DEPARTMENT OF THE AIR FORCE
OFFICE OF THE SECRETARY

MEMORANDUM August 1, 1968

Col Worthman -

There are 3 video channels specified. Channels 1 & 2 are identical; Channel 3 is similar, with more coarse resolution requirements.

Channels 1 & 2 have ground resolutions (from 496 nm) of 133 ft; however, angular resolution is .044 mr.

Channel 3 has a ground resolution (from 496 nm) of 179 ft; however, angular resolution is .059 mr.

P.S. These are theoretical values assuming appropriate optics. JKM

~~TOP SECRET~~

HANDLE VIA BYEMAN CONTROL SYSTEM

SURVEY APPLICATIONS COORDINATING COMMITTEE

Washington, D. C.

August 26, 1968

MEMORANDUM FOR THE EXECUTIVE SECRETARY, SURVEY APPLICATIONS COORDINATING COMMITTEE

SUBJECT: Review of Goddard Space Flight Center Specification for Two-inch Return Beam Vidicon Camera System

This is in response to your memorandum, BYE 17566-68, dated July 30, 1968.

The Department of Defense members of the Survey Applications Coordinating Committee have reviewed Goddard Space Flight Center's specification for a two-inch return beam vidicon camera system (S-733-P-4). Since the characteristics of the flight model optical lens are not provided in this specification (the NIKKOR-EL lens is specified for bench testing only), we have made our preliminary assessment on the assumption that the vidicon is the resolution-limiting element of the system. On this basis, we calculate resolutions of 0.044 milliradians for channels 1 and 2, and 0.059 for channel 3. Such sensor systems would not, of course, be compatible with the security guidelines contained in the SACC charter. A definitive analysis of the actual system resolving capability cannot be made in the absence of data on the flight model lens.

In addition, you should probably edit the ground resolution specifications in addendum paragraph 3.11.2 of the July 23, 1968 revision to S-733-P-4, which are not compatible with the theoretical capabilities of the vidicon specified in the basic document.

In reviewing this material, it occurs to us that it is probably too early to specify exact applications for this vidicon. Couldn't the vidicon be

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HANDLE VIA BYEMAN CONTROL SYSTEM

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CONTROL NO BYE 13382-68

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PAGE 1 OF 2 PAGES

developed as a component, irrespective of its potential uses? Since a total system is not defined in the specification, it seems logical to delete references to space applications from the document and to allow the vidicon to proceed as a technical development on its own merits. Later on, if you should desire to integrate the vidicon into a sensor system, another review of the total system would be in order.

John Kirk

JOHN KIRK
Co-Chairman

Col Worthman,

Paul

This may be the "test case" NASA wants to use to break the angular resolution guidelines.

I am inclined to take the initiative and work our answer JJ with Flat, Foster, & Wilson if you see it the same way.

John
7-31-68

RAR-B-16

~~SECRET~~

HANDLE VIA BYEMAN
GIONTHICE SYSTEM ONLY

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

THE ADMINISTRATOR

30 JUL 1968

MEMORANDUM FOR: Mr. John E. Kirk
DOD Co-Chairman, SACC

SUBJECT: Work Statement for Test Engineering Model of a Two-inch Return Beam Vidicon Camera System

The attached subject document is submitted for the review and comment by the DOD SACC Members. The R&D Resume (Form 1122) 160-75-03-04-51 was commented on by your BYE 52698/67 dated 20 September 1967.

Attention is invited to the resolution specifications in paragraph 3.11.2 and to addendum paragraph 3.11.2 of the 23 July 1968 revision. This interprets the expected system performance in terms of the limiting ground resolution from 496 nautical miles altitude.

The NASA SACC Members have asked for an early reply.

Floyd J. Sweet
Secretary, SACC

Attachment
as stated

BYE-17566/68

HANDLE VIA BYEMAN
GIONTHICE SYSTEM ONLY

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Bye-17566-68
This document consists of 1 pages
No. 1 of 2 Copies, Series A

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S-733-P-4
Revised
March 11, 1968
Revised
July 23, 1968

GSFC SPECIFICATION FOR

TWO-INCH RETURN BEAM

VIDICON CAMERA SYSTEM

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

Approved for Release: 2021/12/09 C05137009

S-733-P-4
Revised
March 11, 1968

GSFC SPECIFICATION

FOR A TWO-INCH RETURN BEAM

VIDICON CAMERA SYSTEM

Prepared by: Oscar Weinstein — March 11, 1968
Oscar Weinstein — Date
Applications Experiments Branch

Approved by: Harvey Ostrow — 3/11/68
Harvey Ostrow, Head — Date
Earth Sensors Section

A. E. Jones, Chief — 3/13/68
Systems Division — Date

GODDARD SPACE FLIGHT CENTER

GREENBELT, MARYLAND

1. SCOPE

This specification describes the requirements for (a) the ruggedization, fabrication and test of six (6) Two-inch Return Beam Vidicons (RBV), and (b) for the study, development, fabrication and test of a shuttered high-resolution multispectral camera system utilizing the above ruggedized sensors. The necessary support equipment required in the design and test shall also be developed and provided under this program.

2. APPLICABLE DOCUMENTS

The following documents, of the issues in effect, as amended or revised, on date of initiation for bids form a part of thi specification. No revisions affecting this program may be made to the applicable documents without prior approval by the Technical Officer. Where a conflict exists between this specification and other documents, this specification shall govern.

2.1 SPECIFICATIONS

2.1.1 S-320-NI-3A, dated September 22, 1967, "An Environmental Specification for Nimbus D Subsystems," GSFC

2.1.2 GSFC Specification S-450-P-1A, Amendment 1, "Quality and Reliability Provisions for Nimbus D Procurements," dated August 18, 1965, and amended June 23, 1966. (This document delineates the applicable provisions of NPC 200-2, 200-4, and 250-1, which are listed under Paragraph 2.2)

2.1.3 GSFC Specification S-450-P-3, "Screening of Semiconductors for the Nimbus Meteorological Satellite Program," dated December 2, 1965. (AED Specification #1721353, Revision S is considered an acceptable substitute or supplement.)

2.1.4 GSFC Specification S-450-P-4, "Screening of High Usage Electronic Parts for the Nimbus Satellite Program," dated January 31, 1966. (AED Specification #1840339, Revision G is considered an acceptable substitute or supplement.)

2.1.5 GSFC Specification S-300-P-1A, "Printed Wiring Boards," MIL-B-22205 requirement on Head Sealable Bags is waived; the use of plastic zipper bags is acceptable.

2.1.6 GSFC Specification S-711-P-1, "Microelectronic Circuits, Digital, Silicon, Monolithic, General Specification for" (AED "Specification for DIL Integrated Circuits, #1840890, Revision B is also acceptable).

2.1.7 AED Specification #8030020, "Workmanship Specification, NASA Compliant".

2.1.8 GSFC Specification S-250-P-1, "Contractor Prepared Monthly, Periodic, and Final Project Reports," dated January 1967.

2.1.9 GSFC Preferred Parts List, revised semi-annually, and parts lists such as RCA-AED Preferred Parts List, such as TIROS M Parts List 1960802, Revision G, which reference high reliability or military parts specifications.

2.2 NASA PUBLICATIONS

2.2.1 Nimbus Handbook for Experimenters (Nimbus D), Revision 2, dated December 1967

2.2.2 NPC 200-2, 200-3, 200-4, and 250-1

2.2.3 Mil. Handbook 217A

3. REQUIREMENTS

3.1 GENERAL DESCRIPTION

The objectives of this program are (a) to develop a space qualified version of the 2-inch RBV; (b) to design, fabricate and test one Feasibility Model (FM) of a camera system utilizing the above type of sensor; (c) to fabricate and test a Test Engineering Model (TEM) three camera multispectral system based on the results obtained from the tests of the FM; and (d) to fabricate the necessary support equipment.

Each television system will consist of the following:

a. Ruggedized 2-inch RBV
b. Camera electronics
c. Camera controller for supplying timing and synchronizing signals to the cameras.
d. Optics configuration including a lens, focal plane shutter mechanism, and three spectral filters

3.2 The contractor's efforts in this program are delineated as follows: All material and services required by this contract shall be in complete conformance with the constraints and requirements as specified.

3.2.1 The contractor shall meet expeditiously all reporting requirements.

3.2.2 The contractor shall provide an effective project management, personnel and control.

3.3 A Technical Officer shall be designated by NASA/GSFC to direct the contractor's efforts in meeting the requirements of this work statement and specification. His responsibility shall include the following:

3.3.1 Provide the contractor with technical directions required to implement the program.

3.3.2 Provide the review of technical decisions, designs, reports and evaluation conducted by the contractor during the contractual effort. The Technical Officer will respond within ten (10) work days after receiving any documents requiring his approval. At the expiration of this 10-day period, automatic approval may be assumed.

3.3.3 The Technical Officer shall be given at least three working days prior notification of any environmental or acceptance testing. The Technical Officer, or his designee, may attend such tests at their option at any time.

3.4 The program shall consist of four phases:

I Tube ruggedization, qualification, and test
II Camera system design study
III Design, fabrication, and test of one Feasibility Model (FM) camera
IV Fabrication and test of a three camera Test Engineering Model (TEM)

3.5 REQUIREMENTS-PHASE ONE

During Phase I a ruggedized 2-inch RBV design shall be developed to meet the environmental specifications called for by the document of paragraph 2.1.1. Six (6) such vidicons will be subjected to the specified flight level environmental conditions to prove workmanship. Two copies of the tube specification shall be delivered to the Technical Officer upon the contractor's intra-division negotiation of an order for vidicons.

3.5.1 Pre-environmental electrical tests will be performed to establish that the six tubes meet the following performance:

* Resolution: As specified in Paragraph 3.11.15
* Image size: 1 inch X 1 inch, minimum
* Storage characteristics: 80% signal remaining ten seconds after exposure at 2500 TV lines
* Highlight signal-to-noise ratio: As specified in Paragraph 3.11.15

* Microphonics: if microphonics occur, they shall not have a duration of more than 10% of the raster period. Microphonics persisting longer than the above value shall not have a greater peak-to-peak amplitude than 5% of the black to white video signal as measured at 0.04 fcs. If the microhponics frequency is equal or lower than the horizontal line rate, such that it cannot be displayed in an 'A' scope, the determination shall be made by means of a kinescope presentation. For the purpose of this measurement, the display shall be adjusted to provide a minimum of nine $\sqrt{2}$ grey levels. The microphonic interference shall then be measured by means of a microdensitometer and it shall not exceed 1/20th of maximum white. All six tubes must pass the microphonics test in a camera of final configuration.
* Blemishes: the maximum size of any blemish, spot, or smudge, and the maximum number allowable within the reticles, expressed as a percentage of the picture height when normally scanned, are as follows:

over 1.5%	none
0.5 to 1.5%	one
0.32 to 0.5%	five
0.12% and under	any number

A spot or blemish shall be defined as a defect demonstrating a contrast of 2:1 or more. Minimum separation between any two spots is limited to 5% of picture height measured in any direction.

* Reticle geometry specification (See Paragraph 3.12.6)

3.5.2 Environmental tests (non-operating). A dummy housing will be fabricated as a test fixture for shock and vibration tests. Vibration, shock, and acceleration tests shall be conducted on prototype tubes only, at prototype levels specified by the document referenced in paragraph 2.1.1 of this specification. The six flight quality tubes will be subjected to flight level vibration only.

3.5.3 Post-environmental electrical tests will be conducted as per Paragraph 3.5.1. These tests shall demonstrate that the six tubes still meet the required performance specification as stated in Paragraph 3.5.1

3.6 REQUIREMENTS - PHASE II

During Phase II the overall camera design and the individual circuit specifications shall be detailed. A design study report shall be prepared to include, but not be limited to, the following areas:

a. Dynamic beam regulation: During the design-study phase several methods of beam optimization shall be considered. The final selection shall be the simplest method consistent with performance requirements.

b. Shading minimization and shading correction methods
c. Noise reduction and RFI susceptibility
d. Power supply regulation and stability
e. Dark current and temperature compensation
f. Shuttering and automatic light control: the nominal exposure time shall be 4.5 mS $\pm$ 0.2 mS. Two additional exposure times, one half and twice the nominal, shall be generated by the camera subsystem as a method of illuminance control. The shutter-time range shall be a function of the sun angle and shall be controlled by signal derived from solar-paddle position. A method for overriding this automatic mode shall be provided by command means in which case commands shall be used to select any of the three pre-selected exposure times. The resolution degradation at 9 mS exposure is a function of the ground speed. However, exposure non-uniformity at the faster speed shall be no greater than $\pm$ 8% over the exposed area.
g. Use of integrated circuits
h. Grounding: a grounding system analysis shall be performed to minimize ground loops and cross talk. The analysis shall justify the chosen grounding method.
i. Packaging approach
j. Optical system parameters: this portion of the study shall be the design of an appropriate optical system to satisfy an Earth Resources Satellite mission, including the best method of providing spectral filtering.
k. Determination of the necessity for thermal control of the optical system and sensor photoconductor.
l. Configuration of the system programmer; This unit shall be slaved to the spacecraft clock and it shall also be capable of accepting horizontal synchronizing signals from a rotating head wideband tape recorder (not part of this effort.) In addition to the signals required for camera operation, the programmer shall be capable of providing signals for the operation of an on-board tape recorder (not part of this effort), and to provide means for vertical synchronization of a ground display during mission operation.
m. Dual mode of operation: the cameras shall be able to operate, by command, in either a node or targe modes. Special attention shall be paid to the design of the target preamplifier in order to achieve a circuit with the lowest Noise Figure commesurate with the state-of-the-art.
n. Methods for resolving picture registration problems.

The phase II study period shall form the basis for selecting the parameters for the subsequent detailed camera design. A conceptual design review and a preliminary design review shall be held prior to issuance of the design study report, and a final design review shall be held when the subsystem design is complete. Action items resulting from these design reviews will be completed in Phase II. NASA shall have the right to attend and participate in all design reviews throughout all phases of the program.

During Phase II the contractor will make available for review all study and experimental results pertaining to this camera system which has been developed prior to this contract.

3.7 REQUIREMENTS - PHASE III

During Phase III a single camera Feasibility Model (FM) shall be built and tested. The FM shall have the mechanical and electrical interfaces and dimensions as the Test Engineering Model (Phase IV of the program) but shall not use preconditioned components and shall not contain potting required for structural resistance to vibration. The FM shall undergo temperature tests over the prototype temperature range of -5°C to +55°C and atmospheric pressure. Performance of the system shall meet the minimum performance specification s over the +10°C to +30°C temperature range, and the accepted degraded performance over the 0°C to 9°C and 31°C to 45°C ranges. Thermal tests above 45°C and below 0°C are intended for establishing confidence in the system design, and that no catastrophic failure modes exist.

The FM shall be capable of operating in a thermal-vacuum chamber from +10°C to +40°C for checkout of spacecraft facilities. An accelerated thermal-vacuum test, 24 hours at each temperature extreme, shall be performed. Corona survival specification will not be invoked for this test.

The FM shall be subjected to a vibration survey at low excitation levels from 20 to 2000 cps. The levels shall be high enough to excite major modes. The results of the survey shall be delivered, along with the analysis, to the NASA Technical Officer.

Final acceptance test of the FM shall be conducted in all three spectral bands of interest using the final lens design. The contractor shall prepare ambient and environmental test procedures. After review and approval by the Technical Officer, the contractor shall conduct the environmental test agreed upon the this phase of the program.

3.8 REQUIREMENTS - PHASE IV

During this phase of the program a three camera Test Engineering Model (TEM) shall be built and tested. The TEM shall have the mechanical and electrical interfaces and dimensions as the FM. All components shall be procured and preconditioned to Paragraph 2.1 specification. One of the three cameras of the TEM shall be subjected to the complete prototype level environmental qualification specified in the document of Paragraph 2.1.1. The other two cameras of the TEM shall be tested over the 0°C to 45°C temperature range at atmospheric

pressure only. Each of the three cameras of the TEM shall be tested with its corresponding spectral band filter. Performance over the temperature ranges discussed in Paragraph 3.7 shall be as specified. The contractor shall prepare ambient and environmental test procedures. After review and approval by the Technical Officer, the contractor shall conduct the tests required for this phase of the program.

3.8.1 Whenever testing the FM or TEM cameras, appropriate loads shall be added to the programmer to simulate as close as possible the normal mode of operation of a three camera subsystem. These dummy loads shall also simulate all transient conditions in their amplitude and frequency response.

3.9 SUPPORT TEST EQUIPMENT (STE)

The STE shall be designed and fabricated to be used in the construction, checkout, and acceptance testing of the FM and TEM subsystems. The STE shall provide all the necessary inputs and shall accept all of the outputs from the camera subsystem to enable complete and normal operation of the camera subsystem as defined by the mission parameters. An appropriate type collimator shall be defined to facilitate performance measurements throughout the complete testing cycle. This collimator shall have provision for several test patterns, including ones with contrast ratios of 10:1, 5:1, and 2:1. The types of charts selected shall be defined in the test procedures and they shall be those best suited to test a camera system for an Earth Resources Satellite mission. To adequately simulate the spacecraft during test, an identical grounding philosophy shall be utilized in the design of the STE as in the design of the spacecraft camera subsystem. If it is necessary to violate this philosophy because of the commercial test equipment (for example if power and signal grounds cannot be isolated) this fact shall be documented and the information furnished to the Technical Officer. A simulated spacecraft ground shall also be provided in the STE and all frames, modules, etc., shall be connected to this ground. The STE will be housed in standard racks equipped with casters for easy transportability. The STE will include, as a minimum, the following major functions:

3.9.1 Command Simulation

A Command Simulator will be provided to generate the necessary commands for operating the camera subsystem. It will include such features:

a. Positive indication of specific commands sent

b. Protective interlock between critical command combinations

c. Command sequence timing interlock to prevent successive commands from being generated at a rate which might jeopardize the system under test.

d. Functional grouping of command functions

3.9.2 Telemetry Monitoring and Recording

The Telemetry Monitoring and Recording system will facilitate monitoring any combination of telemetry points via a test point panel. A manually controlled scanner will be used in order to obtain continuous monitoring and printout of a specific telemetry channel.

3.9.3 Clock Signal

The STE will provide a reference frequency source for use by the camera system, the collimators, and the STE chassis, and it may meet the specification for the Nimbus D clock given in the document referenced in Paragraph 2.2.1. All power supplies shall have current limiting, over-voltage protection, and monitoring meters where desirable.

3.9.4 Display and Camera

A 2000 TV lines minimum kinescope monitor display will be provided to aid in the camera subsystem set-up and test. The monitor display will have sweep expansion capability to permit the measurement of camera limiting resolution. The unit shall have provision for mounting a photographic camera (to be included).

3.9.5 Cables and Breakout Boxes

The cables necessary to mate the camera subsystem to the STE shall be provided as part of the STE. These cables shall electrically resemble the spacecraft harness as closely as possible and shall have breakout boxes (or equivalent rack-mounted test point panels) to facilitate monitoring all wires.

3.9.6 Standard Test Equipment

The STE shall include any standard test equipment necessary to test and maintain the camera subsystem and the STE.

3.10 SENSOR

The performance of all six sensors shall meet the performance requirements of this specification. All the 2-inch RBV's shall be mechanically and electrically interchangeable. However, individual vidicons may be examined and selected for possible advantages in performance within a particular spectral band.

3.11 MINIMUM REQUIREMENTS - CAMERA PERFORMANCE

All the minimum performance requirements shall be met by the FM and the TEM over the temperature range of 10°C to 30°C. Degree of allowable degraded performance at other temperature levels is given in a later paragraph. All system measurements shall be made with the shading correction circuits adjusted for normal operation.

3.11.1 Highlight Sensitivity

Highlight sensitivity shall occur at 0.04 foot-candle-seconds in channels 1 and 2 and 0.1 foot-candle-seconds in channel 3. The channels are defined in Paragraph 3.12.3.

3.11.2 Resolution at Highlight Brightness

a. Center - The camera system shall provide a minimum of 4500 TV lines limiting resolution in channels 1 and 2, and 3400 TV lines in channel 3.

b. Edge - Edge limiting resolution shall be no less than 80% of the value obtained at the center of the image.

Referring to Figure 1, center resolution performance shall be met within the circle with a radius of 0.34A, no less than 90% of center resolution at the perimeter of the inner circle, and no less than 80% of center resolution at the perimeter of the outer circle.

All limiting resolution measurements shall be demonstrated by means of "A" scope and kinescope displays.

3.11.3 Signal-to-Noise Ratio at Highlight Brightness

A signal-to-noise ratio of at least 35 db peak signal to rms noise in channels 1 and 2, and 32 db in channel 3, shall be realized when measuring a 10 TV line test pattern without aperture correction. The value obtained with optimum aperture correction shall be measured for information purposes. Chopper spikes shall be no greater than 10% of peak video with aperture correction.

3.11.4 Reduced Contrast Ratio Performance

The system parameters described in Paragraphs 3.11.2 and 3.11.3 shall be evaluated also with test patterns having contrast ratios of 10:1, 5:1, and 2:1. The measurements are to be made at ambient temperature and pressure, and the results recorded for information.

3.11.5 Gray Scale

Eleven shades of gray shall be obtained from the camera system, as measured with an "A" scope, when imaging a gray scale wedge in which the transmission of successive steps change by increments of $\sqrt{2}$. A 100:1 dynamic range shall be deomonstrated by means of an "A" scope presentation.

3.11.6 Shading

Vertical and horizontal shading of the system shall not exceed 15%. Shading correction circuits may be used to achieve this performance. The shading specification shall be met within the reticle geometry.

3.11.7 Image Distortion

The geometric distortion of the usable image from the camera system shall not exceed 1% in both the vertical and horizontal dimensions.

3.11.8 Skew

The deflection skew shall not exceed ±0.5 degree.

3.11.9 Geometric Linearity

Camera linearity shall be better than 1%.

3.11.10 Aspect Ratio

The aspect ratio shall be 1:1 at initial setup, at ambient conditions.

3.11.11 Size and Centering

The scanning raster size and centering shall be maintained with time and temperature to within a maximum variation of ±2%.

3.11.12 Residual Image

The residual image at the end of the prepare cycle shall be less than 5%.

3.11.13 Storage

80% of signal shall remain after 10 seconds at 2500 TV lines.

3.11.14 Spots and Blemishes

The maximum number and size of spots and blemishes permitted shall not exceed those specified in Paragraph 3.5.1. Streaking, caused by improper clamping and/or frequency response shall not be acceptable. The edges of the black to white transitions shall be sharp and free of edge enhancement effects.

3.11.15 Spectral Response

The sensors shall have sufficient spectral sensitivity in the 400 to 850 millimicron band to meet the performance requirements. The performance of the FM and the TEM in their spectral bands shall be as follows:

Parameter	Spectral Band (mμ)		
	500-570	640-720	690-830
Center Resolution (TV lines)	4500	4500	3400
Edge Resolution (TV lines)	3600	3600	2700
Signal-to-Noise Ratio (db)	35	35	32
Shading (Max. vertical & horizontal)	15%	15%	15%
Gray Scale ($\sqrt{2}$ steps)	11	11	9

A simulated solar source shall be used to provide 0.04 fcs at the tube faceplate prior to spectral filter insertion in channels 1 and 2, and 0.1 fcs prior to spectral filter insertion in channel 3.

3.11.16 Target Performance

The FM and the TEM shall have the capability of selecting, by ground command, either target or anode mode of operation. The performance of the system in the target mode shall be as follows:

Center Resolution - Same as anode (Paragraph 3.11.2a)
Edge Resolution - Same as anode (Paragraph 3.11.2b)
Signal-to-Noise Ratio - 30 db min. without aperture correction
Gray Scale - $11\sqrt{2}$ steps min.

3.11.17 Video Signal Characteristics

The video chain, target and anode, including aperture correction, shall have no amplitude variations greater than $\pm$1.5 db from 10 Hz up to the frequency at which positive peaking takes over. With aperture correction, roll-off beyond the zero reference point of the compensated video band shall be at least 18 db/octave. This data shall be documented for each subsystem prior to the start of an acceptance test.

The video levels out of the camera subsystem shall be nominally as follows:

a. Tip of sync - 0 v $\pm$ 0.1 v
b. Black level - minus 1.5 v $\pm$ 0.1 v
c. White level - minus 5.5 v $\pm$ 0.2 v

Clippers shall be provided in the camera to prevent black level and white level excursions from exceeding the specified limits. Other video characteristics shall be as follows:

a. Horizontal blanking time - 10%
b. Horizontal sync - 5% centered within the horizontal blanking time. The back and front porches thus obtained shall be at the same level as video black.
c. Vertical blanking time - 4%
d. Readout frame time - 5 seconds (4.8 seconds active)
e. Line rate - 1250 lines/second
f. Total active scan lines - 6000
g. Horizontal line time - 800 microseconds (720 microseconds active)
h. Video bandwidth - 4 MHz
i. Video signal output impedance - 50 ohms or less. This output shall be short-circuit proof.

3.11.18 Temperature Compensation

The FM and TEM systems shall provide specification performance over the temperature range of 10°C and 30°C. The following performance specifications shall be met in the 0°C to 9°C and 31°C to 45°C temperature ranges:

		Channels 1 & 2	Channel 3
a.	Highlight Signal-to-Noise Ratio	33 db min.	30 db min.
b.	Center Resolution	Same as ambient	
c.	Edge Resolution	Same as ambient	
d.	Shading (vertical & horizontal)	25% max.	25% max.
e.	Cray Scale (dynamic range)	80:1 min.	40:1 min.
f.	Residual Image	Same as ambient	
g.	Storage	Same as ambient	
h.	Video Gain	Same as ambient	

3.12 SYSTEM CONFIGURATION AND OTHER PERFORMANCE REQUIREMENTS

The camera subsystem design and mode of operation shall be based on the orbital parameters of an Earth Resources Satellite mission. The following nominal orbit parameters apply:

a. Orbit altitude - 496 nautical miles (sun synchronous)
b. Picture ground coverage - 100 x 100 statute miles
c. Picture overlap - 10% along the orbit track
d. Exposure timing for three cameras - simultaneous exposure
e. Readout for three cameras - sequential readout
f. Maximum allowable smear - ½ TV element
g. Sun Angle - 60 degrees solar zenith angle at 50 degrees north latitude at vernal equinox.

The Phase II study shall show in detail how the mission constraints have been taken into consideration in the selection of the optics, the mode of operation, and the expected system performance.

3.12.1 Optical Assembly

The optical assembly shall consist of a lens, a spectral filter, and a shutter mechanism.

During initial or bench testing of the FM, a commercial type lens, such as a NIKKOR -EL, with a field of view of 17 degrees and a 63 mm. focal length may be used. However, the acceptance and qualification tests shall be performed with the final lens configuration. This final configuration shall satisfy the mission requirements and the camera performance specifications.

3.12.2 Lens Alignment

Means shall be provided for aligning the perpendicularity of the optical axis to the faceplate of the image sensor to maintain required resolution performance. Alignment of the geometric reticle pattern with respect to a given fixed reference (camera mounting feet) shall be better than ±0.1 degrees. Optical references for three axes alignment in the spacecraft shall be included.

3.12.3 Spectral Filters

The FM and TEM shall be designed to operate in three distinct spectral bands. The bands of interest are:

Channel	Spectral Response (10% points)
1	500 to 570 millimicrons
2	640 to 720 millimicrons
3	690 to 830 millimicrons

Three such filters shall be available to be placed in the FM for testing, and each camera of the TEM shall have one of the above filters.

3.12.4 Shutter Assembly

The shutter assembly shall be a double blade focal plane shutter. The exposure duration shall be uniform over the exposed photoconductor within a maximum variation of ±5% for exposure times of 3.0 milliseconds or greater. Timing pulses to the shutter shall be provided such that exposure time and the resultant photoconductor illuminance can be changed in three discreet steps. The system shall have the capability of deriving these three exposure times either automatically from the solar paddle position, or by ground command.

The nominal center exposure time value shall be selected so as to maintain image smear to less than ½ TV element. The degradation expected at the higher and lower exposure times shall be defined in the Phase II study.

3.12.5 Reticle Geometry

Reticle markings shall be etched on the face of the vidicon. The resultant image derived shall have sharply defined linear markings free of distortion and raggedness. The linear dimensions and format shall be based on the ones used in the Advanced Vidicon Camera System for Nimbus A, scaled accordingly to the 2-inch RBV dimensions. The final reticle configurations shall be defined by the Contractor and agreed upon by the Technical Officer at or before the completion of Phase II.

3.12.6 Beam Regulation

A beam current regulator shall be provided to compensate for decrease of vidicon cathode emission as a function of time. The system shall also include means for automatically adjusting the beam current to the proper value for just discharging the peak scene highlights. The dynamic beam regulator circuit shall be capable of being disabled by ground command.

3.12.7 Sequence of Camera Operation

The Phase II study shall show the expected sequence of camera operation required to satisfy the mission requirements. Although a tape recorder is not a part of this effort, the system shall be configured on the assumption that one will be required for the final mission. In addition to the required signal outputs for proper camera operation, the programmer shall also provide external signals for operation of a tape recorder, and a multiplexer. The expected modes of operation shall be: Direct, Direct/Record, and Record.

3.12.8 Integrated Circuits

Integrated circuits shall be used wherever feasible.

3.12.9 Test Points

Test points shall be provided for the camera subsystem to the extent necessary to determine the status of the camera as well as metering points by which alignment of the camera subsystem may be implemented. Short circuit protection of these points shall be provided. The camera subsystem shall operate within specifications in the event of short circuit of the monitoring points or upon removal of the short. These test points shall be provided through separate plugs. The points shall not be utilized during environmental test; only telemetry data shall be used to analyze system performance. Each camera shall have a minimum of 25 test points, and the programmer a minimum of 10 test points. All these shall be defined during Phase II and shall be approved by the Technical Officer prior to incorporation in the final design.

3.12.10 Commands

These functions shall be supplied by the spacecraft and the document of Paragraph 2.2.1 shall be adhered to for spacecraft interfaces and design practice. The command signals will be pulses with a minimum width of 50 milliseconds, and are capable of driving up to two 12 volt, 1 watt magnetic latching relay windings. The two ends of each relay coil shall be brought out as a twisted pair. These leads shall not be returned to ground in the spacecraft command-control system. The referenced document specifies the noise characteristics of the command signals, as well as the type of relays permitted and design constraints.

The following is a minimum list of commands required in the operation of the system:

a. Clock A (spacecraft)
b. Clock B (tape recorder)
c. Power On
d. Power Off
e. Standby On
f. Standby Off
g. Camera 1 On
h. Camera 1 Off
i. Camera 2 On
j. Camera 2 Off
k. Camera 3 On
l. Camera 3 Off
m. Exposure Automatic
n. Exposure Preset
o. Preset 1
p. Preset 2
q. Preset 3
r. Anode Mode
s. Target Mode
t. Dynamic Beam Regulator In
u. Dynamic Beam Regulator Out
v. Record Mode
w. Direct Mode
x. Direct/Record Mode
y. Start Prepare

The final command list shall be defined during Phase II, and shall be approved by the Technical Officer.

3.12.11 Telemetry

Telemetry is to be used to the fullest extent as a means of monitoring camera subsystem performance during tests. A separate keyed connector shall be provided for the telemetry outputs. It shall be possible to short the telemetry output to ground or to other telemetry outputs without damaging the telemetry circuitry or affecting in any manner whatsoever the operation of the camera subsystem. Calibration data shall be provided for each telemetry point at $0^{\circ}C$, $+25^{\circ}C$, and $+50^{\circ}C$. A family of three curves for each analog indicator shall be drawn, except that temperature indicators shall have a single curve for temperatures from $-5^{\circ}C$ to $+55^{\circ}C$, with the general shape of the curve indicated down to $-25^{\circ}C$ and up to $+70^{\circ}C$. All telemetry shall be in accordance with the requirements of Paragraph 2.2.1.

The final list of telemetry points, and their classification (digital or analog), shall be defined during Phase II and shall be subject to approval by the Technical Officer. The minimum number of telemetry points per camera shall be twenty (20).

3.12.12 Keyed Connectors

Keyed connectors shall be utilized to prevent connector insertion into improper receptacles.

3.12.13 Noise Susceptibility

The operation of the camera subsystem shall not be disturbed nor performance degraded when the system is subjected to RF fields in the VHF and S-bands of as much as 1 volt per meter, adjacent to the camera system. In addition, the system shall perform within specifications when as much as 1 volt peak-to-peak noise of 15 to 100 microseconds bursts is fed into the power supply bus. These requirements shall be in accordance with the document of Paragraph 2.2.1.

3.12.14 Grounding

The grounding philosophy used for the camera subsystem design shall adhere to the one used in the document of Paragraph 2.2.1. Any deviations shall be justified to the Technical Officer and approved by him. A complete grounding analysis and drawing shall be provided during Phase II.

3.12.15 Power Supply

The camera subsystem shall operate within specifications when supplied from minus 24.5 Vdc $\pm$ 2% power source. The characteristics of this power supply, such as output impedance, peak current limitations, transients, noise, etc., are listed in the document of Paragraph 2.2.1. The camera subsystem performance shall adhere to those constraints, including survival and non-degradation under the listed abnormal conditions.

3.12.16 Power Consumption

The peak power consumption for the camera subsystem will be determined during Phases II and III. A power profile of the camera subsystem shall be provided and updated quarterly. The maximum power dissipation shall not exceed 81 watts per camera, without taking into consideration surges caused by the shutter solenoids. When taking these surges into consideration, these shall not violate the peak current limitations imposed by the document of Paragraph 2.2.1. A special effort shall be made during the design to explore means of reducing the overall power consumption well below the specified value. The unregulated spacecraft bus will be available to supply power to the shutter solenoids.

3.13 ENVIRONMENTAL REQUIREMENTS

The ruggedized RBV's shall meet the environmental requirements stated in Paragraph 3.5.2. The FM shall meet the environmental requirements stated in Paragraph 3.7. The TEM shall meet the environmental requirements stated in Paragraph 3.8, except that the Vacuum-thermal cycle given in by the document of Paragraph 2.1.1 shall be modified as shown in Fig. 2, and additional data obtained at each of the 10 degree transitions. The contractor shall prepare environmental test procedures. After review and approval by the Technical Officer, the contractor shall conduct the required tests.

3.13.1 Corona

The camera subsystem shall be designed with the capability of operating during the entire evacuation and back-fill phases of a thermal/vacuum cycle without damaging the camera or permanently degrading its performance. During the environmental thermal/vacuum test of the one camera of the TEM shall be tested accordingly and survival of the system shall be demonstrated. This survival capability shall also apply should corona occur during the thermal/vacuum cycle due to the outgassing of any component of the system.

3.13.2 Radiation Levels in Orbit

The camera system will be designed for a lifetime of one year in orbit. Engineering analysis shall be furnished to establish that the system, including lens, filter elements, vidicon, electron circuitry, interconnecting harness and potting compounds, will be capable of one year lifetime in the orbital environment, including the radiation levels expected by June 1969 for a 500 nautical mile orbital height. These levels shall be furnished by NASA.

3.13.3 System Calibration

The TEM shall be calibrated prior to delivery. The photometric calibration method shall be generated during the design phase and included in the test procedure which will be submitted for approval by the Technical Officer.

3.14 MECHANICAL REQUIREMENTS

The mechanical configuration of the camera subsystem shall meet the design practices and requirements invoked by the document referenced on Paragraph 2.2.1.

3.14.1 Weight

The total weight of the 3-camera system shall not exceed 120 pounds, including optics. A weight summary shall be provided and updated quarterly, according to the requirements invoked in the document of Paragraph 2.2.1.

3.14.2 Packaging

The system packaging configuration and requirements shall satisfy the document of Paragraph 2.2.1.

4. QUALITY ASSURANCE PROGRAM

The contractor shall establish and maintain quality and reliability programs for the TEM which complies with the provisions of the documents referenced in Paragraph 2. Only the reliability assurance requirements shall apply to the FM. A plan shall be submitted with the proposal and shall include the contractor's organization for the quality assurance function in flow chart form. His plan, based on the documents referenced in Paragraph 2., will assure that the quality element is incorporated in the design, parts, fabrication and test phases of the contract. Provisions of these documents not deemed applicable by the contractor shall be set forth with justification for their inapplicability, and will form the basis for negotiation prior to contract award.

4.1 Drawing and Change Control

Schematics, assembly drawings, parts lists, lists of materials, specifications and other design documentation shall be kept updated and a change control procedure shall be in being to assure that only correct drawings are used in the fabrication and test of subsystems. Copies of all parts lists and schematics shall be furnished to the Technical Officer for information. Copies of revisions to drawings, ECN's, AN's, etc. shall be furnished to the Technical Officer, on a quarterly basis so that parts lists may be kept current.

5. MANAGEMENT

The contractor shall designate experienced management and engineering and supervisory labor personnel specifically for this contract. The contractor shall provide a project organization chart showing personnel assignments. This chart shall be monitored throughout the contract. The contractor shall provide charts showing the detailed planned phasing of the effort required by this specification and all items called for by this specification.

6. REPORTS AND DOCUMENTATION

6.1 Equipment logs shall be kept on each circuit board until integrated into the subsystem. At that time a new log will be started for the subsystem. The logs shall contain all test results from incoming part inspection to delivery of the subsystem.

The equipment logs shall be used to prepare a subsystem test log which will contain all pertinent Acceptance and Environmental Test Data, Telemetry Calibration curves for the unit, and a chronological narrative of the subsystem test history.

Ten (10) copies each of a test log, environmental log, and calibration log for each subsystem shall be supplied. They shall be shipped to the Technical Officer within 30 days after delivery of the respective unit. However, preliminary data shall be supplied concurrently with hardware delivery.

Two (2) copies of all pages of all log books shall be submitted monthly to the Technical Officer.

6.2 Monthly, quarterly, and final reports shall be based on S-250-P-1, "Specification for Contractor Prepared Monthly, Periodic, and Final Reports", dated January 1967. In general, the requirements of S-250-P-1 shall be followed. Any exceptions and deviations from this document shall be noted in the proposal and shall be subject to negotiation prior to contract award.

6.2.1 As part of the monthly progress reports, the contractor shall submit weight data and information in order to permit spacecraft weight control actions to be implemented. The contractor shall also report the following:

Power Profile - Power required vs time vs subsystem functions, electrical connections including number, location and pin assignment.

The contractor shall submit the above information at the start of fabrication of the FM and shall update as necessary.

6.2.2 The contractor shall provide a comprehensive review of the technical progress made in each quarter. Detailed information concerning technical performance, or test progress with quantitative and/or qualitative data shall be included. Electrical schematics with input signals to the left of the schematic, output signal to the right of the schematic shall also be included. The waveforms shall include amplitude and frequency characteristics. The name and function of a particular stage or stages on the schematic shall be included. Mechanical drawings shall be limited to overall

assembly drawings of layouts to fully describe the item under consideration. Block-diagrams and/or layouts shall be included to describe performance during the quarter. Size, weight, and power profile considerations for the subsystem shall also be included.

6.2.3 The final report shall be a comprehensive review of the technical progress made throughout the program. Schematics and engineering drawings with sufficient explanation to describe their functions, shall be included. The size, weight, power, performance, mechanical drawings and layouts, block diagrams, and additional items to fully explain the system shall be a part of this report. Recommendations to improve or simplify the system for future applications shall be a part of this report. This report shall contain sufficient information to provide a detailed description of the progress from design through final configuration.

6.2.4 The contractor shall provide on a monthly basis a sequential milestone events charts for each identifiable unit, module, or subassembly. This chart shall be in the form of a horizontal flow chart.

6.2.5 The contractor shall provide, on a monthly basis, a summary of funds allocated, funds expended, and estimated funds to completion. The reportable increments of work shall coincide with the milestone event units. NASA Form 533 or 533A shall be used for this purpose.

6.3 Fifty (50) copies of an Operation and Maintenance Manuals for the TEM shall be prepared with reproducibles. Two (2) draft copies shall be submitted four (4) weeks after delivery of the system. Review by the NASA Technical Officer shall be required prior to publication. A four (4) week review cycle will be maintained. This manual shall contain a detailed description of the camera subsystem with emphasis on complete schematics, signal flow diagrams, board layout diagrams, necessary mechanical assemblies and/or layouts, operation, test procedures, and maintenance.

6.3.1 Ten (10) copies of an Instruction Manual for the TEM with reproducibles. This instruction manual shall contain schematic diagrams and operating instructions.

6.3.2 Fifty (50) copies of an Operation and Maintenance Manual, with reproducibles, for the STE. Two (2) draft copies shall be submitted on (1) week after delivery of the TEM. Review by the NASA Technical Officer shall be required prior to publication. Review will be completed within four (4) weeks. This manual shall provide the detailed description for operating and maintaining the STE and shall contain information similar to Paragraph 6.3.

6.3.3 The contractor shall provide two (2) complete printed sets of all updated documentation applicable to the design, procurement, fabrication, test and qualification of the subsystem. Documentation to be provided shall be that data normally established by the contractor to implement and control the program.

6.4 FM Performance Specification and Performance Test Plans shall be submitted for approval before the FM acceptance tests. Final issue shall be one (1) month after GSFC approval. These documents shall include information in the form of block diagrams, figures, written description, data sheets, and procedures sufficient to indicate to the Technical Officer that the FM system testing will show performance in accordance with the requirements of this specification. After GSFC approval, these documents shall form part of this specification. All changes and updating of these documents shall require approval by the Technical Officer.

6.5 Paragraph 6.4 is also applicable to the TEM subsystem.

6.6 Test Procedures shall be generated for testing the FM and the TEM and submitted to the NASA Technical Officer for his approval. In addition to a final ambient test, the procedures shall include environmental and post-environmental tests. In addition to the system level test, the contractor shall conduct tests at the circuit board level. These procedures shall be available to NASA at the contractor's plant but NASA approval is not required on these lower echelon test procedure documents.

6.7 Two (2) copies of FM Vibration Survey.

6.8 Two (2) copies of the 2-inch RVB Specification.

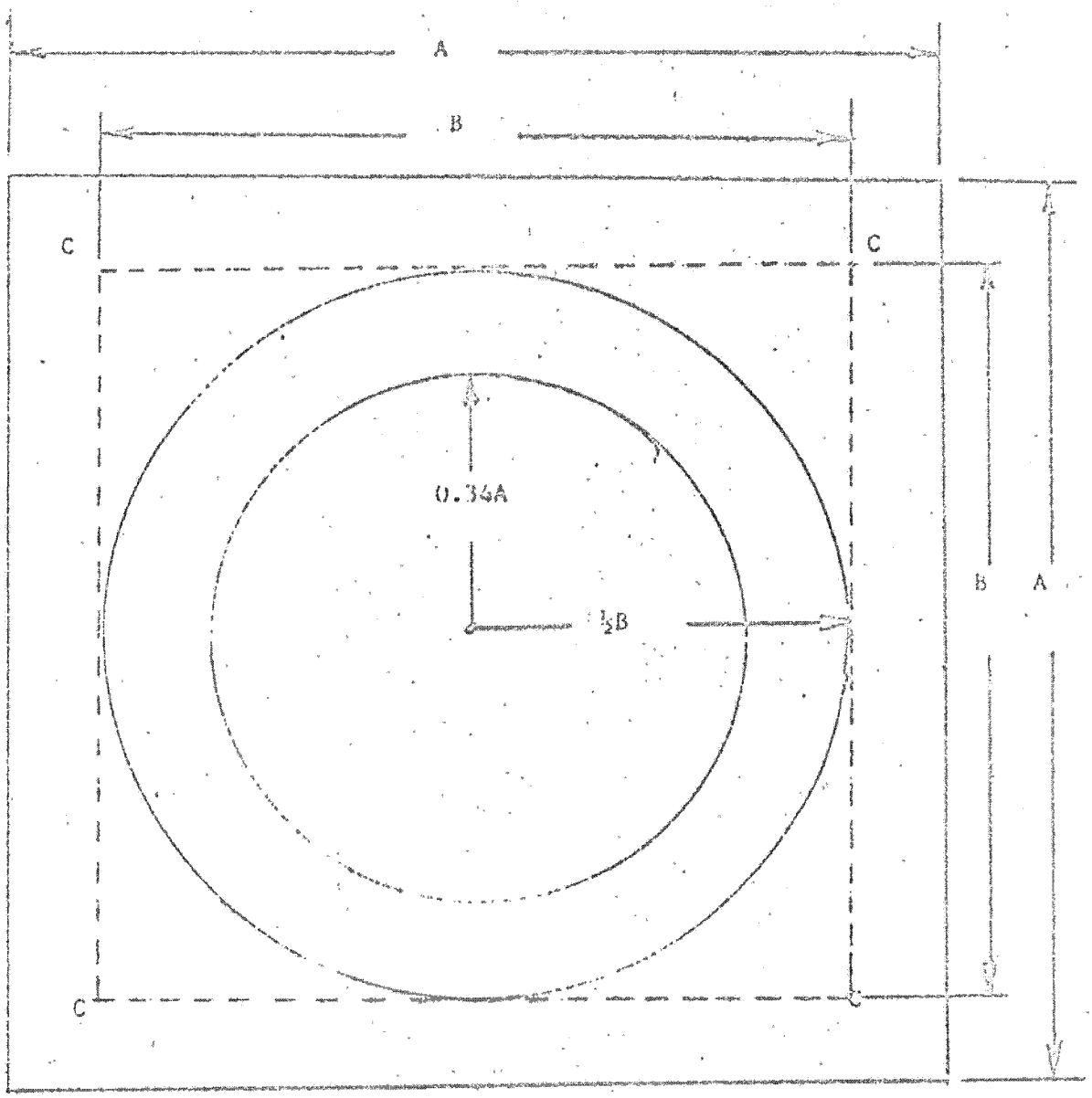
6.9 Two (2) copies of the 2-inch RVB Environmental Test Specification and Procedure. This document requires approval of the NASA Technical Officer prior to proceeding with the tests.

6.10 Ten (10) copies of the Phase II Design Study Report two (2) weeks after completion of this phase.

6.11 Test Log, Calibration Curves, and Photometric Calibration shall be supplied with each camera system and contain a documentation of the performance of the camera at final acceptance tests.

7. SPARES PROVISIONING

The contractor shall provide a spares provisioning plan and generate a spares provisioning list including estimated costs of each component. The provisioning plan shall be submitted to NASA for discussion and comment, and, after approval, be used as a base-line for establishing a recommended spares provisioning list. Costs shall not be included in the proposal for spares components. A spares provisioning plan shall be supplied 3 months after date of contract and the list 3 months after approval of spares provisioning plan. The actual spares to be purchased will be separately negotiated.

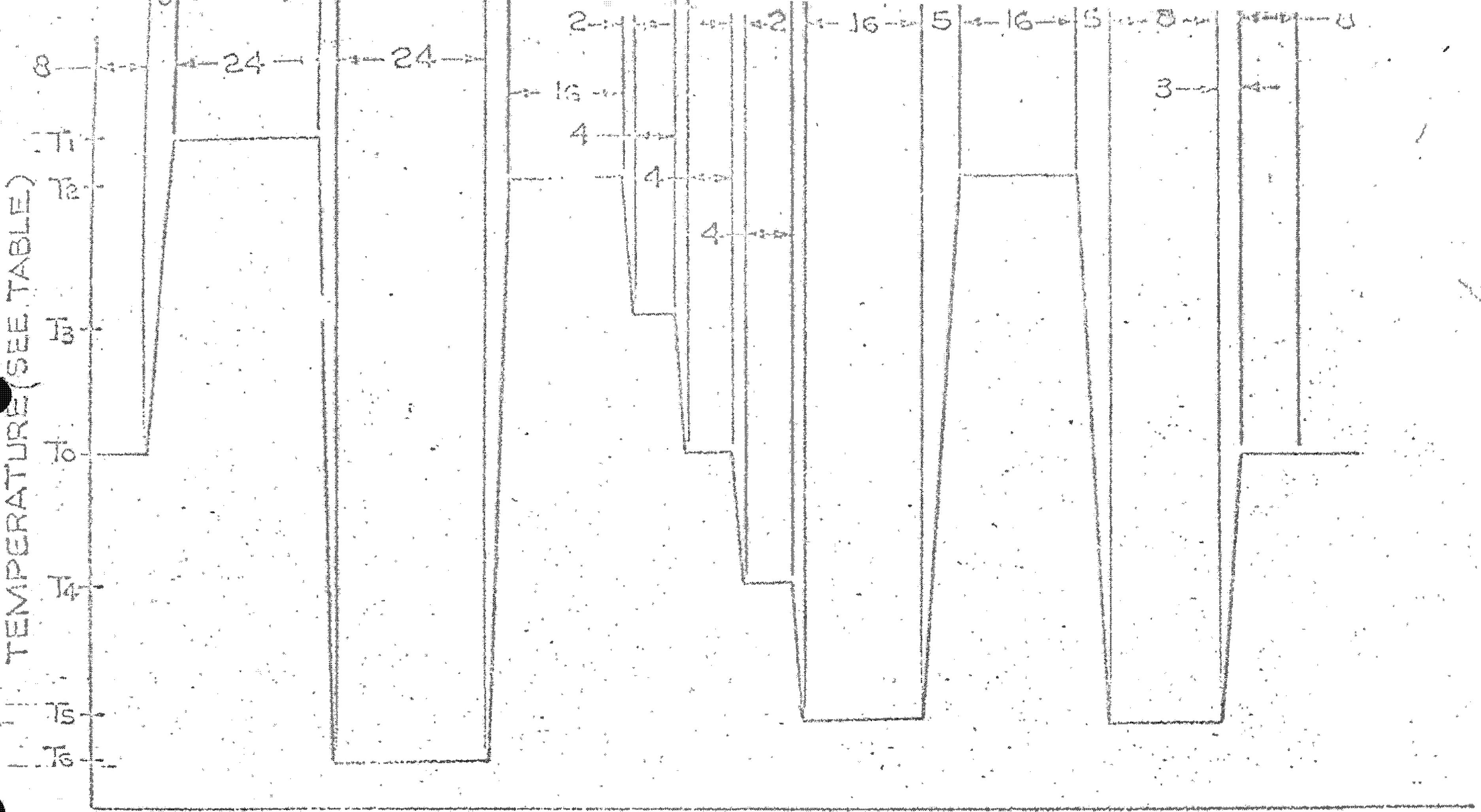


A = MAXIMUM RASTER DIMENSION

B = AREA OF MAXIMUM LIMITS FOR MEASUREMENTS
(B = 0.837A)

C = CORNER LOCATION

FIGURE 1 - VIDICON FACEPLATE FORMAT



TEMPERATURE (°C)		
T #	PROTOTYPE	FLIGHT
T1	+55	+50
T2	+50	+45
T3	+35	+35
T0	25	25
T4	+15	+15
T5	0	+5
T6	-5	0

FIGURE 2

July 23, 1968

ADDENDUM TO
GSFC SPECIFICATION FOR
TWO-INCH RETURN BEAM
VIDICON CAMERA SYSTEM

S-733-P-4

Revised

March 11, 1968

The following corrections are to be made in the March 11, 1968 revision of document S-733-P-4:

Paragraph 3-11 - Add at end of Paragraph:

Unless otherwise noted all requirements refer to the Anode signal mode of operation.

Paragraph 3-11.2 - Insert prior to A as follows:

Although camera measurements shall be otherwise specified the ground resolution shall be calculated on the basis of imaging a two to one contrast ratio scene having an average brightness equal to ½ the highlight brightness. Under these conditions the limiting ground resolution shall be 550 feet per optical line pair in channels one and two; 730 feet per line pair in channel 3.

The camera picture element measurements shall be as follows:
Paragrpah 3-11.15 - Spectral Bands - Change (500 to 570) to (475 to 575)

Change (640 to 720) TO (580 to 680)

Paragraph 3-12 - Item B -- Change picture ground coverage from 100 X 100 statue TO 100 x 100 Nautical Miles

Paragraph 3-12.3 - Spectral Filters - - Add a spectral response change 10% points TO 50% points. Channel one, change (500 to 570) TO (475 to 575) Channel 2, change (640 to 720) TO (580 to 680)

17566 30 June 68

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT ACCESSION	3. AGENCY ACCESSION	
		NS	733-160750304

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
01 29 68	D. Change (09-01-67)	U (RPT) U (WORK)	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE: 160-75-03-04-51

10b. PRIOR NUMBER/CODE:

11. TITLE:
(U) High Resolution Return Beam Vidicon Camera System

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. COMPL. DATE	15. FUNDING AGENCY
01000 Meteorology; 007100 Geology	05 68		

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN YEARS	b. FUNDS (Thousands)
B. Contract	b. NUMBER: Pending a. DATE	PRIOR FY	0.5	600
	c. TYPE d. AMOUNT	CURRENT FY	0.1	250

19. GOVT LAB/INSTALLATION/ACTIVITY
NAME: NASA/Goddard Space Flight Center
ADDRESS: Greenbelt, Maryland 20771
REAP INDIV.: Weinstein, O.; Systems Division
TEL: 301-982-6679 (Commercial)

20. PERFORMING ORGANIZATION
NAME: RCA/AED
ADDRESS: Princeton, New Jersey
INVESTIGATOR'S PRINCIPAL ASSOCIATE: Max Mesner
TEL: 609-448-3400 TWX

21. TECHNOLOGY UTILIZATION

22. COORDINATION

23. KEYWORDS:
High Resolution Cameras

24. (U) Technical Objectives: To develop a TV camera system utilizing a two-inch Return Beam Vidicon capable of providing nominally 6000 TV lines resolution. This is roughly an order of magnitude improvement over vidicon type TV cameras available at this time.

To develop means of obtaining meaningful quantitative data on brightness and spectral response, and of maintaining the system calibration during spacecraft environmental changes.

To investigate the unique requirements on a ground display system by the high resolution information from the proposed camera system.

25. (U) Approach: The work is planned in the following phases: (1) Test and evaluation of the two-inch Return Beam Vidicon performance capability. (2) Tube ruggedization (target/mesh). (3) Camera system design study; (4) Feasibility model development and test; (5) Development of a test engineering multi-spectral camera system; and (6) Development and fabrication of specialized test equipment.

The feasibility model camera system will provide an electrical model for test and evaluation purposes. A three camera test engineering model will be designed to verify that simultaneous multi-spectral information can be obtained from the system.

26. (U) Progress: A test camera has been built and a number of sensors evaluated. It has been demonstrated that nominally 4500 TV lines can be achieved with a S/N ratio of 35 db at .04 fcs faceplate illumination. Additional tests are continuing to define the optimum methods for operating the sensor to achieve reliable performance.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT

32. FUNDS ($ K)	IN-HOUSE	CONTRACT
PRIOR FY 68	–	600
CURRENT FY 69	–	250
NEXT FY 70	–	–

33. UNIQUE PROJECT: Space Applications SRT
34. SUB PROGRAM: Earth Resources
35. TASK AREA: Interdisciplinary Instrumentation Feasibility

K. Mooney

NASA FORM 1132 (Rev. Nov. 68)
(Many Use Identical to DD Form 1498)

907-720 U.S. GOVERNMENT PRINTING OFFICE: 1968 O-295-068

Cancelled 20 Sept 67 B 52698

TECHNICAL STATEMENTS CONCERNING NASA S-733-P-4

The Two-Inch Return Beam Vidicon Tube specified in NASA S-733-P-4 is theoretically capable of producing angular resolutions of 0.044 milliradians in channels 1 and 2, and 0.059 milliradians in channel 3. The flight model lens is not specified; therefore, the assumption is made that the Return Beam Vidicon Tube is the limiting element of the system. The NIKKOR-EL (63 mm focal length) lens is specified for bench testing only. The Vidicon Tube/NIKKOR-EL lens combination is theoretically capable of angular resolutions of 0.0905 in channels 1 and 2, and 0.12 in channel 3.

The ground resolution specifications stated in addendum paragraph 3.11.2 of the July 23, 1968 revision to S-733-P-4 are not compatible with the theoretical capabilities of the Vidicon Tube specified in the basic document.

An analysis of the actual system resolving capability is not possible without further flight model lens definition.

Resolution Calculations & Conclusions for 2" Return Beam Vidicon System

Specifications:

Image Size: 1" x 1", minimum
Ground Scene: 100 x 100 n. nautical miles
Altitude: 496 nautical miles
No. of Lines: Channels 1 & 2 - 4500
Channel 3 - 3400

Calculations:

A - Ground Resolution:

a) $\frac{100 \text{ nautical miles} \times 6.08 \times 10^3 \text{ ft/nautical mile}}{4500 \text{ lines}} = R_{ground_a}$

$R_{g_a} = 133 \text{ ft/line}$

R_{ground_a} = Ground Resolution of Channels 1 & 2

b) $\frac{100 \text{ nm} \times 6.08 \times 10^3 \text{ ft/nm}}{3400 \text{ lines}} = R_{ground_b}$

$R_{g_b} = 179 \text{ ft.}$

R_{ground_b} = Ground Resolution of Channels 3

3- Angular Resolution:

a)

$496\ nm \times 6.08 \times 10^3 = Altitude_1$

$A_1 = 3.02 \times 10^6\ ft$

$R\alpha_a = \frac{133\ ft}{3.02 \times 10^6\ ft} = \frac{R_{ga}}{A_1}$

$R\alpha_a$ = angular Resolution of Channels 1 & 2

$R\alpha_a = .044$ milliradians

b)

$A_1 = 3.02 \times 10^6\ ft$

$R\alpha_b$ = angular Resolution of Channels 3

$R\alpha_b = \frac{179\ ft}{3.02 \times 10^6\ ft} = \frac{R_{gb}}{A_1}$

$R\alpha_b = .059$ milliradians

3

Conclusions:

a- Channels 1, 2 have angular resolutions less than 0.1 milliradians. In fact, .044 mr.

b- Channel 3 has an angular resolution less than 0.1 milliradians. In fact, .059 mr.

c- July 23 1968 revision does not correctly interpret the system performance in terms of the limiting ground resolution of the Ikebana Beam Vidicon System.