnormal Supercritical Helium Pressure Rise

During prelaunch tests on the supercritical helium tank, an abnormal rate of pressure rise was observed, and a special test was added to evaluate the problem. Pressure rise rates as high as 14 psi/hr were noted, compared to the normal rate of 8 psi/hr. Based on a nominal lunar landing, the tank was determined to be acceptable even with the abnormally high rise rate. During the countdown, the pressure rise rate was 8 psi/hr and at lift-off the tank pressure was 356 psia.

An inflight profile of the tank pressure versus time is presented in figure 8. During the mission, the crew entered the lunar module at 55 hours, 3 hours earlier than planned, to observe the supercritical helium rise rate and to determine if any corrective action was required. At this time, the crew reported a supercritical helium tank pressure of approximately 720 psia, which corresponded to an average rise rate of 6.53 psi/hr and was within expected ranges. After the first descent propulsion system firing at 61-1/2 hours, the helium tank exhibited a pressure rise rate of approximately 11.5 psi per hour. The pressure rise continued at this rate until after the second descent propulsion maneuver. Subsequent to the second firing, the pressure rise rate increased further to 33 psi. The pressure rise associated with this rate caused the safety burst disk to rupture at a pressure of approximately 1937 psia.

The pressure rise rate after a descent engine firing should normally remain at the level as before the firing. The most likely cause of this anomaly is the presence of a gaseous contaminant, most probably hydrogen, in the space between the inner and outer tanks. The contaminant would be condensed on the tank walls during filling and chill-down operations and remain in this state until sufficient heat was added to vaporize the contaminate. This state change would cause the thermal conductivity of the insulation to increase as the vacuum degraded within the space between the tanks. Since titanium has a tendency to absorb free hydrogen molecules, it is possible to observe this phenomenon at temperatures above the boiling point of hydrogen.

A special test to screen the tanks for all future spacecraft prior to vehicle assembly has been implemented to assure that the tanks are suitable for flight. In addition, the tank design is being investigated to determine the means by which the vacuum jacket can become contaminated, what the contaminant might be, and any other possible causes of the increased thermal conductivity.

This anomaly is open.

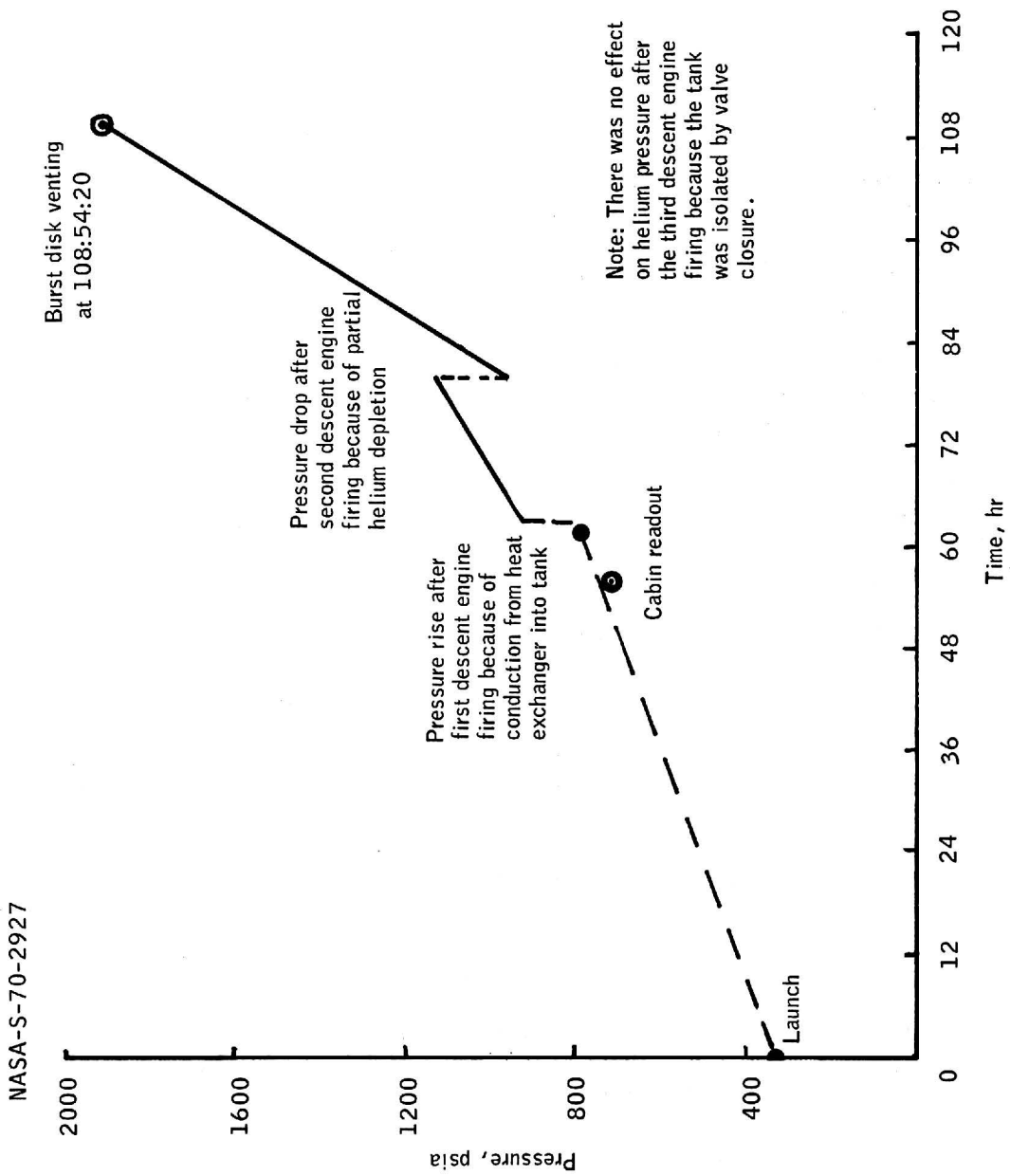


Figure 8.- Inflight profile of supercritical helium tank pressures.

Abnormal Descent Stage Noise

At 97:14:42, the crew reported a thumping noise and snowflakes venting from quadrant 4 of the lunar module descent stage. All four descent batteries experienced current transients at 97:13:53 for about 2 seconds, with corresponding drops in dc bus voltage (fig. 9). Also, the glycol pressure differential for the heat transport system decreased momentarily, indicating that the glycol pump slowed down for a brief period.

The crew stated that the current spikes occurred not more than 30 seconds before the thumping noise, and not afterwards, and that there was no activity in the vehicle at that time. The current spikes were probably caused by a momentary short circuit in the Lunar Module Pilot side of the dc electrical system, which includes descent batteries 1 and 2 (fig. 10). The current surge was not high enough to open the balance load cross-tie circuit breakers nor to trip a battery off the bus as a result of an overcurrent or reverse current condition.

Descent battery 2 experienced the highest current surge, which was off-scale high and in excess of 60 amperes. This condition could have been a reverse current into the battery, since the instrumentation system cannot differentiate between reverse and forward currents. Immediately after the current surges, battery 1 current returned to the value existing immediately before the surges. However, battery 2 provided about 80 percent of the total current. Within 10 minutes thereafter, all batteries were properly sharing the current load.

At 99:51:09, battery 2 gave an indication of a battery malfunction (discussed in more detail in a subsequent section). One possible cause of this problem is the battery electrolyte bridging either the temperature switch terminals or the wiring. All available evidence indicates that battery 2 experienced an electrical fault of some type. The most probable condition is electrolyte leaking from one or more cells and bridging the high-voltage or low-voltage terminal to the battery case (fig. 11). This and other types of faults will be introduced into a descent battery to determine what faults could produce similar current surges. These tests should indicate if a current surge could cause the battery to make a thumping noise or to vent and produce solid particles similar to those observed.

Other lunar module components, such as the pyrotechnic batteries and the experiment equipment, are also under investigation as possible sources of the noise and the snowflakes.

This anomaly is open.

NASA-S-70-2928

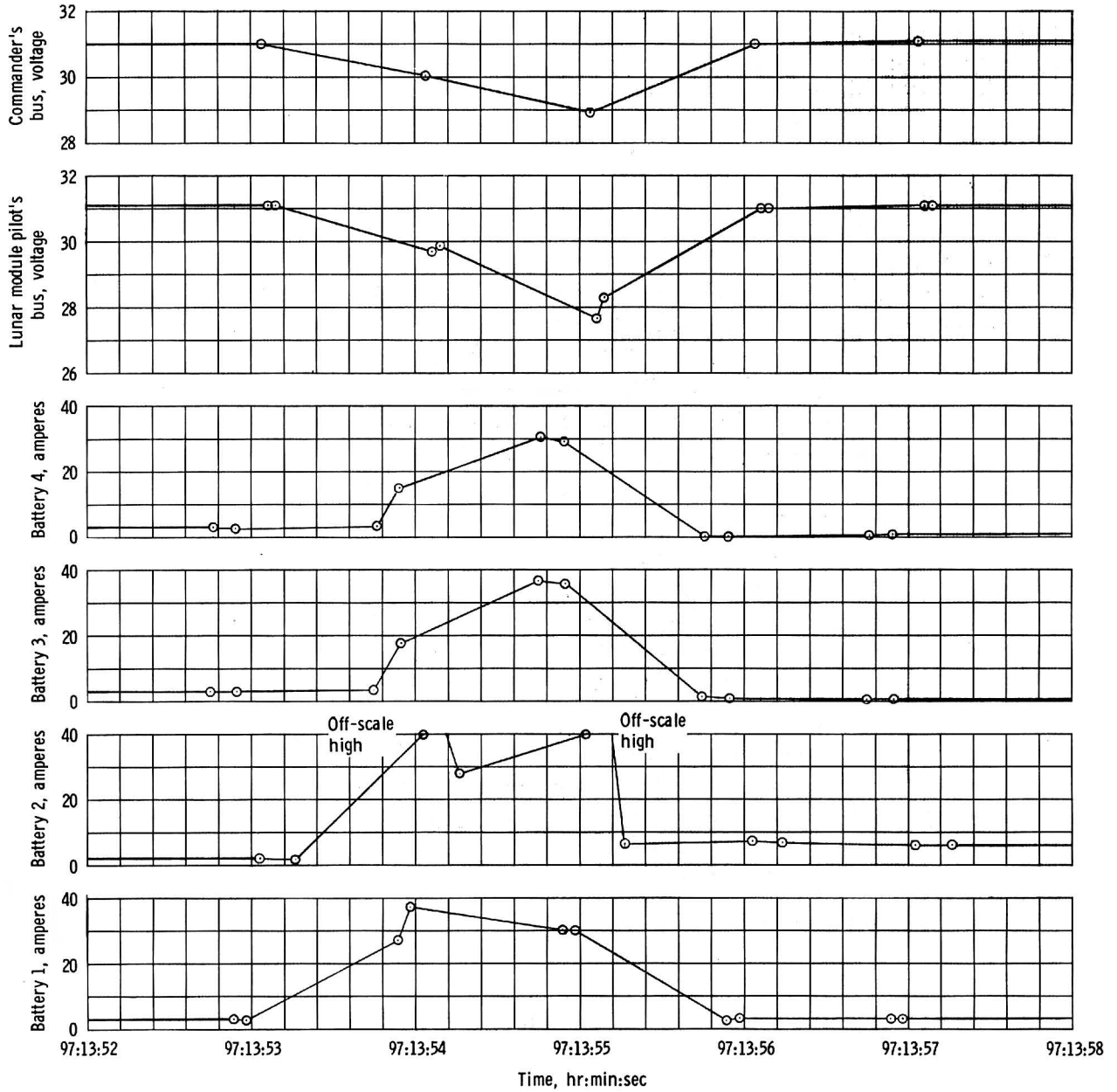


Figure 9. - Battery transients.

NASA-S-70-2929

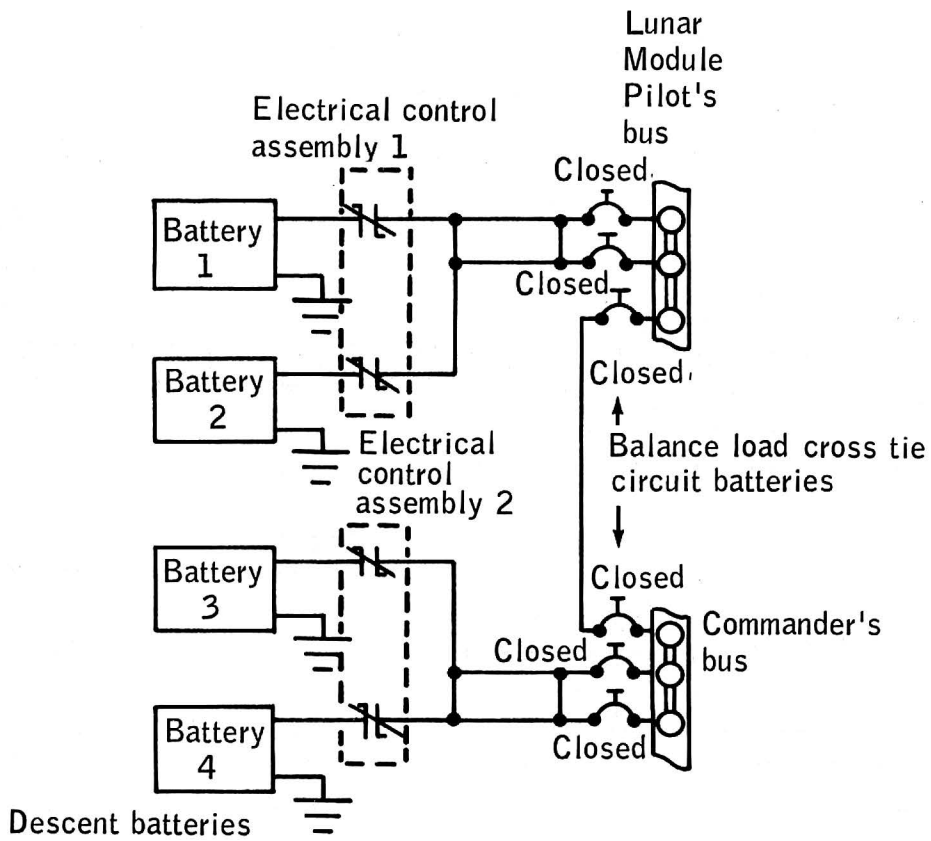


Figure 10.- Descent batteries/bus configuration.

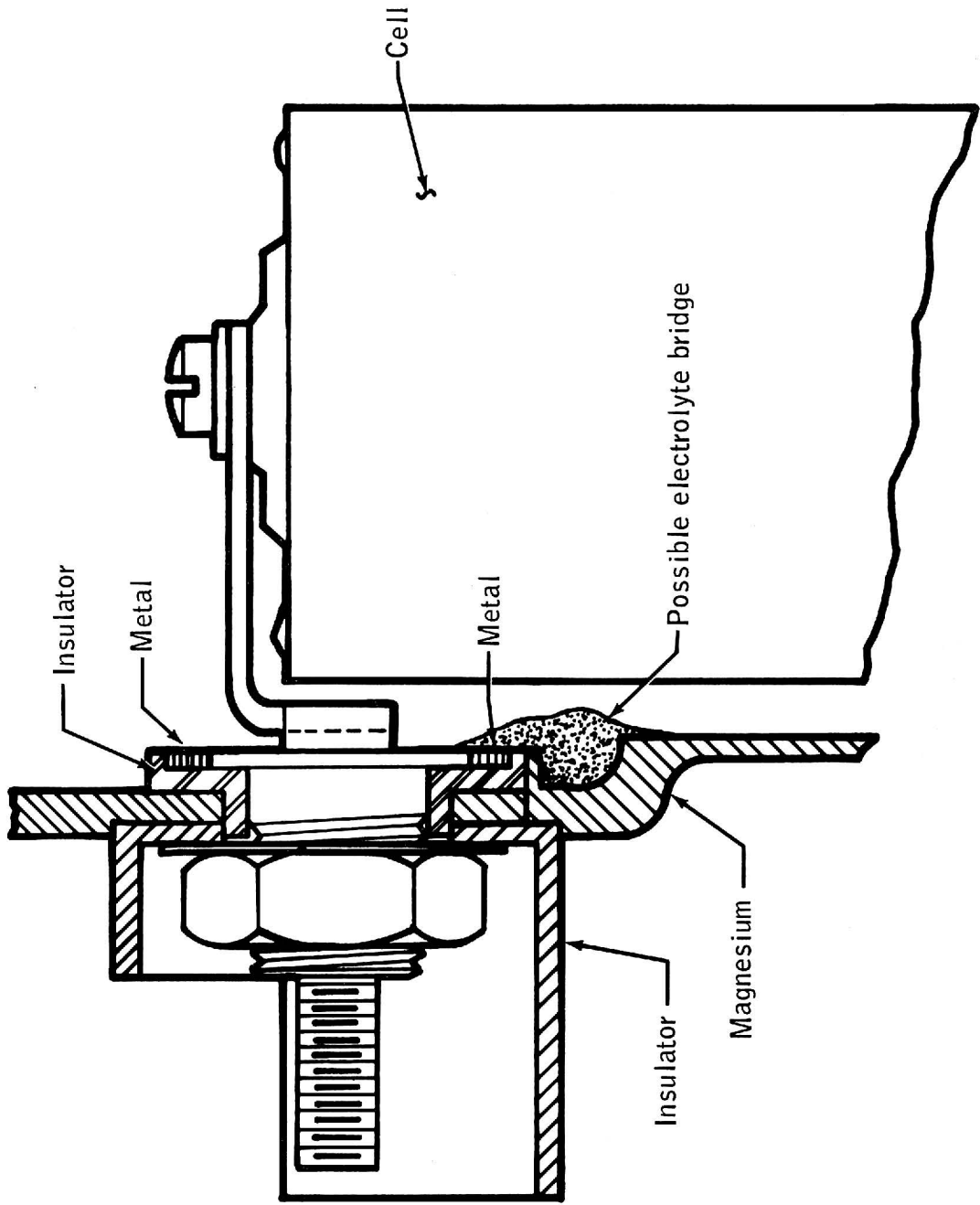


Figure 11.- Descent battery terminal.

Descent Battery 2 Malfunction Light On

The battery malfunction light illuminated at 99:51:09 with a corresponding master alarm. The malfunction was isolated to battery 2 by switching the power temperature monitor switch to the battery 2 position and observing the corresponding component caution light. This analysis indicated that either a battery 2 overtemperature, overcurrent, or reverse current condition had occurred (fig. 12).

A battery overcurrent could not have occurred, because the electrical control assembly did not automatically remove the battery from the electrical buses. The battery was manually removed from the bus for over an hour and then reconnected. The battery malfunction light extinguished when the battery was removed from the bus but illuminated immediately when the battery was reconnected. This sequence indicates that a reverse current condition was not the cause of the malfunction indication because reverse current must exist for 4 to 6 seconds before the electrical control assembly will again illuminate the light. The remaining possible cause is either a battery overtemperature condition or a malfunction in the overtemperature sensing and display circuit.

Glycol loop temperatures and battery performance before and after the warning indicated that the battery was operating normally and at a normal temperature. Temperature is sensed in the battery by five bi-metallic, hermetically sealed, snap-action temperature sensing switches connected in parallel. These switches have experienced no prior failures and are designed to close at 145 percent $\pm 5^{\circ}$ F and open at 125 percent $\pm 5^{\circ}$ F.

After the battery was replaced on the bus, the light remained illuminated for a brief period and then began flickering intermittently. Since the light flickered on and off, switch hysteresis would preclude that a temperature switch was being activated. A low resistance path (less than 250 kilohms) between the switch wires or from the signal wire to ground will actuate the light. This could have been caused by the battery electrolyte bridging the switch terminals. Contamination in the auxiliary relay of the electrical control assembly could also have caused the light to illuminate. These relays have a history of contamination and are not screened before installation.

The wiring, battery, and relays are under investigation.

This anomaly is open.

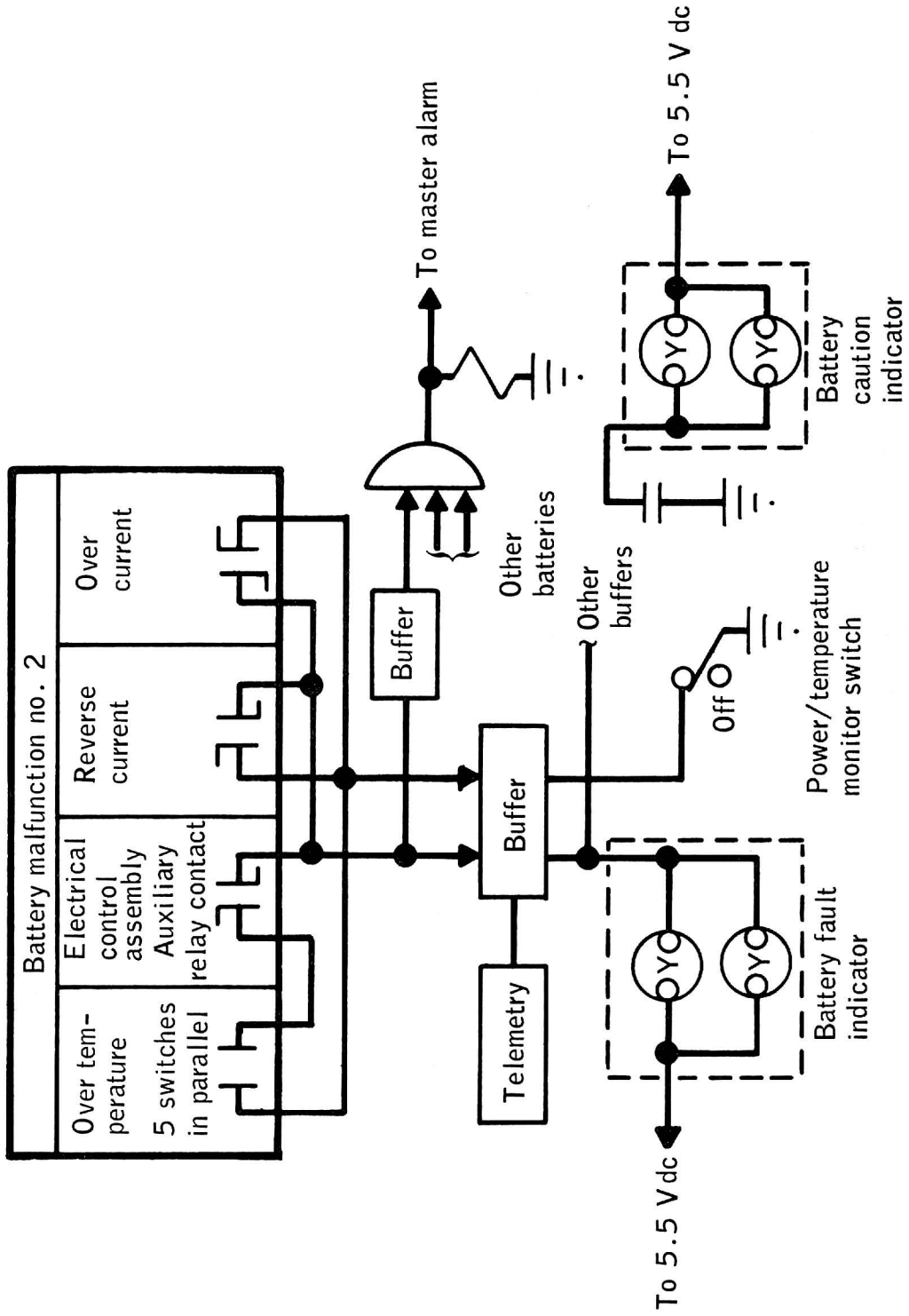


Figure 12.- Battery 2 malfunction circuit.

Ascent Oxygen Tank 2 Shutoff Valve Leak

During the flight, the pressure in the ascent stage oxygen tank 2 increased, indicating a reverse leakage through the shutoff valve from the oxygen manifold (fig. 13) into the tank. The leak rate, with a maximum differential pressure of 193 psi, varied from about 0.22 lb/hr (70 000 scc/hr) to zero when the tank pressure reached manifold pressure. Allowable leakage for the valve in either direction is 360 scc/hr. Preflight test data indicate a reverse leakage of 360 scc/hr and no excessive leaking in the forward direction.

The internal portion of three valves of this type had been replaced previously on the spacecraft because of excessive leakage through the ascent oxygen tank 1 shutoff valve. A rolled, or displaced, O-ring (fig. 14) was found to be the cause of the leakage. When the valve is installed, the forward O-ring can roll when it passes the manifold port. Subsequent pressure cycling can cause the O-ring to move and cause a leak.

The valve installation procedure is being evaluated to determine if a better means can be found to preclude rolling, or displacing, the forward O-ring. Also, a method of measuring the valve leakage in both directions, with new leakage limits at both high and low pressure differentials, is being evaluated for use at the launch site.

This anomaly is open.

Window Shade Cracking

The left-hand window shade showed three large cracks when it was first placed in the stowed position during flight (fig. 15).

Cracking as a result of embrittlement of the shades has been previously identified as a problem. The manufacturer had reprocessed the shades by reheating and quenching to obtain an acceptable configuration. Prior to flight, a set of the new shades were available for the Apollo 13 spacecraft if they were needed. The shades already installed were examined visually for cracks, cycled ten times each, and reexamined. No indication of cracks was found, and these shades were subsequently used for flight.

Inflight examination of the cracked shade indicated that the three cracks, which extended 80 percent of the distance across and in the upper left 40 percent portion, propagated from sewing stitch holes on the periphery of the shade. Close examination of these holes indicated that short cracks, 1/8-inch long or less, extended from more than 80 percent of the stitch holes in a direction parallel with the curl axis of the shade. The

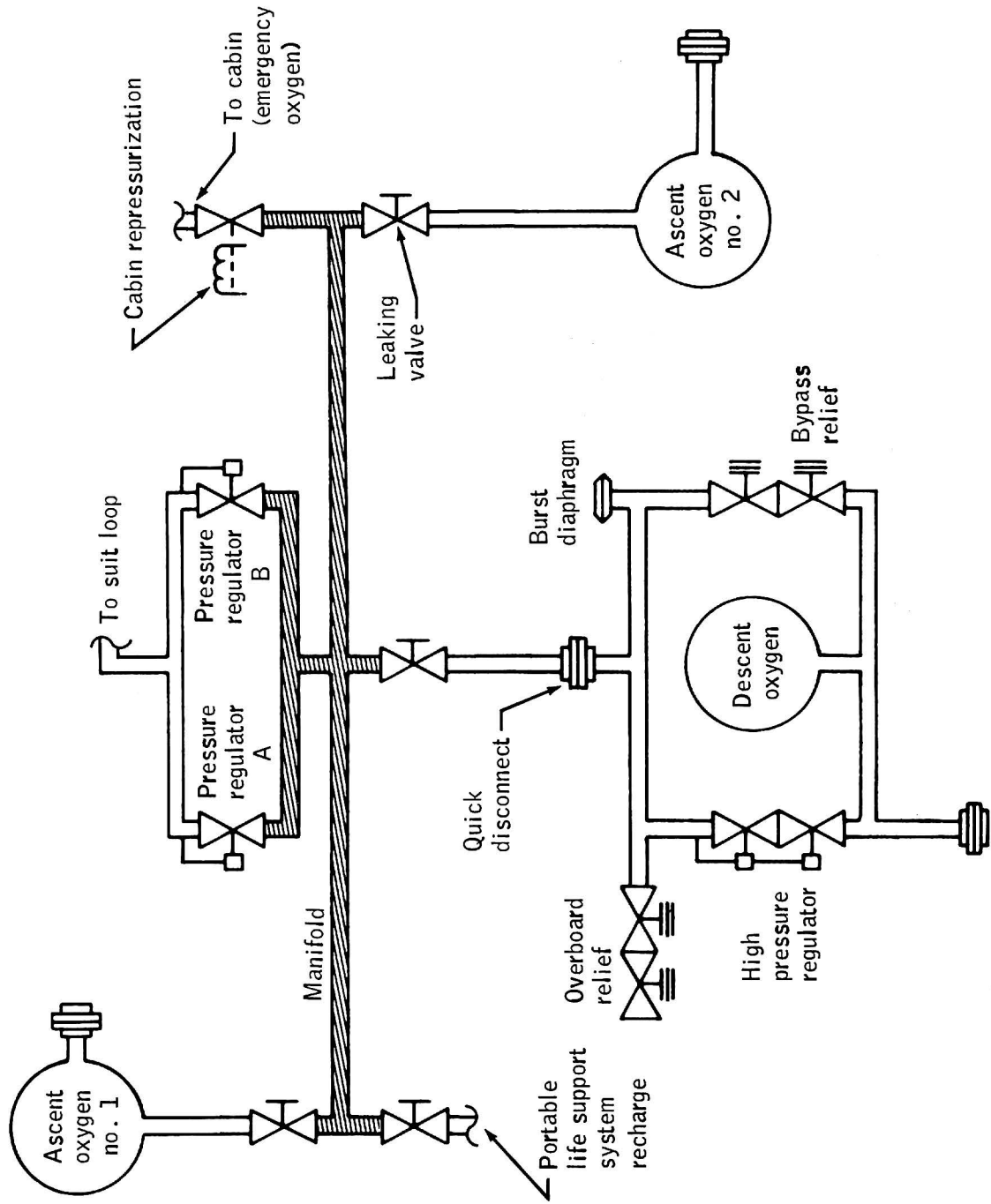


Figure 13. - Oxygen supply system .

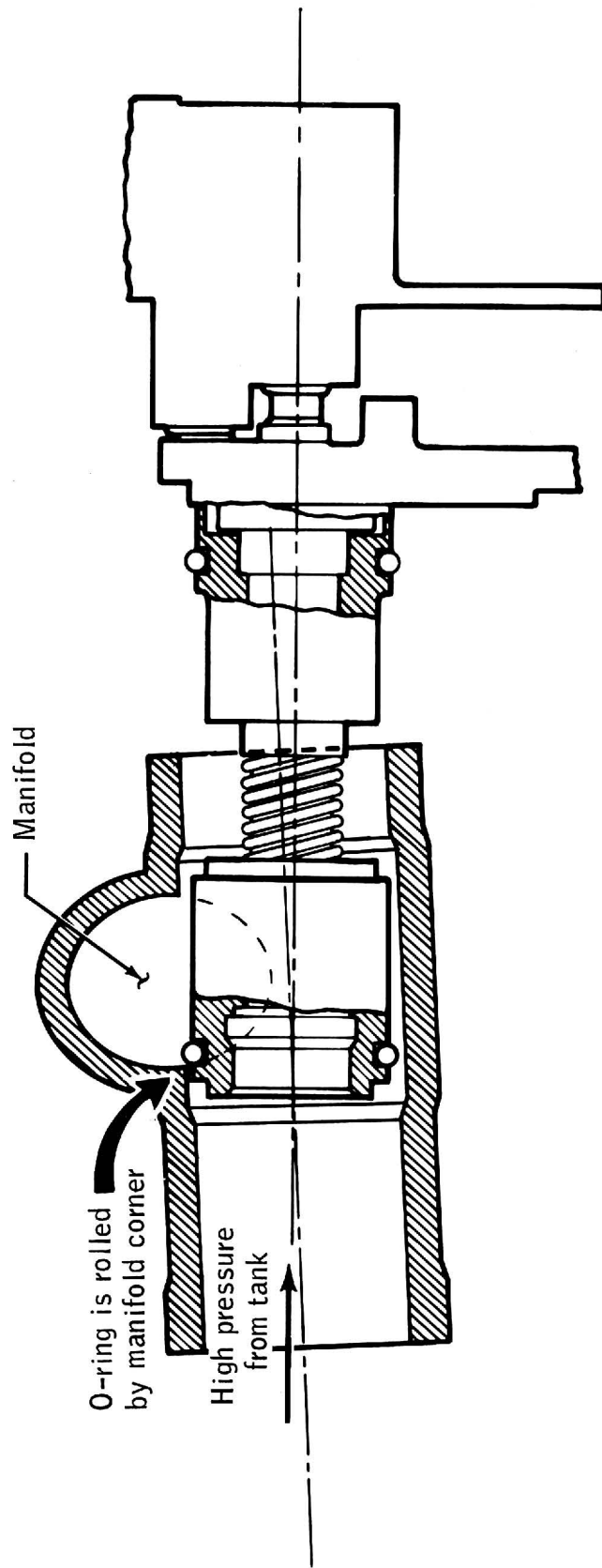


Figure 14.- Oxygen tank shutoff valve partially installed.

NASA-S-70-2934



Figure 15.- Cracked left-hand window shade.

shades are heat formed into a curl so that any crack parallel with the curl axis would tend to "self-extend" when the shade was deployed, or uncurled. In effect, the material would be stress relieving itself through cracking.

A failure analysis has indicated the cracks are caused by excessive brittleness and can be controlled by proper heating and quenching to give a more ductile material.

The process to produce an acceptable shade with a ductility in excess of 25 percent is being developed by the supplier. New shades employing the more ductile material will be manufactured using techniques that preclude sewing directly onto the Aclar material. The shades will be subjected to a design verification test that will include complete mission simulation of thermal vacuum cycling. A design verification test will be performed.

This anomaly is closed.

GOVERNMENT FURNISHED EQUIPMENT

Lens Bumper Loose On Lunar Module 16-mm Camera

During inflight familiarization in the lunar module, it was found that although the camera was properly mounted on the window bracket, the Teflon bumper had fallen out of the lens opening. Frequent removal of the bumper can remove the interference material such that the bumper can fall out during launch. For future missions the outside diameter of the bumper base will be swaged to provide an interference fit into the lens threads and thread relief.

This anomaly is open.

Failure of the Interval Timer Set Knob Loose

When the interval timer, normally stowed in the command module, was being set, the set knob came off. This knob is held to the shaft by a set screw secured with Loctite C, which apparently does not provide a strong enough retention. Consideration is being given to replacing the set screw with a roll pin.

This anomaly is open.

Improper Nasal Spray Operation

When attempts were made to use the two nasal spray bottles in the command module medical kit, no medication could be obtained from one bottle and only two or three sprays could be obtained from the other. On previous flights, there had been a tendency for the spray to be released too fast, therefore a piece of cotton was inserted in the 9-cc bottle to hold the 3-cc of medication. Chamber tests had indicated that this change was satisfactory. The returned spray bottles will be examined for medication content in the cotton.

This anomaly is open.

