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543.

PRELIMINARY ENGINEERING DESCRIPTION

of the

SURVEY CAMERA

for the

APOLLO MAPPING AND SURVEY SYSTEM

Volume 2 of 2 Volumes

Prepared by

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Volume 2

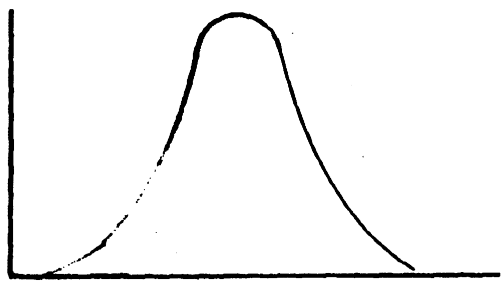
APPENDIX A

SINE-WAVE RESPONSE

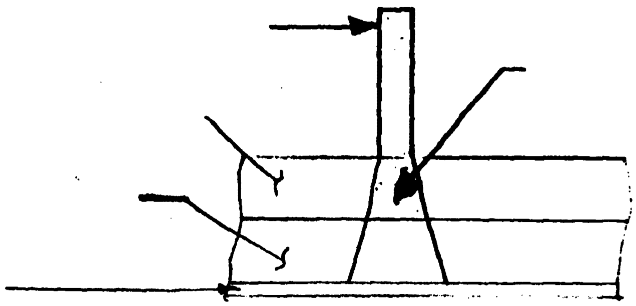
GENERAL

Sine-wave analysis is a mathematical technique which is useful in analyzing each element of a system and the system as a whole with regard to their effects on the quality of the photographic image produced. This appendix gives a cursory description of sine-wave response. A comprehensive discussion of the subjecg can be found in the references listed at the conclusion of this appendix.

If it were possible to start with an infinitely small spot of light and to image it with a lens, the image would not be infinitely small. Diffraction and aberrations in the lens would spread the image out over a finite area. The intensity distribution of the light in this area is called the point-spread function. A cross section might look something like this:



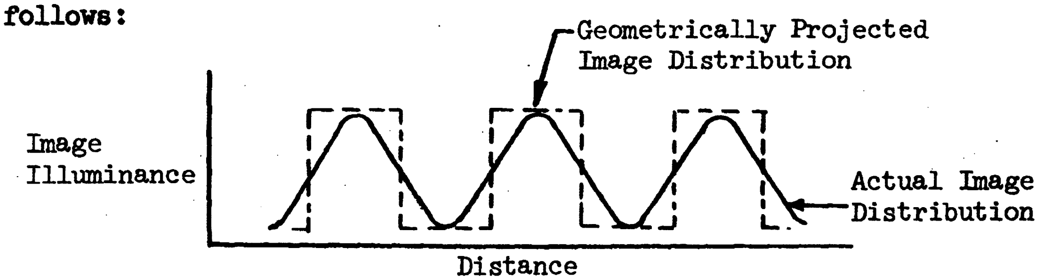
Similarly, if it were possible to image an infinitely small spot of light on a piece of film, the light distribution in the film would not be a narrow shaft through the thickness of the emulsion, but would spread out because of diffraction, reflection, atsorption, and so on. The light distribution in the emulsion might look like this:



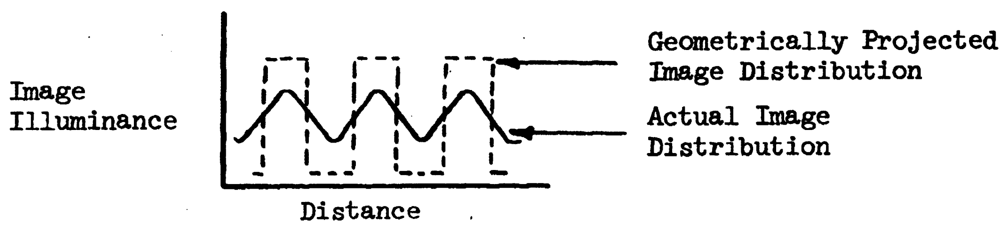
Now consider a light source consisting of a small but finite spot, imaged on a piece of film by a lens. Each infinitesimal element of the source forms its own spread function and all of these combine to make the spot image. Similarly, each element of the image forms its own spread function in the emulsion. These combine to produce the light distribution in the emulsion which in turn determines the distribution of density in the developed film. This distribution of density is a fundamental index of the quality of the photographic image. However, it is difficult to measure directly the distribution in the image of a point source because the measuring sensor must be much smaller than the image. The sensor must have high sensitivity, and its position with respect to the timage is critical. If a line source is used insteqd of a point source, the scanning aperture of the measuring device can be a slit and the light available for measurement is greatly increased. A line source can be thought of as a series of point sources, and the image as a series of overlapping point-spread functions. The energy cross section of this image is called the line-spread function. The point-spread function and the line-spread function are not equal, but they are mathematically related. The line-spread function is therefore a valid measure of the quality of the image.

TEST OBJECTS

The most common type of test object is one made up of a series of broad, sharply defined lines rather than of one narrow line. The spacing of the lines determines the magnitude of the light variation in the image. When the spacing of lines in the image of the test object is slightly larger than the light spread function of the image, the energy cross section of the actual image and the geometrically projected image may be shown as follows:

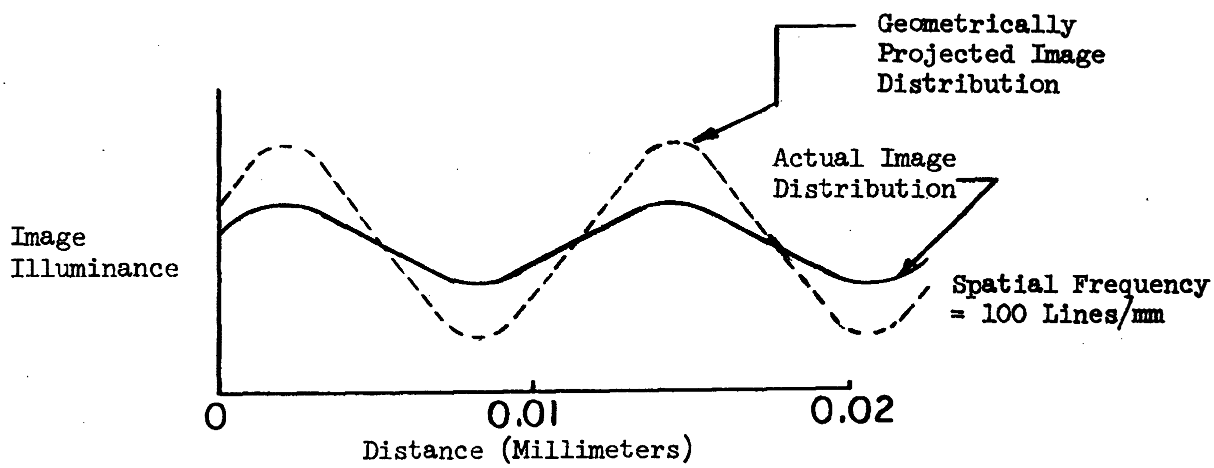


As the spacing and width of lines in the test object decrease, the light variation in the image is decreased as follows:



The magnitude of the light variations in the image is clearly related to the line-spread function, but to establish this relationship mathematically is tedious. Square-wave test objects are therefore used only to determine the spatial frequency at which light variations in the image are no longer discernible to the eye. This is the well-known resolving-power test. Since resolving power depends on the variation of light in the image, which in turn is related to the spread function, there is in general good correlation between the resolving power of a system and the size of the spread function. The shape of the spread function, however, is not derivable from measurements of resolving power.

If the light configuration of the object varies as a sine wave instead of as a square wave, the image produced by a linear system is sinusoidal in character and is completely defined by measuring the maximum and minimum light values in the image. For a typical case, the actual image and the geometrically projected image of a sine-wave test object can be shown as follows:



An important advantage in the use of the sine-wave test object lies in the fact that it is relatively easy to show mathematically the relationship between the line-spread function of a system and the light variations in the image measured over the spatial frequency spectrum. A plot of these measured light variations against spatial frequency, called the sine-wave response, is equivalent to the line-spread function and contains the same information with respect to the quality of the system. A more detailed discussion of sine-wave response as applied to the photographic system follows.

Sine-wave test objects have been made and the transmittance variations measured as a function of the spatial frequency of the sine wave. When such a test object is placed in front of an extended source of known luminance, the luminance variation at any frequency can be expressed as follows:

$$M = \frac{I_{max} - I_{min}}{I_{max} + I_{min}} \qquad (1)$$

where I_{max} and I_{min} are the maximum and minimum luminance values and M is defined as the modulation of the test object. The fact that the luminance modulation of the test object is, in general, a function of spatial frequency can be stated mathematically as follows:

$$f\,(w,\,x) = D + A\,(w)\,\sin wx \qquad (2)$$

where $D = \frac{I_{max} + I_{min}}{2}$, the average liminance level;

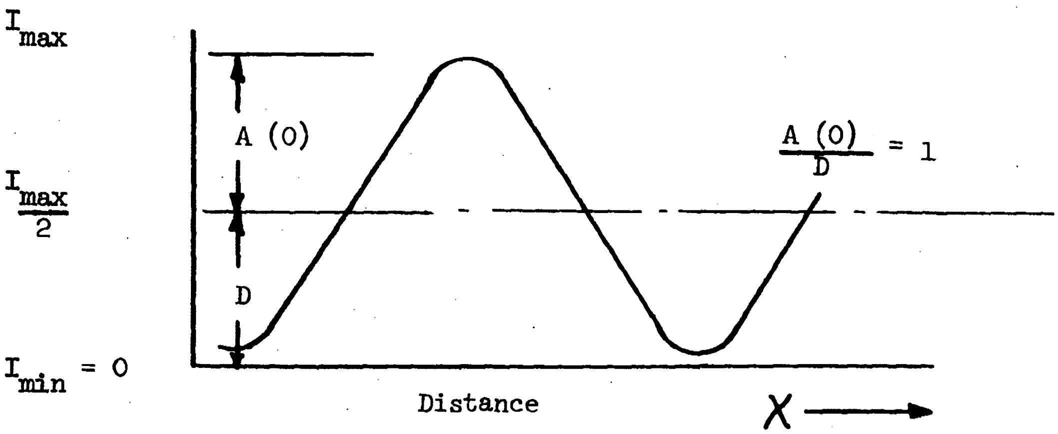
$A\,(w) = \frac{I_{max} - I_{min}}{2}$, the amplitude of the luminance modulation; and

w = spatial frequency of the chart.

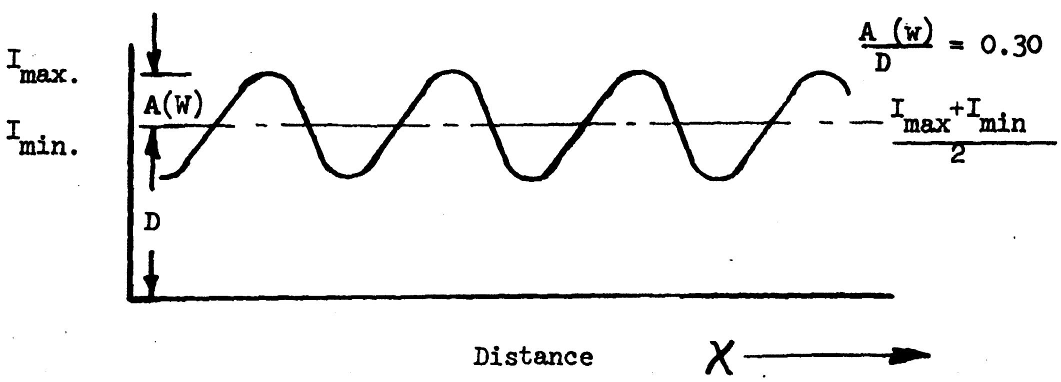
Rewriting equation (1) in terms of the amplitude A(w) and the average level D, the modulation is given by:

$$M = \frac{I_{max} - I_{min}}{I_{max} + I_{min}} = \frac{A\,(w)}{D}$$

At low frequencies (w 0), the minimum luminance in the test object can be made to approach zero, so that the modulation might appear as follows:



In this case the modulation, $\frac{A\ (0)}{D}$, is said to be 100%. Similarly at some higher frequency the modulation of the test object might appear as follows:



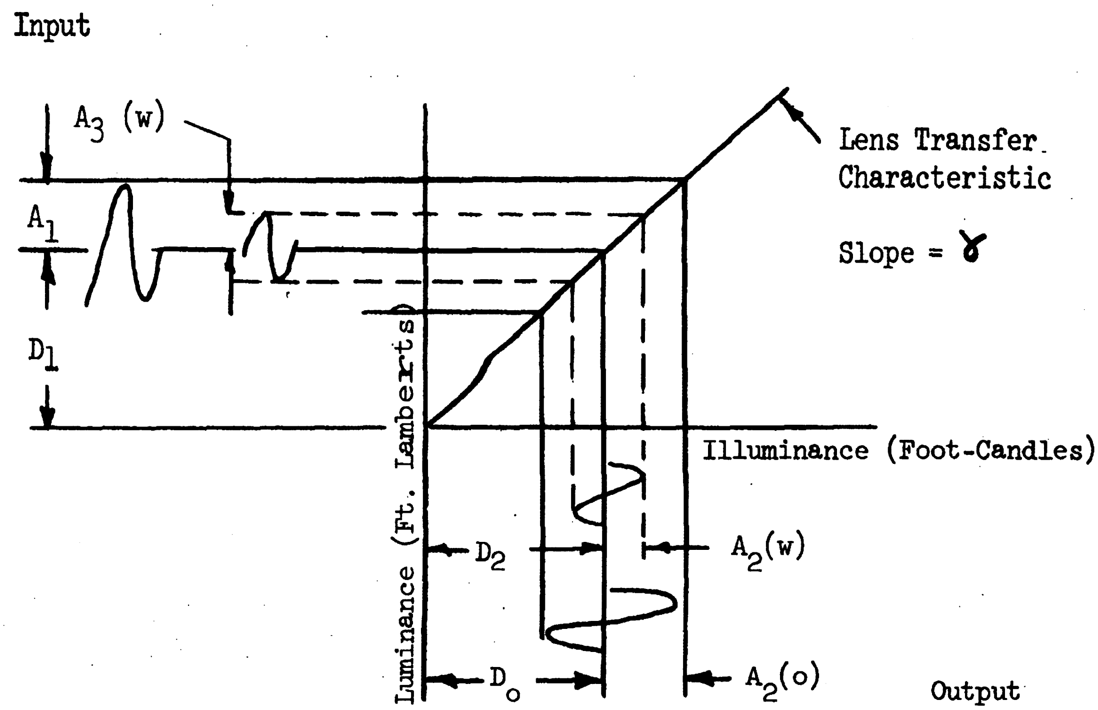
The modulation, $\frac{A(w)}{D}$, is about 30% in this case. This change in the modulation of the test object with frequency is taken into account in obtaining the sine-wave response of a lens-film system.

EXPLANATION OF SINE-WAVE RESPONSE

The best way to define the sine-wave response of a system is to consider a typical sine-wave test of a lens, together with the mathematical expressions for the imput and output functions.

One method of determining the sine-wave response of a lens is to use the lens to image a sine-wave test object onto a fine slit with a phototube behind it. The output of the phototube is measured as the slit scans the image. The effect of the spread function of the lens is to reduce the amplitude of modulation in the image without altering its sinusoidal character. This property of the lens to transfer a sine-wave test object (inputs in units of luminance) into a sine-wave image (outputs in units of illuminance) is fundamental to the sine-wave analysis of a system, and systems exhibiting this property are said to be linear systems. For a mathematical definition of a linear system, see reference 12.

The steady-state transfer characteristic of a lens or of any linear system can be shown as a straight line having a slope,   , as follows:



MODULATION OF TEST OBJECT

If an ideal sine-wave test object is assumed, having a constant amplitude for all frequencies, equation 2 describing the sine-wave input may be rewritten:

$$f\ (w,\ x) = D_1 + A_1 \sin w\, x \qquad (4)$$

where the modulation,

$$M_1 = \frac{A_1}{D_1} \qquad (5)$$

is independent of frequency.

MODULATION OF IMAGE IN A LINEAR SYSTEM

The illuminance variations in the image may be described by the equation

$$g\ (w,\ x) = D_2 + A_2\ (w) \sin \quad w\, x + \quad (w) \qquad , \qquad (6)$$

where (w) is called the phase shift. A phase shift is associated with a non-symmetrical spread function. In the analysis of performance of a lens system on axis, spread functions are in general symmetrical so that the phase shift is zero. The expected modulation at all frequencies for a perfect system would be equal to the modulation at very low frequency,

$$M_0 = \frac{A_2 (w)}{D_o} \qquad (7)$$

and the actual modulation at any frequency is

$$M_2 = \frac{A_2 (w)}{D_2} \qquad (8)$$

The difference between equation (7) which gives the modulation expected from a perfect system and equation (8) which gives the modulation of an actual system is the reduction in peak-to-peak amplitude of the signal and a possible shift in average illuminance level from D_o to D_2 (which could occur if the lens transfer characteristic varies with frequency).

SINE-WAVE RESPONSE OF A LINEAR SYSTEM

By definition, the ratio of the modulation at some frequency to the modulation at zero frequency, $\frac{M_2}{M_o}$, is called the sine-wave response of the system at that frequency. Dividing equation (8) by equation (7) the sine-wave response is given by

$$R (w) = \frac{A_2 (w)\ D_o}{A_2 (o)\ D_2} = \frac{A_2 (w)}{A_2 (o)} \qquad (9)$$

since the average levels D_o and D_2 are equal for a linear system and cancel. Sine-wave response can also be defined in terms of the input and output modulation as follows:

$$R(w) = \frac{M_2}{M_1} \tag{10}$$

since the gain of a linear system acts on the average level as well as on the amplitude, and the output modulation at zero frequency, M_0 , is therefore equal to the input modulation, M_1.

EFFECTIVE INPUT MODULATION

The effective input modulation is given by

$$M_3 = \frac{A_3\ (w)}{D_1} \tag{11}$$

where the effective input modulation, M_3, is obtained by projection of the maximum and minimum values in the output back throught the transfer characteristics of the system.

SINE-WAVE RESPONSE OF A NON-LINEAR SYSTEM

By definition, the sine-wave response of the system is the ratio of the effective input modulation, M_3 , to the actual input modulation, M_1 , given by

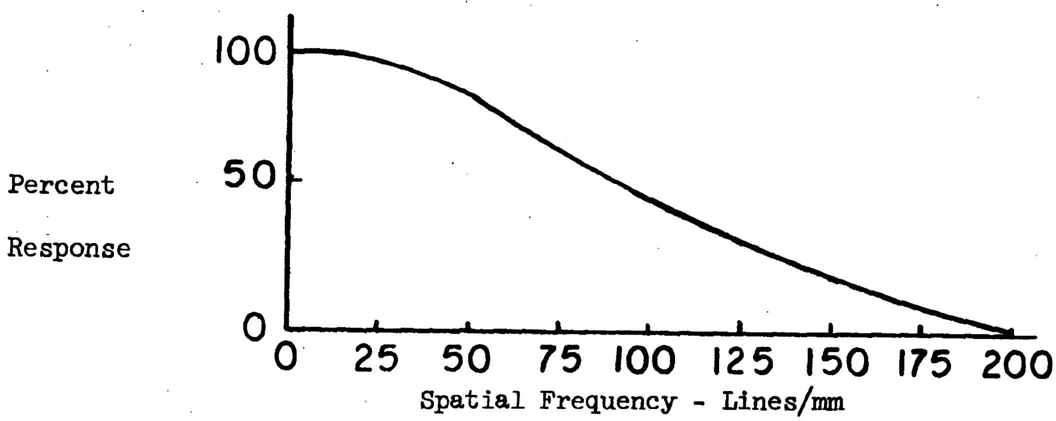
$$R(w) = \frac{A_3\ (w)}{D_1} \cdot \frac{D_1}{A_1} = \frac{A_3\ (w)}{A_1} \tag{12}$$

Note: This definition is equivalent to the definition given by equation (9) where the system is linear since $A_3(w) = A_2(w)$ and $A_1 = A_2(0)$.

Further, if the test-object modulation is 100%, $A_1 = D_1$ and the sine-wave response is sometimes given as

$$R(w) = \frac{A_3(w)}{D_1}$$

The sine-wave test of a lens consists in measuring the sine-wave response at selected frequencies from very low frequencies to frequencies at which the lens response approaches zero. A typical plot of response vs spatial frequency might look like this:



The response of a film is found by using the film to photograph sine-wave test objects through a lens. The photographic images on the test film are developed along with special calibration images that make it possible to plot the transfer characteristics for the film. Because the photographic process is nonlinear, the photographic image of a sine-wavetest object is not sinusoidal, either in transmission or in desity, and it becomes necessary to state the sine-wave response of a film in terms of the effective exposure rather than of transmittance. The effective exposure modulation of the film $A_4(w)/D_2$ can be found by projection of the maximum and minimum density values back through the transfer characteristic of the film. The effective exposure modulation is then referred to the object space of the lens by projection through the transfer characteristic of the lens. This procedure is illustrated on the opposite page.

The effective input modulation, $\frac{A_3(w)}{D_1}$, is then compared with the test object modulation, $\frac{A_1}{D_1}$, where the ratio $\frac{A_3(w)}{A_1}$ is the combined sine-wave response of the lens and film. It follows then that the response of the film alone, $R_F(w)$, is obtained by dividing the response of the lens-film combination, $R_{LF}(w)$, by the response of the lens, $R_L(w)$, since

$$R_{LF}(w) = \frac{A_3(w)}{A_1},$$

$$R_L(w) = \frac{A_2(w)}{A_2(0)} = \frac{A_2(w)}{A_1}$$

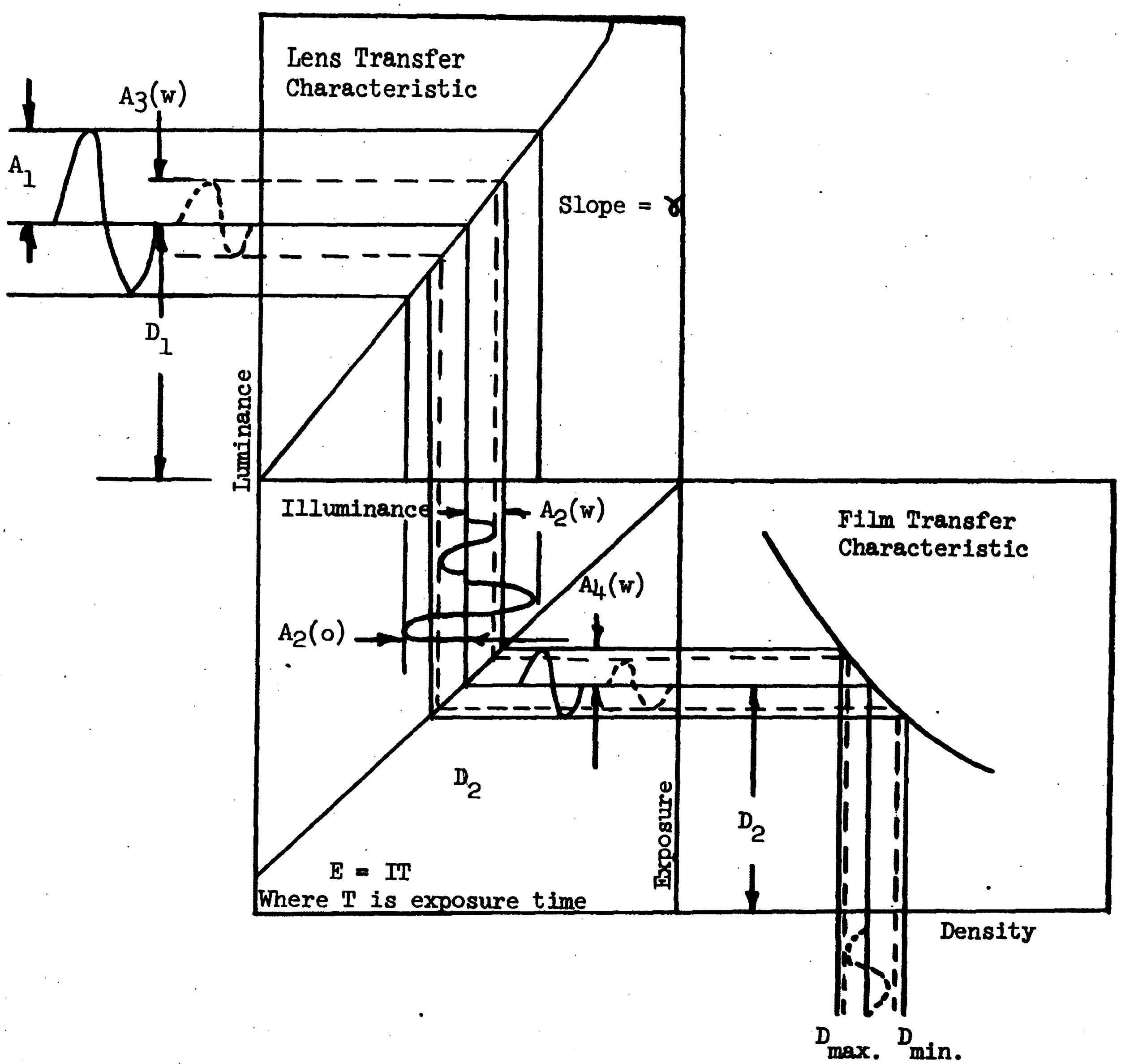
and $$R_F(w) = \frac{R_{LF}(w)}{R_L(w)} = \frac{A_3(w)}{A_1} \times \frac{A_1}{A_2(w)} = \frac{A_3(w)}{A_2(w)}$$

Since

$$A_3(w) = A_4(w),$$

$$R_F(w) = \frac{A_4(w)}{A_2(w)}$$

where $\frac{A_4(w)}{A_2(w)}$ is by definition the response of the film. By a similar argument, the effective response of the test object can also be divided out if necessary.


Lens Transfer Characteristic
A3(w)
A1
Slope = γ
D1
Luminance
Illuminance
A2(w)
Film Transfer Characteristic
A4(w)
A2(o)
D2
D2
E = IT
Where T is exposure time
Exposure
Density
Dmax.
Dmin.

As is done in electronic circuitry, the subsystem can be divided into elements such that the output of each individual element is independent of the characteristics of the next element; for example, the image formed by the lens at the film plane is independent of the smear caused by IMC error. Under this condition and with the assumption that the system is linear, the output of one element can be treated as the input of the next. Therefore, the sine-wave response of each element can be multiplied to obtain the combined effect of two or more elements. Once the sine-wave response of the film has been determined, any system of elements ahead of the film that compiles with the above restrictions can be combined with the film by multiplying the response of the individual elements, frequency by frequency.

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10. R. L. Lamberts, "Measurement of Sine-Wave Response of a Photographic Emulsion", J. Opt. Soc. Am., 49: 425-428 (1949).

11. J. A. Eyer, "Spatial Frequency Response of Certain Photographic Emulsions", J. Opt. Soc. Am., 938-944 (1958).

12. J. L. Bower and P. M. Schultheiss, Introduction to the Design of Servomechanisms, John Wiley and Sons Inc., New York, Chapter 1 (1958).

APPENDIX B

IMAGE SMEAR

The magnitude of the IMC error or smear in the film plane can generally be determined from camera tolerances. For performance studies, it is necessary to convert the image spread caused by smear to a modulation transfer function. The following discussion indicates the method of converting the calculated values of smear to a modulation transfer function or MTF.

Figure B-1 is the "Line Spread Function" that appears on the film of a point object if the slit (shutter) is 100% efficient. The point is smeared a distance , and no other degradations are present.

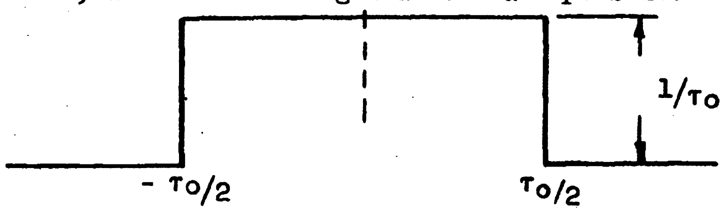

FIGURE B-1

If the slit is not 100% efficient, then two things happen:

1. The total smear is slightly longer.
2. The edges are no longer as sharp.

This is depicted in Figure H-2.

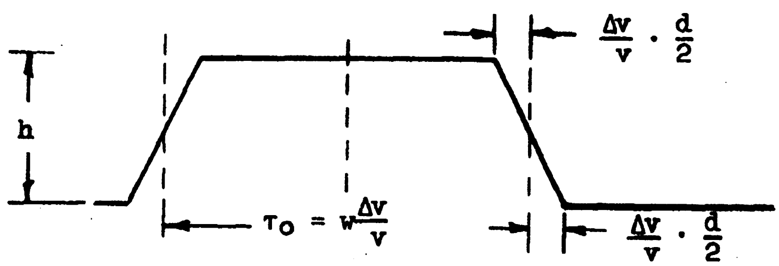

FIGURE B-2

where: d = Diameter of the cone of light at the slit aperture plate

w = Slit width

$\frac{v}{V}$ = Uncompensated image motion

Note in particular that the definition of is the smear that would occur if the slit were 100% efficient.

With reference to Figure B-2, the total light that would have produced the image if all points had received the same amount of light is proportional to:

$$h\ (w + d)\ \frac{v}{V}$$

The total light that produces the image is proportional to:

$$h\ \ (w + d) + (w - d)\ \ \frac{v}{2V}\ \ =\ h\ w\ \frac{v}{V}$$

The ratio of these two quantities is used as a measure of slit efficiency and is denoted by E. Therefore:

$$E = \frac{w}{w+d} \qquad \text{and} \qquad d = \frac{w - we}{e}$$

In terms of the E notation, the length of the base of Figure C-2 is:

$$(\ w + d\ )\ \frac{v}{V}\ =\ \frac{v}{V}\ \frac{w}{e}\ =\ \frac{}{E}$$

The length of the top is:

$$(\ w\ -d)\ \frac{v}{V}\ =\ \frac{v}{V}\qquad w - \frac{w - wE}{E}\ =\ \frac{(2E - 1)}{E}$$

By theory of linear systems then, if the area of Figure B-2 is normalized to 1, the MTF is the Fourier Transform of the resulting function. This function is shown in Figure B-3.

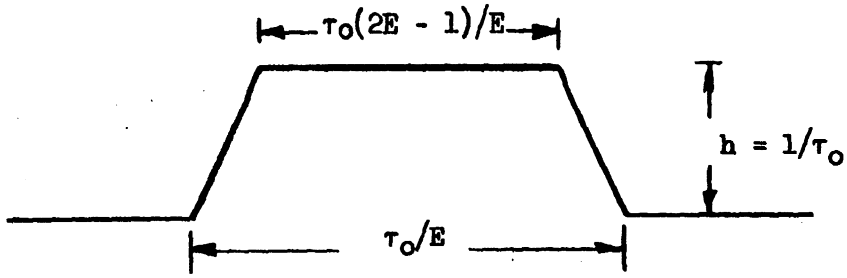

FIGURE B-3

There are several ways to obtain the transform of Figure B-3. The method used was to appeal to the linearity property of the Fourier Transform and recognize that Figure B-3 is the difference of the two triangles given in Figure B-4.

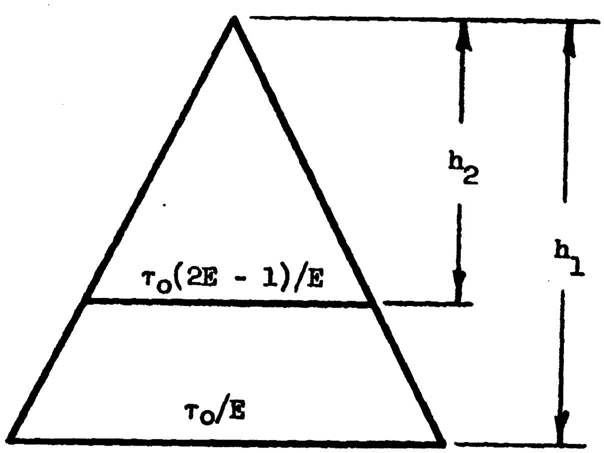

FIGURE B-4

The values of h_1 and h_2 satisfy the relations:

$$h_1 - h_2 = 1/\tau_c$$

and

$$\frac{h_1}{h_2} = \frac{\tau_c/E}{\tau_c(2E-1)/E} = \frac{1}{2E-1}$$

If these equations are solved, the result is:

$$h_1 = \frac{1}{2\tau_c\ (1-E)}$$

$$h_2 = \frac{(2E-1}{2\tau_c\ (1-E)}$$

Now the transform of the triangle in Figure C-5 is:

$$G(\nu) = B\ \frac{\sin\alpha}{\alpha}^{2}$$

where $B = A_1$; $\alpha = \pi\tau_1\nu$; and ν = Spatial Frequency.

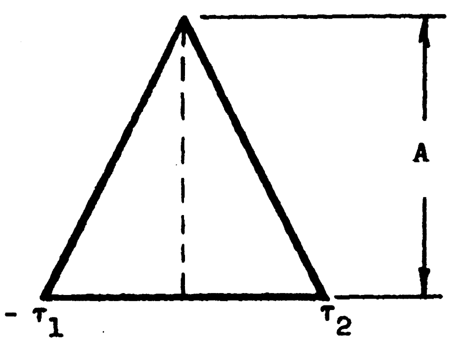

FIGURE B-5

Therefore the Fouriter Transform of Figure B-3 is:

$$G(\ ) = \frac{1}{2\tau_0(1-E)} \cdot \frac{\tau_0}{2E} \cdot \left[\frac{\mathrm{SIN}\ (\pi\nu\tau_0/2E)}{\pi\nu\tau_0/2E}\right]^2 - \frac{2E-1}{2\tau_0(1-E)} \cdot \frac{\tau_0(2E-1)}{2E} \cdot \left[\frac{\mathrm{SIN}\ (\pi\nu\tau_0(2E-1)/2E)}{\pi\nu\tau_0\ (2E-1)/2E}\right]^2$$

$$G(\ ) = \frac{E}{\pi^2\nu^2\tau_0^2(1-E)} \cdot \mathrm{SIN}^2\ (\pi\nu\tau_0/2E) - \mathrm{SIN}^2\ (\pi\nu\tau_0(2E-1)/2E)$$

$$\text{or } G(\nu) = \frac{\mathrm{SIN}\ (\pi\nu\tau_0)}{\pi\nu\tau_0} \cdot \frac{\mathrm{SIN}\left[\pi\nu\tau_0\left(\frac{1}{E}-1\right)\right]}{\pi\nu\tau_0\left(\frac{1}{E}-1\right)}$$

The MTF's for two shutter efficiencies can be obtained from the nomograph in Figure B-6, which has been derived from the preceding equation. For example, if one follows the dotted line from the lower right to the upper left, a smear of 2.9 microns at a spatial frequency of 100 lines per milimeter corresponds to a transfer factor for smear of 85 percent at a 74 percent shutter efficiency.

If the camera is designed to provide a nominal 0.008 inch clearance between the slit and the emulsion surface, and the relative aperture is f/4.0, the diameter of the light cone at the slit (d) is 0.002 inch. Let the slit width (w) be 0.0083 inch. Substituting these values in the shhtter-efficiency equation:

$$\text{Shutter Efficiency} = \frac{w}{w+d} = \frac{0.0083}{0.0083 + 0.002} = 81 \text{ percent}$$

Once the normalized smear plus shutter efficiency curve has been calculated the modulation transfer factor at a given spatial frequency in lines per millimeter may be read from the appropriate scale for the calculated value of image smear. By multiplying the MTF for smear by the MTF's for other elements of the system, a combined MTF describing the system can be determined.

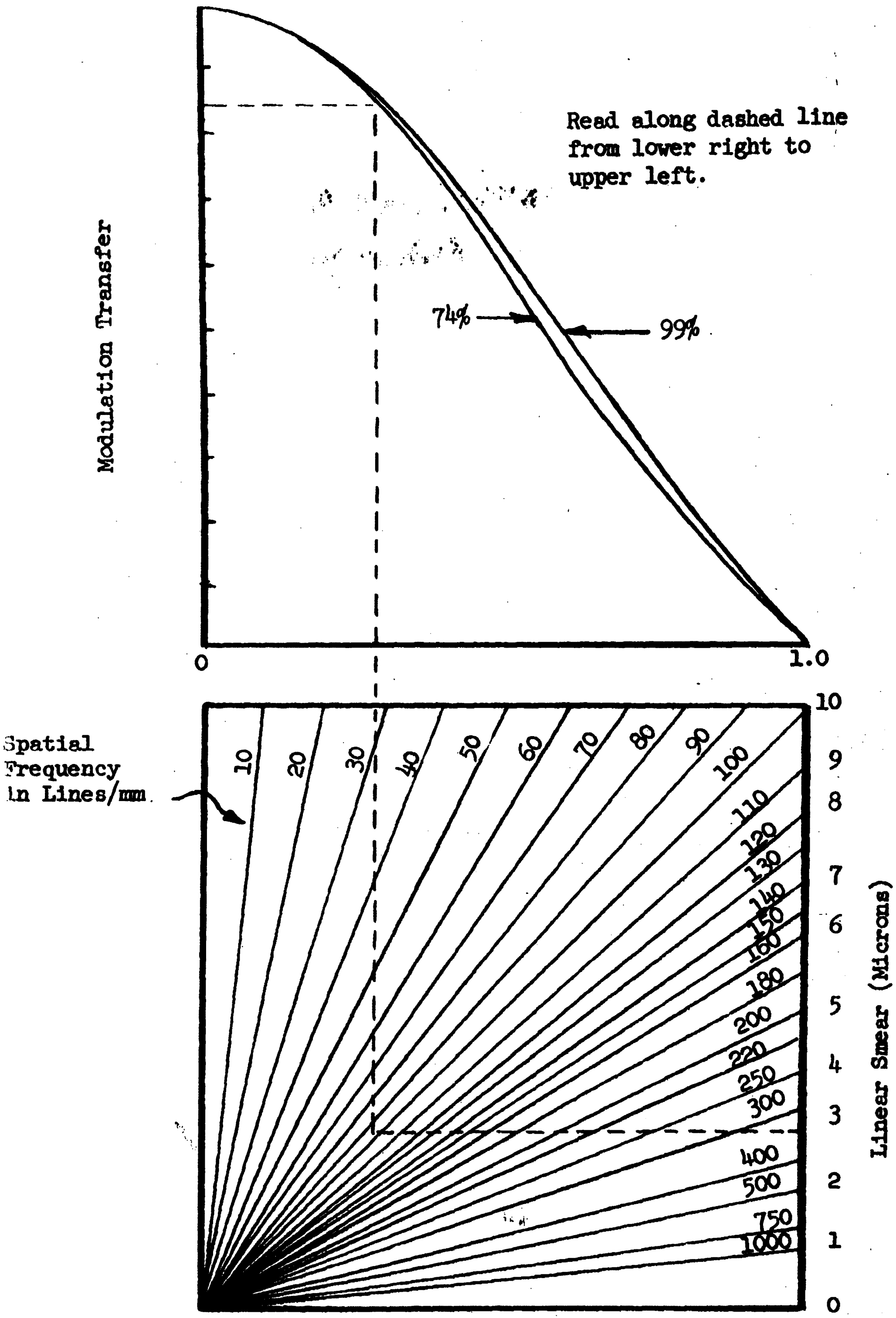

Figure B-6. MTF of Linear Image Smear for Shutter Efficiencies of 99 and 74 Percent

Appendix C

Smear Equations and Budgets

The following equations and tables give an estimate of smear for the strip camera-satellite system.

The orbit-fixed coordinate system has its origin at the center of gravity of the vehicle with +X positive backward along the direction of vehicle motion, +Z positive vertically directed away from the moon and +Y forming a right-hand system.

The camera-fixed coordinate system has its origin at the nodal point of the equivalent thin lens focusing element. The x axis is in the across-the-slit direction and the y axis is in the along-the-slit direction so that the image plane is parallel to the x-y plane. The positive directions of x and y are defined such that positive X and Y smears on the ground become positive x and y smears in the image plane. The +z axis forms a right-hand system. The positive sense of all angles is established by the right-hand rule for both coordinate systems.

Transforming Smears On The Ground Into Smears In The Image Plane

A known X component of smear in the image plane x_1, may be transformed into smear on the ground, X_1, by the relation:

$$X_1 = x_1 \frac{h}{F} \sec^2 \Sigma \sec \Omega$$

A known Y component of smear in the image plane, y_1, may be transformed into smear on the ground, Y_1, by the relation:

$$Y_1 = y_1 \frac{h}{F} \sec \Sigma \sec^2 \Omega$$

Equations for smear in the image plane are given in Table C-1. Each smear contributor may be assigned to one of two categories depending on the frequency with which the smear varies. The first category consists of errors X_1 to X_{11} and Y_1 to Y_{11} which vary within a single mission. The resultants of errors X_{12} to X_{17} and Y_{12} to Y_{17} are fixed for an entire mission. Since the errors are independent, they may be root-sum-squared within each category. The smear contributors from each category must be combined to produce an over-all limiting smear.

Total smear, S_x or S_y =

$$\sqrt{\sum_{i=1}^{11} S_i^2} + \sqrt{\sum_{i=12}^{17} S_i^2}$$

where Si is the smear due to the i th contributor listed in Tables C-2 through C-6 of this appendix.

The smear summaries included in this Appendix are listed below:

Table C-2 - The nominal smear summary, which represents the smear for nominal tolerances and nadir V/h sensing.

Table C-3 - A smear summary which represents the condition where the V/h sensor is directed along the line of sight.

Table C-4 - A smear summary for programmed V/h.

Table C-5 - A smear summary for Eastman Kodak Company's design goals.

Table C-6 - A smear summary for NAA attitude tolerances without the LEM.

The tolerances in Tables C-5 and C-6 are identical with those of Table C-2, with the exception of items 2 through 7. Resolution values in the tables are for 1/100 second exposure time, 2:1 tri-bar contrast, and the basic film (advanced type 4404 with exposure index of 6).

TABLE C-1

Image Plane Smear Equations

Knowledge of Altitude (or in-track V/h error)	$X_1 = -W\Delta^{h/h}$	$Y_1 = 0$
Roll	$X_2 = -W A_X \tan\Omega$	$Y_2 = 0$
Pitch	$X_3 = -W A_Y(\cos\Omega + \sec\Omega) \tan\Sigma$	$Y_3 = W A_Y \sec\Sigma \sin\Omega$
Yaw	$X_4 = -W A_Z \text{Sin}\,\Omega \tan\Sigma$	$Y_4 = -W A_Z \cos\Omega \sec\Sigma$
Roll Rate	$X_5 = 0$	$Y_5 = \frac{wh}{V_x} \dot{A}_x \sec\Sigma \sec\Omega$
Pitch Rate	$X_6 = \frac{Wh}{V_x} \dot{A}_y \sec^2\Sigma$	$Y_6 = \frac{wh}{V_x} \dot{A}_y \tan\Sigma \sec\Sigma \tan\Omega$
Yaw Rate	$X_7 = \frac{Wh}{V_x} \dot{A}_z \tan\Omega \sec^2\Sigma$	$Y_7 = \frac{wh}{V_x} \dot{A}_z \tan\Sigma \sec\Sigma$
Crab	$X_8 = -W \Delta\chi \tan\Omega$	$Y_8 = -W\Delta\Sigma$
Vibration	$X_9 = \frac{Wh}{V_x F} (\text{vib}) \sec^2\Sigma \sec\Omega$	$Y_9 = 0$
Stereo Servo	$X_{10} = -4W \Delta\Sigma_M \tan\Sigma \cos\chi$	$Y_{10} = 4W\Delta\Sigma_M \tan\Sigma \sin\chi$
Film Drive Speed	$X_{11} = -W \frac{\Delta V_F}{V_F}$	$Y_{11} = 0$
Roll Alignment	$X_{12} = -W B_x \tan\Omega$	$Y_{12} = 0$
Pitch Alignment	$X_{13} = -W B_y (\cos\Omega + \sec\Omega) \tan\Sigma$	$Y_{13} = W B_y \sec\Sigma \sin\Omega$
Yaw Alignment	$X_{14} = -W B_z \sin\Omega \tan\Sigma$	$Y_{14} = -W B_z \cos\Omega \sec\Sigma$

firror Mounting Crab	$X_{15} = -W\ M_c\ \tan \Omega$	$Y_{15} = -W\ M_c$
;ereo	$X_{16} = -4W\ M_s\ \tan \Sigma\ \cos \chi$	$Y_{16} = 4W\ M_s\ \tan \Sigma\ \sin \chi$
ıowledge of focal length	$X_{17} = -W\ (\Delta F/F)$	$Y_{17} = 0.$

TABLE C-1 (cont'd.)

NOMENCLATURE

X_i = Component of smear on ground parallel to the ground track for the ith contributor

X_i = Component of smear in the image plane perpendicular to the slit for the ith contributor

Y_i = Component of smear on ground perpendicular to the ground track for the ith contributor

y_i = Component of smear in the image plane parallel to the slit for the ith contributor

W = Slit width

h = True altitude of the camera above ground

F = Focal length

Δh = Uncertainty in knowledge of altitude

Σ = Stereo angle of line of sight

Σ_m = Stereo mirror angle = /2

$\Delta \Sigma_m$ = Uncertainty in stereo mirror angle due to errors in the positioning mechanism

Ω = Obliquity angle of the line of sight

χ = Crab angle of the mirror

Table C-2

SUMMARY OF IMAGE MOTION ERRORS WITH NOMINAL TOLERANCES AND NADIR V/H SENSING

				Image Smear			
				30 N.M. Alt.		80 N.M. Alt.	
*Smear Contributor	Tolerance	2 Sigma Variability	Tolerance Allocation	Across slit Microns-X	Along slit Microns-Y	Across slit Microns-X	Along slit Microns-Y
.. V/H Sensor Error	± 0.5%	± 0.33%	C/P	1.75	0	.226	0
2. Roll Attitude Control	± 0.75°	± 0.5°	CSM	0	0	0	0
3. Pitch Attitude Control	± 0.75°	± 0.5°	CSM	2.45	0	.85	0
4. Yaw Altitude Control	± 0.75°	± 0.5°	CSM	0	4.74	0	1.64
5. Roll Rate Control	± 0.015°/sec.	± 0.01°/sec.	CSM	0	3.28	0	3.28
6. Pitch Rate Control	± 0.015°/sec.	** No contribution	CSM	0	0	0	0
7. Yaw Rate Control	± 0.015°/sec	± 0.01°/sec.	CSM	0	.88	0	.88
8. Crab Servo	Not used	-	C/P	-	-	-	-
9. Film Drive Vibration	0.4 mm/sec.	0.267 mm/sec.	C/P	2.66	0	2.66	0
0. Stereo Servo Error	± 0.22°	± 0.15°	C/P	1.47	0	.51	0
.. Film Velocity Steps	± 0.25%	± 0.30%	C/P	1.57	0	.54	0
Film Velocity Drift	± 0.2%						
2. Roll Alignment	± 0.04°	± 0.027°	CSM	0	0	0	0
3. Pitch Alignment	± 0.04°	± 0.027°	CSM	.13	0	.05	0
4. Yaw Alignment	± 0.10°	± 0.067°	CSM	0	.63	0	.22
5. Mirror Mounting (Crab)	± 0.05°	± 0.033°	C/P	0	.32	0	.10
6. Mirror Mounting (Stereo)	± 0.05°	± 0.033°	C/P	.32	0	.11	0
7. Knowledge of Focal Length	± 0.1 In.	± 0.067 In.	C/P	.46	0	.16	0
				X	Y	X	Y
...tal smear combined for T = .01 sec. exposure (microns)				5.13	6.54	3.09	4.01
...namic resolution (1/mm) 2:1 contrast and basic film				[redacted]		[redacted]	
...atic Resolution (1/mm) 2:1 contrast and basic film							
...ound Resolution (inches) 2:1 contrast and basic film						25.4	24.9
...ometric Mean Ground Resolution (inches)						25.2	

3.3(b)(1) 3.3(b)(1)

* Possible disturbances and vibrations produced by the spacecraft mechanisms or astronauts are not included.
** Included in Item 1.

Table C-3

SUMMARY OF IMAGE MOTION ERRORS WITH INTEGRAL V/H SENSING

	*Smear Contributor	Tolerance	2 Sigma Variability	Tolerance Allocation	Image Smear: 30 N.M. Alt. Across slit Microns-X	Image Smear: 30 N.M. Alt. Along slit Microns-Y	Image Smear: 80 N.M. Alt. Across slit Microns-X	Image Smear: 80 N.M. Alt. Along slit Microns-Y
1.	V/H Sensor Error (In track)	± 0.5%	± 0.33%	C/P	1.75	0	.61	0
2.	Roll Attitude Control	± 0.75°	** No contribution	CSM	0	0	0	0
3.	Pitch Attitude Control	± 0.75°	** No contribution	CSM	0	0	0	0
4.	Yaw Attitude Control	± 0.75°	** No contribution	CSM	0	0	0	0
5.	Roll Rate Control	± 0.015°/sec.	** No contribution	CSM	0	0	0	0
6.	Pitch Rate Control	± 0.015°/sec.	** No contribution	CSM	0	0	0	0
7.	Yaw Rate Control	± 0.015°/sec.	** No contribution	CSM	0	0	0	0
8.	Crab Servo	± 0.10°	± 0.095°	C/P	0	.872	0	.3032
	V/H Crab Error (cross track)	± 0.10°			-	-	-	-
9.	Film Drive Vibration	0.4 mm/sec.	0.267 mm/sec	C/P	2.67	0	2.68	0
10.	Stereo Servo Error	± 0.22°	± 0.15°	C/P	1.48	0	.513	0
11.	Film Velocity Steps	± 0.25%	± 0.30%	C/P	1.58	0	.549	0
	Film Velocity Drift	± 0.2%			-	-	-	-
12.	Roll Alignment	± 0.04°	± 0.027°	CSM	0	0	0	0
13.	Pitch Alignment	± 0.04°	± 0.027°	CSM	.133	0	.046	0
14.	Yaw Alignment	± 0.10°	± 0.067°	CSM	0	.637	0	.221
15.	V/H Alignment (Crab)	± 0.10°	± 0.067°	C/P	0	.615	0	.214
16.	Mirror Mounting (Stereo)	± 0.05°	± 0.033°	C/P	.325	0	.113	0
17.	Knowledge of Focal Length	± 0.1 In.	± 0.067 In.	C/P	.458	0	.159	0
					X	Y	X	Y
	Total Smear Combined for T = .01/sec. Exposure (Microns)				[redacted]	[redacted]	[redacted]	[redacted]
	Dynamic Resolution (1/mm) 2:1 contrast and basic film							
	Static Resolution (1/mm) 2:1 contrast and basic film							
	Ground Resolution (inches) 2:1 contrast and basic film						25.4	
	Geometric Mean Ground Resolution (inches)							

* Possible disturbances and vibration produced by the spacecraft mechanisms or astronauts are not included.
** Included in Item 1.

Table C-4

SUMMARY OF IMAGE MOTION ERRORS WITH GROUND PROGRAMMED V/H

				Image Smear 30 N.M. Alt.		Image Smear 30 N.M. Alt.	
*Smear Contributor	Tolerance	2 Sigma Variability	Tolerance Allocation	Across slit Microns-X	Along slit Microns-Y	Across slit Microns-X	Along slit Microns-Y
1. Knowledge of Altitude	± 0.5 N.M.	± 0.33 N.M.	Tracking	5.8	0	.759	0
2. Roll Attitude Control	± 0.75°	± 0.5°	CSM	0	0	0	0
3. Pitch Attitude Control	± 0.75°	± 0.5°	CSM	2.46	0	.855	0
4. Yaw Attitude Control	± 0.75°	± 0.5°	CSM	0	4.75	0	1.65
5. Roll Rate Control	± 0.015°/sec.	± 0.01°/sec.	CSM	0	3.30	0	3.31
6. Pitch Rate Control	± 0.015°/sec.	± 0.01°/sec.	CSM	3.41	0	3.42	0
7. Yaw Rate Control	± 0.015°/sec.	± 0.01°/sec.	CSM	0	.884	0	0.886
8. Crab Servo	Not Used	--	C/P	--	--	--	--
9. Film Drive Vibration	0.4 mm/sec.	0.267 mm/sec.	C/P	2.67	0	2.68	0
10. Stereo Servo Error	± 0.22°	± 0.15°	C/P	1.48	0	0.513	0
11. Film Velocity Steps	± 0.25%	± 0.30%	C/P	1.58	0	0.549	0
Film Velocity Drift	± 0.2%		C/P	--	--	--	--
12. Roll Alignment	± 0.04°	± 0.027°	CSM	0	0	0	0
13. Pitch Alignment	± 0.04°	± 0.027°	CSM	0.133	0	0.046	0
14. Yaw Alignment	± 0.10°	± 0.067°	CSM	0	.637	0	0.221
15. Mirror Mounting (Crab)	± 0.05°	± 0.033°	C/P	0	.303	0	0.105
16. Mirror Mounting (Stereo)	± 0.05°	± 0.033°	C/P	.324	0	0.113	0
17. Knowledge of Focal Length	± 0.1 In.	± 0.067 In.	C/P	.458	0	0.159	0
				X	Y	X	Y
Total Smear Combined for T = .01/sec. Exposure (Microns)				8.54	6.56	4.76	4.05
Dynamic Resolution (1/mm) 2:1 contrast and basic film				[redacted]	[redacted]	[redacted]	[redacted]
Static Resolution (1/mm) 2:1 contrast and basic film				[redacted]	[redacted]	[redacted]	[redacted]
Ground Resolution (inches) 2:1 contrast and basic film				[redacted]	[redacted]	28.2	25.0
Geometric Mean Ground Resolution (inches)				[redacted]		26.6	

* Possible disturbances and vibrations produced by spacecraft mechanisms or astronauts are not included.

Table C-5

SUMMARY OF IMAGE MOTION ERRORS USING EKC DESIGN GOAL ATTITUDE TOLERANCES

	*Smear Contributor	Tolerance	2 Sigma Variability	Tolerance Allocation	Image Smear 30 N.M. Alt. Across slit Microns-X	30 N.M. Alt. Along slit Microns-Y	80 N.M. Alt. Across slit Microns-X	80 N.M. Alt. Along slit Microns-Y
1.	V/h Sensor Error	± 0.5%	± 0.33%	C/P	1.75	0	.226	0
2.	Roll Attitude Control	± 0.6°	± 0.4°	CSM	0	0	0	0
3.	Pitch attitude Control'	± 0.6°	± 0.4°	CSM	1.96	0	.679	0
4.	Yaw Attitude Control	± 0.6°	± 0.4°	CSM	0	3.79	0	1.31
5.	Roll Rate Control	± 0.006°/sec	± 0.004°/sec	CSM	0	1.32	0	1.31
6.	Pitch Rate Control	± 0.006°/sec	** No contribution	CSM	0	0	0	0
7.	Yaw Rate Control	± 0.006°/sec	± 0.004°/sec	CSM	0	.353	0	.351
8.	Crab Servo	Not Used	--	C/P	--	--	--	--
9.	Film Drive Vibration	0.4 mm/sec.	0.267 mm/sec.	C/P	2.66	0	2.66	0
10.	Stereo Servo Error	± 0.22°	± 0.15°	C/P	1.47	0	.51	0
11.	Film Velocity Steps	± 0.25%	± 0.30%	C/P	1.57	0	.54	0
	Film Velocity Drift	± 0.2%						
12.	Roll Alignment	± 0.04°	± 0.027°	CSM	0	0	0	0
13.	Pitch Alignment	± 0.04°	± 0.027°	CSM	.13	0	.05	0
14.	Yaw Alignment	± 0.10°	± 0.067°	CSM	0	.63	0	.22
15.	Mirror Mounting (crab)	± 0.05°	± 0.033°	C/P	0	.32	0	.10
16.	Mirror Mounting (stereo)	± 0.05°	± 0.033°	C/P	.32	0	.11	0
17.	Knowledge for Focal Length	± 0.1 in.	± 0.067 in.	C/P	.46	0	.16	0
					X	Y	X	Y
	Total Smear Combined for T = .01 second exposures (Microns)				[redacted]		[redacted]	
	Dynamic Resolution (1/mm) 2:1 contrast and basic film							
	Static Resolution (1/mm) 2:1 contrast and basic film							
	Ground Resolution (inches) 2:1 contrast and basic film						25.4	[redacted]
	Geometric Mean Ground Resolution (inches)							

* Possible disturbances and vibrations produced by the spacecraft mechanisms or astronauts are not included.
** Included in Item 1

Table C-6

SUMMARY OF IMAGE MOTION ERRORS USING NAA ATTITUDE TOLERANCES WITHOUT LEM

				Image Smear			
				30 N.M. Alt.		80 N.M. Alt.	
*Smear Contributor	Tolerance	2 Sigma Variability	Tolerance Allocation	Across slit Microns-X	Along slit Microns-Y	Across slit Microns-X	Along slit Microns-Y
1. V/h Sensor Errors	± 0.5%	± 0.33%	C/P	1.75	0	.226	0
2. Roll Attitude Control	± 0.75°	± 0.5°	CSM	0	0	0	0
3. Pitch Attitude Control	± 0.75°	± 0.5°	CSM	2.45	0	.848	0
4. Yaw Attitude Control	± 0.75°	± 0.5°	CSM	0	4.74	0	1.64
5. Roll Rate Control	± 0.028°/sec	± 0.019°/sec	CSM	0	6.25	0	6.23
6. Pitch Rate Control	± 0.010°/sec	** No contribution	CSM	0	0	0	0
7. Yaw Rate Control	± 0.010°/sec	± 0.0067°/sec	CSM	0	.590	0	.589
8. Crab Servo	Not Used	--	C/P	--	--	--	--
9. Film Drive Vibration	0.4 mm/sec	0.267 mm/sec	C/P	2.66	0	2.66	0
10. Stereo Servo Error	± 0.22°	± 0.15°	C/P	1.47	0	.51	0
11. Film Velocity Steps	± 0.25%	± 0.30%	C/P	1.57	0	.54	0
Film Velocity Drift	± 0.2%						
12. Roll Alignment	± 0.04°	± 0.027°	CSM	0	0	0	0
13. Pitch Alignment	± 0.04°	± 0.027°	CSM	.13	0	.05	0
14. Yaw Alignment	± 0.10°	± 0.067°	CSM	0	.63	0	.22
15. Mirror Mounting (crab)	± 0.05°	± 0.033°	C/P	0	.32	0	.10
16. Mirror Mounting (stereo)	± 0.05°	± 0.033°	C/P	.32	0	.11	0
17. Knowledge of focal length	± 0.1 in.	± 0.067 in.	C/P	.46	0	.16	0
				X	Y	X	Y
Total Smear Combined for T = .01 second exposure (microns)				[redacted]	[redacted]	[redacted]	[redacted]
Dynamic Resolution (1/mm) 2:1 contrast and basic film				[redacted]	[redacted]	[redacted]	[redacted]
Static Resolution (1/mm) 2:1 contrast and basic film				[redacted]	[redacted]	[redacted]	[redacted]
Ground Resolution (inches) 2:1 contrast and basic film				[redacted]	[redacted]	[redacted]	30.1
Geometric Mean Ground Resolution (inches)				[redacted]	[redacted]	[redacted]	

* Possible disturbances and vibrations produced by the spacecraft mechanisms or astronauts are not included.
** Included in Item 1

APPENDIX D
EXPOSURE MODULATION AND RESOLUTION

1. INTRODUCTION

The performance of this photographic system can be specified in terms of the ground dimension that can be resolved through the system, using standard Air Force resolving-power targets at 2:1 contrast. These square-wave targets, therefore, are used in finally evaluating the performance of the system. During the development of a system, however, it is more convenient to analyze system and component performance by sine-wave response techniques. In order to take advantage of the mathematical simplicity of the sine-wave response technique to describe a photographic system, it is necessary to establish the relationship between the limiting resolution of the system to a square-wave test object and the sine-wave response of the system at the limiting resolution frequency.

This appendix describes the mathematical and experimental procedures used for the prediction of limiting resolution when the lens system is described by a theoretical sine-wave response curve and the film is characterized by measured data, either in the form of a sine-wave response curve or a calibration curve of the limiting resolution frequency of the film vs aerial image modulation. The term, aerial image modulation, refers to the actual modulation of light incident on the film as distinguished from the effective input modulation defined in Appendix A.

2. THE EQUIVALENCE OF SQUARE-WAVE AND SINE-WAVE ANALYSIS FOR THE PREDICTION OF LIMITING RESOLUTION

The relationship between sine-wave and square-wave response can be shown by considering the simple case of a lens. Because the sine-wave and square-wave responses of a linear system are mathematically related, it is possible to predict the square-wave resolution of a lens from sine-wave response data if the characteristics of the resolution measuring device can be defined. Two factors need to be specified: (1) the contrast or modulation of the test object and (2) the threshold aerial image modulation to which the measuring device will respond. (Note that a lens contributes no noise, and the average light level in the image is assumed to be well above the absolute sensitivity of the receiver.) Equation 10 of Appendix A can be restated as follows:

$$\overline{M}_1 \overline{R}(w) = \overline{M}_2(w) \qquad (1)$$

where $\overline{M}_1$ is the square-wave modulation of the test object, $\overline{R}(w)$ the square-wave response of the lens at frequency (w), and $\overline{M}_2$ is the square-wave aerial image modulation. The square-wave response, $\overline{R}(w)$, is given by the expression

$$\overline{R}(w) = \frac{4}{\pi}\left[R(w) - \frac{R(3w)}{3} + \frac{R(5w)}{5} - \frac{R(7w)}{7} + \cdots\cdots\cdots \right] \qquad (2)$$

where R(w) is the sine-wave response at w lines/mm in the absence of astigmatism.[1]

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1. J. W. Coltman, "The Specification of Imaging Properties by Response to A Sine-Wave Input," Journal of the Optical Society of America, June 1954.

Astigmatism is a field aberration and is not present on the axis of the photographic system. When $\overline{M}_2$ is the threshold square-wave aerial image modulation of the receiver and $\overline{M}_1$ is known, then the threshold square-wave response of the lens, $\overline{R}$, can be determined by equation (1). Using the sine-wave response curve of the lens and equation (2), the frequency, w, corresponding to the threshold square-wave response can be determined. This frequency is the limiting resolution of the lens. It is important to note that in solving equations (1) and (2) for the limiting resolution frequency, the square-wave response, $\overline{R}(w)$, is required only at or near the limiting resolution frequency where the higher order terms of equation (2) become negligible. Transformation from sine-wave to square-wave response, therefore, may be simplified by the following approximation, since $\frac{R(3w)}{3}$ and succeeding terms of equation (2) are small compared to R(w):

$$\overline{R}(w) \approx \frac{4}{\pi} R(w) \qquad (3)$$

Since the threshold aerial image modulation of a system generally occurs at high frequencies, the square-wave threshold response and the sine-wave threshold response are related by the constant, $4/\pi$, and both occur at the same frequency. Therefore, in determining the limiting resolution frequency by this method either the square-wave or the sine-wave response of the lens can be used, provided the constant, $4/\pi$, is taken into account. For example, when measurements of the square-wave resolution of a known lens are used to establish a prectical value for threshold aerial image modulation, $\overline{M}_2$, and when the sine-wave response approach is to be used, the constant, $4/\pi$, is included in the experimentally determined value of the constant $\overline{M}_2$.

In practice, equation (1) is written in terms of the sine-wave response of the lens:

$$M_1 R(w) = M_3(w) \tag{4}$$

where $M_3(w)$ is a function of frequency which is referred to as the aerial image modulation required at the resolution limit. In general, equation (4) is more convenient for predictions of resolution and is valid for this purpose as long as $M_3(w)$ can be determined by experiment.

3. AERIAL IMAGE MODULATION REQUIRED TO RESOLVE AIR FORCE TARGETS

In a photographic system, measurements of resolution depend in some measure on the film granularity or noise in the system and the ability of the receiving device to respond to small signals in the presence of this noise. Every effort is made to eliminate both of these factors in sine-wave response measurements; that is, apertures are selected to integrate out the effect of noise and in general the signal level is well above the threshold sensitivity of the measuring device. Because of the method of measurement used, sine-wave response data alone do not provide sufficient information for the prediction of resolution, since the noise affecting the resolution measurement has been filtered out. Threshold response characteristics of the receiver and the effect of noise in the system must be introduced before the limiting resolution of the system can be determined.

Prediction of the lens-film resolution from sine-wave response data is complicated by the fact that film cannot be treated as a linear element of the system and the threshold contrast discrimination of the eye is influenced by grain "noise" or the apparent graininess of the film.

Graininess, in turn, depends on the exposure used in producing the photographic image and the method of processing the film. To avoid the problem of finding a general mathematical expression relating these variables to lens-film resolution, the following empirical methods are employed.

All of the effects associated with the film process, including granularity, can be taken into account by means of a calibration of the particular film and film process to be used in the system. The calibration of the film consists in measuring the resolution of the film in combination with a lens for which the sine-wave response is known. By varying the test object modulation, M_1, and computing the modulation of light incident on the film, $M_3(w)$, from equation (4), a calibration curve of limiting resolution frequency of the film vs aerial image modulation of the light incident on the film can be plotted. Lens-film resolution can then be determined from this curve for any system of elements preceding the film, as long as the modulation in the aerial image can be calculated and average exposure levels are preserved. The independence of element characteristics described in Appendix A must also be preserved.

Curves A and B of Figure D-1 are the computed modulation curves at 2:1 contrast for the 77-inch lens, including the effect of the proposed S/C smear tolerances for vertical V/H measurement. Curve A is for lines perpendicular to the slit; curve B for lines parallel. The exposure is 1/100 second. Curve C of Figure D-1 indicates the experimental threshold aerial image modulation required to resolve an Air Force target as a function of frequency expressed in lines per millimeter. The limiting frequencies were established by visual measurement of Air Force test objects photographically recorded on Kodak Type 4404 Film by a lens system for which the sine-wave response is know. The corresponding aerial image modulation was calculated

A. System Modulation at 2:1 Contrast
(lens + smear of 6.53 microns - lines perpendicular to slit)

B. System Modulation at 2:1 Contrast
(lens + smear of 5.13 microns - lines parallel to slit)

C. Aerial Image Modulation Required to Resolve an Air Force Target
(average of experimental resolution data on Kodak Type 4404 Film)

Figure D-1. Aerial Image Modulation for Resolution on Kodak Type 4404 Film for this known lens system at the limiting frequencies established by visual measurement. The intersections of curves A and B with curve C yield system resolutions of [redacted] for lines parallel and perpendicular to the slit respectively. The geometric mean resolution is [redacted] which is equivalent to an [redacted] ground resolution at an altitude of 30 nautical miles.

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Phase II

Exposure Unit

Specification No.

Prepared by
EASTMAN KODAK COMPANY
Advance Development Projects Group
Apparatus and Optical Division
Rochester, New York

Original Prepared by ____________________

Original Reviewed by ____________________

Original Approved by ____________________

Original Release Date ______

Revision	Pages Affected	Date	Approved by

Preliminary Specification	Contracted Portion of the Exposure Unit
Specification No. *	Release Date:

1. SCOPE, MISSION AND TASK

1.1 Scope - This specification defines the requirements of the Contracted Portion of the Exposure Unit. It includes the performance and environmental requirements, and defines the quality assurance provisions required to determine compliance with the requirements and preparation of the unit and parts for delivery.

1.2 Mission - It shall be the mission of the exposure unit to move film past a slit opening in an aperture plate to produce latent images on the film in either stereo or continuous photographic modes of operation. It shall have the capability of step variable uniform film speeds, provide programmable selection of various slit openings to control exposure, record data signals from external sources on the edge of the film, and provide a means of focus adjustment in the specified environment.

1.3 Task - It shall be the task of the contractor to design, develop, fabricate, test and deliver according to the required schedule, hardware including an engineering model, exposure unit mock-up, reliability test model, qualification test model, production model(s), one set of tools, fixtures, and accessories necessary to repair, handle, adjust and operate the exposure unit, and a recommended spare parts list to insure uninterrupted operation for the designed life of the exposure unit.

The contractor shall perform tests at his plant based on quality assurance provisions of this specification and submit documentation for each test.

*To be supplied by a later revision.

An operating log for each model shall be submitted containing data such as operating time and malfunction reports generated through tests, and recorded by serial number.

The contractor shall design the slit aperture plate to this specification and submit drawings to Eastman Kodak Company who will then develop, fabricate, test and deliver them to the contractor.

The contractor shall also conform with all other requirements of 401-102.

2. APPLICABLE DOCUMENTS

2.1 General - The following specifications, standards, drawings, and publications of latest issue in effect on date of invitation for bids, form a part of this specification. Applicability of the listed documents shall depend on their specific reference in this specification. In the event of conflict between the listed documents and this specification, this specification shall take precedence.

SPECIFICATIONS

Military	
MIL-I-26600	Interference Control Requirements, Aeronautical Equipment
MIL-Q-9858	Quality Control System Requirements
Eastman Kodak Company	
401-101	Instructions for Preparation of Drawings by Contractors
*401-106	Contractor Reliability Requirements
401-122	Technical Requirements for Contractors Programmable Slit Assembly

*To be supplied by a later revision.

STANDARDS

Military

MIL-STD-12B	Abbreviations for Use on Drawings and Technical Type Publications
MIL-STD-171	Preparation, Painting, and Finishing for Metal and Wood Surfaces

Eastman Kodak Company

401-104-1	Designing for High Reliability
401-104-2	Attaining Reliable Manufacture
401-108	Design Standard for Human Factors, Engineering

DRAWINGS

Eastman Kodak Company

400-114	Potentiometer, Precision, Continuous Rotation
400-124	Connector, Jam Nut Receptacle, Hermetic Seal
400-149	Switch, Subminiature, Momentary Action
400-221	Enamel, Black, Semi-Dull 11414
405-104	Instructions for Finishing Magnesium, Dull Black
405-113	Procedure for Iridite No. 14 Thermal Finish
405-114	Procedure for Finishing Stainless Steel Dull Black
405-118	Instructions for Masking Protective Coatings (Iridite) Prior to Finishing
405-130	Procedure for Iridite No. 15 Finish for Magnesium
405-144	Procedure for Cleaning and Relubricating Unshielded Bearings
*	Data Signal Configuration

*To be supplied by a later revision.

*	Thermistor Probe Assembly
*	Procedure for Surface Treatment Housing Assembly Camera
*	Exposure Unit Space Limitations
*	Exposure Unit Schematic
*	Wiring Diagram, Exposure Unit Pressure Shell
*	Film Format "B"
*	Subsystem D Space Limitations
*	Slit Aperture Plate

3. REQUIREMENTS

That portion of the exposure unit to be contracted shall consist of a completely functioning unit without subsystem D and shall comply with these requirements.

3.1 Definition - The exposure unit consists of the following subassemblies:

(a) Subsystem D
(b) Focus Drive Assembly
(c) Programmable Slit Assembly
(d) Data Recording Assembly
(e) Pressure Shell
(f) Film Drive Assembly
(g) Reference Axes

3.1.1 Subsystem D - Subsystem D is that portion of the exposure unit which is not contracted. This subsystem shall be developed and fabricated by Eastman Kodak Company and shall be assembled and aligned to the completed exposure unit subsequent to exposure unit testing. The exposure unit shall be designed to provide the proper interfaces and supports for mounting this subassembly.

3.1.2 Focus Drive Assembly - The Focus Drive Assembly shall consist of the necessary equipment to provide specified rate and range for focus adjustment of the exposure unit.

3.1.3 Programmable Slit Assembly - The Programmable Slit Assembly shall provide a programmable selection of slit openings to control film exposure. The requirements of the programmable slit assembly are defined in Eastman Kodak Company specification *.

3.1.4 Data Recording Assembly - The Data Recording Assembly shall convert external signals to suitable marks on the film.

3.1.5 Pressure Shell - The Pressure Shell is an enclosure in which the exposure unit is contained and equipped to provide a seal with the film supply and lens elements to maintain pressure requirements.

3.1.6 Film Drive Assembly - The Film Drive Assembly includes a drive motor and gear reduction to provide uniform film speeds determined by the frequency of the power source.

3.1.7 Reference Axes - Reference axes are indicated on Eastman Kodak Company drawing *. Positive rotational unbalance is defined as clockwise direction when viewing each axis from the negative direction to the positive direction.

3.1.8 Exposure Unit Mock-up - The Exposure Unit Mock-up is a unit which simulates the average power consumption and heat dissipation, has the external configuration and finish, and has the weight and center of gravity of the exposure unit.

3.2 Inputs - The exposure unit shall meet the requirements of this specification when supplied with the inputs defined by the following.

*To be supplied by a later revision.

3.2.1 Film - With suitable adjustments the camera shall be capable of meeting the requirements of this specification with either .0029 ± .0002 inch thick polyester thin base film or .0055 ± .0002 inch thick tri-acetate film. The film shall be $9.460 {}^{+.010}_{-.005}$ inches wide.

3.2.1.1 Film to Slit Plate Spacing - A means shall be provided for adjusting the spacing between the slit plate and film plane to maintain the required distance of 3.4.7 item (d) for the specified film thickness.

3.2.1.2 Film Tension - The exposure unit shall meet the requirements of this specification with nominal input and output film tensions of 3 pounds ± 1/4 pound from an external source. Output tension shall be equal to or exceed input tension by no more than 1/2 pound and be uniform in magnitude during exposure unit operation. Take-up in the external film handling system occurs normally during photography or at any time the take-up looper departs from its "empty" position. Film tension during take-up nominally will be 3 1/4 ± 1/4 pounds; however, instantaneous starting transients may rise to 7 pounds.

3.2.1.3 Film Edge Wander - The maximum film edge wander in the exposure unit from input to output shall not exceed ±.025 inch with no more than one cycle in any 4 foot length of film. The maximum angular misalignment of the film coming into the exposure unit from the loopers shall not exceed ±2 minutes of arc angular misalignment.

3.2.2 Optical - The optical input to the exposure unit is a visible image from the lens assembly. It is focused and oriented relative to the locating surface and dowels, and of a size indicated on Eastman Kodak Company drawing *.

Illumination may be variable and actual exposure shall be determined by the programmable selection of a specific slit width in the aperture plate for a given film speed. Field angle of lens image is 6.4° and the image size at film plane shall be 8.668 inches.

*To be supplied by a later revision.

3.2.3 Electrical Power - The exposure unit shall meet the requirements of this specification when supplied power as outlined below. Except for film drive and instrumentation, available power shall be 28 ± 3.0 volts d.c.

3.2.3.1 Film Drive - Power to the film drive motor shall be from an external two phase step-variable frequency source, having a voltage to frequency ratio constant within ±10 percent. Nominal voltage at 400 cycles per second frequency shall be * volts (R.M.S.). Frequency range shall be provided in * steps of 0.5 percent or smaller, differential ranging from (200) to (500) cycles per second. Mean film speed of * inches per second shall correspond to a * cycle per second frequency. Total power consumption shall not exceed (12) watts.

3.2.3.2 Subsystem D - Power to subsystem D shall be the responsibility of Eastman Kodak Company, but the contractor shall install leads from the connector as per Eastman Kodak Company drawing *.

3.2.3.3 Data Recorder - Power requirements for the data recorder shall be specified by contractor, approved and supplied by Eastman Kodak Company.

3.2.3.4 Focus Control Drive - Power to the focus control motor shall be specified by the contractor, approved and supplied by Eastman Kodak Company.

3.2.3.5 Instrumentation Voltage

3.2.3.5.1 Thermistor - A +22 ± 0.1 volt d.c. regulated voltage shall be used for power to a temperature sensor (thermistor). The power source shall be the responsibility of Eastman Kodak Company.

3.2.3.5.2 Platen Position - A +5 ± 0.1 volt d.c. regulated voltage shall be used for power to the platen position indicator circuit. Power source shall be the responsibility of Eastman Kodak Company.

*To be supplied by a later revision.

() = number subject to revision.

3.2.4 Data Signals - Two data signals will be supplied to the exposure unit from an external source. The data signal characteristics will be as specified in Eastman Kodak Company specification *. The data signals shall be amplified within the exposure unit as required to drive the data recording lamps which provide data recording in accordance with section 3.4.12.

3.2.5 Commands - No direct command switching shall be done in the exposure unit. Switching of power and instrumentation shall be external to the exposure unit. Instrumentation shall be "on" continually when in target area. Power to film drive, focus drive motor, subsystem D, and data signals shall be directed "on" and "off" from an external point.

3.3 Electrical Requirements

3.3.1 Connectors - The connectors shall be in compliance with Eastman Kodak Company drawing 400-*. The connectors and connector pin assignments of the exposure unit are as follows: *

3.3.1.1 Location - Each connector shall be located in compliance with Eastman Kodak Company drawing *.

3.3.1.2 Leakage - At the connector the resistance between any electrical connection, except shields, within the exposure unit shall be 100 megohms minimum with an applied voltage of 100 volts d.c. ±10 percent.

3.2.2 Instrumentation - Instrumentation shall be provided in the exposure unit to monitor the following conditions of operation. Power for instrumentation shall be the responsibility of Eastman Kodak Company.

3.3.2.1 Temperature - The contractor shall install a thermistor probe in accordance with Eastman Kodak Company drawing * to monitor temperature within the exposure unit. The probe shall be supplied by Eastman Kodak Company and installed physically as near the film as practical. The exact location shall require Eastman Kodak Company approval.

*To be supplied by a later revision.

3.3.2.2 Platen Position - The contractor shall provide platen position instrumentation consisting of two (2) continuous rotation potentiometers, Eastman Kodak Company drawing 400-114, to indicate the platen position throughout its total range of adjustment. Wiring shall be in accordance with Eastman Kodak Company drawing 401-104-1.

The coarse potentiometer shall be designed to rotate 355 ± 3.0 degrees for 0.020 inches of movement of platen in relation to lens, and shall have a 5 ± 3.0 degrees null point. The fine potentiometer shall turn five (5) revolutions for each revolution of the coarse potentiometer. Adjustment of film plane shall be ±0.010 inches from reference focus position called out in Eastman Kodak Company drawing *. The zero adjustment of the coarse potentiometer shall correspond with the limit of negative (toward lens) focus adjustment. The zero adjustment of the fine potentiometer shall correspond to the zero position of the coarse potentiometer within five (5) degrees. Positive and negative extremes of adjustment shall be limited by switches, Eastman Kodak Company drawing 400-149.

Maximum allowable backlash from platen to potentiometer is equivalent to 5° of rotation of the fine potentiometer, equals 1° of rotation of the coarse potentiometer.

3.3.2.3 Subsystem D Instrumentation - Instrumentation for subsystem D shall be the responsibility of Eastman Kodak Company. The contractor shall install necessary wiring to accommodate this instrumentation as outlined in Eastman Kodak Company drawing *. The contractor shall provide mounting in the pressure shell for an assembly as specified by Eastman Kodak Company.

*To be supplied by a later revision.

3.3.3 Electromagnetic Interference Control - The exposure unit shall meet all the requirements defined by MIL-I-26600 for class Ib equipment, during its operating and non-operating phase. In addition to the requirements defined by MIL-I-26600, any conducted interference, within a frequency range of 15 to 15000 cycles per second, impressed on the external 28 volt d.c. power supply circuit by the exposure unit shall not exceed 0.05 ampere peak-to-peak.

Internal d.c. motors or pulsating electrical devices shall be filtered or shielded to operate within the requirements of MIL-I-26600. Their location in relation to subsystem D shall require Eastman Kodak Company approval.

3.3.4 Wiring - All wiring in the exposure unit shall be designed to conform with Eastman Kodak Company drawing * and * and fabricated to conform with requirements of 401-104-2.

3.3.4.1 Grounding - A grounding screw shall be provided within the pressure shell adjacent to the mounting pads for grounding four leads from Subsystem D.

3.3.4.2 Instrumentation Return - Instrumentation return shall be connected to d.c. return at a point external to the exposure unit and shall be completely isolated from d.c. return within the exposure unit.

3.4 Mechanical Requirements

3.4.1 Configuration - The external dimensions of the exposure unit shall not exceed the limiting dimensions of the Eastman Kodak Company drawing *.

3.4.2 Weight - The weight of the exposure unit shall not exceed 25 pounds.

3.4.3 Angular Disturbance - The total angular disturbance due to angular momentum shall not exceed the following values where these limits are based on a exposure unit operation of approximately 10 seconds or a period of focus adjustment of approximately 2 minutes.

*To be supplied by a later revision.

(a) Around X reference axis -

$\Delta I\theta_X = 0.045$ slug ft^2 (radians)

(b) Around Y reference axis -

$\Delta I\theta_Y = 0.42$ slug ft^2 (radians)

(c) Around Z reference axis -

$\Delta I\theta_Z = 0.42$ slug ft^2 (radians)

Orientation of reference axes shall be in compliance with 3.1.7.

3.4.4 Mounting - The exposure unit shall mount on spacers on four reference surfaces of the lens barrel and shall be oriented by two dowels on the exposure unit mating with dowel holes on the reference surfaces as shown on Eastman Kodak drawing *.

3.4.5 Alignment - All elements of the exposure unit effecting photography and film tracking shall be aligned to comply with Eastman Kodak Company drawing *.

3.4.5.1 Film Tracking - The exposure unit shall be capable of accommodating the maximum film edge wander and angular misalignment inputs of 3.2.1.3. The film advancing through the exposure unit shall not oscillate in the direction of film width through more than one cycle in 4 feet of film. Maximum allowable displacement of the film edge from input to output shall not exceed ±.025 inch.

3.4.6 Finish - All painted surfaces shall be smooth and free of blemishes, blisters, and similar defects.

3.4.6.1 Mounting Surfaces - Magnesium mounting surfaces shall be finished with iridite No. 15 per Eastman Kodak Company drawing 405-130. Aluminum mounting surfaces shall be finished with iridite No. 14 per Eastman Kodak Company drawing 405-113.

*To be supplied by a later revision.

3.4.6.2 External and Internal Surfaces - These surfaces shall be thermally and photographically black with the finishes listed as follows:

3.4.6.2.1 Magnesium - All magnesium surfaces except mounting surfaces shall be finished according to instructions on Eastman Kodak Company drawing 405-104 using dull black enamel listed on Eastman Kodak Company drawing 400-221.

3.4.6.2.2 Aluminum -

(a) Internal finish of the pressure shell and all aluminum surfaces except mounting surfaces shall be in accordance with instructions of EK 401-104-1, section 3.2.2.20, page 22, using black anodize. Where electrical bonding is required, it shall be masked and finished with Iridite 14.

(b) External finish of the pressure shell shall be evaporated aluminum as per revised procedure *, except where electrical bonding is required. At these points it shall be masked and finished with Iridite 14.

3.4.6.2.3 Stainless Steel - Where required for thermal or photographic purposes all stainless steel surfaces shall be finished according to instructions on Eastman Kodak Company drawing 405-114 using dull black enamel of drawing 400-221. Where no paint finish is required or desired on the stainless steel and where smoothness requirements allow, it shall be passivated in accordance with MIL-STD-171, Finish 5.4.

3.4.6.2.4 Other Metals - Where a finish is required on metal surfaces other than those listed above these may be found in Eastman Kodak Company standard 401-104-1.

3.4.6.2.5 Other Finishes - Where a finish other than that specified for a specific metal surface is desirable, it shall be approved by Eastman Kodak Company prior to its application.

*To be supplied by a later revision.

3.4.6.2.6 Masking - On mounting surfaces and other surfaces within the exposure unit where electrical bonding is required, they shall be masked prior to painting as outlined on Eastman Kodak Company drawing 405-118.

3.4.6.2.7 Identification Numbers - The identification numbers shall be procured from Eastman Kodak Company for electrical components, terminal boards, barrier strips, connectors, etc.

3.4.6.2.8 Lettering - Terminal boards, barrier strips, electrical components, and connectors shall be labeled as to identification, control or function. Lables shall appear either on or immediately adjacent to, preferably below, the item to be identified. Labels shall be brief. Highly similar names shall be avoided. Abbreviations shall be common, meaningful, and be followed by a period. Abbreviations, where possible, shall conform to MIL-STD-12B.

3.4.6.2.9 Color - Lettering shall be applied with white or yellow paint having non-fogging photographic qualities in accordance with 401-104-1. Lettering shall be protected against abrasion by a cover coat of clear lacquer in accordance with 401-104-1.

3.4.6.2.10 Application - Upper case lettering, such as Gothic condensed capitals, shall be used in preference to lower case.

3.4.6.2.11 Symbols - Abstract symbols, such as circles, squares, stars, etc., shall be avoided. Common meaningful symbols such as %, +, -, etc., are acceptable.

3.4.6.2.12 Size of Letters - Labeling shall be 12, 18, or 24 point type size.

3.4.6.3 Identification - Each unit shall be permanently identified by a name plate permanently attached and of a design approved by Eastman Kodak Company. Identification shall include at least the following:

*To be supplied by a later revision.

Part Number of Final Assembly

Serial Number

3.4.7 Critical Dimensions - Certain dimensions not appearing on Eastman Kodak Company drawing *, but necessary in the exposure unit design are the following:

(a) Distance from film plane to field flattener lens: 1.1356 inches (reference)

(b) Film shall enter and leave the forward (-X side) of the exposure unit and run parallel to each other, spaced 1 inch apart. It shall move past the aperture toward the back of the exposure unit (+X axis).

(c) The exposure unit shall mount on spacers on reference surfaces of the lens barrel so that the film plane shall be at the nominal focus position, and adjustment shall be in center of adjustment range.

(d) The aluminized surface of the slit aperture plate shall be held to an apparent 0.010 ± 0.001 inch from the platen surface for 0.0029 inch thick film and 0.0126 ± 0.001 inch for an 0.0055 inch thick film.

(e) The surface of the field flattener lens is 1.183 inches (reference) above the reference surface.

3.4.8 Material - Components, assemblies, and subassemblies forming a portion of this equipment, or the complete equipment, shall be composed of materials, parts, and processes which comply with the provisions of this specification.

3.4.9 Lubrication - Where required, all parts, subassemblies, or components shall be lubricated with materials contained in Eastman Kodak Company standard 401-104-1. Bearings shall be lubricated in accordance to Eastman Kodak Company procedure drawing 405-144.

*To be supplied by a later revision.

3.4.10 Pressure Shell - It shall be designed to provide a seal with the film supply chute and the lens elements as shown on Eastman Kodak Company drawing *. It shall include equipment required to make the seal with the lens element.

It shall contain sealed openings to provide access for adjustment of the slit aperture plate, alignment and adjustment of the exposure unit, threading the film, replacement of data recording equipment, and removal and replacement of the functioning portion of the exposure unit.

The pressure shell and seal shall be designed to withstand a maximum pressure differential from inside to outside of 4.0 psia.

Leak proof connectors of 3.3.1 shall be assembled to the pressure shell for instrumentation and power. Location of connectors is shown on the Eastman Kodak Company drawing *.

3.4.10.1 Leak Rate - With air at 80°F and an internal pressure of 3 psia, the leak rate of the assembled pressure shell shall not exceed 5 cubic centimeters per minute. The contractor shall check the leak rate of the package and report to Eastman Kodak Company.

Leak rate shall be checked at a maximum operating differential pressure level (3 psia) from inside to outside.

The pressure seal shall be leak tested prior to delivery to Eastman Kodak Company using necessary seals and simulated interfaces at the film chute and lens element openings.

3.4.11 Film Drive - The film drive mechanism shall provide the required motion for moving film past the aperture slit to form latent images on the film. It shall operate from an external step frequency power source, the frequency determining the speed of the film drive. Its purpose is to equilibrate the speed of the film with that of the image moving past the slit in order to minimize the smear in the latent image.

*To be supplied by a later revision.

3.4.11.1 Film Speed vs. Frequency - The range of film speeds shall be from * inches per second to * inches per second in one half percent, or smaller, steps for a total of * steps. The nominal film speed corresponding to the nominal frequency of the drive motor shall be * inches per second at exactly * cycles per second frequency. The accuracy of the frequency of each step shall be held within ±0.1 percent or less. The following table lists the step number, frequency, and film speed through the complete range.

Step No.	Frequency (cps)	Velocity (in./sec.)
*	*	*

3.4.11.2 Drive Motor - The drive shall be a 2 phase * volt * cycle hysteresis synchronous motor. Its output torque shall be sufficient to bring the film drive up to speed within the time requirements of this specification. Contractor shall report power factor of each phase to Eastman Kodak Company who will make required corrections. Voltage frequency ratio of the external supply voltage shall be held constant within 10 percent.

3.4.11.3 Starting and Stopping Transients - The time intervals from "turn-on" power until the film drive is up to speed (starting transient) shall not exceed 0.5 second.

The time interval from "turn off" power until the film drive stops (stopping transient) shall not exceed 0.5 second.

3.4.11.4 Modes of Operation - The exposure unit film drive shall be designed to operate in either stereo or continuous photography. Stereo operation may be defined as exposure unit "on" periods of 5 seconds to 50 seconds separated by "off" periods of 4 seconds minimum. Continuous operation is defined as exposure unit "on" time, at either a single film speed or at various film speeds, without "off" periods, of intervals up to 15 minutes.

*To be supplied by a later revision.

3.4.11.5 Film Speed Variation - Film speed variations can be of two types: first, an oscillatory variation from the required film speed, and second, a uniform variation which results in a uniform film speed faster or slower than specified. The former results in banding, the latter does not. However, both result in image smear. It shall be a requirement that total image smear for all exposure times shall not exceed * microns. It shall be a design goal to achieve a maximum variation from specified velocity of 0.1 percent Δ velocity and a maximum oscillatory variation which will result in image smear of one (1) micron.

3.4.11.6 Holding of Film - During exposure unit "off" periods, the exposure unit shall be required to hold the film to prevent movement of film in excess of 1/4 inch.

3.4.12 Data Recording - Data shall be recorded on the film as exposed marks in compliance with Eastman Kodak Company drawing *. Two recording units shall be used to record the two sets of data marks simultaneously on the film. The data marks shall be approximately 0.005 inch long in the direction of film width.

The data marks shall be discernable by eye on film processed in accordance with procedure of section 6.2 and shall have an exposed density of no less than 0.5 at the fastest film speed and a Δ density of not less than 0.3 at the slowest film speed. This requirement shall apply at the minimum supply voltage and for the entire service life of the exposure unit.

The data recorders shall respond to and record the input data signals of section 3.2.4. Both sets of data marks shall coincide with the picture image produced at that instant as specified on Eastman Kodak Company drawing *.

*To be supplied by a later revision.

Data optics shall be adjusted for optimum focus and secured to maintain focus and location in the specified environment.

3.4.13 Focus Control - The focus drive assembly shall provide continuous, bi-directional focus adjustment for the exposure unit. It shall be capable of adjusting the film plane toward or away from the lens, provide rigid support for the platen and prevent any movement when not in use in the specified environment.

Total adjustment capability shall be a movement of the platen ±0.0100 inch from the nominal focus position. The exposure unit shall be designed and adjusted to have equal scope adjustment in each direction when the system is in focus. Adjustment limits shall be determined by switches. When these positions are reached, adjustment shall be allowed only in a direction away from the limit. For wiring details, see Eastman Kodak Company drawing *. The rate of adjustment shall be 0.00025 inch ± 10 percent per second.

3.4.14 Slit Aperture Plate - The slit aperture plate shall consist of a 0.125 inch thick flat optical glass plate, aluminized on one surface to a density of 3.0 (minimum) and having slits and openings etched into the aluminized surface as specified in Eastman Kodak Company drawing *. It shall be mounted rigidly so that will not vibrate. The slit aperture shall be made of filter glass in accordance with requirements of Eastman Kodak Company drawing *.

It shall be the responsibility of the contractor to design the slit aperture plate. It shall be the responsibility of Eastman Kodak Company to develop, fabricate, test, and deliver to the contractor the completed aperture plates.

*To be supplied by a later revision.

3.4.14.1 Aperture Plate Format - The aperture plate shall have etched in the aluminized surface, slits which are .0292, .0207, .0146, .0104, .0073, .0052, .0037 inch wide and a tapered test slit. Slits other than the test slit shall be 8.468 inches long. The slits shall be spaced so no stray light can pass through the adjacent slits when one slit is in position.

The aperture plate shall have a fiducial line 0.002 inch wide at both ends of the main slits. An opening in the plate or in the frame for data recording shall be provided. Two sets of yaw slits, one at each end of the main slits, shall be provided, each 0.100 inch long and 0.054 inch from the centerline of the main slit. A set consists of two slits, one is one-third of the width of the main slit, the other is two-thirds of the width of the main slit. See Eastman Kodak Company drawing *.

3.4.14.2 Positioning and Adjusting - The slit aperture shall be positioned and adjusted in accordance with the requirements of Eastman Kodak Company specification * for the Programmable Slit Mechanism. A visual indicator shall be included to designate which slit is in use.

3.4.15 Subsystem D - The supplying, installing in exposure unit, and testing of this subassembly portion of the exposure unit shall be the responsibility of Eastman Kodak Company. The contractor shall provide the mounting, interfaces, clearances and wiring required for this assembly as shown on Eastman Kodak Company drawings * , * , * . Mounting shall align subsystem D parallel to reference dowels and reference surface and shall be sufficiently rigid to maintain position of this subassembly.

3.4.16 Design Information - The contractor shall submit to Eastman Kodak Company the following information in a preliminary and also in a final form:

(a) Weight of Exposure Unit

(b) Size of Exposure Unit

*To be supplied by a later revision.

(c) Center of gravity related to 3 reference axes

(d) Moment of Inertia related to 3 reference axes

(e) Angular disturbance around each of 3 reference axes

(f) Electrical characteristics of all motors

(g) Power requirements and parameters

(h) Leak rate of pressure shell

(i) Thermal mock-up information

(j) Accessibility requirements for loading, adjustments, replacements, and trouble shooting

(k) Slit aperture plate design

(l) Wooden mock-up outline drawing

3.4.17 Index Marks - Index marks 0.005 inch wide visible when observing film plane through the lens shall be provided at the centerline of the film. These shall be placed as near the film plane as possible. The index marks shall be used for centering test equipment with the exposure unit.

3.5 Photographic Requirements

3.5.1 Slit Aperture Plate - Imperfections in the aperture shall not produce streaks on the film more than 0.020 inches wide in the area of the picture image, and 0.002 inches wide in the yaw slits.

3.5.2 Stray Light - Stray light fogging in the exposure unit from external or internal sources shall not exceed the density of exposed image by more than 0.1 during expected duty cycles of the exposure unit. Between photographic bursts stray light fogging in an area beyond 2 inches of the centerline of slit shall not exceed density of exposed image by more than 0.1; within 2 inches of the slit, fogging will be allowed.

3.5.3 Smear and Banding - Smear and banding in the photographic image shall be limited by the requirements of film speed variations of 3.4.11.5.

*To be supplied by a later revision.

3.5.4 Data Marks - The photographic requirements for the data marks shall be in accordance with 3.4.12.

3.5.5 Orientation of Image - The location of the image shall conform with the requirements of drawing *. The platen and slit aperture plate shall be held parallel to the centerline of the two locating dowels within ±.002 inch and the center of platen to dowel distance shall be in compliance with drawing *, so that image motion will be parallel to the edge of the film and the axis of the optical image will coincide with the centerline of the film.

3.5.6 Film Abrasion - No film abrasion attributable to the exposure unit shall be allowed.

3.5.7 Dirt on Film - Maximum dirt speck or image of same on the processed film shall not exceed 30 microns in size. The density of dirt specks on the processed film of sizes up to 30 microns shall not exceed one per 1 1/2 square inches attributable to the exposure unit.

3.5.8 Image Wander - The image shall not displace relative to the film edge in excess of ±0.016 resulting from contracted device.

3.6 Accessibility Requirements - The exposure unit and pressure shell shall be designed for accessibility for the following adjustments, replacements, and installations:

(a) Threading film into exposure unit when mounted to the lens assembly.

(b) Adjusting slit aperture position as described in Section 3.4.14.2

(c) Focusing and checking focus. The platen shall be designed to be easily removable and replaced with a focus fixture to check optimum focus position.

(d) Installing Subsystem D. Ports or openings shall be provided in the pressure shell to allow adjustment and alignment of Subsystem D.

*To be supplied by a later revision.

(e) Replacement and alignment of the slit aperture plate. Disassembly of exposure unit may be permitted if a replacement of slit aperture plate is required in case of damage. All slit aperture plates as mounted in frames shall be interchangeable.

(f) Easy replacement and alignment of the data recorder lamps. The data recorder assemblies shall be interchangeable.

3.7 Alignment Requirements - The exposure unit shall be completely adjusted and aligned by the contractor for the following items:

(a) The film plane shall be positioned so that equal scope of adjustment is possible on the platen in the positive and negative directions from the reference focus position.

(b) Data marks shall be focused and oriented on the film as per Eastman Kodak Company drawing *.

(c) The slit aperture plate shall be aligned with the reference dowels and surfaces for parallelism and orientation to image a picture on the film as per Eastman Kodak Company drawing *.

(d) The platen shall be correctly aligned with the slit aperture plate in spacing, parallelism and orientation. See section 3.4.5 requirements.

(e) All rollers shall be aligned in parallelism with the reference dowels and surfaces either within 0.001 inch and transversly within 0.005 inch, or otherwise positioned to track film within requirements.

3.8 Fixtures and Accessories Required - Contractor shall supply necessary tools, fixtures, and accessories to handle, adjust, focus, align, and operate the exposure unit.

Contractor shall supply a focus fixture to check alignment and focus of exposure unit to requirements of Eastman Kodak Company drawing * and section 3.6 (c). Eastman Kodak Company will provide the reticle plate portion of fixture.

3.9 Environmental Requirements

*To be supplied by a later revision.

3.9.1 Non-Operating - The exposure unit shall survive the environmental conditions listed below without any impairment of its capability.

3.10 General Requirements

3.10.1 Design Considerations - During the various stages of design, the following items listed in the order of relative importance shall be given consideration:

(a) Performance
(b) Reliability
(c) Fail Safe Features
(d) Weight
(e) Serviceability
(f) Power Consideration
(g) Flexibility

3.10.2 Manufacturing Standards - The exposure unit shall conform to the manufacturing standards section of Eastman Kodak Company standards 401-104-2.

3.10.3 Interchangeability - Exposure units of the same model, regardless of series designation, exclusive of Engineering and Reliability Test Models shall be interchangeable or replaceable when updated to the latest revisions.

3.10.4 Life

3.10.4.1 Service Life

3.10.4.1.1 Testing Life - The exposure unit shall have a testing life of 150 hours of ON time. During the testing life period, the exposure unit shall be capable of operating continuously for a 120 minute period. The exposure unit shall also be capable of a minimum of * ON and OFF operations during * minutes out of a * minute period with each ON time having a minimum duration of * seconds.

*To be supplied by a later revision.

3.10.4.1.2 Mission Life - After completion of the specified testing life, the exposure unit shall have a mission life of ** hours ON time. During the mission life period, the exposure unit shall be capable of operating continuously for a 120 minute period. The exposure unit shall also be capable of a minimum of ** ON and OFF operation during ** minutes out of a ** minute period, with each ON time having a minimum duration of ** seconds. The exposure unit shall have the above mission life when operated under any of the specified operating conditions.

3.10.4.2 Shelf Life - The exposure unit shall have a shelf life of 24 months minimum.

3.10.5 Parts and Materials Selection - All parts and materials in the exposure unit shall be approved by Eastman Kodak Company. Eastman Kodak Company approval of parts does not release the contractor of responsibility for design and manufacture of hardware which satisfies the performance requirements of this specification. In the specification of parts, consideration shall be given to the following:

(a) Contractor's Preferred Parts List, (Approved by Eastman Kodak Company).

(b) Reliability Approved Parts, Eastman Kodak Company, Standards "Designing for High Reliability" 401-104-1.

(c) Military Standard Parts approved for use in appropriate environment.

(d) Other standard high quality industrial type parts.

3.10.6 Reliability

3.10.6.1 General - The provisions of Eastman Kodak Company specification 401-106 shall be met throughout the design and manufacture of the exposure unit.

3.10.7.2 Failure Rate - The minimum mean time between failures for the exposure unit when operating within the requirements of this specification is * hours.

*To be supplied by a later revision.

3.10.6.3 Disposition of Variances - Variances from the requirements of this specification shall require Eastman Kodak Company approval. Also, when a variance occurs between a part and its associated drawing, a notification of variance shall be submitted to Eastman Kodak Company for approval.

3.10.6.4 Contract Conformance - The exposure unit shall conform to all requirements of this specification. All design, development, fabrication and test procedures shall conform to Eastman Kodak Company specifications 401-101 and 401-122.

3.10.7 Human Engineering - Where feasible, the provisions of "Design Standard for Human Factors, Engineering", drawing 401-108, shall be followed.

3.11 Documentary Requirements

3.11.1 Quality Control - Procedures shall be prepared and documented by the contractor, subject to the approval of Eastman Kodak Company, defining a quality control system that shall fulfill the requirements of this specification.

3.11.1.1 Inspection Reports - Inspection reports including records of in-process inspection shall be generated and maintained by the contractor. These reports shall be made available, upon request, to Eastman Kodak Company. Continuity of records and identity of parts assembled shall likewise be maintained and made available to Eastman Kodak Company.

3.11.1.3 Certification of Parts - Parts not manufactured or tested by the contractor, shall be documented through certification by fabricator, and such documentation shall be made available to Eastman Kodak Company.

3.11.1.3 Alignment, Calibration - Records shall be generated, documented and made available to Eastman Kodak Company, of the alignment and calibration of all measuring and test equipment for the exposure unit.

*To be supplied by a later revision.

3.11.1.4 Test Procedures - Qualification and Acceptance Test Procedures for the exposure unit that demonstrate the conformance with the requirements of this specification shall be established and documented by contractor, subject to approval of Eastman Kodak Company.

3.11.1.5 Performance Record - All data, including operating time and malfunction reports and analyses, generated through tests, shall be recorded by serial number, preserved as a performance record in a log book, and submitted to Eastman Kodak Company with each exposure unit.

3.11.1.6 Design Review Check List - Design review check lists shall be prepared by contractor collaborating with Eastman Kodak Company personnel on reproducible forms prior to the associated design review meeting.

3.11.2 Drawings - All engineering drawings and associated lists prepared by contractor for the purpose of defining those requirements of design, inspection and testing shall be prepared in accordance with Eastman Kodak Company specification 401-101.

3.11.3 Specification - The contractor shall generate material to complete performance requirements and description of the exposure unit. Such material shall be submitted to Eastman Kodak Company for approval. The approved material shall be incorporated into this specification by Eastman Kodak Company.

3.11.4 Instruction Manual - The contractor shall provide manuals containing operating and maintenance information in conformance with Eastman Kodak Company drawing 401-122. It shall be subject to Eastman Kodak Company approval.

3.11.5 Acceptance Test Report - The contractor shall prepare a report which documents all test data accumulated during acceptance testing of the exposure unit. This report shall contain all information necessary to show the degree to which the exposure unit conforms to this specification.

3.11.6 Electromagnetic Interference Control Plan - An EMI control plan in accordance with MIL-I-26600 for class Ib equipment shall be prepared and submitted for Eastman Kodak Company approval with the Preliminary Design Report of 1.3.6.3, Eastman Kodak Company document 401-122.

3.11.7 Other Reports - In addition to the documentation rquired by prior sections of this specification, the contractor shall deliver to Eastman Kodak Company all other reports required by 401-122 and shall prepare and deliver to Eastman Kodak Company a spare parts list in accordance with Eastman Kodak Company specification 401-122.

4. QUALITY ASSURANCE PROVISIONS

The quality control system requirements of MIL-Q-9858 and Eastman Kodak Company specification 401-106 shall be met throughout the design and manufacture of the exposure unit. Testing shall be limited to provisions listed in this section.

4.1 Classification of Tests - The inspection and testing of the exposure unit shall be classified as follows:

(a) Qualification Tests

(b) Acceptance Tests

4.2 Qualification Tests - No qualification testing shall be conducted by the contractor. The test procedures shall comply with 3.11.1.4.

4.2.1 Visual Inspection - All parts, subassemblies, and assemblies shall be inspected for conformance with Eastman Kodak Company standard 401-104-2 and dimensional, alignment, accessibility and some general requirements of this specification.

4.2.2 Drawing Conformance - All parts, subassemblies and assemblies shall be inspected for conformance with their associated drawings.

4.2.3 Performance Tests - The exposure unit shall be tested for its ability to comply with the electrical, mechanical, and photographic requirements of section 3 of this specification.

4.2.4 Environmental Tests - The exposure unit shall be subjected to acceleration, shock, and vibration requirements as specified in section 3. Following completion of these tests, the exposure unit shall be inspected visually for damage and performance tests of 4.2.3 shall be repeated.

4.2.5 Diagnosis Report - Following the environmental qualification tests, diagnosis shall be made of any impairment of the performance of the exposure unit, and a full report shall be prepared according to the requirements of 3.11.1.5.

4.2.6 Life Test - The exposure unit shall be tested for its ability to meet the service life requirements in the specified environments of this specification.

4.3 Acceptance Tests - Acceptance tests shall be performed by the contractor on all deliverable models of the exposure unit. The test procedure shall be in accordance with 3.11.1.4. The acceptance tests shall include visual inspection, drawing conformance, performance tests, in section 4.2.1, 4.2.2, 4.2.3 and modified environmental tests.

4.3.1 Modified Environmental Test - The modified environmental tests under acceptance testing shall be limited to random vibration-white noise excitation-for 5 minutes in each of 3 mutually perpendicular axes as follows:

* cycles per second
* g^2/cps

Following vibration testing the performance tests shall be repeated to assure that the exposure unit suffered no impairment of its capabilities.

*To be supplied by a later revision.

4.4 Test Conditions

4.4.1 Alignment and Calibration - The alignment and calibration of the test equipment and all recorded data shall be in accordance with the requirements defined in 3.11.1.3

4.4.2 Environmental Conditions - The atmospheric conditions for all tests shall be within the ranges specified in section 3.9.2.

4.4.3 Electrical, Mechanical and Optical - The electrical, mechanical and optical inputs and outputs applied to the exposure unit shall be in accordance with the section 3 of this specification.

4.5 Monitoring and Surveillance - Eastman Kodak Company reserves the right to conduct quality surveys in the contractor's plant for quality system evaluation and for periodic review of contractor's performance. Eastman Kodak Company also reserves the right to witness all acceptance tests. Contractor shall advise Eastman Kodak Company in advance the date of each proposed acceptance test. Inspection support may be given the contractor by placing in-residence inspection personnel at the contractor's plant, if necessary.

5. PREPARATION FOR DELIVERY

5.1 Packaging - All parts, subassemblies, and assemblies for shipment as separate items, shall be cleaned, labeled, and sealed in transparent plastic bags. The bags shall be partially evacuated before sealing. They shall then be packaged in fitted and padded boxes.

5.1.1 Major Assemblies - The major assemblies after cleaning and sealing in plastic bags as above, shall be packaged in fitted and padded boxes. The boxes shall be reusable and equipped with hinges and latches. Each box shall have its proper identification.

5.1.2 Small Parts - Small parts, such as screws, nuts, retaining rings, etc., shall be cleaned and sealed in plastic bags as above. There shall be a reasonable quantity of parts, and only one part number per bag.

5.2 Packing - All parts, subassemblies and assemblies, as packaged, shall be crated to avoid damage during shipment by common carrier as follows:

(a) Major assemblies in fitted boxes shall be crated individually.

(b) Other assemblies and subassemblies shall be crated individually.

(c) Small parts, in plastic bags shall be grouped and each group crated individually.

The package shall be such as to protect the contents from external observation and shall not indicate the contents.

5.2.1 Packing List - A list of all parts included in a crate shall be placed immediately beneath the cover of the crate.

5.3 Warning Notice - A warning notice which indicates that the plastic bags shall not be opened due to cleanliness requirements, shall be prominently displayed on each list and on each plastic bag.

6. NOTES

6.1 Application - The background data explaining the intended use of the exposure unit is not required for this specification.

6.2 Test Processing of SO-132 Film

6.2.1 Processing Method - Test processing of Kodak Experimental High Definition Aerial Film, SO-132, may be performed in trays, tanks or continuous film processors. The proposed process system should be checked with sensitometric exposures (1B type) to show general conformance with the "aim curve for Kodak D-19 Developer, Figure 1".

6.2.2 Processing Procedures

(a) Solutions

Developer	- Kodak D-19 Developer
Stop Bath	- Kodak Stop Bath SB-1 or SB-5
Fixing Bath	- Kodak Rapid Fixer with Hardener

(b) Temperature - 68°F

(c) Sequence and Time

Developer	- 8 minutes
Stop Bath	- 30 seconds
Fixing Bath	- 5 minutes
Wash	- 15 - 20 minutes

(d) Agitation - Continuous agitation shall be provided during development according to standard techniques for the process employed.

6.2.2.1 Darkroom Lighting - Development shall take place in total darkness. Lights may be turned on 30 seconds after the film has been placed in the fixing bath.

6.2.2.2 Process Control - A sensitometric exposure (1B type) shall be processed with test samples to provide a standard for evaluating test results. The aim curve for this product is Figure E-1. Standard exposures will be provided by Eastman Kodak Company if required.

6.2.3 Test Evaluation - Figure E-1 is the aim curve for SO-132 film. Results obtained in any test process can be converted to the equivalent densities that would be produced by processing to the aim curve as follows:

(a) Determine the densities of the test exposures and the 1B strip.

(b) Plot the sensitometric curve.

(c) From the curve obtain the exposure (Log E) required to produce the test exposure densities.

(d) Applying these Log E values to Figure E-1, obtain the densities that will be produced when SO-132 is processed to the aim curve.

6.3 Company Confidential

(a) The contractor shall not disclose any information concerning work being done or to be performed or any informaiton received from Kodak in connection with the work, to anyone other than to Kodak's and contractor's employees and officers directly connected with work under this specification, who have a need to know such information for performance under this specification. The restriction of this section shall continue in effect for 12 months upon completion or termination of the work.

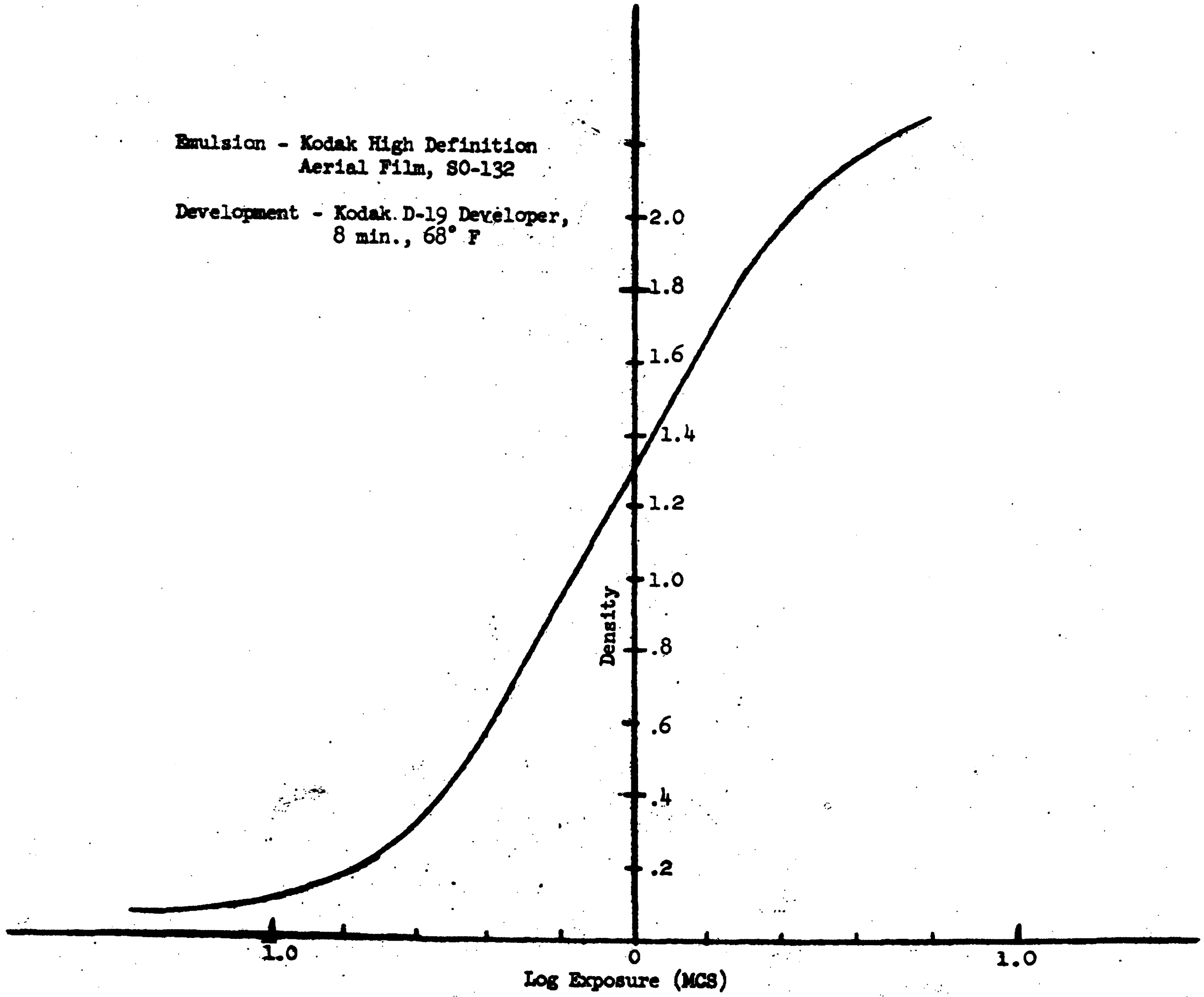


Figure E-1. Aim Curve for SO-132

(b) All data, drawings and specifications delivered by the contractor shall be the property of Kodak and the contractor agrees to hereby grant to Kodak, a royalty free, non-exclusive and irrevocable license to publish, reproduce, dispose of and to authorize others to do so, all such data, drawings, specifications and information therein supplied by contractor.

Sheets ________

APPENDIX F

Preliminary

Focus Control Unit

Specification No. *

Prepared by
EASTMAN KODAK COMPANY
Advanced Development Projects Group
Apparatus and Optical Division
Rochester, New York

Preliminary Specification	Focus Control Unit
Specification No.	Release date:

1. SCOPE, MISSION AND TASK

1.1 Scope - This specification defines the Focus Control Unit. It includes the performance and environmental requirements, and defines the quality assurance provisions required to determine compliance of the focus control unit with these requirements.

1.2 Mission - It shall be the mission of the focus control unit to supply the necessary signals to a related system to focus the payload exposure unit by analyzing signals received from another related system.

1.3 Task - The required task is to design, develop, manufacture, test and deliver to Eastman Kodak Company (EKC) a focus control unit which complies with the requirements of this specification.

2. APPLICABLE DOCUMENTS

2.1 The following specifications, standards, and publications of latest issue in effect on date of invitation for bids, form a part of this specification. Applicability of the listed documents shall depend on their specific reference in this specification. In the event of a conflict between the listed documents and this specification, this specification shall take precedence.

SPECIFICATION

Military

MIL-Q-9858	Quality Control System Requirements
MIL-I-26600	Interference Control Requirements, Aeronautical Equipment

Eastman Kodak Company

401-101	Instructions for Preparation of Drawings by Subcontractors
401-122	Technical Requirements for Proposals and Subcontracts
	Signal Gating Module
	Camera Assembly
	Focus Detector

STANDARDS

Military

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes

Eastman Kodak Company

401-104-1	Designing for High Reliability
401-104-2	Attaining Reliable Manufacture
401-108	Design Standard for Human Factors Engineering

DRAWINGS

Eastman Kodak Company

401-111	Instructions for Preparation of Equipment Manuals
405-130	Procedure for Iridite No. 15 Finish for Magnesium
405-152	Procedure for Low Emissivity Coating of Materials
*	Focus Control Unit
*	Schematic Diagram, Focus Control Unit
*	Camera Payload Command Information

2.2 Control Drawings - None required for compliance with this specification.

*To be supplied by a later revision.

3. REQUIREMENTS

3.1 Definitions - The focus control unit is an integral part of the focus control system of the camera payload. The focus control system of the camera payload is defined as the equipment required to determine the focus condition of the camera payload, develop output signals capable of describing the focus condition, and adjust focus either by direct command or by performing the function automatically. The focus control system consists of the following assemblies:

(a) Focus Control Unit
(b) Focus Detector Assembly
(c) Focus Drive Assembly

3.1.1 Focus Control Unit - The focus control unit is that portion of the focus control system defined by this specification. The focus control unit shall accept signals from the focus detector assembly, interpret them, and provide output signals which indicate the condition of focus of the camera payload optical system. In the automatic mode, the focus control unit shall provide output signals capable of operating the focus drive assembly to produce the best optical focus of the camera payload. The focus control unit shall consist of the following elements:

(a) Automatic gain control amplifier
(b) Signal gating module
(c) Integrators, unity gain amplifiers, and differential amplifier
(d) Monitoring logic and power switches

3.1.1.1 Automatic Gain Control Amplifier - The automatic gain control amplifier is a fixed-gain ac amplifier with a variable-attenuator input. The attenuator is controlled by feedback loop from the larger of the two signals coming out of the unity gain amplifiers of 3.1.1.3. The input signal to the amplifier is provided by the focus detector assembly.

3.1.1.2 Signal Gating Module - The signal gating module is a gating network, triggered by synchronizing pulses provided by the focus detector assembly. The synchronizing pulses are related to the active portions of the input signal and cause the alternate switching of the input signal from one output channel to the other. It also has the function of blocking all signals during transition periods of the input signal. The signal gating module shall be in accordance with EKC specification *.

3.1.1.3 Integrators, Unity Gain Amplifiers, and Differential Amplifier - The two signals coming out of the signal gating module of 3.1.1.2 are fed into separate integrators. These are rectifiers which have short time constant characteristics (3 seconds) for rising voltages, but long time constants (10 seconds) for decreasing voltages. The output is, therefore, a d-c signal which is approximately proportional to the level of the active portion of the input signal. Each d-c signal is then fed into a corresponding unity gain amplifier which, in addition to transforming impedance, maintains a fixed relation between its output voltage and input voltage with respect to load, time, and temperature. The outputs from the unity gain amplifier are fed to a differential amplifier which compares their amplitude, the instrumentation output channels, e_A and e_B, and to the AGC amplifier control selector circuit. The differential amplifier output is proportional to the difference between the two input signals. This signal is fed to the logic circuits of 3.1.1.4 and to the instrumentation output channel e_T.

3.1.1.4 Monitoring Logic and Power Switches - The logic circuits monitor e_A, e_B, and e_T. When the channel output signals are beyond what are considered normal limits, the power switches are immobilized. That is, when in the automatic mode, the focus motor drive shall not operate if the output voltages, e_A, and e_B, are greater than $+5.2 \pm 0.2$v dc, or less than

+0.6 ± 0.1 v dc. The power switches are activated by the differential amplifier output signal to provide power to operate the focus drive assembly and correct for a defocused condition when the system is placed in the automatic focus mode. Part of the logic circuitry is used to select the focus error threshold which must be exceeded for the automatic focus mode to require a correction. These thresholds are set to 2.0 ± 0.1v dc and 3.0 ± 0.1v dc. (In-focus level is 2.5v dc).

3.1.2 Focus Detector Assembly - The focus detector assembly is that portion of the focus control system which converts the incoming light into electrical signals meaningful to the subsequent portions of the system. It is located in the exposure unit and consists of the following elements:

(a) Focus System Optics
(b) Focus Shifter Assembly
(c) Focus Detector
(d) Pre-amplifier

The focus detector assembly shall be in accordance with EKC specification *.

3.1.3 Focus Drive Assembly - The focus drive assembly is that portion of the focus control system which actually changes the focus of the camera payload and monitors its position. The focus drive assembly shall be located in the exposure unit and shall be capable of being operated either manually or automatically by the focus control unit. The focus drive assembly shall function in accordance with Eastman Kodak Company specification *. The focus drive assembly shall consist of the following elements:

(a) Focus Drive Motor
(b) Platen Position Potentiometers

3.2 Electrical Requirements

3.2.1 Inputs - The focus control unit shall meet the requirements of this specification when the terminals indicated in 3.2.5.1 are supplied with the following inputs:

3.2.1.1 Power - Applied voltage and current values shall be as specified in Table I. Note that some power is transferred through the assembly to the exposure unit and is not necessarily dissipated within it. The last column lists the power consumption of the exposure unit portion of the system. Surge currents from the ±22v dc supply shall decay to 37 percent of their initial values in 15 milliseconds or less. Surge current amplitude is peak transient current minus steady state current.

TABLE I

APPLIED VOLTAGE AND CURRENT VALUES

Voltage (dc)	Regulation	Max. Surge Current	Max. Operating Focus Control Unit Current	Max. Operating Current (Exposure Unit Portion)
+28	+3.0v -3.0v	1.0 amp.	60 ma	200 ma
+22	+0.1v	400 ma	150 ma	2.0 ma
-22	±0.1v	250 ma	125 ma	---
+5	±0.1v	---	---	0.25 ma

3.2.1.2 Commands - Application of the plus 28v dc to the J* pin* shall initiate operation of the focus control system. The maximum current drain from the command source shall be 0.1 ampere. The system shall turn off upon removal of the voltage (open circuit). The commands for manual and automatic focus control system operation shall be applied external to the system and shall be as defined in EKC specification *.

*To be supplied by a later revision.

3.2.1.3 Synchronizing Signals - Two synchronizing input signals shall be supplied to the focus control unit. They shall be identified as the synchronizing pulse train A, and the synchronizing pulse train B, and shall correspond to the time sequence of the focus shifter assembly in the focus detector assembly. The synchronizing signal waveform and time relationships are shown in Figure F-1. The time period between the plus A and minus A synchronizing pulses shall be designated the A gate period which corresponds to the time when the focus signal is fed to the A channel integrator. The time period between the plus B and minus B synchronizing pulses shall be designated the B gate period, which corresponds to the time when the focus signal is fed to the B channel. The normal gate repetition rate shall be 30 cps. The rate may vary continuously from 25 to 40 cps. The load impedance for the synchronizing pulses shall be no less than 1000 ohms. The amplitude of the pulses may vary from 1.5 to 4.5 volts peak. Noise and spurious signals in either synchronizing input shall not exceed 0.6 volt peak. The rise time (10 percent to 90 percent points) of the leading edge of the synchronizing pulses shall be less than 400 microseconds.

3.2.1.4 Input Focus Signal - The input focus signal to the focus control unit shall have an a-c amplitude modulated waveform. Its carrier frequency shall be within the range of 380 to 1500 cps. The amplitude modulation frequencies shall be in the range of 0 to 40 cps. The general waveform of the input signal shall be as shown in Figure F-1. The rms signal amplitude during the A gate period shall be designated as the A signal amplitude. The rms signal amplitude during the B gate period shall be designated as the B signal amplitude. The A and B period repetition rate may vary from 25 to 40 cps. The amplitude range of the input signal shall be from 4 millivolt rms during either the A or B gate periods to 400 millivolts rms. The period in which this variation can take place shall not be

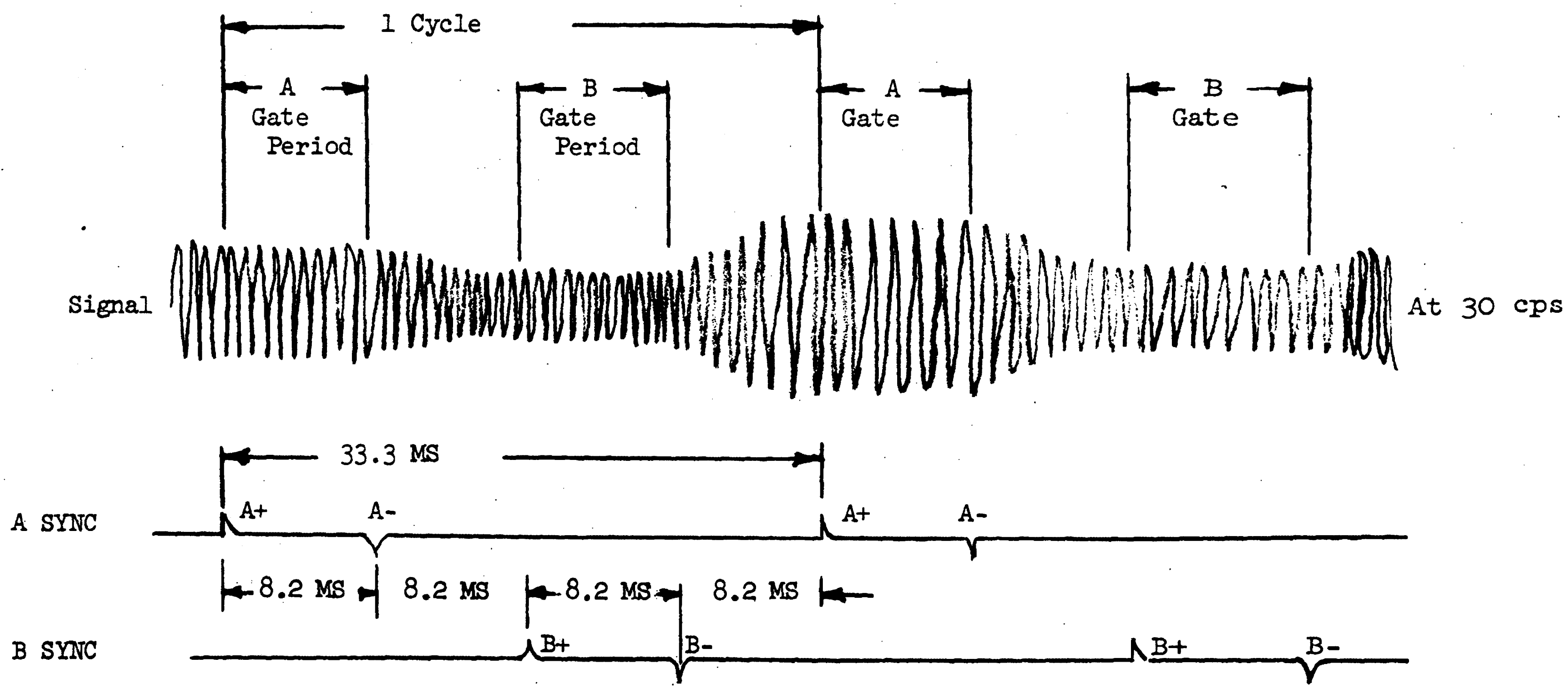


Figure F-1. Synchronizing Signal Waveform less than 150 milliseconds. The ratio of the A signal amplitude to the B signal amplitude (A/B) for normal operation, shall be within the range of 0.1 and 10. Ratios beyond this range shall be considered abnormal. The impedance of the input signal source shall be 6,000 ohms ±10.0 per cent.

3.2.2 Outputs - The following output signals shall be obtained when the necessary input power is supplied to the focus control unit and the input signals are as specified.

3.2.2.1 Switched Power - With the application of the power-on command as defined in paragraph 3.2.1.2 plus 22v dc and plus 28v dc shall appear at the terminals indicated as "switched" "22v dc power" and "switched 28v dc power". With the application of the "power-off" command, the voltages at the indicated terminals shall be zero.

3.2.2.2 Focus Motor Power - In the manual mode of operation, focus motor lead terminals of J * shall exhibit the following conditions:

(a) For a forward drive command, Motor Lead B shall be 28v dc positive with respect to Motor Lead A.

(b) For a reverse drive command, Motor Lead A shall be 28v dc positive with respect to Motor Lead B.

(c) In the absence of a command, both motor leads shall be connected to dc return or maintained at 28 volts positive with respect to d-c return.

When the unit is operating in the automatic focus mode, the connections of the automatic focus outputs are made to the focus motor lead connections external to the unit. The automatic focus outputs are present at the designated terminals under the following conditions:

When e_T is less than +2.0 ±0.1v dc and e_B is greater than +0.6 ±0.1v dc, a forward drive output shall be present as defined by (a) above.

When e_T is greater than +3.0 ±0.1v dc and e_A is greater than +0.6 ±0.1v dc, a reverse drive output shall be present as defined by (b) above.

When e_T is between +2.0 ±0.1 and 3.0 ±0.1v dc, the output shall be defined by (c) above.

Values of e_A or e_B greater than +5.2 ±0.2v dc or less than 0.6 ±0.1v dc are defined as abnormal and shall be considered to be beyond the correction capability of the focus system. Therefore, there shall be no automatic focus output signals present under those conditions and the output shall be defined by (c) above.

3.2.2.3 Instrumentation Power Output - Plus 5.0 ±0.1v dc shall appear on the instrumentation power terminal of J* when power is applied to the focus control unit.

3.2.2.4 Channel A and B Outputs - The output voltages for channels A and B shall be designated e_A and e_B respectively. They shall be in the range of 0 to 5v dc. Figure F-2 indicates the nominal room temperature values of e_A and e_B for various input signal ratios. At any one temperature within the range specified in Section 3.3, (e_B - e_A) for a given unit shall repeat within 0.100v dc total for A/B between 0.1 and 10.0. At 74 ±5F all units shall be within ±0.40v dc of Figure F-2. For a given unit and any A/B between 0.5 and 2.0, (e_B - e_A) shall repeat within 0.3v dc total. For any other A/B between 0.1 and 10.0, (e_B - e_A) for a given unit shall repeat within 1.0v dc.

3.2.2.5 Focus Signal Output - The focus signal output shall be designated e_t. It shall be a voltage in the range of -0.25 to +22v dc. Figure F-3 indicates the nominal room temperature value of e_T for various input signal ratios. At any one temperature within the range specified in Section 3.3, e_T for a given unit shall repeat within 0.500v dc total for any A/B between 0.1 and 10.0. For all units, e_T shall be within the shaded area of Figure F-3 for A/B between 0.8 and 1.25.

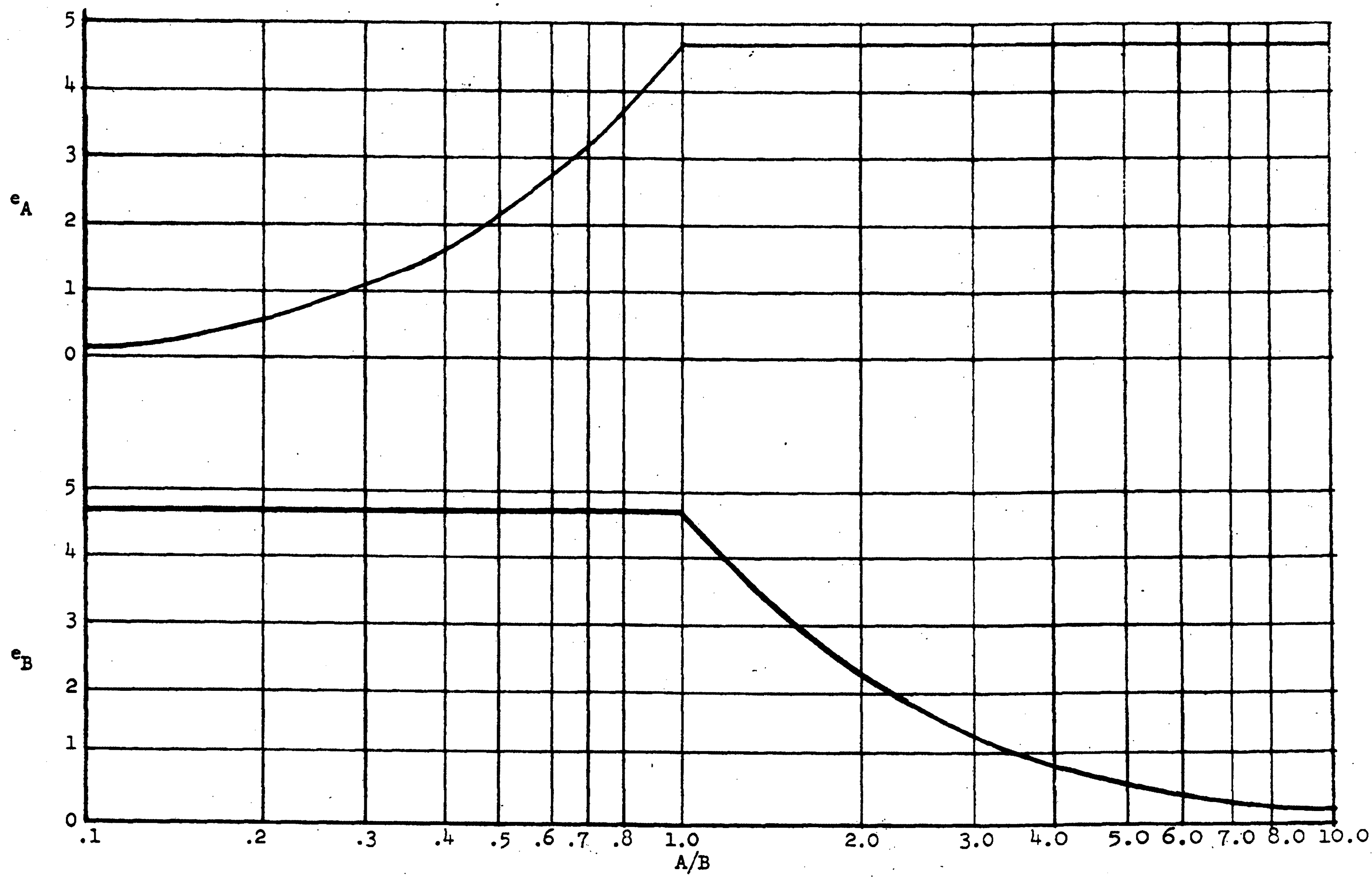


Figure F-2. Temperature vs Input Signal

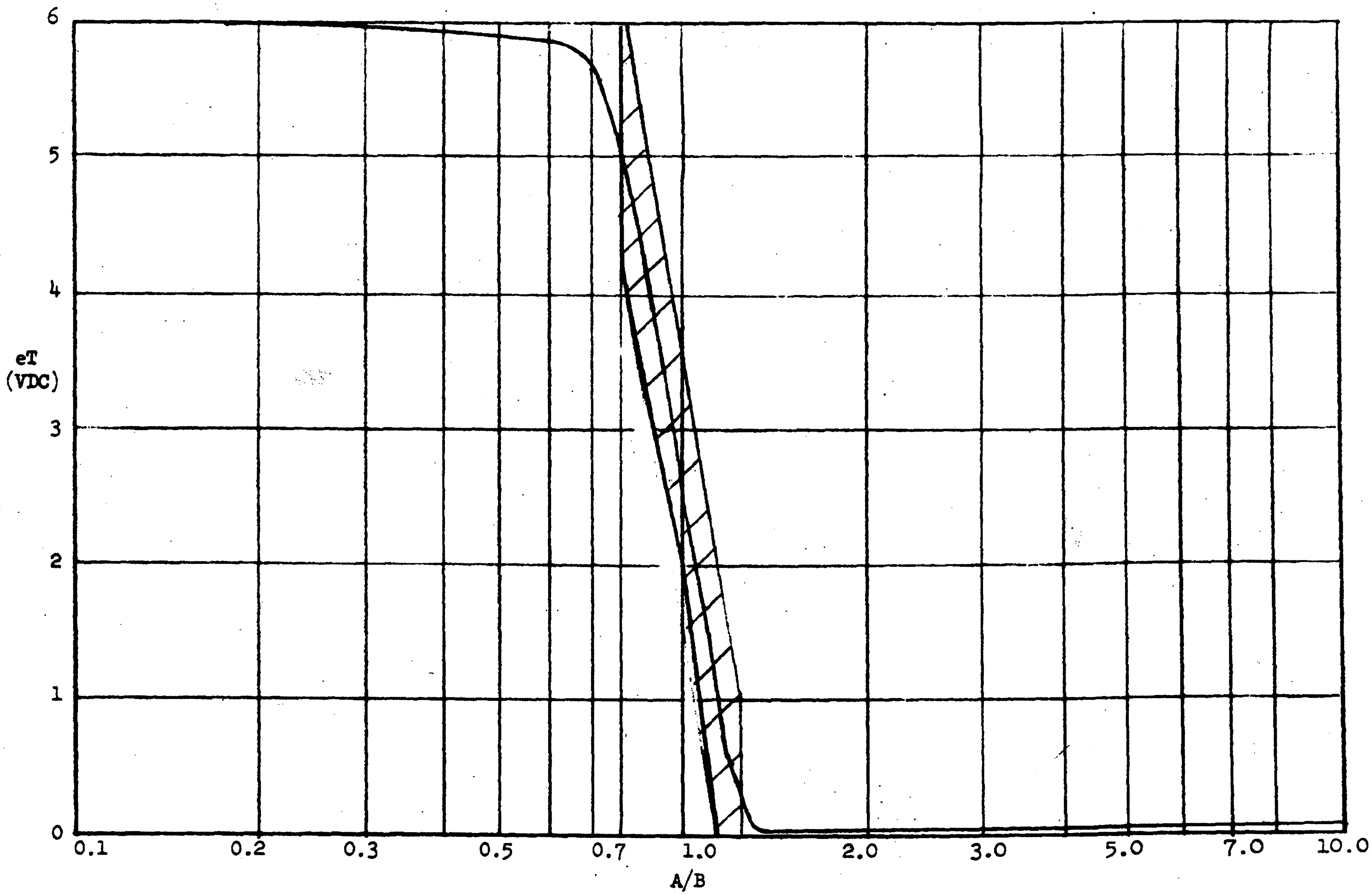


Figure F-3. Temperature vs Input Signal

3.2.3 Response Time - For this specification, response time shall be defined in terms of a step function input. The step input shall be generated by applying an input signal ratio A/B = 10, then suddenly decreasing A to obtain a value of A/B = 1; and by applying an input signal ratio A/B = 0.1, then suddenly decreasing B to obtain a value of A/B = 1.0. The e_A and e_B values shall be within 38 percent of their calibration values (for A/B = 1.0), three seconds after the step function input.

3.2.4 Warm-Up Time - The focus control unit shall meet the performance requirements of this specification within 30 seconds of the time when all power and signals are supplied to it.

3.2.5 Connections

3.2.5.1 Connectors - The connectors and connector pin assignments for the focus control unit shall be as follows:

Connector J* - EKC 400-*

Pin Letter	Function
*	No connection
	No connection
	Instrumentation return
	Shields
	(Platen position coarse)
	No connection
	(e_t)
	Shield
	5v dc supply
	No connection
	No connection
	No connection

*To be supplied by a later revision.

Pin Letter	Function
*	Focus motor, lead A
	Focus motor, lead B
	Automatic focus output, lead A
	Automatic focus output, lead B
	22v dc return
	No connection
	(e_A)
	(e_B)
	No connection
	No connection
	+22v dc supply
	Spare
	Spare
	Spare
	D-C return
	(Platen position, fine)
	+28v dc supply
	-22v dc supply

Connector J* - EKC *

Pin Letter	Function
*	(Platen position, fine)
	Focus motor, lead A
	Focus motor, lead B
	No connection
	Instrumentation power 5v dc
	(Platen position, coarse)
	Spare

*To be supplied by a later revision.

Pin Letter	Function
*	Switched v dc power
	Spare synchronizing pulse B - shield
	Input signal
	Synchronizing pulse A+
	Synchronizing pulse B+
	Spare
	Synchronizing pulse B-
	D-C return
	Synchronizing pulse A - shield
	+22v dc supply
	Instrumentation return (+22 v and 5v)
	No connection
	Input signal - return
	Input signal - shield
	Synchronizing pulse A-
	Shields
	Switches +22v dc power

3.2.5.2 Leakage - The leakage resistance between any electrical connection, except shields, within the unit and the chassis ground of the assembly shall be 100 megohms minimum, with an applied voltage of 100v dc $\pm$ 10 percent.

3.2.5.3 Continuity - Continuity between any connector pins as shown on the schematic diagram, EKC drawing * shall be demonstrated by exhibiting a resistance of no greater than 0.1 ohms. No adverse affects such as deterioriation of wire insulation or abnormal temperature rise shall be noted when the connection is conducting a current of 0.5 amperes for 5 minutes.

*To be supplied by a later revision.

3.2.6 Power Consumption - The power consumed within the focus control unit shall not exceed 8.0 watts average.

3.2.7 Electromagnetic Interference - The focus control unit shall meet the requirements of MIL-I-26600 for Class Ib equipment. In addition to the requirements defined by MIL-I-26600, any conducted interference within the frequency range of 15-15,000 cps impressed on the power supply inputs by the assembly shall not exceed 0.030 ampere peak-to-peak.

3.2.8 Instrumentation Return - The instrumentation return shall be connected to the d-c return at a point external to the focus control unit and shall be completely isolated from the d-c return within the focus control unit.

3.2.9 Cementing of Components - All electrical parts shall be cemented to component boards in accordance with Eastman Kodak Company Standard 401-102-2, Section 4.1.4.1.

3.3 Environmental Requirements - A complete environmental design criteria establishing all of the levels of environment to which the payload and its components will be subjected will be established at a later date.

3.4 Mechanical Requirements

3.4.1 External Configuration - The external configuration for the focus control unit shall be as shown on EKC drawing *.

3.4.2 Weight - The weight of the focus control unit shall not exceed 12 pounds.

3.4.3 Finish - Iridite No. 15 for magnesium per EKC drawing 405-130 inside; reflective evaporated, outside per EKC drawing 405-152.

3.4.4 Identification - Each focus control unit shall be identified with part and serial numbers only. The format and lettering type shall be as shown in EKC standard 401-104-1, section 3.3.7. The location of the identification marking shall be as shown in EKC drawing *.

3.5 General Requirements

3.5.1 Design Attributes - Design shall be in accordance with the requirements of EKC standard 401-119. Throughout the various stages of design, consideration shall be given to the items listed below. Items are listed in order of relative importance.

(a) Performance
(b) Reliability
(c) Fail-safe features
(d) Weight
(e) Serviceability
(f) Power consumption
(g) Flexibility

3.5.2 Manufacturing Standards - The focus control unit shall conform to the manufacturing standards of EKC standard 401-104-2.

3.5.3 Interchangeability - Components of all equipment of the same model, regardless of series designation exclusive of experimental and prototype systems, when up-dated to the latest revisions shall be interchangeable or replaceable.

3.5.4 Ease of Assembly and Maintenance of Equipment - Mechanical and electrical components shall be designed and constructed to require a minimum of skill, experience, and time necessary to assemble and maintain them. The components' design and construction shall minimize the need for holding or supporting these components during final positioning and fastening.

3.5.5 Life

3.5.5.1 Service Life

3.5.5.1.1 Testing Life - The focus control unit shall have a testing life of 150 hours of ON time. During the testing life period, the focus control unit shall be capable of operating continuously for 150 seconds out of a 10 minute period. The focus control unit shall also be capable of a minimum of * ON and OFF operations during * minutes out of a * minute period with each ON time having a minimum duration of * seconds.

3.5.5.1.2 Mission Life - After completion of the specified testing life, the focus control unit shall have a mission life of ** hours ON time. During the mission life period, the focus control unit shall be capable of operating continuously for 150 seconds out of a 10 minute period. The focus control unit shall also be capable of a minimum of ** ON and OFF operations during ** minutes out of a ** minute period, with each ON time having a minimum duration of ** seconds. The focus control unit shall have the above mission life when operated under any of the specified operating conditions.

3.5.5.2 Shelf Life - The focus control unit shall have a shelf life of 24 months minimum.

3.5.6 Reliability - The design and fabrication of the equipment shall be such as to provide adequate and consistent performance of its required function, with a minimum margin of error. The design for reliability shall include the use of parts, materials, and processes which provide for complete calibration, ease in detection of errors, and the application of human engineering design factors of Eastman Kodak standard 401-108, to prevent any damage to, or impairment of, the primary equipment. Reliability of the equipment shall provide for ease of maintenance in compliance with 3.5.3, and shall demonstrate its ability to meet the service life requirements of 3.5.4.1.

3.5.7 Disposition of Variances - Variances from the requirements of this specification shall require EKC written approval. Variance of all other drawings from specification requirements shall require contractor action only.

3.5.8 Contract Conformance - The focus control unit shall conform to the requirements of this specification.

3.5.9 Human Engineering - Where feasible, the provisions of Eastman Kodak Company standard 401-108 shall be followed.

3.5.10 Safety of Personnel

3.5.10.1 Mechanical - The design of the equipment shall be such as to provide maximum convenience and safety to personnel when installing, operating, and maintaining or replacing the equipment. Sharp projections or edges on parts or components shall be avoided.

3.5.10.2 Electrical - Provisions shall be made to prevent personnel from accidentally coming in contact with voltages in excess of 40 volts, including potentials on charged capacitors when the power system is in its normal operation condition.

3.5.10.2.1 Ground Potential - The design and construction of the equipment shall be such that all external parts be at ground potential at all times.

3.5.11 Failure Rate - The focus control assembly shall have a minimum mean time between failures (MTBF) of * hours ("on" time).

3.6 <u>Documentary Requirements</u> - Procedures shall be prepared and documented by the contractor, subject to the written approval of Eastman Kodak Company, defining a quality control system that shall fulfill the requirements of this specification. The documentary requirements shall include but shall not be limited to, the following:

3.6.1 Drawings - All engineering drawings and associated lists prepared by the contractor for the purpose of defining those requirements of design, inspection, and tests, shall be prepared in accordance with EKC specifications 401-101 and 401-122. Any contractor's drafting manual outlining requirements for preparation of drawings may be submitted to Eastman Kodak Company for written approval. Upon receipt of such approval from Eastman Kodak Company, the contractor may use his manual in lieu of the Kodak Drafting Manual.

3.6.2 Specifications - The contractor shall generate material to complete performance requirements and description of the equipment contained in this specification. Such material shall be submitted to EKC for written approval. The approved material shall be incorporated into the specification by EKC.

3.6.3 Manuals - The contractor shall provide manuals containing operating and maintenance information in conformance with EKC drawing 401-111.

3.6.4 Inspection Reports - Inspection Reports shall be generated and maintained by the contractor. These reports, as well as in-process inspection, shall be made available, upon request, to EKC. Continuity of records and identity of parts assembled, shall likewise be maintained and made available to EKC.

3.6.5 Verification of Purchased Items - Verification that purchased items not manufactured or tested by the contractor meet specified requirements shall be documented, and such documentation shall be made available to EKC.

3.6.6 Alignment and Calibration - Records shall be generated, documented, and made available to EKC, of the alignment and calibration of all measuring and test equipment for the focus control electronics.

3.6.7 Test Procedures - Qualification and acceptance test procedures for the focus control unit that demonstrate conformance with the requirements of this specification shall be established and documented by the contractor and submitted to EKC for written approval.

3.6.8 Performance Record - All data, including operating time and malfunction reports generated through tests, shall be recorded by serial number and preserved as a performance record in the log book.

4. <u>QUALITY ASSURANCE PROVISIONS</u>

The quality control system requirements of MIL-Q-9858 shall apply. Testing of the focus control unit shall be limited to provisions listed in this section.

4.1 <u>Classification of Tests</u> - The inspection and testing of the focus control electronics shall be classified as follows:

(a) Qualification tests

(b) Acceptance tests

4.2 <u>Qualification Tests</u> - The qualification tests shall be conducted by the contractor on one focus control unit of any given design. The focus control unit shall not be used as an operational unit following the qualification tests. The test procedures shall comply with 3.6.7, and shall include, but shall not be limited to the following:

4.2.1 Visual Inspection - All parts, subassemblies and assemblies shall be inspected for conformance with the manufacturing standards, EKC drawing 401-104-2.

4.2.2 Drawing Conformance - All parts, subassemblies, and assemblies shall be inspected for conformance with their respective drawings.

4.2.3 Performance Tests - The assembly shall be tested for its ability to meet all of the performance requirements of section 3.2, with the exception of paragraph 3.2.5.2 in which an 0.5 ohm value may be substituted for the 0.1 ohm.

4.2.4 Environmental Qualification Tests - The focus control unit shall be subjected to the environmental requirements as specified in section 3.3.1. Following completion of these tests, the focus control unit shall be visually inspected for damage, and the performance tests of 4.2.3 shall be repeated.

4.2.5 Diagnosis Report - Following the environmental qualification tests, diagnosis shall be made of any impairment of performance of the focus control unit, and a full report shall be written.

4.2.6 Life Test - The focus control unit shall be tested for compliance with the service life requirements of 3.5.4.

4.3 <u>Acceptance Tests</u> - The acceptance tests shall be performed by the contractor on each item of the focus control unit. The test procedures shall be in accordance with 3.6.7. The acceptance tests shall include visual inspection, drawing conformance, and performance tests, of 4.2.1, 4.2.2, 4.2.3, respectively. EKC reserves the right to have the acceptance tests performed at EKC, Rochester, New York.

4.3.1 Environmental Acceptance Tests - The focus control unit shall be subjected to the requirements specified in 3.3.2. Following completion of these tests, the focus control unit shall be visually inspected. The performance tests of 4.2.3 except for EMI tests shall be repeated.

4.4 <u>Test Conditions</u>

4.4.1 Alignment and Calibration - The alignment and calibration of the focus control unit and recorded data shall be in accordance with the requirements of 3.6.6.

4.4.2 Atmospheric Conditions - The atmospheric conditions for all tests shall be in compliance with section 3.3.1.

4.4.3 Electrical Conditions - The electrical inputs and outputs of the components under test shall be in compliance with section 3.2.

4.5 Documentation - The documentation of the focus control unit shall be in compliance with the requirements stated in section 3.6.

4.6 Monitoring and Surveillance - EKC reserves the right to witness all qualification and acceptance tests, and to conduct quality surveys in the contractor's plant for quality system evaluation and for periodic review of contractor's performance. Inspection support may be given the contractor by placing in-residence inspection personnel at their plant, if necessary.

4.7 Sampling - When applicable, sampling procedures and inspection by attributes shall be in accordance with MIL-STD-105.

5. PREPARATION FOR DELIVERY

5.1 Packaging - All parts, subassemblies, and assemblies, for shipment as separate items and not for assembly to a payload, shall be cleaned, labeled, and sealed, with their identification, in transparent plastic bags. The bags shall be partially evacuated before sealing.

5.1.1 Major Assemblies - The major assemblies after cleaning and sealing in plastic bags as above, shall be packaged in fitted and padded boxes. The boxes shall be reusable and shall be equipped with hinges and latch. Each box shall have its proper identification.

5.1.2 Small Parts - Small parts, such as screws, nuts, retaining rings, etc., shall be cleaned and sealed in plastic bags as above. There shall be a reasonable quantity of parts, and only one part number per bag.

5.2 Packing - All parts, subassemblies, and assemblies, as packaged, shall be crated for shipment as follows:

(a) Major assemblies in fitted boxes shall be crated individually.

(b) Other assemblies and subassemblies shall be crated individually.

(c) Small parts, in plastic bags, shall be grouped and each group crated individually.

5.3 Packing List - A list of all parts included in a crate shall be placed immediately beneath the cover of the crate.

5.4 Warning Notice - A warning notice to indicate that the plastic bags shall not be opened until ready for use or inspection due to cleanliness requirements, shall be prominently displayed in each list and on each plastic bag.

6. NOTES

None required for compliance with this specification.

SPECIAL HANDLING

~~SECRET~~

APPENDIX G

Preliminary

FOCUS DETECTOR ASSEMBLY

Specification No.__________

Prepared by
EASTMAN KODAK COMPANY
Advanced Development Projects Group
Apparatus and Optical Division
Rochester, New York

Preliminary Specification | Focus Detector Assembly

Specification No. * | Release Date:

1. SCOPE AND MISSION

1.1 Scope - This specification defines the Focus Detector Assembly. It includes the performance and environmental requirements, and defines the quality assurance provisions required to determine compliance of the focus detector assembly with these requirements. The focus detector assembly shall be installed within the exposure unit.

1.2 Mission - It is the mission of the focus detector assembly to accept an optical input from the camera payload optical system and to convert that optical input to an electrical output signal which is related to the optical focus of the camera payload. It shall also provide synchronizing pulses which are related to the timing sequence of the output signal characteristics.

1.3 Task - The required task is to design develop, manufacture, test, and deliver to Eastman Kodak Company a focus detector assembly which complies with the requirements of this specification.

2. APPLICABLE DOCUMENTS

2.1 The following specifications, standards, and publications of latest issue in effect on the date of invitation for bids, form a part of this specification. Applicability of the listed documents shall depend on their specific reference in this specification. In the event of conflict between the listed documents and this specification, this specification shall take precedence.

SPECIFICATIONS

Military

MIL-Q-9858	Quality Control System Requirements
MIL-I-26600	Interference Control Requirements, Aeronautical Equipment

Eastman Kodak Company

401-101	Instructions for Preparation of Drawings by Subcontractors
401-122	Technical Requirements for Proposals and Subcontracts
401-110	Quality Control System Requirements for Vendors and Contractors

STANDARDS

Military

MIL-STD-171A	Finishing of Metal and Wood Surfaces

Eastman Kodak Company

401-100	Drafting Manual
401-104-1	Designing for High Reliability
401-104-2	Attaining Reliable Manufacture
401-106	Subcontractor's Reliability Requirements
401-113	Reliability Approved Parts List

DRAWINGS

Eastman Kodak Company

401-111	Instructions for Preparation of Equipment Manuals
405-118	Instructions for Masking Protective Coatings (Iridite) Prior to Finishing
405-130	Procedure for Iridite No. 15 Finish for Magnesium
405-162	Procedure for Stencil Identification Marking Chassis, Component Boards and Connectors
405-185	Procedure for Iridite No. 14 Chromate for Aluminum (Non-etching)
*	Chopper Disc
*	Subsystem D Space Limitations
*	Mount Assembly, 45° Mirror
*	Reticle
*	Plate Assembly, Motor Mounting
*	Base Plate and Condensre System Assembly
*	Preamplifier Assembly
*	Exposure Unit Schematic Diagram
*	Wall-Side Housing, Right
*	Exposure Unit Assembly

3. REQUIREMENTS

3.1 Definitions - The focus detector assembly is the portion of the focus control system that detects and converts the input optical signal to the exposure unit into electrical signals which can be interpreted in terms of system focus. It is located within the exposure unit and consists of the following subassemblies:

(a) Motor Mounting Plate Assembly
(b) Base Plate and Condenser System Assembly
(c) Pre-amplifier Assembly

3.1.1 Motor Mounting Plate Assembly - This subassembly contains the motor, the focus shifter disc, and the magnetic pickups which generate the synchronizing pulses.

3.1.2 Base Plate and Condenser System Assembly - This subassembly is mounted on the exposure mechanism frame. It contains a 45° mirror, the 22.5 line per millimeter reticle with an interference filter coating for controlling the spectrum of the light reaching the detector, and the optical elements necessary to collect the light passing through the reticle and focus it on the active area of the detector.

3.1.3 Pre-Amplifier Assembly - This subassembly consists of the potted, shielded pre-amplifier and the silicon cell detector. The amplifier is attached to the exposure unit pressure shell while the detector assembly is attached to the condenser system assembly on the movable exposure unit mechanism frame.

3.1.4 Focus Direction Conventions - The following conventions shall be used in reference to focus direction. The forward direction is away from the lens or in the plus Z axis direction. Platen position instrumentation shall increase in voltage output when the focus drive motion is forward. The forward focus drive command, shall apply plus 28 volts d.c. to focus motor lead B.

The output signal ratio (A/B) is defined as the ratio of the output signal amplitude during the A channel gate period to the output signal amplitude during the B channel gate period. By definition, the platen shall be in the forward or plus region when the A/B ratio is less than 1.0.

Conversely, the reverse direction is toward the lens or in the minus Z axis direction. Platen position instrumentation shall decrease in voltage output when the focus drive motion is reverse. The reverse focus drive command, shall apply plus 28 volts d.c. to focus motor lead A. The output signal ratio, A/B, shall be greater than 1.0 when the platen is in the reverse or minus region.

3.2 Optical Requirements

3.2.1 Optical Input - The optical input to the focus detector assembly shall be through the lens opening of the exposure unit and shall be at nominal focus at the exposure unit focal plane. For the purposes of this specification, the exposure unit focal plane is defined as a plane, 2.3186 inches from, and parallel to, the exposure unit mounting surface (measured in the plus Z axis direction). Provision is made in the exposure unit to move the film plane through a range of from plus 0.010 inch to minus 0.010 inch from the nominal image focal plane. The optical signal shall have the following characteristics:

3.2.1.1 Spectrum - The spectral content of the optical input signal shall conform to that of a 5800° to 6000°K black body radiator over the range of 0.5 to 0.7 microns.

3.2.1.2 Illumination Range - For the purposes of this specification, the maximum image detail (highlight) illumination shall be defined as in the range of * to * foot-candles. The nominal highlight illumination shall be 22 foot-candles. The minimum image detail illumination shall be no more than one-fifth the maximum illumination and may approach zero.

3.2.1.3 Image Content - The image content shall be that of an aerial image of a scene on a scale of * or a contrived pattern having a power spectrum such that the signal at * lines per millimeter is equivalent to that of the ground scene.

For the purposes of this specification, the image content shall be defined as that contained in a 0.500 inch square aperture which is located at a 16.0 inch diameter at the top of the "chopper disc" which is part of the Focus Control Test Set.

3.2.1.4 Image Content Motion - The image content shall move at a rate of * inches per second in a direction perpendicular to the aperture slit.

3.2.1.5 Image Size - The image size shall be such that at least 20 percent of the reticle is illuminated.

3.3 <u>Electrical Requirements</u>

3.3.1 Connections - Connection to the focus detector assembly shall be made through connector * (Eastman Kodak Company drawing 400- *) of the exposure unit. Pin designations of * and intermediate terminal strip designations shall be as follows:

Pin No.	TB No.	Function
*	2002-13	Synchronizing Pulse A-
	2001-1	Switched +22VDC
	2002-17	Switched +28VDC Power
	2001-11	Synchronizing Pulse B Shield
	2001-4	Focus Detector Output Signal
	2002-11	Synchronizing Pulse A+
	2001-12	Synchronizing Pulse B+
	2001-13	Synchronizing Pulse B-
	2002-19	DC Return
	2002-10	Synchronizing Pulse A Shield
	2001-3	Focus Detector Output Signal Ground and +22v dc Return
	2001-5	Focus Detector Output Shield

3.3.2 Leakage - The leakage resistance between either pin *, *, or * or J* and the exposure unit case shall be greater than 10 megohms with a maximum applied voltage of 10vdc. The leakage resistance between any other connector pin, except for shields, and the exposure unit case shall be greater than 100 megohms with an applied voltage of 100 ± 10vdc. The shield on the preamplifier shall be capacity-coupled to 22vdc return.

3.3.3 Power - The following input power shall be applied to the connector terminals in 3.3.1.

Voltage	Regulation	Surge Current	Maximum Operating Current
+28VDC	+3.0V	1.0 amp	200 ma
	-3.0V		
+22VDC	±0.1V	150 ma	2 ma

* To be supplied in a later revision.

3.3.4 Outputs

3.3.4.1 Synchronizing Signals - The two synchronizing pulse transitions, A and B, shall be generated by the focus detector assembly as described in 3.1.1. The synchronizing pulse wave forms and time relationships are shown in Figure G-1. The normal gate repetition rate shall be 30 cycles per second. For +28 VDC power supply variations between +25 VDC and +31 VDC the repetition rate of the pulses shall be between 25 to 40 cycles per second and the amplitude of the pulses shall be between 1.5 and 5.0 volts zero-to-peak. Noise and spurious signals in either synchronizing channel shall not exceed 0.6 volt peak. The peak time (10 percent to 90 percent points) of the leading edge of the synchronizing pulses shall be no greater than 600 microseconds.

3.3.4.2 Focus Detector Output Signal - The output signal of the focus detector assembly shall have an AC amplitude modulated waveform as shown in Figure G-1. Its carrier frequency shall be within the range of 380 to 1500 cycles per second. The amplitude modulation frequencies shall be in the range of 0 to 40 cps.

The amplitude range of the output focus signal during either the A or B gate periods shall be from 4 millivolt RMS to 400 millivolts RMS when the specified optical inputs are supplied.

The output signal shall not exceed 1.0 millivolt RMS when there is no optical input.

The ratio of the A gate period output signal to the B gate period signal (A/B) is related to the focal plane position of the optical input signal and is shown in Figure G-2. The A/B ratio shall be within the shaded area indicated in Figure G-2. For any individual unit, the A/B values for

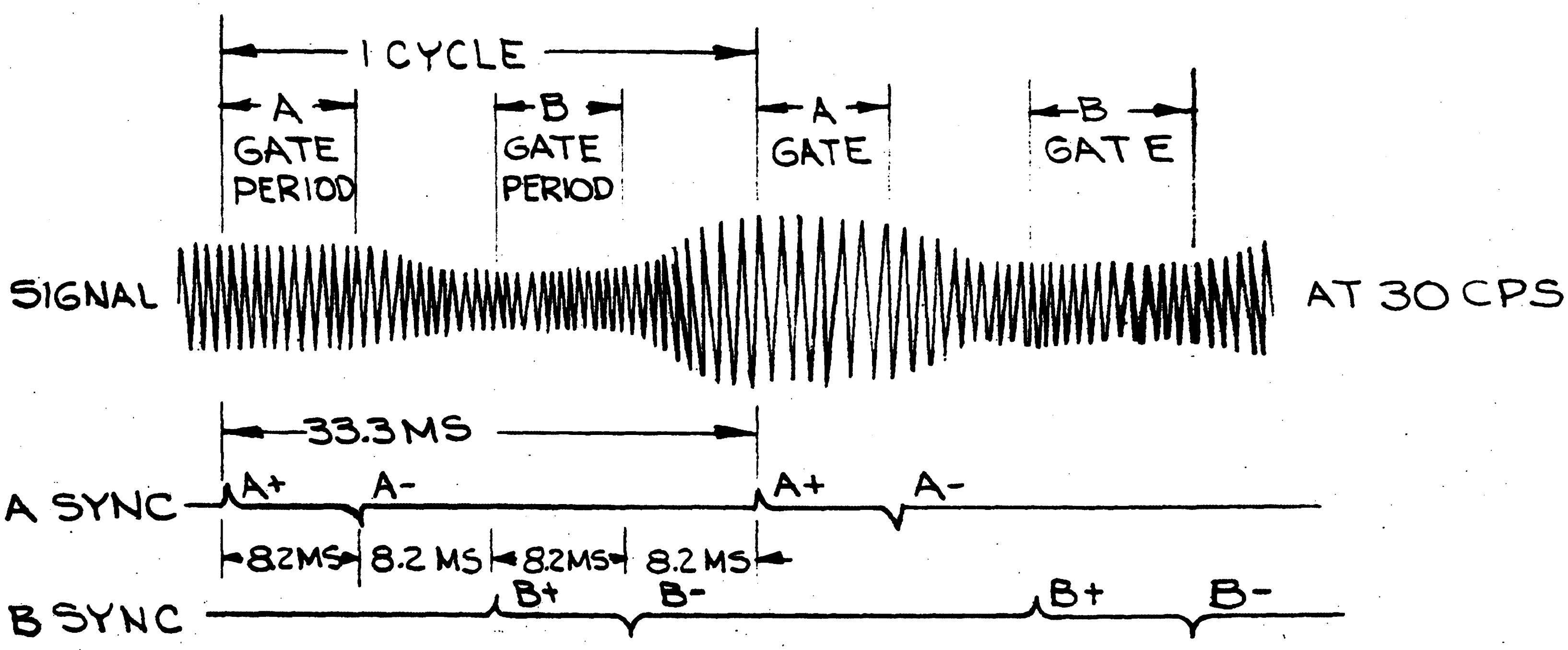
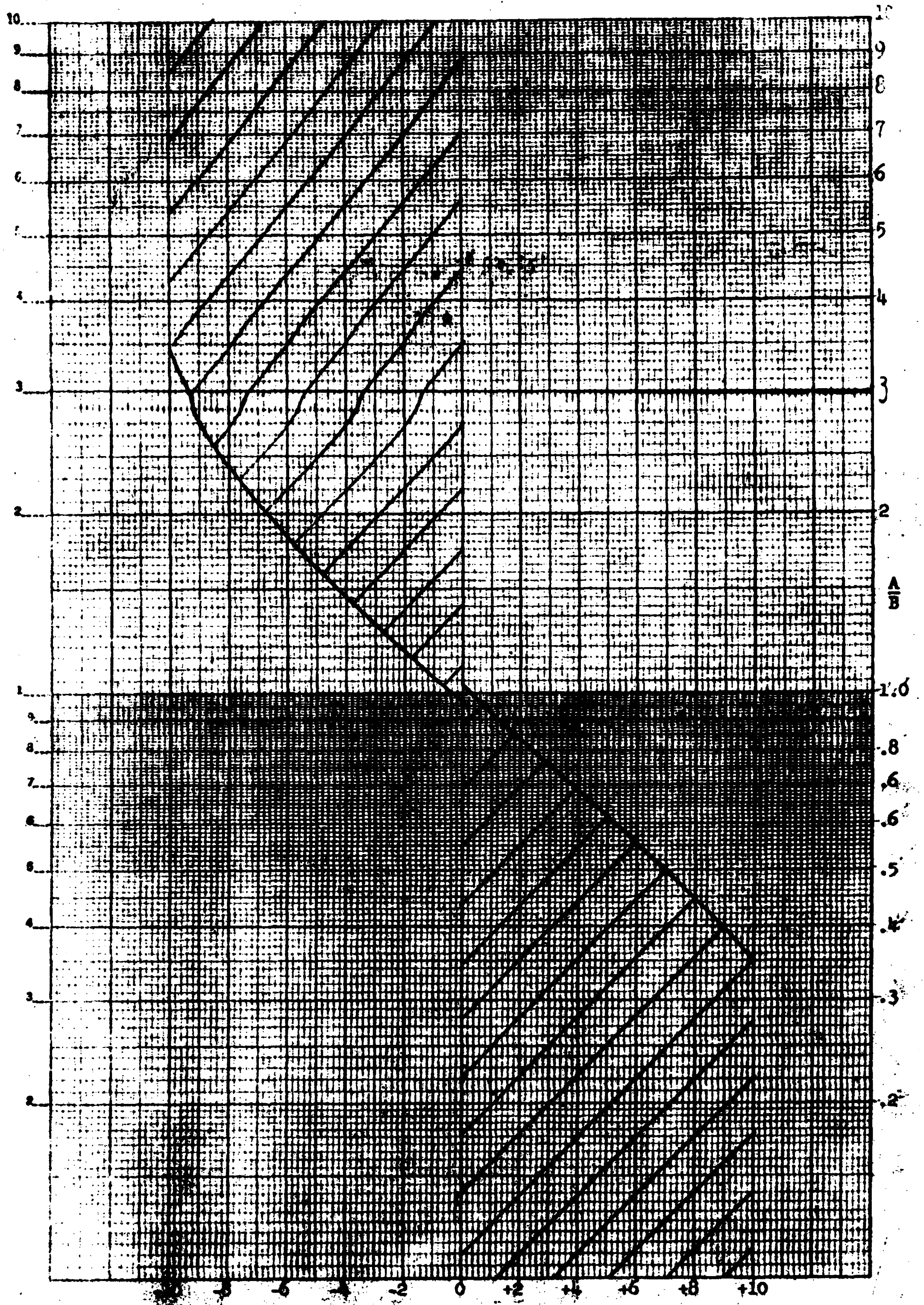


Figure G-1. Synchronizing Signal Waveform



Film Plane Position Referenced to Image Plane Position in Thousandths of an Inch

Figure G-2

3.3.5 Electro Magnetic Interference - The assembly shall meet the (EMI) requirements of MIL-I-26600 for Class 1b equipment. In addition to the requirements defined by MIL-I-26600, any conducted interference, within the frequency range of 15-15,000 cps, 28 volt d.c. power supply circuit by the assembly shall not exceed 0.020 ampere peak-to-peak.

3.4 Environmental Requirements - A complete environmental design criteria establishing all of the levels of environment to which the payload and its components will be subjected will be established at a later date.

3.5 Mechanical Requirements

3.5.1 Configuration - The mechanical, optical and preamplifier assemblies of the focus detector assembly shall be a part of the exposure unit and shall be contained in the space limitations of Eastman Kodak Company drawing *.

3.5.2 Weight - The weight limitations shall be established by a future revision.

3.5.3 Mounting - The motor mounting plate assembly containing the focus shifter assembly shall be installed in the exposure unit on pads provided in the lens seal ring of the exposure unit pressure shell shown on Eastman Kodak Company drawing *. The other mechanical and optical assemblies shall be assembled to a base plate sufficiently rigid to maintain alignment of the assembly when subjected to the specified environment and shall be located as shown in Eastman Kodak Company drawing *. The preamplifier shall mount to the side of the exposure unit pressure shell with screws in holes shown on Eastman Kodak Company drawing *.

3.5.4 Motor Mounting Plate Assembly - This assembly consists of drive mechanism, the focus shifter, the magnetic pickups, and mounting plate.

3.5.4.1 Focus Shifter - The focus shifter disc shall be a plane-surfaced glass disc having two semicircular areas of different thickness. The alternate interposition of the different glass thickness in the optical path causes the image focal plane to move a minimum of ±0.0055 and a maximum of ±0.0065 inch from the equivalent exposure unit focal plane.

3.5.4.1.1 Balance of Shifter Disc - Balance in the shifter disc due to the thicknesses of glass and steel segments shall be corrected by balancing to an accuracy of 30×10^{-5} inch-ounces of force unbalance. To maintain the amplitude of the induced electrical voltage in the magnetic pickups, spacing between the rotating segment and the magnetic pickups shall be adjustable. End play and wobble of the rotating disc shall be held to a minimum.

3.5.4.2 Magnetic Pickups - The magnetic pickups shall be so arranged that a positive (start) pulse is generated when the glass transition has just passed out of the optical path and a negative (stop) pulse is generated just before the next glass transition enters the optical path. The two magnetic pickups are designated as the A and B channel synchronizing pulse generators. The A gate period is defined as the time interval between start and stop pulses from the A channel sync pulse generator and corresponds to the time when the thin glass segment is in the optical path. The B gate period is the time interval between the B channel start and stop sync pulses and corresponds to the time when the thick glass segment is in the optical path.

3.5.4.3 Drive Mechanism - The rotating disc shall be driven by a drive mechanism maintaining nominal speed at 1800 RPM, with an allowable variation from 1500 to 2400 RPM. The rotor of the drive motor shall be balanced dynamically in the planes of the ends of the core to no greater than 5×10^{-6} inch displacement at the bearings for 1800 RPM operation. It shall bring the rotating disc up to speed within 10 seconds.

3.5.4.4 Mounting Plate - The focus shifter assembly shall be mounted to a rigid plate positioned and located as outlined in Eastman Kodak Company drawing *. It shall be an integral assembly capable of being installed from the bottom of the exposure unit through the lens-exposure unit seal opening. It shall be attached to that portion of the exposure unit which does not move in focusing.

3.5.4.5 Alignment - The focus detector assembly shall be aligned and adjusted in accordance with Eastman Kodak Company drawing *.

3.5.4.5.1 Magnetic Pickups - Mechanical spacing between each magnetic pickup and the rotating segment shall be adjusted to induce voltages of the required amplitude as outlined in section 3.3.

3.5.4.5.2 Focus Shifter Disc - The rotating focus shifter disc shall be positioned so that it shall not obstruct light-rays to the slit aperture plate in the exposure unit and shall not vignette light to the reticle.

3.5.5 Base Plate and Condenser System Assembly - This subassembly shall contain a 45° mirror, a reticle and the condenser lens assembly which collects and focuses light passing through the reticle to the surface of the detector.

3.5.5.1 45° Mirror - This mirror shall be installed into an adjustable mount and aligned with the required accuracy of Eastman Kodak Company drawing * to reflect light from the lens to illuminate the entire reticle.

3.5.5.2 Reticle - The reticle is a glass plate, of at least one square inch in area, with a 22.5 line per millimeter grid ruled on one surface and an interference filter coating on the other in accordance with Eastman Kodak Company drawing *. It shall be aligned so that the optical axis of light rays to the reticle shall be coincident with its geometric center and the plane of the reticle surface shall be at right angles to the axis.

The reticle position shall be adjusted in the X-axis so that the image focal plane shall fall equally ahead and behind the reticle, when the light rays pass alternately through the thin and thick segments of the focus shifter glass disc.

3.5.5.3 Condenser Lens Assembly - This assembly consists of multiple lens elements whose axes shall be in line when mounted in accordance with Eastman Kodak Company drawing *. The elements shall be rigidly held to withstand the required environment. The condenser lens assembly shall be positioned to align its axis with that of the reticle and in as close proximity to it as physically possible to receive the maximum light energy from the reticle.

3.5.5.3.1 Detector - The detector, which is part of the preamplifier, shall be attached to the condenser lens assembly. Its photosensitive surface shall be positioned at the optimum focal plane of the condenser lens and oriented to center the light image in the area of the detector surface.

3.5.6 Material - Component assemblies and subassemblies forming a portion of this equipment or the complete equipment, shall be composed of materials, parts and processes which comply with the provision of this specification.

3.5.6.1 Finish - All painted surfaces shall be smooth and free of blemishes, blisters and similar defects. The focus detector system (which may consist of dissimilar metals and plastics) shall be finished in accordance with applicable part drawings to minimize the following: film fogging, contact erosion, galvanic corrosion, surface contamination, corrosion during storage and dirt generation.

3.5.6.1.1 Mounting Surfaces - Magnesium mounting surfaces shall be finished with Iridite No. 15 in accordance with Eastman Kodak Company standard 401-104-1.

3.5.6.1.2 Aluminum - One coat of Iridite No. 14, colored, or equivalent, shall be used in accordance with Eastman Kodak Company drawing 405-185.

3.5.6.1.3 Magnesium - Components having exposed enclosures of magnesium shall have a durable, firmly bonded, electrically conductive finish such as Iridite No. 15 colored or equivalent, in accordance with Eastman Kodak Company drawing 405-130.

3.5.6.1.4 Stainless Steel - Passivate in accordance with MIL-STD-171, Finish 5.4. Black oxide finish shall be (Alkaline Chromate) per MIL-STD-171 Finish 3.3.2, Class II.

3.5.6.1.5 Masking - On mounting surfaces and other surfaces within the exposure unit where electrical bonding is required, the surfaces shall be masked prior to painting as outlined on Eastman Kodak Company drawing 405-118.

3.5.6.1.6 Identification Numbers - The identification numbers for electrical components, terminal boards, barrier strips, connectors, etc., shall be in agreement with Eastman Kodak Company drawing *.

3.5.6.1.7 Lettering - Terminal boards, barrier strips, electrical components, and connectors shall be labeled as to identification, control or function. Labels shall appear either on or immediately adjacent to, preferably below, the item to be identified. Labels shall be brief. Highly similar names shall be avoided. Abbreviations shall be common, meaningful, and be followed by a period. Abbreviations, where possible, shall conform to Eastman Kodak Company standard 401-100.

3.5.6.1.8 Color - Lettering shall be applied in accordance with Eastman Kodak Company drawing 405-162.

3.5.7 Dust Generation - Dust particle count shall not exceed 2,000 particles per liter. The distribution of particles shall have a three Sigma limit which shall not exceed a particle size of 30 microns.

3.5.8 Lubrication - Where required, all parts, subassemblies or components shall be lubricated with materials in accordance with requirements noted on applicable drawings.

3.6 General Requirements

3.6.1 Design Considerations - During the various stages of design, the following items listed in order of relative importance shall be given consideration:

(a) Performance
(b) Reliability
(c) Fail Safe Features
(d) Weight
(e) Serviceability
(f) Power Consideration
(g) Flexibility

3.6.2 Manufacturing Standards - The focus detector assembly shall conform to the manufacturing standards of Eastman Kodak Company standard 401-104-2.

3.6.3 Interchangeability - Focus detector assemblies of the same model, regardless of series designation, exclusive of engineering and reliability test models shall be interchangeable or replaceable when up-dated to the latest revisions.

3.6.4 "On" Time - "On" time shall mean continuous operation.

3.6.5 Life

3.6.5.1 Service Life

3.6.5.1.1 Testing Life - The focus detector assembly shall have a testing life of 150 hours of ON time. During the testing life period, the focus detector assembly shall be capable of operating continuously for 150 seconds out of a 10 minute period. The focus detector assembly shall also be capable of a minimum of * ON and OFF operations during * minutes out of a * minute period with each ON time having a minimum duration of * seconds.

3.6.5.1.2 Mission Life - After completion of the specified testing life, the focus detector assembly shall have a mission life of ** hours ON time. During the mission life period, the focus detector assembly shall be capable of operating continuously for 150 seconds out of a 10 minute period. The focus detector assembly shall also be capable of a minimum of ** ON and OFF operations during ** minutes out of a ** minute period, with each ON time having a minimum duration of ** seconds. The focus detector assembly shall have the above mission life when operated under any of the specified operating conditions.

3.6.5.2 Shelf Life - The focus detector assembly shall have a shelf life of 24 months minimum.

3.6.6 Parts and Materials Selection - All parts and materials in the focus detector assembly shall be approved by Eastman Kodak Company. Eastman Kodak Company approval of parts is not a release of responsibility for design and manufacture of hardware which satisfies the performance requirements of this specification. In the specification of parts, consideration shall be given to the following:

(a) Reliability Preferred Parts List, Eastman Kodak Company Standard, 401-113.

(b) Contractor's Preferred Parts List, (Approved by Eastman Kodak Company).

(c) Project peculiar parts may be submitted with satisfactory supporting evidence for approval by Eastman Kodak Company.

3.6.7 Reliability

3.6.7.1 Provisions - The provisions of Eastman Kodak Company standard 401-106 should be met throughout the design and manufacture of the focus detector assembly.

3.6.7.2 Failure Rate - The minimum acceptable meantime between failures for the focus detector assembly when operating at a maximum duty cycle shall be * hours.

3.6.7.3 Disposition of Variances - Variances from the requirements of this specification shall require Eastman Kodak Company approval.

3.6.7.4 Contract Conformance - The focus detector assembly shall conform to the requirements of this specification. All design, development, fabrication and test procedures shall conform to Eastman Kodak Company specifications 401-101 and 401-122.

3.7 <u>Documentary Requirements</u> - Procedures shall be prepared and documented defining a quality control system that shall fulfill the requirements of this specification . The documentary requirements shall include but shall not be limited to the following:

3.7.1 Drawings - All engineering drawings and associated lists for the purpose of defining those requirements of design, inspection and testing shall be prepared in accordance with Eastman Kodak Company specification 401-101.

3.7.2 Specifications - Complete performance requirements and description of focus detector assembly shall be prepared.

3.7.3 Manuals - Manuals containing operating and maintenance information in conformance with Eastman Kodak Company specification 401-111, shall be prepared.

3.7.4 Inspection Records - Inspection records shall be generated and maintained. These reports, as well as in-process, inspection, shall be made available to Eastman Kodak Company.

3.7.5 Verification of Purchased Items - Verification of purchased items not manufactured or tested by Eastman Kodak Company shall be documented.

3.7.6 Alignment and Calibration - Records shall be generated and documented of the alignment and calibration of all measuring and test equipment for the focus detector assembly.

3.7.7 Test Procedures - Qualification and acceptance test procedures for the focus detector assembly that demonstrate conformance with the requirements of this specification shall be established and documented.

3.7.8 Performance Record - All data, including operating time and malfunction reports and analyses, generated through tests, shall be recorded by serial number, preserved as a performance record in a log book for each focus detector assembly.

3.7.9 Design Review Check List - Design review check list shall be prepared on reproducible forms prior to the associated design review meetings.

4. QUALITY ASSURANCE PROVISIONS

The quality control system requirements of MIL-Q-9858, Eastman Kodak Company specifications 401-106 and 401-110 shall be met throughout the design and manufacture of the focus detector assembly. Testing shall be limited to provisions listed in this section. Prior to testing, the focus detector assembly shall be assembled to the exposure unit and aligned in accordance with Eastman Kodak Company drawing.

4.1 Classification of Tests - The inspection and testing of the focus detector assembly shall be classified as follows:

(a) Qualification Tests

(b) Acceptance Tests

4.2 Qualification Tests - The qualification tests shall be conducted on one focus detector system of a design similar to flight models. The focus detector assembly shall not be used as an operational unit following the qualification tests. The test procedures shall comply with 3.7.7 and shall include, but shall not be limited, to the following:

4.2.1 Visual Inspection - All parts, subassemblies and assemblies shall be inspected for conformance with the manufacturing standards, Eastman Kodak Company drawing 401-104-2.

4.2.2 Drawing Conformance - All parts, subassemblies and assemblies shall be inspected for conformance with their respective drawings.

4.2.3 Performance Tests - The focus detector assembly shall be tested for its ability to comply with the requirements of section 3.

4.2.4 Environmental Qualification Tests - The focus detector assembly shall be subjected to acceleration, shock and vibration requirements as specified in section 3.4.2. Following completion of these tests, the focus detector assembly shall be visually inspected for damage, and the performance test of 4.2.3 shall be repeated.

4.2.5 Diagnosis Report - Following the environmental qualification tests, diagnosis shall be made of any impairment of performance of the focus detector assembly components, and a full report shall be written.

4.2.6 Life Test - The focus detector assembly shall be tested for compliance with the service life requirements of section 3.6.5.

4.3 Acceptance Tests - The acceptance test of 3.4.4 shall be performed on each item of the focus detector assembly. The test procedure shall be in accordance with 3.7.7. The acceptance tests shall include visual inspection and drawing conformance of 4.2.1 and 4.2.2 and the performance tests to demonstrate compliance with the optical and electrical requirements of 3.2 and 3.3.1 through 3.3.4.

4.3.1 Environmental Acceptance Tests - The focus detector assembly shall be subjected to the requirements specified in 3.4.4. Following completion of these tests, the focus detector assembly shall be visually inspected. The performance tests of 4.3 shall be repeated.

4.4 Test Conditions

4.4.1 Alignment and Calibration - The alignment and calibration of the focus detector assembly and recorded data shall be in accordance with the requirements of 3.7.6.

4.4.2 Atmospheric Conditions - The atmospheric conditions for all tests shall be in compliance with section 3.4.

4.4.3 Electrical Conditions - The electrical inputs and outputs of the focus detector assembly shall be in compliance with section 3.3.

5. PREPARATION FOR DELIVERY

5.1 Packaging - All parts, subassemblies, and assemblies shall be cleaned, labeled and sealed in transparent plastic bags. The bags shall be partialy evacuated before sealing. They shall then be packaged in fitted boxes.

5.1.1 Major Assemblies - The major assemblies after cleaning and sealing in plastic bags as above, shall be packaged in fitted and padded boxes. The boxes shall be reuseable and equipped with hinges and latches. Each box shall have its proper identification.

5.1.2 Small Parts - Small parts such as screws, nuts, retaining rings, etc., shall be cleaned and sealed in plastic bags as above. There shall be a reasonable quantity of parts and only one part number per bag.

5.1.2.1 Glass - Thin glass parts and assemblies with glass parts shall be cleaned and packaged with care to prevent breakage. Boxes with padding will be required.

5.2 Packing - Packing not required since the focus detector will be shipped as a part of camera payload assembly.

6. NOTES - Note required for compliance with this specification.

APPENDIX H

DESIGN REVIEW CHECK LIST INSTRUCTIONS

1.0 DESIGN REVIEW CHECK LISTS

The Design Review Check Lists are used to aid in the systematic collection of design data by the design engineer for a specific subassembly. These check lists shall be submitted to the design review engineer at least seven working days before the scheduled meeting. The check lists provide a format for tabulation of design data generated in the normal course of design development and an index to the planned development program.

1.1 General Information

Reproducible design review check-list forms will be furnished by the Reliability Section. Forms for Reliability Check Lists are shown on pages H-7 through H-27.

The design complexity will determine the number of sheets necessary for each individual check list.

Each check list shall contain the hardware nomenclature assigned by Project Engineering.

Design review Check Lists I through XIX shall be submitted for the preliminary design review. Updated Check Lists I through XVII and XX through XXII shall be submitted for the major design review. (Checklist XVIII and XIX are replaced by Check List XXI). Updated Check Lists I through XVII and XX through XXII shall be submitted for the final design review and no other check lists are required. Updating of check lists shall consist of crossing out an old entry and making a new entry or preparing a new check list if more convenient. Check Lists I through XIII inquire into problem definition;

Check Lists XIV through XIX examine the proposed design solution; Check Lists XX through XXII provide part stress analysis data and general information concerning nonconforming parts and design and manufacturing practices.

1.2 Check List I, Statement of Equipment Purpose - Check List I shall consist of a statement of the design engineer's interpretation of the purpose of the hardware to be designed.

1.3 Check Lists II and III, Surrounding Environment - Check Lists II and III shall detail the environment to which the subassembly will be exposed. On Check List II, the "duration of exposure" is defined as the total operating or non-operating time during which the sub-assembly will be exposed to the surrounding environment.

In the Column headed "Circumstances Under Which the Most Severe Environment Occurs," a "Q" or a "D" shall be entered in the narrow left-hand column to denote "qualification testing" or "design use". The duty cycle or duration of exposure shall be entered in the right-hand column.

Under the column headed "Information and Specific Values", enter one of the following in the left-hand column:

a. The level specified by the technical specification.

b. The level estimated by the design engineer, if not specified in the technical specification. (Include source reference material under the reference column)

c. The space shall be left blank when the level is unspecified by the technical specification and no estimate has been made by the design engineer.

In the right-hand column, the letter "I" (Inconsequential) shall be entered when the specified level is of no consequence in design considerations for the hardware.

"References" shall indicate by number the titled reference on the "References for Check List", page 31.

On Check List III, "Duration of Exposure" is the sum total of operating and nonoperating time that the hardware is exposed to the surrounding environment.

1.4 Check List IV, Environment Generation - Check List IV shall define the environments generated by the hardware.

"Total Rate, Magnitude, or Limit of Generation" shall be completed according to the same instructions used for "Information and Specific Values" used on Check Lists II and III.

1.5 Check List V, Physical Requirements - Check List V shall describe the physical requirements for the subassembly. The letter N/A shall be placed in the information space if the parameter definition is not applicable to the design. The informational space shall be left blank if the information is unknown or unspecified. If the design engineer has estimated the level of a significant physical requirement for the design, the value shall be entered and the applicable source reference entered in the "reference" column.

1.6 Check Lists VI through XIII, Functional Requirements - The functional requirements or parameters of the electrical, mechanical, optical, and photographic portions of the hardware shall be entered in these check lists. The entries shall be limited to the input and output parameters for the major functional blocks defined by the block diagram and for the hardware as a unit.

1.7 Check List XIV, Priorities - The design engineer's priority policy shall be established on Check List XIV. This policy shall set forth the order of preference, importance, or merit of the following: design considerations, cost, schedule, reliability, weight, power consumption, volume, and individual performance characteristics.

Each major, individual, performance characteristic shall be identified and assigned the same status as the other listed considerations. Additional design considerations shall be included where applicable. Priorities shall be numbered 1, 2, 3, etc. A given priority number may be assigned to more than one design consideration.

1.8 Check List XV, Design Development - Check List XV shall detail the proposed design solution.

1.9 Check Lists XVI and XVII, Design Verification - Check List XVI shall describe those portions of the design which will be verified through analytical computations and previously published reports. Check List XVII specifies the test that will be performed to verify the design.

1.10 Check Lists XVIII and XIX, Preliminatry Part Estimate - Check Lists XVIII and XIX shall provide an estimate of design complexity through listing by category the parts to be used in the design. "General Type of Parts" shall include:

a. Part classification such as carbon, film or wirewound resistor.
b. Level of part reliability such as Reliability Preferred Parts List, Minuteman status, high reliability, and commercial grade.

1.11 Check List XX, List of "Non-Preferred Parts" - Check List XX shall tabulate parts to be used which are not listed in the Reliability Preferred Parts List, Kodak document 401-113. "Justification for Use of Parts" shall identify reliability data which supports this justification.

1.12 Check List XXI, Part Stress Analysis- Check List XXI shall include data covering the consequence of failure of parts and, the part stress analysis plan and status. Check List XXI shall be used in conjunction with the Parts List, specified in the Drafting Manual, EK document 401-100.

"Part Identification (Reference Designation)" shall include reference designations such as the electrical schematic nomenclature Q_1, R_1 or a brief description of the mechanical part by location or function such as: "Hold-down screw, right-hand," or "Idler gear set screw". In situations where the parts list item gives the total of certain identical parts used in the hardware without indicating the specific application, further breakdown may or may not be required. The grouping of four mounting screws is an example in which no further breakdown is required. In this case, the consequence of failure would be analyzed for a catastrophic failure of the four screws and not for each individual screw. A further breakdown of identical part totals would be required for ten identical transistors mounted on a heat sink where each transistor might be a different circuit. In this case, a circuit failure could result in an entirely different consequence of failure for the hardware.

Where further part breakdown is required, a Roman numeral shall be entered in the part identification column and an additional Check List XXI shall be used for the required breakdown. The additional check list sheets shall be identified with these Roman numerals and the original check list page number: page 26, I-VI; or page 26, VII-X. The original check list sheet shall be numbered with the page number of the appropriate Parts List sheet.

Consequences of Failure" shall be completed employing a rating system established by the design engineer. The following example is for a regulated power supply.

A: Failure means total loss of output voltages

B: Failure means degradation of regulation

C: Failure means loss of test point information only

D+Z: Additional consequences of failure

In addition, where appropriate, a subscript 1, 2, 3, etc., shall be used with the letter designation to define the mode of failure such as: 1. for a short circuit. 2. for an open circuit in the case of an electrical part, 3. for a locked shaft, or 4. for a broken pin coupling in the case of a mechanical part. The significant mode of failure may be parameter degradation such as loss of gain for a transistor or misalignment for a bearing rather than a catastrophic mode of failure. The design engineer shall use his engineering judgment to determine the significant single or multiple part modes of failure, and shall list one or more entries in this column where applicable.

"Basis for Stress Analysis" consists of two categories: Engineering Judgment and Detailed Analysis. The Engineering Judgment category shall be used for those parts generally recognized by experience and judgment as being stressed significantly below their individual capacities. The Detailed Analysis category shall be used whenever a comprehensive stress analysis is required. A Detailed Analysis may include both theoretical analyses and engineering test measurements. For example, the voltage levels for transistor junctions may be theoretically calculated or a circuit measurement may be made. The Enclosed analysis may include a theoretical calculation or an engineering test report.

1.13 Check List XXII, Deviations for Design and Manufacturing Standards - This check list is provided for noting all deviations from Design and Manufacturing Standards, Kodak document 401-119.

DOCUMENT CONTROL NO. ____________
COPY NO. ____________
SHEETS ____________

RELIABILITY CHECK LIST

for

Hardware Nomenclature ____________

Drawing Number ____________

Completed by ____________

Original Completion Date ____________

Latest Revision Date ____________

Design Reviewed by ____________

Page ______

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. ____________

REFERENCES FOR CHECK LISTS

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________
11. ____________________
12. ____________________
13. ____________________
14. ____________________
15. ____________________

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Page ______

CHECK LIST I

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

STATEMENT OF EQUIPMENT PURPOSE

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CHECK LIST IIA

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

HARDWARE'S SURROUNDING ENVIRONMENT DURING OPERATION	CIRCUMSTANCES UNDER WHICH THE MOST SEVERE ENVIRONMENT OCCURS INCLUDE DURATION OF EXPOSURE		INFORMATION AND/OR SPECIFIC VALUES		REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
ATMOSPHERIC CONDITIONS						
Humidity						
Maximum Pressure						
Minimum Pressure						
Rate of Pressure Change						
Maximum Temperature						
Worst Comb. of Temp. Pressure & Humidity						
Corrosive						
Erosive						
Explosive						
Film Fogging						

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CHECK LIST IIB

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

HARDWARE'S SURROUNDING ENVIRONMENT DURING OPERATION	CIRCUMSTANCES UNDER WHICH THE MOST SEVERE ENVIRONMENT OCCURS INCLUDE DURATION OF EXPOSURE	INFORMATION AND/OR SPECIFIC VALUES		REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
RADIATION					
RFI/EMI (Include Radiation and Conduction)					
Infra-red					
Visible					
Ultraviolet					
X-Ray					
ACCELERATION		__ AXIS	__ AXIS		
Magnitude					
Duration					

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CHECK LIST IIC

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

HARDWARE'S SURROUNDING ENVIRONMENT DURING OPERATION	CIRCUMSTANCES UNDER WHICH THE MOST SEVERE ENVIRONMENT OCCURS INCLUDE DURATION OF EXPOSURE	INFORMATION AND/OR SPECIFIC VALUES			REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
VIBRATION						
Combined Sine-Random		No	Yes			
SINE VIBRATION						
Sweep Rate						
Magnitude		Freq. Range (CPS)	__ AXIS	__ AXIS		
		to				
		to				
		to				
		to				
		to				
		to				
		to				
		to				

Rev. Date: Sept., 1963 Check List IIC Page ____

CHECK LIST IID

HARDWARE NOMENCLATURE ________________ DOCUMENT CONTROL NO. ________

HARDWARE'S SURROUNDING ENVIRONMENT DURING OPERATION	CIRCUMSTANCES UNDER WHICH THE MOST SEVERE ENVIRONMENT OCCURS INCLUDE DURATION OF EXPOSURE	INFORMATION AND/OR SPECIFIC VALUES			REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
RANDOM VIBRATION						
Duration						
Magnitude		Freq. Range (CPS)	___ AXIS (G²/CPS)	___ AXIS (G²/CPS)		
		TO				
		TO				
		TO				
Roll Off						
SHOCK						
Direction						
Magnitude						
Duration						
Pulse Shape						

Rev. Date: Sept., 1963 Check List IID Page ______

CHECK LIST IIIA

HARDWARE NOMENCLATURE ________________ DOCUMENT CONTROL NO. ________

HARDWARE'S SURROUNDING ENVIRONMENT DURING NON-OPERATION	CIRCUMSTANCES UNDER WHICH THE MOST SEVERE ENVIRONMENT OCCURS INCLUDE DURATION OF EXPOSURE	INFORMATION AND/OR SPECIFIC VALUES	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
ATMOSPHERIC CONDITIONS				
Humidity				
Maximum Pressure				
Minimum Pressure				
Rate of Pressure Change				
Maximum Temperature				
Minimum Temperature				
Worst Comb. of Temp. Pressure & Humidity				
Corrosive				
Erosive				
Explosive				
Film Fogging				

Rev. Date: Sept., 1963 Check List IIIA Page ______

CHECK LIST IIIB

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

HARDWARE'S SURROUNDING ENVIRONMENT DURING NON-OPERATION	CIRCUMSTANCES UNDER WHICH THE MOST SEVERE ENVIRONMENT OCCURS INCLUDE DURATION OF EXPOSURE	INFORMATION AND/OR SPECIFIC VALUES	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
RADIATION				
RFI/EMI (Include Radiation and Conduction)				
Infra-red				
Visible				
Ultraviolet				
X-Ray				
ACCELERATION		___ AXIS ___ AXIS		
Magnitude				
Duration				

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CHECK LIST IIIC

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

HARDWARE'S SURROUNDING ENVIRONMENT DURING NON-OPERATION	CIRCUMSTANCES UNDER WHICH THE MOST SEVERE ENVIRONMENT OCCURS INCLUDE DURATION OF EXPOSURE	INFORMATION AND/OR SPECIFIC VALUES			REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
VIBRATION						
Combined Sine-Random		No	Yes			
SINE VIBRATION						
Sweep Rate						
Magnitude		Freq. Range (CPS)	___ AXIS	___ AXIS		

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CHECK LIST IIID

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

HARDWARE'S SURROUNDING ENVIRONMENT DURING NON-OPERATION	CIRCUMSTANCES UNDER WHICH THE MOST SEVERE ENVIRONMENT OCCURS INCLUDE DURATION OF EXPOSURE	INFORMATION AND/OR SPECIFIC VALUES			REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
RANDOM VIBRATION						
Duration						
Magnitude		Freq. Range (CPS)	___ AXIS	___ AXIS		
Roll Off						
SHOCK						
Direction						
Magnitude						
Duration						
Pulse Shape						
Drop Distance						

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CHECK LIST IVA

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

GENERATION OF ENVIRONMENT BY HARDWARE	CIRCUMSTANCES UNDER WHICH THE MOST SEVERE ENVIRONMENT IS GENERATED INCLUDE DUTY CYCLE (WHERE APPLICABLE)	TOTAL RATE, MAGNITUDE OR LIMIT OF GENERATION	PARTS/SUB-ASS'Y THAT GENERATE MOST OF THE ENVIRONMENT	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
Heat			1. 2. 3.		
EXHAUSTS					
Corrosive			1. 2. 3.		
Erosive			1. 2. 3.		
Explosive			1. 2. 3.		
Film Fogging			1. 2. 3.		
Moisture			1. 2. 3.		

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CHECK LIST IVB

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

GENERATION OF ENVIRONMENT BY HARDWARE	CIRCUMSTANCES UNDER WHICH THE MOST SEVERE ENVIRONMENT IS GENERATED INCLUDE DUTY CYCLE (WHERE APPLICABLE)	TOTAL RATE, MAGNITUDE OR LIMIT OF GENERATION	PARTS/SUB-ASS'Y THAT GENERATE MOST OF THE ENVIRONMENT	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
RADIATION					
RFI/EMI (Include Radiation and Conduction)			1. 2. 3.		
Infra-red			1. 2. 3.		
Visible			1. 2. 3.		
Ultraviolet			1. 2. 3.		
X-Ray			1. 2. 3.		

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CHECK LIST VA

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

PHYSICAL REQUIREMENTS	REQUIREMENTS AND/OR SPECIFIC VALUES (WITH TOLERANCES)	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
Weight			
Volume			
Size, Shape, Orientation and Method of Mounting*			
Finish on Exterior Surfaces			
Finish on Mounting Surfaces			
General Methods of Heat Transfer			
Center of Gravity			
Static Balance			
Moment of Inertia			

*Attach diagram if necessary

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CHECK LIST VB

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

PHYSICAL REQUIREMENTS	REQUIREMENTS AND/OR SPECIFIC VALUES (WITH TOLERANCES)	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
Required Mechanical Adjustments			
ACCESSIBILITY FOR:			
Installation			
Cabling and Connectors			
Maintenance			
Testing			
Use			
LIFE			
Shelf Life (Months)			
Total Operating Life*	Hours of Operation		
Service Life	Hours of Operation		
Testing Life (In House + Field)	Hours of Operation		
Range of Duty Cycle Encountered During Service Life			
Range of Duty Cycle Encountered During Testing Life			

*Total Operating Life = Service + Testing

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CHECK LIST VI

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

CHARACTERISTICS OF ELECTRICAL INPUT SIGNALS	INPUT SIGNAL NO. 1	INPUT SIGNAL NO. 2	INPUT SIGNAL NO. 3	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
Signal Nomenclature					
Amplitude (Min-Max)					
Frequency Range					
Signal/Noise Ratio					
Source Impedance at Frequency Range of Signal					
Ground Reference					
Leakage Resistance (Signal Lead to Case)					
Description of Waveform (Attach Diagram if Necessary)					
LOGIC					
Level of "One"					
Level of "Zero"					
Pulse Width					
Rise Time					
Fall Time					

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CHECK LIST VII

HARDWARE NOMENCLATURE ____________________ DOCUMENT CONTROL NO. __________

CHARACTERISTICS OF ELECTRICAL OUTPUT SIGNALS	OUTPUT SIGNAL NO. 1	OUTPUT SIGNAL NO. 2	OUTPUT SIGNAL NO. 3	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
Signal Nomenclature					
Amplitude (Min-Max)					
Frequency Range					
Signal/Noise Ratio					
Source Impedance at Frequency Range of Signal					
Ground Reference					
Leakage Resistance (Signal Lead to Case)					
Description of Waveform (Attach Diagram if Necessary)					
LOGIC					
Level of "One"					
Level of "Zero"					
Pulse Width					
Rise Time					
Fall Time					

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CHECK LIST VIII

HARDWARE NOMENCLATURE ____________________ DOCUMENT CONTROL NO. __________

CHARACTERISTICS OF REQUIRED ELECTRICAL POWER	SUPPLY NO. 1	SUPPLY NO. 2	SUPPLY NO. 3	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
Voltage Nomenclature					
Voltage Magnitude (Min-Max)					
Frequency (Min-Max)					
Number of Phases					
Allowable Noise/Ripple (Measured Across What Impedance)					
Allowable Transients (Amplitude and Duration)					
Source Impedance (Over What Frequency Range)					
Current Per Phase (Min-Max)					
Phase Balancing					
Power Factor					
Ground Reference					
Leakage Resistance (From Power Line to Case)					
Short Circuit Protection					
No Load Protection					

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CHECK LIST IX

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

CHARACTERISTICS OF OUTPUT ELECTRICAL POWER*	OUTPUT NO. 1	OUTPUT NO. 2	OUTPUT NO. 3	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
Voltage Nomenclature					
Voltage Magnitude (Min-Max)					
Frequency (Min-Max)					
Number of Phases					
Allowable Noise/Ripple (Measured Across What Impedance)					
Allowable Transients (Amplitude and Duration)					
Source Impedance (Over What Frequency Range)					
Current Per Phase (Min-Max)					
Phase Balancing					
Power Factor					
Ground Reference					
Leakage Resistance (From Power Line to Case)					
Short Circuit Protection					
No Load Protection					

*To be filled out only by power supply designers.

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CHECK LIST XA

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

CHARACTERISTICS OF MECHANICAL INPUTS TO HARDWARE	INPUT 1 (INCLUDE TOLERANCES)	INPUT 2 (INCLUDE TOLERANCES)	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
LINEAR MOTION ACTING ON HARDWARE				
Nomenclature of Linear Motion				
Force-Distance Relationship*				
Force-Time Relationship*				
Input Power of Motion				
Source Inertia Characteristics				
ALLOWABLE REACTIONS ON SOURCE OF LINEAR MOTION				
Loads Parallel to Motion of Input Device (Operating)				
Loads Non-Parallel to Motion of Input Device (Operating)				
Loads Parallel to Motion of Input Device (Non-Operating)				
Loads Non-Parallel to Motion of Input Device (Non-Operating)				

*Use Graphs When Necessary.

Rev. Date: Sept., 1963 Check List XA Page ______

CHECK LIST XB

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

CHARACTERISTICS OF MECHANICAL INPUTS TO HARDWARE	INPUT 1 (INCLUDE TOLERANCES)	INPUT 2 (INCLUDE TOLERANCES)	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
ROTARY MOTION ACTING ON HARDWARE				
Nomenclature of Rotary Motion				
Torque-Time Relationship*				
Angular Velocity-Time Relationship*				
Angular Velocity-Torque Relationship*				
Source Inertia Characteristics				
ALLOWABLE REACTIONS ON SOURCE OF ROTARY MOTION				
Thrust Load on Shaft (Operating)				
Radial Load on Shaft (Operating)				
Thrust Load on Shaft (Non-Operating)				
Radial Load on Shaft (Non-Operating)				
TOLERANCES ON INPUT SHAFT				
Radial and/or End Play				
TIR of Shaft				
Perpendicularity of Shaft (State Reference Plane)				

*Use Graph When Necessary

Rev. Date: Sept., 1963 Check List XB Page ____

CHECK LIST XIA

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

CHARACTERISTICS OF MECHANICAL OUTPUTS OF HARDWARE	OUTPUT 1 (INCLUDE TOLERANCES)	OUTPUT 2 (INCLUDE TOLERANCES)	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
LINEAR MOTION PRODUCED BY HARDWARE				
Nomenclature of Linear Motion				
Force-Distance Relationship*				
Force-Time Relationship*				
Distance-Time Relationship*				
Output Power				
Efficiency of Device Producing Linear Motion				
Output Inertia Characteristics*				
REQUIREMENTS FOR LINEAR MOTION OUTPUT MECHANISMS				
Loads Parallel to Motion of Output (Operating)				
Loads Non-Parallel to Motion of Output (Operating)				
Loads Parallel to Motion of Output (Non-Operating)				
Loads Non-Parallel to Motion of Output (Non-Operating)				

*Use Graph When Necessary.

Rev. Date: Sept., 1963 Check List XIA Page ____

CHECK LIST XIB

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

CHARACTERISTICS OF MECHANICAL OUTPUTS OF HARDWARE	OUTPUT 1 (INCLUDE TOLERANCES)	OUTPUT 2 (INCLUDE TOLERANCES)	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
ROTARY MOTION PRODUCED BY HARDWARE				
Nomenclature of Rotary Motion				
Torque-Time Relationship*				
Angular Velocity-Time Relationship*				
Angular Velocity-Torque Relationship*				
Efficiency of Mechanism Producing Rotary Motion				
Unbalanced Angular Momentum Characteristics*				
REQUIREMENTS FOR ROTARY OUTPUT MECHANISMS				
Thrust Load On Shaft (Operating)				
Radial Load On Shaft (Operating)				
Thrust Load On Shaft (Non-Operating)				
Radial Load On Shaft (Non-Operating)				
TOLERANCES ON OUTPUT SHAFT				
Radial and/or End Play				
TIR				
Perpendicularity of Shaft (State Reference Plane)				

*Use Graph When Necessary

Rev. Date: Sept., 1963 Check List XIB Page ______

CHECK LIST XIIA

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

OPTICAL CHARACTERISTICS	VALUES AND TOLERANCES	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
OPTICAL/MECHANICAL DIMENSIONS			
Equivalent Focal Length			
Back Focal Length			
Flange Focal Distance			
Magnefication (Scale)			
PHOTOMETRIC DIMENSIONS AND CHARACTERISTICS			
STOPS			
F-Number			
T-Number			
Field of View			
Vignetting (Illumination Function)			
Transmission			
Flare (Veiling Glare)			
Spectral Range			

Rev. Date: Sept., 1963 Check List XIIA Page ______

CHECK LIST XIIB

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

OPTICAL CHARACTERISTICS	VALUES AND TOLERANCES	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
IMAGERY AND OPTICAL PERFORMANCE			
RESOLVING POWER			
TARGET CHARACTERISTICS			
Style			
Polarity (Transparent/Opaque)			
Illumination (Back/Front)			
RECEIVER			
Film Type			
Processing			
Variation in Field of View			
Variation with Orientation			
MODULATION TRANSFER FUNCTION (SINE WAVE RESPONSE)			
Curve Specification			
Variation in Field of View			
Variation with Orientation			

Rev. Date: Sept., 1963 Check List XIIB Page ______

CHECK LIST XIII

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

CHARACTERISTICS OF FILM TO BE USED	VALUES AND TOLERANCES	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
Type			
Width			
Type of Base			
Thickness			
Weight per 1000 feet			
Moisture Content (At Percent Relative Humidity)			
Tensile Strength			
Brittleness			
Scratch Resistance			
Dimensional Stability			
Heat Capacity			
Electrification Properties			
Storage Properties			
Resolving Power			
Modulation Transfer Function			
Spectral Transmittance			

Rev. Date: Sept., 1963 Check List XIII Page ______

CHECK LIST XIV

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

Designate in order what the top priorities are in the development of this hardware.*

PRIORITY	FEATURE	REASON FOR PRIORITY	MANNER AND INSTANCES OF POLICY EXECUTION TO MAINTAIN PRIORITY	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED

*The usual priority features are: Cost, Schedule, Reliability, Light Weight, Serviceability, Power Consumption, Small Volume and Performance Characteristics.

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CHECK LIST XV

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

DESCRIPTION OF PROPOSED SOLUTION

Include: Principles, Features, Limitations, Priorities, Compromises, Recognized Problem Areas, Failure Prevention, Techniques and the Use of Redundancy.

Rev. Date: Sept., 1963 Check List XV Page ____

CHECK LIST XVI

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

DESIGN APPROACHES AND METHODS FOR VERIFYING DESIGN	DESCRIPTION OF APPROACH	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
What documents, such as memos, reports and journals, have been or will be searched for design information?			
What types of calculations and/or analyses have been or will be made to determine such things as: tolerance accumulation effects, environmental degradation effects; error assignments, etc?			

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CHECK LIST XVII

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

TESTS USED TO VERIFY THE DESIGN	ASPECTS OF THE DESIGN TESTED	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
Breadboards:			
Engineering Prototypes:			
Qualification Tests:			
Acceptance Tests:			
Miscellaneous Tests:			

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CHECK LIST XVIIIA

HARDWARE NOMENCLATURE ____________________ DOCUMENT CONTROL NO. __________

PRELIMINARY ELECTRICAL PART ESTIMATION	ESTIMATED TOTAL QUANTITY	GENERAL TYPES OF PARTS	%*	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
Capacitors					
Connectors					
Crystals					
Diodes					
Filters					
Fuses					
Generators					
Light Sources					
Micro-Modules					
Motors					
Potentiometers					
Relays					
Resistors					
Switches					

*Enter percent of parts that are in the preferred parts list.

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CHECK LIST XVIIIB

HARDWARE NOMENCLATURE ____________________ DOCUMENT CONTROL NO. __________

PRELIMINARY ELECTRICAL PART ESTIMATION	ESTIMATED TOTAL QUANTITY	GENERAL TYPES OF PARTS	%*	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
Thermistors					
Transformers					
Transistors					
Vacuum Tubes					

Rev. Date: Sept., 1963 Check List XVIIIB Page ______

CHECK LIST XIX

HARDWARE NOMENCLATURE ____________________ DOCUMENT CONTROL NO. __________

PRELIMINARY MECHANICAL PART ESTIMATION	ESTIMATED TOTAL QUANTITY	GENERAL TYPES OF PARTS	%*	REF.	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED
Ball Bearings					
Roller Bearings					
Needle Bearings					
Sleeve Bearings					
Belts					
Clutches					
Differentials					
Gears					
Seals					
O-Rings					

*Enter percent of parts that are in preferred parts list.

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CHECK LIST XX

HARDWARE NOMENCLATURE ____________________ DOCUMENT CONTROL NO. __________

LIST OF PARTS NOT IN RELIABILITY PREFERRED PARTS LIST (DWG. NO. 401-113)	JUSTIFICATION FOR USE OF PART	FOR DESIGN REVIEW USE ONLY ACTION REQUIRED

Rev. Date: Sept., 1963 Check List XX Page ______

CHECK LIST XXI -PARTS STRESS ANALYSIS

HARDWARE NOMENCLATURE ____________ DOCUMENT CONTROL NO. ____________

PART IDENTIFICATION (REF. DESIGNATION)	CONSEQUENCES OF FAILURE	BASIS OF STRESS ANALYSIS			
		ENGINEERING JUDGEMENT	DETAILED ANALYSIS		
			REQUIRED	COMPLETED	ENCLOSED
		( )	( )	( )	( )

CHECK LIST XXI

CHECK LIST XXII

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. ____________

DEVIATION FROM ACCEPTED DESIGN AND MANUFACTURING STANDARDS		REASONS FOR DEVIATION	FOR DESIGN REVIEW USE ONLY
CHAPTER OR TITLE	PARAGRAPH		ACTION REQUIRED

Rev. Date: Sept., 1963

HARDWARE NOMENCLATURE ______________________ DOCUMENT CONTROL NO. __________

ADDITIONAL INFORMATION FOR CHECK LISTS

Rev. Date: Sept., 1963

Used With Check List __________
Page ______

APPENDIX I

REPRESENTATIVE STRESS ANALYSIS SHEETS (RELIABILITY)

Included in this appendix are the forms used to collect stress analysis information on all parts used in a major subassembly, for subsequent use in design review recommendations.

RELIABILITY ANALYSIS DATA - TRANSISTORS

ASSEMBLY NAME ____________

DRAWING NUMBER ____________

AMBIENT CONDITIONS		
TEMP	HUMIDITY	PRESSURE

SCHEM REF DESIG	400 DASH NUMBER	QUAL STATUS	POWER DISSIPATION		MAX JUNC TEMP RATED	MAX CASE TEMP APPLIED	FAILURE RATE x 10^{-6}	PARAMETERS BV_C				
			RATED	APPLIED				TEST CONDITIONS	MIN RATED / APPLIED	TYP RATED / APPLIED	MAX RATED / APPLIED	UNIT RATED / APPLIED

COMPLETED BY ____________ DATE ____________

DESIGN REVIEWED BY ____________

RELIABILITY ANALYSIS DATA - TRANSISTORS

ASSEMBLY NAME ____________________

DRAWING NUMBER ____________________

AMBIENT CONDITIONS		
TEMP	HUMIDITY	PRESSURE

PARAMETERS

BV_E					hFE					hfe				
TEST CONDITIONS	MIN	TYP	MAX	UNIT	TEST CONDITIONS	MIN	TYP	MAX	UNIT	TEST CONDITIONS	MIN	TYP	MAX	UNIT
	RATED	RATED	RATED	RATED		SPEC'D	SPEC'D	SPEC'D	SPEC'D		SPEC'D	SPEC'D	SPEC'D	SPEC'D
	APPLIED	APPLIED	APPLIED	APPLIED		REQ'D	REQ'D	REQ'D	REQ'D		REQ'D	REQ'D	REQ'D	REQ'D

COMPLETED BY ____________________ DATE ____________________

DESIGN REVIEWED BY ____________________

RELIABILITY ANALYSIS DATA – TRANSISTORS

ASSEMBLY NAME ______________________

DRAWING NUMBER ______________________

AMBIENT CONDITIONS		
TEMP	HUMIDITY	PRESSURE

PARAMETERS

TEST CONDITIONS	foc—				TEST CONDITIONS	I_{cbo}				TEST CONDITIONS	R(SATURATED)			
	MIN	TYP	MAX	UNIT		MIN	TYP	MAX	UNIT		MIN	TYP	MAX	UNIT
	SPEC'D REQ'D	SPEC'D REQ'D	SPEC'D REQ'D	SPEC'D REQ'D		SPEC'D REQ'D	SPEC'D REQ'D	SPEC'D REQ'D	SPEC'D REQ'D		SPEC'D REQ'D	SPEC'D REQ'D	SPEC'D REQ'D	SPEC'D REQ'D

COMPLETED BY ______________________ DATE ______________________

DESIGN REVIEWED BY ______________________

RELIABILITY ANALYSIS DATA - TRANSISTORS

ASSEMBLY NAME ____________________

DRAWING NUMBER ____________________

AMBIENT CONDITIONS		
TEMP	HUMIDITY	PRESSURE

SCHEM REF DESIG	400 DASH NUMBER	REMARKS

COMPLETED BY ____________________ DATE ____________

DESIGN REVIEWED BY ____________________

PAGE 4 OF 4

DIODES

Manufacturer's Type No:

Drawing No:

	Min	Typ	Max	Unit	Test Conditions
Peak Inverse Voltage					
Specified					
Required					
Forward Voltage Drop					
Specified					
Required					
Reverse Current					
Specified					
Required					
Peak Forward Surge Current					
Specified					
Required					
Power Dissipation					
Specified					
Required					
Average Rectified Forward Current					
Specified					
Required					

	Min	Typ	Max	Unit	Test Conditions
Zener Voltage					
Specified					
Required					
Max. DC Zener Current					
Specified					
Required					

Assembly Name:

Assembly Dwg. #:

Schematic Dwg #:

Schematic Designation:

GEARS – DATA COLLECTION SHEET

WEAR LIFE — BEAM STRENGTH

Ass'y No.	Part No.				Lube*	Gear Dia (in)	Pinion Diam. (in)	Pinion Speed (RPM)	Gear Torque (in-oz)	Tooth Face Width (in)	Total Gear Tooth Compos. Error (in)x10^{-4}	Modulus of Elasticity lbs/in^2 Gear (x10^{-6})	Modulus of Elasticity lbs/in^2 Pinion (x10^6)	Number of Teeth Gear	Number of Teeth Pinion	Factor lbs/in^2	Press Angle (DEG)	Contact Stress σ max	Gear Life (Cycles from Fig. I, II&III)	Life Factor	Resultant Life	Life Required	W_s Max. Load	Circular Pitch P	Form Factor (Y from Table III)	Stress Concent. Factor (K_T)	Resultant Stress in Material S	Endurance Limit Stress of Material
I4 (1-4)	I4 (5-8)	I4 (9-12)	I4 (-16)	I4 (-20)	I4 (-22)	F7.4 (1-7)	F7.4 (-14)	F6.0 (-20)	F7.2 (-27)	F6.4 (-33)	I4 (-37)	F5.1 (-42)	F5.1 (-47)	I4 (-51)	I4 (-55)	F6.0 (-61)	F5.1 (-66)											

*0 = No
1 = Yes

APPENDIX J

RELIABILITY DESIGN REVIEW RECOMMENDATIONS

Included in this appendix are three forms used to convey information pertaining to all design review recommendations.

Ball-Bearing Analysis Sheet

Dynamic Loading

Rotational-speed-rpm

Test time - revolutions

Operational life - revolutions

Allowable number of failures in operational life (1-Reliability)

C/P required

Dynamic radial load

Equivalent load P

Dynamic thrust load

Rotation factor

Dynamic load rating C required

Static Loading

Static radial load (max.)

Static equivalent load P_o

Static thrust load (max.)

Static load rating C_o required

Bearing Required

Lubricant

Kind of shield or seal

Retainer material

Bearing material

Radial play

Identification no.

Application Factors

Race misalignment

Roundness of housing bore

Roundness of shaft

Bore fit

Shaft fit

Bore finish

Shaft finish

Environmental Conditions

Vibration

Shock

Temperature

Corrosion

Magnetic field

Dirt

Other

SHEET ___ OF ___ SERIAL NUMBER ______

RELIABILITY DESIGN REVIEW RECOMMENDATION

PROJECT: __________ ACTION REQ'D. BY: (NAME & DATE) __________

DRAWING NUMBER: __________ ORIGIN DATE: ______

ASSEMBLY IDENTIFICATION: __________

REFERENCES: __________

ACTION PRIORITY		CLASSIFICATION
_____ A IMMEDIATELY		_____ CRITICAL
_____ B AS SOON AS POSSIBLE		_____ MAJOR
_____ C ON FUTURE RE-DESIGN		_____ MINOR

RECOMMENDATION: __________

DISCUSSION: __________

D. R. ENGINEER __________ APPROVED BY: __________

DISTRIBUTION LIST: __________

SHEET ____ OF ____ SERIAL NUMBER ________

RELIABILITY DESIGN REVIEW RECOMMENDATION REPLY

PROJECT: ______________________ ACTION REQ'D. BY: ______________________
(NAME & DATE)

DRAWING NUMBER: ______________________ ORIGIN DATE: ______________________

ASSEMBLY IDENTIFICATION: ______________________

REFERENCES: ______________________

DATE FOR INITIATION OF ACTION: ______________________

ESTIMATED DATE OF COMPLETION: ______________________

DESCRIPTION OF ACTION OR PROPOSED ACTION: ______________________

DESIGN ENGINEER: ______________________ APPROVED BY: ______________________

DISTRIBUTION LIST: ______________________

SHEET ____ OF ____ SERIAL NUMBER ________

RELIABILITY DESIGN REVIEW RECOMMENDATION STATUS

PROJECT: ________ ACTION REQ'D. BY: ________
(NAME & DATE)

DRAWING NUMBER ________ ORIGIN DATE: ________

ASSEMBLY IDENTIFICATION: ________

REFERENCES: ________

DATE/STATUS DISCUSSION:

DISTRIBUTION LIST: ________

Document	Electromagnetic Interference Control Plan for Camera Payload
Document No.	Release Date:

1. SCOPE

This document defines the electromagnetic interference control plan to be followed during the design and test of the Camera Payload and its components. Areas covered include:

a. The circuit design guides to be used for controlling electromagnetic interference generation and susceptibility of the Camera Payload and its components.

b. Design, testing and review schedules which the design engineer should follow to inform himself of the degree of compliance with MIL-I-26600 and EMI-10A that his design has achieved, thus enabling him to take corrective action as required prior to finalizing of the design.

c. Personnel assigned direct responsibility for the Electromagnetic Interference (EMI) design and testing effort.

d. Component test schedules.

e. Test Facilities.

2. APPLICABLE DOCUMENTS

The following specifications, standards, drawings, and publications of latest issue in effect form a part of this plan. Applicability of the listed documents depend on their specific reference to this plan. In the event of conflict between the listed documents and this plan, this plan shall take precedence.

SPECIFICATIONS

Military

MIL-I-26600	Interference Control Requirements, Aeronautical Equipment

Military

MIL-STD-826	Electromagnetic Interference Test Requirements and Test Methods

NASA

EMI-10A	Addendum to MIL-I-26600

DRAWINGS

Eastman Kodak Company

EMI Board Charter

3. REQUIREMENTS

3.1 General

3.1.1 Definitions

3.1.1.1 Breadboard - The term breadboard refers to the circuitry used in development of the components.

3.1.1.2 Component - The term component refers to units which are assembled to make the Camera Payload.

3.1.1.3 C/P - Camera Payload

3.1.1.4 S/M - Service Module of the Apollo spacecraft.

3.1.1.5 C/M - Command Module of the Apollo spacecraft.

3.1.1.6 C/SM - Command and Service Modules of the Apollo spacecraft when mated and functioning together.

3.1.1.7 MIL-I-26600 - Unless specifically noted otherwise reference to MIL-I-26600 herein shall be understood to include reference to EMI-10A.

3.1.1.8 Malfunction - For the purpose of determining compliance with the document or the documents referenced herein, a malfunction shall be considered to exist if any operation, actuation, or functioning of the equipment under test occurs at any time other than when such operation, actuation, or functioning is commanded or scheduled to occur as the result of a previously inserted command in accordance with the normal operation of the equipment.

3.1.2 C/P - Compliance of the C/P to MIL-I-26600, Class Ib will be a design goal. Implementation of this design goal will be achieved by the internal Eastman Kodak Company requirement that components be designed to meet MIL-I-26600, Class Ib. Eastman Kodak Company does not plan to conduct MIL-I-26600 tests on a complete C/P.

3.1.3 Components - It will be an internal Eastman Kodak Company requirement that components be designed to meet MIL-I-26600, Class Ib.

3.1.4 Extended Range - No direct design effort will be expended to reduce generated interference below 150 KC. Testing for generated interference below 150 KC will be done only to the extent deemed desirable for informational purposes.

3.1.5 Design Approach - Throughout the design phase EMI tests will be performed on breadboard models of the components prior to finalizing the design. Appropriate attenuation will be added to the circuits and hardware where required, obviating the necessity for compromises to the design that frequently result where EMI "fixes" are added after the design is release.

3.1.6 Contractors - Several components will be designed and built by contractors. The design specification for the contracted components will require compliance with the EMI requirements of MIL-I-26600. The contractors will be required to submit an interference control plan at the preliminary design review. The preliminary design review will be held approximately 35 days after award of contract. The preliminary design review will permit detailed evaluation of the contractor's contemplated EMI effort early enough to determine the contractors' understanding of the necessary emphasis to be placed on EMI control.

3.2 Interference Attenuation; Design Procedures and Techniques - This section calls out each source that is expected to exist and discusses the probable method or methods which will be used for attenuating the generated interference.

3.2.1 Relays; Signal Switching - Relays may be used to perform switching. Such relays may possibly be switched with low voltage or without voltage on their switching contacts. Generally, these relays will be controlled by pulse type commands across the C/P-C/SM interface. These relays will not necessarily have EMI suppression on their switching contacts. These relays will have two diodes in series across each coil to prevent the inductive "kick" when power is removed. It is expected that signal switching relays will meet the limits of MIL-I-26600 without added suppression parts. If they do not conform, nonconformance should be less than 10 db and only in narrow frequency bands.

3.2.2 Relays and Mechanical Switches; Voltage Switching - The following will apply to the use of relay contacts and mechanically actuated switches used to switch voltages of 5 to 32 volts. Contacts which switch less than 5 volts may be proven during breadboard testing to require less stringent treatment than that proposed in this paragraph.

All switch and relay contacts which are required to meet the EMI control requirements of MIL-I-26600 will be filtered with LC filters. For relays, the preferred method will be to locate the relay or relays in a shield module which will act as a thorough EMI shield. Removable covers will be provided with EMI gaskets if required. All entrance and exit wires to the shield module will pass through appropriate filters. The relay coil will be filtered by filters or thru-pass capacitors as required. Figure K-1 represents a typical relay installation.

All mechanically actuated contacts will be filtered. Shielding of the switch shall be complete except that the top of the switch will be open to provide a means of actuation. Figure K-2 is a typical EMI-free switch arrangement.

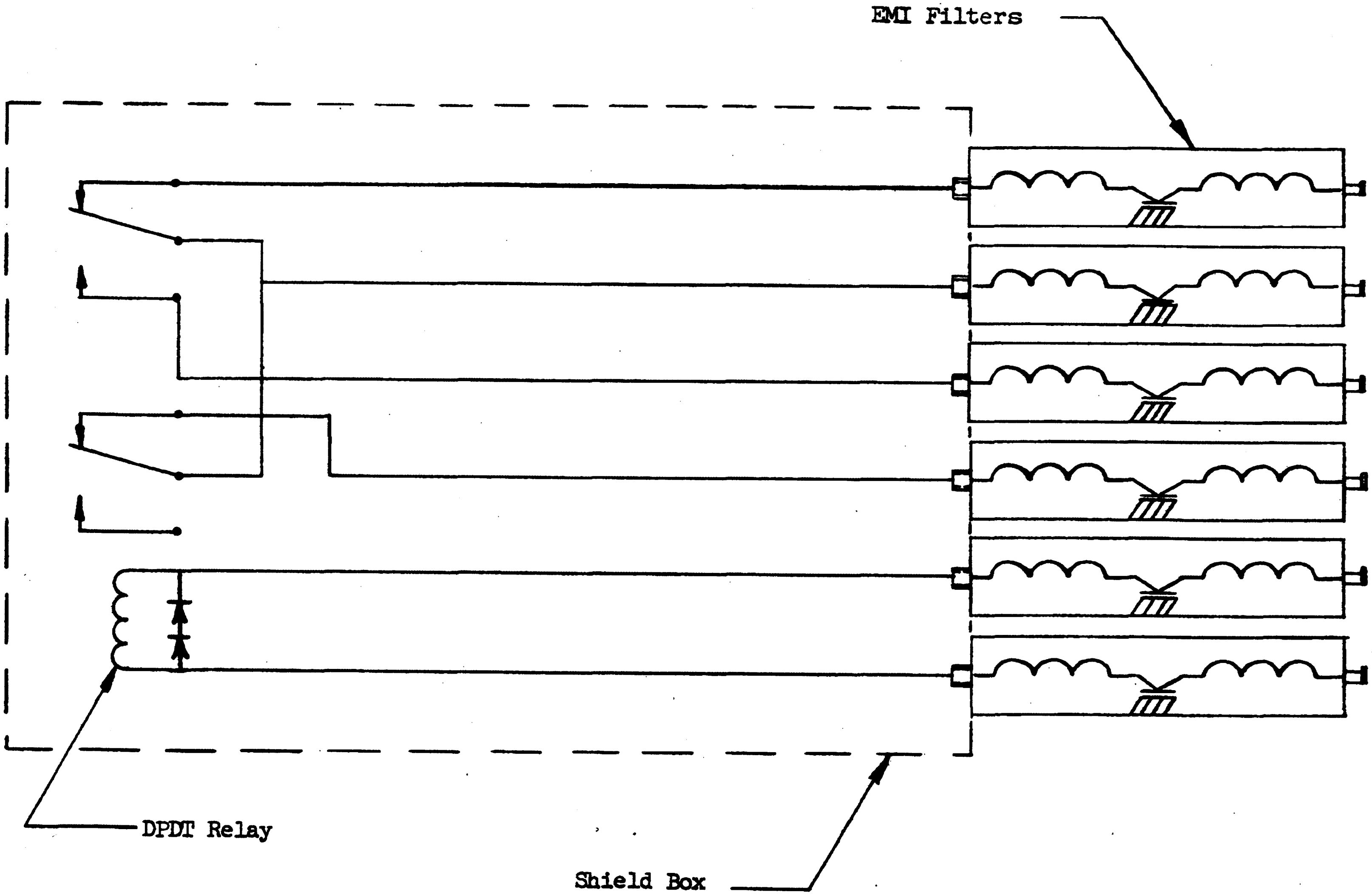

Figure K-1.

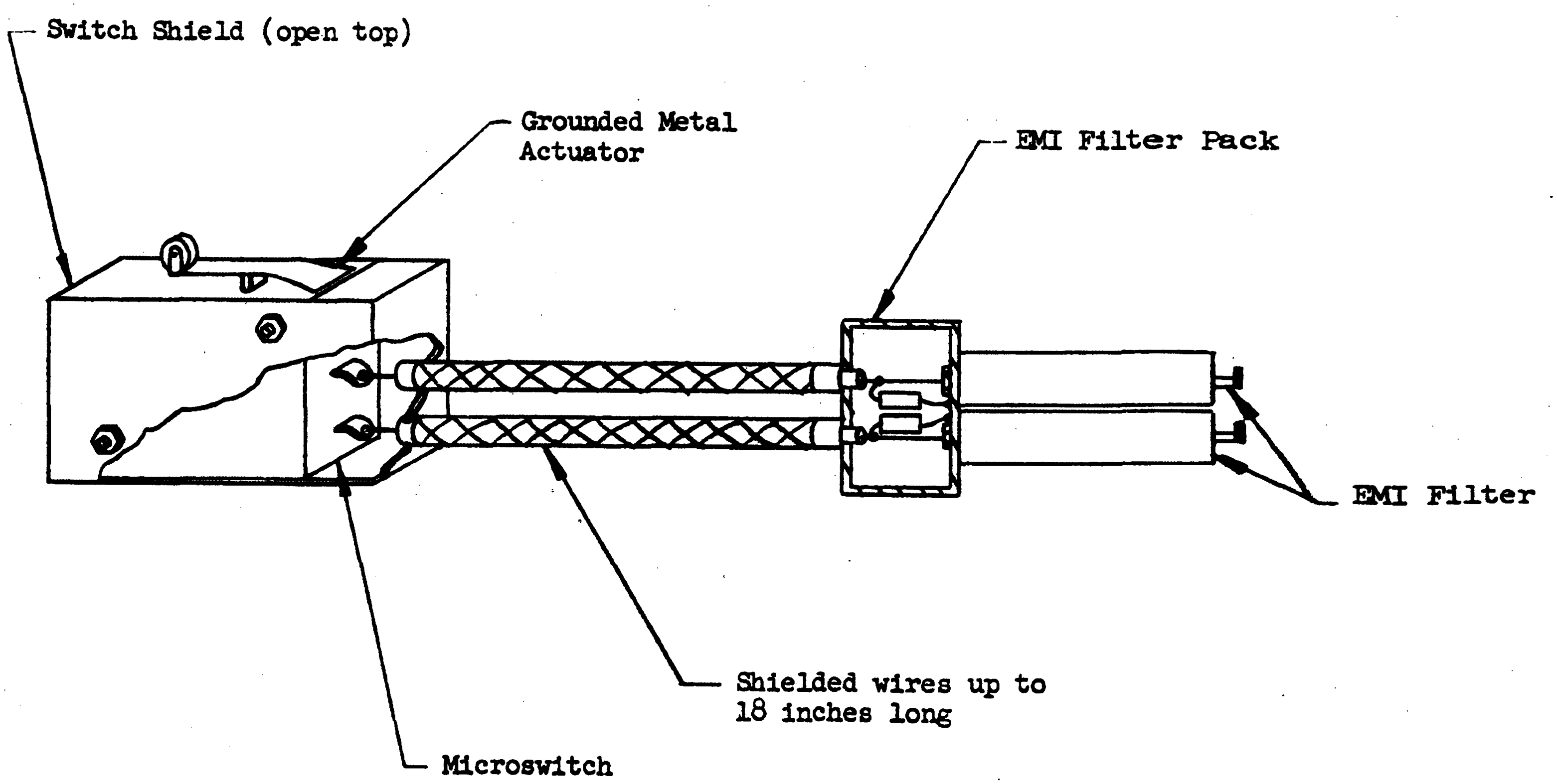
Switch Shield (open top)
Grounded Metal Actuator
EMI Filter Pack
EMI Filter
Shielded wires up to 18 inches long
Microswitch

Figure K-2.

3.2.3 Remote Filter Packs - Mechanically operated switches are frequently more conveniently filtered by using a remote filter pack as shown in Figure K-2. Switches using a remote filter pack frequently have a characteristic of producing a sharply tuned radiated interference in the 25-50 mc region - depending on the filter configuration. Figure K-3 shows a schematic arrangement that will meet the EMI control requirements of MIL-I-26600. The 0.005 μf capacitor of conventional type (not necessarily thru-pass) eliminates the 25-50 mc response.

3.2.4 Shaft Position Encoders - EMI treatment of shaft-position encoders will depend on the type of encoder, voltage involved, and rate-of-voltage change. Encoders which directly operate 28 volt dc relay circuits will require EMI shielding of all circuitry that does not pass through filters. The interface between the encoder circuitry and the power source will require filters.

Encoders which operate at a level in the range of 2 to 5 volts and a high impedance level may require only simple RC networks to slow the rate of voltage change sufficiently to permit operation without additional shielding or filtering.

3.2.5 Transducers - EMI treatment of the various types of transducers will depend on the operating voltage level, the circuit impedance, and the rate-of-voltage change. Where make-break contact type devices are used with voltages in the 0-5 volt range the degree of shielding and filtering will be determined during breadboard EMI tests. Most devices which respond in a

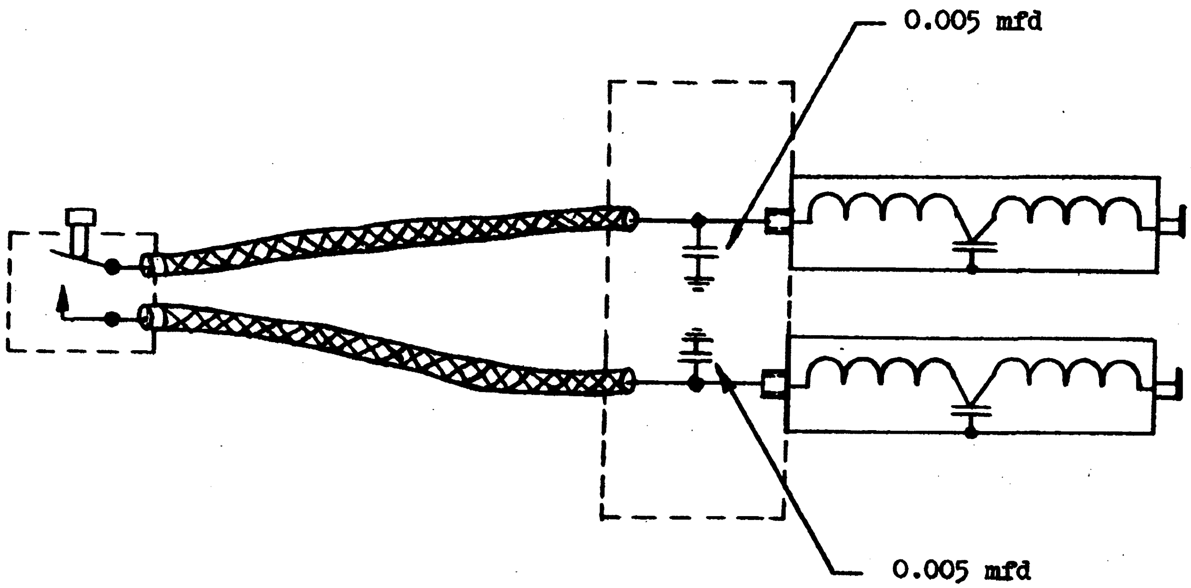

Figure K-3.

linear manner will have rate-of-voltage changes which are free of EMI. Sliding contact devices such as potentiometers will require careful evaluation of interference level vs time-in-service.

3.2.6 Transistor Switches - Transistor switches will have their switching rate controlled, where permitted, to prevent generation of EMI in excess of limits. Actuators of the transistor switches will be either short-lead hard switching of 1 volt or less, slow rise time devices, or filtered and shielded devices if voltages which cause EMI are being switched.

3.2.7 Transistor Trigger Circuits - Trigger circuits such as Schmitt trigger circuits will be evaluated during breadboard testing for generated EMI. If EMI is generated and switching amplitude or speed cannot be reduced, filtering and shielding will be applied as necessary.

3.2.8 Transistor Multivibrator Circuits - DC-DC converters use a type of transistor multivibrator. This circuit involves fast rise time voltage and current pulses. Filtering and shielding will be applied as necessary.

3.2.9 DC Motors - DC motors will have an EMI filter in each lead. Shielded wires will be used between the motor and the filters with the shields bonded to both the motor case and the filters.

3.2.10 DC Solenoids - DC solenoids will have two diodes in series applied across their coils to attenuate the inductive "kick". Any arrangement of switch circuitry associated with the solenoid which reduced EMI will also reduce the rate-of-current change so that inductive "kick" should not be excessive and the diodes may possibly be omitted.

3.2.11 Inductive Loads; Sine-Wave Powered - Inductive loads which have voltages of near sine-wave shapes applied, do not in themselves generate EMI. When the power to these loads is switched abruptly, interference will be generated. Unless the rate of switching can be controlled by such techniques as filtering of power switch or the closing and opening of the switches synchronized with the zero voltage and zero current points, respectively, complete shielding of the voltage source, ac power switch (except for actuator access port-see Figure K-2, wiring and load will be required.

If some delay can be tolerated, the necessity of switching ac sine-wave power (with the attendant filtering and shielding problems) can be eliminated by switching in a controlled fashion the dc power to a solid-state amplifier which produces the ac power.

3.2.12 Inductive Loads; Non-Sine-Wave Powered - Inductive loads which are subjected to ac voltages having a fast rise time will be treated by using the following techniques, as required.

a. EMI filters which slow the rate of voltage and current change sufficiently to meet EMI control requirements of MIL-I-26600 without seriously degrading circuit performance. Circuitry preceeding the EMI filters will probably require shielding.

b. Zener diodes to absorb voltage spikes which are not required for normal circuit performance.

c. Complete shielding of voltage source, wiring-to-load and load to prevent radiation of generated interference.

d. Filtering of the dc supply lines into the ac source to eliminate conducted and radiated interference.

Step (c) will be applied only if steps a, b, d, or a combination of steps a, b, d, is insufficient to eliminate the radiated EMI.

3.2.13 Switching of AC Voltages; Sine and Square Waveshapes - Loads which have ac voltages applied are discussed in 3.2.11 and 3.2.12. If the power to these loads is hard-switched between the ac source and the load, one of the following techniques will be required to meet MIL-I-26600.

a. Shielding and filtering of the switch.

b. Complete shielding of the voltage source, switch (except for actuation access port), wiring and load - with filtering of any power input lines to the ac source.

The following problem areas attend filtering of an ac hard-switch.

a. Obtaining filter capacitors with known reliability rating for ac application.

b. Loading of the ac supply by the filter capacitors.

c. Necessity for grounding the ac return line to the structure ground plane to prevent by-passing of the switch via the EMI filter capacitors.

3.2.14 AC Motors - The discussions of 3.2.11, 3.2.12, and 3.2.13 apply when various waveforms and switching are applied to ac motors.

3.2.15 Capacitive Loads and Tungsten Lamps - In-rush current will be limited where required by choke coils and/or resistors in series with the capacitors or lamps. In extreme cases, solid-state current limiters will be used. The preceeding techniques will assist in control of EMI in the extended frequency range of 30 cps to 150 KC. These techniques also reduce the surge load on command sources originating across the interface.

3.2.16 R.F. Oscillators - R.F. oscillators will generate CW interference. Filtering of the power leads and shielding of the oscillator will be necessary if the unsuppressed oscillator does not meet the test limits.

3.2.17 Corona - Corona is not generated, regardless of atmospheric pressure, at voltages below 250 volts. The only component circuit which may generate voltages exceeding 250 volts, is the neon timing lamp amplifier. The voltage in this circuit may go as high as 475 volts. Circuit operation at pressures corresponding to a 100,000 and 200,000 feet altitude region will be checked. If corona generated EMI exceeds the test limits, it will be necessary to pressurize or encapsulate the high voltage components of the timing lamp amplifier. Circuitry to reduce the operating voltage will be investigated.

3.2.18 Timing Lamp and Drive Voltage - It is expected that drive voltages used for timing lamps will have fast rise times. The timing lamps may be gas-filled devices. The timing voltage generating and amplifying circuitry will require shielding to meet the EMI control requirements of MIL-I-26600. The gas-filled lamps aggravate the EMI condition and will require consideration with respect to shielding.

3.2.19 EMI Gasketing - EMI gasketing will be used as required where component covers must be EMI tight.

3.2.20 Engineer-Design Draftsman Working Relationship - The design engineer will guide the draftsman in the following areas which are peculiar to EMI generation and susceptibility.

a. Wire routing - separation of susceptible wiring from interference sources.

b. Shield enclosure configuration, gasketing, cover fastening.

c. Filter location.

d. Bonding provisions.

e. Part placement.

3.3 Susceptibility Reduction; Design Procedures and Techniques - The components contain several items which could be susceptible to the EMI sources of MIL-I-26600. This section calls out the potentially susceptible items and discusses the expected method or methods to be used for reducing the susceptibility of each item.

3.3.1 Low Level Amplifiers - Susceptibility to radiated r.f., capacitive coupled audio interference and transient spikes will be reduced by locating preamplifiers near the source of signal. Power line conducted interference will be reduced by use of solid-state voltage regulators of passive filters as required. Power return wiring will be given attention to prevent ground loops which could introduce interference to low level circuits.

3.3.2 Telemetry Circuits - Telemetry circuits will operate in the 0-5 volt dc output range. In most instances this voltage level plus the output impedance of less than 10 K ohms makes them immune to r.f. susceptibility. Where telemetry originates at low level, the precautions of 3.3.1 will apply. Audio susceptibility will be treated through the use of filtering or regulated voltage sources and care in dc return wiring, see 3.4.5.

3.3.3 Power Converters - Power converters will be used to supply closely regulated voltages for functions such as powering amplifiers and telemetry. Susceptibility of converters to r.f. will be prevented by the same arrangement that attenuates the EMI of converters (3.2.8). Audio susceptibility will be prevented by filtering and by using solid-state voltage regulators on the converter outputs.

3.3.4 Audio Susceptibility Resulting from EMI Filters - When several inputs are used in a logical arrangement to control a unit such as a relay, it sometimes occurs that the combination of EMI filters is such that resonances of the filters take place in the 50 cps - 15 KC region used in audio susceptibility testing. The resultant resonance can cause malfunction of the switching arrangement when certain types of circuitry and filters are used. The following procedures will be applied as required to prevent switching malfunction from EMI filter resonances.

a. All switching will be done in the "hot" dc line - no switching in the dc return line.

b. The necessity of diodes in circuits containing LC storage elements will be considered with respect to the rectification of the audio interference voltage that can result. The EMI filters themselves slow the current changes enough so that the diode may not be required for inductive "kick" reduction.

c. Relays for 28 v dc service having less than 5.0 volts dc dropout characteristics will be recognized as susceptible to hanging closed when used with diodes across their coils in circuits when interference is suppressed by LC EMI filters.

d. Addition of resistance on the supply side of EMI filters to reduce the "Q" of the filters will be considered.

e. Attention will be given to establishing an interface agreement to provide less than 10 milliohms resistance between the system structure ground and the return terminal of the dc power source. This low resistance connection will act to reduce any coupling of the audio interferring voltage around open switches via the capacitors in the EMI filters.

f. Installation of filter (s) in component power lines which attenuates audio interference below the value which results in component susceptibility will be considered.

3.3.5 Cables - The following techniques will be considered for reducing susceptibility that may originate from cross coupling in cables.

a. Run low level, high impedance circuits in cables separate from circuits which contain high level switching pulses and ac currents and voltages.

b. Shielding and twisting of supply and return conductors for ac loads.

c. Reduction of capacitative coupling between circuits while going through connectors by a pin selection method which places shield carrying pins between signal carrying pins.

d. Drawing details which carefully describe shield termination procedures at connectors.

e. Locate components so that cable lengths from susceptible components are as short in length as possible.

3.3.6 Wiring Harness - Wiring harnesses in the components shall be subject to the same considerations as cables with respect to cross coupling.

3.3.7 Power Supply and Return Lines - Attention will be given to eliminating or minimizing impedances in the supply and return lines which are common to two or more circuits. Since the impedance of a power distribution system may be common to many loads, any current modulation caused by a given load will cause voltage modulation at the power distribution point. The magnitude of this varying voltage is a function of the varying current and the magnitude of the power distribution system impedance. This ripple or transient voltage present on the power system busses may present a problem to other more sensitive loads.

3.3.8 Pyrotechnic Devices - Susceptibility of pyros to spurious signals shall be controlled as follows:

a. Pyro wiring will be twisted pairs with an over-all shield.

b. The shield will be grounded to the structure at both the pyro end and at the firing circuit.

c. Pyro wiring will not be routed through cables containing wires which have high level steady state ac currents or switching transients.

d. Pyro wiring will be routed in close proximity to the structure to reduce shield loop area. (Induced r.f. currents in the shield are a function of the area between the shield and the ground plane formed by the structure.)

e. Attention will be given to the use of high current pyros as a susceptibility reducing measure.

3.3.9 Transient Conducted Susceptibility - The environment in which the equipment must operate will determine the transient conditions to which components will be subjected. Detailed component specifications will delineate a conducted transient allowance determined to be applicable to that component based upon its electrical location within the C/P and the requirement to follow. No temporary or permanent damage will result in the C/P or any of its components when a 50 volt positive or negative pulse, with a time width of 10 microseconds, and a repetition rate of 10 pulses per second, is inducted on each +28 volt (nominal) dc power supply lead at the C/P-C/SM interface in accordance with Methods 1001 and 5006-1 of MIL-STD-826.

3.4 Grounding

3.4.1 C/P Structure - The structure of the C/P will be constructed to provide one common dc and r.f. ground plane. Efforts in welding, bolting, riveting and bonding jumper application will be directed toward achieving less than a 10 milliohm resistance between any two points on the C/P structure. When a bonding jumper is used, it will have a length to width ratio not exceeding 5 to 1. Bonding jumpers may be copper sheet or copper braid. Copper sheet bonding jumpers shall be preferred to copper braid.

3.4.2 C/P to C/SM Bonding - It is desirable that the requirements of 3.4.1 apply to the C/P-C/SM interface. Efforts will be directed toward negotiating an interface agreement calling for less than 1 milliohm C/P-C/SM interface resistance.

3.4.3 Components - The bonding requirements of 3.4.2 will apply to components. The component-structure interface dc resistance will be less than 1 milliohm.

3.4.4 Conductor Shields - No conductor shield will be used to carry signal currents. Shields carried in a cable will be carried through a pin on the connector. In general, shields will be grounded at both the sending and receiving end, since they will not be subject in inter-structure currents, due to the required r.f. ground plane nature of the structure. Shields will be woven copper or tinned copper braid with 90 percent coverage.

3.4.5 Circuit Return Lines - From a dc standpoint, the power return, instrumentation return and other returns will be electrically isolated from each other and from the structure within the C/P. These returns will be carried across the interface and connected within the C/SM to the power supply ground and the structure at one point.

3.5 <u>EMI Suppression Components</u> - The principal EMI suppression component will be a T section cartridge type filter which is a proven highly reliable unit. Figure K-4 is a schematic of this unit.

This unit has been proven capable of attenuating generated interference to meet the interference control requirements of MIL-I-26600 in 28 v dc circuits of 1 ampere or less when properly used.

3.6 <u>Extended Range</u> - The design goals for the turn-on current surge and the steady-state current variation from the power source will be defined for each component. These definitions will provide some degree of control over the generated EMI from components in the frequency range below the 150 KC lower limit of MIL-I-26600.

3.6.1 Turn-On Current Surge - The design goal for the turn-on current surge drawn from the primary power source by any component will not exceed 3 times the maximum steady-state current.

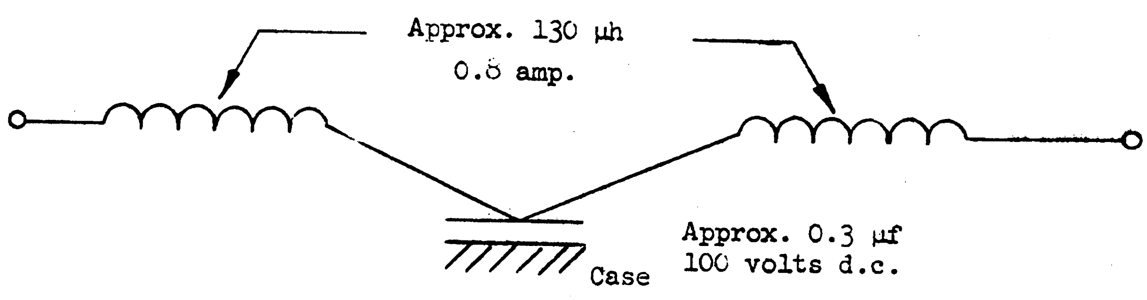

Figure 4

Figure K-4.

3.6.2 Steady-State Current - The design goal for the peak-to-peak variation in current demand from the primary power source by any component, except during turn-on and turn-off, will not exceed 10 percent of the average current.

4. QUALITY ASSURANCE

4.1 Exceptions to MIL-I-26600

4.1.1 Components - The highest fundamental frequency in the C/P is approximately 0.680 mc. Therefore, no components will be tested above 1000 mc for CW generation or r.f. susceptibility.

4.2 Personnel

4.2.1 EMI Engineering - Coordination of the over-all EMI design effort will be the responsibility of a specific engineer who is a member of the C/P design group. The engineer's primary responsibility will be to insure that all design personnel, including contractors, apply the effort which would reasonably result in designs which meet the EMI control requirements of MIL-I-26600. The engineer will advise in the preparation of abbreviated test plans for breadboard and prototype component tests and assist in evaluating the test results.

4.2.2 Technical Liaison Group - The technical liaison group will monitor the contractor's design effort, providing an interchange of information between the contractor and Eastman Kodak Company during the component design phase. This information interchange specifically includes the area of the contractor's EMI design effort.

4.2.3 Reliability Design Review

4.2.3.1 In-House Design - Prior to the release of the component design for preparation of drawings, the reliability group will conduct a preliminary design review and a major design review. The design of the component and the test data from breadboard EMI tests will be evaluated for compliance with MIL-I-26600.

4.2.3.2 Contracted Components - Contracted components will be subject to the same type of design review as called out for in-house components 4.2.3.1.

4.2.4 EMI Board

4.2.4.1 EMI Board Charter - An EMI Board Charter, Eastman Kodak Company drawing*, will be prepared to detail the make-up, functions and procedures of the EMI Board. The primary function of the board will be to define and resolve EMI interface problems. The board will be composed of at least one member each from the National Aeronautics and Space Administration, North American Aviation, the United States Air Force, Aerospace Corporation, and Eastman Kodak Company.

4.2.5 Quality Control Engineering

4.2.5.1 EMI Test Plan - The EMI test plan for components will be prepared by a Quality Control Engineer. The Quality Control Engineer will have the services of the EMI engineer for consultation during preparation of the test plan.

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* To be supplied by a later revision.

4.2.5.2 EMI Test - The EMI test of components will be conducted under the direction of the Quality Control Engineer.

4.2.5.3 EMI Test Report - The EMI test report for components will be prepared by the Quality Control Engineer.

4.2.5.4 Contracted Components - The EMI test plan, testing, and test report for contracted components will be the responsibility of the contractor. The documentation and test effort will be subject to monitoring, review and approval of the Quality Control Department and the EMI Engineer.

4.3 <u>Engineering Tests</u>

4.3.1 Breadboards and Prototypes - Throughout the design phase EMI tests will be performed on breadboard models of the components prior to finalizing the design. Appropriate attentuation will be added to circuits and hardware where required. Formal test procedure and test reports will not be written for breadboard testing.

4.4 <u>Component Tests</u>

4.4.1 Component Testing - The first three production units of each component will be EMI tested and reported in accordance with Section 4.2.5 during acceptance testing. If all units of a component successfully meet the limits of the test report or are otherwise deemed acceptable, subsequent EMI testing will be abbreviated or waived.

4.4.2 Qualification Tests - EMI qualification test data will be obtained from EMI tests conducted on components during acceptance testing since EMI requirements are the same in both cases.

4.5 Disposition of Deviations - Nonconformance of components to the limits of the associated test plan will be forwarded to the EMI Board, NASA and NAA.

5. TEST FACILITIES

5.1 Screen Room - Testing of components for interference generation at Eastman Kodak Company will be performed in a screened enclosure. The screened enclosure is approximately 7 1/2 feet high, 16 feet wide and 20 feet long.

Testing of the contracted components may be performed in screened enclosures located at any contractor's facility.

5.2 Measuring Equipment

5.2.1 Generated Interference Testing - Generated interference will be measured at Eastman Kodak Company using Empire Devices, Noise and Field Intensity Meter, Model NF-105 and associated support equipment. Testing performed by contractors may be done using either Empire Devices or Stoddart equipment. Extended range testing of conducted generated interference, if required, will be done from 30 cps to 150 KC using the Empire Devices, Noise and Field Intensity Meter, NF-105 and the Stoddart, Radio Interference - Field Intensity Meter, NM-40A.

5.2.2 Susceptibility Testing - Standard laboratory signal generators which meet the 50 ohm output requirements of MIL-I-26600 will be used. Audio susceptibility testing will be limited to a maximum of 50-volt-amperes into the component under test. Beyond the requirements of MIL-I-26600, component response to conducted transient interference will be investigated, if deemed necessary.

5.3 EMI Test Equipment

5.3.1 Component - Test equipment which is required for commanding, powering and loading the component under test will be designed to generate less EMI than permitted by the limits of MIL-I-26600 so that it will not degrade the EMI performance of the component.

6. NOTES

Not required for compliance with this specification.

1. SCOPE

1.1 Scope - This document defines the environmental conditions which the CP Payload and its components may encounter in service, the criteria which should be used in designing to meet these conditions, and the environmental levels to be used in qualification and acceptance testing.

1.2 Purpose - The purpose of this publication is to consolidate into one document the established design and test criteria for the CP Payload and its components. This document shall be used as a guide in design of payload and preparation of design and test specifications.

2. APPLICABLE DOCUMENTS

2.1 The following specifications, standards, and other publications were used as reference in the preparation of this criteria.

SPECIFICATIONS

Military

MIL-E-5272C	Environmental Testing, Aeronautic and Associated Equipment, General Specification for.
MIL-E-4970	Environmental Testing, GSE, General Specification for.
MIL-M-8090	Mobility Requirements, GSE, General Specification for.
MIL-I-26600	Interference Control Requirements, Aeronautical Equipment.

3. REQUIREMENTS

3.1 Definitions

3.1.1 Components - A component is an assembly of parts, the aggregate weight of which does not exceed 75 lbs., arranged within a single package designed to perform a specific function. The component reacts to environments; this reaction subjects the supporting structure to secondary disturbance.

3.1.2 Special Components - The special components are those which are mounted in the re-entry vehicle. All components of the payload shall survive all environments through Orbital Flight phase (Tables I and II); in addition, the special components shall survive the environments of the De-Orbit and Separation, Re-entry, Recovery to Impact, and Retrieval phases (Table III).

3.1.3 Major Assemblies - A major assembly is one whose physical weight exceeds 75 lbs. and may therefore be expected to have considerable effect on the supporting structure when reacting to environments. The following items of equipment shall be considered within the category of major assemblies.

(a) Payload Structure - with payload components installed.
(b) Lens Assembly
(c) Film Supply Cassette Assembly
(d) Stereo Mirror Assembly

3.1.4 Payload - The payload consists of a complete assembly of major assemblies and components.

3.1.5 "g" Loads - "g" loads are multiples of the weight of an item in a standard gravity field.

3.1.5 Limit Loads - Limit loads represent the maximum reasonable loads that equipment is expected to experience under specified conditions of operational use. The loads given in these criteria are limit loads unless otherwise stated.

3.1.7 Critical Load - The critical load is the load at which the component, part, or assembly will be affected in such a manner that it can no longer perform the function for which it was designed.

3.1.8 Axes Orientation

3.1.8.1 Longitudinal Axis - The payload longitudinal axis is defined as that axis which is parallel to the longitudinal axis of the flight vehicle. The longitudinal axis of a component is that axis which is parallel to the payload longitudinal axis when the component is mounted in the payload. The positive direction is defined as forward along the vehicle. The payload longitudinal axis shall be identified as the X axis.

3.1.8.2 Lateral Axes

3.1.8.2.1 Payload Lateral Axes - The payload lateral axes are those two principal axes which are mutually perpendicular to each other and to the longitudinal axis. The payload lateral axes shall be identified as the Y and Z Axes. In the normal flight attitude, the Z axis passes thru the center of the moon.

3.1.8.2.2 Component Axes are parallel to, and designated in the same manner as the payload axes.

3.2 Life Phases

3.2.1 Operational Phases - The following operational phases shall represent life phase characteristics from fabrication through recovery and post-flight handling.

(a) Transportation and Storage
(b) Handling and Mating
(c) Pre-flight
(d) Powered Flight
(e) Orbital Flight
(f) De-Orbit and Separation
(g) Re-entry
(h) Recovery and Impact
(i) Retrieval

3.2.1.1 Storage and Transportation - This phase shall include transport by motor vehicle and aircraft from factory to Assembly Building. The payload shall be packaged in such a manner as to limit shock, vibrations, and accelerations to levels less severe than the powered flight environments.

3.2.1.2 Handling and Mating - Handling and mating shall consist of removal of the payload from its shipping container, assembly into the service module, and subsequent checkout operations prior to the pre-flight phase.

3.2.1.3 Pre-Flight - The pre-flight phase shall consist of service module-photographic payload removal from trailer, mating to missile, and that period during which the vehicle is assembled to the Saturn fairing prior to start of automatic countdown.

3.2.1.4 Powered Flight - The powered flight airborne phase shall consist of that time from start of automatic countdown through shut-off, and separation, from the Saturn.

3.2.1.5 Orbital Flight - The orbital flight phase shall consist of flight around the earth, trans-lunar and flight around the moon for a maximum period (to be determined later).

3.2.2 The following phases basically apply to Eastman Kodak Company components in the re-entry vehicle from instant of de-orbit and separation to retrieval.

3.2.2.1 De-Orbit and Separation - The de-orbit and separation phase shall consist of that time during which the re-entry vehicle is oriented and propelled along the de-orbit trajectory, separated from the service module, and descends to an altitude of (later) feet.

3.2.2.2 Re-entry - The re-entry environment shall include that portion of the re-entry trajectory from (later) feet altitude to (later) feet altitude.

3.2.2.3 Recovery to Impact - The recovery to impact phase shall include that portion of re-entry vehicle descent from parachute deployment to impact.

3.2.2.4 Retrieval - The retrieval phase shall consist of that time from impact of re-entry vehicle through record recovery and shall include all field phases prior to processing.

3.3 <u>Service Conditions</u> - The environmental conditions given in Tables I, II, and III are the actual in-service conditions for which the payload and components shall be designed and are identified with specific phases of

TABLE I

ENVIRONMENTAL DESIGN CRITERIA

Payloads, Major Assemblies

Environments -A-	Storage and Transportation -B-	Handling and Mating -C-	Pre-Flight -D-	Powered Flight -E-
Vibration	Later	Later	Later	Later
Acceleration	Later	Later	Later	Later
Shock	Later	Later	Later	Later
Acoustic Noise	Later	Later	Later	Later

Environments -A-	Orbital Flight -F-
Vibration	Later
Acceleration	Later
Shock	Later
Acoustic Noise	Later

TABLE I (continued)

Environments -A-	Storage and Transportation -B-	Handling and Mating -C-	Pre-Flight -D-	Powered Flight -E-	Orbital Flight -F-
Temperature	Low Extreme Static ambient air temp. +0° F for 8 hrs. High Extreme +125° F	Low Extreme Static ambient air temp. +20°F for 8 hours High Extreme +125° F for 4 hours per *Special Control	Low Extreme Flowing ambient air +20° F High Extreme 100° F max. flowing air temp. inter-nal to pay-load vehicle for 2 hours *Special Control	Low Extreme Static ambient air temp. +32°F High Extreme +160° F (occurr-ing between removal of pre-flight coolant air and high altitude flight) *Special Control	Components to be subjected to local mean radia-tion sink tempera-ture from +120° F to -160° F and local mean conduc-tion sink tempera-tures from +80° F to -100° F. *Special Control
Pressure	30.5 to 11.1 in. hg. abs.	30.5 to 28.5 in. hg. abs.	30.5 to 28.5 in. hg. abs.	30.5 to 1 x 10^{-11} in. hg. abs. Film System Pressure 0-4 psig.	1 x 10^{-11} in. hg. abs. Film System Pressure .25 -1.25 psig.
Relative Humidity	100% R.H. including condensation due to temp. reduction. 115° F max., 40° F min. at R.H. = 95 ±5% Special Control - Humidity in the vicinity of the	Special Control The relative humidity shall be 40 ±5% at 70° ±5°F during record installa-tion period. Same conditions are required for	Same as B	Negligible Record System 35 to 60%	Negligible Record System 35 to 60%

*Special Control: Where design includes special specified control on temperature conditions for satisfactory operation these special conditions shall be defined in technical design interface documents.

TABLE I (continued)

Environments -A-	Storage and Transportation -B-	Handling and Mating -C-	Pre-Flight -D-	Powered Flight -E-	Orbital Flight -F-
Relative Humidity	camera payload shall be such as to prevent any formation of frost or condensation on the camera payload itself.	camera payload installation.			
Explosive or Corrosive Atmosphere	Later	Later	Later	Later	Later
Life (duration)	Any distance using mechanized carrier transportation media. Payload equipment, excluding "O" Rings and other replaceable items subject to deterioration, shall be capable of operation after a storage period of 1 yr. in a sheltered area.	60 days	Later	Later	Later
Precipitation Salt Spray, Sand and Dust	Negligible, on basis of packaging during transportation, and protection throughout mating, handling and preflight periods.	Negligible	Negligible	Negligible - Protected by Service Module.	Same as E

TABLE I (continued)

Environments -A-	Storage and Transportation -B-	Handling and Mating -C-	Pre-Flight -D-	Powered Flight -E-	Orbital Flight -F-
Fungus	Equipment shall be capable of withstanding fungus growth as encountered in continental U.S. It shall be subject to procedures MIL-E-5272C, para. 4.8.	Same as B	Same as B	Negligible	Negligible
RF - Interference	The requirements of MIL-I-26600 for case IB equipment, shall apply as a design objective.				

TABLE II

ENVIRONMENTAL DESIGN CRITERIA
Components (less than 75 pounds each)

Environments -A-	Storage and Transportation -B-	Handling and Mating -C-	Pre-Flight -D-	Powered Flight -E-	Orbital Flight -F-
Vibration	Later	Later	Later	Later	
Acceleration	Later	Later	Later	Later	
Shock	Later	Later	Later	Later	
Acoustic Noise	Later	Later	Later	Later	
Vibration					Later
Acceleration					Later
Shock					Later
Acoustic Noise					Later
Temperature	<u>Low Extreme</u> Static ambient air temp. +0° F for 8 hrs. <u>High Extreme</u> +125° F	<u>Low Extreme</u> Static ambient air temp. +20° F for 8 hrs. <u>High Extreme</u> +125° F for 4 hrs. per day *Special Control	<u>Low Extreme</u> Flowing ambient air +20°F <u>High Extreme</u> 100° F max. flowing air temp. internal to payload vehicle for 2 hrs. *Special Control	<u>Low Extreme</u> Static ambient air temp. +32° F <u>High Extreme</u> +160° F (occurring between removal of pre-flight coolant air and high altitude flight) *Special Control	Components to be subjected to local mean radiation sink temperature from +120° F to -160° F and local mean conduction sink temperatures from +80° F to -100° F. *Special Control

<u>Special Control:</u> Where design includes special specified control on temperature conditions for satisfactory operation these special conditions shall be defined in technical design interface documents.

TABLE II (continued)

Environments -A-	Storage and Transportation -B-	Handling and Mating -C-	Pre-Flight -D-	Powered Flight -E-	Orbital Flight -F-
Pressure	30.5 to 11.1 in. hg. abs.	30.5 to 28.5 in. hg. abs.	30.5 to 28.5 in. hg. abs.	30.5 to 1 x 10^{-11} in. hg. abs. Film System 0-4 psig.	1 x 10^{-11} in. hg. abs. Film System Pressure .25-1.25 psig.
Humidity	100% R.H. including condensation due to temp. reduction. 115° F max. 40° F min. at R.H. = 90 ±5% <u>Special Control</u>- Humidity in the vicinity of the camera payload shall be such as to prevent any formation of frost or condensation on the camera payload itself.	<u>Special Control</u> The relative humidity shall be 40 ±5% at 70° ±5° F during record installation period. Same conditions are required for camera payload installation.	Same as B	Negligible <u>Record System</u> 35 to 60%	Negligible <u>Record System</u> 35 to 60%
Explosive or Corrosive Atmosphere	Later	Later	Later	Later	Later
Life (Duration)	Any distance using mechanized carrier transportation media. Payload equipment, excluding "O" Rings and other replaceable items subject to	60 days	Later	Later	Later

TABLE II (continued)

Environments -A-	Storage and Transportation -B-	Handling and Mating -C-	Pre-Flight -D-	Powered Flight -E-	Orbital Flight -F-
Life (duration) (cont'd)	deterioration, shall be capable of operation after a storage of one year in a sheltered area.				
Precipitation, Salt Spray, Sand and Dust	Negligible - on basis of packaging during transportation, and protection throughout mating, handling and pre-flight period.	Negligible	Negligible	Negligible - protected by Service Module	Same as E
Fungus	Equipment shall be capable of withstanding fungus growth as encountered in continental U.S. It shall be subject to procedures MIL-E-5272C, para. 4.8	Same as B	Same as B	Negligible	Negligible
RF - Interference	The requirements of MIL-I-26600 for Case IB equipment shall apply as a design objective.				

TABLE III

SPECIAL COMPONENTS IN RE-ENTRY VEHICLE

Special components shall be subject to all conditions of Table II, and in addition, to the environmental phases listed below

Environmental	De-Orbit & Separation	Re-Entry	Recovery to Impact	Retrieval
Vibration	Later	Later	Later	Later
Acceleration	Longitudinal (later)	Later	Later	Later
Shock	Later	Later	Later	Later
Acoustic Noise	Later	Later	Later	Later
Temperature	Same as Orbital Flight *Special Control	Linear temp. 400° F at max. dynamic pressure. 500° F at chute deployment. *Special Control	Same as re-entry *Special Control	Low Extreme Static ambient air temp. -40° F High Extreme +160° F *Special Control
Pressure	1×10^{-10} to 5×10^{-7} in. hg. abs.	5×10^{-7} to 4.6 in. hg. abs.	5.6 to 30.5 in hg. abs.	16.8 to 30.5 in. hg. abs.
Humidity	Negligible	Negligible	Negligible	Impact - Equipment shall be designed to operate after exposure to 100% RH, including temporary condensation due to temperature reduction.

*Special Control: Where design includes special specified control on temperature conditions for satisfactory operation these special conditions shall be defined in technical design interface documents.

TABLE III (continued)

Special components shall be subject to all conditions of Table II, and in addition, to the environmental phases listed below

Environments	De-Orbit & Separation	Re-Entry	Recovery to Impact	Retrieval
Explosive or Corrosive Atmosphere	Negligible	Negligible	Negligible	Negligible
Life (duration)	Later	Later	Later	Later
Precipitation, Salt Spray, Sand and Dust	Negligible	Negligible	Negligible - Protected by re-entry vehicle and its seal.	Sand and Dust - A condition of 20kts wind velocity at 425 to 775 mm hg. pressure, and dust density - 0.01 gr/ft^3 for 24 hours max.
Fungus	Negligible	Negligible	Same as Storage and Transportation in Table II.	Same as Storage and Transportation in Table II.
RF - Interference	The requirements of MIL-I-26600 for Case IB equipment, shall apply as a design objective.			

their operational life. These conditions are the maximum expected, without inclusion of additional safety factors.

3.4 Design Requirements

3.4.1 Factory of Safety - A factor of safety is the ratio of critical load to limit load. A ratio of 1.5 is sued when structural failure will endanger personnel in the immediate area. This 1.5 ratio is used for ground handling, assembly, transportation and pre-launch conditions. In accordance with established practice for missile design, a ratio of 1.25 is used for all other conditions. These factors are reflected in the qualification test levels.

3.4.2 Static Load Requirements

3.4.2.1 Design Procedures - The design conditions given in this section comprise design loads applicable to the major load bearing structure. Permanent set in any element shall be permissible providing it does not interfere with theoperation of the system or components.

The design levels are determined by the product of the limit "g" load and required factor of safety. A longitudinal loading shall be combined vectorially with a single lateral loading. This load shall be applied, either as a resultant or by simultaneous application, in a longitudinal plane through each lateral axis in both directions. Where symmetry exists about a given axis, one typical direction is sufficient.

3.4.3 Environmental, Qualification, Acceptance Test Criteria, Variances.

3.4.3.1 Environmental Design Criteria - The environmental conditions specified in Table I shall apply to complete camera payload and major assemblies. The environmental conditions in Table II shall apply to components of the payload. Table III shall apply to special components in the re-entry vehicle.

3.4.3.2 Qualification Test Criteria - The qualification test criteria of Section 4 consist of environmental tests that payload, major assemblies, and components - representative of the desirable design - shall be required to withstand.

3.4.3.3 Acceptance Test Criteria - The acceptance test criteria of Section 5 consist of environmental tests that the payload, major assemblies, components and special components shall be required to withstand.

3.4.3.4 Variances, Additional Requirements - The camera payload, major assemblies, and associated components shall be capable of meeting the qualification and acceptance tests of this criteria, as a minimum. Additional environmental tests may be specified in individual test requirement specifications. Variance from the test parameters of these criteria shall require concurrence of the cognizant departments.

3.4.4 Static Design Loads - Appendix B* indicates data and design considerations which may be used to determine static design loads which are equivalent to the expected imposed dynamic loads. This data may be used for designing fixtures and components to withstand shock and vibration tests.

4. <u>QUALIFICATION CRITERIA</u>

The test given in this section shall be applied to at least one of each item of any given design. The item shall not be used as an operational

* Appendix B to this specification will be supplied later.

unit following the qualification tests. The item shall be placed on one of the three following categories.

(a) Payload and Major Assemblies

(b) Components

(c) Special Components

4.1 Payloads, Major Assemblies - The qualification criteria for the payload and its major assemblies shall include the following levels of vibration, acceleration, and shock. The payload shall be positioned with the X axis vertical and the film supply cassette end uppermost for these tests.

4.1.1 Vibration - See Table IV

4.1.2 Acceleration

4.1.2.1 Payload Structure - The payload structure shall be tested under acceleration loading of 4.1.2.2 as part of the payload assembly test.

4.1.2.2 Payload, Lens, Film Supply Cassette - These assemblies shall be subjected to the following constant acceleration "g" forces for a period of (later) minutes in each of 3 mutually perpendicular axes.

Limit Load		Critical Load
Longitudinal Axis	(later)	(later)
Lateral Axes (both directions)	(later)	(later)

Limit loads shall be applied singly and combined vectorially. Critical loads shall be applied singly only.

4.1.3 Shock

4.1.3.1 Payload

4.1.3.1.1 Packaged - The payload as packaged for shipment shall withstand a 12 inch drop of one end of package with opposite end resting on floor; and a repetition of this drop using the opposite end.

4.1.3.1.2 Unpackaged - The camera payload shall be subjected to three shocks in each direction along each of three mutually perpendicular axes, as follows:

Longitudinal:	Later
Lateral:	Later

4.1.3.2 Structure - Test as part of payload.

4.1.3.3 Lens - Same as payload 4.1.3.1.2.

4.1.3.4 Film Supply Cassette - Same as payload 4.1.3.1.2.

4.1.4 Temperature, Non-Operational - The payload without record shall withstand a temperature range from 0° to 125°F with an 8 hour dwell at 0°F.

4.1.5 Pressure - Operation - The payload with record shall be capable of operating at pressures from ambient to 1×10^{-11} in. of Hg. abs.

4.1.6 Acoustic Noise, Non-Operational - The payload with record in supply cassette shall withstand an acoustic noise level (later).

4.2 Components - The qualification criteria for the components shall include the following levels of vibration, acceleration, and shock:

4.2.1 Vibration - See Table IV

4.2.2 Shock - (later)

4.2.3 Acceleration - Only those components which could reasonably be affected by sustained loading shall be tested. Those which are obviously of rugged construction need not be accelerated individually, as payload assembly acceleration will serve to qualify them.

Each component tested shall be subjected to sustained acceleration for not less than three minutes, in each direction, along each of three mutually perpendicular axes, at the following levels:

Longitudinal Axis:	later
Lateral Axes: (both directions)	later

4.2.4 Fungus - The components shall withstand the fungus conditions encountered in the continental United States as defined in MIL-E-5272C paragraph 4.8.

4.3 Special Components - The qualification criteria for the special components shall include the following:

4.3.1 Powered Flight Environment - The special components, with only the film which they contain during the pre-orbital powered flight phase, shall be subjected to the tests of 4.2. Following these tests they shall be required to meet all their orbital functional requirements.

4.3.2 De-Orbit to Recovery - The special components, containing their maximum quantity of film shall be subjected to the following levels of vibration, shock, and acceleration. Following these tests they shall be required to meet only those functional requirements necessary during the post-orbital phase.

4.3.2.1 Vibration - Vibrate special components in accordance with 4.1.1 or 4.2.1 which ever is applicable. (Film take-up cassette may be a component or a major element depending on amount of film contained. As such, this assembly shall be qualification tested as a component with no film, and as a major element with a full load of film.)

4.3.2.2 Shock - (later)

4.3.2.3 Acceleration - The special components shall be subjected to sustained acceleration for not less than five minutes, in each of five directions, at the following levels:

(later)

TABLE IV

QUALIFICATION VIBRATION TEST

While in the launch-operative condition, the equipment shall be vibrated under the conditions of this table. Vibration shall be applied consecutively in each of these orthogonal missile axes. The vibration shall be applied and measured at the equipment mounting points in the case of components and major elements, and at the payload interfaces in the case of the payload. Performance parameters shall be measured during and/or after the vibration test, as appropriate. The components, major elements, and payload shall operate without failure, malfunction, or out-of-tolerance performance degradation during the vibration test and/or post-test checkout, as appropriate.

Vibration
(later)

5. ACCEPTANCE CRITERIA

The tests given in this section shall apply to each item of equipment for detecting workmanship defects. The items shall be placed in one of the three following categories.

(a) Payload and Major Assemblies
(b) Components
(c) Special Components

5.1 Payload, Major Assemblies - The environmental acceptance criteria for the payload and major assemblies shall be limited to vibration.

Each unit shall be vibrated in accordance with Table V.

5.2 Components - The environmental acceptance criteria for subassemblies and components shall be limited to vibration in accordance with Table V.

5.3 Special Components

5.3.1 Acceptance Levels, Re-entry Vehicle Cassette - The environmental acceptance criteria for sub-assemblies and components shall be limited to vibration in accordance with Table V. The take-up cassette shall not contain film during this test.

TABLE V

ACCEPTANCE VIBRATION TEST

While in the launch-operative condition, the equipment shall be vibrated under the conditions of this table. Vibration shall be applied consecutively in each of the three orthogonal axes for the separate components, and in the

TABLE V (continued)

longitudinal only for major assemblies and the payload. The vibration shall be applied and measured at the equipment mounting points, in the case of components and major elements, and at the payload interfaces in the case of the payload. Performance parameters shall be measured during and/or after the vibration test as appropriate. The components, major assemblies, and payload shall operate without failure, malfunction, or out-of-tolerance performance degradation during the vibration test and/or a post test checkout, as appropriate.

VIBRATION

(later)

6. BACKGROUND INFORMATION

6.1 Clean Room Requirements

6.1.1 Dust Particle Distribution and Count - The dust particles as results of air filtering shall follow a normal distribution. The three Sigma limit of this distribution shall not exceed a particle size of 30 microns. Particle count shall not exceed 2000 particles per liter. This specification shall apply to the room closed without occupant or equipment.

6.1.2 Room Design - The room design shall specify that all surfaces shall be hard and easily washable. Ledges, cracks and other inaccessible or difficult to clean areas shall be avoided. Conditioned air shall be used, and the clean areas shall be maintained under slight positive pressure. Air shall be filtered by appropriate filters located as close to the room as practical.

6.1.3 Uniforms, Locker Area, Cleaning Equipment - Personnel working within the clean areas shall wear uniforms. A convenient locker area in close proximity to clean areas shall be provided. Expensive man cleaning equipment shall not be required by this criteria.

6.1.4 Temperature, Clean Areas - The clean areas temperature shall be maintained at 70° ±2° F.

6.1.5 Relative Humidity, Clean Areas - The relative humidity in the clean areas shall be maintained at 45 ±5%.

NOTICE

When Government drawings, specifications or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs to responsibility nor any obligation whatsoever; and the fact that the Government may have formulated furnished, or in any way supplied the said drawings, specifications, or other data, is not to be gegarded by implication or otherwise an in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

APPENDIX M

MOTOR SPEED DRIVE

Specification No.

Prepared by
EASTMAN KODAK COMPANY
Advanced Development Projects Group
Apparatus and Optical Division
Rochester, New York

Prepared by____________________

Reviewed by____________________

Approved by____________________

Release Date ____________

Revision	Pages Affected	Date	Approved by

Phase II Specification	Motor Speed Drive
Specification No.*	Release Date:*

1. SCOPE, MISSION AND TASK

1.1 Scope - This specification defines the Motor Speed Drive, hereinafter referred to as MSD. It includes the performance and environmental requirements, and defines the quality assurance provisions required to determine compliance of the MSD (prime equipment), with these requirements.

1.2 Mission - It shall be the mission of the MSD, when power is supplied, to provide single-phase and two-phase power at the required voltage and frequency in response to binary coded commands.

1.3 Task - The required task is to design, develope, manufacture, test, and deliver to Eastman Kodak Company an MSD and an MSD mock-up which complies with the requirements defined in this specification.

2. APPLICABLE DOCUMENTS

The following specifications, standards, drawings and publications of latest issue in effect on date of invitation for bids, form a part of this specification. Applicability of the listed documents shall depend on their specific reference in this specification. In the event of conflict between the listed documents and this specification, this specification shall take precedence.

SPECIFICATIONS

Military

MIL-Q-9858	Quality Control System Requirements
NR 515	Control of Nonconforming Supplies
MIL-I-26600	Interference Control Requirements, Aeronautical Equipment

* Denotes information to be supplied at a later date.

STANDARDS

Eastman Kodak Company

401-119	Design and Manufacturing Standards

DRAWINGS

Eastman Kodak Company

405-115	Procedure for Thermal Finish, Epoxy Black or White Enamel
405-130	Procedure for Iridite No. 15 on Magnesium
405-152	Procedure for Aluminizing Aluminum, Magnesium and Polystyrene Parts
405-185	Procedure for Iridite No. 14 for Aluminum

OTHER PUBLICATIONS

Eastman Kodak Company

401-122	Technical Requirements for Contracts

3. REQUIREMENTS

3.1 Definitions - The equipment required by this specification consists of the following:

a. Motor Speed Drive (MSD)

b. MSD Mock-up

3.1.1 Motor Speed Drive - The MSD shall consist basically of a step variable frequency generator and power amplifier.

3.1.2 MSD Mock-up - The MSD mock-up is a unit which simulates the average power consumption and heat dissipation, has the external configuration and finish, and has the weight and center of gravity of the MSD. The requirements of the MSD mock-up shall be in accordance with 3.5.9.

3.2 Electrical Requirements

3.2.1 Inputs - The MSD shall meet the requirements of this specification when supplied with the following:

3.2.1.1 Voltage - The MSD shall operate from a dc supply of +28.0 $\pm$3.0 volts. A +22.0 $\pm$0.1 volts dc source shall be provided for instrumentation.

3.2.1.2 Input Commands - The following input commands shall be supplied to the MSD.

3.2.1.2.1 ON-OFF Command - ON-OFF command shall consist of 1 binary-command bit. When an ON command is received, the MSD shall supply two-phase power as specified in 3.2.2.1 and single-phase power as specified in 3.2.2.2. When an OFF command is received, the MSD shall discontinue supplying two-phase power and single--phase power.

3.2.1.2.2 Frequency Control Command "A" - The "A" frequency control command consists of 9 binary-coded command bits supplied from an external source in parallel form on 18 wires. A binary "one" shall be presented as a $+28 {}^{+3.0}_{-8.0}$ volt, 40 millisecond, or longer, pulse on one of the two wires associated with each bit. A binary "zero" shall be presented as a $+28 {}^{+3.0}_{-8.0}$ volt, 40 millisecond or longer, pulse on the other of the two wires associated with each bit.

3.2.1.2.3 Frequency Control Command "B" - The "B" frequency control command consists of 9 binary-coded command bits supplied from an external source in parallel form on 9 wires. A binary "one" shall be presented as a * volt level on a command wire. A binary "zero" shall be presented as zero volts on the command wire.

3.2.1.2.4 Command Transfer - In addition to the 9 bit frequency control command, two wires will be supplied from source "B" for commanding transfer. These wires are a temporary malfunction and a permanent malfunction. A binary "one" will be a * volt level and a binary "zero" will be zero volts.

Source "A" will also provide three wires to control transfer. An override signal will be represented as a closed circuit (resistance less than 1 ohm) between the common terminal and the normally closed binary 1 terminal of a set of contacts. The return is presented as a closed circuit (resistance less than 1 ohm) between the common termal and the normally open binary 1 terminal of this set of contacts. Contact rating of the command switch will be 1 amp (resistance load at 50 volts dc).

The logic for transfer is shown in the table below.

A = 1 malfunction

A = 0 no malfunction

B = 1 override

B = 0 return

A	B	Input
0	0	"A"
0	1	"B"
1	0	"B"
1	1	"B"

The MSD shall be required to respond to frequency control command "A" or frequency control command "B" in accordance with the following schedule.

(1) The MSD shall normally respond to frequency control "B".

(2) Upon receipt of a frequency control command "B" temporary malfunction signal, the MSD shall immediately respond to frequency control command "A" and shall continue to respond to frequency control command "A" until the temporary malfunction signal is remov ed at which time the MSD shall resume response to frequency control command "B".

(3) Upon receipt of a frequency control command "B" permanent malfunction signal, the MSD shall respond as in (2) above except that the MSD shall continue to respond to frequency control command "A" until manually reset.

(4) Upon receipt of an OVERRIDE command, the MSD shall respond as in (2) above. Return of MSD response to frequency control command "B" shall occur on receipt of the RETURN command.

3.2.1.2.5 Command Storage - The frequency control command "A" shall be stored within the MSD at the last received command level at all times. Command storage shall be provided even though all power may be removed from the MSD. Frequency control command "B" shall not be stored within the MSD.

3.2.1.3 Motor Power Test Voltage - A voltage of +28 ±3.0 volts dc positive with respect to dc return may be applied to the MSD in order to test the motor power output when the MSD is in the OFF state. The source of the test voltage shall be capable of providing the current required by the MSD to drive the motor. The MSD shall meet all the requirements of this specification with this voltage applied except for instrumentation output of 3.2.2.3.

3.2.2 Outputs - The MSD shall provide the following outputs when the power is commanded ON by the ON-OFF command bit or when the motor power test voltage is applied.

3.2.2.1 Two-Phase Power - The MSD shall provide two-phase power to drive an external motor in accordance with Eastman Kodak Company drawing * when an ON command is received. The output frequency shall cover a range from (200) cps to (500) cps in response to the 9 bit binary coded command word as shown in Table I.

The output waveform may be either a square wave or sine wave. The phase difference shall be 90 ±5 degrees. The equivalent half-wave single ended output voltage shall be 16 x frequency/400 volts zero-to-peak ±10 percent.

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* To be supplied by a later revision.

( ) Number subject to change.

COMMAND CODE

STEP NO	BIT NO	9 (MOST)	8	7	6 (SIGNIFICANT)	5	4	3	2	1 (LEAST)	2-PHASE POWER OUTPUT FREQUENCY CPS
0		*	*	*	*	*	*	*	*	*	LOWEST
1											
2											
3											
N											
M		*	*	*	*	*	*	*	*	*	HIGHEST

<u>COMMAND CODE CONFIGURATION</u>
<u>FOR MSD</u>

TABLE M-1

3.2.2.2 Single-Phase Output - The MSD shall supply a single-phase signal when an ON command is present. The single-phase output signal shall be twice the two-phase power output frequency.

Waveform:	Sine wave
Voltage:	The voltage shall be 150 $\pm$10 volts RMS
Load:	Transformer coupled $/Z_L/$ = *

3.2.2.3 Two-Phase Motor Power Instrumentation - One electrical output, positive with respect to instrumentation return, shall be provided to indicate the presence or absence of the two-phase power output as specified in 3.2.2.1. The output voltage shall be 1.5 $\pm$0.2 volts for no power output, 3.0 $\pm$0.2 volts for one-phase output, and 5 $\pm$0.2 volts for both phase outputs. Under no circumstances shall the output level exceed the limit of 6 volts positive with respect to test point return and 0.25 volt negative with respect to test point return.

3.2.2.4 Single-Phase Instrumentation - One electrical output positive with respect to instrumentation return shall be provided to indicate the presence or absence of the single phase output as specified in 3.2.2.2. The output voltage level shall be * .

3.2.2.5 Frequency Test Point - A single-phase output signal whose frequency is proportional to the motor drive frequency shall be provided as a frequency test point. The open circuit output voltage shall be 5 $\pm$1.0 volt peak-to-peak. The test point output impedance shall not exceed 5,000 ohms. Inadvertant shorting of this output to ground shall not cause any degradation in either the signal-phase or two-phase power outputs.

* To be supplied by a later revision

3.2.3 Connectors - Connectors location and orientation shall be as shown in Figure *. The connectors and connector pin assignments for the MSD shall be as follows:

Connector No. 1	Deutsch Tri-kam Receptacle	Part No. DTK * Eastman Kodak Co. Drawing 400-*
Pin Letters	Function	
*	*	
Connector No. 2	Deutsch Tri-kam Receptacle	Part No. DTK * Eastman Kodak Co. Drawing 400-*
Pin Letter	Function	
*	*	
Connector No. 3	Deutsch Tri-kam Receptacle	Part No. DTK * Eastman Kodak Co. Drawing 400-*
Pin Letter	Function	
*	*	
Connector No. 4	Deutsch Tri-kam Receptacle	Part No. DTK * Eastman Kodak Co. Drawing 400-*
Pin Letter	Function	
*	*	

3.2.4 Insulation Resistance - The dc resistance between any electrical connection, except shield, and the chassis of the MSD shall be 100 megohms minimum with an applied voltage of 100 volts $\pm$10 percent.

* To be supplied at a later revision.

3.2.5 Shields - Leads which carry signals having a high electromagnetic interference content shall be shielded. Shields shall be connected to the MSD enclosure at the originating end. The length of any pig-tail between the shield ferrule and the MSD enclosure shall be less than 4 inches in length. Shields shall not be used as signal carrying conductors.

3.2.6 Warm-Up. The MSD shall supply single phase and double-phase power within a 0.2 second warm-up period and motor power instrumentation within 0.1 second warm-up period after an ON command.

3.2.7 Power Consumption - The power consumed by the MSD shall be kept to a minimum consistent with the performance and reliability requirements of this specification. When operating, the average power (including that power to the MSD necessary to drive the external motor) shall not exceed 20 watts at 28.0 volts dc When nonoperating, the MSD power shall not exceed 0.1 watt. Any surge currents shall not exceed 2.0 amperes.

3.2.8 Electromagnetic Interference Control. The MSD shall meet the requirements of MIL-I-26600 for Class Ib equipment. In addition to the requirements defined by MIL-I-26600, any conducted interference, within frequency range of 15-15,00 cps, impressed on the 28 volt dc power supply circuit by the MSD shall not exceed 0.075 amperes peak-to-peak.

3.2.9 Instrumentation Return - Instrumentation return shall be connected to dc return at a point external to the MSD and shall be completely isolated from dc return within the MSD.

3.2.10 Instrumentation Output Impedance - The instrumentation output impedance with power ON or OFF shall not exceed 5000 ohms.

3.3 Environmental Requirements

A complete environmental design criteria establishing all of the levels of environment to which the payload and its components will be subjected will be established at a later date.

3.4 Mechanical Requirements

3.4.1 External Configuration - The external configuration of the MSD shall be as shown in Figure *.

3.4.2 Weight - The weight of the complete MSD shall not exceed 10 pounds.

3.4.3 Parts and Materials - Parts and material selection and control shall be in accordance with Section 3.10 of Eastman Kodak Company document 401-122.

3.4.4 Finish - As applicable the parts of the MSD shall be finished in accordance with chapter 12 of Eastman Kodak Company Standard 401-110 to minimize any and all of the following: degradation of photosensitive materials, contact errosion, galvanic corrosion, surface contamination and corrosion during storage. Special thermal considerations may involve use of epoxy enamels and coating of magnesium in accordance with Eastman Kodak Company Drawings 405-115, 405-152, and Standard 401-119.

3.4.4.1 Mounting Surfaces - Magnesium mounting surfaces shall be finished with Iridite No. 15 in accordance with Eastman Kodak Company Drawing 405-130. Aluminum mounting surfaces shall be finished with Iridite No. 14 in accordance with Eastman Kodak Company Drawing 405-185.

3.4.5 Identification - The MSD shall be marked for identification by appropriate part and serial numbers, in accordance with Figure M-1 and Figure M-2.

3.5 General Requirements

3.5.1 Design Attributes - Design shall be in accordance with the requirements of Eastman Kodak Company Standard 401-119. Throughout the various stages of design, consideration shall be given to the items listed below. Items are listed in order of relative importance.

SAMPLE IDENTIFICATION

PART NO. 1400-XXX
SERIAL NO. 110000

Lettering is: Upper case, vertical Commercial Gothic 3/16 inch high.

SAMPLE

Figure M-1

EXPLANATION OF NUMBERING SYSTEM

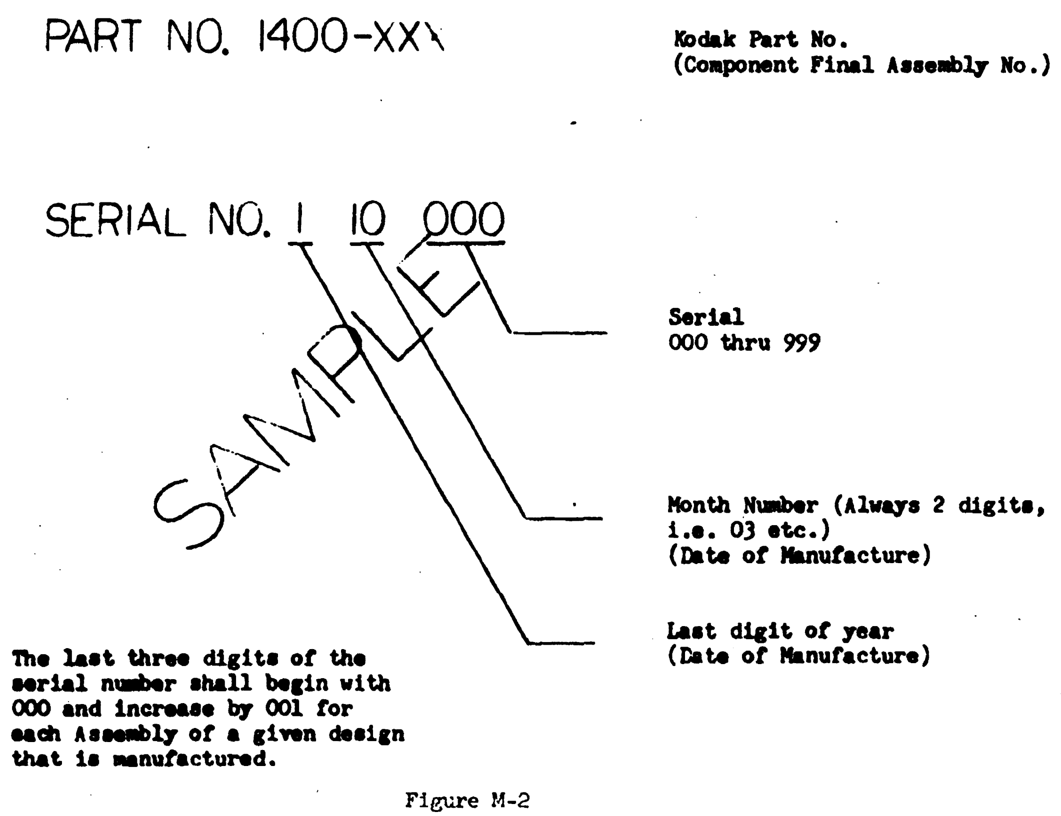


Figure M-2

a. Performance

b. Reliability

c. Fail Safe Features

d. Weight

e. Serviceability

f. Power Consumption

g. Flexibility

3.5.2 Manufacturing Standards - The MSD shall conform to the manufacturing standards contained in Eastman Kodak Company Standard 401-119.

3.5.3 Interchangeability - Parts and assemblies of the MSD of the same model, regardless of series designation, exclusive of experimental, prototypes and mock-ups shall be interchangeable electrically and mechanically.

3.5.4 Life

3.5.4.1 Service Life

3.5.4.1.1 Testing Life - The MSD shall have a testing life of 150 hours of ON time. During the testing life period the MSD shall be capable of operating continuously for a 120 minute period. The MSD shall also be capable of a minimum of ** ON and OFF operations during ** minutes out of a ** minute period with each ON time having a minimum duration of ** seconds.

3.5.4.1.2 Mission Life - After completion of the specified testing life, the MSD shall have a minimum mission life of * hours of ON time. During the mission life period, the MSD shall be capable of operating continuously for a 120 minute period. The MSD shall also be capable of a minimum of * ON and OFF operations during * minutes of a * minute period, with each ON time having a minimum duration of * seconds. The MSD shall have the above mission life when operated at randomly selected output frequencies and under any of the specified operating conditions.

** To be determined by contractor.
* To be supplied by a later revision.

3.5.4.2 Shelf Life - The MSD shall have a shelf life of 24 months minimum.

3.5.5 Reliability Requirements

a. The contractor shall meet the reliability requirements defined in Section 3 of Eastman Kodak Company document 401-122.

b. The equipment specified in this document shall have a Mean-Time-Between-Failure of at least * hours (90 percent confidence level statistics).

c. In conjunction with reliability testing as referenced in Section 3.8 of Eastman Kodak Company document 401-122, the contractor shall make an estimate of the demonstrated equipment reliability stating the confidence level of statistics used.

   In lieu of this requirement, test results including running time and failure shall be supplied by the contractor.

3.5.6 Disposition of Variances - Variances from the requirements of this specification, drawings and procedures referenced herein, and Eastman Kodak Company Standard 401-119 shall require Eastman Kodak Company written approval. Variances of all other drawings not affecting the requirements of this specification, shall require contractor action only.

3.5.7 Contract Conformance - The MSD shall conform to the requirements of this specification.

3.5.8 Safety of Personnel

3.5.8.1 Mechanical - The MSD design shall provide maximum convenience and safety to personnel when installing, operation, maintaining, replacing the MSD. No sharp projections or edges on parts or assemblies shall be permitted.

3.5.8.2 Electrical - Provisions shall be made to prevent personnel from accidentally coming in contact with voltages in excess of 40 volts, including potentials on charged capacitors, when the MSD is in its normal operating condition.

* To be determined by contractor.

3.5.9 MSD Mock-Up - The MSD mock-up shall meet the following requirements utilizing the characteristics of the MSD design at the time of delivery.

Configuration:	The MSD mock-up shall have the external configuration and finish of the MSD and consist of machined castings or weldments of the same material. The unit need not be machined internally except to mount required components.
Weight and Center of Gravity:	The MSD mock-up shall have the mass and center of gravity of the MSD design within ±5 percent as demonstrated by weighing.
Heat Capacitance:	The MSD mock-up shall have the heat capacitance of the MSD design within ±10 percent as demonstrated by calculation.
Power Consumption:	The MSD mock-up shall simulate the power consumption of the MSD design by dissipation in a resistor which replaces the electronics components of the MSD design. The resistor shall be selected to produce the average power dissipation of the MSD.
Electrical Connection:	Two electrical connections to the resistor shall terminate at pins * and * of the electrical connector * used in the MSD design.
Design:	The MSD mockup shall be capable of meeting the qualifications test levels of Section 3.3.1.

3.6 Documentary Requirements

3.6.1 Drawings - Drawings, associated lists, and documents prepared by the contractor defining the requirements of design, procurement, fabrication and assembly of the MSD shall be prepared in accordance with section 5 of Eastman Kodak Company Document 401-122.

* To be supplied by a later revision.

3.6.2 Specifications - The contractor shall generate material to complete performance requirements and description of the MSD contained in this specification. Such material shall be submitted to Eastman Kodak Company for written approval. The approved material shall be incorporated into the specification by Eastman Kodak Company.

3.6.3 Manual Material - The contractor shall provide manual material containing operating and maintenance information in accordance with 1.3.11 and section 6 of Eastman Kodak Company document 401-122.

3.6.4 Receiving, In-Process, and Final Inspection - Inspection reports shall be generated and maintained by the contractor. These reports shall include receiving, in-process, and final inspection reports in accordance with 2.3 and 2.5 respectively of Eastman Kodak Company document 401-122.

3.6.5 Reports - The contractor shall submit the following reports to Eastman Kodak Copmany. The formats and contents applicable shall be in accordance with the reference paragraphs and sections of Eastman Kodak Company document 401-122.

		Paragraphs	Sections
a.	Technical Progress Report	1.3.6.1	
b.	Red Flag Report	1.3.6.2	
c.	Preliminary Design Report	1.3.6.3	
d.	Major Design Report	1.3.6.4	
e.	Final Design Report	1.3.6.5	
f.	Performance Evaluation Report	1.3.6.6	
g.	Failure Report and Failure Analysis	1.3.6.7	3.9
h.	Final Technical Report	1.3.6.8	
i.	Acceptance Test Report		2.12.2
j.	Acceptance Inspection Report		2.12.1
k.	Qualification Test Report	3.8.3.2	

		Paragraphs	Sections
l.	Reliability Test Report		3.7
m.	Operating Time Log	2.9	
n.	Reliability Program Plan		3.3

3.6.6 Verification of Purchased Items - A certificate of compliance for purchased parts shall be provided by the contractor. This certification of compliance shall state that the manufacturer has on record data to demonstrate that the purchased part shall conform to the requirements of the applicable Eastman Kodak Company drawing. MS and AN standard parts will not require a certificate of compliance.

3.6.7 Calibration - Records of the calibration of the MSD and all measuring and test equipment shall be generated and documented, in accordance with 2.8 of Eastman Kodak Company document 401-122.

3.6.8 Inspection and Procedures - Qualification, acceptance and inspection test procedures, for the MSD that demonstrate conformance to the requirements of this specification shall be prepared and documented by the contractor in accordance with section 1.3.12 of Eastman Kodak Company document 401-122.

3.6.9 Reliability Prediction - The contractor shall provide reliability information in accordance with 3.6 of Eastman Kodak Company document 401-122.

3.6.10 Electromagnetic Interference Control Plan - An EMI control plan in accordance with MIL-I-26600 Class Ib shall be prepared and submitted for Eastman Kodak Company approval with the Preliminary Design Report of 1.3.6.3, Eastman Kodak Company document 401-122.

3.7 Design Review Meetings

Design review meetings shall be held in accordance with section 3.11 and the design reviews of Table 1-1 of Eastman Kodak Company document 401-122.

4. QUALITY ASSURANCE PROVISIONS

The quality control system requirements of MIL-Q-9858, and section 2 of Eastman Kodak Company document 401-122 shall apply. Quality control shall maintain a system for controlling nonconforming supplies in accordance with NR 515. Testing of the MSD shall be limited to provisions listed in this section.

4.1 Classification of Tests

The inspection and testing of the MSD shall be classified as follows:

a. Qualification Tests
b. Acceptance Tests

4.2 Qualification Tests

Qualification testing of the MSD shall be in accordance with section 3.8.3 of Eastman Kodak Company document 401-122. The contractor shall conduct a qualification testing program to demonstrate the capability of the design to meet the qualification levels of section 3.3.1. The qualification test precedure of section 3.6.8 of this specification shall be followed. The qualification test shall include but not be limited to the following:

4.2.1 Visual Inspection - All parts, subassemblies, and assemblies shall be inspected for conformance to the manufacturing standards of Eastman Kodak Company standard 401-119.

4.2.2 Drawing Conformance - All parts, subassemblies, and assemblies shall be inspected for conformance to their respective drawings.

4.2.3 Performance Tests - The MSD shall be tested for its ability to comply with the performance requirements of sections 3.2, 3.4, and 3.5.

4.2.4 Environmental Qualification Tests - The MSD shall be subjected to the environmental levels of section 3.3.1. Subjecting the MSD to the specified environmental conditions separately shall be considered adequate in lieu of testing all possible or probable combinations except for the operation portion where worst case combinations shall be used. Following completion of these tests, the MSD shall be visually inspected for damage, and the performance tests of 4.2.3 shall be repeated. Any impairment of performance of the MSD shall be reported in accordance with item g. of 3.6.5.

4.2.5 Life Test - The MSD shall be tested for its ability to meet the service life requirements of 3.5.4.1.

4.3 Acceptance Tests

Acceptance testing of the MSD shall be part of the task and follow the acceptance test procedure in accordance with 2.11 of Eastman Kodak Company document 401-122. The acceptance tests shall include but not be limited to:

4.3.1 Visual Inspection - All parts, subassemblies, and assemblies shall be inspected for workmanship, cleanlinesses, and wiring.

4.3.2 Drawing Conformance - All parts, subassemblies and assemblies shall be inspected for conformance to their respective drawings.

4.3.3 Performance Test - The MSD shall be tested for its ability to meet all the performance requirements that are defined in sections 3.2 and 3.4 of this specification. The MSD shall meet foregoing requirements both before and after being subject to acceptance test vibration of 4.3.4.

4.3.4 Vibration Tests - The MSD shall be tested for its ability to meet the vibration requirements of 3.3.2.

4.4 Test Conditions

The atmospheric conditions for all tests shall be within the environmental ranges specified in section 3.3 except as required in 4.2.4.

4.5 Monitoring and Technical Surveillance

Eastman Kodak Company reserves the right to have technical representatives visit the contractor's facilities periodically to maintain technical surveillance of the contract. Eastman Kodak Company reserves the right to have technical representatives in residence at the contractor's facilities, if conditions warrant.

4.6 Sampling

Not required for this specification.

5. PREPARATION FOR DELIVERY

5.1 Shipping, Handling, and Storage

Each MSD shall be cleaned, labeled, sealed, with its identification in a transparent plastic bag, and packaged in a fitted, padded box. It shall be the responsibility of the contractor to insure that the packing and packaging provides adequate protection for the MSD to withstand the environmental conditions specified in the shipping handling environmental requirements of 3.3.1.3. It shall also be the responsibility of the contractor to insure that the specified environmental conditions are not exceeded prior to receipt of the MSD by Eastman Kodak Company.

6. NOTES

6.1 Applicability -

Details of intended use are not required for this specification.

Phase I Specification

Photographic Subsystem
Survey Camera

Specification No. 1600-105

Prepared By
EASTMAN KODAK COMPANY
Advanced Development Projects Group
Apparatus & Optical Division
Rochester, New York

Prepared by: ______________________

____

____

Phase I Specification	Photographic Subsystem
Specification No. 1600-105	Release Date:

1. SCOPE AND MISSION

1.1 Scope - This specification defines the Photographic Subsystem Survey Camera of the Apollo Mapping and Survey System. Included are the performance and environmental requirements, and quality assurance provisions required to determine compliance of the subsystem to these requirements. This specification also indicates many related items necessary for the performance of the task. This specification shall reference subsidiary specifications of the photographic subsystem survey camera and to that extent serves as an index for this group of documents.

1.2 Mission - It shall be the purpose of the survey camera photographic subsystem of the Apollo Mapping and Survey (M&S) system to provide very high resolution photography of the surface of the moon for detection of hazards to a manned landing craft (LEM).

2. APPLICABLE DOCUMENTS

The following specifications, standards, and publications of latest issue in effect, form a part of this specification. Applicability of the listed documents shall depend on their specific reference in this specification. In the event of conflict between the listed documents and this specification, this specification shall take precedence.

SPECIFICATIONS

Military

MIL-Q-9858	Quality Control System Requirements

Eastman Kodak Company

1600-104	EKC/NAA Program Interface
1600-106	Survey Camera Flight Model Payload
*	Aerospace Ground Equipment
*	Environmental Design Criteria
*	Support Equipment
*	Interface Drawing Effectivity Schedule
*	Final Product
*	Structure
*	Exposure Unit
*	Lens Assembly
*	Supply Cassette
*	Take-up Cassette
*	Stereo Servo
*	Crab Servo
*	View-Port Door Servo

*To be supplied by a later revision.

Eastman Kodak Company

*	Film Drive Electronics
*	V/h Sensor
*	Power Control and Conversion Unit
*	Thermal Control System
*	Command Decoder
*	Instrumentation Processing Unit
*	Test Console
*	Portable Test Set
*	Secondary Standard
*	Breakout Box
*	Cable Test Point Board
*	Leak Rate Test Set
*	Line-of-Sight Test Set
*	Cradle
*	Truck
*	Erector
*	Shipping Container
*	Lifting Yoke
*	Integration Lifting Yoke
*	Mobile Hoist
*	Film Splicer
*	Film Loading Kit
*	Film Viewer
*	Lens Assembly Lifting Yoke
*	Purging Equipment
*	Environmental Test Fixture
*	Collimator

Eastman Kodak Company

*	Weight and Center of Gravity Test Set
*	Cable Test Set
*	Film Drive Test Set
*	Focus Control Test Set
*	Stereo Servo Test Set
*	Supply Cassette Test Set
*	Target for Moving Target Assembly
*	Wood Mock-up
*	Thermal Model
*	Engineering Model

STANDARDS

Eastman Kodak Company

401-119	Design and Manufacturing Standards

DRAWINGS

Eastman Kodak Company

1600-100	C/P-CSM Mechanical Interface
1600-101	C/P-SIC Mechanical Interface
1600-102	Electrical Interface
1600-103	Thermal Interface
*	Camera Payload Command Information
*	Camera Payload Instrumentation Information
*	Film Format
*	Lens Flat Mirror Alignment and Adjustment Procedure
*	Lens and Camera Adjustment Procedure

OTHER PUBLICATIONS

Eastman Kodak Company

401-122 Technical Requirements for Contracts

3. REQUIREMENTS

The photographic subsystem associate contractor, Eastman Kodak Company (EKC), shall provide the design, fabrication, tests, and support necessary to perform the required mission of 1.2. The film thus obtained shall be returned to an earth recovery site by the command module.

3.1 Definitions

For the purpose of this photographic subsystem specification the following definitions are given:

3.1.1 Camera Payload (C/P) - The camera payload portion of the photographic subsystem consists of the flight equipment required to:

a. Collect visual information on photographic film.
b. Store the film prior to exposure.
c. Wind the exposed film on a take-up spool.
d. Permit transfer of retrieval cassette to the command module.
e. Electrically control and monitor the performance of the photographic subsystem by external command and telemetry links.

In the text, a flight model camera payload or survey camera is referred to as a flight payload, for brevity.

3.1.1.1 C/P Components - The camera payload is the equipment and mechanisms required for space-flight operations, or demonstration on earth of such capability of the subsystem, except those assemblies and mechanism which are the responsibility of other subsystems; this C/P equipment and associated specifications are listed in Table I.

TABLE I

Camera Payload Components

Component	Specification
Structure	*
Exposure Unit	*
Lens Assembly	*
Supply Cassette	*
Take-up Cassette	*
Stereo Servo	*
Crab Servo	*
View-Port Door Servo	*
Focus Control Unit	*
Cables	*
Film-Drive Electronics	*
V/h Sensor	*
Power Control and Conversion Unit	*
Thermal Control System	*
Command Decoder	*
Instrumentation Processing Unit	*

* To be supplied by a later revision.

3.1.2 Aerospace Support Equipment (ASE) - Aerospace support equipment is the equipment, other than flight equipment, required for the photographic subsystem. Aerospace ground equipment (AGE) is that aerospace support equipment used in operations following shipment of the camera payload from the manufacturer's facility. "In-house" equipment or hardware is that aerospace support equipment used only at Eastman Kodak Company facility or a subcontractors' facilities.

3.1.2.1 ASE Components - The aerospace support equipment consists of various assemblies, some of which operate in conjunction with each other and others which operate independently. Such interfaces between ASE components will be in accordance with individual component specifications as listed in Table II.

TABLE II

Representative Aerospace Support Equipment

Component	Specification*	Recommended for use at: EKC	NAA	Launch Complex
C/P Test Equipment				
Test Console		X		X
Portable Test Set		X	X	X
Secondary Standard		X	X	X
Breakout Box			X	X
Cable Test Point Board		X	X	X
Leak Rate Test Set		X	X	X
Line-Of-Sight Test Set		X		X
C/P Handling Equipment				
Cradle		X		
Truck		X	X	X
Erector		X	X	X
Shipping Container		X		
Lifting Yoke		X	X	X
Integration Lifting Yoke		X	X	X
Mobile Hoist		X		X
Film Support Equipment				
Film Splicer		X	X	X
Film Loading Kit		X	X	X
Film Viewer		X	X	X
Special Tools				
Lens Assembly Lifting Yoke		X		
Purging Equipment		X		

TABLE II (Contd)

Representative Aerospace Support Equipment

Component	Specification*	Recommended for use at: EKC	NAA	Launch Complex
Environmental Test Fixture		X		
Special Test Equipment				
Collimator		X		
Weight and Center of Gravity Test Set		X		
Cable Test Set		X		
Film Drive Test Set		X		
Focus Control Test Set		X		
Stereo Servo Test Set		X		
Supply Cassette Test Set		X		

*To be supplied by a later revision.

3.1.3 Hardware Designations - Definitions of hardware as assembled is designated as follows:

3.1.3.1 System - The system integrates those subsystems and facilities required to fulfill the system objectives.

3.1.3.2 Subsystem - The photographic subsystem consists of:

a. Aerospace flight equipment, all those airborne equipments such as payloads, models, mock-ups, etc., specified in this document.

b. The aerospace ground equipment and spares required to support the aerospace flight equipment.

3.1.3.3 Module - A module is a group of assemblies with a single or similar function which can operate when separated from other modules within a system or subsystem.

3.1.3.4 Assembly - An assembly is a combination of parts, subassemblies and units usually assembled in a single package.

3.1.3.5 Unit - A unit is an assembly of parts, subassemblies or assemblies, the aggregate weight of which does not exceed 75 pounds, arranged within a single package and designed to perform a specific function.

3.1.3.6 Major Assembly - A major assembly is an assembly of parts, subassemblies or assemblies, the aggregate weight of which exceeds 75 pounds, arranged within a single package and designed to perform a specific function.

3.1.3.7 Component - A component is the hardware or equipment combined to form a subsystem and which is of convenient size for design purposes and thus has an individual hardware specification.

3.1.4 Spacecraft (SC) - The spacecraft is the hardware placed in earth orbit by the launch vehicle or booster. The apollo spacecraft consists of the command module, service module, camera payload and lunar excursion module.

3.1.4.1 Command Service Module (CSM) - The flight system consists of the command module and service module connected into one unit with or without the camera payload installed.

3.1.4.2 Command Module (CM) - The command module is that portion of the command service module which houses the astronauts and will re-enter the earth's atmosphere at the end of the mission.

3.1.4.3 Service Moduel (SM) - The service module is that portion of the command service module which houses the camera payload, stellar index camera, and other subsystems and provides structural continuity between the basic booster and the command module.

3.1.4.4 Stellar Index Camera (SIC) - The stellar index camera is a separate subsystem which has two basic functions:

a. Photograph predetermined star fields to identify location of photography.

b. Photograph areas of the lunar surface for topographical mapping.

3.1.5 Other Definitions

3.1.5.1 Associate Contractor - An associate contractor is one of several contractors associated with production of complete system; a contractor having direct responsibility to the customer for one or more complete subsystems.

3.1.5.2 Interface - An interface is a physical or abstract boundry between two subsystems; such an interface defines the areas of mutual responsibility, interest or limitations of concern to associate contractors involved. These interfaces may be mechanical, electrical or environmental; as an example: The physical surfaces and spacings in the mating of several parts, modules, units, or subsystems; or an activity, such as loading of flight film into the camera payload. The interfaces are controlled by the documented in Table III.

TABLE III

Interface Documents (cross index)

NAA No./EK No.		Title
*	1600-104	EKC/NAA Program Interface Specification
*	*	External and Internal Design Criteria
*	*	Interface Drawing Effectivity Schedule
*	*	Camera Payload Command Information
*	*	Camera Payload Instrumentation Information
*	1600-100	C/P-SCM Mechanical Interface
*	1600-102	Camera Payload Electrical Interface
*	1600-103	Camera Payload Thermal Interface
FC&I No./EK No.		
*	1600-101	C/P-SIC Mechanical Interface

3.1.5.3 Smear - Degradation of image quality caused by uncompensated image motion relative to the film is called smear. This is usually specified in equivalent feet at ground level.

3.2 Electrical Requirements

3.2.1 Photographic Subsystem - The general photographic subsystem electrical requirements are specified in the following paragraphs. The electrical requirements of individual components for aerospace flight and aerospace support equipment are specified in applicable individual specifications. Aerospace flight and aerospace support equipment shall be electrically compatible.

3.2.1.1 Instrumentation - The camera payload shall provide instrumentation outputs to the command service module for recording and telemetering to an earth station. These instrumentation outputs shall be available at the launch complex assembly building and launch facility during ground testing at the launch site as stated in Eastman Kodak Company specification * . The instrumentation shall provide data on C/P operation, temperature, stereo and crab position of the stereo mirror, film handling, focus detector operation, V/h sensor performance, and position of the view-port door. The instrumentation shall conform to Eastman Kodak Company specification * . The schedule by which the payload instrumentation shall be changed (if required) from payload to payload will be reflected in an effectivity schedule to be supplied when required.

3.2.1.2 Power - Electrical power from the service module shall be supplied to the camera payload as unregulated plus 28 volts dc . (nominal) for environmental control and C/P operation. All power shall be supplied through the electrical interface. Unless otherwise required by component specifications the ground equipment shall be capable of operating with commercially available power.

* To be supplied by a later revision.

3.2.2 Camera Payload - The electrical requirements for the camera payload shall be in accordance with the applicable component specifications of Table I.

3.2.3 Aerospace Support Equipment

3.2.3.1 Payload Test Equipment - The power requirements for the payload test equipment shall be in accordance with 3.2.1.2. Additional requirements shall be in accordance with the applicable Eastman Kodak Company component specifications of Table II.

3.2.3.2 Payload Handling Equipment - Electrical requirements for the payload handling equipment shall be in accordance with the individual Eastman Kodak Company specifications of Table II.

3.2.3.3 Film Support Equipment - The electrical requirements of the film support equipment shall be in accordance with the individual Eastman Kodak Company specifications of Table II.

3.2.3.4 Special Tools - The electrical requirements of the special tools shall be in accordance with the individual Eastman Kodak Company specifications of Table II.

3.2.3.5 Special Test Equipment - The electrical requirements of the special test equipment shall be in accordance with the individual Eastman Kodak Company specifications of Table II.

3.2.4 Interfaces

3.2.4.1 Aerospace Flight Equipment - The flight payload electrical interface shall conform to the requirements of Eastman Kodak Company specification * which shall contain the following information:

a. Interface interconnections and pin assignments
b. Conducted noise specification
c. Test connector requirements, display and recording information
d. Umbilical test connector requirements, display and recording information
e. Overload protection requirements
f. Power requirements
g. Time data-signal configuration
h. Instrumentation signal information
i. Command structure

3.2.4.2 EMI Compatibility - The design of the camera payload shall reflect the requirements of Eastman Kodak Company specifications * .

3.3 Environmental Requirements

3.3.1 Photographic Subsystem - The subsystem shall be designed to complete a mission successfully in the encountered environments. These environmental requirements shall include all phases starting with shipment from the manufacturer's plant and ending with recovery and processing of retrieved film after lunar flight.

3.3.2 Camera Payload

3.3.2.1 General - The flight model payload shall comply with the environmental requirements of Eastman Kodak Company specification * . Included in

* To be supplied by a later revision.

these specifications are environmental conditions relating to the following life phases:

a. Storage and Transportation
b. Handling and Mating
c. Preflight
d. Powered flight
e. Earth-Parking orbit
f. Translunar Flight
g. Lunar orbit
h. Retrieval and Camera Payload Separation
i. Transearth Flight
j. Re-entry
k. Parachute Deployment to Impact
l. Water Impact and Recovery Film

The environmental characteristics considered are:

a. Vibration and Shock
b. Acceleration
c. Acoustic Noise
d. Temperature
e. Pressure
f. Humidity
g. Explosive or Corrosive Atmosphere
h. Condensation
i. Salt Spray, Sand and Dust
j. Fungus
k. Electromagnetic Interference (EMI)
l. Radiation

* To be supplied by a later revision.

3.3.2.2 Lens - Provisions shall be made by Eastman Kodak Company and (through interface agreement) by associate contractors to control the lens environment in accordance with Eastman Kodak Company specification * .

3.3.2.3 Stereo Mirror - Provisions shall be made by Eastman Kodak Company and (through interface agreement) by associate contractors to control the stereo mirror environment in accordance with Eastman Kodak Company specification * . It shall be the responsibility of Eastman Kodak Company to design, fabricate, install, and provide for the operation of the flight payload view-port door to introduce an acceptance thermal input to the stereo mirror and lens assembly. Interface requirements for installation are given in Eastman Kodak Company specification * . Details of port door operation are specified in 3.7.5.2 and Eastman Kodak Company drawing 1600-103.

3.3.2.4 Earth Re-entry - The associate contractor supplying the command module is responsible for the maintenance of all environmental conditions required in the command module. It is important that the film environment during re-entry into the earth's atmosphere and recovery sequences shall be in accordance with Eastman Kodak Company specification * . Attention should be devoted to preventing the injection of contaminants due to possible pressure differentials during this phase of the mission.

3.3.3 Deliverable Hardware

3.3.3.1 Aerospace Flight Equipment - The environmental requirements for the deliverable airborne models shall be in accordance with Eastman Kodak Company specification and with the applicable specifications of table IV.

* To be supplied by a later revision.

3.3.3.2 Aerospace Support Equipment - The environmental requirements of the aerospace support equipment shall be in accordance with the applicable specifications of table II.

3.3.4 Interfaces

3.3.4.1 Aerospace Flight Equipment - The environmental interface requirements to insure satisfactory mission operation of the integrated system shall be in accordance with Eastman Kodak Company specification * .

3.4 Mechanical Requirements

3.4.1 Photographic Subsystem - The photographic subsystem shall correlate and integrate the mechanical requirements of the aerospace flight equipment and the aerospace support equipment in a manner which ensures the compatibility necessary for the subsystem to meet its performance requirements.

3.4.2 Camera Payload - The mechanical requirements shall be in accordance with applicable Eastman Kodak Company specifications of table I.

3.4.2.1 Axes Orientation - The orientation and nomenclature of the flight payload axes are as follows:

Roll Axis X	Parallel to the longitudinal axis of the spacecraft; positive in the direction of the spacecraft velocity vector.
Yaw Axis Z	Perpendicular to the roll axis and in the orbit plane; negative in the direction of the area to be photographed.
Pitch Axis Y	Defined by the right-hand rule; mutually perpendicular to the yaw and roll axes at their intersection.

* To be supplied by a later revision.

Positive rotation about any of these axes shall be defined by the right-hand rule. The datum plane shall be at station 290.75 with Y and Z axes interescting the X axis at the center of the camera payload.

3.4.2.2 External Dimensions - The over-all dimensions and station positions of the camera payload shall be in accordance with Eastman Kodak Company drawing 1600-100. The subsystem shall extend from about station 205.75 to station 351.62 as defined by the associate contractor. The component support tube of the structure shall be approximately 36 inches in diameter. Additional detail, space envelope, and interfaces of Eastman Kodak Company specification * .

3.4.2.3 Weight and Center of Gravity - The maximum weight and center of gravity of the camera payload shall meet the requirements of Eastman Kodak Company specification 1600-104.

3.4.2.4 Moment and Products of Inertia - Calculated values of moments and products of inertia shall be supplied by Eastman Kodak Company in accordance with Eastman Kodak Company specification 1600-104.

3.4.2.5 Unbalanced Angular Momentum - The camera payload shall meet the unbalanced angular momentum requirements of Eastman Kodak Company specification 1600-104.

3.4.2.6 Material - All materials used for the film enclosure of the camera payload shall be chosen from a list of materials which do not adversely affect the photographic properties of the film. The material used for the camera payload shall be of the lightest weight possible consistent with good engineering practices. The material requirements for each component and assembly shall be in accordance with component drawings.

* To be supplied by a later revision.

3.4.2.7 Mechanical Alignment - The mechanical alignment tolerances of the camera payload shall be in accordance with applicable Eastman Kodak Company drawings and specifications. The maximum smear produced by variations in alignment shall be compatible with that specified in 3.7.4.2.

3.4.2.8 Structural Requirements - The structural requirements for the camera payload shall be in accordance with Eastman Kodak Company specification 1600-104.

3.4.3 Deliverable Hardware

3.4.3.1 Aerospace Flight Equipment - The mechanical requirements for the deliverable airborne models shall be in accordance with Eastman Kodak Company specifications 1600-106 and applicable specifications.

3.4.3.2 Aerospace Support Equipment - The aerospace support equipment mechanical requirements shall be in accordance with the applicable Eastman Kodak Company specifications of Table II.

3.4.4 Interfaces

3.4.4.1 Aerospace Flight Equipment - The C/P-CSM interface shall be in accordance with Eastman Kodak Company drawing 1600-100. The mechanical requirements for this interface shall be in accordance with Eastman Kodak Company specification 1600-104.

3.4.4.2 Stellar Index Camera - The C/P-SIC interface shall be in accordance with Eastman Kodak Company drawing 1600-101.

3.5 Optical Requirements

3.5.1 Photographic Subsystem - The photographic subsystem shall correlate and integrate the optical requirements of the aerospace flight equipment and aerospace support equipment to ensure conformance of the subsystem to its performance requirements.

3.5.2 Camera Payload - The C/P optical requirements shall be as follows:

3.5.2.1 Lens and Stereo Mirror

3.5.2.1.1 Focal Length - The nominal focal length of the lens system shall be 77 inches and shall be in accordance with Eastman Kodak Company specification * .

3.5.2.1.2 Aperture - The aperture of the C/P lens assembly shall be such that this aperture in conjunction with the focal length shall produce a nominal F-number of 3.95. The T-stop of the lens system for white light shall be 5.4 as demonstrated by appropriate calculation and appropriate reflectance and transmission measurements. There shall be a stereo mirror whose nominal position is at an angle of 37.5 degrees or 52.5 degrees to the optical axis of the lens. An aperture shall be attached to the stereo mirror with dimensions that limit the axial beam to no less than [redacted] diameter. The aperture, in conjunction with the stereo mirror, shall not cause more than 0.5 percent axial vignetting when the stereo mirror is moved to either of its two positions.

3.5.2.1.3 Alignment - The lens assembly shall be aligned in accordance with Eastman Kodak Company drawing 1600-103. The alignment of the C/P lens and stereo mirror assembly shall not cause a loss of image quality greater than allowed by this specification. The detail alignment tolerances on this alignment shall be in accordance with Eastman Kodak Company specification * .

3.5.2.1.4 Resolving Power - The on-axis resolution of the lens and stereo mirror shall be adequate to supply the photographic subsystem with the capability to meet the resolution requirements of section 3.7.

3.5.2.2 Exposure Unit

3.5.2.2.1 Focus Provisions - The camera payload shall provide focusing in accordance with Eastman Kodak Company specification * . A pre-focus correction shall be made to compensate for the shift in focus caused by the difference in object distance between operations at orbital altitude in a vacuum and the collimator setting at infinity in air in the laboratory.

3.5.2.2.2 Slit Aperture Plate - *

3.5.2.2.3 Film Drive Specifications - The exposure unit shall drive the film at any of * film drive velocities upon receipt of the appropriate electrical power frequencies from the film-drive electronics of 3.2.2.9. The appropriate film drive velocity shall be that velocity which most closely approximate the rate of motion of the image of the scene being photographed. It shall move the film with sufficient accuracy to prevent image degration, due to banding and excess smear, as required in Eastman Kodak Company specification * and this specification.

3.5.2.3 Lens and Camera Alignment - The lens and exposure unit shall be aligned in accordance with Eastman Kodak Company drawing * .

* To be supplied by a later revision.

3.5.3 Deliverable Hardware

3.5.3.1 Aerospace Flight Equipment - The optical requirements for the deliverable airborne modles shall be in accordance with Eastman Kodak Company specification * and applicable specifications.

3.5.3.2 Aerospace Support Equipment - The aerospace support equipment optical requirements shall be in accordance with applicable Eastman Kodak Company specifications of table II.

3.5.3.2.1 Collimator Assembly - The collimator shall require a parabolic mirror and associated optical equipment capable of meeting the requirements of Eastman Kodak Company specification * for testing the optical characteristics of the photographic payload.

3.5.4 Interfaces

3.5.4.1 Aerospace Flight Equipment - The optical interface requirements to insure satisfactory orbital operation of the integrated system shall be in accordance with Eastman Kodak Company specification 1600-104.

3.6 Film Requirements

3.6.1 Film Type - The film shall be a composite material consisting of a thin flexible sheet with a light-sensitive emulsion coating. The film used shall be classed as a Kodak high-definition aerial film on Estar thin base.

* To be supplied by a later revision.

3.6.2 Physical Characteristics - The subsystem will use commercially available film. The physical characteristics of the film shall be in accordance with Eastman Kodak Company specification * .

3.6.3 Photographic Characteristics - The film shall have photographic characteristics in accordance with Eastman Kodak Company specification *.

3.6.4 Film Quantity - The camera payload shall have a capacity of 3000 feet of Estar thin-base film whose maximum thickness including emulsion coating is no greater than 0.0033 inch.

3.7 General Requirements of the Photographic Subsystem

3.7.1 Launch and Injection Into Earth Orbit - The environmental conditions during the launch and injection into earth orbit shall be in accordance with Eastman Kodak Company specification *. All units and assemblies within the flight payload portion of the spacecraft shall be inactive during launch sequence, with the exception of film-supply reel torque motor which shall be energized prior to lift off. This voltage shall be maintained throughout all powered flight sequences occurring during the mission prior to separation of the retrieval cassette.

3.7.2 Space-Flight Requirements

3.7.2.1 Environmental - The flight payload shall be capable of operating within the environmental conditions of space in accordance with Eastman Kodak Company specification *.

3.7.2.2 Standard Orbit - The standard orbit shall be considered to be a rear circular lunar orbit of stable-nominal altitude within the range of 30 to 80 n.mi. having a maximum inclination of 10° (retrograde or direct).

*To be supplied by a later revision.

3.7.2.2.1 Altitude - The flight payload shall meet the requirements of this specification when operating in an altitude range of 30 to 80 nautical miles above its nadir on a sphereoid of radius 938.5 nautical miles which approximates the shape of the moon.

3.7.2.2.2 Inclination - The flight payload shall meet the requirements of this specification when in lunar orbits whose orbital inclination may vary between 170 and 175.9 degrees.

3.7.2.2.3 Eccentricity - The flight payload shall meet the requirements of this specification when launched into an orbit which maintains the sun angle during photography between the angles of * and * . Orbits which do not remain within this sun angle range will be accompanied by a decrease in CP performance.

3.7.2.3 Orbit Particularity - The flight payload shall comply with the requirements of this specification only when the command service module is operating in the orbit specified in 3.7.2.2, and shall not comply during maneuvers required to return the payload to the specified orbit as during plane changes. Maintaining the command service module in the specified orbit shall be the responsibility of an associate contractor.

3.7.2.4 Attitude Control - The flight payload shall be capable of meeting the requirements of this specification only when the CSM attitude is held within the limints which produce smear less than or equal to the tolerance given in this specification. Attitude control shall be the responsibility of a subsystem supplied by an associate contractor.

* To be supplied by a later revision.

3.7.2.5 Communications - The flight payload shall receive commands from and transmit instrumentation voltages to a communications subsystem provided by an associate contractor.

3.7.2.6 Tracking - Tracking and vehicle ephemeris data shall be supplied by an associated subsystem which is the responsibility of an associate contractor.

3.7.3 Coverage

3.7.3.1 Area of Interest - The flight payload shall be capable of photographing lunar areas within boundaries which encompass the 10 specified landing sites. The northern and southern boundry is set by the inclination of the orbit and the eastern and western boundaries are basically set by the lunar orbit injection time and the duration of the mission as defined by this specification.

3.7.3.2 Obliquity Aiming - The flight payload shall be capable of photographing areas to the left and right of the CSM ground track when rotated up to * degrees from the vertical about its longitudinal axis when the vehicle is in the specified altitude range of 3.7.2.2.1.

3.7.3.3 Modes of Operation - The flight payload shall be capable of taking five types of photographs. These types are:

a. Stereo pairs,
b. Stereo/mono pairs,
c. Continuous strip,
d. Alternate-orbit strip stereo,
e. Contiquous stereo strips.

* To be supplied by a later revision.

3.7.3.3.1 Stereo Pairs - A stereo pair consists of two photographs of the same area. These photographs are taken looking forward and aft with respect to the local vertical from consecutive positions along the orbit track.

3.7.3.3.2 Stereo/mono Pairs - A stereo/mono pair consists of two photographs of partially overlapped coverage areas. These areas are slightly displaced with respect to each other in track and in essence combine to define a total target area which is slightly larger than the coverage a normal stereo pair can provide. The first frame is taken on a forward-looking stereo angle and the second frame is taken at an aft-looking stereo angle.

3.7.3.3.3 Continuous-Strip Photography - A continuous-strip photograph is a single-strip photograph nominally taken at either stereo angle or a coverage area.

3.7.3.3.4 Alternate-Orbit Strip Stereo - Alternate-orbit strip stereo consists of a series of partially overlapping (approximately 60 percent) strip photos where each alternate strip photograph employes the opposite stereo look angles.

3.7.3.3.5 Contiguous Stereo Strips - Contiguous stereo strips are similar to alternate-orbit strip stereo in that each stereo frame is obtained during successive orbits. The difference lies in the fact that vehicle roll is employed with contiguous stereo strip to provide a second frame coverage identicle to the first frame coverage. Thus 100 percent stereo coverage of a strip area is achieved in two phases over the area.

* To be supplied by a later revision.

3.7.3.4 Photographic Format - The photographic format shall be in accordance with Eastman Kodak Company drawing * . The resultant time data tracks of this format shall have a minimum density of * at the slowest film velocity (IMC) and a minimum density above fog of * at the fastest film velocity (IMC) after the completion of processing in accordance with Eastman Kodak Company specification * . The film format shall record images through the smear slits. This smear record provides a means of checking the roll and yaw attitude with respect to the nadir when appropriate measurements are made.

3.7.3.5 Quantity of Photography - The payload shall be capable of photographing 3000 feet of film in lunar orbit independent of the photographic mode of operation. (modes are outlined in paragraph 3.7.3.3)

3.7.4 System Resolution - The camera payload shall provide a geometric mean ground resolution of about [redacted] along the centerline of the format at a 2:1 contrast ratio (apparent contrast at the camera) for photography at a payload altitude of 30 nautical miles and sun altitudes between 15 and 45 degrees. To facilitate test procedures this requirement is restated in terms of the resolution measured on film of the flight payload and the allowable smear tolerances for the CSM and other associated subsystems. Conformance to subsystem specifications delineating subsystem resolution and smear requirements shall constitute implicit conformance to the system resolution requirements.

3.7.4.1 Flight Payload Resolution - The flight payload resolution shall be tested utilizing a 2:1 low contrast target of the type defined in figure 7 of MIL-STD-150A. When tested in this manner, the average value of the geometric mean of the horizontal and vertical resolution shall not be less than * lines/millimeter to meet the design goal and * lines/millimeter as a minimum requirement in the region of ±0.5° about the optical axis (0°).

* To be supplied by a later revision.

Conformance to this requirement shall be demonstrated at camera film velocity of * inches per second using the * inch wide slit when photographing the target introduced above and defined in Eastman Kodak Company specification * . Only flight payload smear contributions are included in the design goal resolution of * lines/millimeter. Note that * and * lines/millimeter payload resolution, when combined with smear contribution from other subsystems, corresponds to * and *foot ground resolution respectively at an altitude of 30 nautical miles. At an altitude of 80 nautical miles, this smear corresponds to ground resolutions of * and * feet respectively. Those requirements include a 3-sigma tolerance on the camera payload components as follows:

a.	Crab compensation	*
b.	Crab servo error	*
c.	Film drive (discrete * percent steps)	* 0.2 percent
d.	Film-drive vibration amplitude	0.4 mm/sec.
e.	Film-drive drift	0.2 percent
f.	Stereo servo error	±0.22°
g.	Mirror mounting error (crab)	±0.05°
h.	Mirror mounting error (stereo)	±0.05°
i.	Testing errors	± *

3.7.4.2 Smear Tolerances - The maximum allowable smear produced at the center of the filed by all smear contributors, including those given in the notes of section 6.1, shall be as follows for operation at an altitude of 30 and 80 nautical miles.

* To be supplied by a later revision.

Command Service Module

Photography at 30 Nautical Miles	Photography at 80 Nautical Miles
S_x (SCM) = * feet	S_x (SCM) = * feet
S_y (SCM) - * feet	S_y (SCM) - * feet

The symbols S_x and S_y represent the summation of smear contributors in accordance with the procedures of section 6.1. Conformance to subsystem smear requirements shall constitute conformance to this requirement.

3.7.4.2.1 Flight Payload Smear - That portion of the total allowable smear allocated to the flight payload shall be as follows:

Flight Payload

Photography at 30 Nautical Miles	Photography at 80 Nautical Miles
S_x (CP) = * feet	S_x (CP) = * feet
S_y (CP) = * feet	S_y (CP = * feet

The method of computing these smear contributions shall be in accordance with the method used in sample calculation of section 6.1.

3.7.4.2.2 Allocation of Smear to Other Subsystems - Conformance to the system requirements of 3.7.4 and 3.7.4.2 shall be contingent upon conformance to the following additional smear tolerances at an altitude of 30 and 80 nautical miles.

* To be supplied by a later revision.

Service Module (Not including CP)

	Photography at 30 Nautical Miles	Photography at 80 Nautical Miles
On-Axis	S_x (SM) = * feet	S_x (SM) = * feet
	S_y (SM) = * feet	S_y (SM) = * feet
Yaw vibration contribution (Off-axis)	S_y (SM) = * feet	S_y (SM) = * feet

Tracking (in absence of V/h sensor)

	Photography at 30 Nautical Miles	Photography at 80 Nautical Miles
Knowledge of altitude	S_x (ALT) = * feet	S_x (ALT) = * feet

3.7.4.2.3 Site Acquisition - Acquisition of a site defined by a definite boundry will require the following knowledge of vehicle position and attitude (2σ)

Altitude	0.33 n.mi
Cross track	0.4 n.mi
Intrack	0.1 n.mi
Pitch attitude	±0.5 degrees

* To be supplied by a later revision.

3.7.5 Flight Payload Programming

3.7.5.1 Supply Spool Torque Motor - The torque motor shall be turned on prior to launch and shall remain on throughout the powered flight portion of the launch and injection into orbit sequence, and during all other powered flight sequences ocurring during the mission prior to separation of the retrieval cassette.

3.7.5.2 Flight Payload View-Port Door - When the port is open it shall not vignette the light beams to the lens-mirror system. The view-port door shall be operned for as short a time as is consistent with completing the photographic mission. The door will be opened just prior to the start and closed immediately after the completion of a photographic or focus pass. The view-port door shall be open during any photographic operation or focus sequence. Requirements for view-port door operation shall be in accordance with Eastman Kodak Company specification * and drawing * .

3.7.5.3 Stereo Mirror Motion - The stereo mirror shall be capable of achieving two positions which permit photogrrphy at stereo angles of ±15° from vertical. The resolution requirements on CP performance are applicable only when commanded movement of the stereo mirror is satisfied prior to the time when the exposure unit has achieved the commanded image motion compensation velocity. The stereo mirror shall take no more than 3.2 seconds to move from one position to the opposite position.

3.7.5.4 Obliquity Aiming - Obliquity aiming shall be accomplished by a rotation of the entire command service module. This maneuver shall be accomplished by an attitude control sybsystem which is the responsibility of an associate contractor. The command for obliquity position shall be

* To be supplied by a later revision.

received in sufficient time to allow completion of motion prior to camera operation. The minimum range of obliquity positions shall be ± * degrees in steps of * degrees. The obliquity maneuver shall not prohibit completion of any required mode of operation.

3.7.5.5 Instrumentation - CP instrumentation shall be turned on when the camera payload ON command is in effect. The instrumentation requirements shall be in accordance with Eastman Kodak Company specification 1600-106.

3.7.5.6 Preparation for Film Retrieval - The preparations for the retrieval of the exposed film shall provide the maximum protection for the photographic latent image and maximum reliability for the separation sequence. Under normal operations, sufficient camera operation will be programmed to empty the film-supply cassette and achieve a telemetry indication and all film has been transported to the retrieval cassette. When the supply of film is exhausted, or the film is cut, film tension will drop and the take-up motor shall run continuously until CP power is off.

Devices provide by Eastman Kodak Company shall cut thefilm, seal the retrieval cassette, and separate it from the camera payload.

To meet these requirements, the following sequency shall be performed.

a. Empty the film-supply cassette
b. Program an additional 300 feet of film run-out
c. Activate the cutter-sealer
d. After sealing, turn off CP power
e. Separate the film chute
f. Transfer exposed film to the command module

3.7.5.7 Photographic Subsystem Programming - The photographic subsystem programs are not the responsibility of this subsystem contractor, however, it shall be required that such programming comply with the camera payload restrictions necessary for the successful operation of the photographic subsystem.

3.7.6 Focus Control by Subsystem - The photographic subsystem shall provide a focus control system as part of the flight hardware. This system shall have the ability to sense camera focus, and adjust to correct focus if necessary while in orbit and when an acceptable image velocity for the focus sequence is present at the film plane as specified in Eastman Kodak Company specification * .

3.7.7 Handling of Recovered Film - After earth landing of the command module the handling of the film shall be in accordance with Eastman Kodak Company specification * .

3.7.8 Operational Film Processing - The photographic subsystem shall meet the requirements of this specification provided the film is processed to meet the requirements of Eastman Kodak Company specification * .

3.8 Deliverable Hardware

3.8.1 Aerospace Flight Equipment

3.8.1.1 Structural Mock-Up - The structural mock-up shall be a nonoperating model of the complete flight payload. It shall simulate size, but not weight or any other characteristics. It shall be dimensionally accurate at the exterior envelope and at the mating interfaces, including electrical and mechanical connections. Requirements for the structural mock-up shall be in accordance with Eastman Kodak Company specification * .

* To be supplied by a later revision.

3.8.1.2 Thermal Model Payload - The thermal model payload shall contain simulated electrical loads and instrumentation to permit the accurate determination of temperature distribution under simulated flight environments. The thermal model payload shall represent the thermal characteristics which exist in flight payloads. Requirements for the thermal model payload shall be in accordance with Eastman Kodak Company specification * .

3.8.1.3 Engineering Model - This model shall be representative of the first flight model payload design, but shall be modified as required or indicated by the results of engineering review or testing. The unit shall be designed to meet applicable specifications for flight payloads, but will not be required to pass the environmental testing of these specifications. Requirements of the engineering model shall be in accordance with Eastman Kodak Company specifications * .

3.8.1.4 Flight Model Payload - The flight payload models shall be comprised of assemblies specified by table I. The flight model payload shall expose film in orbit upon receipt of command from associated subsystems; store unexposed film from launch until time of exposure and wind exposed film into the retrieval cassette for the retrieval phase. The flight payload shall include structures and mechanism required for orbital operation of the equipment except those which are included in other subsystems, as defined in Eastman Kodak Company specification * .

The requirements of the flight payload shall be in accordance with Eastman Kodak Company specification * .

* To be supplied by a later revision.

3.8.1.4.1 Reliability Test Model - The reliability test model shall be fabricated and assembled to be identical with the flight model payload, Eastman Kodak Company specification * and shall be updated in a similar fashion. This model shall be subjected to reliability testing to establish modes of failure under environmental extremes and to accumulate the maximum possible operating time. The reliability test model shall be tested in accordance with Eastman Kodak Company specification *.

3.8.2 Aerospace Support Equipment - The aerospace support equipment shall be in accordance with applicable Eastman Kodak Company specification listed in Table II.

3.8.3.1 Payload Test Equipment - It provides the flight payload with signals, power inputs, and test points for the outputs of all transducers.

3.8.2.1.1 Test Console - The test console consists of all components and equipment which are essential to supply the power for operating the camera payload and any associated test collimator equipment. In conjunction with the collimator, the console provides the stimuli required to induce proper flight payload operations and a display of the output of all desired flight payload circuit voltages.

3.8.2.1.2 Portable Test Set - The portable test set is a portable, less versatile, version of the test console. It provides the flight payload with signal and power inputs for limited operation when the flight payload is away from the collimator, and test points for the outputs of all transducers in the flight payload.

3.8.2.1.3 Line-Of-Sight Test Set - The line-of-sight test set shall determine position accuracy of the stereo and crab servo drives. The test set shall provide for a line-of-sight alignment of the complete flight payload optical

*To be supplied by a later revision.

assembly with respect to a flight payload reference surface. The test set shall check alignment subsequent to environmental testing and handling. The line-of-sight test set shall be in accordance with Eastman Kodak Company specification *.

3.8.2.1.4 Leak Rate Test Set - Specifica sections of the flight payload shall be required to maintain an internal air pressure in accordance with Eastman Kodak Company specification *. The leak rate test set shall determine the rate at which this internal pressure changes when the flight payload pressure differentials are equivalent to those existing in an operating environment. A leak detector shall be required for locating the source of leaks.

3.8.2.1.5 Cable Test Point Board (Set) - The cable test point board shall be a rack and test-jack panel arrangement including insertion cables which may be introduced between various C/P subassemblies when mounted on the camera payload.

3.8.2.1.6 Breakout Box - The breakout box shall be used at the CSM-C/P interface as an insertion box to provide switching and break-out capability during functional and integration tests, and trouble shooting.

3.8.2.1.7 Secondary Standard - The secondary standard shall be capable of calibrating meters, measuring equipment and recorders in the electrical test equipment and correlating these calibrations with laboratory or primary standards.

3.8.2.2 Payload Handling Equipment - The payload handling equipment listed in Table II shall be capable of handling the camera payload. Table II lists the individual specification number for each of the payload handling equipment items. A description of individual items is as follows:

*To be supplied by a later revision.

3.8.2.2.1 Mobile Hoist - The general purpose mobile hoist shall be used for general handling, e.g. replacement of parts and assemblies.

3.8.2.2.2 Truck - The truck is a mobile platform for supporting the cradle and its contents horizontally during assembly, and transportation between assembly and test stations.

3.8.2.2.3 Lifting Yoke - The CP lifting yoke is a structure used to attach a hoist to the cradle containing the camera payload.

3.8.2.2.4 Erector - The erector shall be capable of rotating the cradel and contents from a horizontal to vertical position and back again without vibration, shock damage, or distortion to the cradle contents. The erector shall be required equipment when the camera payload is removed from its cradel.

3.8.2.2.5 Shipping Container - The CP shipping container will receive the camera payload and its cradel. The shipping container shall minimize injurious effects of transportation and incident handling upon the contents. It shall provide and maintain a clean inert interior atmosphere.

3.8.2.2.6 Integration Lifting Yoke - The CP integration lifting yoke is a structure that shall, in conjunction with a hoist, provide support for the camera payload during and after removal from the cradle when in a vertical position. It may be used to lower the flight payload into the service module during mating.

3.8.2.2.7 Cradle - The cradle shall be a rigid handling device to hold, protect and provide support for the camera payload. It shall be designed to support the camera payload in a manner similar to that of the service module.

3.8.2.3 Film Support Equipment - Table II lists the specifications for a representative list of individual items of film support equipment. A description of the individual items is as follows:

3.8.2.3.1 Film Splicer - The film splicer shall be capable of making thin, uniform reliable splices on 9.5-inch wide film which shall pass through the camera and film-transport system.

3.8.2.3.2 Film Loading Kit - The film loading kit shall consist of items essential for loading and threading the film into camera payload before or after mating with the service module.

3.8.2.3.3 Film Viewer - The film viewer shall provide a suitable means of viewing the processed film output of the camera payload for visual and microscopic inspection on an illuminated viewing table. Suitable film handling and measuring equipment shall also be provided in the design of the record viewer.

3.8.2.4 Special Tools - Table II lists the specifications for a representative list of individual special tools used for "in-house" operation by the payload manufacturer.

3.8.2.5 Special Test Equipment - Table II lists the specifications for a representative list of individual special test equipment used for "in-house" operations by the payload manufacturer.

3.9 General Requirements

3.9.1 Manufacturing Standards - The photogrrphic subsystem components shall conform to the manufacturing standards of Eastman Kodak Company standard 401-119.

3.9.2 Interchangeability - Components of all equipment, of the same model, regardless of series designation, exclusive of experimental and prototype systems, shall be interchangeable electrically and mechanically after updating to the latest revisions.

3.9.3 Ease of Assembly and Maintenance of Equipment - Mechanical and electrical components shall be designed and constructed to require a minimum of skill, experience and time necessary to assemble and maintain them. The design shall eliminate, in so far as possible, any misassembly of parts or mismating of electrical connections. Component design and construction shall minimize the need for holding or supporting these components during final positioning and fastening.

3.9.4 Service Life - Service life is defined as operational or "wear time" from final payload assembly through the flight operational phase. This includes all performance at Eastman Kodak Company and the John F. Kennedy Space Center as well as flight operation.

The complete flight payload shall be able to survive a service life of * stereo pairs utilizing * feet of film, or its equivalent. This equivalent shall be considered operation of the flight payload which does not cause any part of the flight payload to be operated for an accumulated time or under a stress greater than would be employed in taking the above defined stereo pairs.

Though the duty cycles of individual components vary, the life of these individual components shall be adequate to allow the completion of the subsystem service life. The individual component service life shall be given in the applicable component specification.

*To be supplied by a later revision.

3.9.5 Reliability - A primary objective of the design and manufacture of the photographic subsystem is to achieve high reliability in accordance with Eastman Kodak Company specification 401-122. The reliability requirements shall be to achieve a 95 percent probability of obtaining 60 percent information return for the performance requirements listed below:

a. Capable of being placed into a lunar orbit and performing its functions in that environment.

b. Resolving power equivalent to 12 inches from a 30-nautical-mile altitude for a MIL-STD0150A target at 2:1 contrast and at the center of the frame, as specified in section 3.7.4.

c. Area Coverage - On command, and in a maximum of eight days of lunar orbit, be capable of exposing the entire film supply in modes of operation specified in this document.

d. Capable of protecting the film during launch, earth-moon transit and on orbit prior to exposure, performing the necessary film handling tasks specified in this specification, and protecting the exposed film during return to the earth's surface.

3.9.6 Disposition of Variances - Variances from the requirements of this specification, drawings and procedures referenced herein and Eastman Kodak Company standard 401-119 shall require Eastman Kodak Company approval.

3.9.7 Contract Conformance - Conformance to the contract is executed when the photographic subsystem conforms to the requirements of this specification.

3.9.8 Human Engineering - Where feasible the provisions of Eastman Kodak Company standard 401-108 shall be followed.

3.9.9 Safety of Personnel

3.9.9.1 Mechanical - The design of all equipment shall provide maximum convenience and safety to personnel when installing, operating, and maintaining or replacing the equipment. Sharp projections on edges of cabinets, doors and similar parts shall be avoided.

3.9.9.2 Electrical - Provisions shall be made to prevent personnel from accidently coming in contact with voltages in excess of 40 volts, including potentials on charged capacitors when the subsystem equipment is in normal operating condition.

3.9.9.2.1 Ground Potential - The design and construction of all equipment shall be such that all external parts, shields and electrical returns other than instrumentation returns shall be at ground potential at all times.

3.10 Documentary Requirements

3.10.1 Drawings - Drawings, associated lists and documents prepared by Eastman Kodak Company defining requirements of design, procurement, fabrication and assembly of deliverable equipment shall be prepared in accordance with section 5 of Eastman Kodak Company document 401-122.

3.10.2 Specifications - Eastman Kodak Company shall generate specifications completing the performance requirements and description for the equipment indicated in this specification.

3.10.3 Manuals - An integrated series of equipment-oriented (Utility) technical manuals shall be provided by Eastman Kodak Company. These manuals shall be available with delivery of equipment.

3.10.4 Receiving, In-Process and Final Inspection - Inspection reports shall be generated and maintained by Eastman Kodak Company. These reports shall include receiving, in-process and final inspection data in accordance with 2.3 and 2.5 of Eastman Kodak Company document 401-122.

3.10.5 Calibration - Records of the calibration of all measuring and test equipment shall be generated and documented in accordance with 2.8 of Eastman Kodak Company document 401-122.

3.10.6 Inspection and Test Procedures - Qualification and acceptance test procedures for the subsystem that demonstrate conformance to the requirements of this specification shall be prepared and documented by Eastman Kodak Company, in accordance with section 1.3.12 of Eastman Kodak Company document 401-122.

3.10.7 Performance Record- All data including operating time and malfunction reports, generated through tests shall be recorded by serial number and preserved as a performance record in the log book defined by Eastman Kodak Company drawing * .

4. QUALITY ASSURANCE PROVISIONS

The quality control system requirements of MIL-Q-9858 and Eastman Kodak Company document 401-122 shall apply. Inspection and testing of the subsystem shall be in accordance with provisions listed in this section.

4.1 Classification of Inspections and Tests - The inspection and testing of the subsystem shall be classified as follows:

a. Acceptance Inspection
b. Acceptance Test
c. Qualification Test
d. Reliability Test

4.2 Acceptance Inspection - The acceptance inspection shall be performed on each unit of deliverable hardware in accordance with 2.10 of Eastman Kodak Company document 401-122. The inspection procedure and report format shall be in accordance with section 2.12.1 of Eastman Kodak Company document 401-122.

The acceptance inspection shall include the following:

4.2.1 Workmanship Inspection - All parts, subassemblies and assemblies shall be inspected for conformance to the manufacturing standards of Eastman Kodak Company standard 401-119.

4.2.2 Drawing and Specification Conformance - All parts, subassemblies and assemblies shall be inspected for conformance to their respective drawings and this specification.

4.3 Acceptance Test - The acceptance test shall be performed by Eastman Kodak Company on each unit of deliverable hardware in accordance with 2.11 of Eastman Kodak company document 401-122. The test procedure and report format shall be in accordance with section 2.12.2 of Eastman Kodak Company document 401-122. The acceptance tests shall include the following:

4.3.1 Performance Test - The subsystem equipment shall be tested for its ability to conform to the performance requirements in section 3.

4.3.2 Environmental Test - The subsystem equipment shall be tested to the environmental requirements of section . Following completion of these tests the subsystem shall be visually inspected. The performance tests of 4.3.1 shall be repeated as required.

4.3.3 EMI Test - The subsystem shall be tested for its ability to conform to the EMI requirements of section 3.

4.4 Qualification Test - Qualification tests shall be performed on one flight payload to demonstrate the capability of the design to meet qualification levels and performance requirements of Eastman Kodak Company specification *. The flight payload selected shall pass an acceptance inspection and an acceptance test prior to a qualification test. The reliability test models of 3.8.1.5.2 shall be used in this qualification test. The qualification test procedure and report format shall comply with section 3.8.3 of Eastman Kodak Company document 401-122 and shall include:

4.4.1 Performance Test - The camera payload shall be tested for its ability to comply with the performance requirements of section 3.

4.4.2 Environmental Test - The camera payload shall be subjected to the environmental requirements of section 3.3. Following completion of these tests the camera payload shall be visually inspected for damage, and the test of 4.4.1 shall be repeated.

4.4.3 Lift Tests

4.4.3.1 Camera Payload - The service life capability of the camera payload shall be evaluated for compliance with requirements of Eastman Kodak Company specification 1600-106 and this specification.

4.4.3.2 Aerospace Support Equipment - All items of ground equipment shall be designed for compliance with service life requirements of applicable Eastman Kodak Company specifications. Life tests shall not be performed.

4.4.4 EMI Test - The camera payload shall be tested for its ability to conform to the EMI requirements of section 3.

4.4.5 Test Diagnosis - Following the qualification test, diagnosis shall be made of any impairment of the performance of the camera payload. The results of the diagnosis shall be included in the qualification test report.

4.6 Acceptance Tests - The flight model payloads and aerospace support equipment shall be acceptance tested as follows:

4.6.1 Flight Model Payloads - Acceptance tests shall be performed on each flight model payload. The test procedures shall comply with 3.10.6 and shall be in accordance with Eastman Kodak Company specification 1600-106 and shall include, but not be limited to the following:

4.6.1.1 Visual Inspection - All parts, subassemblies and assemblies of the payloads shall be inspected for conformance to the manufacturing standards, Eastman Kodak Company standard 401-119.

4.6.1.2 Drawing Conformance - All parts, subassemblies and assemblies of the payloads shall be inspected for conformance to their respective drawings.

4.6.1.3 Performance Tests - The flight payload models shall be tested for ability to comply with the requirements of Eastman Kodak Company specification 1600-106.

4.6.2 Aerospace Support Equipment - Acceptance tests shall be performed on all aerospace support equipment. The acceptance test procedure shall comply with 3.10.6 and shall be in accordance with applicable Eastman Kodak Company specifications and shall include but not be limited to the following:

4.6.2.1 Visual Inspection - All parts, subassemblies and assemblies of the ground equipment shall be inspected for conformance to the manufacturing standards, Eastman Kodak Company standard 401-119.

4.6.2.2 Drawing Conformance - All parts, subassemblies and assemblies of ground equipment shall be inspected for conformance with their respective drawings.

4.6.2.3 Performance Tests - All aerospace support equipment shall be tested for ability to meet the requirements of individual specifications of Table II.

4.6.3 Other Equipment - Other deliverable airborne equipment and mock-ups shall be subjected to performance tests in accordance with applicable specifications for each item.

4.6.4 Environmental Acceptance Tests

4.6.4.1 Flight Model Payloads - Each payload shall be subjected to the acceptance vibration test levels specified in Eastman Kodak Company specification *.

4.6.4.2 Aerospace Support Equipment - Environmental acceptance tests of aerospace support equipment shall not be required.

4.7 Reliability Testing - A series of tests shall be performed utilizing the reliability test models to estimate safety margins and investigate modes of failure, due to extremes of environmental or operating conditions or due to extended operation (life testing). Results of these tests, together with results of qualification testing and applicable testing of other airborne models listed in Table IV shall constitute fulfillment of the laboratory test program requirements.

4.8 Test Conditions

4.8.1 Calibration - The alignment and calibration of all measuring and test equipment for the subsystem and the recorded data shall be in accordance with the requirements of 3.10.5.

4.8.2 Atmospheric Conditions

4.8.2.1 Flight Model Payloads - The atmospheric conditions for all flight payload tests, shall be in accordance with the temperature, barometric pressure and relative humidity requirements of Eastman Kodak Company specification *.

4.8.2.2 Aerospace Support Equipment - The atmospheric conditions for all items of aerospace support equipment tested shall be in accordance with operating and nonoperating conditions of applicable Eastman Kodak Company specification of Table II.

4.8.3 Electrical Conditions - The electrical inputs and outputs of the subsystem components under test shall be in compliance with section 3.

5. PREPARATION FOR DELIVERY

5.1 Camera Payloads - The camera payload shall be packed and packaged in the camera payload shipping container, Eastman Kodak Company specification *.

5.2 Aerospace Support Equipment - All items of aerospace support equipment shall be suitably packed, packaged and marked for shipment by common carrier. The packing shall provide protection for the equipment to withstand the general environmental conditions incident to handling, transportation and storage commensurate with the method of shipment.

Where practical, each component shall be packed separately to minimize size and weight. Shipping and handling of the equipment shall be supervised at every stage by responsible personnel. All items shall be caution placarded in prominent locations in order to minimize the possibility of handling mishaps.

5.2.1 Packaging (Separate Components or Items) - All subassemblies and assemblies for shipment as separate items (other than complete payloads) shall be cleaned, labeled, and sealed with their identification in transparent plastic bags. The bags shall be partially evacuated before sealing. Boxes shall not generate dirt or dust and shall be suitable for use or temporary storage in a clean room.

5.2.1.1 Major Assemblies - The major assemblies after cleaning and sealing in plastic bags as above, shall be packed in fitted and padded boxes. The boxes shall be reusable and shall be equipped with hinges and latches. Each box shall bear proper identification.

*To be supplied by a later revision.

5.2.1.2 Small Parts - Small parts, such as screws, nuts, retaining rings, etc., shall be cleaned and sealed in plastic bags. There shall be reasonable quantity of parts, and only one part number per bag.

5.3 Packing - All parts, subassemblies and assemblies, as packaged, shall be crated for shipment as follows:

a. Major assemblies in fitted boxes shall be crated individually.

b. Other assemblies and subassemblies shall be crated individually.

c. Small parts in plastic bags, shall be grouped and each group crated individually.

5.4 Packing List - A list of all parts included in a crate shall be placed immediately beneath the cover of the crate.

5.5 Warning Notice - A warning notice which indicates that the plastic bags shall not be opened prior to assembly due to cleanliness requirements, shall be prominently displayed on each list and on each plastic bag.

6. NOTES

6.1 Smear Allocation and Subsystem Performance Tolerances - If the location and attitude of the orbiting satellite are known, it is theoretically possible to determine a film speed that would comepnsate almost exactly for image motion along the center line of the photograph. Errors in knowledge of satellite location and attitude, the small changes in attitude during exposure, vibrations in the film-drive mechanism and the discreteness of the film-velocity steps can cause slight errors in image motion compensation that will produce smear.

The formulas in table V give the X and Y components of the object smear on the ground at the center of the field. The total smear $\overline{S}$ is defined by the vector equation $\overline{S} = (\overline{V}_g - \overline{V}_f)\ T$. In this equation $\overline{V}_g$ is the apparent velocity in feet per second of the point of intersection of the lens axis with the lunar surface, $\overline{V}_f$ is the velocity in feet per second of the film as projected on the surface at this same point, and T is the duration of exposure in seconds. The vector difference $(\bar{V}_g - \bar{V}_f)$ is determined by the use of formulas in table V for vertical photography and photography at oblique and stereo positions and is tabulated for an altitude of 30 and 80 nautical miles in Table VI.

Table V

X and Y Components of Object Smear on Ground*

*To be supplied by a later revision.

Table VI

Summary of Image-Motion Errors at 30 and 80 N. Mile Altitude*

*To be supplied by a later revision.

Table N-2

Summary of Image Motion Errors
Nominal Tolerances and Nadir V/h Sensing

*Smear Contributor	Tolerance	2σ Variability	Tolerance Allocation	30 N.M. Alt. Across slit Microns-X	30 N.M. Alt. Along slit Microns-Y	80 N.M. Alt. Across slit Microns-X	80 N.M. Alt. Along slit Microns-Y
1. V/h sensor errors	± 0.5%	± 0.33%	C/P	1.75	0	.226	0
2. Roll attitude control	± 0.75°	± 0.5°	CSM	0	0	0	0
3. Pitch attitude control	± 0.75°	± 0.5°	CSM	2.45	0	.85	0
4. Yaw altitude control	± 0.75°	± 0.5°	CSM	0	4.74	0	1.64
5. Roll rate control	± 0.015°/sec	± 0.01°/sec	CSM	0	3.28	0	3.28
6. Pitch rate control	± 0.015°/sec	**No contribution	CSM	0	0	0	0
7. Yaw rate control	± 0.015°/sec	± 0.01°/sec	CSM	0	.88	0	.88
8. Crab (steps and servo)	Not used	-	C/P	-	-	-	-
9. Film drive vibration	0.4 mm/sec	0.267 mm/sec	C/P	2.66	0	2.66	0
10. Stereo servo error	± 0.22°	± 0.15°	C/P	1.47	0	.51	0
11. Film velocity steps	± 0.25%	± 0.30%	C/P	1.57	0	.54	0
Film velocity drift	± 0.2%						
12. Roll alignment	± 0.04°	± 0.027°	CSM	0	0	0	0
13. Pitch alignment	± 0.04°	± 0.027°	CSM	.13	0	.05	0
14. Yaw alignment	± 0.10°	± 0.067°	CSM	0	.63	0	.22
15. Mirror mounting (crab)	± 0.05°	± 0.33°	C/P	0	.32	0	.10
16. Mirror mounting (stereo)	± 0.05°	± 0.033°	C/P	.32	0	.11	0
17. Knowledge of focal length	± 0.1 In.	± 0.067 Inches	C/P	.46	0	.16	0
		--		X	Y	X	Y
Total smear combined for T = .01 sec. exposure (microns)				[redacted]		[redacted]	[redacted]
Dynamic resolution (1/mm) 2:1 contrast							
Static resolution (1/mm) 2:1 contrast						25.4	24.9
Ground resolution (inches)							
Geometric mean ground resolution (inches)						25.2	

*Possible disturbances and vibrations produced by the spacecraft mechanisms or astronauts are not included.
**Included in Item 1

Table N-1

Image Plane Smear Equations

Knowledge of Altitude	$X_1 = -W\,\Delta h/h$	$Y_1 = 0$
Roll	$X_2 = -W\,A_X \tan\Omega$	$Y_2 = 0$
Pitch	$X_3 = -W\,A_Y(\cos\Omega + \sec\Omega)\tan\Sigma$	$Y_3 = W\,A_Y \sec\Sigma \sin\Omega$
Yaw	$X_4 = -W\,A_Z \sin\Omega \tan\Sigma$	$Y_4 = -W\,A_Z \cos\Omega \sec\Sigma$
Roll Rate	$X_5 = 0$	$Y_5 = -\frac{wh}{V_x}\dot{A}_x \sec\Sigma \sec\Omega$
Pitch Rate	$X_6 = \frac{Wh}{V_x}\dot{A}_y \sec^2\Sigma$	$Y_6 = \frac{-wh}{V_x}\dot{A}_y \tan\Sigma \sec\Sigma \tan\Omega$
Yaw Rate	$X_7 = \frac{Wh}{V_x}\dot{A}_z \tan\Omega \sec^2\Sigma$	$Y_7 = \frac{wh}{V_x}\dot{A}_z \tan\Sigma \sec\Sigma$
Crab	$X_8 = -W\,\Delta_x \tan\Omega$	$Y_8 = -W\Delta X$
Vibration	$X_9 = \frac{Wh}{V_x F}(vib)\sec^2\Sigma \sec\Omega$	$Y_9 = 0$
Stereo Servo	$X_{10} = -4W\Delta\Sigma_M \tan\Sigma \cos X$	$Y_{10} = 4W\Delta\Sigma_M \tan\Sigma \sin X$
Film Drive Speed	$X_{11} = -W\frac{\Delta V_F}{V_F}$	$Y_{11} = 0$
Roll Alignment	$X_{12} = -W\,B_x \tan\Omega$	$Y_{12} = 0$
Pitch Alignment	$X_{13} = -W\,B_y(\cos\Omega + \sec\Omega)\tan\Sigma$	$Y_{13} = W\,B_y \sec\Sigma \sin\Omega$
Yaw Alignment	$X_{14} = -W\,B_z \sin\Omega \tan\Sigma$	$Y_{14} = -W\,B_z \cos\Omega \sec\Sigma$
Mirror Mounting Crab	$X_{15} = -W\,M_c \tan\Omega$	$Y_{15} = -W\,M_c$
Stereo	$X_{16} = -4W\,M_s \tan\Sigma \cos X$	$Y_{16} = 4W\,M_s \tan\Sigma \sin X$
Knowledge of Focal Length	$X_{17} = -W\,(\Delta F/F)$	$Y_{17} = 0.$

A_x = Roll error angle (includes error in obliquity maneuver)

A_y = Pitch error angle

A_z = Yaw error angle

$\dot{A}_x$ = Roll rate error

$\dot{A}_y$ = Pitch rate error

$\dot{A}_z$ = Yaw rate error

B_x = Vehicle alignment error about roll axis

B_y = Vehicle alignment error about pitch axis

B_z = Vehicle alignment error about yaw axis

ΔX = Error in crab compensation (steps and servo error)

Vib = Amplitude of the linear velocity error of the platen due to vibration

ΔV_F = Amplitude of the linear velocity error of the platen due to discreteness and drift of the drive mechanism and/or electronics

M_c = Angular error in stereo mirror crab alignment (radians)

M_s = Angular error in stereo mirror stereo alignment (radians)

NOMENCLATURE

X_i = Component of smear on ground parallel to the ground track for the ith contributor

x_i = Component of smear in the image plane perpendicular to the slit for the ith contributor

Y_i = Component of smear on ground perpendicular to the ground track for the ith contributor

y_i = Component of smear in the image plane parallel to the slit for the ith contributor

W = Slit width

h = True altitude of the camera above ground

F = Focal length

h = Uncertainty in knowledge of altitude

Σ = Stereo angle of line of sight

Σ_m = Stereo mirror angle $= \Sigma/2$

m = Uncertainty in stereo mirror angle due to errors in the positioning mechanism

Ω = Obliquity angle of the line of sight

χ = Crab angle of the mirror

NOTICE

When Government drawings, specifications or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any was supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

APPENDIX O

RELIABILITY PROGRAM

1.1 Introduction

This section discusses the reliability program that is recommended by EKC for the M & S Program. In addition, this section is intended to be a fore-runner of the Reliability Program Plan required per paragraph 2.2.2 of NPC 250-1.

1.2 Applicable Documents

The following documents form a part of the reliability plan. Applicability of the listed documents will be to the extent that they are referenced in subsequent paragraphs of this section.

a.	NPC 250-1	National Aeronautics and Space Administration, Reliability Program Provisions for Space System Contractors.
b.	401-100	Eastman Kodak Company, Drafting Manual
c.	401-113	Eastman Kodak Company, Reliability Preferred Parts List.
d.	401-115	Specification Control Drawing Index
e.	401-119	Eastman Kodak Company, Design and Manufacturing Standards
f.	401-122	Eastman Kodak Company, Technical Requirements for Contracts.
g.	403-121B	Eastman Kodak Company Failure Reporting and Analysis.
h.	Y-000011-IH	Work Statement for Apollo Mapping and Survey System.

(These documents are not forwarded as a part of the Survey Camera Preliminary Engineering Description).

1.3 General

1.3.1 Philosophy. The reliability program will follow basic procedures established on past programs with the necessary modifications to meet the objectives of this project. Further, the program is intended to meet the reliability requirements of NASA document NPC 250-1.

The reliability program described in this document will be carried out through all phases of design, development, manufacture, testing and operation. The over-all reliability program (meetings, reviews, tests, etc.,) and its relationship to the general design, fabrication and assembly activites is illustrated in Figure 0-1. The items in this figure are described in more detail in other parts of this section.

The reliability program is based on the following philosophy: Reliability can only be achieved by an intense awareness, vigilance and attention to detail by every member of the project team. A thorough program of monitorship and continuous reliability status indication is necessary to sharpen this awareness and highlight areas of weakness for timely corrective action.

In order to implement this basic philosophy, the reliability program is based on the following elements:

(1) Recognition of the concept of inherent reliability of the design and concentration of effort in the design phase. Applicable design principles include the following:

a. Simplicity of design

b. Standardization of parts and components

c. Derating of parts

d. Effects of parameter variability

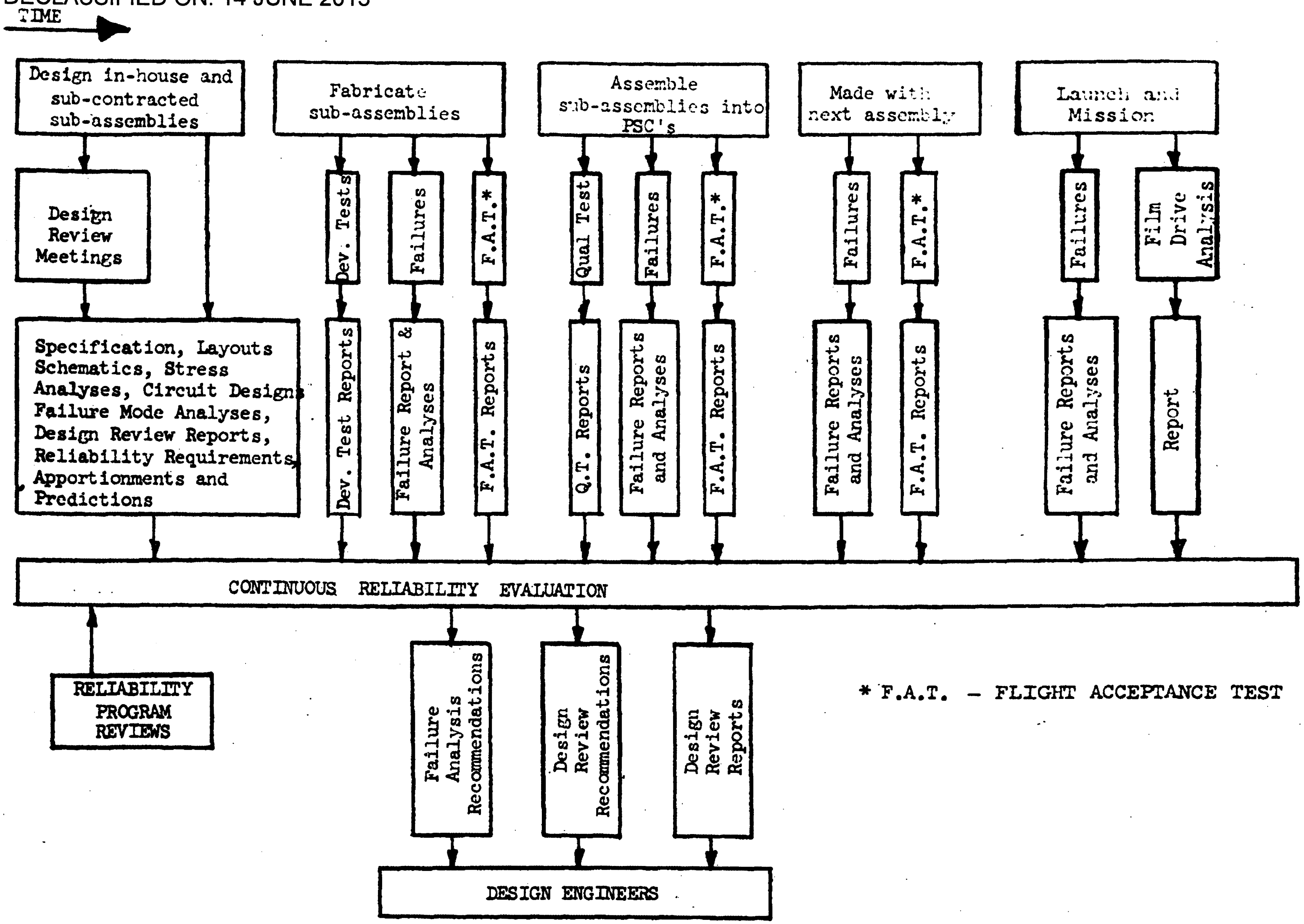


Figure O-1. Reliability Program

e. Redundancy consideration

f. Consideration of human factors in assembly and maintenance.

g. Proof of design through developmental and qualification testing

h. Analysis of design

i. Analysis of test results

j. Qualification of parts and components

k. Feed-back of reliability information and recommendations to designers

(2) Assurance that a failure reporting system is maintained that includes failure reports, failure analyses, corrective action, and corrective action follow-up.

(3) Plan for testing and evaluating the equipment early in the program to determine "mechanisms of failure" so that information is available as a basis for design improvement.

(4) Designation of specific milestones at which factors affecting the reliability of the equipment can be objectively reviewed and reported.

(5) Assurance that subcontractors' and manufacturers' reliability programs are capable of achieving and maintaining a high level of reliability.

(6) Establishment of a reliability study program to yield quantitative reliability requirements and predictions and to aid in making design decisions.

(7) Presentation of an organized indoctrination program in order to develop a reliability consciousness in all personnel.

1.3.2 Applicability. The provisions of this Reliability Program Plan are applicable to all parts of the survey camera payload (C/P) which are designed and fabricated both in-house and by subcontractors. The reliability effort on AGE hardware will be limited to the following:

(1) Approving parts for those items of ground equipment called out in the task lists.

(2) Applying the full reliability program, as described in this program plan to the Survey C/P shipping container.

1.3.3 Organization. The reliability program will be conducted by the Reliability Section, Space Projects Organization, Apparatus and Optical Division, Eastman Kodak Company. The Reliability Section will act as an independent advisory group to the project manager and associated engineering groups on matters that affect the reliability of deliverable airborne hardware. Figure 0-2 shows how the Reliability Section fits into the overall Space Projects Organization.

Reliability engineers will be permanently assigned to the project and will be physically located in close proximity to the design engineers. In addition, specialists can be called in from other projects to assist the reliability engineers. This reliability organization is in general accordance with NASA Document NPC 250-1.

The Reliability Section is divided into five groups as follows:

a. Reliability Design Review and Analysis
b. Reliability Testing
c. Parts Selection and Qualification
d. Reliability Monitoring
e. Reliability Requirements and Prediction

The program of each of the five groups is described in Sections 4.10.4 through 4.10.8.

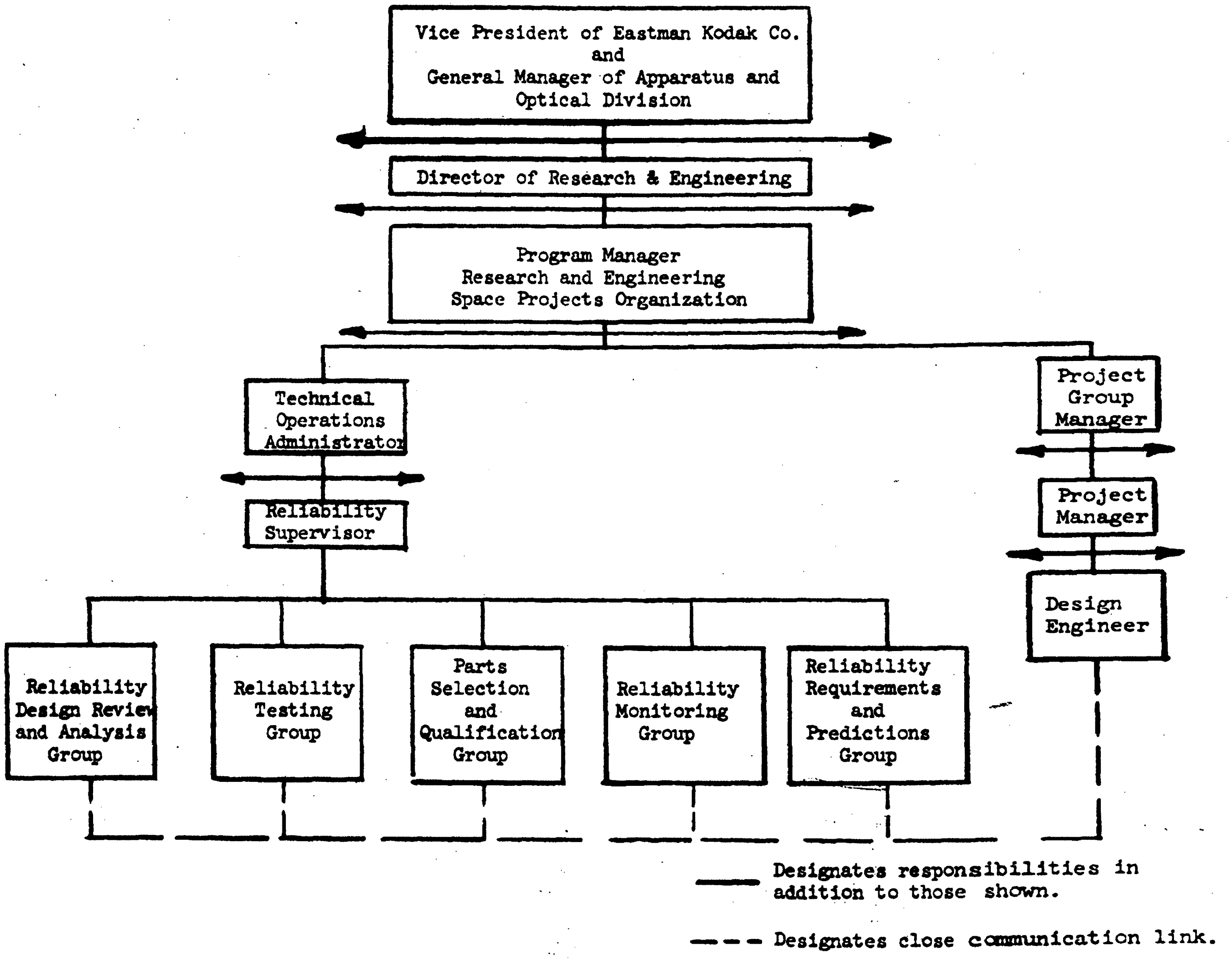


Figure 0-2. Reliability Organization

1.4 Reliability Design Review and Analysis

The reliability design review program is an organized method for objectively evaluating the engineering design from the aspect of reliability. The Reliability Design Review and Analysis Group thoroughly reviews the design as it is developed. The principles followed include:

(1) Adhering to adequate safety margins.

(2) Recognizing environmental conditions.

(3) Determining dynamic stresses resulting from environmental conditions.

(4) Performing other reliability analyses that contribute to the solution of reliability problems.

The design review effort includes:

(1) Conducting a continuing, independent review of the engineering effort.

(2) Holding design review meetings with the responsible design groups during the course of the design.

(3) Reviewing those matters which affect the reliability of the design after the design has been released.

Design review check lists, frequent liaison with design engineering personnel and review of engineering drawings provide timely information for the design review engineers.

1.4.1 Independent Design Review. The reliability section conducts independent reviews of the engineering effort during the course of the design. This effort consists of the detailed day by day study and liaison that provides the major portion of the reliability assistance to the design engineer and provides the background for the design review meetings. Particular emphasis is placed on reviewing the system and subsystem requirements, the design approach, the specifications, and the interface requirements prior to the Preliminary Design Review meeting.

The independent design review effort consists of a critical examination of the design to determine the risk areas and includes the following areas:

(1) Circuit design, aimed toward the use of simple straightforward designs with fail-safe features, stability, standardization, a minimum number of parts, and other appropriate considerations.

(2) Parts, components and material selection application and test results.

(3) Consideration of the mode, effect, and criticality of various failures.

(4) Electrical stresses under both steady state and transient conditions.

(5) Mechanical stresses arising from manufacturing, packaging, service, transportation and operation.

(6) Adequacy of optical designs to insure consistently good optical performance under specified conditions.

(7) Thermal stresses due to high or low temperatures resulting from packaging, service, transportation and orbital flight conditions.

(8) Adequacy of the specification in terms of meeting the operational and environmental requirements.

1.4.2 Design Review Meetings. Three in-house Reliability Design Review Meetings would be scheduled on all new Survey C/P subassemblies. The number of Design Review Meetings held on modified existing designs will be directly related to the extent of the modifications made to the hardware. Design review effort will be required, on a limited basis, on unchanged subassemblies to ascertain the compatibility of these subassemblies with the new and modified subassemblies.

The three Design Review Meetings are called the Preliminary Design Rview Meeting (PDR), the Major Design Review Meeting (MDR), and the Final Design Review Meeting (FDR). These meetings constitute a well-established, routine, Kodak Space Projects Organization procedure applying to major subassemblies. The meetings are technical working meetings and are scheduled early in a program.

A report on the preliminary major, and final design reviews is issued internally for the express purpose of documenting reliability comments and recommendations. These items and associated responses are in addition to the recommendations and responding actions defined in Paragraph 1.10.5. . A set of design review check lists, developed on previous programs as tools in the design review activity, are used in all in-house and subcontracted design areas. Sample check lists and instructions for their preparation are presented in Appendix A. The check lists are based on the premise that the best environment for design effort is one in which all aspects of the design problem are well defined, and the most effective design effort must employ an orderly and systematic method of pursuit for the design solution.

Attendance at Design Review Meetings is limited to a number of essential specialists in order to achieve optimum effectiveness. The attendees are individuals who are familiar with the design through study of layouts, schematics and completed checklists and who can make positive contributions to the meeting. The attendees include representatives from Reliability, Project, Quality Control, Technical Liaison, Standards, Production Engineering, Subcontracts, and others who may be required to increase the effectiveness of the meeting.

1.4.2.1 Preliminary Design Reviews. These reviews are held when sketches, simplified schematics, and necessary calculations exist which support the feasibility of the proposed design approach. The PDR emphasizes the design requirements and the understanding of these requirements by the responsible engineering personnel. Design requirements subject to review at the meetings include, but are not necessarily limited to, the following:

(1) Purpose of the equipment.

(2) Operating and non-operating ambient environmental conditions (i.e., vibration, shock, temperature, pressure, etc.).

(3) Environmental effects produced by the design (i.e., heat, vibration, electromagnetic interference, etc.).

(4) Physical requirements (i.e., weight, size, moment of inertia, etc.).

(5) Functional requirements (i.e., electrical, mechanical and optical requirements, such as voltage regulation, source impedance, signal-to-noise ratio, mechanical tolerance, starting torque, resolving power, photometric characteristics, etc.).

(6) Ground rules (i.e., policies relating to the relative importance of reliability, performance, weight, etc.).

(7) Reliability requirements

The foregoing approach recognizes that an adequate design solution requires an adequate description of the problem, and reduces the need for future corrective engineering effort.

The proposed design solution will be reviewed by thoroughly examining the following areas:

(1) Statement of proposed solution (i.e., recognized problem areas, design limitations, trade-off compromises, etc.).

(2) Design approach (i.e., block diagrams, layouts, calculations, etc.).

(3) Tests proposed to verify the design.

(4) Preliminary parts count (provides a partial complexity index for reliability prediction purposes).

(5) Documentation (i.e., estimates of the required drawings, shop procedures, test procedures, etc.).

1.4.2.2 Major Design Reviews. These reviews are held when the necessary engineering layouts, schematics, and stress analyses (see Appendix I for representative stress analysis sheets) required to completely define the equipment have been completed.

The MDR inquires into the design adequacy through examination of the following items:

(1) Open items that were generated prior to the MDR.

(2) Block diagrams, schematic diagrams, calculations and applicable engineering test results.

(3) Compliance of packaging to environmental and performance requirements.

(4) Utilization of preferred design standards and reliability preferred parts. Design and Manufacturing Standards, Eastman Kodak Company document 401-119 is actively being maintained and will be used. Reliability Preferred Parts List, Eastman Kodak Company document 401-113, is also maintained and will be used as the prime source of approved parts (see paragraph 1.6.1).

(5) Capability of equipment performance to meet the specified operating requirements with normal manufacturing variability of parts as well as with the predicted deterioration of parts due to environmental stress and use.

(6) Stress analyses required to substantiate the design.

(7) Failure mode, effect, and criticality analyses.

(8) Parts application review.

1.4.2.3 Final Design Review. Final design reviews are held within approximately two weeks of final drawing release. The design and manufacturability of the equipment is evaluated by examining the following items:

(1) Open items generated prior to the FDR.

(2) Drawings, specifications and manufacturing procedures.

(3) Manufacturing processes.

(4) Results of tests that may have been conducted.

1.4.3 Sustaining Design Review. A sustaining Design Review effort is maintained to assess the effects of events that occur after the Final Design Review Meeting. This effort is conducted by Reliability Engineers who have participated in the Design Review Meetings and who are thoroughly familiar with the designs. This effort includes the following tasks:

(1) Secure an adequate disposition of all open items.

(2) Continuously review design changes to insure that the reliability of the design is maintained or improved. Formal Design Reviews of such changes are held if required as determined by the Reliability Section.

(3) Implement failure reports and failure analyses for all failures of manufactured parts, components and subsystems. The failure reports and analyses accomplish the following:

a. Report the probable mode and cause of failure.

b. Classify the failure (i.e., critical, major, or minor).

c. Recommend necessary corrective action.

(4) Participate in the review and dispositioning of waivers and deviations of parts, assemblies and components.

(5) Maintain a list of limited life items which will be separately identified by their expected life and required replacement life.

(6) Review the results of qualification tests as the tests are completed.

Design surveillance activities, as applicable, are carried out during the manufacturing, field testing, launch, and orbital operations of the program as well as during in-house testing operations.

1.4.4 Critcality Analyses. Failure mode, effect, and criticality analyses are coordinated by the Design Review Group. The analyses are used in the in-house Major and Final Design Review Meetings. The following items are used in preparation of such analyses:

(1) EKC Design review checklists.

(2) Various design review analyses.

(3) Discussions with Systems Engineering and Project Design Engineers.

(4) Schematics and drawings.

(5) Indentured parts lists.

(6) Thermal, electrical, and mechanical stress analyses.

(7) Statistical services of the Reliability Analysis Group.

1.5 Reliability Testing. Reliability testing effort will be implemented early in the program to bridge the gap between theory and practice. In view of the numerous qualified designs that will be used on the survey camera, the degree of testing required on each subassembly will have to be established commensurate with the design history of each component. Unchanged subsystems will require only limited additional testing while all new subsystems will be subject to complete reliability testing. The testing program will emphasize developmental and qualification testing at the subassembly and C/P levels.

Test plans, as described in Paragraph 1.10.8 will be prepared by EKC. The preparation of the test plans will be the responsibility of Reliability Section. Test plans will be prepared for the following tests:

(1) Component qualification tests.
(2) C/P qualification test
(3) C/P reliability demonstration test
(4) C/P electromagnetic interference test

Further, the Reliability Testing Group will prepare test procedures (Paragraph 1.10.9) and test reports (1.10.10) for the above mentioned tests.

The performance of the tests listed above is the responsibility of the Reliability Testing Group. However, the tests will be conducted by Quality Control engineers and technicians under the direction of the Reliability Testing Group. This results in increased efficiency since Quality Control personnel are more familiar with the hardware and testing procedures through having conducted acceptance testing.

1.5.1 Developmental Testing. The Reliability Testing group will assist the Project Design groups in conducting developmental tests on various subassemblies of the Survey C/P. The Reliability section will review and comment on test procedures prepared by Project.

Developmental tests, as distinguished from breadboard tests, are conducted after the design has reached a fairly sophisticated level which closely approaches the flight model physical and electrical configuration. These tests include various electrical, pressure and thermal over-stresses as well as operation under, or after being exposed to, the mission environmental conditions.

1.5.2 Qualification Testing.

1.5.2.1 Survey C/P. A Qualification Test will be conducted on the Qualification Model C/P in accordance with the test plan submitted by the Reliability Section.

This Qualification Test is aimed at demonstrating the capability of the equipment, as designed, to operate under, and/or survive, the worst environmental, electrical power, and electrical signal conditions it will encounter in transportation and flight operation. Further, overstress testing is performed to determine modes of failure. The environmental conditions of primary concern are:

(1) Launch vibration
(2) Launch shock
(3) Launch acceleration
(4) Operating temperature extremes
(5) Operating temperature gradients
(6) Hard vacuum
(7) Transporation and handling vibration, shock, and temperature extremes.

Typical problems that are investigated during and after the Qualification Tests include:

(1) Structural weakness

(2) Resonances at frequencies that cause detrimental interactions.

(3) Operating temperatures of individual parts that are too high for adequate reliability.

(4) Operational instability, loss of alignment, degradation of output, etc., resulting from stresses induced by the above environments.

(5) Loss of pressure from any pressurized component.

1.5.2.2 Survey C/P Components. Components not qualified on previous programs will be subject to Qualification testing to establish the adequacy of the component. Paragraph 1.5.2.1 defines qualification environmental conditions to be considered.

1.5.3 Reliability Demonstration Tests. A Reliability Demonstration Test will be conducted on the Reliability Demonstration Model C/P. This test will demonstrate the capability of the equipment to operate through two simulated normal missions without failure.

For purposes of defining the Reliability Demonstration Test, a simulated mission cycle profile will be used.

1.5.4 Electromagnetic Interference Test. The Qualification Model Survey C/P will be EMI tested in accordance with the procedures outlined in MIL-I-26600 in order to evaluate the ability of the over-all integrated system to meet the test requirements of MIL-E-6051C.

1.6 Parts Reliability

The parts reliability program will continually select parts and upgrade the quality of the parts used through a parts evaluation program. The activities in the "parts reliability" area are routine and represent an effort that is always active. The effort in this area includes the tasks defined in subsequent paragraphs of this section.

1.6.1 Parts Selection Program. The primary effort of the parts selection activity is to prepare and maintain a list of reliable parts and to investigate and approve (or disapprove) project peculiar parts. The following ground rules will be followed with respect to selection of parts and materials,

(1) Selection of parts will be made from EK Preferred Parts List 401-113 except that ground equipment parts may also be selected from applicable MIL specifications and/or good commercial standards.

(2) Selection of material shall be made from double asterisk items listed in 401-115 except that ground equipment material may also be selected from applicable MIL specifications and/or good commercial standards.

Parts not listed in 401-113 may be used if adequately supported by documentation based on significant test results or pertinent prior use. This documentation may come from IDEP or SPWG reports (see Paragraph 1.6.2). For those parts that must be further evaluated, the following tasks are performed by the Reliability Parts Selection Group.

(1) Critically examine parts from a design standpoint to determine that each is able to meet the design requirements and withstand the expected environments.

(2) Survey the part manufacturing facilities to determine that the manufacturing techniques and the inspection activities are able to maintain adequate and uniform quality.

(3) Establish test requirements and procedures for the comparative evaluation of parts which include:

a. Examination for characteristics important to the application.

b. Extended performance tests preceded by appropriate environmental stresses. The tests will be designed to determine failure rates and mean time between failures for the parts after being subjected to various environmental stresses.

c. Test parts at increased stress levels to determine modes of failure which are typical of normal operation of the parts.

(4) Establish the requirements for and determine the adequacy of receiving inspection procedures.

It is anticipated that a large number of existing qualified designs, and hence qualified parts, will be used. Therefore, the use of new, unproven parts will be minimal.

1.6.2 Parts Selection Sustaining Program. The following tasks constitute a sustaining effort in the parts reliability program:

(1) Create and/or approve the specification control drawings (400-series drawings) which delineate the important physical, operational and environmental requirements of the parts. This does not include the drafting effort.

(2) Determine the mode and reason for each part failure that caused an equipment malfunction and recommend corrective action.

(3) Approve waivers and authorized variations on purchased parts.

(4) Keep abreast of the state-of-the-art in the parts field through activities such as the following:

a. Participate as full members in the Interservice Data Exchange Program (IDEP) and the Space Parts Working Group (SPWG). The Minuteman Working Group contributes information to SPWG. As a result, Minuteman Reliability information will be available.

b. Maintain up-to-date files of manufacturer's catalogues, of technical data, and of test results for parts applicable to the program.

1.7 Reliability Monitoring

The reliability of the final product depends upon the design of the equipment; however, the inherent reliability of the design can be maintained only by an adequate manufacturing and quality control program. The reliability monitoring program is oriented toward minimizing problems in these areas by performing the tasks described by subsequent paragraphs of this section. Discrepancies in any of the following areas, and any appropriate recommendations relative to such discrepancies are formally reported to Project Management, as necessary.

1.7.1 Manufacturing and Assembly Operation. Manufacturing and assembly operations are periodically observed to determine:

a. Adequacy of procedures and methods.

b. Adequacy of tools and equipment.

c. Adherence to specified procedures.

d. Adherence to Kodak Standard 401-119.

1.7.2 Quality Control Program. Quality Control operations are monitored to determine:

a. Adequacy of incoming inspection procedures and practices.

b. Adequacy of Quality Control procedures and practices.

c. Adequacy of test equipment and test procedures.

1.7.3 Handling and Storage. Reliability Monitoring personnel periodically observe storage and assembly areas to determine the adequacy of handling and storage procedures and practices.

1.7.4 Subcontracting. Reliability Monitoring personnel visit potential subcontractors to determine the adequacy of the reliability program of each subcontractor prior to the award of subcontracts. These reviews include an analysis of the scope, responsibilities, goals, authority, organization and other pertinent aspects of the subcontractor's plants to insure that the subcontractor is maintaining a good reliability program and to insure compliance with EKC requirements.

The tools used in the subcontractor monitoring task include EKC manuals 401-119 and 401-122. Both manuals will apply to all hardware subcontracts.

1.8 Reliability Requirements and Prediction

Reliability requirements and prediction encompasses the analytical, statistical, and mathematical, efforts associated with the reliability program. As a primary basis for these efforts, the Requirements and Prediction group develops a reliability mathematical model which includes functional block diagrams and detailed piece-part count analyses which consider the effects of derating and environmental conditions in determining applicable failure rates. The model will take into account the fact that the output of the system is photographic information. In this regard, the functional diagram will be used to study the relationships among reliability, quantity of photography, and quality of photography.

The reliability model is utilized to apportion design reliability goals to the functional component assemblies and to prepare and update reliability estimates. In addition, the reliability model provides the basis for reliability assessments to be made upon completion of the C/P qualification testing and at subsequent milestones to be determined.

Statistical services are provided by the Requirements Group to insure that proper consideration is given to reliability objectives in statistically designed experiments and data evaluation.

Preliminary study of the Survey C/P indicates that a varied degree of design effort will be required on each subassembly. Appropriate reliability trade-off studies will be performed commensurate with the amount of design and design review effort expended on each area.

1.9 Reliability Training and Organization

It is anticipated that most of the personnel associated with this program will have been associated with other high reliability programs. However, for those who have not, the program described in this section will apply.

1.9.1 Design Engineers. A series of reliability review sessions will be held for Design Engineer personnel. These lectures stress the means by which the reliability of the product can be enhanced during the design of the product. The use of various reliability documents (Reliability Preferred Parts Lists, Failure Reports, and Analysis, etc.) and the function of the various Reliability groups is reviewed at these sessions.

1.9.2 Production Personnel. Reliability briefing sessions are held for production personnel. These sessions stress the ways in which production personnel can avoid degrading the inherent reliability of the design. The importance of good reliability practices (careful part handling, following procedures exactly, cleanliness and the like) will be pointed out at these meetings.

1.9.3 Subcontractors. While no formal program is generally planned for subcontractors, they are made aware of the EKC reliability requirements and responsibilities. Various reliability documents including 401-122, are sent to potential subcontractors with the Request for Proposal and form a part of any resulting subcontract. Reliability Monitoring personnel visit the subcontractor's plant periodically to insure that the contractor is using good reliability practices and procedures. Before a subcontract is placed, a vendor survey team including a Reliability Engineer will visit, or will have visited the facilities to be sure that the potential subcontractor maintains an acceptable reliability program.

1.10 Reliability Documentation

Reliability documentation is submitted by the Reliability Section specialized Reliability forms. These reports are described in the following paragraphs.

1.10.1 Monthly Reliability Program Report. Reliability will prepare a section to be included in the Monthly Technical Report.

Status Reports will be submitted by Program Management. The Reliability Report will include the following items:

(a) Failure analyses summary
(b) Parts and materials qualification status list
(c) Reliability analyses and supporting data
(d) Design review activities
(e) Reliability monitoring activities
(f) Qualification test status
(g) Hardware reliability status

The monthly report will also contain an updated reliability prediction for the Survey C/P System. If the prediction has not changed, the value will be reported along with an appropriate statement.

1.10.2 Subassembly Specifications. The Reliability Section assists in the preparation of the reliability statements for each of the subassembly specifications.

1.10.3 Design Review Reports. Design review reports are submitted to the Project Manager following each design review meeting. These reports list reliability factors produced since the latest design review, comment on the reliability of the present design and recommend action that project should take for increased reliability.

1.10.4 Reliability Recommendations. An established formal procedure for reporting reliability recommendations will be used. A Reliability Design Review Recommendation (see Appendix C for sample forms) will be written by a Design Review Engineer and approved by the supervisor of the Reliability Section whenever he feels that a reliability problem should formally be brought to the attention of the personnel responsible for the hardware in question. The recommendation will be addressed and sent to the Project Manager and distributed to the responsible Design Engineer and other associated personnel. Four possible courses of action are then available. These are:

(a) The Project Manager or responsible Design Engineer will take action to satisfy the intent of the recommendation and document this action by using a Reliability Design Review Recommendation Reply form (page 2 Appendix C) which is approved by the Project Manger.

(b) Reliability will retract the recommendation should additional information be obtained which indicates that a formal recommendation is not required. The reason for the retraction will be defined mutually by Project Management and the Reliability Section and will be documented on the Reliability Design Review Recommendation Reply form.

(c) Reliability will modify the recommendation should additional information indicate the a modification is in order. The reason for the modification will be defined by the Reliability Section and will be documented on the Reliability Design Review Recommendation Reply form before the modified recommendation is issued. The action on the modified recommendation will then be identical with that described as the course of action in Par.(a) above.

(d) The recommendation will be referred to a higher organizational level for a final decision in those cases where an agreement between the Reliability Section and Project Management cannot be reached.

Page 3 of Appendix C will be used by the design review engineer to keep track of the status of each recommendation (action taken, no action taken, reply received, recommendation closed, etc.)

1.10.5 <u>Failure Reports and Failure Analyses</u>. A failure reporting and analysis procedure, instituted on past programs will be maintained. The purpose of failure reporting and analysis is fourfold:

(a) To report all failures to responsible people,

(b) To record the cause of failure,

(c) To recommend corrective action that should be taken to prevent similar future failures, and

(d) To record any corrective action taken as a result of the failure analysis.

Failures are reported on the standard form shown in Figure 0-3. The failure reports are prepared by the person responsible for the hardware at the time the failure occurred--in most cases Quality Control (QC) personnel. The failure report must be signed by the cognizant QC engineer and Reliability engineer before work can proceed. After the failure report is properly signed, work can proceed and copies of the failure report are distributed. The copies are distributed as follows:

(a) Cognizant Design Review Engineer
(b) Cognizant Quality Control Engineer
(c) Cognizant Design Engineer
(d) Project Manager
(e) Production Engineering

Failure analyses are prepared on the standard form shown in Figure 0-4 by the cognizant Design Review Engineer. He has the assistance of the Parts Reliability Group, or other groups as required, to help determine the cause of failure and recommend corrective action. Failure analyses receive the same distribution as failure reports. The group to whom the recommendation is addressed (Receiving Inspection, Quality Control, Design Engineering, etc.) is required to complete the section of the analysis describing the action taken.

Subcontractors are required to use the failure reporting and analysis system as described above. All analyses by subcontractors must be approved by the cognizant EKC Design Review Engineer before the item is closed.

EASTMAN KODAK COMPANY – APPARATUS & OPTICAL DIVISION

FAILURE REPORT

AO 128C REV. 5-63

1. FAILURE LOCATION (DWG. TITLE)	2. DWG. NO.	3. SER. NO.	4. MANUFACTURER	5. REPORT NO.
A. MAJOR COMPONENT OR ASSEMBLY	A.	A.	A.	6. DEPT. EQUIPMENT TYPE:
B. CHASSIS OR SUB-ASSEMBLY	B.	B.	B.	A. PRIMARY ☐
C. FAILED PART	C.	C.	C.	B. SUPPORT ☐

7. EFFECT ON MAJOR COMPONENT: ☐ CRITICAL ☐ MAJOR ☐ MINOR

8. DESCRIPTION OF TEST: (BENCH, INSTALLATION, INSPECTION, OPERATIONAL, ENVIRONMENTAL, ETC.) (INCLUDE TEST NUMBERS IF AVAILABLE)

☐ ACCEPTANCE TEST ☐ IN PROCESS TEST ☐ RELIABILITY OR QUALIFICATION TEST

☐ ENGINEERING TEST PROC. NO. ____________ PARA. NOS. ____________

DETAIL

9. DESCRIPTION OF FAILURE: (GIVE SYMPTOMS OBSERVED: ENVIRONMENTAL & OPERATIONAL CONDITIONS PART WAS SUBJECTED TO PRIOR AND DURING FAILURE)

10. AUTHORIZATION TO PROCEED

☐ WITH TEST ☐ WITH REPAIR ☐ WITH FAILURE ANALYSIS

☐ OTHERS (EXPLAIN) ____________

QUALITY CONTROL ENG ____________

DESIGN REVIEW ____________

RELIABILITY ENG ____________

11. ORIGINATED BY	12. DATE OF FAILURE	TIME

COPIES: STD. DIST. PLUS:

WHITE - STAFF SERVICES
GREEN - DESIGN REVIEW
PINK - INSPECTION
YELLOW - LOG BOOK

Figure 0-3. Failure Report Form

EASTMAN KODAK COMPANY – APPARATUS & OPTICAL DIVISION

FAILURE ANALYSIS

AO 1281-(REV.11-61)

1. FAILURE LOCATION: (Name)
A. Major Component or Assembly

B. Chassis or Sub-Assembly

C. Failed Part

2. HAS THIS PART FAILED BEFORE

☐ Yes ☐ No

If yes, See Report No. ______

Failure Report No. ______

3. FAILURE CATEGORY: ☐ Early Failure ☐ Human Initiated Failure ☐ Wear Out Failure (Time to Failure ______ Hrs.)

4. MODE OF FAILURE (Manner or way part failed)

5. CAUSE OF FAILURE: (Attach Photos or Sketches as required)

6. FAILURE CLASSIFICATION: ☐ Nonconformance to Design ☐ Design

ANALYST | Date of Analysis / /

7A. RECOMMENDED CHANGE: ☐ Fabrication Methods ☐ Inspection Procedure ☐ Specifications ☐ Design ☐ Other ______

B. DESCRIPTION OF CHANGE: ______

______

Reliability Approval ______

8. DESCRIPTION OF ACTION TAKEN:

9. ACTION TAKEN BY: ______ NAME ______ GROUP | DCO NO. ______ OR EFFECTIVE DATE / /

COPIES:

Figure O-4. Failure Analysis Form

The failure reporting and analysis system becomes effective on any part or subassembly as soon as it has been demonstrated that a part or subassembly performs properly. The failure reporting and analysis system is more fully described in EKC document 403-121B.

1.10.6 Other Reports. Other miscellaneous reports are issued by the Reliability Section on an "as required" basis to insure that the reliability of the Survey C/P is maintained. These reports include Qualification Test Reports and others of a similar nature.

1.10.7 Subcontractor Reporting. Three design review meetings will usually be conducted on each subcontracted item by the Design Review Group. (See Para. for a discussion of modified existing subsystems). A Design Review Report, similar to the in-house design review reports will be submitted to the project manager for his disposition.

1.10.8 Test Plans. The Reliability Testing Group will prepare test plans for the tests listed in section 1.5 These test plans will accomplish the following:

(a) Briefly describe the purpose of each test
(b) Show the test schedule
(c) Describe the facilities to be used for each test
(d) Briefly describe the environmental surrounding each test
(e) Describe the role of the test in the evaluation of system reliability
(f) Describe the planned use of the test data

1.10.9 Test Procedures. Test procedures, prepared by the reliability testing group, describe the detailed step-by-step actions necessary to conduct the test. These test procedures are prepared for each of the tests listed in Para.

1.10.10 Test Reports. Test reports will be prepared for each of the tests listed in Para. 1.5.

1.11 Subcontractor Reliability Program

Subcontractors to EKC for procurement of major subassemblies of the Survey C/P and the Survey C/P shipping container will follow essentially the same reliability program as does EKC. Subcontractors will be contractually obligated to meet the reliability requirements contained in EKC Document 401-122.

Technical Requirements for Contracts, EKC Doc. 401-122

The reliability requirements of 401-122 include, but are not limited to, the following:

(a) Two or three design review meetings to be conducted by the Kodak Design Review Group (See Para. 1.4.2 for a discussion of modified existing subsystems).

(b) Selection of parts from EKC 401-113.

(c) Use of EKC Document 401-119, Design and Manufacturing Standards.

(d) Qualification testing.

(e) Failure reporting and analysis.

(f) Reliability monitoring.

(g) Reliability predictions.

Subcontractor's may use their own preferred parts list or design and manufacturing standards with prior approval from Kodak.

Copy No. ____________

Sheets ____________

APPENDIX P

Preliminary Specification
For the
Crab Servo Assembly

Specification No. *

Prepared by
EASTMAN KODAK COMPANY
Advanced Development Projects Group
Apparatus and Optical Division
Rochester, New York

Original Prepared by ____________

Original Reviewed by ____________

Original Approved by ____________

Original Release Date ____________

Revision	Pages Affected	Date	Approved by

Preliminary Specification for the Crab Servo Assembly

Specification Number* Release Date: *

1. SCOPE, TASK, AND ASSEMBLY MISSION

1.1 Scope - This specification defines the responsibilities of the contractor, and also the requirements for the crab servo assembly, hereinafter called the Assembly.

1.2 Task - The required task is to design, develop, manufacture, test and deliver to Eastman Kodak Company, a positioning servomechanism and a mockup which comply with the requirements defined in subsequent sections of this specification.

1.3 Assembly Mission - It shall be the mission of the assembly to position its output shaft, and hence a load, in a manner which minimizes the error between the input stimulus and load of a unity feedback system. Upon receipt of a malfunction signal from an associated system, the assembly shall position the load to a discrete position defined by an encoder which is part of the assembly.

2. APPLICABLE DOCUMENTS

The following specifications, standards, drawings, and publications of the latest issue in effect on date of invitation for bids, form a part of this specification. Applicability of the listed documents shall depend on their specific reference in this specification. In the event of conflict between the listed documents and this specification, this specification shall take precedence.

SPECIFICATIONS

Military

MIL-Q-9858	Quality Control System Requirements
NR 515	Control of Nonconforming Supplies
MIL-I-26600	Interference Control Requirements, Aeronautical Equipment

STANDARDS

Eastman Kodak Company

401-119	Design and Manufacturing Standards

DRAWINGS

Eastman Kodak Company

405-115	Procedure for Thermal Finish, Epoxy Black or White Enamel
405-130	Procedure for Iridite No. 15 on Mangesium
405-152	Procedure for Aluminizing Aluminum, Magnesium and Polystyrene Parts
405-185	Procedure for Iridite No. 14 for Aluminum
*	Crab Servo Assembly Outline Configuration

OTHER PUBLICATIONS

Eastman Kodak Company

401-122	Technical Requirements for Contracts

3. REQUIREMENTS

3.1 Definitions - The equipment required by this specification consists of the following:

(a) Crab Servo Assembly

(b) Crab Servo Mockup

3.1.1 Crab Servo Assembly - The assembly shall consist basically of a positioning drive and power amplifier which shall comprise a portion of a closed-loop dc servomechanism.

3.1.2 Crab Servo Assembly Mockup - The assembly mockup is a unit which simulates the average power consumption and heat dissipation, has the external configuration and finish, and has the weight and center of gravity of the crab servo assembly. The requirements of the crab servo mockup shall be in accordance with paragraph 3.5.9.

3.2 Electrical

3.2.1 Connector - The connector used on the Assembly shall be a Deutsch type DTKH**.

3.2.2 Connector Pin Assignments - The connector pin assignments shall be as tabulated below:

Function	Pin *
+28 volts dc	
28 volt return	
+5 volts dc	
5 volt return	
Drive Command (Wire A)	
Drive Command (Wire B)	
Override Command	
Override Return	
Position Indicator Output	
Instrumentation Return	
Spare Cable Wire	
Spare Cable Wire	

3.2.3 Leakage - The dc resistance between any electrical connection, except shields and dc motor leads, and the chassis of the Assembly shall be 100 megohms minimum with an applied voltage of 100 volts dc $\pm$ 10 percent. The dc resistance between any motor lead and chassis shall be 50,000 ohms minimum with an applied voltage of 100 volts dc $\pm$ 10 percent.

3.2.4 Inputs - The Assembly shall meet all the requirements of this specification when supplied with the inputs defined by the following two paragraphs.

3.2.4.1 Power - (a) +28 ± 3 volts dc
(b) +5 ± 0.1 volts dc

The 5 volt supply shall be used only to power the position indicator circuit. The Assembly shall be capable of withstanding input voltages as high as 32 volts dc without permanent performance degradation.

3.2.4.1.1 Power Overload Protection *

3.2.4.2 Commands

3.2.4.2.1 Drive Commands - The signals causing the assembly to drive are provided on two wires (A and B). Wire A positive and Wire B at zero shall drive the assembly output shaft clockwise. Wire B positive and Wire A at zero shall drive the assembly output shaft counterclockwise.

3.2.4.2.2 Override Command - A wire for overriding is provided. The presence of positive voltage on this wire shall disconnect the drive command and connect the encoder (described in 3.2.6) as the input. This encoder shall drive the output shaft to 0°.

3.2.4.2.3 Command Voltages - The command voltage shall be an analog voltage of zero to plus 5 volts dc corresponding to a zero to 1416° input angle.

The override voltage shall be a +* volt level.

The encoder voltage shall be +* volts dc.

3.2.4.2.4 Command Source Impedance - *

3.2.5 Position Indicator - An electrical analog output shall be provided that shall indicate the position of the Assembly output shaft when at rest, to within ± 50 degrees of the actual shaft position. This accuracy shall be attainable when the indicator circuit is loaded with a resistance of 135,000 ohms ±1 percent. The output voltage shall vary linearly with load motion and traverse a range of approximately 0 volts to 5 volts; 2.5 volts shall be 0°; 0 volts shall be -1416 degrees and 5.0 volts shall be +1416 degrees. The input impedance presented to the dc source by this indicator circuit shall be 5K or less. Power for this circuit shall be derived from the +5.0 volts source supplied to the Assembly. The tolerance on the 5 volt supply may be neglected when computing position indicator accuracy.

3.2.6 Encoder

The encoder shall drive the servo shaft to zero degrees when the shaft is at either a positive or negative angle. When the shaft reaches zero degrees the encoder shall disconnect.

3.2.7 Power Consumption - The power consumed by the Assembly shall be kept to a minimum consistent with the performance and reliability requirements of this specification. When driving, the maximum power shall not exceed 21 watts. When not in the process of driving, the power shall be less than 0.04 watts. Any surge currents shall not exceed 2.75 amperes.

3.2.8 Electromagnetic Interference Control - The Assembly shall meet the requirements of MIL-I-26600 for Class Ib equipment. In addition to the requirements defined by MIL-I-26600, any conducted interference, within the frequency range of 15-15,000 cps, impressed on the +28 volt dc power supply circuit by the MSD shall not exceed 0.075 amperes peak-to-peak.

3.2.9 Instrumentation Return - Instrumentation return shall be connected to dc return at a point external to the MSD and shall be completely isolated from the dc return within the MSD.

3.2.9.1 Instrumentation Output Impedance - The instrumentation output impedance shall not exceed 5000 ohms.

3.2.9.2 Instrumentation Overload Protection - Accidental short circuiting of the instrumentation output shall not cause any degration in any other output circuit.

3.2.10 Drive Limiting - Limiting actiona shall be provided within the Assembly to ensure that in no instance shall the Assembly be capable of driving its output shaft more than * degrees beyond the two extreme required positions.

3.2.11 Warmup Time - The assembly shall operate within a 0.5 sec warm-up period after power is turned on.

3.2.13 Power Loss - The assembly shall function in accordance with the requirements of this specification should the +28 volt dc supply be switched on or off after a given command has been satisfied. Should electrical power be removed from the Assembly while it is in the process of driving to a given position, the Assembly shall meet all the requirements of this specification when power is reapplied.

3.3 Environmental Requirements

A complete environmental design criteria establishing all of the levels of environment to which the payload and its components will be subjected will be established at a later date.

3.4 <u>Mechanical</u>

3.4.1 External Configuration - The external configuration of the Assembly shall be as shown on * .

3.4.2 Output Shaft - The Assembly output shaft configuration shall be as shown on * . The output shaft end play shall not exceed 0.0005 inch and the output shaft eccentricity shall not exceed 0.005 inch TIR (measured at load end of shaft) when driving the load described by the Load paragraph of this specification.

3.4.3 Weight - The weight of the Assembly shall be kept to a minimum consistent with the size, performance, and reliability requirements of this specification. In no event shall the weight exceed 4 pounds.

3.4.4 Finish

3.4.4.1 Mounting Surfaces - Magnesium mounting surfaces shall be finished with Iridite 15 per 405-130. Aluminum mounting surfaces shall be finished with Iridite 14 in accordance with EKC drawing 405-185.

3.4.4.2 Exterior Surfaces - All exterior housing surfaces, except mounting surfaces, shall be finished per 405-152.

3.4.5 Identification - Each Assembly shall be identified with a part number and a serial number only. The format and lettering type shall be as shown in Figure P-1.

The Assembly identification shall be applied and overcoated in accordance with the methods and procedures defined or reference in 401-119. The color of the identification shall be black.

The electrical connector shall be identified as J * by means of appropriate marking adjacent to the connector on the Assembly housing. The connector identification shall be the same style, size and color lettering that is used for Assembly identification.

SAMPLE IDENTIFICATION

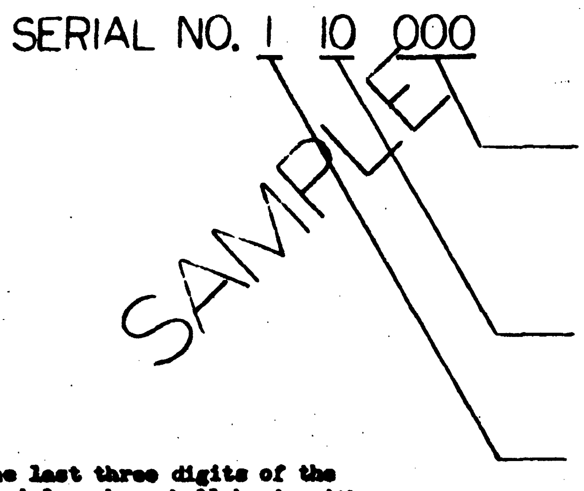
PART NO. 1400-XXX
SERIAL NO. 110000

SAMPLE

Lettering is: Upper case, vertical Commercial Gothic 3/16 inch high.

EXPLANATION OF NUMBERING SYSTEM

PART NO. 1400-XXX — Kodak Part No. (Component Final Assembly No.)



Serial
000 thru 999

Month Number (Always 2 digits, i.e. 03 etc.)
(Date of Manufacture)

Last digit of year
(Date of Manufacture)

The last three digits of the serial number shall begin with 000 and increase by 001 for each Assembly of a given design that is manufactured.

Figure P-1.

3.4.6 Load - The assembly shall meet the requirements of this specification when driving an inertial load with a one inch pitch diameter standard Acme leadscrew, having five threads per inch, coupling system as shown in Figure P-2. The inertia of the leadscrew itself is 0.125 lb-in^2. The lever arm between the centerline of the leadscrew and the pivot point of the load is 34.052 inches ±0.030 inch. The **maximum** inertia of the load to be driven is 25 slug-feet^2 ; however, the Assembly shall meet the requirements of this specification should the load inertia be any value less than 25 slug-feet^2.

In addition to the inertial load, the Assembly shall also be capable of simultaneously driving any friction load within the range of 0 to 1 inch-pound as measured at the output shaft of the Assembly.

The Assembly shall be capable of withstanding any axial thrust loading of its output shaft which may be impaired to it due to driving the load described in the preceding paragraphs of this section. In addition to the operating thrust loading, the Assembly shall withstand, non-operating, a thrust loading of 300 pounds axially, on its output shaft in either direction.

3.4.7 Positioning Accuracy

The motor shall respond to an input voltage of * volts or more.
The encoder shall be able to position the output shaft at 0 degrees ±45 minutes .

3.3.8 Transition Time *

3.4.9 Overshoot and Hunting *

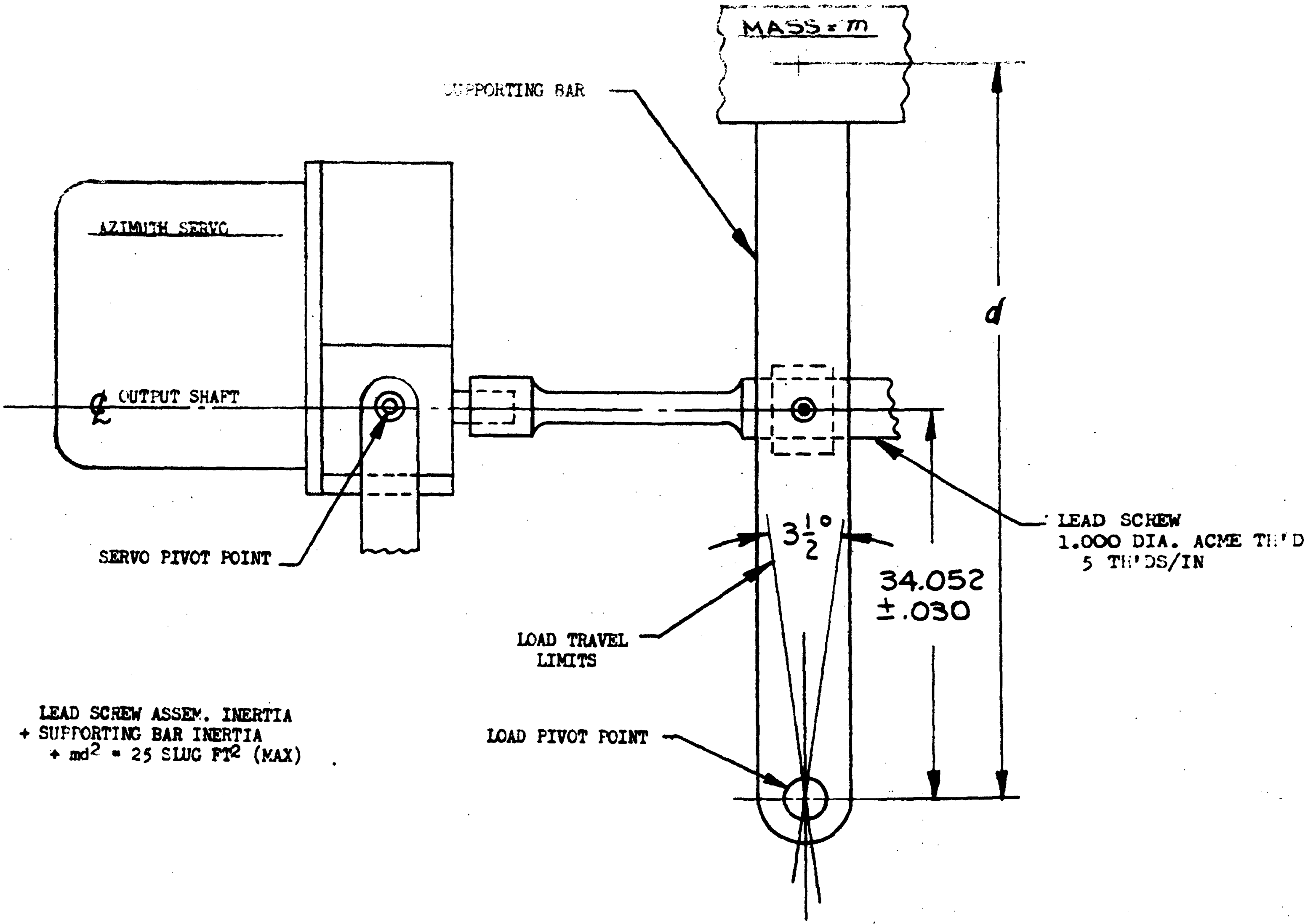


Figure P-2. Coupling System

3.4.10 Leak Rate - If the Assembly is a sealed package it shall be so designed that it can be purged at any time with a known gas mixture for the purpose of measuring leak rate. A charging port shall be located as indicated by * .

The gas mixture used for leak rate measurements shall contain 10 percent ± 2 percent helium by volume. The exact purging mixture shall be specified on the final assembly drawing.

The Assembly shall be capable of operating in accordance with the requirements of this specification with the helium mixture in it, thus eliminating the need for opening the Assembly after a leak rate test has been completed.

The Assembly shall have been leak tested prior to delivery to Eastman Kodak Company. The Assembly shall be delivered to Eastman Kodak Company with the helium mixture in it at a nominal pressure of one atmosphere.

3.4.14 Position Centering - A means shall be provided to indicate when the Assembly Output shaft has been positioned to within ± 2 degrees of the nominal center of the 0 degree shaft position. They may consist of index marks on the shaft and housing which, when aligned, correspond to the desired position, or some similar method.

3.5 General Requirements

3.5.1 Design Attributes - Design shall be in accordance with the requirements of Eastman Kodak Company standard 401-119. Throughout the various stages of design, consideration shall be given to the items listed below. Items are listed in order of relative importance.

a. Performance
b. Reliability
c. Fail Safe Features
d. Weight
e. Serviceability
f. Power Consumption
g. Flexibility

3.5.2 Manufacturing Standards - The Assembly shall conform to the manufacturing standards contained in Eastman Kodak Company standard 401-119.

3.5.3 Interchangeability - Parts and assemblies of the same model, regardless of series designation, exclusive of experimental, prototypes and mock-ups shall be interchangeable when up-dated to the latest revisions.

3.5.4 Life

3.5.4.1 Testing Life- The Assembly shall have a testing life of 150 hours ON time. During the life test period, the Assembly shall be capable of operating continuously for 15 minutes out of a 100 minute period. The Assembly shall also be capable of a minimum of * ON and OFF operations during * minutes out of a * minute period with each ON time having a minimum duration of * seconds.

3.5.4.1.2 Mission Life - After completion of the specified testing life, the Assembly shall have a minimum mission life of ** hours on ON time. During the mission life period, the Assembly shall be capable of operating continuously for 15 minutes out of a 100 minute period. The Assembly shall also be capable of a minimum of ** ON and OFF operations during ** minutes out of a ** minute period, with each ON time having a minimum duration of ** seconds. The assembly shall have the above mission life

* To be determined by contractor.
** To be supplied by a later revision.

when operated at randomly selected output speeds and under any of the specified operating conditions.

3.5.4.2 Shelf Life - The Assembly shall have a shelf life of 24 months minimum.

3.5.5 Reliability Requirements

a. The contractor shall meet the reliability requirements defined in section 3 of Eastman Kodak Company document 401-122.

b. The equipment specified in this document shall have a Mean-Time-Between-Failure of at least 500 hours (90 percent confidence level statistics).

c. In conjunction with reliability testing as referenced in section 3.8 of Eastman Kodak Company document 401-122, the contractor shall make an estimate of the demonstrated equipment reliability stating the confidence level of statistics used.

   In lieu of this requirement, test results including running time and failures shall be supplied by the contractor.

3.5.6 Disposition of Variances - Variances from the requirements of this specification, drawings and procedures referenced herein, and Eastman Kodak Company standard 401-119 shall require Eastman Kodak Company written approval. Variances of all other drawings not affecting the requirements of this specification, shall require contractor action only.

3.5.7 Contract Conformance - The Assembly shall conform to the requirements of this specification.

3.5.8 Safety of Personnel

3.5.8.1 Mechanical - The Assembly design shall provide maximum convenience and safety to personnel when installing, operating, maintaining, or replacing the Assembly. No sharp projections or edges on parts or assemblies shall be permitted.

3.5.8.2 Electrical - Provisions shall be made to prevent personnel from accidentally coming in contact with voltages in excess of 40 volts, including potentials on charged capacitors, when the Assembly is in its normal operating condition.

3.5.9 Assembly Mockup - The Assembly mockup shall meet the following requirements utilizing the characterictics of the Assembly design at the time of delivery.

Configuration:	The Assembly mockup shall have the external configuration and finish of the Assembly and consist of machined castings or weldments of the same material. The unit need not be machined internally except to mount required components.
Weight and Center of Gravity:	The Assembly mockup shall have the mass and center of gravity of the Assembly design within ±5 percent as demonstrated by weighing.
Heat Capacitance:	The Assembly mockup shall have the heat capacitance of the Assembly design within ±10 percent as demonstrated by calculation.
Power Consumption:	The Assembly mockup shall simulate the power consumption of the Assembly design by dissipation in a resistor which replaces the electronics components of the Assembly design. The resistor shall be selected to produce the average power dissipation of the Assembly.

In lieu of this requirement, test results including running time and failures shall be supplied by the contractor.

Electrical Connection: Two electrical connections to the resistor shall terminate at pins * and * of the electrical connector * used in the design.

Design: The Assembly mockup shall be capable of meeting the qualifications test levels of section * .

3.6 Documentary Requirements

3.6.1 Drawings - Drawings, associated lists, and documents prepared by the contractor defining the requirements of design, procurement, fabrication and assembly of the Assembly shall be prepared in accordance with section 5 of Eastman Kodak Company document 401-122.

3.6.2 Specifications - The contractor shall generate material to complete performance requirements and description of the Assembly contained in this specification. Such material shall be submitted to Eastman Kodak Company for written approval. The approved material shall be incorporated into the specification by Eastman Kodak Company.

3.6.3 Manual Material - The contractor shall provide manual material containing operating and maintenance information in accordance with 1.3.11 and section 6 of Eastman Kodak Company document 401-122.

3.6.4 Receiving, In-Process, and Final Inspection - Inspection reports shall be generated and maintained by the contractor. These reports shall include receiving, in-process, and final inspection reports in accordance with 2.3 and 2.5 respectively of Eastman Kodak Company document 401-122.

3.6.5 Reports - The contractor shall submit the following reports to Eastman Kodak Company. The formats and/ contents as applicable shall be in accordance with the reference paragraphs and sections of Eastman Kodak Company document 401-122.

		Paragraphs	Sections
a.	Technical Progress Report	1.3.6.1	
b.	Red Flag Report	1.3.6.2	
c.	Preliminary Design Report	1.3.6.3	
d.	Major Design Report	1.3.6.4	
e.	Final Design Report	1.3.6.5	
f.	Performance Evaluation Report	1.3.6.6	
g.	Failure Report and Failure Analysis	1.3.6.7	3.9
h.	Final Technical Report	1.3.6.8	
i.	Acceptance Test Report		2.12.2
j.	Acceptance Inspection Report		2.12.1
k.	Qualification Test Report	3.8.3.2	
l.	Reliability Test Report		3.7
m.	Operating Time Log	2.9	
n.	Reliability Program Plan		3.3

3.6.6 Verification of Purchased Items - A certificate of compliance for purchased parts shall be provided by the contractor. This certification of compliance shall state that the manufacturer has on record data to demonstrate that the purchased part shall conform to the requirements of the applicable Eastman Kodak Company drawing. MS and AN standard parts will not require a certificate of compliance.

3.6.7 Calibration - Records of the calibration of the Assembly and all measuring and test equipment shall be generated and documented, in accordance with 2.8 of Eastman Kodak Company document 401-122.

4. QUALITY ASSURANCE PROVISIONS

The quality control system requirements of MIL-Q-9858, and section 2 of Eastman Kodak Company document 401-122 shall apply. Quality control shall maintain a system for controlling nonconforming supplies in accordance with NR 515. Testing of the Assembly shall be limited to provisions listed in this section.

4.1 Classifications of Tests - The inspection and testing of the Assembly shall be classified as follows:

a. Qualification Tests
b. Acceptance Tests

4.2 Qualification Tests - Qualification testing of the Assembly shall be in accordance with section 3.8.3 of Eastman Kodak Company document 401-122. The contractor shall conduct a qualification testing program to demonstrate the capability of the design to meet the qualification levels of section 3.3.1. The qualification test procedure of section 3.6.8 of this specification shall be followed. The qualification test shall include but not be limited to the following:

4.2.1 Visual Inspection: All parts, subassemblies, and assemblies shall be inspected for conformance to the manufacturing standards of Eastman Kodak Company standard 401-119.

4.2.2 Drawing Conformance - All parts, subassemblied, and assemblied shall be inspected for conformance to their respective drawings.

4.2.3 Performance Tests - The Assembly shall be tested for its ability to comply with the performance requirements of sections 3.2,3.4, and 3.5.

4.2.4 Environmental Qualification Tests - The Assembly shall be subjected to the environmental levels of section 3.3.1. Subjecting the Assembly to the specified environmental conditions separately shall be considered adequate in lieu of testing all possible or probable combinations except for the operation portion where worst case combinations shall be used. Following completion of these tests, the Assembly shall be visually inspected for damage, and the performance tests of 4.2.3 shall be repeated. Any impairment of performance of the Assembly shall be reported in accordance with item g. of 3.6.5.

4.2.5 Life Test - The Assembly shall be tested for its ability to meet the service life requirements of 3.5.4.1.

4.3 Acceptance Tests - Acceptance testing of the Assembly shall be part of the task and follow the acceptance test procedure in accordance with 2.11 of Eastman Kodak Company document 401-122. The acceptance tests shall include but not be limited to:

4.3.1 Visual Inspection - All parts, subassemblies, and assemblies shall be inspected for workmanship, cleanlinesses, and wiring.

4.3.2 Drawing Conformance - All parts, subassemblies and assemblied shall be inspected for conformance to their respective drawings.

4.3.3 Performance Test - The Assembly shall be tested for its ability to meet all the performance requirements that are defined in sections 3.2 and 3.4 of this specification. The Assembly shall meet foregoing requirements both before and after being subject to acceptance test vibration of 4.3.4.

4.3.4 Vibration Tests - The Assembly shall be tested for its ability to meet the vibration requirements of 3.3.2.

4.4 Test Conditions - The atmospheric conditions for all tests shall be within the environmental ranges specified in section 3.3 except as required in 4.2.4.

4.5 Monitoring and Technical Surveillance - Eastman Kodak Company reserves the right to have technical representatives visit the contractor's facilities periodically to maintain technical surveillance of the contract. Eastman Kodak Company reserves the right to have technical representatives in residence at the contractor's facilities, if conditions warrant.

4.6 Sampling - Not required for this specification.

5. PREPARATION FOR DELIVERY

5.1 Shipping, Handling, and Storage - Each Assembly shall be cleaned, labeled, sealed, with its identification in a transparent plastic bag, and packaged in a fitted, padded box. It shall be the responsibility of the contractor to insure that the packing and packaging provides adequate protection for the Assembly to withstand the environmental conditions specified in the shipping handling environmental requirements of 3.3.1.3. It shall also be the responsibility of the contractor to insure that the specified environmental conditions are not exceeded prior to receipt of the Assembly by Eastman Kodak Company.

6. NOTES

6.1 Applicability - Details of intended use are not required for this specification.

APPENDIX R

Computer Calculation of Luminance for Cones on the Lunar Surface

The range of brightnesses for the elements of a cone on the lunar surface has been calculated on the IBM 7044 Computer. The results of these calculations have been plotted versus sun elevation, camera angle and cone angle.

The computer program has the following parameters:

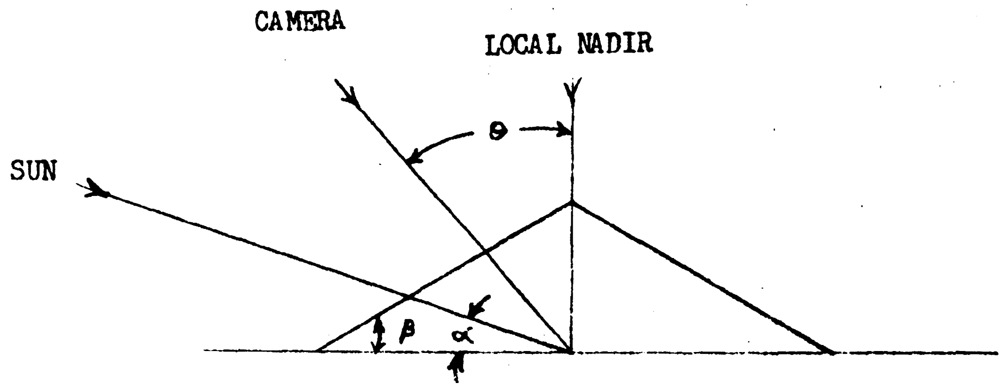
(1) Albedo is equal to 0.07
(2) Lunar surface illumination is 12,000 ft.-lamberts
(3) Lens transmittance is 0.53
(4) Lens f/# is 3.95

The sun elevation angle, camera angle and cone angle are defined in Figure R-1. Figure R-2 plots background illumination vs sun elevation for a range of camera angles. Figures R-3 through R-7 plot minimum illumination for a range of cone and camera angles as a function of sun elevation. Figures R-8 through R-12 have similar plots for maximum illumination.

The luminance in the image plane was calculated using the following relationship:

$$I \text{ (meter candles)} = \frac{10.76 \, B_o \qquad T}{4 \, (f/\#)^2}$$

B_o = 12,000 ft.-lamberts
ρ = albedo = 0.07
Φ = photometric function
T = lens transmittance = 0.53
f/# = f-number = 3.95



α = Sun Elevation Angle
Range 15° to 60°

θ = Camera Angle
Range -15° to +15°
θ is Positive as Shown

β = Cone Angle
Range 15° to 60°

Figure R-1

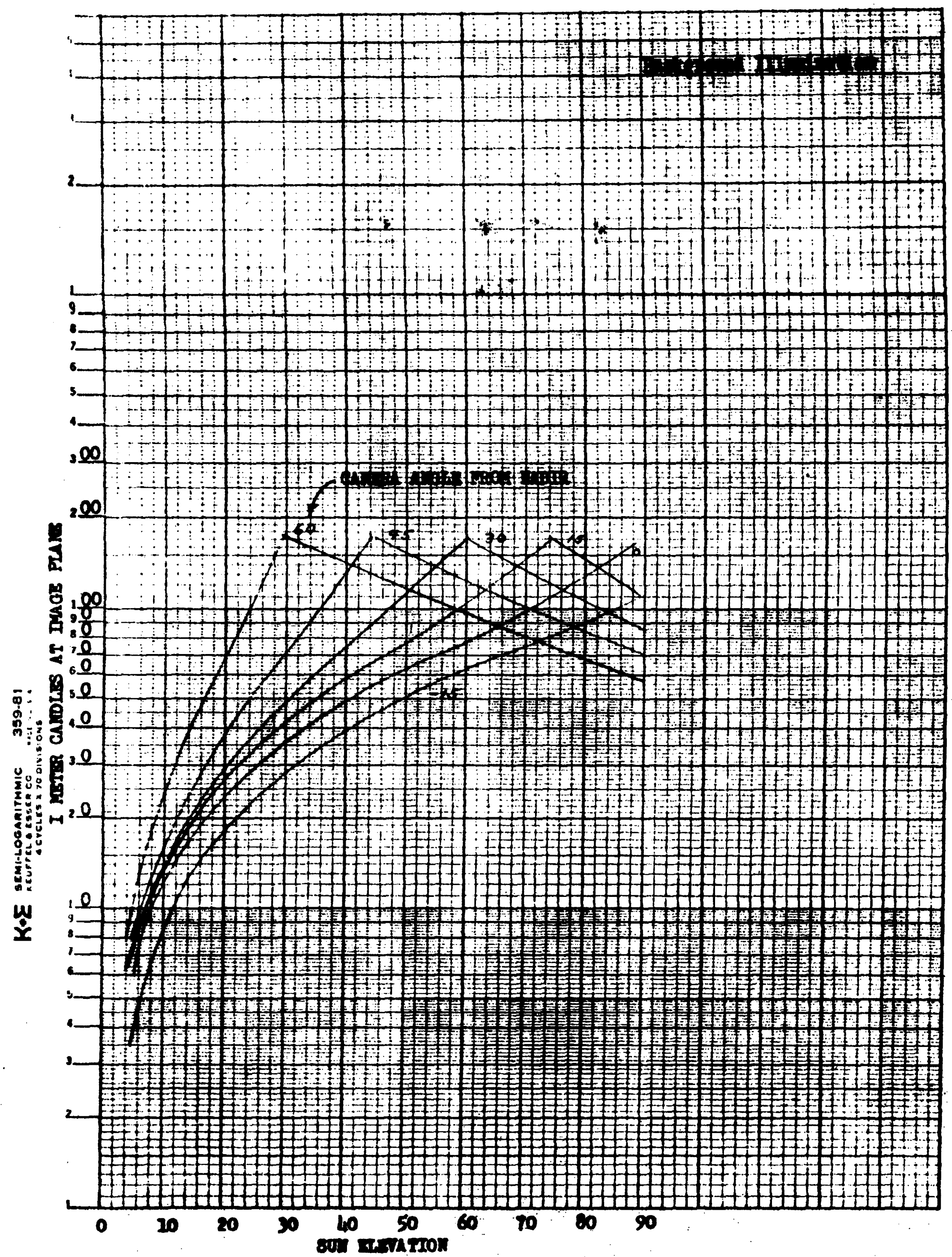

CAMERA ANGLE FROM NADIR
60
45
30
15
0
I METER CANDLES AT IMAGE PLANE
SUN ELEVATION
0
10
20
30
40
50
60
70
80
90
K+E SEMI-LOGARITHMIC 359-81

Figure R-2

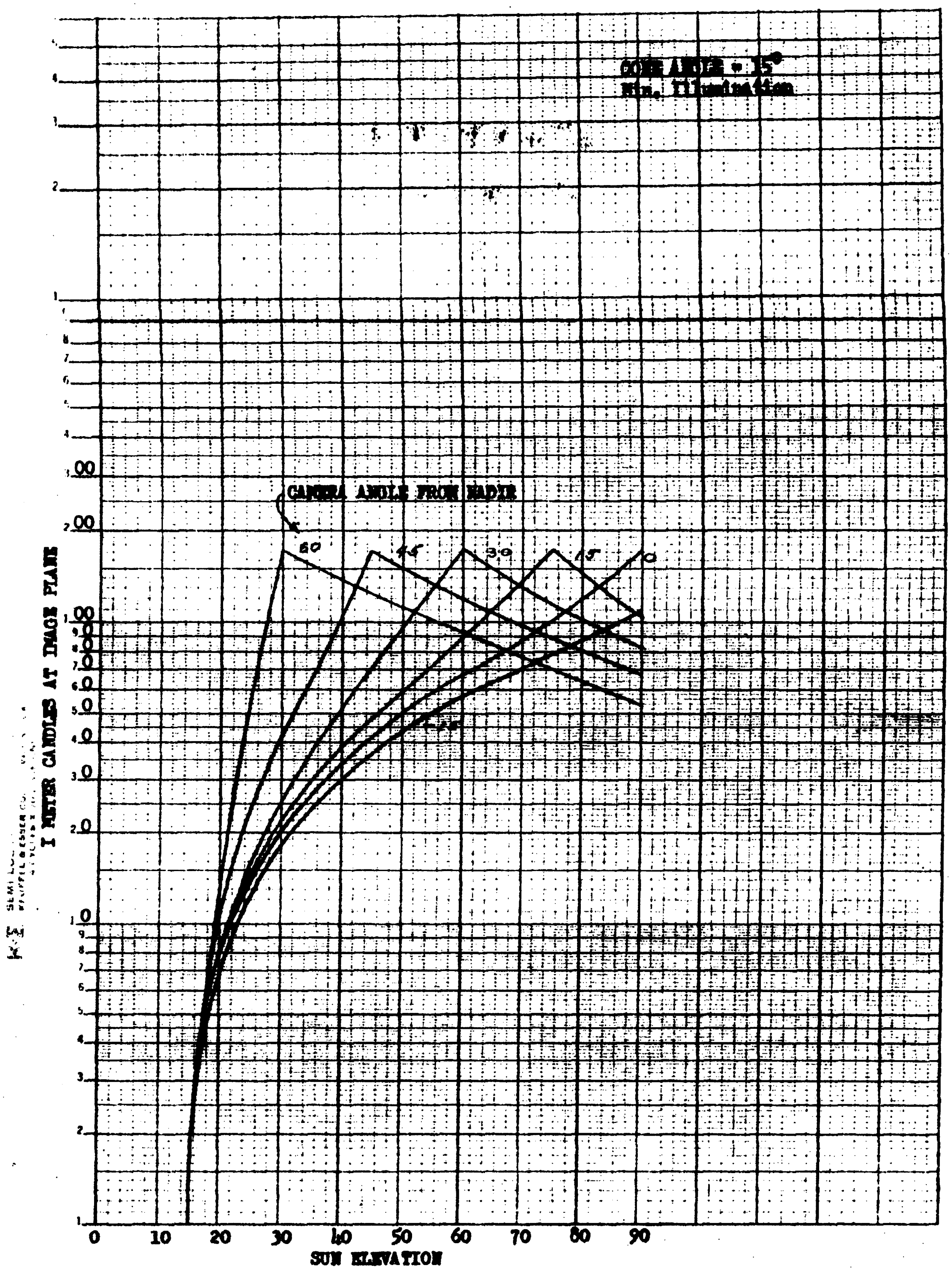

CONE ANGLE = 15°
Min. Illumination
CAMERA ANGLE FROM NADIR
60
45
30
15
0
I METER CANDLES AT IMAGE PLANE
SUN ELEVATION
0
10
20
30
40
50
60
70
80
90

Figure R-3

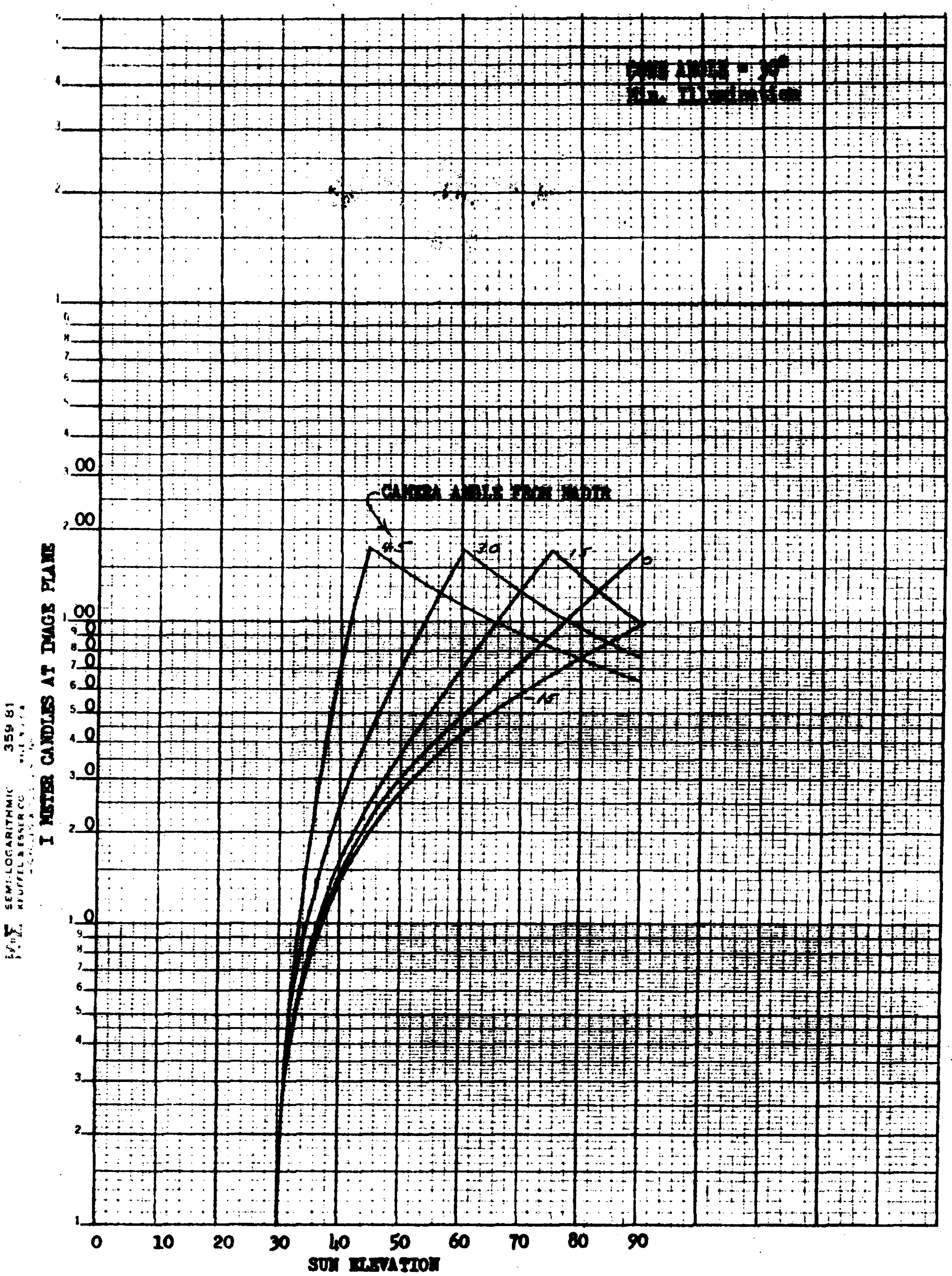

CAMERA ANGLE FROM NADIR
45
30
15
0
-15
I METER CANDLES AT IMAGE PLANE
0 10 20 30 40 50 60 70 80 90
SUN ELEVATION

Figure R-4

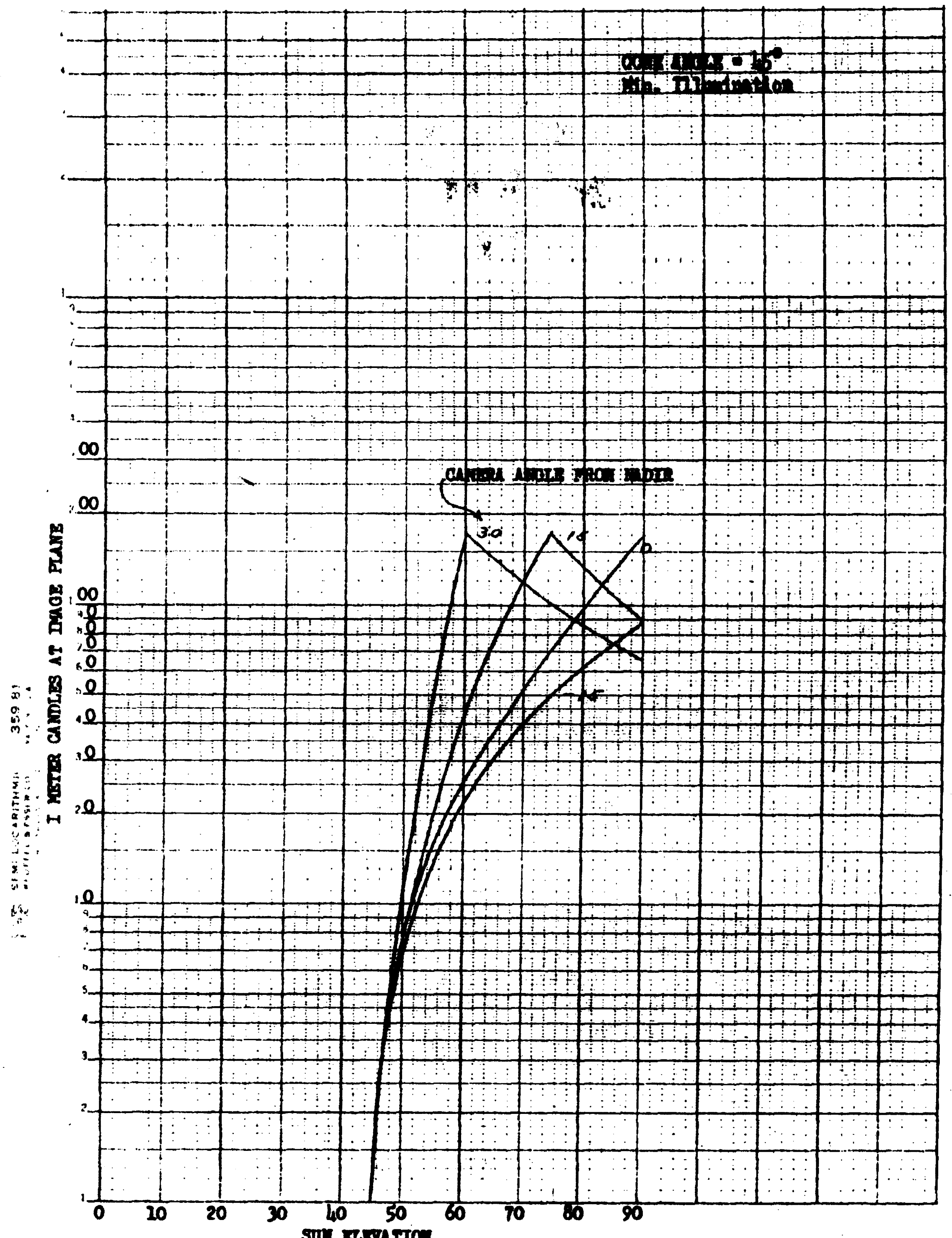

Min. Illumination
CAMERA ANGLE FROM NADIR
30
15
0
I METER CANDLES AT IMAGE PLANE
0
10
20
30
40
50
60
70
80
90
SUN ELEVATION

Figure R-5

NRO APPROVED FOR RELEASE
DECLASSIFIED BY: C/IRRG
DECLASSIFIED ON: 14 JUNE 2013

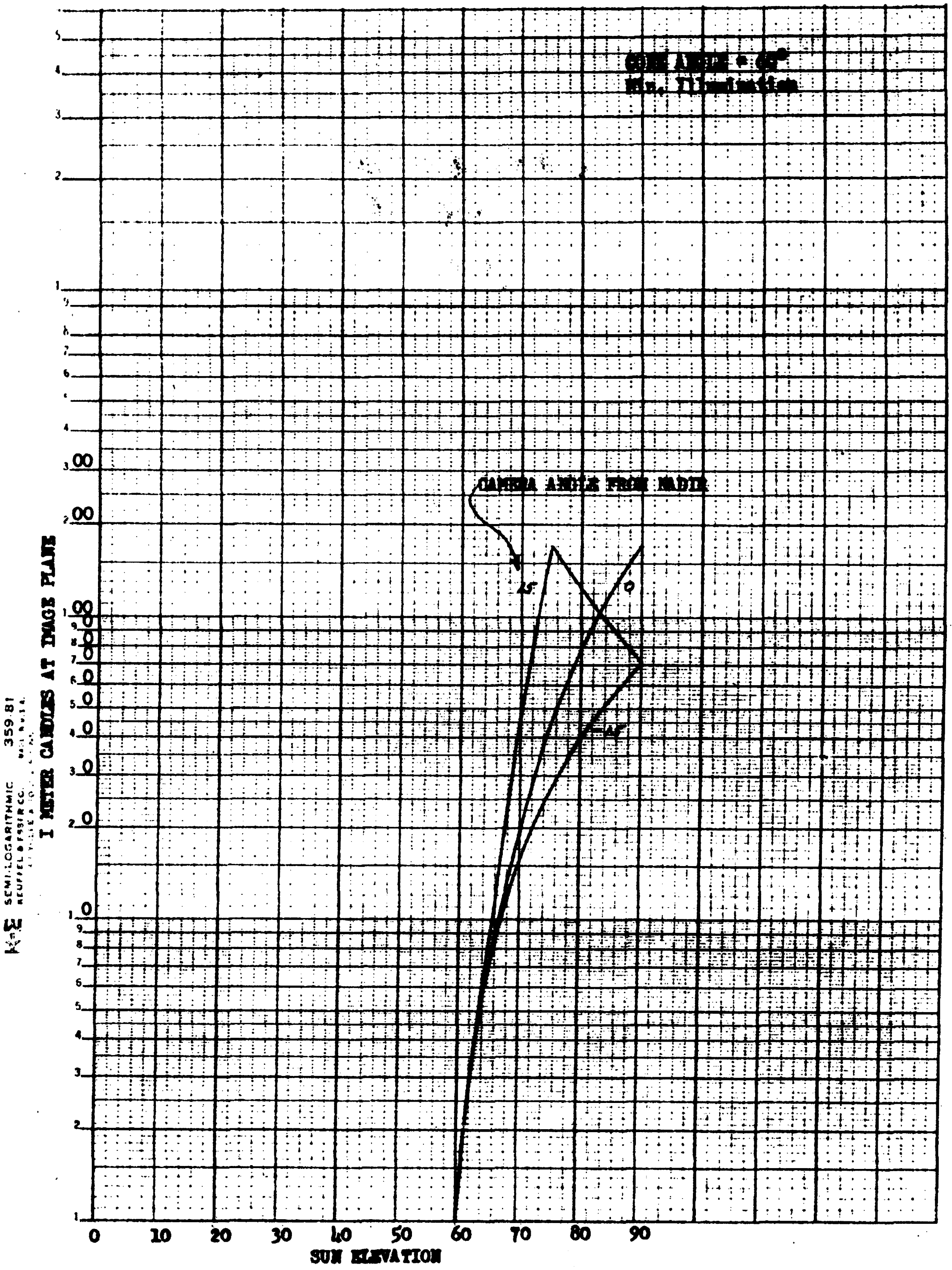


Figure R-6

SPECIAL HANDLING

SECRET

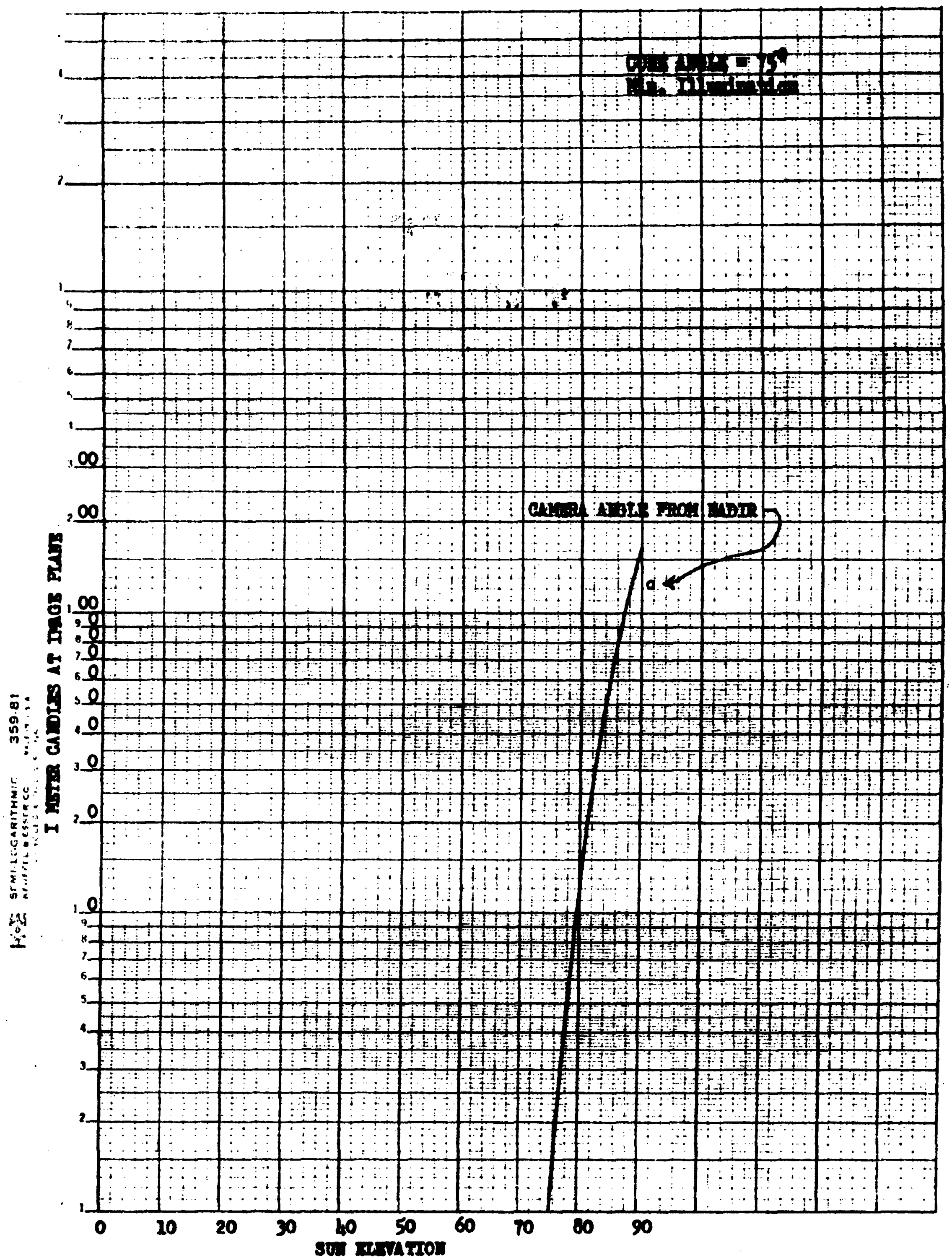


Figure R-7

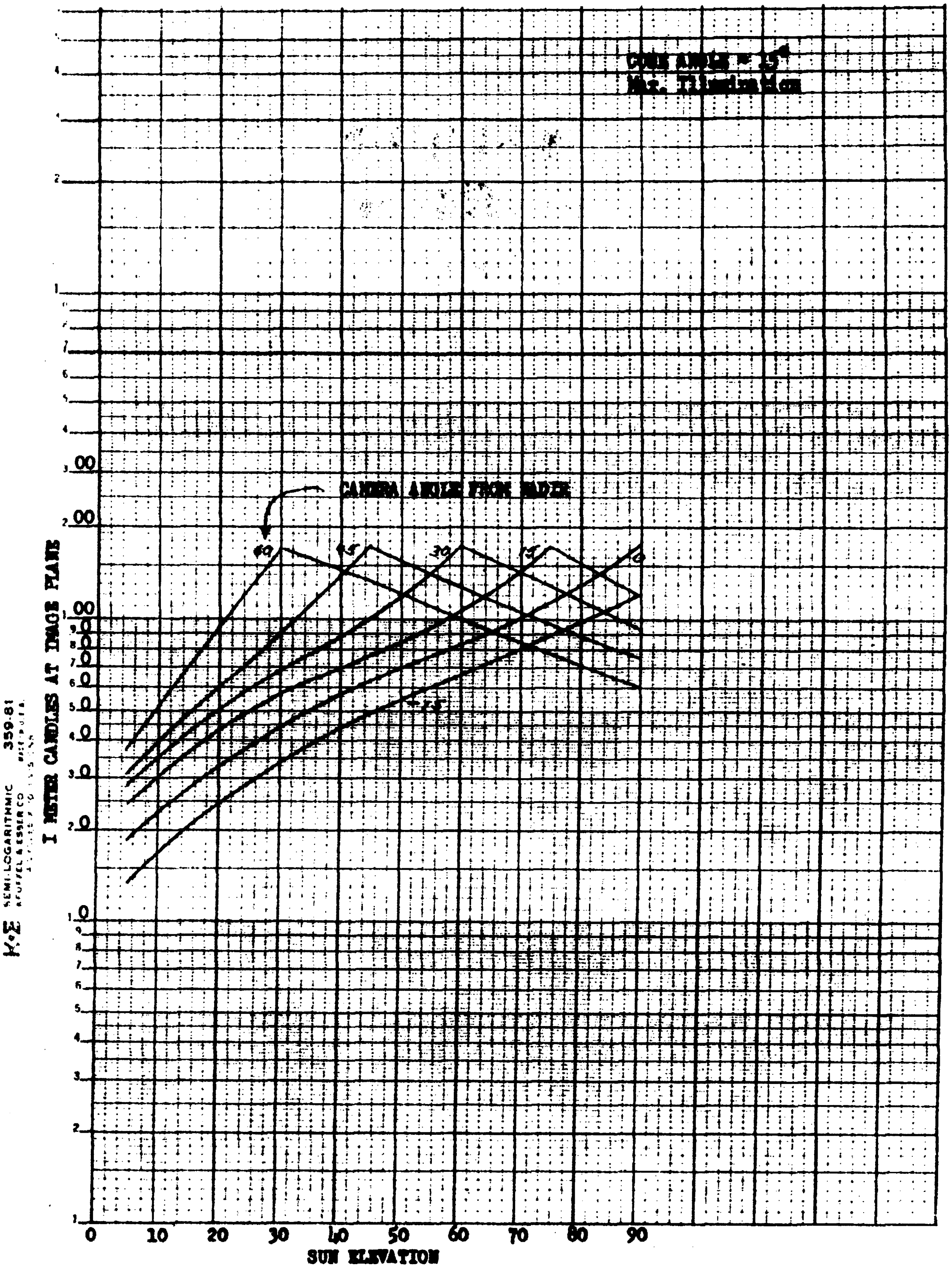

CAMERA ANGLE FROM NADIR
60
45
30
15
0
7.5
I METER CANDLES AT IMAGE PLANE
0
10
20
30
40
50
60
70
80
90
SUN ELEVATION
K+E SEMI-LOGARITHMIC 359-81

Figure R-8

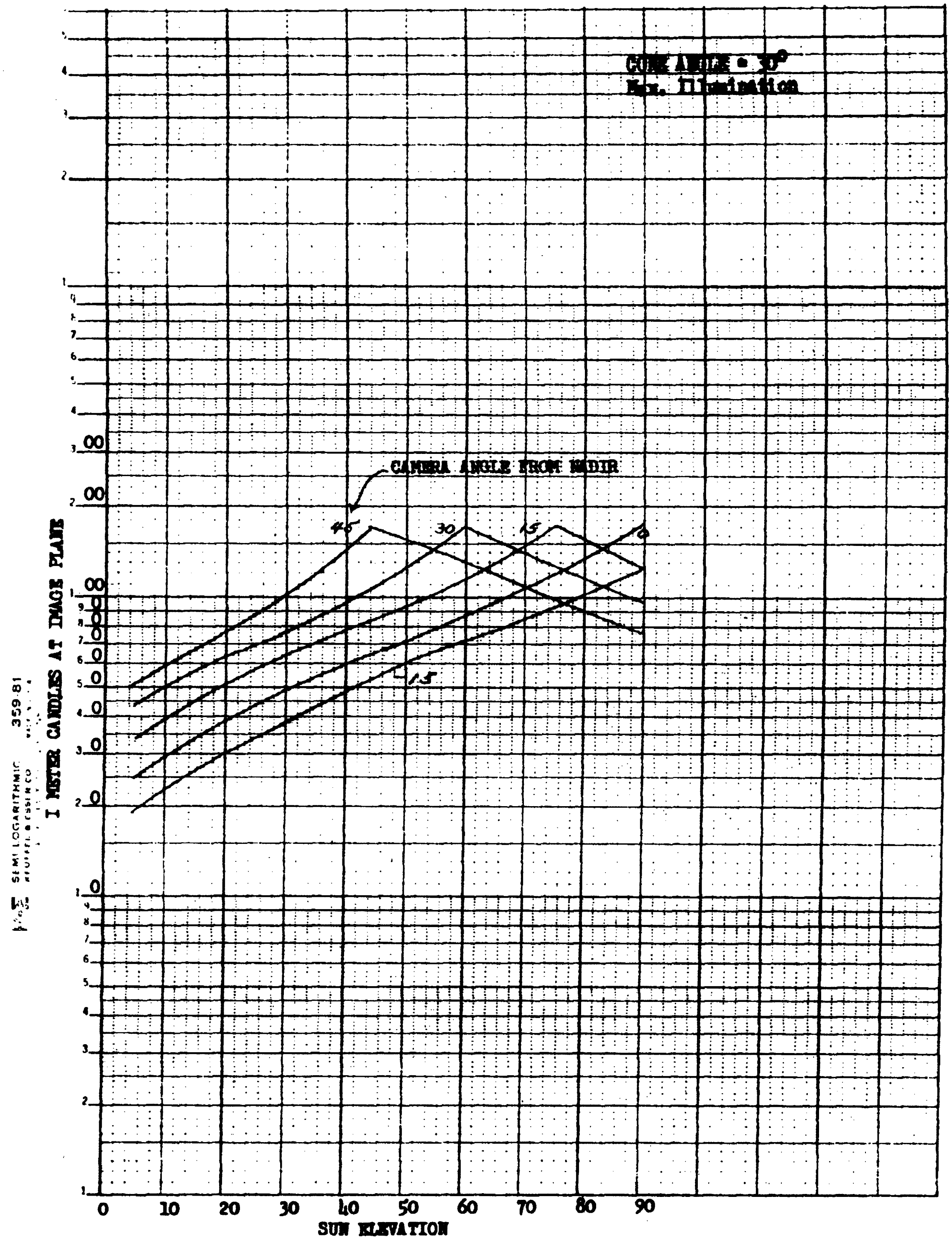

CAMERA ANGLE FROM NADIR
45
30
15
0
15
I METER CANDLES AT IMAGE PLANE
0
10
20
30
40
50
60
70
80
90
SUN ELEVATION

Figure R-9

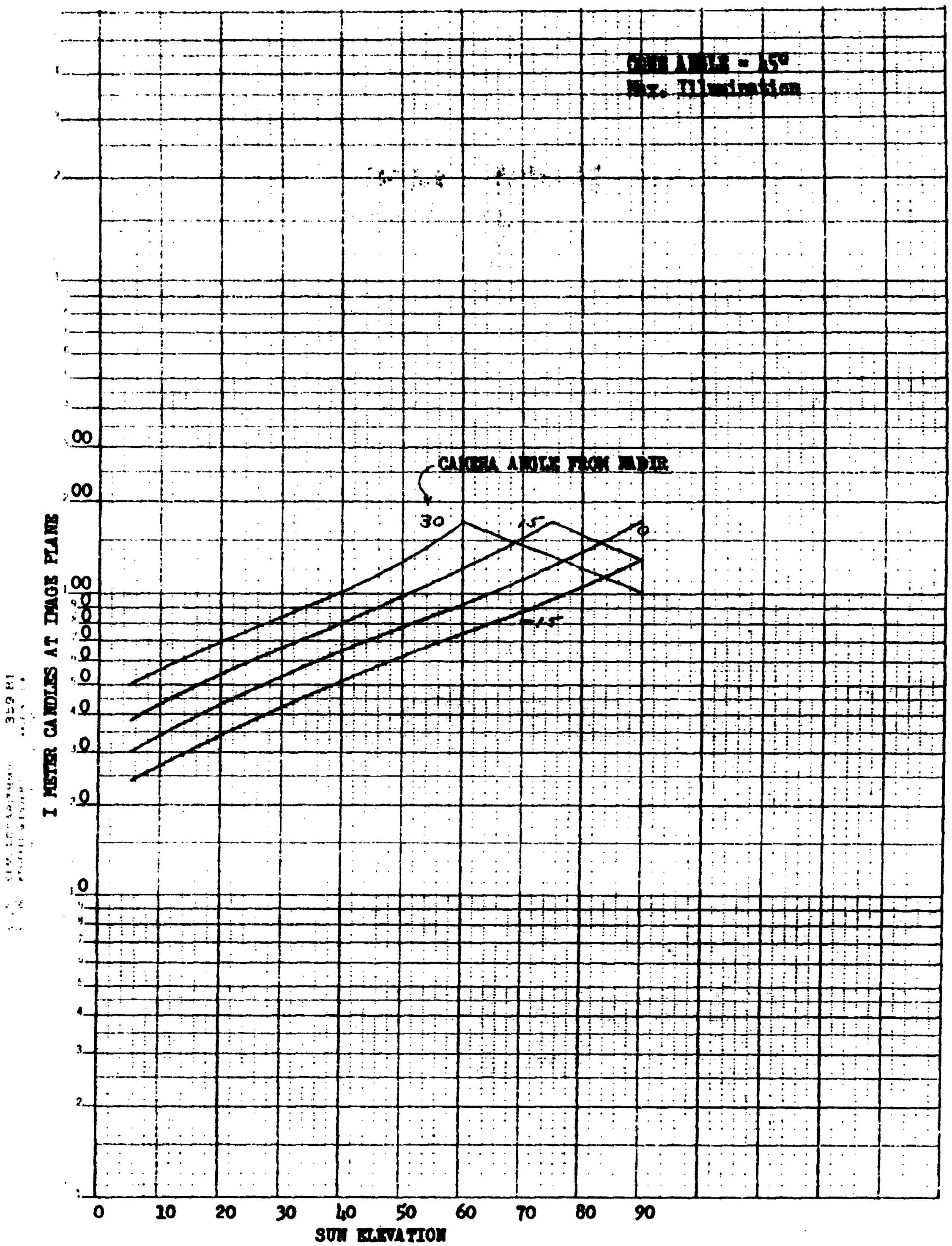

Max. Illumination
CAMERA ANGLE FROM NADIR
30
15
0
-15
I METER CANDLES AT IMAGE PLANE
0
10
20
30
40
50
60
70
80
90
SUN ELEVATION

Figure R-10

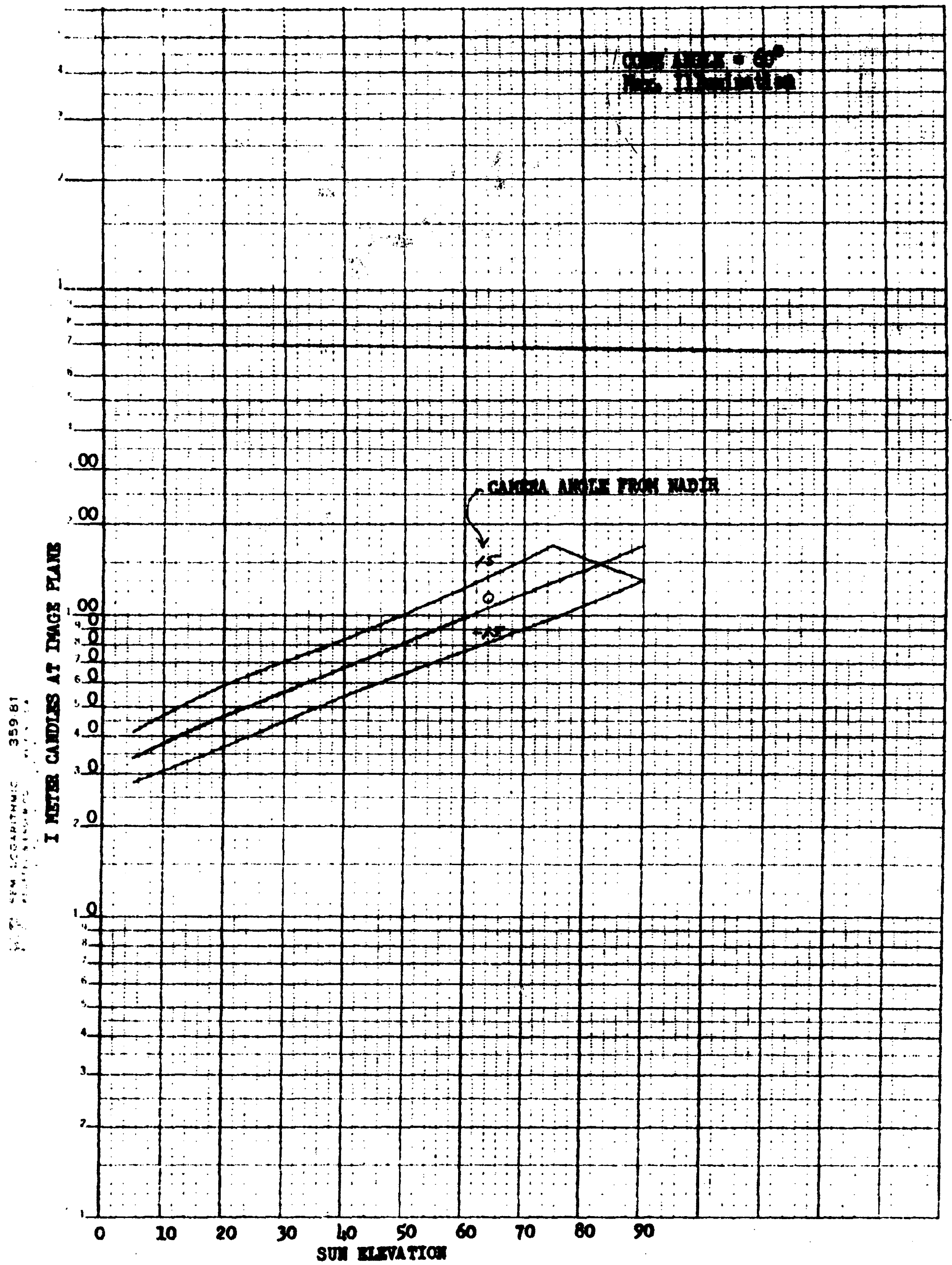

CAMERA ANGLE FROM NADIR
15
0
I METER CANDLES AT IMAGE PLANE
0
10
20
30
40
50
60
70
80
90
SUN ELEVATION

Figure R-11

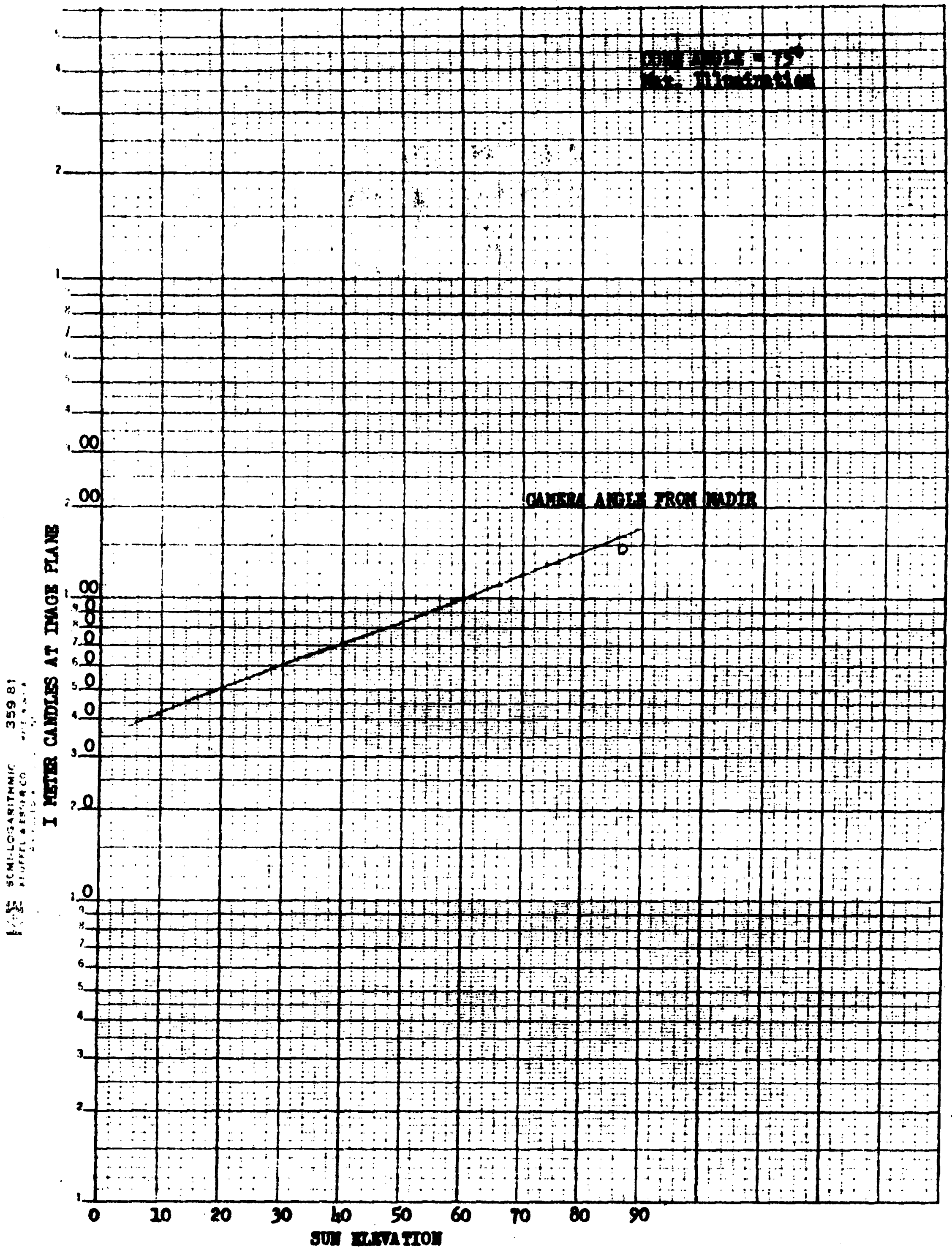

CAMERA ANGLE FROM NADIR
I METER CANDLES AT IMAGE PLANE
0 10 20 30 40 50 60 70 80 90
SUN ELEVATION

Figure R-12

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Sheets ________

APPENDIX S

Preliminary

V/H Sensor

Specification No. *

for

by

Prepared by ________________________________

Reviewed by ________________________________

Approved by ________________________________

Release Date ______________

Revision	Pages Affected	Date	Approved by

Preliminary Specification V/H Sensor

Specification No. Release Date:

1. SCOPE AND MISSION

1.1 Scope

This specification defines a V/h scanner and associated optics and electronics, a component assembly, hereafter referred to as V/h Sensor. It includes the performance and environmental requirements, and defines the quality assurance, reliability, and performance test provisions required to determine compliance of the V/h Sensor with these requirements.

1.2 Mission

It shall be the mission of the V/h Sensor to supply an output proportional to the relative velocity to distance (altitude) ratio of an object acquired by the component optics. Additionally, the sensor shall supply an output proportional to the crab attitude about the optical axis with respect to the V/h Sensor.

1.3 Task

The required task is to design, develop, manufacture, test, and deliver to Eastman Kodak Company a V/h sensor which complies with the requirements of this specification.

2. APPLICABLE DOCUMENTS

2.1 Specifications, Standards, Drawings

The following specifications, standards, drawings, and publications of latest issue in effect on date of contract negotiation, form a part of this specification. Applicability of the listed documents shall depend on their specific reference in this specification. In the event of conflict between the listed documents and this specification, this specification shall take precedence. Any deviations allowed from the listed specifications will be defined as a part of the contractor work statement.

SPECIFICATIONS

Military

MIL - I-26600	Interference Control Requirements, Aeronautical Equipment
MIL - Q-9858	Quality Control System Requirements

STANDARDS

Eastman Kodak Company

401-108	Design Standard for Human Factors, Engineering
401-113	Reliability Preferred Parts List
401-119	Design and Manufacturing Standards
401-122	Technical Requirements for Contracts

DRAWINGS

Eastman Kodak Company

405-130	Procedure for Iridite 15 on Magnesium
405-162	Procedure for Stencil Identification Marking of Mechanical or Electrical Assemblies or Parts
405-185	Procedure for Iridite 15 for Aluminum

3. REQUIREMENTS

The V/h Sensor shall provide the necessary outputs in compliance with the following requirements.

3.1 Definitions - The V/h Sensor shall consist of the following subassemblies:

a. Scanner Head
b. Scanner Carriage
c. Scan Optics
d. Optics Carriage
e. V/h Structure
f. Electronics

3.1.1 Scanner Head - The scanner head shall be designed to convert the optical image of the target to a video signal. The scanner head shall provide the capability of comparing a signal with a signal from a previous scan cycle image to generate position error signals.

3.1.2 Scanner Carriage

The scanner carriage shall be designed to support the scanner head. Freedom of movement perpendicular to the Y-Z plane of the V/h sensor shall be provided to permit track of an object in the optical field.

The scanner carriage shall contain the necessary servo elements to drive the scanner head in the track of the optical image perpendicular to the Y-Z plane of the V/h sensor as described by Eastman Kodak Company drawing

3.1.3 Scan Optics

The scan optics shall be designed to place the optical image on the face of the scanner head. The scan optics shall be capable of maintaining the optical image in focus and on the scanner head within the limits of image movement occurring during the time the V/h sensor is establishing its output signals. The scan optics shall utilize an existing lens for focussing the image and shall operate on a space-share basis with other optical hardware in accordance with Eastman Kodak Company Mechanical Interface drawing*.

3.1.4 Optics Carriage

The optics carriage shall be designed to support the scan optics and provide a freedom of movement for the scan optics in the Y-Z plane as defined by Eastman Kodak Company Mechanical Interface drawing*.
The optics carriage shall contain the necessary parts of a servo loop to drive the scan optics in its degree of freedom to allow it to maintain the optical image in focus and on the face of the scanner head.

3.1.5 V/h Structure - The V/h structure shall be designed to provide mounting points for the internal portions of the V/h Sensor. It shall maintain parts in rigid alignment among themselves and be integrated to the focusing lens structure to maintain the image in focus on the scanner head.

3.1.6 Electronics - The electronics shall provide the necessary power supplies, amplifiers, signal processing and logic circuits to provide the required outputs of Section 3.3.3.

3.2 Electrical Requirements - The V/h Sensor shall be required to operate on inputs and provide outputs in compliance with this section.

3.2.1 Inputs - The following inputs shall be used by the sensor.

3.2.1.1 Power Input Voltages - The power input voltages for the V/h Sensor shall be +28 ±3 volts dc; +5 volts dc for instrumentation shall also be provided.

3.2.1.1.1 Overvoltage Protection - The V/h Sensor shall be capable of withstanding power input voltages up to 32 volts at zero source impedance.

3.2.2 Outputs - The V/h Sensor shall supply the following outputs.

3.2.2.1 Crab Attitude Signal

The V/h sensor shall provide a continuous analog output signal proportional to the crab attitude angle.
The crab attitude angle is reference to the V/h sensor plane and is defined by Eastman Kodak Company drawing *,

3.2.2.1.1 Crab Attitude Voltage

The crab attitude dc output voltage shall be available at two wires and shall be as defined in Figure 1. The voltage shall be equal to 3 volts per degree crab angle, with a saturated voltage from ±1.5° to ±3°.

3.2.2.1.1.1 Crab Attitude Voltage Linearity

The output voltage shall be linear within ±5% from -1/2 degree to + 1/2 degree.

3.2.2.1.1.2 Crab Attitude Voltage Error

The voltage error at 0 degrees shall not exceed ±0.1 degrees equivalent voltage, from 0° to 1° with a gradual increase in error to ±10 percent from 1.5° to 2.0°.

3.2.2.1.2 Crab Attitude Output Imedance - The output impedance shall be 5000 ohms ±50 ohms.

3.2.2.1.3 Overload Protection

The performance of all other outputs of the V/h sensor shall not be degraded by having a short circuited load on the crab attitude output line.

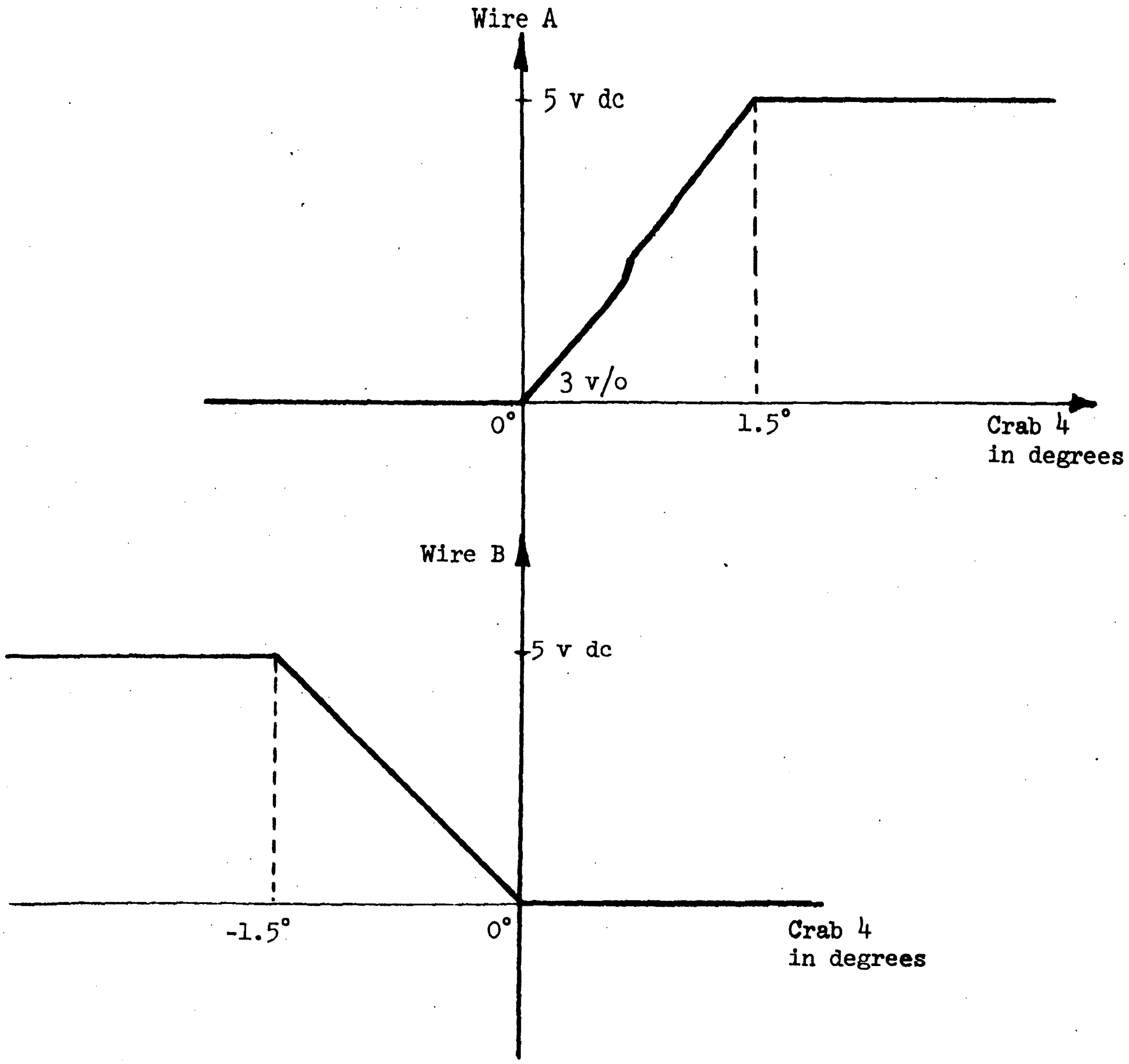
Wire A
5 v dc
3 v/o
0°
1.5°
Crab 4
in degrees
Wire B
5 v dc
-1.5°
0°
Crab 4
in degrees

Figure S-1.

3.2.2.1.4 Noise Level - Noise on the output line shall not exceed 10 millivolts rms as measured over a bandwidth of 0 to * cps.

3.2.2.2 V/h Signal

The V/h Sensor shall provide a 9 bit parallel binary signal directly proportional to the velocity to distance ratio of a target moving in the field-of-view of the lens of 3.4.3.1 and as shown in Eastman Kodak Company drawing * . This signal shall be held during each sweep and it shall be updated at the end of each sweep. The V/h output shall be measured in a direction parallel to the Z-Z plane and perpendicular to the optical axis of the lens of 3.4.3.1. This output shall be available whenever power is applied to the V/h Sensor.

3.2.2.2.1 V/h Binary Number. To be supplied later.

3.2.2.2.1.1 V/h Binary Number Voltage. - A binary I shall be represented by the presence of +3 volts dc and a binary zero by the presence of zero volts.

3.2.2.2.2 V/h Output Error. - The V/h Sensor shall give a V/h output with an error of not greater than ± 0.5 percent from the actual V/h.

3.2.2.2.3 V/h Output Impdeance. - The internal impedance of the V/h output shall be 10000 ohms resistance or less.

3.2.3 Instrumentation Signals

Instumentation shall be provided to monitor the following information:

3.2.3.1 V/h Output Instrumentation Signal. The V/h Sensor shall be instrumented to provide a dc output proportional to V/h. The output shall represent this V/h value within ±0.5 percent. This accuracy is based on a nominal effective focal length of 10 inches.

3.2.3.1.1 V/h Output Instrumentation Voltage. The V/h instrumentation voltage level shall be limited to a voltage between 0 and +5 volts dc. Plus 5.0 volts dc shall correspond to a V/h value of 0.036 radians/second.

3.2.3.1.2 V/h Analog Instrumentation Impedance. The internal impedance of the V/h analog instrumentation line shall be 10,000 ohms or less resistive.

3.2.3.1.3 V/h Analog Instrumentation Overload. The V/h Sensor shall be capable of withstanding without damage or degradation of other output, a permanent short or back voltage not exceeding ±10 volts.

3.2.3.1.4 V/h Analog Instrumentation Noise. The noise and ripple content of the instrumentation voltage shall be 50 millivolts p-p or less. Noise bandwidth shall be 10 cps to 10 mc.

3.2.3.2 Crab Output Instrumentation Signal

The V/h Sensor shall provide a dc output proportional to the crab angle. This output shall have an error not greater than ±0.1 degrees equivalent voltage from 0° to 1°.

3.2.3.2.1 Crab Instrumentation Voltage. The crab instrumentation voltage shall be limited to 0 to 5 volts dc. Zero degrees crab shall be represented by 2.5 volts. Negative crab shall be represented by values of voltage less than 2.5 volts and positive values of crab shall be represented by voltages greater than 2.5 volts.

3.2.3.3 Malfunction Instrumentation Signal

The V/h sensor shall have two outputs to represent a malfunction of the V/h sensor operation. One output shall indicate a major malfunction in the V/h sensing unit. The other output shall indicate a temporary and correctable malfunction. The major malfunction signal will come on during a major malfunction. The temporary malfunction signal shall come on and remain on until the malfunction is corrected.

3.2.3.3.1 Defuntion of a Major Malfunction. A major malfunction is defined as a failure of the V/h Sensor itself which causes the V/h to give incorrect data or no data at all.

3.2.3.3.2 Definition of a Temporary Malfunction. A temporary malfunction is defined as an incorrect output of the V/h sensor due to lack of sufficient signal input as defined in 3.4.3.2.

3.2.3.3.3 Malfunction Voltage. A malfunction shall be indicated by the pressure of 3 volts dc. Lack of malfunction shall be indicated by 0 voltage on the output line.

3.2.3.3.4 Malfunction Output Impedance. Internal impedance of the malfunction instrumentation line shall be 10,000 ohms or less, resistive.

3.2.3.3.5 Noise Level. To be supplied at a later date.

3.2.4 Returns

All returns shall be isolated from case and structure and from each other.

3.2.5 Power Consumption

3.2.5.1 Operational Power Consumption

The total power required for the V/h sensor shall be less than 12.6 watts average.

3.2.5.2 "Off" Condition Power Consumption. There shall be no power required when the V/h sensor is "off".

3.2.6 Warm-Up

The V/h sensor shall be capable of operating according to this specification but the output may not necessarily meet the specified accuracy, within 1 second after power is applied.

3.2.7 Time Constants

The V/h sensor shall be capable of performance to the following time constants: V/h System Time Constant, Scanner Carriage and V/h System Step Change Time Constant and Crab System Ramp Change Time Constant.

3.2.7.1 Scanner Carriage. IMC Drive Time Constant. The scanner carriage drive system shall start up from zero and reach correct speed in 0.2 ±0.05 seconds from the time of arrival of a V/h "ON" control signal. This accuracy shall be obtained within the V/h range of 0.05 to 0.03 rad./sec.

3.2.7.2 V/h System Time Constant. The V/h Sensor shall be capable of following a step change in V/h of 1.0 percent with a time constant of not greater than * seconds.

3.2.7.3 V/h System Step Change Time Constant. The V/h sensor shall be capable of operating with an average slewing speed of percent /sec. or greater when subjected to a V/h step change in V/h of 50 percent.

3.2.7.4 Crab System Ramp Change Time Constant. The V/h sensor shall be capable of following a change from constant crab angle to a 2/5°/sec slope of crab change in not more than 2 seconds.

3.2.8 Current Carrying Devices, Leakage, and Insulation Resistance

There shall be 100 megohms or greater leakage resistance at 100 ±10 volts d-c between any point in the V/h sensor electrical circuitry and the chassis. Insulating materials used shall be adequate to prevent insulation breakdown under all operating conditions. Moisture absorption of all insulating materials shall be less than one per cent. Current carrying devices shall have a capacity greater than design requirements.

3.2.9 Fuses

The electrical wiring shall be protected by fuses. The scan carriage servo drive shall be fused separately from the ramainder of the V/h sensor circuitry.

3.2.10 Identification

Single wires on cables, and cables fitted with connectors, shall be clearly marked to indicate drawing reference designation and to guide personnel in locating mating elements during assembly or replacement of parts in accordance with Eastman Kodak Company Document 401-119.

3.2.11 Electromagnetic Interference Control - The V/h sensor shall meet the requirements of MIL-I-26600 for Class 1 b equipment. In addition to the requirements defined by MIL-I-26600, any conducted interference, within the frequency range of 15- 15,000 cps, impressed on the +28 volt d.c. power supply circuit by the V/h sensor shall not exceed 0.050 amperes, peak-to-peak.

3.2.12 Electrical Wiring - All electrical wiring shall be done in accordance with Eastman Kodak Company document 401-119. The electrical connections to the V/h Sensor and the pin assignment shall be defined by Eastman Kodak Company drawing.

3.3 Environmental Requirements - A complete environmental design criteria establishing all of the levels of environment to which the payload and its components will be subjected will be established at a later date.

3.4 Mechanical Requirements

3.4.1 Size - The form factor of the V/h Sensor shall be in compliance with Eastman Kodak Company drawing *.

3.4.2 Weight - The weight of the V/h Sensor shall be a minimum in accordance with good engineering practice. The weight of the V/h Sensor shall not exceed 10.0 pounds.

3.4.3 Optical Interface

3.4.3.1 Associated Optics - The V/h Sensor shall utilize the optical image formed by a 10-inch focal length aerial lens mounted on a structure external to the V/h Sensor for V/h tracking. There shall be sufficient, readily accessible, adjustments on the V/h Sensor to assure compatibility when mated with the Eastman Kodak Company 10-inch lens. The lens shall not be part of the V/h Sensor but shall be part of an Eastman Kodak Company Assembly. The lens characteristics shall be as specified in Eastman Kodak Company Specification *.

3.4.3.2 V/h Sensor Operating Range

3.4.3.2.1 Illumination - The V/h Sensor shall meet the performance requirements of this specification when operated from the image transmitted by the lens of paragraph 3.4.3.1. The average focal plane scene illumination provided by the lens, uncorrected for V/h Sensor optical elements shall be * to * meter-candles. The V/h Sensor shall continue to operate outside this illumination range with some degradation in contrast and target concentration response. The transmitted light will be in the wavelength between 4000 and 7000 Angstroms. Contrast ratio shall be 2:1.

3.4.3.2.2 V/h Operating Range - The V/h Sensor shall be designed to operate in the V/h range of 0.008 to 0.035 radians per second and under a crab attitude of ± 1 1/2 degrees. V/h Sensor shall be operable, but may have lesser accuracy than required by this specification, within the V/h ranges of * to * and * to *.

3.4.3.2.3 Information Input - The V/h Sensor shall meet the requirements stated in this specification with an information input of * bits per scanner revolution (a population density of * bits per square mile). The V/h shall be in a malfunctioning state if the information input is less than * bits per scanner revolution.

3.4.4 Mechanical Interface - V/h Sensor shall contain adequate adjustment to bring the V/h Scanner into the focal plane of the lens and the scanner carriage and optics carriage into alignment with the axis of the lens of paragraph 3.4.3.1. The mounting points of the V/h Sensor, dimensions and location of mechanical output shaft, and alignment requirements are defined in the Eastman Kodak Company drawing *.

3.4.5 Assembly Axes - The contractor shall define the V/h Sensor coordinate axes system with respect to the interface mounting points of Eastman Kodak Company drawing *.

3.4.6 Assembly and Disassembly - The V/h assemblies shall be removable from the next level of assembly without removal or disassembly of any of its or associated assembly parts. This shall be in agreement with Eastman Kodak Company drawing *.

3.4.7 Optical Obscuration - The V/h Sensor shall not obscure the optical path as defined on Eastman Kodak Company drawing *.

3.4.8 Materials - Parts and subassemblies forming a portion of the assembly shall be composed of materials, parts and processes which comply with the provisions of this specification.

3.4.9 Finish - The V/h Sensor shall be finished in accordance with part drawings to minimize all of the following: degradation of photosensitive materials, contact erosion, galvanic corrosion, surface contamination and corrosion during storage. In the case of degradation of photosensitive materials, Eastman Kodak Company shall be consulted for selection of proper finishes.

3.4.9.1 Finish Coat - The following finishes shall be used when applicable as determined by the material used.

3.4.9.1.1 Aluminum - One coat of Iridite No. 14, colored, in accordance with Eastman Kodak Company drawing 405-185.

3.4.9.1.2 Magnesium - Components having exposed enclosure of magnesium shall have a durable, firmly bonded, electrically conductive finish such as Iridite No. 15, colored, in accordance with Eastman Kodak Company drawing 405-130.

3.4.10 Identification - The V/h Sensor and all its parts shall be marked for identification by appropriate part and serial numbers, in accordance with Eastman Kodak Company drawing 405-162.

3.4.11 Thermal Control - Adequate radiation and conductive means of thermal control shall be employed to maintain parts well below maximum permissible operating temperature under all operating conditions and to prevent the occurrence of local hot spots within the V/h Sensor. The thermal control design shall be carried out in conjunction with Eastman Kodak Company and shall be approved by Eastman Kodak Company as part of the formal design approval.

3.4.12 Dust Generation - Dust generation shall be held to a minimum. Any dust generated within the V/h Sensor shall be confined to the V/h Sensor to eliminate any adverse affect on the remainder of the assembly.

3.4.13 Lubrication - Lubrication shall be limited to that specified on part of unit drawing. Lubrication for the V/h Sensor shall be selected to minimize the following: Degradation of photo-sensitive materials, fretting corrosion surface and optical element contamination and corrosion during storage. In the case of degradation of photo-sensitive materials, the Eastman Kodak Company shall be consulted for selection of proper lubricant.

3.4.14 Stress Analysis - Structural and thermal stress analysis shall be made by the contractor to show compliance with the specification. Margins of safety shall be based on material allowance as given in specification MIL-HDBK-5.

3.4.15 Impulse - The V/h Sensor shall not apply, at any time, an impulse of greater than * inch pound seconds through its mounting feet.

3.4.16 Unbalanced Angular Momentum - The unbalanced angular momentum of theV/h Sensor shall be limited to 0.001 inch pound seconds or less.

3.5 General Requirements

3.5.1 Manufacturing Standards - The V/h Sensor units shall conform to the manufacturing standards contained in Eastman Kodak Company document 401-119. The contractor's manufacturing standards may be submitted to Eastman Kodak Company for written approval. Upon receipt of such approval from Eastman Kodak Company, the contractor may use his manufacturing standards in lieu of Eastman Kodak Company manufacturing standards.

3.5.2 Interchangeability - Subassemblies of all equipment of the same model, regardless of series designation, exclusive of experimental and prototype systems, shall be interchangeable or replaceable. A list of interchangeable items shall be submitted to Eastman Kodak Company for approval.

3.5.3 Ease of Assembly and Maintenance of Equipment - Subassemblies shall be designed and constructed to require a minimum of skill, experience, and time necessary to assemble and maintain them. The subassembly parts design and construction shall minimize the need for holding or supporting these assembly parts during final positioning and fastening.

3.5.4 Life

3.5.4.1 Service Life

3.5.4.1.1 Testing Life - The V/h Sensor shall have a testing life of 150 hours of ON time. During the testing life period, the V/h Sensor shall be capable of operating continuously for 15 minutes out of a 100 minute period. The V/h Sensor shall also be capable of a minimum of * ON and OFF operations during * minutes out of a * minute period with each ON time having a minimum duration of * seconds.

3.5.4.1.2 Mission Life - After completion of the specified testing life, the V/h Sensor shall have a mission life of ** hours ON time. During the mission life period, the V/h Sensor shall be capable of operating continuously for 15 minutes out of a 100 minute period. The V/h Sensor shall also be capable of a minimum of ** ON and OFF operations during ** minutes out of a ** minute period, with each ON time having a minimum duration of ** seconds. The V/h Sensor shall have the above mission life when operated under any of the specified operating conditions.

3.5.4.2 Shelf Life - The V/h Sensor shallhave a shelf life of 24 months minimum.

3.5.5 Reliability - The reliability requirements shall be in accordance with Eastman Kodak Company document 401-122. The design for reliability shall include the use of parts, materials, and processes which provide a mean - time-between failure of greater than 3000 hours. The prediction shall be in accordance with the procedures of MIL-HDBK-217 (or Section 8 of the Rome Air Development Center, Reliability Notebook). The derived failure rates for those parts whose normal modes of operation are neither cyclic nor intermittent should be multiplied by a stress factor of 16. Other failure rate sources may be applicable upon approval by Eastman Kodak Company Reliability.

3.5.6 Disposition of Variances - Variances from the requirements of this specification, and control drawings referenced herein, shall require Eastman Kodak Company written approval. Variances of all other drawings not affecting the requirements of this specification, shall require contractor action only.

3.5.7 Contract Conformance - The V/h Sensor equipment shall conform to the requirements of this specification and Eastman Kodak Company document 401-122.

3.5.8 Safety of Personnel

3.5.8.1 Mechanical - The design of the V/h Sensor shall provide maximum convenience and safety to personnel when installing, operating, and maintaining or replacing the equipment. Sharp projections or sharp edges on parts or assemblies shall be avoided.

3.5.8.2 Electrical - Provisions shall be made to prevent personnel from accidentally coming in contact with voltages in excess of 40 volts, including potentials on charged capacitors when the V/h Sensor is in its normal operation conditions.

3.5.8.2.1 Ground Potential - The design and construction of the V/h Sensor shall be such that all external parts be at ground potential at all times.

3.5.9 Preferred Parts - The contractor shall select and use parts and materials consistent with the reliability and life factors of the hardware. Parts shall be selected per Eastman Kodak Company drawing 401-122.

3.6 Documentary Requirements

3.6.1 Drawings - All engineering drawings and associated lists prepared by the contractor for the purpose of defining requirements of design, inspection, and tests, shall be prepared in accordance with Eastman Kodak Company document 401-122. The contractor's drafting manual outlining requirements for preparation of drawings may be submitted to Eastman Kodak Company for written approval. Upon receipt of such approval from Eastman Kodak Company, the contractor may use his manual in lieu of the Kodak Drafting Manual.

3.6.2 Manuals - The contractor shall provide information on operation and maintenance of the V/h Sensor for use in preparation of manuals by Eastman Kodak Company.

3.6.3 Inspection Reports - Inspection reports shall be generated and maintained by the contractor. These reports, as well as in process inspection, shall be made available, upon request, to Eastman Kodak Company Continuity of records and identity of parts assembled, shall likewise be maintained and made available to Eastman Kodak Company.

3.6.4 Verification of Purchased Items - Verifications of compliance for purchased parts shall be made available by the contractor. Verification of compliance shall be a document received with the pruchased parts from the manufacturer. This document shall state that the manufacturer has on record data to demonstrate that the purchased part shall conform to the requirements of the contractor's specification control drawing. MS and AN standard parts shall not require a verification of compliance.

3.6.5 Alignment and Calibration - Records shall be generated, documented and made available to Eastman Kodak Company, of the alignment and calibration of all measuring and test equipment for the V/h Sensor.

3.6.6 Test Procedures - Qualification and acceptance test procedures for the V/h Sensor that demonstrate conformance with the requirements of this specification shall be established and documented by the contractor, and submitted to Eastman Kodak Company for written approval.

3.6.7 Performance Record - All data, including operating time and malfunctions reports, generated through tests, shall be recorded by serial number and preserved as a performance record.

4. <u>QUALITY ASSURANCE PROVISIONS</u>

The provisions of MIL-Q-9858 Quality Control System Requirements and Eastman Kodak Company Standard 401-122 Technical Requirement for Contracts shall apply.

4.1 Test Procedures - The contractor shall write qualification and acceptance test procedures for the V/h Sensor. These procedures shall be in accordance with Eastman Kodak Company document 401-122. Eastman Kodak Company shall approve of all test specifications before start of testing.

4.1.1 Classification of Tests - The inspection and testing of the V/h Sensor shall be classified as follows:

(a) Qualification Tests
(b) Acceptance Tests

4.2 Qualification Tests - The qualification tests shall be conducted by the contractor on one V/h Sensor of any given design. This V/h Sensor or any part thereof shall not be used on or as an operational unit following the qualification tests. The test procedure shall comply with paragraph 3.6.6, and shall include, but shall not be limited to, the following:

4.2.1 Visual Inspection - All parts, subassemblies and assemblies shall be inspected for conformance with the manufacturing standards, Eastman Kodak Company document 401-119.

4.2.2 Drawing Conformance - All parts, subassemblies and assemblies shall be inspected for conformance with their respective drawings.

4.2.3 Performance Tests - The V/h Sensor shall be tested for its ability to comply with the performance requirements of Section 3.

4.2.4 Environmental Qualification Tests - The V/h Sensor shall be subjected to acceleration, shock, vibration, temperature, pressure, humidity, and E.M.I. requirements as specified in Section 3.3. Following completion of these tests, the V/h Sensor shall be visually inspected for damage, and the performance tests of 4.2.3 shall be repeated.

4.2.5 Diagnosis Report - Following the environmental qualification tests, diagnosis shall be made of any impairment of performance of the V/h Sensor assemblies, and a full report shall be written and submitted to Eastman Kodak Company.

4.2.6 Life Test - The V/h Sensor shall be tested for compliance with the service life of 3.5.4 and 3.5.6.

4.3 Acceptance Tests - Acceptance tests shall be performed by the contractor on the V/h Sensor. The acceptance tests procedures shall be in accordance with paragraph 3.6.6. The acceptance tests shall include inspection, drawing conformance and performance tests of paragraphs 3.2, 3.3, 3.4, 4.2.1, and 4.2.2. Eastman Kodak Company reserves the right to have additional acceptance tests performed at Eastman Kodak Company, Rochester, New York.

4.3.1 Diagnosis - Following the acceptance tests, diagnosis shall be made to any impairment of performance of the V/h assemblies, and a full report shall be written and submitted to Eastman Kodak Company at the time of hardware delivery.

4.4 Alignment and Calibration - The alignment and calibration of V/h Sensor assemblies and recorded data shall be in accordance with the requirements of 3.6.5 and 3.6.6.

4.5 Documentation - The documentation of the V/h Sensor shall be supplied to the Eastman Kodak Company in accordance with the requirements stated in Section 3.6, and delivered with the hardware.

4.6 Monitoring and Surveillance - Eastman Kodak Company reserves the right to witness all qualification and acceptance tests, and to conduct quality surveys in the contractor's plant for quality system evaluation and for periodic review of contractor's performance. Inspection support may be given contractor by placing in-residence inspection personnel at their plant, if desirable.

5. PREPARATION FOR DELIVERY

5.1 Packaging - All parts, subassemblies, and assemblies for shipment as separate items, shall be cleaned, labeled, and sealed, with their identification, in transparent plastic bags. The bags shall be partially evacuated before sealing.

5.1.1 Major Assemblies - The major assemblies, after cleaning and sealing in plastic bags as above, shall be packaged in fitted and padded boxes. The boxes shall be reusable and shall be equipped with hinges and latch. Each box shall have its proper identification.

5.1.2 Small Parts - Small parts, such as screws, nuts, retaining rings, etc., shall be cleaned and sealed in plastic bags as above. There shall be a reasonable quantity of parts, and only one part number per bag.

5.2 Packing - All parts, subassemblies, and assemblies, as packaged, shall be crated for shipment as follows:

(a) Major assemblies in fitted boxes shall be crated individually.
(b) Other assemblies and subassemblies shall be crated individually.
(c) Small parts, in plastic bags, shall be grouped and each group crated individually.

5.3 Packing List - A list of all parts included in a crate shall be placed immediately beneath the cover of the crate.

APPENDIX T

Phase I Specification

EKC/NAA PROGRAM INTERFACE
SPECIFICATION NO. 1600-104

Prepared by
EASTMAN KODAK COMPANY
ADVANCED DEVELOPMENT PROJECTS GROUP
APPARATUS AND OPTICAL DIVISION
ROCHESTER, NEW YORK

Prepared By: ______________________

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Approval

NAA ______________________ EKC ______________________

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Phase I Specification	EKC/NAA Program
Specification No. 1600-104	Release Date:

1. SCOPE AND MISSION

1.1 Scope - This specification defines the interfaces which exist between Eastman Kodak Company (EKC) and North American Aviation (NAA) for the Apollo Mapping and Survey System program. This specification is the top EKC-NAA interface document of the Apollo Mapping and Survey System; all other interface documents will be referenced herein.

1.2 Mission - It is the mission of the camera payload (C/P) interfaces with the other assemblies of the command service module to provide for the necessary electrical inputs and outputs, mechanical support and protection, and environmental protection including the required thermal paths and barriers. These interfaces are divided into four areas, electrical, mechanical, thermal and environmental. Interfaces also exist between aerospace flight equipment (AFE) and aerospace ground equipment (AGE) and these interfaces involving the C/P are covered by this specification.

2. APPLICABLE DOCUMENTS

The following specifications, standards, drawings and publications of the latest issue in effect form a part of this specification. Applicability of the listed documents form a part of this specification. In the event of conflict between the listed documents and this specification, this specification shall take precedence.

SPECIFICATIONS

Military

MIL-E-6051C	Electrical-Electronic System Compatibility and Interference Control Requirement for Aeronautical Weapons Systems, Associated Subsystems and Aircraft
MIL-I-26600	Interference Control Requirements, Aeronautical Equipment
EMI-10A	NASA Addendum to MIL-I-26600

Interface (Maintenance responsibility for these documents to be in accordance with 5.1)

Eastman Kodak Company Maintenance

EK Number	Title
1600-105	Photographic Subsystem Specification
1600-106	Survey Camera Paylod (Flight Model)

North American Aviation Maintenance

EK Number	NAA Number	Title
*	*	External and Internal Design Criteria

* To be supplied by a later revision.

STANDARDS

Eastman Kodak Company

401-119 Design and Manufacturing Standards

North American Aviation

*

DRAWINGS

Interface (Maintenance responsibility for these documents to be in accordance with 5.1)

Eastman Kodak Company Maintenance

EK Number	NAA Number	Title
*	*	C/P Command Information
*	*	C/P Instrumentation Information
1600-100	*	C/P - CSM Mechanical Interface
1600-102	*	C/P - CSM Electrical Interface
1600-103	*	C/P - CSM Thermal Interface
1600-101	*	C/P-SIC Mechanical Interface (Reference Only)

Eastman Kodak Company

* Camera Payload Electrical Simulator

* To be supplied by a later revision.

3. REQUIREMENTS

3.1 Nomenclature - A complete set of definitions is given in EKC specification 1600-105. The following definitions shall apply in this specification.

3.1.1 Command Module (C/M) - The command module is that portion of the command service module which houses the astronauts and will re-enter the earth's atmosphere at the end of the mission.

3.1.2 Service Module (S/M) - The service module is that portion of the command service module (CSM) which houses the C/P and assemblies from several other subsystems.

3.1.3 Photographic Subsystem (PS) - The PS consists of the C/P and associated EKC ASE. Photographic processing equipment is not included.

3.1.4 Camera Payload (C/P) - The C/P or survey camera portion of the photographic subsystem consists of flight equipment required to collect visual information on photographic film, transport the film and store this film in a take-up cassette. It includes the necessary C/P electrical equipment.

3.1.4.1 Camera Payload Take-up Cassette - The C/P Take-up cassette is that part of the C/P which contains the film exposed during the photographic mission and will be removed and stowed in the command module for recovery.

3.1.5 Aerospace Support Equipment (ASE) - The ASE shall consist of implements or devices required to inspect, test, service, adjust, calibrate, measure, handle, transport, or otherwise maintain the intended functional operating status of the photographic subsystem. The ASE includes special tools, test devices, calibration standards and instruments required by ground operating equipment. Special test equipment, special tools and special industrial requirements for "in-house" use by the manufacturer are a part of this category.

3.1.5.1 Aerospace Ground Equipment (AGE) - The AGE is that part of the ASE required for operational phases of the C/P following shipment by the manufacturer.

3.1.6 Stellar Index Camera (SIC) - The SIC or mapping camera is a separate subsystem produced by an associate contractor with some interfaces with the C/P.

3.2 Electrical Interface - This section defines the electrical characteristics of the power, command signals, instrumentation signals, and data signals transmitted across the electrical interface between the camera payload and the command service module. Electrical interface responsibilities and authority shall terminate at the interface connectors. Connector types and connector pin assignments shall be as shown on EKC drawing 1600-102.

3.2.1 Power - Electrical power shall be supplied to the C/P as unregulated 28 volts dc, originating in fuel cells located in the service module. Power to the C/P shall be supplied over two separate circuits designated as operational 28 v d-c and environmental 28 v d-c. The operational power shall be positive as measured with respect to d-c return. The environmental power shall be positive as measured with respect to environmental return. Power required by the C/P having special characteristics shall be derived from the +28 volts d-c operational power supply by conversion and/or regulation. Special characteristic power generated by the C/P shall not be utilized by the CSM or its components except as is incidental to the transmission of command, instrumentation, and other operational signals across the C/P CSM interface.

Operational and environmental power circuits and returns shall be electrically isolated in the C/P. All values shall be as measured at the interface connector.

3.2.1.1 Operational Power - Plus 28 volts dc power, referred to as "+28 volts dc" hereinafter and in drawings and other specifications, shall be operational power by definition. Operational power shall be utilized by the C/P for all functions not specifically assigned to the environmental power supply. The operational power supply circuits in the C/P shall be isolated from the environmental power supply circuits in the C/P. The operational power shall have the characteristics specified in paragraphs 3.2.1.1.1 through 3.2.1.1.4 at the interface at all times the C/P is operated by the CSM.

3.1.1.1.1 Voltage - The operational power steady-state voltage shall be $28.0 ^{+3.0}_{-2.0}$ volts dc as measured between the supply wires and the return wires at the interface throughout the eleven-day translunar and orbital lifetime assuming normal C/P operation. Throughout the same period the transient voltage measured between the supply wires and dc return wires at the interface shall be no less than 25.0 volts and no more than 32.0 volts during any surge as defined in 3.1.1.1.2. The C/P shall not be harmed by the application of any voltage up to 32.0 volts .

3.2.1.1.2 Load Current - The normal load current demand of the C/P on the operational power supply, during any operating period, shall not exceed 7.0 amperes at 28 volts. When the current is so restricted, the voltage present at the interface as measured between the supply wires and return wires shall be maintained within the steady state voltage limits specified in 3.2.1.1.1. Operational power supply surge current demand of the C/P shall not exceed 17.0 amperes and this transient shall decay to the normal load current in less than 0.5 second. During the transient, the voltage present at the interface as measured between the supply wires and the return wires shall be maintained within the transient voltage limits specified in 3.2.1.1.1.

3.2.1.1.3 Power Consumption - Assuming normal operation throughout the eleven-day translunar and orbital lifetime, the C/P shall not consume more than 2500 watt-hours of electrical energy from the operational power supply. Operational power consumption during the three-day translunar lifetime shall not exceed 500 watt-hours.

3.2.1.1.4 Power Availability - Operational power shall be available from the operational power supply during the translunar lifetime for a period of at least sufficient duration to perform C/P health checks. The health checks shall be performed during the postlaunch earth-orbital phase and during the translunar lifetime. Operational power shall be available during the eight-day lunar orbital lifetime of the CSM or at least until the film supply has depleted, whichever shall occur first.

3.2.1.2 Environmental Power - Plus 28 volt d-c power, referred to as "+28-volts d-c environmental" hereinafter and in drawings and other specification, shall be environmental power by definition. Environmental power shall be used for all environmental heaters within the C/P. The environmental power shall have the characteristics specified in 3.2.1.2.1 through 3.2.1.2.4 at the interface at all times the C/P is operated by the CSM.

3.2.1.2.1 Voltage - The environmental power supply shall provide not less than 25.0 volts dc nor more than 32.0 volts dc as measured between the supply wires and d-c return wires at the interface assuming normal operation of the C/P environmental control system during the eleven-day translunar and orbital lifetime. The C/P environmental control system shall be able to withstand the application of any voltage up to 32.0 volts.

3.2.1.2.2 Load Current - The maximum current drain of the environmental control system on the environmental power supply shall not exceed 3.6 amperes at 28 volts. When the current is so restricted, the voltage present at the interface as measured between the supply wires and d-c return wires shall be maintained within the limits specified in 3.1.1.2.1.

3.2.1.2.3 Power consumption - The C/P environmental control system shall not consume more than 1,500 watt-hours of electrical energy per day from the environmental power supply.

3.2.1.2.4 Power Availability - Power from the environmental power supply shall be available on demand from launch until at least the last programmed C/P operation, which is film retrieval, at which time these circuits may be disconnected from the environmental power supply.

3.2.1.3 Overload Protection - The camera payload shall incorporate electrical overload devices so that the command service module power system shall never be subjected to sustained short circuit or excesssive loading by the C/P.

3.2.2 Commands - Commands with characteristics as shown in table I shall be presented on connectors and pins as shown on EKC drawings 1600-102. The functionally descriptive command identifications established in table I shall be used on drawings and specifications but shall not constitute a part of the interface agreement. North American Aviation shall be responsible for generating and presenting the commands in accordance with this specification and subsequent operational specifications defining the times at which the signals shall be presented to the C/P. Impedances shown in table I are the load values presented by the C/P at the interface connector.

3.2.2.1 Signal Characteristics - The command signal characteristics to be presented to the camera payload shall be in accordance with 3.2.2.1.1, 3.2.2.1.2, 3.2.2.1.3 and table I.

3.2.2.1.1 Type "A" Command- A type "A" command shall be transmitted across the electrical interface to the C/P as an electrical signal between two wires. One wire, the command return, shall be common to all commands. Another wire shall exist and be unique for each command. The state of each command at the interface shall be defined as follows:

Command State	Characteristic
Zero:	A binary zero ("0")state exists when the d-c resistance between the command wire and the command wire and the command return wire is less than 0.1 ohm.
One:	A binary one ("1") state exists when a d-c voltage $28 \pm {}^{+4}_{-6}$ positive with respect to command return is present on a command wire when loaded as specified in table I.

TABLE I

COMMANDS

Abbreviations: IMC = Image Motion Compensation
MSD = Motor Speed Drive
MSB = Most Significant Bit
LSB = Least Significant Bit
V/h - Velocity/altitude

Command Code	Command Type	Command State	Command Name	Function	Camera Payload Impedance (ohms)
COD1	A	0	Payload Power	C/P de-energized	675 ± 75
COD1	A	1	Payload Power	C/P energized	675 ± 75
COD2	A	0	Camera Control	Exposure unit de-energized	675 ± 75
COD3	A	1	Camera Control	Exposure unit energized	675 ± 75
COD3	A	0	Stereo Mirror Position Control	Stereo mirror forward	675 ± 75
COD3	A	1	Stereo Mirror Position Control	Stereo mirror aft	675 ± 75
COD4	A	0	Door Control	View-port door closed	675 ± 75
COD4	A	1	Door Control	View-port door open	675 ± 75
COD5	A	0	IMC: Auto/Manual	IMC speed controlled by real-time commands	675 ± 75
COD5	A	1	IMC: Auto/Manual	IMC controlled by V/h sensor	675 ± 75
COD6	B		IMC MSB ON	IMC code MSB "1"	1200 ±180
COD7	B		IMC MSB OFF	IMC code MSB "0"	1200 ±180

TABLE I (Contd)

COMMANDS

Command Code	Type	Command State	Command Name	Function	Camera Payload Impedance (ohms)
COD8	B		IMC 2nd MSB ON	IMC code 2nd MSB "1"	1200 ± 180
COD9	B		IMC 2nd MSB OFF	IMC code 2nd MSB "0"	1200 ± 180
COD10	B		IMC 3rd MSB ON	IMC code 3rd MSB "1"	1200 ± 180
COD11	B		IMC 3rd MSB OFF	IMC code 3rd MSB "0"	1200 ± 180
COD12	B		IMC 4th MSB ON	IMC code 4th MSB "1"	1200 ± 180
COD13	B		IMC 4th MSB OFF	IMC code 4th MSB "0"	1200 ± 180
COD14	B		IMC 5th MSB ON	IMC code 5th MSB "1"	1200 ± 180
COD15	B		IMC 5th MSB OFF	IMC code 5th MSB "0"	1200 ± 180
COD16	B		IMC 6th MSB ON	IMC code 6th MSB "1"	1200 ± 180
COD17	B		IMC 6th MSB OFF	IMC code 6th MSB "0"	1200 ± 180
COD18	B		IMC 7th MSB ON	IMC code 7th MSB "1"	1200 ± 180
COD19	B		IMC 7th MSB OFF	IMC code 7th MSB "0"	1200 ± 180
COD20	B		IMC 8th MSB ON	IMC code 8th MSB "1"	1200 ± 180
COD21	B		IMC 8th MSB OFF	IMC code 8th MSB "0"	1200 ± 180
COD22	B		IMC LSB ON	IMC code LSB "1"	1200 ± 180
COD23	B		IMC LSB OFF	IMC code LSB "0"	1200 ± 180

TABLE I (Contd)

COMMANDS

Command Code	Type	Command State	Command Name	Function	Camera Payload Impedance (ohms)
COD24	A	0	Focus Control	Focus system de-energized	675 ± 15
COD24	A	1	Focus Control	Focus system energized	675 ± 15
COD25	B		Strip Stereo	C/P adjusted for strip stereo photography	1200 ± 180
COD26	B		Panning	C/P adjusted for panning photography	1200 ± 180
COD27	B		Slit MSB ON	Slit positioning "1"	1200 ± 180
COD28	B		Slit MSB OFF	Slit positioning code "0"	1200 ± 180
COD29	B		Slit LSB OFF	Slit positioning code "1"	1200 ± 180
COD30	B		Slit LSB OFF	Slit positioning code "0"	1200 ± 180
COD31		0	Torque Motor Control	Film supply brake controlled by C/P	*
		1	Torque Motor Control	Film supply brake locked	*
COD32	A	1	Focus: Auto/ Manual	Focus controlled by C/P	675 ± 75
COD33	A	0	Focus Forward	None	675 ± 75
COD33	A	1	Focus Forward	Move platen away from lens	675 ± 75
COD34	A	0	Focus Reverse	None	675 ± 75

TABLE I (Contd)

COMMANDS

Command Code	Command Type	Command State	Command Name	Function	Camera Payload Impedance (ohms)
COD34	A	1	Focus Reverse	Move platen forward lens	675 ± 75
COD35	B		Empty Supply	MDS and take-up operated continuously	1200 ± 180
COD36			Cut Film		*
COD37			Separate		*
COD38	C		400 pps	Generate data signals	*
COD39	C		Time/Position Label	Generate data signals	*

3.2.2.1.2 Type "B" Commands - A type "B" command shall be transmitted across the interface to the camera payload as positive pulses between two wires. One wire, the command return, shall be common to all commands. Another wire shall exist and be unique for each command. The pulse shall be plus 28^{+4}_{-6} volts with respect to command return. Pulse width shall be $1.0^{+0.+}_{-0.1}$ second.

3.2.2.1.3 Type "C" Command - Type "C" commands are data signals. They shall have the characteristics shown below, measured between the command wire and the command return at the interface. The interface connector pins shall be as shown on EKC drawing 1600-102.

Command Code	Specification					
COD38	Frequency	400 pps ± *%				
	Pulse Width	0.00125 ± * % second				
	Amplitude					
		Mark	*	±	*	vdc
		Space	*	±	*	vdc
	Source Impedance					
		Mark	*	±	*	vdc
		Space	*	±	*	vdc

* To be supplied by a later revision.

3.2.3 Instrumentation

3.2.3.1 Umbilical Instrumentation - The instrumentation circuits specified in Table II of this specification shall be supplied to the CSM unbilical connector. Interconnection between the C/P - CSM interface and spacecraft umbilical connector and associated AGE shall be the responsibility of NAA .

3.2.3.1.1 Circuit Protection - The umbilical instrumentation circuits shall be so designed that any accidental line-to-line or line-to-ground faults which may occur will not degrade the performance of the C/P.

3.2.3.1.2 Data Presentation - The umbilical instrumentation data shall be presented as described in Section 4 and Table II of this specification. The presentation of umbilical instrumentation data shall be the responsibility of NAA.

3.2.3.1.3 Electrical Characteristics - The umbilical instrumentation electrical characteristics shall be as specified in Table II of this specification.

3.2.3.1.4 Availability - The umbilical instrumentation data shall be available, presented in accordance with Section 4 and Table II of this specification, whenever the spacecraft umbilical connector is connected to the CSM. In any event it shall not be disconneted prior to the torque motor command umbilical instrumentation confirmation that the torque motor command has been received immediately prior to launch.

3.2.2.2 Test Connector Instrumentation - The instrumentation circuits specified in Table III of this specification shall be supplied to the test connector at the C/P- CSM interface. Interconnection between the C/P test connector and the AGE shall be the responsibility of NAA. Test connector instrumentation shall be supplied from the CSM to the AGE via hard-lines in accordance with the requirements of section 4 and table III of this specification.

3.1.3.2.1 Circuit Protection - The test connector instrumentation circuits shall be so designed that any accidental line-to-line or line-to-ground faults which may occur will not degrade the performance of the C/P.

3.2.3.2.2 Data Presentation - The test connector instrumentation data shall be presented as described in section 4 and table III of this specification. The presentation of test connector instrumentation data shall be the responsibility of NAA.

3.2.3.2.3 Electrical Characteristics - The test connector instrumentation electrical characteristics shall be as specified in table III of this specification.

3.2.3.2.4 Availability - The test connector instrumentation data shall be available, presented in accordance with Section 4 and table III of this specification, on demand whenever the test connector is available to the AGE as specified in Section 4. In any event instrumentation data from the test connector shall be available to within fifteen (15) minutes of the time when personnel must clear the tower at which time the test connector instrumentation shall be discontinued.

3.2.3.3 Flight Instrumentation - The C/P shall transmit to the flight interface connector at the C/P - CSM interface . The flight instrumentation signals specified in table IV. The connector and pin assignments shall be as shown in EKC drawing 1600-102. Instrumentation signals shall be presented between the designated circuit and instrumentation return. It shall be the responsibility of NAA to process and make available flight instrumentation in accordance with the requirements of this specification.

3.2.3.3.1 Circuit Protection - The flight instrumentation circuits shall be so designed that any accidental line-to-line or line-to- ground faults which may occur will not degrade the performance of the C/P.

3.2.3.3.2 Data Presentation - Flight instrumentation data shall be presented as described in section 4 and table IV of this specification.

3.2.3.3.3 Electrical Characteristics - The flight instrumentation electrical characteristics shall be as specified in table IV of this specification.

3.2.3.3.4 Availability - Each flight instrumentation point is assigned to one of three priority levels (A, B or C). Flight instrumentation shall be available, presented as specified in 3.2.3.3.3, in accordance with the following schedule:

"A" priority - "A" priority flight instrumentation shall be available in real time.

"B" priority - "B" priority flight instrumentation shall be available in near real time. Real time processing will be acceptable if available.

"C" priority - "C" priority flight instrumentation shall be available as post flight evaluated data.

Near real time availability shall permit a maximum delay of 60 minutes between the time of occurrence of an event and the time at which instrumentation data is available, presented as specified in 3.2.3.3.3.

3.2.3.4 Calibration - Each instrumentation circuit defined by this specification shall be calibrated before the C/P is delivered to NAA for integration into the CSM. Separate calibration data peculiar to each payload shall be delivered indicating the output of each instrumentation circuit at the CP-CSM interface when loaded and tested in accordance with the requirements of this specification.

3.2.4 Returns - All return wires shall be electrically isolated from ground and the C/P structure. Within the C/P, dc return, environmental return, instrumentation return, data signal return and command return wires shall be electrically isolated from each other and shall cross the interface independently. Prior to operation of the C/P , all return wires crossing the interface shall be connected together to the CSM unipoint. Connection of C/P returns wires to the CSM unipoint ground shall be the responsibility of NAA.

3.2.5 Grounding - The C/P structure shall be electrically connected to the CSM structure through a grounding strap (s). The resistance per strap installation shall not exceed one milliohm. The resistance measured between any point on the C/P structure and the CSM unipoint ground shall not exceed 10 miliohms. All cases, bases, and mountings within the C/P shall be electrically connected to the C/P structure. Ground straps in accordance with this paragraph shall be supplied by NAA.

3.2.6 Shielding - All shields and shield braids within the C/P shall be electrically connected to cases and mountings or C/P structure as appropriate.

All shields and shield braids shall be electrically isolated from returns within the C/P. The shields of shielded interface wires shall be carried through the interface connectors on individual connector pins. Shield pin assignments shall be in accordance with 1600-102.

3.2.8 Electromagnetic Interference - The C/P, the command service module with associated vehicle components and aerospace ground equipment shall operate satisfactorily not only independently, but also with each other and in conjunction with other equipment which may be located near by. Mutual compatibility of and with the C/P shall be determined in accordance with MIL-E-6051C and such compatibility shall be demonstrated by NAA. The C/P shall be designed to meet the requirements of MIL-I-26600, for class Ib equipment and EMI-10A. In addition to the requirements defined by MIL-I-26600 any conducted interference within the frequency range of 15 to 15,000 cps impressed on the operational 28 v dc or the environmental 28 v dc circuits by the C/P shall not exceed 0.70 amperes peak-to-peak.

3.2.8 Connectors - The specification of the CP-CSM interface connectors within the camera payload shall be the responsibility of Eastman Kodak Company. The specification of connectors within the command service module which originate or terminate at the C/P-CSM interface shall be the responsibility of North American Aviation. The C/P-CSM connector pin assignments shall be as specified in EKC drawing 1600-102. C/P connector type shall be Deutsch DTK or approved equivalent. Within the C/P space pins and spare circuits shall be provided for each interface connector in accordance with the following schedule.

No. of Connector Pins	Spare Pins	Spare Circuits
24 or less	Not less than 2	None
24 to 61	Not less than 3	Not less than 1
61 and over	Not less than 4	Not less than 2

Spare pins shall have no connection within the C/P. Spare pins shall be identified in specifications and drawings with the symbol "NC". Spare circuits shall consist of two wires per circuit and shall be identified in specifications and drawings as "SPARE". Both wires shall originate at the interface connector and terminate in either the command processing unit, power conversion and control unit or the instrumentation processing unit of the C/P in accordance with 3.2.9.

3.2.9 Interface Cable Configuration - Within the C/P and command service module, wires terminating at the C/P-CSM interface functionally shall be segregated such that any one cable is composed only of wires of similar function. Three functional categories shall be recognized; power, command, and instrumentation. Cable termination at interface connectors shall be such that any one interface connector provides interface interconnection of one and only one functional category of wires. Spare circuits originating at the interface shall be routed in a cable of a functional category corresponding to that of the connector of origin and shall terminate in units of the same functional category only. The use of spare circuits shall be restricted so that a given spare circuit may be utilized to carry only signals of the functional category to which the spare circuit is assigned.

3.2.9.1 Identification - Cables terminating in the C/P shall be coded with the P and J numbers as shown on EKC drawing 1600-102. Identification of cables within the C/P shall be the responsibility of Eastman Kodak Company. Identification of cable within the CSM whose terminating connectors mate with the C/P interface connectors shall be the responsibility of NAA.

3.3 Mechanical - The following paragraphs define the mechanical interface existing between EKC and NAA (C/P-SCM).

The requirements for this interface are also described in EKC drawings 1600-100 and 1600-101.

3.3.1 Structural Loads - Limit loads applicable to critical phases of the mission shall be in accordance with EKC specification * . There shall be no yield at limit loads and no failure at 1.50 times limit loads.

3.3.2 Inertial Loads - The inertial limit loads, which are considered to act through the center of gravity (cg) of the C/P for each mission phase shall be in accordance with EKC specification * .

3.3.3 Center of Gravity - The weight and center of gravity of the C/P, including the retrieval cassette in the launch condition, and loaded with 3,000 feet of flight film shall be:

Weight Maximum	1213 pounds
CG location: reference to station	290.75
$\bar{X}$	-12.91 ± 1.0 inches
$\bar{Y}$	+0.88 ± 0.5 inch
$\bar{Z}$	-0.38 ± 0.5 inch

3.3.4 Mass Moments of Inertia - The nominal values of the mass moments of inertia of the C/P about the X, Y and Z axes of the C/P shall be:

C/P with Take-up Cassette,
Full Supply Cassette

Axis	(Slug ft^2)
I_{xx}	49.00 ± 10 percent
I_{yy}	555.00 ± 10 percent
I_{zz}	548.00 ± 10 percent

3.3.5 Weight and Balance Reports - EKC shall furnish to NAA a periodic status report to include calculated values of the weight, center of gravity location, mass moments and products of inertia and predicted maximum error. All EKC weight and balance data will be referenced to an axis system shown on EKC drawing 1600-100 and having its origin at station 290.75 in the NAA coordinate system unless otherwise noted.

3.4 Thermal - The thermal interface shall be in accordance with this specification and EKC drawing 1600-103.

3.4.1 Assignment of Responsibilities - Thermal interface responsibilities are general, descrived as follows:

a. NAA shall provide all blanket insulation which is fastened to the service module sector walls, except for that on the view-port door.

b. EKC shall provide active heater power in the lens bay and on the EKC view-port door.

c. NAA shall provide the active heater power in the stereo mirror bay required by the 70 F isothermal boundary in this region.

3.5 Attitude Control - To achieve smear tolerances in accordance with EKC specification 1600-105 the following attitude control tolerances (2-sigma variability) are needed:

	Roll degrees	Pitch degrees	Yaw degrees	Roll Rate degrees per sec.	Pitch Rate degrees per sec.	Yaw Rate degrees per sec.
Nominal (Minimum acceptable)	±0.5	±0.5	±0.5	±0.01	±0.01	±0.01
Design Goal	±0.4	±0.4	±0.4	±0.004	±0.004	±-.004

3.5.1 Alignment - The C/P shall be accurately aligned to the CSM. This alignment shall be the responsibility of NAA. The required alignment of the C/P to the attitude control reference shall be (3-sigma variability):

Roll	±0.04 degrees
Pitch	±0.04 degrees
Yaw	±0.04 degrees

3.6 Environmental - Environmental, active externally and internally, shall be in accordance with EKC specification * and as supplemented by the following paragraphs. Ground conditioning for the camera payload while on the launch pad shall be the responsibility of NAA.

3.6.2 Humidity - The allowable humidity shall be in accordance with EKC specification * .

3.6.3 Film Environment - The photographic characteristics of the film shall not be degraded due to external or internal contaminants or environmental factors.

3.6.3.1 Photographic Contamination - Materials which can be located adjacent to the film are identified in EKC standard 401-119. In the event desired materials in EKC standard 401-119. In the event desired materials are not included in this standard, representative samples shall be tested. Changes in the photographic characteristics of the proposed film due to external or internal contaminants shall not exceed the following values:

Photographic speed	0.04
Gamma (slope of density vs exposure curve	0.05
Maximum density	0.03

Each associate contractor shall be responsible for checking all materials, near or adjacent to the film and provided by them, for compatibility with the above requirements.

3.6.2.2 Physical Damage - The physical characteristics of the film shall not be degraded by mottling, scratches, digs or abrasions. Where effects in the above areas are noted, EKC shall make final judgement on design adequacy.

3.6.2.3 Light - Accumulated stray light impinging on any portion of the film from external or internal light sources shall not exceed 0.01 meter-candle-second during transport or storage in the assembly.

3.6.3 Dirt - The gaseous environment which the C/P sees, shall not contain a dust particle count greater than 2000 particles per liter in the particle diameter range of 1 to 30 microns or 8 particles of dirt per liter with a diameter greater than 30 microns.

3.6.4 Film Enclosure Pressure Control - Gases contained in the camera payload will be vented into the service module sector except for a small amount retained in the film enclosure and sealed electronic packages.

3.7 Clean Room - The use of clean-room facilities, when specified, refers to an enclosed room with all surfaces readily and easily cleaned. Such surfaces shall not generate dust particles under normal usage. Internal air shall be maintained at a slight positive pressure in relation to all surrounding areas. An air filtering system shall supply air with a particle cound not to exceed 2000 particles per liter in the particle diameter range of 1 to 30 microns and no particles of dirt with a diameter greater than 30 microns. The air shall be sampled with the room closed and without occupants or equipment. When the clean room is in use the air shall be sampled at the air supply outlet to the clean room.

4. AEROSPACE SUPPORT EQUIPMENT (ASE)

The ASE and flight equipment interfaces between EKC and NAA are specified in terms of the operational phases at which they occur. Each operational phase is treated independently and the equipment requirements are stated in each phase. This specification will cover only AGE and not "in-house" equipment. The operational phases covered are:

a. Premating testing phase
b. Mating phase
c. Simulator flight test phase
d. Pre-launch assembly phase
e. Launch phase
f. Flight operations phase

4.1 Premating Testing Phase

The premating testing phase shall include testing necessary to check the C/P-CSM electrical interface prior to installation of the C/P flight model. Equipment necessary to accommodate the phase of testing *.

4.2 Mating Phase - All ASE required to transport, handle, checkout, service, orient and assembly the C/P shall be the responsibility of EKC. All ASE required to transport, handle, checkout, service, orient and assembly the mated service module and C/P shall be the responsibility of NAA. NAA shall be responsible for C/P cleanliness after mating. All necessary test equipment and/or servicing equipment required for troubleshooting the C/P after installation into the service module shall be the responsibility of EKC.

4.2.1 Payload Installation - The installation of the C/P into the service module shall be accomplished with the service module longitudinal (X) axis in the vertical position.

4.2.2 Alignment Equipment - All ASE required to determine alignment of the stabilization reference axis with the C/P reference axis shall be the responsibility of NAA. The C/P reference axis shall be defined in accordance with EKC drawing 1600-100.

4.3 Simulated Flight Test Phase - All ASE required to simulate commands, to monitor and record system performance and otherwise support the simulated flight test shall be responsibility of and supplied by NAA.

4.3.1 Instrumentation Signals - All C/P instrumentation signals, EKC drawing * , after appropriate signal processing by NAA shall be displayed and recorded on chart recorders by NAA.

* To be supplied by a later revision.

4.3.1.1 Recording - The following equipment shall be provided by NAA for monitoring and recording the C/P signals.

a. Pin-type chart recorders to consist of * analog pins and * event pin recorders.

b. One digital device for measuring and permanently recording MSD frequency (BIL2).

c. One digital ohmmeter for measuring and permanently recording temperature sensor resistances (BIL3 and BIL4).

d. One display and reset device for master tell-tale (BIL6) memory circuit.

NAA shall make provision for an unambiguous time correlation between events recorded and the SM programmer time. The recording and/or monitoring equipment shall be capable of meeting the frequency response and accuracy requirements in accordance with table III. The overall accuracy of the instrumentation signal measurements shall be as specified in figure * .

4.4 Prelaunch Assembly Phase - All ASE required to transport, erect, and mate the service module to the rest of the spacecraft shall be supplied by NAA.

4.5 Launch Phase - Interfaces which exist during this phase of operation will be defined at a later date.

4.6 Flight Operation Phase - Interfaces which exist at the ground control and tracking stations will be defined at a later date.

* To be supplied by a later revision.

5. NOTES

5.1 Revision Procedures - The procedure to be used for revising the NAA/EKC interface documents listed in 2, is herewith defined.

5.1.1 Documents Prepared by Eastman Kodak Company

a. EKC will prepare, upon receipt of a letter from NAA approved by the proper validating representatives, or when desired by EKC, two identical master copies of a design change order (hereinafter called a DCO) and process them within EKC incorporating the necessary EKCvalidating signatures. An approval block for NAA will be provided. Both master copies of the DCO will be forwarded to NAA for their review and approval. If the revision is agreed to by NAA, both master copies will be signed by the appropriate NAA representatives.

b. The DCO becomes an official change to the interface agreement when signed by both EKC and NAA. One completely validated DCO master will be retained by NAA for their reproduction and distribution. The other DCO master will be returned to EKC for their internal use.

c. Until such a time as both EKC and NAA have signed the DCO masters, no agreement has been made and no changes will be entered on masters of the basic drawings or specifications.

5.1.2 Documents Prepared by NAA

a. NAA will prepare, upon receopt of a letter from EKC approved by the proper validating representatives, or when desired by NAA, two identical master copies of a configuration control document and process them within NAA incorporating the necessary validating signatures. An approval block for EKC will be provided. Both master copies of the configuration control document will be forwarded to EKC for their review and approval. If the revision is agreed to by EKC, both master copies will be signed by the appropriate EKC representatives.

b. The configuration control document becomes an official change to the interface agreement when signed by both EKC and NAA. One complete validated configuration control document master will be retained by EKC for their reproduction and distribution. The other configuration control document master will be returned to NAA for their internal use.

c. Until such a time as both EKC and NAA have signed the configuration control document masters, no agreement has been made and no changes will be entered on masters of the basic drawings or specifications.

d. Drawings and specifications will be reissued on a quarterly basis, or as required depending on the number of configuration control documents processed.

TABLE II

Umbilical Instrumentation

Function	Code	Source Impedance (Kilohms) Min.	Max.	Instrumentation Voltage (Nominal) Min.	Max.	Max. Data Freq. in cps.	Measurement Accuracy Note 1	Terminating Impedance Megohoms Note 4
Film tension	BIL 1	5.1	10.2	1.0	5.0	5	±0.1 volt	*
MSD frequency	BIL 2	1.0	5.0	*	*	-	+ ±0.5 cps	*
Stereo mirror temperature	BIL 3	40	100	Note 2	Note 2	1	±100 ohms	Not applicable
Component support tube temperature station *	BIL 4	40	100	Note 2	Note 2	1	±100 ohms	Not applicable
Torque motor command	BIL 5	9.0	11.0	0	33.0	1	Note 3	*
Master telltale	BIL 6	*	*	*	*	*	*	*
Spare								

NOTES:

1. The umbilical instrumentation AGE readout shall be within the accuracy specified referenced to the CP-CSM interface. The specified accuracy shall include the AGE accuracy.

2. These circuits each consist of a thermistor connected between the umbilical instrumentation wire and the umbilical return. The instrumentation voltage is dependent upon the AGE specified. Under no condition shall the power input to either instrumentation circuit exceed 2 milliwatts.

3. The torque motor command umbilical instrumentation is a binary signal having nominal levels of zero volts corresponding to absence of command and +28 volts dc corresponding to presence of command. The measurement accuracy shall be recognition of the binary states without error.

4. Terminating impedance shall be the responsibility of North American Aviation.

To be supplied by a later revision.

TABLE III

Test Connector No. I Instrumentation

Function	Code	Flight Code Equiv.	Source Impedance in K ohms Min.	Source Impedance in K ohms Max.	Instrumentation Voltage (Nominal) Min.	Instrumentation Voltage (Nominal) Max.	Max. Data Freq. in cps	Priority	Terminating Impedance
Camera Film Path Temperature	TSP1	IMP1	4.2	5.6			0.1	±0.1 volt	
Storage Cassette Temperature	TSP2	IMP2	4.2	5.6			0.1	±0.1 volt	
Stereo Mirror Differential Temperature	TSP3	IMP3	0	5.0			7	±0.1 volt	
Stereo Mirror Temperature	TSP4	IMP4	4.2	5.6			1	±0.1 volt	
Lens Barrel Differential Temperature	TSP5	IMP5	0	5.0			0.1	±0.1 volt	
45° Mirror Temperature	TSP6	IMP6	4.2	5.6			0.1	±0.1 volt	
Component Support Tube Temperature Station****	TSP7	IMP7	4.2	5.6			0.1	±0.1 volt	
Component Support Tube Temperature Station *	TSP8	IMP8	4.2	5.6			0.1	±0.1 volt	
Component Support Tube Temperature Station *	TSP9	IMP9	4.2	5.6			0.1	±0.1 volt	
Component Support Tube Temperature Station *	TSP10	IMP10	4.2	5.6			0.1	±0.1 volt	
Component Support Tube Temperature Station *	TSP11	IMP11	4.2	5.6			0.1	±0.1 volt	
Slit Position	TSP12	IMP12	0	5.0			1		
Stereo Position	TSP13	IMP13	0	5.0			1	±0.1 volt	
Film Take-Up Qty. Coarse	TSP14	IMP14	0	5.0			1	±0.1 volt	
Film Take-Up Qty. Medium	TSP15	IMP15	0	5.0			1	±0.1 volt	
Film Take-Up Qty. Fine	TSP16	IMP16	0	5.0			1	±0.1 volt	
Film Tension	TSP17	IMP17	0	5.0			5	±0.1 volt	
MSD Frequency	TSP18	IMP18	0	5.0			-	±0.5 cps	

Table III (Continued)

Function	Code	Flight Code Equiv.	Source Impedance in K ohms Min.	Source Impedance in K ohms Max.	Instrumentation Voltage (Nominal) Min.	Instrumentation Voltage (Nominal) Max.	Max. Data Freq. in cps	Priority	Terminating Impedance
Platen Position Coarse	TSP19	IMP19	0	5.0	*	*	1	±0.1 volt	
Platen Position Fine	TSP20	IMP20	0	5.0			1	±0.1 volt	
Focus "A" Channel	TSP21	IMP21	0	1.0			5	±0.1 volt	
Focus "B" Channel	TSP22	IMP22	0	1.0			5	±0.1 volt	
Focus Output	TSP23	IMP23	0	1.0			5	±0.1 volt	
Supply Cassette Film Path Temperature	TSP24	IMP24	4.2	5.6			0.1	±0.1 volt	
Port Door Tell Tale	TSP25	IMP25	*	*			*	*	
Environmental Power Supply	TSP26	IMP26	0	5.0			0.1	±0.1 volt	
Take-Up Motor Current	TSP27	IMP27	0	5.0			2.5	±0.1 volt	
Calibration	TSP28	IMP28	*	*				*	
Instrumentation Return	TSP RET	IMP RET							
Instrumentation Return	TSP RET	IMP RET							
V/h Malfunction	TSP29	IMP29							
Data Signal "A"	TSP30	IMP30							
Data Signal "B"	TSP31	IMP31							
V/h Output	TSP32	IMP32							
Crab Output	TSP33	IMP33							
Crab Position	TSP34	IMP34							
Payload Master Tell Tale	TSP35	IMP35	*	*	*	*	*	*	*

Note I: The test connector instrumentation AGE readout shall be within the accuracy specified referenced to the CP-CSM interface. The specified tolerance shall include the accuracy of the aerospace ground equipment.

* To be supplied by a later revision.

Table III (Continued)

Function	Code	Flight Code Equiv.	Source Impedance in K ohms, Min.	Source Impedance in K ohms, Max.	Instrumentation Voltage (Nominal) Min.	Instrumentation Voltage (Nominal) Max.	Max. Data Freq. in cps	Priority	Terminating Impedance
Payload Power	TSP40	COD1							
Camera Control	TSP41	COD2							
Stereo Mirror Position Control	TSP42	COD3							
Door Control	TSP43	COD4							
IMC Auto/Manual	TSP44	COD5							
IMC Speed Most Significant Bit ON	TSP45	COD6							
IMC Speed Most Significant Bit OFF	TSP46	COD7							
IMC Speed 2nd Most Significant Bit ON	TSP47	COD8							
IMC Speed 2nd Most Significant Bit OFF	TSP48	COD9							
IMC Speed 3rd Most Significant Bit ON	TSP49	COD10							
IMC Speed 3rd Most Significant Bit OFF	TSP50	COD11							
IMC Speed 4th Most Significant Bit ON	TSP51	COD12							
IMC Speed 4th Most Significant Bit OFF	TSP52	COD13							
IMC Speed 5th Most Significant Bit ON	TSP53	COD14							
IMC Speed 5th Most Significant Bit OFF	TSP54	COD15							
IMC Speed 6th Most Significant Bit ON	TSP55	COD16							
IMC Speed 6th Most Significant Bit OFF	TSP56	COD17							

Table III (Continued)

Function	Code	Flight Code Equiv.	Source Impedance in K ohms Min.	Source Impedance in K ohms Max.	Instrumentation Voltage (Nominal) Min.	Instrumentation Voltage (Nominal) Max.	Max. Data Freq. in cps	Priority	Terminating Impedance
IMC Speed 7th Most Significant Bit ON	TSP57	COD18							
IMC Speed 7th Most Significant Bit OFF	TSP58	COD19							
IMC Speed 8th Most Significant Bit ON	TSP59	COD20							
IMC Speed 8th Most Significant Bit OFF	TSP60	COD21							
IMC Speed Least Significant Bit ON	TSP61	COD22							
IMC Speed Least Significant Bit OFF	TSP62	COD23							
Focus Control	TSP63	COD24							
Strip Stereo	TSP64	COD25							
Panning	TSP65	COD26							
Slit Most Significant Bit ON	TSP66	COD27							
Slit Most Significant Bit OFF	TSP67	COD28							
Slit Least Significant Bit ON	TSP68	COD29							
Slit Least Significant Bit OFF	TSP69	COD30							
Torque Motor Control	TSP70	COD31							
Focus: Auto/Manual	TSP71	COD32							
Focus Forward	TSP72	COD33							
Focus Reverse	TSP73	COD34							
Empty Supply	TSP74	COD35							
Cut Film	TSP75	COD36							
Separate	TSP76	COD37							
400 pps	TSP77	COD38							
Time/Position Label	TSP78	COD39							

TABLE IV

Flight Instrumentation

Function	Code	Equiv. Code	Source Impedance in K ohms Min.	Max.	Instrumentation Voltage (Nominal) Min.	Max.	Max. Data Freq. ~~in~~ cps	Priority	Terminating Impedance
Exposure Unit Film Path Temperature	IMP1	TSP1	4.2	5.6	*	*	1	B	*
Storage Cassette Temperature	IMP2	TSP2	4.2	5.6			1	C	
Stereo Mirror Differential Temperature	IMP3	TSP3	0	5.0			1	B	
Stereo Mirror Temperature	IMP4	TSP4	4.2	5.6			1	C	
Lens Barrel Differential Temperature	IMP4	TSP5	0	5.0			1	B	
45° Mirror Temperature	IMP6	TSP6	4.2	5.6			1	C	
Component Support Tube Temperature Station *	IMP7	TSP7	4.2	5.6			1	C	
Component Support Tube Temperature Station *	IMP8	TSP8	4.2	5.6			1	C	
Component Support Tube Temperature Station *	IMP9	TSP9	4.2	5.6			1	C	
Component Support Tube Temperature Station *	IMP10	TSP10	4.2	5.6			1	C	
Component Support Tube Temperature Station *	IMP11	TSP11	4.2	5.6			1	B	
Slit Position	IMP12	TSP12	0	5.0			1	A	
Stereo Mirror Position	IMP13	TSP13	0	5.0			1	C	
Film Take-Up Qty. Coarse	IMP14	TSP14	0	5.0			1	B	
Film Take-Up Qty. Medium	IMP15	TSP15	0	5.0			1	B	
Film Take-Up Qty. Fine	IMP16	TSP16	0	5.0			1	A	
Film Tension	IMP17	TSP17	0	5.0			5	C	
MSD Frequency	IMP18	TSP18	0	5.0	*	*	-	B	

Table IV (Continued)

Function	Code	Equiv. Code	Source Impedance in K ohms Min.	Source Impedance in K ohms Max.	Instrumentation Voltage (Nominal) Min.	Instrumentation Voltage (Nominal) Max.	Max. Data Freq. in cps	Priority	Terminating Impedance
Platen position coarse	IMP19	TSP19	0	5.0	*	*	1	A	*
Platen position fine	IMP20	TSP20	0	5.0			1	A	
Focus "A" channel	IMP21	TSP21	0	1.0			5	A	
Focus "B" channel	IMP22	TSP22	0	1.0			5	A	
Focus output	IMP23	TSP23	0	1.0			5	A	
Supply cassette film path temperatures	IMP24	TSP24	4.2	5.6			1	C	
Port door tell tale	IMP25	TSP25	*	*			*	A	
Environmental power supply	IMP26	TSP26	0	5.0			0.1	C	
Take-up motor current	IMP27	TSP27	0	5.0			2.5	C	
Calibration	IMP28	TSP28	*	*			*	B	
Instrumentation return	IMP RET	TSP RET	*					B	
V/h malfunction	IMP29	TSP29						B	
Data signal "A"	IMP30	TSP30						C	
Data signal "B"	IMP31	TSP31						C	
V/h output	IMP32	TSP32						A	
Crab output	IMP33	TSP33						C	
Crab position	IMP34	TSP34						B	
Payload master tell tale	IMP35	TSP35	*	*	*	*	*	*	

* To be supplied by a later revision.

NOTICE

When Government drawings, specifications or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any was supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

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APPENDIX U

Preliminary Specification

For The

Stereo Servomechanism Assembly

Specification No. *

Prepared by

EASTMAN KODAK COMPANY
Advanced Development Projects Group
Apparatus and Optical Division
Rochester, New York

Original Signed by:
Prepared by ______________________

Reviewed by ______________________

Approved by ______________________

Release Date ______________________

Revision	Pages Affected	Date	Approved by

Preliminary Specification | Stereo Servomechanism Assembly

Specification No. * | Release Date: *

1. SCOPE, MISSION AND TASK

1.1 Scope - This specification defines the Stereo Servomechanism Assembly hereinafter referred to as the Assembly. It includes the performance and and environmental requirements, and defines the quality assurance provisions required to determine compliance of the Assembly with these requirements.

1.2 Mission - It shall be the mission of the Assembly to position its output shaft, ie, the stereo mirror, at any one of two discrete positions.

1.3 Task - The required task is to design, develop, manufacture, test and deliver to Eastman Kodak Company an Assembly and Assembly mockup which complies with the requirements defined in this specification.

2. APPLICABLE DOCUMENTS

2.1 General - The following specifications, standards, drawings and publications of latest issue in effect on date of invitation for bids, forma a part of this specification. Applicability of the listed documents shall depend on their specific reference in this specification. In the event of conflict between the listed documents, and this specification this specification shall take prededence.

SPECIFICATIONS

Military

MIL-Q-9858	Quality Control System Requirements
MIL-I-26600	Interference Control Requirements, Aeronautical Equipment

Eastman Kodak Company

401-113	Reliability Preferred Parts List

STANDARDS

Eastman Kodak Company

401-119	Design and manufacturing standards

DRAWINGS

Eastman Kodak Company

405-130	Procedure for Iridite No. 15 on Magnesium
405-152	Procedure for Aluminizing Aluminum, Magnesium and Polystyrene Parts
405-185	Procedure for Iridite No. 14 on Aluminum
*	Stereo Servo Assembly Outline Configuration

OTHER PUBLICATIONS

Eastman Kodak Company

401-122	Technical Requirements for Contractors

2.2 Control Drawings - There are no applicable control drawings.

3. REQUIREMENTS

3.1 Definitions - The equipment required by this specification consists of the following:

a. Stereo Servomechanism (Assembly)

b. Stereo Servomechanism Assembly Mockup

3.1.1 Stereo Servo - The Assembly shall consist basically of a driving mechanism with its associated control circuitry.

3.1.2 Assembly Mockup - The Assembly Mockup is a unit which simulates the average power consumption and heat dissipation of the Assembly. It also has the external configuration, finich, weight and center of gravity of the Assembly. The requirements of the Assembly mockup shall be in accordance with paragraph 3.5.9.

3.2 Electrical

3.2.1 Connector - The connector used on the Assembly shall be a Deutsch DTKH.

3.2.2 Connector Pin Assignments - The connector pin assignments shall be as tabulated below:

Function	Pin
+28 volt dc supply	*
28 volt return	*
+5 volt dc supply	*
5 volt return	*
Instrumentation Output	*
Command Bit N.O.	*
Command Bit N.C.	*
Command Bit Common	*

* To be supplied at a later date.

3.2.3 Leakage - The dc resistance between any electrical connection, except shields and dc motor leads, and the chassis of the Assembly shall be 100 megohms minimum with an applied voltage of 100 volts dc ±10 percent. The dc resistance between any motor lead and chassis shall be 50,000 ohms minimum with an applied voltage of 100 volts dc ±10 percent.

3.2.4 Inputs - The Assembly shall meet all the requirements of this specification when supplied with the following inputs:

3.2.4.1 Power - (a) $+28^{+3}_{-3}$ volts dc
(b) +5 ± 0.1 volts dc

The +5 volt supply shall only be used to power the instrumentation circuit.

The Assembly shall be capable of withstanding input voltages as high as 32 volts dc without permanent performance degradation.

3.2.4.2 Commands - The Digital signals used to drive the Assembly to any one of the two required positions shall be supplied from an external source. The command word shall contain one binary bit. The command bit shall be supplied on three wires from a set of SPDT contacts. A binary "zero" shall be presented by a closed circuit (resistance less than 1 ohm) between the common terminal and the normally closed terminal of a set of contacts. A binary "one" shall be presented as a closed circuit (resistance less than 1 ohm) between the common terminal and the normally open terminal of a set of contacts. The contact rating of the command switches shall be one ampere (resistive load) at 50 volts dc. The command code shall be as follows:

Stereo Mirror Position	Command Code
0° (reference)	0
+15°	1

3.2.5 Instrumentation - A 0 to +5 volt dc output shall be provided to indicate the Assembly output shaft position to within ± 50 degrees of the actual shaft position. The output voltage shall be a linear function of the output shaft angular position. In no instance shall the output voltage exceed +5.0 volts or be less than 0 volt.

3.2.5.1 Output Impedance - The instrumentation output impedance shall be resistive and shall not exceed 5000 ohms.

3.2.5.2 Return - The instrumentation return shall be connected to the dc return at a point external to the Assembly and shall be completely isolated from the dc return within the Assembly.

3.2.6 Power Consumption - The Assembly power consumed by the Assembly shall be kept to a minimum consistent with the performance and reliability requirements of this specification. When operating, the average power consumed shall not exceed 32 watts at +28 volts dc. When not in the process of attempting to satisfy a command, the maximum power required from the +28 volt dc source shall be * volts. Any surge currents shall not exceed 2.75 amperes.

3.2.7 Radio Frequency Interference - The Assembly shall meet all the requirements defined by MIL-I-26600 for class I b equipment, during its operating phase. In addition to the requirements defined by MIL-I-26600, any conducted interference within a frequency range of 15-15000 cycles per second, impressed on the +28 volt dc power supply circuit by the Assembly shall not exceed 0.125 ampere peak-to-peak.

3.2.8 Overload Protection - A means shall be provided within the Assembly that will disable the drive, within a time range of 5 to 8 seconds after the command was applied, if the command has not been satisfied by that time. The drive shall be disabled in a manner such that essentially no power is required other than that required by the instrumentation and reference diode circuits. The overload circuit shall be self-reset whenever a new input command is applied.

The overload circuit timing cycle shall be self-reset within a period of 0.5 second after the drive has been disabled either due to overload circuit operation or stopping as a result of satisfying a command.

3.2.9 Drive Limiting - Electrical limiting shall be provided within the Assembly to ensure that it will never drive the output shaft more than 65 degrees beyond the two extreme required positions.

3.2.10 Shields - Leads which carry signals having a high electromagnetic interference content shall be shielded. Shields shall be connected to the Assembly enclosure at the originating end. The length of any pig-tail between the shield ferrule and the Assembly enclosure shall be less than 2 inches in length. Shields shall not be used as signal carrying conductors.

3.3 Environmental Requirements

A complete environmental design criteria establishing all of the levels of environment to which the payload and its components will be subjected will be established at a later date.

3.4 <u>Mechanical</u>

3.4.1 External Configuration - The external configuration of the Assembly shall be as shown on Eastman Kodak Company Drawing * .

3.4.2 Output Shaft - The assembly output shaft configuration shall be as shown on Eastman Kodak Company drawing * . The output shaft end play shall not exceed 0.0005 inch and the output shaft eccentricity shall not exceed 0.005 inch TIR(measured at load end of shaft) when driving the load described by the Load paragraph of this specification.

3.4.3 Weight - The weight of the assembly shall be kept to a minimum consistent with the size, performance, and reliability requirements of this specification. In no event shall the weight exceed 4 pounds.

3.4.4 Parts and Materials - Parts and material selection and control shall be in accordance with section 3.10 of Eastman Kodak Company document 401-122.

3.4.5 Finish

3.4.5.1 Mounting Surfaces - Magnesium mounting surfaces shall be finished with Iridite No. 15 in accordance with Eastman Kodak Company drawing 405-130. Aluminum mounting surfaces shall be finished with Iridite No. 14 in accordance with Eastman Kodak Company drawing 405-185.

3.4.5.2 Exterior Surfaces - All exterior housing surfaces, except mounting surfaces, shall be finished in accordance with Eastman Kodak Company drawing No. 405-152.

3.4.6 Identification - Each assembly shall be identified with a part number and a serial number only. The format and lettering type shall be as shown in Figure U-1.Refer to Figure U-2 for details with regard to selection of the part number and serial number. The assembly identification shall be applied and overcoated in accordance with the methods and procedures defined or referenced in 401-119. The color of the identification shall be black. The electrical connector shall be identified as * by means

SAMPLE IDENTIFICATION

PART NO. 1400-XXX
SERIAL NO. 110000

SAMPLE

Lettering is: Upper case, vertical Commercial Gothic 3/16 inch high.

Figure U-1

EXPLANATION OF NUMBERING SYSTEM

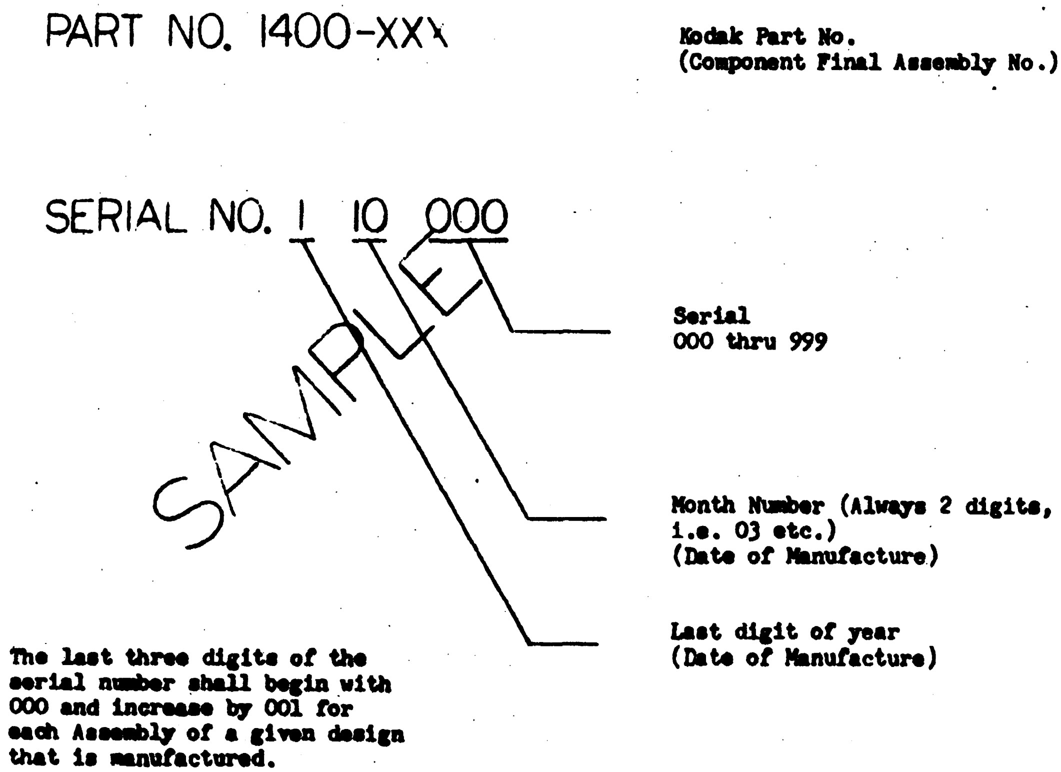

Figure U-2

of appropriate marking on the assembly housing adjacent to the connector. The connector identification shall be the same style, size and color lettering as that used for the assembly identification.

3.4.7 Load - The assembly shall meet the requirements of this specification when driving an inertial load with a one inch pitch diameter standard Acme leadscrew, having five threads per inch, coupling system as shown in Figure U-3. The inertial of the leadscrew itself is 0.163 lb. -in.^{2} . The lever arm between the centerline of the leadscrew and the pivot point of the load is 7.438 inches ± 0.030 inch. The maximum inertial of the load to be driven is 4 slug-feet ^{2}; however, the assembly shall meet the requirements of this specification should the load inertia be any value less than 4 slug - feet ^{2}.

In addition to the inertial load, the assembly shall also be capable of simultaneously driving any friction load within the range of 0 to 1 inch - pound as measured at the output shaft of the assembly.

The assembly shall be capable of withstanding any axial thrust loading of its output shaft which may be imparted to it due to driving the load described in the preceding sections of this paragraph. In addition to the operating thrust loading, the assembly shall withstand a non-operating thrust loading of 300 pounds axially, on its output shaft in either direction, when in a non-operating state.

3.4.8 Shaft Positioning - A one bit binary code input shall cause the output shaft of the assembly, and hence the stereo mirror, to travel to any one of two discrete positions. The output shaft positions corresponding to the two input command shall be as follows:

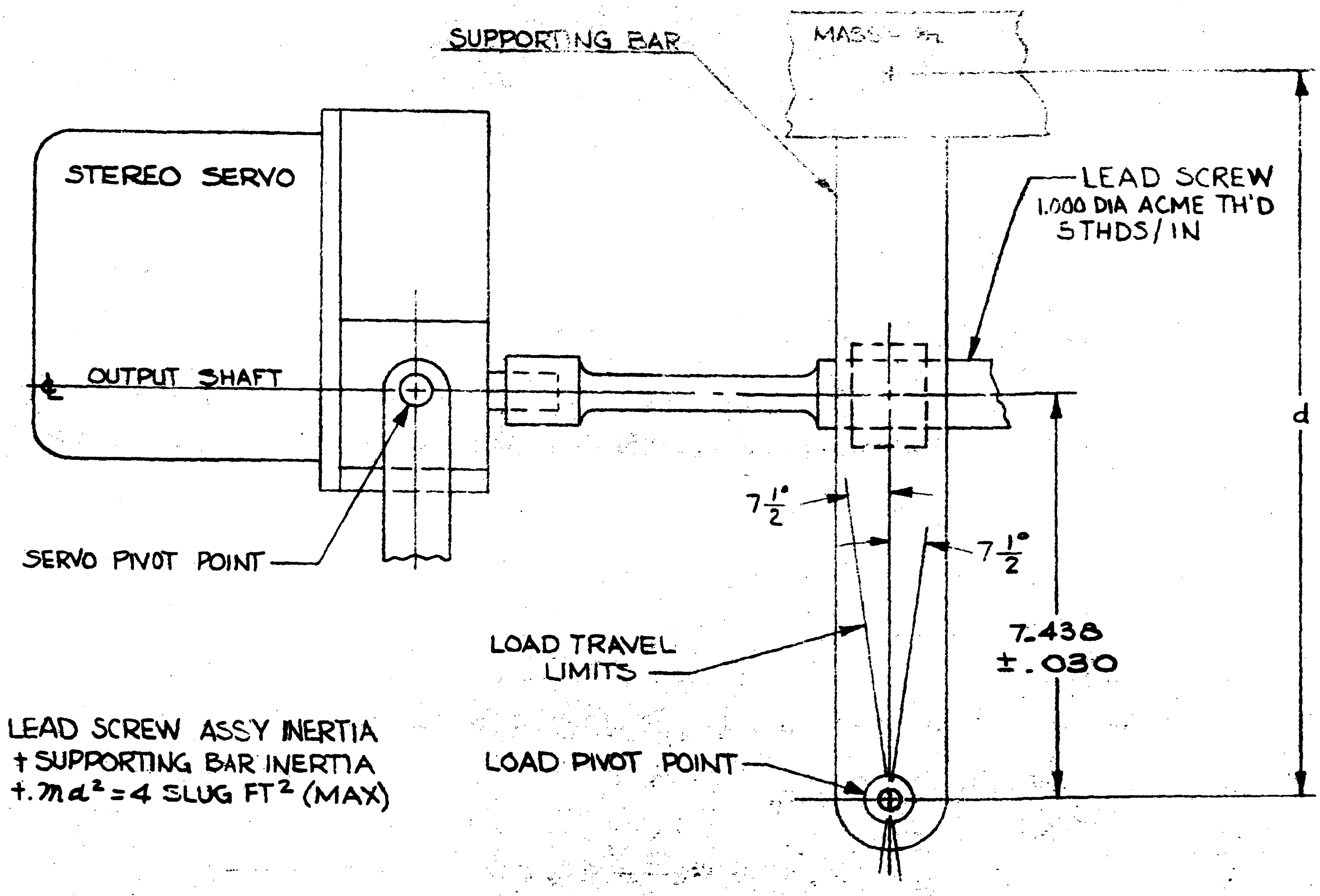
SUPPORTING BAR
MASS
STEREO SERVO
LEAD SCREW
1.000 DIA ACME TH'D
5THDS/IN
OUTPUT SHAFT
d
$7\frac{1}{2}°$
$7\frac{1}{2}°$
SERVO PIVOT POINT
LOAD TRAVEL
LIMITS
7.438
±.030
LEAD SCREW ASSY INERTIA
+ SUPPORTING BAR INERTIA
$+ md^2 = 4$ SLUG FT^2 (MAX)
LOAD PIVOT POINT

Figure U-3.

Input Command	Required Shaft Position
0	0.0 degree (reference)
1	+3496 degrees

3.4.9 Positioning Accuracy - The actual output shaft positions of the assembly shall be attained within ± 40 degrees of the required position.

3.4.10 Output Shaft Rotation - An increasing natural binary code input shall cause the assembly output shaft to rotate in a clockwise direction when viewed from the load end of the shaft.

3.4.11 Transition Time - The assembly shall be capable of driving the load from either position to the other within 4.0 seconds when operating continuously.

3.4.12 Overshoot and Hunting - There shall be no overshoot or hunting present in the operation of the assembly while it is operating in accordance with the requirements of this specification.

3.4.13 Repositioning Capability - If input electrical power is present, the assembly shall return its output shaft to within the specified positioning tolerance should any external mechanical disturbance cause the shaft to rotate after the desired position has been reached. The assembly shall retain this repositioning capability should the output shaft be externally driven 120 degrees beyound either of the two positions.

3.4.14 Leak Rate - The assembly shall be a sealed package. It shall be designed so that it can be purged at any time with a known gas mixture to measure the leak rate. A charging port shall be located as shown on Eastman Kodak Company drawing No. * .

* To be supplied at a later date.

The gas mixture used for leak rate measurement shall contain 10 percent ± 2 percent helium by volume. The exact purging mixture shall be specified on the final assembly drawing.

The assembly shall be capable of operating in accordance with the requirements of this specification with the helium mixture in it, thus eliminating the need for opening the assembly after a leak rate test has been completed.

The assembly shall be leak tested prior to delivery to Eastman Kodak Company. It shall be delivered to Eastman Kodak Company with the helium mixture in it at a nominal pressure of one atmosphere.

3.4.15 Position Centering - A means shall be provided to indicate when the Assembly Output shaft has been positioned to within ± 2 degrees of the nominal center of the 0 degree(reference) shaft position. This may consist of index marks on the shaft and housing which, when aligned, correspond to the desired position, or some similar method.

3.5 General

3.5.1 Design Attributes - Design shall be in accordance with the requirements of Eastman Kodak Company Standard 401-119. Throughout the various stages of design, consideration shall be given to the items listed below. Items are listed in order of relative importance.

(a) Performance
(b) Reliability
(c) Fail Safe Features
(d) Light Weight
(e) Serviceability
(f) Power Consumption
(g) Flexibility

3.5.2 Manufacturing Standards - The assembly shall conform to the manufacturing standards contained in Eastman Kodak Company Standard 401-119.

3.5.3 Interchangeability - Parts and assemblied of the assembly of the same model, regardless of series designation, exlusive of "Engineering Models" shall be completely interchangeable.

3.5.4 Life

3.5.4.1 Servie Life -

3.5.4.1.1 Testing Life - The assembly shall have a testing life of * hours of ON time. During the testing life period, the assembly shall be capable of operating continuously for * minutes out of a * minute period. The assembly shall also be capable of a minimum of * ON and OFF operations during * minutes out of a * minute period with each ON time having a minimum duration of * seconds.

3.5.4.1.2 Mission Life - After completion of the specified testing life, the assembly shall have a minimum mission life of * hours of ON time. During the mission life period, the assembly shall be capable of operating continuously for * minutes out of a * minute period. The assembly shall also be capable of a minimum of * ON and OFF operations during * minutes out of a * minute period, with each ON time having a minimum duration of * seconds. The assembly shall have the above mission life when operated under any of the specified operating condition.

3.5.4.2 Shelf Life - The assembly shall have a minimum shelf life of 24 months.

* To be supplied at a later date.

3.5.5 Reliability Requirements -

a. The contractor shall meet the reliability requirements defined in Section 3 of Eastman Kodak Company Document 401-122.

b. The assembly shall have a minimum Mean-Time-Between-Failures of * hours (90 percent confidence level statistics) when operated at the maximum duty cycle defined in the Service Life paragraph of this specification.

c. In conjunction with reliability testing as referenced in Section 3.8 of Eastman Kodak Company Document 401-122. The contractor shall make an estimate of the demonstrated equipment reliability stating the confidence level of statistics used. In lieu of this requirement, test results including running time and failures shall be supplied by the contractor.

3.5.6 Disposition of Variances - Variances from the requirements of this specification, drawings and procedures referenced herein, and from Eastman Kodak Company Standard 401-119 shall require Eastman Kodak Company written approval. Variances of all other drawings not affecting the requirements of this specification shall require contractor action only.

3.5.7 Contract Conformance - The assembly shall conform to all the requirements of the specification. All design, development, fabrication and test procedures shall conform to Eastman Kodak Company Document 401-122.

3.5.8 Safety of Personnel

3.5.8.1 Mechanical - The assembly design shall provide maximum convenience and safety to personnel when installing, operating, maintaining or replacing the assembly. No sharp projections or edges on parts or assemblies shall be permitted.

3.5.8.2 Electrical - Provisions shall be made to prevent personnel from accidentally coming in contact with voltages in excess of 40 volts, including potentials on charged capacitors, when the assembly is in its normal operating condition.

* To be supplied at a later date.

3.5.9 Assembly Mock-up - The assembly mock-up shall meet the following requirements utilizing the characteristics of the assembly design at the time of delivery.

Configuration	The assembly mock-up shall have the external configuration and finish of the assembly and consist of machined castings or weldments of the same material. The unit need not be machined internally except to mount required components.
Weight and Center of Gravity:	The assembly mock-up shall have the mass and center of gravity of the assembly design within ±5 percent as demonstrated by weighing.
Heat Capacitance:	The assembly mock-up shall have the heat capacitance of the assembly design within ±10 percent as demonstrated by calculation.
Power Consumption:	The assembly mock-up shall simulate the power consumption of the assembly design by dissipation in a resistor which replaces the electronics components of the assembly design. The resistor shall be selected to produce the average power dissipation of the assembly.
Electrical Connection:	Two electrical connections to the resistor shall terminate at pins * and * of the

* To be supplied at a later date.

	electrical connector * used in the assembly design.
Design:	The assembly mock-up shall be capable of meeting the qualification test levels of Section 3.3.1.

3.6 Documentary.

3.6.1 Drawings - Drawings, associated lists, and documents prepared by the contractor defining the requirements of design, procurement, fabrication and assembly of the assembly shall be prepared in accordance with section 5 of Eastman Kodak Company document 401-122.

3.6.2 Specifications - The contractor shall generate material to complete performance requirements and description of the assembly contained in this specification. Such material shall be submitted to Eastman Kodak Company for written approval. The approved material shall be incorporated into the specification by Eastman Kodak Company.

3.6.3 Manual Material - The contractor shall provide manual material containing operating and maintenance information in accordance with 1.3.11 and section 6 of Eastman Kodak Company document 401-122.

3.6.4 Receiving, In-Process, and Final Inspection - Inspection reports shall be generated and maintained by the contractor. These reports shall include receiving, in-process, and final inspection reports in accordance with 2.3 and 2.5 respectively of Eastman Kodak Company document 401.122.

3.6.5 Reports - The contractor shall submit the following reports to Eastman Kodak Company. The formats and contents as applicable shall be in accordance with the referenced paragraphs and sections of Eastman Kodak Company document 401-122.

		Paragraphs	Sections
a.	Technical Progress Report	1.3.6.1	
b.	Red Flag Report	1.3.6.2	
c.	Preliminary Design Report	1.3.6.3	
d.	Major Design Report	1.3.6.4	
e.	Final Design Report	1.3.6.5	
f.	Performance Evaluation Report	1.3.6.6	
g.	Failure Report and Failure Analysis	1.3.6.7	3.9
h.	Final Technical Report	1.3.6.8	
i.	Acceptance Test Report		2.12.2
j.	Acceptance Inspection Report		2.12.1
k.	Qualification Test Report	3.8.3.2	
l.	Reliability Test Report		3.7
m.	Operating Time Log	2.9	
n.	Reliability Program Plan		3.3

3.6.6 Verification of Purchased Items - A certificate of compliance for purchased parts shall be provided by the contractor. This certification of compliance shall state that the manufacturer has on record data to demonstrate that the purchased part shall conform to the requirements of the applicable Eastman Kodak Company drawing. MS and AN standard parts will not require a certificate of compliance.

3.6.7 Calibration - Records of the alignment and calibration of the assembly and all measuring and test equipment shall be generated and documented, in accordance with 2.8 of Eastman Kodak Company document 401-122.

3.6.8 Inspection and Test Procedures - Qualification, acceptance, and inspection test procedures for the assembly that demonstrate conformance to the requirements of this specification shall be prepared and documented by the contractor, in accordance with section 1.3.12 of Eastman Kodak Company document 401-122.

3.6.9 Reliability Prediction - The contractor shall provide reliability information in accordance with 3.6 of Eastman Kodak Company document 401-122.

3.6.10 Electromagnetic Interference Control Plan - An EMI control plan in accordance with MIL-I-26600 Class Ib shall be prepared and submitted for Eastman Kodak Company approval with the Preliminary Design Report of 1.3.6.3, Eastman Kodak Company document 401-122.

3.7 Design Review -

3.7.1 Design Review Check Lists - Design Review check lists shall be completed by the subcontractor and supplied in reproducible form to Eastman Kodak Company prior to the associated design review meetings.

3.7.2 Design Review Meetings - Design review meetings shall be held in accordance with section 3.11 and the design reviews of Table 1-1 of Eastman Kodak Company document 401-122.

4. QUALITY ASSURANCE PROVISIONS

The quality control system requirements of MIL-Q-9858, and section 2 of Eastman Kodak Company documents 401-122 shall apply. Testing of the assembly shall be limited to provisions listed in this section.

4.1 Classification of Tests - The inspection and testing of the assembly shall be classified as follows:

a. Qualification Tests

b. Acceptance Tests

4.2 Qualification Tests - Qualification testing of the assembly shall be in accordance with section 3.8.3 of Eastman Kodak Company document 401-122. The contractor shall conduct a qualification testing program to demonstrate the capability of the design to meet the qualification levels of section 3.3.1. The qualification test procedure of section 3. 6.8 of this specification shall be followed. The qualification test shall include but not be limited to the following:

4.2.1 Visual Inspection: All parts, subassemblies, and assemblies shall be inspected for conformance to the manufacturing standards of Eastman Kodak Company standard 401-119.

4.2.2 Drawing Conformance - All parts, subassemblies, and assemblies shall be inspected for conformance to their respective drawings.

4.2.3 Performance Tests - The assembly shall be tested for its ability to comply with the performance requirements of sections 3.2, 3.4, and 3.5.

4.24 Environmental Qualification Tests - The assembly shall be subjected to the environmental levels of sections 3.3.1. Subjecting the assembly to the specified environmental conditions separately shall be considered adequate in lieu of testing all possible or probable combinations except for the operation portion where worst case combinations shall be used. Following completion of these tests, the assembly shall be visually inspected for damage, and the performance tests of 4.2.3 shall be repeated. Any impairment of performance of the assembly shall be reported in accordance with item g. of 3.6.5.

4.2.5 Life Test - The assembly shall be tested for its ability to meet the service life requirements of 3.5.4.1.

4.3 Acceptance Tests - Acceptance testing of the assembly shall be part of the task and follow the acceptance test procedure in accordance with 2.11 of Eastman Kodak Company document 401-122. The acceptance tests shall include but not be limited to:

4.3.1 Visual Inspection - All parts, subassemblies, and assemblies shall be inspected for workmanship, cleanlinesses, and wiring.

4.3.2 Drawing Conformance - All parts, subassemblies and assemblies shall be inspected for conformance to their respective drawings.

4.3.3 Performance Test - The assembly shall be tested for its ability to meet all the performance requirements that are defined in sections 3.2 and 3.4 of this specification. The assembly shall meet foregoing requirements both before and after being subject to acceptance test vibration of 4.3.4.

4.3.4 Vibration Tests - The assembly shall be tested for its ability to meet the vibration requirements of 3.3.2.

4.4 Test Conditions - The atmospheric conditions for all tests shall be within the environmental ranges specified in section 3.3 except as required in 4.2.4.

4.5 Monitoring and Technical Surveillance - Eastman Kodak Company reserves the right to have technical representatives visit the contractor's facilities periodically to maintain technical surveillance of the contract. Eastman Kodak Company reserves the right to have technical representatives in residence at the contractor's facilities, if conditions warrant.

4.6 Sampling - Not required for this specification.

5. PREPARATION FOR DELIVERY

5.1 Shipping, Handling, and Storage - Each assembly shall be cleaned, labeled, sealed, with its identification in a transparent plastic bag, and packaged in a fitted, padded box. It shall be the responsibility of the contractor to insure that the packing and packaging provides adequate protection for the assembly to withstand the environmental conditions specified in the shipping handling environmental requirements of 3.3.1.3. It shall also be the responsibility of the contractor to insure that the specified environmental conditions are not exceeded prior to receipt of the assembly by Eastman Kodak Company.

6. NOTES

6.1 Applicability - Details of intended use are not required for this specification.

APPENDIX V

Preliminary
Specification

**Programmable Slit Mechanism
for the Exposure Unit**

Specification No. *

Prepared by
EASTMAN KODAK COMPANY
Advanced Development Projects Group
Apparatus and Optical Division
Rochester, New York

Original Prepared by ____________________

Original Reviewed by ____________________

Original Approved by ____________________

Original Release Date ____________

Revision	Pages Affected	Date	Approved by

Preliminary Specification	Programmable Slit Mechanism for the Exposure Unit.
Specification No. *	Release Date: *

1. SCOPE, MISSION AND TASK

1.1 Scope

This specification defines the Programmable Slit Mechanism (sometimes called a Slit Positioner) for the Exposure Unit. It includes the performance and environmental requirements, and defines the quality assurance provisions required to determine compliance with these requirements. For the sake of brevity, the Programmable Slit Mechanism will hereinafter be referred to as the positioner.

1.2 Mission

It shall be the mission of the positioner to control, on command, the film exposure by accurately positioning the desired slit of the slit aperture plate.

1.3 Task

The required task is to design, develop, manufacture, test and deliver to Eastman Kodak Company a positioner and positioner mockup which complies with the requirements of this specification. The positioner shall be installed into engineering, reliability and production exposure units. These exposure units shall be delivered in accordance with an established schedule. Tools, fixtures, and accessories necessary to repair, handle, adjust, align and operate the positioner shall be supplied by the contractor to Eastman Kodak Company.

* To be supplied at a later date.

2. APPLICABLE DOCUMENTS

2.1 General

The following specifications standards, drawings and publications of latest issue in effect on date of invitation for bids, form a part of this specification. Applicability of the listed documents shall depend on their specific reference in this specification. In the event of conflict between the listed documents and this specification, this specification shall take precedence.

SPECIFICATIONS

Military	
MIL-Q-9858	Quality Control System Requirements
MIL-I-26600	Interference Control Requirements, Aeronautical Equipment
Eastman Kodak Company	
401-113	Reliability Preferred Parts List
401-115	Control Drawing Index
*	Performance Requirements for Exposure Unit

STANDARDS

Eastman Kodak Company	
401-119	Design and Manufacturing Standards

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* To be supplied at a later date.

DRAWINGS

Eastman Kodak Company

*	Potentiometer, Precision, Continuous Rotation
405-130	Procedure for Iridite No. 15 on Magnesium
405-144	Procedure for Changing and Lubrication of Unshielded Bearings
405-185	Procedure for Iridite No. 14 on Aluminum
*	Film Format
*	Slit Aperture Plate Black
*	Space Allocation Drawing for Slit Positioner
*	Mechanism Assembly, Slit Plate
*	Mechanism Assembly, Internal
*	Exposure Unit
*	Drive Assembly, Film

OTHER PUBLICATIONS

Eastman Kodak Company

401-122	Technical Requirements for Contracts

2.2 Control Drawings

There are no applicable control drawings.

3. REQUIREMENTS

In addition to complying with the performance requirements of the Exposure Unit, Eastman Kodak Company specification * , the Exposure Unit shall have

* To be supplied at a later date.

a positioner installed and aligned in conformance with the requirements of this specification.

3.1 <u>Definitions</u>

The equipment required by this specification consists of the following:

A) Positioner - The positioner is comprised of the following major subassemblies:
   (a) Slit Aperture Plate
   (b) Potentiometer
   (c) Encoder
   (d) Drive Mechanism
   (e) Switching Circuitry
   (f) Detent Clamps

B) Positioner Mockup

3.1.1 <u>Positioner</u>

3.1.1.1 Slit Aperture Plate - The slit aperture plate is a glass plate of required size with suitable slit openings engraved in a metallic coating on its surface. The slits control the exposures of specified film (see Eastman Kodak Company drawing * , "Film Format"). The slit aperture plate may be clear optical glass or yellow filter flass, as designated by Eastman Kodak Company.

3.1.1.2 Potentiometer - The potentiometer is used to indicate which slit opening has been positioned for photography.

3.1.1.3 Encoder - The encoder is used to decode digital signals coming to the exposure unit from an external source and to control the power which moves the slit plate to a commanded slit position.

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* To be supplied at a later date.

3.1.1.4 Drive Mechanism - The drive mechanism consists of a drive motor, gearing and indexing devices which provide approximate positioning of the slit plate.

3.1.1.5 Switching Circuitry - The switching circuitry consists of a solid state electronic package which provides switching of drive motor power with a minimum generation of electromagnetic interference (EMI).

3.1.1.6 Detent Clamps - The detent clamps provide the necessary accuracy in positioning of slits and hold the slit plate securely when the drive mechanism is not operating . Sequencing of the detent clamps is provided by the drive mechanism.

3.1.2 <u>Positioner Mockup</u>

The positioner mockup is a unit which simulates the average power consumption and heat dissipation of the positioner. It also has the external configuration, finish, weight and center of gravity of the positioner. The requirements of the positioner mockup shall be in accordance with paragraph * .

3.2 <u>Electrical</u>

3.2.1 Connectors - The connectors used on the positioner shall be Deutsch types DTK* and DTK*.

3.2.2 Connector Pin Assignments - The connector pin assignments shall be tabulated as follows:

* To be supplied at a later date.

Function	Connector	Pin
+28 volt dc supply	*	*
28 volt reutrn	*	*
+5 volt dc supply	*	*
5 volt return	*	*
No. 1 Command Bit Common (Most Significant)	*	*
No. 1 Command Bit NO (Most Significant)	*	*
No. 1 Command Bit NC (Most Significant)	*	*
No. 2 Command Bit Common	*	*
No. 2 Command Bit NO	*	*
No. 2 Command Bit NC	*	*
No. 3 Command Bit Common (Least Significant)	*	*
No. 3 Command Bit NO (Least Significant)	*	*
No. 3 Command Bit NC (Least Significant)	*	*
Test Command Lead A	*	*
Test Command Lead C	*	*
Test Command Lead B	*	*
Instrumentation Output	*	*

3.2.3 Leakage Resistance - The dc resistance between any electrical connection within the positioner, except shields and dc motor leads, and the chassis of the exposure unit shall be 100 megohoms minimum with an applied voltage of 100 volts dc ± 10 percent. The dc resistance between any motor lead and chassis shall be 50,000 ohms mimimum with an applied voltage of 100 volts dc ± 10 percent.

* To be supplied at a later date.

3.2.4 Inputs - The positioner shall meet all the requirements of this specification when supplied with the following inputs:

3.2.4.1 Power -

(a) +28 ± 3 volts dc

(b) +5 ± 0.1 volts dc

The +5 volt supply shall only beused to power the instrumentation circuit. The positioner shall be capable of withstanding input voltages as high as 32 volts dc without permanent performance degradation.

3.2.4.2 Commands - The digital signals used to drive the positioner to any one of the seven "operational" positions shall be supplied from an external source in parallel form. Each command word shall contain three binary bits. Each bit of a command word shall be supplied on three wires from a set of single pole double throw contacts. A binary "zero" shall be presented as a closed circuit (resistance less than 1 ohm) between the common terminal and the normally closed terminal of a set of contacts A binary "one"shall be presented as a closed circuit (resistance less than 1 ohm) between the common terminal and the normally open terminal of a set of contacts. The contact rating of the command switches shall be one ampere (resistive load) at 50 volts dc. The command code shall be as follows:

Slit Position	No. 1 Bit (Most Significant)	No. 2 Bit	No. 3 Bit (Least Significant)
1	0	0	0
2	0	0	1
3	0	1	0
4	0	1	1
5	1	0	0
6	1	0	1
7	1	1	0
8 (test)	1	1	1

Slit widths shall progress from the narrowest at position 7 to the widest at position 1.

A 111 input command is not a valid command during the operational mode, as opposed to testing mode, and any circuitry associated with this command shall be completely independent of any other circuitry. The 111 encoder position, ie, the eighth slit position, shall be used for testing only.

3.2.5 Instrumentation - A 0 to +5 volt dc output shall be provided to indicate the positioner output shaft position, ie, the slit plate position, to within ± * degrees of the actual shaft position. The output voltage shall be a linear function of the output shaft angular position or slit plate motion from slit 1 to slit 8. In no instance shall the output voltage exceed 5.0 volts or be less than 0 volt.

3.2.5.1 Output Impedance - The instrumentation output impedance shall be resistive and shall not exceed 5000 ohms.

3.2.5.2 Return - The instrumentation return shall be connected to the dc return at a point external to the exposure unit and shall be completely isolated from the dc return within the positioner.

3.2.6 Power Consumption - The power consumed by the positioner shall be kept to a minimum consistent with the performance and reliability requirements of this specification. When operating, the average power consumed shall not exceed 9 watts at +28 volts dc. When not in the process of attempting to satisfy a command, the maximum power required from the +28 volts dc source shall be * watts. Any surge currents shall not exceed 1.5 amperes.

* To be supplied at a later date.

3.2.7 Electromagnetic Interference - The positioner shall meet the requirements of MIL-I-26600 for class Ib equipment. In addition to the requirements defined by MIL-I-26600, any conducted interference within a frequency range of 15-15000 cycles per second, impressed on the +28 volt dc power supply circuit by the positioner shall not exceed 0.035 ampere peak-to-peak.

3.2.8 Drive Limiting - Electrical limiting shall be provided within the positioner to ensure that it will never drive the slit plate beyond either of the two extreme operational positions.

3.2.9 Shields - Leads which carry signals having a high electromagnetic interference content shall be shielded. Shields shall be connected to the exposure unit enclosure at the originating end. The length of any fig-tail between the shield ferrule and the exposure unit exclosure shall be less than 2 inches in length. Shields shall not be used as signal carrying conductors.

3.2.10 Warm-Up Time - There shall be no warn-up time required by the positioner.

3.2.11 Power Loss - The positioner shall function in accordance with the requirements of this specification should the +28 volt dc supply be switched on or off after a given command has been satisfied. Should electrical power be removed from the positioner at any time while in the process of driving to a given position, the positioner shall meet the functional requirements of this specification when power is reapplied.

3.2.12 Drive Direction - Upon receipt of a command requiring motion, the positioner shall drive the slit plate to the commanded position by the most direct route.

3.2.13 Overshoot and Hunting - There shall be no overshoot or hunting present in the operation of the positioner which it is operating in accordance with the requirements of this specification.

3.2.14 Repositioning Capability - Should any mechanical disturbance cause the slit plate to reach a position which is beyond the outer dead bands in the encoder, the positioner shall relocate the slit plate correctly when power is reapplied. The positioners shall locate the slit plate correctly as commanded to any one of the seven operational slit positions, without the aid of the eighth (test) bit, when the slit plate is at any position.

3.3 Environmental Requirements

A complete environmental design cirteria establishing all of the levels of environment to which the payload and its components will be subjected and will be established at a later date.

3.4 Mechanical

3.4.1 External Configuration - The external configuration of the positioner shall be as shown on Eastman Kodak Company drawing _*_. The output shaft end play shall not exceed _*_ in TIR (measured at load end of shaft) when driving the load described by the load paragraph of this specification.

3.4.3 Weight - The weight of the positioner shall be kept to a minimum consistent with the size, performance and reliability requirements of this specification. In no event shall the weight exceed 3.5 pounds.

* To be supplied at a later date.

3.4.4 Parts and Materials - Parts and materials selection and control shall be in accordance with section 3.10 of Eastman Kodak Company document 401-122.

3.4.5 Finish - The surface of all positioner subassemblies shall be finished in accordance with Eastman Kodak Company standard 401-119.

3.4.5.1 Mounting Surfaces - Magnesium mounting surfaces shall be finished with Iridite No. 14 in accordance with Eastman Kodak Company drawing 405-185.

3.4.6 Identification - Each positioner shall be identified with a part number and a serial number only. The format and lettering type shall be as shown in Figure V-1.Refer to Figure V-2 for details with regard to selection of the part number and serial number. The positioner identification shall be applied and overcoated in accordance with the methods and procedures defined or referenced in 401-119. The color of the identification shall be black. The electrical connectors shall be identified as _*_ and _*_ by means of appropriate marking on the positioner adjacent to the connector. The connector identification shall be the same style, size and color lettering as that used for the positioner identification.

3.4.7 Load - The positioner shall meet the requirements of this specification when driving on inertial load with a Geneva and gear coupling system as shown on Eastman Kodak Company drawing _*_ . The maximum inertia of the load to be driven is _*_ slug ft^2. In addition to the inertial load, the positioner shall also be capable of simultaneously driving any other associated loads, such as friction and gear loads.

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* To be supplied at a later date.

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SAMPLE IDENTIFICATION

PART NO. 1400-XXX
SERIAL NO. 110000

Lettering is: Upper case, vertical Commercial Gothic 3/16 inch high.

FIGURE V-1

EXPLANATION OF NUMBERING SYSTEM

PART NO. 1400-XXX — **Kodak Part No. (Component Final Assembly No.)**

SERIAL NO. 1 10 000

- 000 — **Serial 000 thru 999**
- 10 — **Month Number (Always 2 digits, i.e. 03 etc.) (Date of Manufacture)**
- 1 — **Last digit of year (Date of Manufacture)**

The last three digits of the serial number shall begin with 000 and increase by 001 for each Assembly of a given design that is manufactured.

FIGURE V-2

3.4.8 Mounting - The positioner shall provide means for clamping the slit plate rigidly in position to avoid banding during operation of the exposure unit. During non-operational periods, the positioner shall allow no movement of the slit plate.

3.4.9 Movement - The positoner mechanism shall operate without binding or developing excessive friction which could impair its functioning throughout service life in the specified environment.

3.4.10 Positioning and Alignment - The positioner shall be aligned to the following critical dimensions and shall accurately locate the slit plate to these dimensions during the period of its required life:

(a) The metallic coating surface of the slit aperture plate shall be 0.010 ± 0.001 inch from the platen (drum) surface.

(b) The centerline of the slit openings shall be paralled with the exposure unit reference dowels within 0.002 inch.

(c) The centerline of the slit shall be 5.250 ± 0.002 inches from the centerline of the exposure unit reference dowels.

(d) When moving from one slit to another the fiducial marks shall not be displaced more than 0.003 inch in the direction of the Y axis of the exposure unit.

(e) The slit plate shall be aligned laterally so that the minus Y axis fiducial mark shall be 1.400 ± 0.015 inches from the centerline of the adjacent reference dowel.

3.4.11 Replacement - The positioner shall be designed to permit removal and installation of slit aperture plates without major disassembly of the exposure unit or removal of the exposure unit housing.

3.4.12 Interchangeability of Slit Plates - All slit plates, exclusive of engineering models, shall be completely interchangeable to permit replacement without requiring additional alignment.

3.4.13 Slit Transition Time - The positioner shall move the slit plate from one slit to an adjacent slit in less than 4 seconds upon receipt of a command.

3.4.14 Slit Aperture Plate - The slit paerture plate shall be a flat glass plate containing a total of eight slit openings comprising seven photographic slits and one test slit. The slit plate shall conform to the requirements of Eastman Kodak Company drawings *____ and *____ .

The seven photographic slits shall have the following widths:

Slit Position	Width (inch)
1	0.0292
2	0.0207
3	0.0146
4	0.0104
5	0.0073
6	0.0052
7	0.0037

3.4.15 Lubrication - Where required, all parts, subassemblies, or assemblies whether fabricated or purchased by the contractor shall be lubricated in accordance with materials specified in Eastman Kodak Company standard 401-119. Bearings shall be lubricated in accordance with Eastman Kodak Company drawing 405-144.

* To be supplied at a later date.

3.4.16 Accessibility Requirements - The positioner shall be located to permit easy accessibility for installation, adjustment, replacement and servicing of any portion of the assembly.

3.4.17 Fixtures and Accessories - The contractor shall supply necessary tools, fixtures and accessories to handle, install, replace, adjuct, align and operate the positioner or any part of the positioner.

3.5 General

3.5.1 Design Attributes - Design shall be in accordance with the requirements of Eastman Kodak Company Standard 401-119. Throughout the various stages of design, consideration shall be given to the items listed below. Items are listed in order of relative importance.

(a) Performance
(b) Reliability
(c) Fail Safe Features
(d) Light Weight
(e) Serviceability
(f) Power Consumption
(g) Flexibility

3.5.2 Manufacturing Standards - The positioner shall conform to the manufacturing standards contained in Eastman Kodak Company Standard 401-119.

3.5.3 Interchangeability - Parts and assemblies of the positioner of the same model, regardless of series designation, exclusive of "Engineering Models" shall be completely interchangeable.

3.5.4 Life

3.5.4.1 Service Life

3.5.4.1.1 Testing Life - The positioner shall have a testing life of 150 hours of ON time. During the testing life period, the positioner shall be capable of operating continuously for 5 minutes out of a 20 minute period. The positioner shall also be capable of a minimum of *____ ON and OFF operations during *____ minutes out of a *____ minute period with each on time having a minimum duration of *____ seconds.

3.5.4.1.2 Mission Life - After completion of the specified testing life, the positioner shall have a minimum mission life of *___ hours of ON time. During the mission life period, the positioner shall be capable of operating continuously for 5 minutes out of a 20 minute period. The positioner shall also be capable of a minimum of *____ ON and OFF operations during *____ minutes out of a *____ minute period, with each on time having a minimum duration of *____ seconds. The positioner shall have the above mission life when operated under any of the specified operating conditions.

3.5.4.2 Shelf Life - The positioner shall have a minimum shelf life of 24 months.

3.5.5 Reliability Requirements

(a) The contractor shall meet the reliability requirements defined in Section 3 of Eastman Kodak Company Document 401-122.

* To be supplied at a later date.

(b) The positioner shall have a minimum Mean-Time-Between-Failures of *___ hours (90 percent confidence level statistics) when operated at the maximum duty cycle defined in the Service Life paragraph of this specification.

(c) In conjunction with reliability testing as referenced in Section 3.8 of Eastman Kodak Company Document 401-122. The contractor shall make an estimate of the demonstrated equipment reliability stating the confidence level of statistics used. In lieu of this requirement, test results including running time and failures shall be supplied by the contractor.

3.5.6 Disposition of Variances - Variances from the requirements of this specification, drawings and procedures referenced herein, and Eastman Kodak Company Standard 401-119 shall require Eastman Kodak Company written approval. Vairances of all other drawings not affecting the requirements of this specification shall require contractor action only.

3.5.7 Contract Conformance - The positioner shall conform to all the requirements of this specification. All design, development, fabrication and test procedures shall conform to Eastman Kodak Company Document 401-122.

3.5.8 Safety of Personnel

3.5.8.1 Mechanical - The positioner design shall provide maximum convenience and safety to personnel when installing, operating, maintaining or replacing the positioner. No sharp projections or edges on parts or assemblies shall be permitted.

3.5.8.2 Electrical - Provisions shall be made to prevent personnel from accidentally coming in contact with voltages in excess of 40 volts, including potentials on charged capacitors, when the positioner is in its normal operating condition.

* To be supplied at a later date.

3.5.9 Positioner Mock-up - The positioner mock-up shall meet the following requirements utilizing the characteristics of the positioner design at the time of delivery.

Configuration:	The positioner mock-up shall have the external configuration and finish of the positioner and consist of machined castings or weldments of the same material. The unit need not be machined internally except to mount required components.
Weight and Center of Gravity:	The positioner mock-up shall have the mass and center of gravity of the positioner design within ± 5 percent as demostrated by weighing.
Heat Capacitance:	The positioner mock-up shall have the heat capacitance of the positioner design within ± 10 percent as demonstrated by weighing.
Power Consumption:	The positioner mock-up shall simulate the power consumption of the positioner design by dissipation in a resistor which replaces the electronics components of the positioner design. The resistor shall be selected to produce the average power dissipation of the positioner.
Electrical Connection:	Two electrical connections to the resistor shall terminate at pins *__ and *__ of the electrical connector *__ used in the positioner design.
Design:	The positioner mock-up shall be capable of meeting the qualification test levels of Section 3.3.1.

* To be supplied at a later date.

3.6 Documentary

3.6.1 Drawings - Drawings, associated lists, and documents prepared by the contractor defining the requirements of design, procurement, fabrication and assembly of the positioner shall be prepared in accordance with section 5 of Eastman Kodak Company document 401-122.

3.6.2 Specifications - The contractor shall generate material to complete performance requirements and description of the positioner contained in this specification. Such material shall be submitted to Eastman Kodak Company for written approval. The approved material shall be incorporated into the specification by Eastman Kodak Company.

3.6.3 Manual Material - The contractor shall provide manual material containing operating and maintenance information in accordance with 1.3.11 and section 6 of Eastman Kodak Company document 401-122.

3.6.4 Receiving, In-Process, and Final Inspection - Inspection reports shall be generated and maintained by the contractor. These reports shall include receiving, in-process, and final inspection reports in accordance with 2.3 and 2.5 respectively of Eastman Kodak Company document 401-122.

3.6.5 Reports - The contractor shall submit the following reports to Eastman Kodak Company. The formats and contents as applicable shall be in accordance with the referenced paragraphs and sections of Eastman Kodak Company document 401-122.

	Paragraphs	Sections
a. Technical Progress Report	1.3.6.1	
b. Red Flag Report	1.3.6.2	
c. Preliminary Design Report	1.3.6.3	
d. Major Design Report	1.3.6.4	
e. Final Design Report	1.3.6.5	
f. Performance Evaluation Report	1.3.6.6	
g. Failure Report and Failure Analysis	1.3.6.7	3.9
h. Final Technical Report	1.3.6.8	
i. Acceptance Test Report		2.12.2
j. Acceptance Inspection Report		2.12.1
k. Qualification Test Report	3.8.3.2	
l. Reliability Test Report		3.7
m. Operating Time Log	2.9	
n. Reliability Program Plan		3.3

3.6.6 Verification of Purchased Items - A certificate of compliance for purchased parts shall be provided by the contractor. This certification of compliance shall state that the manufacturer has on record data to demonstrate that the purchased part shall conform to the requirements fo the applicable Eastman Kodak Company drawing. MS and AN standard parts will not require a certificate of compliance.

3.6.7 Calibration - Records of the alignment and calibration of the positioner and all measuring and test equipment shall be generated and documented, in accordance with 2.8 of Eastman Kodak Company document 401-122.

3.6.8 Inspection and Test Procedures - Qualification, acceptance, and inspection test procedures for the positioner that demonstrate conformance to the requirements of this specification shall be prepared and documented by the contractor, in accordance with section 1.3.12 of Eastman Kodak Company document 401-122.

3.6.9 Reliability Prediction - The contractor shall provide reliability information in accordance with 3.6 of Eastman Kodak Company document 401-122.

3.6.10 Electromagnetic Interference Control Plan - An EMI control plan in accordance with MIL-I-26600 Class Ib shall be prepared and submitted for Eastman Kodak Company approval with the Preliminary Design Report of 1.3.6.3, Eastman Kodak Company document 401-122.

3.7 Design Review

3.7.1 Design Review Check Lists - Design Review check lists shall be completed by the subcontractor and supplied in reproducible form to Eastman Kodak Company prior to the associated design review meetings.

3.7.2 Design Review Meetings - Design review meetings shall be held in accordance with section 3.11 and the design reviews of Table 1-1 of Eastman Kodak Company document 401-122.

4. QUALITY ASSURANCE PROVISIONS

The quality control system requirements of MIL-Q-9858, and section 2 of Eastman Kodak Company documents 401-122 shall apply. Testing of the positioner shall be limited to provisions listed in this section.

4.1 Classification of Tests

The inspection and testing of the positioner shall be classified as follows:

(a) Qualification Tests

(b) Acceptance Tests

4.2 Qualification Tests

Qualification testing of the positioner shall be in accordance with section 3.8.3 of Eastman Kodak Company document 401-122. The contractor shall conduct a qualification testing program to demonstrate the capability of the design to meet the qualification levels of section 3.3.1. The qualification test procedure of section 3.6.8 of this specification shall be followed. The qualification test shall include but not be limited to the following:

4.2.1 Visual Inspection - All parts, subassemblies, and assemblies shall be inspected for conformance to the manufacturing standards of Eastman Kodak Company standard 401-119.

4.2.2 Drawing Conformance - All parts, subassemblies, and assemblies shall be inspected for conformance to their respective drawings.

4.2.3 Performance Tests - The positioner shall be tested for its ability to comply with the performance requirements of sections 3.2 , 3.4 and 3.5.

4.2.4 Environmental Qualification Tests - The positioner shall be subjected to the environmental levels of section 3.3.1. Subjecting the positioner to the specified environmental conditions separately shall be considered adequate in lieu of testing all possible or probable combinations except for the operation portion where worst case combinations shall be used. Following completion of these tests, the positioner shall be visually inspected for damage, and the performance tests of 4.2.3 shall be repeated. Any impairment of performance of the positioner shall be reported in accordance with item g. of 3.6.5.

4.2.5 Life Test - The positioner shall be tested for its ability to meet the service life requirements of 3.5.4.1.

4.3 <u>Acceptance Tests</u>

Accpetance testing of the positioner shall be part of the task and follow the acceptance test procedure in accordance with 2.11 of Eastman Kodak Company document 401-122. The acceptance tests shall include but not be limited to:

4.3.1 Visual Inspection - All parts, subassemblies, and assemblies shall be inspected for workmanship, cleanlinesses, and wiring.

4.3.2 Drawing Conformance - All parts, subassemblies and assemblies shall be inspected for conformance to their respective drawings.

4.3.3 Performance Test - The positioner shall be tested for its ability to meet all the performance requirements that are defined in sections 3.2 and 3.4 of this specification. The positioner shall meet foregoing requirements both before and after being subject to acceptance test vibration of 4.3.4.

4.3.4 Vibration Tests - The positioner shall be tested for its ability to meet the vibration requirements of 3.3.2.

4.4 Test Conditions

The atmospheric conditions for all tests shall be within the environmental ranges specified in section 3.3 except as required in 4.2.4.

4.5 Monitoring and Technical Surveillance

Eastman Kodak Company reserves the right to have technical representatives visit the contractor's facilities periodically to maintain technical surveillance of the contract. Eastman Kodak Company reserves the right to have technical representatives in residence at the contractor's facilities, if conditions warrant.

4.6 Sampling

Not required for this specification.

5. PREPARATION FOR DELIVERY

5.1 Shipping, Handling, and Storage

Each positioner shall be cleaned, labeled, sealed, with its identification in a transparent plastic bag, and packaged in a fitted, padded box. It shall be the responsibility of the contractor to insure that the packing and packaging provides adequate protection for the positioner to withstand the environmental conditions specified in the shipping handling environmental requirements of 3.3.1.3. It shall also be the responsibility of the contractor to insure that the specified environmental conditions are not exceeded prior to receipt of the positioner by Eastman Kodak Company.

6. NOTES

6.1 Applicability

Details of intended use are not required for this specification.

NOTICE

When Government drawings, specifications or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished or in any was supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

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APPENDIX W

Preliminary Specification

for

VIEW-PORT DOOR SERVO MECHANISM

Specification No. __________

Prepared by
EASTMAN KODAK COMPANY
Advanced Development Projects Group
Apparatus and Optical Division
Rochester, New York

Original Signed by:
Prepared by: ______________________________

Reviewed by: ______________________________

Approved by: ______________________________

Release Date: ______________

Revision	Pages Affected	Date	Approved by

Preliminary Specification

VIEW-PORT DOOR SERVOMECHANISM

Specification No. *______

Release Date: *__________

1. SCOPE, MISSION AND TASK

1.1 Scope - This specification defines the View-Port Door Servomechanism hereinafter referred to as VPDS. It includes the performance and environmental requirements, and defines the quality assurance provisions required to determine compliance of the VPDS with these requirements.

1.2 Mission - It shall be the mission of the VPDS to open or close the view-port door upon receipt of a one bit command word.

1.3 Task - The required task is to design, develop, manufacture, test, and deliver to Eastman Kodak Company a VPDS and a VPDS mock-up which complies with the requirements defined in this specification.

2. APPLICABLE DOCUMENTS

2.1 General

The following specifications, standards, drawings, and publications of latest issue in effect on date of invitation for bids, form a part of this specification. Applicability of the listed documents shall depend on their specific reference in this specifications. In the event of conflict between the listed documents and this specification, this specification shall take precedence.

SPECIFICATIONS

Military

MIL-Q-9858 Quality Control System Requirements

MIL-I-26600 — Interference Control Requirements, Aeronautical Equipment

Eastman Kodak Company

401-113 — Reliability Preferred Parts List

STANDARDS

Eastman Kodak Company

401-119 — Design and Manufacturing Standards

DRAWINGS

Eastman Kodak Company

405-130 — Procedure for Iridite No. 15 on Magnesium

405-152 — Procedure for Aluminizing Aluminum, Magnesium and Polystyrene Parts.

405-185 — Procedure for Iridite No. 14 on Aluminum

OTHER PUBLICATIONS

Eastman Kodak Company

401-122 — Technical Requirements for Contracts

2.2 Control Drawings - There are no applicable control drawings.

3. REQUIREMENTS

3.1 Definitions - The equipment required by this specification consists of the following:

a. View-Port Door Servomechanism (VPDS).

b. VPDS Mock-up.

3.1.1 View-Port Door Servomechanism - The VPDS shall consist basically of a driving mechanism with its associated control circuitry.

3.1.2 VPS Mock-up - The VPDS Mock-up is a unit which simulates the average power consumption and heat dissipation of the VPDS. It also has the external configuration, finish, weight, and center of gravity of the VPDS. The requirements of the VPDS mock-up shall be in accordance with section 3.5.9.

3.2 Electrical

3.2.1 Connector - The connector used on the VPDS shall be a Deutsch DTKH* .

3.2.2 Connector Pin Assignments - The connector pin assignments shall be as tabulated below:

Function	Pin
+28 volt dc supply	*
28 volt return	
+5 volt dc supply	
5 volt return	
Command Bit N.O.	
Commoand Bit Common	
Instrumentation Ouput	

3.2.3 Leakage - The dc resistance between any electrical connection, except shields and dc motor leads, and the chassis of the VPDS shall be 100 megohms minimum with an applied voltage of 100 volts dc ±10 percent. The dc resistance between any motor lead and chassis shall be 50,000 ohms minimum with an applied voltage of 100 volts ±10 percent.

3.2.4 Inputs - The VPDS shall meet the requirements of this specification when supplied with the following inputs:

3.2.4.1 Power - a) $+28 \begin{smallmatrix}+3 \\ -3\end{smallmatrix}$ volts dc

b) +5 ±0.05 volts dc

The +5 volt supply shall only be used to power the instrumentation circuit.

The VPDS shall be capable of withstanding input voltages as high as 32 volts without permanent performance degradation.

The digital signals used to drive the VPDS to any are of the two required positions shall be supplied from an external source. The command word shall contain a one binary bit.

3.2.4.2 Commands - The command bit shall be supplied on three wires from a set of single pole double throw contacts. A binary ZERO or OFF shall be presented as a closed circuit (resistance less than 1 ohm) between the common terminal and the normally closed terminal of a set of contacts. A binary ONE or ON shall be presented as a closed circuit (resistance less than 1 ohm) between the common terminal and the normally open terminal of a set of contacts. The contact rating of the command switches shall be one ampere (resistive load) at 50 volts dc.

3.2.4.2.1 ON-OFF Command - When a binary one (an ON command) is received, the VPDS shall release the motor brake and the output shaft shall supply a torque satisfying the load requirements specified in section 3.4.7. When the command input reverts to a binary ZERO (an OFF command) , the VPDS shall continue to supply torque in accordance with the requirements of section 3.4.7 until the ON command has been satisfied, i.e., the required load position has been reached, or until the overload protection, as described in paragraph 3.2.8, deenergizes the drive motor.

In no instance, however, shall an OFF command begin circuit operation.

The time relationship between the ON and OFF commands shall be such that the OFF command is always received before the commanded load position has been satisfied.

3.2.5 Instrumentation - A 0 to +5 volt dc output shall be provided to indicate the VPDS output shaft position to within ± 9 degrees of the actual shaft position. In no instance shall the output voltage exceed +5.0 volts or be less than 0 volt.

3.2.5.1 Output Impedance - The instrumentation output impedance shall be resistive and shall not exceed 5000 ohms.

3.2.5.2 Return - The instrumentation return shall be connected to the dc return at a point external to the VPDS and shall be completely isolated from the dc return within the VPDS.

3.2.6 Power Consumption - The power consumed by the VPDS shall be kept to a minimum consistent with the performance and reliability requirements of this specifications. When operating, the average power consumed shall not exceed 9 watts at +28 volts dc. When not in the process of satisfying a command, the maximum power required from the +28 volt dc source shall not exceed * watts. Any surge current shall not exceed * amperes.

3.2.7 Electromagnetic Interference - The VPDS shall meet the requirements of MIL-I-26600 for Class Ib equipment. In addition to the requirements defined by MIL-I-26600, any conducted interference, within a frequency range of 15-15000 cycles per second, impressed on the +28 volt dc power supply circuit by the VPDS shall not exceed 0.035 ampere peak-to-peak.

* To be supplied at a later date.

3.2.8 Overload Protection - A means shall be provided within the VPDS that will disable the drive, within a time range of 5 to 8 seconds after the command was applied, if the command has not been satisfied by that time. The drive shall be disabled in a manner such that essentially no power is required other than that required by the instrumentation and reference diode circuits.

The overload circuit shall be self-reset whenever a new one input command is applied.

The overload circuit timing cycle shall be self-reset within a period of 5 second after the drive has been disabled either due to overload circuit operation or stopping as a result of satisfying a command.

3.3 Environmental Requirements

A complete environmental design criteria establishing all of the levels of environment to which the payload and its components will be subjected will be established at a later date.

3.4 <u>Mechanical</u>

3.4.1 External Configuration - The external configuration of the VPDS shall be as shown on Eastman Kodak Company drawing * .

3.4.2 Output Shaft - The VPDS output shaft configuration shall be as shown on Eastman Kodak Company drawing * . The output shaft end play shall not exceed ____ in. and the output shaft eccentricity shall not exceed * in. TIR (measured at load end of shaft) when driving the load described by the load paragraph of this specification.

3.4.3 Weight - The weight of the VPDS shall be kept to a minimum consistent with the size, performance and reliability requirements of this specification. In no event shall the weight exceed * pounds.

3.4.4 Parts and Materials - Parts and material selection and control shall be in accordance with Section 3.10 of Eastman Kodak Company document 401-122.

3.4.5 Finish

3.4.5.1 Mounting Surfaces - Magnesium mounting surfaces shall be finished with Iridite No. 15 in accordance with Eastman Kodak Company drawing 405-130. Aluminum mounting surfaces shall be finished with Iridite No. 14 in accordance with Eastman Kodak Company drawing 405-185.

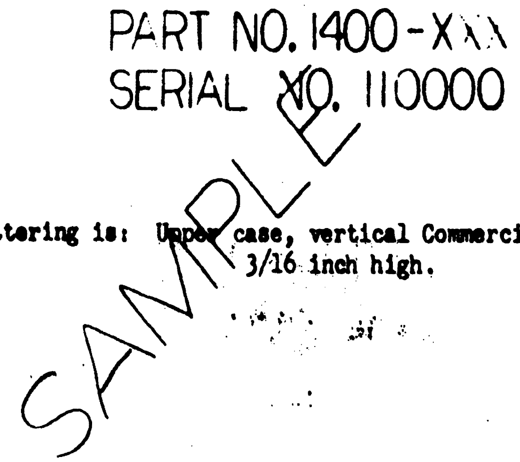
3.4.5.2 Exterior Surfaces - All exterior housing surfaces, except mounting surfaces, shall be finished in accordance with Eastman Kodak Company drawing No. 405-152.

3.4.6 Identification - Each VPDS shall be identified with a part number and a serial number only. The format and lettering type shall be as shown in Figure W-1. Refer to Figure W-2 for details with regard to selection of the part number and serial number. The VPDS identification shall be applied and overcoated in accordance with the methods and procedures defined in 401-119. The color of the identification shall be black. The electrical connector shall be identified as _____ by means of appropriate marking on the VPDS housing adjacent to the connector. The connector identification shall be the same style, size and color lettering as that used for the VPDS identification.

SPECIAL HANDLING

~~SECRET~~

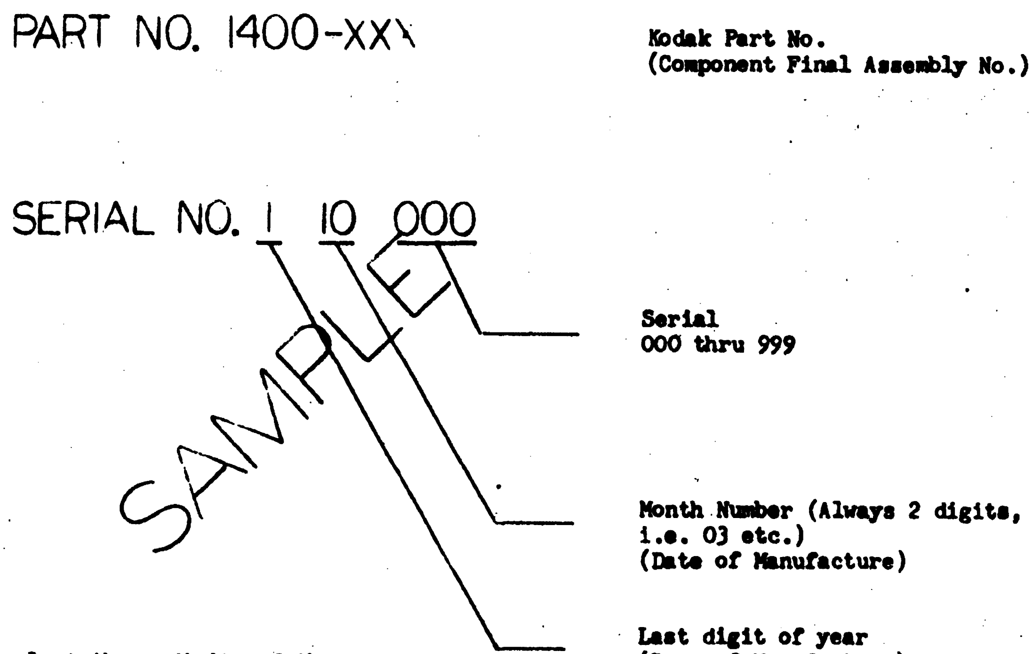
SAMPLE IDENTIFICATION



Lettering is: Upper case, vertical Commercial Gothic 3/16 inch high.

Figure W-1

EXPLANATION OF NUMBERING SYSTEM



The last three digits of the serial number shall begin with 000 and increase by 001 for each Assembly of a given design that is manufactured.

Figure W-2

3.4.3 Weight - The weight of the VPDS shall be kept to a minimum consistent with the size, performance and reliability requirements of this specification. In no event shall the weight exceed * pounds.

3.4.4 Parts and Materials - Parts and material selection and control shall be in accordance with Section 3.10 of Eastman Kodak Company document 401-122.

3.4.5 Finish

3.4.5.1 Mounting Surfaces - Magnesium mounting surfaces shall be finished with Iridite No. 15 in accordance with Eastman Kodak Company drawing 405-130. Aluminum mounting surfaces shall be finished with Iridite No. 14 in accordance with Eastman Kodak Company drawing 405-185.

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3.4.7 Load - The VPDS shall meet the requirements of this specification when driving an inertial load with a Geneva coupling system as shown on Eastman Kodak Company Drawing * . The maximum inertia of the load to be driven is * slug $ft.^2$. In addition to the inertial load, the VPDS shall also be capable of simultaneously driving any other associated loads, such as friction, and gear loads.

3.4.8 Shaft Positioning - A binary ONE input shall cause the output shaft of the VPDS to travel to one of two positions. The two output shaft positions corresponding to the input command shall be 0 degree (reference) and 180 degrees.

3.4.9 Positioning Accuracy - The two actual output shaft positions of the VPDS shall be attained within ± 1 degree of the required position.

3.4.10 Output Shaft Rotation - The input command shall cause the VPDS output shaft to rotate in a clockwise direction when viewed from the load end of the shaft.

3.4.11 Transition Time - The VPDS shall be capable of driving the load from either position to the other within a maximum of 4 seconds after receipt of the input command.

3.4.12 Overshoot and Hunting - There shall be no overshoot or hunting present in the operation of the VPDS while it is operating in accordance with the requirements of this specification.

3.4.13 Repositioning Capability - If input electrical power is present, the VPDS shall return its output shaft to within the specified positioning tolerance should any external mechanical disturbance cause the shaft to rotate after the desired position has been reached.

3.4.14 Leak Rate - The VPDS shall be a sealed package. It shall be designed so that it can be purged at any time with a known gas mixture to measure the leak rate. A charging port shall be located as shown on Eastman Kodak Company Drawing No. * .

The gas mixture used for leak rate measurement shall contain 10 percent ±2 percent helium by volume. The exact purging mixture shall be specified on the final assembly drawing.

The VPDS shall be capable of operating in accordance with the requirements of this specification with the helium mixture in it, thus eliminating the need for opening the VPDS after a leak rate test has been completed.

The VPDS shall be leak tested prior to delivery to Eastman Kodak Company. It shall be delivered to Eastman Kodak Company with the helium mixture in it at a nominal pressure of one atmosphere.

3.4.15 Position Centering - A means shall be provided to indicate when the VSDP output shaft has been positioned to within ±0.1 degree of the nominal center of the 0 degree (reference) shaft position. This may consist of index marks on the shaft and housing which, when aligned, correspond to the desired position, or some similar method.

3.5 General

3.5.1 Design Attributes - Design shall be in accordance with the requirements of Eastman Kodak Company Standard 401-119. Throughout the various stages of design, consideration shall be given to the items listed below. Items are listed in order of relative importance.

(a) Performance
(b) Reliability
(c) Fail Safe Features
(d) Light Weight
(e) Serviceability
(f) Power Consumption
(g) Flexibility

3.5.2 Manufacturing Standards - The VPDS shall conform to the manufacturing standards contained in Eastman Kodak Company Standard 401-119.

3.5.3 Interchangeability - Parts and assemblies of the VPDS of the same model, regardless of series designation, exclusive of "Engineering Models" shall be completely interchangeable **when updated to the latest revisions.**

3.5.4 Life

3.5.4.1 Service Life -

3.5.4.1.1 Testing Life - The VPDS shall have a testing life of * hours of ON time. During the testing life period, the VPDS shall be capable of operating continuously for * minutes out a * minute period. The VPDS shall also be capable of a minimum of * ON and OFF operations during * minutes out of a * minute period with each on time having a minimum duration of * seconds.

3.5.4.1.2 Mission Life - After completion of the specified testing life, the VPDS shall have a minimum mission life of * hours of ON time. During the mission life period, the VPDS shall be capable of

* To be supplied at a later date.

operating continuously for * minutes out of a * minute period. The The VPDS shall also be capable of a minimum of * ON and OFF operations during * minutes out of a * minute period, with each on time having a minimum duration of * seconds. The VPDS shall have the above mission life when operated under any of the specified operating conditions.

3.5.4.2 Shelf Life - The VPDS shall have a minimum shelf life of 24 months.

3.5.5 Reliability Requirements -

a. The contractor shall meet the reliability requirements defined in Section 3 of Eastman Kodak Company Document 401-122.

b. The VPDS shall have a minimum Mean-Time-Between-Failures of * hours (90 percent confidence level statistics)when operated at the maximum duty cycle defined in the Service Life paragraph of this specifications.

c. In conjunction with reliability testing, as referenced in Section 3.8 of Eastman Kodak Company Document 401-122, the contractor shall make an estimate of the demonstrated equipment reliability stating the confidence level of statistics used. In lieu of this equipment, test results including running time and failures shall be supplied by the contractor.

3.5.6 Disposition of Variances - Variances from the requirements of this specification, drawings and procedures referenced herein, and from Eastman Kodak Company Standard 401-119 shall require Eastman Kodak Company written approval. Variances of all other drawings not affecting the requirements of this specifications shall require contractor action only.

3.5.7 Contract Conformance - The VPDS shall conform to all the requirements of this specification. All design, development, fabrication, and test procedures shall conform to Eastman Kodak Company Document 401-122.

3.5.8 Safety of Personnel

3.5.8.1 Mechanical - The VPDS design shall provide maximum convenience and safety to personnel when installing, operating, maintaining or replacing the VPDS. No sharp projections or edges on parts or assemblies shall be permitted.

3.5.8.2 Electrical - Provisions shall be made to prevent personnel from accidentally coming in contact with voltages in excess of 40 volts, including potentials on charged capacitors, when the VPDS is in its normal operating conditions.

3.5.9 VPDS Mock-up - The VPDS mock-up shall meet the following requirements utilizing the characteristics of the VPDS design at the time of delivery.

Configuration:	The VPDS mock-up shall have the external configuration and finish of the VPDS and consist of machined castings or weldments of the same material. The unit need not be machined internally except to mount required components.
Weight and Center of Gravity:	The VPDS mock-up shall have the mass and center of gravity of the VPDS design within ±5 percent as demonstrated by weighing.
Heat Capacitance:	The VPDS mock-up shall have the heat capacitance of the VPDS design within ±10 percent as demonstrated by calculation.

Power Consumption:	The VPDS mock-up shall simulate the power consumption of the VPDS design by dissipation in a resistor which replaces the electronics components of the VPDS design. The resistor shall be selected to produce the average power dissipation of the VPDS.
Electrical Connection:	Two electrical connections to the resistor shall terminate at pins __*__ and __*__ of the electrical connector __*__ used in the VPDS design.
Design:	The VPDS mock-up shall be capable of meeting the qualifications test levels of Section 3.3.1.

3.6 Documentary.

3.6.1 Drawings - Drawings, associated lists, and documents prepared by the contractor defining the requirements of design, procurement, fabrication and assembly of the VPDS shall be prepared in accordance with section 5 of Eastman Kodak Company document 401-122.

3.6.2 Specifications - The contractor shall generate material to complete performance requirements and description of the VPDS contained in this specification. Such material shall be submitted to Eastman Kodak Company for written approval. The approved material shall be incorporated into the specification by Eastman Kodak Company.

* To be supplied at a later date.

3.6.3 Manual Material - The contractor shall provide manual material containing operating and maintenance information in accordance with 1.3.11 and section 6 of Eastman Kodak Company document 401-122.

3.6.4 Receiving, In-Process, and Final Inspection - Inspection reports shall be generated and maintained by the contractor. These reports shall include receiving, in-process, and final inspection reports in accordance with 2.3 and 2.5 respectively of Eastman Kodak Company document 401-122.

3.6.5 Reports - The contractor shall submit the following reports to Eastman Kodak Company. The formats and contents as applicable shall be in accordance with the referenced paragraphs and sections of Eastman Kodak Company document 401-122.

		Paragraphs	Sections
a.	Technical Progress Report	1.3.6.1	
b.	Red Flag Report	1.3.6.2	
c.	Preliminary Design Report	1.3.6.3	
d.	Major Design Report	1.3.6.4	
e.	Final Design Report	1.3.6.5	
f.	Performance Evaluation Report	1.3.6.6	
g.	Failure Report and Failure	1.3.6.7	3.9
h.	Final Technical Report	1.3.6.8	
i.	Acceptance Test Report		2.12.2
j.	Acceptance Inspection Report		2.12.1
k.	Qualification Test Report	3.8.3.2	
l.	Reliability Test Report		3.7
m.	Operating Time Log	2.9	
n.	Reliability Program Plan		3.3

3.6.6 Verification of Purchased Items - A certificate of compliance for purchased parts shall be provided by the contractor. This certifications of compliance shall state that the manufacturer has on record data to demonstrate that the purchased part does conform to the requirements of the applicable Eastman Kodak Company drawing. MS and AN standard parts will not require a certificate of compliance.

3.6.7 Calibration - Records of the alignment and calibration of the VPDS and all measuring and test equipment shall be generated and documented, in accordance with 2.8 of Eastman Kodak Company document 401-122.

3.6.8 Inspection and Test Procedures - Qualification, acceptance, and inspection test procedures for the VPDS that demonstrate conformance to the requirements of this specification shall be prepared and documented by the contractor, in accordance with section 1.3.12 of Eastman Kodak Company document 401-122.

3.6.9 Reliability Prediction - The contractor shall provide reliability information in accordance with 3.6 of Eastman Kodak Company document 401-122.

3.6.10 Electromagnetic Interference Control Plan - An EMI control plan in accordance with MIL-I-26600 Class Ib shall be prepared and submitted for Eastman Kodak Company approval with the Preliminary Design Report of 1.3.6.3, Eastman Kodak Company document 401.122.

3.7 Design Review -

3.7.1 Design Review Check Lists - Design Review check lists shall be completed by the subcontractor and supplied in reproducible form to Eastman Kodak Company prior to the associated design review meetings.

3.7.2 Design Review Meetings - Design review meetings shall be held in accordance with section 3.11 and the design review of Table 1-1 of Eastman Kodak Company document 401-122.

4. QUALITY ASSURANCE PROVISIONS

The quality control system requirements of MIL-Q-9858, and section 2 of Eastman Kodak Company documents 401-122 shall apply. Testing of the VPDS shall be limited to provisions listed in this section.

4.1 Classification of Tests - The inspection and testing of the VPDS shall be classified as follows:

a. Qualification Tests
b. Acceptance Tests

4.2 Qualification Tests - Qualification testing of the VPDS shall be in accordance with section 3.8.3 of Eastman Kodak Company document 401-122. The contractor shall conduct a qualification testing program to demonstrate the capability of the design to meet the qualification levels of section 3.3.1. The qualification test procedure of section 3.6.8 of this specification shall be followed . The qualification test shall include but not be limited to the following:

4.2.1 Visual Inspection- All parts, subassemblies, and assemblies shall be inspected for conformance to the manufacturing standards of Eastman Kodak Company standard 401-119.

4.2.2 Drawing Conformance - All parts, subassemblies, and assemblies shall be inspected for conformance to their respective drawings.

4.2.3 Performance Tests - The VPDS shall be tested for its ability to comply with the performance requirements of sections 3.2, 3.4, and 3.5.

4.2.4 Environmental Qualification Tests - The VPDS shall be subjected to the environmental levels of section 3.3.1. Subjecting the VPDS to the specified environmental conditions separately shall be considered adequate in lieu of testing all possible or probably combinations except for the operation portion where worst case combinations shall be used. Following completion of these tests, the VPDS shall be visually inspected for damage, and the performance tests of 4.2.3 shall be repeated. Any impairment of performance of the VPDS shall be reported in accordance with item g. of 3.6.5.

4.2.5 Life Test - The VPDS shall be tested ofr its ability to meet the service life requirements of 3.5.4.1.

4.3 Acceptance Tests - Acceptance testing of the VPDS shall be part of the task and follow the acceptance test procedure in accordance with 2.11 of Eastman Kodak Company document 401-122. The acceptance tests shall include but not be limited to:

4.3.1 Visual Inspection - All parts, subassemblies, and assemblies shall be inspected for workmanship, cleanlinesses, and wiring.

4.3.2 Drawing Conformance - All parts, subassemblies and assemblies shall be inspected for conformance to their respective drawings.

4.3.3 Performance Test - The VPDS shall be tested for its ability to meet all the performance requirements that are defined in sections 3.2 and 3.4 of this specification. The VPDS shall meet foregoing requirements both before and after being subject to acceptance test vibration of 4.3.4.

4.3.4 Vibration Tests - The VPDS shall be tested for its ability to meet the vibration requirements of 3.3.2.

4.4 Test Conditions - The atmospheric conditions for all tests shall be within the environmental ranges specified in section 3.3 except as required in 4.2.4.

4.5 Monitoring and Technical Surveillance - Eastman Kodak Company reserves the right to have technical representatives visit the contractor's facilities periodically to maintain technical surveillance of the contract. Eastman Kodak Company reserves the right to have technical representatives in residence at the contractor's facilities, if conditions warrant.

4.6 Sampling - Not required for this specification.

5. PREPARATION FOR DELIVERY

5.1 Shipping, Handling, and Storage - Each VPDS shall be cleaned, labeled, sealed, with its identification in a transparent plastic bag, and packaged in a fitted, padded box. It shall be the responsibility of the contractor to insure that the packing and packaging provides adequate protection for the VPDS to withstand the environmental conditions specified in the shipping handling environmental requirements of 3.3.1.3. It shall also be the responsibility of the contractor to insure that the specified environmental conditions are not exceeded prior to receipt of the VPDS by Eastman Kodak Company.

6. NOTES

6.1 Applicability - Details of intended use are not required for this specification.

APPENDIX Y

Phase I Specification

Survey Camera Payload
(Flight Model)

Specification No. 1600-106

Prepared by
EASTMAN KODAK COMPANY
Advanced Development Projects Group
Apparatus and Optical Division
Rochester, New York

Prepared by ______________________

____

____

Phase I Specification	Survey Camera Payload (Flight Model)
Specification No. 1600-106	Release Date:

1. SCOPE AND MISSION

1.1 Scope - This specification defines of the Survey Camera Payload (flight model) hereinafter referred to as the camera payload (C/P). It includes the performance and environmental requirements, and defines the quality assurance provisions required to determine compliance of the C/P with these requirements.

1.2 Mission - The C/P shall include hardware of flight configuration for the airborne portion of a satellite surveillance and mapping system capable of photographing areas of interest from the following altitudes: 30 nautical miles and 80 nautical miles. The C/P shall be capable of;

a. storing the unexposed film from launch until time of exposure,
b. exposing film in lunar orbit upon receipt of command from the spacecraft,
c. delivering the exposed film for storage to the C/P take-up cassette retrieval components for retrieval by an astronaut.

The camera payload shall include the structures and mechanisms required for orbital use of the equipment except those which are the responsibilities of other subsystems as defined in Eastman Kodak Company (EKC) specification 1600-104 (C/P-SCM interface specification). The C/P shall be capable of producing stereo pairs or continuous strip photography.

2. APPLICABLE DOCUMENTS

The following specifications, standards, drawings and publications of the latest issue in effect form a part of this specification. Applicability of the listed documents form a part of this specification. In the event of conflict between listed documents and this specification, this specification shall take precedence.

SPECIFICATIONS

Military	
MIL-E-6051C	Electrical-Electronic System Compatibility and Interface Control Requirements for Aeronautical Weapon Systems, Associated Subsystems and Aircraft
MIL-Q-9858	Quality Control Systems Requirements
MIL-I-26600	Interference Control Requirements, Aeronautical Equipment
EMI-10A	NASA Addendum to MIL-I-26600
PL-SCM Interface	
1600-104	C/P-SCM Interface Specification
Eastman Kodak Company	
1600-105	Photographic Subsystem
*	Structure Assembly
*	Exposure Unit
*	Lens Assembly
*	Supply Cassette
*	Take-up Cassette
*	Stereo Servo
*	Crab Servo
*	View-Port Door Servo
*	Focus Control Unit
*	Cables
*	Motor Speed Drive Unit
*	V/h Sensor
*	Power Control and Conversion Unit
*	Thermal Control System
*	Command Processing Unit

*To be supplied by a later revision.

*	Instrumentation Processing Unit
*	Final Product Specification
*	Target for Moving Target Assembly
*	Payload Shipping Container

STANDARDS

Military

MIL-STD-150A	Photographic Lenses

Eastman Kodak Company

401-119	Design and Manufacturing Standards

DRAWINGS

PL-SCM Interface

1600-100	C/P-SCM Mechanical Interface
1600-102	C/P-SCM Electrical Interface
1600-103	C/P-SCM Thermal Interface

Eastman Kodak Company

*	Camera Payload Assembly
*	Camera Payload Schematic Diagram
*	Film Format
*	Command Code, Film Velocity
*	Command Information, Camera Payload
*	Instrumentation Information, Camera Payload
*	Shipping Container for Camera Payload
*	Thermal Control System

OTHER PUBLICATIONS

Eastman Kodak Company

401-122	Technical Requirements for Contracts

*To be supplied by a later revision.

3. REQUIREMENTS

The detailed requirements contained in referenced component specifications shall be used as component hardware acceptance criteria. The components shall function compatibly to meet the requirements of this specification when integrated to form the camera payload assembly. The C/P shall comply with the requirements of this specification. The C/P as a subsystem shall be capable of producing high resolution photographic information.

EKC specification 1600-104 defines the interfaces which exist between the C/P and other parts of the command service module.

The requirements defined by this specification are based on maximum use of other spacecraft subsystems and, in particular, the spacecraft computer. The degree of dependence of the C/P upon other spacecraft subsystems can be revised through the use of a command/programmer adapter and, if required, an instrumentation adapter between the spacecraft and the C/P to permit operation in either an unmanned lunar orbital mirrion or any of several modified manned lunar orbital missions without requiring redesign or modification of the C/P.

3.1 Operating Requirements - The C/P shall provide facilities to supply, transport, expose and collect the film without significant degradation of the latent image or the film.

The combined effects of external or internal contaminants due to external environments on the film-transport enclosure, shall not alter the film characteristics beyond the following values:

Photographic speed	±0.04
Gamma	±0.05
Maximum Density	± *

*To be supplied by a later revision.

The accumulated stray light impinging on any portion of the film from external or internal light sources shall not exceed 0.01 meter-candle-second during transport or storage in the C/P. Stray light fogging is allowable within two inches of a positioned slit in the aperture plate between periods of photography.

The physical characteristics of the film shall not be degraded by mottling, scratches, digs, film-layer adherence, static discharge or water streaks. Where affects in the above area are noted, EKC shall make final judgement on design adequacy.

The C/P consists of the following major assemblies: exposure unit, lens assembly, film-handling system, stereo, crab, and view-port door servos, structure, focus control unit, motor speed drive unit, V/h sensor, power control and conversion unit, command processing unit, instrumentation processing unit, thermal-control system and cables required to electrically connect the components.

3.1.1 Exposure Unit - The exposure unit shall control C/P photography by maintaining the film in the image plane and controlling exposure time. The exposure unit shall move film past a slit opening in an aperture plate to produce latent images on the film for either stereo or continuous photographic modes of operation. The exposure unit shall record data signals from external sources on the edge of the film. The exposure unit and its operational requirements shall be in accordance with EKC specification *. The exposure unit includes the following principal assemblies:

a. Film Drive
b. Programmable Slit
c. Data Recording
d. Focus Detector
e. Focus Drive

*To be supplied by a later revision.

3.1.1.1 Film Drive - The film-drive roller is driven by a dual-range hysteresis-synchronous-motor and gear-train assembly. The film velocity is determined by the frequency of the power input to the motor and the selected gear-train ratio. Electrical power comes from the motor speed drive (MSD) unit of 3.1.6 and provides drive power at * selectable frequencies having 0.5 percent or smaller increments and ranging from 200* to 500** cycles per second. The film drive shall move the film in synchronism with the ground image with sufficient accuracy to prevent image degradation, due to banding and smear, as specified in 3.2.1.3. At the C/P subsystem test level the average film velocities shall be within 0.2 percent of the values of EKC drawing *.

3.1.1.2 Slit-Aperture Plate Positioning - The slit-aperture plate shall be capable of being positioned at any of eight available slits; four at 30 nautical miles and three at 80 nautical miles, plus one additional slit which is provided for ground testing. The exposure unit shall include a visual indicator to designate which slit is in operating position. The four available photographic slits for use at 30 nautical miles altitude shall have nominal widths of 0.0292, 0.0207, 0.0146, and 0.0104 inch. The three available photographic slits at 80 nautical miles altitude shall have nominal widths of 0.0073, 0.0052, 0.0037 inch. The appropriate photographic slit at each altitude shall be selected by commands generated by the C/P or received from the command service module.

The test slit will be programmed using a command word, which will be available only through use of the test console or the portable test set. Slit plate position shall be indicated by slit-position instrumentation. The slit positioner shall be in accordance with EKC specification *.

*To be supplied by a later revision.
**Values subject to revision.

3.1.1.3 Data Recording - Two data tracks for COD38 and COD39 time signals shall be recorded on the film as defined in EKC drawing *. Two amplifiers, 3.1.11, shall amplify the two time signals to expose the data track portion of the film by means of two data lamps.

3.1.1.4 Focus Drive Assembly - The focus control system shall provide continuous bidirectional focus adjustment for the exposure unit as indicated by the focus detector assembly. The focus detector assembly is primarily an optical unit producing an electrical output related to the focus condition of the exposure unit. The focus control unit, 3.1.7, processes this electrical output to produce an electrical signal indication of direction of platen movement to improve focus. The focus drive assembly converts the electrical signal to mechanical movement of the platen. Focus direction conventions are as follows: The forward drive direction of platen movement is away from the lens and in the plus Z axis direction, the reverse drive direction is toward the lens and in minus Z axis direction. Nominal focus for the exposure unit shall be as defined in 3.1.2.1. Electrical stops shall be provided to limit platen motion to 0.010 inch in either direction from nominal focus position. The activation of the electrical stop shall not prevent the platen from being operated in the opposite direction.

3.1.1.4.1 Instrumentation Output - Platen position instrumentation consists of two continuous rotation potentiometers mechanically coupled to the exposure unit platen. The two potentiometers are coupled together by a 5:1 ratio gearing, consequently one degree of rotation of the first or coarse potentiometer results in five degrees of rotation of the second or fine potentiometer. The voltage versus platen position relationships of TSP19 and TSP20 shall be as defined in 3.4.3.1.

3.1.1.5 Focus Detector Assembly - The focus detector shall process a portion of the optical input of the exposure unit through a reticle and focus shifter disc to a photocell.

*To be supplied by a later revision.

3.1.1.5.1 Optical Input - The optical input to the focus detector assembly shall pass through the C/P optical system. This optical input for the purpose of testing shall have the following characteristics.

3.1.1.5.1.1 Spectrum - The spectral content of the optical input shall conform to that of a 6050°K black body radiator over the range from 0.5 to 0.7 microns.

3.1.1.5.1.2 Luminance Range - The maximum scene luminance shall be defined as approximately 1,900 foot-lamberts. The average minimum scene luminance shall be approximately 600 foot-lamberts.

3.1.1.5.1.3 Scene Content - The optical input scene content shall be the random dot pattern generated by flashed sheet of film enlarged 15 times. The density range of the pattern shall be 0.70 ± 0.2 with a film base plus gross fog density of 0.1 ± 0.1.

3.1.1.5.1.4 Scene Content Motion - The image of the scene shall move across the reticle at a nominal velocity of 2.06 inches per second for a lens-to-object distance of 30 nautical miles and of 0.71 inches per second for a lens-to-object distance of 80 nautical miles. Image motion shall be parallel to the X axis of the camera payload.

3.1.1.5.2 Reticle - The focus detector assembly shall contain one ruled reticle. The reticle shall have 22.5** lines per millimeter ruling.

3.1.1.6 Exposure Unit Film Path Instrumentation - Film path temperature instrumentation TSP1 shall provide an output as indicated in 3.4.3.

3.1.2 Lens Assembly - The elements of the lens assembly include both mirrors and lenses. The elements are; the stereo mirror, the meniscus lens, the primary mirror, the diagonal mirror and a group of lens elements known collectively as the field-flattener. The optical input to the exposure unit is a visual image from the lens assembly. Illumination may be variable and film exposure shall be determined by programming the appropriate slit in the aperture plate for the given illumination and film velocity.

*To be supplied by a later revision.

**Value subject to revision.

Two absolute-temperature sensors shall be provided to monitor stereo mirror cell temperature at points indicated by EKC drawing *. The instrumentation output of one sensor, TSP4 shall be as defined in 3.4.3.1. The instrumentation output of the other sensor, BIL3 shall be as defined by EKC drawing *.

3.1.2.1 Focus Requirements - The best photographic focus of the optical system shall occur within * inch of the nominal focus or midpoint of the total focus range of the exposure unit. This position shall be determined by dynamic photographic tests, 3.2.1.3, using a 300-inch collimator. The target shall meet the requirements of EKC specification * and shall have an apparent color temperature in the range of * degrees Kelvin as seen from the exit port of the collimator.

3.1.3 Film-Handling System - The film-handling system components are the film-supply cassette, exposure unit (section 3.1.1) and C/P take-up cassette.

3.1.3.1 Film-Supply Cassette - The supply cassette shall deliver film to and withdraw film from the exposure unit. The film-supply cassette shall also store and protect the film supply during all phases of operation. The supply cassette shall be capable of accepting film loaded on a flanged spool and shall contain provisions for maintaining constant tension on the film, within the section. The housing shall act as a common enclosure for loopers capable of storing sufficient film and compensating for supply, exposure unit and take-up drive differentials. A relief valve is located in the supply cassette housing skin to relieve internal pressure at a safe rate. The film-supply cassette and its operational requirements shall be in accordance with EKC specification *.

3.1.3.1.1 Film Supply - The supply cassette shall be capable of accepting 3000 feet of a Kodak high-definition aerial film on Estar thin base, 0.0030 ± 0.0003 inch thick and 9.460 ± 0.010 inches wide.

*To be supplied by a later revision.

3.1.3.1.2 Supply-Reel Brake - The supply-reel brake provides a means for maintaining film tension and a brake for the supply spool.

3.1.3.1.3 Instrumentation Output - Film supply instrumentation shall consist of supply-cassette film-path temperature, TSP24, film tension, TSP17, film quantity, coarse (1000-foot interval) TSP14, film quantity, medium (254-foot interval), TSP15 and film quantity, fine (30-foot interval), TSP16. The instrumentation outputs shall be in accordance with 3.4.3.1.

3.1.3.2 C/P Take-up Cassette - The C/P take-up cassette components shall include; the drive mechanism for film take-up, storage for exposed film during all phases of operation and the cutter. The C/P take-up cassette components and operational requirements shall be in accordance with EKC specification *.

3.1.3.2.1 Take-up Storage Capability - The take-up spool shall be capable of storing 3000 feet of film 0.0030 ± 0.0003 inch thick, 9.460 ± 0.010 inches wide. This take-up spool contained within the take-up cassette shall be removable from the C/P take-up components.

3.1.3.2.2 Take-Up Drive - The take-up-spool drive mechanisms shall be capable of taking up film as released to it by the film supply cassette and of maintaining film tention at the film supply release point.

3.1.3.2.3 Instrumentation Outputs - C/P take-up cassette instrumentation shall consist of sensors to measure take-up motor current, TSP27, and retrieval-cassette film-path temperature, TSP2. The instrumentation outputs shall be in accordance with 3.4.3.1.

3.1.3.3 Starting and Stopping Transients - Film velocity shall be in accordance with 3.1.1.1, 0.5** seconds after receipt of the camera ON command. The total quantity of film advanced through the camera after receipt of the camera OFF command shall be limited to * inches.

*To be supplied by a later revision.

**Number subject to revision.

3.1.4 Servos

3.1.4.1 Stereo Servo - Stereo aiming of the C/P is accomplished by rotating the stereo mirror about an axis parallel to the C/P pitch axis subject to modification by crab adjustment. The operational requirements of the stereo servo shall be in accordance with EKC specification *.

3.1.4.1.1 Shaft Positioning - A one-bit binary-code input command shall direct the output shaft of the stereo servo assembly to move the stereo mirror to either one of two discrete positions. The two stereo mirror positions shall be +7.5° and -7.5°. Reference zero-degree stereo mirror position occurs when the stereo mirror surface is at an angle of 45° to the optical axis. The stereo mirror positions corresponding to the two input commands shall be in accordance with EKC specification *. The stereo mirror shall be positioned within a tolerance of ±0.22° root-sum-squared (RSS).

3.1.4.1.2 Repositioning Capability - The servo shall return to a command position when power is applied, if the mirror is positioned against the mechanical stops.

3.1.4.1.3 Overshooting and Hunting - There shall be no overshooting or hunting present during the operation of the stereo servo.

3.1.4.1.4 Transition Time - The stereo servo shall be capable of driving the load from one position to the other position within 4.0 seconds.

3.1.4.1.5 Instrumentation Output - The stereo servo instrumentation output shall indicate stereo mirror position as defined in 3.4.3.1.

3.1.4.2 Crab Servo - The crab servo shall be used with the stereo mirror of 3.1.2, and V/h sensor, 3.1.9, in a feedback system to maintain zero apparent yaw angle at the V/h sensor. The crab servo shall drive the stereo mirror, a position potentiometer, and an encoder. Crab motion is rotation of the

*To be supplied by a later revision.

stereo mirror with respect to the C/P about an axis parallel to the X axis. If the V/h sensor malfunctions, the V/h input shall be disconnected from the crab servo and the internal encoder shall drive the stereo mirror to a crab angle of zero-degree.

The crab servo shall compensate for apparent yaw angle change in 6 seconds or less. At no time shall the difference between yaw angle and crab angle be greater than 0.2 degrees, under control of the V/h sensor.

3.1.4.3 View-Port Door Servo (VPDS) - The view-port door servo is a digital servo which on command, controls the opening and closing of the viewport door. It is a simple d-c drive controlled by the agreement or disagreement of the input command with a code generated by a shaft encoder. The operational requirements of the view-port door servo shall be in accordance with EKC specification *.

3.1.4.3.1 Shaft Positioning - A "1" input command shall cause the output shaft of the view-port door servo to rotate either from the reference, 0-degree, to the 180-degree position or from the 180-degree position back to the reference. The door shall be closed when the output shaft is at the reference position and opened when at the 180-degree position.

A"0" input command shall not cause the circuit to operate. The two required output shaft positions of the view-port door servo shall be attained within ±1° of the required position.

3.1.4.3.2 Repositioning Capability - The servo shall return to a command position when power is applied should an external mechanical disturbance cause the shaft to rotate after the desired position has been reached.

3.1.4.3.3 Overshooting and Hunting - There shall be no overshooting or hunting present in the view-port door servo when operating in accordance with the requirements of EKC specification *.

*To be supplied by a later revision.

3.1.4.3.4 Transition Time - The view-port door servo shall be capable of driving the load from either position to the other within * seconds maximum after receipt of an input command.

3.1.4.3.5 Instrumentation Output - The view-port door servo instrumentation output shall indicate the output shaft position and be as defined in 3.4.3.1.

3.1.5 Structure - The C/P structure positions and supports the major assemblies of the C/P such as lens, stereo mirror, exposure unit, and film-handling system. The requirements of the structure shall be in accordance with EKC specification *. Absolute-temperature sensors shall be provided to monitor structure temperature at the points indicated by EKC drawing *. The instrumentation outputs of five of these sensors, TSP7, TSP8, TSP9, TSP10 and TSP11 shall be as defined in 3.4.3.1. The instrumentation output of one sensor BIL4 shall be as defined in EKC drawing *.

3.1.6 Motor Speed Drive Unit - The motor speed drive unit provides two-phase power to the film-drive system, at the specified voltage and frequency in response to binary-coded commands. The operational requirements of the motor speed drive unit shall be in accordance with EKC specification *.

3.1.7 Focus Control Unit - The focus control unit evaluates the focus condition of the C/P as reflected by the focus detector of section 3.1.1.5, and generates analog output signals which indicate the focus condition. Manual and automatic modes of focus adjustment shall be provided; the command requirements for mode selection and system operation shall be in accordance with EKC specification *. In the automatic mode the output signals shall be routed directly to the focus drive assembly of 3.1.1.4, for focus adjustment. In the manual mode, the output signals shall be routed to the real-time instrumentation processing of the command module. Focus adjustment shall be made as required by real-time command of the focus drive assembly. The focus control unit shall be in accordance with EKC specification *.

*To be supplied by a later revision.

3.1.8 Temperature Control - The temperature of the C/P shall be controlled by 13 independent heater assemblies. Each heater assembly shall consist of resistance heater elements connected to the environmental power supply by heater controllers actuated by a temperature sensitive element. The locations of heater assemblies and their power requirements shall be in accordance with EKC drawing *. The operating limits for these heater systems shall be nominal heater ON temperature 69.8F, and nominal heater OFF temperature 71.4F. Electrical circuitry shall be in accordance with portions of EKC drawing *.

3.1.9 V/h Sensor - The V/h sensor shall be capable of measuring two parameters: the forward velocity relative to height, or altitude and apparent yaw angle, in accordance with EKC specification *. The forward V/h sensing accuracy shall be ±0.5 percent or better. The apparent yaw angle sensing accuracy shall be ±0.1 degree or less from 0 to ±1 degree yaw angle and ±*° or better from ±1 to ±2 degree yaw angle for any roll rate up to 0.03 degrees per second.

3.1.9.1 V/h Input - The V/h sensor shall operate over the following ranges:

a. a V/h range of 0.0091 to 0.0364 radians/sec,
b. a yaw angle range of -2 degrees to +2 degrees,
c. a brightness range of 3 to 25 meter candles,
d. an object contrast of 1.7:1 minimum,
e. minimum object population of * objects per square nautical mile

3.1.9.2 V/h Output - The forward V/h output shall be in 9-bit parallel binary-coded format with V/h steps of 0.5 percent or less. Forward V/h output shall be supplied to the motor speed drive unit of 3.1.6. The crab correction output shall be an analog output available on two wires to the crab servo of 4.2. Positive crab shall be represented by a positive d-c voltage on one wire and zero voltage on the other wire; negative crab shall be the opposite.

*To be supplied by a later revision.

Each command bit of the forward V/h output shall be represented as follows: a binary 1 shall be plus 3 volts, a binary zero shall be zero volts. Crab correction output voltage, shall be an analog signal of 0 to plus 5 volts d-c corresponding to a yaw angle range of 0 to 2 degrees.

3.1.10 View-port Door Open Tell-Tale - This component provides an instrumentation signal to indicate the state (open or closed) of the view-port door and information relative to previous door operations. The instrumentation of TSP25 shall be as defined in 3.4.3.1.

3.1.11 Command Processing Unit - The command processing unit shall function as a junction and distribution box for all command inputs from the CP-CSM interface and command outputs distributed to C/P components. The command processing unit shall include command logic necessary to sequence C/P operations and provide switching as necessary to accommodate command inputs from the spacecraft required for backup to C/P components. The time/position data signal and 400-cps data signal shall be diplexed to provide a 400-cps time/position label and a 10-cps time/position label, which shall be data signal "A" and data signal "B", respectively, suitable for amplification and use in exposure of data tracks on the film.

3.1.12 Instrumentation Processing Unit - The instrumentation processing unit shall function as a junction and distribution box for all C/P instrumentation inputs and instrumentation outputs to the C/P-CSM interface. It shall include two differential-temperature amplifiers and such other signal conditioners as required by C/P instrumentation.

3.1.13 Power Conversion and Control Unit - The power conversion and control unit shall function as a junction and distribution box for all input C/P power wires and power wires distributed to C/P components. The unit shall provide power switching functions to operate the C/P in accordance with this specification. The unit shall include power converters and regulators as required to supply the following voltages to certain C/P components.

*To be supplied by a later revision.

a. +22.0, ±0.1 volts, dc; * amperes

b. -22.0, ±0.1 volts dc; * amperes

c. +5.0, ±0.1 volts dc; * amperes

d. +3.0, ±0.05 volts dc; * amperes

The +5.0 volt output and the +22.0 volt outputs shall be derived from the unregulated +28 volt dc operational power supply independently. The +3.0 volt output shall not be derived from the +5.0 volt power supply.

3.1.14 Cables - The cabling assemblies shall provide the appropriate connection to each electrical package and functional unit. The electrical requirements shall be in accordance with EKC specification *.

3.2 Photographic Requirements

3.2.1 Film - Measurable characteristics are:

3.2.1.1 Base Plus Gross Fog Density - The base density plus gross fog shall be less than 0.2.

3.2.1.2 Gamma - The gamma shall be *. The gamma shall be measured on the straight line portion of the H and D curve.

3.2.1.3 Resolution - The average value of the geometric mean of the horizontal and vertical resolution shall not be less than * lines/millimeter to meet the design goal and * lines/millimeter as a minimum requirement in the region ±0.5° about the optical axis (0°). Note that * and * lines/millimeter payload resolution, when combined with the smear contribution from other subsystems results in * and * feet ground resolution respectively. These requirements include the 3-sigma tolerances on the C/P components as follows:

a.	Crab Servo	±0.10 degree
b.	Film Drive Steps	±0.25 percent
c.	Film Drive Drift	±0.2 percent

*To be supplied by a later revision.

d.	Film Drive Vibration Amplitude	4 microns at 1/100 sec. exposure
e.	Stereo Servo	±0.22 degree
f.	Mirror Mounting Error (Crab)	±0.05 degree
g.	Mirror Mounting Error (Stereo)	±0.05 degree
h.	Knowledge of Focal Length	±0.1 inch
i.	V/h Crab Correction	±0.10 degree

Resolution shall be tested utilizing a 2:1 low-contrast target of the type defined in figure 7 of MIL-STD-150A. Conformance to this requirement shall be demonstrated at the following camera film velocities: *

Best photographic focus shall be determined in previbration testing by performing a minimum of three photographic focus tests at 0° and ±0.5°. The focus position resulting in the highest geometric mean (GM) common for all focus curves considered to be representative shall be defined as best focus. The average of the curves shall be a minimum of * lines/millimeter GM (average of 0 degree and ±0.5 degree) at this best focus position. This position shall be used for the remainder of the acceptance testing.

The post vibration best focus position shall be no greater than 0.0015 inch from the best focus position determined during previbration tests.

3.2.1.4 Exposure - The exposure shall be adjusted by selection of a slit width. Under the following conditions: *

3.2.1.5 Data Marks - Both sets of data marks of 3.1.1.3 shall coincide within 0.0025 inch with the picture image produced at that instant. The data marks shall be discernible by eye on processed film and shall have an exposed density of no less than 0.5 at the fastest film velocity and Δ density range between data mark and space of not less than 0.3 at the slowest film velocity, when film is processed to meet the requirements of EKC specification *

*To be supplied by a later revision.

3.2.1.6 Orientation of Image - The location of the image shall conform to the requirements of EKC drawing *. The slit aperture plate shall be oriented so that the centerline of the slit is perpendicular to the edge of the film within ±0 degree 15 minutes.

3.2.1.7 Film Abrasion - Film abrasion and degradation of film by the film handling system shall be limited by the requirement of section 3.

3.2.1.8 Film Damage - The film shall suffer no damage during payload operation which would degrade the photographic quality of the image to a level lower than that specified in EKC specification 1600-105.

3.2.1.9 Film Velocity Variation - Maximum oscillatory film velocity variations shall not exceed * percent, rms of the average velocity. The zero to peak oscillatory film velocity variation shall not exceed * percent of the average velocity two-sigma limit.

This requirement shall not apply during the start transient or during take-up motor operation.

3.2.2 Slit Plate Streaking - On film having a background density of approximately 1.0 the total width of streaks found in processed film caused by imperfections in each operational slit in the slit aperture plate shall not exceed 0.5 percent of the slit length, and no more than five streaks shall occur in any 0.100 inch width of film. No streak shall have a ΔD related to background density which exceeds that given by the equation $\Delta D = 0.51 - 24.5W$, where W is the width of the streak in inches. Only streaks having a ΔD greater than ±0.03 shall be recorded as defects.

3.3 Mechanical Requirements

3.3.1 Size - The C/P design configuration shall be capable of being totally enclosed within the space allocation as defined by EKC drawing 1600-100. The actual size and configuration of the C/P shall conform to EKC drawing *. The maximum diameter is 57 inches; length is 146 inches.

*To be supplied by a later revision.

3.3.2 Weight and Center of Gravity

3.3.2.1 Weight - The payload component assembly weight shall be as follows:

a. C/P in service module in launch condition less film 1158 pounds

b. C/P components (take-up cassette) in command module for retrieval, less film 6 pounds

c. Film (3000 feet) 55 pounds

3.3.2.2 Center of Gravity - The center of gravity of the camera payload in the launch condition including 3000 feet of film shall be located as follows with reference to station 290.75:

$\bar{X}$	-12.91 ± 1.0 inches
$\bar{Y}$	+0.88 ± 0.5 inch
$\bar{Z}$	-0.38 ± 0.5 inch

3.3.3 Reference Axes - The orientation and nomenclature of the camera payload axes are as follows:

Roll Axis X	Parallel to the longitudinal axis of the spacecraft; positive in the direction of the spacecraft velocity vector.
Yaw Axis Z	Perpendicular to the roll axis in the orbit plane; negative in the direction of the area to be photographed.
Pitch Axis Y	Defined by the right-hand rule; mutually perpendicular to the yaw and roll axes at their intersection.

Positive rotation about any of these axes shall be defined by the right-hand rule. The datum plane shall be at station 290.75 with Y and Z axes intersecting the X axis at the center of the camera payload.

3.3.4 Materials and Finishes - Materials and finishes shall be in accordance with individual parts specifications and drawings.

3.3.5 Identification - All component assemblies shall be identified in serial form. Material and letter size shall conform to individual component specifications.

3.3.6 Pressure and Leak Rate - The leak rate of the film transport enclosure shall be the maximum permissible consistent with maintaining the required performance characteristics of the parts internal to the enclosure.

3.4 Electrical Requirements

3.4.1 Payload Power - One power supply shall be required for camera payload operation and another supply for environmental control.

3.4.1.1 Operational Supply - The unregulated +28 volts dc operational supply is the primary source for the camera payload. This voltage is inverted, rectified, and regulated to provide plus and minus 22.0 ± 0.1 volts dc for various instrumentation circuits and the focus control system plus 5.0 ± 0.1 volts dc for instrumentation and plus 3.0 ± 0.05 volts dc for logic circuit operation. The normal load current is determined by the components operating at any given instant. Normal load current, during any operating period, shall not exceed 7 amperes. Maximum steady-state component-load currents shall be in accordance with table 1. Under normal operating conditions the surge current transient shall not exceed 17 amperes and this transient shall decay to normal load current in less than 0.5 second. Maximum surge current amplitude and duration for specific payload functions shall be in accordance with table II.

3.4.1.2 Environmental Supply - Environmental power of plus 28 volts dc unregulated is used for all environmental heaters within the C/P. The power consumption and operating schedule of the heater assemblies is dependent upon the translunar and orbit parameters and the service module temperature control equipment operation. The maximum steady state current drain shall be 3.6 amperes at plus 28 volts.

*To be supplied by a later revision.

TABLE I

Maximum Component Currents

(Milliamperes)

*

*To be supplied by a later revision.

TABLE II

Maximum Surge Currents

*

*To be supplied by a later revision.

Figures 2 through * Output Voltages of the Camera Payload Instrumentation*

*To be supplied by a later revision.

3.4.2 Commands - C/P commands are identified by the functions initiated by the commands. Commands shall be provided for the following functions:

Payload Power ON-OFF

Camera Operation ON-OFF

Stereo Mirror Positioning

View-Port Door Operation

Image Motion Compensation

Focus Operation

Mode of Camera Operation

Slit Plate Positioning

Film Handling Operations

Take-up Cassette Operation

Command functions shall be in accordance with applicable individual component requirement sections and in EKC drawing 1600-102.

3.4.3 Instrumentation - Instrumentation shall provide information required for commanding of the camera payload and for failure analysis. Included in this instrumentation shall be temperature transducers, stereo mirror and view-port door position-monitoring devices, film handling monitors, focus information, platen position-monitoring, and slit plate position-monitoring.

3.4.3.1 Flight Instrumentation - The flight instrumentation points shall be in accordance with EKC drawing 1600-102 and figures 2 through * . The output tolerances of figures 2 through * shall apply to C/P hardware only, and do not include errors due to commutating, recording, transmitting and measurement equipment.

*To be supplied by a later revision.

Flight instrumentation shall have the characteristics defined by EKC specification 1600-104 at the C/P-CSM interface.

3.4.3.2 Test Connector Instrumentation - The test connectors * and * shall convey command verification and instrumentation outputs. The test points shall be in accordance with EKC drawing *.

3.4.3.3 Umbilical Instrumentation - The umbilical instrumentation shall be in accordance with EKC drawing *. The umbilical instrumentation shall be maintained up to liftoff at launch. The following information shall be available via the umbilical instrumentation circuits:

- Film Tension
- Motor Speed Drive Frequency
- Stereo Mirror Temperature
- Lens Bay Temperature
- Torque Motor Command
- Master Tell-Tale Indicator

3.4.4 General

3.4.4.1 Leakage Resistance - The leakage resistance between any interface connector pin, excepting those connected to shields, and the C/P structure ground shall be 10 megohms minimum with an applied voltage of 10v dc +10 percent.

3.4.4.2 Electromagnetic Interference (EMI) - The camera payload shall be designed to meet the EMI control requirements of MIL-I-26600 for class Ib equipment and EMI-10A, the NASA addendum to MIL-I-26600. In addition, each major component of the C/P shall individually meet the requirements of MIL-I-26600 for class Ib equipment when tested as a unit. Compliance with these requirements shall be demonstrated during qualification testing only. In addition, the C/P will meet the testing requirements only of MIL-E-6051C.

*To be supplied by a later revision.

3.5 Environmental Requirements - The C/P shall meet the environmental requirements of EKC specification *.

3.6 General Requirements

3.6.1 Service Life - The service life is defined as operational or "weartime" from final C/P assembly through the flight operational phase. This includes all performance at Eastman Kodak Company and John F. Kennedy Space Center as well as flight operation.

The complete C/P shall be capable of surviving a service life utilizing 12,000 feet of film, or equivalent.

The service life of each component shall be in accordance with its applicable component specification.

3.6.2 Reliability - The reliability of the C/P shall be as high as practicable in fulfilling the objectives of the C/P mission. The reliability program shall be carried out through all phases of design, development, manufacture testing and operation and shall ensure the use of parts, materials and processes which provide good and consistent performance in compliance with the requirements of this specification.

3.6.3 Calibration - Verification of calibration of all measuring and test equipment shall be documented prior to C/P tests.

3.7 Documentary Requirements - Procedures shall be prepared and documented by EKC, defining a quality control system that shall fulfill the requirements of this specification. The documentary requirements shall include, but shall not be limited to the following:

3.7.1 Drawings - All engineering drawings and associated lists prepared for the purpose of defining those requirements of design, inspection and tests shall be prepared in accordance with EKC document 401-122.

*To be supplied by a later revision.

3.7.2 Specifications - Material shall be generated to complete the performance requirements and description of the equipment contained in this specification.

3.7.3 Inspection Reports - Inspection reports shall be generated and maintained. These reports, as well as in-process inspection, shall be made available, by EKC.

3.7.4 Certification of Items - Certification of items not manufactured or tested by EKC, shall be documented and such documentation shall be made available by EKC.

3.7.5 Calibration - Records shall be generated, documented and made available by EKC of the alignment and calibration of all measuring and test equipment.

3.7.6 Test Procedures - Qualification and acceptance test procedures for the payload that demonstrate conformance with the requirements of this specification shall be established and documented.

3.7.7 Performance Record - All data including operating time and malfunction reports, generated through tests, shall be recorded by serial number and preserved as a performance report

3.7.8 Manuals - Technical manuals of the utility level shall be prepared for the C/P.

4. QUALITY ASSURANCE PROVISIONS

The quality control system requirements of MIL-Q-9858 and Eastman Kodak Company document 401-122 shall apply. Inspection and testing of the flight model C/P shall be in accordance with provisions listed in this section.

4.1 Classification of Inspections and Tests - The inspection and testing of the C/P shall be classified as follows:

a. Acceptance Inspection

b. Acceptance Test

c. Qualification

4.2 Acceptance Inspection - The acceptance inspection shall be performed on each unit of deliverable hardware in accordance with 2.10 of Eastman Kodak Company document 401-122. The inspection procedure and report format shall be in accordance with section 2.12.1 of EKC document 401-122. The acceptance inspection shall include the following:

4.2.1 Workmanship Inspection - All parts, subassemblies and assemblies shall be inspected for conformance to the manufacturing standards of EKC standard 401-119.

4.2.2 Drawing and Specification Conformance - All parts, subassemblies and assemblies shall be inspected for conformance to their respective drawings and this specification. EKC shall submit written certification that the delivered hardware conforms to the drawings of 5.3.6 and change control procedure of 5.3.16.2 of EKC document 401-122.

4.3 Acceptance Test - The acceptance test shall be performed by the EKC on each C/P in accordance with 2.11 of EKC document 401-122. The test procedure and report format shall be in accordance with section 2.12.2 of EKC document 401-122. The acceptance tests shall include the following:

4.3.1 Performance Test - The C/P shall be tested for its ability to conform to the performance requirements of section 3.

4.3.2 Environmental Test - The C/P shall be tested to the environmental requirements of 3.5. Following completion of these tests, the payload shall be visually inspected. The performance tests of 4.3.1 shall be repeated as required.

4.3.3 EMI Test - The C/P shall be tested for its ability to conform to the EMI requirements of 3.4.5.2, to the extent deemed necessary to reasonably expect to meet the test requirements of MIL-E-6051C.

4.4 Qualification Test - A qualification test shall be conducted on one C/P to demonstrate the capability of the design to meet qualification levels of the technical specification. The C/P shall pass an acceptance inspection and an acceptance test prior to a qualification test. The qualification test procedure and report format shall comply with section 3.8.3 of EKC document 401-122 and shall include:

4.4.1 Performance Test - The C/P shall be tested for its ability to comply with the performance requirements of section 3.

4.4.2 Environmental Test - The C/P shall be subjected to the environmental requirements of 3.5. Following completion of these tests the C/P shall be visually inspected for damage, and the test of 4.4.1 shall be repeated.

4.4.3 EMI Test - The C/P shall be tested for its ability to conform to the EMI requirements of 3.4.4.2.

4.4.4 Life Test - The C/P shall be tested for compliance with service life requirements of 3.6.1.

4.4.5 Test Diagnosis - Following the qualification test, diagnosis shall be made of any impairment of the performance of the C/P. The results of the diagnosis shall be included in the qualification test report.

5. <u>PREPARATION FOR DELIVERY</u>

5.1 <u>Packing and Packaging</u>

5.1.1 The payload shall be enclosed and sealed in the shipping container as described in EKC specification *.

The packaging shall be done in accordance with the instructions supplied in drawing *.

6. <u>NOTES</u>

None required for compliance with this specification.

*To be supplied by a later revision.

NOTICE

When Government drawings, specifications or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any was supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.