14 July 1964

To: DISTRIBUTION

From: [redacted]

Subject: YAW PROGRAMMER - FAILURE MODE ANALYSIS

1. INTRODUCTION

The purpose of this Failure Mode Analysis is to enumerate the possible modes of failure on the yaw programmer which may occur during a flight, to describe the possible causes of failure, and to recommend the proper action.

2. FAILURE MODES

2.1 No Mechanical Rotation

No mechanical rotation of the motor, gearhead, and resolver link is indicated by a lack of change in the orbital function TLM potentiometer output.

2.1.1 Probable Causes of Failure

a. Failure of the motor or its phasing capacitor.
b. Mechanical failure in the gear train.
c. Relay (400 cps ON-OFF) failed in the "off" position.
d. Failure to receive the start command (Brush 14.) Analyze the intermix stepper and V/H programmer start stepper telemetry to determine whether Brush 14 was received in the command box.
e. Fuse in the 400 cps line had blown.

2.1.2 Action

Send RTC 14 (Command Override) which grounds the yaw function output.

2.2 Loss of Automatic Reset Capability

The loss of automatic reset capability results in continuous operation of the motor instead of stopping at the end of 89 (+0, -1) minute. The indication of this failure mode will be from the gradual loss of synchronism between the desired yaw function and the actual yaw function, as indicated by the TLM potentiometer output.

2.2.1 Probable Causes of Failure

a. Failure of the automatic reset switch, in either the N.C. position or the N.O. position.
b. Failure of relay (400 cps ON-OFF) in the "on" position.
c. Failure of the blocking diodes in the automatic reset lin

2.2.2 Action

Send RTC 14 (command override) which grounds the yaw function output.

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2.3 Command Override Failure

Loss of command override (RTC 14) capability is indicated by the command override telemeter point, which is operated off one of the contacts of the relay flip flop.

2.3.1 Probable Causes of Failure

a. Failure of the relay flip flop.
b. Failed to receive the override command. (RTC 14).

2.3.2 Action

No action can be taken.

2.4 Others

Although very improbable, there are numerous other possible failure mode which can occur but cannot be detected by telemetry and therefore no action can be taken. However, a catastrophic failure due to the yaw programmer is unlikely. A dual failure is required for a possible catastrophic failure, i.e., a failure in the vehicle horizon sensor and an undetected yaw programmer failure.

Since the yaw function output is only indirectly monitored by the TLM potentiometer, it is possible that the yaw function output be incorrect even though the potentiometer indicates correct yaw function output. The test history of the yaw programmer indicates that this type of failure is very unlikely.

Open circuits in the transformer, or resolver, may result in no yaw function output to the guidance system. This cannot be detected through telemetry and therefore RTC 14 will not be given. However, this is not a catastrophic failure because the guidance system will see less than 25 ohms to ground.

The worst case undetected failure is a condition where the desired yaw function is 180° out of phase with the actual yaw function. The maximum yaw error in this case will contribute about 8% to the IMC error instead of about 4 percent without the yaw programmer. This IMC error due to the yaw function will add vectorally to the forward motion compensation error which is about 4%. The worst IMC error will be about 10% assuming that the lowest inclination orbit is 65 degrees.

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Manager
PROGRAM I

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