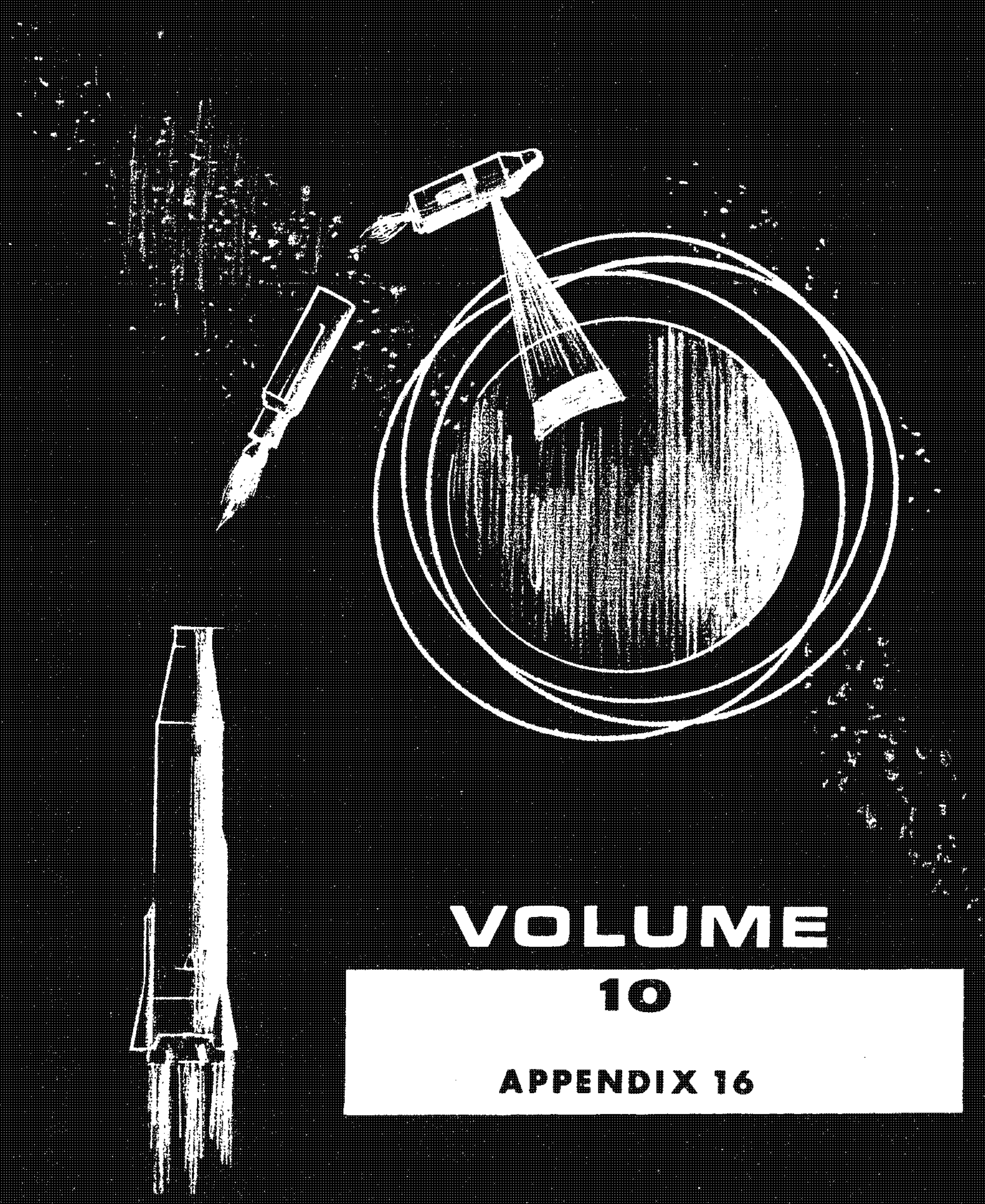
206

PROGRAM REPORT

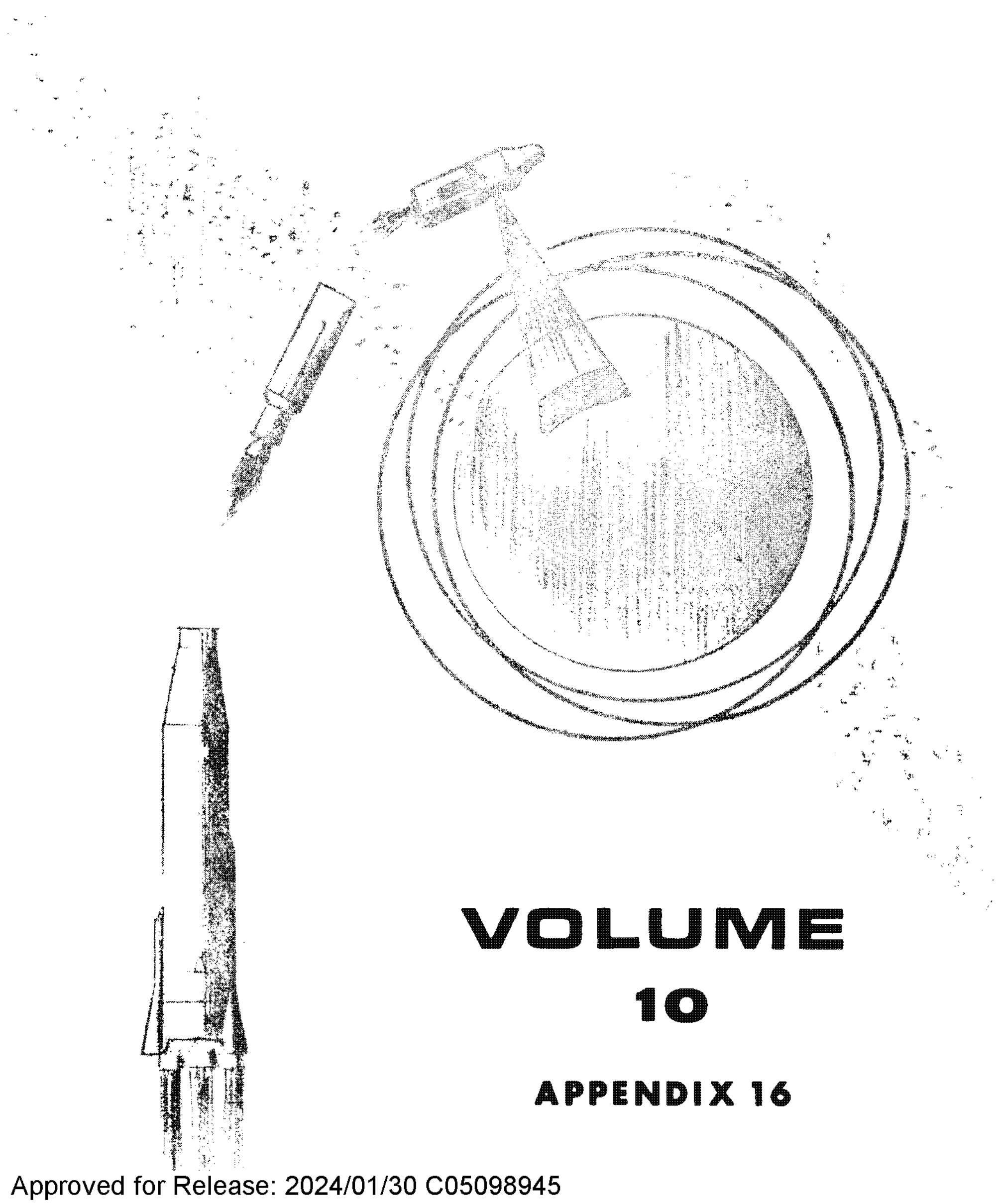


VOLUME
10
APPENDIX 16

THIS DOCUMENT CONTAINS 368 PAGES
NOVEMBER 1967

206

PROGRAM REPORT



VOLUME 10

APPENDIX 16

CONTENTS

APPENDIX 16

QUALIFICATION TEST REPORT

CD-14566
S-R-092

This document
consists of
366 pages.

Qualification Test Report

EASTMAN KODAK COMPANY
Apparatus and Optical Division
Rochester 4, New York

Under Contract
AF-33(616)-7704

Approved By:

J. A. Rodgers

[signature]

Date: 17 April 1964

Copy Number _______

(Supplemental Title Page)

Qualification Test Report

Eastman Kodak Company
Apparatus and Optical Division
Rochester 4, New York

Prepared By: H. C. Lake

Reviewed By: Charles M. Judd

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF TABLES

INTRODUCTION

The purpose of the qualification test program was changed from that of qualifying the FM 1 design which had only a limited mission requirement to that of qualifying the finalized payload design to the greatest extent possible. The qualification testing specified in the "Flight Payload Qualification Test Plan", Eastman Kodak Drawing 802-148, was conducted. (This document is found in Part I of Appendix A.) As can be seen from this plan, testing was conducted at both payload and component levels of assembly. Because environmental test levels for the components proved to be far more severe than the payload levels were, the major design changes that evolved during the test program were qualified by additional component level tests. As a result of extensive retesting at the component level, it is believed that the current flight model (FM 8) is a fully qualified design.

SECTION 1
CONCLUSIONS AND RECOMMENDATIONS

1.1 QUALIFICATION STATUS

1.1.1 Payload

The RM payload satisfactorily passed the following qualification level tests: vibration, film tracking in various orientations, and life in a vacuum environment.

The degree of conformance of the RM payload to the electromagnetic interference (EMI) goals of MIL-I-26600 and Eastman Kodak Company (EKC) Drawing 802-222 was determined.

The RM payload was built before Flight Model No. 1 (FM 1) and many design changes have since been incorporated in recent flight model payloads. Since most of the design changes were qualified at component level testing, which is more severe than payload testing, it is believed on the basis of engineering judgment that qualification testing at the payload level is not necessary. These differences between the RM and FM's 1 through 8 are discussed in Appendix B.

1.1.2 Components

The reliability enhancement components (RC Model) satisfactorily passed each of the tests shown in Table 1-1. In several instances it was necessary to modify the design before successful results could be obtained.

TABLE 1-1

COMPONENT QUALIFICATION TESTS

Tests Conducted

Component	Vibration	Shock	Acceleration	Shipping Temperature	Humidity	Life	EMI	Miscellaneous Tests
Optical System								
Camera	X					X		Velocity smoothness
Slit aperture plate	X			X	X	X		Abrasion test
Lens								Thermal test
Camera shipping container		X						
Film Handling System								
Film supply	X	X	X	X		X		
Film take-up	X	X	X	X		X		
Capsule*	X							Light leak and handling
Accessory shipping container								Drop test
Electronics Components								
Distribution box	X	X	X	X				Operating temperature extremes
Regulated power supply	X	X					X	Thermal shock
Film drive electronics	X	X	X	X				
Focus control electronics	X	X		X	X			
Signal gating module	X	X	X		X	X		Operating-temperature extremes
Door tell-tale assembly	X					X		
Environmental Control System								
Heater controller (used with (thermostats)	X	X				X		Operating-temperature extremes
Heater controller (used with (thermistors)	X					X		Operating-temperature extremes

* The capsule was not intended to be qualified. It served only as a fixture for holding the film handling elements.

TABLE 1-1 (Continued)

Tests Conducted

Component	Vibration	Shock	Acceler-ation	Shipping Temperature	Humidity	Life	EMI	Miscellaneous Tests
Structure								
Elevation plate assembly	X					X		Static load
Servos	X	X	X	X	X	X	X	Axial thrust load and end play
Cables and Related Assemblies								
Cable assembly	X	X	X	X	X	X		
Test box	X	X		X	X			
Junction box	X	X		X	X			
W-1 cable	X	X			X			
Cable support bracket (welded type)	X	X			X			
Cable support bracket (formed type)	X							

The combined sine-random vibration test at the component level was the most difficult test to pass. Because of the successful results of the component qualification tests, the current flight payload (FM 8) is believed to be completely qualified.

Appendix B also lists the significant design differences between FM 8 and the RC. These differences were qualification tested only in the environments which previous testing showed to be the most severe.

1.2 MODIFICATIONS

Numerous modifications were made on flight payloads as a result of qualification testing. Table 1-2 summarizes these modifications.

1.3 DELETED TESTS

A careful review of the test plan showed that it was not necessary to conduct certain component tests and these were deleted from the test plan by revision C. The revised plan is found in Part I of Appendix A. The reasons for the deletion of these tests are explained in Part II of Appendix A.

TABLE 1-2

SUMMARY OF PAYLOAD MODIFICATION AS A RESULT OF QUALIFICATION TESTS

Component	Modification	Reason
Structure	Unibal shaft coated with Teflon.	Unibal was found frozen on its shaft after payload X-axis vibration.
Elevation plate assembly.	Locking device added to azimuth pivot stud nut.	Nut became loose during X-axis vibration of elevation plate assembly.
	Stereo mirror assembly redesigned to move its center of gravity.	This assembly had high transmissibilities during vibration of the elevation plate assembly. However, this was only one factor causing this change, as optical considerations also helped bring it about.
	Drive pin in crabbing servo shaft and lead screw redesigned to include the use of "keepers" to prevent bending stress.	Pin failed in bending during payload Z-axis vibration.
	Drive pin in crabbing servo shaft and lead screw changed from roll pin to solid pin.	Pin failed during Z-axis vibration of the elevation plate assembly.
	Thermostats on primary structure ring moved to different locations on ring and provided with a more resilient mount. Thermostats were later replaced by thermistors, and the design of the controller changed to suit.	Thermostats failed to operate after payload X-axis vibration.
	Two ground straps changed from solid type to braided type.	Failed from bending fatigue during EMI test.
	Azimuth pillow blocks pinned and clearance increased between crabbing servo lead nut and pillow block.	Crabbing servo stalled during operational test following vibration of elevation plate. Failure was caused by misalignment.

TABLE 1-2 (Continued)

Component	Modification	Reason
	Shape of aperture mask changed.	Rod assembly broke loose from mask during resonance search because of fatigue caused by relative motion where the rod is attached.
	Method of safety wiring the stereo servo jam nuts changed.	Jam nuts became loose during payload vibration in the Y axis.
	Method of locking nut on azimuth pivot stud changed.	Stud nut became loose during payload vibration.
Optical system	Additional flexures totaling 36, fabricated from a tougher, hardened spring steel, were added to the assembly.	Flexures found broken and bent after payload vibration.
	Diameter of longitudinal support for primary mirror increased.	Best focus shifted out of range of platen travel after X-axis vibration.
	Parts plugged that were suspected of retaining manufacturing chips.	Metal chips found on meniscus lens, primary structural ring, and inside lens barrel after vibration.
Film supply	The looper potentiometer drive shaft redesigned.	Drive shaft failed from fatigue during payload life test.
	The gear train of the torque motor assembly locked in place to form a more positive drive.	Gear train was not in mesh during qualification vibration test and thus a number of teeth were ground off.
	Nickel plate rollers replaced by emeralon coated rollers.	Rollers rotated during qualification vibration test causing scratching on the film and the roller surfaces.

TABLE 1-2 (Continued)

Component	Modification	Reason
Film take-up	The tension arm assembly reshaped.	With 2700 feet of film on the take-up reel, the tension arm rubbed against the film.
	More polysulfide compound being used to mount the alignment mirror.	Alignment mirror separated from its mount during qualification vibration test.
	Displacement compensator bracket strengthened.	The bracket broke during qualification vibration test.
	The one-way clutch in the drive spool redesigned to incorporate three pawls and a ratchet wheel.	Take-up spool rotated during qualification vibration test.
	Displacement compensator frame strengthened.	The frame showed evidence of cracking during qualification vibration test.
	Chromeplate rollers replaced by the Teflon rollers.	Rollers rotated during qualification vibration test causing scratching of the film and the roller surfaces.
Distribution box	Foam potting added around relay terminals and wires.	Result of failure of relay wires and terminals during vibration.
	Relays epoxied to boards.	Evidence of high stress in relay mounting found after vibration.
	Record transport control foam potted.	Result of failure of component leads in vibration.
	Crimp terminals used instead of solder.	Result of lead breakage in vibration.

TABLE 1-2 (Continued)

Component	Modification	Reason
	Edge of record transport control chamfered.	Result of cold flow of wire insulation, which caused short circuits.
Film drive electronics	Wires supported by bundling with other wires.	Wires broke during vibration.
	Relay section foam potted.	Relays and leads broke during vibration.
	Oscillator section potted with sylgard and capacitors epoxied in place.	Capacitors moved and their leads broke during vibration.
	Duxseal added to oscillator toroid board.	Toroid wires failed in vibration. Duxseal is used for damping.
	Leads to filters rerouted and support added under filters.	Failures of wires and loosening of filters during vibration.
Focus control electronics	Foam potting added around TO-5 transistors (units thru FM 3).	Result of failure of leads during vibration.
	Transistor pins shortened and epoxy potting added in recesses.	Result of failure of pins and leads during vibration.
	Mounting of TO-5 cased transistors changed to provide shortened leads (FM 4 and on).	Improved method of preventing transistor lead failure.
	Solid state switching substituted for relays.	To improve EMI characteristics.
	Leak rate test requirement added at box assembly level.	To increase confidence in leak resistance of box.
Signal gating module	Wires cemented down and some wire runs shortened.	Result of failure of wires during vibration.
Regulated power supply	Redesigned (with EMI improvement as one of the objectives)	Unit failed in EMI test.

TABLE 1-2 (Continued)

Component	Modification	Reason
Servos	EMI filter boxes added.	Units failed in EMI test.
	Screw torque spec. added.	Screws loosened during vibration.
	Capacitor in overload circuit changed to Hyrel type.	Capacitors failed during vibration.
Welded cable support bracket	Design changed to formed type.	Result of failure of the bracket in vibration.

Approved for Release: 2024/01/30 C05098945

SECTION 2
PAYLOAD QUALIFICATION TESTING SUMMARY

2.1 INTRODUCTION

The Reliability Model Payload was used for the payload qualification testing which is specified in the Flight Payload Qualification Test Plan, Eastman Kodak Drawing 802-148 (see Appendix A), and which is described in the following paragraphs. Through this testing it was found that the payload is capable of withstanding its launch and mission environments.

A more detailed account of each of these tests is presented in the individual Reliability Test Reports. These reports, referenced in the following paragraphs, are contained in Appendix E. Appendix C provides a cross reference between these tests and the testing specified in the test plan. Appendix D gives the environmental test criteria of the test plan to which the tests were conducted.

2.2 VIBRATION (Reports No. 49, 68, and 75)

2.2.1 Results

The payload was subjected to three separate qualification sine-random vibration tests. During the first test, the payload was subjected to only X-axis vibration because it had been decided to update the lens as soon as possible. The payload was subjected to all three axes of vibration during the second test. The third test was conducted in all three axes to qualify modifications made as a result of failures in the second test and to investigate stereo mirror flexure failures found in the second test. A combined summary of the results of these three tests is given below.

It appeared that as a result of effective payload damping, the components of the payload experienced relatively small acceleration loads above a frequency of 100 cps. Resonance was found to occur in the frequency range of 15-24 cps.

Although evaluation of the photographic capability of the payload was somewhat impaired by low resolution, it was nevertheless felt that meaningful results were obtained. Photographic tests conducted during the first two tests (photographic testing was not conducted during the third test) showed that the photographic capability of the payload was not significantly affected by vibration. The resolution during each test remained about the same. In the first test there was an apparent change in the photographic best-focus position but in the second test there was little change. In the second test the distance between photographic best focus and best focus as determined by the focus control system increased as vibration testing progressed until it was slightly out of specification after the final axis of vibration. The cause for this condition is believed to have been in the focus detection assembly of the camera.

The electronic component assemblies were not affected by vibration. The three thermostats on the primary structure ring failed during the first test. New thermostats were mounted for the second test and these failed during Y-axis vibration. Three more thermostats mounted in different locations on the ring passed the X-axis vibration in the second test and the Y- and Z-axis vibration in the third test. On FM 7, the thermostats were replaced by a thermister-type temperature controller.

Several mechanical failures occurred during vibration. The significant failures were:

1. The drive pin in the azimuth servo shaft and lead screw sheared at 16 cps during the Z-axis vibration of the second test. As a result, a modification was made which restrained the pin from bending. The pin survived all three axes of vibration during subsequent vibration testing.

2. An inspection of the stereo mirror assembly following the second test revealed that nearly all of its flexures were broken. The third test was run primarily to determine whether this failure would be repeated. In this third test, nearly all the flexures were slightly bent but only a few were actually broken. It is believed that the results of the two tests were different because in the second test, the payload was subjected to extra vibration in the resonant frequency range in the course of qualifying the modification for the drive pin (par. 1 above). Design effort is continuing to alleviate the flexure failure problem.

3. Following the X-axis vibration of the second test, it was observed that the lower component support tube had cracked welds near two mounting holes on the -Z side. The weld cracks may have been caused in part by the fact that a spacer was missing between the tube and the structure.

2.2.2 Conclusions

The payload will survive qualification sine-random vibration. Since engineering judgment indicates that vibration is more severe than shock or acceleration, it is believed that the payload will survive the launch phase of its mission.

2.3 FILM TRACKING IN VARYING ORIENTATION (Report No. 57)

2.3.1 Results

The payload was oriented so that its +Y, +Z, -Z and +X axes were directed downward. The take-up was misaligned by a specified amount, and film was run through the system in each of these orientations. The film handling system properly tracked film under all of these conditions.

When the payload was oriented so that its +Z axis was toward the floor, it was observed that the tension arm assembly in the take-up scratched the film. It is believed that this problem cannot be attributed to the conditions of this test. A newly designed tension arm assembly was installed prior to the second part of the life-in-vacuum test and proved to be satisfactory (see par. 2.4.1).

2.3.2 Conclusions

The film handling system will track film properly regardless of the orientation of the payload. It should therefore track film properly in a state of weightlessness also.

2.4 LIFE OPERATION IN VACUUM (Reports No. 58 and 67)

2.4.1 Results

This test consisted of two parts. The first part (described in Report No. 58) was conducted to verify the payload's capability to perform satisfactorily in a temperature-controlled environment when it operates at a cycling rate equivalent to normal orbital operation during a five-day mission. The second part (described in Report No. 67) was conducted to verify the payload's capability to operate continuously in a vacuum environment and its capability to resolve minor difficulties encountered in the first part.

A comparison of the results of photographic tests conducted before and after the first part of the test showed that the photographic capability of the payload was not affected by the vacuum environment.

During the first part of the test, it was intended to determine whether film velocity smoothness was affected by a vacuum environment. Since test results from this part were not readable because of improper test techniques, test results from the second part of the test had to be relied upon. These results showed that film velocity smoothness was definitely degraded by a vacuum environment. However, since the payload camera had bellows of an obsolete design, it was believed that these results were inconclusive.

The heater systems were seen to operate properly as monitored temperatures were maintained close to thermostat turn-on and turn-off temperatures.

Motor operation was not affected by the vacuum environment as evidenced by the fact that motor currents, for the most part, remained nearly constant. However, the stereo servo motor current varied and was out of specification during the first part of the test. Since the current was out of specification prior to the test, it was felt that this could not be attributed to the conditions of the test but rather to servo alignment problems encountered during assembly. In spite of this condition, servo transition times remained constant and within specification.

The second part of the test, which was conducted after attention had been given to the alignment problem through the modification of the stereo servo bracket, showed no problems of servo motor current.

During the first part of the test, the film handling system demonstrated its capability to track film properly in a vacuum environment. However, when there was nearly 3000 feet of film on the take-up spool, the take-up speed began to decrease until finally it was well below the specification. The cause for this was not attributed to the conditions of this test as it was found that the tension arm assembly was causing excessive drag on the take-up spool. A redesigned tension-arm assembly was used during the second part of the test and no problems were encountered. It was also found during the second part that the film handling system was capable of continuously tracking film in a vacuum with the take-up purposely misaligned.

During the second part of the test the potentiometer drive shaft in the film supply broke. Although this was a wear-out failure and was therefore not attributed to the environment of this test, it is significant because it was the first wear-out failure to occur during payload testing.

2.4.2 Conclusion

The payload will operate properly in vacuum throughout a simulated normal five-day mission.

2.5 ELECTROMAGNETIC INTERFERENCE (EMI) TEST

The EMI test on the Camera Payload subsystem was conducted to determine the degree of compliance with the Interference Control Requirements, Aeronautical Equipment, MIL-I-26600 and Phase II Electromagnetic Interference Specification No. 802-222 (Addendum to MIL-I-26600).

In accordance with these goals, a determination was made of conducted and radiated EMI that the payload generates as well as the susceptibility of the payload to conducted and radiated EMI.

The degree of compliance with the EMI control requirements was reported in S-R-081, CD-12986, dated 28 February 1964.

SECTION 3
COMPONENT QUALIFICATION TESTING SUMMARY

3.1 INTRODUCTION

The testing conducted on the individual components known as the reliability enhancement components (RC Model) is described below. Through this testing, which is specified in the Flight Payload Qualification Test Plan, Eastman Kodak Drawing 802-148 (see Appendix A), it was found that, in general, the components are capable of withstanding their launch, mission, and re-entry environments. Re-entry environments apply only to take-up components.

A more detailed account of the testing of each component is found in individual Reliability Test Reports. These reports are referenced in the following paragraphs and are contained in Appendix E. Appendix C provides a cross-reference between the component tests and the testing outlined in the test plan. Appendix D gives the environmental test criteria of the test plan to which the tests were conducted.

3.1.1 Camera

3.1.1.1 Tests

1. Vibration (Report No. 86)
2. Life (Report No. 101)

3.1.1.2 Results. The RC camera was first subjected to component sine-random vibration in the X-axis. Two critical failures occurred in the focus drive assembly as a result of X-axis vibration. The connecting rod on the focus drive mechanism broke. Analysis showed that the hardness of the part that failed was below the specified requirement. The second critical failure was a broken dip-brazed joint on the focus-drive gear-box housing. Analysis indicated that the defective joint was poorly brazed. A new focus drive assembly was then assembled into the RC camera and vibration in the X-axis was repeated after the Y and Z axes of vibration. The second X-axis vibration was completed with no failures in the focus drive assembly.

The Y-axis component sine-random vibration resulted in one major failure. The flexure mount bracket which fastens to the mechanical frame loosened. Analysis of the failure showed that two screws fastening the bracket to the mechanical frame became loose and caused the epoxy between the bracket and the frame to break. Analysis of the two screws and four others removed during the change showed a possible lack of Loctite and a film of grease on the threads. Since this was not a design failure, a re-vibration was not performed.

Z-axis component sine-random vibration on the RC camera resulted in no major or critical failures.

The RC camera was subjected to a low pressure (0.002 psia) life test utilizing 3,000 feet of film. The camera was operated on a 10 minutes "on", 70 minutes "off" cycle throughout a period of three days.

3.1.2 Lens

3.1.2.1 Test, Thermal (Report No. 30)

3.1.2.2 Results. A thermal test was conducted on a 77-inch lens assembly to determine the effects of temperature on the focal position. The test set-up consisted of thermally isolating the lens assembly from the collimator and enclosing the lens assembly with a thermal tent with an attached air conditioner and heater units.

The thermal test consisted of determining the focal positions for best resolution of the vertical and horizontal bar charts at temperatures of 58 F, 72 F, and 80 F. An Average Temperature versus Focal Position curve was drawn from the points of best resolution and it was determined that the focus position shifted approximately 0.001 inch over a temperature range of 58 F to 80 F. The results of this test are in fair agreement with the calculated focus shift.

3.1.2.3 Conclusions. The focal point was found to shift 0.001 inch as the result of a temperature change from 58 F to 80 F. This amount and its direction are in agreement with the calculated focus shift.

3.2 FILM HANDLING SYSTEM

3.2.1 Film Supply

3.2.1.1 Tests

1. Vibration (Reports No. 46, 62, and 103)
2. Acceleration (Report No. 87)
3. Shock (Report No. 71)
4. Shipping temperature extremes (Report No. 61)
5. Life (Report No. 79)

3.2.1.2 Results. The first sine-random powered flight vibration test (Report No. 46) on the film supply resulted in two major failures. During the X- and Y-axes of vibration, the film tension dropped to zero because one of the tension spring stud nuts came off. An elastic stop nut was then used to replace the plain nut and the locking cement previously used. Vibration in the Z and Y axes resulted in no loss of film tension. Another failure was the brinnelling of the slot in the drive pot shaft by the stainless steel roller stud assembly. The roller bearing was changed to a Teflon bearing. The second vibration test (Report No. 62) was conducted to qualify the EMI filter box assembly which mounts on the side of the looper assembly. No failures resulted. Hardware for the instrumentation augmentation program was qualified in the third vibration test (Report No. 103) and no failures resulted. Operability tests for each of the three vibration tests were completed successfully.

The film supply successfully survived the powered flight acceleration test, shock test, and shipping-temperature-extremes test with no failures. Operability tests before and after each test were successfully completed.

The life test conducted on the film supply resulted in no degradation of any moving parts under a low pressure of 150 microns while operated for a period of twice the orbital life. Operability tests before and after the life test showed no change in performance.

3.2.1.3 Conclusions. The film supply as currently designed will survive the storage and transportation, powered flight, and orbital flight environmental conditions without impairment of its performance.

3.2.2 Film Take-Up

3.2.2.1 Tests

1. Launch vibration (Reports No. 33, 37, 41, and 102)
2. Launch shock (Report No. 44)
3. Launch acceleration (Report No. 74)
4. Re-entry vibration (Report No. 76)
5. Re-entry shock (Report No. 80)
6. Re-entry acceleration (Report No. 76)
7. Shipping temperature extremes (Report No. 45)
8. Life (Report No. 79)

3.2.2.2 Results. Launch vibration was performed on the ALR take-up (Report No. 33) because of its similarity in design to the new ALR^2 take-up. The one-way clutch in the take-up spool did not hold during vibration and allowed the spool to release film. A second failure was the separation of the alignment mirror from its bracket because of an insufficient amount of polysulfide rubber compound. Another major failure was separation of the displacement compensator from the take-up because of a fractured bracket. Vibration in the Z-axis (Report No. 37) was performed on the ALR take-up after the displacement compensator was reassembled. Results of the Z-axis test revealed that the internal pivot shaft of the eccentric roller rubbed against the inner surface of the eccentric roller. Secondly, a set-screw failed to prevent the positioning roller shaft of the eccentric roller from rotating. Third, the displacement compensator frame had two noticeable cracks at the weldments.

The new ALR^2 film take-up incorporated several design changes which resulted from tests on the ALR design. Polysulfide rubber compound was applied along the perimeter of the alignment mirror instead of at four points. The pivot shaft and the bracket, which support the displacement compensator, were strengthened. The set screw for the positioning roller shaft was replaced with a dowel pin and the displacement compensator frame was fabricated as a cast part and strengthened considerably in design. The "one-way" clutch was completely redesigned to incorporate a ratchet wheel and three pawls. Launch vibration in the X, Y, and Z axes was performed on the new ALR^2 film take-up (see Report No. 41). Two screws in the mirror bracket assembly and two screws for the nylon cable clamps loosened. Longer screws are now being used to insure complete engagement into the locking helicoils. Rotation of the rollers during vibration caused a scuffing action between the film and rollers. Chrome rollers now being used are expected to eliminate the film and roller scuffing. Because the stainless steel ball-bearing roller at the end of the tension arm assembly would not rotate freely, it was replaced with a Delrin roller. The ALR^2 film take-up was updated with hardware for the instrumentation augmentation program and with the reversible drive motor assembly. After three axes of launch vibration (Report No. 102), no failures occurred in the instrumentation augmentation hardware. The reversible clutch failed to hold at the beginning of the test because all three pawls were not in contact with the ratchet wheel. The pivot hole in each pawl had an interference fit with the pins. After the holes in the pawls were enlarged for proper clearance, the test was successfully completed.

The ALR^2 film take-up survived launch acceleration and shock tests with no failures or changes in operability performance.

Re-entry vibration, shock, and acceleration testing of the ALR^2 film take-up was successfully conducted with no failures.

The shipping-temperature-extremes test had no effects on operability performance of the ALR^2 film take-up.

Life testing of the ALR^2 film take-up showed no degradation in performance resulting from low pressure, temperature changes, and an operational time of twice an orbital life.

3.2.2.3 Conclusions. The film take-up of the ALR^2 design will survive the storage and transportation and powered flight environmental conditions without impairment of its performance. The film take-up is qualified to wind 3,000 feet of film during orbital flight environmental conditions and will adequately protect 3,000 feet of film during de-orbit environmental conditions.

3.3 ELECTRONIC COMPONENTS

3.3.1 Distribution Box

3.3.1.1 Tests

1. Vibration (Reports No. 40, 72, 73, and 98)
2. Shock (Report No. 42)
3. Acceleration (Report No. 81)
4. Shipping Temperature Extremes (Report No. 84)
5. Operating Temperature Extremes (Report No. 96)

3.3.1.2 Results. The results of the first vibration test (Report No. 40) showed wires and terminals broken in the record transport control module after vibration in the X axis. The next two axes of vibration (Report No. 72) yielded similar results. No failures were detected after Y-axis vibration but broken leads were found in the record transport control module after vibration in the Z axis. The next test (Report No. 73) qualified the record transport control module in all three axes, but a failure was found in the CPL 5 differential amplifier module, consisting of a broken wire and loose terminal, after X-axis vibration. The distribution box also failed in leak rate after X-axis vibration. The final vibration test (Report No. 98) served to qualify a redesigned distribution box with respect to the failures noted above, as well as the additional motor current assembly, since the entire distribution box was vibrated in all three axes without failure.

The distribution box was not adversely affected by the shock test, the acceleration test, and the shipping-temperature-extremes test.

The distribution box complied with all performance and leak rate requirements after the operating-temperature extremes test. The test was conducted only at the low extreme of operating temperature (45 F) and at atmospheric pressure.

3.3.1.3 Conclusions. The current distribution box is capable of withstanding the temperature conditions associated with shipping and storage, non-operating shock, vibration and acceleration conditions associated with launch, and operating life and temperature conditions associated with the mission period.

3.3.2 Regulated Power Supply

3.3.2.1 Tests

1. Vibration (Test Report No. 2)

2. Shock (Test Report No. 1)
3. Thermal Shock (Test Report No. 3)
4. EMI (Test Report No. 4)

3.3.2.2 Results. The results of the vibration test showed that the regulated power supply passed the vibration test without degradation. The test consisted of random vibration only, at a level of 0.1 g^2/cps from 20 to 2000 cps in 3 axes.

The regulated power supply performed satisfactorily after being subjected to the shock test, and the thermal shock test.

The regulated power supply failed to meet the requirements of MIL-I-26600 in conducted interference, radiated interference, and susceptibility to audio-frequency interference.

3.3.2.3 Conclusions. The regulated power supply is capable of meeting the launch and mission environmental conditions with respect to vibration, shock, and temperature. A regulated power supply of more recent design was tested at payload level for EMI.

3.3.3 Film Drive Electronics

3.3.3.1 Tests.

1. Vibration (Reports No. 53, 63, 65, 77, and 85)
2. Shock (Reports No. 51 and 90)
3. Acceleration (Report No. 91)
4. Shipping-Temperature Extremes (Report No. 92)

3.3.3.2 Results. The first three of the vibration tests (Reports No. 53, 63, and 85) which were individual tests in the three axes Z, X, and Y, respectively, showed various failures due to insufficient support and damping of the parts in the motor speed drive. These failures included broken wires at the filter, relays and oscillator board; one relay broken from its mounting; capacitors rotated in their clips; and broken epoxy and leads on the oscillator toroid board.

The next vibration test (Report No. 65) was intended primarily to test specific proposed changes to the areas which previously had been subject to failure. The specific changes were (1) addition of duxseal to the oscillator top board, and (2) re-routing of the wires to the filters. Test results showed that the repaired areas successfully withstood the vibration test. The next vibration test (Report No. 77) served to qualify the motor speed drive which had been updated with the same design changes tested in the previous test, and also the use of sylgard potting in the oscillator section and support blocks under the filters. The results of this test showed that the motor speed drive survived the vibration test in three axes without degradation.

The shock test was conducted twice (Reports No. 51 and 90) because the motor speed drive was updated to include the design changes found necessary in vibration testing. The motor speed drive survived the shock test in both instances without degradation, and was not adversely affected by the shipping and storage temperature test.

3.3.3.3 Conclusions. The motor speed drive as now designed is capable of withstanding the temperature conditions associated with shipping, and the shock, acceleration and vibration conditions associated with launch, without degradation.

3.3.4 Focus Control Electronics

3.3.4.1 Tests

1. Vibration (Test Reports No. 47, 50, 52, 82, 83, and 89)
2. Shock (Test Report No. 38)
3. Shipping-Temperature Extremes (Test Report No. 66)
4. Life (Test Report No. 88)

3.3.4.2 Results. The results of the first two vibration tests (Test Reports No. 47 and 50) revealed failures of the transistor leads and pins and certain wires in the signal gating module. The transistor leads and pins were shortened and potted and the signal gating module wires were cemented in place as a result of this testing. The results of the next three vibration tests (Test Reports No. 52, 82, and 83) showed no degradation in performance as a result of qualification level vibration in all three axes.

The final vibration test (Test Report No. 89) served to quality the focus control electronics for operability after updating with solid-state switching and with cemented-in transistors.

The results of the shock test showed no detrimental effects on the unit.

The shipping-temperature-extremes test had no adverse effect on the operability of the focus control electronics.

The life test had no detrimental effect on the operability of the unit.

Leak-rate tests in conjunction with the Y-axis vibration (Test Report No. 52), shipping-temperature extremes (Test Report No. 66), and life (Test Report No. 88) all showed leak rates in excess of specification. Investigation of the history of the box used on this unit showed that it had been waived because of porosity of the welds. After each occurrence of the excessive leak rate, the porous area was sealed with epoxy, but a permanent repair was not achieved. The leak rate problem was not considered significant because of the history of the box and because the focus control electronics continued to operate satisfactorily throughout the testing.

3.3.4.3 Conclusions. The current design of the focus control electronics is qualified, since it demonstrated capability of operating after exposure to the temperature conditions associated with shipping and the vibration and shock conditions associated with launch. It also demonstrated the capability of operating under life, pressure, and temperature conditions associated with the active mission.

3.3.5 Signal Gating Module

The signal gating module is part of the focus control electronics and has undergone additional testing in that connection (see par. 3.3.4). The tests listed here are those conducted by the signal gating module subcontractor.

3.3.5.1 Tests

1. Vibration (Report No. 6)
2. Shock (Report No. 7)
3. Acceleration (Report No. 8)
4. Operating and Shipping Temperature Extremes (Report No. 9)
5. Humidity (Report No. 10)
6. Life (Report No. 11)

3.3.5.2 Results. The results of the vibration test showed that the signal gating module is capable of withstanding the vibration test conducted, which consisted of random vibration at a level of $0.1g^2/cps$ from 20 to 2000 cps.

The signal gating module survived the shock, acceleration, the operating- and shipping-temperature extremes, and the humidity tests, without adverse effects.

The life test showed that the signal gating module is capable of operating for a period of 150 hours at a pressure of 30 psia.

3.3.5.3 Conclusions. The signal gating module is capable of withstanding the temperature conditions associated with shipping; the vibration, shock, acceleration, and humidity conditions associated with launch; and the life and temperature conditions associated with the mission, without degradation.

3.3.6 Door Telltale Assembly

3.3.6.1 Tests

1. Vibration (Test Report No. 99)
2. Life in Vacuum (Test Report No. 100)

3.3.6.2 Results. The results of the vibration test showed no degradation in performance due to the test. The results of the life test in vacuum showed no degradation in performance due to the low pressure environment during the life period.

3.3.6.3 Conclusions. The door telltale assembly is capable of withstanding launch vibration without damage or degradation. The door telltale assembly is capable of operation without degradation in the vacuum environment anticipated during the mission life.

3.4 ENVIRONMENTAL CONTROL SYSTEM

3.4.1 Heater Controller Assembly - (used with thermostats)

3.4.1.1 Tests

1. Vibration (Report No. 55)
2. Shock (Report No. 70)
3. Operating-Temperature Extremes (Reports No. 56 and 69)
4. Life (Report No. 64)

3.4.1.2 Results. The heater controller survived each of the tests listed in the preceding paragraph.

3.4.1.3 Conclusions. The heater controller assembly will survive its launch environment and will operate properly in its mission environment. It will also survive expected temperature extremes that might be encountered enroute to the launch site.

3.4.2 Heater Controller - (used with thermistors)

3.4.2.1 Tests

1. Vibration (Report No. 93)
2. Operating-Temperature Extremes (Report No. 94)
3. Life (Report No. 97)

3.4.2.2 Results. The heater controller survived the vibration and life tests without incident. However, some difficulties were encountered during the operating-temperature-extremes test. Operability testing after the high temperature portion of the test showed that the controller's fuses had blown.

Since the unit had been operating satisfactorily at the end of the high temperature test, the failure was thought to be human error which occurred during the operability test that followed. After the low temperature portion of the test, the controller would not turn on. This was later found to be caused by a transistor that had failed due to a current overload. Since the unit had been operating satisfactorily at the end of the low temperature test, this failure was also thought to be human error which occurred during the operability test that followed. However, the low temperature portion of the test was repeated to establish complete confidence in the design. The controller survived this test without incident.

3.4.2.3 Conclusions. The heater controller assembly will survive its launch environment and will operate properly in its mission environment. It will also survive expected temperature extremes that might be encountered enroute to the launch site.

3.5 STRUCTURE

3.5.1 Elevation Plate Assembly

3.5.1.1 Tests

1. Vibration (Report No. 32)
2. Life (Report No. 95)
3. Static Load (Report No. 2087-941002, Deflection and Strain Test, Primary Structural Support Assembly, by Bell Aerosystems, dated 13 October 1961).

3.5.1.2 Results. The assembly was subjected to sinusoidal vibration search and qualification tests in order to determine resonant frequencies and areas of design weakness. The resonant frequency range was found to be

18-35 cps and transmissibilities in this range were found to be as high as 33. The most significant design deficiency found in this test was the drive pin in the crab servo shaft and lead screw. This pin broke twice in Z-axis vibration due to excessive bending stresses. This pin has been redesigned. Other failures that occurred were: the azimuth pivot stud nut and several screws became loose, the crabbing servo became unaligned, dirt particles accumulated near the bearings of the thrust bearing assembly and on the gear teeth of the film supply torque motor, and the elevation pivot assemblies were heavily brinnelled by the bearings. The azimuth pivot stud was redesigned as a result of this test. In addition, the finding of high transmissibilities in this test was partially responsible for redesign of the stereo mirror assembly to move its center of gravity.

The elevation plate assembly was subjected to a life-in-vacuum test to determine whether its bearing surfaces would survive the stereo mirror movements required in three five-day missions. It was also desirable to determine whether the assembly would operate properly during such a test. Examination of the bearings after the test showed no damage. The crabbing servo current and transition time increased as testing progressed. However, this was not attributed to the conditions of this test but was analyzed as servo wearout because the servo had been actuated 3200 times prior to this test. The problem was also aggravated because the servo had not been aligned properly before the test.

The static load tests which were conducted by Bell Aerosystems on the primary structural support assembly to test its strength showed no problems.

3.5.1.2 Conclusions. The following conclusions were drawn from the results of the three tests mentioned above:

1. The elevation plate assembly of the design tested in vibration was not capable of withstanding sinusoidal qualification level vibration. It would therefore have been considered a risk item during launch had its design not been changed.
2. The bearing surfaces of the elevation plate assembly will not be damaged during a normal mission.
3. The primary structural support assembly will survive the accelerations encountered during launch.

3.5.2 Servos

3.5.2.1 Tests

1. Vibration (Reports No. 16 and 19)
2. Shock (Reports No. 17 and 19)
3. Acceleration (Reports No. 18 and 19)
4. Humidity (Reports No. 15 and 19)
5. Shipping-Temperature Extremes (Reports No. 14 and 19)
6. Life (Report No. 20)
7. EMI (Report No. 21)
8. Axial Thrust Load (Reports No. 12 and 19)
9. End Play (Reports No. 13 and 19)
10. Sine-Random Vibration (Reports No. 104 and 106)

3.5.2.2 Results. Report No. 19 covers the inspection and operability test after environmental tests. The servo assemblies passed vibration, shock, acceleration, shipping-temperature-extremes, and axial thrust load tests.

The vibration test consisted of random vibration at a level of $.1g^2$/cps from 15 to 2000 cps.

Inspection after the humidity test revealed staining of the finish of the servos after exposure to high humidity.

Results of the end-play measurement showed readings within specification after both servos had been taken apart and reassembled. The azimuth servo was taken apart to remove metal chips from the gear teeth and the elevation servo was taken apart to correct the assembly.

The servos survived the life-test-in-vacuum environment without degradation of performance or significant leakage.

The servos failed in EMI testing, both in conducted and radiated radio-frequency interference.

Special tests were run at a later date to qualify the servos in sine-random vibration. The stereo servo survived the sine-random vibration without degradation. The crab servo showed abrasion resulting from rubbing of the top component board, and a capacitor in the overload circuit failed. After bumpers and a center post were installed on the top board, the second test was conducted. The abrasion was reduced, but a lead on the same capacitor broke. Improvements were made in the bumper design, sine searches were run, and a third test was conducted. This time the evidence of resonance and abrasion were substantially reduced, but the same capacitor failed. The fourth and final test was run after incorporating a high-reliability-type capacitor. The servo successfully survived this test.

3.5.2.3 Conclusions. The servos as currently designed demonstrated their capability to pass the shipping, launch, and mission environments.

3.6 CABLES AND RELATED ASSEMBLIES

3.6.1 Cable Assembly

3.6.1.1 Tests

1. Vibration (Reports No. 22 and 25)
2. Shock (Reports No. 22 and 26)
3. Acceleration (Reports No. 22 and 27)
4. Shipping Temperature Extremes (Reports No. 22 and 23)
5. Humidity (Reports No. 22 and 28)
6. Life (Reports No. 22 and 24)

3.6.1.2 Results. Report No. 22 covers pre-environmental inspection and functional testing of the cables. Results show that the cables were in proper operating condition prior to environmental testing.

Results of the vibration, shock, acceleration, shipping-temperature-extremes, humidity, and life tests all showed no damage or degradation in performance as a result of the environmental testing.

3.6.1.3 Conclusions. The cable assemblies are capable of withstanding the expected shipping, launch, and mission environmental conditions, without degradation.

3.6.2 Test Box

3.6.2.1 Tests

1. Vibration (Report No. 34)
2. Shock (Report No. 35)
3. Shipping-Temperature Extremes (Report No. 36)
4. Humidity (Report No. 43)

3.6.2.2 Results. Vibration test report No. 34 covers three separate vibration tests on the junction box, test box, W-1 cable, and W-1 cable bracket combination. The tests consisted of random vibration at a level of $.1g^2$/cps for 10 minutes. The test box successfully passed the first two of these tests, and is considered qualified. After the third test it was found that 14 wires were broken adjacent to the soldered connections. Investigation showed these broken wires resulted from fatigue failures caused by vibration for 42 minutes at the specified level prior to the test in which failure occurred.

The test box passed the shock, humidity, and shipping-temperature-extremes tests without degradation.

3.6.2.3 Conclusions. The test box is capable of proper operation after exposure to the temperature and humidity conditions associated with shipping, and the vibration and shock conditions associated with launch.

3.6.3 Junction Box

3.6.3.1 Tests

1. Vibration (Report No. 34)
2. Shock (Report No. 35)
3. Shipping-Temperature Extremes (Report No. 36)
4. Humidity (Report No. 43)

3.6.3.2 Results. Vibration test report No. 34 covers three separate vibration tests on the junction box, test box, W-1 cable, and W-1 cable bracket combination. The tests consisted of random vibration at a level of $.1g^2$/cps for 10 minutes. After the first of the three tests, the mounting flange of the junction box was broken in two places. Investigation revealed that this particular unit had undergone previous testing; therefore, this test was not regarded as representative of the capabilities of a new junction box.

A new junction box of the same design was used in the second and third tests which successfully passed the vibration.

The junction box withstood the shock, humidity, and shipping-temperature-extremes tests without degradation.

3.6.3.3 Conclusions. The junction box is capable of proper operation after exposure to the temperature and humidity conditions associated with shipping, and the vibration and shock conditions associated with launch.

3.6.4 W-1 Cable Assembly

3.6.4.1 Tests

1. Vibration (Report No. 34)
2. Shock (Report No. 35)
3. Humidity (Report No. 43)

3.6.4.2 Results. The W-1 cable assembly passed the vibration, shock, and humidity tests without damage or degradation.

3.6.4.3 Conclusions. The W-1 cable assembly is capable of proper operation after being exposed to the vibration, shock, and humidity conditions associated with launch.

3.6.5 Cable Support Bracket

3.6.5.1 Tests

1. Vibration (Reports No. 34 and 78)
2. Shock (Report No. 35)
3. Humidity (Report No. 43)

3.6.5.2 Results. Four separate vibration tests were run on the cable support bracket, together with the junction box, test box, and W-1 cable. The first three of these were random vibration at a level of $.1g^2/cps$ (Report No. 34) and the fourth was sine-random vibration at the levels described in Appendix D (Report No. 78).

The cable support bracket cracked during the first test. Because the results of this test were not generally accepted as representative of the capability of a new bracket, a second test was run.

Because the cable support bracket fractured again during the second test, the bracket was redesigned.

The third test was run with a bracket of the redesigned configuration, but differing from the payload design in that portions of the test bracket were welded where the payload design was formed. This bracket passed the vibration test except for some small cracks at the welds which were judged insignificant. The cable support bracket was qualified on the strength of this test.

The fourth vibration test was run to update the cable support bracket qualification to sine-random requirements. This test was conducted on a bracket of the payload design. The bracket passed the test without degradation.

The cable support bracket withstood the shock and humidity test without degradation.

3.6.5.3 Conclusions. The cable support bracket as currently designed is capable of surviving the vibration, shock, and humidity resulting from launch, without degradation.

Approved for Release: 2024/01/30 C05098945

SECTION 4
SPECIAL TEST RESULTS

4.0 INTRODUCTION

Special reliability tests were conducted to increase the confidence of qualification in certain areas. The results of these tests are given below according to the test items with which they are associated.

4.2 PAYLOAD

4.2.1 Vibration Resonance Search (Report No. 59)

4.2.1.1 Results. The payload was subjected to sine vibration at 1g peak-to-peak level from 5 to 2000 cps in three axes, and readings of g levels at 24 selected points on the assembly were recorded. The resonances were found to be about the same for the RM payload as for the dynamic simulator and for the elevation plate. The levels of transmissibility on the RM payload were found to be lower than the levels on the dynamic simulator in all three axes.

4.2.1.2 Conclusions. No over-all resonant frequency was determined for the payload because the recorded data does not show phase relationships. Resonant points of the RM and dynamic simulator were demonstrated to be similar, but lower levels of excitation at the recorded points showed lower transmissibility for the RM.

4.2.2 Stereo Mirror Qualification in Vibration (Report No. 75)

4.2.2.1 Results. The stereo mirror stayed securely in place throughout the test. Two flexures were observed to be bent or broken after the second (the Z) axis of vibration. Several more flexures were broken and others were bent after the third (the X) axis of vibration. Considerably less damage occurred to the mirror than in the previous test (see Test Report No. 68).

4.2.2.2 Conclusions. The stereo mirror, with its thin plate potted to the inner ring, will remain structurally intact during qualification vibration. Most of the flexures in the stereo mirror assembly will survive qualification level vibration.

4.2.3 Stereo and Primary Mirror Qualification in Vibration (Report No. 109)

4.2.3.1 Results. A stereo mirror with the three-finger mount (the same as the FM 5 configuration) and a primary mirror with the three-finger mount (the same as the FM 7) were assembled to the RM payload and subjected to 3-axes of payload sine-random vibration. The stereo mirror survived the vibration test without structural damage to the glass. Although the potting compound was completely absent at one of the fingers and about 50 percent absent at the other, a stereo mirror with the three-finger mount design has a high probability of surviving a qualification vibration test without structural damage.

On the primary mirror, five small cracks were noticed on the outer groove of the rear side of the mirror. A dimensional check showed that the mirror was structurally weak at the cracked areas. Dimensional checks of the groove thickness on the FM 7 primary mirror showed it to be structurally stronger than the test unit. It was therefore concluded that the FM 7 primary mirror has a high probability of no significant structural damage during a qualification vibration test.

4.2.3.2 Conclusions. The stereo and primary mirror with the three-finger mount will survive the launch vibration environment.

4.2.4 Stereo Mirror Qualification in Vibration (Report No. 112)

4.2.4.1 Results. A stereo mirror assembly with a no-finger mount was subjected to three axes of payload sine-random vibration. This test was conducted on the dynamic simulator payload. An optical check showed no change in the optical quality which had a 0.004 inch to 0.005 inch astigmatism at the beginning of the test. Disassembly of the stereo mirror showed no structural damage to the mirror. One out of six sets of flexure failures have occurred on previous payload qualification tests.

4.2.4.2 Conclusions. Removal of the fingers from mounts for the stereo mirror does not affect the qualification status of the stereo mirror assembly.

4.3 OPTICAL SYSTEM - CAMERA

4.3.1 High Speed Gear Drive Qualification (Report No. 111)

4.3.1.1 Results. The RC camera (with regular gear drive) was tested on the camera test set at ambient pressure. Film velocity smoothness and starting-time data were obtained from the test. After completion of this test, three new gear clusters were assembled in the film drive gear box to increase film velocity. A similar test was then conducted and test results indicate that film velocity smoothness and starting times were not significantly affected by an increase in film speed.

The RC camera (with the high speed gear drive), film supply, and film take-up were assembled (connected) to form a film transport system. The test consisted of operating the camera, at stereo and strip modes, at various film speeds, and varying the take-up motor voltage from 27 to 32.5v dc until 3,000 feet of film was on the take-up reel. Throughout the test, no impairment in operation of the film transport system was noticed.

A 24-hour low pressure (0.002 psia) test was conducted with the camera test set on a flight utilizing 1,000 feet of film. Accurate numerical data on film velocity smoothness and starting times could not be obtained from this test because the velvet-cloth light shield partially obstructed one side of the tapered wedge slit. A visual inspection of the photographic results indicated that the film velocity smoothness and starting times appeared to be within required specifications as compared with other camera test results. It was also concluded from the test that film set is present in a low pressure environment for all drive frequencies. Several one-hour and six-hour waiting periods before camera operations caused the film velocity smoothness in the first four to five frames to be above specification.

4.3.1.2 Conclusions. An increase in film velocity will not affect the photographic portion of an orbital mission.

4.3.2 Slit Aperture Plate Testing (Report No. 107)

4.3.2.1 Results. Slit aperture plates were recently coated with a thinned-out epoxy to protect the aluminized surfaces from scratching. Streaking tests showed that the epoxy coating is subject to scratching over the slit area, which is attributable to oversize film splices (corrective action has been initiated), film accidentally contacting the slit aperture plate during camera threading and other pre-flight tests, and dirt wedging between the slit aperture plate and the film during launch.

Slit aperture plates of the current design omit the use of any epoxy coating with the result that the slit area will not scratch during normal use. The aluminized surfaces are protected with a polyester tape (0.002 inch thick) except for 0.050 inch from the trailing edge of the slit and 0.030 inch from the leading edge of the slit.

The polyester tape was subjected to temperature, humidity, low pressure, vibration, abrasion, and film fogging tests. Environmental testing had no effect on the tape. It appears that the 0.002 inch build-up caused by the polyester tape is sufficient to protect the slits from normal film scraping, but any large dirt particles could be scraped across the unprotected aluminized surfaces.

4.3.2.2 Conclusions. The slit aperture plate with the polyester tape will survive conditions of storage and transportation, powered flight, and orbital flight without limiting its photographic capability.

4.3.3 Camera Shipping Container Shock Test (Report No. 31)

4.3.3.1 Results. A camera shipping container, with a dummy camera packed inside, was subjected to three 1/2 sine wave, 5.5 ±0.5-millisecond, 30g shocks along each of the three mutually perpendicular axes to determine to what degree the container attenuates the shock transmitted to the camera.

It was found that the average peak value of the shocks transmitted to the dummy camera was about 4g.

4.3.3.2 Conclusions. Shock transmitted to the camera is attenuated by a factor of approximately 7.5. The camera shipping container will therefore provide the camera with adequate protection from shock during shipping.

4.4 FILM HANDLING SYSTEM

4.4.1 Capsule and Film Take-up Testing

4.4.1.1 Tests

1. Assembly and Handling (Report No. 48)
2. Light Leak (Report No. 60)
3. Vibration (Report No. 105)

4.4.1.2 Results. Assembly and handling checks of the film take-up with a GE capsule assembly resulted in no serious problems. Three electronic packages within the capsule had to be removed to permit proper adjustments on two of the interface mounts. A tracking test was then successfully conducted with the chute assembled to the capsule and film supply.

A light-leak test on the capsule assembly showed that the cover assembly was translucent to light. A redesigned cover from GE was then tested (see Report No. 105) and no light leaks were found. This light-leak test was equivalent to direct sunlight of a period of 6 minutes. A film-fogging test revealed that the capsule assembly contained no gaseous substances which would fog Kodak Film 4404.

A film take-up assembly mounted in the capsule assembly was subjected to a powered flight vibration test and to a de-orbit vibration test. A tracking test on the film take-up and an alignment check of the film take-up with respect to the capsule were successfully completed after each vibration test. A light-leak test after each vibration showed that the capsule assembly will prevent Kodak Film 4404 from fogging.

4.4.1.3 Conclusions. The film take-up will survive the powered flight and de-orbit vibration environment while mounted to the GE capsule assembly. Kodak Film 4404 is adequately protected from fogging by the GE capsule assembly.

4.4.2 Accessory Shipping Container Drop Test (Report No. 54)

4.4.2.1 Results. The accessory shipping container, in which the film take-up is shipped, was subjected to a drop test to verify the results of a similar test conducted by the container manufacturer. This test differed from the manufacturer's test in that an actual film take-up was used to provide the proper load for the container rather than a dummy weight.

In several cases, the test instrumentation indicated that the acceleration levels of this test exceeded those specified. However, after the drop test was completed (a total of 15 drops), an operability test of the film take-up showed that it had not been damaged.

The results of this test differed from those of the manufacturer's test in that the manufacturer's instrumentation indicated that all accelerations were below the specified maximum level. One possible explanation for this is that the dummy weight was a solid simulation of the take-up and therefore had fewer resonant frequencies than the actual take-up. Also, the fact that the instrumentation methods used in the two tests were different might possibly have contributed to a difference in results.

4.4.2.2 Conclusions. The accessory shipping container for the film take-up is capable of providing adequate protection from shock caused by accidental dropping of the container during shipping.

4.5 QUALIFICATION TEST OF MAIN SHIPPING CONTAINER

4.5.1 Introduction

Qualification tests and report preparation were conducted during the period from 4 May to 27 August 1962 on the main shipping container.

4.5.2 Vibration Tests

These tests indicated a need for redesign and replacement of shock mounts which was done. The test was repeated with acceptable results.

For security reasons, Test Report No. 1646D from the vendor, was not required to be in strict compliance with EKC format. However, the contents of the report completes the tests required by the Qualification Test Procedure Dwg. No. 653-115.

APPENDIX A

PART I

Because the Flight Payload Qualification Test Plan, Eastman Kodak Document 802-148, is referred to in other sections of this report, it is included for reference in this appendix.

EKCo	FLIGHT PAYLOAD QUALIFICATION TEST PLAN	DWG. NO. 802-148

REVISIONS

SYM	DESCRIPTION	DATE	APPROVAL
A	DCO-O-1 Inc. Retyped sheets 2 thru 20. Total sheets now 20. ed	4-4-63	(signed by) J.R. Brown 4-4-63
B	DCO-A-1 Inc. Retyped sheet 7. lml	9-17-63	See DCO-A-1
C	DCO-B-1, B-2 Inc. Revised sheet 4, retyped sheet 1, 7 thru 17, total sheets now 17. lml	1-23-63	See DCO-B-1, B-2

APPROVAL Original signed by: P. E. Murfin /nm J. A. Rodgers 8-7-62, L. K. Parsons 8-8-62, L. Mitchell 8-9-62 H. F. Hicks/maf 8-18-62	SHEET 1 OF 802-148 TOTAL SHEETS: 17 DATE RELEASED: 8-14-62

1. PURPOSE AND SCOPE

1.1 Purpose - This document defines the Qualification Tests to be performed on individual components and major assemblies, and on a completely assembled Camera Payload, in order to adequately verify the capability of this design to meet its functional and environmental requirements.

1.2 Scope - The Qualification Tests specified herein are based on requirements of the Flight Payload Specification and individual component specifications listed in section 3. Functional requirements which are known to be verified during acceptance testing of each flight payload are not included here. The functional and environmental tests specified below shall be performed on at least one item representative of Flight Payload design.

2. REFERENCE DOCUMENTS

The following Eastman Kodak Company specifications are referred to, directly or implicitly, in this Test Plan:

502-115	Cable Assemblies
502-117	Regulated Power Supply
502-118	Environmental Design Criteria Including Qualification and Acceptance Test Levels for RSRS Payload
502-154	Focus Control Electronics Assembly
602-100	Elevation Servo Assembly (Stereo Servo Assembly)
602-101	Azimuth Servo Assembly (Crabbing Servo Assembly)
602-128	Electrical Distribution Component
702-102	Motor Speed Drive (Film Drive Electronics Assembly)
702-135	Forward Record Storage Assembly
702-139	Film Supply Cassette Assembly
802-122	Camera Assembly

802-125	Lens and Flat Mirror Assembly (Lens Assembly)
802-129	Structure Assembly
802-153	Flight Payload Model
802-203	Gain Detector Assembly
802-222	Electromagnetic Interface (Addendum to MIL-I-26600)
808-188	Test Requirements for Camera Assembly

3. REQUIREMENTS

3.1 Definitions

3.1.1 Components, Special Components, Major Assemblies

For the purposes of this Test Plan the definitions of components, special components, and major assemblies shall be those given in paragraphs 3.1.1, 3.1.2, and 3.1.3 of Specification 502-118.

3.1.2 Payload Assembly

The "Payload Assembly" normally consists of a complete functional assembly of the components and major assemblies with special (R/V) components supported in their proper location with respect to the non-recoverable (OCV) portion of the payload. Wherever possible, and specifically for portions of the life testing (par. 3.3.2 below), this configuration shall be used. For certain environmental testing and where necessary for operability testing, the non-recoverable payload section shall be tested apart from the special components. Because the primary structural support of equipment in the R/V lies outside the responsibility of Eastman Kodak Company, these items shall be environmentally tested as components only.

3.2 Inspection and Test

Each component shall have been subjected to inspection and performance testing equivalent to that required in the applicable In-Process Test Procedures before being subjected to Qualification Tests.

3.3 Verification of Functional Capabilities

3.3.1 General

Pre-environmental and post-environmental operability testing shall consist of the applicable functional portion of appropriate Acceptance Test Procedures and/or In-Process Test procedures. In addition, certain functional tests have been specified in section 4, which are not expected to be included in normal acceptance testing. These tests shall be performed at least once on the item to which they relate and they may be repeated for post-environmental operability verification as appropriate.

3.3.2 Life Testing

Ability of the payload to operate satisfactorily for the required period in orbit shall be demonstrated by life testing at the payload assembly level as outlined in section 4. Life requirements contained in individual component specification shall, in general, be verified by this payload assembly testing, except where additional testing is desired at the component level to verify subcontracted design capabilities. Because components will have been operated to some extent during testing prior to their assembly as a complete payload, and because the service life requirement for the payload assembly (par. 3.6.1 of 802-153) is four times the maximum orbital mission life, life testing of the payload assembly for its specified service life period is considered to be adequate for wear-out qualification.

3.3.3 Voltage Extremes

Functional capability of each component shall be verified when operated with specified extremes of voltage inputs, together with the most adverse combination of other functional characteristics (film speed, tension, etc.). Whenever practical, the most adverse environmental characteristics applicable during operation (temperature, atmospheric pressure, etc.) shall also be included. Life testing of the payload assembly shall also include periods of operation at voltage extremes.

(C) 3.3.4 EMI

The complete payload assembly shall be tested for generation of and susceptibility to electro-magnetic interference.

3.4 Verification of Environmental Capabilities

3.4.1 General

Capability of components, major assemblies, and the payload assembly to withstand the environmental conditions anticipated in actual service shall be demonstrated by their ability to operate satisfactorily after exposure to the appropriate environmental qualification levels specified in specification 502-118. These qualification levels have been set higher than the expected use conditions to compensate for absence of combined environments during testing and for variations in characteristics of assemblies other than the single set tested. Appropriate environmental tests shall be those defined in section 4, below. Environmental conditions defined in 502-118 for which no tests are included in section 4 are not considered critical for the assembly involved; therefore qualification to these environments is not considered necessary. Where specifications for subcontracted items have specified more severe environmental tests than are given in 502-118, and it appears desirable to verify that the subcontractor has met specification the more severe tests are defined in section 4.

3.4.2 Operability During Powered-Flight Environments

In general, equipment is not expected to operate during powered flight and therefore need not demonstrate operability during acceleration, shock or vibration tests. The exceptions to this rule are the pressure relief valves and torque motor assembly of the Film Supply Cassette, which must be operable throughout these tests. Power shall be applied wherever it is expected to be applied during the powered-flight phase and may be applied elsewhere if desirable to check for relay chatter, etc.

3.4.3 Limitation on Operability of Special Components

The special components, with only the record which they contain during the pre-orbital powered-flight phase, shall meet all their orbital functional requirements after being subjected to the shock and vibration tests associated with power flight. These components, containing their maximum quantity of record shall be required to meet only those functional requirements necessary to the post-orbital phases after being subjected to the vibration, acceleration and shock tests associated with de-orbit, re-entry and impact.

3.4.4 Analysis of Environmental Test Failures

Because of the limited number of assemblies available for test, and the possible necessity for repeating various tests, some items may be subjected to damaging environments several times. Therefore, as part of the analysis of any failure during such repeat testing, there shall be an investigation for the possibility of the cause of failure being fatigue due to over-testing.

3.4.5 For those components which contain film special attention shall be given to the possible effects of extreme environments on the unexposed film and/or latent image of exposed film. Such effects may include pressure desensitization due to shock; discharge of static electricity; abrasion of emulsion surface; and misalignment of film on transporting rollers and loopers or of spooled film (telescoping).

3.5 Assemblies to be Tested

Each qualification test shall be performed on at least one assembly representative of Flight Payload design. However, all tests specified for a component need not be performed on the same individual unit. To the extent practical, all Payload Assembly tests of section 4.4 below should be performed on the same unit.

3.5.1 Sources of Test Results

The results of any properly documented test which meets the conditions of this Test Plan may be utilized to fulfill requirements for design qualification. The major conditions are that the item tested be representative of flight design and that functional capabilities be adequately demonstrated. Testing of the Engineering Model, Reliability Model or its extra components, or of Flight Model material may thus be utilized in design qualification.

3.5.2 Limitation of Subsequent Use of Assemblies Tested

Assemblies which have been subjected to extremes of potentially damaging environments shall not subsequently be used in deliverable Flight Payloads. Assemblies which have been operated for extended periods (such as life testing) beyond the operation normally associated with assembly and acceptance testing, shall be disassembled and all parts subject to wear or fatigue replaced before using in Flight Payloads.

3.6 Qualification of Hardware

The decision as to whether the payload and components have been qualified shall be made by Project and Reliability. This decision shall include consideration of items such as re-testing required to qualify the design as a result of failures during testing, design differences between qualification hardware and flight hardware, etc, and shall not be limited by the requirements defined in this document.

4. QUALIFICATION TESTS

The following tests, together with functional tests as indicated in par. 3.3 shall constitute the special testing necessary to establish qualification of the design. Operability tests shall be made between individual environmental tests whenever practical; complete operability demonstrations before and after completing all environmental testing is required.

4.1 Non-Recoverable Components

4.1.1 Camera Assembly

The Camera Assembly, drawing 808-750, shall be subjected to the following tests:

4.1.1.1 Vibration in accordance with par. 4.2.1 of specification 502-118.

4.1.1.2 Life Test - The Camera, along with the rest of the transport system, will be cycled to operate 10 minutes out of every 80 minutes in a vacuum chamber at ambient temperature and at a pressure of 0.1 mm of Hg. The test, which shall be run at speed steps 33 and at an operating voltage of 28 volts, will be continued until 3000 feet of film has passed through the Camera. During each operating period, a film velocity smoothness test will be conducted by projecting light from a strobe lamp onto the film through the wedge-shaped Camera slit.

4.1.2 Azimuth and Elevation Servos

The Azimuth Servo, drawing 614-101, and the Elevation Servo, drawing 614-100, shall each be subjected to the following tests:

4.1.2.1 Vibration in accordance with par. 4.2.1 of specification 502-118.

4.1.2.2 Shock in accordance with par. 4.2.2 of specification 502-118.

4.1.2.3 Acceleration in accordance with par. 4.2.3 of specification 502-118.

4.1.2.4 Shipping Temperature Extremes--The equipment shall be stored in a temperature environment of 165°F for 8 hours. Rate of increase of temperature to reach 165°F shall not exceed 1°F per minute. It shall then be removed from the environmental chamber and allowed to cool in still air of normal room temperature until reasonable equilibrium has been reached. Operability of the equipment shall then be demonstrated.

The equipment shall then be stored in a temperature environment of 0°F for 8 hours. Rate of decrease of temperature to reach 0°F shall not exceed 1°F per minute. At the end of 8 hours turn off the refrigeration and leave the equipment in the temperature chamber, allowing the chamber and the equipment to return to room temperature over a period of approximately 16 hours. Operability of the equipment shall again be demonstrated.

4.1.2.5 Life Operation in Vacuum--Operate the Servo Assemblies in a vacuum of 1×10^{-6}mm Hg for a total of 25 hours "ON" time with the following cycling rate:

10 minutes "ON" time, consisting of commanding a new discrete position every five seconds.

80 minutes minimum of "OFF" time during which no command changes are made.

Total time in vacuum shall be 15 days.

4.1.3 Electrical Distribution Component

4.1.3.1 Distribution Box Assembly

The Distribution Box Assembly, drawing 617-114, shall be subjected to the following tests:

4.1.3.1.1 Vibration test in accordance with par. 4.2.1 of specification 502-118.

4.1.3.1.2 Shock test in accordance with par. 4.2.2 of specification 502-118.

4.1.3.1.3 Operating Temperature Extremes--The Distribution Box shall be placed in a test chamber and its temperature stabilized, while not operating, at the chamber conditions given below. The Distribution Box shall then be operated as indicated below to demonstrate continuing satisfactory performance.

Minimum Temperature Conditions - The Distribution Box shall be mounted to an essentially infinite heat sink at 45°F, surrounded by a radiation sink also at 45°F and one atmosphere of circulating air at 45°F. The Box shall be operated 10 minutes out of every 90 minutes for 120 hours (total time). Input voltage shall be 27.0 volts for first third of test shall be increased to 30 volts for second third, and to 32.5 volts for final third of test period.

4.1.3.1.4 Shipping Temperature Extremes in accordance with par. 4.1.2.4 above except that the maximum temperature shall be only 125°F.

4.1.3.1.5 Acceleration test in accordance with par. 4.2.3 of specification 502-118.

4.1.3.2 The Junction Box/Test Box/W-1 Cable/Bracket Assembly

The Junction Box/Test Box/W-1 Cable/Bracket Assembly shall be subjected to the following tests:

4.1.3.2.1 Vibration in accordance with par. 4.2.1 of specification 502-118.

4.1.3.2.2 Shock in accordance with par. 4.2.2 of specification 502-118.

4.1.3.2.3 Shipping Temperature Extremes in accordance with par. 4.1.2.4 above except that the maximum temperature shall be only 125°F. Only the Test Box and Junction Box shall be subjected to this test.

4.1.3.2.4 Humidity Survival--The assembly shall be maintained at 115°F and 90 to 95% R.H. for 10 days in a non-operating condition. It shall then be returned to room ambient conditions, without condensation, and tested for operability.

4.1.4 Focus Control Electronics Assembly

4.1.4.1 Signal Gating Module

The Signal Gating Module, drawing 510-200, shall be subjected to the following tests:

4.1.4.1.1 Vibration in accordance with par. 4.2.1 of specification 502-118.

4.1.4.1.2 Shock in accordance with par. 4.2.2 of specification 502-118, except shock level shall be 30g.

4.1.4.1.3 Acceleration - The module shall be subjected to sustained acceleration of 12g. for 3 minutes in each direction along each of 3 mutually perpendicular axes while the module is not operating.

4.1.4.1.4 Operating Temperature Extremes--The module shall be mounted in a test chamber such that its surface temperature can be maintained at a desired level. The module shall be stabilized at 140 to 145°F and then operated continuously at this temperature for 6 hours. The module shall then be stabilized at 40 to 45°F and again operated continuously for 6 hours.

4.1.4.1.5 Relative Humidity - The module shall be operated continuously for 6 hours at room ambient temperature and 90 percent relative humidity.

4.1.4.1.6 Pressure/Life Test- Performance of the module shall be tested after being subjected to 150 hours of operation at a pressure of 15 pounds per square inch gage.

4.1.4.2 Complete Focus Control Electronics Assembly - The signal gating module is part of the Focus Control Electronics Assembly and becomes part of the complete assembly, drawing 510-105, which shall be subjected to the following tests:

4.1.4.2.1 Vibration in accordance with par. 4.2.1 of specification 502-118.

4.1.4.2.2 Shock in accordance with par. 4.2.2 of specification 502-118.

4.1.4.2.3 Operating Temperature Extremes - The Gain Control shall, after stabilizing at the given chamber temperature, be cycled to operate 10 minutes every 80 minutes for 120 hours (total time) in each of the temperature extreme tests described below:

4.1.4.2.3.1 High Temperature Extreme-The test shall take place in a vacuum of less than 1 x 10^{-4} mm Hg. During the test, the radiation heat sink shall be maintained at a temperature of 105°F and the (essentially infinite) conduction heat sink at a temperature of 95°F.

4.1.4.2.3.2 Low Temperature Extreme-The test shall take place in circulating air at a temperature of 45°F and a pressure of one atmosphere. Radiation and conduction heat sinks shall also be maintained at 45°F.

4.1.4.2.4 Shipping Temperature Extremes in accordance with par. 4.1.2.4 above except that the maximum temperature shall be only 125°F.

4.1.5 Film Drive Electronics (Motor Speed Drive)

The Film Drive Electronics Assembly, drawing 709-200, shall be subjected to the following tests:

4.1.5.1 Vibration in accordance with par. 4.2.1 of specification 502-118.

4.1.5.2 Shock in accordance with par. 4.2.2 of specification 502-118.

4.1.5.3 Shipping Temperature Extremes in accordance with par. 4.1.2.4 above, except maximum temperature to be +165°F.

4.1.5.4 Acceleration in accordance with par. 4.2.3 of specification 502-118.

4.1.5.5 Minimum Command Voltage-The operation of the Oscillator and Power Amplifiers shall be tested when the minimum command pulse amplitude and width is applied.

4.1.5.6 Minimum Data Signal - The operation of the data signal amplifiers shall be tested when the minimum Data Signal amplitude is applied.

4.1.6 Cable Assemblies

One cable assembly in each configuration shall be subjected to the following tests:

4.1.6.1 Vibration in accordance with par. 4.2.1 of specification 502-118.

4.1.6.2 Shock in accordance with par. 4.2.2 of specification 502-118.

4.1.6.3 Acceleration in accordance with par. 4.2.3 of specification 502-118.

4.1.6.4 Shipping and Handling Temperature Extremes in accordance with par. 4.1.2.4 above except that maximum temperature shall be +165°F.

4.1.6.5 Humidity Survival - At 110°F and 90% relative humidity for 10 days.

4.1.7 Heater Control Assembly

The Heater Control Assembly, drawing 516-181 or Heater Control Assembly, Type A, drawing 516-212, shall be subjected to the following tests:

4.1.7.1 Vibration in accordance with par. 4.2.1 of specification 502-118.

4.1.7.2 Shock in accordance with par. 4.2.2 of specification 502-118.

4.1.7.3 Operating Temperature Extremes - The heater control assembly shall be placed in a test chamber and its temperature stabilized, while not operating, at the chamber conditions given below.

4.1.7.3.1 High Temperature Extreme - The heater control assembly shall be operated continuously for 3 days in a temperature chamber having a temperature of 125°F (one atmosphere of circulating air).

4.1.7.3.2 Low Temperature Extreme - The heater control assembly shall be operated continuously for 3 days in a temperature chamber having a temperature of 0°F (one atmosphere of circulating air).

4.1.7.4 Life Operation in Vacuum - The Heater Control Assembly shall be operated for 10 days in a vacuum chamber at a pressure of 1×10^{-6}mm Hg. and a temperature of 70 ± 2°F. The operation shall consist of continuous cycles of 15 minutes "ON" time followed by 15 minutes "OFF" time.

4.2 Major Assemblies

4.2.1 Film Supply Cassette Assembly

The Film Supply Cassette Assembly, drawing 711-185, shall be subjected to the following tests: (Special note shall be taken of par. 3.4.5 above).

4.2.1.1 Vibration in accordance with par. 4.1.1 of specification 502-118, with full film load.

4.2.1.2 Acceleration in accordance with par. 4.1.2.2 of specification 502-118, with full film load.

4.2.1.3 Shock in accordance with par. 4.1.3.4 of specification 502-118, with full film load.

4.2.1.4 Shipping Temperature Extremes in accordance with par. 4.1.2.4 above, without film except that the maximum temperature shall be only 125°F.

4.2.1.5 Operating Temperature Extremes - The Film Supply Cassette Assembly shall be operated while at the minimum and maximum temperatures defined in paragraphs 4.2.1.5.1 and 4.2.1.5.2 to demonstrate continuing satisfactory performance.

4.2.1.5.1 Minimum Temperature Conditions - The Film Supply Cassette Assembly shall be surrounded by a radiation heat sink at 40°F and shall be operated under the following conditions:

No. of Cycles	ON Time per Cycle	OFF Time per cycle	Speed Step	Input Voltage	Film Path Internal Pressure	Chamber Pressure
3	15 min. of approx. 7 sec. bursts with 4 sec. off between bursts.	75 min.	1	27.0 V	One Atmos.	One atmos. of circulating air at 40°F.
1	"	15 min.	32	"	"	"
1	"	"	64	"	"	"
1	"	"	1	32.5 V	"	"
1	"	"	32	"	"	"
1	"	*	64	"	"	"
3	"	75 min.	1	27.0 V	100×10^{-3} mm Hg	1×10^{-4} mm Hg
1	"	15 min.	32	"	"	"
1	"	"	64	"	"	"
1	"	"	1	32.5 V	"	"
1	"	"	32	"	"	"
1	"	"	64	"	"	"
1	Continuous (to exhaust 3000 ft. supply reel)		64	27.0 V	"	"

* No cycling of Film Supply Cassette while test chamber is being evacuated.

EKCo	FLIGHT PAYLOAD QUALIFICATION TEST PLAN	DWG. NO. 802-148

4.2.1.5.2 **Maximum Temperature Conditions**

The Film Supply Cassette Assembly shall be surrounded by a radiation heat sink at 90°F and the chamber shall be evacuated to a pressure less than 1×10^{-4}mm of Hg. The Film Supply Cassette shall then be operated under the following conditions:

No. of Cycles	ON Time per Cycle	OFF Time per cycle	Speed Step	Input Voltage	Film Path Internal Pressure
2	15 min. of approx. 7 sec. bursts with 4 sec. off between bursts	75 min.**	1	27.0 V	100×10^{-3} mm Hg
2	"	"	32	"	"
2	"	"	64	"	"
2	"	"	1	32.5 V	"
2	"	"	32	"	"
2	"	"	64	"	"
1	15 min. continuous	"	1	"	"
1	"	"	32	"	"
1	"	"	64	"	"
500 ft.	continuous		64	"	"
"	continuous (to exhaust 3000 ft supply reel)		64	27.0 V	"

**OFF time shall not exceed this period. If experience gained during testing indicates that OFF time can be reduced, this may be done to accelerate test performance.

4.2.1.6 Operation through the range of internal operating pressures, and after being subjected to the maximum pressure differentials, as required by par. 3.3.1.5 of specification 702-139.

APPROVAL	SHEET 13 OF 802-148 DATE RELEASED 8-14-62

4.2.1.7 Tracking ability with unity gravitational field applied in varying directions, in accordance with par. 3.4.5 of specification 709-139.

4.2.2 Structure

The Structure as defined in specification 802-129 is a collection of parts and assemblies, necessary to support the other payload components, rather than a physically separable entity. Therefore, qualification testing of the Structure is performed principally as part of the Payload Assembly testing. Exceptions to this are the following tests:

4.2.2.1 Static loading of the major load-bearing structural elements, to simulate constant acceleration in accordance with par. 4.1.2.2 of 502-118.

4.2.2.2 Operation in a vacuum of 1×10^{-6} mm Hg. of all bearings, sliding surfaces, etc. which are external to the pressurised portion of the payload as required by par. 3.3.1.3 of specification 802-129. Operation shall be at cycling rates and speeds equivalent to normal expected orbital operation; and shall be continued for 15 consecutive days under vacuum (three times orbital life).

4.2.3 Lens Assembly

In accordance with specification 802-125 environmental tests for qualification of the Lens Assembly shall in general be performed as part of the payload assembly, drawing 805-101. The exception to this is the following test:

4.2.3.1 Focus Stability with Temperature Change - Focus positions of the Lens Assembly shall be measured when the lens is stabilized at various temperatures between the limits specified in par. 3.4.1 of specification 802-125, to determine the stability of focus position with temperature change.

4.3 Special Components (Forward Storage Assembly)

The Forward Storage Assembly, drawing 712-479, shall be subjected to the following tests. Special note shall be taken of par. 3.4.5 above.

4.3.1 Vibration in accordance with par. 4.2.1 of specification 502-118, with only the quantity of film to be in the assembly during powered flight.

4.3.2 Shock in accordance with par. 4.2.2 of specification 502-118, with only the quantity of film to be in the assembly during powered flight.

4.3.3 Shipping Temperature Extremes in accordance with par. 4.1.2.4 above, with no film in the assembly, except that the maximum temp shall be only 125°F.

4.3.4 Subject the Forward Storage Assembly to the same test described for the Supply Cassette Assembly in par. 4.2.1.5 above.

4.3.5 Vibration in accordance with par. 4.1.1 of specification 502-118, with full film load. Operability to be in accordance with par. 3.4.3 above for recovery phases.

4.3.6 Acceleration in accordance with par. 4.3.2.3 of specification 502-118, with full film load. Operability to be in accordance with par. 3.4.3 above for recovery phases.

4.3.7 Shock in accordance with par. 4.3.2.2 of specification 502-118, with full film load. Operability to be in accordance with par. 3.4.3 above for recovery phases.

4.3.8 Tracking capability with extremes of angular and translational deviations combined with one "g" field in varying directions, as required by par. 3.4.2 of specification 702-135.

4.3.9 EMI testing as required by par. 3.2.4 of specification 702-135.

4.4 Payload Assembly

The Camera Payload Assembly shall, after demonstrating satisfactory operability, be subjected to the following tests:

4.4.1 Vibration in accordance with par. 4.1.1 of specification 502-118.

4.4.2 Life Testing in Vacuum

4.4.2.1 Normal Cycling Rate - Operation of the payload in a vacuum of 5×10^{-6}mm of Hg. shall be performed, at a cycling rate approximately equivalent to normal orbital operation, to pass one film load (3000 ft) through the system in a 5 day period. Photographic capability shall be determined before and after the completion of this test, and a photographic camera speed test shall be conducted during the test. The stereo mirror shall be moved intermittently during the "ON" time of each cycle of the program described below:

EKCo	FLIGHT PAYLOAD QUALIFICATION TEST PLAN	DWG. NO. 802-148

Cycles	Total Hours of Test Time	Camera Time/Cycle ON	Camera Time/Cycle OFF	Chamber Wall Temperature
1-8	12	3 min 20 sec.	86 min. 40 sec.	45°F
	24		720 min.	45 to 75°F
9-16	36	3 min 20 sec.	86 min. 40 sec.	75°F
	48		720 min.	75 to 45°F
17-24	60	3 min 20 sec.	86 min. 40 sec.	45°F
	72		720 min.	45 to 75°F
25-32	84	3 min 20 sec.	86 min. 40 sec.	75°F
	96		720 min.	75 to 45°F
33-40	108	3 min 20 sec.	86 min. 40 sec.	45°F
	120		720 min.	45 to 75°F
41-48	132	3 min 20 sec.	86 min. 40 sec.	75°F
	133 hr. 45 min. Continuous at speed 64 until film supply is exhausted			75°F

4.4.2.2 **Extended Life Test** - The camera payload shall be operated continuously in a vacuum chamber having a pressure of 5×10^{-6}mm of Hg. and a wall temperature of 75°F. The test shall consist of two phases, during each of which a 3000 foot roll of film shall be passed through the system. A camera film drive test will be conducted during each phase.

4.4.3 Varying "G" Orientation - The payload, including the Forward Storage Assembly with a rigid inter-connecting mount, shall be operated in various attitudes so that the direction of the earth's gravitational force is varied. The capability of the film handling components to properly track film under these varying force conditions shall be established. (Due to physical limitations of collimator mounting, photographic capability in these various attitudes cannot be checked. This test may be used in verification of tracking ability of individual components, as required by par. 4.2.1.7 and 4.3.8 above).

APPROVAL	SHEET 16 OF 802-148 DATE RELEASED 8-14-62

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4.4.4 EMI Testing - The payload shall be tested for generation of and susceptibility to electromagnetic interference, in accordance with the requirements of Eastman Kodak Company document 802-222.

4.4.5 Thermal Testing - Thermal tests being conducted in cooperation with an associate contractor shall be used to verify capabilities of the thermal control design.

APPENDIX A

PART II

A number of tests were deleted from Test Plan 802-184 by Revisions A and C, and the following table gives the reasons for not conducting the tests. Revision B did not delete any tests.

Component	Test Deleted	Reason
RC camera and RC heater controller (for use with thermistor sensor)	Shock	The assemblies successfully passed qualification-level combined sine-random vibration tests at both the component and payload level. Testing of other similar components indicates that the specified shock and acceleration tests are less severe than the vibration test.
RC camera	Acceleration	
RC camera	Temperature and humidity	Engineering analysis indicates no problems in this area. Testing of other similar components has shown no difficulty over the specified temperature and humidity range.
W-1 cable and cable support bracket	Shipping-temperature extremes	
RC film drive electronics	Life	The assemblies are sealed packages and a low pressure environment should not affect the units. Life and vacuum testing of the same type of components as part of the RM payload was successfully completed.
RC distribution box	Life - low pressure	
RC distribution box	Proof pressure	Tests on the same type of component and similar components in vacuum indicate the ability

Component	Test Deleted	Reason
		of this component to withstand the required differential pressure.
Servo filter boxes	All component level qualification tests	Life, vacuum, EMI, and vibration tests were conducted at the payload level. Engineering analysis and testing of other similar components indicate that no difficulty should be expected from the remaining qualification tests.
All components	EMI tests at component level	Considered unnecessary because EMI evaluation was conducted at payload level.

APPENDIX B

The differences between the test hardware (RM payload and RC components) and the flight payloads are set out below.

Component	Difference	Status	Flight Payloads in Which Difference Existed	Qualification
Camera	Additional EMI filters associated with the focus drive motor.	In flight, not in RM or RC.	FM 1 thru FM 8	Qualified as a part.
	Revised mechanical design of the bellows.	In flight, not in RM.	FM 1 thru FM 8	Qualified in RC and in camera s/n 13.
	Increased speed of camera drive roller (CCN #11)	In flight, not in RM.	FM's 7 and 8	Qualified in RC and in camera s/n 13.
Crab Servo	Structural improvements (expected to be in FM 15)	In RC, not in flight.	FM 1 thru FM 8	Qualified in RC.
	Capacitor change (C804) (expected to be in FM 10)	In RC, not in flight.	FM 1 thru FM 8	Qualified in RC.
	NOTE: The two changes above affect the overload feature of the servo, but not the primary function.			
Distribution box	Different means of supporting leads in the regulated power supply, redesign of amplifier #5, and improved packaging of record transport control module.	In flight, not in RM.	FM 1 thru FM 8	Qualified in RC.
	Addition of motor current module assembly as part of the Instrumentation Augmentation Program.	In flight, not in RM.	FM's 6, 7, & 8	Qualified in RC.

Component	Difference	Status	Flight Payloads in Which Difference Existed	Qualification
Test box	An additional relay, added as a part of the Instrumentation Augmentation program.	In flight, not in RM.	FM 3 thru FM 8	Qualified on the basis of engineering judgment, because the change is minor.
	An added board assembly and wiring changes (CCN #10).	In flight, not in RM.	FM's 7 and 8	Qualified on the basis of engineering judgment, because the change is minor.
	Four additional fuses on a board for data signals A and B.	In flight, not in RM.	FM's 7 and 8	Qualified on the basis of engineering judgment, because the change is minor.
Focus control electronics	Potted transistor leads.	In flight, not in RM.	FM's 1 thru 8	Qualified in RC.
	Solid-state switching	In flight, not in RM.	FM 4 thru FM 8;	Qualified in RC.
Film drive electronics	Sylgard in the oscillator assy; rerouted filter leads; support block under filters.	In flight, not in RM.	FM 2 thru FM 8; not in RM.	Qualified in RC.
	Duxseal on the toroid board assembly.	In flight, not in RM.	FM's 1 thru 8	Qualified in RC.
	EMI filter to decouple the power amplifier and data signal amplifier.	In flight, not in RM.	FM's 1 thru 8	Qualified in RC.
Film supply	Two quantity sensors and a switch, which have been added as a part of the Instrumentation Augmentation program.	In flight, not in RM.	FM 3 thru FM 8	Qualified in RC.

Component	Difference	Status	Flight Payloads in Which Difference Existed	Qualification
	Nickel plated rollers replacing emeralon-coated rollers.	In flight, not in RM or RC.	FM's 7 and 8	Qualified on the basis of engineering testing.
	EMI filter box on side of looper assembly.	In flight, not in RM.	FM's 1 thru 8	Qualified in RC.
Film take-up	Motor reversal feature and Instrumentation Augmentation	In flight, not in RM.	FM 4 thru FM 8	Qualified in RC.
Heater control assembly	Redesigned heater controller, for use with thermistors instead of thermostats.	In flight, not in RM.	FM's 7 and 8	Qualified in RC.
Optical system	Primary mirror with 3-finger mount	In flight.	FM 7	Qualified on the RM
	Stereo mirror with 3-finger mount	In flight.	FM 5	Qualified on the RM
	Stereo mirror with mount having no fingers.	In flight.	FM 8	Qualified on the DS*-1

* Dynamic simulator no. 1.

APPENDIX C
CROSS REFERENCE

The following table is a cross reference between the test summaries in this report and the outline of the tests found in the Flight Payload Qualification Test Plan, Eastman Kodak Drawing 802-148.

Paragraph Number in Test Plan	Test	Paragraph Number in this Report
	Camera	
4.1.1.1	Vibration	3.1.1
4.1.1.2	Life	3.1.1
	Servos	
4.1.2.1	Vibration	3.5.2
4.1.2.2	Shock	3.5.2
4.1.2.3	Acceleration	3.5.2
4.1.2.4	Shipping-temp. extremes	3.5.2
4.1.2.5	Life	3.5.2
	Distribution Box	
4.1.3.1.1	Vibration	3.3.1
4.1.3.1.2	Shock	3.3.1
4.1.3.1.3	Operating-temp. extremes	3.3.1
4.1.3.1.4	Shipping-temp. extremes	3.3.1
4.1.3.1.5	Acceleration	3.3.1
	Junction Box/Test Box/W-1 Cable/Bracket Assembly	
4.1.3.2.1	Vibration	3.6.2, 3.6.3, 3.6.4, 3.6.5, and 3.6.6
4.1.3.2.2	Shock	3.6.2, 3.6.3, 3.6.4, and 3.6.5
4.1.3.2.3	Shipping-temp. extremes*	3.6.2 and 3.6.3

* Test box and junction box only.

Paragraph Number in Test Plan	Test	Paragraph Number in this Report
4.1.3.2.4	Humidity	3.6.2, 3.6.3, 3.6.4, and 3.6.5
	Signal Gating Module	
4.1.4.1.1	Vibration	3.3.5
4.1.4.1.2	Shock	3.3.5
4.1.4.1.3	Acceleration	3.3.5
4.1.4.1.4	Operating-temp. extremes	3.3.5
4.1.4.1.5	Humidity	3.3.5
4.1.4.1.6	Life	3.3.5
	Focus Control Electronics	
4.1.4.2.1	Vibration	3.3.4
4.1.4.2.2	Shock	3.3.4
4.1.4.2.3	Operating-temp. extremes	3.3.4
4.1.4.2.4	Shipping-temp. extremes	3.3.4
	Film Drive Electronics	
4.1.5.1	Vibration	3.3.3
4.1.5.2	Shock	3.3.3
4.1.5.3	Shipping-temp. extremes	3.3.3
4.1.5.4	Acceleration	3.3.3
4.1.5.5	Minimum command voltage**	3.3.3
4.1.5.6	Minimum data signal**	3.3.3
	Cable Assemblies	
4.1.6.1	Vibration	3.6.1
4.1.6.2	Shock	3.6.1
4.1.6.3	Acceleration	3.6.1
4.1.6.4	Shipping-temp. extremes	3.6.1
4.1.6.5	Humidity	3.6.1

** Test was conducted as a part of the operability test that was conducted before and after each environmental test.

Paragraph Number in Test Plan	Test	Paragraph Number in this Report
	Heater Control	
4.1.7.1	Vibration	3.4.1 and 3.4.2
4.1.7.2	Shock	3.4.1
4.1.7.3	Operating-temp. extremes	3.4.1 and 3.4.2
4.1.7.4	Life	3.4.1 and 3.4.2
	Film Supply	
4.2.1.1	Vibration	3.2.1
4.2.1.2	Acceleration	3.2.1
4.2.1.3	Shock	3.2.1
4.2.1.4	Shipping-temp. extremes	3.2.1
4.2.1.5	Operating-temp. extremes	3.2.1
4.2.1.6	Pressure***	3.2.1
4.2.1.7	Film tracking in varying orientation	2.2
	Structure	
4.2.2.1	Static load	3.5.1
4.2.2.2	Operating in vacuum	3.5.1
	Lens	
4.2.3.1	Temperature	3.1.2
	Film Take-up	
4.3.1	Launch vibration	3.2.1
4.3.2	Launch shock	3.2.1
4.3.3	Shipping-temp. extremes	3.2.1
4.3.4	Operating-temp. extremes	3.2.1
4.3.5	Re-entry vibration	3.2.1
4.3.6	Re-entry acceleration	3.2.1
4.3.7	Re-entry shock	3.2.1
4.3.8	Tracking in varying orientation	2.2
4.3.9	EMI	2.4

***This test was conducted as part of the operating-temperature-extremes test.

Paragraph Number in Test Plan	Test	Paragraph Number in this Report
	Payload	
4.4.1	Vibration	2.1
4.4.2	Life	2.3
4.4.3	Film tracking in varying orientation	2.2
4.4.4	EMI	2.4
4.4.5	Thermal	3.1.2

APPENDIX D
ENVIRONMENTAL TESTS

The vibration, shock, and acceleration tests to which the reliability model (RM) payload and the reliability enhancement components (RC Model) were subjected are set out in the table below. These levels are qualification criteria that are specified in Section 4 of the Phase II Specification: Environmental Design Criteria Including Qualification and Acceptance Test Levels for the RSRS* Payload, Eastman Kodak Drawing 502-118.

TABLE D-1
VIBRATION

Payload, film supply, film take-up (re-entry condition), stereo mirror, and primary mirror.

Frequency (cps)	Vibration Levels		
	Sine (g rms)		Random (g^2/cps)
	X axis	Y and X axes	X, Y, and Z axes
5-15	1.1 (Note A)	1.1 (Note A)	0
15-20	Note B	1.1	0
20-50	0.6	1.1	0
50-60	Note C	1.1	0
60-100	1.5	1.1	0
100-300	2.5	2.5	0.025
300-1200	3.5	3.5	0.06
1200-2000	3.5	3.5	Note D

* Recoverable Satellite Reconnaissance System.

TABLE D-1 (Continued)

Components

Frequency	Vibration Levels	
	Sine (g rms)	Random (g^2/cps)
	X, Y, and Z axes	X, Y, and Z axes
5-15	3.5 (Note A)	0
15-20	3.5	0.05
20-300	3.5	0.05
300-1200	5.0	0.12
1200-2000	5.0	Note D

Notes:

A - The low frequency amplitude was limited to half-inch double amplitude.

B - The sinusoidal vibration level was decreased linearly from that specified at 15 cps to that specified at 20 cps.

C - The sinusoidal vibration level was increased linearly from that specified at 50 cps to that specified at 60 cps.

D - The random vibration spectrum was rolled off at a rate of 12 db per octave.

SHOCK

Components. Three 15g shocks were delivered in each direction along each of the three mutually perpendicular axes. Shocks had a rise time of 5.5 ± 0.5 ms (1/2 sinusoidal pulse shape or equivalent).

Film Supply. Three shocks were delivered in each direction along each of the three mutually perpendicular axes, as follows:

Longitudinal:	6.25g fore and aft
Lateral:	3.125g in both directions

Each shock was of 6 ± 0.5 ms, 1/2 sinusoidal pulse shape.

Film Take-up (Re-entry condition). One shock was delivered in each direction along each of the three mutually perpendicular axes except the -X axis. Each shock was of saw-tooth shape, of 20 ms duration, and peaked in 1 ± 0.1 ms. Shock levels were:

Longitudinal:	100g aft
Lateral:	50g in both directions

Payload Structure. The payload structure was tested under static loading to simulate acceleration.

Film Supply. The film supply was subjected to the following constant acceleration g forces for a period of 5 minutes in each of 3 mutually perpendicular axes.

	Limit Load	Critical Load
Longitudinal axis	6.8g	8.5g
Lateral axes	2.5g	3.13g

Components. The components were subjected to sustained acceleration for 3 minutes in each direction along each of the 3 mutually perpendicular axes at the following levels:

Longitudinal axis	8.5g
Lateral axes	3.13g

Film Take-up (Re-entry condition). The film take-up was subjected to sustained acceleration for 5 minutes, in each of 5 directions, at the following levels:

Longitudinal axis	22.5g forward
Lateral axes	12.5g in both directions

The following design objectives stated in requirements section (Section 3) of the same specification served as a guide in planning the following tests:

Payload

Life: Five-day operation in a vacuum at a pressure of 4×10^{-8} mm of Hg

EMI: The requirements of Specification MIL-I-26600

Components

Life: Five-day operation in a vacuum environment at a pressure of 1×10^{-6} mm of Hg.

Shipping-temperature extremes: Exposure to static ambient air at 0°F and 125°F for 8 hours.

Shipping and storage humidity: 100% including condensation due to temperature reduction.

EMI: The requirements of Specification MIL-I-26600.

APPENDIX E

This appendix contains copies of Reliability Test Reports 1 through 112 which were conducted under EKC supervision.

RELIABILITY TEST REPORT

No. 1

Type of Test	Shock
Objective	This test was performed to determine if the Regulated Power Supply will satisfactorily withstand the qualification level of shock specified for individual components, namely, three 15g shocks in each of three mutually perpendicular axes (for a total of 18 shocks). The time to peak of each shock was 5.5 ± 0.5 milliseconds (1/2 sinusoidal pulse shape or equivalent).
Test Item	Regulated Power Supply, Part No. 617-500, S/N 203003

Procedure

The Regulated Power Supply was subjected to a pre-shock operability test to determine the following performance characteristics:

- Leakage
- Regulation, Stability and Efficiency
- Output Ripple and Noise
- Input Ripple and Noise
- Overload Protection
- Output Impedance
- Overvoltage

The Regulated Power Supply was then subjected to the shock levels specified above and the operability tests were repeated except that the input ripple and noise test and the efficiency tests were omitted. Also, in the Regulation and Stability and in the Ripple and Noise tests, measurements were made at no load and at full load only.

Results

Results of the post-shock operability test showed that the Regulated Power Supply performed satisfactorily.

Conclusion

The present design satisfactorily meets the component qualification shock test requirements.

RELIABILITY TEST REPORT

No. 2

Type of Test	Vibration (Random)
Objective	This test was performed to determine if the Regulated Power Supply will satisfactorily withstand the qualification level of vibration specified for individual components, namely, random vibration - white noise excitation - having continuous uniform spectral density distribution of $0.1g^2$/cps in the range of 20-2000cps, with respect to three mutually perpendicular axes. The test duration was ten minutes in each of the three axes.
Test Item	Regulated Power Supply, Part No. 617-500, S/N 203003
Procedure	The Regulated Power Supply was subjected to the vibration levels specified above and the post-shock operability tests were repeated.
Results	Results of the operability test showed that the Regulated Power Supply successfully survived the vibration test.
Conclusion	The present design satisfactorily meets the present qualification vibration test requirements.

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RELIABILITY TEST REPORT

No. 3

Type of Test	Thermal Shock
Objective	This test was performed to determine whether the Regulated Power Supply will satisfactorily withstand extreme conditions of thermal shock possible during transportation. The thermal shock was simulated by two chambers at different temperatures; viz., 0°F and 165°F.
Test Item	Regulated Power Supply, Part No. 617-500, S/N 203,003
Procedure	The Regulated Power Supply was placed in the 0°F chamber for four hours; then without delay (less than five minutes) transferred to the 165°F chamber for four hours. The Regulated Power Supply was then allowed to return to room temperature and the post - shock operability test was repeated.
Results	Results of the operability tests showed that the Regulated Power Supply sustained no damage from the thermal shock test.
Conclusion	The Regulated Power Supply will operate satisfactorily after being subjected to shipping temperature extremes with rapid increase in temperature between these extremes.

RELIABILITY TEST REPORT

NO. 4

Type of Test Electromagnetic Interference Test (EMI)

Objective This test was performed to determine if the Regulated Power Supply would meet the requirements of MIL-I-26600 for class Ib equipment in the operating and non operating condition. Unless otherwise specified, all paragraph and figure references apply to MIL-I-26600.

Test Item Regulated Power Supply, Part No. 617-500, S/N 203,003.

Procedure Test Methods - The test equipment and the Regulated Power Supply were connected, and the noise level measured using the substitution method. The frequency range was scanned using visual (meter) and audio (earphone) detection. When a peak was detected the meter reading or audio signal was compared with a calibrated signal by substituting a signal from the calibrated signal generator of the test instrument.

Test Voltage - To determine the operating voltage for all EMI tests, interference was monitored on all lines at 0.5mc and the Regulated Power Supply primary power was varied from 29.0 to 32.5vdc. Very little variation, about 3 lb, was detected when the voltage was changed and 30vdc was used as the input to the Regulated Power Supply for all tests.

Interference - Conducted (Continuous Operation) - The test frequencies were selected in compliance with paragraph 4.1.7. Three readings per octave were taken and recorded on the data sheet. A graph of the results is shown on Figure 1 of this report. This figure is a plot of the maximum and minimum readings only and does not show the source (line) of each signal.

Both CW and broadband measurements were taken. All lines were monitored for broadband interference but only two lines were monitored for CW interference. Figure 2 of this report is a graph of the CW readings vs. frequency. Since in this section of the test no out-of-spec. readings were detected and since the CW readings appeared to be following the same general pattern, monitoring all lines for CW interference seemed to be unnecessary.

(Transient Operation) For this report the period of transient operation is the time required to change the Regulated Power Supply from an operating to a non operating state or vice versa and includes all necessary stabilization periods to achieve steady state conditions. The change in state was obtained by a SPST mercury switch.

Before using this switch in the EMI tests an investigation of its performance characteristics was made. The switch was connected to a power supply and loaded with a resistor to carry 0.5 amp. d-c. An oscilloscope was then used to monitor the switching operation. No accurate measurements on overshoot or the damped transients were made since the switch operation as viewed on the scope was estimated to be as good as could be expected without filtering; the overshoot was less than 5 per cent of the total and the transient appeared to be about 8 to 10 cycles of a 10mc. (approximately) damped wave.

The same method of test as described above was used. The test set was set at the test frequencies obtained during continuous operation and then the SPST mercury switch was actuated. The results are shown on Figure 3 of this report. Only lines 1 and 4/5 were monitored.

Interference - Radiated - The same techniques described above were used to obtain radiated interference noise measurements. The Regulated Power Supply was operated at 30vdc. Figure 4 of this report is a graph of the results obtained during steady state and transient operation.

Susceptibility (Radio Frequency Conducted) - The Regulated Power Supply was subjected to the signals and conditions specified in 4.3.4.1.1 except that the frequency range was 0.15mc to 920mc. The signal was applied to the line stabilization networks of both input lines.

(Audio Frequency Conducted) - For this test the Regulated Power Supply was subjected to the signals and conditions specified in 4.3.4.1.2. The audio signal was injected into both input power leads.

(Radio Frequency Radiated) - For this test the Regulated Power Supply was subjected to the signals and conditions specified in 4.3.4.2 except that frequency range was .1mc to 920mc.

Results

The Regulated Power Supply failed to meet MIL-I-26600 as follows:

Conducted Interference - Noise levels exceeding those specified in Figure 3 were detected when supplying power to and removing power from the Regulated Power Supply with a SPST mercury switch. The out-of-spec values vs. frequencies are shown in Figure 3 of this report.

Radiated Interference - Noise levels exceeding allowable limits were detected when supplying power to and removing power from the Regulated Power Supply with a SPST mercury switch. The out-of-spec values vs. frequency are shown in Figure 4 of this report.

Susceptibility to Audio Frequency Conducted - The output of the Regulated Power Supply exceeded allowable limits as follows:

Frequency (cps)	Positive Output	Negative Output	Audio (3vac)
232-242	20.73	20.43	Pos. Input
232-242	20.55	20.54	Neg. Input

To meet the specified requirements, the Regulated Power Supply output voltage must fall within the range 22.1 to 21.9vdc, and the ripple and noise shall not exceed 20mv. pp. the voltage was not measured at the Regulated Power Supply terminals but when .08vdc is added to the above readings, to correct for lead resistance, the corrected values remain out-of-spec.

Conclusion

The Regulated Power Supply as now designed does not meet all requirements of MIL-I-26600 for class 1b equipment. As a result of the above tests, an investigation is in progress to modify the Regulated Power Supply so that it will meet the specified portions of MIL-I-26600.

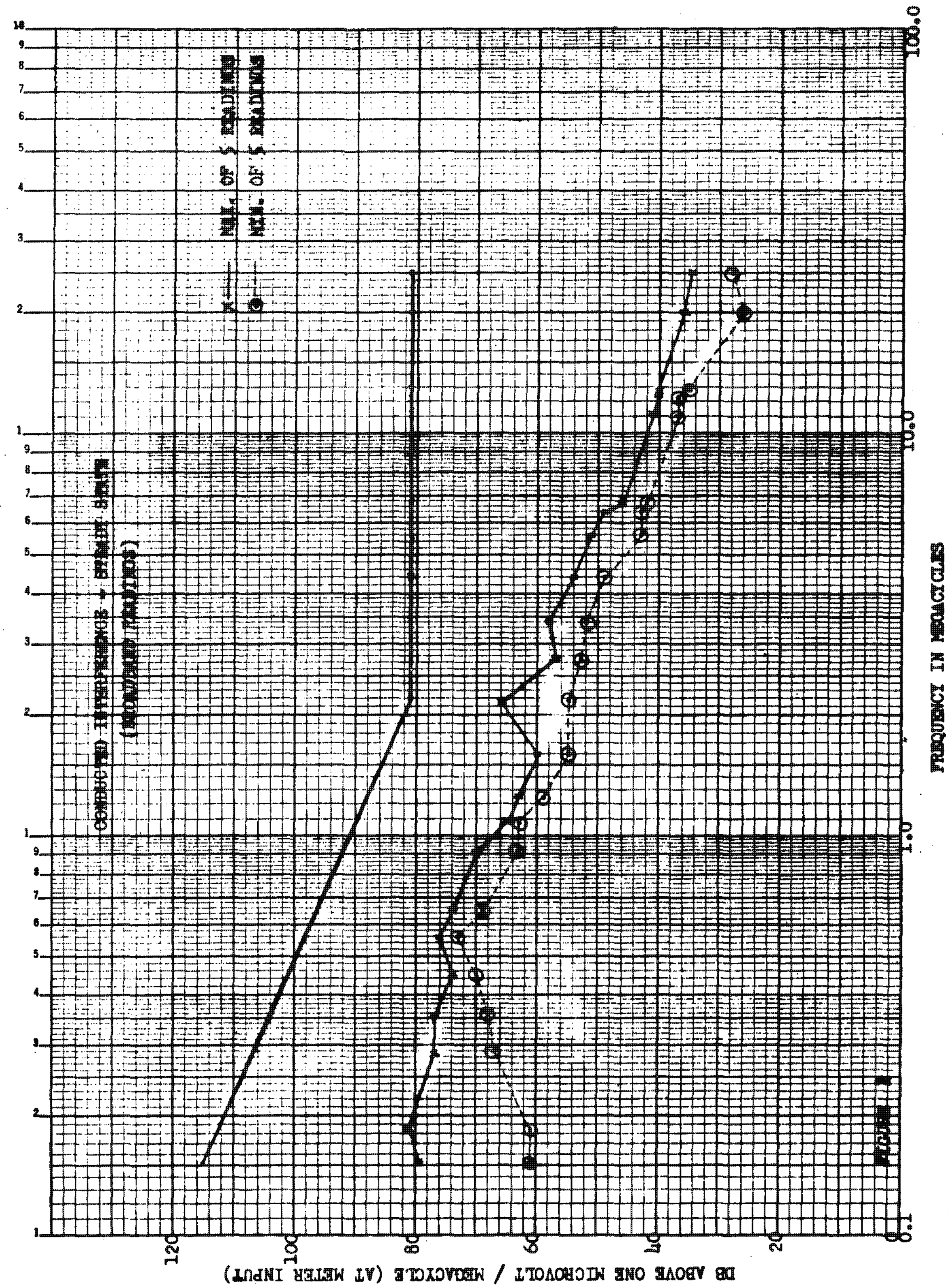

Figure 1. Conducted Interference-Steady State (Broadband)

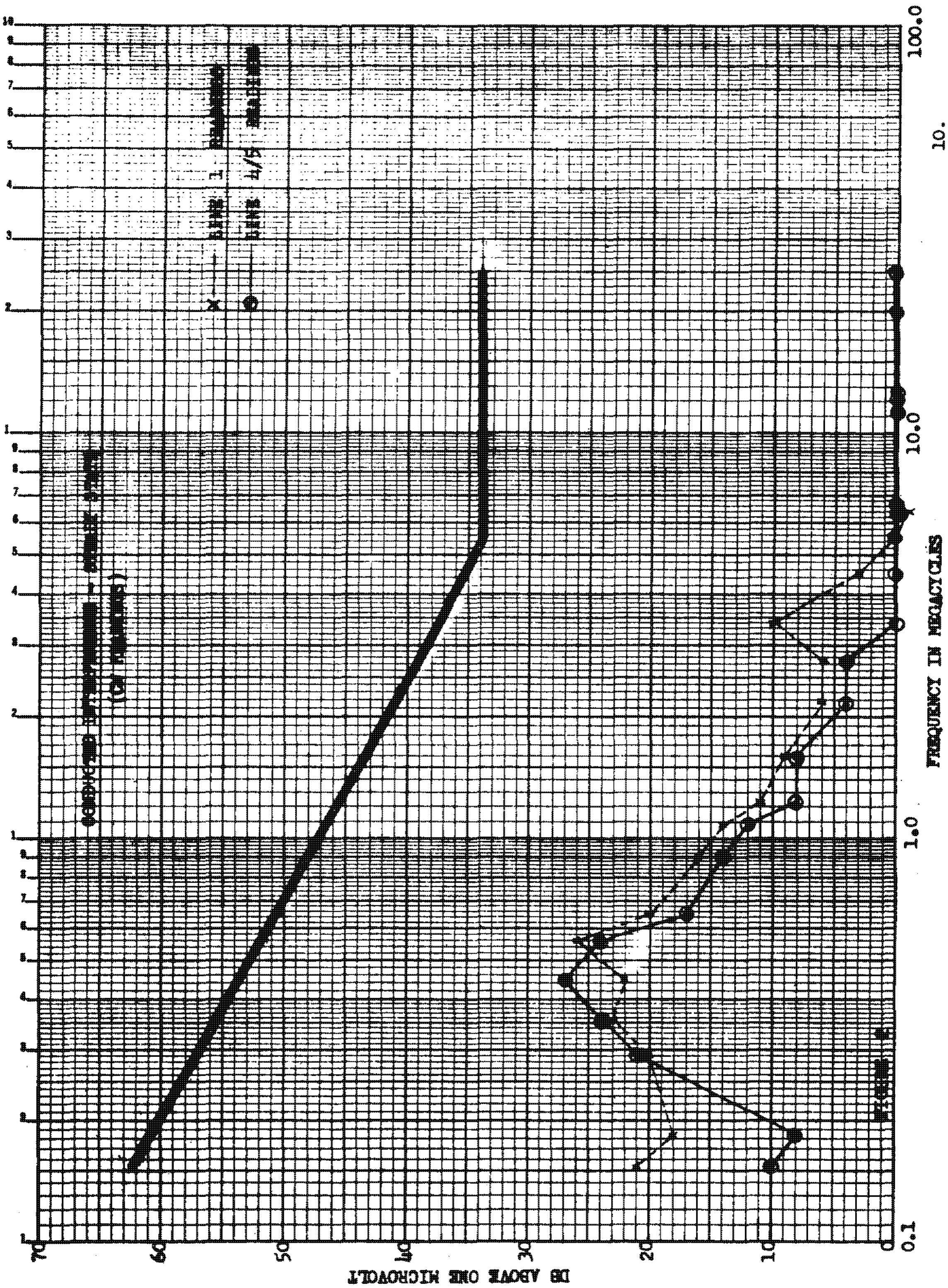

Figure 2. Conducted Interference - Steady State (CW)

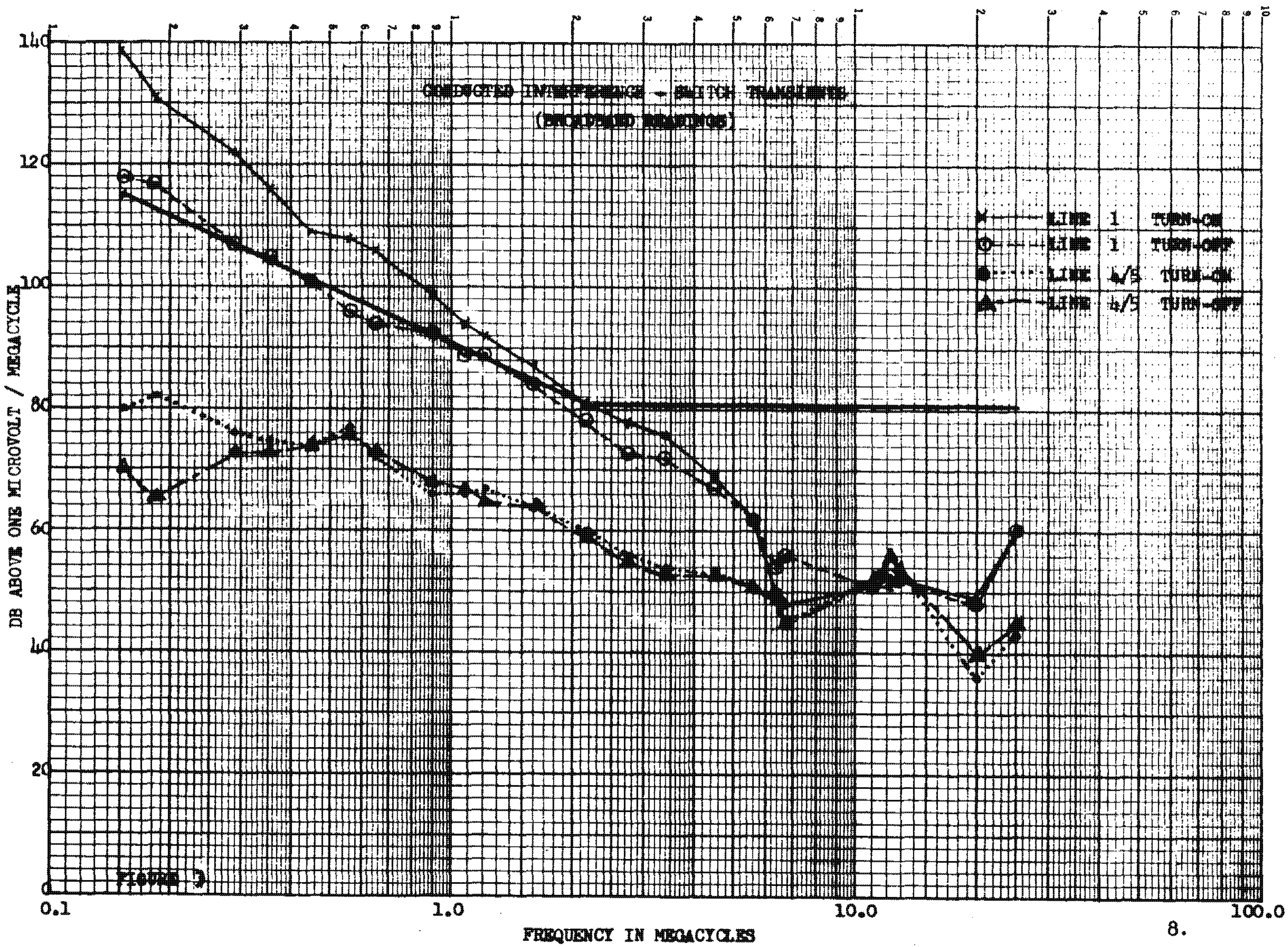

Figure 3. Conducted Interference - Switch Transients (Broadband)

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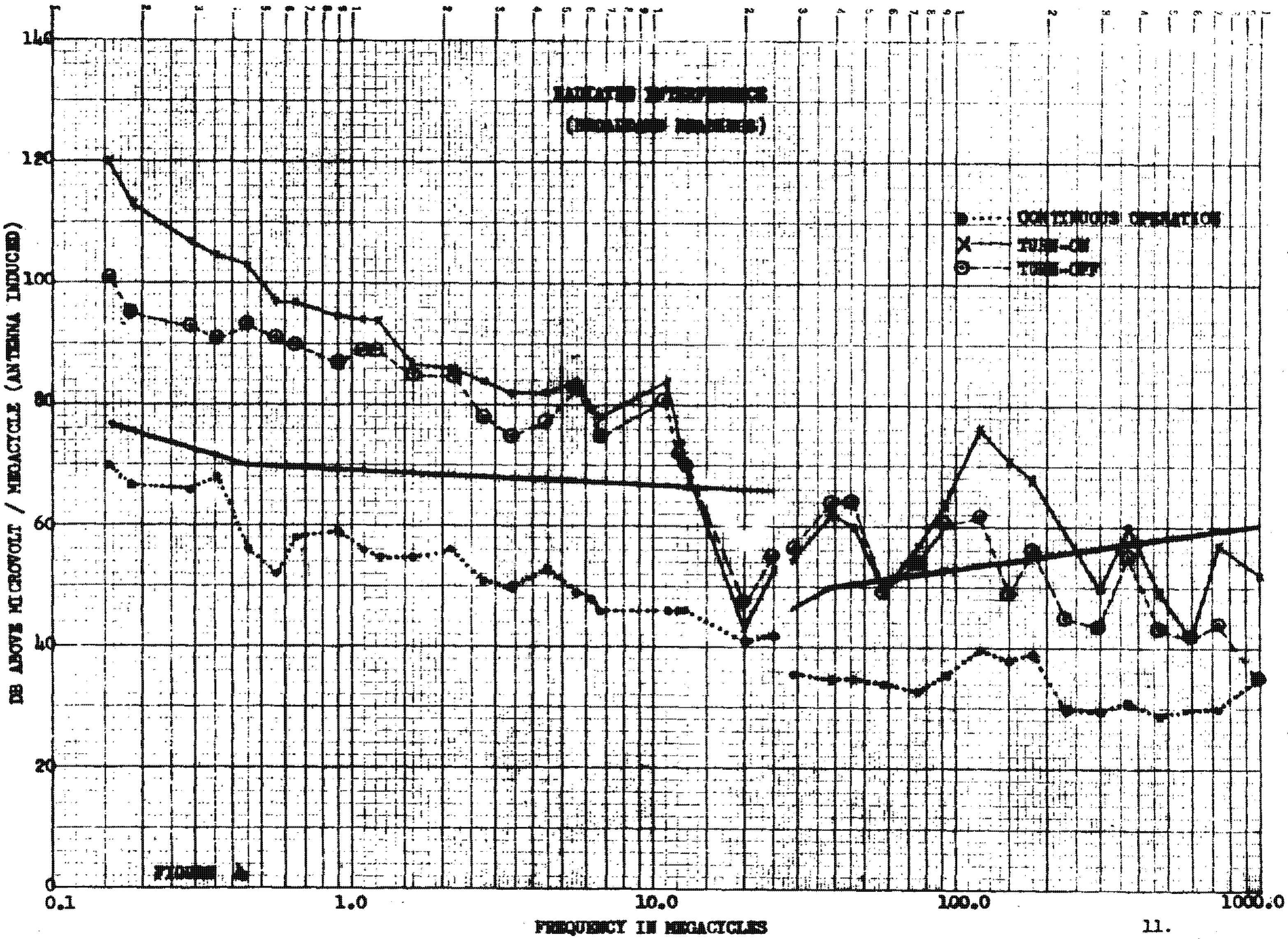


11.

Figure 4. Radiated Interference - Broadband

RELIABILITY TEST REPORT

NO. 5

Results of this test are found in Reliability Test Report No. 34.

RELIABILITY TEST REPORT

NO. 6

Type of Test Vibration (Random)

Objective This test was performed to determine whether the Signal Gating Module will satisfactorily survive the vibration required for qualification of individual components, namely, random vibration - white noise excitation - having a continuous uniform spectral density of $0.1g^2/cps$ in the range of 20-2000 cps with respect to three mutually perpendicular axes. The test duration was 10 minutes in each of the three axes.

Test Item 510-200, Signal Gating Assembly, S/N 201002

Procedure The Signal Gating Module was subjected to the vibration levels specified above. Before and after vibration, operability tests were conducted to ascertain the module's performance characteristics. These were:

- Coincidence of sync. pulse with signal
- Channel unbalance
- Distortion
- Output DC level

Results Results of the operability tests showed that the Signal Gating Module successfully survived this vibration.

Conclusion The present design satisfactorily meets the present qualification vibration test requirements.

RELIABILITY TEST REPORT

NO. 7

Type of Test	Shock
Objective	This test was performed to determine whether the Signal Gating Module would satisfactorily withstand the shocks required by the specification for this sub-assembly. These requirements are: three 30g shocks in each of three mutually perpendicular axes (for a total of 18 shocks). The time to peak of each shock was 5.5 ± 0.5 milliseconds (1/2 sinusoidal pulse shape or equivalent).
Test Item	510-200, Signal Gating Assembly, S/N 201-002
Procedure	The Signal Gating Module was subjected to the shock levels and operability tests, as described for vibration test, were performed.
Results	Results of the operability tests showed that the Signal Gating Module successfully survived the required shock.
Conclusion	The present design of the Signal Gating Module satisfactorily meets the qualification shock test requirements.

RELIABILITY TEST REPORT

NO. 8

Type of Test — Acceleration

Objective — This test was performed to determine whether the Signal Gating Module would satisfactorily withstand levels of acceleration required for component qualification. This acceleration level was simulated by rotating the assembly on a centrifuge to produce a sustained radial acceleration level of 12g for three minutes in each direction along each of three mutually perpendicular axes.

Procedure — The Signal Gating Module was subjected to the above acceleration test, and operability tests as described for the vibration test.

Results — Results of the operability tests showed that the Signal Gating Module sustained no adverse effects from acceleration.

Conclusion — The present design of the Signal Gating Module satisfactorily meets the qualification acceleration test requirements.

RELIABILITY TEST REPORT
NO. 9

Type of Test Thermal Shock/High and Low Temperature Operability

Objectives This test was performed to determine whether the Signal Gating Module will satisfactorily withstand conditions of thermal shock possible during transportation. The conditions for thermal shock were simulated by two chambers at different temperatures; viz., 0°F and 160°F. The ability to operate satisfactorily under extreme temperature conditions (45-140°F) was also determined.

Test Item 510-200, Signal Gating Assembly

S/N 201-002

Procedure The Signal Gating Module was inserted in the 160°F ambient for six hours. Within one minute after removal from the 160°F chamber, the Signal Gating Module was inserted and allowed to remain for six hours in the 0°F environment.

The chamber temperature was then increased to 145°F and the operability tests described for vibration test were repeated. The Signal Gating Module was allowed to operate at 140°F for six hours. The operability test was repeated and noise measurements were taken on the output at this temperature. The chamber was then reduced to 40° - 45°F and the operability and noise tests were repeated at this temperature.

Results Results of the operability tests show that the Signal Gating Module sustained no adverse effects from the thermal shock test and operated satisfactorily at the high and low operating temperature extremes.

Conclusion The Signal Gating Module will survive transportation temperature extremes, and will operate satisfactorily in any anticipated operating temperature extreme.

RELIABILITY TEST REPORT
NO. 10

Type of Test	Relative Humidity
Objective	This test was performed to determine if the Signal Gating Module would operate satisfactorily under maximum relative humidity conditions anticipated in use. Conditions were simulated by a chamber within which the relative humidity was maintained at 90 per cent at ambient temperature.
Test Item	510-200, Signal Gating Assembly S/N 201-002
Procedure	The Signal Gating Module was subjected to the relative humidity environment described above. After six hours operability tests were repeated while the Signal Gating Module was in the specified environment.
Results	Results of the operability tests showed that the Signal Gating Module sustained no adverse effects from the humidity environment.
Conclusion	The Signal Gating Module will operate satisfactorily under the maximum expected humidity environment.

RELIABILITY TEST REPORT
NO. 11

Type of Test Pressure/Life

Objective This test was performed to determine whether the Signal Gating Module would operate satisfactorily under 30 psia pressure, and to determine if it has adequate life to fulfill its mission.

Test Item 510-200, Signal Gating Module

S/N 201-002

Procedure The Signal Gating Module was placed in a chamber and the pressure adjusted to 30 psia. The operability tests described for the vibration test were repeated. The Signal Gating Module was allowed to operate for 150 hours and the operability tests were repeated while in the pressure chamber.

Results Results of the operability tests showed that the Signal Gating Module sustained no adverse effects from the applied pressure, and operated satisfactorily for the 150 hour life test.

Conclusion The Signal Gating Module will operate satisfactorily under pressure and has completed one period of required operating life.

RELIABILITY TEST REPORT

NO. 12

Type of Test	Axial Thrust Load
Objective	To determine the ability of the Servos to withstand axial loads on its shaft while inoperative.
Test Item	Elevation Servo Assembly 614-100, S/N 202002
	Azimuth Servo Assembly 614-101, A/N 202002
Results	Visual inspection and operability tests after the completion of qualification testing showed no damage or impairment of operability.
Conclusion	The Servo Assemblies structurally and operably withstood the qualification level of axial load per drawing 653-101.

RELIABILITY TEST REPORT
NO. 13

Type of Test	End Play and Eccentricity.
Objectives	To determine the amount of end play and eccentricity inherent in the Servos, for compatibility with other parts of the system.
Test Item	Elevation Servo Assembly 614-100, S/N 202002 Azimuth Servo Assembly 614-101, S/N 202002
Procedure	Measure the end play with an axial load of twenty pounds in each direction. Measure eccentricity while commanding shaft rotation.
Results	Maximum end play was .0004" (specification limit .0005). Eccentricity was .0019 max. (specification limit .005). Before completion of this test the azimuth servo had to be taken apart and metal chips removed from gear teeth. The elevation servo was assembled incorrectly and had to be corrected.
Conclusion	The servos tested were within the specified limits of end play and eccentricity, after the corrections mentioned above.

RELIABILITY TEST REPORT
NO. 14

Type of Test	Shipping Temperature Extremes
Objective	To determine whether the Servos are capable of withstanding specified extremes of temperature in the non-operating state.
Test Item	Elevation Servo Assembly 614-100, S/N 202002 Azimuth Servo Assembly 614-101, S/N 202002
Procedure	With each Servo in the test chamber, lower the temperature to 0°F and maintain for 4 hours. Raise the temperature to 165°F and maintain for 4 hours.
Results	Visual inspection and operability tests after the completion of qualification testing showed no damage or impairment of operability to either Servo. (See Test Report No. 19)
Conclusion	The Servo assemblies are capable of withstand the specified limits of temperature in the non-operating state.

RELIABILITY TEST REPORT
NO. 15

Type of Test	Humidity
Objective	To determine whether the Servos are capable of withstanding the specified relative humidity in the non-operating state.
Test Items	Elevation Servo Assembly 614-100, S/N 202002
	Azimuth Servo Assembly 614-101, S/N 202002
Procedure	With the Servos in the humidity chamber increase the humidity to 80% and maintain for 24 hours.
Results	Visual inspection showed staining of the finish of both Servos after humidity testing. Operability checks showed no impairment of operability. (See Test Report No. 19)
Conclusion	The thermal radiation characteristics of the Servos could be altered by exposure to high humidity.
	A program for improved application of the silicon monoxide over-coating has been instituted.

RELIABILITY TEST REPORT
NO. 16

Type of Test	Vibration (random)
Objective	To determine whether the Servos are capable of withstanding the specified levels of random vibration in the non-operating state.
Test Items	Elevation Servo Assembly 614-100, S/N 202002 Azimuth Servo Assembly 614-101, S/N 202002
Procedure	After mounting the Servos on the vibration equipment using the proper fixtures, apply white noise vibration for 5 minutes along each of three mutually perpendicular axes. The excitation will be within a frequency range of 15 to 2000 cps. and shall have a continuous uniform power spectral density of 0.1 g^2/cps.
Results	The vibration test was conducted at the specified levels. Visual inspection and operability tests after the completion of qualification testing showed no damage or impairment of operability of either Servo. (See test Report No. 19)
Conclusion	The servos are capable of withstanding the specified levels of vibration without damage or impairment of operating capability.

RELIABILITY TEST REPORT
NO. 17

Type of Test	Shock
Objective	To determine whether the Servos are capable of withstanding the specified levels of shock, both as, packaged for shipment and as unprotected units.
Test Items	Elevation Servo Assembly 614-100, S/N 202002 Azimuth Servo Assembly 614-101, S/N 202002
Procedure	Apply to each Servo, mounted directly to an environmental test fixture, three mutually perpendicular axes (total of 18 shocks). Each shock to be one-half sine wave, with peak magnitude of 12.5 g. Time from start of pulse to peak value to be 5.5 ± 0.5 ms. Repeat at 30g with the unit packaged for shipment.
Results	Visual inspection and operability tests after the completion of qualification testing showed no damage or impairment of operability. (See Test Report No. 19)
Conclusions	The servos are capable of withstanding the specified levels of shock without damage or impairment of operating capability.

RELIABILITY TEST REPORT
NO. 18

Type of Test	Acceleration
Objective	To determine the ability of the Servos to withstand the specified levels of sustained acceleration.
Test Items	Elevation Servo Assembly 614-100, S/N 202002 Azimuth Servo Assembly 614-101, S/N 202002
Procedure	Apply a 10g acceleration to the Servo along each of three mutually perpendicular axes for three minutes in each direction.
Results	Visual inspection and operability tests after the completion of qualification testing showed no damage or impairment of operability to either Servo. (See Test Report no. 19)
Conclusion	The Servo Assemblies are capable of withstanding the specified levels of acceleration without damage or impairment of operating capability.

RELIABILITY TEST REPORT
NO. 19

Type of Test	Inspection and Operability Test
Objective	To detect any damage and to verify the correct operation of the servos after environmental testing.
Test Items	Elevation Servo Assembly 614-100, S/N 202002 Azimuth Servo Assembly 614-101, S/N 202002
Procedure	Visually inspect. Test insulation resistance. Test leak rate during operation. Apply 34 volts and maximum load and operate for one minute. Run operational check by commanding servo to all positions with rated voltage and light load. Repeat with minimum voltage and maximum load. Test transition time in two directions between the extreme positions. Clamp the load shaft and check time of operation of overload circuit.
Results	Both Servos operated normally, without overshoot or drawing excessive current. The "surge" light on the test stand went on and remained on. This was traced to a fault in the test set. The staining of the finish of both servos during humidity test was observed in this visual inspection.
Conclusion:	The servos are capable of normal operation after the environmental tests. (See also Test Report No. 15)

RELIABILITY TEST REPORT
NO. 20

Type of Test — Vacuum

Objective — To determine the ability of the Servos to operate in a vacuum environment without leakage.

Test Items — Elevation Servo Assembly 614-100, S/N 202002

Azimuth Servo Assembly 614-101, S/N 202002

Procedure — With each Servo in a pressure vessel, reduce the pressure to 1 x 10^{-6} mm. of mercury. Repeat the operational check. Record the leak rate. (The actual procedure used did not include readings of leak rate, but pressure readings were observed.)

Results — Both Servos operated normally. The surrounding pressure continued to reduce during the course of the operational checks, indicating no leakage from the servos.

Conclusion — The Servos are capable of normal operation in the specified reduced pressure environment. No significant leakage was evident.

RELIABILITY TEST REPORT
NO. 21

Type of Test	Electromagnetic Interference and Susceptibility
Objective	To determine the conformance of the Servo assemblies to E.M.I. specification MIL-I-26600.
Test Items	Elevation Servo Assembly 614-100, S/N 202002 Azimuth Servo Assembly 614-101, S/N 202002
Procedure	Test the Servo in accordance with MIL-I-26600 for Radio Frequency conducted and radiated interference, and for conducted and radiated susceptibility. Measure the magnitude and frequency of any conducted interference between 15 and 15,000 cycles impressed on the power supply. Run the overload test with a 3 volt, 50 cycle AC voltage impressed on the input. Repeat at 700 cycles and 15,000 cycles.
Results	The servos meet the specification requirements for audio frequency interference, conducted susceptibility and radiated susceptibility. The servos exceeded the specification requirements for conducted interference from .15 mc. to 25 mc.
Conclusion	Both servos fail to meet the specifications for conducted and radiated radio-frequency interference. A corrective action program was initiated to remedy the situation.

RELIABILITY TEST REPORT

NO. 22

Type of Test: Inspection and Functional (Pre-environmental)

Objective: To determine whether the cables meet acceptance requirements and operate properly prior to environmental testing.

Test Items: Six Cables, as Follows:

Cable No.	Drawing No.	S/N
W-1	518-200	202002
W-2	518-201	"
W-3	518-202	"
W-4	518-203	"
W-5	518-204	"
W-6	518-205	"

Procedure: Inspect each cable for cleanliness, workmanship, and conformance to drawing. Check each cable for proper mating of connectors, electrical continuity and insulation resistance.

Results: No discrepancies were found in wiring or connector mating. Insulation resistance was in excess of 100 megohms.

Conclusion: The cables were in proper operating condition prior to environmental testing.

RELIABILITY TEST REPORT
NO. 23

Type of Test	Shipping Temperature Extremes (cycling)
Objective	To determine the capability of the cables to withstand rapid temperature cycling to the extremes of possible shipping conditions.
Test Items	Six Cables (See Report No. 22)
Procedure	Subject each cable to five continuous cycles of temperature exposure. Each cycle to consist of one hour at 0° ± 5°F followed by one hour at 165° ± 5°F. Return to room temperature, inspect, and repeat the functional tests.
Results	No damage or malfunction resulted from temperature cycling.
Conclusions	The cable assemblies are capable of withstanding the specified levels of shipping temperature extremes.

RELIABILITY TEST REPORT
NO. 24

Type of Test	Vacuum
Objective	To determine the capability of the cables to withstand exposure to reduced pressures, in the non-operating state.
Test Item	W-5 Cable, drawing 518-204, S/N 2.
Procedure	One cable, representative of all cables was placed in a vacuum chamber and subjected to a pressure of $1.14 \times 10^{-6} \pm 1.3 \times 10^{-7}$mm of mercury for 50 hours. Inspection and functional tests were repeated.
Results	The cable showed no damage or degradation from exposure to vacuum.
Conclusions	The cable (which is assumed to be representative of all the cables) is capable of withstanding the specified level of vacuum in the non-operating state.

RELIABILITY TEST REPORT
NO. 25

Type of Test	Vibration
Objective	To determine the capability of the cables to withstand vibration while operating.
Test Items	Six Cables (see Test Report No. 22)
Procedure	Random vibration was applied to each cable for 5 minutes along each of three mutually perpendicular axes. Level was 0.1 g^2/cps ± .01 g^2/cps throughout the frequency range 15 to 2000 cps. All circuits of each cable were connected in series, with current of .25A passed through and each series circuit monitored for discontinuities.
Results	The vibration of W-4 cable in one axis was repeated because of a faulty circuit monitor. At the conclusion of the first run three cable clamps were found broken, but there was no evidence of damage to the cables. The clamps were replaced and there was no further breakage or damage. The teflon was disarranged on cables W-1 and W-3, but no damage resulted.
Conclusion	The cables are capable of withstanding the specified levels of vibration.

RELIABILITY TEST REPORT
NO. 26

Type of Test	Shock
Objective	To determine the capability of the cables to withstand the specified levels of shock without damage or degradation of performance.
Test Items	Six Cables (See Test Report No. 22)
Procedure	Each cable was subjected to three 30 g shocks in each direction along each of three mutually perpendicular axes. (A total of 18 shocks). The time to peak of each shock was 5.5 ms, 1/2 sine pulse shape. All circuits of each cable were connected in series and carried a current of .25 A during test. Cables were monitored for discontinuities. Inspection and functional tests were repeated.
Results:	No evidence of damage or degradation of performance was encountered. One branch of cable W-6 was crushed during mounting. This damage was not due to shock and the test was completed without repairing the damage.
Conclusion	The cables are capable of withstanding the specified levels of shock without damage or degradation.

RELIABILITY TEST REPORT
NO. 27

Type of Test	Acceleration
Objective	To determine the capability of the cables to withstand the specified levels of acceleration without damage or degradation of performance.
Test Items	Six cables (See Test Report No. 22)
Procedure	Each cable subjected to sustained acceleration of 12 g for 3 minutes in each direction along three mutually perpendicular axes. All circuits were connected in and carried a current of .25 A during test. Circuits were monitored for discontinuities. After acceleration, inspection and functional tests were repeated.
Results	No damage or degradation of performance were observed.
Conclusions	The cables are capable of withstanding the specified levels of acceleration without damage or degradation.

RELIABILITY TEST REPORT
NO. 28

Type of Test	Humidity
Objective	To determine the capability of the cables to withstand the specified maximum level of humidity in the non-operating state.
Test Items	Six Cables (See Test Report No. 22)
Procedure	Subject each cable to a relative humidity of 90% ± 5% and temperature of 110°F for ten days. Ends of connectors to be mated with other connectors, and the ends of wires not terminating in connectors to be brought out of the chamber. At the end of the test period, inspect the cables and repeat the functional tests.
Results	No damage or impairment of functional ability were observed.
Conclusion	The cables are capable of withstanding the specified maximum level of humidity without damage or degradation.

RELIABILITY TEST REPORT
NO. 30

Type of Test	Thermal
Objectives	To determine the effect of temperature changes upon the focal plane location of the Lens Assembly, in order to verify the calculated focus shift coefficient.
Test Items	Lens Assembly, S/N 2 Reliability Model, Dwg. No. 807-198.
Procedure	The Lens Assembly, was brought to equilibrium temperature and a series of resolution photos were made at regular focus steps to obtain "best focus" position. This was repeated for various equilibrium temperatures. Results were plotted for temperatures of 58°, 72° and 80°F. and compared with calculations.
Results	The average position of best focus shifted approximately .001 of an inch in the direction predicted over the 22°F. test range.
Conclusion	Calculations were essentially verified. Test technique needs improvement. Tests were terminated early, due to schedule commitments; therefore data is incomplete. This will have to be rerun to evaluate latest design changes which had not been added to this Lens Assembly at the time of testing.

RELIABILITY TEST REPORT NO. 31

Type of Test: Shock

Purpose: To determine the level of shock transmitted to a camera mounted in its carrying case and packed for shipment in a packing crate when shock tested per paragraph 5.2.5 of procedure number 853-104. (3-30 g shocks, each direction, 1/2 sine wave 5.5 ± 0.5 millisecond to peak in each of 3 mutually perpendicular axes).

Date of Test: October 5, 1962

Test Items: Dummy camera 208-882 and DMI Shipping Container for Camera 808-750.

Procedure: Fasten an accelerometer in the center of the dummy camera and place in the shipping container. Place container in packing case surrounded by 6 inches of rubberized horse hair. Mount the packing case on the 6-inch Hygee shock machine and shock the assembly 3 times in each direction along 3 mutually perpendicular axes. Record the shocks on an oscilloscope camera.

Results: The transmitted shocks to the camera averaged about 4g peak with an input of 30 g peak to the outside of the container.

Conclusion: Shock transmitted to the camera is attenuated by a factor of approximately 7.5 when packaged in accordance with the above procedure.

RELIABILITY TEST REPORT NO. 32

Test Item: Elevation Plate Assembly, Drawing 805-102 less Socket Mounting Ring and Primary Support Ring.

Type of Test: Sinusoidal Vibration consisting of low level resonance searches and qualification level tests.

Date of Test: July 23, 1962

Test Purpose:

1. To determine resonant frequencies of the Elevation Plate Assembly by means of a low level sinusoidal vibration input.

2. To determine the effects of qualification level sinusoidal vibration upon the Elevation Plate Assembly.

Conclusions:

a. The Elevation Plate Assembly design tested will not meet the Qualification Vibration levels of 3.75 g in X axis and 3.13 g in lateral axes over the range 8-2000 cps.

b. Redesign is recommended for the Azimuth Pivot Stud & the servo drive shaft pins for reasons of failures below. The Flat Mirror trunnions should be relocated to drastically reduce the eccentricity that produces high amplifications at resonant frequency.

c. Comparisons will be made between resonance data obtained in this test with those to be obtained in payload tests to determine the validity of component data.

Test Procedure:

1. Resonance search

   a. Sixteen accelerometers were attached to the Elevation Plate Assembly at various points of interest.

   b. The Elevation Plate Assembly was subjected to a resonance search in each of the three orthogonal axes in a frequency range of 5-2000 cps. The input was 0.2 inches double amplitude from 5-8 cps. and 1.0 g from 8-2000 cps.

2. Qualification Level Test

a. The Elevation Plate Assembly was subjected to sinusoidal vibration in the X and Z axes in the 5-2000 cps frequency range. The input was 0.5 inches double amplitude from 5-8 cps and 3.75 g from 8-2000 cps for X axis and 3.13 g from 8-2000 cps in the Z axis.

b. After vibration in each axis, the assembly was inspected for damage.

Test Results:

a. Resonance Search disclosed resonances of components at low frequencies in axes of vibration as follows: 18 & 33 cps - Air Supply & Mirror in Z: 20 & 35 cps - servos and mirror in X: 23.5 & 31 cps - Truss and Bridge in Y. The Bridge and Truss acted together to produce the highest transmissabilities of 26.7 & 33.3 respectively at their lowest resonant frequency of 23.5 cps in Y. In addition, as expected, the servos received their highest amplification in Y (21.6) because of the interaction between Truss, Bridge, and Mirror in this axis.

At 31 cps, also in Y, the Air Supply added to this motion to keep the overall responses of the system at relatively high levels. The Aperture Mask resonates at this frequency.

b. Qualification level vibration in X caused the Azimuth Pivot Stud and several other small screws to unscrew and come off. (Failure Report AO-92.) After vibration the Azimuth Servo would not drive the mirror properly. (Failure Report AO-98.) After realignment of the servo lead nut, the assembly was returned to test.

c. During Z axis (qualification level) vibration, the Azimuth Servo drive pin failed, was replaced, and test concluded. Repeat failure was observed when operating servo after tests (Failure Report AO-105).

d. Post vibration operation of the Elevation Servo revealed low insulation resistance, pins to case (Failure Report AO-111).

e. Two other reported failures (AO-114 & 115) were found to lie in the test equipment.

f. Dirt was generated between Delrin bearing surfaces and the Elevation Pivot Assemblies, Drawings 813-249 & 813-250.

g. Dirty grease particles were found near the bearings of the Thrust Bearing Assembly, Drawing 813-253.

h. The Elevation Pivot Assemblies were heavily brinnelled by the bearings, and clearances were reduced to zero.

Approved for Release: 2024/01/30 C05098945

RELIABILITY TEST REPORT NO. 33

Type of Test: Vibration (X-axis)

Test Item: ALR Record Storage Assembly (712-452), S/N 3412.

Purpose: To determine possible weaknesses in the ALR design so that design changes can be applied to the ALRR design before it is released for assembly.

Date of Test: 28 December 1962

Procedure:

a. Wrap approximately $3\frac{1}{2}$ ft. of exposed film on the take-up spool and thread the remainder through the cassette.

b. Place the Cassette on the vibration fixture (208-545) and torque all four mounting bolts to 35 ft. lbs.

c. Attach a spring scale (0-5 lb.) to the film leader and support it by an over-head crane hook with a cord.

d. During vibration maintain $3\frac{1}{2} \pm \frac{1}{4}$ lbs. tension on the film.

e. Perform sine-random vibration according to Appendix D.

Results: The following results of this test are due to vibration in X axis only:

During the random equalization phase over 25 inches of film unwound from the take-up spool at an approximate rate of 8 inches per minute under $3\frac{1}{2}$ lbs. tension. This result could not be duplicated after vibration even with excessive film tension. It is felt that the Clutch Roller Assembly (400-674-102) does not perform its desired function under sine-random vibration. During the same random equalization vibration the polysulfide rubber compound failed to hold the Alignment Mirror (712-497) in the Mirror Bracket. The Mirror jumped out of place and chipped as it hit the vibration fixture.

While the random vibration spectrum shape was being adjusted, three of the mounting tabs on the Compensator Guard (712-457) broke off. The guard was then removed completely for the purpose of continuing the test. The Clutch Roller Assembly also failed to maintain record tension as previously mentioned in the second paragraph.

After the equalization and spectrum-shaping phases the sine-random (qualification level) vibration was begun. During the first 3 minutes of vibration over 25 inches of film unwound from the take-up spool due to failure of the Clutch Roller Assembly to hold the Take-up Reel against 3½ pounds film tension. The film tension was then reduced to one-half pound and vibration was continued. The Take-up Reel did not subsequently rotate. After approximately 4 minutes of sine-random vibration, the Base C (712-464) bracket which supports the Displacement Compensator broke. The vibration test was then discontinued and the Record Storage Assembly was examined for more possible failures. The only other visible failure was a broken lead wire at the base of R603 resistor.

The accelerometers used during the test were recalibrated and showed no change.

Conclusions:

a. A stronger or more positive mounting of the Alignment Mirror is required.

b. The failure of the Compensator Guard is not of direct importance to this component as it is not used in the ALRR design.

c. Failure of the Base C, Displacement Compensator bracket, is of prime importance to the ALRR design, and implies need for a design change. See paragraph 4 part e) of page 4.

d. A more positive method for preventing reverse rotation of the Take-up Reel appears necessary. See paragraph 4 part e) of page 4.

e. Equalization and spectrum shaping took approximately 3.5 minutes each. This is a significant amount of additional vibration, especially for acceptance testing of deliverable items.

f. The general impression obtained from observation of this test is that the sine-random vibration required for qualifying components is far more severe than what the components would be subjected to during launch.

RELIABILITY TEST REPORT NO. 34

Test Item: The test items consisted of the following units:

Test No.	Unit	Dwg. No.	Serial No.
I	Bracket	617-102	7
	Test Box	617-151	207002
	Junction Box	617-106	202002
	Cable W-1	518-200	203004
II	Bracket	617-102	8
	Test Box	617-151	207002
	Junction Box	617-106	205003
	Cable W-1	518-200	203004
III	Bracket	617-102	1077
	Test Box	617-151	207002
	Junction Box	617-106	205003
	Cable W-1	518-200	203004

The Bracket used for test III was the redesigned model, but did not have the aluminized finish, and the construction differed slightly from production units. Production units will have the sides and back formed from one piece and then welded in place. The sides and the back piece on the bracket used for this test were separate pieces welded to the bottom piece to form the assembly.

Type of Test: Vibration

Date of Tests:

Test No.	Date
I	4-16-62
II	5-5-62
III	7-13-62

Test Purpose: To determine if the test item would satisfactorily withstand random vibration (white noise) excitation-having a continuous uniform spectral density distribution of 0.1 g 2/cps. in the range of 20-2000 cps. applied to three mutually perpendicular axes for 10 minutes per axis.

Reliability Test Report No. 34

Conclusions: Test I

The results of this test were not generally accepted as representative of the capabilities of a new Bracket and Junction Box, therefore, Test II was performed.

Test II

The Bracket failed in this test. It was subsequently redesigned to strengthen the weak sections. The Junction Box sustained no damage as a result of this second vibration test and its design was not modified.

Test III

Although cracks developed near the weld in the Bracket and 14 wires were broken in the Test Box, further investigation of the failures revealed circumstances and conditions which vindicate the design.

The cracks that developed were estimated to be peculiar to the Bracket tested; under the same test environment the same cracks should not appear in a production bracket. Also, the cracks did not become worse in the subsequent vibration tests in the other axes. The cracks were not large enough to cause a catastrophic failure so that even if the condition occurred in a production bracket, the mission would not be in jeopardy.

Fatigue was found to be the cause of the failure of the wires in the Test Box as determined by an analysis. The Test Box had been vibrated in two previous tests as shown below. Inspection of this data indicates that the Test Box had withstood 30 minutes of vibration in the required direction before it passed the In-Process tests prior to the 3rd vibration test.

Test	Axes	Duration (Minutes)
1	Z	10
1	Y	9
2	X	10
2	Y	10
2	Z	3

The evaluation of the test results which provide documentation to show that the test item will satisfactorily withstand the qualification vibration test described in "Test Purpose" above can be summarized as follows: The Test Box failed because it was subjected to vibration tests that far exceeded the required length of time for qualification. The Test Box did not fail when subjected only to required vibration tests. The Bracket failure was not critical and should not occur in a production unit. The Junction Box and W-1 Cable satisfactorily withstood vibration testing.

Test Procedure: Test I

Ia. The Test Box, Junction Box and W-1 Cable were mounted on the Bracket, the Bracket was mounted on an environmental test fixture and the test fixture was mounted on the vibration machine.

No previbration performance tests were performed on the Test Box, Junction Box or W-1 Cable. This first test was performed to test the Bracket; the other components were used primarily to present the proper load to the Bracket.

Ib. A resonant search was conducted to detect any fixture resonances. The vibration input for this search was as follows:

Frequency (cps)	Amplitude
5-17	0.2 inches peak to peak
17-2000	± 3g.

The resonant search was conducted in three mutually perpendicular axes. For the tests in this report, the X-axis was assumed to be parallel to the longest edge of the Bracket, the Z-axis was established as perpendicular to the bottom - largest section - of the bracket and the Y-axis was mutually perpendicular to the other two axes.

Ic. The test unit was subjected to the vibration input described in "Test Purpose" above as follows:

Axis	Duration (minutes)	Amplitude (g^2/cps)
Z	10	0.1
Y	4	0.1
Y	5	0.08

The variation in the amplitudes obtained in the Y-axis resulted from limitations on the output of the vibration equipment. The 0.08 was the maximum safe output that the machine was capable of delivering. An explanation for the variation in output between the first 4 minutes and the last 5 minutes would require an investigation of the vibration equipment. Only two axes of vibration were performed due to failures described in "Results" below.

Test II

IIa. The Test Box, Junction Box and W-1 Cable were mounted on the Bracket, the Bracket was mounted on an environmental test fixture, and the test fixture was mounted on the vibration machine.

Like Test I, this test was conducted to investigate the capabilities of the Bracket and, therefore, no In-Process tests were performed. This test was a repeat of Test I. This vibration was a retest of the bracket design used in Test I, performed at the request of Design Engineering who questioned the validity of the original test. The extent of vibration necessary for equalization was thought to have fatigued the original bracket. The Bracket used for Test II (serial 8) and the Junction Box (serial 205003) had not been exposed to any previous vibration tests.

IIb. The test item was vibrated as described in "Test Purpose" above as follows:

Axis	Duration (minutes)	Amplitude (g^2/cps)
X	10	0.1
Y	10	0.1
Z	3	0.1

The axes for this test were the same as described above.

Test III

IIIa. The Test Box, Junction Box and W-1 Cable were tested for continuity and leakage resistance as required by the applicable portions of the In-Process and Acceptance Tests. These In-Process and Acceptance Tests were performed to assure that the components met all requirements of applicable specifications.

IIIb. The Junction Box, Test Box and W-1 Cable were mounted on the Bracket. The Bracket was mounted on an environmental test fixture and the test fixture mounted on the vibration machine.

IIIc. The test item was subjected to the vibration described in the paragraph "Test Purpose" above as follows:

Axis	Duration (minutes)	Amplitude (g^2/cps)
Y	10	0.075
X	10	0.016
Z	10	0.1
X	10	0.1

The 0.075 g^2/cps applied to the test unit in the Y-axis represented the maximum output of the vibration machine. As described above, the required 0.1 g^2/cps could not be obtained without overloading the equipment.

The test unit was vibrated twice in the X-axis direction because of the low reading obtained in the first test. After the first test, it was observed that the indicating accelerometer was in contact with a weld and therefore, gave false readings.

IIId. The In-Process tests described in paragraph IIIa above were repeated.

Test Results: Test I (Search)

No reasonances with amplification factors greater than 2 were detected. Also, no readings normal to the direction of excitation greater than 50 per cent of the maximum level in the direction of excitation were detected.

Test I (Test)

Four fractures developed in the Bracket in the area around the screws which secure the Bracket to the environmental test fixture. The Junction Box also developed fracture in the area around the screws that hold the Box to the Bracket.

Test II

Fractures and cracks developed in the Bracket in the area around the screws that secure the Bracket to the Environmental Test Fixture.

Test III

After being vibrated in the Y-axis, cracks were observed near the weld in the Bracket in two places. As described above, this bracket was made by welding the two side pieces and a back piece to the bottom. The cracks were detected near the weld between the sides and the bottom.

Results of the operability tests revealed that 14 wires were broken in the Test Box.

RELIABILITY TEST REPORT NO. 35

Type of Test: Shock

Date of Test: October 19, 1962

Purpose: To determine the capability of the test items to withstand the qualification shock test of Appendix D without degradation of performance.

Test Item: The test item consisted of the following units:

Unit	Drawing No.	Serial No.
Bracket	617-102	1077
Test Box	617-151	207002
Junction Box	617-106	205003
Cable W-1	518-200	202002

The Test Box, Junction Box and W-1 Cable were mounted on the Bracket which was mounted on an environmental test fixture.

Procedure:

a. The assemblies were subjected to the following pre-shock operability tests:

   The Junction Box was tested for continuity and leakage resistance after being subjected to qualification level vibration. The shock test followed the vibration test; therefore, no separate pre-shock operability tests were necessary. Fourteen wires broke in the Test Box during vibration. These wires were repaired and the Test Box tested for continuity. The W-1 Cable had not been subjected to any previous environmental tests; therefore, the results of the acceptance tests were regarded as pre-shock operability test data.

b. The Junction Box, Test Box and W-1 Cable were mounted on the bracket which was then mounted on the environmental test fixture.

c. The entire assembly was then subjected to the shock test specified in Appendix E.

d. The Junction Box and Test Box were then re-tested as described in Section a. The W-1 Cable was tested for continuity and leakage resistance. The entire assembly was inspected.

RELIABILITY TEST REPORT NO. 35 (Cont'd)

Results: The test results on the Junction Box, Test Box and W-1 Cable, and the inspection indicated that the assembly was not affected by the shock test.

Conclusions: The assembly consisting of the Junction Box, Test Box, W-1 Cable mounted on the applicable bracket successfully passed the qualification shock test.

RELIABILITY TEST REPORT NO. 36

Type of Test: Shipping and Storage Temperature Extremes

Date of Test: October 30, 1962

Purpose: To determine the capability of the test items to satisfactorily withstand the temperatures anticipated during shipping and storage.

Test Items: The items tested were as follows:

Unit	Drawing No.	Serial No.
Test Box	617-151	207002
Junction Box	617-106	205003

Procedure:

a. The Test Box and Junction Box were inspected after the previous environmental test (which was a shock test).

b. The Junction Box was then tested for continuity and leakage resistance and the Test Box was tested for continuity.

c. The test items were then subjected to the Shipping Temperature Extremes Test specified in Appendix D.

d. The inspection and electrical tests described in sections a and b were repeated.

Results: The inspection and tests revealed that the test units were not affected by exposure to the temperature extremes.

Conclusion: The Junction Box and Test Box will operate satisfactorily after being exposed to the shipping and storage temperature extremes specified above.

RELIABILITY TEST REPORT NO. 37

Type of Test: Vibration (X-axis)

Test Item: ALR Record Storage Assembly (712-452), S/N 3412

Purpose: To determine possible weaknesses in the ALR design so that design changes can be applied to the ALRR design before it is released to assembly.

Date of Test: January 8, 1963

Procedure:

a. Wrap approximately 4¼ ft. of exposed film on the take-up spool and thread the remainder through the cassette.

b. Place the Cassette on the vibration fixture (208-545) and torque the four mounting bolts to 35 ft. lbs.

c. Attach a spring balance (0-5 lbs.) to the film leader and support it by an over-head crane hook with a cord.

d. During the vibration test, maintain 3½ ± ¼ pounds tension on the film.

e. Perform sine-random vibration according to Appendix D.

Results: The following results of this test are due to vibration in Z-axis only. The cassette used for this test was not a complete assembly. The Alignment Mirror and Compensator Guard were left off because it was felt that failures similar to those experienced during X-axis vibration would reoccur. Since vibration in the Z axis is not as severe as in the X axis for the Displacement Compensator Base C Bracket, another bracket (same design) was used. No change was made in the Clutch Roller Assembly.

Throughout the complete equalization phase no visible failures occurred on the Cassette. This equalization phase consisted of 4 runs of random vibration (2g to 4g rms) with about 3½ minutes for each run.

After completion of the sine-random vibration (17 minutes), two failures were noted. About 50 inches of film unwound from the Take-up Spool because the Clutch Roller Assembly did not perform its required function. The second failure was a broken Idler Roller Mounting Bracket (712-451).

Upon further analysis of the Record Storage Assembly, it was noticed that the Eccentric Roller of the Displacement Compensator Assembly had some rotational drag and the Positioning Roller Shaft (712-213) of the Eccentric Roller Assembly rotated about 10 degrees. The Displacement Compensator Assembly was then completely disassembled for further investigation. It was found that one end of Shaft A, Pivot (712-206) had rubbed against the internal surface of the Eccentric Roller (712-285). Secondly, the Set screw (400-166-116) did not prevent the Positioning Roller Shaft of the Eccentric Roller Assembly from rotating. Third, the Displacement Compensator Frame (712-215) had two noticeable cracks at the weldments.

As a gross check on the take-up motor, the take-up spool was operated for about 30 seconds with zero film tension. Rotational speed and motor and gear noises seemed satisfactory.

Conclusions:

a. A more positive method for preventing reverse rotation of the Take-up Reel appears necessary, because film tension may be lost during the powered flight phase.

b. The failure of the Idler Roller Assembly is not of direct importance to this component as it is not used in the ALRR design.

c. Rotation of the Positioning Roller Shaft can result in mistracking of film. Therefore, a more positive design other than a setscrew should be applied.

d. Cracks in the Displacement Compensator Frame may weaken the frame to the point of failure or cause mistracking of the film.

RELIABILITY TEST REPORT NO. 38

Type of Test: Shock

Purpose: To determine the capability of the test item to withstand handling shock without damage or degradation of performance.

Date of Test: January 30, 1963

Test Item: Gain Control Electronics Assembly (GCEA) - RC-3545-212004, EK Drawing 510-105.

Procedure: Attach the GCEA to the environmental test fixture and mount the assembly to the shock tester. Perform the shock tests as outlined in Appendix D. Record shocks on an oscilloscope camera. Following shock tests, perform a leakrate and operability check.

Results: Leak Rate check was satisfactory showing that the shock test did not affect the cover seal. The continuity and operability tests were performed and the results were satisfactory.

Conclusion: Shock testing had no detrimental effects upon the Gain Control Assembly.

RELIABILITY TEST REPORT NO. 39

Type of Test: Camera Film Speed Test

Objective: To determine the effect of locked compliance rollers upon smoothness of operation of the camera.

Test Item: Camera 808-750 (S/N 205003) and Camera Test Set

Procedure: Replace Camera parts 808-603, 808-767 and 808-608 with a locking device for the Bellows Assembly. This device negates any effects of compliance rolls during Camera operation.

Install modified camera on the camera test set and perform film speed tests at ambient temperature and pressure per the Acceptance Test Procedure QC-A-250. Expose several frames at speeds 291, 400, and 544.5 cps (steps 1, 33 and 64), all at 28 volts. Process film and compare per cent Δv results with those obtained in acceptance testing of the same camera.

Results:

a) Representative test data obtained in this test are shown for comparison purposes with Acceptance Test data for S/N 205003 Camera using the old design bellows system.

Per cent v (peak-to-peak)	291 cps.	400 cps.	544.5 cps.
Acceptance Test per QC-A-250 dated 6/26/62			
Pre vibration	1.09	1.42	2.02
Post vibration	1.45	1.58	1.99
Locked Roller Test on 1/16/63	1.13	1.32	1.13

b) Some difficulty was experienced with the test set tension system which required extra runs to be exposed in order to obtain what was considered representative data.

Conclusions: The data above indicate that the bellows system in this camera does not assist in reducing velocity fluctuations. However, there was a considerable period of time between acceptance tests and this test. Also, the film dynamics of the actual film supply assembly were not duplicated. Therefore, the results of this test are only qualitative. It is recommended that more extensive and refined repeat testing be accomplished as soon as possible.

RELIABILITY TEST REPORT NO. 40

Type of Test: Vibration

Date of Test: February 26, 1963

Purpose: To determine the capability of the test item to withstand the qualification level vibration test (Appendix D) without degradation of performance.

Test Item: Distribution Box Assembly 617-114 Serial Number 2944.

Procedure:

a. The Distribution Box was subjected to a leak rate test, an inspection, and an In-Process performance test to verify that the Distribution Box had sustained no damage from the previous qualification test (shook).

b. The Distribution Box was mounted on the vibrator and excited in the X axis (as defined by its orientation on the intended application) as described in Appendix D.

c. The Distribution Box was removed from the vibrator and the inspection and In-Process performance tests were repeated.

Results: The results of the In-Process performance tests revealed that the Record Transport Control module in the Distribution Box was not operating properly. A wire was broken on pin 4 of K-1 relay and number 6 terminal was broken on K-2 relay.

Conclusion: It appears that the lead on relay K-1 and the terminal on relay K-2 fatigued due to the movement of this element during the vibration test. There appeared to be no evidence of any workmanship problems. It is recommended that the design be modified as described in Failure Analysis AO 427 in order to meet qualification level vibration requirements.

RELIABILITY TEST REPORT NO. 41

Type of Test: Vibration

Test Item: ALRR Forward Record Storage Assembly (712-479), S/N 5445

Purpose: To determine the capability of the test item to withstand the qualification level vibration test without degradation of performance.

Date of Test: February 13, 1963

Procedure:

a. Perform pre-vibration performance tests.

b. Set-up for vibration and perform an electrical continuity check before and after each axis of vibration.

c. Perform sine-random vibration per Appendix D.

d. Perform post-vibration performance tests after a complete inspection.

Results: The Forward Record Storage Assembly was first vibrated in the Z axis. A total of eight equalization runs were made and it was noticed that on the 7th and 8th run all three rollers (Idler Roller, Eccentric Roller, and Idler Roller C) rotated. White streaks of Teflon coating were observed on the rollers and the film.

After completion of the Z axis vibration test, it was noticed that the Mirror Mount (712-501) was loose. The cause of this was loosening of two screws, and two alignment pins backing out (over half their length). The Mirror Mount was then re-assembled with two longer screws (1/8 inch increase) because the original screws did not extend throughout the length of the locking helicoil. No further loosening of the Mirror occurred throughout the Y and X vibration axes.

Rotation of the Idler Roller C (712-467) caused the continuous rotating pot (Film Quantity Sensor) to rotate 25° during the Z axis vibration.

Vibration in the Y axis also caused the three rollers to rotate but at speeds somewhat slower than in the Z axis. The continuous rotating pot rotated 9° in the same direction as mentioned in the previous paragraph. A total of seven equalization runs were made on this axis.

Three equalization runs were made in the X axis of vibration. During the sine-random run, the method of maintaining film tension was inadequate for the low frequency (0-25 cps) sinusoidal portion. The film tension dropped to zero at several instances and it was noticed that the spool began taking up the film. Another method of maintaining film tension was then used for the remaining portion of the test. All three rollers rotated in a similar manner to that previously mentioned. The continuous rotating pot rotated 16°.

After completion of the vibration test, the ALRR unit was turned over to Inspection. Below is a list of problems which resulted from the sine-random vibration test:

Two screws and two alignment pins backed out causing the large mirror bracket assembly (712-501) to loosen up. A DCO has been issued to call out longer screws.

Teflon coating on the Eccentric Roller (712-294) was scuffed lightly with several indentations (1/8" to 1/4" long). This was probably due to roller rotation during vibration. A chromeplate is being investigated to be sure it does not alter tracking ability.

Teflon coating on the Idler Roller (712-214) was scuffed lightly in several areas. This was probably due to roller rotation during vibration. A DCO has been issued to change the teflon coating to bright chrome.

Teflon coating on the Idler Roller (712-467) was scuffed lightly. This was probably due to roller rotation during vibration. A DCO has been issued to change the teflon coating to bright chrome.

Tension arm roller (712-312) had some binding and rotational drag. A DCO has been issued to eliminate the ball bearings by using a delrin roller.

Helical Coil Insert (400-199-149) "backed in" about ¼ inch on Space Frame Assembly, Lower (712-486). There is no information that this condition existed before vibration.

Two of the Nylon Cable Clamps loosened up because of the Hex. Hd. Screws "backing off". A DCO has been issued to call out longer screws.

Idler Roller of the Displacement Compensator Assembly, and the Metering Roller, were out of parallel by 0.010. Considerable redesign has been put into the compensator assembly and covered by DCO's.

One of three pins retaining Pawls (712-522) backed out slightly beyond staked area. Believed to be a poor stake.

Two lock nuts retaining Connector of Drive Assembly loosened. Reliability reported the lock nuts had been used several times and specifications require that they be used only once.

Two screws (712-188) retaining Connector Cap (712-448) became loose. Reported as inspection problem.

Four screws which support gear box to motor (400-1253) "backed out" completely. Engineering feels that this is a specification control problem because it is a purchased part.

All loose screws and nuts were tightened and the Cassette was subjected to a post-vibration test which consisted of a film tracking test, film speed test, and weight and balance test. The Cassette successfully passed all three portions of the test.

Conclusions:

a. Loosening of the two screws and alignment pins of the Bracket Assembly could possibly cause separation of this assembly from the Cassette and thus cause jamming of the Bracket between the film and drive spool assembly.

b. The sweeper arm of the continuous rotating potentiometer (Film Quantity Sensor) rotated a total of 50° which represents a record quantity error of 42 feet.

c. Binding of the Tension Arm Roller could possibly cause scratching of the film.

d. The scuffing of the rollers against the film could lead to marking of the film as it passed through the system and possible changes in the co-efficient of friction between the record and the eccentric roller which could alter the tracking characteristics.

e. Improved design of screw fasteners and/or appropriate procedures for assembling these screw fasteners will be required.

f. Loosening of the four screws on the gear box of the take-up motor will result in failure of the take-up system. The motor lead wires are the only means of resisting rotation of the motor frame when the gear box is unattached.

RELIABILITY TEST REPORT NO. 42

Type of Test: Shock

Date of Test: February 22, 1963

Purpose: To determine the capability of the test item to withstand the qualification level shock test without degradation of performance.

Test Item: Distribution Box Assembly 617-114 Serial No. 2944.

Procedure:

a. The Distribution Box was subjected to a leak rate test, inspection, and an in-process performance test.

b. The Distribution Box was mounted on the environmental test fixture and subjected to the shock test specified in Appendix D.

c. The leak rate, inspection and in-process performance tests of paragraph a. were repeated.

Results: The post shock tests indicated that the Distribution Box was not affected by the shock test.

Conclusion: The Distribution Box was not affected by the specified shock test.

RELIABILITY TEST REPORT NO. 43

Type of Test: Humidity

Date of Test: December 28, 1962 to January 7, 1963

Purpose: To determine the capability of the test items to withstand the specified humidity environment without damage or degradation of performance.

Test Items: The items tested were as follows:

Item	Drawing No.	Serial No.
Bracket Assembly	617-102	1077
Test Box Assembly	617-151	207-002
Junction Box Assembly	617-106	205-003
W-1 Cable Assembly	518-200	207-002

Procedure:

a. The Test Box, Junction Box and W-1 Cable were tested for continuity and leakage resistance to verify that the test items had sustained no adverse effects from previous environmental tests.

b. The Test Box, Junction Box and W-1 Cable Assembly were mounted on the Bracket Assembly.

c. The test items were then subjected to relative humidity of 90 to 95 percent at a temperature of 115° ± 5°F for 10 days.

d. The continuity and insulation resistance tests of paragraph a were repeated.

e. The test items were then inspected for damage.

Results: The post humidity tests and inspection indicated that the test item was not affected by the humidity test.

Conclusion: The test item will satisfactorily withstand the specified humidity environment.

RELIABILITY TEST REPORT NO. 44

Type of Test: Shock

Test Item: ALRR Forward Record Storage Assembly (712-479), S/N 5445

Purpose: To determine the capability of the test item to withstand the qualification level shock test without degradation of performance.

Date of Test: 20 February 1963

Procedure:

a. Perform operability test.

b. Set up for the assembly shock test and perform an electrical continuity check before and after each direction of shock.

c. Perform the shock test.

d. Perform the post shock tests.

Results: Three 17g, half sinusoidal pulse shocks (4 milliseconds rise time) were first applied to the Cassette in the +Z axis. An electrical continuity check before and after the tests in the ±Z and ±Y axes revealed no change in resistance readings. A visual check was also performed and there were no apparent failures.

Three 15g shocks (3 milliseconds rise time) were applied in the +X axis with no apparent failures or changes in the electrical portion of the Take-up Cassette. The Cassette was then subjected to three 15g shocks (4 milliseconds rise time) in the -X axis. No electrical or visual changes were observed.

The cassette was subjected to a post-shock test which consisted of a film tracking test, film speed test, and instrumentation test. The cassette successfully passed the tracking and instrumentation test, but was slightly below the minimum speed requirement of the film speed test. It was then discovered that the Take-up Motor was one of those which had been inadvertently accepted due to misinterpretation of specification even though it did not meet specifications. The motor was disassembled from the Cassette and subjected to a speed-torque test. The characteristics of the speed-torque test were compared with those made upon receipt of the motor from the vendor and there was no apparent change.

RELIABILITY TEST REPORT NO. 44 (Cont'd)

Conclusions: The Forward Record Storage Assembly (ALRR) successfully passed the shock (Powered Flight) Test without any failures. **Although the results of the speed test were slightly below specifications, this cannot be attributed to the shock test.**

RELIABILITY TEST REPORT NO. 45

Type of Test: Shipping Temperature Extremes Test (Empty reel)

Test Item: ALRR Forward Record Storage Assembly (712-479), S/N 5445

Purpose: To determine the capability of the test item to withstand the shipping temperature extremes test without degradation of performance.

Date of Test: March 8 and 11, 1963

Procedure:

a. Place Cassette into the temperature chamber and perform the high temperature portion of Appendix D.

b. Remove Cassette from the chamber and allow to cool to room temperature.

c. Place Cassette into the temperature chamber and perform the low temperature test of Appendix D.

d. Remove Cassette from the chamber and allow to warm to room temperature.

e. Perform an operability test.

Results: A visual inspection was made of the Cassette after completion of the temperature test and no defects could be found. The Instrumentation Check and Film Tracking Test were successfully completed without any variation from pre-test data.

Conclusion:

a. The Forward Record Storage Assembly (ALRR) successfully passed the Shipping Temperature Extreme test.

RELIABILITY TEST REPORT NO. 46

Type of Test: Vibration

Test Item: Air Supply Assembly(711-185), Rc S/N 1172

Purpose: To determine the capability of the test item to withstand the qualification level vibration test without damage or degradation in performance.

Date of Test: February 26 and March 6, 1963

Procedure:

a. Thread the Air Supply with film and position the looper carriage on the empty take-up side of the looper assembly.

b. Place the cover on the Air Supply and mount the assembly on the vibration fixture (208-590).

c. Perform sine-random vibration according to Appendix D for major assemblies. Apply power to the torque motor during vibration. Perform an electrical continuity check before and after each direction of vibration.

d. Perform post-vibration operability tests after a complete inspection.

Results: After the Air Supply had been mounted on the fixture and both ends pressure sealed, a leak rate was established by using a water manometer and an air pump. Over a period of 15 hours, the pressure dropped from 40.5" of H_2O to 30.1" of H_2O. Not including atmospheric changes, the average leak rate was 0.69" of H_2O (0.025 PSI) per hour.

The Air Supply was first vibrated in the X-axis with the housing pressurized to 34.6" of H_2O (1.25 PSI). The torque motor current and film tension switch (S1005) were monitored throughout the test. The torque motor current and voltage before the test were 435ma and 32.5 vdc, respectively.

Three random vibration equalization runs were made with no change in cassette pressure and film tension (monitored by Ohm meter on R x 1 scale), but the torque motor current dropped to 395 ma. **This can be attributed to a change in contact resistance between the brushes and the commutator during rotation of the supply spool.**

At the beginning of the sine-random vibration run, the film tension dropped to zero during the low frequency sinusoidal portion. Throughout the test, torque motor current remained constant at 375ma and the final pressure reading was 32.6" of H_2O (1.18PSI) over a 17 minute time interval. The Air Supply cover was removed for a visual check and no difficulties were apparent. Correct film tension was restored and an electrical continuity check was made which revealed no change as a result of vibration in the X axis.

The supply cassette was next vibrated in the Y axis. The random equalization phase was run without any significant changes in pressure or film tension except for the torque motor current which dropped from 405ma to 380ma.

After about 5 minutes of sine-random vibration the tension dropped to zero. Torque motor current held constant at 370ma and the final cassette pressure was 35.3" of H_2O. The slight increase in pressure was probably due to atmospheric changes. When the supply cassette cover was removed, it was noticed that a nut completely "backed off" one of the tension spring stud bolts. Two screws on Terminal Board 1001 loosened.

After completion of repair work, the Air Supply was subjected to a post-vibration test which it successfully passed with no significant variation from pre-vibration data.

Before vibrating the supply cassette in the Z axis, locking nuts were used to replace the plain nuts on the stud bolts. Throughout the equalization phase and the mixed sine-random test, correct film tension was maintained. The cassette pressure dropped from 36.5" of H_2O (1.31 PSI) to 31.8" of H_2O (1.15 PSI).

Vibration in the Y axis was repeated again without loss of film tension. When the cover and film were removed, it was noticed that the slot on the Drive Pot Shaft (711-231) was indented due to torsional vibration of the shaft against the Roller Stud Assembly (711-113). The Carriage Assembly did not move too smoothly in certain spots along the looper tracks. An electrical continuity check revealed no change from previous data.

The Air Supply was then subjected to a post-vibration test which was successfully passed.

Below is a description of the malfunctions resulting from the sine-random vibration test.

One nut came off causing the tension spring stud to drop out of anchor block.

Two screws holding TB1001 loosened. (poor workmanship)

Slot on the drive potentiometer shaft (711-231) became indented as it pounded against the roller stud assembly (711-113).

Looper carriage assembly moved roughly in spots along the looper tracks.

Conclusion: Torsional vibration of the drive potentiometer shaft could cause a bearing failure on the roller stud assembly. A review of the fastening devices and the procedures for their installation is required.

RELIABILITY TEST REPORT NO. 47

Type of Test: Vibration

Test Item: Gain Control Electronics Assembly (GCEA), Drawing 510-105, Serial No. 212004, 3545. (RC)

Purpose: To determine the capability of the test item to withstand the qualification level vibration test without degradation of performance.

Date of Test: February 16, 1963

Procedure:

a. The assembly was subjected to an operability test and a leak rate test after the previous shock test.

b. The assembly was mounted on the M-B C210 vibrator for vibration in the Z axis. Z axis is defined as the axis normal to the plane of the mounting feet.

c. The assembly was vibrated in the Z axis at the component level per Appendix D.

Results: The purge plug loosened during the equalization run. During the early part of the vibration run, the purge plug came out. The purge plug was replaced, and no further evidence of loosening was observed. It was concluded that the plug was loose when the test was started.

No other external evidence of physical damage was noted. The assembly was tested for operability on the GCEA Test Set and was found inoperative. Analysis revealed that thirteen transistor leads were broken. After replacement of the transistors, the Signal Gating Module was found to be faulty. A broken wire was discovered which was one of several relatively long wires connecting the component boards to the terminal strip. This unit was repaired by reconnecting the broken wire and cementing all of the longer wires to the cover. All of the transistors of the type which failed (TO-5 case) together with their leads were foam potted.

Conclusion: The Gain Control Assembly as originally designed was incapable of passing sine-random vibration at qualification level. Foam potting is being incorporated into the design to provide better support for the transistor leads and wires.

RELIABILITY TEST REPORT NO. 48

Type of Test:

a. Assembly and handling checks at Forward Record Storage Assembly level.

b. Tracking check with viewing capability and all prime obstacles in place (sealer and cutter were not available for this test).

Test Items:

a. Capsule Assembly (S/N 3013A) and Forward Record Storage Assembly - Rc (S/N 5445) for Test A.

b. Capsule Assembly (S/N 3011A), Chute Assembly, Forward Record Storage Assembly - EM and Record Travel Viewer (745-529) for Test B.

Purpose: To determine the capability of the test items to meet the mechanical interface requirements.

Date of Test: April 4, 1963 - Test A

April 18, 1963 - Test B

Procedure and Results:

All four ball seat screws were disassembled from the Capsule and fitted into the mounting points of the Forward Record Storage Assembly with no difficulty. The Forward Record Storage Assembly was easily positioned into the Capsule and located at the interface mounts. In order to adjust two of the ball studs at the lower spacer (FRSA) mounting points, it was necessary to remove three of the electronic packages from the Capsule. Disassembly and assembly (while FRSA was in Capsule) of these electronic packages did not cause any difficulties. All four adjusting nuts were then positioned onto the ball seats. It was observed that there was no interference in operation of the spool or displacement compensator of the FRSA.

A record travel viewer was mounted in place on the chute and there was no interference with the film and the light source or the telescope. In viewing through the telescope, it was possible to clearly see one edge of the film on the eccentric roller and the idler roller of the displacement compensator. The telescope was then positioned on the other side of the chute and the other end of the eccentric roller was viewed. In both views, the amount of illumination on the object was sufficient.

RELIABILITY TEST REPORT NO. 48 (Cont'd)

Conclusion:

a. The FRSA satisfactorily mates at the interface mounts of the Capsule Assembly.

b. It is necessary to remove three electronic packages from the capsule to make adjustments on two of the interface mounts.

RELIABILITY TEST REPORT NO. 49

Type of Test: Vibration

Date of Test: March 31, 1963 to April 22, 1963

Purpose: To determine the capability of the test item to withstand the X axis qualification levels of vibration without damage or degradation of performance.

Test Item: RM Space Chamber (805-101), Serial No. 211003.

Procedure:

1. Pre-vibration Tests

1.1 Preliminary Electrical Checkout - A Breakout Box was installed to permit access to the desired circuitry and the insulation resistance between all circuits at the electrical interface and chassis ground was determined with 10 volts dc applied potential.

1.2 Test Set-up - The test item was then mounted on a collimator and connected to a test console. The collimator provided the simulated photographic inputs to the test unit. The test console supplied the necessary power and instrumentation to operate and monitor the performance of the test item.

1.3 Film Tracking Test - A film tracking test was performed to determine if film tension was adequate and if there was any damage to the film edges during operation. The tracking was observed at speeds 1, 33 and 64 when the operating power was adjusted to 28 volts dc and 32.5 volts dc.

1.3.1 Tracking When Misaligned - The tracking tests at 28 volts dc and speed steps 1, 33 and 64 were repeated when the record storage was misaligned 9 milliradians in the negative direction around the Z axis and translated 0.33 inches along the Y axis in the negative direction. The test was repeated when the record storage assembly was rotated 9 milliradians about the Z axis in the positive direction and translated 0.33 inches along the Y axis in the positive direction from the initial position. The record storage assembly was then returned to its initial zero-position.

1.4 Timing Signal Amplifier Operation - A cable test point board was inserted between the test console and the test item to determine the telemetry voltages CPL 19 and VTP-19 when the Motor Speed Drive was operating at speed step 01 under the following conditions:

Data Signal Channels A and B off

Data Signal Channel A on and B off

Data Signal Channel B on and A off

Data Signal Channels A and B on

The ON and OFF transients and the rise and decay times of the output pulses were determined.

1.5 Power Control - The steady state power consumption and the characteristics during turn-on were determined for the following:

Operating Power

Focus Control Electronics Assembly

Platen Positioning Motor

Supply Brake Motor

Motor Speed Drive (Speed Step 48)

Elevation Servo

Azimuth Servo

The steady state power consumption only was determined for the following assemblies:

Record Storage Motor

Instrumentation Supply

1.6 Power Instrumentation Calibration - The output voltage of the telemetry for the 5 volt dc instrumentation, the 22 volt regulated power supply and the payload heater power were determined.

RELIABILITY TEST REPORT NO. 49 (Cont'd)

1.7 Focus Mode Operation - The focus control electronics operation was tested by inserting voltmeters in the proper circuits at the break out box and exercising the system in the manual and automatic modes.

1.8 Focus Adjust Operation - The operation of the platen position motor was verified by measuring the time required for the platen to move from one extreme position to the other at 27.0 volts dc and 32.5 volts dc input. By mounting an indicator to register the travel of the platen, a correlation between platen position and related telemetry was obtained.

1.9 Film Drive Capability - The frequency output of the motor speed drive was determined for each speed step with 28 volts dc applied.

1.10 Transport Input System Logic - To evaluate the operation of the film transporting system the following tests were performed:

The system was operated to determine if there was any loss of film tension and to observe the operation of the looper empty switch.

The looper position telemetry was tested.

The looper film capacity was ascertained.

The operation of the supply spool brake was observed to determine if film would be pulled backward through the camera when energized.

The duration of the application of power to the brake and the delay between looper empty switch operation and application of power to the brake was measured. (The supply spool brake operation is automatic and is energized whenever the looper empty switch is actuated.)

1.11 Collimator Set-Up - The test item was aligned on the collimator so that the image of the target was centered on the camera slit.

1.12 Dynamic Focus - Exposures were made at .0005 inch intervals throughout the range of platen travel to determine best dynamic focus position on axis (0° field angle). The test was repeated twice.

1.13 Static Focus - Exposures were made at .0005 intervals throughout the range of platen travel. This test was run to verify dynamic focus tests.

1.14 Dynamic Photo Test - A dynamic photo test was performed. This test can be divided into 5 basic parts:

Slit Evaluation Test

Slit-Data Lamp Alignment

Film Start Transient

Film Stop Transient

Resolution and Film Format

The slit evaluation test was performed to verify that there were no irregularities in the slit which could cause over or under exposure of the film. The slit data lamp alignment test was performed to verify that the data lamps were properly aligned relative to the slit aperture.

The film-start-transient test was performed to verify that the proper film velocity was attained in the specified time after the camera was energized. The film-stop-transient test was performed to verify that the film stopped in the specified time after the camera was de-energized.

The resolution and film format test was performed to verify the photographic capabilities of the Camera Payload. The photographic resolution capabilities of the Camera Payload were obtained from the results of 5 different photographic tests which were run at speed step 51 using the 0.0083 slit as follows:

Field Angle	Power (VDC)
0°	28
-0.5°	28
+0.5°	28
0°	27
0°	32.5

The remainder of the resolution and film format tests was to verify that the exposures had been made at best focus and to verify that the film velocity was correct.

1.15 Environmental Control Check - The test on the temperature controlling system was performed. This test can be divided into 6 basic parts:

Instrumentation Calibration at 70°F

Heater Turn-on and Turn-off

Instrumentation Calibration at 60°F

Instrumentation Calibration at 80°F

Lens Barrel Differential Temperature Amplifier Calibration

Stereo Mirror Differential Temperature Amplifier Calibration

The instrumentation calibration tests at 60°F, 70°F, and 80°F were made by controlling the ambient temperature around the test unit and then measuring the resistances and voltages of the various temperature telemetry circuits.

The heater turn-on and turn-off tests were performed to ascertain the exact temperatures at which the thermostats energize and de-energize the associated heaters. This was accomplished by heating and/or cooling the thermostat under test and monitoring the temperature at which voltage is applied to the heater.

The differential temperature amplifier tests were made by substituting decade box resistances to simulate various conditions for the temperature probe inputs and observing the outputs of the associated telemetry.

1.16 The azimuth and elevation servos were tested for proper operation and stereo mirror positioning accuracy. Positioning accuracy was determined using a theodalite which was set up with reference to the primary line of sight.

1.17 Focus Sensor Calibration - The focus control system was tested in the automatic mode using a collimated target input to the system. The platen position instrumentation outputs were recorded, and by comparing this data with data obtained from the dynamic focus test, it was determined that the platen was automatically driven to best photographic position. This test was performed in five steps as follows:

Target Illumination (amps dc)	Operational Power (vdc)
3.00	28
3.45	28
3.95	28
3.45	27
3.45	32.5

2. Vibration

2.1 The test item was mounted in a test fixture. The test fixture was then suspended over the vibration machine using Bungee chords so that the weight of the Camera Payload and the test fixture would not rest on the vibration machine. The Camera Payload was positioned so that the vibration would be applied along the X axis. Accelerometers were mounted on the test item to monitor 23 different points as follows:

1. Air Supply (X axis)
2. Air Supply (Z axis)
3. Air Supply (Y axis)
4. Stereo Mirror (X axis)
5. Stereo Mirror (Z axis)
6. Pivot, Stereo Mirror (X axis)
7. Primary Support Ring (X axis)
8. Primary Support Ring (Y axis)

9. Primary Support Ring (Z axis)

10. Camera (X axis)

11. Camera (Z axis)

12. Component Support Tube (Vicinity of Gain Control Electronics Assembly)

13. Component Support Tube (Vicinity of locating pivot)

14. Meniscus Flange (Z axis)

15. Meniscus Flange (X axis)

16. Meniscus Flange (Y axis)

17. Test Fixture (Y axis)

18. Test Fixture (Z axis)

19. Test Fixture (X axis)

20. Socket Mounting Ring (X axis)

21. Socket Mounting Ring (Z axis)

22. Socket Mounting Ring (Y axis)

23. Control Accelerometer (-Z at payload-fixture interface)

The rectified output of the above accelerometers were connected to recording equipment.

The accelerometer which was used to determine the input to the test unit was mounted on the interface.

Provisions were made to energize the supply spool brake while the unit was being vibrated.

2.2 The supply spool brake was energized and the test item was subjected to vibration as described in Appendix D.

3. Post-vibration:

3.1 Inspection - The test item was inspected while still in the test fixture, then removed from the fixture, mounted on a payload truck and inspected further.

RELIABILITY TEST REPORT NO. 49 (Cont'd)

3.2 Tests - The pre-vibration performance tests were repeated. 0.009 inch was removed from the shims which separate the camera from its mounting surface in order to make best focus coincident with center of platen travel. Previbration tests showed best focus to be .006 inch from center of platen travel. As discussed in the conclusions, it is felt that only a portion of the remaining .003 inch can be attributed to vibration. The focus test was then repeated.

Results:

Pre-vibration: The payload performed satisfactorily providing a geometric mean dynamic resolution of 107 lines/mm. The following variances from specifications were observed from the results of the pre-vibration operability tests:

The telemetry for film take-up quantity was reversed.

The power consumption for the Motor Speed Drive, the Elevation Servo and the Azimuth Servo exceeded specifications.

The telemetry for the environmental supply was not within specified limits.

The telemetry for the temperature difference on the stereo mirror was not within specified limits.

The results of the dynamic and static focus tests indicated that best photographic focus was not in the center of platen travel. It was decided that some of the problem was probably in the test equipment and, therefore, the camera shims were not changed. Engineering judgement indicated that the test could be continued safely.

Vibration: No visible damage was observed during the actual vibration test. The vibration equipment overload protection circuit turned the vibrator off when resonances occurred at the following frequencies: 230, 570, 650, 800 and 1000 cps.

Post-vibration: 1. Inspection - After vibration the following observations were made:

1.1 Metal chips were found on the meniscus lens, the primary structural ring and inside the lens barrel.

RELIABILITY TEST REPORT NO. 49 (Cont'd)

1.2 Potting material between the stereo mirror and its mounting frame was forced out in several places.

1.3 There appeared to be some grease spots on the 28 inch mirror. (This observation was made through the meniscus lens).

1.4 The stereo mirror azimuth pivot stud had backed out approximately .012 inches.

2. Performance - The payload produced geometric mean dynamic resolution of 102 lines/mm. The following problems were noted:

2.1 Focus - Best photographic focus appeared to shift about .003 inches toward the lens.

2.2 Three thermostats did not operate satisfactorily.

2.3 The telemetry (CPL 13) for stereo mirror position was not within tolerances.

2.4 The ground strap between the stereo mirror and bridge broke during the servo operability test.

Conclusion: The payload will survive X axis vibration as described in Appendix D without critical failures. Photographic resolution was not appreciably affected by the vibration test although a focus shift may have occurred. A lens and stereo mirror assembly of the FM-2 design is being assembled to the payload. This retrofitted assembly will be retested as part of the payload in all three axes of vibration.

The components which were out of specification prior to vibration did not change significantly as a result of vibration. The failures which were experienced were not critical. Corrective measures will be incorporated and subsequently verified by vibration in all three axes. A description of the problems and hardware status follows:

RELIABILITY TEST REPORT NO. 49 (Cont'd)

1. The metal chips will be confined by covering or plugging parts suspected of retaining chips.

2. The stereo mirror cell has been redesigned. The redesigned unit should prevent the potting from being forced out.

3. The grease spots were analyzed as hand and finger prints and were not a result of vibration.

4. The stereo mirror azimuth pivot stud locking design will be altered to prevent relative motion between the locking set screw and the pivot stud.

5. The Unibal was an obsolete design. The nylon portion of this assembly has been replaced with teflon.

6. The apparent 0.003 inch focus shift cannot be definitely attributed to vibration. Due to difficulties with the collimator, some of the shift probably was caused by the test equipment. The collimator is being investigated at the present time.

7. The mounting for the thermostats on the socket mounting ring will be redesigned to incorporate a more resilient material which will reduce the magnitude of the forces transmitted to the unit during handling and vibration. A thermistor temperature controller design is also being developed.

RELIABILITY TEST REPORT NO. 50

Type of Test: Vibration - X axis

Test Item: Gain Control Electronics Assembly, drawing 510-105, Serial No. 212004, 3545. (RC)

Purpose: To determine the effect of qualification level vibration on the Gain Control Electronics Assembly.

Date of Test: March 19, 1963

Procedure:

1. The assembly was subjected to an operability test and leak rate test.

2. The assembly was mounted on the M-B C210 vibrator for vibration in the X axis. The X axis is defined as the longitudinal axis of the assembly.

3. The assembly was vibrated at the level specified in Appendix D in the X axis only.

Results: After completion of the X axis vibration, the assembly was found to be inoperative electrically. Investigation revealed that two power transistor pins were broken. The transistors were replaced, and the recesses around the pins on both transistors were potted with epoxy. These transistors were a different type than the ones which failed during Z axis vibration.

Conclusions: From the foregoing, it was concluded that the Gain Control Electronics Assembly, as originally designed, was incapable of passing qualification level sine-random vibration in the X axis. Epoxy potting is being incorporated into the design to provide better support for the transistor pins.

RELIABILITY TEST REPORT NO. 51

Type of Test: Shock

Test Item: Motor Speed Drive, Drawing 709-200, Serial No. 302005, 4816. (RC)

Purpose: To determine the effect of qualification level shock on the Motor Speed Drive Assembly.

Date of Test: March 27, 1963

Procedure:

1. The assembly was subjected to an operability test and leak rate test.
2. The assembly after being attached to the environmental fixture, was mounted on the shock machine.
3. The asserbly was subjected to shock test per Appendix D.

Results: The operational test after shock showed the Assembly to be non-operative. The trouble was traced to a short circuited transistor. Engineering judgement indicates that the short circuit was not caused by the shock test.

Conclusions: It was concluded that the Motor Speed Drive passed the qualification shock test without degradation.

RELIABILITY TEST REPORT NO. 52

Type of Test: Vibration Y axis

Test Item: Gain Control Electronics Assembly, Drawing 510-105, Serial No. 212004, 3545 (RC)

Purpose: To determine the effect of qualification level vibration on the Gain Control Electronics Assembly.

Date of Test: April 9, 1963

Procedure:

1. The assembly was subjected to an operability test and leak rate test.
2. The assembly was mounted on the M-B (C210) vibrator for vibration in the Y axis. The Y axis is defined as the transverse axis of the assembly.
3. The assembly was vibrated at the level specified in Appendix D.

Results:

The leak rate test immediately prior to the Y axis vibration showed a leak rate of 6.5 mm Hg in 27 minutes. The specification calls for a maximum leak rate of 3.18 mm Hg in one hour. This leak was at the cover seal.

After the Gain Control had been vibrated in the Y axis, it was found to be operable electrically. It was again leak rate tested. This time the leak rate had increased to 9.5 mm Hg in 27 minutes. A new leak was detected at one of the welds. The original leak at the cover was still present, but it could not be measured to see whether the rate had increased. The unit was then given the oomplete operability test. The results correspond very closely to the data taken before vibration.

Conclusions:

It was concluded that the Gain Control Electronics was capable of passing the qualification level sine-random vibration in Y axis from a standpoint of survival of all active parts and internal structural members. The only area which remains to be qualified in this axis is the case seal.

RELIABILITY TEST REPORT NO. 53

Type of Test: Vibration Z axis

Test Item: Motor Speed Drive, Drawing 709-200 Serial No. 302005, 4816. (RC)

Purpose: To determine the effect of qualification level vibration on the Motor Speed Drive Assembly.

Date of Test: April 25, 1963

Procedure:

1. The assembly was subjected to an operability and leak rate test.

2. The assembly was mounted on the M-B C210 vibrator for vibration in the Z axis. The Z axis is defined as the axis normal to the plane of the mounting feet.

3. The assembly was vibrated at the levels specified in Appendix D.

Results: An electrical check immediately following the vibration showed that the assembly would not command "on" and that there was no output on speed steps 1 through 8. The assembly was subjected to a leak rate test, which it passed successfully.

Upon opening the assembly for failure analysis, it was found that one EMI filter was loose and its wire was broken, one board in the oscillator assembly was loose and four wires were broken, also one relay wire was broken. These failures were analyzed as assembly problems rather than design problems.

The assembly was repaired and updated by installing the hyrel type filters and adding the decoupling filter.

Conclusion: The Motor Speed Drive assembly failed during Z axis vibration because it was not properly assembled.

RELIABILITY TEST REPORT NO. 54

Type of Test: Edgewise and Cornerwise Rotational Drop Test

Test Item: Accessory Shipping Container (Dwg. 844-500) and Forward Record Storage Assembly (Dwg. 712-479 - RC)

References:

a. Qualification Test Procedure for the Accessory Shipping Container (Dwg. 853-114)

b. Specification for Accessory Shipping Container (Dwg. 702-183)

c. Test Report No. 1702 B on the Applied Design Company Model 647A Metal Shipping and Storage Container for the Eastman Kodak Company Accessory Unit (Dwg. 702-183)

Purpose: To verify the qualification drop test performed by Applied Design Company.

Date of Test: March 6 and 7, 1963

Procedure:

a. Edgewise Rotational Drop Test (End Drop)

One end of the container was supported on a nominal 5-inch wooden skid and the other end was raised 18 inches off the concrete floor with a hoist which was connected to an eye-bolt on the container with several wraps of tape. The test was carried out by cutting the tape with a razor blade.

b. Cornerwise Rotational Drop Test (Cornerwise Drop)

One end of the container was supported on a step block, one side of which was 5 inches high and the other side 18 inches high. The test was performed by lifting the lowest corner of the other end 18 inches off the floor and then dropping it as described in a.

Results: (Setup) When the handling frame for the take-up cassette was first mounted onto the container bracket, it was noticed that the mating fit was not flush. Metal shims were placed between the handling frame and the bracket in order to achieve a proper fit.

All moving parts (Displacement Compensator and Rollers, Spool, and Tension Arm Assembly) of the Forward Record Storage Assembly were taped to simulate actual shipping conditions.

RELIABILITY TEST REPORT NO. 54 (Cont'd)

Accelerometers were first placed on the take-up as follows: (X, Y, and Z are P/L axes)

Nos. 1, 2, 3 - On back of the alignment mirror mount of the take-up and positioned in all three axes.

No. 4 - On the side frame of the take-up near the spool shaft and positioned in the X axis.

Two double channel oscilloscopes and two Polaroid cameras for recording the wave forms were used for the test.

Test #1 End Drop on Purge Plug End

Three repeated drop tests were performed on the Shipping Container. The results from the first and third drop were not readable because of retracing of the curves on the scope. The second drop showed:

Location	Level
X - Axis Mirror Mount	10g, 4 milli-sec. rise, half-sine wave.
Y - Axis Mirror Mount	No Result } Scope traces were inter-mixed.
Z - Axis Mirror Mount	No Result } Scope traces were inter-mixed.
X - Axis Spool	10g, 3 milli-sec. rise, half-sine wave

Test #2 End Drop on Non-Purge Plug End

Using the same accelerometer arrangement as in Test #1, two repeated drops were performed on the opposite end of the container. Readings from the oscilloscope for the first drop showed:

Location	Level
X - Axis Mirror Mount	12g, 5 milli-sec., half-sine wave
Y - Axis Mirror Mount	11g max., 1 milli-sec. rise
Z - Axis Mirror Mount	6g max., 3 milli-sec. rise
X - Spool	8g, 3 milli-sec. rise

The second drop revealed:

Location	Level
X - Axis Mirror Mount	11g, 6 milli-sec., rise, half-sine
Y - Axis Mirror Mount	Scope did not trigger
Z - Axis Mirror Mount	10g max. 2 milli-sec. rise
X - Axis Spool	8g, 3 milli-sec. rise

Test #3 Cornerwise Drop on opposite purge plug. (Left Corner)

Accelerometer arrangement for this test was the same as for Test #1. Two drops were performed. There were no results from the first drop because the scopes did not trigger, but the second revealed the following:

Location	Level
X - Axis Mirror Mount	7g, 5 milli-sec., rise, half-sine
Y - Axis Mirror Mount	14g max. 2 milli-sec. rise
Z - Axis Mirror Mount	6g max. less than 1 milli-sec. rise
X - Axis Spool	5g max. less than 1 milli-sec. rise

After the second drop it was noticed that one of the wooden skids was splintered on the corner that was dropped.

Test #4 Cornerwise Drop on Purge Plug End (Left Corner)

Using the same accelerometer arrangement as in Test #1, two repeated drops were performed. Results from the first drop were not readable but the second drop showed:

Location	Level
X - Axis Mirror Mount	6g, 7 milli-sec. rise, half-sine
Y - Axis Mirror Mount	No result } Scope traces intermixed
Z - Axis Mirror Mount	No result } Scope traces intermixed
X - Axis Spool	4g max. 2 milli-sec. rise

The accelerometers were re-arranged. The list below shows the new accelerometer locations on the take-up cassette and shipping container: (X, Y and Z are P/L axes)

Nos. 1, 2 - On side of the take-up frame at the spool shaft in the Z and Y axes.

Nos. 3. 4 - On the container near the shock mount in the X and Z axes.

Test #5 End Drop on Purge Plug End

Two repeated drops were performed. Results from the first drop were not readable because the scopes did not trigger. The results for the second drop are shown below:

Location	Level
Z - Axis	Near Shock Mount not readable. Scope trace blurred.
X - Axis	Near Shock Mount 100g max. 5 milli-sec. rise
Z - Axis	Side of TU 9g max. 8 milli-sec. rise
Y - Axis	Side of TU 8g max. 11 milli-sec. rise

Test #6 End Drop on Non-Purge Plug End

The shipping container was dropped once in this test. Accelerometer arrangement was same as in Test #5.

Location	Level
Z - Axis Near Shock Mount	Not readable. Scope trace blurred.
X - Axis Near Shock Mount	100g max. 1 milli-sec. rise
Z - Axis Side of TU	1g max. 5 milli-sec. rise
Y - Axis Side of TU	5g max. 6 milli-sec. rise

RELIABILITY TEST REPORT NO. 54 (Cont'd)

Test #7 Cornerwise Drop Test on opposite end purge plug. (Right Corner)

Three drops were performed during this test. The accelerometer arrangement was the same as for Test #5. The accelerometers on the shock mount were on the shock mount that was on the corner to be dropped. The results of the first drop were as follows:

Location	Level
Z - Axis Near Shock Mount	60g max. 1 milli-sec. rise
X - Axis Near Shock Mount	30g max. 4 milli-sec. rise
Z - Axis Side of TU	1g max. less than 1 milli-sec. rise
Y - Axis Side of TU	2g max. less than 1 milli-sec. rise

During the second drop the container rolled over on its side breaking one of its wheel pins and dented a small area on the outside near the top. The cover to the container was removed and no internal damage could be seen. Results from the third drop were the same as the first.

The Forward Record Storage Assembly used during the test was inspected and subjected to an operability test. No visual damage could be seen and the data from the operability test showed no change from data obtained previous to the Accessory Shipping Container test.

Conclusions:

a. A total of 15 drops were performed on the Accessory Shipping Container without damaging the Forward Record Storage Assembly (ALRR)

b. In several cases, the results indicated that the "g" levels of this test exceeded the maximum specified in reference (b) (10g max. for X-axis and 4g max. for Y, Z axes) and the levels found in the test described in reference (c). One possible explanation for the difference between the results of this test and those of the Applied Design Company is that the load used by Applied Design was a solid simulation of the Forward Record Storage Assembly and had fewer resonant frequencies as compared to the Forward Record Storage Assembly used for this test. Also, it should be stated that since no results were obtained for many of the drops because the traces were intermixed and some of the results were not readable, the instrumentation of this test could be improved significantly.

RELIABILITY TEST REPORT NO. 55

Type of Test: Vibration

Test Item: Heater Control Assembly (516-181) Serial No. 26

Purpose: To determine if the qualification vibration levels defined in Appendix D will cause any detrimental effects on the test item.

Date of Test: March 11, 1963

Procedure:

1. Set up the Heater Control Assembly on the vibration machine.
2. Vibrate to levels described in Appendix D. Perform continuity checks on the fuse after each axis of vibration.
3. Perform operability test.

Results:

1. No fuse failures were noted during or after the vibration test.
2. A screw in terminal no. 2 came out during X axis vibration.
3. The Heater Control Assembly operated properly during post vibration operability testing.

Conclusions: The Heater Control Assembly will survive qualification level sine-random vibration.

RELIABILITY TEST REPORT NO. 56

Type of Test: Low Temperature Operational

Test Item: Heater Control Assembly (516-181) Serial No. 26

Purpose: To determine if 0°F temperature will cause any detrimental effects on the test item.

Date of Test: May 1 to 3, 1963

Procedure:

1. Set up Heater Control Assembly in the low temperature chamber. Lower the temperature to 0°F.
2. Apply 28VDC and measure the heater current through a 100 ohm resistor.
3. After 72 hours of continuous operation, remove power and return to room temperature.
4. Perform operability test.

Results:

1. The Heater Control Assembly operated satisfactorily throughout the 72 hours of test.
2. The Heater Control Assembly operated properly after the low temperature cycle.

Conclusions: The Heater Control Assembly will survive the 0°F low temperature environment with no degradation in performance.

RELIABILITY TEST REPORT NO. 57

Type of Test: Varying Orientation (Film Tracking)

Date of Test: April 22, 1963 through April 24, 1963

Objective: To verify that the payload film handling system will track film properly with the payload in any orientation.

Test Item: RM Space Chamber, Drawing (805-101), Serial No. 211003

Procedure:

1. With the +Y axis of the payload down, (this is the normal P/L orientation when the P/L is mounted on the truck) 750 feet of film was run through its film handling system at speed 64 in each of the following two cases of misalignment:

   a. The take-up cassette misaligned, with respect to the supply cassette, 0.33 inches in the -Y direction and -.009 radians about the Z axis.

   b. The take-up cassette misaligned, with respect to the supply cassette, 0.33 inches in the +Y direction and +.009 radians about the Z axis.

2. The take-up cassette and the chute were then removed from the payload so that the payload could be placed in its vibration fixture. Before the payload was placed into the fixture, it was loaded with 3000 feet of film.

3. The take-up cassette was mounted to the fixture by means of rigid inter-connecting brackets. The take-up cassette bracket chute was not mounted in place due to an error in the rigid inter-connecting brackets which resulted in the film path length being 7 3/8 inches shorter than normal between the supply cassette and the take-up cassette.

4. Using a hoist, chain-fall, and block and tackle, the system was tipped over on its side so that the -Y axis of the payload was toward the floor. Using a theodolite, the take-up cassette was aligned to the supply cassette. The system was rotated so that the +Z axis of the payload was downward. The take-up cassette was again aligned to the supply cassette.

5. Seven hundred feet of film was run through the payload film handling system at speed 64 for each of the following two cases of misalignment:

a. The take-up cassette misaligned, with respect to the supply cassette, 0.33 inches in the -Y direction and +.009 radians about the Z axis.

b. The take-up cassette misaligned, with respect to the supply cassette, 0.33 inches in the +Y direction and -.009 radians about the Z axis.

6. The system was rotated so that the -Z axis of the payload was toward the floor. The take-up cassette was realigned to the supply cassette.

7. Seven hundred feet of film was run through the payload film handling system at speed 64 for each of the following two cases of misalignment:

a. The take-up cassette misaligned, with respect to the supply cassette, 0.33 inches in the -Y direction and -.009 radians about the Z axis.

b. The take-up cassette misaligned, with respect to the supply cassette, 0.33 inches in the +Y direction and +.009 radians about the Z axis.

8. The payload was reloaded with 1000 feet of film and the take-up cassette was realigned to the supply cassette. The take-up cassette was misaligned, with respect to the supply cassette, 0.33 inches in the +Y direction and +.009 radians about the Z axis. The system was set back up so that the +X axis of the payload was downward.

9. Five hundred feet of film was run through the payload film handling system at speed 64.

10. The take-up cassette was misaligned, with respect to the supply cassette, 0.33 inches in the -Y direction and -.009 radians about the Z axis, and the remaining 500 feet of film was run through the payload film handling system at speed 64.

Results:

1. It was found that the inter-connecting brackets used in this test allowed the take-up cassette to deflect 0.028 inches along the Y axis when the payload was rotated from the position of its -Y axis being toward the floor to the position of its +Z axis being toward the floor.

2. The film handling system tracked properly throughout the test. After 560 feet of film had passed through the system in the run in which the +Z axis was toward the floor and the take-up cassette was misaligned, with respect to the supply cassette, 0.33 inches in the +Y direction and +.009 radians about the Z axis, it was observed that the Tension Arm Roller in the take-up cassette began scratching the film. At this time, there was approximately 2850 feet on the take-up spool. It is felt that this film scratching problem cannot be attributed to the conditions of this test. The tension arm assembly used in this test was one of the old design. A new design has been released to eliminate film scratching.

Conclusion: The film handling system will track film properly regardless of the orientation of the payload.

RELIABILITY TEST REPORT NO. 58

Type of Test: Life Operation in Vacuum

Purpose: To verify the capability of the payload to perform satisfactorily in a temperature controlled vacuum environment when operating at a cycling rate equivalent to normal orbital operation.

Date of Test: April 30 to May 5, 1963

Test Item: RM Space Chamber (805-101) Serial No. 211003

Procedure:

1. The payload was instrumented with thermocouples and a .250 inch diameter orifice was assembled to the take-up enclosure.

2. The payload was loaded and threaded with film and placed in the vacuum chamber.

3. A dry run was made to verify that the system was operable and that proper strobe light exposures for banding tests could be made through the vacuum chamber window.

4. The payload was loaded with 3000 feet of film and the chamber pumped down to 3.8×10^{-4} millimeters of mercury.

5. A simulated 5-day mission was run on the payload with the chamber wall temperature alternating between 45°F and 75°F each day. The total number of cycles (or orbits) was 48. Payload operation each 90 min. cycle was as follows:

Sequence I

Servos on 6 sec.

Camera on 7 sec.

Servos on 5 sec.

Camera on 7 sec.

25 sec. total

Sequence I was repeated consecutively 8 times for a total operating time of 3 min., 20 sec. Off time was 86 min., 40 sec.

The first cycle was run at camera speed 8. Each successive cycle the speed was advanced one step so that at the end of the test each speed from 8 through 55 had been exercised.

6. Camera banding tests were conducted after cycles 1, 24 and 48 at camera speed 33 to verify the camera's capability to operate properly in a low pressure environment.

7. At the conclusion of the last banding test, the payload was operated continuously until all the film was wound up on the take-up.

8. The Chamber was returned to atmospheric pressure and temperature and the film was removed for processing and evaluation.

9. The payload was reloaded with 750 ft. of fresh film, mounted on the collimator, and a dynamic photo test and banding test were performed.

Results:

1. Chamber pressure during the 105-hour period between the first and last (48th) cycle went from 3.8×10^{-4} millimeters of mercury to 3.2×10^{-4} millimeters of mercury.

2. The payload pressure, recorded inside the take-up enclosure, varied from .05 to a maximum of .48 millimeters of mercury within 4 minutes after the start of each cycle. This pressure then returned to .23 millimeters of mercury in 6 minutes and back to .07 millimeters of mercury within 40 minutes after the beginning of each cycle.

3. Fluctuations in chamber pressure as a result of bleed-out of payload pressure during each cycle caused a net increase of approximately $.2 \times 10^{-4}$ millimeters of mercury 40 minutes after the beginning of each cycle. By the beginning of the next cycle, the chamber pressure had returned to its original pressure.

4. Take-up motor current was measured rising from 160 milliamps at cycle 20 to 215 milliamps at cycle 47. During the continuous runout period after cycle 48 until all the film was removed from the system, the take-up motor current increased from 220 milliamps to 330 milliamps.

5. Elevation and azimuth servo currents were also recorded from cycle 20 through cycle 47. The azimuth servo current remained nearly constant at 800 milliamps. The elevation servo current varied somewhat during the test, averaging about 1.6 amps. Servo transition times did not change significantly in vacuum.

6. The maximum camera motor temperature rise as measured at the motor winding during any cycle except exhaust cycle was 11.5°F. On the average, within twenty minutes after the end of each cycle, the temperature of the Camera Motor had returned to the pre-cycle temperature.

7. After cycle 48, with the camera at speed 64 for continuous operation over a 70 minute period, the temperature of the camera motor increased from 63.5°F to 90°F in the first 20 minutes and remained at that level to the end of the test.

8. The temperature rise of the take-up motor, as measured at the motor frame between the permanent magnets, averaged about 1.5°F maximum during each of the 48 cycles.

9. After cycle 48 during the final run out of film, the take-up motor temperature increased from 57.1°F to 90°F in one hour, and then rose to 107.4°F within the last ten minutes of the run out. The increased rate of temperature rise from 90°F to 107°F was aggravated by excessive drag on the take-up spool created by the tension arm assembly. This drag also caused the take-up film speed to fall below 6.25 in./sec. (minimum specification requirement) for the last few minutes of runout. The tension arm assembly has been redesigned to eliminate this problem.

10. Examination of the temperatures on the component support tube and primary mirror cell indicated that the heaters performed satisfactorily during the test, maintaining temperatures close to thermostat turn on - turn off temperatures.

11. The primary mirror cell temperature, measured near the unibal fittings, changed less than 3° throughout the entire test.

12. The meniscus lens and the 45° (diagonal) mirror temperature data indicated a total change of 8.5°F and 7.5°F maximum, respectively throughout the test. (Vacuum Chamber)

13. At the beginning of the test, while the chamber was at 45°F, the chamber pressure was inadvertantly returned to approximately 500 mm Hg from approximately 1 micron in a matter of a few seconds. The C/P was removed from the chamber and examined for possible damage due to implosion effects. No evidence of mechanical damage was observed. There were, however, two streaks of moisture, each approximately 3 or 4 inches long, on the inside surface of the meniscus lens caused by two small holes in the barrel and side frame assembly. This was not deemed detrimental to the test so no corrective action was taken.

14. Banding tests conducted prior to the vacuum test showed a Δ v from 1.7 3 percent to 1.8 6 percent for 3 runs. Banding tests in the vacuum after cycles 1, 24, and 48 and a banding test conducted during the post-vacuum operational tests were not readable because of improper test techniques.

Conclusions:

1. The chamber pressure reached during this test was not as low as specified in the procedure due to limitations of the vacuum chamber. However, it is believed that the pressure is down enough so that the effects of temperature and vacuum on payload operation would be significant. The ranges of temperatures experienced by the C/P during this test indicated that the heater systems were working properly and the heat sinks provided for the camera motor and the take-up motor were adequate to provide reliable operation of these units under normal operating conditions.

2. Although the current required by the elevation servo increased approximately .5 ampere, the transition time did not change and therefore, it can be concluded that the servo will position the mirror properly in a vacuum. The azimuth servo performance was not affected by vacuum.

3. A comparison of pre and post vacuum photographic resolution indicated no significant change occurred as a result of the life operation in vacuum.

4. The film handling system will track film properly in vacuum over the full 3000 feet required.

RELIABILITY TEST REPORT NO. 59

Type of Test: Sinusoidal Vibration Search

Purpose: Obtain frequency and g level data from 24 selected points on the RM assembly. Compare these data with that obtained on like measured points during vibration tests previously run on the Dynamic Simulator No. 1 and on the RM Elevation Plate Assembly.

Test Item: RM Space Chamber (805-101) Serial No. 211003

Date of Test: November 2, 1962

Procedure: The RM Assembly was vibrated in the X, Y and Z axes at 1.0 g peak - to - peak, sinusoidally from 5 to 2000 cps at a sweep rate of two octaves per minute. The 24 recorded accelerometer channels, 23 output and 1 input, were read out on Offner Log Converter recorders. Plots of Q (transmissability) vs. frequency were made of each recorded channel and the results compared with plots of similar accelerometer outputs made of the DS-1 and the RM Elevation Plate Assemblies.

Results:

a. Resonances obtained in the Elevation Plate Assembly tests (Reliability Test Report No. 32) also occurred in the DS-1 and RM assembly tests at approximately the same frequencies, but the Q levels in the DS-1 and RM tests were much lower than those in the Elevation Plate Assembly Test (28+ for the former, approximately 6 for the latter).

b. X axis "high Q" frequencies found during the RM assembly test agreed, in general, with those frequencies found in the DS-1 assembly tests, but Q levels in the RM test were roughly half those of the DS-1 tests.

c. Y axis Q levels and frequencies were approximately the same for DS-1 and RM (Q's about 6).

d. Again in Z axis, Q levels and frequencies for DS-1 and RM compared as in (c) above, with the DS-1 having slightly higher Q levels.

Conclusions:

a. Determination of an overall resonant frequency for this design is difficult, since recorded data does not indicate phase relationships. For this reason, only Q (transmissibility) levels could be compared at any frequency for all monitored points.

b. Similarity of the DS-1 and the RM assemblies was fairly well indicated as far as resonant frequencies were concerned, but components of the RM experience lower levels of excitation.

c. Fixture resonances in the higher frequency regions make analysis beyond 100 cps subject to question.

RELIABILITY TEST REPORT NO. 60

Type of Test:

a. Light leak test on Capsule (Sealer & Cutter not available for test) and Chute Assembly.

b. Film fogging to determine compatibility of materials within the Capsule (electronic packages were not prime hardware) and Chute Assembly at atmospheric pressure.

Test Items: Capsule and Chute Assembly - Serial No. 3013A

Purpose: To determine if subject hardware is light tight and does not contain materials which will fog film.

Date of Tests: April 8 to 11, 1963

Procedure and Results:

Two photo flood lamps were used to illuminate the outside surface of the capsule and chute assembly for a total time of 2 hours for the light leak test. A Spectra-Spot Brightness Meter was used to measure the amount of illumination (700 ft. candles) at the surface of the capsule cover. The amount of exposure for this test was equivalent to direct sun light for 8 minutes.

After completion of the test, both strips of film (capsule and chute) were processed. The strip in the chute assembly showed no light leaks as determined by the density checks on the grey scale exposures. But the strip which was in the capsule was completely exposed. In locating the light leak, the cover from the capsule was placed 6 inches in front of a photo flood lamp. It was evident that the cover was translucent.

In the film fogging test, both the chute and capsule assemblies were shielded from light by the use of a black plastic covering. After 48 hours the film was removed and processed. The film strips in the capsule and chute assembly showed no increase in density due to fogging.

Conclusions:

a. The Chute Assembly passed the light leak test. The Capsule cover was found to be translucent which resulted in exposure of the film in the capsule.

b. Compatibility of Materials - The materials being used in the capsule do not cause film fogging.

QUALIFICATION TEST REPORT NO. 61

Type of Test: Shipping Temperature Extremes

Test Item: Air Supply Assembly (711-185) Serial No. 1172

Purpose: To determine the capability of the test item to withstand the shipping temperature extremes without damage or degradation of performance.

Date of Test: April 28 and 29, 1963

Procedure:

1. Place Air Supply (no film) into the temperature chamber and perform the high temperature test per Appendix D.
2. Remove Air Supply and allow to cool to room temperature.
3. Place Air Supply (no film) into the chamber and perform the low temperature test per Appendix D.
4. Remove the Air Supply from the chamber and allow it to warm to room temperature.

Results: A visual inspection was made after completion of the test. White deposits were discovered especially where dissimilar metals are joined in many areas on the looper assembly. One small rust spot was also discovered on the looper track and outer race of one of the bearings.

Without removing any of the corrosive deposits, an operability test was performed which was successfully completed.

Conclusion:

a. The Air Supply Assembly successfully passed an operability test after being subjected to a Temperature Extremes Test.

RELIABILITY TEST REPORT NO. 62

Type of Test: Sine-random Vibration (Re-Test)

Test Item: Air Supply Assembly (711-185), Rc, Serial No. 1172

Purpose: To determine the capability of the test item to withstand the qualification level vibration test without degradation of performance.

Date of Test: April 9, 1963

Procedure:

1. Thread the Air Supply with film and position the looper carriage on the empty take-up side of the looper assembly.

2. Place the cover on the Air Supply and mount the Assembly on the vibration fixture (208-590).

3. Perform sine-random vibration according to Appendix D. Apply power to the torque motor during vibration.

4. Perform a post-vibration operability test after a complete inspection.

Results: The Air Supply Assembly was re-vibrated in the X and Y axes only. Based on engineering judgement, vibration in the Z axis was not performed.

After completion of the X and Y axis vibration, the Air Supply was inspected. It was noticed that the wobble roller (rubber) in the Roller Base Assembly had excessive play perpendicular to the Pivot Pin. Also, several teeth were damaged on the gear assembly of the spool assembly in two places.

Several times during the test it was noticed that the torque motor current dropped from 400 ma to less than 100 ma. This possibly indicates that the torque motor gear train was not in mesh causing the torque motor to turn freely and thus damage a number of teeth on the gear assembly. After replacement of the Gear Assembly and the Wobble Roller, an operability test was performed. The operability test on the Air Supply was successfully completed.

RELIABILITY TEST REPORT NO. 62

Conclusions:

a. The EMI Filter Box Assembly successfully passed the Reliability vibration test.

b. The Wobble Roller and the Torque Motor Assembly which failed in this test were qualified (vibration) completely in a previous test (see Qualification Test Report No. 46). A DCO has been issued which incorporates a locking device on the torque motor gear.

RELIABILITY TEST REPORT NO. 63

Test Item: Motor Speed Drive, Dwg. No. 709-200, Serial No. 005 (4816)

Type of Test: X-axis Vibration

Date of Test: May 14, 1963 (Date of performance of Procedure step 3)

Test Purpose: To determine the effect on the test item of qualification level vibration testing in the X-axis.

Conclusion: The Motor Speed Drive, as presently designed, is not capable of withstanding qualification level vibration in the X-axis. Several design changes are recommended in Appendix 63A, all dealing with more secure mounting of the parts and wires.

Test Procedure:

1) Operability test was performed according to QC In-Process Test Procedure QC-A-307 Par. 5.6. (T206)

2) Leak rate test was performed according to QC-A-341.

3) Vibration in X-axis was performed to the levels defined in Appendix D.

4) Step 2 was repeated.

5) Operability spot check was performed according to QC-A-307, paragraphs 5.4 through 5.6.4, except with data taken in paragraph 5.6.3.17 only on steps 10, 19, 28, 37, 46, 55 and 64. (T235)

Test Results: A summary of the failures and recommended changes is presented in Appendix 63A. Complete test results are in the Reliability Test Group files and will be made available, to those interested, upon request.

APPENDIX 63A

Failure Summary

Failure Report No.	Failure	Recommended Change
	Pre-vibration	
AO-640	A2 Voltages out of spec. steps 01, 02, 03, 06.	None - Waived on AO-657
AO-641	Motor Power B Distortion out of spec. steps 01, 48.	None - Waived on AO-647
	Post-vibration	
AO-651	Period x 10 readings out of spec. on step 1. Period x 10 reads zero and motor fail to run on step 48.	See below

Analysis of the above reveals the following:

	Failure	Recommended Change
1.	Two wires broken at relays.	Better support for the wires.
2.	One relay mounting ear completely broken off.	A method is needed to steady the relay cases against rocking.
3.	One wire broken off at the oscillator board.	None - probably due to overstress in previous vibration testing.
4.	One filter was loose in its mounting hole.	Use correct mounting holes and cement the filters in place.
5.	Large capacitors had rotated in their clips.	Cement the capacitors into the clips.

RELIABILITY TEST REPORT NO. 64

Test Item: Heater Control Assembly, Dwg. 516-181, S/N 26

Type of Test: Life Test in Vacuum

Date of Test: 28 May through 7 June 1963

Test Purpose: The purpose of this test was to demonstrate the ability of the Heater Control Assembly to survive a ten (10) day exposure to vacuum conditions and meet the requirements of Specification 516-181, Control Assembly, Heater.

Conclusion: The test specimen was not adversely affected by exposure to vacuum and operated properly during and after the test.

Test Procedure:

(1) Perform paragraphs 5.2 through 5.4 (operability) of QC-A-301.

(2) Perform vacuum-life test as defined in Appendix 64A.

(3) Repeat step 1.

Results: The test specimen operated properly throughout the test. Complete test data are on file in the Reliability Test Group files and will be made available to those interested on request.

APPENDIX 64A

1. Life Test Procedure

   1. Subject the specimen to 1 x 10^{-6} torr vacuum.
   2. Using a dummy load (100Ω resistor) cycle the specimen with a 50% duty cycle, each cycle being approximately 54 seconds. (27 sec. on, 27 sec. off)
   3. Maintain in vacuum and continuously cycle for a period of 10 days minimum.
   4. Record the vacuum tank pressure and the currents in the Heater Control Assembly power supply and dummy load circuits periodically throughout the test.

RELIABILITY TEST REPORT NO. 65

Test Item: Motor Speed Drive, Dwg. No. 709-200, Serial No. 8049, (009).

During Tests A and B (below) the Motor Speed Drive was F-1 design except that it did not have Duxseal on the oscillator toroid board. During Test C the Motor Speed Drive was F-1 design. During Test D the Motor Speed Drive was F-1 design except with the filter wires re-routed according to Authorized Variation AO-1659.

Type of Test:	Test A	Vibration (Sine)
	Test B	Vibration (Sine-Random)
	Test C	Vibration (Sine-Random)
	Test D	Vibration (Sine-Random)
Date of Test:	Tests A and B	June 19, 1963
	Test C	June 24, 1963
	Test D	June 27, 1963

Test Purpose:

Test A: The purpose of this test was to determine whether the Motor Speed Drive would withstand the sine vibration specified in Appendix D before subjecting the unit to the combination sine-random vibration test specified in Appendix D.

Test B: The purpose of this test was to determine whether the Motor Speed Drive would withstand the sine-random qualification vibration specified in Appendix D.

Test C: The purpose of this test was to determine if the oscillator toroid support board and associated wiring would physically withstand the sine-random qualification level of vibration specified in Appendix E when modified as described in Authorized Variation AO-1656. This authorizes the use of Duxseal between the oscillator toroid support board and the filter box, to reduce the vibration levels experienced by the component board during previous vibration tests.

Test D: The purpose of this test was to determine if the filter wiring of the Motor Speed Drive would physically withstand the sine-random qualification level of vibration specified in Appendix D when modified as specified in Authorized Variation AO-1659. This authorizes the re-routing of wires to eliminate excessive motion and subsequent stress on the filter wires during vibration.

Conclusion:

Test A: The Motor Speed Drive performance did not change significantly after being subjected to the specified sine vibration test.

Test B: The Motor Speed Drive before alteration as specified in Test Purpose - Test C and D - above, was not capable of withstanding the sine-random vibration specified in Appendix D.

Tests C and D: The sections of the Motor Speed Drive modified as specified above were not physically damaged by the vibration tests.

Several failures occurred and a summary of each failure is shown in Appendix 65A.

Test Procedure:

Test A

1. A pre-vibration operability test was performed in accordance with In-Process Test Procedure QC-A-307, Paragraphs 5.1 through 5.7 (Test T-319).

2. The Motor Speed Drive was subjected to sine vibration as specified in Appendix D. During the test the Motor Speed Drive was energized, the wave shape of the motor power voltage was monitored on an oscilloscope, and the period of the frequency was measured at speed steps 10, 19, 28, 37, 46, 55 and 64.

3. The Motor Speed Drive was tested in accordance with QC-A-307 sections as follows: 5.6.1.1 through 5.6.3.3 and sections of 5.6.4.2 through 5.6.4.5 to demonstrate that the data signal amplifiers were operating (Test T-329).

Test B

1. The Motor Speed Drive was subjected to sine-random vibration as specified in Appendix D in the Y axis. A failure occurred after a few seconds of random vibration, before sine vibration was applied.

2. The period of the frequency of the output of the Motor Speed Drive was measured for all speed steps and this revealed that speeds 41 through 56 were inoperable (T-334). The Motor Speed Drive was then inspected and the cause of failure determined.

3. The Motor Speed Drive was repaired and modified by inserting Duxseal compound on top of the oscillator toroid support board to damp vibrations which caused the failure. (Authorized Variation AO-1656).

Test C

1. The Motor Speed Drive was tested for operability in accordance with QC-A-307 sections 5.1 through 5.5. The applicable sections of 5.6 were performed to determine the Motor Power Test Point voltage, the Motor Power Test Point voltage distortion, and the voltage across phase A and phase B at speed steps 01, 10, 19, 28, 46, 55, 64. The applicable sections of paragraph 5.6.4.2 were performed to verify that the data signal amplifiers were operating, and the period of the frequency for all 64 speed steps was measured (Test T-352).

2. The Motor Speed Drive was then subjected to the sine-random vibration specified in Appendix D in the Z axis. The motor speed drive was energized during the vibration test and the wave shape of the output motor voltage was monitored on an oscilloscope. During the test, the period the frequency for speed steps 01, 10, 19, 20, 37, 46, 55, 64 was measured.

3. At 64 cps the output of phase A failed and at 220 cps the output of phase B failed. The cover of the Motor Speed Drive was removed and the unit was inspected to determine the cause of failure.

4. A broken lead was discovered on filter FL-305 which was the cause of failure at 220 cps. The wire was repaired, then the Motor Speed Drive was reassembled. The cause of the failure at 64 cps was a shorted output transistor. This failure was not repaired at this time.

5. The Motor Speed Drive was mounted for vibration in the Y axis and after the third equalization run no signals could be obtained on the monitoring test set.

6. The cover was again removed and an inspection of the Motor Speed Drive was made. An output power transistor, Q-325 (2N1016C), and a by-pass capacitor C313 were replaced. (The transistor failed during Z axis, see paragraph 3 above, and the capacitor failed during Y axis - see test results.)

7. The period of the frequency and the Motor Power Test Point voltage were measured at speed steps 01, 10, 19, 28, 37, 46, 55 and 64. The distortion of phase A and phase B voltage was determined at speed steps 01, 28 and 64.

8. The Motor Speed Drive was then subjected to the sine-random vibration specified in Appendix D in the Y axis. Power was applied to the specimen and the outputs monitored as specified above (Test A, paragraph 2).

9. The period of frequency, the voltage of the Motor Power Test Point, and the percent distortion of Motor Power A and Motor Power B voltage were measured at speed steps 01, 10, 19, 28, 37, 46, 55 and 64.

10. The Motor Speed Drive was then subjected to the sine-random vibration specified in Appendix D in the X axis. Power was applied to the specimen and the outputs monitored as stated in 8 above.

11. The period of the frequency and the Motor Power Test Point voltage were measured at speed steps 01, 10, 19, 28, 37, 46, 55 and 64.

12. An analysis of the difficulties experienced in the preceding tests was initiated. Before the analysis was complete a modification was made on the filter wires to eliminate relatively long spans of unsupported wire, and thereby prevent motion and subsequent stress on the affected wires during vibration. (Authorized Variation AO-1659)

<u>Test D</u>

1. The following measurements were made at speed steps 01, 10, 19, 28, 37, 46, 55 and 64: Period of the frequency, Motor Power Test Point voltage, percent distortion on phase A and phase B output voltage.

   Output was present on only three steps. (See results)

2. The unit was mounted for sine-random vibration as specified in Appendix D in the X axis. Power was applied to the specimen during equalization but was removed before the test start because outputs from the three remaining speed steps were lost during equalization.

3. The Motor Speed Drive was then subjected to the sine-random vibration specified in Appendix D in the X, Y, and Z axes. Between each axis the cover was removed from the specimen and an inspection was made to verify the condition of the modified assembly.

Test Results:

Test A

The results of the operability tests before and after sine vibration (Test A) show no degradation in performance of the Motor Speed Drive due to the sine vibration.

Test B

After a few seconds of sine-random vibration in the Y axis - Procedure, Test A, Paragraph 4 - there was no output from the oscillator on speed steps 41 through 56 and the periods on the remainder of the speed steps decreased by about 8 percent. (Failure Report AO-770).

An inspection of the Motor Speed Drive revealed some broken inductor leads. These inductor leads were embedded in epoxy. During vibration this epoxy cracked and broke the leads. An investigation of the magnitude of the forces experienced by this oscillator board during vibration indicated forces resulting in accelerations as high as 150g. Duxseal was assembled in the Motor Speed Drive on top of the toroid support board, to reduce these forces. (Authorized Variation AO-1656).

Test C

When vibrated in the Z axis (combined sine-random), after the insertion of Duxseal, an output transistor, Q-320 (2N1016) shorted at about 64 cps of the sine sweep, resulting in loss of output in the A phase. (Failure Report AO-786). At about 220 cps of the sine sweep a lead on FL-305 filter broke, resulting in complete loss of output. (Failure Report AO-756).

After completion of testing in the Z axis the Motor Speed Drive cover was removed and the lead that broke was resoldered to FL-305. This repair restored the output in B phase only.

During equalization for vibration in the Y axis a capacitor C-313 shorted. (Failure Report AO-787). The Motor Speed Drive was again opened and the power transistor Q 320 and the capacitor C-313 were replaced. The oscillator frequency and motor power test point voltages measured at speed steps 01, 10, 19, 28, 37, 46, 55, and 64.

Distortion was measured at steps 01, 28, and 64. After being vibrated in the Y axis the period of the frequency of steps 01, 10, 19, 28, 37, 46, 55, and 64 decreased about 1 percent. (Failure Report AO-789).

The results after vibration in the X axis indicated that this axis of vibration did not affect the performance of the Motor Speed Drive.

The Motor Speed Drive was again opened and inspected. The cause of the decrease in period after Y axis vibration was found to be broken capacitor leads on C-304, C-339, and C-336. (Failure Report AO-789). None of the Failures in the three axes were related to the oscillator board which had been treated with Duxseal.

Test D

A modification to eliminate the cause of the filter lead failure (AO-756) was made according to Authorized Variation AO 1659, and the Motor Speed Drive was tested for operability. An inspection of this operability data indicated that outputs were present only on speed steps 01, 10, 19, indicating that the previous failure analysis was incomplete. However, the vibration test was continued, since the primary purpose was to investigate the effect of the filter lead modification.

Power was applied to the M.S.D. during equalization for the X axis, but was removed during the test (3 axes) because output from the remaining 3 speed steps was lost during X axis equalization.

Inspections after each axis of vibration indicated that the wires did not break and that the rearrangement of the filter leads was satisfactory.

Complete test data are in the Reliability Test Group files, and will be made available, to those interested, upon request.

Approved for Release: 2024/01/30 C05098945

APPENDIX 65A

Failure Report No.	Failure	Recommended Change
AO-770	Broken inductor leads.	Use of Duxseal (AO-1656).
AO-786	Shorted Power Transistor Q-320. (2N1016C)	This area is under investigation. See Failure Reports AO-499 and 500. *
AO-756	Broken lead on filter.	Re-route cables (AO-1659).
AO-787	Shorted capacitor C-313.	Investigate vibration levels with respect to manufacturers recommendation.
AO-789	Increased oscillator frequency.	Pot the oscillator section of the Motor Speed Drive.
AO-796	No output.	Pot the oscillator section of the Motor Speed Drive.

NOTE: All failures of this nature on type 2N1016C transistors in the Motor Speed Drive have occurred when the M.S.D. was being tested with a test set. None have occurred at the Space Chamber level.

1 October 1963

RELIABILITY TEST REPORT NO. 66

Test Item: Gain Control Electronics Assembly, Dwg. No. 510-105, S/N 3545 (212004). The GCEA is F-1 design.

Type of Test: Shipping and Storage Temperature Extremes

Date of Test: July 1 and 2, 1963

Test Purpose: The purpose of this test was to determine the capability of the Gain Control Electronics to withstand exposure to high temperature and low temperature environments.

Conclusion: The Gain Control Electronics was not adversely affected by exposure to temperature extremes as described in Appendix D.

Test Procedure:

1) Leak rate test QC-A-325, Rev. C, Paragraph 8 was performed on the GCEA after the previous environmental test. (Test 3A-244)

2) Operability test QC-A-325, Revision C, Paragraph 5.1 through 5.9.8 was performed on the GCEA. (Test T-316)

3) The temperature extremes test was performed. The test consisted of 8 hours at 125°F and 8 hours at 0°F as described in Appendix D. (Test 3A-263)

4) Step 2 was repeated. (Test T-403)

5) Step 1 was repeated. (Test 3A-283)

Test Results: The operability test results showed no degradation in performance due to the temperature extremes test.

The leak rate test results showed a change in leak rate from a pre-test value of 2 mm Hg/hr to a post test value of 6 mm Hg/hr. Although the unit leaked at a rate higher than the 3.18 mm Hg/hr. maximum specified, the porous area, which leaked in this test, had previously been covered with epoxy. The epoxy apparently was affected by the temperature extremes. Epoxy would not normally be present.

Complete test results are in the Reliability Test Group files and will be made available, to those interested, upon request.

APPENDIX 66A

Failure Summary

Failure Report No.	Failure	Recommended Change
AO 851	Leak Rate was approximately double the specified value.	None: This failure was previously analyzed as poor workmanship.

RELIABILITY TEST REPORT NO. 67

Test Item: Space Chamber Assembly, Dwg. 805-101, S/N 211003

Type of Test: Extended Life Operation in Vacuum

Date of Test: 29 June - 2 July 1963

Test Purposes: The purpose of this test was to verify the capability of the C/P system to operate satisfactorily under the following conditions which are contained in Appendix 67A.

a. Vacuum environment

b. Ambient temperature

c. Forward Record Storage misaligned at maximum limits.

d. Continuous mode of operation

Conclusions:

a. In general, the C/P system performed successfully under the conditions stated above.

b. Heat sinks on motors and electronic components kept generated temperatures within expected ranges.

c. Low pressure operation produced no discernable static flashing on record.

d. Specified misalignment of the Record Storage Assembly had no effect upon tracking capability of the C/P system in a vacuum environment.

e. There was a change in $\% \Delta \nu$ of the film between atmosphere and vacuum. The RM payload camera has an obsolete design bellows damper system, however, so it was felt that the test results were not valid.

The performance of the complete film handling system, including the camera, will be tested in vacuum using the R_c components. The R_c camera has the redesigned bellows damper system.

f. Transition times and current drain on both Azimuth and Elevation Servos remained within specifications and did not vary throughout the test.

g. The rapid rate of decrease in film velocity during run out experienced previously in Reliability Test No. 58 was not present in this test. Redesign of the Take-up Tension Arm eliminated the drag imposed upon an almost full reel of film.

Test Procedure: Performed paragraph 5.7.5 (Extended Life Operation) of Qualification Test Procedure for the Camera Payload Subsystem, Dwg. No. 853-117, DCO, O-1.

Results:

1. The Air Supply Looper Potentiometer Drive Shaft failed at the beginning of paragraph 5.7.5.2 above. (Radial cracks, developed in a sharp shoulder relief during previous tests, widened to produce shaft breakage. Details were reported in Failure Report AO-806). This constituted the only failure during this test and the first wear-out failure encountered since testing of the C/P began.

2. Temperatures of the Take-up and Camera motors stayed within limits predicted by earlier engineering tests for this mode of operation (Camera motor approximately 110° - 115°F; Take-up motor to 90° - 95°F range) at 75°F ambient temperature. Temperature-time graphs of Camera motor, Camera feet and MSD feet plotted show the relation of MSD temperatures to Camera operation. The MSD operating temperatures also remained within expected ranges for this type of test.

3. Each roll of record wound evenly on the take-up spool.

4. Pressure inside the chamber during the test averaged 7×10^{-4} mm of mercury with 1.0 mm of mercury pressure inside the Record Storage Assembly during continuous mode operation.

Complete test data are in the Reliability Test Group files and will be made available, to those interested, upon request.

APPENDIX 67A

TABLE OF CONDITIONS

Cycles	Total Hours Test Time	Camera time/cycle On	Camera time/cycle Off	Chamber Wall Temp. °F.	C/P Volts
1-8	12	3 min. 20 sec.	86 min. 40 sec.	45	32.5
	24	---------	720	45 to 75	
9-16	36	3 min. 20 sec.	86 min. 40 sec.	75	31.0
	48	---------	720	75 to 45	
17-24	60	3 min. 20 sec.	86 min. 40 sec.	45	30.0
	72	---------	720	45 to 75	
25-32	84	3 min. 20 sec.	86 min. 40 sec.	75	29.0
	96	---------	720	75 to 45	
33-40	108	3 min. 20 sec.	86 min. 40 sec.	45	28.0
	120	---------	720	45 to 75	
41-48	132	3 min. 20 sec.	86 min. 40 sec.	75	27.0
Run Out	---	Continuous at Speed 64		75	27.0

RELIABILITY TEST REPORT NO. 68

Test Item: Reliability Model Camera Payload, Drawing No. 805-101, Serial No. 211-003. The status of the RM Payload design changes is as follows using the FM 1 as a reference:

1) The RM Payload had the FM-2 design lens system.

2) The RM Camera did not have the improved bellows design, the improved slit plate positioning mechanism, and the EMI fix.

3) The RM Elevation Bridge was not changed to prevent interference with the servo filters.

4) The RM Servos, Gain Control Electronics, Motor Speed Drive, and Air Supply did not have high reliability type diodes.

5) The RM Electrical Distribution Box did not have the revised master umbilical tell-tale and associated circuitry, the redesigned differential temperature amplifiers, the potted electrical connectors, and the redesigned Regulated Power Supply.

6) The RM Gain Control Electronics did not have the foam-potted transistor leads.

7) The RM Motor Speed Drive did not have a filter added to decouple the motor power amplifier and the data signal amplifier.

8) The RM Record Storage did not have the increased clearance to allow film to clear the upper spacer. The RM does have a snubber roller, FM-1 does not.

Type of Test: X, Y and Z Axes Vibration

Date of Test: June 5, 1963 through June 21, 1963

Test Purpose: The purpose of this test was to determine if the RM Payload would survive the qualification level X,Y and Z axes vibration defined in Appendix D and meet the performance requirements defined in the Phase II, Flight Payload Model, Specification No. 802-153, Rev. F.

Conclusions:

1) The lens system is considered qualified to survive vibration. However, the sensitivity of the test to performance changes was somewhat impaired due to low resolution of the RM lens. Some slight changes in best focus position occurred but it is believed that this was most probably due to test conditions and/or test equipment.

2) The elevation plate assembly is considered qualified for vibration except for the redesigned keepers on the Azimuth Servo shaft. (Subsequent testing has qualified these parts)

3) All electrical components operated satisfactorily through the three axes of vibration. Some out-of-tolerance conditions existed before vibration, but no change in performance occurred as a result of vibration.

4) The field tilt that was present before the first axis of vibration did not appear to change during the three axes of vibration. However, it is difficult to determine tilt because the focus curves do not peak sharply.

5) The Relay checks performed per special reliability test procedure no. 1 (CD-8961, S-INT-4975) showed that relay K801 in the Azimuth Servo latched during X-axis vibration. This did not affect the stereo mirror position operation.

6) The camera film speed variation resulting from vibration, although not within specifications, is not considered significant enough to require retesting the camera and film drive electronics at the payload level.

Test Procedure:

1) Performed Preliminary Electrical Checkout, Paragraph 5.4 of QC Acceptance Test Procedure 804-104, Revision B-3.

2) Performed Payload Film Tracking test, Paragraph 5.5.1 of QC Acceptance Test Procedure 804-104, Revision B-3.

3) Performed Power, Command, Control and Response Test, Paragraph 5.5.2 through 5.5.2.1.20 of QC Acceptance Test Procedure 804-104, Revision B-3.

4) Repeated Azimuth Servo Checkout, Paragraph 5.5.2.1 of 804-104, B-3. A jack under the truss assembly tilted the structure and caused erroneous readings on the first test.

5) Performed Power, Command, Control and Response Test, Paragraph 5.5.2.2 through 5.5.2.7.33 of QC Acceptance Test Procedure 804-104, Revision B-3.

6) Performed Environmental Control Checkout, Paragraph 5.5.3 of QC Acceptance Test Procedure 804-104, Revision B-3.

7) Mounted the Payload on the west collimator.

8) Performed Static Focus Test per Paragraph 1.1 of Special Reliability Test Procedure No. 2.

9) Performed Dynamic Photo Focus, Paragraph 5.5.5 of QC Acceptance Test Procedure 804-104, Revision B-3.

10) Performed Focus Sensor Calibration, Paragraph 5.5.6 of QC Acceptance Test Procedure 804-104, Revision B-3.

11) Performed Slit Evaluation, Slit Data Lamp Alignment, and Film Start-Stop Transients per Special Reliability Test Procedure No. 5.

12) Moved Payload to the east collimator.

13) Re-shimmed Camera because best focus was too near the reverse stop. CPL 20 equal to 0.5 to 0.75 volts.

14) Repeated steps 8 and 10.

15) Performed Dynamic Photo Test per Special Reliability Test Procedure No. 4.

16) Replaced Elevation Servo Mounting Bracket with FM-2 Design Bracket (AO 996 - B 19747).

17) Replaced Elevation Servo Lead Screw because it was binding up and drawing excessive current. (AO-996 - B 20202)

18) Repeated Azimuth and Elevation Servo theodolite readings, Paragraphs 5.5.2.1.16-B and 5.5.2.2.2-B of QC Acceptance Test Procedure 804-104, Revision B-3.

19) Performed Relay check per Special Reliability Test Procedure No. 1 (CD-8961, S-INT-4975).

20) Performed Y axis vibration.

21) Performed visual inspection. (AO-996-B 20138)

22) Repeated step 19.

23) Repaired failures of Y axis vibration. (See Table 1, failures AO 722, 729, 730, 731, 732 and 736). (AO-996-B 20346)

24) Repeated step 19.

25) Performed Z axis vibration to 16 cycles. (See Table 1 Failure AO-737).

26) Performed visual inspection. (AO-996-B 20830)

27) Repaired failure that occurred at 16 cycles of the Z axis.

28) Repeated vibration in Z axis at 16 cycles. (See Appendix B, Failure AO-740)

29) Performed visual inspection. (AO-996-B 19972)

30) Incorporated redesign of Azimuth Servo Drive Pin. (DCO No's. 813-442, 0-1 and 813-443, 0-1)

31) Continued vibration in the Z axis. Sweep from 50 to 2000 cycles, and then completed 16 to 50 cycles.

32) Performed visual inspection. (AO-996-B 20646)

33) Repeated step 19.

34) Repeated steps 1, 2, 3, 5 and 6.

35) Mounted Payload on east collimator.

36) Repeated steps 8, 9 and 10.

37) Performed Slit Evaluation, Slit Data Lamp Alignment, and Film Start - Stop Transients per step 2a and 2b of Special Reliability Test Procedure No. 3.

38) Performed Dynamic Photo Test per Paragraph 2c of Special Reliability Test Procedure No. 3.

39) Removed Camera to inspect lens barrel at Camera mounting feet.

40) Repeated steps 8 and 9.

41) Removed Camera and remounted Camera because of improper mounting in step 39.

42) Repeated step 19.

43) Repaired failure that occurred in Y-Z axis vibration (Table 1, Failure AO-749).

44) Performed vibration in the X axis.

45) Performed visual inspection. (AO-996, B-20431)

46) Repeated step 19.

47) Repeated step 1.

48) Performed visual check of record tracking. All other checks under step 2 had been previously qualified in X axis.

49) Repeated step 18.

50) Performed Azimuth and Elevation Servo current measurements. All other checks under step 3 had been previously qualified in X axis.

51) Mounted Payload on the East collimator.

52) Repeated steps 8 and 9.

53) Repeated step 10 at 3 amperes illumination only.

54) Repeated step 15.

55) Repeated steps 8 and 9. Results of step 52 had poor density, resolution and IMC.

56) Performed Motor Speed Drive frequency checks at speeds 1, 9, 10, 17, 19, 25, 28, 33, 37, 41, 46, 49, 51, 57 and 64. Poor IMC of step 55 indicated possible MSD failure.

57) Repeated steps 8, 9 and 15. Results of steps 54 and 55 again had poor density, resolution and IMC.

58) Repeated step 8. Results of step 57 had poor exposures.

59) Performed Heater Turn-on, Turn-off Temperature Verification, Paragraph 5.10.3.2 of QC Acceptance Test Procedure 804-104, Revision B-3.

60) Performed Lens, MSD, and Camera inspection. (AO-996, B-24040, B-24042, B-20172)

Test Results: The test results are compiled as follows:

1) **Table 1** - Test Failures
2) **Table 2** - Dynamic Focus Test Results
3) **Figure 1** - Focus Curves Plotted from Static Focus Tests
4) **Figure 2** - Focus Curves Plotted from Dynamic Focus Tests

Complete test data are in the Reliability Test group files and will be made available, to those interested, upon request.

Table 1

Failures in RM Payload During Qualification Vibration

Date	Failure Rept. No.	Axis	Failure	Explanation
6/10/63	AO 722	Y	Thermostats on Support Ring Failed	A design change was incorporated after Y axis. A preliminary version of the redesign passed Z axis, and the final version passed X axis. The new design has since been qualified in the Y and Z axes.
6/10/63	AO 729	Y	The jam nuts which couple the Azimuth Servo lead screw to the Azimuth Servo shaft loosened.	The jam nuts were not properly wired. They were rewired for Z axis, and finally the safety wires were replaced by roll pins after 16 cycles in Z axis.
6/10/63	AO 730	Y	The dowel pin the Azimuth Servo shaft worked out about 1/4 inch.	Excessive forces from vibration allowed the pin to work out. A design change was incorporated during Z axis vibration which provided a retaining feature.
6/10/63	AO 731	Y	The relief valve in the Air Supply loosened in vibration.	No locktite was placed on the screw threads during assembly.
6/10/63	AO 732	Y	Azimuth Pivot Stud loosened.	The Helicoil which holds the stud set screw was defective and did not hold the set screw. A new helicoil was assembled to the structure and the set screw remained tight through Z and X axes.
6/10/63 6/13/63 6/18/63	AO 733 AO 749 AO 785	Y Z X	Teflon scrapings found on both sides of the spherical pads of the primary structural ring.	High shock loads, bearing pressure and the relative motion between the pads caused the scrapings.
6/10/63 6/13/63 6/18/63	AO 735 AO 750 AO 779	Y Z X	Dirt and aluminizing chips found on the meniscus lens.	Aluminum tape that was used in place of aluminizing flaked off during vibration.
6/10/63	AO 736	Y	The spring lock for the brake band was out of the slot of the anchor stud.	The spring lock possibly was not replaced before vibration. This has been retested in Y axis and passed.

Table 1 (CONT'D)

Failures in EM Payload During Qualification Vibration

Date	Failure Rept. No.	Axis	Failure	Explanation
6/11/63	AO 737	Z	Drive pin in the Azimuth Servo shaft and lead screw sheared at 16 cps.	A design change in the drive pin and the jam nuts on the azimuth servo shaft and lead screw was incorporated. The redesign was successfully tested through X axis and through 15 to 2000 cycles in Z axis. The new design has since been qualified in the Y and Z axes.
6/13/63 6/18/63	AO 749 AO 785	Z X	Teflon on the unibal shaft was badly shreaded.	High shock loads, bearing pressure, and the relative motion between the unibal and unibal shaft caused the scrapings.
6/13/63 6/18/63	AO 751 AO 782	Z X	Lower component support tube had cracked welds near two mounting holes (-Z side).	Excessive Vibration at low frequencies caused fatiguing of the welds. Also a spacer was missing.
6/18/63	AO 778	X	Ends of Platen marked from striking mechanism frame.	The platen mount motion was greater than the 0.030 inch clearance between the platen and mechanism frame. No camera degradation resulted.
6/18/63	AO 780	X,Y,Z	Upper and lower support tubes contained metal chips, teflon chips, epoxy, and polishing compound.	It was felt that the dirt was generated during assembly and accumulated in the support tubes during vibration.
6/18/63	AO 781	X	One screw between upper support tube and primary structural ring came loose (+Z side). Two screws between lower support tube and primary structural ring came loose (-Z side)	New screws were not used in assembly before vibration. Thus the locking Helicoils did not hold the old screws tightly.
6/18/63	AO 783	X	Pivot Stud Clearance gap was 0.002 inch.	Improper Clearance between flat mirror trunion block and clamp assembly existed before vibration.
6/10/63	AO 784	X	Dowel pin through nut on pivot stud backed out about 1/16 inch.	
6/21/63	AO 886	X,Y,Z	Flexures on stereo mirror broken and longitudinal supports were bent.	The broken flexures were probably caused by excessive vibration when the crabbing servo drive pin sheared in Z axis vibration.

E-131

TABLE 2: DYNAMIC FOCUS RESULTS

Speed 51, 0°F.A. .0088 inch Slit, 28 V Operating Voltage

Process Ticket No.	Photographic Best Focus			Focus Sensor Best Focus	% IMC Error (Measured from IMC Circles)	% Change from Nominal Film Speed (From Data Track)	Density of Step 6
	CPL-20* Volts	H & V OM Resolution Lines/mm	Vertical Resolution Lines/mm	CPL-20 Volts			
1268 (pre Y,Z)	3.135	78	79	2.753	-0.975	-0.075%	1.47
1272 (post Y,Z)	3.413	77	73	2.865	+5.068	-0.25%	1.47
1276 (post Y,Z)**	3.302	83	83	2.865	+3.320	-0.125%	1.44
1280 (post Y,Z)***	3.289	77	74	------	-3.76	-0.20%	1.49
1287 (post X,Y,Z)	3.249	69	69	2.929	+3.042	-0.050	1.24
1290 (post X,Y,Z)****	3.501	75	77	2.929	+0.78	-0.150%	1.22

* CPL-20 - Platen Position, 0.25V = 0.001 inch.

** Results of Dynamic Focus Test that is run after Dynamic Photo Tests

*** Performed after Camera was removed for mounting feet inspection

**** Performed because of apparent change in field tilt in Process Ticket 1287

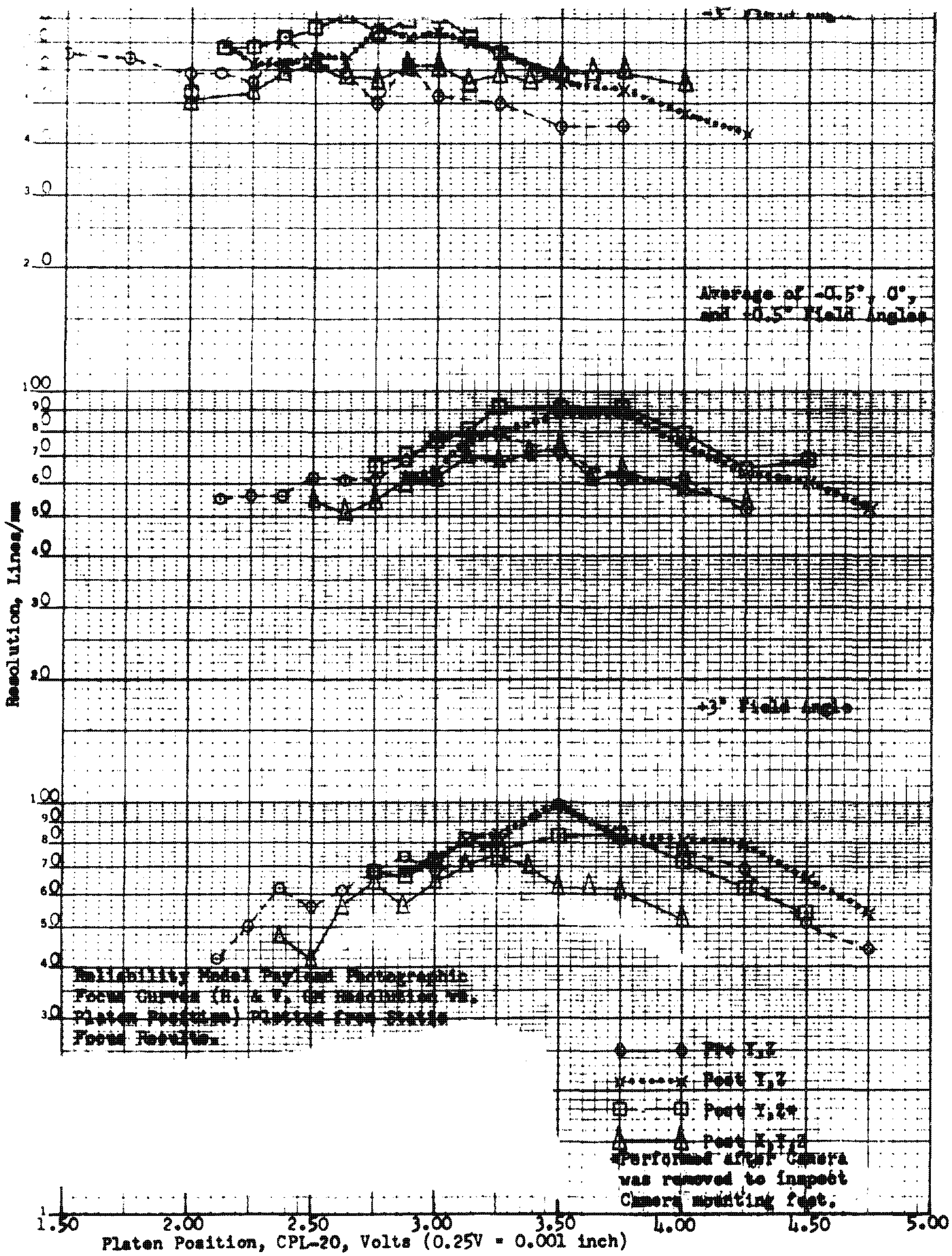


Figure 1. RM Focus Curves Plotted from Static Focus Results

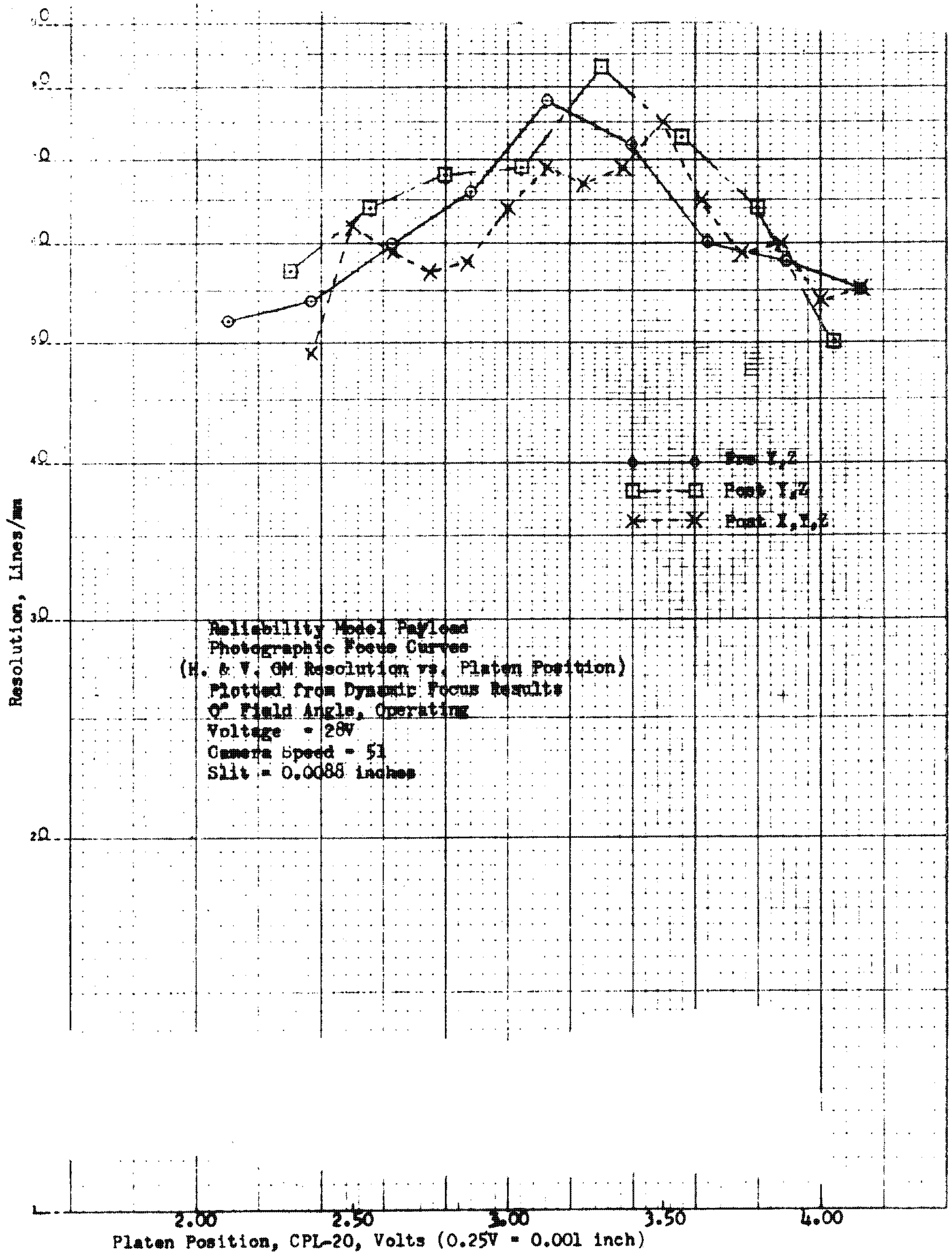


Figure 2. RM Focus Curves Plotted from Dynamic Focus Results

RELIABILITY TEST REPORT NO. 69

Test Item: Heater Control Assembly, Dwg. No. 516-181, S/N 26.

Type of Test: Shipping Temperature Extreme - High (For low temperature, see Reliability Test Report No. 56)

Date of Test: May 8, 1963 to May 10, 1963

Test Purpose: The purpose of this test was to determine if the Heater Control Assembly would withstand the high temperature environment for three days, as defined in Appendix 69A and meet the performance requirements of Drawing No. 516-181, Note 11.

Conclusions: The Heater Control Assembly has successfully passed the high temperature test.

Test Procedure:

1) Perform paragraph 5.1 through 5.4.28 (Operability) of QC In-Process Test Procedure QC-A-301, Revision A-5.

2) Perform high temperature environment test according to Appendix 69A.

3) Repeat step (1).

Test Results: The test data are tabulated on the sheets in Table 1.

APPENDIX 69A

The Heater Control Assembly shall be stored in a temperature environment of 125°F for 72 hours. Rate of increase of temperature shall not exceed 1°F per minute. Remove the Heater Control Assembly from the chamber and allow to cool in room temperature until an equilibrium has been reached.

TABLE 1

TEST ITEM Heater Control Assembly
TEST ITEM DWG. NO. 516-181
TEST ITEM SERIAL NO. 26

DATE May 7, 1963 to May 10, 1963
PROCEDURE NAME In-Process, Heater Control Assembly
PROCEDURE NO. QC-A-301, Revision A-5

Procedure Paragraph Reference	FUNCTION NAME	UNITS	REQUIRED Min.	REQUIRED Max.	MEASURED Pre Test	MEASURED Test*	MEASURED Post Test	Failure Report Number	Procedure Deviation Reference
5.3.11	Insulation Resistance	ohms	100 meg		400K meg		400K meg		
5.4.13	Fuse Current	ma	540	660	575		585		
5.4.17	Load Voltage - Heater On	vdc	25.8	28.5	27.83		27.9		
5.4.21	Switching Transistor Voltage	vdc	—	.450	0.419		0.414		
5.4.27	Leakage - Heater Off	vdc	—	.005	.000		.001		

*ENVIRONMENTAL TEST High Temperature

E-137

RELIABILITY TEST REPORT NO. 70

Test Item: Heater Control Assembly, Dwg. No. 516-181, S/N 26

Type of Test: Shock

Date of Test: May 20, 1963

Test Purpose: The purpose of this test was to determine if the Heater Control Assembly would survive qualification level shock defined in Appendix D and meet the performance requirements of Dwg. No. 516-181, Note 11.

Conclusion: The Heater Control Assembly will survive qualification level shock.

Test Procedure:

1) Perform paragraphs 5.1 through 5.4.28 (Operability) of QC In-Process Test Procedure QC-A-301, Revision A-5.

2) Perform ±X, ±Y, and ±Z axes shock test per Appendix D. Check continuity of the fuses after each shock.

3) Repeat step (1).

Test Results: The test data are tabulated on the data sheet in Table 1.

TABLE 1

TEST ITEM Heater Control Assembly
TEST ITEM DWG. NO. 516-182
TEST ITEM SERIAL NO. 26

DATE May 20, 1963
PROCEDURE NAME In-Process, Heater Control Assembly
PROCEDURE NO. QC-A-301, Revision A-5

Procedure Paragraph Reference	FUNCTION NAME	UNITS	REQUIRED Min.	REQUIRED Max.	MEASURED Pre Test	MEASURED Test*	MEASURED Post Test	Failure Report Number	Procedure Deviation Reference
5.3.11	Insulation Resistance	ohms	100 meg	—	400K meg		90K meg		
5.4.13	Fuse Current	ma	540	660	585		575		
5.4.17	Load Voltage - Heater On	vdc	25.8	28.5	27.9		27.84		
5.4.21	Switching Transistor Voltage	vdc	—	.450	.414		.429		
5.4.27	Leakage - Heater Off	vdc	—	.005	.002		.00		

*ENVIRONMENTAL TEST Shock

RELIABILITY TEST REPORT NO. 71

Test Item: Air Supply Assembly, Dwg. No. 711-185, S/N 1172

Type of Test: Shock Test

Date of Test: June 25, 1963

Test Purpose: The purpose of this test was to determine if the Air Supply would survive the qualification shock levels defined in Appendix D and meet the performance requirements defined in the Air Supply Test Procedure QC-A-308, Rev. F.

Conclusion: The Air Supply will survive the shock levels defined in Appendix D and meet the performance requirements of QC-A-308, Rev. F.

Test Procedure:

A) Perform paragraphs 5.1 through 5.18 and 5.20 through 5.22 of Test Procedure for Air Supply (QC-A-308, Rev. F.).

B) Perform the shock test according to Appendix D.

C) Repeat Procedure A after the Air Supply has been inspected.

Test Results: The actual levels applied to the Air Supply are shown in Appendix 71A.The horisontal Hyge shock machine at Lincoln Plant is incapable of delivering short-time pulse with a low "G" input. Based on engineering judgment, the actual qualification shock test was more severe than the required test. Therefore, the air supply will survive the shock levels defined in Appendix D. Complete test data, including pictures of the shock wave forms, are in the Reliability Test Group files and will be made available to those interested upon request.

Reliability Test Report No. 71

APPENDIX 71A

Shock levels applied to Air Supply:

Axis	G's	Time Duration (millisec.)
+X	5.8	9
-X	6.0	9
+Y	3.3	10
-Y	3.1	10
+Z	3.1	6
-Z	3.0	10

Wave shape was 1/2 sinusoidal.

RELIABILITY TEST REPORT NO. 72

Test Item: Distribution Box, Dwg. No. 617-114, Serial No. 2944

Type of Test: Vibration (Y and Z axis)

Date of Test: May 14, 1963 (Y axis)

May 15, 1963 (Z axis)

Purpose: The purpose of this test was to determine if the Distribution Box would survive the qualification level Y and Z axis vibration defined in Appendix D and subsequently meet the performance requirements defined in Phase II Electrical Distribution Component Specification No. 602-128.

Conclusion: The test item, as designed on the test date, will not meet requirements after being subjected to the qualification level vibration specified in Appendix D. No failures were detected after vibration in the Y axis. After vibration in the Z axis, broken leads on capacitors C-2 and C-32 and a broken lead on diode CR2 in the Record Transport Control Module prevented the test item from performing satisfactorily. A severed epoxy bond between capacitors and the component board indicated that the board was experiencing excessive motion during the test. The stresses accompanying this motion provide conditions which may cause other failures. The test item met leak rate requirements after vibration in both axes.

Test Procedure:

1) The test item was modified to correct the cause of the failure that occurred in the previous vibration test. The results of this test are documented in Reliability Test Report No. 40 (S-INT-4773). The modification consisted of enclosing the area where the failure occurred with foam epoxy.

2) The test item was operability tested per In-Process Test QC-A-304, Revision C-2 (Test No. T-187).

Reliability Test Report No. 72

3) The test item was tested for leak per QC-A-325, Revision C (Test No. 3A-191).

4) The test item was then subjected to the vibration levels specified in Appendix D in the Y-axis.

5) The test item was then subjected to portions of QC-A-304 as a cursory test to detect effects of Y axis vibration. The selected portions were as follows:

Paragraph	Module
5.5	Fuse
5.7 & 5.8	Take-up Transport Control Module
5.11 & Voltage Measurements of 5.14	Regulated Power Supply
5.18 @ 70° only	Differential Amplifier CPL-3
5.23 @ 70° only	Differential Amplifier CPL-5

6) The test item was then subjected to the vibration levels specified in Appendix D in the Z axis.

7) The operability test specified in paragraph 5 above was repeated.

8) A leak rate test per QC-A-325, Revision C was performed (Test No. 3A-308).

Results: The operability test performed after vibration in the Y axis indicated that the Distribution Box was not damaged by this test.

The operability test performed after vibration in the Z axis indicated that the Record Transport module was not operating satisfactorily. Power on the supply brake was not removed within plus or minus 0.25 second after the take-up relay was de-energized (Reference Failure Report AO 653).

The leak rate test after vibration in the Y and Z axis was 0.5 mm of Hg per hour; leak rate requirements allow 3.175 mm of Hg per hour. The Take-up Transport module was removed from the Distribution Box and the following troubles were

a. Loose leads (open circuit) in capacitors C-2 and C-32.

b. Epoxy bond between C-32 on C-2 capacitors and component board severed.

c. Broken wire at diode CR2.

d. Relay K-2 remained in its latched state.

Complete test data are in the Reliability Test Group files and are available upon request.

RELIABILITY TEST REPORT NO. 73

Test Item: Distribution Box, Dwg. No. 617-114, Serial No. 2944

Type of Test: Vibration (X, Y & Z axes)

Date of Test: June 1, 1963

Purpose: The purpose of this test was to determine if the Distribution Box would survive the qualification level X, Y and Z axes vibration defined in Appendix D and subsequently meet the performance requirements defined in Phase II Electrical Distribution Component Specification No. 602-128.

Conclusion: The test item, as designed on the date of test, will not meet requirements after being subjected to the qualification level vibration specified in Appendix D. The Record Transport Control Module and the Fuse Module successfully withstood vibration in all three axes. After vibration in the X axis, a loose terminal and a broken wire were noticed in (CPL-5) Differential Amplifier module. Both Differential Amplifiers had successfully withstood vibration in the Y and Z axes in a prior test (Reference Reliability Report No. 72). The Distribution Box failed to meet leak rate requirements after vibration in the X-axis; in the previous test referenced above the leak rate requirements were met after vibration in the Y and Z axes. After vibration in the Y and Z axes, a transistor (Q-126) failed which disabled the plus 22 volt portion of the Regulated Power Supply module. This Regulated Power Supply previously passed all three axes of qualification vibration, and therefore, is considered qualified.

Test Procedure:

1) The test item was modified to correct the cause of the failure that occurred in the previous vibration test. The results of this test are documented in Reliability Test Report No. 72. The modification consisted of potting a complete section of the Record Transport Module.

2) The test item was operability tested per In-Process test procedure QC-A-304, Revision D (Test No. T-265).

3) The test item was tested for leak per QC-A-325, Revision C (Test No. 3A-224).

4) The test item was then subjected to the vibration levels specified in Appendix D in the X axis.

5) The test item was then retested per QC-A-304, Revision D (Test No. T-265 Post X axis).

6) The test item was then tested for leak per QC-A-325, Revision C.

7) The test item was then subjected to the vibration levels specified in Appendix D in the Y axis.

8) The test item was then subjected to portions of QC-A-304 as a cursory test to detect effects of Y axis vibration. The portions selected were as follows:

Paragraph	Module
5.5	Fuse
5.7 & 5.8	Take-up Transport Control Module
5.11 & Voltage Measurement of 5.14	Regulated Power Supply
5.18 @ 70° only	Differential Amplifier CPL-3
5.23 @ 70° only	Differential Amplifier CPL-5

9) The test item was then subjected to the vibration levels specified in Appendix D in the Z axis.

10) The abridged operability test described in paragraph 8 above was repeated.

Results: After vibration in the X axis, the Distribution Box failed leak rate (Reference Failure Report AO 689) and the Differential Amplifier (CPL-5) failed. A terminal was loose on TB-3 and a wire between pin 6 and terminal 6 was missing. (Reference Failure Report AO 688) No other defects were noted.

Performance tests after vibration in the Y axis indicated that the test item was not affected.

After vibration in the Z axis, a transistor (Q-126) failed which disabled the plus 22 volt portion of the Regulated Power Supply.

Complete test data are in the Reliability Test Group files and available upon request. A summary of the failures is shown in Appendix 73A.

APPENDIX 73A

FAILURE SUMMARY

Failure Report No.	Failure	Recommended Change
AO 688	Loose terminal and missing wire in Differential Amplifier module. Caused incorrect outputs on CPL-5.	Redesign terminals.
AO 689	Excessive leak rate.	(Failure not analyzed)
AO 691	Faulty transistor caused loss of plus 22 volt portion of Regulated Power Supply.	No change. Unit has been qualified.

RELIABILITY TEST REPORT NO. 74

Test Item: Forward Record Storage Assembly (FRSA), Dwg. No. 712-479, S/N 5445

Type of Test: Acceleration (Powered Flight)

Date of Test: June 4, 1963

Test Purpose: The purpose of this test was to determine if the Forward Record Storage Assembly would survive the qualification acceleration levels defined in Appendix D and meet the performance requirements defined in the Forward Record Storage Test Procedure QC-A-337, Revision C.

Conclusions: The FRSA will survive the acceleration levels defined in Appendix D and meet the performance requirements of QC-A-337, Revision C. One failure occurred during the post acceleration test but was not attributed to the acceleration test.

Test Procedure:

A) Perform paragraphs 5.6 (film speed test), 5.7 (instrumentation check) and 5.9 (tracking test) of Test Procedure for FRSA (QC-A-337, Revision C).

B) Perform the acceleration test according to Appendix D.

C) Repeat Procedure A after the FRSA has been inspected.

Test Results: The FRSA was inspected upon completion of the acceleration test and no visual damage was noticed.

The post operability test was successfully completed with the exception of the bias angle test. The bias angle previous to the acceleration test was 0° 44' (0° 45' is the required specification) and the post test result is 1° 15'.

A check was made on parallelism between rollers of the FRSA which showed that the rollers were not within tolerances. This is one possible cause for the out of specification bias angle. Another possible reason is distortion of the side frames on the FRSA by the handling frame which adapts the FRSA to the test stand. This has been a troublesome area in the past.

Despite the out of specification bias angle, tracking of the FRSA was excellent and the failure angles were nearly equal.

Complete test data are in the Reliability Test Group files and will be made available, to those interested, upon request.

RELIABILITY TEST REPORT NO. 75

Test Item: RM Payload, Dwg. No. 805-101, Serial No. 211003

Type of Test: Qualification Vibration

Date of Test: August 4 and 5, 1963

Test Purposes: The purposes of subjecting the payload to the qualification vibration test defined in Appendix D were as follows:

1. Primary

   a. To determine whether the stereo mirror, when held with its thin plate potted to the Inner Ring, would remain structurally intact during vibration.

   b. To determine whether the Stereo Mirror Assembly flexures would survive vibration.

2. Secondary

   a. To determine whether the Azimuth Servo drive pin, which was redesigned as a result of an earlier failure in vibration, would survive that portion of the qualification vibration test in which it was yet unqualified - all of the Y axis and 5-15 cps in the Z axis.

   b. To determine whether the three thermostats that are mounted on the Primary Structural Ring would survive that portion of the qualification vibration test in which they were yet unqualified - the Y and Z axes.

Conclusions:

1. The stereo mirror, when held with its thin plate potted to the Inner Ring, will remain structurally intact during qualification level vibration.

2. Most of the flexures in the stereo mirror assembly will survive qualification level vibration.

3. The Azimuth Servo drive pin will survive Y axis qualification level vibration and 5-15 cps in the Z axis.

4. The thermostats on the Primary Structure Ring will survive Y and Z axis qualification vibration.

Test Procedure:

1. Serial No. 14 stereo mirror was installed in the RM Payload with its thin plate potted to the Inner Ring. The light shield which fastens to the Outer Ring was left off in order to facilitate between-axes inspection.

2. The supply cassette was loaded with 3000 feet of film and the film was threaded through the Camera and film supply cassette.

3. The payload, without its chute and take-up cassette, was moved into the vibration area and mounted in its vibration fixture for Y axis vibration according to procedure QC-A-513A.

4. The stereo mirror was positioned at 0° in elevation and 0° in azimuth. Power was applied to the Torque Motor in the film supply cassette.

5. The payload was vibrated in the Y axis to the levels defined in Appendix D.

6. The payload was inspected for damage due to vibration. This inspection included removing the Outer Ring from the Stereo Mirror Assembly in order to examine the flexures. The thermostats on the Primary Structure Ring were given an operability check.

7. The payload was rotated 90° for vibration in the Z axis.

8. Power was applied to the Torque Motor and the payload was vibrated in the Z axis to the levels defined in Appendix D.

9. Step 6 was repeated.

10. The fixture-payload combination was remounted on the vibrator for vibration in the X axis.

11. Power was applied to the Torque Motor and the payload was vibrated in the X axis to the levels defined in Appendix D.

12. Step 6 was repeated and the payload was removed from the fixture.

Test Results: The results of this test were as follows:

1. Y axis vibration

   a. During vibration the system dumped at 280, 440, and 800 cps due to fixture resonances. The payload was examined visually after each dump. No evidence of damage was observed.

   b. Post-vibration inspection results:

      1. The stereo mirror was still securely in place.

      2. The flexures in the Stereo Mirror Assembly were undamaged.

      3. The Azimuth Servo drive pin was undamaged.

      4. The thermostats on the Primary Structure Ring were operable.

2. Z axis vibration

   a. During vibration the system dumped at 290 and 960 cps. The payload was examined visually after each dump. No evidence of damage was observed.

   b. Post-vibration inspection results:

      1. The stereo mirror was still securely in place.

      2. One of the flexures in a stack of flexures was broken and a small crack was found in another part of the same flexure (see Figure 1). None of the other flexures were observed to be damaged; it is conceivable, however, that some of the hidden flexures could have been damaged.

      3. The Azimuth Servo drive pin was undamaged.

      4. The thermostats on the Primary Structural Ring were operable.

3. X axis vibration

   a. During vibration the system dumped at 275 and 950 cps. The payload was examined visually after each dump.

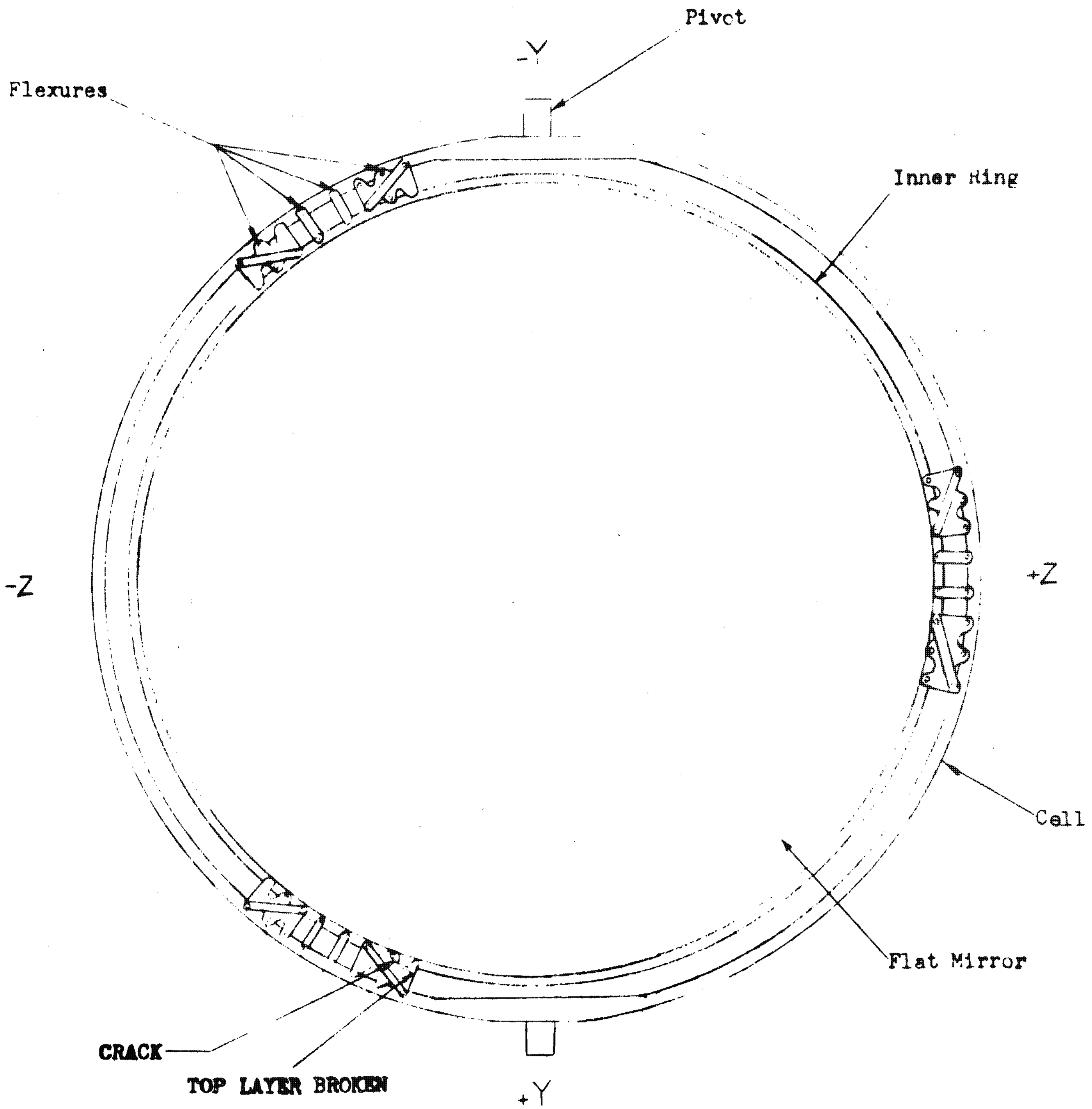


Figure 1. Location of Failures after Z-Axis Vibration

No evidence of damage was observed.

b. Post vibration inspection results:

1. The stereo mirror was still securely in place.

2. The rest of the flexures in the stack of flexures that had one broken flexure after Z axis vibration were broken. The crack that started in Z axis vibration had become larger. Another crack was found in the same flexure and part of the flexure was bent. A new crack was also found in one of the short flexures. Four other flexures were bent. Figure 2 shows the locations of these cracks and bends. The rest of the flexures were without visible damage.

This test was performed on the RM Payload with a modified stereo mirror. When the former stereo mirror was replaced, it was discovered that nearly all the flexures were broken (see Table 1 of Reliability Test Report No. 68). The former stereo mirror had been subjected to a qualification level vibration test in all three axes as a part of the RM Payload. During the Z axis vibration testing, the Payload was subjected to some additional testing in the 15-24 cps region due to failure and subsequent redesign of the azimuth servo pin. An inspection of the Payload (which did not include removal of the stereo mirror cell cover) and a test of the Payload following vibration did not indicate any problem with the stereo mirror. The Payload had also been transported to and from Lincoln Plant without a shipping container for EMI testing prior to discovering the broken flexures. However, a careful review of the shipping operation makes it appear unlikely that the transportation had any significant affect on the flexure problem.

A piece was missing from the thick plate and egg-crate structure of the stereo mirror glass blank used in this test. This piece was chipped out some time prior to the test. However, it is believed that this defect had little effect on the test results. Its dimensions and weight are given in Figure 3.

As indicated above, there was considerably less damage to the stereo mirror flexures as a result of this vibration test compared to the former test. The explanation for this is not clear since there were a number of differences between the tests. However, it is believed that the extra vibration the former stereo mirror received in the 15 to 24 cps region in the Z axis is the most probable cause for the additional damage.

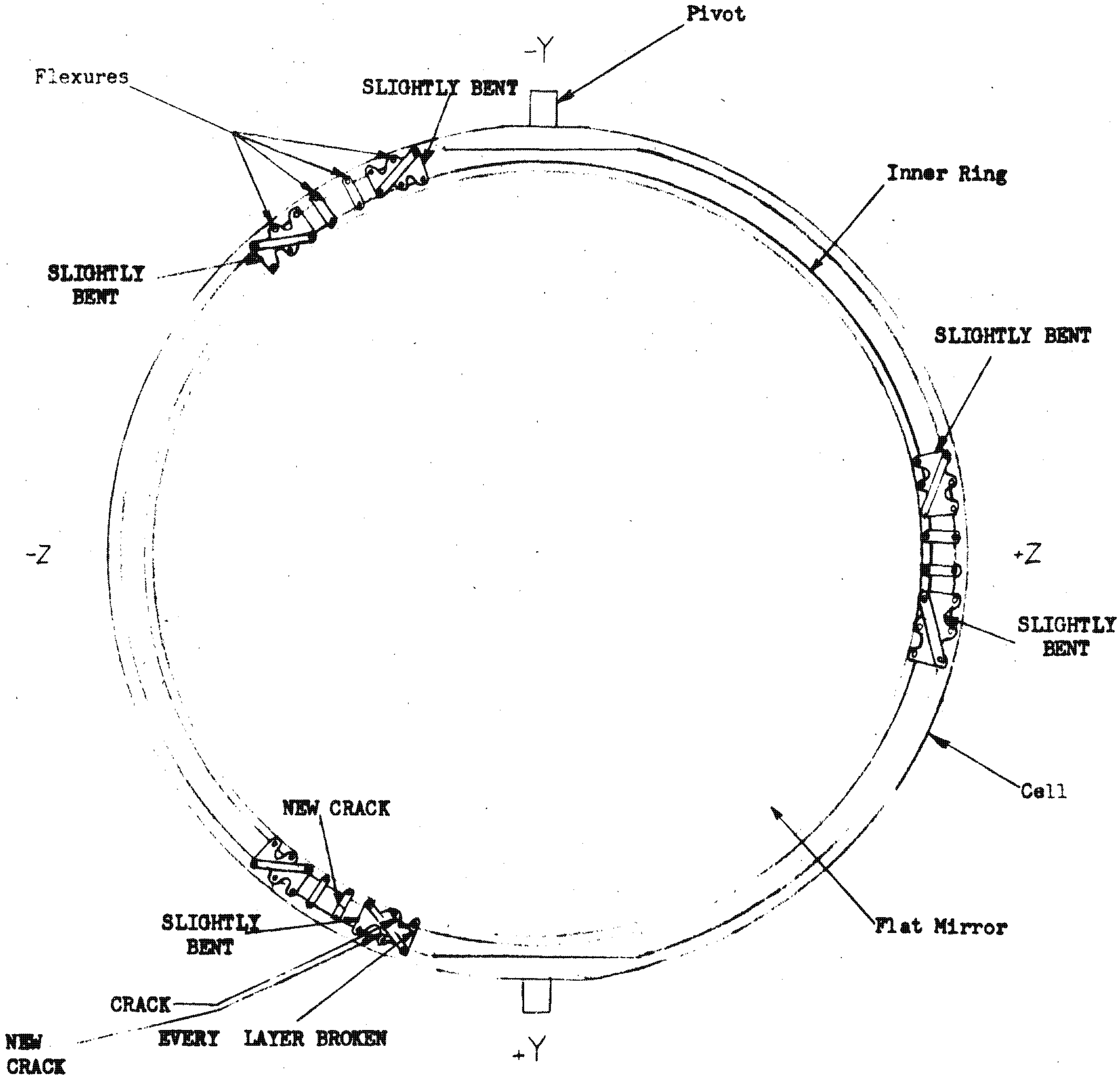
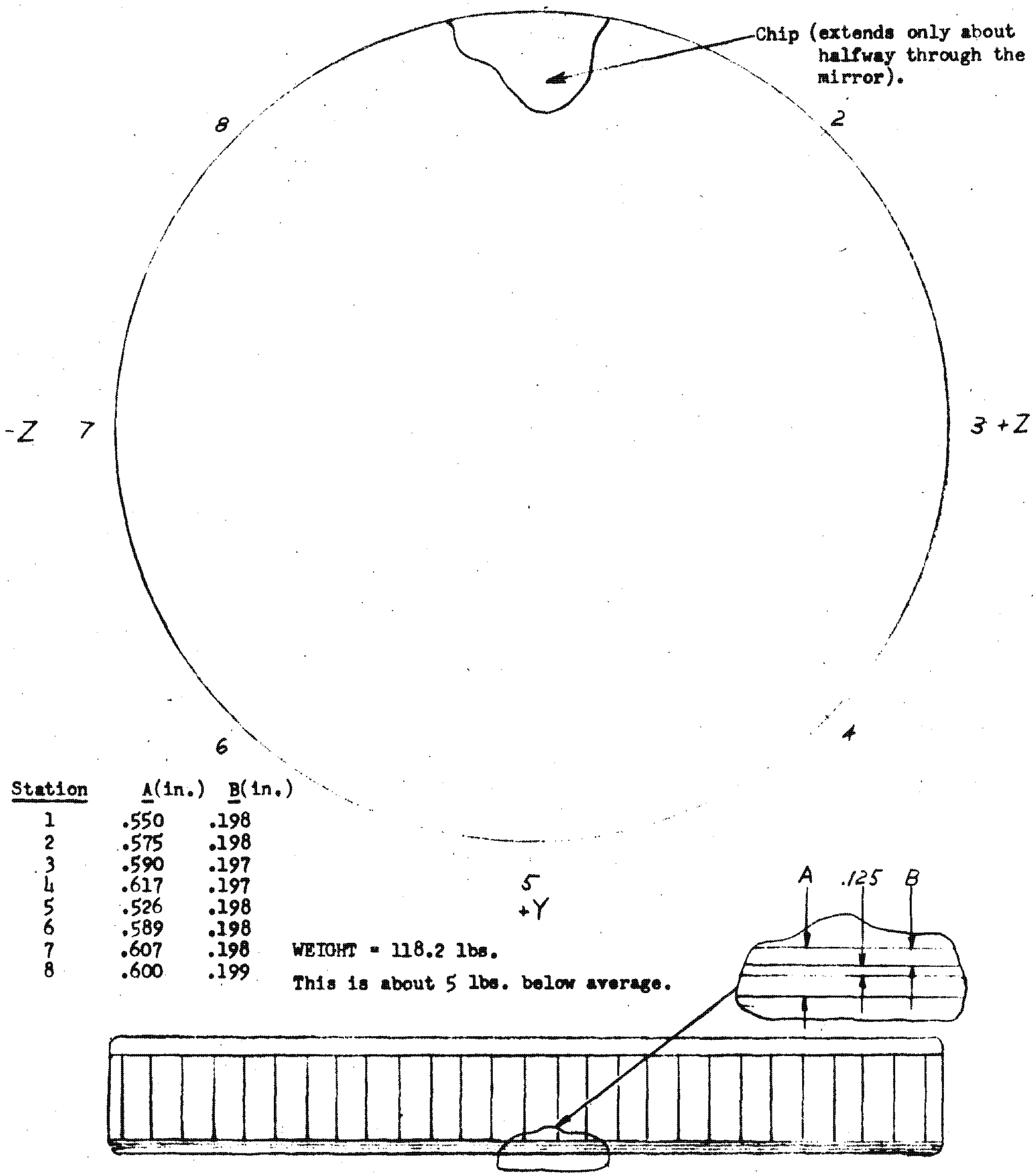


Figure 2. Location of Failures after X-Axis Vibration

As a result of the flexure failures that occurred in this test and the previous test, a design change will be made beginning with the F-205 Payload. This change will incorporate an additional 12 flexures and six snubbers will be added to limit the lateral motion of the mirror.



Station	A(in.)	B(in.)
1	.550	.198
2	.575	.198
3	.590	.197
4	.617	.197
5	.526	.198
6	.589	.198
7	.607	.198
8	.600	.199

WEIGHT = 118.2 lbs.

This is about 5 lbs. below average.

Figure 3. Weight and Dimensions of the Flat Mirror

RELIABILITY TEST REPORT NO. 76

Test Item: Forward Record Storage Assembly, Dwg. No. 712-479, S/N 5445

Type of Test: De-orbit Vibration and De-orbit Acceleration

Date of Tests: 1 and 22 July 1963

Test Purpose: The purpose of this test was to determine if the Forward Record Storage Assembly would survive the qualification re-entry vibration and acceleration levels defined in Appendix D , and store and protect 3,000 feet of film from damage.

Conclusion: The FRSA will survive the vibration and acceleration levels defined in Appendix D and adequately store and protect 3,000 feet of film.

Test Procedure:

A) Prepare eight strips of 9 1/2 inch wide by 2 ft. long unexposed film and place two latent images (grey scales) on each of the eight strips.

B) Wind 3,000 ft. of exposed film onto the take-up spool and interleave each of the eight strips of unexposed film at every 375 feet.

C) Assemble the take-up spool and mount the FRSA to the vibration fixture.

D) Vibrate the FRSA according to the levels shown in Appendix D

E) Inspect the FRSA for broken or damaged parts.

F) Accelerate the FRSA according to the levels shown in Appendix D.

G) Repeat Procedure E.

H) Process each of the eight strips of unexposed film.

I) Record density readings of the grey scales on each of the processed strips.

Test Results: The FRSA successfully survived the de-orbit vibration and acceleration tests with no broken or damaged parts.

In a dark enclosure, each of the eight unexposed strips of film were removed from the spool and then sent out for processing. The eight strips were analyzed by taking density readings of the grey scale portion. These readings were compared to the density readings of a control strip and the difference was negligible.

RELIABILITY TEST REPORT NO. 77

Test Item: Motor Speed Drive, Dwg. No. 709-200, Serial No. 302005 (4816)

Type of Test: Sine-Random Vibration

Date of Test: July 19 through 22, 1963

Test Purpose: The purpose of this test was to determine the capability of the Motor Speed Drive to withstand the qualification level sine-random vibration described in Appendix D.

Conclusion: The Motor Speed Drive is capable of withstanding the qualification level sine-random vibration defined in Appendix D.

Test Procedure:

1. The unit was checked on the Motor Speed Drive Test Set to assure operability. The only readings recorded before vibration were period (1/f) readings at speed steps 1, 10, 19, 28, 37, 46, 55 and 64. These speed steps were selected because correct operation of the MSD at these speeds indicates operation of all oscillator components.

2. The MSD was vibrated at the levels defined in Appendix D in the Z axis.

3. A more complete operability check was performed. This check consisted of recording readings of Period x 10, A1, A2, B1 and B2 output voltages, % distortion and Motor Power Test Point voltages at the same selected speed steps as in Procedure par. 1. Data Signal Amplifier Test Point output was also measured.

4. The MSD was vibrated at the levels defined in Appendix D in the Y axis.

5. Procedure par. 3 was repeated.

6. The MSD was vibrated at the levels defined in Appendix D in the X axis.

7. Procedure par. 3. was repeated.

8. A complete operability test in accordance with QC-A-307, revision C paragraphs 5.4 through 5.6.4 was performed.

Test Results:

This vibration test was initially intended for engineering evaluation and as a result only frequencies were measured prior to Z axis vibration. Upon completion of the first axis (Z) of vibration the decision was made to perform a more complete operability test after each axis and use the results to verify qualification of the MSD through vibration. Engineering judgment indicated that there was sufficient data prior to Z axis vibration to verify qualification.

As discussed below, the frequencies were out of tolerance prior to the start of the vibration test. However, the changes observed as a result of the test were insignificant. The A_2 voltage and motor power test point voltage were also out of tolerance prior to the start of the test, but these voltages did not change significantly as a result of the test. All other performance characteristics were within specification. Visual inspection of the Motor Speed Drive after all three axes of vibration indicated that no physical damage occurred during vibration.

Based on the above results, the Motor Speed Drive, with the changes described in Appendix 77A is considered qualified with respect to vibration.

The oscillator for this Motor Speed Drive was accepted without being tuned and therefore the frequency outputs were out of tolerance. A summary of frequencies and voltages which were out of tolerance is given in Appendix 77B.

Complete test data are in the Reliability Test Group files, and will be made available, to those interested, upon request.

APPENDIX 77A

Significant Structural Design Changes

DCO No.	Description of Change
709-202 F-1	Addition of Duxseal on oscillator top board.
709-200 D-1	Rerouting of wires to the filters of the power command relay.
709-202 F-1	Addition of sylgard potting to oscillator section.
709-200 D-1	Addition of supporting blocks under filters.

APPENDIX 77B

Out of Tolerance Test Results

Parameter	Spec. Limits		Pre-vibration	Post Z Axis	Post Y Axis	Post X Axi
Period X 10						
Step 01	34339	34408	37450	37477	37489	37489
Step 10	31397	31460	34250	34275	34286	34285
Step 19	28708	28765	31350	31310	31320	31317
Step 28	26249	26301	28570	28588	28594	28592
Step 37	24000	24049	26250	26140	26145	26142
Step 46	21944	21989	23810	23793	23796	23795
Step 55	20065	20105	21600	21589	21590	21589
Step 64	18346	18383	*19920	19532	19532	19530
A_2 Voltage						
Step 01	9.8	14.8		8.7	8.7	8.7
Step 10	10.8	16.2		10.0	10.0	9.9
Step 19	11.8	17.7		11.8	11.7	11.7
Motor Power Test Point						
Step 01	1.7	2.6		1.3	1.4	1.2
Step 10	2.1	2.9		1.8	1.9	1.8
Step 19	2.5	3.3		2.2	2.3	2.2
Step 28	2.9	3.7		2.6	2.7	2.6
Step 37	3.3	4.1		2.8	3.0	2.9
Step 46	3.7	4.5		3.1	3.2	3.2
Step 55	4.1	4.8		3.4	3.6	3.5
Step 64	3.8	4.7		3.5	3.5	3.4

* Probable measurement error.

RELIABILITY TEST REPORT NO. 78

Test Item: Cable Support Bracket, Dwg. No. 617-102, Rev. E-1
Serial No. 4542

Type of Test: Qualification Vibration

Dates of Test: August 23, 26, and 28, 1963

Test Purpose: To determine whether the Cable Support Bracket that is fabricated by forming rather than by welding would remain structurally intact during the qualification vibration test defined in Appendix D.

Conclusion: The Cable Support Bracket will remain structurally intact during vibration.

Test Procedure:

1) The W-1 Cable, Test Box, and Junction Box from the EM Space Chamber were mounted to the bracket in order to provide proper weight conditions during the test.

2) The bracket was mounted to the vibrator for vibration in the X axis (see Figure 1 for orientation of axes).

3) The bracket was vibrated in the X axis.

4) The bracket was subjected to a post-vibration inspection.

5) The bracket was rotated 90° for vibration in the Y axis.

6) The bracket was vibrated in the Y axis.

7) Step 4 was repeated.

8) After the vibrator had been rotated 90° for vertical vibration, the bracket was mounted to the vibrator for vibration in the Z axis.

9) The bracket was vibrated in the Z axis.

10) Step 4 was repeated.

Results: No damage to the bracket was found after each axis of vibration.

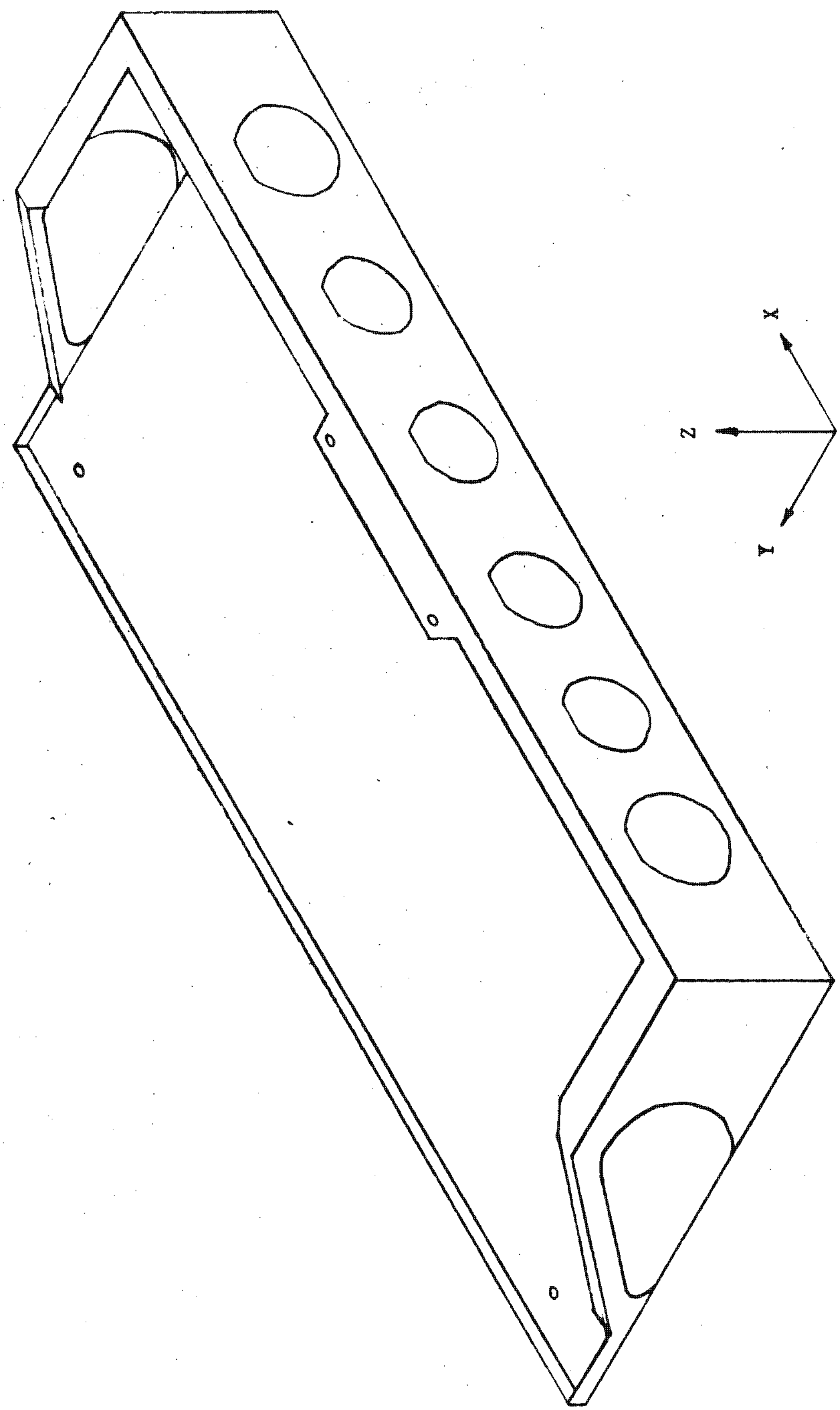


Figure 1. Orientation of Axes for Cable Support Bracket

RELIABILITY TEST REPORT NO. 79

Test Items:

1) Forward Record Storage Assembly, Drawing No. 712-479, S/N 5445.

2) Air Supply Assembly, Drawing No. 711-185, S/N 1172.

Type of Test: Life Test

Date of Test: 7 through 10 May 1963

Test Purpose: To determine if the above test items will perform satisfactorily (two times orbital life) according to specifications 702-135, Revision B (Forward Record Storage Assembly) and 702-139, Revision C (Air Supply Assembly) in an environment of high vacuum and varying temperature.

Conclusions: The Forward Record Storage Assembly and Air Supply will survive the life test and perform satisfactorily according to specifications 702-135 and 702-139. Since a test camera was not available at the time of this test, it was not determined if the looper assembly will affect the velocity smoothness of the platen roller.

Test Procedure: See Drawing No. 853-108, Qualification Test Procedure for Transport System.

Test Results: A simulated platen roller operated by a 28V dc motor was used to represent a camera to enable operation of the looper truck. Approximate speed steps (1, 32, 64) were achieved by varying the voltage supplied to the dc motor.

The complete film path was not enclosed throughout this test for the purpose of maintaining a surrounding environment with a lower pressure and greater temperature range.

The operation of the take-up motor, simulated camera and torque motor were controlled by the looper limit switches and a series of relays. The simulated camera was capable of operating on a stereo or strip mode operation. Strip mode was only used during the exhaust run.

Two 3,000 foot spools of fresh film were used for the life test. The first spool was used for the cold temperature test (test No. 1) and the second spool was used for the hot temperature test (test No. 2).

Cold Temperature Test:

The program for operational sequence is shown in Figure 1. It was originally planned for the "off" time to be 75 minutes but it was discovered that a cooling period of 30 minutes for the take-up motor was sufficient.

The operating pressures are shown in Figure 2. The rise in pressure is a result of the moisture content on the film as it is spooled from the supply reel. Operating pressure for the continuous run phase is similar to each of the cycles.

Figure 3 shows the take-up motor current and take-up film velocity throughout the test. The speed vs. torque curve for the take-up motor was out of specification prior to this test and this condition would attribute to the low film velocities near the beginning and end of the test.

The temperature of the take-up motor was monitored (see Figure 4) with a thermocouple on the center of one of its magnetic poles. Each line shows the temperature rise during each of the 16 cycles and the continuous run phase. The steep rise in temperature at the end of the test is explained in the footnote (*) in Figure 1. Also included in Figure 4 are the temperatures of the chamber wall and take-up film path.

After completion of this test the 3,000 feet of film on the take-up reel was processed and examined for any physical or photographic defects. No defects were noticed.

Hot Temperature Test:

Operational program, operating pressures, take-up current and velocity, and take-up motor temperatures are shown in Figures 5, 6, 7, and 8 respectively. The discussions for Figures 1, 2, 3, and 4 of the cold test also apply respectively to Figures 5, 6, 7, and 8.

During cycles 7 and 8 the transport system was electrically floated for the purpose of detecting any static discharge between the film and the rollers. After completion of the test the 3,000 feet of film was processed and no static discharge was noticed. Also, physical and photographic defects were not present.

RELIABILITY TEST REPORT NO. 79

PROGRAM OF TEST NO. 1 - COLD TEMPERATURE

Cycle No.	Approx. Camera Speed . Step	TU Motor & Torque Motor Voltage	"On" Time Per Cycle	"Off" Time After Cycle No.
1	1	27.0 V dc	15 min.	30 min.
2	1	27.0 V dc	15 min.	15 min.
3	1	27.0 V dc	15 min.	15 min.
4	32	27.0 V dc	15 min.	45 min.
5	64	27.0 V dc	15 min.	30 min.
6	1	32.5 V dc	15 min.	30 min.
7	32	32.5 V dc	16 min.	12.5 hrs.
8	64	32.5 V dc	15 min.	30 min.
9	1	27.0 V dc	15 min.	30 min.
10	1	27.0 V dc	15 min.	30 min.
11	1	27.0 V dc	15 min.	30 min.
12	32	27.0 V dc	15 min.	30 min.
13	64	27.0 V dc	15 min.	30 min.
14	1	32.5 V dc	15 min.	30 min.
15	32	32.5 V dc	15 min.	30 min.
16	64	32.5 V dc	15 min.	10 min.
Continuous Run	64	*27.0 V dc	31 min.	----

*During the last 250 feet of film the voltage supplied to the take-up motor was increased to 30 V dc. Rubbing of the tension arm on the film surface caused the film velocity in the take-up to fall below the camera speed. S/N 5445 take-up cassette had not been updated to latest DCO with respect to the tension arm assembly.

FIGURE 1

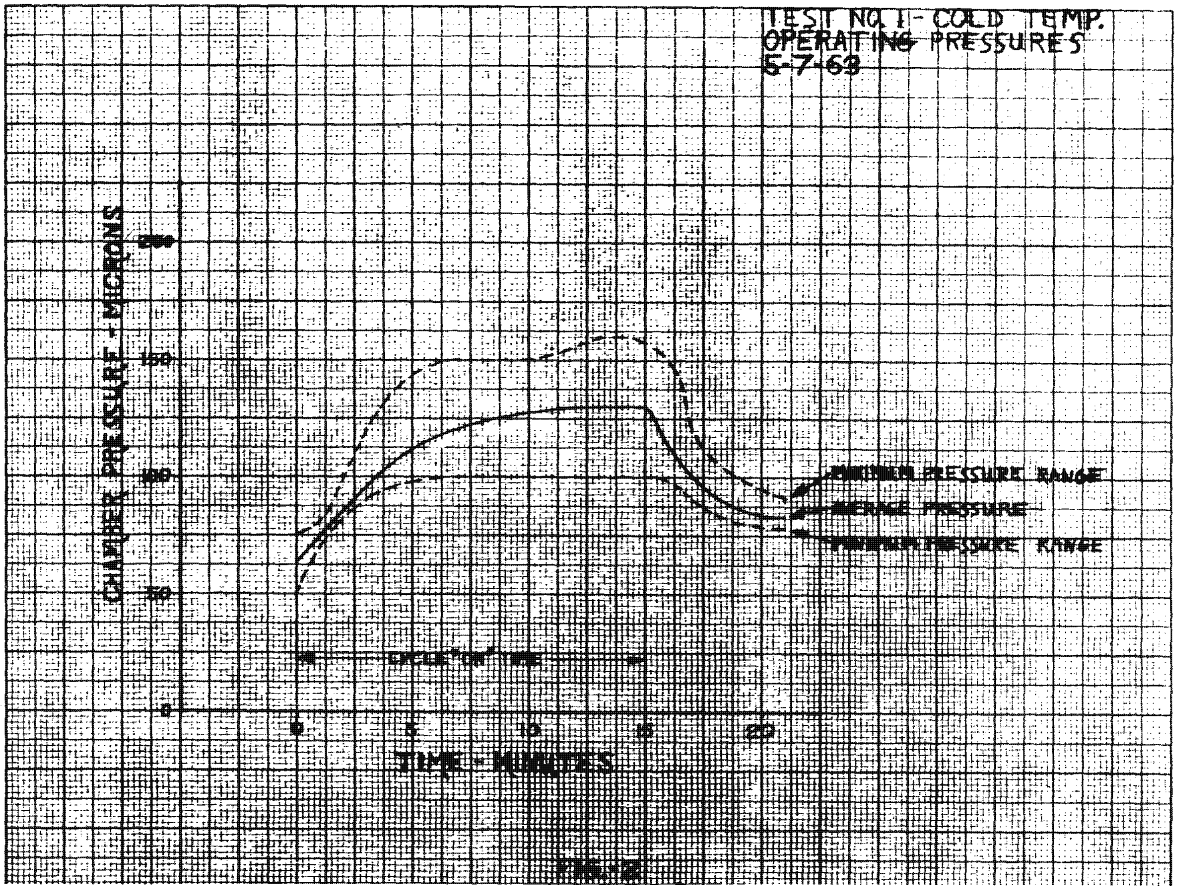


Figure 2. Curve of Operating Pressures, Cold Temperature Test

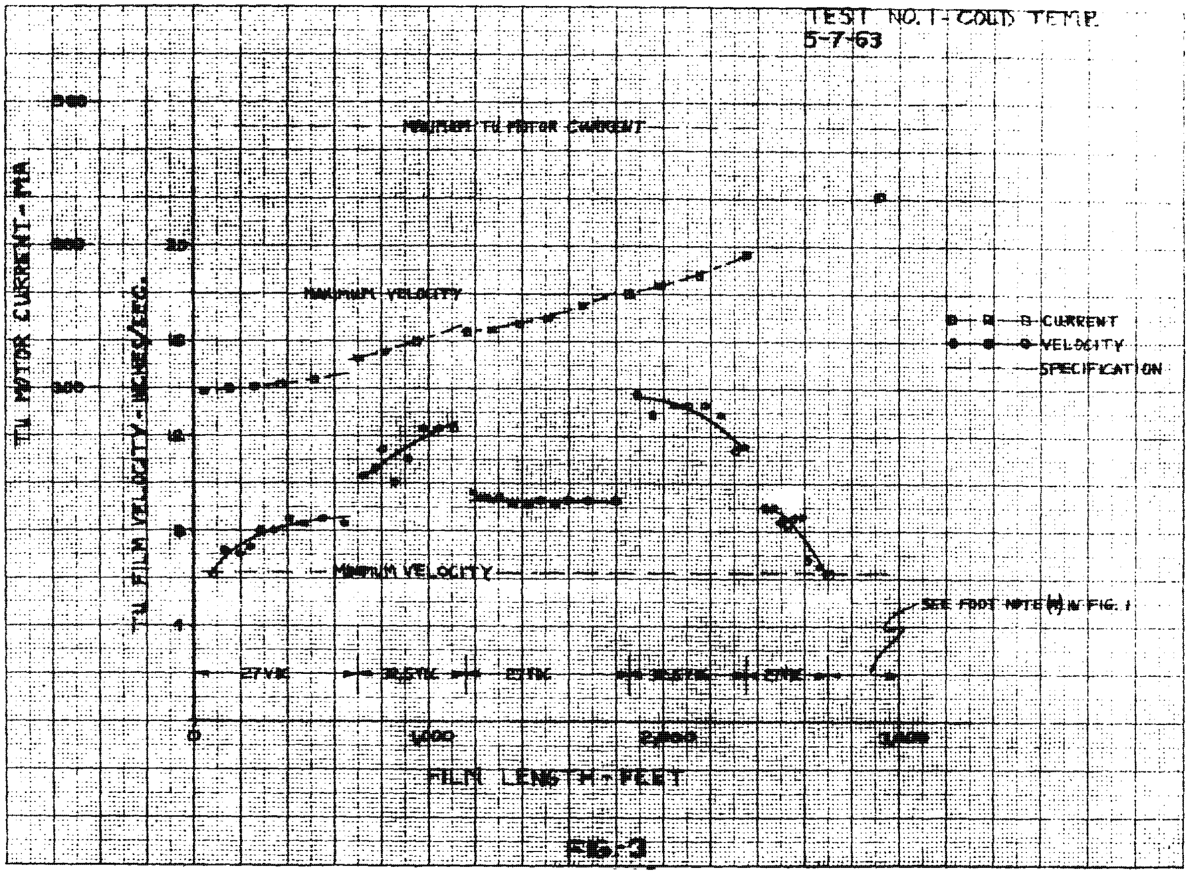


Figure 3. Curve of Take-up Motor Current and Take-up Film Velocity - Cold Temperature Test

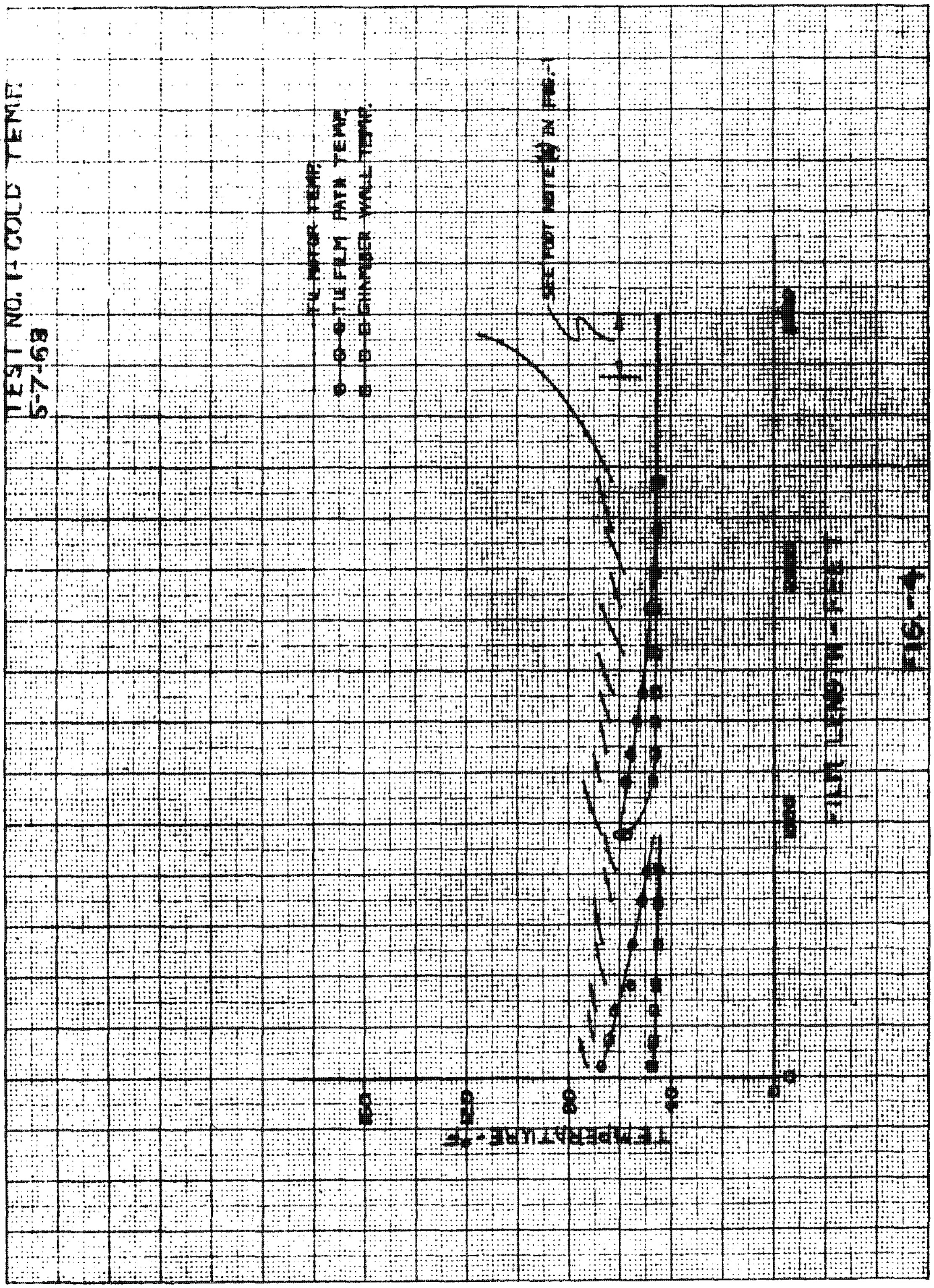


Figure 4. Take-up Motor Cold Temperature Curve

RELIABILITY TEST REPORT NO. 79

PROGRAM OF TEST NO. 2 HOT TEMPERATURE

Cycle No.	Approx. Camera Speed Step	TU Motor & Torque Motor Voltage	"On Time Per Cycle	"Off Time After Cycle No.
1	1	27 V dc	15 min.	30 min.
2	1	27 V dc	15 min.	30 min.
3	32	27 V dc	15 min.	30 min.
4	32	27 V dc	15 min.	30 min.
5	64	27 V dc	15 min.	30 min.
6	64	27 V dc	15 min.	30 min.
7	64	32.5 V dc	15 min.	30 min.
8	64	32.5 V dc	15 min.	12.75 hrs.
9	1	32,5 V dc	15 min.	30 min.
10	1	32.5 V dc	15 min.	30 min.
11	32	32.5 V dc	15 min.	30 min.
12	32	32.5 V dc	15 min.	30 min.
13	1	32.5 V dc	15 min.	30 min.
14	32	32.5 V dc	15 min.	30 min.
15	64	32.5 V dc	15 min.	30 min.
Continuous Run	64	*27 V dc	-----	------

*During the last 250 feet of film the voltage supplied to the take-up motor was increased. Rubbing of the tension arm on the film surface caused the film velocity in the take-up to fall below the camera speed. S/N 5445 take-up cassette had not been updated to latest DCO with respect to the tension arm assembly.

FIGURE 5

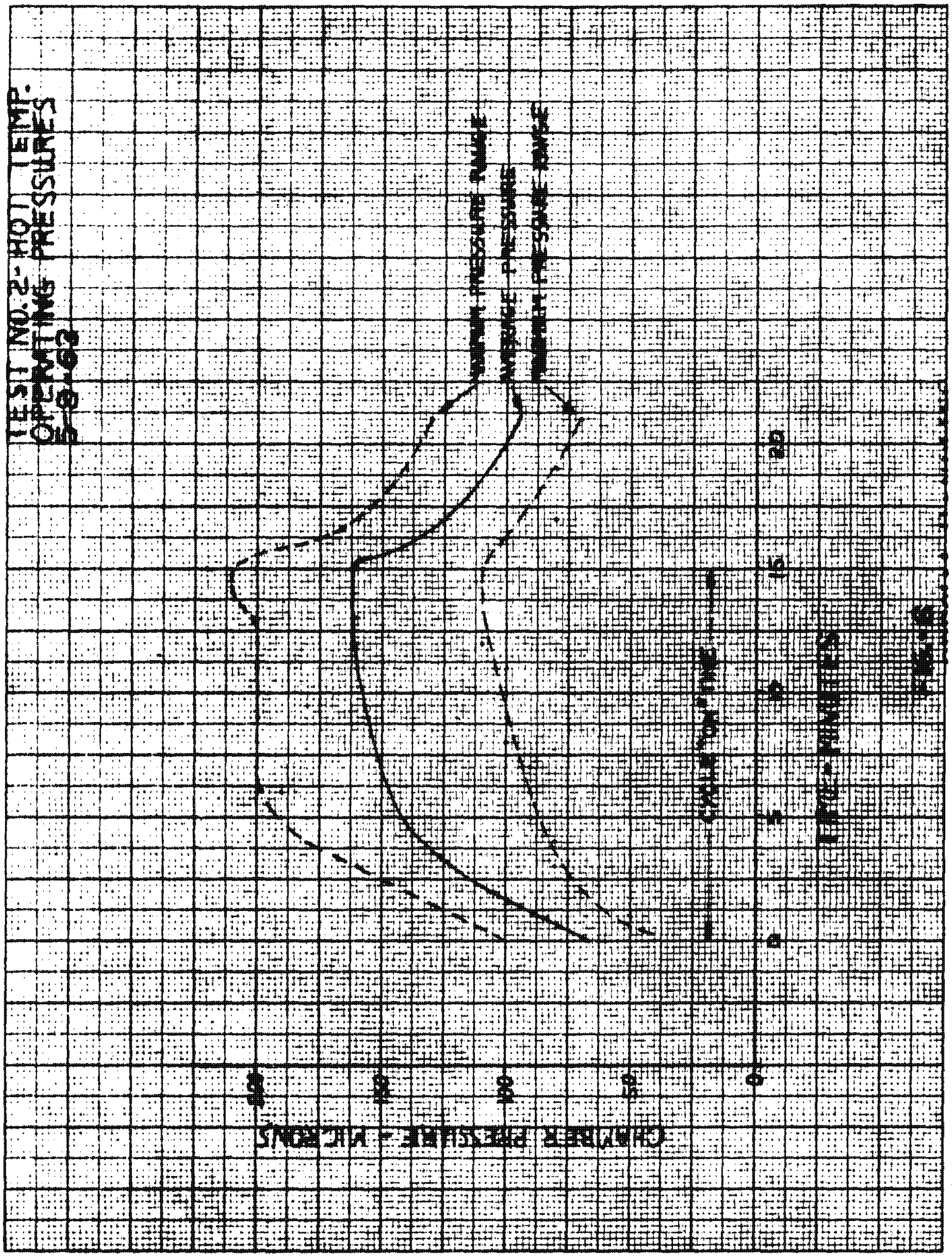


Figure 6. Curve of Operating Pressures, Hot Temperature Test

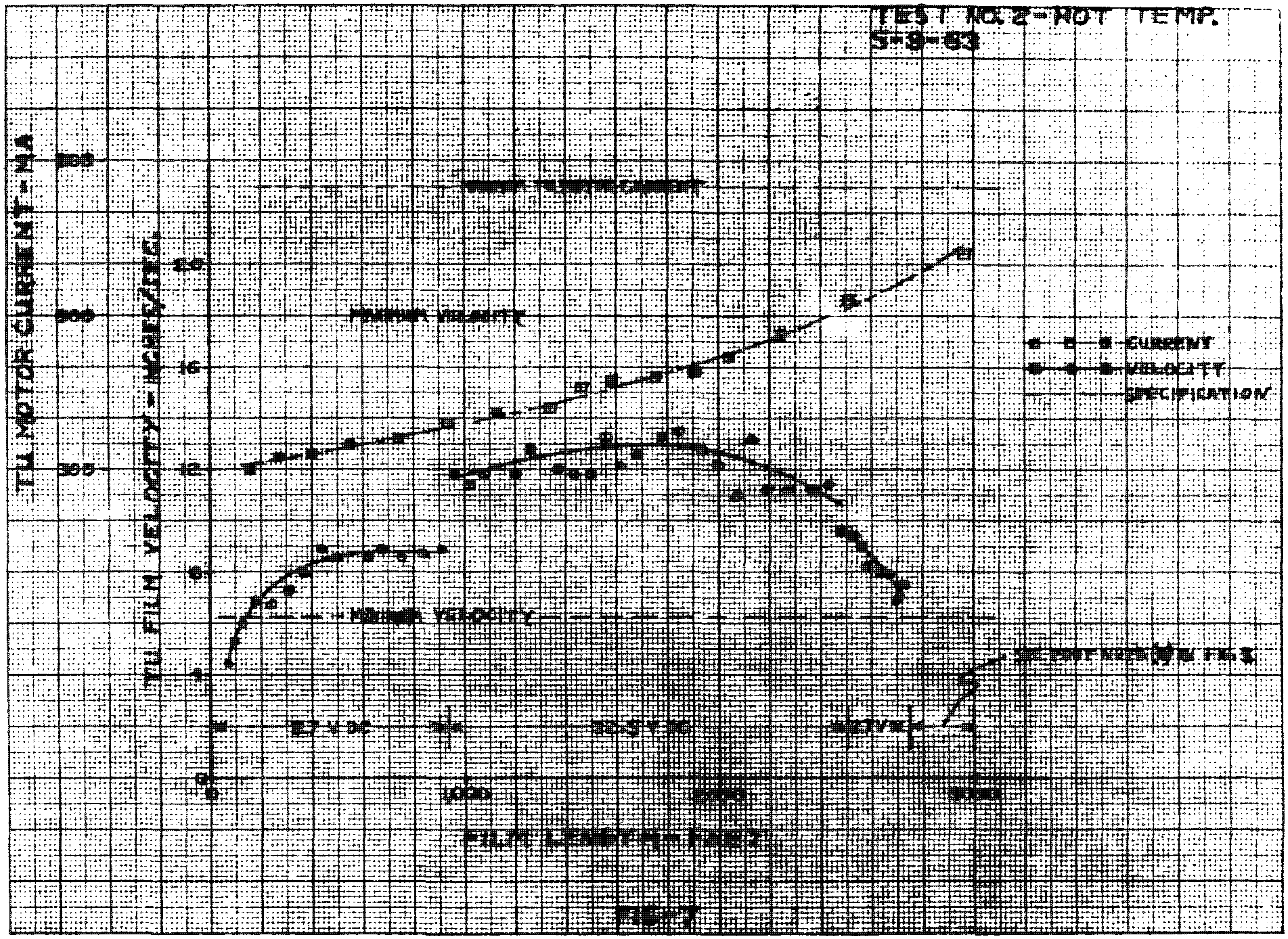


Figure 7. Curve of Take-up Motor Current and Take-up Film Velocity-Hot Temperature Test

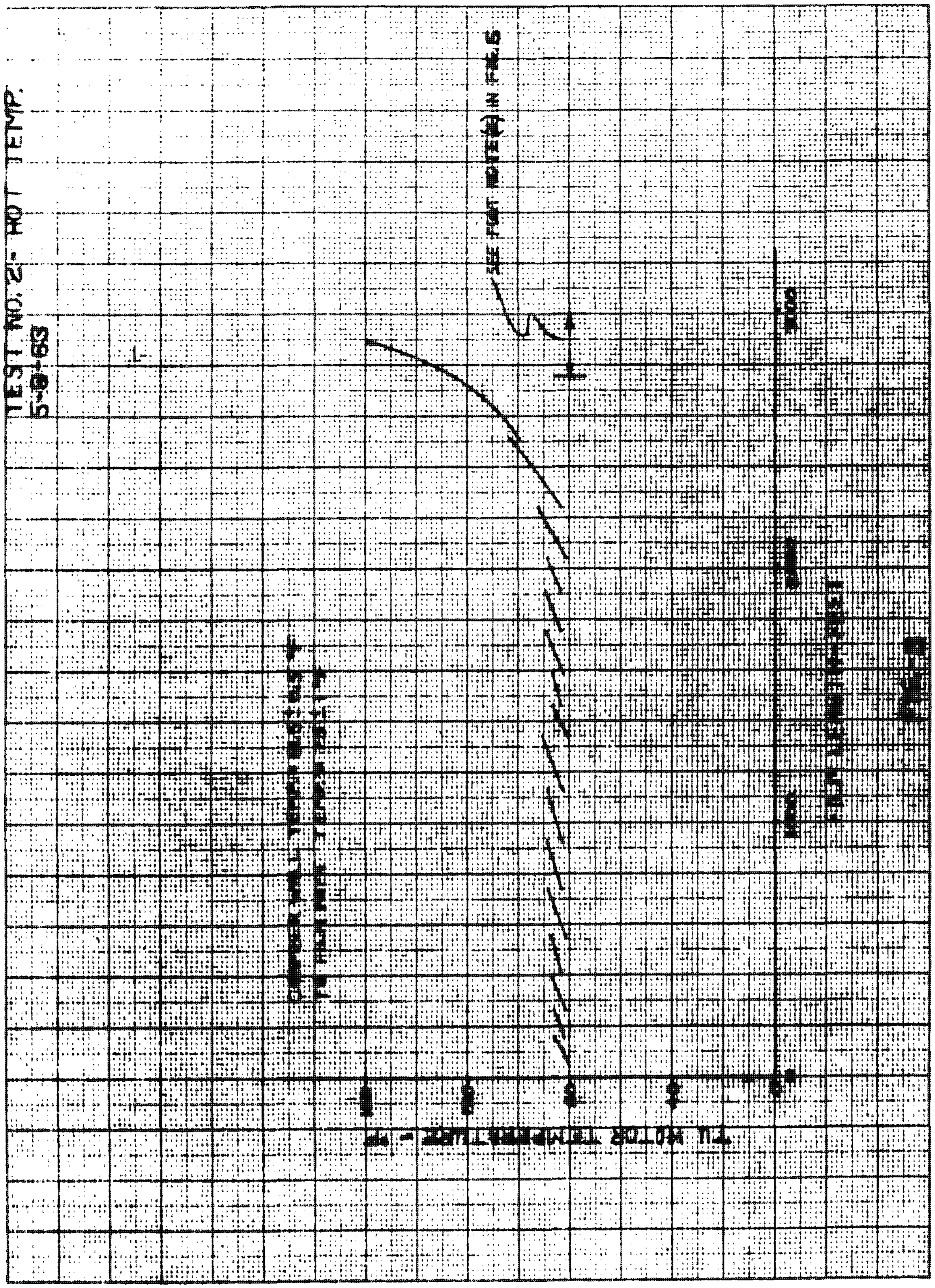


Figure 8. Take-up Motor Hot Temperature Curve

Approved for Release: 2024/01/30 C05098945

RELIABILITY TEST REPORT NO. 80

Test Item: Forward Record Storage Assembly (FRSA), Dwg. No. 712-479, S/N 5445

Type of Test: Shock (De-orbit)

Date of Test: 14 August 1963

Test Purpose: The purpose of this test was to determine if the Forward Record Storage Assembly would survive the qualification re-entry shock levels defined in Appendix 80A and store and protect 3,000 feet of film from damage.

Conclusion: The FRSA will survive the re-entry shock levels defined in Appendix 80A and adequately store and protect 3,000 feet of film.

Test Procedure:

a) Prepare eight strips of 9 1/2 inch wide by 2 feet long unexposed film and place two latent images (grey scales) on each of the eight strips.

b) Wind 3,000 feet of exposed film onto the take-up spool and interleave each of the eight strips of unexposed film at every 375 feet.

c) Assemble the take-up spool and mount the FRSA to the shock fixture.

d) Shock the FRSA according to the levels shown in Appendix 80A.

e) Inspect the FRSA for broken or damaged parts.

f) Process each of the eight strips of unexposed film.

g) Record density readings of the grey scales on each of the processed strips.

Reliability Test Report No. 80

Test Results:

The FRSA successfully survived the de-orbit shock test with no broken or damaged parts.

The actual "G" loads applied to the FRSA in the axial directions were not within the required specification (see Appendix 80A). Due to the limitations of the in-house test equipment, the actual "G" load was 20G compared to a specified load of 25.6G. Based on engineering judgment, the specified shock loads are not too severe for the FRSA and the actual test "G" loads are adequate to verify qualification.

In a dark enclosure, each of the eight unexposed strips of film were removed from the spool and then sent out for processing. The eight strips were analyzed by taking density readings of the grey scale portion. These readings were compared to the density readings of a control strip and the difference was negligible.

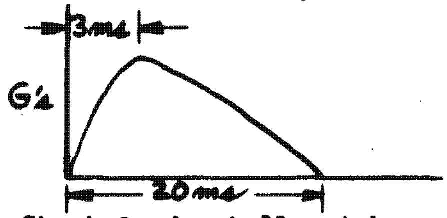
Reliability Test Report No. 80

APPENDIX 80A

Shock levels from Specification 702-135, Rev. B-1, Forward Record Storage Assembly, paragraph 3.3.1.3.2:

Axial 25.6G X Direction

Lateral 21.2G Y,Z Direction



Shock loads shall not be applied concurrently.

Shock levels applied to FRSA:

Axis	Load (G's)	Rise Time (ms)	Time Duration (ms)
-X	17	3	3 1/2
-X	17	3	3 1/2
-X	20	3	3 1/2
+X	20	3	3 1/2
+X	19	3	3 1/2
-Y	21	2	7
-Y	26	1 1/2	6
+Y	23	2	6
+Y	18	3	8
+Y	22	2	6
-Z	27	3	6
+Z	22	2	6
+Z	20	2	3

Note: The number of shocks in each direction exceeded the required number (one shock in each direction required) because of the trial and error method used to obtain the specified "G" loads.

RELIABILITY TEST REPORT NO. 81

Test Item: Distribution Box, Dwg. No. 617-114, Serial No. 2944

Type of Test: Acceleration

Date of Test: September 13, 1963

Purpose: The purpose of this test was to determine if the Distribution Box would meet the performance and leak rate requirements defined in Phase II Electrical Distribution Component Specification No. 602-118 after being subjected to the acceleration test defined in Appendix D.

Conclusion: The test results indicated that the Distribution Box met all performance and leak rate requirements after being subjected to the qualification acceleration test.

Test Procedure:

1) The test item was operability tested per QC-A-304, Revision D. (Test No. T-595)

2) The test item was tested for leak per QC-A-325, Revision C. (Test No. 3A-362)

3) The test item was subjected to the acceleration test specified in Appendix D.

4) The operability test specified in paragraph 1 above was repeated. (Test No. T-600)

5) The leak rate test specified in paragraph 2 above was repeated. (Test No. 3A-362)

Results: The operability test results indicated that the test item met all specification requirements before and after the acceleration test.

When tested in accordance with QC-A-325, the leak rate of the test item was so small that a measurement could not be obtained.

Reliability Test Report No. 81

Complete test data are in the Reliability Test Group files, and will be made available to those interested, upon request.

RELIABILITY TEST REPORT NO. 82

Test Item: Gain Control Electronics Assembly Drawing No. 510-105, Serial No. 3545 (212004). This unit is F-1 design.

Type of Test: Sine-random Vibration (Z Axis)

Date of Test: June 13, 1963

Test Purpose: The purpose of this test was to determine the capability of the test item to withstand the qualification level vibration (Z axis) defined in Appendix D.

Conclusion: The Gain Control Electronics Assembly is capable of withstanding qualification level vibration in the Z axis.

Test Procedure:

1) Operability Test, QC-A-325, B-1, 2, C, paragraph 5.1 through 5.9.8, was performed after the previous (X) axis of vibration. (Test T-299)

2) The GCEA was mounted on the M-B C210 vibrator and was vibrated in the Z axis. Z axis is defined as the vertical axis of the assembly. (Test 3A-243)

3) Leak rate test, QC-A-325 paragraph 8, was performed on the assembly. (Test 3A-244)

4) Operability test, QC-A-325, B-1, 2, C paragraph 5.1 through 5.9.8 was performed on the assembly. (T-316)

Test Results: The Gain Control Electronics Assembly showed no degradation in performance after vibration in the Z axis. The leak rate test, which was the first one performed since prior to X axis vibration, showed an increase of .5 mm Hg per hour after the two axes of vibration. The leak rate remained well within specification. Complete test results are in the files of the Reliability Test Group, and will be made available, to those interested, on request.

RELIABILITY TEST REPORT NO. 83

Test Item: Gain Control Electronics Assembly, Dwg. No. 510-105, Serial No. 3545 (212004). This unit is F-1 design.

Type of Test: Sine-Random Vibration (X axis)

Date of Test: June 8, 1963

Test Purpose: The purpose of this test was to determine the capability of the Gain Control Electronics to withstand the qualification level sine-random vibration defined in Appendix D.

Conclusion: The Gain Control Electronics is capable of withstanding the qualification level vibration defined in Appendix D.

Test Procedure:

1) Operability test, QC-A-325, B-1, 2, C paragraph 5.3 through 5.11, was performed on the GCEA. (Test T-228)

2) Leak rate test, QC-A-325 paragraph 8, was performed on the GCEA. (Test 3A-230)

3) The assembly was mounted on the M-B C210 vibrator and was vibrated in the X axis. X axis is defined as the longitudinal axis of the assembly.

4) Operability test, QC-A-325, B-1, 2, C paragraph 5.1 through 5.11, was performed on the GCEA. (Test T-299)

Test Results: The GCEA showed no degradation in performance due to the X axis vibration.

Complete test data are in the Reliability Test Group files, and will be made available, to those interested, upon request.

RELIABILITY TEST REPORT NO. 84

Test Item: Distribution Box, Drawing No. 617-114, Serial No. 2944. The status of the Distribution Box design changes is as follows using the Distribution Box of the FM-1 Payload as a reference.

1. The terminal strips in the Differential Amplifiers of the test item employ crimp type terminals instead of solder type (617-114, Rev. H-1).

2. In the Record Transport module of the test item the base has been relieved to eliminate pinching and subsequent grounding of the cable. (Ref. Waiver No. 7795) The change corresponding to this waiver on future production is 617-218 C-1.

Type of Test: Shipping Temperature Extremes

Date of Test: September 17, 1963 (Low Temperature)

September 19, 1963 (High Temperature)

Purpose: The purpose of this test was to determine if the Distribution Box would meet the performance and leak rate requirements defined in Phase II Electrical Distribution Component Specification No. 602-118 after being subjected to the shipping temperature extremes test defined in Appendix D.

Conclusion: The test results indicated that the Distribution Box complied with all the performance and leak rate requirements after being subjected to the qualification shipping temperature extremes test.

Test Procedure:

1) The test item was tested for leak per QC-A-325 Revision D (Test No. 3A-362).

2) The test item was operability tested per QC-A-304 Revision D (Test No. T-600).

3) The test item was subjected to the low temperature portion of shipping temperature extremes test specified in Appendix D. (Test No. 3A-365)

4) The operability test specified in paragraph 2 above was repeated. (Test No. T-610)

5) The test item was then subjected to the high temperature portion of the shipping temperature extremes test specified in Appendix D (Test No. 3A-370).

6) The operability test of paragraph 2 above was repeated (Test No. T-627).

7) The leak rate test specified in paragraph 1 above was repeated (Test No. 3A-376).

Results:

The results of the operability and leak rate tests indicated that the test item complied with all specification requirements before and after being subjected to the shipping temperature extremes tests.

Complete test data are in the Reliability Test Group files and will be made available to those interested, upon request.

RELIABILITY TEST REPORT NO. 85

Test Item: Motor Speed Drive, Dwg. No. 709-200, Serial No. 4816 (302005). The M.S.D. was F-1 design, except that it did not have duxseal on the oscillator toroid support board.

Type of Test: Sine-Random Vibration, Y axis

Date of Test: June 13, 1963

Test Purpose: The purpose of this test was to determine the capability of the Motor Speed Drive to withstand the qualification level sine-random vibration described in Appendix D. (Y axis only)

Conclusion: The Motor Speed Drive, as presently designed is not capable of withstanding qualification level vibration in the Y axis.

Test Procedure:

1. Operability Test QC-A-307 Revision A, Paragraph 5.4 through 5.6.4 was performed on the assembly. (Test T-293)
2. Leak rate test QC-A-307 Appendix I was performed on the Assembly. (Test 3A-246)
3. Vibration was performed in the Y axis in accordance with the levels defined in Appendix D. (Test 3A-239)
4. Step 1 was repeated. (Test T-309)
5. Step 2 was repeated. (Test 3A-246)

Test Results: The Motor Speed Drive failed in Operability Test after the Y axis vibration. A summary of the failures and recommended changes is presented in Appendix 85A. Complete test data are in the Reliability Test Group files, and will be made available to those interested upon request.

APPENDIX 85A

Failure Report No.	Failure	Recommended Action
AO 724	Motor Power Test Point output out of specification.	None - Waived on Waiver AO-681
AO 745	No frequency reading on counter - indicates oscillator not working.	Pot the oscillator section. Epoxy all capacitors into their clips. Review tolerance buildup of oscillator board "L" support.

AO 724 detail:

Step	Specification Min.	Specification Max.	Actual
55	4.1	4.8	4.0
64	3.8	4.7	3.6

RELIABILITY TEST REPORT NO. 86

Test Item: Camera Assembly, Dwg. No. 808-750, S/N 004
S/N 004 Camera was the same as F-201 configuration except for the EMI fix.

Type of Test: Powered Flight Vibration

Date of Test: 8 June to 1 August 1963

Test Purpose: The purpose of this test was to determine if the RC Camera Assembly would survive the qualification vibration levels defined in Appendix D and meet tne performance requirements of QC-A-350, In-Process Test Procedure for Camera Assembly and QC-A-326, In-Process Test Procedure for Gain Detector Assembly. See Appendix 86A for detailed description of QC-A-350 and QC-A-326.

Conclusion: The RC Camera Assembly will survive the qualification vibration levels defined in Appendix D and meet the performance requirements in QC-A-350 and QC-A-326.

Test Procedure:

A) Move the slit plate to the .0083" position.

B) Thread the camera with 9 1/2" wide exposed film and tape one end of the film to the chute section.

C) Position the damper roller limit pins to the center of their confining holes by applying 3 lbs. tension to the free end of the film and then tape the remaining end of the film to the chute section.

D) Mount the camera to the vibration fixture (208-367) and vibrate according to the levels shown in Appendix D.

E) Inspect the camera for broken or damaged parts.

F) Perform a post-vibration test according to Appendix 86A.

Test Results: S/N 004 Camera, built by EMI, was at one time the engineering model. After considerable updating to the F-201 configuration (no EMI fix) by the Assembly Group, S/N 004 Camera became the RC model for component testing. Upon completion of the updating phase the RC Camera was completely acceptance tested, similar to flight models, and made available for qualification testing on 7 June 1963.

X-Axis Vibration - 8 June 1963

Below is a list of failure reports, analysis and recommendations as a result of X-axis vibration:

Failure Report Number	Failure	Analysis	Recommendations
AO-717	Connecting Rod (808-646) on Focus Drive Mechanism broke.	Hardness reading on failed part was R_B 75. Drawing 808-646 requires a hardness of RC 26 to 33.	Initiate action to insure that the connecting rods are fabricated properly with respect to heat treatment and hardness.
AO-718	Mechanical frame seems to have hit cover in two spots and top of housing in one spot.	Mechanism frame became somewhat free to move when connecting rod and gear box housing failed, and could easily interfere with the housing cover.	No action required.
AO-719	Rollers are scratched and dirty.	Torsional vibration of the rollers caused a scuffing effect between the roller surfaces and the film.	The use of chrome rollers should be investigated.
AO-720	Dip brazed joint on focus drive gear box housing (808-880) broke.	The failed joint was poorly brazed (25% of brazed area was void, brazed area was dirty and contaminated by signs of oxide, and weld joint had an insufficient amount of fillet).	A specified fillet should be noted on the drawing to insure a stronger weld. Investigate the manufacturer's methods for dip brazing. Especially, the procedures used for cleaning and preparing the parts for dip brazing.

Failure Report Number	Failure	Analysis	Recommendations
AO-720 continued		Tension Test on an adjacent dip brazed weld revealed a tensile strength of 5,050 PSI. Tensile strength for the base material is approximately 45,000 PSI.	

The RC Camera was returned to Assembly and refitted with a new focus drive mechanism assembly (scheduled for S/N 007 Camera). After repairs were completed the RC Camera was tested according to all paragraphs of QC-A-350 and QC-A-326 (see Appendix 86A). See Appendix 86B for velocity smoothness results and start and stopping transients.

As a result of failures, AO-717 and AO-720 the RC Camera was re-vibrated on 22 July 1963. Failure AO-718 is a direct result of failures AO-717 and AO-720. Failure AO-719 is still an open item and re-vibration will be considered when a design change is made.

Qualification Sine Vibration X,Y,Z Axes - 22 June 1963

The vibration levels used for this test were part of the qualification sine levels (see Appendix D) with a frequency range of 5 to 50 cps.

No failures occurred as a result of qualification sine vibration.

A post-vibration operability test was performed according to paragraphs 5.5 through 5.7 and 5.11 through 5.18 of QC-A-350 and 5.4 through 5.7 of QC-A-326 (see Appendix 86A). For velocity smoothness results and start and stopping transients see Appendix 86B.

Y-Axis Vibration - 26 June 1963

Below is a list of failure reports, analysis and recommendations as a result of Y-axis vibration:

Failure Report Number	Failure	Analysis	Recommendations
AO-793	Flexure mount bracket (808-588) which fastens to mechanical frame loosened.	Two screws fastening the bracket to the mechanical frame loosened causing the epoxy between the bracket and frame to break.	See paragraphs III and VI of Dwg. No. 405-209 "Procedure for Use and Application of Loctite".

Failure Report Number	Failure	Analysis	Recommendations
AO-793 continued		Analysis of the two screws and four others removed during the fix showed a possible lack of loctite and a film of grease on the threads.	
AO-794	Cover and mechanical frame show a scraped area in one spot.	Scraping between cover and mechanical frame was a result of flexure bracket on mechanical frame loosening and possibly excessive deflection at the top of the mechanical frame with respect to the cover at the resonant frequencies.	Check tolerances between the mechanical frame and the cover.
AO-795	Rollers are dirty.	See AO-719 under X-axis vibration, 8 June 1963	

S/N 004 Camera was returned to Assembly for repairs as a result of failure AO-793. Post-vibration testing consisted of paragraphs 5.5, 5.6, 5.7, 5.12, 5.13, 5.16 and 5.18 of QC-A-350A (see Appendix 86A). Velocity smoothness results and start and stopping transients are shown in Appendix 86B.

Although failure AO-793 is considered critical, a re-vibration is not necessary since this was not a design weakness. Failure AO-794 is a result of failure AO-793. For a discussion of AO-795 see X-axis vibration, 8 June 1963.

Z-Axis Vibration - 10 July 1963

Below is a failure report, analysis and recommendation as a result of Z-axis vibration:

Number	Failure	Analysis	Recommendations
AO-832	Rollers are dirty.	See AO-719 under X-axis vibration - 8 June 1963.	See AO-719 under X-axis vibration - 8 June 1963.

A post vibration test consisted of paragraphs 5.12, 5.13, 5.16 and 5.18 of QC-A-350A (see Appendix 86A). Velocity smoothness results and start and stopping transients are shown in Appendix 86B.

For a discussion of AO-795, see X-axis vibration, 8 June 1963.

X-Axis Vibration (Re-test) - 22 July 1963

Below is a list of failure reports, analyses and recommendations as a result of X-axis vibration:

Failure Report Number	Failure	Analysis	Recommendations
AO-867	Two of the dual wire struts (808-886) on the upper beam assembly (808-951) broke.	Failure was of the fatigue type caused by stress reversals and accelerated by the presence of nicks and tool marks on the metal surfaces. This failure is probably a direct result of AO-872 and the fact that the camera has been "over" vibrated.	Struts should be checked visually prior to assembly to insure surface smoothness particularly in and adjacent to areas where forming has taken place.
AO-869	Screw retaining cable clamp loosened.	Cable clamp screw "backed out" about one-half of a turn and at this position the screw felt quite secure. This failure is due to the fact that the camera has been "over" vibrated.	

Failure Report Number	Failure	Analysis	Recommendations
AO-872	Strut between upper beam and bellows broke.	Failure was of the fatigue type caused by stress reversals and accelerated by the presence of a light uniform spiral tool mark running along the complete length of the strut. This failure is probably a direct result of AO-867 and the fact that the camera has been "over" vibrated.	Struts should be checked visually prior to assembly to insure surface smoothness.

Since the focus drive connecting arms and focus drive gear box housing did not fail in the second X-axis vibration, the design of these two parts is qualified.

The RC Camera was returned to assembly and the struts on the upper beam assembly were replaced. After repairs were completed, the RC Camera was tested according to all paragraphs of QC-A-350 and QC-A-326 (see Appendix 86A). Although the velocity smoothness results after this last vibration are not within specification, this can be attributed to "over" vibration of the RC Camera.

Failures AO-867, AO-869 and AO-872 are a result of an "over" vibration test and qualification of these parts were determined in the first X-axis vibration.

Complete test data are in the Reliability Test Group files and will be made available, to those interested, upon request.

APPENDIX 86A

QC-A-350, In-Process Test Procedure for Camera Assembly.

Paragraph	5.5	Platen Position and Focus Rate Tests, Platen Vertical
	5.6	Platen Position and Focus Rate Tests, Platen Horizontal
	5.7	DC Power Measurements
	5.8	AC Power Measurements
	5.9	Thermistor Operation Test
	5.11	Banding and Slit Image Streaking
	5.12	Film Velocity Smoothness Tests, On Axis
	5.13	Stopping Test
	5.14	Slit Image Orientation and Operational Fogging
	5.16	Film Velocity Smoothness Tests - Off Axis - Counterclockwise
	5.18	Film Velocity - Smoothness Tests - Off Axis - Counterclockwise

QC-A-326, In-Process Test Procedure for Gain Detector Assembly

Paragraph	5.4	Leakage Resistance Test
	5.5	Input Current Measurements
	5.6	Synchronising Signal Measurement
	5.7	Gain Detector Signal Measurements

APPENDIX 86B

Drive Freq.	Film Velocity % ΔV Max. 0.75% Spec.	Smoothness On Axis % ΔV RMS No Spec.	Starting Trans. 0.75 Sec. Max.	Stopping Trans. 1.0 Sec. Max.
Pre-Vibration X-Axis Data				
291 cps	0.674%	0.289%	0.303 Sec.	
352	0.638	0.227	0.272	Test not performed
400	0.510	0.231	0.300	
460	0.567	0.235	0.282	
544.5	0.532	0.201	0.294	
Post-Vibration X-Axis Data				
291	0.956*	0.341	0.138	0.605
352	0.674	0.257	0.340	0.636
400	0.708	0.271	0.450	0.650
460	0.699	0.305	0.325	0.499
544.5	0.780*	0.240	0.338	0.573
Post-Vibration Sine X,Y,Z-Axes Data				
291	0.850*	0.293	0.330	0.770
352	0.885*	0.300	0.318	0.454
400	0.876*	0.238	0.325	0.475
460	0.652	0.268	0.304	0.477
544.5	0.425	0.189	0.309	0.529
Post-Vibration Y-Axis Data				
291	0.602	0.211	0.358	0.688
352	0.566	0.223	0.386	0.795
400	0.539	0.228	0.400	0.700
460	0.482	0.202	0.391	0.608
544.5	0.567	0.208	0.353	0.750
Post-Vibration Z-Axis Data				
291	0.849*	0.299	0.385	0.550
352	0.495	0.282	0.340	0.522
400	0.650	0.271	0.400	0.375
460	0.765*	0.307	0.326	0.369
544.5	0.567	0.259	0.323	0.382
Post-Vibration X (re-test) Axis Data				
291	1.350	0.594	0.605	0.633
352	0.972	0.469	0.545	0.477
400	1.280	0.439	0.475	0.825
460	0.935	0.438	0.543	0.911
544.5	0.958	0.511	0.382	0.647

* Investigation of camera film drive smoothness at these drive frequencies indicate that it was not significantly affected by vibration. This investigation reveals:

1. Inconsistency of velocity smoothness results with the camera test set.

2. During the evaluation phase, one stray reading out of 100 readings can cause an increase in % ΔV Max. by as much as 0.3%.

RELIABILITY TEST REPORT NO. 87

Test Item:	RC Air Supply Assembly, Drawing No. 711-185, S/N 1172. The RC Air Supply was the same as F-201 configuration.
Type of Test:	Acceleration Test
Date of Test:	19 and 20 September 1963
Test Purpose:	The purpose of this test was to determine if the Air Supply would survive the qualification acceleration levels defined in Appendix D and meet the performance requirements defined in the Air Supply Test Procedure, QC-A-308, Revision F. (see Appendix 87A).
Conclusion:	The Air Supply will survive the acceleration levels defined in Appendix D and meet the performance requirements of QC-A-308, Revision F.
Test Procedure:	a) Thread the Air Supply with film and position the looper carriage on the empty take-up side of the looper assembly. b) Place the cover onto the Air Supply and mount the assembly onto the environmental fixture (208-590). c) Perform the acceleration test according to levels defined in Appendix D. d) Perform a post-acceleration operability test after a complete inspection.
Test Results:	The Air Supply Assembly successfully survived the powered flight acceleration test with no broken or damaged parts and subsequently performed satisfactorily according to QC-A-308, Revision F. (See Appendix 87A)

Approved for Release: 2024/01/30 C05098945

Reliability Test Report No. 87

APPENDIX 87A

QC-A-308, Rev. F., In-Process Test Procedure for Air Supply Assembly

Paragraph	5.5	Drag Brake Tension Test (Empty Spool)
	5.6	Tension Looper Tension Test (Empty Spool)
	5.8	Drag Brake Tension Test (Full Spool)
	5.9	Tension Looper Tension Test (Full Spool)
	5.15	Instrumentation Test
	5.16	Temperature Sensor Test
	5.17	Torque Motor Tension Test
	5.18	Pressure Test
	5.20	Light Leak Test
	5.21	Film Tracking and Wander Test (Full Spool)
	5.22	Film Tracking and Wander Test (Empty Spool)

RELIABILITY TEST REPORT NO. 88

Test Item: Gain Control Electronics Assembly, Dwg. No. 510-105, Serial No. 3545 (212004).

The Gain Control Electronics Assembly was the same as the F-1 design, at the time of this test.

Type of Test: Life and Operating Temperature Extremes

Date of Test: August 15 through 25, 1963

Test Purpose: The purpose of this test was to determine the capability of the test item to operate according to the performance requirements of Specification 502-154 when exposed to the conditions defined in Appendix88A,for a period simulating its active life.

Conclusion: The Gain Control Electronics Assembly is capable of operating for its specified life period in the environment defined in Appendix 88A.

Test Procedure:

1. Operability Test, QC-A-352, Revision O, was performed on the Gain Control Electronics Assembly. (Part of Test T-488) Two failures occurred and were repaired. (Failure Reports AO-900 and 903, see Appendix 88B)

2. The Gain Control Electronics Assembly was placed on the bench adjacent to the vacuum chamber, and connected to the test set using the same test harness and chamber wall connectors to be used in the vacuum test. Operability Test, QC-A-352, Revision O, was performed on the Gain Control Electronics Assembly. (Part of Test T-488)

3. Leak Rate Test, QC-A-325, Revision C, Paragraph 8, was performed on the Gain Control Electronics Assembly.

4. The Gain Control Electronics Assembly was placed in the vacuum chamber, together with the radiation and conduction heat sinks and with thermocouples mounted on the heat sinks and on the top and bottom of the Unit. The vacuum chamber was pumped down and the temperature was stabilized at 105°F for both radiation and conduction sinks. Input voltage was set to 32.5 vdc.

5. The test was abbreviated to three days at low pressure due to a conflict with another group for use of the vacuum chamber. Because of this, the Gain Control Electronics Assembly was energized for 10 minutes of each 50 minute period for three days instead of 10 minutes of each 90 minute period for five days as originally planned. The exact length of the test was regulated to give a total operating time equal to that originally planned. Output readings on CPL 21, 22 and 23 and status of forward and reverse lights on the test set were recorded during each operating period. At the end of three days the Gain Control Electronics Assembly was returned to ambient pressure and temperature.

6. The Gain Control Electronics Assembly was removed from the vacuum chamber and the test set-up was reconstructed. Operability Test, QC-A-352, Revision 0, was performed. The life test was repeated using a temperature of 45°F on both heat sinks, 27 vdc input, and atmospheric pressure. The Gain Control Electronics Assembly was energized 10 minutes each 90 minute period for five days.

7. QC-A-325, Revision C, Paragraph 8, leak rate test was performed on the Gain Control Electronics Assembly (Test AO-337).

Test Results: The measurement of gain control outputs taken throughout the test showed no degradation in performance. Although the actual test pressure (2×10^{-5} mm Hg.) was higher than the specified value (1×10^{-6} mm Hg.), this difference was judged to be insignificant.

The leak rate went from an initial value of .2 mm Hg./hr. to 9 mm Hg./hr. This final leak rate was out of tolerance (Failure Report AO-1000). However, the gain control performance did not change during or after the test and therefore the design has been qualified.

Complete test data are on file in the Reliability Test Group and will be made available, to those interested, upon request.

APPENDIX 88A

The test conditions for life testing the Gain Control Electronics were as follows:

1st Three Days

Radiation heat sink temperature:	105°F
Conduction heat sink Temperature:	105°F
Input voltage:	32.5 vdc
Pressure:	2×10^{-5} mm Hg.

2nd Five Days

Radiation heat sink temperature:	45°F
Conduction heat sink temperature:	45°F
Input voltage:	27 vdc
Pressure:	Atmospheric

APPENDIX 88B

Failure Report No.	Failure	Recommended Change
AO-900	Leakage resistance too low.	No action. This failure has been previously reported and action taken. See Failure Analysis AO-239.
AO-903	Broken jumper wire on top board.	No action. This failure was due to overstress because the unit had been through five axes of vibration.
AO-1000	Leak rate too high.	No action. This condition is caused by a faulty weld, and is not a design problem.

RELIABILITY TEST REPORT NO. 89

Test Item: Gain Control Electronics Assembly, Dwg. No. 510-105, Serial No. 3545 (212004). At the time of this test, the Gain Control Electronics had been updated to F4 design by the incorporation of solid state switching, and by cementing in the TO-5 transistors.

Type of Test: Sine-Random Vibration (3 axes)

Date of Test: September 7, 1963

Test Purpose: The purpose of this test was to determine the capability of the Gain Control Electronics Assembly to operate according to the requirements of Specification 502-154 after having been subjected to the vibration test described in Appendix D.

Conclusion: The Gain Control Electronics Assembly is capable of withstanding the qualification level vibration described in Appendix D.

Test Procedure:

1) Operability Test QC-A-325, paragraphs 5.1 through 5.11 was performed on the G.C.E.A. (Test T-560)

2) The Gain Control Electronics Assembly was vibrated in the Z axis at the levels defined in Appendix D. (Part of Test 3A-348)

3) Operability Test QC-A-352, paragraphs 5.4 through 5.8 was performed on the G.C.E.A. (Part of test T-573)

4) The Gain Control Electronics Assembly was vibrated in the X axis at the levels defined in Appendix D. (Part of Test 3A-348)

5) Paragraph 3 was repeated. (Part of Test T-573)

6) The Gain Control Electronics Assembly was vibrated in the Y axis at the levels defined in Appendix D. (Part of Test 3A-348)

7) Operability test QC-A-325, paragraphs 5.1 through 5.11 was performed on the G.C.E.A. (Test T-574)

Test Results: The results of the operability tests taken between axes of vibration and after the complete vibration test showed no degradation in performance.

Complete test data are in the Reliability Test Group files, and will be made available, to those interested, on request.

RELIABILITY TEST REPORT NO. 90

Test Item: Motor Speed Drive, Dwg. No. 709-200, Serial No. 8049 (009). The Motor Speed Drive had been updated from F-1 design to F-2 design by the following additions:

1. Sylgard potting in the oscillator.
2. Re-routing of wiring to filters.
3. Support block under the outboard filters.

Type of Test: Shock

Date of Test: September 10, 1963

Test Purpose: The purpose of this test was to determine the capability of the Motor Speed Drive to withstand the qualification level shock described in Appendix D.

Conclusion: The Motor Speed Drive is capable of withstanding the qualification level shock described in Appendix D.

Test Procedure:

1. Operability Test, QC-A-307, Paragraphs 5.1 through 5.7 was performed on the Motor Speed Drive (Test T-561).
2. Leak Rate Test, QC-A-307, Appendix I, was performed on the Motor Speed Drive.
3. Shock Test according to the specifications of Appendix D was performed on the Motor Speed Drive (Test 3A-352).
4. Paragraph 1 was repeated (Test T-583).
5. Paragraph 2 was repeated (Test 3A-360).

Test Results: The Motor Speed Drive withstood the shock test without serious degradation of performance. Two failure reports were written (see Appendix 90A).

The change in period reported in Failure Report AO-934 was not considered a result of the shock test. The amount of change was not great enough to cause the frequency to be out-of-specification limits if the pre-test frequencies had been in the center of the tolerance range.

The out-of-specification condition on Motor Power Test Point reported in Failure Report AO-998 is a condition which has occurred on many Motor Speed Drives. Redesign is currently in progress to bring this output within specification.

Complete test data are in the Reliability Test Group files, and will be made available to those interested upon request.

APPENDIX 90A

Failure Report No.	Failure	Recommended Action
AO-984	Frequencies out of spec. on three speed steps.	None - waived on the basis that the amount of change was small and was not a result of the shock test.
AO-998	Motor Power Test Point voltages out of spec. on three speed steps.	The tolerance on the Motor Power Test Point voltage should be changed, and corrective action should be taken to place the actual voltage in the center of the tolerance range.

RELIABILITY TEST REPORT NO. 91

Test Item: Motor Speed Drive, Drawing No. 709-200 Serial No. 8049(009). The M.S.D. had been updated from F-1 design to F-2 design by the following changes:

1. Sylgard potting in the oscillator.
2. Rerouting of wiring to filters.
3. Support block under the outboard filters.

Type of Test: Acceleration

Date of Test: September 13, 1963.

Test Purpose: The purpose of this test was to determine the capability of the Motor Speed Drive to withstand the qualification level acceleration described in Appendix D.

Conclusion: The Motor Speed Drive is capable of withstanding the qualification level acceleration described in Appendix D.

Test Procedure:

1. Leak rate and operability tests were performed on the M.S.D. after the previous test, which was shock. See Reliability Test Report No. 90.
2. The M.S.D. was subjected to acceleration at the levels described in Appendix D. (Test No. 3A361)
3. Leak Rate test was performed on the M.S.D. in accordance with Appendix A of QC-A-307. (Test No. 3A359)
4. Operability test QC-A-307 paragraphs 5.1 thru 5.7 was performed on the M.S.D. (Test No. T599)

Test Results: The results of the operability test after acceleration showed no significant degradation in performance.

One failure occurred. (Failure Report AO-987; see Appendix 91A). This failure resulted in changes of frequency at several speed steps, six of which went out of specification limits. The failure was not considered a result of acceleration testing. The amount of the frequency change was insufficient to cause the frequency to be out of specification if the pre-test frequencies had been in the center of the tolerance range.

Complete test data are in the Reliability Test Group files, and will be made available, to those interested, on request.

APPENDIX 21A

Failure Report Number	Failure	Recommended Action
AO-987	Frequencies out of spec on six speed steps.	None - waived on the basis that the amount of change was small and did not result from the acceleration test.

Approved for Release: 2024/01/30 C05098945

Reliability Test Report No. 92

Test Item

Motor Speed Drive, Dwg. No. 709-200 Serial No. 8049(009). The M.S.D. had been updated from F-1 design to F-2, F-3 and F-4 design by the following changes:

1. Sylgard potting in the oscillator.
2. Rerouting of wiring to the filters.
3. Support block under the outboard filters.

Type of Test: Shipping and Storage Temperature extremes.

Date of Test: Sept. 16 thru Sept. 19, 1963

Test Purpose: The purpose of this test was to determine the capability of the Motor Speed Drive to withstand the Shipping and Storage temperature test described in Appendix D.

Conclusion: The Motor Speed Drive is capable of withstanding the Shipping and Storage temperature test specified in Appendix D.

Test Procedure:

1) Leak rate and operability tests were performed on the unit after the previous test, which was acceleration. (See Reliability Test Report No. 91.)

2) The M.S.D. was subjected to the low temperature portion of the test described in Appendix D. (Part of test No. 3A-366)

3) Operability test QC-A-307 Paragraphs 5.1 through 5.7 was performed on the M.S.D. (Test No. T-609)

4) The M.S.D. was subjected to the high temperature portion of the test described in Appendix D. (Part of test No. 3A-366)

5) Operability test QC-A-307 Paragraphs 5.1 through 5.7 was performed on the M.S.D. (Test No. T-626)

6) Leak Rate Test was performed on the M.S.D. according to Appendix A of QC-A-307. (Test No. 3A-282)

Test Results:

The results of the operability tests after each portion of the Shipping temperature test showed no significant degradation in performance.

One failure occurred in the operability test following the low temperature portion of the test. (Failure Report AO-997, See Appendix 92A). Two failures occurred in the operability test following the high temperature portion of the test. (Failure Reports AO-1013 and AO-1014, See Appendix 92A).

Two of the above failures dealt with oscillator frequencies out of specification limits. The amount of change in frequency from the pre-test value was not great enough to cause the frequencies to be out of specification limits if the pre-test values had been in the center of the tolerance range.

The other failure concerned Motor Power Test Point Voltage. This is a condition which has occurred on many M.S.D.'s. Action is currently being taken to bring this output within specification.

None of the above are considered to be due to the Shipping and Storage Temperature Test.

Complete test data are in the Reliability Test Group Files, and will be made available, to those interested, on request.

APPENDIX 92A

Failure Report No.	Failure	Recommended Action
AO 997	Frequency out of spec. at 13 Speed steps.	Waived on the basis that the amount of change was small and was not due to the temperature test.
AO 1013	Frequency out of spec. at 20 Speed steps.	Waived on the basis that the amount of change was small and was not due to the temperature test.
AO 1014	Motor Power Test Point Voltage out of spec. at 2 Speed steps.	Waived. See recommendations in Failure Analysis AO 1001.

RELIABILITY TEST REPORT NO. 93

Test Item:	Heater Controller Assembly, Dwg. No 516-235-2, Serial No. A-037
Type of Test:	Qualification Vibration
Date of Test:	September 19, 1963
Test Purpose:	To determine whether the Heater Controller Assembly would survive qualification vibration.
Conclusion:	The Heater Controller Assembly will survive qualification vibration.
Test Procedure:	The Heater Controller was subjected to the qualification sine-random vibration test described in Appendix D. This assembly had passed the acceptance test prior to qualification vibration. The axis order of vibration was Z, Y and X. It was then subjected to an operability test which consisted of performing paragraphs 5.3, 5.4 and 5.5 of QCA-351.
Test Results:	The post-vibration operability test showed that the controller performed properly after vibration. Complete test data are on file in the Reliability Test Group files, and will be made available, to those interested, on request.

RELIABILITY TEST REPORT NO. 94

Test Items: Heater Controller Assemblies, Drawing No. 516-235-2, Serial Nos. A-037 and A-134. This design is to be used with thermistor sensors. The F-1 had the design which was used with thermostat sensors.

Type of Test: Shipping and Operating Temperature Extremes

Date of Test: September 20, 1963 to October 7, 1963

Test Purpose: To determine whether the Heater Controller would survive the following two tests, both of which are described in Appendix 94A.

1. Shipping Temperature Extremes which was a qualification test.

2. Operating Temperature Extremes which was a special Reliability test.

Conslusion: The Heater Controller will survive the Shipping Temperature Extremes test and will operate properly during the Operating Temperature Extremes test.

Test Procedure: Although this test had the twofold purpose mentioned above, only one test was actually conducted. The following procedure was used for this test:

1. The Heater Controller (S/N A-037) was hooked up inside a temperature chamber which had been stabilized at a temperature of 125°F. (Figure 1 shows the test set-up.)

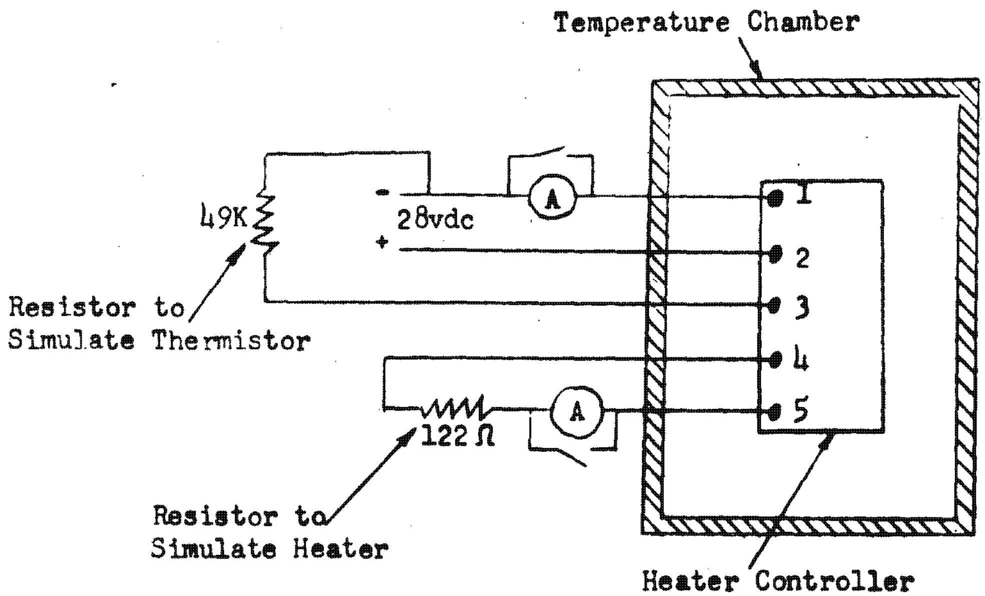


Figure 1 Test Set-up

2. The controller was then operated 9 hours per day for 3 days.

3. After the high temperature test was completed, the controller was subjected to an operability test which consisted of performing paragraphs 5.3, 5.4, and 5.5 of QCA-351.

4. The controller was then returned to the temperature chamber, which was now stabilized at 0°F, and it was operated continuously for 3 days (in this portion of the test a 63K resistor, which simulated the thermistor in the heater operated condition, replaced the 49K resistor shown in Figure 1 so that current would pass through the simulated heater). The controller was then again subjected to the operability test.

5. Due to a failure the results of the low temperature test were questionable and the test was repeated using a new Heater Controller Assembly (S/N A-134).

Test Results: It was discovered after the high temperature test had been completed that the controller had been operated only 9 hours per day rather than 24 hours per day. This deviation from the procedure was inadvertently made because the power had been unknowingly turned off each night of the test. This does not prevent the Heater Controller from being qualified for the high shipping temperature extreme (125°F) because there is no requirement that the controller operate during this test. The shipping temperature extremes test consists of having the unit remain in the temperature chamber for 8 hours at a temperature of 125°F and for 8 hours at a temperature of 0°F.

During the fuse test of the post high temperature operability test it was found that the two fuses of the controller had blown (Failure Report No. AO-1016). Since the controller was still operating at the end of the high temperature test, this failure was believed to have been human initiated sometime near the beginning of the operability test. After the fuse had been replaced, the operability test was successfully completed.

During the operability test following the first low temperature test it was found that the controller would not turn on (Failure Report No. 1031). This failure seemed to be due to an open transistor and a shorted transistor. Although no definite conclusion was reached as to why this failure occurred, it was again believed to be human initiated during the operability test because the controller was still on at the end of the low temperature test. The low temperature test was repeated with a different controller; it successfully passed the operability test that followed.

Appendix 94B presents a summary of the failures encountered in this test.

Complete test data are on file in the Reliability Test Group files, and will be made available, to those interested, on request.

APPENDIX 94A

SHIPPING AND OPERATING TEMPERATURE EXTREMES TEST

The following is a description of the test of this report which is given in paragraphs 5.7 and 5.8 of Qualification Test Procedure Number 553-120. The procedure states that the Heater Controller is to be operated continuously at atmospheric pressure for 3 days at a temperature of 125°F and for 3 days at a temperature of 0°F. The Heater Controller was actually operated 9 hours per day for 3 days during the high temperature test.

APPENDIX 94B

FAILURE SUMMARY

Failure Report Number	Failure	Recommended Action
AO-1016	Blown fuses found during operability test following high temperature test.	Make the Heater Controller Test Set available as soon as possible.
AO-1031	Heater Controller would not turn on following first low temperature test.	Make the Heater Controller Test Set available as soon as possible.

RELIABILITY TEST REPORT NO. 95

Test Item: Elevation Plate Assembly, Drawing No. 805-162, Serial Number 206004. The RM Elevation Plate Assembly was like FM-1 except the RM Elevation Elevation Plate Assembly Bridge had not been modified to prevent interference with the Servo Filter Boxes.

Type of Test: Life in Vacuum

Date of Test: May 17 through 24, 1963

Test Purpose: The purpose of this test was to determine if the Elevation Plate Assembly bearing surfaces could survive the mirror movements required in three five-day orbits, and meet the performance requirements defined in the Phase II, Flight Payload Model, Specification No. 802-153, Revision G.

Conclusions: The RM Elevation Plate Assembly is considered qualified to survive life in vacuum. The Azimuth Servo steady state current did increase as the test progressed, but this was analyzed as servo wearout because the servo had been actuated 3200 times before the beginning of the life test. Post life test inspection showed that no bearing surface degradation occurred.

Test Procedure:

1. Assembled Servos to Elevation Plate Assembly, and checked alignment and current requirements.
2. Performed the Life Test in Vacuum per Appendix 95A. Chamber pressure was 8×10^{-8} inches of Hg. at the start of the test, and did not reach 4×10^{-8} inches of Hg. until cycle 56. Engineering judgment indicates that the small differential in pressure did not affect the test.
3. Performed visual inspection.
4. Performed QC In-Process Tests per Procedures QC-A-252 and QC-A-282.

Test Results: The Elevation Servo operated within specification limits throughout the seven-day test, a total of 3824 actuations.

The Azimuth Servo steady state current requirements were not within specification limits before or during any part of the test. This excessive current requirement was caused by the misalignment of the servo shaft and servo lead screw. Efforts to correct the misalignment before the test by replacing the lead screw with identical stock parts were not successful. The Azimuth servo did complete 25 cycles of the test (1600 actuations) before exceeding the positioning time specification limit, and operated 3825 times during the entire test.

Chamber pressure, positioning time, and servo current vs. cycle number are shown in Figure 1.

APPENDIX 95A

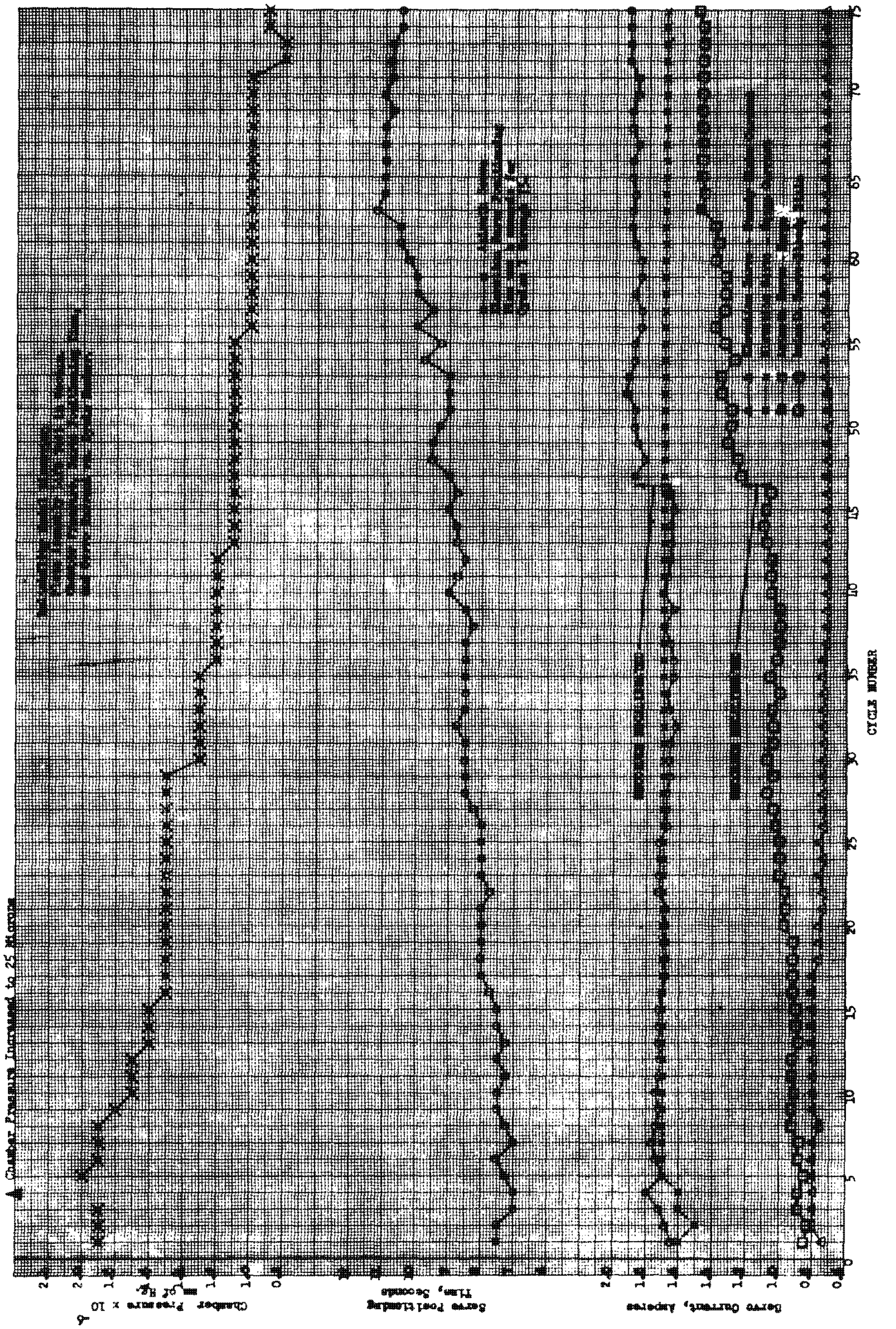
Install the Elevation Plate Assembly in the Vacuum Chamber with the mirror trunnion vertical, and the Azimuth Servo side down. Reduce chamber pressure to 4×10^{-8} inches of mercury absolute. Program each servo to operate approximately 15 minutes out of each 1 1/2 hour period, 11 periods per day with command changes approximately every 12 seconds.

Command changes are to be as follows:

Elevation Servo: 00, 01, 10, 01, 00, 01, 10, 01, 00, 01, 10, 01, 00, 01, 10, 01

Azimuth Servo: 000, 111, 001, 110, 010, 101, 011, 100, 111, 000, 110, 001, 101, 010, 100 and 000

Apply the above program to the Elevation Plate Assembly for a total operating time of 25 hours. (Seven days elapsed time) Monitor chamber pressure for at least eight periods per 24 hours.



Chamber Pressure Increased to 25 Microns
Chamber Pressure x 10^-6 mm of Hg.
Servo Positioning Time, Seconds
Servo Current, Amperes
CYCLE NUMBER

E-225/226

RELIABILITY TEST REPORT NO. 96

Test item: Distribution Box, Drawing No. 617-114, Serial No. 2944
The state of the Distribution Box design change is as follows, using the Distribution Box of the FM-1 Payload as a reference.

1) The terminal strips in the Differential Amplifiers of the test item use crimp type terminals instead of solder type (617-114, Rev. H-1)

2) In the Record Transport Module of the test item the base has been relieved to eliminate pinching and subsequent grounding of the cable. (Ref. Waiver No. 7795). The change corresponding to this waiver on future production is 617-218 C-1.

Type of Test: Operating Temperature Extremes

Date of Test: 23 September 1963 to 30 September 1963

Purpose: The purpose of this test was to determine if the Distribution Box would meet the performance and leak rate requirements defined in Phase II Electrical Distribution Component Specification No. 602-118 after being subjected to the operating temperature extremes test defined in Appendix 96A.

Conclusion: The test results indicated that the Distribution Box complied with all the performance and leak rate requirements after being subjected to the specified operating temperature extremes test.

Test Procedure:

1) The test item was operability tested per QC-A-304, Revision D (Test No. T-627).

2) The test item was leak rate tested per QC-A-325, Revision D. (Test No. 3A-376).

Test Procedure:

3) The test item was subjected to operating temperature extremes test specified in Appendix 96A. (Test No. T-631). A timer was fabricated to simulate a take-up motor operation cycle of 3 seconds on 3 seconds off (approximately) during each 10 minute period when the test item was energized.

4) The operability test of paragraph 1 above was repeated (Test No. T-665).

5) The leak rate test of paragraph 2 above was repeated (Test No. 3A-389).

Results:

The results of the operability and leak rate tests indicated that the test item complied with all specification requirements before and after being subjected to the operating temperature extremes test.

During the 67th cycle after 100.5 hours of life test, a 5 vdc signal appeared on CPL-3 when the relay that normally energizes the supply spool brake motor was energized. Failure Report AO-1027 was prepared to document this erratic behavior of CPL-3.

When the test item was returned to ambient temperature the difficulty described on Failure Report AO-1027 disappeared. The Differential Amplifier for CPL-3 was removed from the Distribution Box and operability tested per QC-A-333. (Test No. T-675). When tested per QC-A-333 the operability of the amplifier was verified at 55°F and at 120°F. The amplifier was replaced and the test item connected and set up to duplicate conditions when the initial failure occurred; the test item operated satisfactorily and CPL-3 output was normal. Since the failure disappeared and the operation of CPL-3 is not vital to the operation of the space chamber, the failure analysis was discontinued.

Complete test data are in the Reliability Test Group Files and will be made available to those interested upon request.

APPENDIX 96A

Operating Temperature Extremes - The Distribution Box shall be placed in a test chamber and its temperature stabilized, while not operating, at the chamber conditions given below. The Distribution Box shall then be operated as indicated below to demonstrate continuing satisfactory performance.

Minimum Temperature Conditions - The Distribution Box shall be mounted to an essentially infinite heat sink at 45°F, surrounded by a radiation sink also at 45°F and one atmosphere of circulating air at 45°F. The Box shall be operated 10 minutes out of every 90 minutes for 120 hours (total time). During the operating periods, the 22V power supply, Record Transport Control Module and Differential Amplifiers shall all be operating under simulated load. Input voltage shall be 27.0 volts for the first third of the test, shall be increased to 30 volts for the second third, and to 32.5 volts for the final third of the test period.

RELIABILITY TEST REPORT NO. 97

Test Item: Heater Controller Assembly, Dwg. No. 516-235-2, Serial No. A-134. This design is to be used with thermistor sensors. The F-1 had the design which was used with thermostat sensors.

Type of Test: Life in Vacuum

Date of Test: October 8 through 18, 1963

Test Purpose: To determine whether the Heater Controller would survive the life in vacuum test described in Appendix 97A.

Conclusion: The Heater Controller will survive the life in vacuum test.

Test Procedure: 1) The Heater Controller was hooked up inside a vacuum chamber. (Figure 1 shows the test set-up)

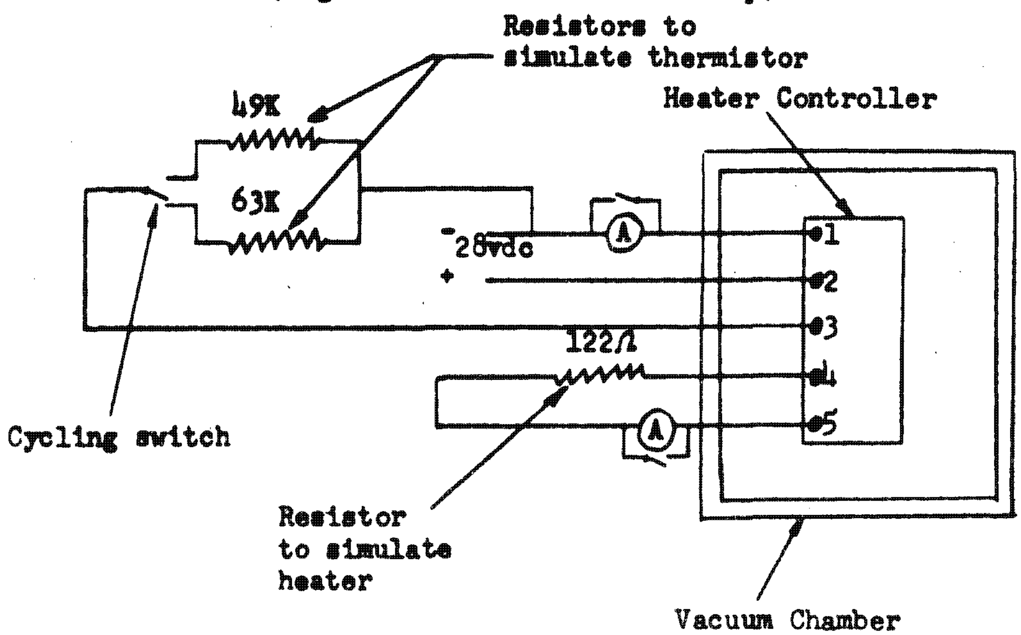


Figure 1

Test Set-up

2) The chamber was evacuated.

3) The controller was then operated continuously for 10 days in cycles of 27 seconds "on" and 35 seconds "off".

The chamber wall was at ambient temperature except for the first 16 hours of the test when it was at 160°F.

Input and heater currents were measured occasionally during the test to determine whether the controller was operating properly.

4) Upon the completion of the 10th day of operation, the chamber was returned to atmospheric pressure and the controller was removed from the chamber.

5) The controller was then subjected to an operability test which consisted of performing paragraphs 5.3, 5.4, and 5.5 of QC-A-351.

Test Results:

When the test was 16 hours old, it was discovered that the chamber wall heaters had been accidentally turned on and as a result the chamber wall temperature had risen to 160°F. The heaters were turned off and the wall temperature eventually stabilized at ambient temperature which was about 80°F. Although this temperature is about 10 degrees above that specified in the qualification test procedure (see Appendix 97A)it is felt that operating at this temperature throughout the rest of the test was not a significant deviation from the procedure. This deviation was made because the vacuum chamber has no cooling facilities.

Another deviation from the procedure was made in that the controller was cycled continuously throughout the test rather than in 15 minute operating periods separated by 15 minutes "off" time (see Appendix 97A). Since operating the controller continuously is the more severe test, the qualification status of the unit should not be affected by this deviation.

The chamber pressure decreased from 2×10^{-4}mm of Hg. immediately after evacuation to 5×10^{-7}mm of Hg. at the end of the test.

Measurements of input and heater currents during the test indicated that the controller was operating properly. The unit successfully passed the operability test which followed.

Complete test data are on file in the Reliability Test Group files, and will be made available to those interested upon request.

APPENDIX 97A

The following is a description of the test of this report which is given in paragraph 5.5 of Qualification Test Procedure No. 553-120. The procedure states that the test is to consist of operating the Heater Controller during 15 minute periods with 15 minutes "off" time between periods. Each operating period is to consist of cycling the controller for 30 seconds "on" and for 30 seconds "off". The test is to take place in a vacuum chamber which is at a pressure of 1×10^{-6}mm of Hg. and at a temperature of 70°F ± 2°F.

RELIABILITY TEST REPORT NO. 98

Test Item: Distribution Box, Dwg. No. 617-114, Serial No. 2944 (005).

The status of the Distribution Box design changes is as follows, using the FM-1 Distribution Box as a reference:

1) The terminal strips in the Differential Amplifiers of the test item use crimp type terminals instead of solder type. (617-114, Revision H-1)

2) In the Record Transport Module of the test item, the base has been relieved to eliminate pinching and subsequent grounding of the cable. (Ref. Waiver No. 7795) The change corresponding to this waiver on future production is 617-218, Revision C-1.

3) The Distribution Box had been updated to include the Motor Current Assembly, in accordance with Change Reason No. 31-1187.

Type of Test: Sine-Random Vibration (3 axes)

Date of Test: October 25, 1963

Test Purpose: The purpose of this test was to determine the capability of the Distribution Box, updated with Motor Current Assembly (as required for Instrumentation Augmentation change), to withstand the Sine-Random Vibration test described in Appendix D.

Conclusion: The Distribution Box, with Motor Current Module. is capable of withstanding the test described in Appendix D, with respect to both performance and leak rate.

Test Procedure:

1) Operability Test QC-A-304, Rev. D-1, Par. 5.3 through 5.25, 5.31 and 5.32 was performed on the Distribution Box. (Test T-733)

2) Leak Rate Test QC-A-304, Par. 5.27 was performed on the Distribution Box. (Test 3A-432)

3) The Distribution Box was vibrated in the Y axis at the levels of Appendix D. (Part of Test 3A-433)

4) Operability Test, QC-A-304, Rev. D-1, Par. 5.3 and 5.5 through 5.23 was performed on the Distribution Box. (Part of Test T-742)

5) The Distribution Box was vibrated in the X axis at the levels of Appendix D. (Part of Test 3A-433)

6) Paragraph 4 was repeated. (Part of Test T-742)

7) The Distribution Box was vibrated in the Z axis at the levels of Appendix D. (Part of Test 3A-433)

8) Operability Test, QC-A-304, Rev. D-1, Paragraphs 5.3 through 5.25, 5.31 and 5.32 was performed on the Distribution Box. (Test T-745)

9) Leak Rate Test, QC-A-304, Par. 5.27 was performed on the Distribution Box. (Test 3A-439)

Test Results: The results of the operability tests between axes of vibration and at the completion of the three axes of vibration showed no degradation in the performance of the Distribution Box.

The leak rate tests before and after vibration showed no increase in the leak rate.

Complete Test Data are in the Reliability Test Group files and will be made available, to those interested, upon request.

RELIABILITY TEST REPORT NO. 99

Test Item: Door Telltale Assembly, Dwg. No. 813-425, Serial No. 310A019

Type of Test: Sine-Random Vibration (3 Axes)

Date of Test: October 15, 1963

Test Purpose: The purpose of this test was to determine the capability of the Door Telltale Assembly to withstand the vibration test described in Appendix D.

Conclusion: The Door Telltale Assembly is capable of withstanding the vibration test described in Appendix D.

Test Procedure:

1) Operability Test, QC-A-354, was performed on the Door Telltale Assembly.

2) The Door Telltale Assembly was vibrated in three axes at the levels described in Appendix D. (Test 3A-412) The Door Telltale was given an operability spot check following the first two axes of vibration.

3) Operability Test, QC-A-354, was performed on the Door Telltale Assembly. (Test T-712)

Test Results: The results of the operability spot checks between axes and the operability test after the complete vibration test showed no degradation in performance of the Door Telltale Assembly.

Complete test data are in the Reliability Test Group files, and will be made available to those interested upon request.

RELIABILITY TEST REPORT NO. 100

Test Item: Door Telltale Assembly, Drawing No. 813-425, Serial No. 310A019

Type of Test: Life in Vacuum

Date of Test: October 21 through 29, 1963

Test Purpose: To determine the capability of the Door Telltale Assembly to operate according to the requirements of Specification No. 802-239 when exposed to an ambient pressure of 1×10^{-6} mm of Hg.

Conclusion: The Door Telltale Assembly is capable of operation in accordance with Specification No. 802-239 when exposed to an ambient pressure of 1×10^{-6} mm of Hg.

Test Procedure:

1. The Door Telltale Assembly was subjected to Operability Test QC-A-354 as a part of the previous (vibration) test. See Reliability Test Report No. 99.

2. The Door Telltale Assembly was mounted on the panel of the Door Telltale Test Set. The panel was then installed in the vacuum chamber. Operability spot check was performed to check out the mounting and wiring of the Door Telltale. The vacuum chamber was pumped down.

3. The Door Telltale was operated by turning the light of the Door Telltale Test Set on and off, and readings of the output were taken during ten minutes of each ninety minutes for five days. The Door Telltale was returned to atmospheric pressure.

4. Operability Test, QC-A-354, was performed on the Door Telltale Assembly (Test T-750).

Test Results: The operability testing performed on the Door Telltale Assembly while in the vacuum environment showed no degradation in performance.

The pressures attained during the first 3 1/2 days of the test average approximately 1×10^{-5}, and the pressure for the last 1 1/2 days of the test averaged 1.2×10^{-6} rather than the specified value of 1×10^{-6}. The test was considered to be a valid indication of the performance of the Door Telltale Assembly under the specified pressure conditions.

The results of the operability test performed after the completion of the vacuum test showed no degradation in performance of the Door Telltale Assembly.

Complete test data are on file in the Reliability Test Group files, and will be made available, to those interested, on request.

RELIABILITY TEST REPORT NO. 101

Test Item:

1) RC Camera Assembly, Drawing No. 808-750, S/N 004. S/N 004 Camera was the same as F-201 configuration except for omission of the EMI fix. Qualification vibration on the RC Camera was completed on 8 June 1963 and the unsymmetrical bellows (same design being used on current flight cameras) survived.

2) RM Camera Assembly, Drawing No. 808-750, S/N 003. S/N 003 Camera was the same as F-201 configuration except for omission of the EMI fix and replacement of the unsymmetrical bellows with the new symmetrical bellows design. Qualification vibration of the symmetrical bellows in the RM Camera was completed on 11 October 1963.

Type of Test: Camera Life Test

Date of Test: 17 October to 30 October 1963

Test Purpose:

1) To determine if film velocity smoothness in the RC and RM Cameras will be affected by low pressure and a definite number of stereo and strip mode operations.

2) To determine if a fresh roll of Kodak Park film, Type 4404, contains any loose film products that would deposit onto the slit aperture plate of the RC and the RM Cameras.

3) To determine if the focus drive mechanism in RC Camera will perform satisfactory in low pressure.

Reliability Test Report No. 101

CD-12988
S-INT-6143
11 November 1963

Conclusions:

1) Low pressure greatly affects the film velocity smoothness in the RC and RM Cameras. Visual inspection of the unsymmetrical and symmetrical bellows reveals no fractures, cracks, or oil leakage after subjected to a definite number of actuations in a low pressure environment.

2) Kodak Park film, Type 4404, did not deposit any film products on the slit aperture plate of the RC and RM Cameras when examined with a 150 power microscope.

3) Low pressure did not affect the focus drive operation in the RC Camera.

Test Procedure: The set-up for this test is described in Drawing No. 853-108, Qualification Test Procedure for Transport System.

Test Results: The results of this test will be discussed in the order of the test purposes.

Film Velocity Smoothness:

The determination of film velocity smoothness in low pressure was obtained by flashing a Strobotac light through the vacuum chamber port window, and with the aid of a flat mirror the light rays were directed onto the slit aperture plate (wedge slit setting).

Both cameras were operated on a 10 minute "on", 70 minute "off" cycle throughout a period of three days. Figures 1 and 2 summarize the testing sequence and test results of the RC and the RM Cameras.

Discussion of Figure 1 - Throughout the low pressure test on the RC Camera the bellows did not perform satisfactorily. The film velocity smoothness and normal starting time at atmospheric pressure is represented in Figure 3. Figure 4 shows the effects of low pressure (<0.1 PSI) on film velocity and starting time.

The only apparent reason for the great change in film velocity smoothness would be a defective bellows in the RC Camera. Although, no cracks or oil deposits could be seen on the bellows, the defect could possibly be one or several entrapped air bubbles.

Discussion of Figure 2 - The results from the RM Camera test are similar to the RC Camera test (Figure 1). While the RM Camera was cycled from 150 feet to 758 feet of film, the film velocity smoothness and starting time changed by a considerable amount. One explanation for this considerable change would be a relocation of an air bubble from the active or resevoir bellows to the channel tube which supports the flow of oil between both bellows.

Kodak Park Film 4404:

Before starting the "Film Velocity Smoothness" test the RC Air Supply and RC and RM Cameras were cleaned of any loose dirt particles on the rollers and slit aperture plates. Upon completion of each test both cameras were examined for deposits of film products on the slit aperture plates (wedge slit) with the slit alignment microscope assembly (808-800) at 150 power. No deposits of film products could be seen on the wedge slits, but there were traces of dirt particles ranging to a maximum size of about 0.002 inches in length with a maximum density of seven particles over a 0.035 inch diameter.

To verify that the particles on the wedge slits were common dirt, an additional test was performed. The wedge slit on the RM Camera was cleaned from dirt and exposed to the atmosphere in Building 3 - 1st floor (Inspection Area) for a period of 30 minutes. At the end of the test the wedge slit was again examined and the size and number of dirt particles was similar to that previously described in the last paragraph.

Focus Drive

After completion of the life test (3 days at 0.002 PSI), the focus drive mechanism in the RC Camera was operated four times in both directions with the platen vertical and horizontal at atmospheric pressure and 0.002 PSI.

Complete test data are in the Reliability Test Group files and will be made available, to those interested, upon request.

Reliability Test Report No. 101

RC Camera S/N 004 (Unsymmetrical Bellows) Test Results

Date of Test	Support Equipment	Life Test Film Footage Accumulative	Camera Operating Pressure	%ΔV Max. at 400 cps drive frequency 0.75% max. spec.	Starting Time 0.75 sec. max spec.	No. of Stereo modes accumualtive	No. of Strip modes accumulative
10-17-63	(RC Air Supply & RM Take-up)	242 ft.	Atmos.	0.99 %	0.53 sec	0	80
10-18-63	"	337 ft.	0.002 PSI	8.8 %	*	0	122
10-18-63	"	1000 ft.	0.002 PSI	14.9 %	*	145	299
10-19-63	"	1710 ft.	0.002 PSI	13.5 %	*	240	346
10-19-63	"	2271 ft.	0.002 PSI	8.9 %	*	340	441
10-21-63	"	2781 ft.	0.002 PSI	16.7 %	*	434	534
10-30-63	Camera Test Set	----	Atmos.	0.65 %	0.55 sec	---	---
10-30-63	"	----	1.0 PSI	1.98 %	0.60 sec	---	---
10-30-63	"	----	0.1	3.67 %	*	---	---
10-30-63	"	----	0.01 PSI	4.2 %	*	---	---
10-30-63	"	----	0.002 PSI	4.1 %	*	---	---

* Damping distance is 4 to 6 inches (see Figure 4)

E-241

HM Camera S/N 003 (Symmetrical Bellows) Test Results

Date of Test	Support Equipment	Life Test Film Footage Accumulative	Camera Operating Pressure	%Max. at 400 cps drive frequency 0.75% max. spec.	Starting Time 0.75 sec. max spec.	No. of Stereo modes accumulative	No. of Strip modes accumulative
10-19-63	Camera Test Set	---	Atmos.	0.78 %	0.50 sec	---	---
10-22-63	(RC Air Supply & HM Take-Up)	60 ft.	Atmos.	1.08 %	0.43 sec	0	20
10-22-63	"	90 ft.	1.0 PSI	1.63 %	0.60 sec	0	33
10-22-63	"	110 ft.	0.1 PSI	2.24 %	0.58 sec	0	40
10-22-63	"	130 ft.	0.01 PSI	1.94 %	0.48 sec	0	47
10-22-63	"	150 ft.	0.002 PSI	2.42 %	0.50 sec	0	59
10-22-63	"	758 ft.	0.002 PSI	9.2 %	*	97	193
10-23-63	"	1265 ft.	0.002 PSI	13.9 %	*	197	285
10-23-63	"	1771 ft.	0.002 PSI	11.8 %	*	297	379
10-24-63	"	2276 ft.	0.002 PSI	12.8 %	*	397	472
10-24-63	"	2771 ft.	0.002 PSI	8.2 %	*	494	547
10-30-63	Camera Test Set	----	Atmos.	1.05 %	0.50 sec	---	---
10-30-63	"	----	1.0 PSI	1.68 %	0.58 sec	---	---
10-30-63	"	----	0.1 PSI	3.3 %	*	---	---
10-30-63	"	----	0.01 PSI	3.6 %	*	---	---
10-30-63	"	----	0.002 PSI	3.9 %	*	---	---

* Damping distance is 4 to 7 inches (see Figure 4)

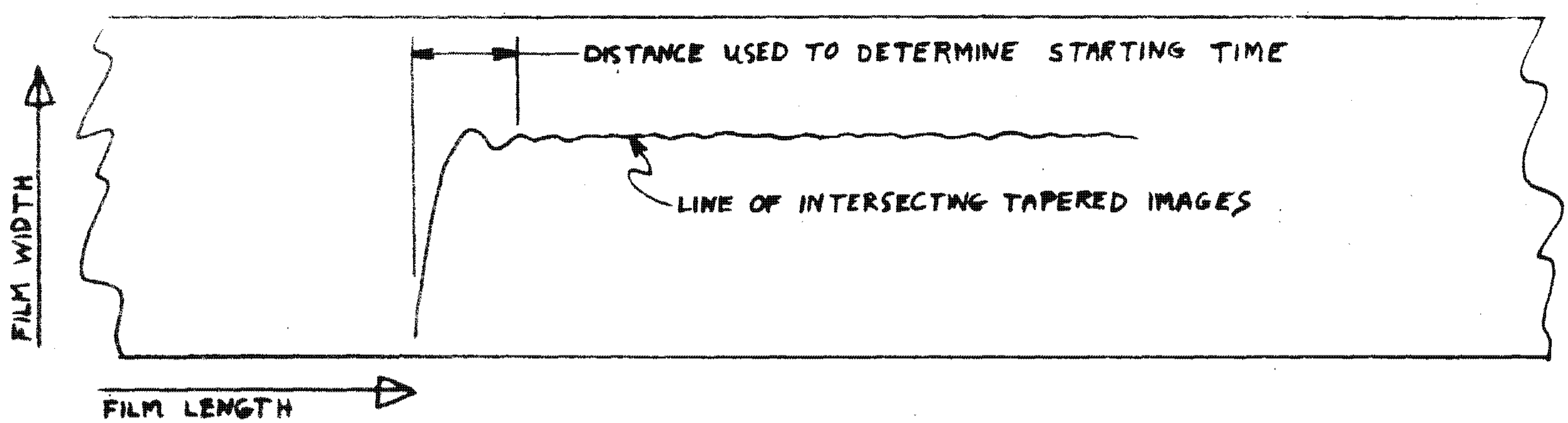


Figure 3. Typical Velocity Smoothness and Starting Time, Atmospheric Pressure

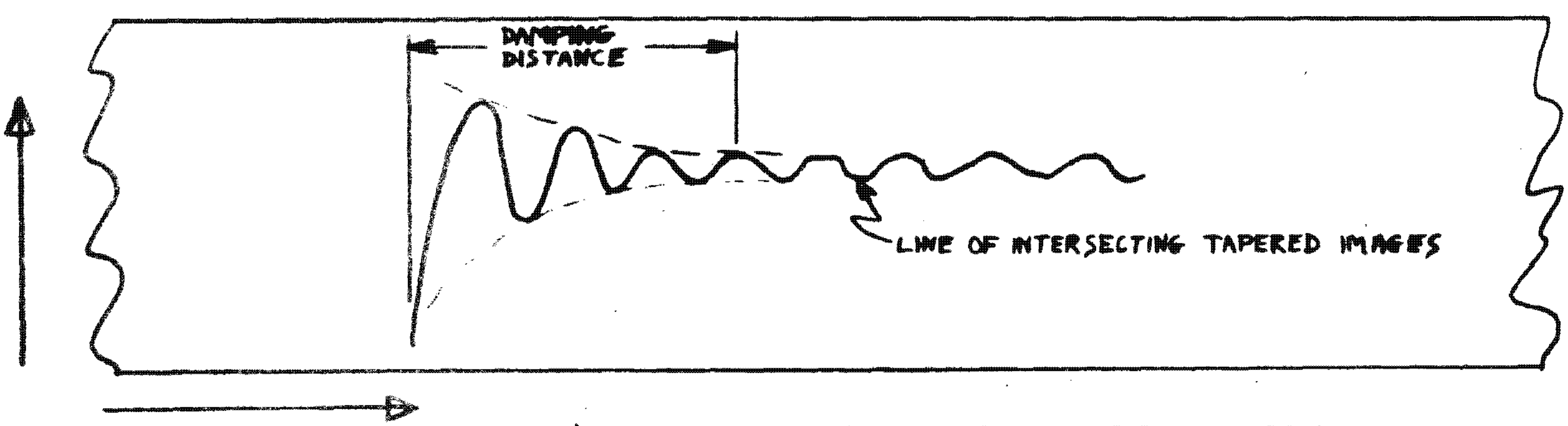


Figure 4. Typical Velocity Smoothness and Damping Distance, Low Pressure

Approved for Release: 2024/01/30 C05098945

RELIABILITY TEST REPORT NO. 102

Test Item: Forward Record Storage Assembly (FRSA), Dwg. No. 712-479, Revision E-2, S/N 5445. The RC FRSA was the same as F-205 configuration.

Type of Test: Vibration (Powered Flight) - Instrumentation Augmentation

Date of Test: 17 and 18 September 1963

Test Purpose: The purpose of this test was to determine if the instrumentation augmentation (reel rotation) and the reversible drive motor assembly of the FRSA will survive the powered flight qualification vibration levels defined in Appendix D and meet the performance requirements of QC-A-337, Revision E (see Appendix 102A).

Conclusion: The instrumentation augmentation and reversible drive motor assembly of the FRSA will survive the vibration levels defined in Appendix D and operate satisfactorily according to the tests outlined in Appendix 102A.

Test Procedure:

a) Perform a pre-vibration operability test (see Appendix 102A).

b) Wrap approximately 10 feet of exposed film onto the take-up spool and thread the remainder through the cassette.

c) Mount the FRSA to the vibration fixture (208-1240) and vibrate according to the levels defined in Appendix D. Maintain 3 1/2 pounds film tension throughout the test.

d) Perform a post-vibration operability test (see Appendix 102A) after the FRSA has been inspected.

Test Results:

The RC FRSA was updated to the F205 configuration. Upon completion of the updating phase, an operability test was performed and satisfactorily completed. Results of the qualification vibration test are discussed below:

Instrumentation Augmentation

After three axes of qualification vibration (see Appendix D) on the FRSA, the magnetic pick-up and the solid state electronic component board were inspected and no broken or damaged parts were visible. An operability test (see Appendix 102A) was performed and successfully completed.

Reversible Drive Motor Assembly

The FRSA was first vibrated in the X-axis and during the sinusoidal vibration sweep (5-2000 cps) a failure occurred at a frequency of 17 cps.

A0-996 - Take-up spool oscillated (taking up and releasing film).

Analysis of A0-996 revealed that all three pawls of the drive motor assembly were not in contact with the ratchet wheel. The pivot hole in each pawl had an interference fit with the pins.

It was recommended that the holes in the pawls be enlarged for proper clearance of the pins.

Upon rework of the pawls (enlarge pivot holes) the unit was reassembled and vibration in the Z and Y axes were satisfactorily completed.

Vibration in the X-axis was started, but between 14 to 20 cps of sine the take-up spool began "taking-up" film. At this frequency range the FRSA was displaced to a half inch double amplitude which made it difficult to hold proper film tension since the film length was directed along the X-axis. The remaining frequency range in the X-axis was satisfactorily completed.

In order to qualify the reversible drive motor assembly of the FRSA at the low frequency range, the FRSA was again vibrated from 5 to 20 cps of sine with the film directed along the Z-axis. The take-up spool did not rotate during this test.

During the inspection of the Air Supply two other failures were noticed:

AO-1006 - Emralon scraped from pawls.

Analysis showed that scraping occurred at the forward portion of the pawls due to the ratchet wheel and the guiding surfaces.

It was recommended that the emralon be removed from the forward portion of the pawls.

AO-1007 - Motor (400-1381) housing loosened.

Analysis revealed that two screws on end of motor (end opposite motor shaft) loosened. Inspection of the screws showed that three to four threads were engaged and no Loctite was present.

It was recommended that longer screws with Loctite should be used.

The post-vibration operability test (see Appendix 102A) was successfully completed after failures AO-1006 and AO-1007 were repaired.

Complete test data are in the Reliability Test Group files and will be made available, to those interested, upon request.

QC-A-337, Revision E, In-Process Test Procedure for Forward Record Storage Assembly:

Paragraph *5.6 - Film Speed Test

5.7 - Instrumentation Check

*5.8 - Reversing Motor Test

* Although these tests are not part of Instrumentation Augmentation, it was desirable at this time to qualify the reversible drive assembly and the new 400-1381 take-up drive motor.

RELIABILITY TEST REPORT NO. 103

Test Item: RC Air Supply, Drawing No. 711-185, S/N 1172. The RC Air Supply was same as F-204 configuration.

Type of Test: Vibration (Powered Flight) - Instrumentation Augmentation

Date of Test: 9 to 11 October 1963

Test Purpose: The purpose of this test was to determine if the instrumentation augmentation (film quantity and film tension) of the Air Supply will survive the powered flight qualification vibration levels defined in Appendix D and meet the performance requirements of QC-A-308, Revision G (see Test Procedure (a)).

Conclusion: The instrumentation augmentation of the Air Supply will survive the vibration levels defined in Appendix D and operate satisfactorily according to the test outlined in Test Procedure (a).

Test Procedure:

(a) Perform a pre-vibration operability test according to paragraph 5.15, Instrumentation Check, of QC-A-308, Revision G, In-Process Test Procedure for Air Supply.

(b) Thread the Air Supply with film and position the looper carriage on the empty take-up side of the looper assembly.

(c) Place the cover onto the Air Supply and mount the assembly onto the environmental fixture (208-590).

(d) Perform the vibration test according to levels defined in Appendix D.

(e) Perform a post-vibration operability test after a complete inspection.

Test Results: The Air Supply was subjected to a pre-vibration instrumentation check which was successfully completed. Upon completion of three axes of qualification vibration (see Appendix E), the Air Supply was inspected for broken or damaged parts but none were found on the instrumentation assemblies. A post-vibration instrumentation check was performed and successfully completed.

While the RC Air Supply was being updated with instrumentation augmentation the roller stud assembly (711-113) was replaced with a teflon roller. After three axes of qualification vibration the roller stud assembly failed:

AO-1054 - Teflon bearing in spiral groove of drive pot shaft does not rotate.

Failure analysis reveals that torsional vibration of the drive pot shaft caused a repeated shock load on the teflon roller stud assembly which resulted in "flattening out" the roller.

It was recommended that a Delrin roller be used.

During the inspection phase of the RC Air Supply one other failure was visible:

AO-1053 - Wire harness from looper assembly to connector J662 has teflon damaged on one wire.

Analysis reveals that the wire harness from connector J662 to looper assembly has an unsupported length of about eight to nine inches. During vibration the wire harness could easily scrape against one of the roller bushings on the side of the looper assembly.

It was recommended that the wire harness be supported with cable clamps.

RELIABILITY TEST REPORT NO. 104

Test Item: Elevation Servo, Drawing No. 614-100, Serial No. 207005
This Servo was equivalent to F-1 design.

Type of Test: Sine-Random Vibration

Date of Test: April 11, 1963

Test Purpose: To determine the capability of the test item to withstand the vibration described in Appendix D.

Conclusion: The Elevation Servo is capable of withstanding the vibration described in Appendix D without degradation.

Test Procedure: The procedure for this test consisted of following Acceptance Test Procedure, QC-A-282, Revision A-1 with the exception that the vibration levels were those described in Appendix D. The test was performed by Eclipse Pioneer Division, Bendix, Corp.

Test Results: The results of this test showed no degradation in the operation of the Elevation Servo as a result of the vibration test.

One non-conformance to specification was noted both before and after vibration. This non-conformance consisted of surge currents above the specification levels. This non-conformance was waived.

Bendix Test Report, dated 11 April 1963, is on file in the Reliability Test Group files and will be made available, to those interested, upon request.

RELIABILITY TEST REPORT NO. 105

Test Items:

a) Forward Record Storage Assembly (FRSA), RC S/N 5445. The RC FRSA has been updated to the F-205 configuration.

b) G.E. Capsule Assembly, Reliability Model, S/N 3013A. The RM Capsule contains prime hardware except for the dynamically simulated electronic packages and electrical harness assembly.

Type of Test:

1) Powered Flight Vibration

   a) Film fogging (pyros)

   b) Light leak

   c) Tracking check

   d) Alignment check

2) De-orbit Vibration

   a) Light leak

Date of Test: 11 September to 14 October 1963

Test Purpose: To determine if the Forward Record Storage Assembly will survive the powered flight and de-orbit vibration levels (see Appendix D) when supported by G.E. Capsule Assembly, and if G.E. Capsule Assembly will adequately protect Kodak Film 4404 from fogging.

Conclusion: The Forward Record Storage Assembly, supported by G.E. Capsule Assembly, will survive both vibration tests. Kodak Film 4404 is adequately protected from fogging by the G.E. Capsule Assembly.

Test Procedure: 1) Powered Flight Vibration

a) Prepare capsule assembly for film fogging (pyros) test. Assemble pyros to cutter assembly according to G.E. Dwg. 20S3200 and place a 3 foot unexposed film strip along the internal contour of the capsule. With the cutter in the open position, secure the cover assembly onto the capsule. Actuate the pyros with 28 vdc and after one hour process the 3 foot film strip.

b) Prepare capsule assembly for light leak test. Place a 3 foot unexposed film strip along the internal contour of the capsule and position the cutter to the closed position. Place the cover assembly onto the capsule and illuminate the cover surface to 900 foot candles for 60 minutes.

c) Set up a transport system (Camera, Air Supply, FRSA and Capsule) and perform a tracking check with the FRSA positioned "on-axis".

d) With the aid of a flat parallel bar and a vernier depth gauge measure the perpendicular distance from the cover plane to the two G.E. mirror alignment surfaces on the FRSA. These two measurements will determine the position of the Y-axis about the Z-axis.

e) Prepare the capsule assembly for vibration by threading 10 feet of film through the FRSA, set the cutter assembly to the open position, and mount the capsule assembly to the vibration fixture (208-1104).

f) Vibrate capsule assembly to the levels defined in Appendix D and perform step 1-D of Procedure after each axis of vibration. Maintain 3 1/2 lb. film tension.

g) Repeat steps 1-C and 1-B of Procedure.

2) De-orbit Vibration

a) Wind 3,000 feet of film onto the take-up spool and set the cutter to closed position.

b) Vibrate the capsule assembly to the levels defined in Appendix D.

c) Repeat 1-B of Procedure.

Results:

Before discussing the results of these tests, it should be mentioned that previous testing on the RM Capsule Assembly was performed. Reliability Test Report No. 48, discusses "Assembly and handling checks at FRSA level", and "Tracking check with viewing capability and all prime obstacles in place". Reliability Test Report No. 60, discusses "Light leak test on Capsule and Chute Assembly" and "Fogging of Film due to any gaseous substance within the Capsule and Chute Assembly at atmospheric conditions".

Powered Flight Vibration Test

Actuating a set of pyros for the purpose of triggering the cutter and sealer assembly does not produce any gaseous discharge which would fog a strip of unexposed film after a period of one hour. Density checks on the grey scale exposures of the test strip and a control strip showed no difference in the readings.

The pre-vibration light leak test on the cover and capsule assembly was successfully completed. The amount of light exposure and time for this test was equivalent to direct sun light for a period of about 6 minutes.

A pre-vibration tracking test on the FRSA (mounted in the capsule and the cover in its proper position) was performed to verify the tracking capability of the recovery unit. This test was successfully completed.

After completion of the X-axis vibration an alignment check showed that the FRSA rotated 0.67° about the Z-axis and shifted 0.06 inches in the -X axis direction. Inspection of the mounting points in the capsule revealed that one of the longitudinal (X-axis) adjustments loosened because of improper locking prior to vibration. Revised drawings and special tools were not available at the time of this test. Proper locking techniques were then applied to all adjustments and vibration in the Y and Z axes were successfully completed. Verification of the alignment check for the X-axis was determined during the de-orbit vibration test and there was no change in the measurements.

Final inspection of the FRSA after powered flight vibration revealed no damage to any of the parts or subassemblies. It was noticed at the time three failures on the G.E. Capsule Assembly.

1) One screw (fastener for one of the electronic packages) loosened completely. This particular package was removed during assembly of the FRSA into the capsule. The same screws were used and a locking cement was not applied.

2) Cutter and sealer assembly was inoperable. Three screws on the actuator arm loosened causing a complete failure in actuating the cutter. These screws showed a possible lack of locking cement.

3) Bottom of capsule contained several particles of paint and aluminum chips.

A post-vibration tracking check and light leak test were satisfactorily completed.

De-orbit Vibration Test

Three axes of de-orbit vibration (see Appendix D) were successfully completed on the RC FRSA while mounted in the RM Capsule Assembly. The FRSA was loaded with 3,000 feet of film. Inspection of the FRSA after the vibration test revealed no damage to the unit. On the bottom of the Capsule dirt particles of paint and aluminum chips were noticed. This same condition also existed after the powered flight vibration test. A final light leak test was then performed and successfully completed.

Test Item: Azimuth Servo, Dwg. No. 614-101, Serial No. 207005

During Test A the servo was F-1 design.

During Test B and C the servo was updated by the addition of a center post and bumpers which are first used on F-15.

During Test D the servo included the post and bumpers as above and the G.E. Hyrel Capacitor which was first used on F-10.

Type of Test: Sine-random Vibration

Date of Test: Test A - April 3 - 11, 1963

Test B - July 15 - 24, 1963

Test C - November 4 - December 3, 1963

Test D - January 21 - 24, 1964

Test Purpose: To determine the capability of the test item to withstand the vibration described in Appendix D.

Conclusion: The servo as updated before the final test is capable of withstanding the vibration described in Appendix D.

Test Procedure: The procedure for all four tests (A through D) consisted of following Acceptance Test Procedure, QC-A-252, Revision A-1 with the exception that the vibration levels were those specified in Appendix D. The test was performed by Eclipse-Pioneer Division, Bendix Corp.

Test Results: Test A: At the conclusion of the sine-random vibration, the overload circuit failed. The failure was caused by capacitor C804. This was termed a wearout failure, although later experience with this and other servos makes it seem more likely that this failure was a direct result of the vibration. Failure report AO 617. There was abrasion inside the cover as evidenced by powder deposits, and several fasteners were loose.

Test B: This test was performed after installing bumpers and a center post for additional support of the top component board. The rubbing of the boards on the cover was considerably reduced, but there was still some black powder residue. A lead on capacitor C804 broke. This capacitor was mounted incorrectly in that it had a plastic sleeve which was not called for on the drawing, and the sleeve, rather than the body of the capacitor, was epoxied down.

At this time it was still considered that the first failure of C804 was wearout and the second failure of C804 was partially due to improper mounting. Bendix was directed to conduct sine searches with accelerometers mounted in the area of C804.

Test C: This test was conducted with improved bumpers and center post. The overload circuit failed again - Failure Report No. 1134. This was again traced to capacitor C804. Failure analysis showed that the slug is inadequately supported in this type of capacitor. This allowed motion of the slug during vibration which rubbed through the tantalum oxide dielectric, resulting in excess leakage. Relay K801 broke loose from its mounting. This failure was not considered significant because the relay had successfully withstood two previous complete tests and several sine searches. Also the design of the mounting foot of the relay had already been improved from the design which failed. This test was much "smoother" due to reduction of the internal resonances and the accumulation of particles found in the cover was again lessened.

Test D: This test was conducted with a G.E. Hyrel capacitor in place of the Sprague unit previously used as C804. The servo survived the test without degradation.

Complete test results are in the Reliability Test department files, and will be made available, to those interested, upon request.

APPENDIX 106A

Failure Summary

Failure Report No.	Failure	Recommended Action
A0617	Overload Circuit Failed. Traced to high leakage in C804.	Wearout failure Replace the part.
No report number; apparently not formally reported.	Overload circuit failed. Broken lead on C804.	Improper mounting. Mount the capacitor without a plastic sleeve.
A01134	Overload Circuit Failed. Failure in C804.	Replace the capacitor with a G.E. Hyrel type.

Approved for Release: 2024/01/30 C05098945

RELIABILITY TEST REPORT NO. 107

Test Item: Slit Aperture Plates.
Appen. 107A lists the various test items.

Type of Tests: Appen. 107A shows the tests that were performed on each test item by a check mark.

Date of Tests: 15 October to 18 November 1963

Test Purpose: To qualify several design approaches for a new Slit Aperture Plate (SAP).

Conclusions: Present designed Slit Aperture Plates with polyester tape and epoxy bead will survive the environmental tests described in Appendix D. The aluminized surface from the edge of the slit to the edge of the tape is unprotected which indicates that scratching of this surface is possible. If TiAu can be vacuum coated onto the aluminized surfaces, this would be a good protective coating.

Test Results: Slit Aperture Plates were recently coated with a "thinned out" epoxy to protect the aluminized surfaces from scratching. Streaking tests have shown that the epoxy coating is subject to scratching over the slit area which can be attributed to over size film splices, film accidentally contacting the Slit Aperture Plate during camera threading and other pre-flight tests, and dirt wedging between the Slit Aperture Plate and the film during launch. Over size film splices have been investigated and corrective action was established.

Present designed Slit Aperture Plates omit the use of an epoxy coating so that the slit area will not scratch during normal use. The aluminized surfaces are protected (except for 0.050 inches from the trailing edge of the slit and 0.030 inches from the leading edge of the slit) with a polyester tape.

The following discussion will describe the advantages and disadvantages of each test item in Appendix 107A.

Polyester Tape

Strips of polyester tape No. 850 were placed onto the aluminized surfaces of a test plate and a bead of epoxy was placed along the edges of the tape (see Drawing 808-501, Revision N, for procedure). Inspection of the plate before environmental testing revealed no high spots in the tape and the average thickness of the tape was 0.0022 inches. Environmental testing (see Appen.107A) had no effects on the tape. Observation during the low pressure test revealed no entrapped air bubbles and the abrasion test showed no scratching over the unprotected aluminized surface. It appears that the 0.002 inch build-up by the polyester tape is sufficient to protect the slits from normal film scraping, but any large dirt particles could be scraped across the unprotected aluminized surfaces.

Positop Photo Resist

A Positop solution was spun onto the aluminized surface of a test plate. With the use of an ultraviolet light shining on the reverse side of the plate, the Positop solution over the slit areas becomes exposed. The exposed Positop solution is then washed away leaving a protective coating over the aluminized surfaces. Baking the test plate at 150°C for 20 minutes hardens the photo resist. Inspection of the photo resist plate revealed a surface build-up of about 0.0003 in. Environmental testing (see Appen. 107A),except for the abrasion test, did not affect the photo resist. The abrasion test did remove some of the photo resist coating down to the aluminized surface. One or two particles were noticed over the slit area which indicates that Positop is a possible source for generating dirt.

Stainless Steel Mask

A slit plate pattern (slits slightly enlarged) was chemical milled from stainless steel metal (0.0016 inches thick) to form a mask. A heat reactivating cement (Armstrong) was sprayed onto the mask to a thickness of about 0.0015 inches and allowed to dry. The mask was then positioned onto a slit aperture plate (reject plate) and heated to 250°F for 30 minutes for the purpose of bonding the steel mask to the Slit Aperture Plate. During the cooling process, there is some difficulty in maintaining a surface parallelism of 0.0005 inches because of the differences in the coefficie s of expansion for the stainless steel mask and the glass plate. After the temperature and humidity test, it was noticed that the surface parallelism of the glass plate changed by 0.0002 inches and after the vibration test a 0.0007 inch change was noticed. Also, some areas of the mask were not bonded to the glass plate. The stainless steel mask offers better resistance to abrasion than the polyester tape, but since the surface parallelism dimension can not be maintained, this design would not be suitable.

Air Slit Plate

A stainless steel slit aperture plate was fabricated by spacing metal rails to form a slit plate pattern and cementing the ends to two plates. During the vibration test the cement failed to hold one of the metal rails in place. Another problem was maintaining the 0.0005 inch surface parallelism dimension.

Epon 828 Epoxy

A thin coating of Epon 828 Epoxy was spun onto a test plate. The abrasion test produced scratches on the Epon 828 Epoxy over the slit areas which indicates that this design is unsuitable.

Kodak Photo Resist (KPR)

Kodak Photo Resist is the reverse process of Positop Photo Resist since the exposed Kodak Photo Resist solution remains hard and will not wash away. Kodak Photo Resist solution was spun onto a test plate and exposed. The abrasion test revealed that Kodak Photo Resist is more abrasion resistant than Positop Photo Resist and does not leave any dirt particles over the slit area. At present, the Kodak Photo Resist is still being investigated for its application to slit aperture plates.

Titanium - Gold Alloy (TiAu)

TiAu was vacuum coated onto a glass plate and an abrasion test was performed. Results show that TiAu plating is a good abrasive resistant material and suitable for Slit Aperture Plates. Instead of using aluminizing to form the slit patterns, several attempts were made using TiAu, but the edges of the slits were ragged and not within the proper tolerance.

Nickel Plate

TiAu was first vacuum coated onto a glass plate and then a coating of nickel was plated onto the TiAu. The abrasion resistance of the nickel is excellent, as expected, but with the unsuccessful attempts of making a Slit Aperture Plate with TiAu, the nickel plate could not be used.

APPENDIX 107A

TEST ITEM	Temperature 125°F - 8 hrs. 0°F - 8 hrs.	Humidity 90 to 95% 85 to 90°F 4 hrs.	Low Pressure 3×10^{-5}mm of Hg 5 days	Vibration See Appendix B	Abrasion See foot note (*)	Film Fogging 5 days at 0.05 PSIA
Polyester Aluminum Tape	X	X	X	X	X	X
Positop Photo Resist	X	X	X	X	X	X
Stainless Steel Mask	X	X	X	X	X	
Air Slit Plate				X		
Epon 802 Epoxy					X	
KPR					X	
TiAu					X	
Nickel Plate					X	

* The face of the Slit Aperture Plate is placed onto the emulsion surface of film moving at a velocity of 2.78 inches/sec. for a period of 15 seconds. The normal force is equal to the weight of the Slit Aperture Plate.

RELIABILITY TEST REPORT NO. 108

Test Item: Space Chamber Drawing No. 805-101, Serial No. F-206, except the Camera which was Serial No. 004 (RC), and the Forward Record Storage Assembly which was Serial No. 9958 (F7).

Type of Test: E.M.I. Audio Frequency Conducted Susceptibility

Date of Test: January 7 and 8, 1964

Test Purpose: The purpose of this test was to reproduce, on a production model Space Chamber, an E.M.I. non-conformance which previously occurred on the RM Space Chamber. The nature of this non-conformance was that the take-up motor failed to turn off when the looper switch was actuated, with 3 volts RMS injected at frequencies 2.2KC to 8.1 KC and 14 KC to 19KC.

Conclusion: The take-up motor of a production Space Chamber runs with the looper switch open, when audio frequency E.M.I. is injected into the +28V operational line at various frequencies.

Recommendation: It is recommended as a result of this test that funds be made available for a joint effort by Reliability and Design Engineering to analyze this non-conformance using the RM or EM Space Chamber.

Test Procedure: The basic procedure planned for this test was to follow Procedure 553-116, Paragraph 4.4.2.2 except that no photography was performed, and the frequency limits for the injected signal were selected as 480 cps. to 64KC. See Appendix 108A.

The space chamber was set up and put in operation in stereo mode with MSD speed at step 48. The 3V signal was injected, beginning at 480 cps and sweeping upward to 64 KC. At several frequencies the Test Console circuit breaker tripped, removing power from the Space Chamber. This necessitated reducing the injected AC voltage.

The frequency band from 1000 cps to 20 KC was scanned with 1 1/2V. injected signal. The remainder of the band to 64KC was scanned using 1V. injected signal.

The frequencies where the most pronounced resonances were noted were rechecked. The test was then stopped because the take-up was laboring, and it was felt that there was a possibility of damage being done to prime hardware. Failure Report No. AO-1157; see Appendix 108B.

Test Results:

Resonances were observed at several frequencies of injected signal. In many cases it could not be determined whether the take-up motor would run with the looper switch actuated because the 28V. circuit breaker tripped. The resonant frequencies at which this occurred were 1360 cps, 4700 cps, 12.2KC, 22KC, and 27KC.

The points at which the take-up motor ran with the looper switch open (which normally stops the take-up motor by dropping a relay) were as follows:

Frequency of Injected Signal	Injected Voltage Motor Operates	Injected Voltage Motor Returns to Normal
4000 cps.	2V. RMS	1.85V. RMS
5000 cps.	1.5	1.2
6300 cps.	.5	.4

Complete test data are on file in the reliability Test Group files and will be made available, to those interested, upon request.

APPENDIX 108A

The following is copied from Procedure 553-116:

4.4.2 Susceptibility to Conducted Audio Frequency

4.4.2.1 Test Setup - The test setup will be in accordance with Figure X. The instrumentation to inject and monitor the audio signal will be in accordance with Figure IX. The signal strength of the injected audio frequency shall be maintained at 3 volts RMS over the frequency range 30 cps to 15 KC and for 15 KC to 150 KC refer to Figure 7 of 802-222* for voltage level. The audio frequency delivered to the payload shall be limited to 50 volt amperes. Monitor the audio voltage on the oscilloscope and verify that the wave shape does not depart seriously from a sine wave.

4.4.2.2 Photographic Test - Operate the payload as described in section 4.4.1.1.7 above and inject the audio signal on the plus 28 volt dc operational line. Use the following schedule to facilitate correlation of film with the octaves of injected audio signal.

DATA SIGNAL SWITCH POSITION	FREQUENCY OCTAVE
40	30 - 60 cps
41	60 - 120 cps
42	120 - 240 cps
43	240 - 480 cps
44	480 - 1000 cps
45	1 - 2 KC
46	2 - 4 KC
47	4 - 8 KC
48	8 - 16 KC
49	16 - 32 KC
50	32 - 64 KC

*Figure 7 of 802-222, referred to above, calls for a reduction of the injected signal in a logarithmic curve from 3V. at 15 KC to 1V. at .2 MC.

Appendix 108A (Cont'd)

DATA SIGNAL SWITCH POSITION	FREQUENCY OCTAVE
51	64 - 128 KC
52	128 - 150 KC

During the test it may become necessary to reload the system with film. By monitoring CPL-15 the amount of film in the take-up cassette can be ascertained. CPL-15 will register about 0.3 volts dc for an empty take-up cassette and about 4.8 volts for 3,000 ft. When the take-up is full instruct the Assembly Department to install a new 3,000 ft. roll of flight type film.

APPENDIX 108B

Failure Summary

Failure Report No.	Failure	Recommended Change
AO-1157	Take-up operated slowly and at a non-uniform rate. Motor sounded very labored. Caused by pawls binding against the slots in the cup, which in turn was caused by a reduced size limiting pin which allowed too much cup rotation.	Widen the slots in the cup to stop pawls from binding.

RELIABILITY TEST REPORT NO. 109

Test Item: (1) Stereo Mirror Assembly, Drawing No. 807-367, S/N 308. S/N 308 Stereo Mirror was the same as F-205 configuration with the "3-fingered mounts" (each finger located at each of the longitudinal supports) and 6 sets of flexures (2 sets located at each of the longitudinal supports).

(2) Primary Mirror Assembly, Drawing No. 807-430, S/N 251. S/N 251 Primary Mirror Assembly was the same as S/N 252 Primary Mirror (possible selection for F-207) with the "3-fingered mounts" (each finger located between each of the longitudinal supports) and 15 sets of flexures.

Type of Test: Qualification Vibration

Date of Test: 9 January to 13 January 1964

Test Purpose: To determine if Test Items (1) and (2) will survive 3 axes of Qualification Vibration as defined in Appendix D with no structural damage.

Conclusions: (1) Based on engineering analysis and test results, the "3-fingered mount" Stereo Mirror has a high probability of surviving a qualification vibration test with no structural damage.

(2) Test results, subsequent measurements, and engineering analysis show that the S/N 252 Primary Mirror has a high probability of no significant structural damage during a qualification vibration test.

Procedure: (1) Prepare RM Space Chamber with Test Items (1) and (2) and inspect completely before test.

(2) Vibrate the RM Space Chamber in the X-axis (see Appendix D).

(3) Partially disassemble the Stereo and Primary Mirror (see Test Results) and inspect for damaged parts.

(4) After both mirrors are assembled vibrate the Space Chamber in the Z and Y axes (see Appendix D).

(5) Repeat (3) of Procedure.

(6) After both mirrors are assembled perform a 1 G peak sine sweep on the Space Chamber (instrumented with accelerometers).

(7) Completely disassemble the Stereo and Primary Mirror and depot each mirror f·om its inner cell.

Test Results: The results of this test will be discussed in the order of the tests performed. Since the RM Space Chamber is a part of this test it should be mentioned that it had previously been subjected to 7 axes of qualification level vibration.

X-Axis Vibration:

Partial disassemble

(A) Removed aperture mask and thermal ring from the Stereo Mirror.

(B) Removed both component support tubes.

(C) Removed back cover from the Primary Mirror.

Failures

(A) 8 screws, on two sets of flexures, on outer ring of Stereo Mirror loosened. One set of flexures bent (2 out of 6 cracked) and another set bowed slightly (see Figure I).

(B) One flexure screw loosened (screw appeared not to be in midgrip of Helicoil) and 3 sets of flexures buckled or bowed on the Primary Mirror (see Figure 2).

(C) Lower component support tube had two fractured welds at the primary structure end and -Z side. The two fractured welds did exist prior to the test but were smaller in size.

Re-assemble

(A) 8 screws which loosened on the Stereo Mirror were fastened with Loctite. The bent set of flexures were replaced and the bowed set was straightened. All flexure mounting screws on the stereo outer cell were torqued tested.

(B) The screw which loosened on the Primary Mirror was replaced with a 1/8 inch longer screw and fastened with Loctite.

(C) Primary back cover, aperture mask, and thermal ring were replaced.

(D) Component support tubes (upper and lower) from the EM Space Chamber were used in place of the RM tubes. Screws and locknuts were used in place of the cam fasteners on the EM tubes to achieve a better simulation of present design.

Z-Axis Vibration:

There was no disassembling of the RM Space Chamber after the Z axis vibration. A visual inspection revealed no failures.

Y-Axis Vibration:

Partial disassemble

(A) Removed aperture mask and thermal ring from the Stereo Mirror.

(B) Removed both component support tubes.

(C) Removed back cover from the Primary Mirror and removed the Primary Mirror from the Air Heater.

Failures

(A) One spherical mounting bolt on the elevation plate assembly loosened due to a dowel pin "backing out". A dowel pin on one other spherical mounting bolt "backed out" halfway. These pins have been used in previous qualification vibration tests.

(B) Welds on the EM component support tubes cracked in a similar manner as the RM tubes.

(C) One fracture was noticed on two sets of flexures (see Figure 1) on the Stereo Mirror.

Re-assemble

(A) Primary Mirror and back cover were replaced.

(B) Component support tubes were replaced.

(C) Aperture mask and thermal shield were re-assembled to the Stereo Mirror.

1G (peak) Sine Sweep Vibration:

This test was performed for the purpose of obtaining instrumentation data (accelerometer readings) for aiding engineering evaluation of the vibration fixture for the Air Heater Assemblies. The 1G sine sweep vibration test is a non-destructive test as compared to the qualification vibration test.

The Stereo and Primary Mirrors were then completely disassembled and inspected for any structural damage. The results of this inspection will be discussed separately for each mirror.

Stereo Mirror

Final disassembly of the Stereo Mirror consisted of depotting the glass from the inner cell. This was accomplished by cutting the inner cell into 6 equal segments and applying heat to each segment until the potting compound softens considerably. Each segment is then separated from the glass. Careful inspection of the glass showed no chips or fractures.

Examination of the 6 inner cell segments showed that potting compound was lacking about 100% at one of the finger mounts and 50% at another finger mount. Insufficient amounts of potting compound also were noticed where finger mounts had been located. Also, it is evident that some of the potting compound had flowed from the finger mount region down onto the inner surface of the cell. Since the S/N 308 Stereo Mirror is one of the earlier models, the old techniques of applying potting compound were used.

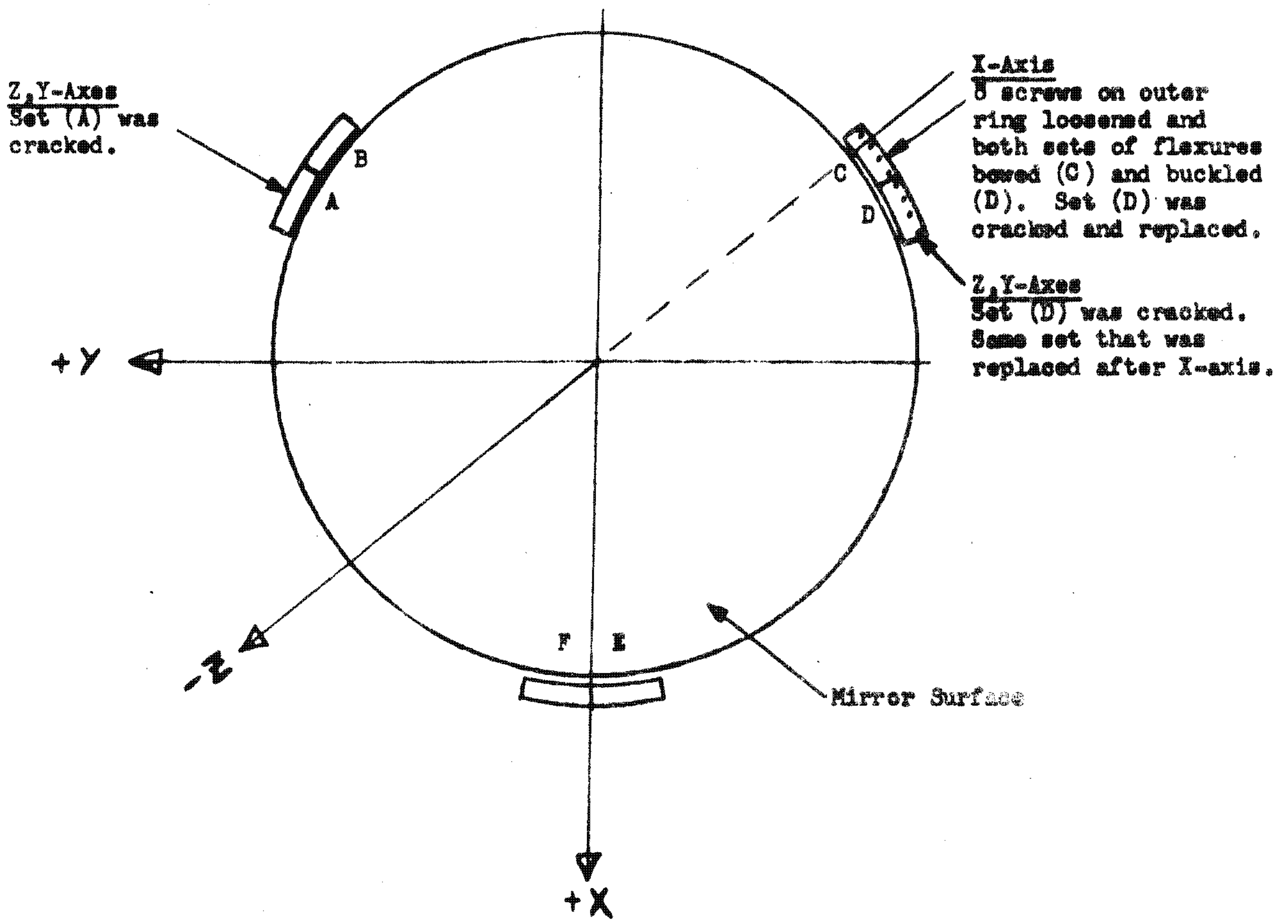
Primary Mirror

After the Primary Mirror was disassembled from the RM Space Chamber and brought into the clean room, small cracks in the glass were noticed (see Figure 2). Before depotting the glass an optical test was performed on the mirror. Results from this test showed the quality of the mirror to be marginal. Since previous data was not available no conclusions could be made on the change of optical quality as a result of the vibration test.

After depotting the mirror from the inner cell, it was evident that the cracks were located (see Figure 2) where a finger mount had been removed (all but 3 of the fingers were removed to simulate the S/N 252 Primary Mirror). However, it could not be proven that the cracks in the glass were caused by the removal of the finger mounts. It was then decided to investigate the problem further and to base all conclusions on the assumption that the cracks occurred during the vibration test.

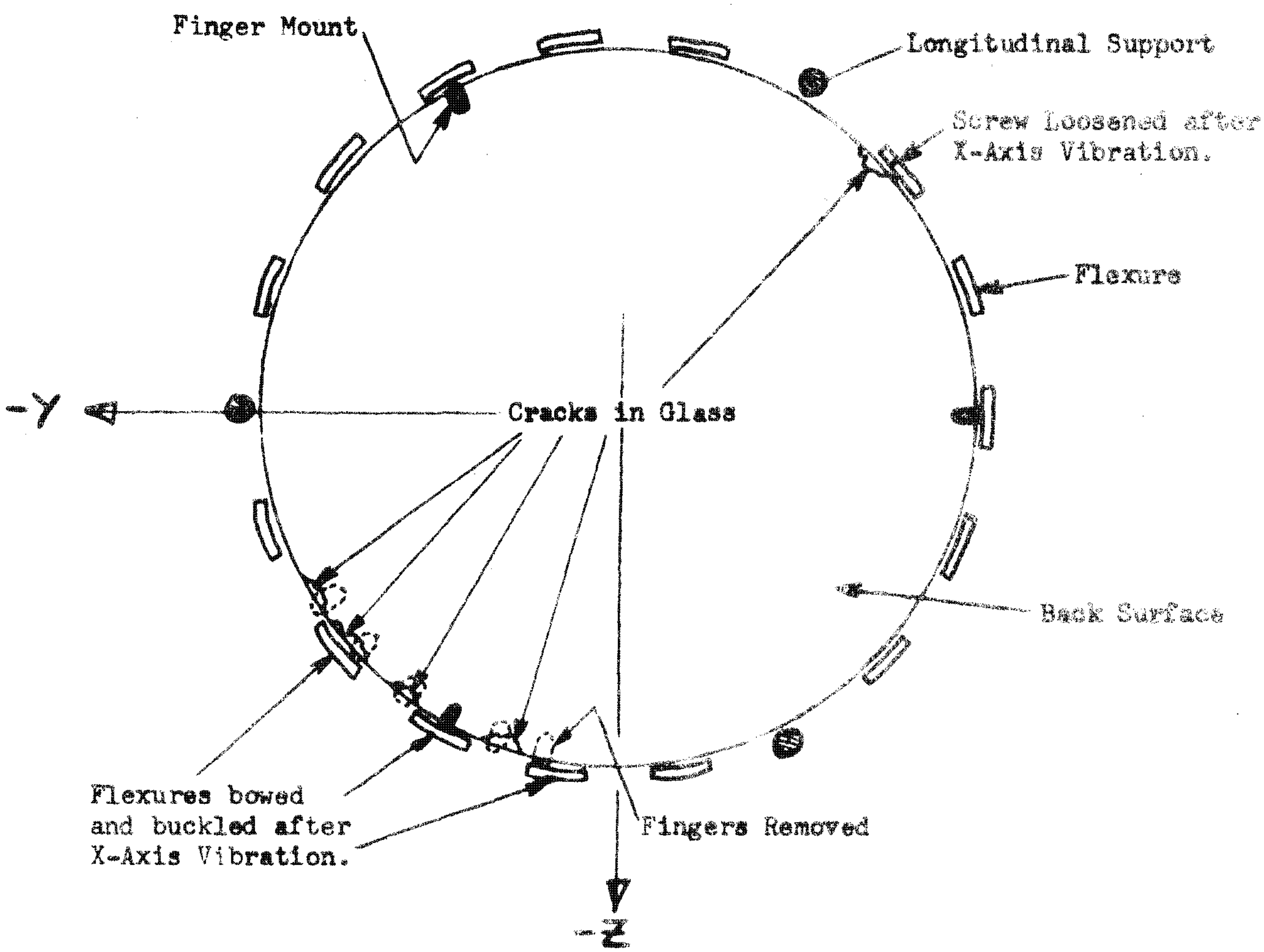
Further investigation showed that the thickness of the lower lip (see Figure 2) at the cracked areas ranged from 0.075" to 0.131" with an average thickness of 0.097". Measurements at the uncracked areas ranged from 0.108" to 0.265" with an average thickness of 0.172". It is evident that the lower lip was structurally weaker at the cracked areas.

Inspection records (Waiver #AO-7061) on the S/N 252 Primary Mirror showed the back plate thickness to be 0.638" to 0.672". The thickness of the lower lip was then calculated to be 0.168" to 0.202". Therefore, it is concluded that S/N 252 Primary Mirror has a high probability of no significant structural damage during a qualification level vibration test.



A→F Represents Flexures

Figure 1. Stereo Mirror Failures after Y-Axis Vibration (Sketch)



SIDE VIEW OF MIRROR

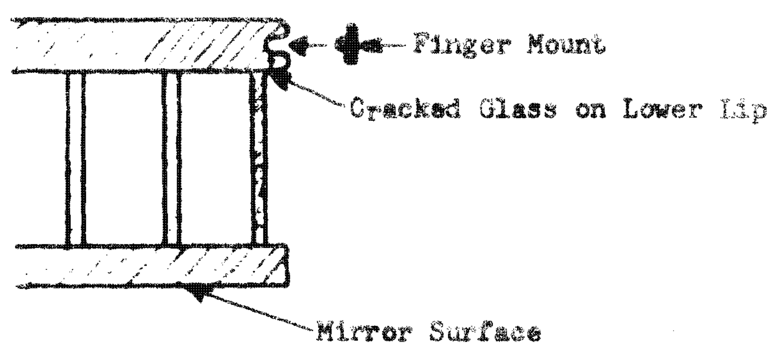


Figure 2. Primary Mirror Failures (Sketch)

RELIABILITY TEST REPORT NO. 110

Test Item: Space Chamber Drawing Number 805-101, Serial No. EM, with a simulated camera and with Forward Record Storage Serial Number 2944 (RC).

Type of Test: E.M.I. Audio Frequency Conducted Susceptibility

Date of Test: January 24-30, 1964

Purpose of Test: To again reproduce the EMI non-conformance which originally occurred on RM Space Chamber, and which was demonstrated on F-206 Space Chamber (See Reliability Test Report No. 108) and to isolate a specific cause of the non-conformance.

Conclusion: The EMI non-conformance, which was that the take-up motor ran with the looper empty switch open when 3V RMS audio signal was injected, did occur again using the EM space chamber. The condition was caused by resonance of the E.M.I. filters and the coil of relay K1 of the Record Transport Control Unit.

Test Procedure: The procedure for this test was to perform Procedure 553-116, Paragraph 4.4.2.2 except that no photography was performed, and frequency was limited to 480 cps. to 64 KC. See Appendix 108A. In addition, the entire frequency band of the injected EMI signal (30 cps. to 150 KC) was scanned with the camera off, to determine whether the take-up motor would start without being switched on.

Test Results: The results of this test showed that the take-up motor would start and run with 3V RMS in the band between 5900 cps. and 7950 cps. The peak of the resonance was found to be at 6900 cps. At this frequency, the Take-up Motor would start at 1.6V RMS and turn off at 1.15V RMS.

With the camera on and with 3V RMS injected, the T-U Motor continued to run when the looper empty switch was actuated throughout the band from 3KC to 12KC. Another point was found at 24KC where the motor would continue to run momentarily but then shut off.

Oscilloscope readings across the coil of relay K-1 in the Record Transport Control Unit, which is the relay that controls the T-U Motor, showed voltages in the range of 30 to 40 volts peak-to-peak (unilateral, approximately sine wave form), just before the relay actuated and the T-U motor started.

It was determined that the problem was the result of resonance involving the relay coil and the EMI filters. A portion of the capacitive part of this resonant circuit bridges the contacts of the looper empty switch so that the E.M.F. remains on when the switch is open. This E.M.F. is rectified by the diode across the relay coil so that a DC level is produced at the relay coil.

Various things were tried to cut down this effect. A successful "fix" was achieved by adding 30 ohms in series with FL-308 in the M.S.D., 30 ohms in series with FL 1003 in the Air Supply and 30 ohms and a new filter in the line to the locking contact of the relay. These additions effectively reduced the peak of the resonance so that insufficient voltage was produced to cause the relay to malfunction.

The entire band of frequency was scanned with the additional parts in place, without any evidence of malfunction.

Test Item:

(1) RC Camera Assembly, Drawing No. 808-750, S/N 004. S/N 004 Camera was the same as F-201 configuration except for omission of the EMI fix and the addition of a high speed gear box (CCN #11).

(2) RC Forward Record Storage Assembly, Drawing No. 712-479, S/N 5445. The RC FRSA was the same as F-205 configuration.

(3) RC Air Supply Assembly, Drawing No. 711-185, S/N 1172. The RC Air Supply was the same as F-204 configuration.

(4) Camera Assembly, Drawing No. 808-750, S/N 013. S/N 013 Camera is on F208 P/L.

Type of Tests:

(1) Camera Operation - Regular Speed Gear Drive vs. High Speed Gear Drive - Atmospheric Conditions

(2) Film Transport System operation with high speed camera gear box.

(3) Camera Operation - High Speed Gear Box and Increased Drive Roller Diameter - Low Pressure.

Date of Test: 16 December 1963 to 21 February 1964

Test Purpose:

(1) To determine if the film transport system is capable of operating with an increase in camera film speed (CCN #11).

(2) To determine if film velocity smoothness, starting times and average film velocity are affected by an increase in film velocity when operated in a low pressure (0.002 PSIA) environment.

(3) To determine if "film set" exists at the start of low pressure (0.002 PSIA) camera operations.

Conclusions:

(1) An increase in camera film speed (CCN #11) does not affect operation of the film transport system.

(2) Photographic test results indicate that film velocity smoothness, starting times and average film velocity were not significantly affected by an increase in film speed (CCN #11).

(3) "Film set" does exist at the start of the first four or five frames of low pressure camera operations.

Test Results:

(1) Camera Operation - Atmospheric

Film velocity smoothness and starting times were determined on the RC S/N 004 Camera (regular gear drive) using the camera test set. Since the bellows in the S/N 004 Camera did not operate satisfactorily at low pressure, only ambient testing could be performed. Three sets of tests were performed and the results are shown below:

Drive Freq.	Film Velocity Smoothness 1	2	3	Starting Times 1	2	3
291 cps.	.46%	.60%	.82%	.72sec.	.85sec.	.72 sec.
352	.53	.46	.67	.64	.66	.77
400	.60	.54	.54	.60	.50	.53
460	.51	.62	.51	.50	.83	.50
544.5	.43	.50	.60	.59	.50	.52

After completion of this test 3 new gear clusters were assembled into the film drive gear box. The rubber drive roller was not changed to an increased diameter rubber roller so that only a 34% increase in film velocity was used instead of 38%. Similar tests were performed and the results are shown below:

Drive Freq.	Film Velocity Smoothness 1	2	3	Starting Time 1	2	3
291 cps.	.99%	.53%	.56%	1.63sec.	.54sec.	1.38sec.
352	.74	.49	.49	1.50	.51	.79
400	.74	.57	.63	.65	.53	.51
460	.92	.53	.56	.63	.63	.58
544.5	.78	.74	.46	.80	.80	.64

(2) Film Transport System

The RC S/N 004 Camera (high speed gear drive), RC Air Supply and the RC Take-up were assembled together to form a film transport system. The Air Supply was loaded with 3,000 feet of film and transport system was then threaded and prepared for operation. The test consisted of operating the Camera at stereo and strip modes at various film speeds, and varying the take-up motor voltage from 27 to 32.5V dc until 3,000 feet of film is on the take-up reel, Throughout this test all moving assemblies were observed for proper operation. The main items of concern, such as looper truck travel, movement of the damper roller limit pins in the Camera and operation of the brake band, showed no impairment in operation.

(3) Camera Operation - Low Pressure

S/N 013 Camera (high speed gear drive) was used for the 24 hour low pressure test and Appendix A describes the test sequences. This test was performed with the camera test set utilizing 1050 feet of film.

Accurate numerical data on film velocity smoothness and starting times could not be obtained from this test because the velvet cloth light shield partially obstructed one side of the tapered wedge slit. A visual inspection of the photographic results indicated that the film velocity smoothness and starting times appeared to be within the required specifications as compared with other camera test results.

It was also concluded from this test that "film set" is present in a low pressure environment for all drive frequencies. Several one hour and six hour waiting periods before camera operations caused the film velocity smoothness in the first 4 to 5 frames to be above specifications. These results indicate that approximately 13 feet of film must be cleared at the start of any photographic operation after a one hour or more waiting period in a low pressure environment.

APPENDIX 111A

Test Sequence

Nomenclature:

A = film velocity smoothness test at 291 cps drive frequency

B = film velocity smoothness test at 352 cps drive frequency

C = film velocity smoothness test at 400 cps drive frequency

D = film velocity smoothness test at 460 cps drive frequency

E = film velocity smoothness test at 544.5 cps drive frequency

/ = clear frame

* = ambient pressure for step (1) only

Steps (2) through (23) are low pressure (0.002 PSI)

(1)* ABCDE/ABCDE//

(2) ABCDE/ABCDE//

(3) Wait 1 hour - maintain 3 lbs. film tension

(4) ABCDEABCDE/

(5) Wait 1 hour - maintain 3lbs. film tension

(6) BCDEABCDEA/

(7) Wait 1 hour - maintain 3 lbs. film tension

(8) CDEABCDEAB/

(9) Wait 1 hour - maintain 3 lbs. film tension

(10) DEABCDEABC/

(11) Wait 1 hour - maintain 3 lbs. film tension

(12) EABCDEABCD//

(13) ABCDE/ repeat this sequence 10 times

(14) Wait 1/2 hour - maintain 3 lbs. film tension

(15) Repeat (13)

(16) Wait 6 hours - maintain 3 lbs. film tension

(17) AAAAAAAAAA//

(18) Repeat (13)

(19) Wait 1/2 hour - maintain 3 lbs. film tension

(20) Repeat (13)

APPENDIX 111A (Cont'd)

(21) Wait 6 hours - maintain 3 lbs. film tension

(22) Repeat (17)

(23) Repeat (13)

Approved for Release: 2024/01/30 C05098945

RELIABILITY TEST REPORT NO. 112

Test Item: (1) Stereo Mirror Assembly, Drawing No. 807-367, S/N 353. S/N 353 Stereo Mirror was the same as F-208 configuration with no finger mounts.

Type of Test: Qualification Vibration

Date of Test: 19 to 22 February 1964

Test Purpose: To determine if Test Item (1) will survive 3 axes of Qualification Vibration as defined in Appendix D with no structural damage.

Conclusion: (1) The Stereo Mirror Assembly, with no finger mounts, will survive 3 axes of qualification vibration with the exception of the flexures. One out of six sets of flexures completely broke and the others were slightly cracked or bent. It is recommended that the flexure design be replaced with an improved design.

Procedure:

(1) Perform an optical check on Test Item (1) as mounted on the truss assembly.

(2) Prepare DS-1 Space Chamber with Test Item (1) and inspect completely before test.

(3) Vibrate the DS-1 Space Chamber in the X, Z and Y axes and inspect between axes.

(4) Repeat (1).

(5) Disassemble Test Item (1) for further inspection.

Test Results: The S/N 353 Stereo Mirror (no finger mounts) was vibrated by utilizing the DS-1 Space Chamber. The RM Space Chamber is currently being prepared for CCN #12 testing. After completion of the X and Z axes of qualification vibration no structural damage was noticed except for cracked welds on the -Z side of the component support tubes. After the Y-axis one set of flexures were twisted or broken as viewed through one of the openings in the back cover of the Stereo Mirror. This condition did not exist before the Y-axis vibration test.

Results of the optical check showed a 0.004" to 0.005" astigmatism before the vibration test and a 0.005" to 0.006" astigmatism after the test. Since the accuracy of this measurement is in the order of 0.002", the change can be considered insignificant.

Disassembling of the Stereo Mirror showed no structural damage to the mirror, or any noticeable movement of the mirror with respect to the inner cell. The [illegible] hardness of the potting compound at the time of the test was 52 to 55. Failures did occur in the flexures and Figure [illegible] gives a detailed description. During the disassembly [illegible] all screws and nuts were tightly secured.

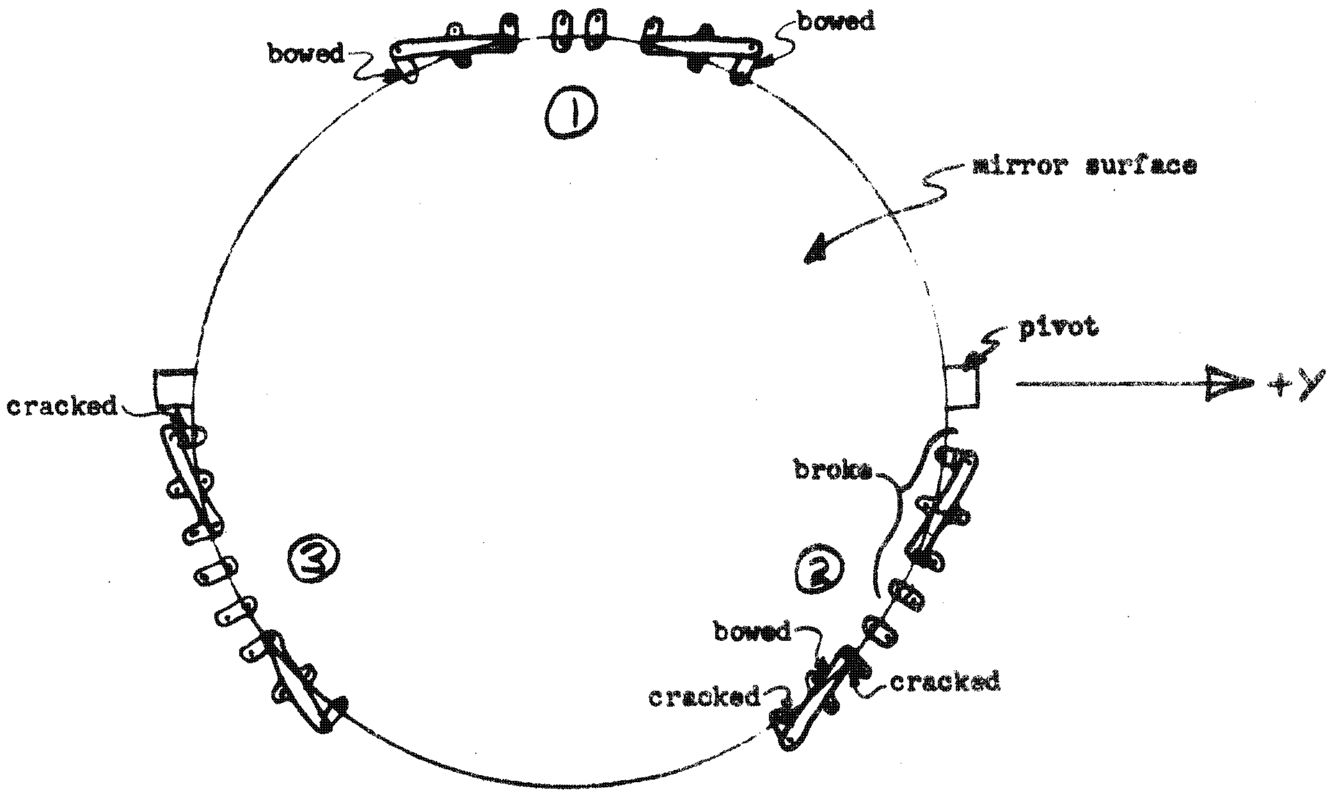


Figure 1. Sketch Showing Stereo Mirror Flexure Failures

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