LEBAR — FINAL COPY

LUNAR TV CAMERA

EXHIBIT A

STATEMENT OF WORK

August 15, 1966

NASA/MSC

List of Tables

List of Illustration

TABLE OF CONTENTS

SPECIFICATION

TELEVISION EQUIPMENT, APOLLO SPACECRAFT

1. Scope

This specification covers the requirements for the design, manufacture, and test of a television camera and associated hardware, hereinafter referred to as the equipment, for Apollo Spacecraft.

a. The camera will be required to operate within the Apollo Command Module during pre-launch, earth orbit, translunar, and transearth phases of the Lunar mission. It will be transferred to the Lunar Excursion Module (LEM) for descent to the Moon, and will be required to operate from within the LEM during Lunar Staytime only. The camera will be required to operate upon lunar surface during lunar day or lunar night. Total mission time will be 360 hours. Total lunar staytime will be a maximum of 44 hours. The camera will be required to operate for a maximum of 8 consecutive hours and a minimum of 6 consecutive hours for 2 different periods during the lunar staytime. Afterwards the camera will be transferred to the Command Module for the use during the transearth phase. When the camera is not in operation during the lunar staytime, it will be stowed in the LEM controlled environment.

NOTE: The camera must be designed to handle both lunar day and night missions; however, it will be assumed that knowledge of whether the mission will be day or night will be available early enough to make small modifications to the

camera thereby enabling savings in weight, volume, power dissapation or equipment complexity.

b. The accessory equipment of the camera will be required in various configurations for support of camera operation during the different phases of ground testing and flight. Table I below identifies the accessories with respect to their environment during the lunar mission and the illustrations included herein which give their overall physical characteristics.

TABLE I

Item	Description	CM	LEM	Lunar Surface	Fig.
1.	CM Storage Frame	X			1
2.	LEM Storage Frame		X		2*
3.	Telephoto Lens Holder		X		3
4.	Day/Night Lens Holder		X		4
5.	Wide Angle Lens	X			5
6.	Telephoto Lens	X	X	X	6
7.	Lunar Day Lens		X	X	7
8.	Lunar Night Lens		X	X	8
9.	CM Cable	X			9
10.	LEM Cable		X		10**
11.	Cable Connector	Ground	use	only	11
12.	Bulkhead Receptacle		X		12
13.	Thermal Shields (2)	X	X	X	13

*Figure 2 - Shall be changed for purposes of this contract to incorporate a spring holding clip such that the camera can be mounted into the storage frame with one hand by the suited astronaut (reference paragraph 3.5.2).

**Figure 10 - Shall be changed for purposes of this contract to incorporate a non-slip surface to the camera handle such that the astronaut's gloved hand will exhibit negligible slip when in contact with the handle.

2. Applicable Documents

2.1 Applicability

The following documents, of the issue dates specified below, form a part of this specification to the extent specified herein. When the requirements of this specification and the requirements of the documents referenced herein are in conflict, the order of precedence shall be as follows:

a. This specification

b. Documents referenced herein.

2.1.1 Government Documents

Specifications

Military

MIL-S-3151 10 March 1950	Sound Level Measuring Equipment
MIL-E-5272 20 January 1960	Environmental Testing, Aeronautical and Associated Equipment General Specification for
MIL-A-8625 14 December 1954	Anodic Coatings for Aluminum and Aluminum Alloys
MIL-A-26669 14 July 1959	Acoustical Noise Tests, Aeronautical and Associated Equipment
MIL-STD-810 (USAF) 14 June 1962	Environmental Test Methods for Aerospace and Ground Equipment

MIL-E-6051C MIL-I-26600 MSC-EMI10A	Electromagnetic Interference Specification
NPC-200-2 20 April 1962	Quality Program Provisions for Space System Contractors
NPC-250-1 30 July 1963	Reliability Program Provisions for Space Systems Contractors
MSFC-PROC-158B 12 April 1962	Soldering of Electrical Connections (High Reliability), Procedure for (Use for soldering only) Use insulated teflon wire, MIL-W-16878, Type E and EE. The high temperature solder/Federal Specification QQ-S-571D composition SN10 and SB5 in addition to type in paragraph VI.A; 1.A of 158B is allowed.
MIL-STD-130 8 September 1958	Identification Marking of US Military Property
MIL-STD-143 15 June 1960	Specification and Standards, Order of Precedence for the Selection of
MIL-STD-202 14 March 1960	Test Methods for Electronic and Electrical Component Parts

3. Requirements

These requirements shall be applicable to the extent specified in detail in Section 4, Development and Qualification Testing.

3.1 Material, Parts and Processes

All materials, parts and processes used in the manufacture of equipment furnished hereunder shall be of high and uniform quality and capable of withstanding the mechanical, electrical, environmental conditions specified. All materials, parts and processes shall require NASA (MSC) approval in accordance with Para 6.3. As a guide to the selection of materials, the following criteria is established. The chemical and physical analysis of raw material as required by NPC 200-2 shall not be required.

3.1.1 Ignition Temperature

The ignition temperature of any material used shall be no less than 50 degrees F. above the maximum operating temperature of any element of the equipment furnished hereunder.

3.1.2 Weight Loss

No material used in the equipment shall experience a weight loss in excess of 1 percent after 2 weeks of operation under the specifi ed environments.

3.1.3 Sublimitation

3.1.3.1 Acceptable

The following metals, or their alloys, are acceptable:

Molybdenum	Silicon	Silver
Chromium	Beryllium	Tin
Titanium	Copper (except brasses)	Lead
Iron (steel)	Gold	Bismuth
Cobalt	Germanium	Iridium
Nickel	Aluminum	Lithium
Brass(plated)		Magnesium

3.1.3.2 Unacceptable

The following metals , or their alloys, are unacceptable:

Cadmium
Zinc

3.1.4 Selection of Specifications and Standards

Specifications and standards for necessary commodities and services not specified herein shall be selected using Standard MIL-STD-143 as a guide.

3.1.5 Selection of Parts

Air Force, Navy (AN), and Military Standards (MS) parts and parts covered by Military Specifications designation may be used and shall be identified as such on the contractor's drawings. Commercial parts may be used where no Military parts exist, but shall be subject to NASA(MSC) approval in accordance with Para 6.3. The establishment of all failure rates and

performance variations as a function of time and environmental stress shall require NASA (MSC) approval in accordance with Paragraph 6.3. Verification of failure rates and performance variations by means of component testing is not required.

3.1.6 Protective Treatment

Protection shall be afforded materials that may deteriorate when exposed to the environmental conditions encountered during installation or use. All nutrient materials used shall be treated against any known fungi.

3.1.7 Toxic Effects

Materials that may create or liberate toxic products when exposed to the environmental conditions specified herein are prohibited.

3.1.8 Electrical Connections

All electrical connections requiring soldering shall be soldered in compliance with Specification MSFC-PROC-158B. The technique to be employed for connections which are not soldered shall be throughly documented and presented to NASA-MSC for approval, in accordance with Para 6.3.

3.1.9 Anodizing

Aluminum alloy shall be anodized in accordance with Specification MIL-A-8625.

3.1.10 Ignition Proof

Electrical equipment, or the operation of the same, shall not be capable of igniting any explosive mixture existing in the cabin, and shall not contribute to the generation of toxic, noxious, flamable, or explosive mixtures as defined in MIL-STD-810.

3.1.11 Oxygen Exposure

The materials shall be capable of functioning in an atmosphere of pure (100%) oxygen before, during, and after exposure to all applicable environmental conditions.

3.2 Design and Construction

Design of equipment furnished hereunder shall include consideration for minimum weight. Construction of the equipment furnished hereunder shall employ the latest state-of-the-art techniques and shall facilitate compliance with the requirements hereof at the degree and level of reliability specified.

3.3 Performance

The equipment furnished hereunder shall be capable of operation within the limits specified.

3.3.1 Operating Conditions

The equipment shall be capable of operation with a maximum power dissipation of 6.5 watts, under the following input voltage conditions:

a. Steady voltage between 24 and 31.5 volts DC.

(1) Low Line Limits -- 20 volts for periods not exceeding five seconds.

(2) Transient Voltage Limits (absolute values)

(a) Positive: 78 volts for 10 microseconds at 10 pps repetition rate for a period of five minutes.

(b) Negative: 100 volts for 10 microseconds at 10 pps repetition rate for a period of five minutes.

(3) Ripple - 3 volts peak-to-peak 50 - 20,000 cps

b. DC shall be independent of equipment ground.

c. Performance, as specified, is not required during a normal transient or low line voltage conditions. However, equipment

(Page 8 - NOT USED)

shall remain undamaged as a result of exposure to transient or low line voltages.

3.3.2 Redundancy

Circuits shall be redundant only as required for reliability. No circuit design compromise shall be made in the application of redundancy.

3.3.3 Scanning Parameters

The scanning parameters for the Apollo TV Camera shall be consistent with the Composite Video and Sync Format shown in Figure 14 and the details in the following paragraphs.

3.3.3.1 Line and Frame Scan

An internal oscillator with a maximum tolerance $\leq 0.02\%$ shall be used to provide the timing reference for two modes of operation. All countdown and pulse durations for both modes are obtained by binary countdown from the basic oscillator frequency. The operating mode is selected by activating a single externally available switch. One mode is at 10 frames per second and has 320 lines per frame including the lines blanked during vertical retrace. The other mode is at 0.625 frames per second and has 1280 lines including those blanked during vertical retrace. Every other line in the 1280 line mode may be blanked to improve signal current.

3.3.3.2 Line Blanking Interval and Synchronizing Information

3.3.3.2.1 Horizontal Figure 14

The horizontal blanking interval shall be 10.5 percent maximum of the total line time. During the blanking interval the horizontal waveform shall:

a. In the 10 fps., 320 line mode have a referenced level of four microseconds minimum (front porch), provide synchronization information for 20 microseconds nominal, and return to the reference level for an additional four microseconds (back porch).

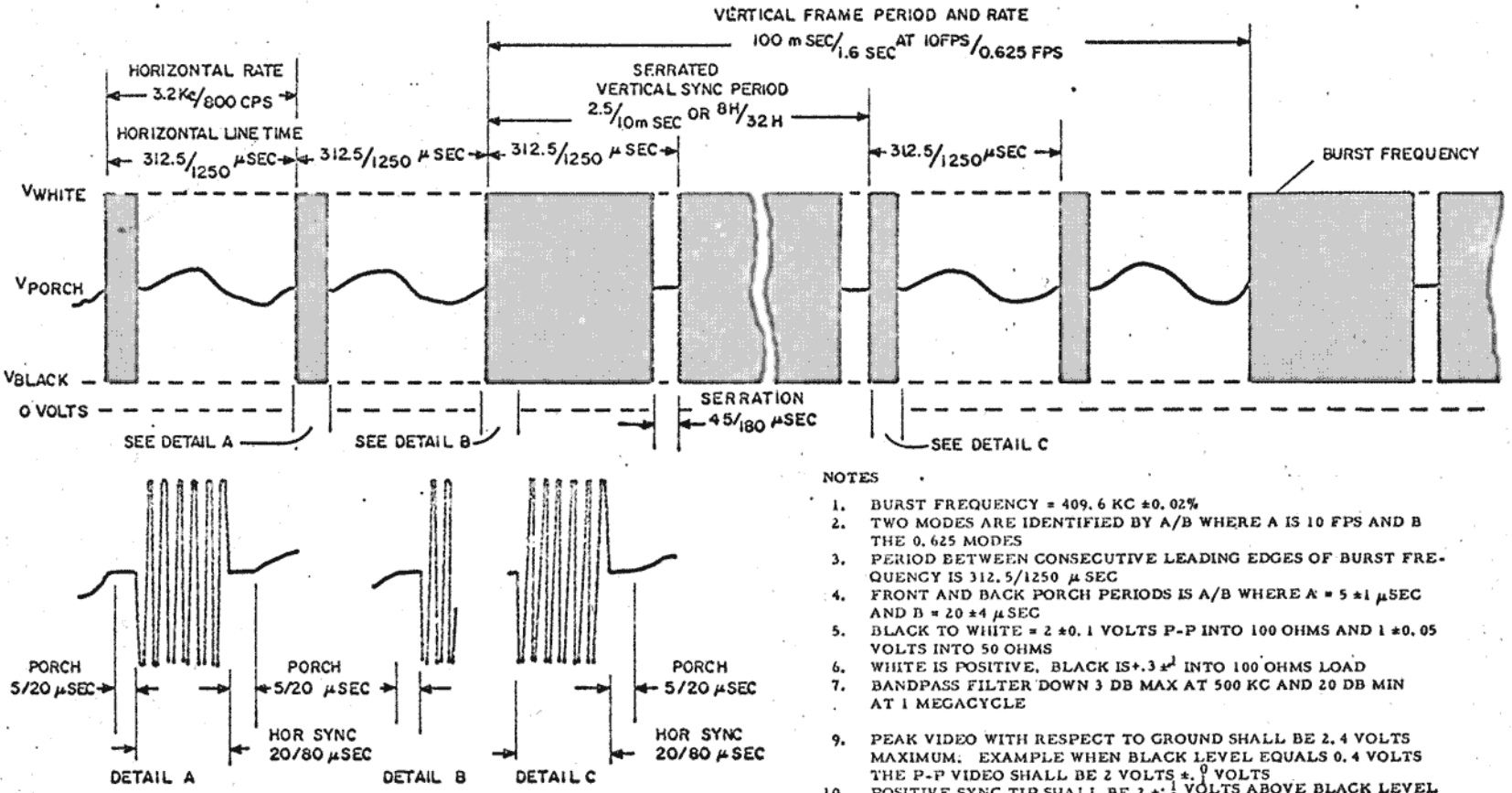


Figure 14 - TV CAMERA COMPOSITE VIDEO AND SYNC FORMAT

NOTES

1. BURST FREQUENCY = 409.6 KC ±0.02%
2. TWO MODES ARE IDENTIFIED BY A/B WHERE A IS 10 FPS AND B THE 0.625 MODES
3. PERIOD BETWEEN CONSECUTIVE LEADING EDGES OF BURST FREQUENCY IS 312.5/1250 μ SEC
4. FRONT AND BACK PORCH PERIODS IS A/B WHERE A = 5 ±1 μSEC AND B = 20 ±4 μSEC
5. BLACK TO WHITE = 2 ±0.1 VOLTS P-P INTO 100 OHMS AND 1 ±0.05 VOLTS INTO 50 OHMS
6. WHITE IS POSITIVE, BLACK IS +.3 ±.1 INTO 100 OHMS LOAD
7. BANDPASS FILTER DOWN 3 DB MAX AT 500 KC AND 20 DB MIN AT 1 MEGACYCLE

9. PEAK VIDEO WITH RESPECT TO GROUND SHALL BE 2.4 VOLTS MAXIMUM. EXAMPLE WHEN BLACK LEVEL EQUALS 0.4 VOLTS THE P-P VIDEO SHALL BE 2 VOLTS $\pm^{0}_{.1}$ VOLTS
10. POSITIVE SYNC TIP SHALL BE 2 $\pm^{.1}_{0}$ VOLTS ABOVE BLACK LEVEL BUT SHALL NOT EXCEED PEAK WHITE VIDEO
11. PORCH LEVEL SHALL BE 1/2 BLACK TO WHITE VOLTAGE EXCURSION ±0.1 VOLTS
12. CAMERA OUTPUT STAGE IS A CURRENT SOURCE PRODUCING 2 VOLTS P-P INTO 100 OHM EXTERNAL LOAD OR 1 VOLT INTO 50 OHM EXTERNAL LOAD

13. Negative Burst level = video black $^{+.1}_{-.0}$ Black level is the minimum signal (video or sync) excursion.

b. In the 0.625, 1280 line mode have a reference level of 16 microseconds minimum (front porch), provide synchronization information for 80 microseconds nominal, and return to the reference level for an additional 16 microseconds minimum (back porch).

c. The synchronization information shall be a burst of sine-wave oscillations with a peak-to-peak value equal to the black and white voltage excursion levels of the video information. The frequency of the synchronization information shall be such that it is in phase or locked to the internal clock.

3.3.3.2.2 Vertical

The vertical blanking interval shall be 2.75 percent maximum of the frame period. The waveform shall consist of sinewave oscillations as described above but serrated such that the periods between the leading edges of the burst frequencies will be equal to the corresponding horizontal line time for the mode in use. Serrations between the frequency bursts will be at the reference dc level and will be 45 microseconds nominal for the 10 frame per second mode and 180 microseconds nominal for the 0.625 frame per second mode, and will occur prior to horizontal sync time.

3.3.4 System Video Bandwidth

The system video output response characteristics shall be flat within plus or minus 1db to 250kc and plus or minus 3 db at 500 kc. The low frequency response at 4 cps prior to dc restoration shall be plus or minus 3 db. The system's video output maximum signal at 1 mc shall be at least 20 db below the maximum output at 250 kc. The maximum tilt through the clamp shall be less than 4%.

3.3.5 Grey Scale Rendition

The equipment shall produce 7 logarithmic EIA grey scales as viewed on a monitor. The individual grey scale area shall be vertical bars equivalent to a 30 TV-line area.

3.3.6 Aspect Ratio

The equipment shall provide image tube surface scanning such that the aspect ratio of the finalized picture is 4:3. The scanning format shall be within the scene imaged on the image sensor.

3.3.7 Load Characteristics

The equipment shall be capable of developing a 2 plus or minus .1 volt maximum peak-to-peak video signal across a 100 ohm resistance load; or 1 plus or minus 0.05 volt peak-to-peak video signal across a 50 ohm resistance load. The peak-to-peak video signal is referenced to a 0.3 $\pm$ .1 volt black level and clipping is permitted to control maximum peak swing.

3.3.8 Controls

3.3.8.1 Electrical

Except for designed-in automatic adjustments, the equipment shall be capable of operation without electrical adjustments after initial installation. The automatic controls shall hold the peak video output between 1 to 2

volts over entire light range when working into 100 ohm load.

3.3.8.2 Optical

The optical system shall require no manual adjustment.

3.3.9 Resolution

Category 1 equipment: One qualified equipment minimum shall be capable of producing a minimum of:

10 fps	100 television lines at 45% square wave response point referenced to a window chart.
10 fps	200 television lines at 20% square wave response point referenced to a window chart.
.625 fps	100 television line at 45% square wave response point referenced to a window chart.
.625 fps	200 television line at 28% square wave response point referenced to a window chart.
.625 fps	300 television line at 15% square wave response point referenced to a window chart.
.625 fps	500 television lines limiting

Category 2 equipment:

Six qualified equipments minimum shall be capable of producing a minimum of:

10 fps	100 television lines at 55% square wave response referenced to a window chart.
10 fps	200 television lines at 20% square wave response referenced to a window chart.
.625 fps	100 television lines at 55% square wave response referenced to a window chart.
.625 fps	200 television lines at 28% square wave response referenced to a window chart.

.625 fps — 300 television lines at 12% square wave response referenced to a window chart.

.625 fps — 425 television lines limiting.

Category 3 equipment:

Three production prototype equipments shall be capable of producing as a minimum that defined under category 2, paragraph 3.3.9.

Category 4 Equipment:

Four STM equipments shall be capable of producing as a minimum that defined under Category 2, paragraph 3.3.9, less 10%.

Category 5 Equipment:

Two STM equipments shall be capable of producing as a minimum that defined under Category 2, paragraph 3.3.9.

Category 6 Equipment:

The engineering model cameras shall be used for engineering purposes to demonstrate feasibility.

3.3.10 Temperature Control

The equipment shall include self-cooling or heating provisions as may be required consistent with normal spacecraft and lunar environments. A suitable temperature indicator will be developed that will provide indication of safe operating temperature. The unit break-in point for temperature indicator use will be mutually established at the conclusion of the development program.

3.3.11 Black Level Direction

The equipment shall develop white positive polarity across the resistive load defined in Paragraph 3.3.7.

3.3.12 - Signal-to-noise

Category 1 and 2 equipment as defined in paragraph 3.3.9 shall produce as a minimum:

a. 40 db when operated at 10 frames per second when operated on the lunar surface with .09 foot candles or higher as defined in paragraph 3.4.2.3.1 incident highlight illumination at the optics input.

b. 26 db when operated at 10 f/s looking through the LEM window with .0056 foot candles incident high light illumination at the optics input.

c. 29 db when operated at 10 frames per second on the lunar surface with .007 foot candles incident high light illumination at the optics input.

Category 3, 4 and 5 equipment as defined in paragraph 3.3.9 shall produce as a minimum:

a. 35 db when operated at 10 frames per second when operated with .09 foot candles or higher as defined in paragraph 3.4.2.3.1 incident highlight illumination at the optics input.

b. 23 db when operated at 10 frames per second looking through the LEM window with .0056 foot candles incident high light illumination at the optics input.

c. 26 db when operated at 10 frames per second on the lunar surface with .007 foot candles incident high light illumination at the optics input.

Category 1, one qualified equipment minimum defined in paragraph 3.3.9, shall produce as a minimum:

d. 28 db when operated at .625 F/S per second or higher on the lunar surface with a .045 foot candle or higher as defined in paragraph 3.4.2.3.1 incident highlight illumination at the optics input.

e. 17 db when operated at .625 frames per second looking through the LM window with .0056 foot candles incident highlight illumination at the optics input.

Three qualified equipments minimum defined in catagory 2, paragraph 3.3.9 shall produce as a minimum:

f. 27 db when operated as defined in paragraph 3.3.12 D

g. 17 db when operated as defined in paragraph 3.3.12 E.

Three qualified equipments maximum defined in catagory 2, paragraph 3.3.9 shall produce as a minimum:

h. 24 db when operated as defined in paragraph 3.3.12D

i. 17 db when operated as defined in paragraph 3.3.12E

Three production equipments defined in catagory 3, paragraph 3.3.9, shall produce as minimum that defined in paragraph 3.3.12H and I.

Signal-to-noise shall be measured from a photograph taken of an individual line of video. The camera shutter speed shall be at least 5 frame times.

Formula shall be $20 \log \frac{\text{PP signal}}{\text{PP Black level noise}} \times 6$

STM equipment defined in paragraph 3.3.9 Category 4 and 5 shall produce:

24 db when operated as defined in paragraph 3.3.12D

17 db when operated as defined in paragraph 3.3.12E

3.3.13 Linearity

Overall system geometric distortion shall be less than 5% of picture height.

3.3.14 Picture Quality

3.3.14.1 - Spots due to tube defects shall not exceed the criteria contained in figure 20. This spot criterion does not apply to STM and P type equipments, but development and qualification test objectives shall not be compromised by spots.

3.4 Environmental Requirements

3.4.1 Non-Operating (Pre-Launch)

The equipment, packaged for shipping, ground handling, transportation and storage, shall be capable of performance as specified immediately after exposure to the following natural and induced environments separately or in natural combinations. No verification testing will be required.

a. Temperature

A range from minus 20 degrees F. to plus 140 degrees F. for 2 weeks for transportation. A range of from plus 25 degrees F. to plus 105 degrees F. for 3 years, and superposition of solar radiation of 360 British thermal units (Btu) per square foot per hour for 6 hours per day for 30 days for storage.

b. Altitude

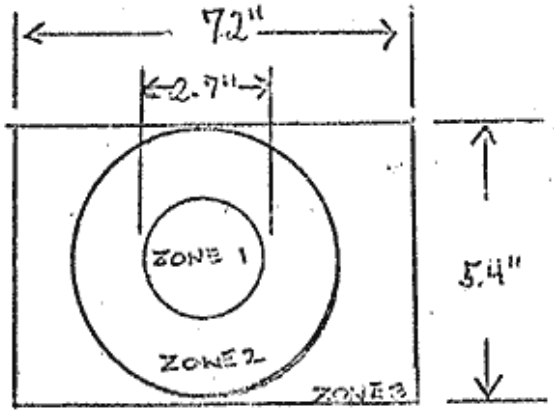
35,000 feet for 8 hours for transportation and 6,000 feet for 3 years for storage. Sensor (tube) may be operated during this period as established in end item data package maintenance procedure.

Figure 20

Lunar TV Camera Blemish Specification

Operate camera tube with normal scan of 3/8 X 1/2 inch.

In the monitor use a CRT having a nine inch diagonal (3 X 4 aspect ratio)



Rejection Criteria /1

Spot size (inches)

	Number Allowed		
	Zone 1	Zone 2	Zone 3
< 0.015	/2	/2	/2
0.015 to 0.050	5 /3	3 /3	5 /3
0.050 to 0.065	0	1	3 /3
> 0.065	0	0	0

/1 To be considered a spot, light or dark, contrast must be greater than 2 to 1.

/2 Spots under 0.015 not to be counted.

/3 Minimum separation between any two spots shall be 0.50 inch.

Under 0.59 usec no spot

.0255 inch/usec

0.59 µsec // 0.015 inch
1.98 µsec // 0.05 inch
2.55 µsec // 0.065 inch

Spots up to 2.55 µsec

c. Humidity

95 plus or minus 5 percent relative, including condensation of water.

d. Rain

0.6 inch per hour for 12 hours.

e. Sand and Dust

Equivalent to 140 mesh silica flour with particle velocity of 500 feet per minute.

f. Fungus

As found in tropical areas, including that specified in Specification MIL-E-5272.

g. Salt Spray

Equivalent to 20 percent salt solution for 50 hours

h. Ozone

3 year exposure to 0.05 ppm concentration

i. Vibration

5 to 27.5 cps plus or minus 1.56 g; 27.5 to 52 cps 0.043 inch double amplitude (da); 52 to 500 cps plus or minus 6.00 g. Vibration shall be performed in accordance with MIL-E-4970A.

j. Shock

30 g. for 11 plus or minus 1 millisecond (msec).

3.4.2 Non-Operating (Launch and Post-Launch)

3.4.2.1 Command Module

a. Temperature

Zero degrees F to plus 100 degrees F normal cabin operation plus 160 degrees F emergency cabin operation.

b. Acceleration

7 g's for five minutes during launch.

c. Humidity

95 ±5% relative

d. Pressure

258 mm of Hg (normal); 1×10^{-10} mm of Hg (emergency)

e. Shock

The camera case and mounting shall withstand a 78 g shock. The wave form shall be half sine with 11 millisecond duration for emergency earth landing conditions.

f. Oxidation

100% oxygen at 258 mm of Hg.

g. Vibration

In accordance with Table II.

h. Corrosive Contaminents

Salt atmosphere as caused by human perspiration, the effect is simulated by exposure to 1% salt solution by weight for 48 hours.

TABLE II - VIBRATION

Acoustical testing shall be applied to a non-operating image sensor assembly only.

Acoustical (.0002 dynes/cm^2, reference)

Test time shall be five minutes.

Octave Band CPS	Intensity DB
90 to 180	129 plus 3, minus 3
180 to 355	124 plus 3, minus 3
355 to 710	125 minimum
710 to 1400	115 minimum
1400 to 2800	107 minimum
2800 to 5600	99 minimum
5600 to 11,200	90 minimum
Overall	130 minimum

Mechanical - The equipment shall be designed for the following random vibrations along each of the three mutually perpendicular major axes. The time of the test shall be 15 minutes per axis.

a. Random - Linear increase at 3 db/octave from 0.008 g^2/cps at 10 cps to 0.06 g^2/cps at 70 cps; constant at 0.06 g^2/cps from 70 to 425 cps with a linear decrease from 0.06 g^2/cps at 425 cps at 3 db/octave to 2000 cps.

3.4.2.2 LEM Cabin (Separation, Descent, Hover, Touchdown and Lunar Stay)

a. Temperature

0 degrees F to 100 degrees F normal cabin operation

plus 160 degrees F emergency cabin operation

b. Acceleration

1.1 g during descent

c. Shock

8.0 g 10 -20 ms

d. Humidity

95 ± 5% relative

e. Pressure

258 mm of Hg (normal); 1×10^{-14} mm of Hg

(uncontrolled cabin)

f. Oxidation

100% oxygen at 258 mm of Hg

g. Vibration

All mission phases are as indicated in Figures 15 and 16. Factors of 1.3 and 1.3^2 are to be applied to the sinusoidal and random vibrations respectively to convert to qualification test levels.

h. Corrosive Contaminants

Same as 3.4.3.1.h

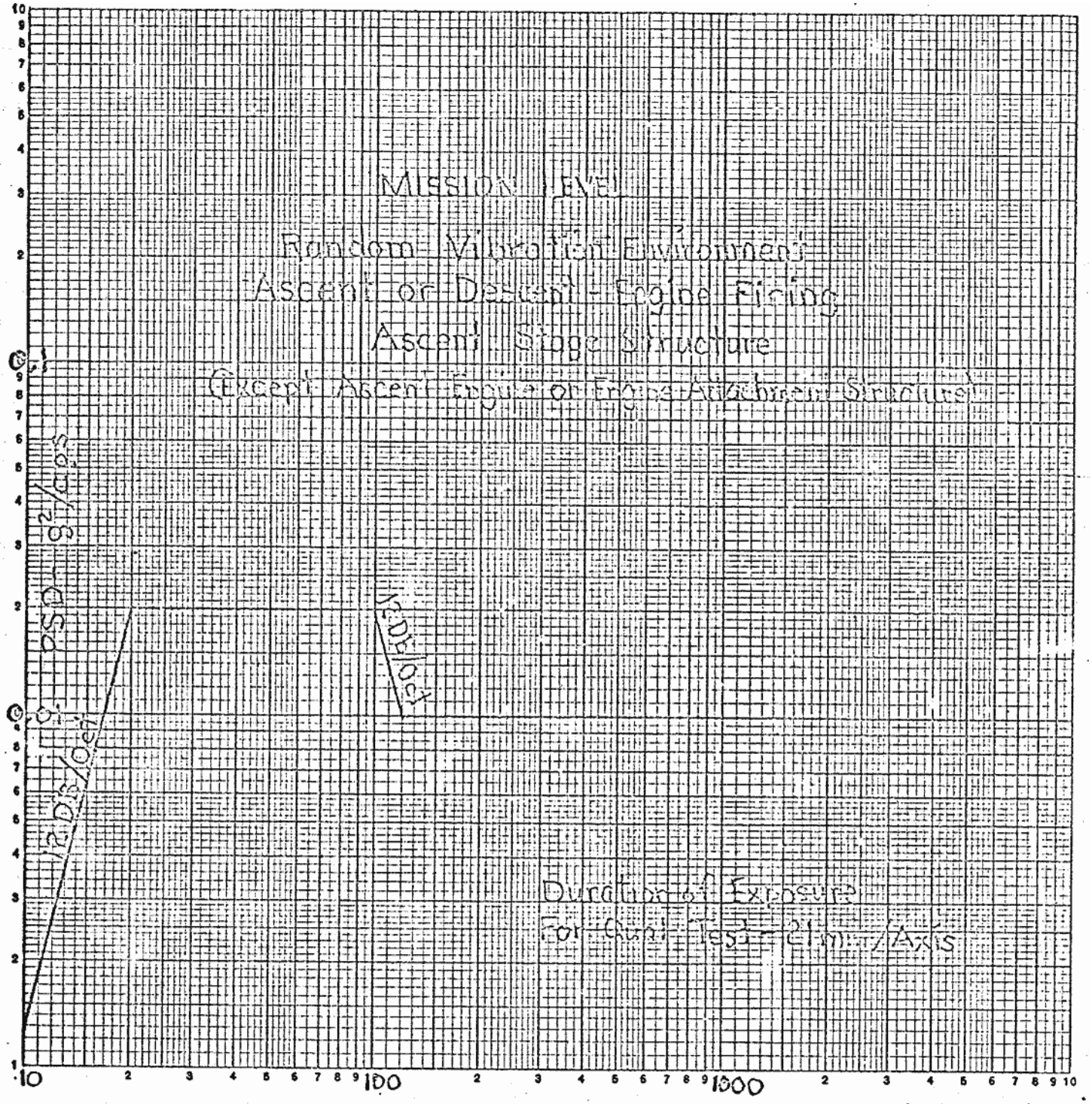


Figure 15. LEM Random Vibration Environment

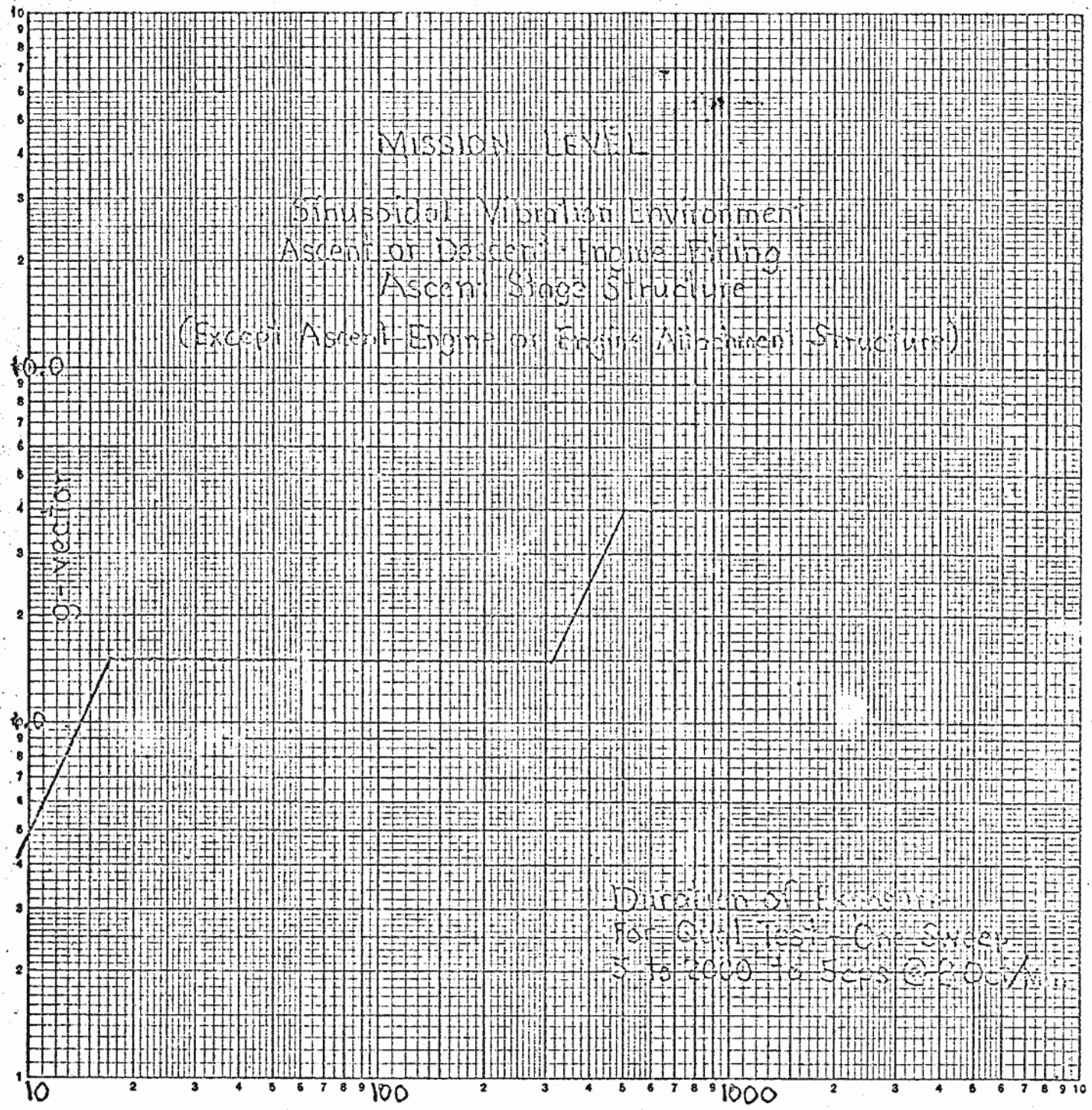


Figure 16: LEM Sinusoidal Vibration Environment

3.4.2.3 Lunar Surface

a. Temperature

Lunar surface, +250 degrees F (day) to -300 degrees F (night); deep space, -450 degrees F; solar input, 440 Btu/hr/ft^2 (day)

b. Pressure

1 X 10^{-14} mm of Hg.

c. Radiation and Meteoroid Environment

As indicated in Figures 17 and 18 and NASA/MSC Engineering Criteria Bulletin EC-1, meteoroid environment in near-earth, cislunar, and near-lunar space.

3.4.2.3.1 Illumination Levels Lunar Day

12,600 ft candles to 20 ft candles incident highlight illumination at optical input

Lunar Night

.007 ft. candle to 1.2 foot candles incident highlight illumination at the optical input.

NOTE: These levels will be reduced to 80% when viewed from within the LEM cabin.

3.4.3 Operating

3.4.3.1 Command Module

Same as 3.4.2.1 except that operation during vibration, acceleration and after 78 g shock is not required; however, no part of the equipment shall become free as a result of the shock. No operation during 160 degrees F emergency condition required but thermal indicator can be used as guide for safe operation during this period.

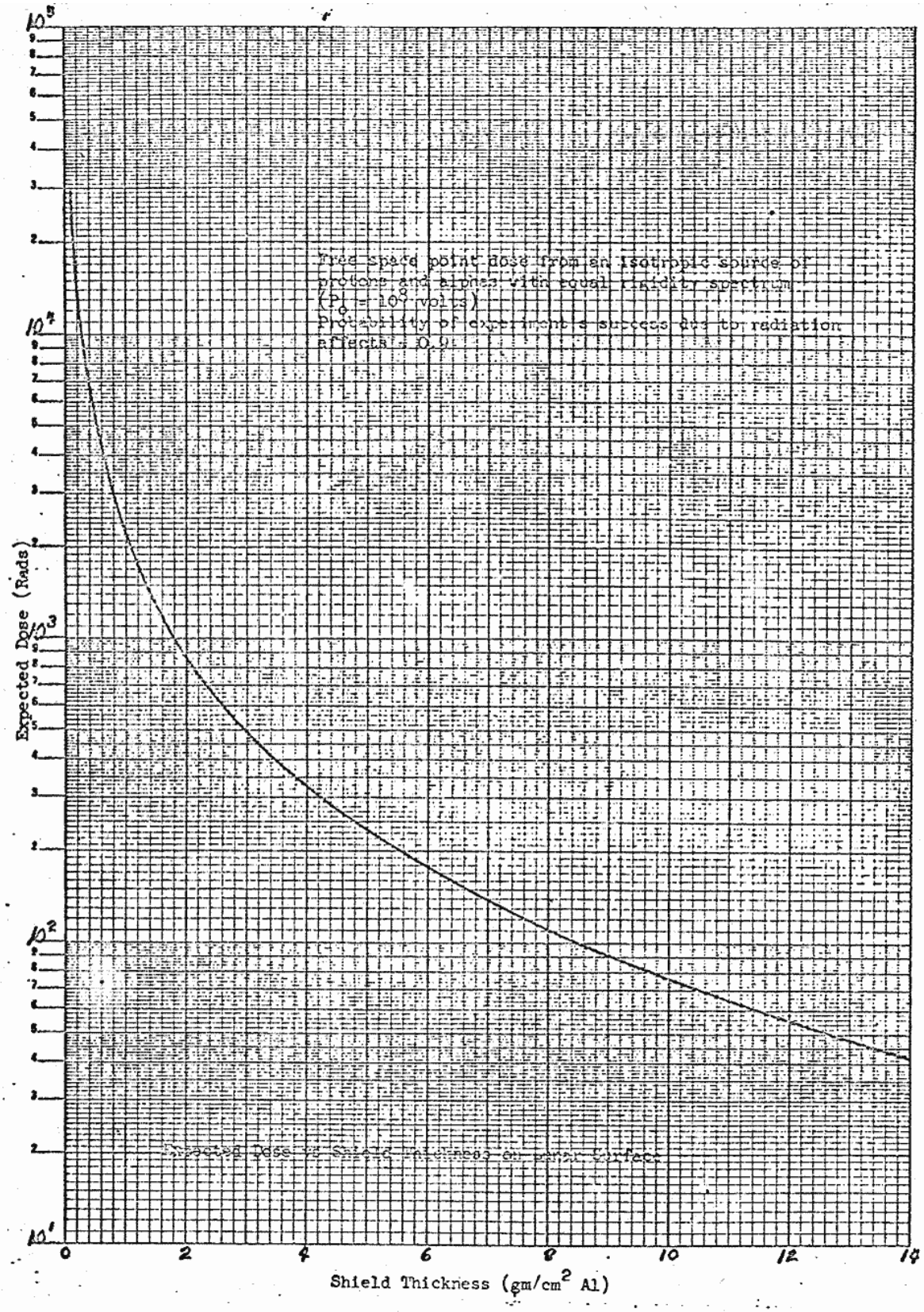
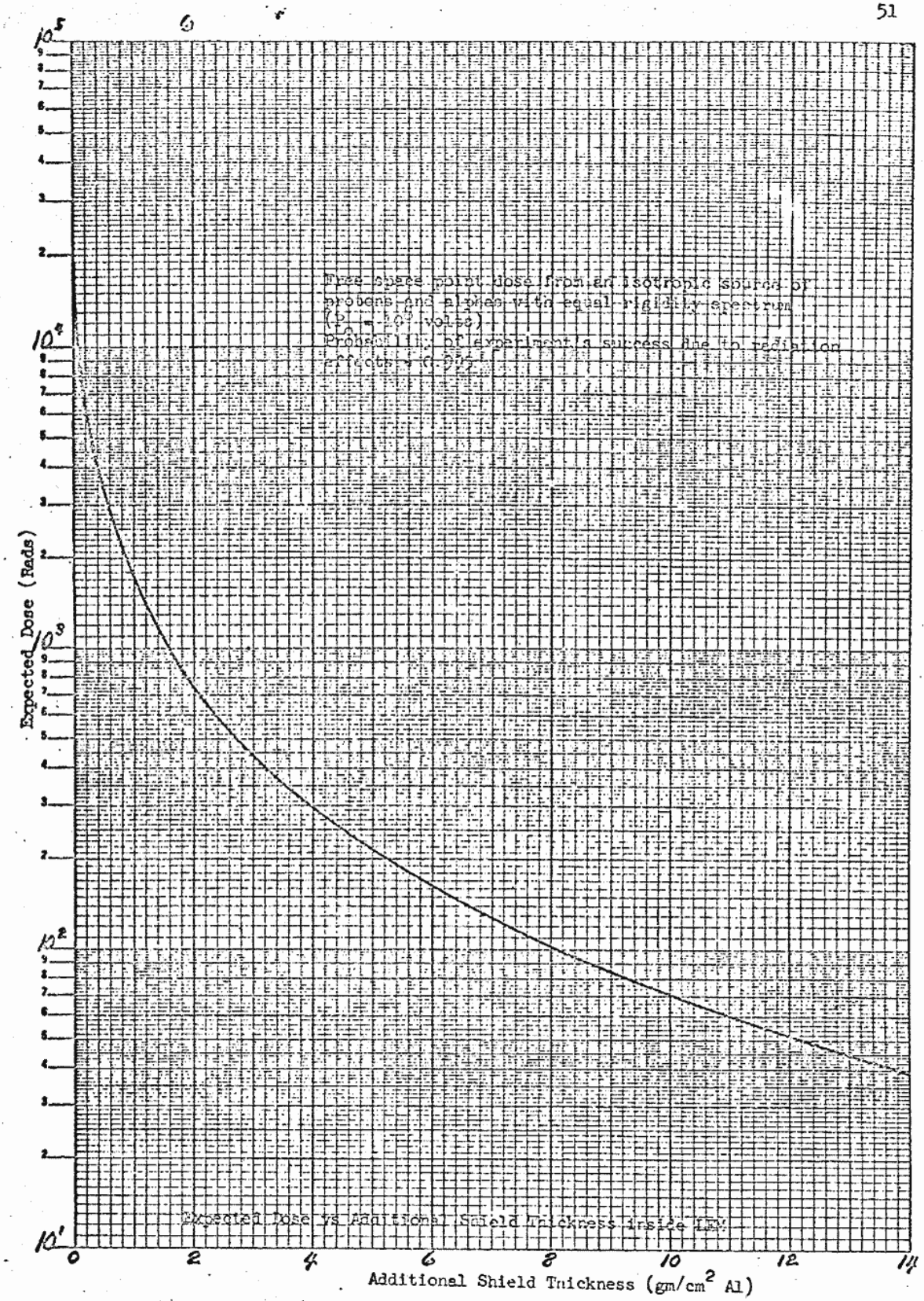


Figure 17. Radiation Dosage on Lunar Surface for 1 year period



Expected Dose vs Additional Shield Thickness Inside Tav

Figure 18

3.4.3.2 LEM Cabin

Same as 3.4.2.2 except that acceleration, shock, and vibration are to be omitted. No operation during 160 degrees F emergency condition required, but thermal indicator can be used as guide for safe operation during this period.

3.4.3.3 Lunar Surface

Same as 3.4.2.3

3.4.3.4 Pre-Launch

Same as 3.4.2.1 except no acceleration, shock and vibration and with the addition of Salt Spray (equivalent to 1% salt solution) as found in coastal areas.

3.5.1 Test Points

3.5.1.1 Internal

Internal test, or access points shall be available for bench maintenance. These points shall include, but not be limited to the following:

a. Video pre-amp output
b. Composite video output
c. Horizontal and vertical sweep waveform
d. Horizontal and vertical blanking waveform
e. Focus voltage
f. Horizontal and vertical ramp trigger and sync waveform
g. Internal oscillator output
h. DC voltage regulator output
i. Line voltage input

j. Signal ground

k. Critical sensor element voltages

3.5.1.2 External

The equipment shall include the following external test points for checkout with ground support equipment. These points shall be located on the external test connector of Para 3.5.4.1.

a. Composite video output

b. Unregulated dc supply voltage

c. Signal ground

3.5.2 Portability

The equipment shall be portable and shall be provided with a hand holding device, such as a light weight round functional handle.

3.5.3 Elapsed Time Meter

The assembled camera shall be supplied with an approved miniature elapsed time meter, which shall record time that input power is applied, and this shall include all test time. This meter is not to be part of the camera package, but will be connected externally and will be disconnected before flight.

3.5.4 External Connectors

3.5.4.1 Test Connector

An external test connector approved by NASA/MSC in accordance with Para 6.3, shall be provided for monitoring power input and video output during pre-launch periods only. The connector shall be capped and the cap shall be within equipment contour, if the connector is a

permanent part of the camera. This does not apply if the connector is to be a temporary element in the cable which normally connects the camera to the spacecraft.

3.5.4.2 Operational Connector

An external operational connector approved by NASA according to Para 6.3 shall be provided for the following:

a. Power input (2 wires)

b. Video output (coax)

The connector shall be capable of mating and unmating operations in all mission environments and shall be compatible with the lunar surface TV cable.

3.5.5 Optics

The equipment shall be provided with lenses as necessary to meet the performance requirements specified in Para 3.3 for the following scenes.

3.5.5.1 Command Module

Interior views and views out of the window.

3.5.5.2 LEM Cabin and Lunar Surface

a. View of earth from moon

b. View of astronaut from LEM cabin or LEM vicinity. Astronaut will walk 1000 feet away from LEM.

c. View of LEM as seen by astronaut. Astronaut will be as far as 80 feet away.

d. View of general lunar landscope as seen by astronaut in LEM cabin or as far as 80 feet away from LEM.

3.6 Electromagnetic Interference Suppression

The equipment shall be designed to meet the requirements of MIL-E-6051C, MIL-I-26600, and MSC-EMI10A.

3.7 Identification of Product

Equipment furnished under the requirements of this specification shall be durably and legibly marked in accordance with the requirements of MIL-STD-130 as follows:

Item Name _____
Manufacturer's Part Number _____
Manufacturer's Serial Number _____
Manufacturer's Name _____
Contract Number _____
NASA NSN Number _____
NASA NTN Number _____
U. S. _____

3.8 Model Classifications

3.8.1 Breadboard Model

This is an assembly of preliminary circuits and parts to prove the feasibility of a device, circuit, equipment, system, or principle in rough form without regard to the eventual overall design or form of parts.

3.8.2 Service Test Model

This is a model designed to meet the performance requirements of the specification. This model employs approved parts or

their interchangeable equivalents. It may be used to demonstrate the reproducibility of the equipment design. This applies to STM 5 and 6; STM 1, 2, 3, and 4 may use non-approved parts.

3.8.3 Prototype Model

This is a flightweight model suitable for complete evaluation of all physical and functional characteristics. It is of final mechanical and electrical form, employs approved parts, and is fabricated with approved tooling and processes. This is the model which is subjected to qualification tests.

3.8.4 Qualified Model

This is the final flightweight model employing approved parts and fabricated with approved tooling and processes. It shall be identical to the prototype model which has successfully completed its qualification tests.

3.8.5 Identification and Traceability

Identification and traceability shall be in accordance with a contractor specification derived from NPC-200-2 following negotiation and acceptance by NASA/MSC. This paragraph shall apply to all cameras beginning with STM 5.

3.9 Life

3.9.1 Storage Life

Equipment shall have a storage life of 3 years, during which time the equipment will be operated as necessary to maintain the equipment. Contractor shall indicate required operation during storage.

3.9.2 Service Life

Equipment shall be capable of operation as specified herein for 622 hours of exposure to the specified environments, which includes 250 hours of pre-launch ground checkout.

3.10 Reliability

It shall be design goal that the equipment have a 0.999 probability of performing as required for 14 consecutive days. The contractor must conform with NPC-250-1. The following ground rules are to apply regarding certain reliability tasks:

a. Updating of the reliability estimates is to be done only once at a time after all design has been finalized and in most economical manner.

b. The failure mode effect and criticallity analysis is to be deleted.

c. The qualification status list is to be prepared one time only after all design has been finalized and in most economical manner.

d. Evaluation of testing results is to be limited and primarily concentrated in areas where failures occur.

e. Formal circuit analysis by Reliability Engineering is not required.

3.11 Weight

The weight of the camera only, excluding handle, connector and the optical system shall not exceed 7.25 pounds.

3.12 Interchangeability

All parts or equipment having the same part number shall be physically and functionally interchangeable. This paragraph shall apply to all cameras beginning with STM 5.

3.13 Workmanship

Equipment furnished under the requirements of this specification shall be fabricated in a workmanlike manner complying with sound industry practice. Particular attention shall be given to neatness and thoroughness of working parts, assemblies, plating, welding, and freedom of parts from burrs and sharp edges that might damage associated equipment or cause injury to operating personnel.

3.14 Stowage Equipment

The camera will be supplied with stowage equipment for both the Command Module and LEM Spacecraft. The CM stowage equipment as shown in Fig. 1 will consist of a stowage frame for the camera containing integral stowage provisions for the Telephoto and Wide Angle Lenses. The LEM stowage equipment will consist of a stowage frame (Fig. 2) and separate containers (Figs. 3 and 4) for the telephoto lens and the Lunar Day or Lunar Night lenses.

3.15 Lenses

In order to meet the optical requirements of par. 3.5.5, four lenses as described by Figures 5, 6, 7 and 8 are to be supplied with the camera. When the camera is operated within the Command Module it will use the Wide Angle or Telephoto lens. When the camera is used in the LEM on the Lunar Surface it will use the Telephoto, the Lunar Day or the Lunar Night lens.

3.16 Cables

The camera will be supplied with cables containing two power leads and two video (coax) leads. These cables, which are defined in Figures 9 and 10, will be used to permit operation of the camera within the Command Module and LEM Spacecraft.

3.17 Cable Connector

A cable connector identical to that used on the LEM cable and described in Fig. 11 will be supplied by the contractor to permit construction of various cables to be used with the camera during ground tests.

3.18 Bulkhead Receptacle

A bulkhead receptacle (Fig. 12) will also be supplied by the contractor. The receptacle will be used to join the LEM cable to the LEM Spacecraft wiring.

3.19 Thermal Shields

A thermal shield kit consisting of two thermal shields and described in Fig. 13 will be supplied by the contractor for use with the camera on lunar night missions. The function of the shields will be to permit the operation of the camera in the lunar night low temperature environment.

3.20 Noise Current

The equivalent preamplifier input noise current shall be equal to or less than $.5 \times 10^{-9}$ amperes.

3.21 Temperature Indicator

A temperature indicator shall be included on or in the camera such that a visual indication of camera temperature is produced. Unsafe temperatures (both high and low) shall be indicated.

4.0 Quality Assurance Provisions

4.1 Quality Control

The contractor shall have or establish a program of quality control conforming to the requirements of Specification NPC-200-2.

4.1.1 Surveys

The government reserves the right to conduct Engineering, Reliability, Quality Control, and other surveys as may be deemed necessary to adequately evaluate the contractor's capabilities or to witness, or to designate witnesses for tests, either as consultants or as representatives of government agencies. Unless otherwise specified, the contractor shall be responsible for the performance of all tests prior to submission for government acceptance. Except as otherwise specified, the contractor may utilize his own facilities or any commercial laboratory acceptable to the government.

4.2 Classification of Tests

Tests performed on equipment furnished hereunder shall be classified as follows:

a. Development tests

b. Qualification tests

c. Acceptance tests

4.3 Test Conditions

4.3.1 Test Facilities

Unless otherwise specified herein, all test facilities and conditions shall be in accordance with Specification MIL-E-5400.

4.3.2 Test Equipment

Equipment used to measure item parameters shall not introduce an error greater than 10 percent of the tolerance on the parameter; that is, if a parameter tolerance is plus or minus 10 percent the equipment error shall not be greater than plus or minus 1.0 percent of the parameter nominal value.

4.3.3 Measurements

All measurements shall be made with instruments that have been calibrated and certified in accordance with Specification NPC-200-2.

4.3.4 Notice of Tests

NASA/MSC shall be advised not less than 96 hours prior to any scheduled test specified. No test shall be delayed if the NASA/MSC representative fails to appear if the above notice provision has been complied with.

4.3.5 Test Results Approval

NASA/MSC approval is required on all acceptance and qualification tests. Approval shall be granted only after inspection of the test specimens by NASA/MSC.

4.3.6 Notice of Failure

NASA/MSC shall be advised within 48 hours of any failures occuring during the performance of any development, qualification, or acceptance test if the above notice provision has been complied with.

4.3.7 Design Changes

After successful completion of the design development tests, no design changes or alternations in the operations incidental to manufacturing the assembly shall be made without prior approval of NASA/MSC.

4.4 Development and Qualification Tests

The contractor shall conduct those tests necessary to ensure that the design and construction are compatible with the performance requirements and operating environments specified, and to determine that the materials, parts, components and circuits fit the application. The development/qualification test program plan which was submitted to NASA/MSC was approved in accordance with Paragraph 6.3.7.

4.4.1 Functional Tests

The functional tests at the start of the Development tests shall consist of the Acceptance tests defined in Para 4.6 (less 4.6.2, vibration), and the Standard Functional Tests shall be performed prior to and following each environmental test program. Standard Functional Test performance lists shall be as defined by the contractor, but shall consist of the following tests as a minimum:

a. Input power supply variation and power consumption

b. Video waveform, fast and slow scan

c. Resolution, 3 voltage levels, 2 light levels

d. Linearity, 3 voltage levels, 1 light level

Resolution and linearity measurements shall be made using a test pattern projector.

4.4.2 Humidity

The camera shall be subjected to Method 507 of MIL-STD-810 with the following modifications; 15-100% relative humidity between temperature limits of 55 degrees F to 90 degrees F maximum as shown in Figure 19. Scan parameters, TV monitor noise, and power drain shall be monitored during the tests. The Standard Functional tests shall be performed following removal of the camera from the chamber. Exposed optical elements may be cleaned with a cloth prior to functional tests.

4.4.3 Salt Spray

The camera shall be subjected to Method 509 of MIL-STD-810, with the exception, that a one percent salt solution by weight shall be used. The camera shall operate during two 4-hour periods and for the final two hours of the 48-hour test period. Scan parameters, TV Monitor noise, and power drain shall be monitored while the camera is operated during exposure to the salt spray environment. Following the 48-hour exposure, the camera shall be removed from the chamber and shall be subjected to the standard functional tests. Exposed optical elements may be cleaned with a cloth prior to functional tests. External camera surfaces may be cleaned following test.

4.4.4 Acoustics

This test shall be run on the SEC Vidicon only. A non-operating tube shall be mounted to support structure for the test.

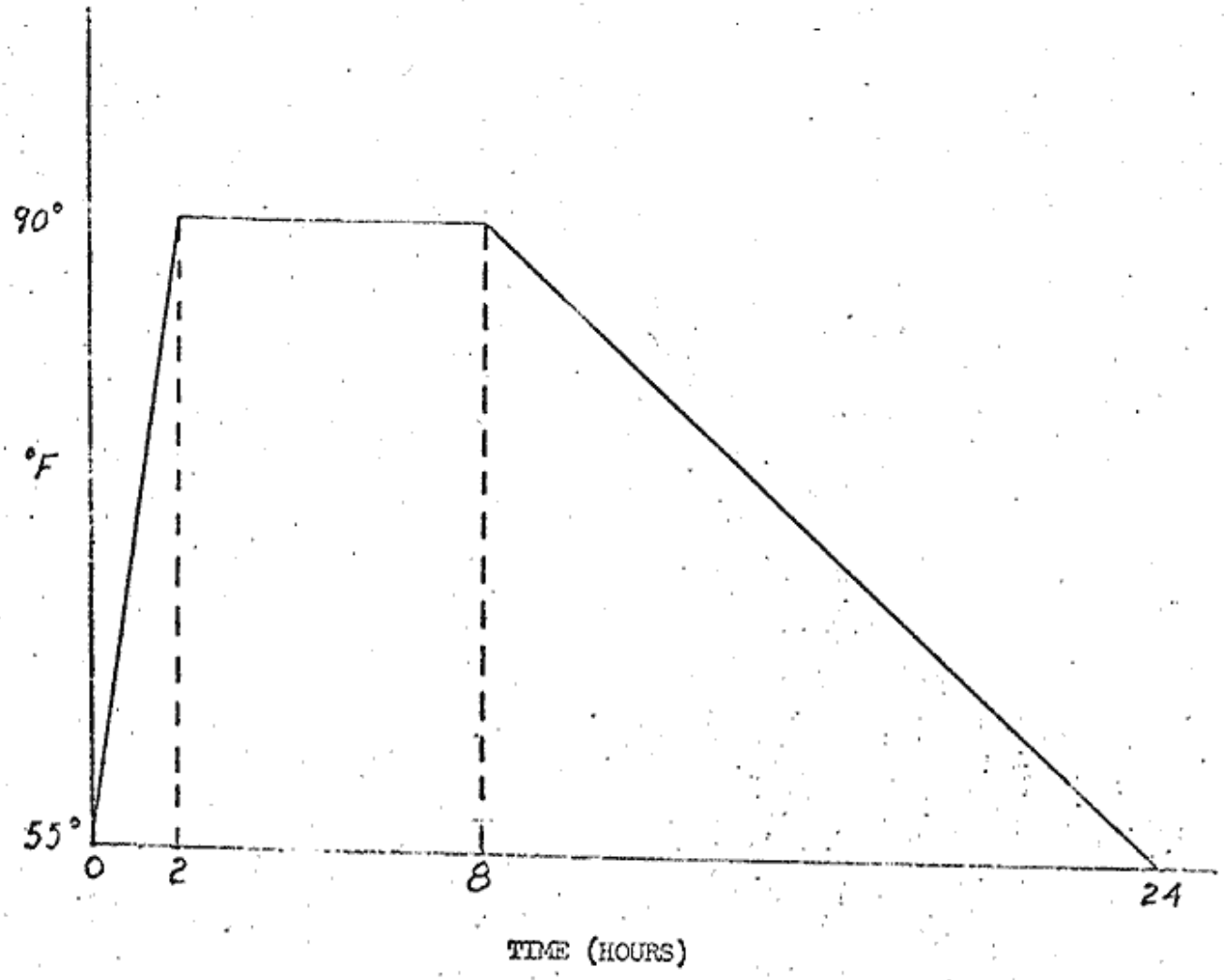


Figure 19- Humidity Test - One Cycle

The test shall be conducted in a reverberant enclosure to the following acoustic noise spectrum:

Overall 130 db min

90-180 cps at 129 ± 3 db

180-355 cps at 124 ± 3 db

355-710 cps at 124 db min

710-1400 cps at 115 db min

1400-2800 cps at 107 db min

2800-5600 cps at 99 db min

5600-11,200 cps at 90 db min

re 0,0002 Dynes/cm - Duration 5 min

Test data shall be accumulated on a minimum of two SEC tubes and the data included in the Camera Development Test Report.

4.4.5 Vibration

4.4.5.1 Mounting Description

The camera and stowage frame shall be attached to a fixture capable of transmitting the vibration condition specified herein. Attachment of the camera and stowage frame to the fixture shall closely simulate the service mounting. The vibration equipment shall be equalized to compensate for fixture resonance. All lines connected to the camera for data recording or actuation shall not appreciably affect the vibration inputs. The magnitude of the applied vibration shall be monitored on the test fixture near the camera mounting points. The camera vibration shall be monitored in its three major axes and other critical axes as necessary.

4.4.5.2 Command Module Vibration

The following random vibration shall be applied along each of the three mutually perpendicular major axes:

a. Random

3 db per octave increase from 0.008 g^2/cps at 10 cps to 0.06 g^2/cps at 70 cps. Constant at 0.06 g^2/cps from 70 to 425 cps with a 3 db per octave decrease from 425 to 2000 cps.

b. Time shall be 15 minutes per axis for random vibration. The equipment shall show no effects of physical damage as a result of the vibrations.

c. The camera shall not be operated during vibration tests.

4.4.5.3 LEM Cabin Vibration

The following sine and random vibration shall be applied separately along each of the three mutually perpendicular major axis.

a. Sine

10 to 17 cycles level of 0.13" double amplitude; constant acceleration of 1.95 g's peak for 17 to 310 cps; 310 to 500 cps level of .0004 double amplitude; and from 500 to 2000 cps level of 5.2 g's peak.

Duration

One sweep 10 to 2000 to 10 cps at 2 octave per minute.

b. Random

Linear increase from .0022 g^2/cps at 10 cps to 0.0338 g^2/cps at 20 cps. Constant amplitude of 0.0338 g^2/cps from 20 to 100 cps. Linear decrease from 0.0338 g^2/cps at 100 cps to

.0169 g^2/cps at 120 cps. Constant amplitude of .0169 g^2/cps from 120 cps to 2000 cps.

Duration

21 minutes per axis.

The camera shall not be operated during the LEM Cabin vibration. The camera shall be subjected to the Standard Functional tests following each axis of vibration.

4.4.6 Electromagnetic Interference

The camera shall be tested to the requirements of MIL-E-6051C, MIL-I-26600 and MSC-EMI10A. Tests on one camera shall be limited to generated interference measurements at frequencies below 100 MC.

4.4.7 Explosive Atmosphere

The camera shall be exposed to explosive vapors per MIL-T-5422, Test Proc. #1 (same as MIL-E-5272) at sea level only. During the exposure the camera shall be operated, but shall not be required to monitor a test pattern.

4.4.8 Shock

a. The camera shall be submitted to lunar landing shock in accordance with MIL-STD-810 Method 516, Procedure I, with the following modifications: the shock pulse shall be half sinewave of 8 g peak with a 11 $\pm$ 1 ms duration. The camera shall be subjected to the standard functional tests following the shock test.

b. A mock-up of the STM cameras shall be subjected to the 78 g emergency landing re-entry shock pulse. The mock-up shall

be subjected to one shock pulse in each of the three cardinal axes. The waveform shall be half sine with 11 $\pm$ 1 millisecond pulse duration. Retrofit of the mock-up shall be allowed between axes; however, at the termination of the shock test, there shall be no case punctures or separation from mounting hardware.

4.4.9 Thermal Vacuum

a. Lunar Day

The camera shall be subjected to pressure equal to 5 X 10^{-6} mm of Hg or less for a period of 25 hours. A lunar surface temperature of +250 degrees F, a deep space temperature of -300 degrees F, and a solar flux of one solar constant shall be simulated. The camera shall be operated and performance monitored during each of two 8-hour periods. Performance shall be checked with the lunar day lens. All functional requirements of the camera shall be verified during the lunar day environment.

b. Lunar Night

The camera shall be subjected to a pressure equal to 5 X 10^{-6} mm Hg or less for a period of 25 Hours. The environment shall be simulated by a surrounding shroud maintained at -300 degrees F. The camera shall be operated continuously and performance monitored during each of two 8-hour periods. Performance shall be checked with the lunar night lens and all functional requirements verified.

4.4.10 Normal Cabin

The camera shall be subjected to a pressure of 5 psia oxygen atmosphere with chamber wall surfaces held at +90 degrees F. The camera shall be operated continuosuly and all functional requirements verified following temperature stabilization.

4.4.11 Off-Limit

Overstress tests shall be performed on both cameras. One camera shall be subjected to power, light, and temperature overstresses (including the emergency LEM Cabin environment). The second camera shall be subjected to power, light, and vibration overstress. Functional tests performed during overstress testing shall be at the Contractor's discretion but shall, in general, consist of those tests performed during normal environmental tests.

a. Power Overstress

The input voltage shall be adjusted in 1 volt increments from 24 V DC to 18 V DC and from 31.5 V DC to 34.5 V DC while a standard test pattern is monitored under nominal light conditions. Positive transients from 79-98 V DC input line in 5 V DC increments, pulse width 10 µsec, 10 pps repetition rate, and 5 minutes at each voltage increment. Negative transients from minus 100 V DC to minus 120 V DC shall also be provided in 5 volt increments. The test shall be terminated at any voltage level if recovery times become excessive.

b. Light Overstress

The cameras shall be subjected to highlight photocathode illumination levels of 50% above the maximum lunar day illumination in 15% and 30% overstress increments. The light overstress shall be provided under both large and small ambient change conditions. Light level shall be reduced in 6 db increments below minimum lunar night conditions until significant resolution and/or contrast deterioration is observed.

c. Temperature Overstress

Temperature overstress tests shall be subjected to two 8-hour thermal-vacuum tests with all conditions as prescribed for the lunar day test except that the lunar surface shroud temperature and solar radiation simulation shall be as follows:

Cycle	Lunar Surface Shroud Temp.	Solar Simulator
1	275°F	1.25 solar constants
2	290°F - 300°F	1.5 solar constants

d. Emergency Cabin

The emergency cabin environment shall be simulated with all conditions as specified for the normal cabin environment except that the wall temperature shall be 130 $\pm$ 5 degrees F and the chamber pressure shall be 1 X 10^{-6} T orr maximum. The test shall be continued for four hours or until the camera radiating plane temperature exceeds 130 degrees F.

e. Vibration Overstress

The camera shall be subjected to levels of 1.5 and 2.0 times the mission level vibration for 5 minutes per axis. The camera operation shall be checked after each test. The test shall be terminated if a failure occurs.

f. Shock Overstress

This test shall be the same as that required in paragraph 4.4.8a above except the shock pulse shall be 15 g peak.

4.5 Qualification Tests

The contractor shall conduct tests to demonstrate compliance with this specification and to verify critical design margins. The tests shall be performed in accordance with Table III. Tests successfully performed for non-critical environments as part of development test on STM units shall not be re-run unless pertinent design changes have been made. Data from these tests shall be submitted to show compliance with qualification requirements. Critical tests as shown in Table III shall be performed during qualification tests. In addition, tests not successfully completed during development tests shall be performed.

4.5.1 Failure

Any deviation from performance criteria will be considered a failure as follows:

Type A Failure: Physical deterioration or destruction to the point where the camera is inoperable, or a change in camera parameter is measured, which exceeds twice the established tolerance as referenced to the initial reading.

Type B Failure: Any change in camera performance which exceeds the established tolerance, but does not qualify as a type "A" failure.

A type "A" failure shall require immediate analysis and corrective action prior to the continuance of Dev./Qual Test.

A type "B" failure shall be permitted to continue to completion in qualification or development test and analysis and corrective action shall be initiated at that time to all undeveloped cameras.

In the event of any failure that is attributed to a deficiency in the SEC tube, no corrective action that requires tube redesign effort shall be initiated. Corrective action which would normally be taken in the camera assembly to correct such deficiencies shall not be precluded.

For the purpose of this specification, the following exceptions to the above definitions are stipulated:

a. Burst frequency = 409.60 $\pm$ .02% absolute. Exceeding this tolerance shall be classified as a type "A" failure.

b. % response and S/N ratio: A deviation of 10% from the initial reading shall be classified as a type "B" failure.

4.5.2 Qualification Criteria

A product shall be considered qualified after successful completion of the qualification tests. Special considerations are as follows:

a. Off-limit tests

Successful completion of the qualification tests is contingent upon the equipment meeting the performance and environmental requirements. Design margin verification is not part of qualification.

b. Mission Life Tests

The assigned unit to the life test shall be required to complete two mission sequences (ground checkout time plus all mission test environments and corresponding durations) without maintenance.

4.5.3 Test Specimens

Three specimens shall be subjected to the tests specified in Table III.

4.5.4 Input Variation

The specimen shall be operated under the specified extremes of light input (see 3.4) and power input (see 3.3.1). Specimen operation shall comply with Para 4.4.1.

4.5.5 Life Test

The specimen shall be submitted to the following life test. Electrical tests in each environment shall be consistent with the electrical tests prescribed for the applicable development test environment.

TABLE III

DEVELOPMENT AND QUALIFICATION TEST REQUIREMENTS AND SEQUENCES

	Test Environment	Exhibit A Paragraph	T787220 Paragraph	Test Sequence and Units* STM-5	STM-6	P1	P2	P3	Accessories**
1.	Functional	4.4.1	3.3	1	1	1	1	1	
2.	Vibration	4.4.5	4.1/6.2	2	-	2	-	-	1→13
3.	Humidity	4.4.2	4.2/5.3	3	6	(3)	(6)	-	1→13
4.	Salt Spray	4.4.3	4.3	4	-	(4)	-	-	1→13
5.	Explosion	4.4.7	4.7	9	-	(6)	-	-	5,10,12
6.	EMI	4.4.6	4.5/5.2	5	5	(5)	(5)	-	5,9
7.	Shock ***	4.4.8	5.4	-	7	-	(7)	-	1→4, 6→13
8.	Acoustic Noise	4.4.4	5.4	ON TUBE ONLY					
9.	Lunar Day	4.4.9a	5.1.3/7.2	-	2	-	2	-	2,3,4,6,7,10,12
10.	Normal Cabin	4.4.10	5.1.4/7.1	-	3	-	4	-	1,5,6,7,9
11.	Lunar Night	4.4.9b	5.1.5/7.1	-	4	-	3	-	2,3,4,6,8,10,11,12,13
12.	Overstress	4.4.11							
	a. Emgr. Cabin	4.4.11d	5.5.1	-	11	-	-	-	1,6,9
	b. Lunar Day	4.4.11c	5.5.5	-	10	-	-	-	7,10
	c. Power	4.4.11a	4.7.3/5.3	6	8	-	-	-	-
	d. Light	4.4.11b	4.7.4/5.4	7	9	-	-	-	-
	e. Vibration	4.4.11e	4.7.5	8	-	-	-	-	5
13	Life	4.5.5	8.2	-	-	-	-	2	1→13

Notes: * Circled tests will be performed on the prototype units only if related STM units fail to meet dev. test requirements (i.e., failed STM-5 tests will be repeated on P1 and failed STM-6 tests will be repeated on P2).

** The numbers in this column correspond to the numbered accessories in table 1-2 and indicate the environments in which each accessory is to be qualified. The comment in Note 1 applies to failures.

*** Camera and lens mockups will be used for the CM reentry tests and STM-6 camera will be used for the lunar landing shock test.

Step 1 - Ground Operation

Duration: 250 hours continuous operation

Environment: Laboratory conditions except unit case temperature maintained at 100° ±10°F

Evaluation: Check input current and voltage every 4 hours. Conduct a complete electrical test every 24 hours.

Step 2 - Launch Vibration

Environment: Mount unit to simulate Command Module installation. Vibrate along each axis at the levels specified by 4.4.5.2 for a period of 5 minutes per axis.

Operation: Operation not required during vibration test.

Evaluation: Abbreviated electrical check before test. Complete electrical check after test.

Step 3 - Mission Phase I (186 hours total duration)

a. Command Module

Duration: 75 hours

Environment: Corrosive contaminants: one percent salt solution by weight.

Temperature: 70° to 80°F. Dew Point: 55°F to 65°F respectively (i.e., RH≅ 60% at all times)

Operation: One hour per each eight hours of test.

Evaluation: Complete electronic check after test.

b. LEM - Lunar Night

Duration: 12 hours

Environment: 10^{-6} mm of Hg max lunar night temperature: $-300^{\circ}F$

Operation: Continuous

Evaluation: Complete electronic check during operation (both modes)

c. LEM - Lunar Day

Duration: 12 hours

Environment: 10^{-6} mm Hg max lunar surface temperature $+250^{\circ}F$, $-300^{\circ}F$ deep space combined with solar simulation of one solar constant.

Operation: continuous unless max camera design temperature is exceeded.

Evaluation: Complete electronic check during operation (both modes)

d. LEM - cabin

Duration: 12 hours

Environment: 10^{-6} mm of Hg maximum, cabin wall temperature $100^{\circ}F$

Operation: Continuous unless maximum camera design temperature is exceeded.

Evaluation: Complete electronic check during operation (both modes)

e. Command Module

Duration: 75 hours

Environment: Corrosive contaminants: one percent salt solution by weight, temperature: $70^{\circ}F$ to $80^{\circ}F$. Dew Point: $55^{\circ}F$ to $65^{\circ}F$ respectively (i.e., RH $\simeq$ 60% at all times)

Operation: One hour per each eight hours of test

Evaluation: Complete electronic check after test.

Step 4 - Launch Vibration

Repeat Step 2

Step 5 - Mission Phase II (186 Hours Total Duration)

a. Repeat Step 3 a

b. Repeat Step 3 b

c. Repeat Step 3 c

d. Repeat Step 3 d except cabin wall temp to be 130°F

e. Repeat Step 3 e

4.6 Acceptance Tests

Unless otherwise specified prior to delivery of any assembly to NASA/MSC, the contractor shall perform the tests as delineated in Table IV. In addition, the contractor shall perform any other tests necessary to reasonably assure reliable performance during operating conditions. In the event that any component of any assembly fails any part of the acceptance test, NASA/MSC may reject the entire lot of which the failed assembly is representative, and return to the contractor any items of the lot which have been delivered but not accepted. The Contractor shall correct all deficiencies prior to resubmitting rejected articles for acceptance tests.

4.6.1 Examination of Product

This test shall be an inspection to verify that the materials, design , constructions, necessary dimensional characteristics, marking, and workmanship comply with the requirements of this specification.

4.6.2 Acceptance - Vibration Tests

The equipment shall be subjected to the following vibration: random - linear increase from 0.0025 g^2/cps at 10 cps to 0.015 g^2/cps at 60 cps; 0.015 g^2/cps from 60 to 400 cps with a linear decrease from 0.015 g^2/cps at 400 cps to 0.003 g^2/cps at 2000 cps. Time shall be five minutes

for each axis.

4.6.3 Functional Test

The functional test shall be as established by the contractor and approved by NASA/MSC, in accordance with Para 6.3. The test shall include a demonstration of overall picture quality as well as performance. The test shall prove equipment compliance with Para 3.3.

TABLE IV ACCEPTANCE TESTS AND SEQUENCE OF TESTS

Test Paragraph	Name of Test	Sequence Testing
4.6.1	Examination of Product	1
4.6.2	Acceptance - Vibration Tests	2
4.6.3	Functional Tests	3

5. Preparation for Delivery

5.1 General Provisions

The provisions specified herein govern "Preparation for Delivery" to NASA/MSC, Grumman Aircraft Engineering Corporation (GAEC), or North American Aviation Facilities (NAA).

5.2 Level of Protection

The contractor shall develop and use methods of preservation, packaging, and packing which will adequately protect the item against corrosion, contamination, physical damage or other deterioration during transport to

NASA/MSC, Grumman Aircraft Engineering Corporation (GAEC), or North American Aviation (NAA) and during subsequent indoor storage for a period of 90 days. The contractor shall prepare a sketch or brief description or both of the proposed methods of preservation, packaging, packing marking and where applicable , special handling features to protect the item from normal anticipated hazards encountered in transportation.

5.3 Marking for Shipment

Containers shall be durably marked in a legible manner in such a way that the marking shall not become damaged when the containers are opened. The markings shall provide the following information:

5.3.1 Unit Containers

Control Number_____

Part Number_____

Mfg Type or Part Number_____

Qty this Package_____ Lot No.____ (if applicable)_____

Serial Number_____

Mfger_____ Date of Mfg_____

Purchase Order No._____

5.3.2 Shipping Containers

When the shipping container is packed with one or more like items, it shall be marked in accordance with Para 5.3.1 above and the contractor's standard markings for address and precautionary handling. Shipping containers packed with unlike items shall be marked with the contractor's standard markings for address and precautionary handling. All shipping containers shall be marked with the word APOLLO in letters a minimum of one (1) inch high.

6. Notes

6.1 Intended Use

The equipment is intended to provide visual data to ground receiving stations during the Apollo lunar mission.

6.2 Existing Equipment

When the contractor has existing equipment which, in his opinion, is similar enough to satisfy the requirements hereof with minor deviations, such equipment shall be proposed. This procedure is recommended when, in the opinion of the contractor, such deviations result in advantages in cost, weight, size and delivery.

6.3 Approval Procedure

All items requiring approval by NASA/MSC shall be fully documented and submitted to NASA/MSC at least three (3) weeks prior to their usage. If a disapproval notice is not received prior to the end of the three (3) week period, the item shall be considered to have been approved. The disapproval notice shall take the form of an official correspondence from the Contracting Officer and will indicate that the item is not to be implemented until it is changed and resubmitted for approval. In no case shall the contractor be relieved of his obligation to meet the requirements of the contract.

7.0 Reports

7.1 The contractor shall supply weekly status reports via TWX.

7.2 Further documentation requirements shall be as indicated in NPC 200-2 and NPC 250-1 or elsewhere in the contract.

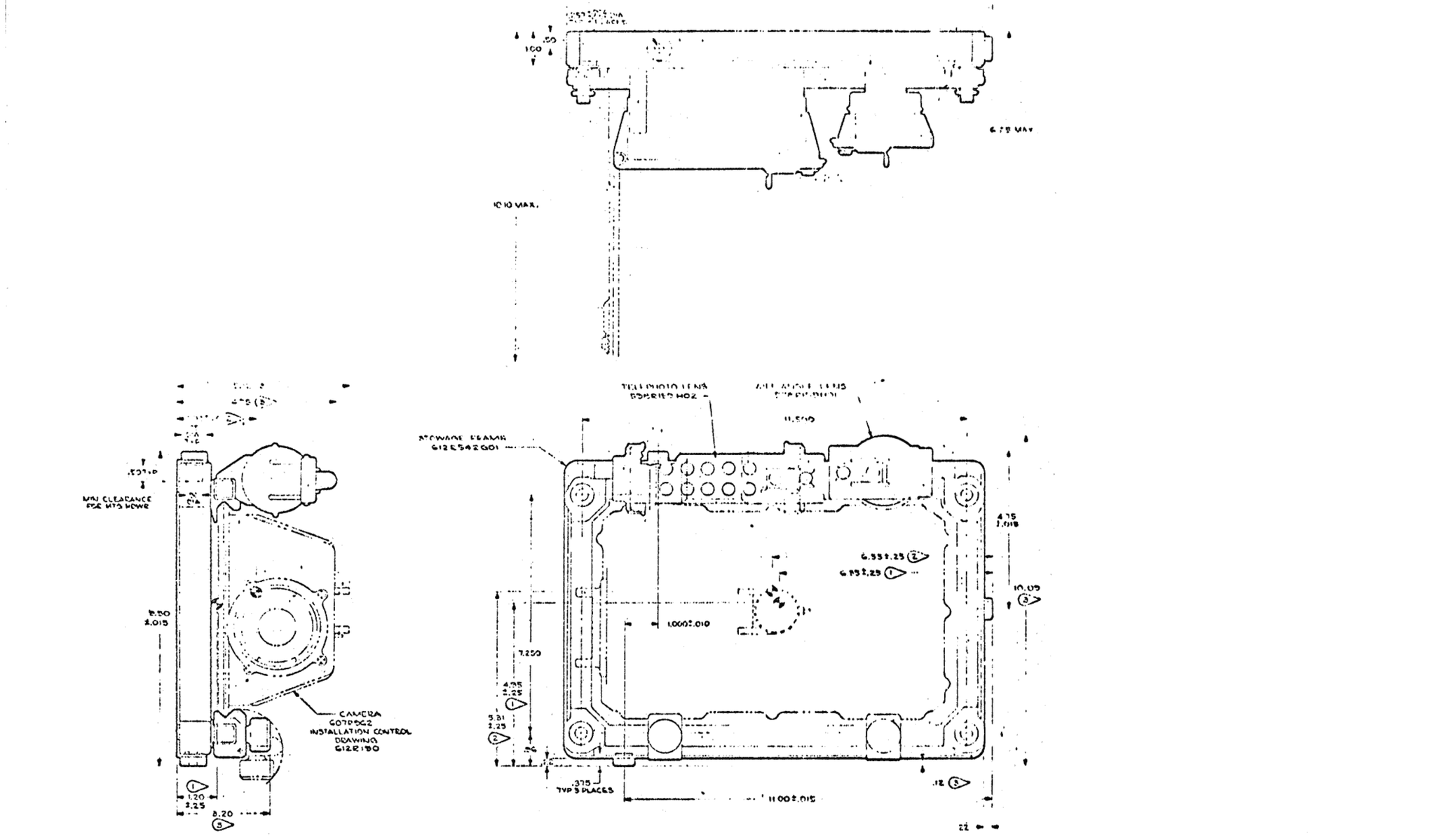


FIGURE 1

③ DENOTES THESE DIMENSIONS REQUIRE AN ADDITIONAL .12 FOR DYNAMIC CLEARANCE.

② DENOTES DIMENSIONS TO CG FOR CAMERA, LENS, AND STOWAGE FRAME.

① DENOTES DIMENSIONS TO CG FOR STOWAGE FRAME ONLY.

Westinghouse Electric Corporation

E 97942 G51R28

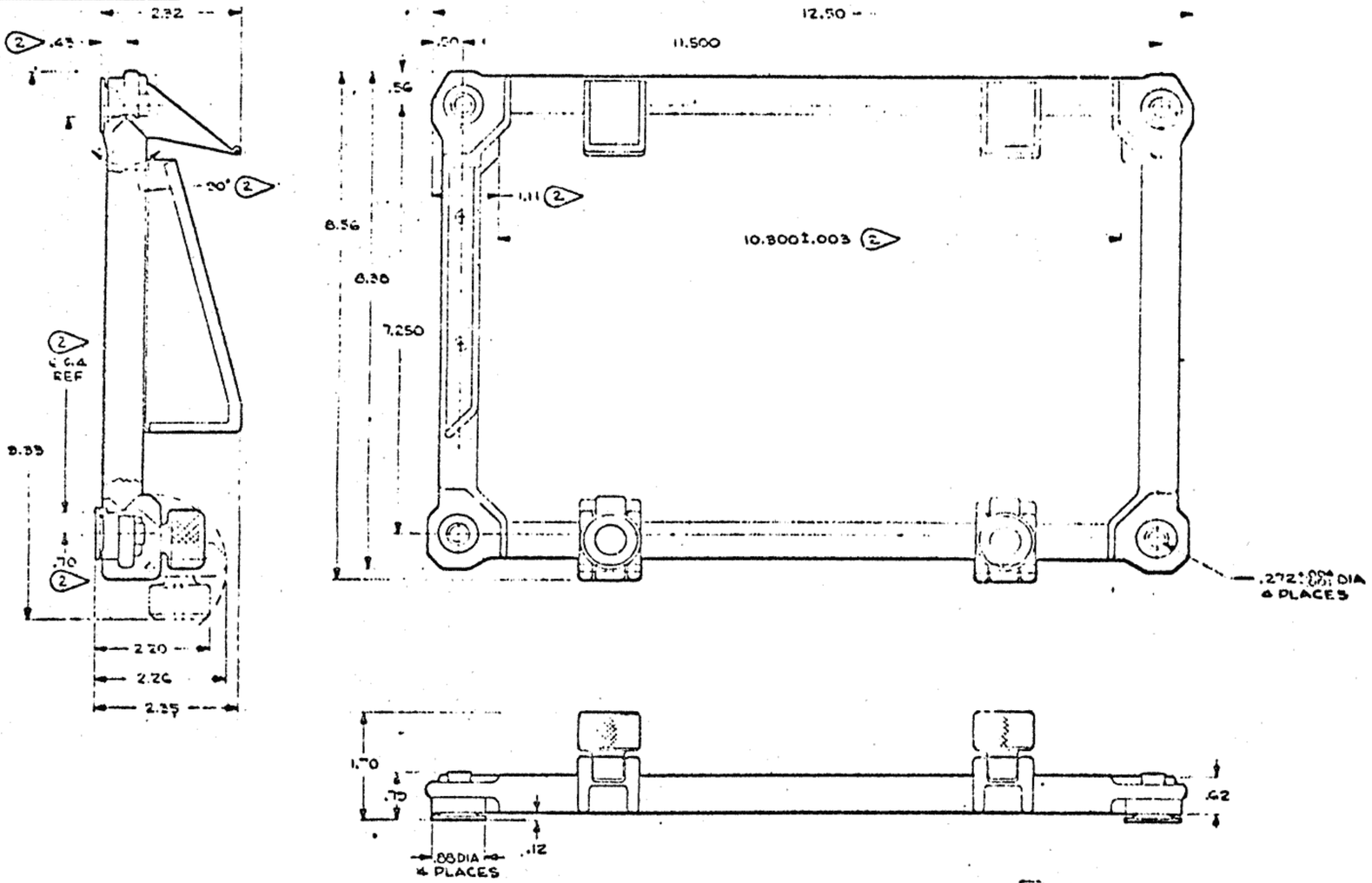


FIGURE 2

(2) REF DIMENSIONS FOR INSTALLATION OF CAMERA G078962 PER INSTALLATION CONTROL 612R190.

(1) A .12 CLEARANCE IS REQUIRED ALL AROUND FOR DYNAMIC EXCURSION

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPR
	B	OPENING RELEASED		

REF		612R190-01		STOWAGE FRAME			
QTY REQD	CODE IDENT NUMBER	PART NO.	*	DESCRIPTION	GOVT OR COML SPEC	(M) SPEC	ITEM NO.

* V-VENDOR ITEM, SEE SOURCE CONT DWG — LIST OF MATERIALS

——	LIDAR TV
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES DO NOT SCALE TOLERANCES ON DEC

2 PLACE	3 PLACE	ANGLES
±.01	±.005	±—

FINISH SEE SPEC 90501

ORIGINAL DATE OF DWG 1 AUG 82

DRAFTSMAN — APPD

CHKD — APPD

APPD

DESIGN ACTIVITY APPROVAL

PROCURING ACTIVITY APPROVAL

CONTRACT NO. F33657-82-C-2000

Westinghouse Electric Corporation
DEFENSE AND SPACE CENTER BALTIMORE MD., U.S.A.

TITLE: INSTALLATION CONTROL
STOWAGE FRAME
LIDAR TV CAMERA

SIZE	CODE IDENT NO.	DWG NO.
D	97942	612R646

SCALE 1/1 WEIGHT 1.22 SHEET 1 OF 1

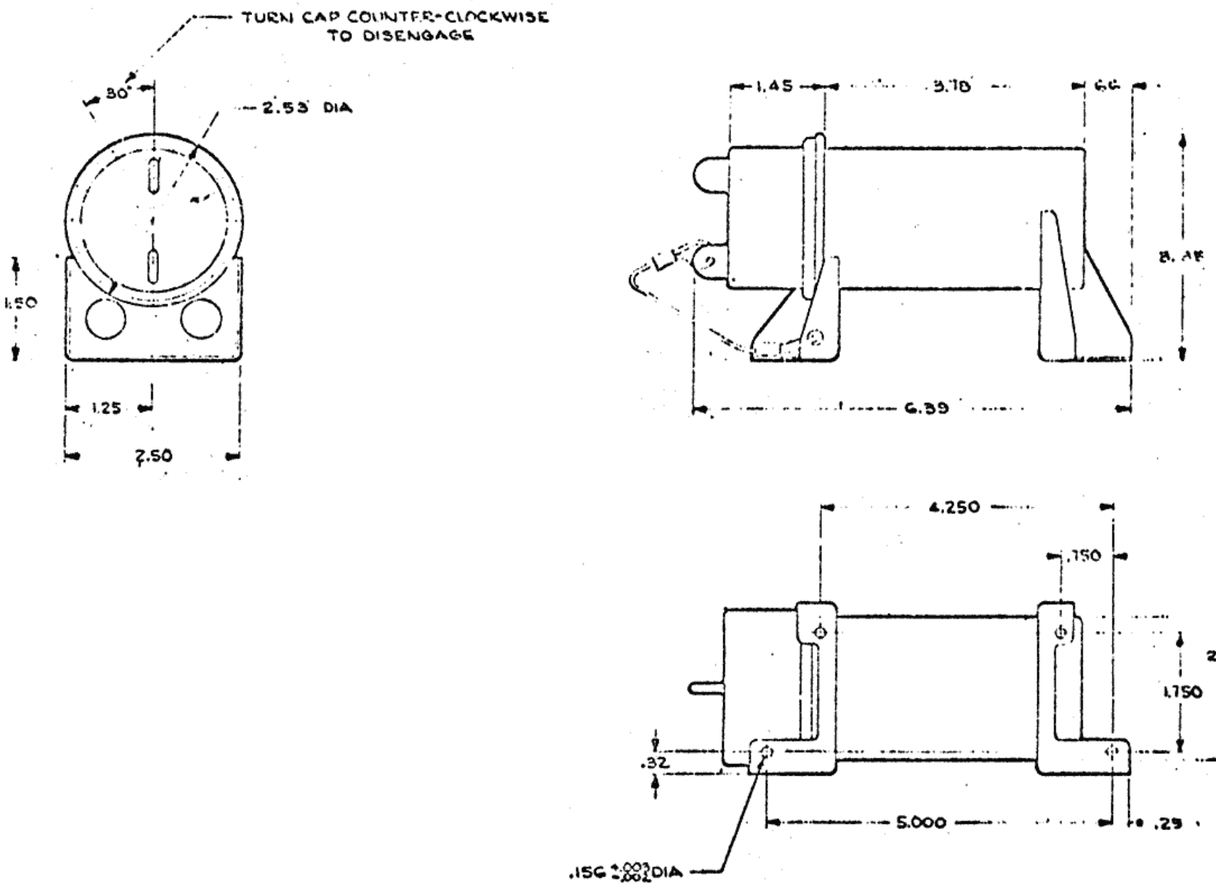


FIGURE #3

REVISIONS

LTR	DESCRIPTION	DATE	APPROVED
A	ORIGINAL RELEASE		

ITEM	QTY	CODE IDENT NUMBER	PART NO.	DESCRIPTION	GOVT OR COML SPEC	SPEC
			SUBASSY	LENS HOLDER, TELECINE		

P.V. VENDOR ITEM - SEE APPLICABLE CONT. DOC. — LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. DO NOT SCALE. TOLERANCES ON DEC: 2 PLACE ±.06, 3 PLACE ±.005, ANGLES ±2.0°. APPD SEC SPEC 30501

ENGINEER — DATE OF DRG — APPD
DESIGNED — APPD
DRAWN — APPD
CHECKED — APPD
DESIGN ACTIVITY APPROVAL

PRODUCING ACTIVITY APPROVAL

Westinghouse Electric Corporation
DEFENSE AND SPACE CENTER — BALTIMORE, MD., U.S.A.

TITLE: INSTALLATION CONTROL LENS HOLDER LUNAR TV CAMERA P2

SIZE	CODE IDENT NO	DWG NO.
D	07942	612R651

SCALE 1/1 — WEIGHT — LB. — SHEET 1 OF 1

NEXT ASSY	USED ON
—	LUNAR TV

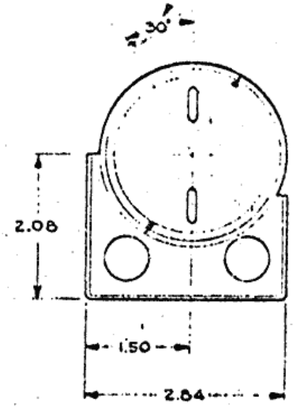
APPLICATION

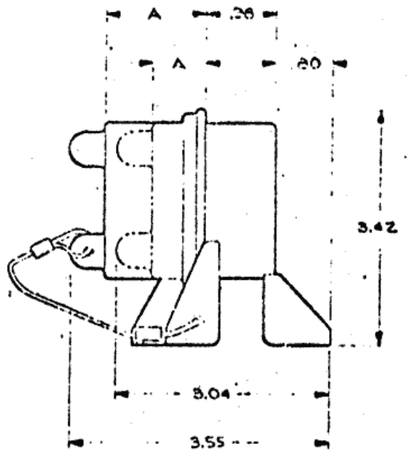
GOVT

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	DRAWING RELEASED		

TURN CAP COUNTER-CLOCKWISE TO DISENGAGE

2.66 DIA





	A DIM
DAY LENS	.76
NIGHT LENS	1.20

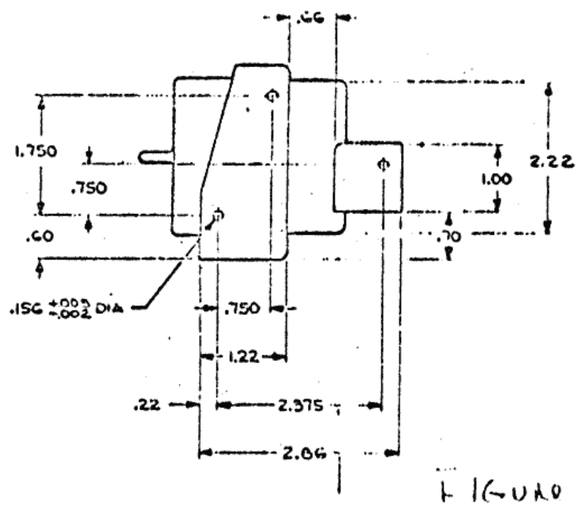


FIGURE B4

ITEM NO.	QTY	CODE IDENT NUMBER	PART NO.	DESCRIPTION	GOVT OR COMM SPEC	MFR SPEC
3						
2						
1			SPECIFICATION	LENS HOLDER ASSEMBLY		

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES PROPRIETARY TOLERANCES PER MIL-STD-

2 PLACE	3 PLACE	ANGLES
±.06	±.005	±1.0°

FINISH SEE SPEC

DESIGNED BY

DRAFTSMAN

CHECKED

ENGR APPD

DESIGN ACTIVITY APPROVAL

PROCURING ACTIVITY APPROVAL

Westinghouse Electric Corporation
DEFENSE AND SPACE CENTER (C) BALTIMORE MD., U.S.A.

TITLE
INSTALLATION CONTROL
LENS HOLDER
LUNAR TV CAMERA B2

SIZE	CODE IDENT NO.	DWG NO.
D	97942	612R650

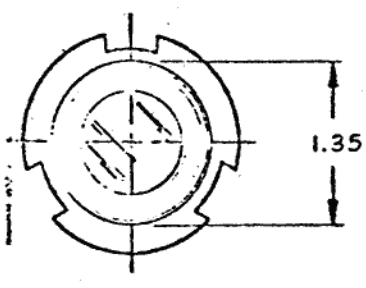
SCALE 1/1 | WEIGHT .2 LB | SHEET 1 OF 1

NEXT ASSY	USED ON
APPLICATION	LUNAR TV

GOVT

(C)

REVISION	SYM	
RELEASED ENG. RELEASE FIG. 4 ADDED Z C-4 FIG. REV. Z C-4 DIM ADDED Z D-3 MAX ADDED TO 1.30 Z E-2 1.250 WAS 1.850 ± .002 Z C-2 ADD C.G. REF. TO 2.75 ADD C.G. REF. TO 1.007 WAS 1.620 Z D-2 NOTE 3.2 ADDED TO Z E-3 C.G. PER ADDED TO .88 Z B-2 MAX ADDED TO 1.19 Z E-1 .020 R TO 30° DIM ADDED ENG RELEASE Z D-3 1.31 WAS 1.30 Z B-2 1.20 WAS 1.19 4-9-66	A B D	



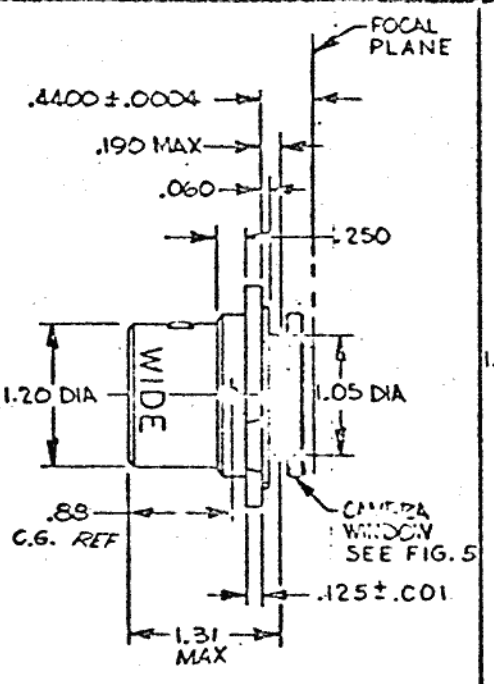
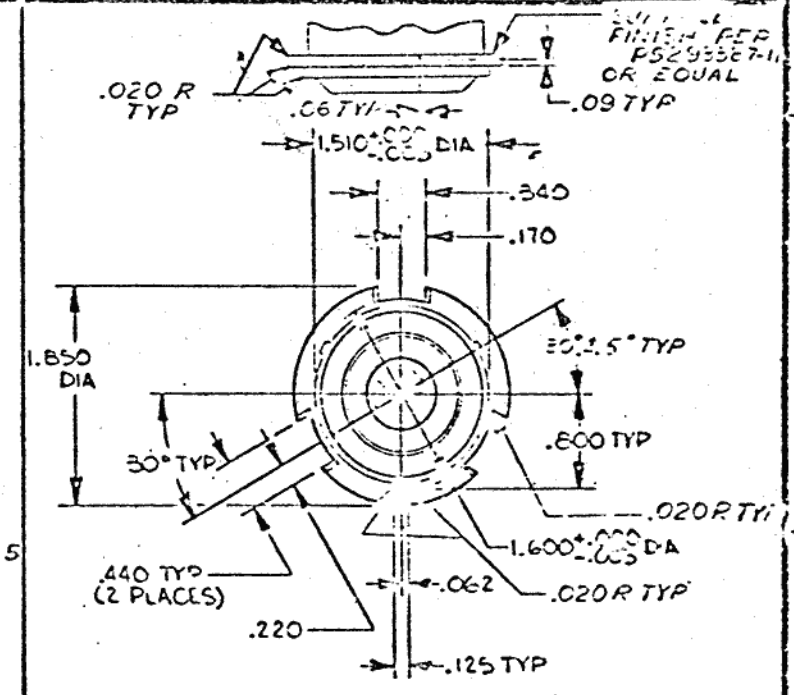


FIGURE 5



TYPICAL FOR ALL LENSES

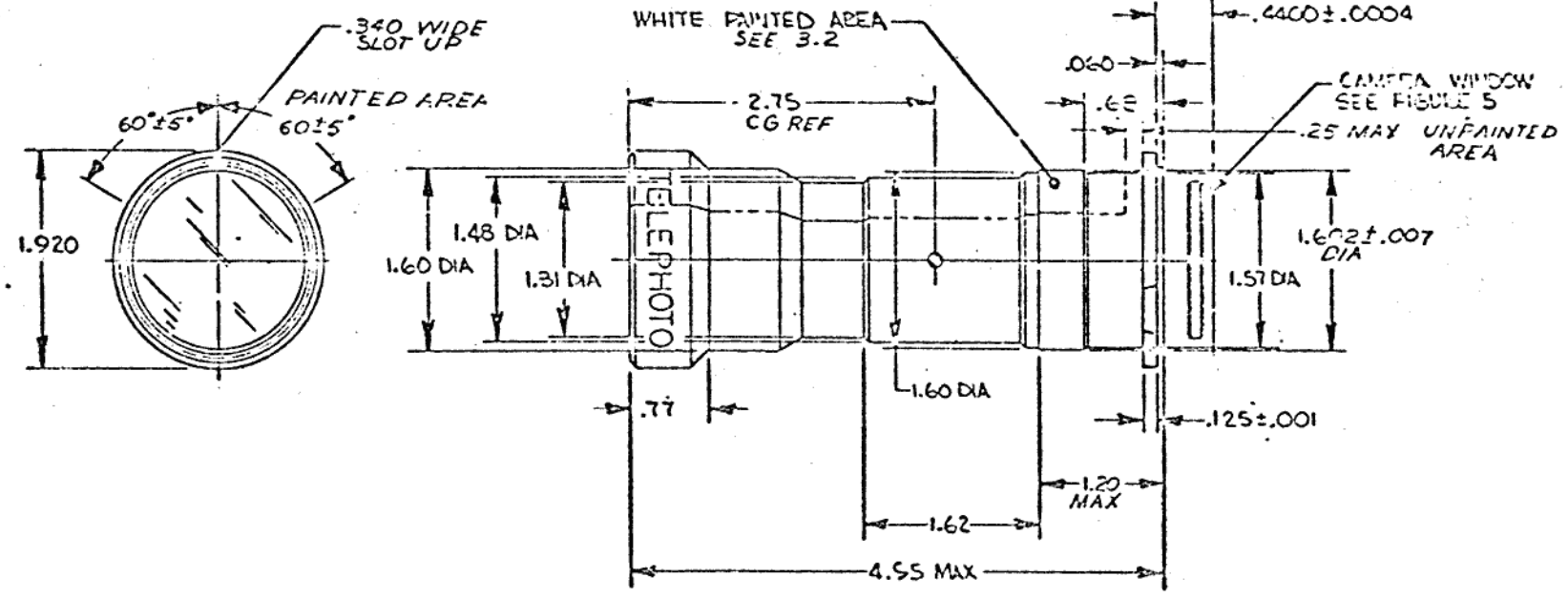


FIGURE 6

SIZE	CODE IDENT NO.	DWG NO
C	97942	57CR159
SCALE NONE		SHEET 3 REV /

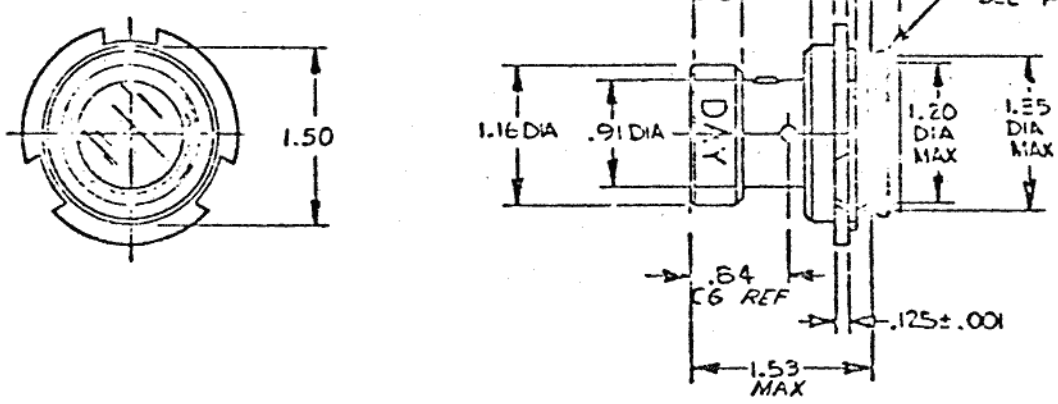


FIGURE 7

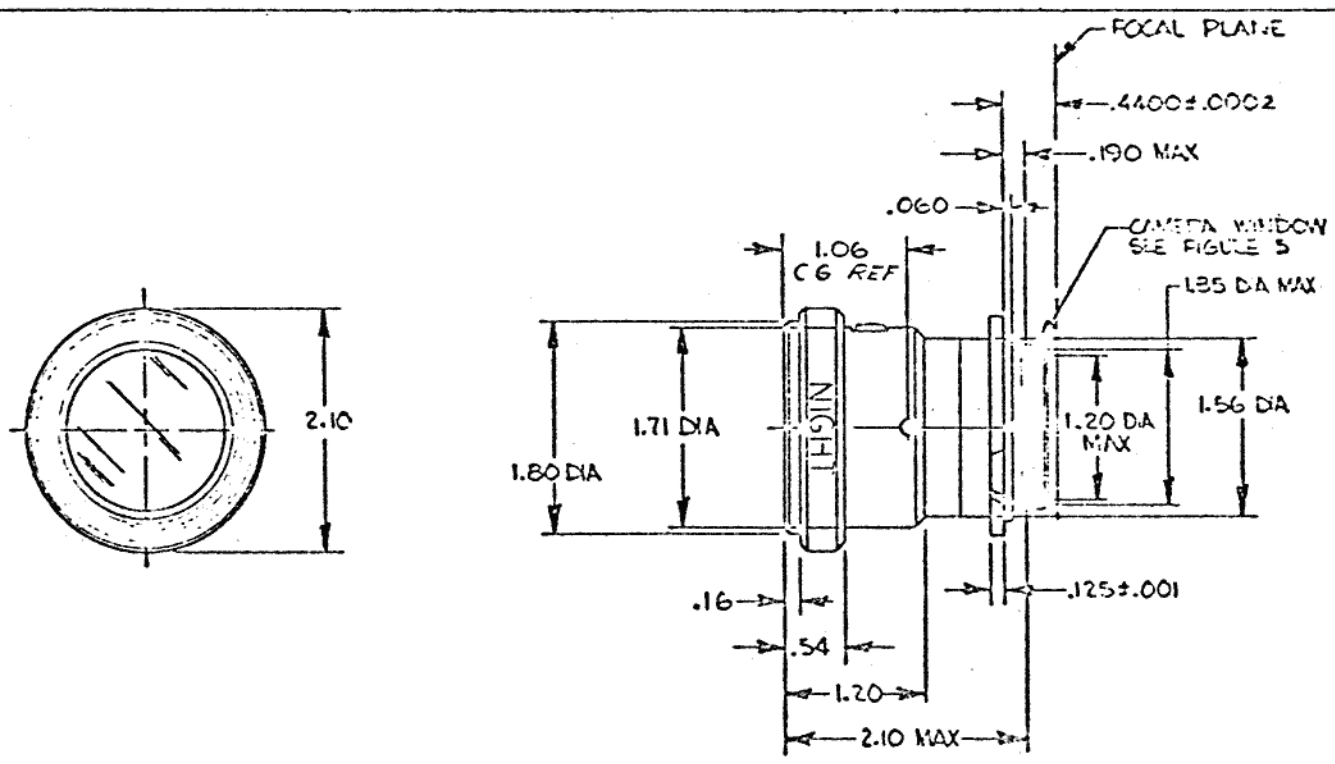
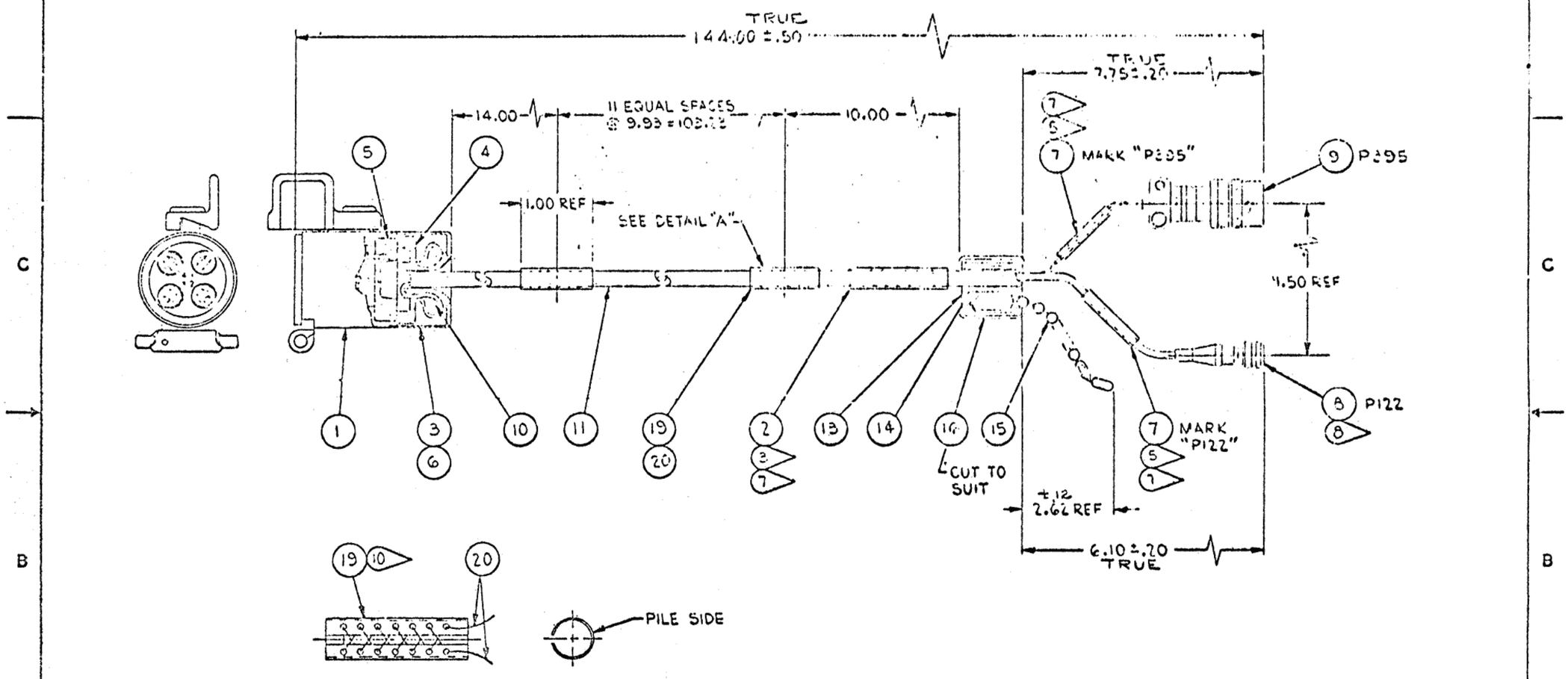


FIGURE 8

SIZE	CODE IDENT NO.	DWG NO
C	97942	5T0R150
SCALE NONE		SHEET 4

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
D				



DETAIL "A"
TYP. 12 PLACES
SCALE 2/1

FIGURE 9

SIZE	CODE IDENT NO.	DWG NO.
C	[illegible]	50SB835
SCALE 1/1		SHEET 3

REVISIONS				
LTR	DESCRIPTION	DATE	APPROVED	
A	DRAWING RELEASED			

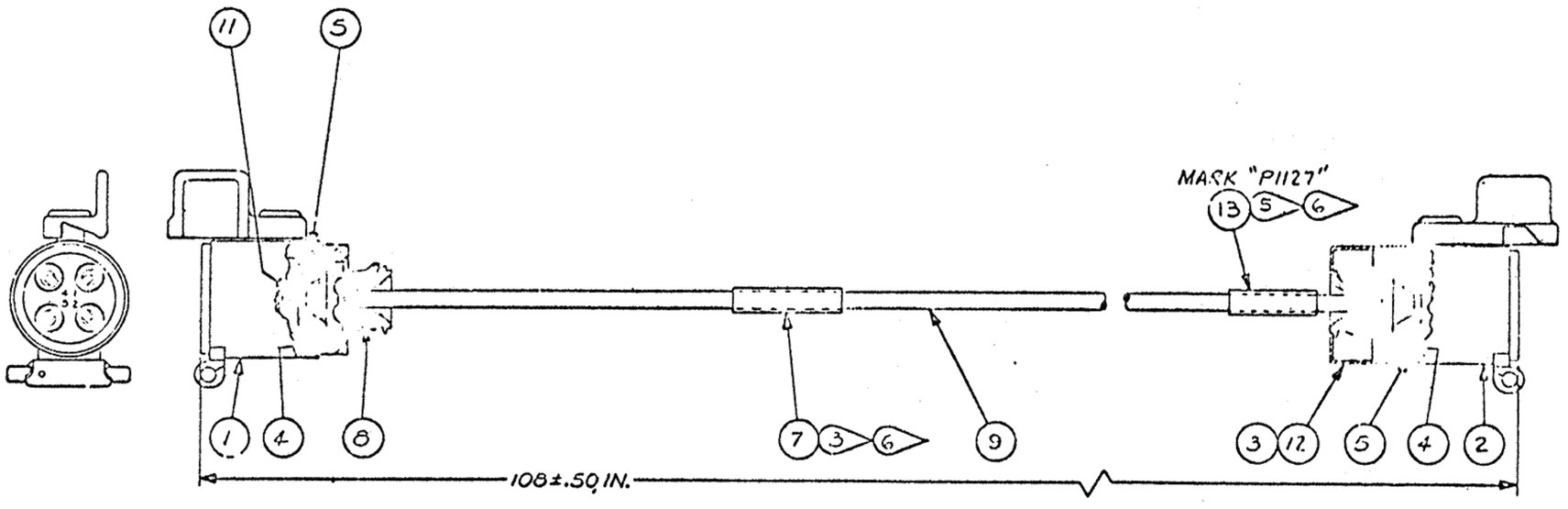


FIGURE 10

6. ASSEMBLE PER PROCESS SPEC 595264-32.
5. HOT STAMP PER PROCESS SPEC 595264-502, .12 HIGH CHARACTERS.
4. ASSEMBLE PER PROCESS SPEC 595264-206.
3. MARK SERIAL NO. (WSN___) PER PROCESS SPEC 595264-502, .12 HIGH CHARACTERS (HOT STAMP).
2. ASSEMBLE (10) TO SHIELD PER PROCESS SPEC 595264-207
1. CABLE PREPARATION & ASSEMBLY
   SLIDE BRAIDED OUTER JACKET BACK & EXPOSE COAXIAL CABLE & POWER LEADS.
   [illegible] HOLE IN BRAIDED OUTER JACKET [illegible] THROUGH THE EXPOSED [illegible] COAXIAL

QTY	CODE IDENT NO.	PART NO.	ITEM	DESCRIPTION	GOVT OR COML SPEC	SPEC	ITEM NO.
2				TUBING-1.000 F.093 EXP I.D. KYNAR		4470 IVA	14
1		412R253H01		MARKER			13
2		MS21352C04-12		SCREW-SOCKET HD			12
1				WIRE-2 IN. OF #22 CU	[illegible]	[illegible]	11
1				WIRE-2 FT OF #22 WHITE	MIL-W-16878/4	[illegible]	10
1				CABLE-10 FT		2156 [illegible]	9
1				TFT-LACING TAPE .40" TEST		4152 [illegible]	8
1		412R564H03		MARKER			7
REF		T785747		TEST SPEC			6
2		513C010H01		SEAL			5
2		51ER06E1P01		CABLE CLAMP			4
1		417L034H01		COVER			3
1		412R16-0602		CONNECTOR ASSEMBLY			2
1		512R16-0701		CONNECTOR ASSEMBLY			1

LIST OF MATERIALS

	LUNAR TV CAM
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DO NOT SCALE. TOLERANCES ON DEC.
2 PLACE ± 3 PLACE ± ANGLES ±

[illegible] 59-3548

[illegible] Electronics Corporation
[illegible] FARMINGDALE, L.I., N.Y. ○ BALTIMORE, MD., U.S.A.

DRAWN	[illegible] 1 Mar 66
CHECKED	MANNHEIM
APPD	[illegible]
APPD	[illegible]
DESIGN ACTIVITY APPROVAL	
PROCURING ACTIVITY APPROVAL	

TITLE
CABLE ASSEMBLY
LEM CABIN CABLE
LUNAR TV CAMERA AI

SIZE	CODE IDENT NO.	DWG NO.
C	[illegible]	[illegible]

SCALE 1/1 SHEET 1 OF 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	DRAWING RELEASED		
	B	[illegible] L/M, AS, AG		
	C	[illegible]		

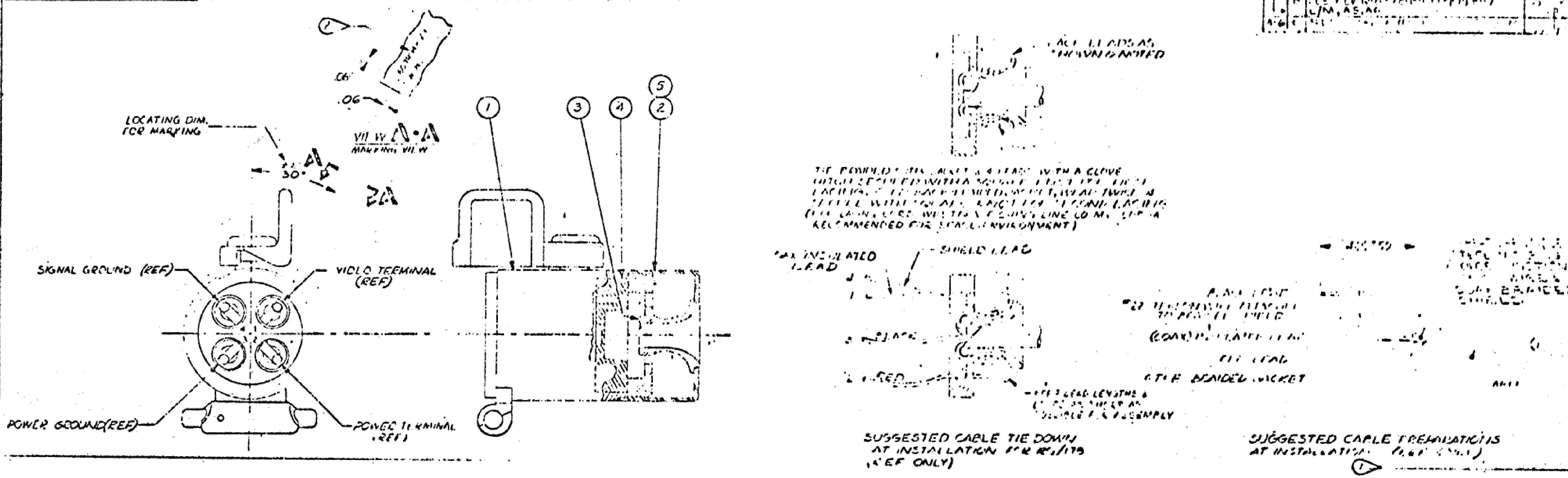


FIGURE 11

3. TEST PER T785747.
2. MARK PART NO. & SERIAL NO PER PROCESS SPEC 595264-503, BLACK, .06 HIGH.
1. SUGGESTED CABLE PREPARATION & ASSEMBLING TO CABLE CLAMP AT INSTALLATION.
   (a) SLIDE ② AND ③ OVER CABLE. SLIDE THE BRAIDED OUTER JACKET BACK & EXPOSE COAXIAL CABLE & POWER LEADS.
   ~~(b) MAKE HOLE IN BRAIDED OUTER JACKET. THEN WORK PIECES~~ THRU. THE BRAID BECOMES A PIGTAIL.
   (c) COAX SHIELD TERMINATION SIMILIAR TO WESTINGHOUSE PROCESS SPEC 595264-207.

QTY REQD	CODE IDENT NUMBER	PART NO.		DESCRIPTION	GOVT OR COML SPEC	SPEC	ITEM NO.
REF		T785747		TEST SPEC			
2		[illegible]		[illegible] SOCKET HD			
1		[illegible]		SEAL			
1		[illegible]		CLAMP CABLE			3
1		[illegible]		COVER			2
1		[illegible]		CONNECTOR ASSY			1

LIST OF MATERIALS

NEXT ASSY	USED ON
	[illegible] TV

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. DO NOT SCALE. TOLERANCES ON DEC

2 PLACE	3 PLACE	ANGLES
±	± .03	±

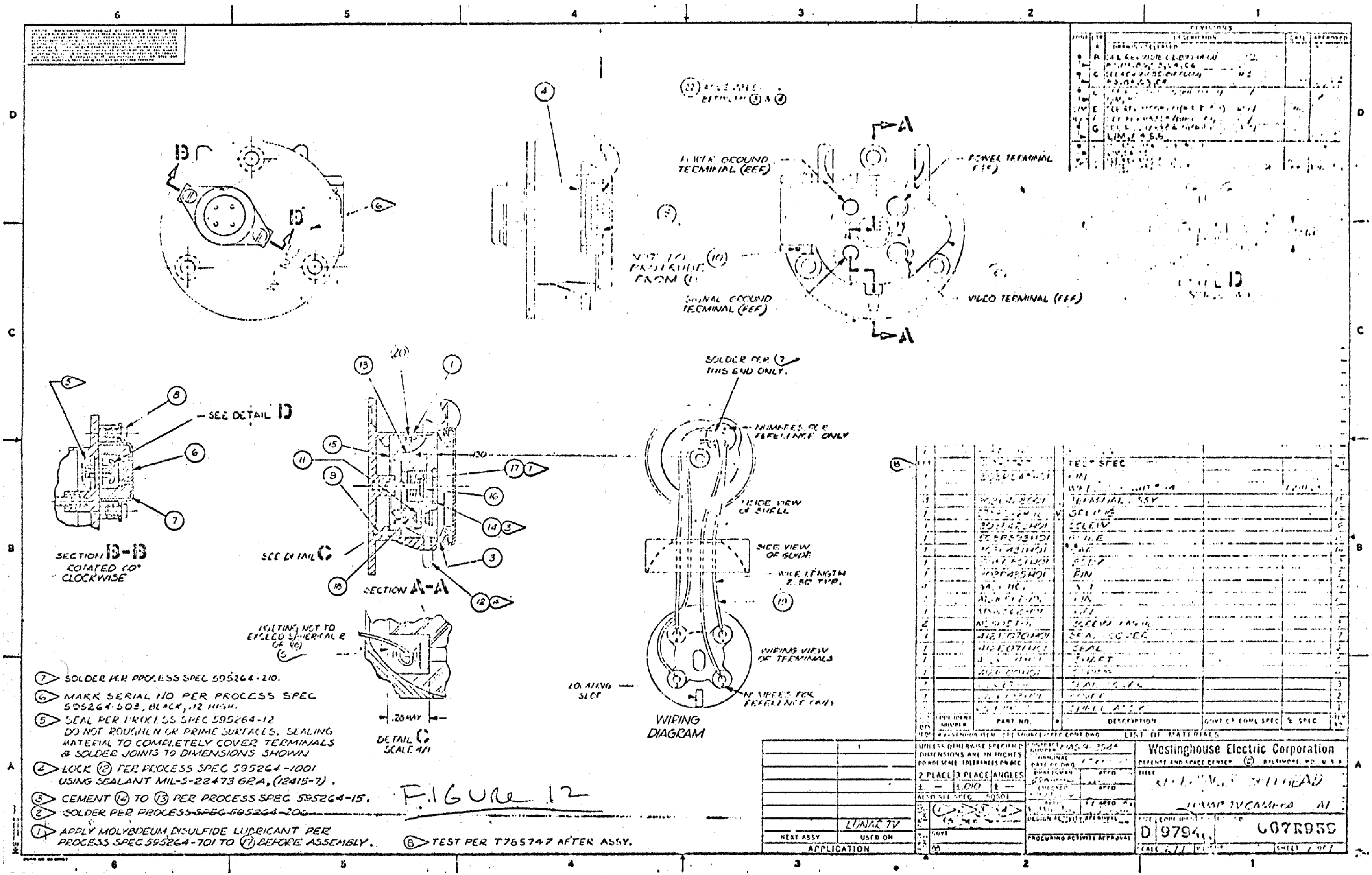
ALSO SEE SPEC 90501

Westinghouse Electric Corporation
DEFENSE AND SPACE CENTER, BALTIMORE, MD., U.S.A.

TITLE: CONNECTOR PLUG [illegible] TV CAMERA

SIZE	CODE IDENT NO	DWG NO
D	97942	607R948

SCALE 2/1 WEIGHT SHEET 1 OF 1



BB
SEE DETAIL B
SECTION B-B
ROTATED 60° CLOCKWISE
SEE DETAIL C
SECTION A-A
DETAIL C
SCALE 4/1
.20 MAX
.120
POWER GROUND TERMINAL (REF)
POWER TERMINAL (REF)
SIGNAL GROUND TERMINAL (REF)
VIDEO TERMINAL (REF)
SOLDER PER 7 THIS END ONLY.
NUMBERS FOR REFERENCE ONLY
INSIDE VIEW OF SHELL
SIDE VIEW OF GUIDE
WIRE LENGTH 2.50 TYP.
WIRING VIEW OF TERMINALS
LOCATING SLOT
NUMBERS FOR REFERENCE ONLY
WIRING DIAGRAM
7 SOLDER PER PROCESS SPEC 595264-210.
6 MARK SERIAL NO PER PROCESS SPEC 595264-503, BLACK, .12 HIGH.
5 SEAL PER PROCESS SPEC 595264-12
DO NOT ROUGHEN OR PRIME SURFACES. SEALING MATERIAL TO COMPLETELY COVER TERMINALS & SOLDER JOINTS TO DIMENSIONS SHOWN
4 LOCK 12 PER PROCESS SPEC 595264-1001 USING SEALANT MIL-S-22473 GRA, (12415-7).
3 CEMENT 14 TO 13 PER PROCESS SPEC 595264-15.
2 SOLDER PER PROCESS SPEC 595264-206
1 APPLY MOLYBDEUM DISULFIDE LUBRICANT PER PROCESS SPEC 595264-701 TO 17 BEFORE ASSEMBLY.
8 TEST PER T765747 AFTER ASSY.
REVISIONS
TEST SPEC
TERMINAL ASSY
PIN
SEAL
SHELL ASSY
PART NO.
DESCRIPTION
LIST OF MATERIALS
LUNAR TV
NEXT ASSY
USED ON
APPLICATION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
2 PLACE ± —
3 PLACE ±.010
ANGLES ± —
Westinghouse Electric Corporation
DEFENSE AND SPACE CENTER BALTIMORE, MD., U.S.A.
LUNAR TV CAMERA
D 9794

FIGURE 12