REPORT OF APOLLO 204 REVIEW BOARD

TO

THE ADMINISTRATOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

N.A.S.A. HISTORICAL ARCHIVES

NO.

APPENDIX D

PANELS 1 thru 4

(6) COMMENTS ON DATA

At about 8 minutes prior to the crew call of fire the accumulator quantity pressure measurement started a gradual decrease which continued to the time when the cabin pressure rose because of the fire. The supply pressure measurement, which also senses changes of pressure within the glycol system, showed an associated change during this period of time. See Panel 18 Report for further discussion.

g. COMMUNICATION

(1). The communication system was in launch configuration except for the following:

(a). Only one data storage electronic assembly voice recorder (DSEA) was installed, but was not electrically connected. Two DSEA's are required for launch configuration, with only one connected.

(b). Only one bio-med tee adapter was installed (SRP position). For flight there would be three.

(c). CMD Pilot was using a flight-space cobra cable (-51) instead of the normal cable (-41); the cobra cable was changed during the "live mike" troubleshooting.

(d). Audio control panel and cobra cable switches were in position to facilitate testing as a workaround for the "live mike" problem.

(e). The USBE was in the "transponder only" mode (power amplifier "off"). The launch configuration transponder power amplifier mode would have been selected at T-10 minutes. Figure 4.7-1 shows the astronaut umbilical communication system cobra cable, tee adapter, etc.

(2). COMMENTS ON DATA

(a). All data reviewed indicates that the spacecraft communication system performed normally between 23:30:00 GMT and LOS, except for the following:

(1). VHF/FM DROPOUT - A momentary dropout occurred in the RF detected PCM video wave-train at 23:30:54.85 GMT and lasted for approximately 30 milliseconds. MSOB and the TEL IV signal strength parameters of the VHF/FM carrier had a momentary dropout coincident with the PCM video dropout. See Panel 18 Report for further discussion.

(2). C-BAND DROPOUT - A C-band dropout occurred at 23:30:54.85 GMT and lasted for 1.7 seconds (see Figure 3-2). The dropout was indicated in the receiver decoder and in the transmitter output. Both are PCM data points which are sampled 10 times per second, and both have RC time constants of 0.1 second. See Panel 18 Report for additional details.

(3). "LIVE MIKE" CONDITION - Voice tape analysis and PCM data records showed a "live mike" (constant keying) condition existed from the CMD Pilot position during a considerable portion of the final test period. See Panel 18 Report for greater detail.

(b). VOICE RECORDINGS

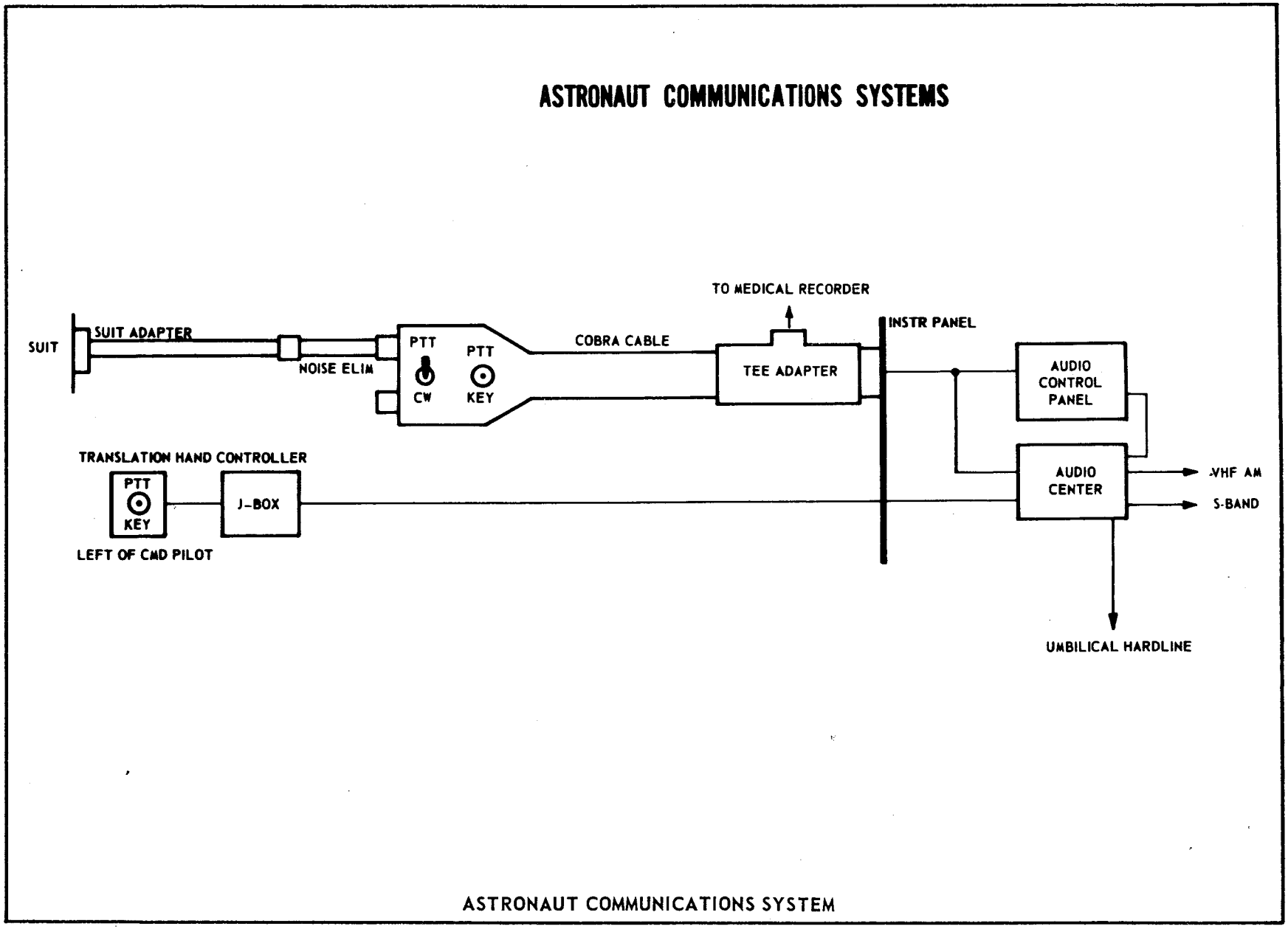
Voice recordings were made in the Manned Spacecraft Operations Building (MSOB) ACE Station, MSOB Open Loop Communication Station (MOLC), Blockhouse 34, MCCK at Cape Kennedy, MSC-Houston, and NAA Downey via Houston (see Figure 4.7-2). The data from these tapes were studied in an attempt to determine possible clues to the cause and crew reaction to the fire. A transcript was made of the S-band and VHF/AM tracks of the MOLC voice tape from 23:29:45.5 GMT to LOS. This tape was chosen because it contained the only direct S-band voice from the S/C and was less noisy than the OIS tapes.

(c). ANALYSIS OF OSCILLOGRAPH RECORDING

The voice transmissions shown in Figure 3-9 were analyzed with the use of MOLC tapes and PCM data. This figure shows the VHF/AM and S-band voice tracks oscillograph readout from 23:29:42.5 GMT to LOS.

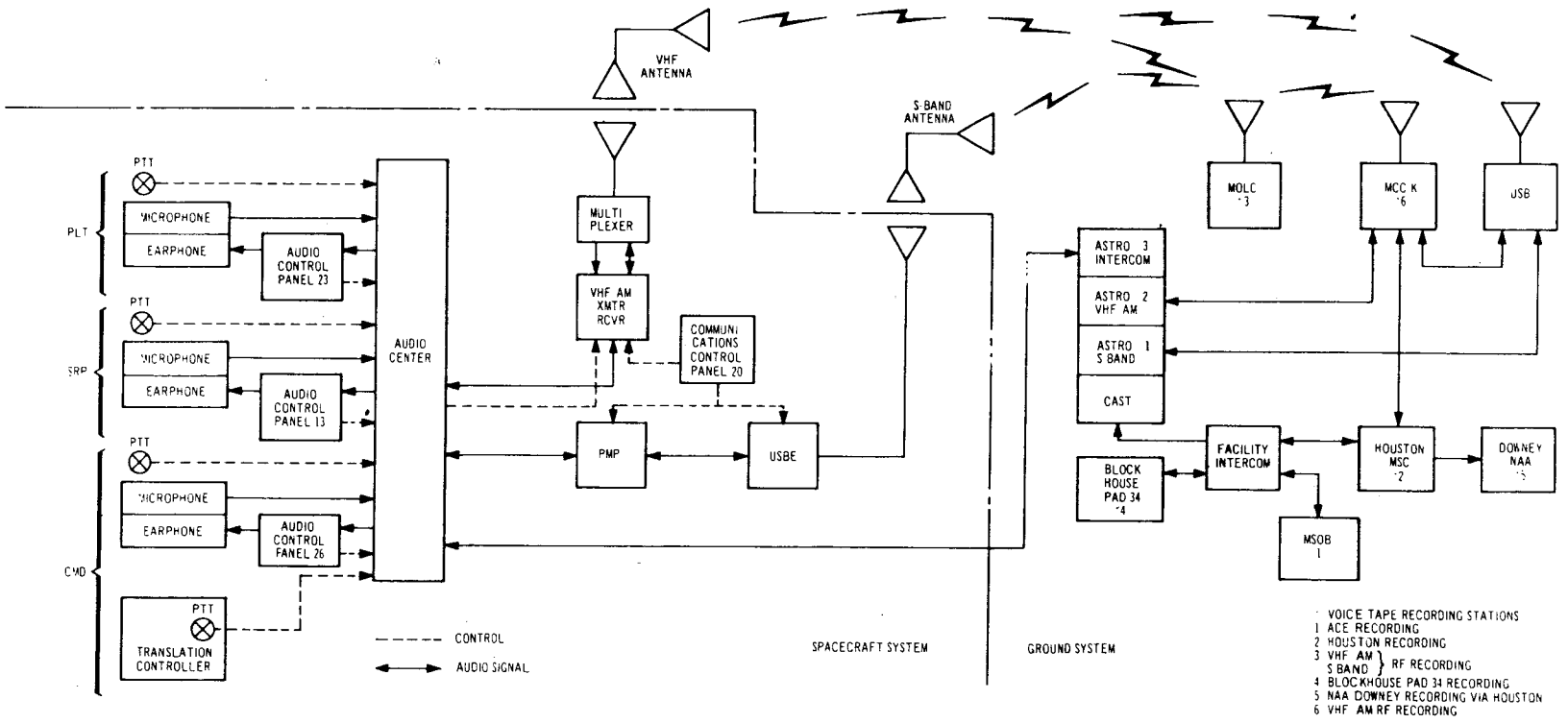
(1). 23:29:42.5 to 23:30:14 GMT

(a). The CMD was transmitting on S-band. The SRP made a voice transmission on S-band and VHF/AM. There was no voice transmission by the PLT.



ASTRONAUT COMMUNICATIONS SYSTEM

FIG. 4.7-1



AUDIO COMMUNICATIONS EQUIPMENT INTERFACES

(b). The ground personnel were transmitting to the S/C on S-band. The voice of the CMD was being turned around by the CAST (astro communicator console) system and retransmitted to the S/C on VHF.

(c). The "live mike" noises are not evident, probably because of the higher noise level caused by the uplink S-band being patched to the MOLC RF recorder.

(2). 23:30:14 to 23:31:00 GMT

(a). There were no voice transmissions from the S/C.

(b). The ground personnel were not transmitting to the S/C on VHF.

(c). There was no change in the "live mike" condition. Considerable amounts of noise similar to those obtained when a microphone is brushed or tapped, including breathing sounds, were evident. Some of the louder noises appear to have had sufficient amplitude to trigger the uplink VHF/AM via CAST.

(3). 23:31:00 GMT TO LOS

(a). There were two series of voice transmissions on S-band. The times for these two transmissions are detailed in Figure 3-9. No voice communications on VHF were made from the S/C during this time period.

(b). The ground personnel were not transmitting to the S/C on VHF. The voice transmissions from the S/C were being turned around by the CAST system and were retransmitted to the S/C on VHF.

(d). ANALYSIS OF VOICE TAPES DURING THE PERIOD OF FIRE

The tape transcripts of the voice tapes from the Command Module during the time period of the fire (referred to as the first and second transmission, on Table 4.7-1), have been extensively analyzed. This analysis included a review of all transmissions prior to the fire that were made by the crew during the test in an attempt to aid in the determination of who made these last two transmissions and what was said. This analysis was made by NASA personnel familiar with the communication systems, the crew and their voice characteristics, the sequence of events before, during and after the fire as determined during the accident investigation. The Apollo 204 Review Board also reviewed these transmissions. Experts at the Bell Telephone Laboratories also performed extensive analysis of the tape record. Review by other experts, such as Civil Aeronautics Board accident investigation personnel, is currently in progress. Any new findings from these additional reviews will be included in Appendix G of the Final Report.

Except for a portion of the first transmission, which is quite clear, the remainder of the first and second transmission is not clear and it is impossible to define exactly what was said by the crew. Two points made by the Bell Telephone Laboratory experts, however, should be noted:

(1). The present state-of-the-art of analysis of voice records is such that little, if anything, can be determined as to what was said if the recording is not sufficiently clear to be intelligible by listening alone. Analysis, however, can, under these circumstances, provide some clues; but these clues cannot be used to definitely determine which crew member initiated the transmission.

(2). When the recording of the transmission is not clear, there will be nearly as many interpretations of what was said as there are qualified listeners. Many interpretations of what was said have been made. A summary of these interpretations is made in the following paragraphs.

The analysis of the first voice transmitted is as follows:

This transmission began at 23:31:04.7 GMT with an exclamatory remark. This transmission is not clear. Most listeners believe this initial remark was one of the following:

"Hey "

"Fire "

"Break "

Most listeners believe, and laboratory analysis supports this belief, that this transmission was made by the Command Pilot. This remark is followed by a short period of noise (bumping sounds, etc.).

TABLE 4.7-1 TRANSCRIPT OF VOICE CHANNEL FOR LAST 27 SECONDS

MOLC VHF/AM TRACK TRANSCRIPT		MOLC S-BAND TRANSCRIPT	
		23:30:55.5	(Noise)
		23:30:56	(Breathing sound)
		23:30:56.5	(Noise)
		23:30:58.1	(Noise)
23:30:58.5	(Short noise 0.6 sec)		
		23:31:04	(Breathing sound)
23:31:04.7	*(First voice transmission)	23:31:04.7	(First voice transmission of spacecraft problem)
23:31:10.0	(End of first transmission)	23:31:10.0	(End of transmission)
		23:31:16.8	(Second voice transmission of spacecraft problem)
23:31:17.1	(Second voice transmission)		
23:31:21.8	(End of second transmission)	23:31:21.8	(End of second transmission)
		23:31:22.4	(LOS)

* Analysis of these transmissions appears in paragraph 4.7

The second portion of this first transmission begins at 23:31:06.2 GMT with an unclear word. Most listeners believe the first to be one of the following:

"I've"

"We've"

The remainder of this transmission is quite clear and is: ".....Got a fire in the cockpit", followed by a clipped word sounding like "VHEH", which ended at 23:31:10 GMT. Many listeners believed this transmission to have been made by the Pilot. Some believe it could have been made by the Command Pilot or the Senior Pilot. However, laboratory analysis assigns the greatest probability that it was made by the Pilot, but the results of the analysis do not negate the possibility that one of the other crew members could have made the transmission.

The analysis of the second voice transmission is as follows:

Following a 6.8 second period of no transmission the second transmission began at 23:31:16.8 GMT and ended at 23:31:21.8 GMT. The entire second transmission is somewhat garbled. This second transmission, therefore, is subject to wide variation of interpretation as to content and as to who was making the transmission or transmissions. The general content is what appears to be three separate phrases and it has been interpreted several ways by many listeners. The following is a list of some of the interpretations that have been made:

(1). "Fighting a bad fire - Let's get out.....
Open 'er up."

(2). "We've got a bad fire - Let's get out.....
We're burning up."

"I'm reporting a bad fire....I'm getting out..Oh, AAH." (Scream)

Some people feel that the very end of this second transmission is a scream or the start of one. Many listeners believe this transmission was made by the Pilot.

It should be noted that:

(1). The total time duration of these two transmissions was brief, lasting 17.1 seconds; the first lasted 5.3 seconds and the second lasted 5.0 seconds, with a 6.8 second period of no transmission between.

(2). The transmissions provide evidence only of the time the crew first transmitted a report of the existence of the fire and do not provide any direct information as to the cause of the fire.

H. FUEL CELL AND CRYOGENIC GAS STORAGE SYSTEM

(1). FUEL CELLS

Fuel cells were inactive and were not being monitored during the incident. A review of the data from 23:26:00 GMT to the incident indicated no fuel cell anomalies.

(2). CRYOGENIC GAS STORAGE SYSTEM (CGSS)

The CGSS was inactive during the test. Gas was supplied to the environmental control system from "K" bottles through port OP on the service module. A review of data from 23:26:00 GMT to the incident indicated no anomalies in the CGSS.

i. PROPULSION (SPS AND RCS)

(1). SERVICE PROPULSION SYSTEM CONFIGURATION

The differences from the normal launch countdown configuration were as follows:

Propellant tanks, helium storage tanks, and engine actuation system GN2 tanks were not serviced to flight pressures but were at low (normal) blanket pressures (using GN2).

(2). COMMENTS ON SPS DATA

All data on the SPS remained normal and constant until loss of data.

(3). REACTION CONTROL SYSTEM CONFIGURATION

CSM RCS was configured for launch with the following exceptions:

(a). The engine simulators were installed in lieu of actual engine circuitry.

(b). No consumables were on board. The scupper supports were in place.

(c). A temperature thermocouple was taped to CM "B" system oxidizer isolation valve to monitor valve temperature rise during plugs out mission run.

(d). The engine throat plugs and flow sensors were partially installed in preparation for flight readiness test. The engine covers were installed on quad engines. CM engines were environmentally sealed with tape.

(4). COMMENTS ON RCS DATA

A simulated SM RCS +X engine static firing had been completed at approximately 23:15:00 GMT using Pilot's rotation controller. No anomalies were observed in this test. Following the simulated static firing the CSM RCS system was monitored for remainder of the active test. A review of the data tapes for the period 23:26:00 GMT to 23:31:30 GMT did not disclose any system anomalies. Significant RCS data peculiarities are detailed below:

(a). A linear rise in temperature from an ambient condition of 70° F to 197° F occurred between 23:31:19.858 GMT and loss of signal at 23:31:22:432 GMT on CR4561T. This transducer is a resistance thermometer type and is spot welded to the upper surface of CM RCS "A" CCW engine between frames No. 21 and 22, (closer to frame 21), and behind panel CM 18. It is also covered with 3/4 inches of insulating Q-felt. A second transducer, CR2201T, mounted on the oxidizer injector value of the same engine, showed no temperature increase. Although this transducer is of a similar resistance type, it was bonded to and encapsulated in silicon rubber. It was also 90 degrees further around the engine on its outward side and located between frames no. 20 and 21 (closer to frame 21). Although partially covered by the boost protective cover, CR2201T was exposed to ambient conditions (panel CM 19). The sudden rise in temperature of CR4561T is indicative of exposure to flame at the time of cabin pressure vessel rupture. Time correlation with other rupture data points must take into account the fact that the engine and transducer are enclosed with insulating Q-felt as noted above.

(b). The RCS propellant isolation circuit breakers (CB16 and CB15) on panel 25 were found to be open during post-fire inspection. Further inspection revealed that the circuit breakers' stems were only slightly smutted indicating that the circuit breakers opened after the fire started to subside.

(c). The RCS selector switch was found in the SM-A position rather than the SM-D position called for by the procedure. This switch selects a particular SM quad for parameter monitoring and has no change-of-state function. The SM-A position is assumed to be a pilot's natural reaction to return to the initial monitoring position instead of leaving it in the final position following simulated static fire.

j. CREW SYSTEMS, BIOMED, AND EXPERIMENTS

(1). SYSTEM CONFIGURATION

The biomed system was in launch configuration with the following exceptions:

(a). An E. O. was released to pot the octopus cable connectors to prevent breakage of connector back shells. Planning was also in work to wrap the cable with tefglas and attach Velcro to provide attach points for support of the cable.

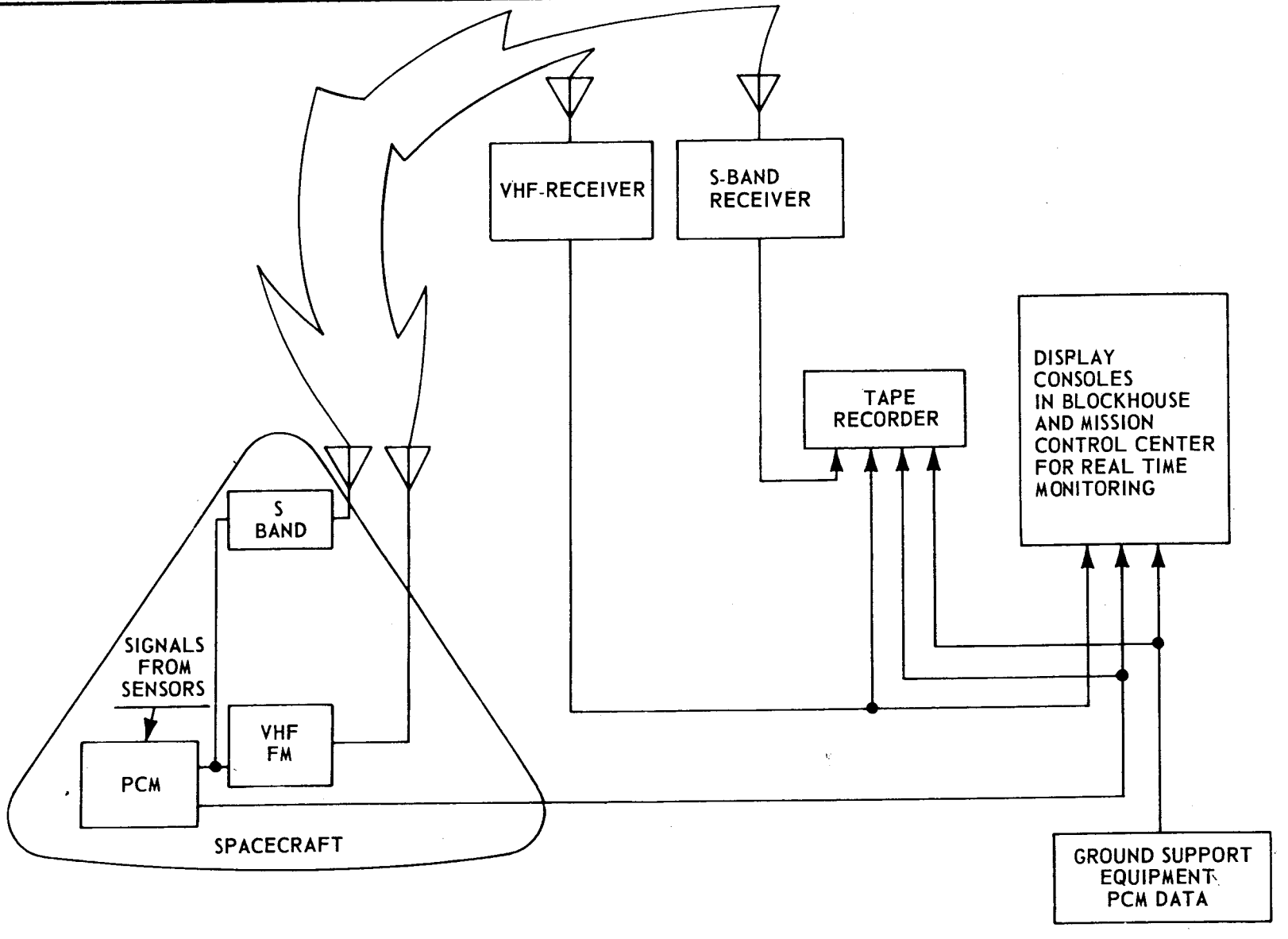
(b). Only one biomed tee adapter was installed and this was in the SRP position. The biomed parameters for the SRP position were being monitored on both PCM and the MDAS recorder and the time of incident.

Only the crew systems equipment required to support OCP-FO-K-0021-1 was stowed in the S/C. The stowed crew systems equipment which has an electrical interface with the S/C (cameras, hygrometer, alignment sight) were not connected to the S/C at the time of the accident.

(2). COMMENTS ON DATA

(a). PCM and MDAS recorder data throughout the test was normal except for several noise glitches which appeared on the biomed data channels. Physicians verified these glitches were not normal biomedical data. The first glitch occurred at 18:28:02 GMT and recurred randomly with the last one at 23:24:00 GMT. These noise spikes are believed to be caused by RFI, which has been duplicated during post-incident bench test by glitching the input power. From the time the MDAS was turned on and the timer reset to zero (17:36:02 GMT) until LOS of the timer (23:31:21.2 GMT), the timer operated normally with no loss of, or change in, timing.

(b). Based on the PCM and MDAS data available from S/C 012, there is no indication that the biomed system contributed to the case of the incident.



FLOW OF DATA INFORMATION FROM S/C AND GROUND SUPPORT EQUIPMENT