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27 December 1968

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FROM: [redacted]

SUBJECT: Final Report of J-49 (1048) Failure

The intention of this report is to apprise the Community of the J-49 (1048) Mission failure, analysis and final conclusion. This report includes data that has been previously disseminated but is considered very relevant for this discussion.

Summary

A. Problem - During rev. 180 of Mission 1048-2 (J49), the forward looking camera failed during camera operation. Failure of the camera was such that upon removal of the operate command the camera could not be electrically "shut down". The aft looking camera successfully completed the Mission.

Inspection of the recovered take up unit revealed the aft camera film severely tangled in the forward camera spool with loops of film wound around both spools.

B. The following are facts derived from telemetry data:

1. Loss of the commutator on Rev. 175 through Rev. 223. Returned to normal operation after main water seal closed.

2. Rev. 182 [redacted] indicated a continuous electrical load of 1.2 amps regulated power and 3.5 amps unregulated power. Power drain was equivalent to a single instrument operation.

3. Rev. 183 [redacted] verified regulated power load was from payload system. Forward camera input metering control was in the 99%, indicating shuttle had been on output side of last control change.

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4. Rev. 190 [redacted] verified forward camera had failed. The lens drive and film metering drive linkages were inoperative. The S.I. unit was not cycling. S.I. control and power load indicated the internal operate command for the forward camera was energized because the failure of the metering control linkage prevented the unit from being shut down.

5. Rev. 224 and Rev. 231 data verified the forward camera drive motor and tachometer were operating and would follow a V/H voltage change. System temperatures were normal. Cycle counter indicated the last frame was 71 on Rev. 181. A total of 94 frames were programmed for Rev. 181.

C. The following are data derived from the recovered film analysis:

1. The tail end of the forward camera was torn and not cut at approximately 6 inches into the format of Rev. 181 Frame 70.

2. Image sharpness indicates that frame 70 was in the rails at the time of exposure.

3. Last 43 feet of forward camera material was damaged.

4. A film splice was located 402 feet prior to the torn end of forward camera film.

5. The aft camera film depletion occurred on frame 20 of a 92 cycle operation on Rev. 216.

D. The following is a description of the recovered take-up unit prior to film recovery:

1. The aft camera film was severely tangled in the forward camera spool and in the S.I. take up puck arm assembly. Loops of film were around both take up spools.

2. Both take ups jammed.

3. All capsule resistance checks were normal.

4. Brake release and take up motion were normal after film de-spooled.

5. Forward camera wraps appeared soft.

6. Tangled film needed to be cut to execute de-spooling. 43 feet of the forward camera was damaged, but processed.

7. Inspection of the empty capsule revealed no torn or loose pieces of film. There was scoring of the forward spool flange by the puck arm. The forward camera spool puck arm was bent, however, some of the bending may have occurred while attempting to untangle the film.

Analysis

A. During the 1048 Pet Meeting, several failure modes were analyzed in an effort to establish the cause of the forward camera flight failure. Considerable weight was given to the belief that an abrubt stoppage of a camera would be detected on the vehicle guidance telemetry. It was also assumed that the instrumentation would respond in the same manner it has in the past during similar ground test experiences. The following table lists the most likely possibilities and data for either supporting and/or non-supporting these possibilities.

   1. See attached table

B. Subsequent to the 1048 Pet Meeting, several tests were conducted at Itek to further evaluate or substantiate the possible failure modes. A J1 instrument, engineering model, not exactly a J1 camera but representative of the film transport system was used. A summary of the tests are listed here:

   1. Various tests were conducted using pre-nicked and pre-cut film. These tests were to see if the nicked or cut film would eventually be torn by the camera, resulting in an instrument jam and sheared pin. Results of test did indicate the instruments could jam but did not shear any pins.

   2. Take up tests revealed that the tag end of the film of a continuously rotating spool, similar to 1048-2, was badly shredded and damaged. Results were not similar to 1048-2 conditions.

   3. A test with a supply spool indicated that a free running full or semi full spool would tend to cause the spool to unwrap after several minutes. Centrifugal force caused the wraps to work their way out toward the spool rim. Results of this test could indicate a cause for the 1048-2 recovered bucket condition.

4. One test, where the output shaft of the motor assembly was clamped and driven against a stop, resulted in a sheared pin. However, this test in no way simulates what might have happened in 1048-2.

5. Itek conclusions from their various tests are:

   a. The film will not break by forces within the camera unless the edge has been previously cut or nicked.

   b. Itek was unable to satisfy a proposed failure mode by having the film jam up, causing a pin to shear.

   c. The unspooling test duplicated to some measure the wrap characteristic on the number 1 take up.

   d. A loss of a pin in the main drive assembly was the only known way to explain this camera failure and be commensurate with the telemetry data. However, there is no known physical way that a loose taper pin can stay in place for even a short operation of the system.

Conclusion

It was the consensus of the investigating team at the P.E.T. Meeting that the failure mode most generally acceptable to all of the observed conditions is the loss of the pin in the main drive motor assembly. The tearing of the film remains unanswered but is believed to be a secondary effect of the failure.

The subsequent test/analysis at Itek provides another possible failure mode that links the torn film and camera failure to a single failure mode. However, this failure mode would most likely cause the camera to come to an abrubt stop with a subsequent vehicle perturbation.

In conclusion, we do not feel the J-49 failure was caused by an inherent design deficiency but was in nature, one of a kind. It should be noted here that there has been no similar failure to the main drive motor assembly in the history of the Corona M/J Systems, including ground test. The resulting action to be taken as a result of this failure is an inspection of the main drive assembly, with application of Cepox to the pins, during the final flight readiness for the remaining J1 systems. J3 systems exhibit a different assembly from the J1 systems.

We recommend this failure be considered closed.

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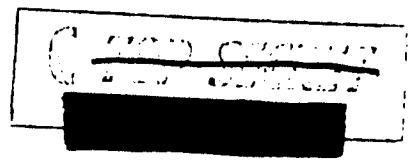
CAMERA FAILURE ANALYSIS

Cause	Supporting	Non-Supporting	Comments
1. Film Transport	a. Torn Film b. Camera Non-functioning c. Repetitive nick & crease pattern on film (very remote).	a. Vehicle Guidance T/M indicates no abnormal perturbation. b. Normal current loads (no fuses blown) c. Shuttle in 99% position d. No T/M indication on two continuous channels (Lens Rotation & Center Format) a. Torn film was not necessitated by failure.	Minimum film metered - 37 inches Maximum film metered - 62 inches Film tear appears to have taken place between I.R. assembly and the air twist after the shuttle.
2. Pin Loss in Motor Drive	a. No T/M indication on two continuous T/M chan. (Lens Rotation & Center Format) b. Operative Motor & Tach c. Tach Response follows V/H input. d. Shutdown had minor effect on guidance. e. Current load was normal. Camera failed to shut down, no action of S-107 shutdown switch.		a. The splice that passed on Rev. 18 Frame 23, possibly loaded the sys such that a pin or pins were part ially fractured that finally sever at the time of failure.
3. Torn Film from Supply Cassette	a. None w/o further analysis	a. Good photography to point of tear. b. T/M indicated supply spool was not rotating. Torn film would result in spool rotating continuously.	



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CAMERA FAILURE ANALYSIS (CONTINUED)

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Cause	Supporting	Non-Supporting	Comments
4. Miscellaneous			
A. Single Drive Belt Breakage	None	Loss of lens rotation & C.F. T/M requires two (2) belts breakage.	No belt failures have been experienced on any M/J1/J3 System
B. Frame-Metering Wrap	None	a. Missing T/M would be available. b. Camera could be shut down. c. Vehicle perturbation should be noted at jamb-up.	
C. Input Metering Mistrack	None	a. No evidence of mistrack on film. b. Load on instrument of magnitude to shear pin in the motor should cause vehicle perturbation.	
*D. Tach Failure	Time word indicated 3% speed up frames (68 to69)	a. Frame 70 photography indicates normal speed.	Further time word analysis will be performed.
5. Wrap/Mess in Take-up	None	No. 2 camera operated throughout mission.	The Wrap/Mess was an effect and not cause of the camera No. 1 failure.

* Subsequent investigation revealed an error in the original data. No error in cycle rate occurred as originally reported.

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