RELIABILITY EVALUATION PLAN

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WESTINGHOUSE ELECTRIC CORPORATION
Aerospace Division
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1. Introduction

The Reliability Evaluation Plan for the Lunar TV Camera Project encompasses the formalized test requirements for deliverable hardware from the part supplier's testing through and including camera development, qualification, and acceptance testing of the flight qualified model.

The purpose of the Reliability Evaluation Plan is: (1) to assure that there is an organized flow of pertinent data which, evaluation, indicates the effectiveness of, and provides fuidance to, the reliability program, and (2) to assure that the necessary tests are performed for demonstrating that the equipment meets the performance and environmental requirements.

Section 2 is a general discussion of the Reliability Evaluatiin Plan and includes part of the philosophy which dictated its organization.

Section 3 consists of the Integrated Test Program (ITP), the details of which will be further defined in the respective Purchasing Department Specifications, Test Specifications, Test Procedures, and Inspection Detail cards. It is not intended that each test identified in Section 3 be separately documented and in fact many, if not most, will be included as parts of large overall specifications and procedures.

In addition to the testing defined in the ITP, there is an extensive series of evaluation tests performed by the design engineers on equivalent parts, components, sub-assemblies and breadboards. These tests are described as appropriate in the various monthly progress reports and in technical memoranda. The engineering evaluation tests are informal and outside the scope of the ITP in that they are conducted under cognizance of the technical director and the responsible design engineers in accordance with test requirements and procedures that have not previously been formally documented and subject to review and/or approval by the project office and NASA (MSC). Such testing includes, but is not limited to the following:

- Analytical Model Testing - Environmental assessment of the mechanical and thermal configuration achieved by subjecting mechanical mockups of projected configuration to critical environmental tests. The results of such tests are analyzed to determine applicability to the final design and to obtain recommendations as to test emphasis or special instrumentation for later testing.
- Part Selection Development Testing - Where required for the purpose of accurately specifying part parameters and variability, and to check for existance of critical failure modes of newly developed parts, tests are conducted on small sample lots.
- Sub component and Component Design Tests - Evaluation testing by design engineers on all circuits and complete boards as they are developed. Testing consists of functional and thermal environment performance checks.
- Material Tests - In most cases materials are evaluated on the basis of prior data. Qualification for each anticipated material application is evaluated by material specialists. Where no deficiences are noted the part is given preliminary acceptance and the information is sent to NASA (MSC) for review. Final acceptability will be assigned based on camera level qualification testing. In cases of critical applications where

sufficient prior data does not exist, special material testing may be conducted.

2. General Plan

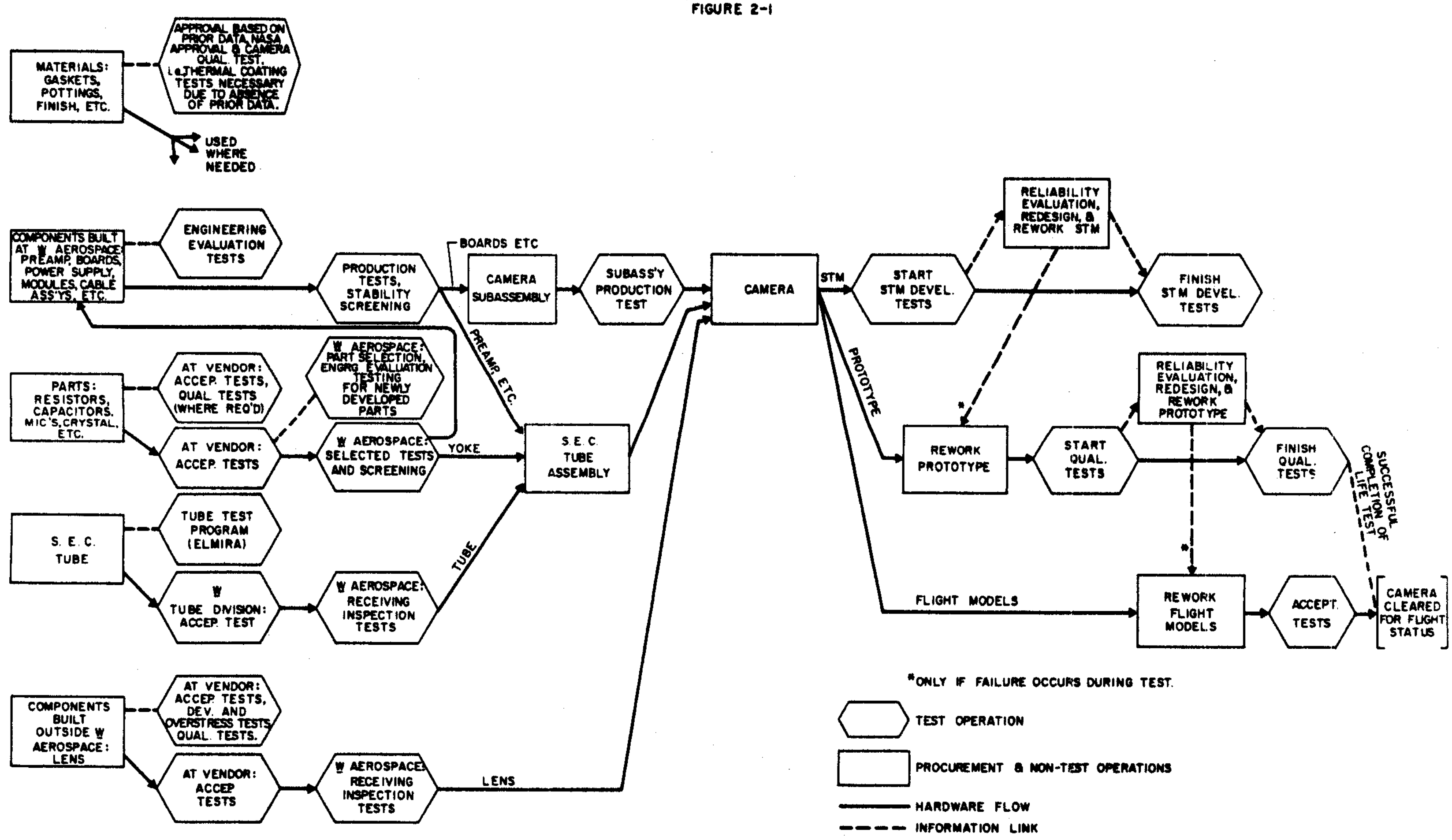
The ITP is conducted at various levels of assembly as reflected in figure 2-1 and for the purpose of this discussion these are defined as:

- Parts - Basic electrical building blocks (usually purchased from suppliers or in a few special cases made in-house) which as assemblies of material would perform no recognized electrical function if disassembled.
- Materials - Non-electrical elements, alloys, or assemblies which are used for support, thermal control protection or non-electrical functions.
- Components - Assemblies of parts and materials into the next higher functional unit. These may be purchased as a unit or assembled in-house.
- Camera Subassembly - The completed electronic Camera assembly, less the lens and lunar camera tube subassembly.
- Camera Tube
- Camera

The relationship between test types and assembly levels and the time phasing of testing for the program are illustrated in figures 2-1 and 2-2.

Camera assembly testing for the development, qualification and acceptance test phases has been specified by NASA in the statement of work (exhibit A), and is also repeated in essence in paragraph 4.3 of the Reliability Program Plan. These tests and their associated test procedures are to be further detailed in Westinghouse Test Specifications (T-Spec) and Test Procedures.

TEST PLAN, LUNAR TV CAMERA
FIGURE 2-1



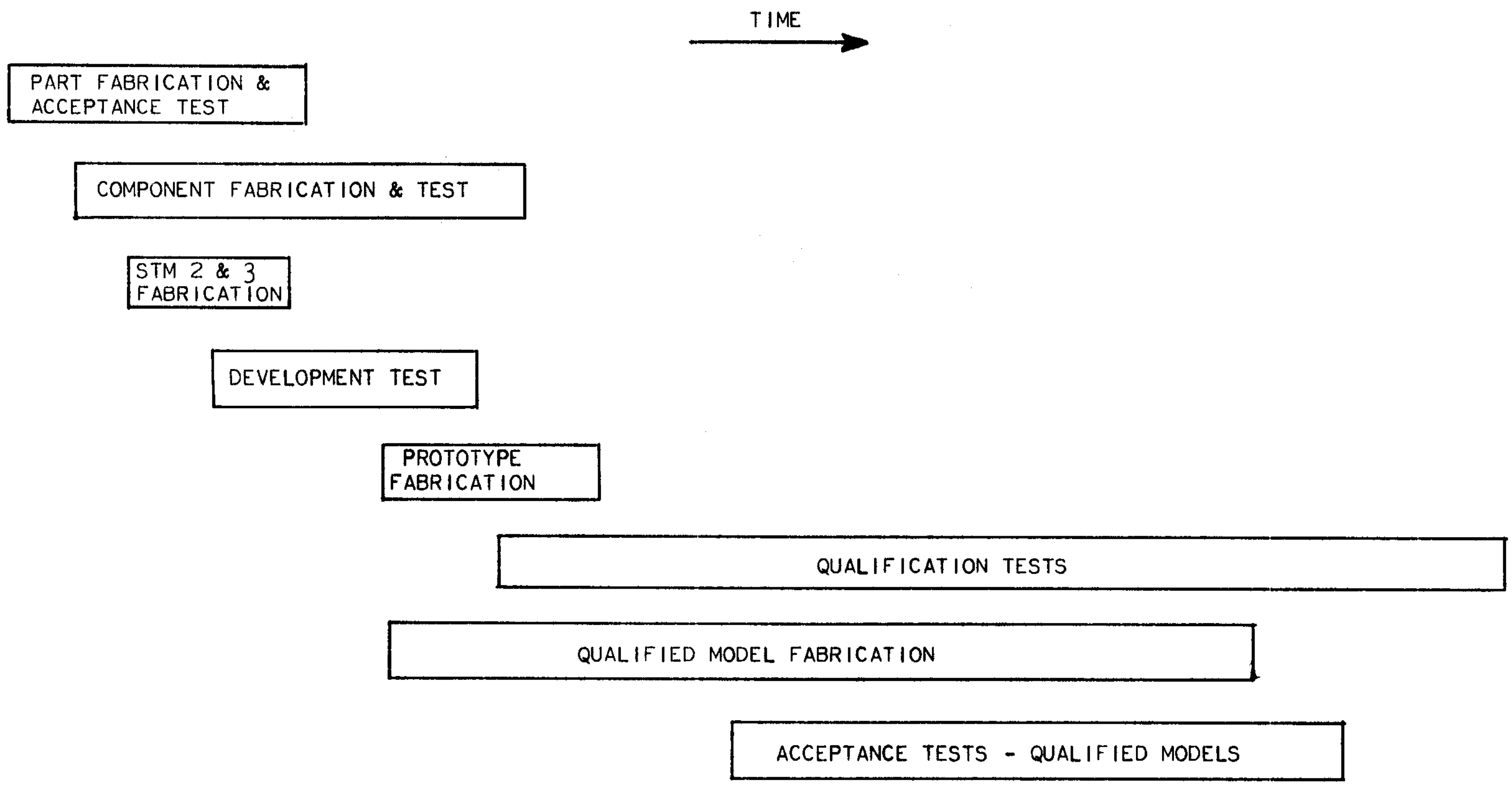


FIGURE 2-2 TIME PHASE DIAGRAM, INTEGRATED TEST PROGRAM

Testing at lower assembly levels is defined by Westinghouse, considering applicable failure modes, sensitive environments, interrelationship of test elements, relative effectiveness, and program schedules. The detailed test requirements for all levels are part of the respective T-Specs or Inspection Detail Cards.

Camera qualification testing is performed to demonstrate conformance of design to specification performance and environmental requirements. A discrepancy during qualification testing could be expected to result in any or all of the following actions for the indicated failure types:

- Test error-revision of test specification.
- Quality discrepancy - correction and feedback to prevent recurrance.
- Part failure - change of part, change of supplier, modification or increased screening tests, review of design analysis, redesign.
- Operation out of tolerance - review of design analysis, review and revision of parts selection and application, redesign.

Failure during the off-limits portion of the qualification test would be evaluated in light of expected design capability, existance of satisfactory safety margin and relevance of failure mode. NASA (MSC) would be notified of analysis results.

Camera development testing is performed to evaluate design capability. In addition, evaluation of stress levels to produce expected failure modes and consideration of occurrence under mission conditions will be emphasized.

Action to be taken in event of discrepancies would follow the same pattern as described under qualification testing above.

Camera acceptance testing is performed to demonstrate compliance with performance requirements of the equipment specification.

Completion of design assurance and proof testing prior to this phase should assusre a mature design. Only isolated quality discrepancies would be expected at this time. Action would consist of the correction of the discrepancy and then feeback for increased surveillance to prevent reccurrence.

Westinghouse Receiving Inspection, a function of Product Reliability conducted under the quality program, consists of selected tests and inspections to verify supplier test results and provide additional screening for increased confidence.

The Lunar TV Camera must use the newest state-of-the-art parts to meet the weight, volume, and power requirements imposed by the application. Documented reliability data is not available at present on these parts. Careful selection of high quality parts from suppliers of known prior performance is supplemented by acquiring and analyzing data from the test program as the parameter trends on the parts and assembly to evolve an improved product if the initially anticipated reliability goals are not met. Were parts of well documented reliability to be used, it would not be possible to later reduce the size and weight to acceptable limits without invalidating previously acquired data.

Testing is keyed to the expected environment and to the areas of known failure modes of equivalent parts. Resistors, capacitors, RF chokes, yokes, crystal units and similar parts are tested in this manner. Special developmental testing is performed on parts and subassemblies of significantly new design such as the integrated circuits, low voltage power supply, high voltage power supply, video circuits, sweep circuits and the counter chain. Microcircuit flip-flops and gates are in an intermediate test category between the two extremes since they are standard parts albeit quite complex, relatively new, and of insufficiently well documented history. The camera tube is in separate category and is subject to a comprehensive development and qualification test program detailed in the applicable purchase specification. Overall emphasis is to judge where the greatest increase in reliability confidence can be obtained through the test program and still have an impact on the final design of the product. The test program avoids undue verification in areas of extremely low expected probability of failure.

Screening evaluations and tests are used on parts and assemblies. Data is acquired in the manufacturing process, acceptance tests, receiving inspection, and certain specialized screening tests and is evaluated to determine if otherwise fully acceptable parts and components exhibit any unusual variation in the observed parameters. Any part or component which exhibits unusual variations is removed from the lot which is to be used on flight or qualified models. Such parts may still be used for the various phases of testing and development.

The screening operation will reject parts which could conceivably have greater reliability than those that pass, however, the element of uncertainty is such that any significant variations from the usual are considered as unacceptable. A considerable amount of judgement is employed in the evaluation of information available for screening. For these reasons suppliers may not be held strictly accountable for parts which do not pass the screening operation and such parts may be utilized for test and development purposes.

The intent of the acceptance testing and screening is to eliminate potential failures without degrading the life performance of the part, material, and completed camera. The test and screening criteria are established by analysis of existing data in the development of the TV Camera. The criteria and procedures would have to be reevaluated as part of the failure analysis should any failure occur after an item had passed the respective test and screening. The evaluation in the event of failure must take into account the qualification status of any failed part since it is necessary to proceed with the Development and Qualification Testing of completed TV Camera assemblies before all the parts and components have completed their respective qualification tests.

An additional type of testing which is relatively new in its application to electronic equipment is some form of overstress testing. Depending on the specific objective and the degree to which overstress is applied, this general category of testing is also known as reliability safety margin verification testing, off-limits testing and step stress testing.

This type of testing has been developed to replace reliability assurance techniques of statistical demonstration, which is idealized, and which requires both unit-hours of test time which are not normally available in space hardware programming, and normal mission operation, which would occur too late to be of any value.

The test is intended to sample the degree of safety margin that exists between the maximum single or combined load (stress) and the minimum strength due to part quality variations.

The unit to be tested is first subjected to the maximum conditions of the mission environmental profile. Any failure which occurs during this simulated mission profile necessitates corrective action to remove the cause of failure unless it can be proven that the test technique was in error.

On the basis of the engineering analysis and judgement, environmental limits are specified which are greater than normal mission stress but which are less than the point at which abnormal part failure modes might be expected. The difference between the specified levels and the mission environmental conditions is divided into increments. Starting at the mission conditions, environmental stress is increased to successively higher and higher levels until failure occurs or until a satisfactory level is reached.

Overstress testing is performed for only the minimum amount of time necessary to stabilize at the programmed stress level. The intent of overstress testing is to sample the strength distribution of the subsystem parts in relation to the stress distribution of the environment. The weak links of reliability occur as failures in the overlap region of these two distributions and their upgrading by corrective action results in improved engineering confidence.

As the test is not conducted in the time domain to any significant degree, shifting in part strength distribution with time is not determined and, therefore, such testing cannot offer a complete solution to the reliability assurance problem. As noted above, the test is a compromise between a need which is unfeasible to implement and the acceptance of the unfavorable risk inherent in having no reliability testing.

The development tests on the Service Test Models (STM) are preceded by the engineering evaluation tests of the Breadboard, the Thermal Mockup (also used as a mechanical mockup for the vibration tests) and the Engineering Model. The STM #1 actually is coincident in time with the Engineering Model. Both are nearly in the final configuration. STM #1 is required only to meet the basic functional requirements for its portion of the development tests and uses best-available parts and a commercial grade lens. The Engineering Model is an advanced breadboard, and is used for evaluating electrical performance over the operating temperature range and for debugging any circuit or configuration problems that are found.

The Engineering Model may also be used as a "dog" unit on which any improvements may be tried out before incorporation into STM #2 and #3 or the Prototypes.

The engineering evaluation of the Engineering Model and the Thermal Mockup (thermal and vibration tests) precedes the construction of STM #2 and #3 which are intended to be of the full final configuration. STM #2 and #3 will meet all performance and environmental requirements and will use all parts, materials, and processes intended for the Prototype Model. Substitutions of equivalents are made only where parts or materials are not available from the production lot which is intended for use on the Prototype and Qualified Models. In general, part qualification tests will be completed prior to assembly of the test models and it is necessary to use parts of the same production run which have passed only acceptance tests.

Final assembly of the Prototype Models precedes completion of the Development Tests on STM #2 and #3 and the Qualified Models are well advanced in final assembly before the Prototype Models are through the Qualification tests. The Qualified Models will not be cleared for flight status until: (1) the completion of all tests on the preceding models and parts, (2) the test data is analyzed, and (3) the Qualified Models reflect the configuration which passed the tests. This approach runs the risk of rework and scrappage, however, it is more economical since it enables better control over the production process by performing equivalent operation with the same set-up and ensures that all units have a valid lot identity. Whenever production is interrupted, there is the possibility of personnel changes and other effects.

Rework of the prototype models found necessary on the basis of the development tests will be delayed until an appreciable amount rework needs have accumulated and the modifications will be performed on a batch basis just before starting the qualification tests. Similarly, rework of the flight (qualified) models found necessary due to the development and qualification tests will be delayed and will be performed on a batch basis before conducting the acceptance tests on the respective units. The length of the life test requires that the initial deliveries to NASA (MSC) be made before completion of the full qualification tests and as a consequence these units must be reworked, acceptance tested, and shipped prior to full clearance for flight status.

Reliability evaluation resulting from testing on the Lunar TV Camera Program will be of a qualitative nature. The amount of unit-hour testing scheduled will not yield statistically valid quantitative data if the true equipment reliability approaches its assigned goal.

Discrepancies occuring during any testing will be reviewed to determine need for revision of reliability program planning. Potential areas for action would include changes in reliability training, data analysis, vendor evaluation, derating policy, part application, test planning and revisions in the Quality Program.

3. Integrated Test Program

The development, qualification, and acceptance tests defined in the statement of work include several which can only be performed on parts, components, and on the unsealed camera. In such cases the test documents will, as applicable:

(1) reference supplier's part-test documents.

(2) contain the test procedure to be followed and data sheets to be filled in at the lower test level where a reference up to the higher test level document is practical in the lower level document.

(3) reference the test procedure and data sheets in the lower test level.

In no case is it planned to duplicate supplier's qualification or development tests. Tests on the Aerospace Division manufactured components or camera will be repeated only insofar as such prior tests are performed primarily as production checks and are not available for witnessing by NASA (MSC) within the 96-hour notice-of-test required by the statement of work. This procedure will necessarily involve gaps measured in months between specific tests within a given camera test sequence.

The production and QC (Quality Control) personnel will be trained and will gain experience through the fabrication and testing of the engineering model and STM #1. Engineering will assist directly in this training phase. Thereafter, QC personnel will be responsible for production and acceptance testing of all subsequent parts and cameras although engineering will be on-call for assistance.

All development testing on STM #2 and #3 and all qualification testing performed at the Aerospace Division on completed cameras will be performed by the Aerospace Test Center in accordance with detailed test specifications and procedures. The tests will be conducted by Test Center personnel and overall test direction will be under cognizance of Test Directors appointed by the Project Office.

One of the Test Directors will always be present for any test or on-call for those tests which are run on a 24-hour basis. Engineering will be on-call if needed to help the Test Director resolve any problems related to the TV Camera or its auxiliary equipment. The Test Director on duty will have authority to halt or continue any test upon noticing any discrepancy in the test results. It will be the duty of the Test Director to ensure that: (1) the test procedures are being followed, (2) adequate records are kept and forwarded to cognizant personnel, (3) the equipment is protected from unnecessary damage in the event of a design, procedural, or stress discrepancy, (4) assistance, as required, is secured in case of discrepancies, (5) someone is present whenever the equipment or any environmental apparatus is operating, (6) the test schedule is maintained.

3.1 Supplier Tests

A. MIC's (all 25 types)

1. Qualification

2. Acceptance, e.g.:

a. Oscillator block - for LVPS

(1) Power drain

(2) Frequency

(3) Rise and fall time

(4) Signal amplitude

(5) Triggering

(6) Burn-in

b. Driver block (Schmidt Trigger) - for LVPS

(1) Power drain

(2) Signal waveform

(3) Burn-in

B. Transistors, diodes, switch, etc.

C. Crystal - qual., accep. per PDS 21352

D. SEC tube - qual., accep. per PDS 21341

E. Yoke - qual., accep. per PDS 21347

F. Optics (lens ass'y & window) - qual., accep. per PDS 21345

G. Capacitors, Mica

Supplied by Elmenco per 578R170

1. Qualification tests - None performed specifically for Westinghouse - Qualification is based on the Suppliers qualification.

2. Acceptance Tests - Tests and inspections as detailed in MIL-C-5 as applicable. Sample inspection per MIL-STD-105.

   a. Pre-burn in electrical measurements - capacitance, DC leakage, dissipation factor

   b. Burn-in

   c. Dielectric strength

   d. Insulation resistance

   e. Dissipation factor

   f. Capacitance

   g. DC leakage

   h. Insulation resistance at elevated temperature - sample

   i. Temperature coefficient and capacitance drift - sample

   j. Vibration - sample

   k. Temperature and immersion cycling - sample

   l. Terminal strength - sample

   m. Moisture resistance - sample

   n. Life - sample

H. Capacitors, Tantalum

Series J and Z supplied by Kemet per 578R163 and 578R165

1. Qualification tests: Same as G.1 above

2. Acceptance tests: All units undergo the following series of tests as detailed in MIL-C-39003

    a. Immersion

    b. Shock and vibration

    c. Temperature cycling

    d. Life

    e. DC Leakage

    f. Capacitance

    g. Dissipation Factor

    h. Visual examination

    i. X-Ray

I. Potentiometers, wirewound

Supplied by Bourns per 578R189. Tests and inspections as detailed in MIL-R-27208 in accordance with sample inspections per MIL-STD-105.

1. Qualification tests are performed on a periodic basis per MIL-R-27208

2. Acceptance tests

    a. Group A & B inspection tests per MIL-R-27208 on a sampling basis

        (1) Visual & Mechanical examination

        (2) Total Resistance

        (3) End Resistance

        (4) Dielectric withstanding voltage

        (5) Actual effective electrical travel

(6) Insulation resistance

(7) Torque

(8) Thermal Shock

(9) Solerability

(10) Immersion

(11) Continuity

(12) Absolute minimum resistance

(13) Peak Noise

b. Additional tests on a 100% basis are:

(1) Burn-in

(2) Temperature cycling

(3) High temperature stability

J. Potenticmeters, carbon

Supplied by Bourns per 578R190. Tests and inspections as detailed in MIL-R-22097 in accordance with sample inspections per MIL-STD-105.

1. Qualification tests are performed on a periodic basis per MIL-R-22097

2. Acceptance tests

a. Group A & B inspection tests per MIL-R-22097 on a sample basis

(1) Visual & mechanical examination

(2) Total resistance

(3) End resistance

(4) Dielectric withstanding voltage

(5) Actual effective electrical travel

(6) Insulation resistance

(7) Torque

(8) Thermal shock

(9) Solderability

(10) Immersion

(11) Contact resistance variation

b. Additional tests on a 100% basis are:

(1) Burn-in

(2) Temperature cycling

(3) High temperature stability

K. Resistors, carbon composition

Supplied by Allen Bradley per 578R183, 578R184, 578R185 and 578R186. Tests and inspections are as detailed in MIL-R-11.

1. Qualification tests per MIL-R-11 performed on a monthly basis.

2. Acceptance tests consist of Group A inspection per MIL-R-11 on a 100% basis

a. Visual and mechanical examination

(1) Material

(2) Design & construction

(3) Terminals

(4) Marking

(5) Workmanship

b. DC Resistance

L. Resistors, metal film

Supplied by IRC per 578R161. Tests and inspections are as detailed in MIL-R-55182

1. Qualification tests are performed on a periodic basis

2. Acceptance tests

a. Sample inspection per MIL-R-55182

(1) Life

(2) Solderability

(3) Dielectric withstanding voltage

(4) Insulation resistance

(5) Resistance to soldering heat

(6) Moisture resistance

(7) Lead pull test

b. Sample inspection per MIL-STD-105

(1) Visual & mechanical examination

(2) Resistance temperature characteristic

c. Noise test per MIL-STD-202, method 308

d. 100% inspection per MIL-R-55182

(1) Temperature cycling

(2) Overload

(3) Seal

(4) DC resistance

(5) X-Ray

3.2 Receiving Inspection

A. Lunar Camera Tube

Visual inspection will be performed in the clean room by QC inspection personnel to check for any obvious damage which may have occurred during shipment. Final electrical tests and mechanical dimensional checks will be performed at Westinghouse Tube Division under cognizance of the field QC representative at Elmira, N. Y. Handling procedures will be written which will describe in detail those precautions that Aerospace personnel must use.

B. Optical Subsystems

Acceptance tests will be witnessed at the supplier. No tests on the optics will be performed at Westinghouse. Handling procedures will be written for use by Westinghouse personnel. Leakage of the lens assembly seal may be checked at Westinghouse on a sample basis. Incoming inspection will be performed only for the purpose of checking for damage and to determine if test documentation is complete.

C. Integrated Circuits

All final electrical tests will be witnessed at the supplier by field QC representatives. Certain electrical tests will be performed on a sample basis in the clean room at Westinghouse Aerospace. Inspection, test, and handling procedures will be written to reflect requirements specified in the PDS or on the applicable drawing.

D. Deflection Yoke

Electrical and mechanical inspection to be witnessed by field QC personnel at the supplier. Inspection procedures to be written for use in the Receiving Inspection area of the Westinghouse clean room.

A copy of the procedure will be sent to the supplier prior to the delivery of the parts. Inspection in the clean room will include packaging and documentation requirements.

E. Crystal

Electrical tests to be witnessed by a QC representative at the supplier. An inspection procedure will define the details which reflect the drawing and PDS requirements. The supplier will receive a copy of the inspection procedure prior to shipment of the parts. A visual inspection will be performed in the clean room receiving area.

F. Elapsed Time Meter

1. Visual and Mechanical inspection
2. Timing check at voltage extremes
3. Current

G. Other Electrical Parts

1. Transistor and diode electrical sampling checks will be conducted at Receiving Inspection. A Visual examination to check lead condition, marking, packaging, data enclosure, etc. will be made using station instructions.
2. Capacitors
    a. Capacitance
    b. D. C. Leakage
    c. Dissipation Factor
    d. Visual & mechanical examination
3. Mode switch
    a. Visual and mechanical examination
    b. Continuity test, make and break

4. Potentiometers, wirewound and carbon

   a. Visual and mechanical examination

   b. Full winding D. C. resistance

   c. End point resistance

   d. Wiper continuity

5. Resistors, carbon composition

   a. Condition resistors for a period of 48 hours at a temperature of +100°C and store in a humidity controlled area thereafter.

   b. After conditioning perform noise tests and measure D. C. resistance on a 100% basis.

6. Resistors, metal film

   a. Use serialized data from supplier and screen out the upper and lower 5% of distribution.

   b. Screen units per data from noise test performed by supplier.

   c. Visual and mechanical examination

   d. D. C. resistance

   e. Temperature coefficient

H. Fabrication Materials, Gaskets, etc.

Inspection Detail Cards will be written for all materials for which a card does not exist at present. Sample chemical and physical analyses will be made on all critical raw materials. Purchased raw materials, unless an age-life item, will be kept in the raw materials storeroom (LTC). Lot identification will be maintained on all critical items.

3.3 Production Tests

A. Video Pre-amp

1. Adjust bandwidth and measure

2. Measure gain, absolute and differential
3. Measure noise
4. Dynamic range
5. Power consumption

B. HV Transformer for High Voltage Power Supply (HVPS)

1. DC resistance - indicates continuity, wire size, winding tension
2. Voltage ratio
3. Core exciting current
4. Coil insulation - insulation between turns of coil and coil leads.
5. Dielectric strength - leakage between coils and ground
6. Load Test - current, voltage, waveform

C. Camera Tube Assembly

1. Tube short test
2. Yoke Inductance check
3. Preamp power input and signal output check
4. HVPS control signal input and power check
5. Lens coupling test:

   Check ability of lens coupling to accept a lens by using a minimum and a maximum gauge (dummy lenses).

D. Sweep Module

1. Horizontal
   a. Amplitude limits of sweep current
   b. Shape and linearity
   c. Centering
   d. Adjust for equal amplitude in both modes
2. Vertical - same as Horizontal

3. DC power consumption

E. Scan and Sync

1. Oscillator

a. Frequency

b. Amplitude and rise time

c. Waveform Symmetry

2. Horizontal Sync

a. Frequency

b. Sync pulse width

c. Balnk pulse width (Both Modes)

d. Front and back porch

e. Rise time

3. Vertical Sync

a. Frequency

b. Sync pulse width (Both Modes)

c. Rise times

4. Composite

a. Mixed blank

b. Mixed sync (Both Modes)

c. Serrated sync

5. DC Power

F. Video & AGC ALC

1. Video

a. Gain - total and differential

b. Bandwidth

c. Dynamic range

d. Clamp action (Both Modes)

2. AGC

a. Threshold

b. Range

c. Linearity

d. Distortion

e. Response time (Both Modes)

3. ALC

a. Threshold

b. Range

c. Linearity

d. Response time (Both Modes)

e. Gain

f. Scene variation

4. DC Power consumption

G. <u>Low Voltage Power Supply</u>

1. Input regulator

a. Input regulation

b. Load regulation

c. Input power vs output power

d. Noise and spikes

e. Temperature

f. Frequency response

2. Inverter, rectifier, and filter module: Supplies +600 V, +300 V, (-)100 V, +25 V and +7.6 V for the other camera circuits and +16 V, (-)10 V for the LVPS regulator circuits

    a. Load regulation

    b. Input power vs output power

    c. Noise and spikes

    d. Temperature

    e. Dielectric strength

    f. Corona - +600 V only

    g. Frequency response

3. +6 V Regulator

    a. Input regulation

    b. Load regulation

    c. Input power vs output power

    d. Noise and spikes

    e. Temperature

    f. Frequency response

4. (-)8 V Regulator

    Same as +6 V Regulator

H. Connector Receptacle

1. Electrical continuity
2. Dielectric strength
3. Insulation resistance
4. Mechanical movement range
5. Housing leakage (bubble test in mineral oil or water)

I. Camera Housing

1. Plating inspection

2. Leakage - bubble test in mineral oil or water, done before painting and finishing.

J. Camera Subassembly (contains everything except Camera Tube Assembly)

1. Monitor sweep voltages

2. Monitor tube voltages

a. Blank

b. Tgt and mesh

c. High voltage

d. Fil and grid voltages

3. Measure video bandwidth of composite video output

K. Lunar Surface Cable Assembly

1. Electrical continuity

2. Dielectric strength

3. Insulation resistance

4. Mechanical movement - Camera end of cable

a. Sliding sleeve

b. Contacts

5. Mechanical, visual - Vehicle end of cable

a. Housing

b. Contacts

6. High Temperature

a. Flexibility

b. Extensibility

c. Tension, normal load

7. Low Temperature
    a. Flexibility
    b. Extensibility
    c. Tension, normal load

L. Connector Assembly, Fixed Mount
    1. Electrical continuity
    2. Dielectric strength
    3. Insulation resistance
    4. Mechanical movement
        a. Sliding sleeve
        b. Contacts

M. Cabin Cable Assembly
    1. Electrical continuity
    2. Dielectric strength
    3. Insulation resistance
    4. Mechanical movement - Camera end of cable
        a. Sliding sleeve
        b. Contacts
    5. Mechanical, Visual - Vehicle end of cable
        a. Housing
        b. Contacts
    6. Cable flexibility and extensibility

N. Connector, Test Adaptor
    1. Electrical continuity
    2. Dielectric strength
    3. Insulation resistance

4. Elapsed time meter operation

5. Mechanical

    a. Test connection cap

    b. Mating with camera and cable assemblies

    c. Ball socket motion

    d. Seal sleeve motion

    e. Electrical contact motion

O. <u>Camera Functional Tests</u>

Final inspection and adjustment before customer acceptance tests

1. Alignment

    a. Adjust sweeps

    b. Adjust alignment, beam, focus

    c. Install fixed resistors for alignment

    d. Recheck for both modes

    e. Adjust gain

2. Wide Angle lens and cable

    a. S/N vs light level (check ALC output)

    b. Resolution vs light level (lines at percentage response)

    c. Aspect ratio - test pattern

    d. Gray scale vs light level

    e. Output waveform - scope

    f. Linearity - ball chart & test gen. on monitor

    g. Power input variation

    Check camera at 3 light levels with RETMA chart as power is varied. Monitor power supplies.

    h. Repeat for slow mode.

i. Power drain

3. Cable assemblies

a. Fix camera and RETMA chart and light

Check for no variation with cables

4. Lenses - check with each

a. Aspect ratio

b. Resolution

c. Linearity

d. S/N vs light level (only one point with lunar day lens)

5. Smear

P. Storage Container Inspection

3.4 Acceptance Tests

Performed on all finished products other than STM #1 which requires a different test since it is of a non-conforming design.

A. Examination of product. Determines that materials, construction, workmanship, etc. comply with necessary requirements.

B. Vibration testing

1. Camera

Mount with isolators to mounting bracket and use fixed mount connector. Check for loose hardware and electrical connections. Test connector adaptor mounted remote from camera.

2. Cables

a. Cabin cable assembly - survival level

b. Lunar surface cable assembly - survival

c. Fixed mount connector - done on spares only since camera level test includes this connector

C. Functional Testing

1. Power limit operation

   Use RETMA chart to check for changes (including aspect ratio) in operation with input power variation.

   Qualitative check

2. Light limit operation (Both Modes)

   a. Check S/N vs light with one lens

   b. Check Resolution vs light with one lens (% response)

   c. Check Gray Scales vs light with one lens

3. Scanning parameters (Both Modes)

   a. Pulse timing - freq., width, rise time, relative position

   b. Composite video output - black level direction, amplitude, output waveform

4. Video bandwidths

   Checked at subassembly and recorded in camera acceptance test document at time of performance.

   (must connect to tgt to check, turn off tube)

5. Lens assembly interface check

   Check S/N, resolution, linearity, with each lens at one light level for each. Measure HVPS or ALC output.

6. S/N ratio

7. Smear

D. Storage container

E. Cable assemblies

3.5 Development Tests

Performed on STM # 2 and # 3 only.

A. <u>Examination of product</u>

B. <u>Dielectric strength</u>

C. <u>Insulation resistance</u>

D. <u>Functional</u>

1. Overall performance - closed camera for various environments

   a. S/N vs light

   b. Resolution and Gray scales

   c. Linearity

   d. Power variation - affects video level, resolution, gray scale, aspect ratio, centering, linearity, S/N, scan frequency

   e. Waveform

   f. Scan parameters, freq., shape etc. (Both Modes)

   g. Various scene contents

   h. Light level response times

   i. Lens used to be compatible with environment

   j. Smear

2. Internal test points

   a. Power supply

   b. Oscillator

   c. Sync outputs

   d. Sweeps

   e. AGC Threshold

   f. ALC Threshold

   g. Clamp

   h. Beam setting

   i. Highlight exposure

   Camera tube spectral response

E. Electromagnetic Interference - Affects tube with loss of clarity and aspect ratio, noise in picture, jitter, permanent magnitization.

1. Susceptability - Effect of external fields on Lunar TV Camera
    a. Vary light level and note effect on picture with picture with RETMA chart - qualitative measure.
    b. Conductive - insert noise in cable
2. Interference - Effect on external environment by Lunar TV Camera
    a. Conductive
        1. Output signal
        2. Power line and return
    b. Radiative

F. Leakage of sealed parts

G. Humidity and salt spray - affects corona, corrosion. Use cabin cable assembly and mount on bracket. Test connector adaptor outside of chamber.

NOTE: The camera outside surfaces should be washed and cleaned after the humidity and salt spray test and prior to the thermal vacuum tests. Deposits from these tests can affect the thermal balance and such deposits are not representative of accumlations which might occur during in-cabin exposure.

H. Acoustic - affects resolution, aspect ratio, camera structure. Use wide angle lens, fixed mount connector, and vibration isolators.

I. Vibration - affects resolution, timing, modulation of video. Use wide angle lens, cabin cable assembly. Test adaptor connector mounted separately.

J. Acceleration - affects resolution, aspect ratio. Actually a redundant test, gives same data as vibration test.

K. Explosive atmosphere - Use explosive vapor mixed with pure oxygen.

L. Oxygen atmosphere - Camera, all cable assemblies, all lenses, and stowage container

M. Shock - Mock up only

N. Thermal vacuum - affects S/N, aspect ratio, gray scale, linearity, resolution, video levels, response time, power drain, frequency Check thermal balance of operating camera on lunar surface under both day and night simulations.

1. Test lunar day camera at sub-solar point (i.e. camera without shields) with lunar surface cable assembly and lunar day lens. Place test adapter connector outside the chamber. Camera operating - in vacuum chanber - with lunar surface simulator, solar simulator, and deep space simulation. Camera oriented so that top surface normal to solar rays.
2. Test lunar night camera (i.e. with shields attached) with lunar night lens, without solar simulation. Otherwise same as lunar day camera test.

O. Overstress

1. Thermal vacuum - high and low termperature overstress under vacuum
2. Light level input
3. Power variation input
4. Vibration

3.6 Qualification Test

Performed on the three (3) prototypes only and then only after they have passed the acceptance tests.

A. Light input variation

1. S/N
2. Resolution
3. Linearity
4. Response time

B. Power input variation

1. Qualitative measurement - Vary power and note effect on picture with RETMA chart
2. Quantitative
    a. S/N
    b. Resolution
    c. Linearity
    d. Scan parameters
    e. Response time
    f. Power Drain

C. EMI

D. Off limit input variation

1. Power Drain
2. Quality of RETMA chart picture

E. Humidity

F. Explosive atmosphere

G. Vibration

H. Acceleration

I. Acoustics

J. Thermal vacuum

K. High temperature

L. <u>Low temperature</u>

M. <u>Shock</u>

N. <u>Oxygen exposure</u>

O. <u>Vibration, off-limit test</u>

P. <u>High termperature, off-limit test</u>

Q. <u>Storage Container</u>

R. <u>Cable Assemblies</u>