



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

**MSC APOLLO 13 INVESTIGATION TEAM**

FINAL REPORT

PANEL 2

FLIGHT CREW OBSERVATIONS

MAY 1970



MANNED SPACECRAFT CENTER  
HOUSTON, TEXAS



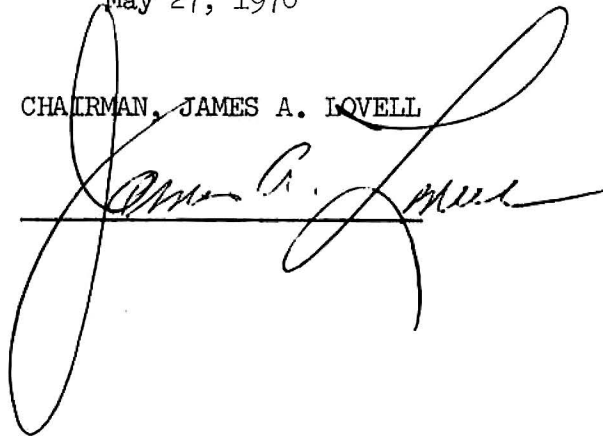
FINAL REPORT

PANEL 2

FLIGHT CREW OBSERVATIONS

May 27, 1970

CHAIRMAN, JAMES A. LOVELL

A large, stylized handwritten signature in black ink, written over a horizontal line. The signature is highly cursive and loops around the line, extending significantly above and below it. It appears to read "James A. Lovell".



PANEL 2

FLIGHT CREW OBSERVATIONS

JAMES A. LOVELL  
CHAIRMAN, PANEL 2  
MSC APOLLO 13 INVESTIGATION TEAM

MEMBERS

John L. Swigert, Jr.  
Fred W. Haise, Jr.  
Thomas K. Mattingly



## PANEL 2

### Flight Crew Observations

At approximately 54:54:00 GET, a loud explosion occurred while the Command Module Pilot was in the left seat, the Commander in the lower equipment bay, and the Lunar Module Pilot in the tunnel. The noise was comparable to that noted in exercising the lunar module repressurization valve. The Command Module Pilot and Lunar Module Pilot also felt a minor vibration or tremor in the spacecraft.

Approximately 2 seconds later, the Command Module Pilot reported a master alarm and a main bus B undervoltage light. Voltage readouts from main bus B, fuel cell 3 current, and reactant flows were all found normal. It was concluded that a transient had occurred. The Command Module Pilot then initiated efforts to install the tunnel hatch.

The Lunar Module Pilot proceeded to the right seat and found the ac bus 2 and ac bus 2 overload lights on, with main bus B voltage, fuel cell 3 current, and fuel cell 3 reactant flows off-scale low. Inverter 2 was then removed from main bus B.

On switching ac electrical loads to ac bus 1, the main bus A undervoltage light illuminated, with a corresponding voltage reading of 25.5. A check of the fuel cells revealed fuel cell 1 reactant flow to be zero. At all times, fuel cells 1 and 2 were tied to main bus A and fuel cell 3 to main bus B, with the proper gray flags displayed.

Efforts to install the tunnel hatch were terminated when the Commander observed venting of material from the service module area. He then reported the oxygen tank 2 pressure was zero and oxygen tank 1 pressure was decreasing. This information pinpointed the problem source to within the command and service modules.

At ground request, fuel cells 1 and 3 regulator pressures were read from the systems test meter, confirming the loss of these fuel cells. AC bus 2 was tied to inverter 1, and the emergency power-down procedure was initiated to reduce the current flow to 10 amps. At ground request, fuel cell 1 and, shortly thereafter, fuel cell 3 were shut down in an attempt to stop the decrease in oxygen tank 1 pressure.

Lunar module powerup was handled quite efficiently by identifying selected segments of an existing procedure, the Lunar Module Systems Activation Checklist. However, the crew had to delete the VHF portion of the communications activation. This procedure also assumed suited operations, so the crew had to turn on suit flow valves and unstow hoses to establish air flow. This extended powerup blended well with the preparation for the subsequent midcourse maneuver to return to a free-return trajectory. A similar real-time update to the 2-hour activation section of the Lunar Module Contingency Checklist was also quite adequate.





Lunar module activation was completed at the time fuel cell 2 reactant flow went to zero because of oxygen depletion. The command and service modules were then powered down completely according to a ground-generated procedure. To form a starting base line for subsequent procedures, each switch and circuit breaker in the command module was positioned according to a ground-transmitted procedure.

Potable water was obtained by periodically pressurizing the potable tank with surge-tank oxygen and withdrawing potable water until the pressures equalized. This method provided potable water for crew use until 24 hours prior to entry, at which time the potable tank was exhausted.

The hatch, probe, and drogue were secured in the couches by lap belt and shoulder harness restraints to prevent movement during subsequent maneuvers.



APOLLO 13 INVESTIGATION TEAM  
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