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Summary of Solar Eclipse Operations in Australia, June 1974

L. W. Lathrop

Sandia Laboratories

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SUMMARY OF SOLAR ECLIPSE OPERATIONS IN AUSTRALIA, JUNE 19[illegible]

L. W. Lathrop
Experiment Projects Division 1253

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Introduction

During the solar eclipse of June 20, 1974, a team of scientists and engineers from the United States and Australia conducted a series of scientific observations to study the temperature distribution in the solar corona. This report summarizes the performance of the rocket-launched experiments.

Two identical experiments were launched, designated as Tests 281-34 and 281-36. Both rocket systems performed nominally. Telemetry data indicated that Test 281-34 failed to acquire the sun before entry into the shadow. Film from the recovered payload verified that the sun was not in view. Test 281-36 appeared to point successfully at the sun. However, the payload was not recovered, and no scientific data were obtained. Table I gives a summary of observed and predicted significant events during the flights. A discussion of the probable cause of the failures follows.

Test 281-34

The telemetry record indicates that the roll output of the stable platform changed about 43 degrees between gyro uncage (-2 minutes) and launch times. A portion of this (17.5 degrees) is a result of actual motion of the launcher going from uncage azimuth to the final launcher setting. The remaining 25.5 degrees is apparently due to roll drift which was considerably outside the drift specification for the stable platform (30 deg/hr). This represents a roll error at launch that would have been translated to a yaw error of about 20 degrees after the programmed roll and pitch maneuvers. Data from the sun sensor

TABLE I

Significant Events During Flight
Tests 281-34 and 281-36

	Test 281-34		Test 281-36	
	Observed	Predicted	Observed	Predicted
Launch	5:11:00 UT	5:11:00 UT	5:11:30 UT	5:11:30 UT
2nd-Stage Fire	+13.1 sec	12.8 sec	13.0 sec	12.8 sec
Nose Blow	+57	56	56	56
Payload Separate and ACS Activate	+75	74	74	74
Despin	+77	76	76	76
ACS Control to Sun Sensor	N/A	-	127	-
Sun in View of On-Target Detector (+¼°)	N/A	-	128	-
Enter Totality, ACS Control to Integrating Rate Gyro. Start Camera	?	190	174	175
Timer Controlled Switch to Integrating Rate Gyro, Start Camera	+191	190	N/A	190
Leave Totality	?	410	405	400
Seal Camera, Baro Arm, Gyro Power OFF	+412	410	412	410
Heat Shield Deploy	+641.5	617	645	617
Parachute Breakwire	+651	627	655	627

substantiate an error of this magnitude. The control eyes of the sensor, with a field of view of about 15 degrees, show some signals; but the target eye, with a 5-degree field of view, does not show the sun in view. Control of the system could not pass to the sun sensor unless the sun was in view of the target eye. The integrating gyro system appeared to maintain the existing attitude at shadow entry within 7 arc-seconds, and the rate was held below 12 arc-seconds/second. The payload was successfully recovered about 2 hours after launch. Subsequent examination of the platform revealed the following:

a. The yaw axis potentiometer showed clear evidence of a deeply burned area at the caged position. This created a depression and rough area at the wiper location in the caged position. Such a rough area could develop high frictional torques in a static condition, producing high static roll error.

b. Broken cage bearing on the roll-yaw gyro caging arm. Remnants of the bearing were found in the gyro-roll gimbal area; in particular, a part of the bearing outer race was stuck to the lubricating grease on the roll gimbal bearing. The roll gimbal was not free to rotate through a full revolution and jammed when moved manually. All parts of the broken bearing were found except one ball which is probably still in the assembly stuck to a magnetic component such as the caging motor.

The burned area of the yaw potentiometer was caused by a voltage being applied at the wiper which, at the near caged position, would be close to the ground tap at the center of the potentiometer. This voltage could have been applied either externally or from an internal short to a high voltage, such as 26 volts ac motor power at slip rings or leaf contacts adjacent to the yaw potentiometer wiper circuit. The latter could have been caused by a piece of the broken cage bearing; however, the cause and time that the bearing was broken remain undetermined. The broken cage arm bearing could only have occurred prior to the final uncage command and only while the platform was either caged or in the process of being caged while high angular rates were applied to the platform or the roll-stabilized gimbal assembly with gyro power on. A review of the handling of the payload showed no time at which the conditions necessary to break the cage arm bearing were known to exist.

Static drift tests on the platform displayed a roll drift of approximately 3 deg/min. This is excessive but not as severe as the 12.75 deg/min encountered during the flight operation. The "hole" or "crater" in the yaw potentiometer was crystallized and, though rough, the potentiometer was electrically continuous and provided a good signal on an oscillograph recorder. Thus the high-current condition could have occurred anytime the platform was operating for the last time, during terminal countdown, in flight, or during reentry prior to power shutoff. It is most likely to have occurred while the wiper was at the zero yaw position and adjacent to the ground tap. It is possible that, while drawing a high current through the one small area, the "plastic pot" resistive element became molten. The molten state of the potentiometer material may be quite viscous and, if so, could have applied a torque about the yaw axis by "capturing" the wiper and thus produced a higher static roll drift than is now present when the potentiometer is in a crystallized state.

Test 281-36

The payload of Test 281-36 was not recovered. Telemetry records indicate that all other aspects of the flight were successful. The stable platform performed well and control was passed to the sun sensor as planned, with the payload pointed at the eclipsing sun within 1/4 degree at shadow entry. The payload entered and left totality within 5 to 10 seconds of prediction. While in the shadow, position control was maintained within 6 arc-seconds and rate control within 12 arc-seconds/second by the integrating gyro. Unfortunately the nature of the experiment required recovery of the film in the spectrograph. The sea-state in the recovery area was known to be undesirable at the time of launch; and, for an ordinary experiment (that is, one which could be postponed), the launch would have been held until more favorable recovery conditions existed. Tests performed on the electronic beacon from the recovered beacon reveal that the quality of the signal may be significantly degraded in high-sea-state conditions. In fact, the signals observed for Test 281-34 were much weaker than normal during the recovery operation. Changes were made in the beacon system prior to further use. However, after these changes were made, another recovery operation failed during November 1974 in Hawaii under very similar conditions. The current recovery system is being evaluated for use during high-sea states to determine possible causes for these problems.

The logistical and operational aspects of the mission were totally successful. Twenty-two engineers and scientists from four United States laboratories participated. The launch complex was constructed and operated with support from local contractors and the following Australian Government agencies:

Commonwealth Scientific and Industrial Research Organization
Department of Housing and Construction
Department of Meteorology
Department of Supply
Department of Civil Aviation
Department of Fisheries and Oceanography
Department of Defense (Navy)
Postmaster General

Details of the operation are contained in the following documents:

(1) Rocket Operations Plan, Australian Eclipse, June 1974, Sandia Laboratories, Albuquerque, NM, SLA-74-0117, March 1974.

(2) Smelser, J. H., Safety Plan for Australian Eclipse Operation in June 1974, Sandia Laboratories, Albuquerque, NM, SLA-74-0139, March 1974.