CORONA TECHNICAL INFORMATION

VOLUME 2

J-3 PANORAMIC CAMERA

J-3 CAMERA SUBSYSTEM

PURPOSE

The purpose of the J-3 camera subsystem is to provide, from a reconnaissance satellite, high resolution stereoscopic photography having reconnaissance, cartographic, and geodetic evaluation capabilities.

PHYSICAL FEATURES

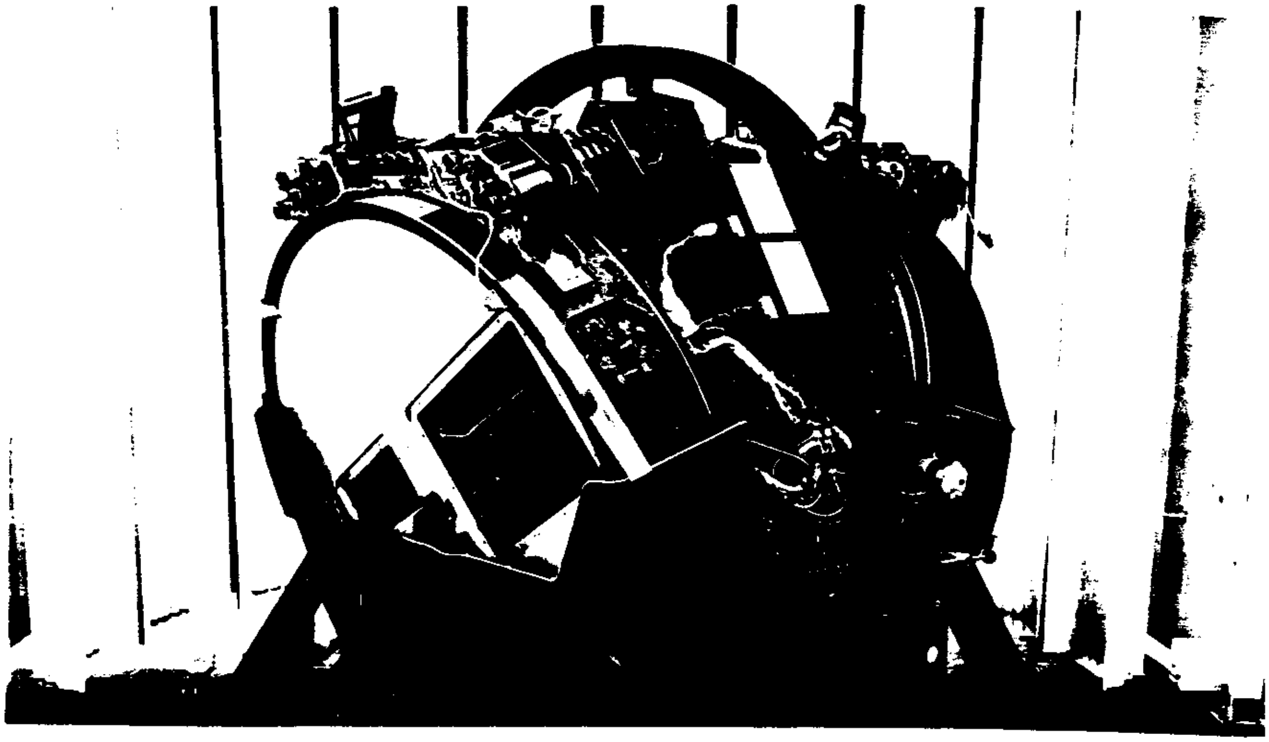
Configuration	30-degree convergent stereo panoramic cameras
Lenses	24-inch focal length, Petzval design
Films available	3404, SO-380, SO-230, SO-205, SO-121, SO-180, SO-242
Film capacity	16,000 feet of 70-mm, 3.0-mil, polyester-base film per camera
	24,000 feet of 70-mm, 2.0-mil, UTB, polyester-base film per camera
Film size (one frame)	31.632 × 2.754 inches
Usable format	29.323 × 2.147 inches

POWER

	Watt Hours 3.75 rad/sec	Watt Hours 2.5 rad/sec	Watt Hours 1.4 rad/sec
24 vdc (unregulated)	1,080	1,620	2,890
115 vac	180	270	480
Combined	1,260	1,890	3,370

OPERATIONAL FEATURES

Altitude	80 to 200 nm
Swath width	116 to 290 nm
Total forward cover	7.73 to 19.33 nm (7.6 percent overlap)



J-3 Payload

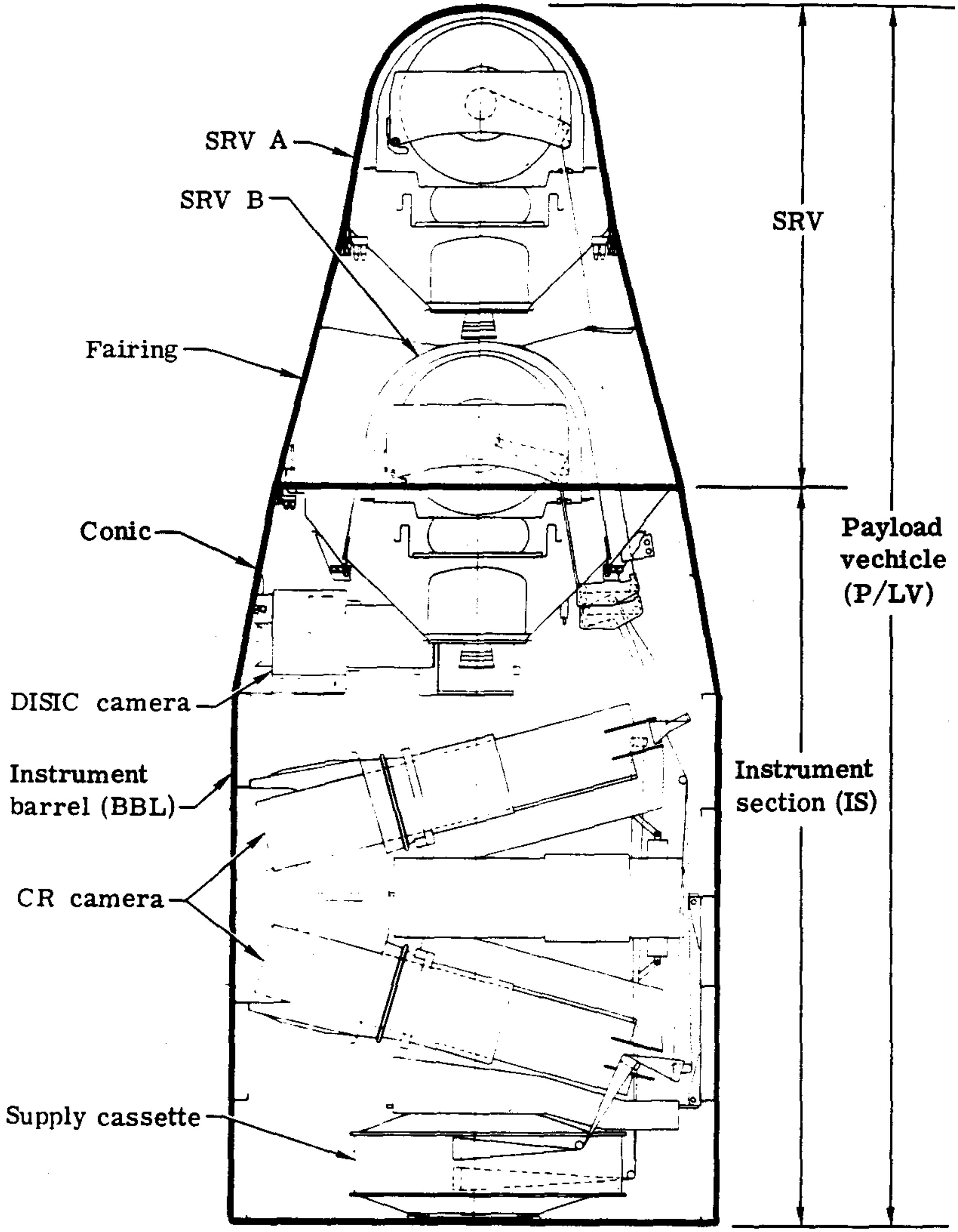
J-3

The complete J-3 system payload consists of the following:

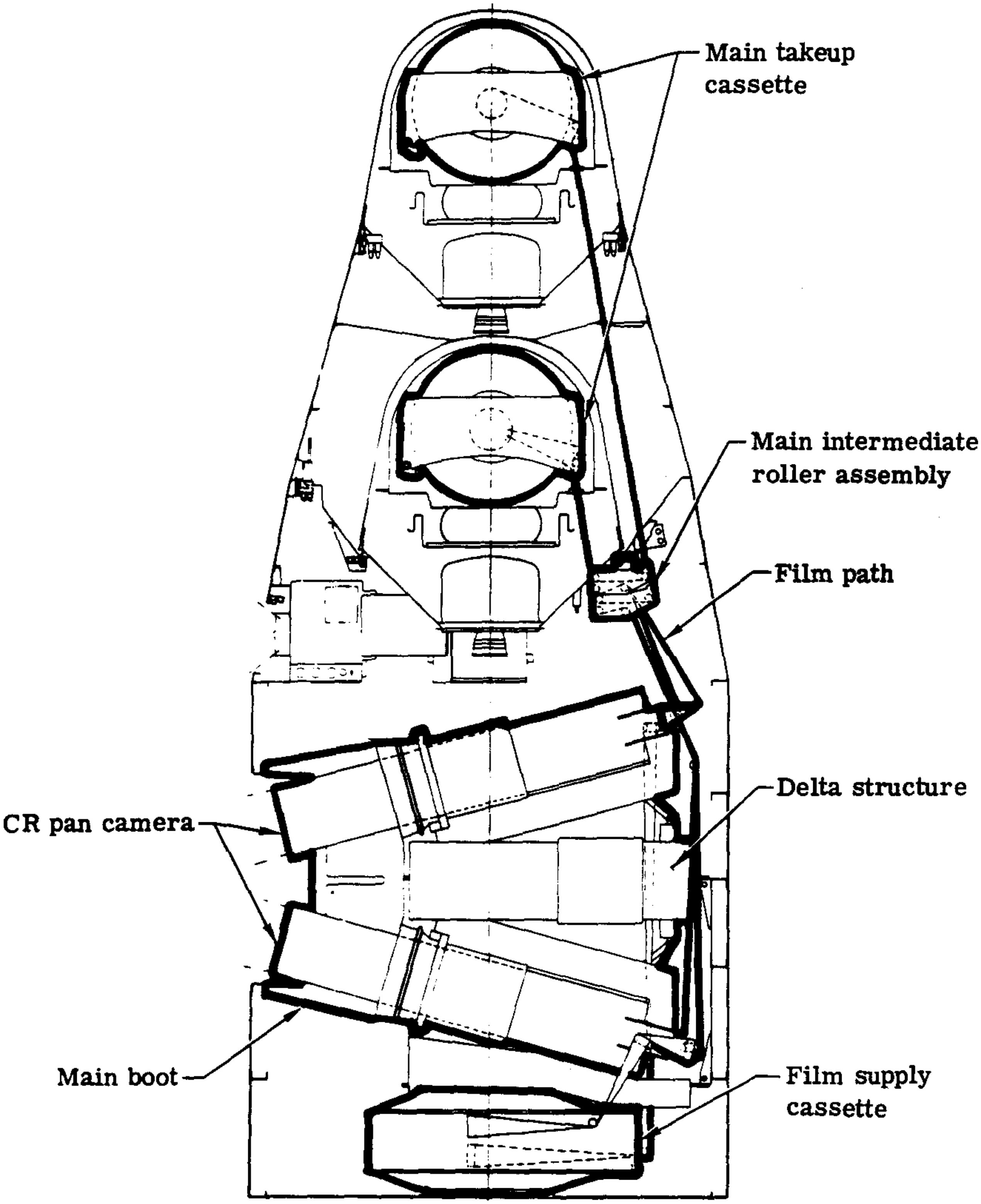
1. Two, 24-inch focal-length, f/3.5 panoramic cameras, each having two integrated 55-millimeter focal length, f/6.3 horizon optics
2. One auxiliary structure (supports both panoramic cameras and the electronics packages to form the so-called camera module)
3. One supply cassette
4. Main supply structure
5. Two takeup cassettes
6. One intermediate roller assembly.

The panoramic cameras are positioned on the auxiliary structure in a V-configuration to provide a 30-degree stereo angle. The auxiliary structure is three-point mounted to the vehicle so that the even serial-numbered camera is located forward and views toward the rear (AFT-looking), and the odd serial-numbered camera is located aft and views forward (FWD-looking). The auxiliary structure also provides the mounting surface for the system electronic packages. The supply cassette, which contains the total film supply for both cameras, is located aft of the camera module. The supply cassette is fastened to a support structure, which is, in turn, three-point mounted to the vehicle. Takeup A, located in recovery vehicle RV-1, and takeup B, located in RV-2, each take up half of the film of each camera. The intermediate roller assembly is attached to the vehicle between takeup B and the camera module.

NOMENCLATURE OF THE MAJOR SEPARABLE COMPONENTS OF THE PAYLOAD VEHICLE



MAJOR COMPONENTS OF J-3 SUBSYSTEM



EXPOSURE CONTROL SUBSYSTEM

PURPOSE

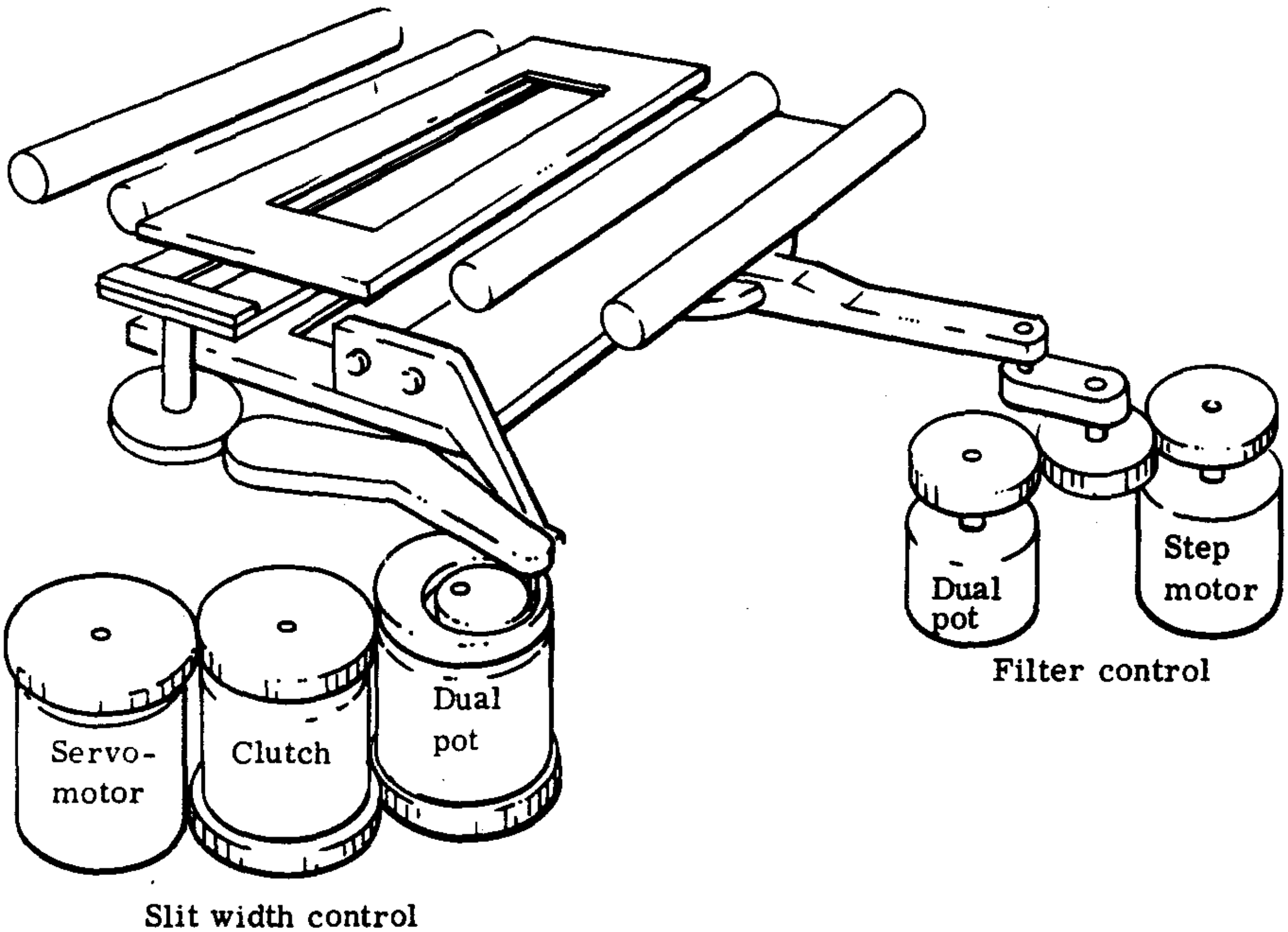
The purpose of the exposure control subsystem is to provide a controllable means of adjusting the exposure in the J-3 and DISIC cameras to be compatible with in-flight changes in film type (filter change), and with changes in target illumination as the satellite passes from night to day or day to night.

CHARACTERISTICS

The exposure control subsystem consists of the following:

1. The switch programmer
2. The four slit width positions in each J-3 instrument
3. The two filter positions in each J-3 instrument
4. The two expcsure control mechanisms in the DISIC.

SLIT WIDTH CONTROL ASSEMBLY IN SCAN HEAD



J-3 FORWARD MOTION COMPENSATION SYSTEM

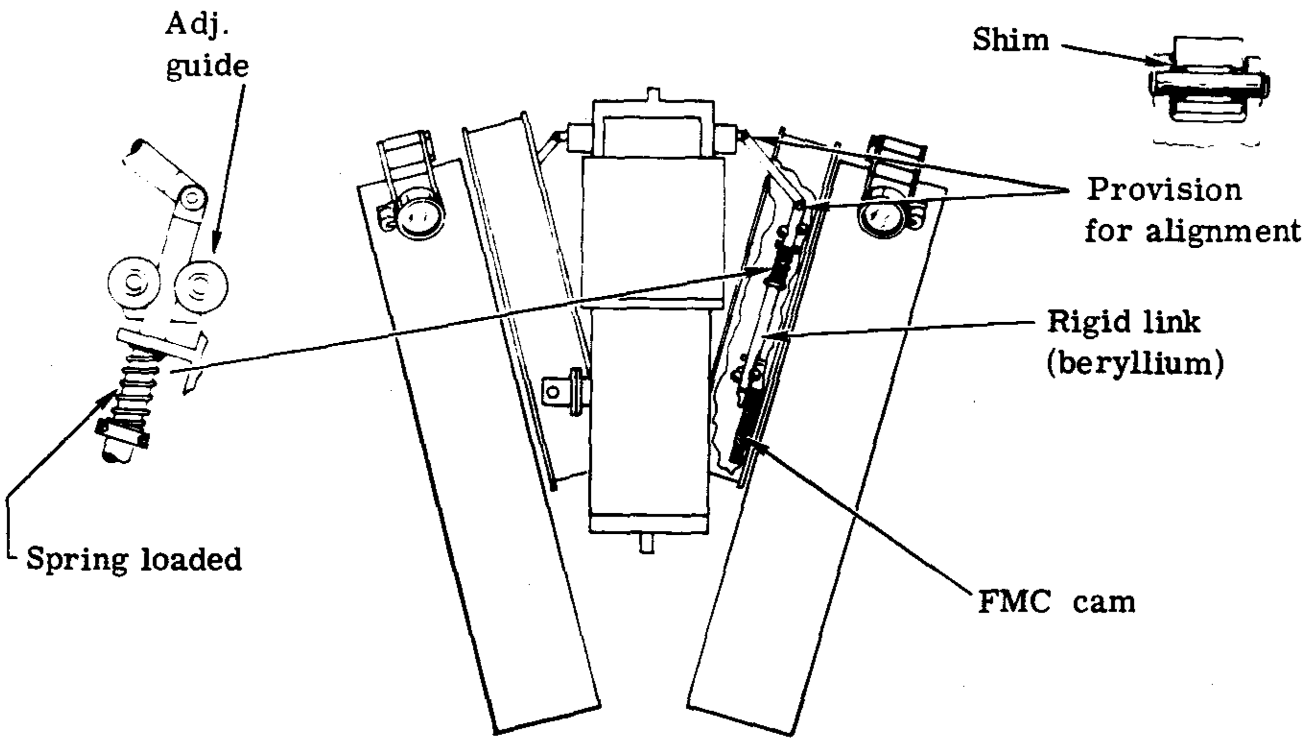
Each camera is independently nodded about an axis parallel to the pitch axis of the vehicle to accomplish forward motion compensation (FMC). The compensation for any given combination of altitude and ground speed (V/h) requires a constant angular rotation during the photographic scan. Since the cycle rate required to maintain constant overlap is also a function of V/h, the nod rate has a fixed relation to the scan rate. The overlap of this system is 7.6 percent at center of format. The required nod is accomplished by a cam-driven linkage, with the pivot point of the camera being located as close to the center of gravity as practical, to keep the inertia forces to a minimum.

The FMC cam and linkage form the equivalent of a planar 4-bar linkage, with the extensive link (cam pushrod) restrained at a constant angle with the driven link (scan shaft), one link fixed (delta), and one member (upper rod) rotatable at each end. The nod axis bearings are offset from each side of the central plane, while all other links are restrained in the center plane by clevis attachments and grooved rollers. The FMC cam and linkage are designed to give a specified ratio of nod angle rate to scan angle rate, and a specified stereo half angle at midscan (15.23 degrees).

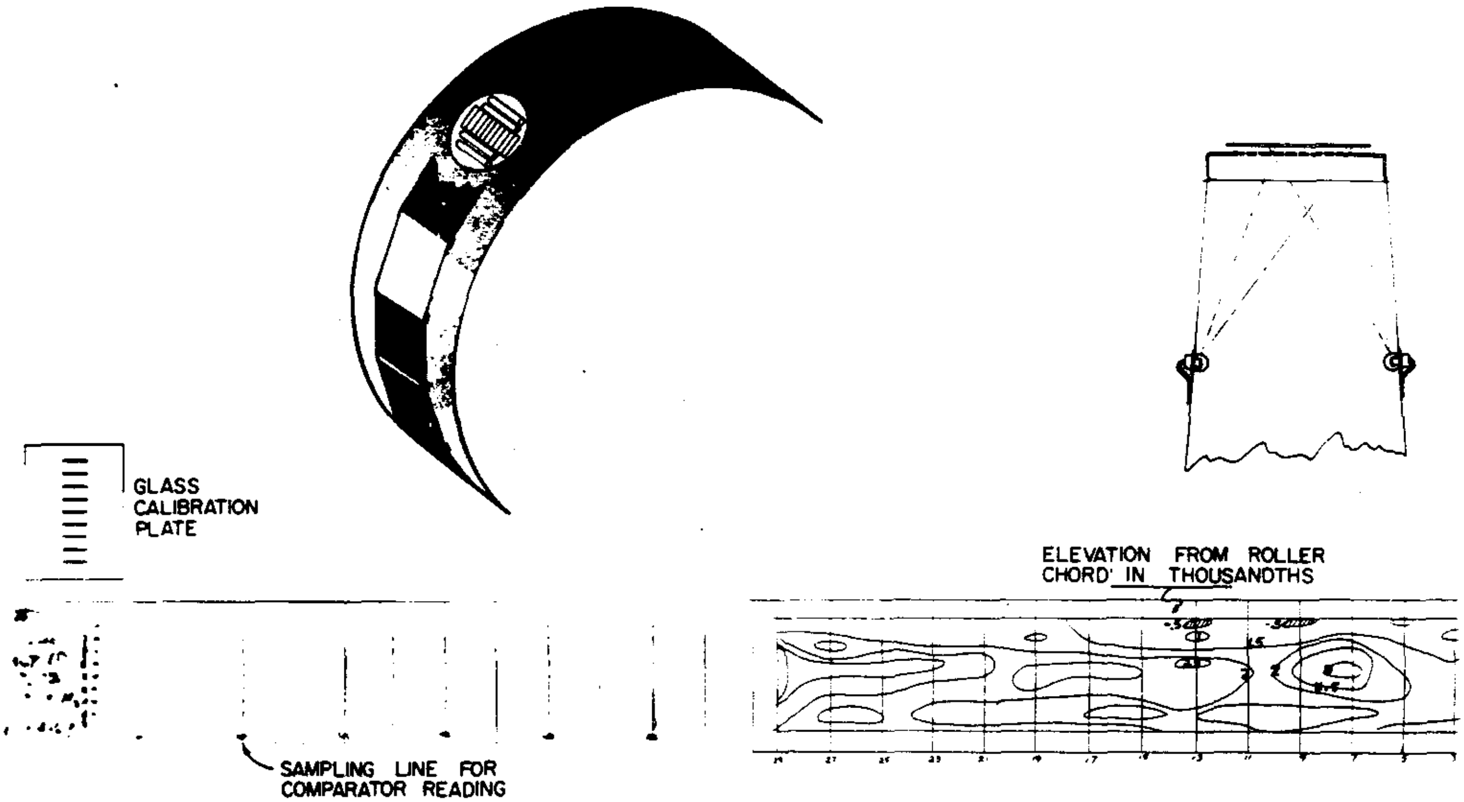
Photographic mission requirements determine the angular rate ratio between nod (FMC) rate and scan rate during the active scan section of the cycle. This ratio is constant and positive for the AFT-looking camera and constant and negative for the FWD-looking camera.

Even though the FMC cam is nearly symmetrical, there is a 180-degree phase difference of nod angle to scan position for the two cameras, making it impossible to interchange the cameras within a system. Once the cameras are assembled, they must remain as such in order to get proper FMC. The cam pushrod assembly is preset and pinned at assembly for proper spring preloading. This assembly is shimmed, aligned, and pinned to a given camera structure and must remain with that structure. The upper rocking link is carefully shimmed to ensure that it (the pushrod) and the scan shaft are coplanar.

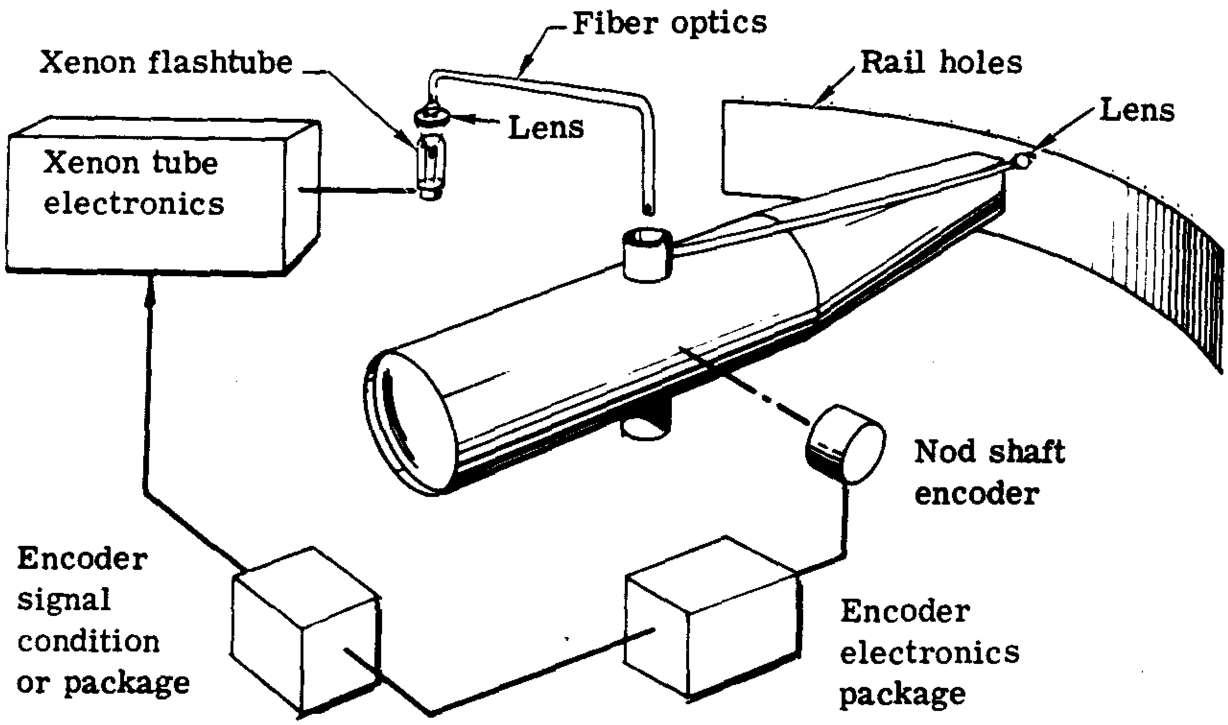
FORWARD MOTION COMPENSATION MECHANISM



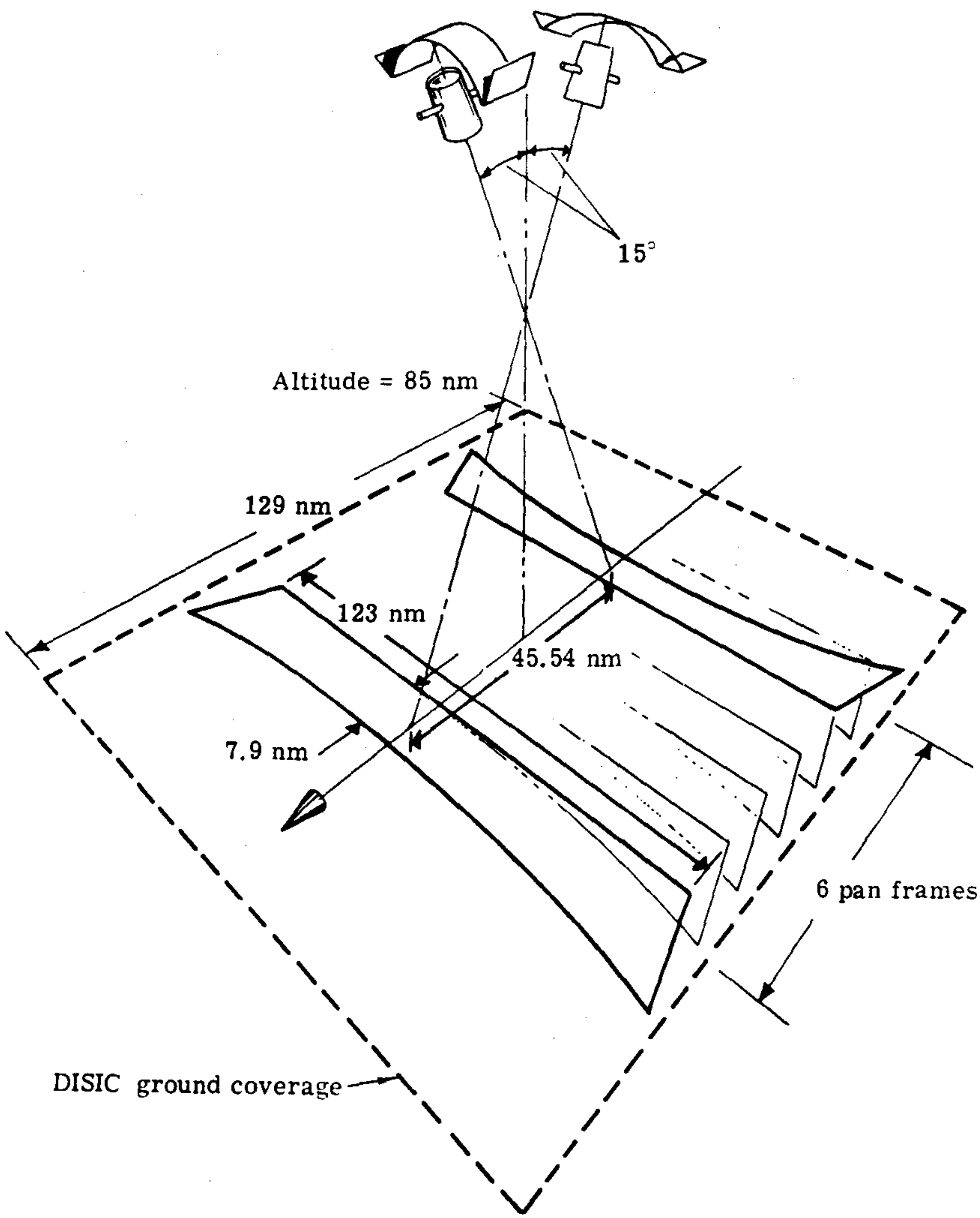
ASCHENBRENNER TEST FOR FILM POSITION



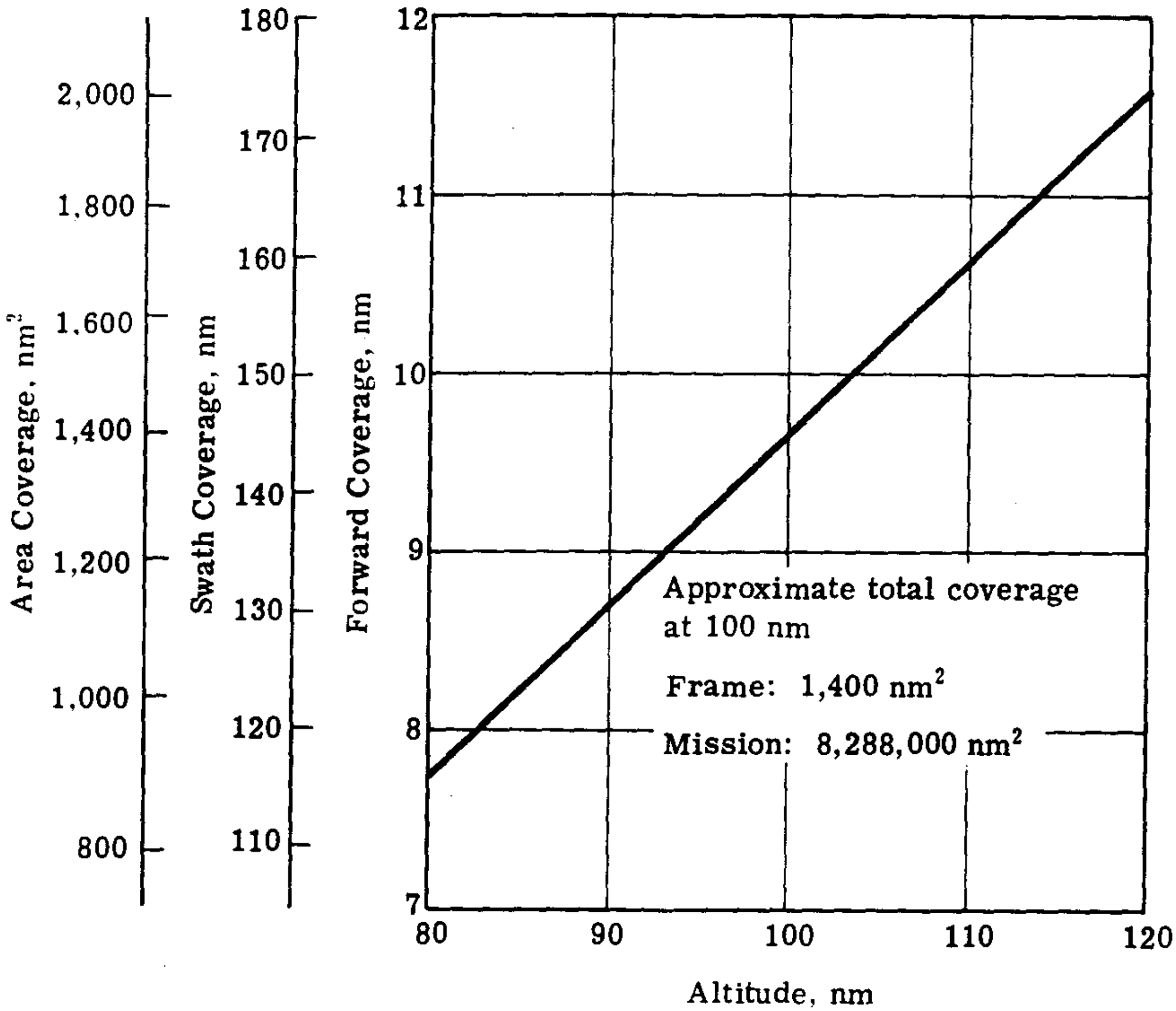
NOD TO SCAN SYSTEM



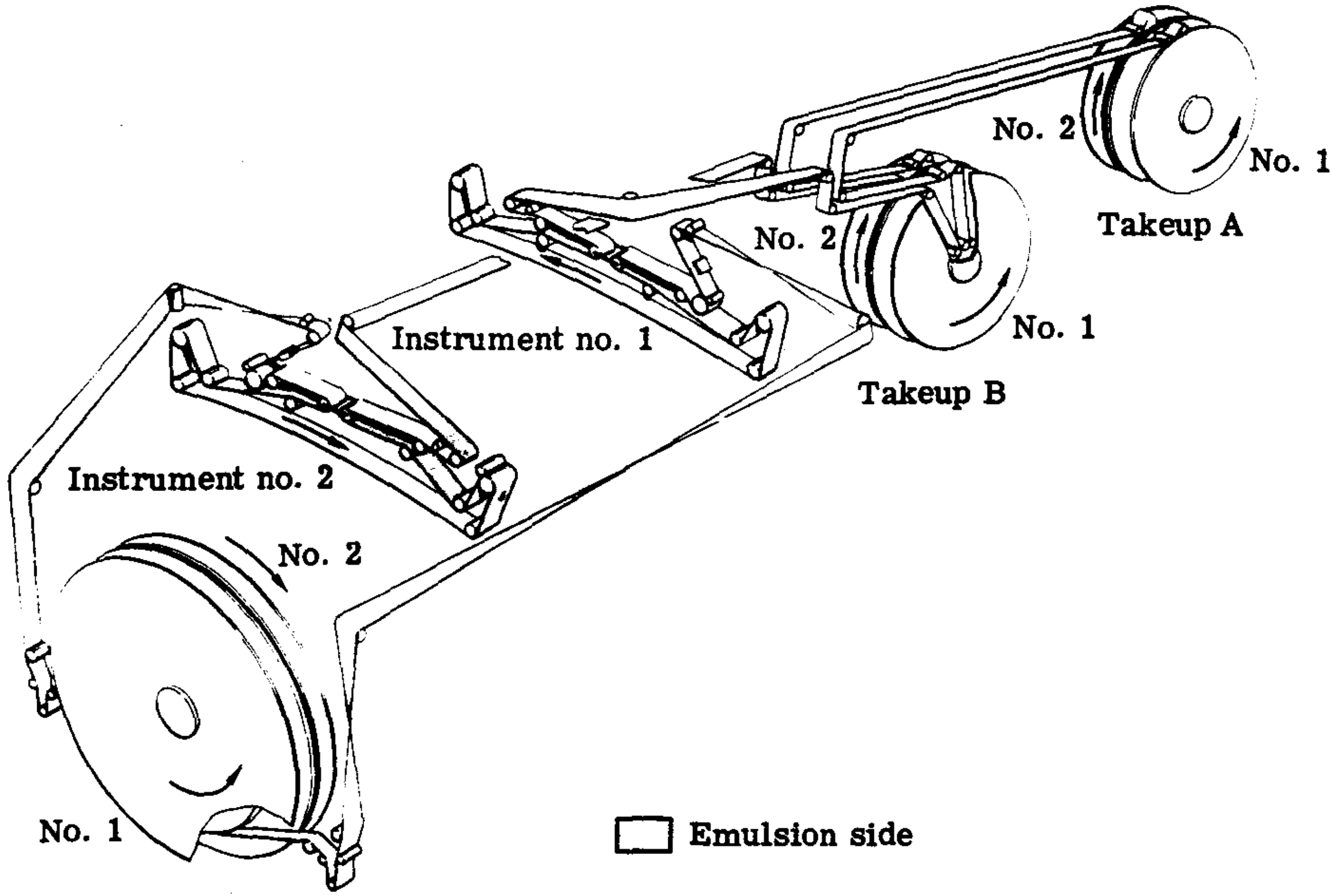
COMPARATIVE GROUND COVERAGES



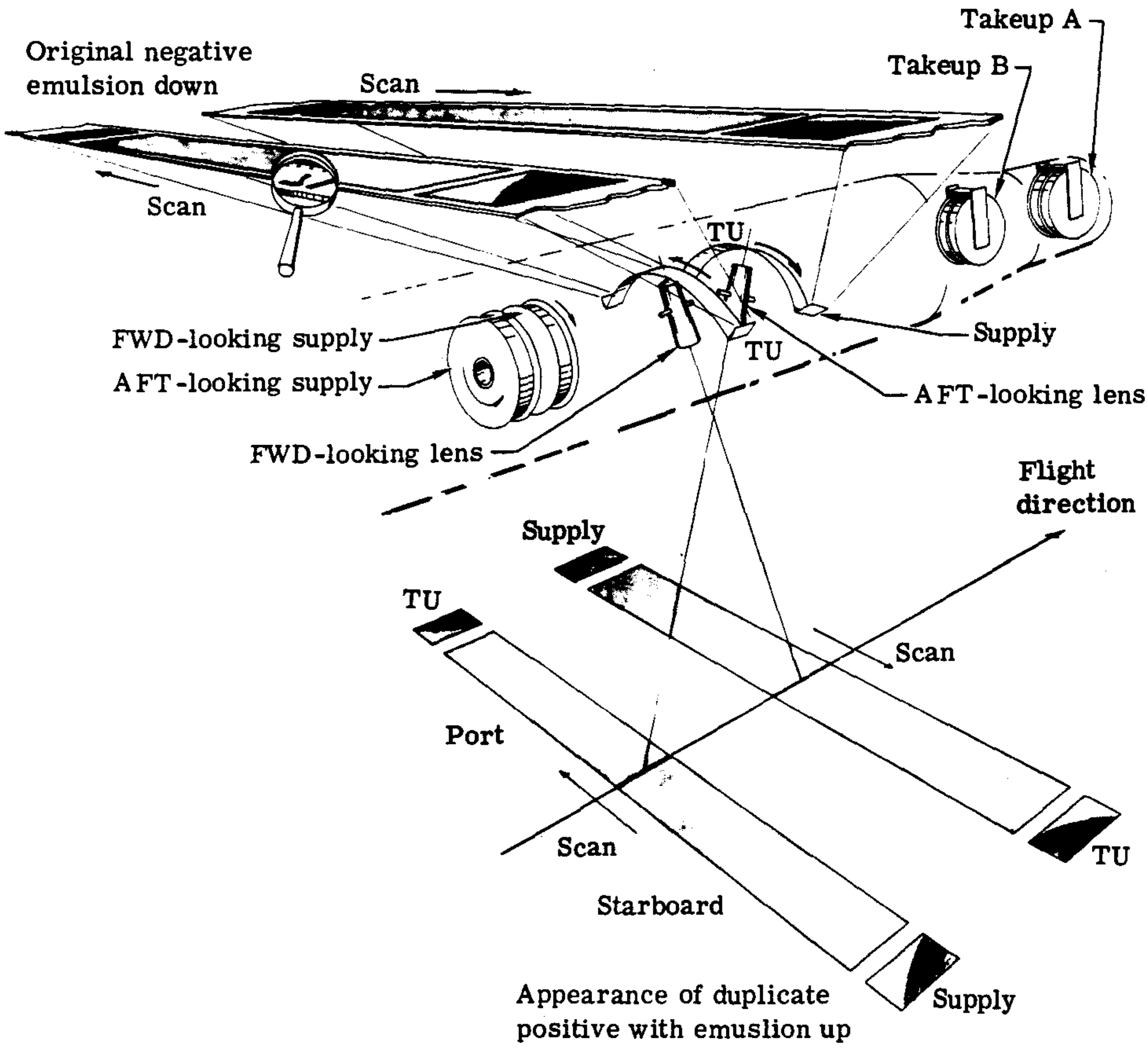
CORONA COVERAGE AS A FUNCTION OF ALTITUDE

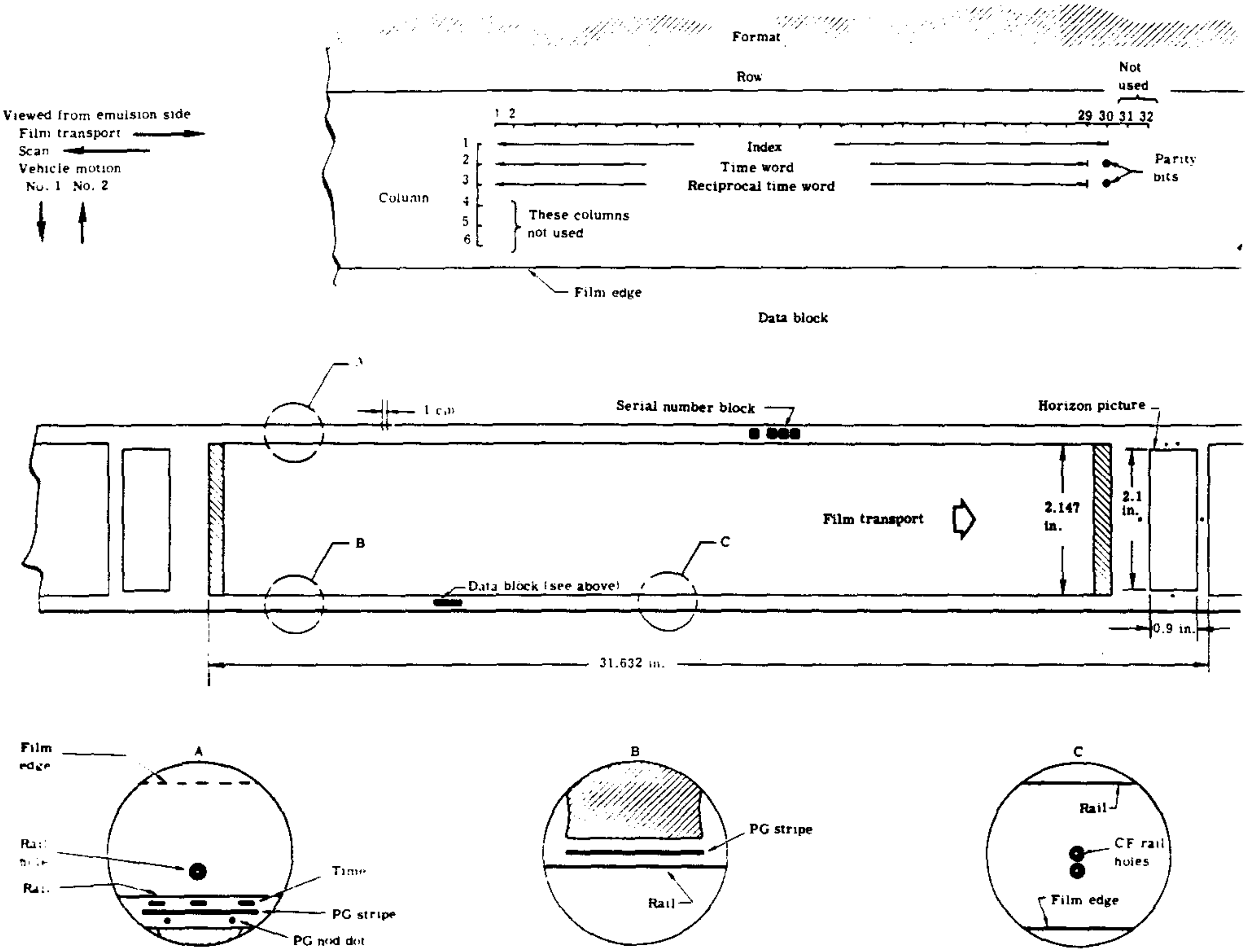


FILM TRANSPORT PATH



CONFIGURATION AND ORIENTATION




Format
Row
Not used
Viewed from emulsion side
Film transport
Scan
Vehicle motion
No. 1 No. 2
1 2
29 30 31 32
Column
1
2
3
4
5
6
Index
Time word
Reciprocal time word
Parity bits
These columns not used
Film edge
Data block
A
1 cm
Serial number block
Horizon picture
Film transport
2.147 in.
2.1 in.
B
C
Data block (see above)
0.9 in.
31.632 in.
Film edge
A
Rail hole
Rail
Time
PG stripe
PG nod dot
B
PG stripe
Rail
C
Rail
CF rail holes
Film edge

DISIC

DUAL IMPROVED STELLAR INDEX CAMERA SUBSYSTEM

PURPOSE

The purpose of the dual improved stellar index (DISIC) camera subsystem is to provide exposed film for use in precision geodetics and cartography, and also for use in conjunction with the main J-3 cameras to aid in establishing vehicle attitude and precise location of reconnaissance points of interest.

PHYSICAL SYSTEM CHARACTERISTICS

Parameter	Terrain Camera	Stellar Camera
Lens	3-inch Ikogon	3-inch Ikotar
Aperture	f/4.5	f/2.8
Film format	4.5 by 4.5 inches	1.25 diameter with flats
Angular coverage	74 by 74 degrees	23½ degrees
Lens distortion	30 microns (R) 5 microns (T)	15 microns (R) 5 microns (T)
Film flattening	By glass plate	By glass plate
Reseau	2.5-mm spacing 10 microns maximum width	2.5-mm spacing 10 microns maximum width
Reseau illumination	Natural	Artificial
Natural fiducials	1 set of four	1 set of four
Shutter type	Rotary	Rotary
Selective exposure time	1/250 second 1/500 second	1.5 seconds

Parameter	Terrain Camera	Stellar Camera
Cycle period	9.375, 12.50, 15.675 and 18.75 seconds (last two not on CR-1 through CR-6)	3.125 seconds (mode I) same as terrain (mode II)
Dual stellar operation	—	Simultaneous, or by selection
Knee angle	100 degrees	100 degrees
Data recording	Time and serial no.	Time and serial no.
Film type (normal)	3400	3401
Width	5 inch	35 mm
Total capacity	2,000 feet	2,000 feet
Metered length	5 inches	3 inches

DISIC SUBSYSTEM WEIGHT

1. DISIC instrument (including film chutes and baffles)	50 pounds
2. Supply cassette	12 pounds
3. Takeup cassettes (2)	13 pounds
4. Film (maximum)	25 pounds
5. Film exit housing	4 pounds
Total	104 pounds

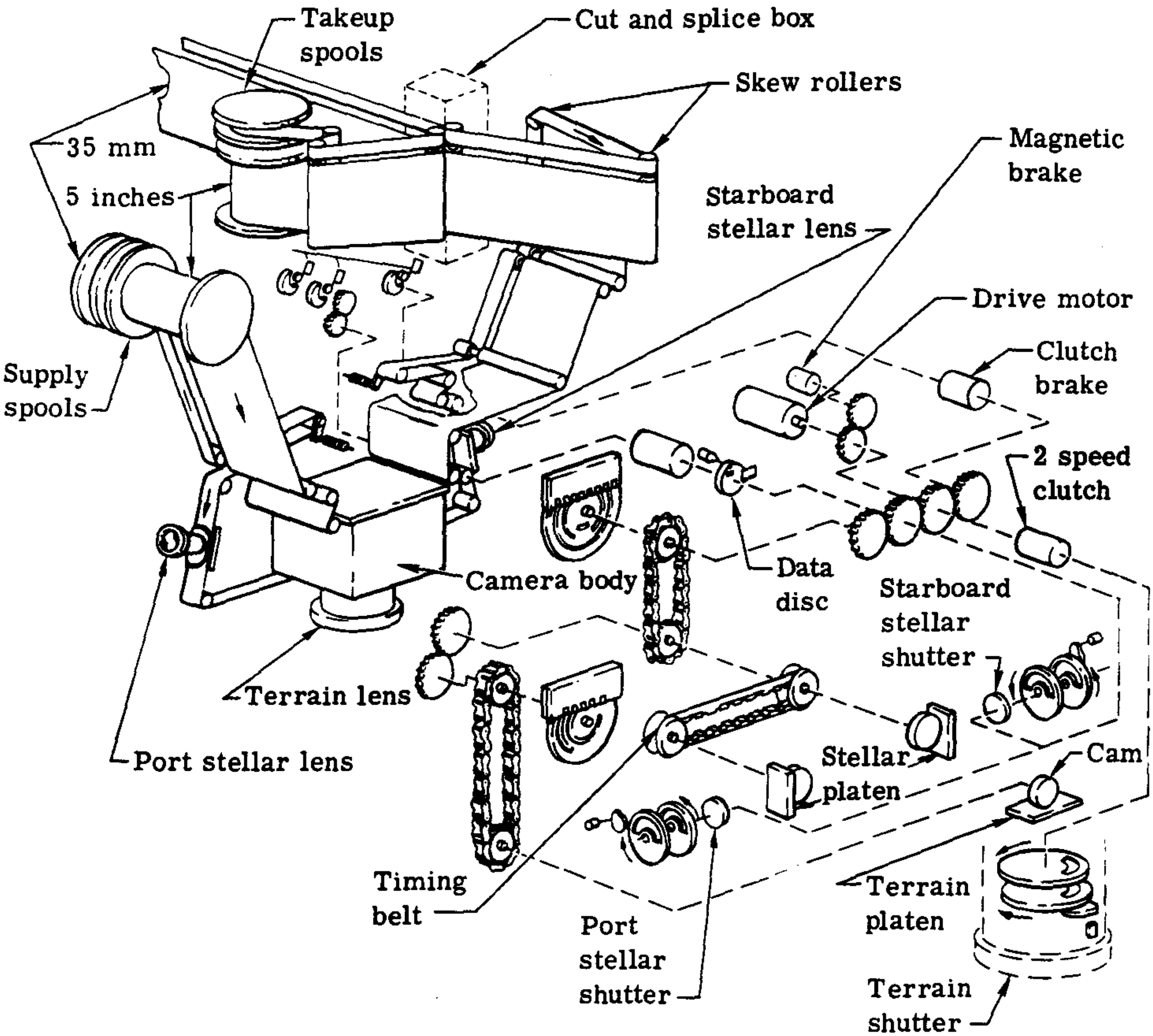
POWER

Index Cycling Rate	Approximate Total Power, watts	Current Total Average Amps
9.375 -second slave	72	3.00 (24 vdc)
9.375-second independent	66	2.75 (24 vdc)

NOTE: (1) The above tabulation gives the predicted average power consumption for the camera subsystem components along with the total current and power. One of two terrain cycling periods (9.375 seconds or 12.500 seconds/cycle) can be selected prior to flight. The numbers in the table above are based on cycling period of 9.375 seconds. This period is expected to be used for most flights, and power consumption at the 12.500-second period will be within 10 percent of those shown for 9.375 seconds.

(2) Power of approximately 850 watt-hours is required for the DISIC subsystem during flight, based on 14 days of active mission life with 2,000 feet of index and stellar film. Mission programming of the DISIC for the independent and slave modes may require less than 2,000 feet of film with a corresponding reduction in the power requirements.

FUNCTONAL SCHEMATIC AND FILM THREADING DIAGRAM



SATELLITE RECOVERY VEHICLE

SATELLITE RECOVERY VEHICLE (SRV)

PURPOSE

The purpose of the satellite recovery vehicle (SRV) is to provide a structural, heat-resistant nose cone section for the launch vehicle, to provide thermal protection for the inner capsule during orbital operations and re-entry, and to provide a separable re-entry vehicle with appropriate subsystems to de-orbit selected physical data.

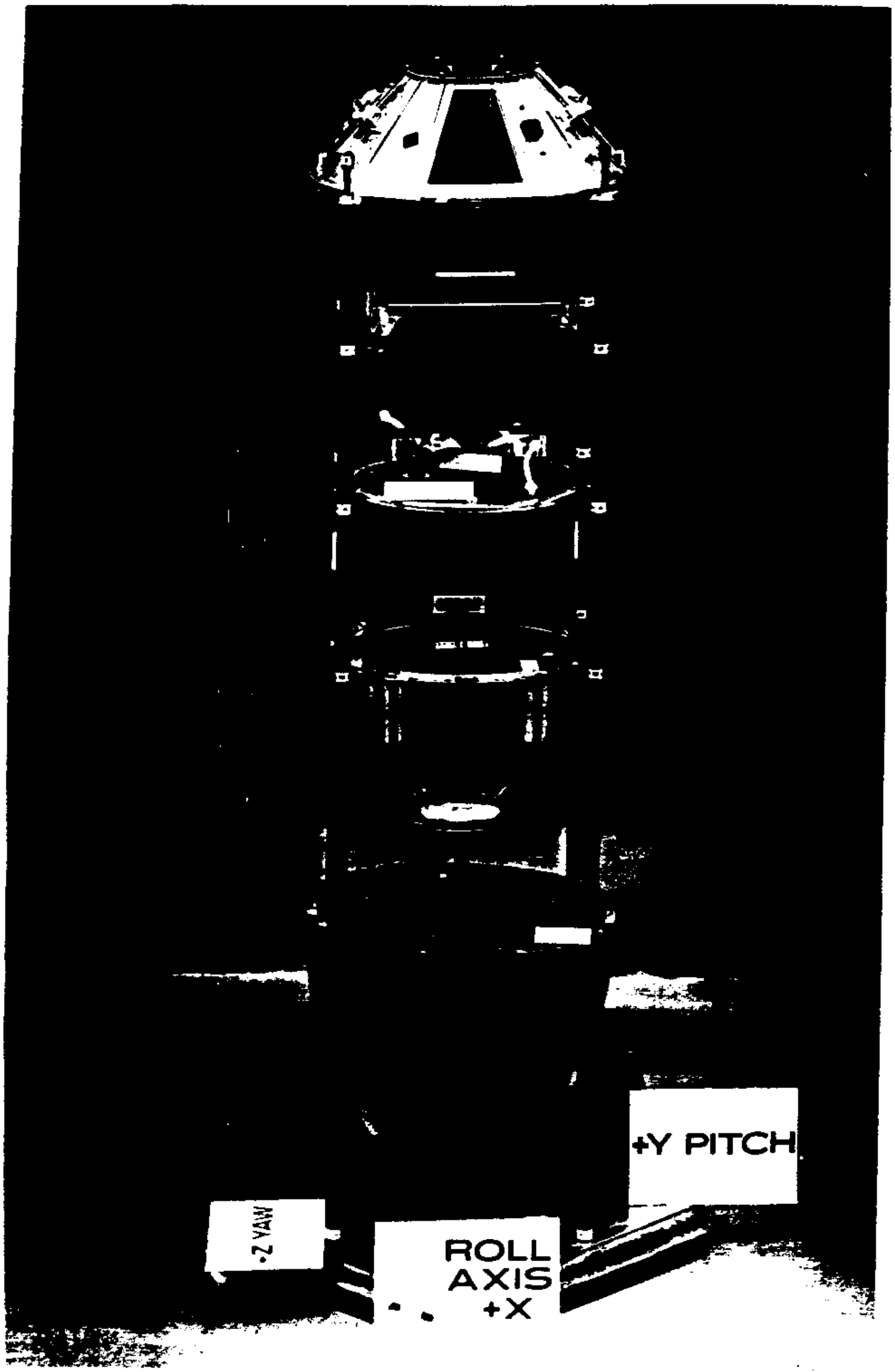
CHARACTERISTICS

Separation weight	414 pounds maximum
Re-entry vehicle	323 pounds maximum
Suspended weight	120 to 217 pounds (nominally 215)
Hypersonic ballistic coefficient	68 pounds/ft^2 maximum
Total impulse (retrorocket)	10,500 pound-seconds ± 3 percent
Rate of descent (at 10,000 feet)	28.5 feet/second maximum
Aerial recovery (JC-130)	15,000-foot altitude maximum 135 knots air speed maximum
Water recovery flotation period	55 to 95 hours
Reliability	0.984 (each SRV)
J-3 panoramic film recovered	80 pounds
DISIC film recovered	11.3 lbs

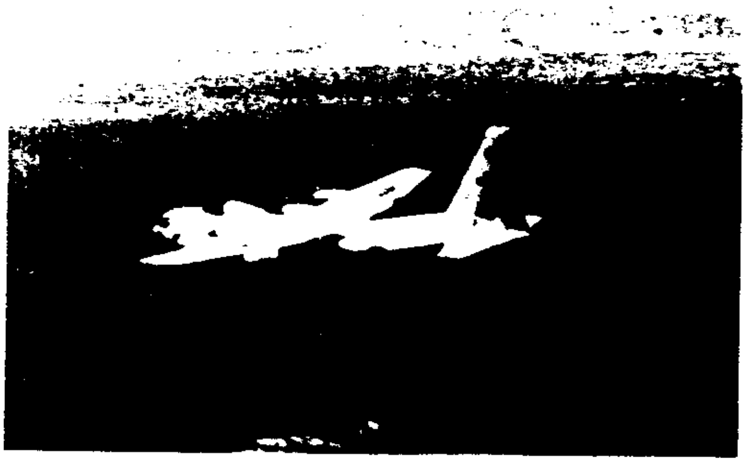
The design system duplicates the spin system, except that the nozzles are pointed in the opposite direction to effect a clockwise spin and are located 90 degrees from each spin nozzle. The despin tank has a working gas pressure of 2,400 psi.

The retro-rocket is a solid-propellant rocket which imparts a thrust of 1,000 pounds for approximately 10-second duration. The purpose is to decelerate the RV. The physical characteristics are listed as follows.

1. Total packaged weight is 63 pounds.
2. Burn time is approximately 8 seconds.
3. Propellant weight is 40 pounds.
4. Specific impulse = $260 \frac{\text{lb-secs}}{\text{lbs}}$
5. Total impulse = $260 \frac{\text{lb-secs}}{\text{lbs}} \times 40 \text{ lbs} = 10{,}400 \text{ lb-secs}$
6. Average thrust = 1,136 lbs
7. Maximum thrust = 1,609 lbs



J-3 Payload



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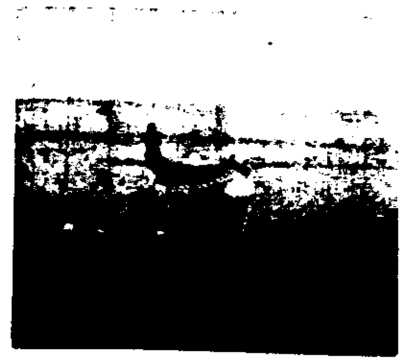

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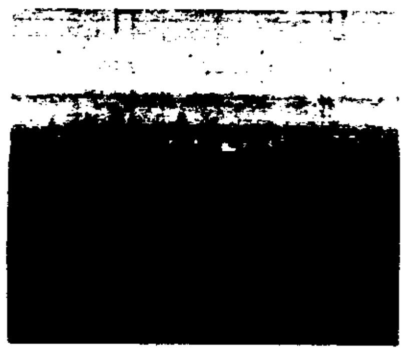

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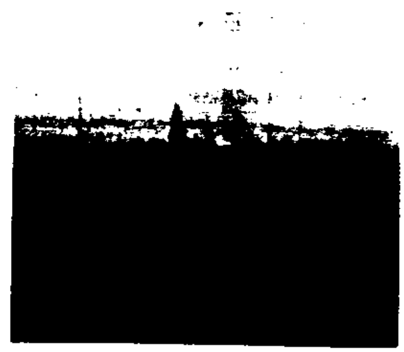

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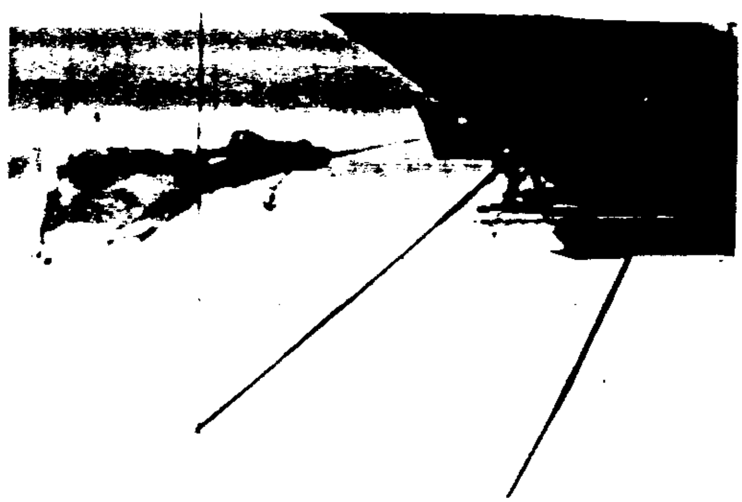

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10× Enlargements of Air Recovery

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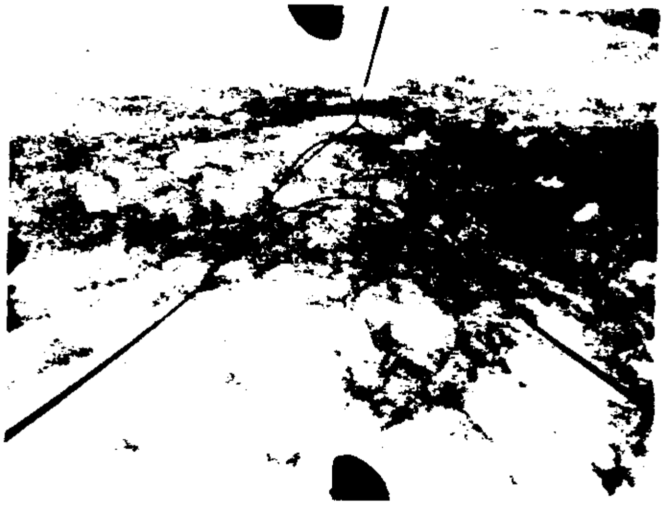
10× Enlargements of Air Recovery



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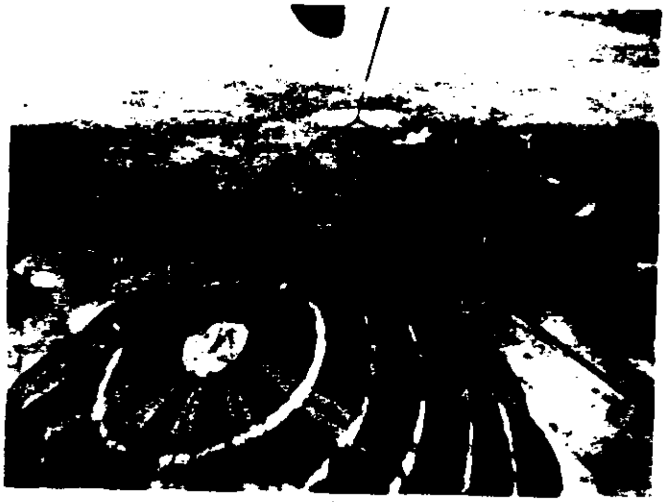

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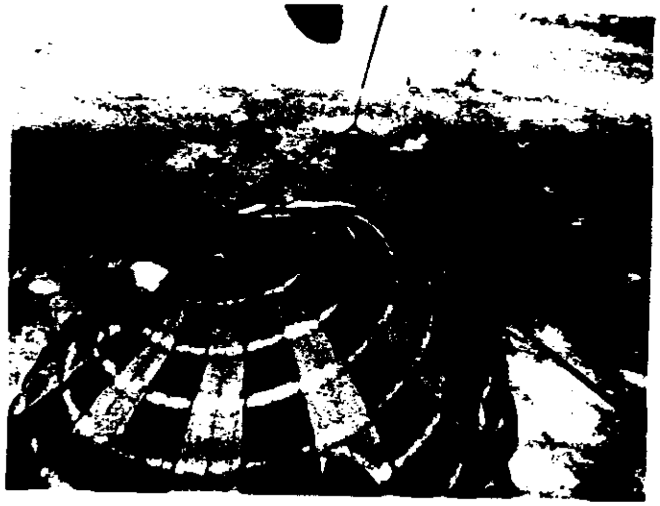

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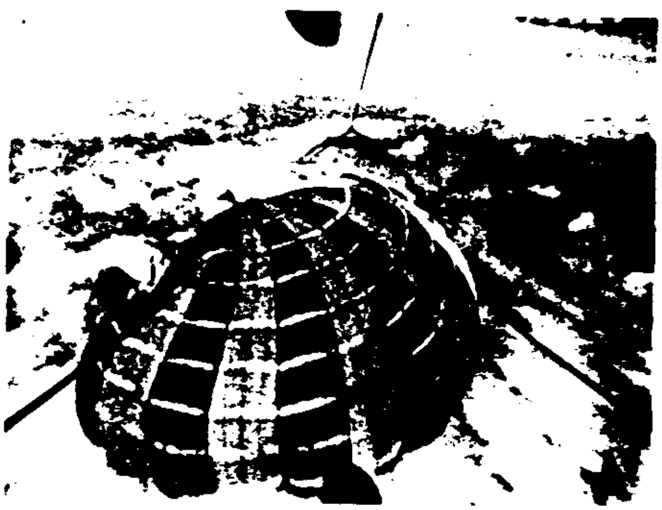

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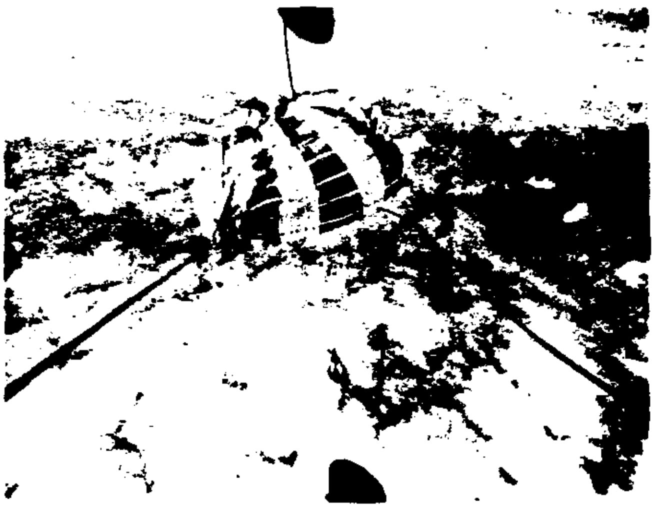

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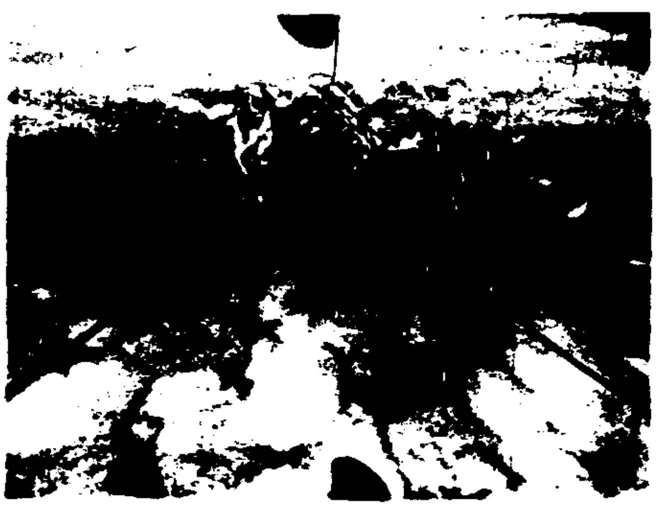

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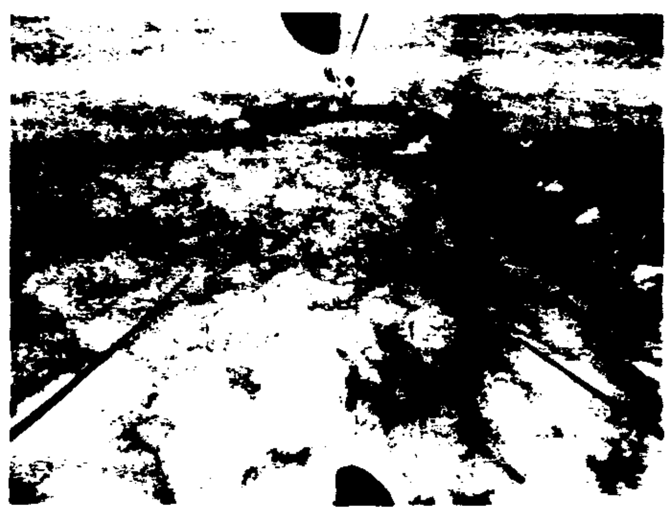

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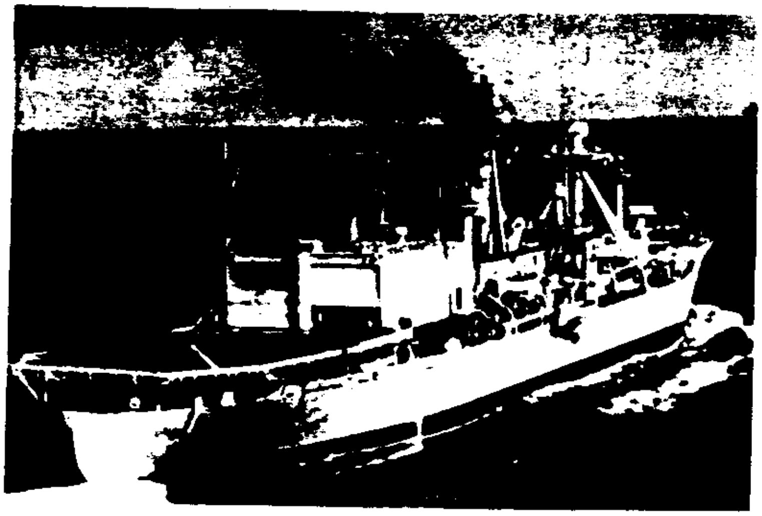

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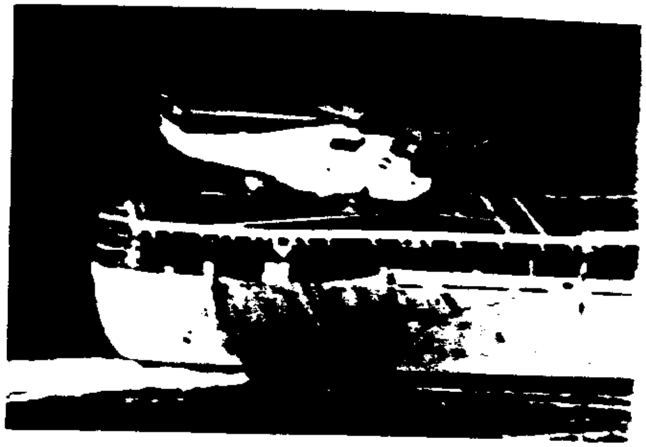

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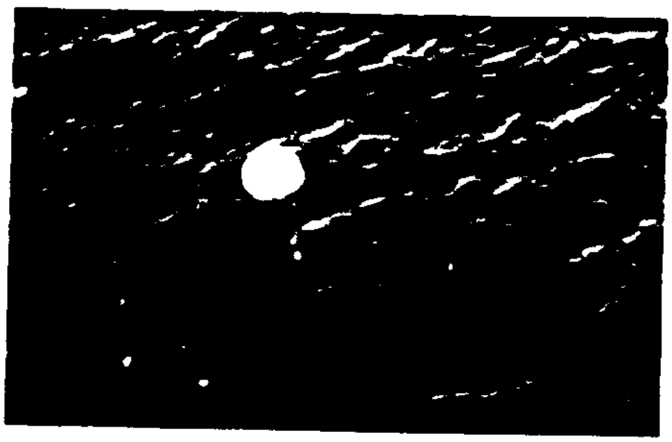

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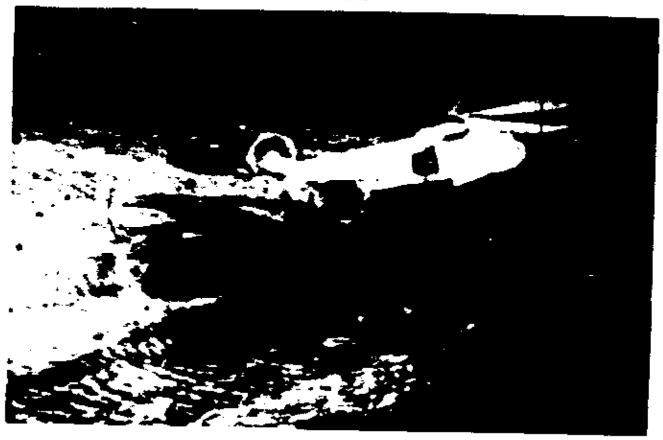

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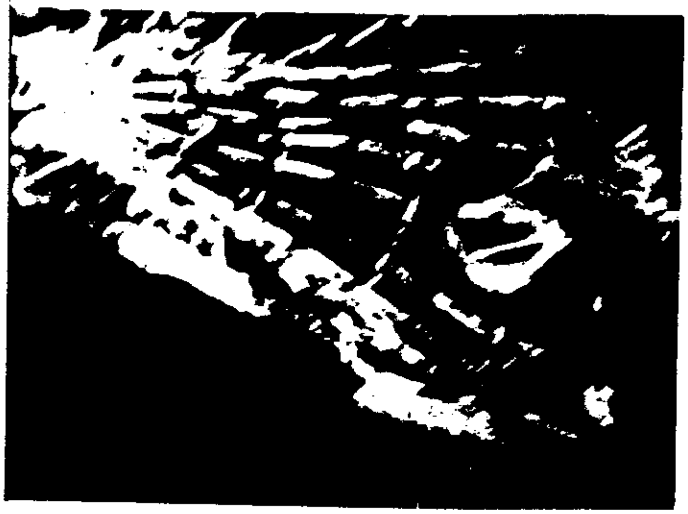
10× Enlargements of Sea Recovery



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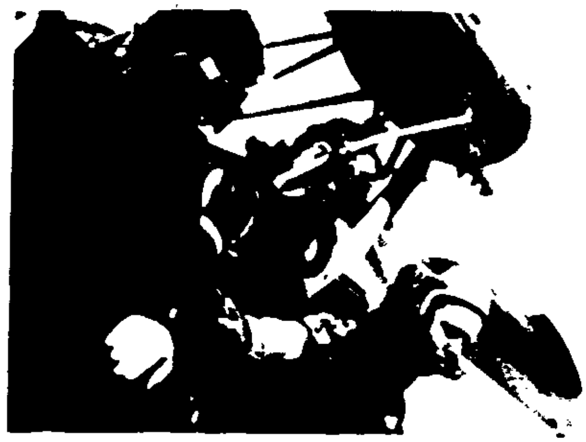

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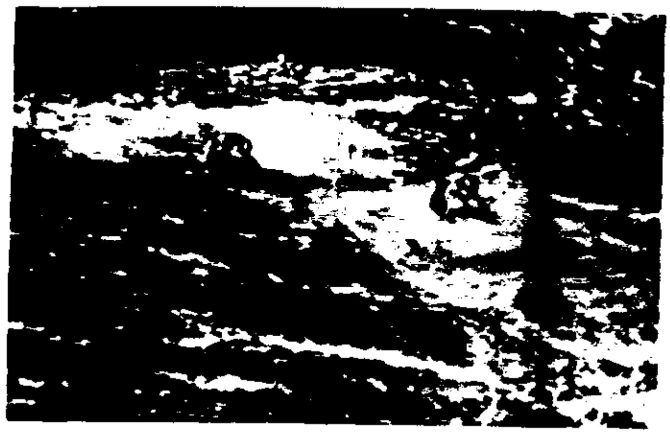

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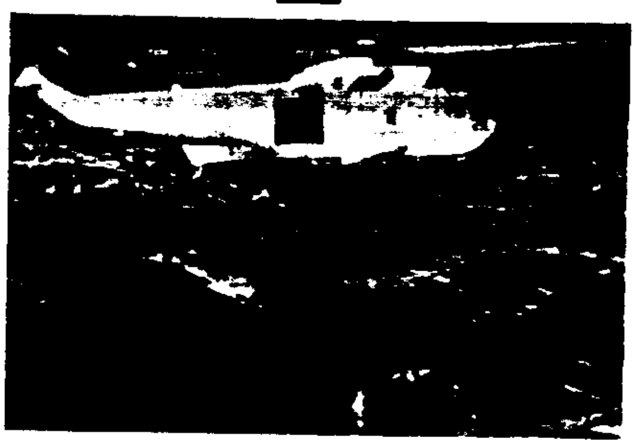

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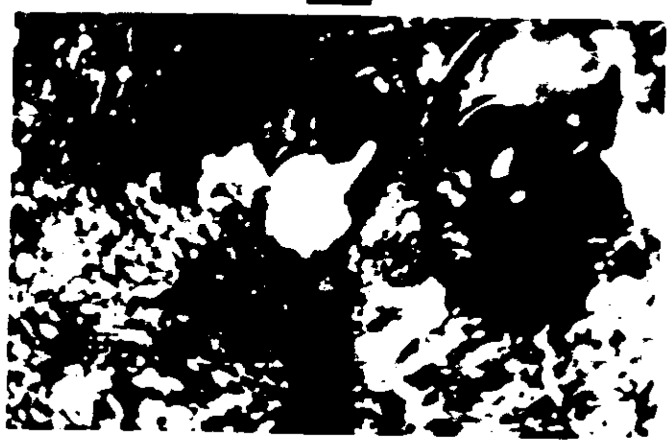

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10× Enlargements of Sea Recovery

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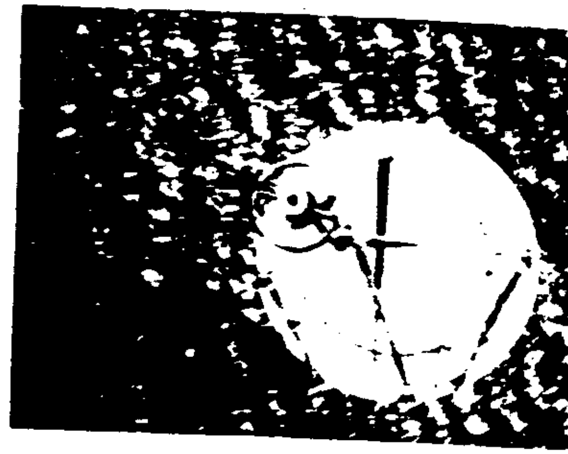

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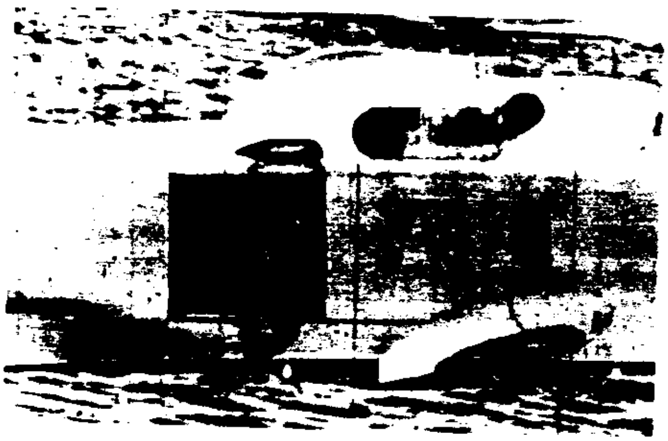

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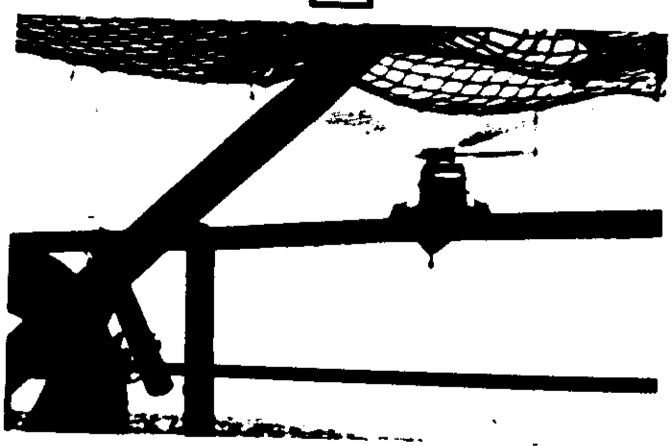

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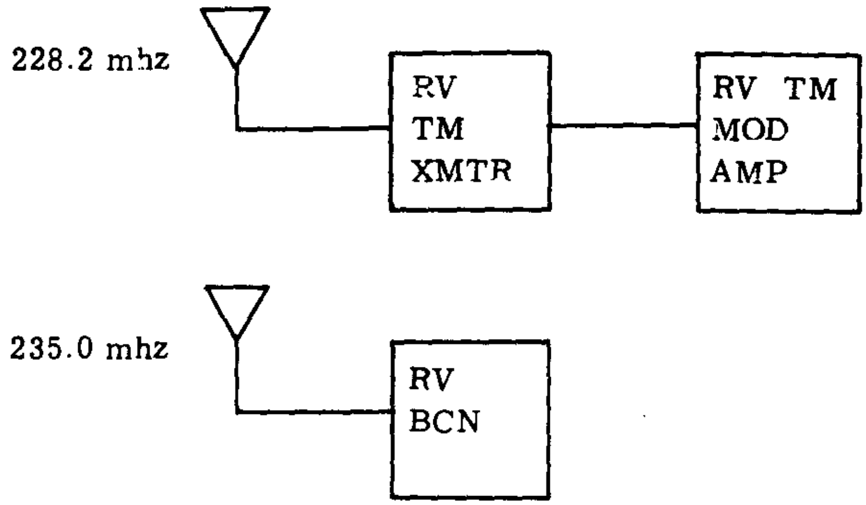
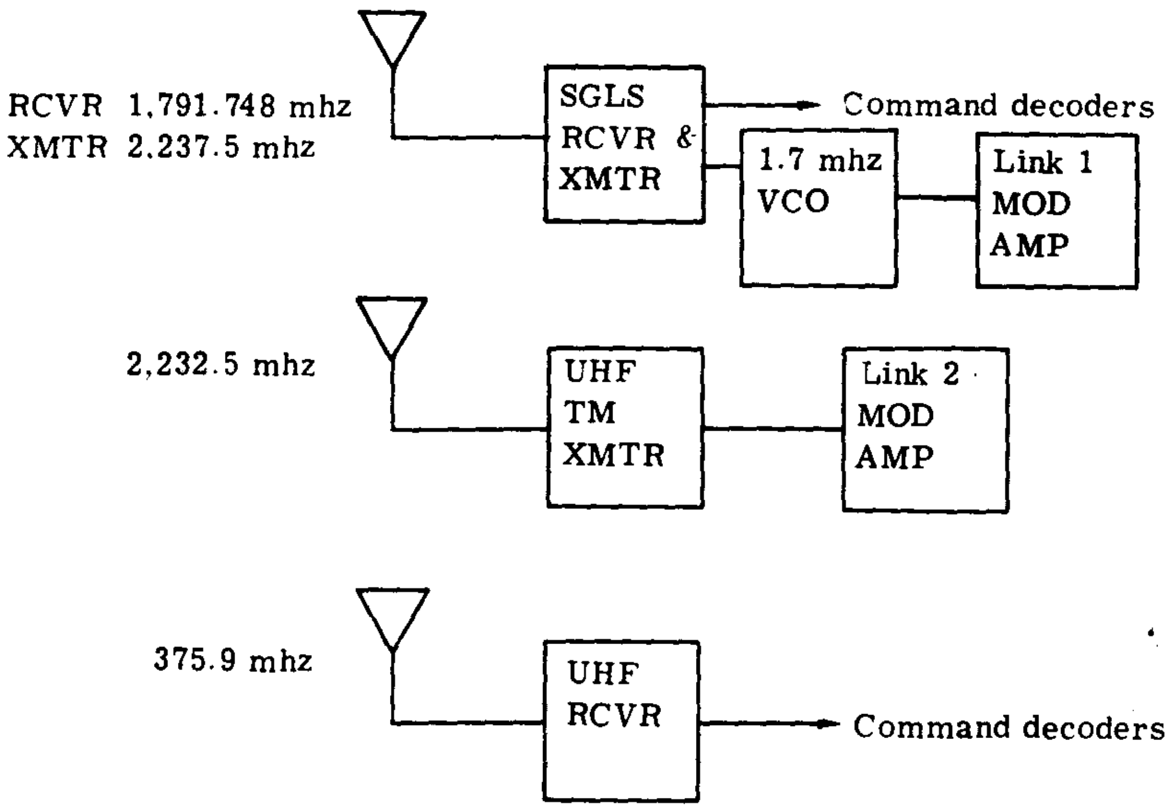
10× Enlargements of Sea Recovery

TELEMETRY

VEHICLE RADIO FREQUENCY EQUIPMENT SGLS CONFIGURATION

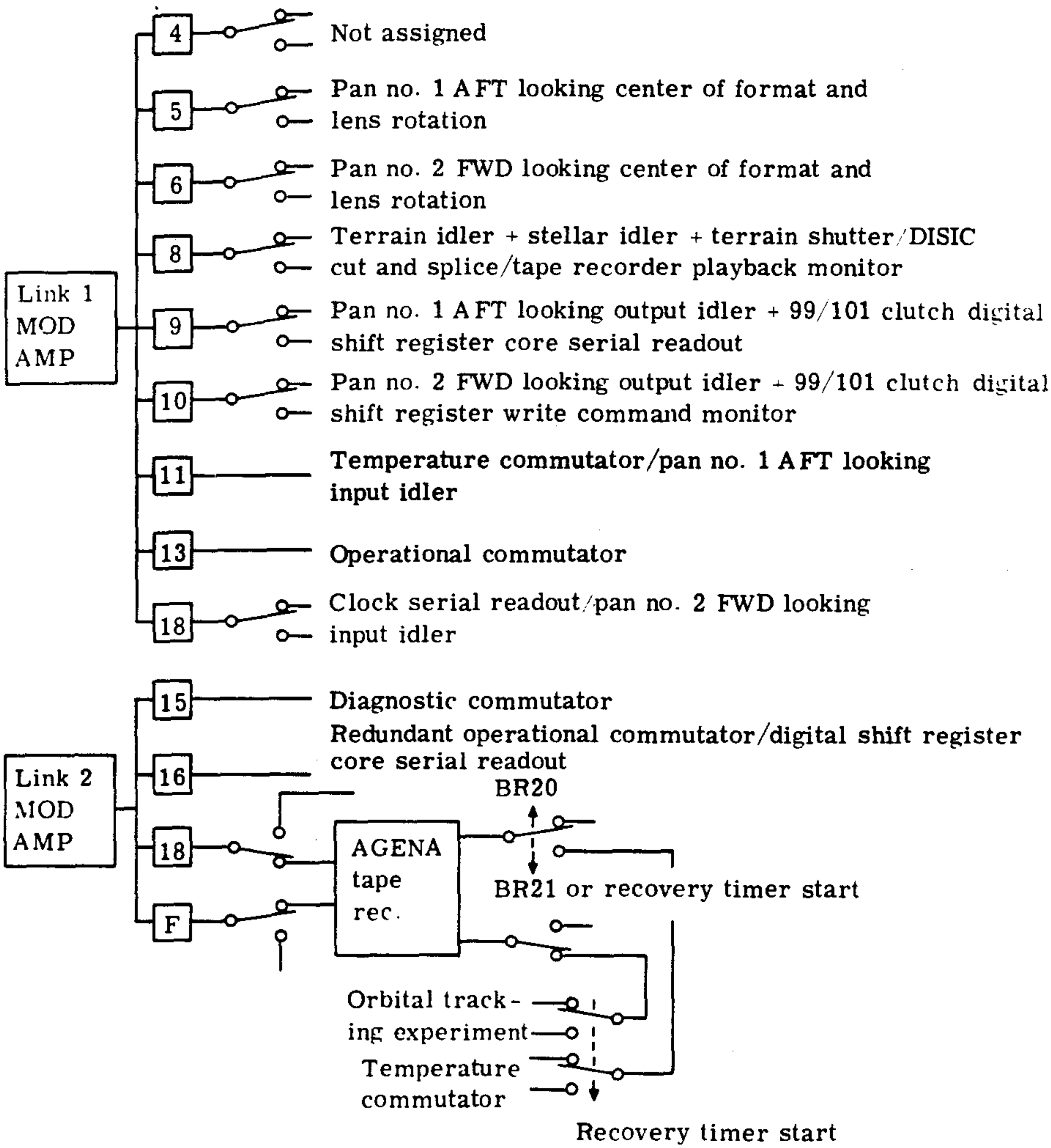


Re-entry vehicle transmitters



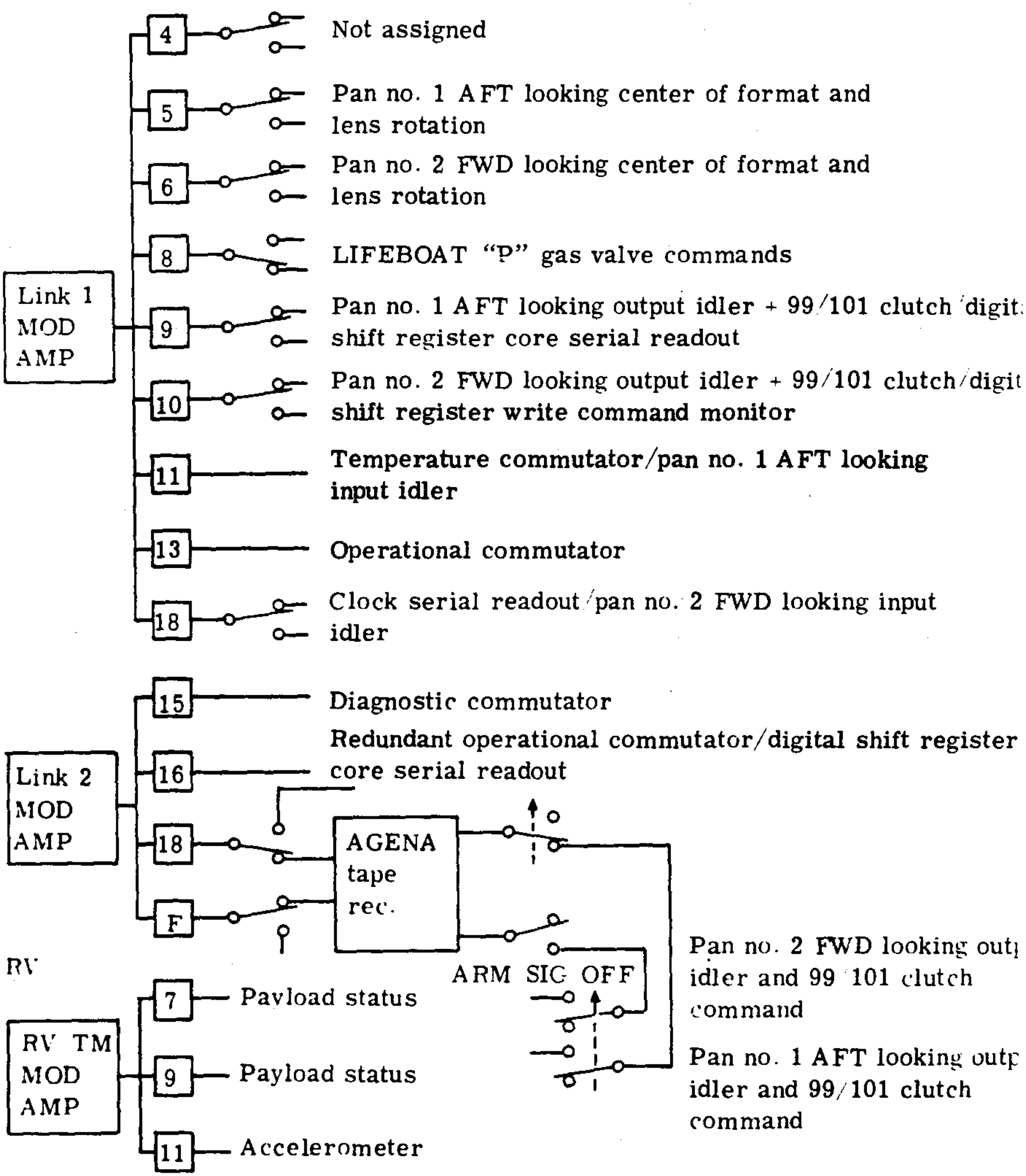
J-3 BLOCK DIAGRAM OF INSTRUMENTATION TELEMETER SYSTEM ORBIT CONFIGURATION

Voltage Control Oscillator

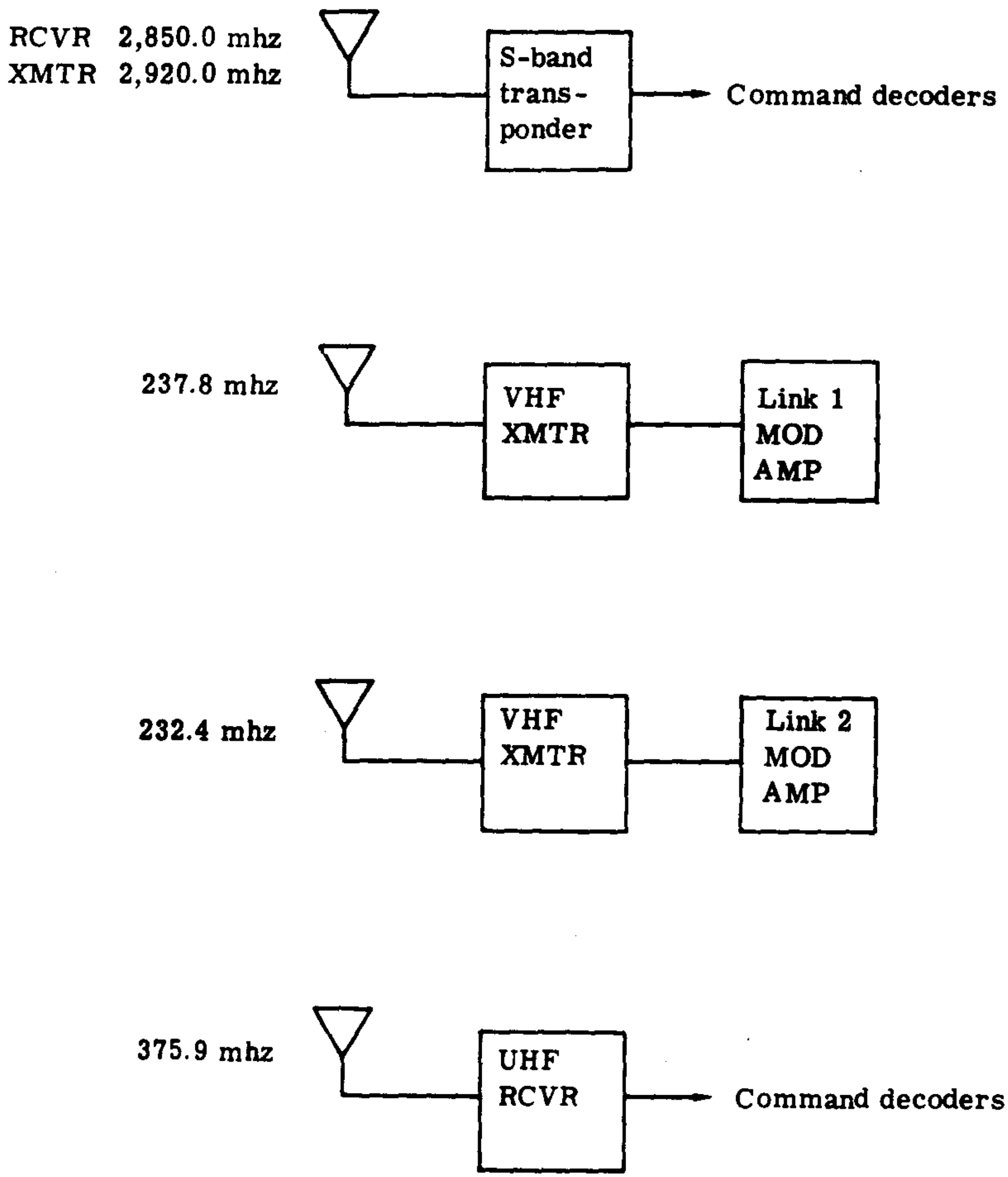


J-3 BLOCK DIAGRAM OF INSTRUMENTATION TELEMETER SYSTEM RECOVERY CONFIGURATION

Voltage Control Oscillator

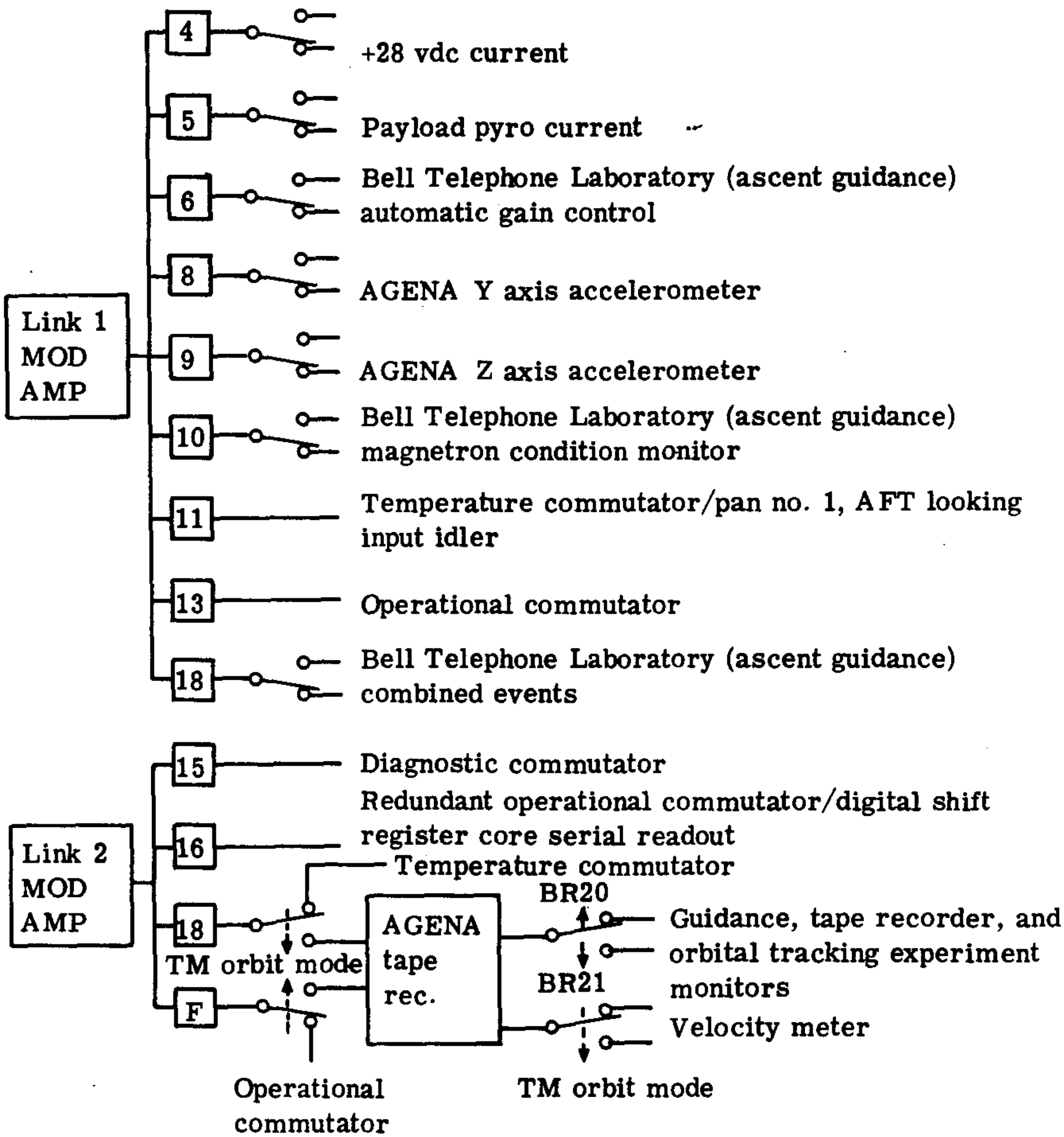


VEHICLE RADIO FREQUENCY EQUIPMENT
PRE-SGLS CONFIGURATION
(J-1; CR-1 THROUGH CR-7)



J-3 BLOCK DIAGRAM OF INSTRUMENTATION TELEMETER SYSTEM ASCENT CONFIGURATION

Voltage Control Oscillator



TELEMETRY CHANNELS ASSIGNED TO A/P

Link 1 Channel 4 - continuous:
- Ascent - vehicle + 28 vdc current
- Orbit and recovery - not used

Link 1 Channel 5 - continuous:
- Ascent - payload pyro current
- Orbit and recovery - pan no. 1 AFT looking lens angular position and center of format

Link 1 Channel 6 - continuous:
- Ascent - ascent guidance gain control
- Orbit and recovery - pan no. 2 FWD looking lens angular position and center of format

Link 1 Channel 8 - continuous:
- Ascent - AGENA Y axis accelerometer
- Orbit - time shared -
  - Terrain idler, stellar idler and terrain shutter of DISIC cut and splice, or tape recoder playback monitor
- Recovery - LIFEBOAT "P" gas valve commands

Link 1 Channel 9 - continuous:
- Ascent - AGENA Z axis accelerometer
- Orbit and recovery - time shared -
  - Digital shift register core serial readout, or pan no. 1 AFT looking output idler and 99/101% clutch

Link 1 Channel 10 - continuous:
- Ascent - ascent guidance magnetron condition
- Orbit and recovery - time shared -
  - Digital shift register write command monitor, or pan no. 2 FWD looking output idler and 99/101% clutch

Link 1 Channel 11 -
- Ascent, orbit and recovery - time shared
- Commutated - temperature data
  - Pan 1 AFT looking temperatures
  - Pan 2 FWD looking temperatures
  - Fairing temperatures

TELEMETRY CHANNELS ASSIGNED TO A/P (Cont.)

DISIC temperatures
DISIC CONIC temperatures
Pressure makeup temperatures
Instrument barrel temperatures
AFT power box cover temperature
V/h programmer temperature
Switch programmer cover temperature
SRV internal temperatures
SRV retro temperatures
Blast shield temperatures

or continuous - pan no. 1 AFT looking input idler

Link 1 Channel 13 - ascent, orbit and recovery:
Commutated - operational command and control monitors
Storage register output
Selector position monitors
Pan operate
Door separation monitors
Pressure makeup bottle pressure
Pan, stellar and terrain takeup diameter monitors
Pan, stellar and terrain cycle monitors
Exposure programmer monitors
Pan slit monitors
Eccentricity program operate relay
FMC function output
Yaw and oblateness operate
Yaw oblateness general position
Pans exposure command

Link 1 Channel 18 - continuous:
Ascent - ascent guidance combined events
Orbit and recovery - time shared -
Clock serial readout or pan no. 2 FWD looking input idler

TELEMETRY CHANNELS ASSIGNED TO A/P (Cont.)

Link 2 Channel 15 - ascent, orbit and recovery
- Commutated - diagnostic data
  - SRV water seals
  - Pan input, intermediate roller and frame meter rotation monitors
  - Pan takeup, supply spool and drive motor voltages
  - Total payload and pyro current monitors
  - Pan horizon optic platen positions
  - Recovery mode and fairing and SRV separate monitors
  - Pan tachometer feedback monitors
  - Unregulated clock and pan operate voltages
  - SRV recovery battery monitors
  - Yaw resolver output
  - DISIC mode and terrain exposure monitor
  - Eccentricity function position monitor
  - 115 v 400 cycle voltage monitor
  - Pan horizon optics platen and shutter commands
  - Pan film door and DISIC cut and splice
  - Terrain and stellar capping and clutch commands
  - Pressure makeup outlet pressure switch
  - Film change detector
  - Terrain and stellar platen positions
  - DISIC motor voltage
  - DISIC operate command and 1 rev per cycle cam position monitor

Link 2 Channel 16 - ascent, orbit and recovery:
- Commutated - operational command and control monitors
  - Same as Link 1 Channel 13 (when switched by real time command)
    - continuous - digital shift register core serial readout

Link 2 Channel 18 - commutated:
- Ascent - temperature commutator (see Link 1 Channel 11)
- Orbit - tape recorder output of temperature commutator, guidance, tape recorder, and orbital tracking experiment monitors
- Recovery - tape recorder output of pan no. 1 output idler and 99/101% clutch

TELEMETRY CHANNELS ASSIGNED TO A/P (Concl.)

Link 2 Channel F

Ascent - operational commutator (see Link 1 Channel 13)

Orbit - tape recorder output of orbital tracking experiment data

Recovery - tape recorder output of pan no. 1 output idler and 99/101% clutch

SRV Telemetry

Channel 7 - continuous - payload status and recovery events

Channel 9 - continuous - payload status and recovery events

Channel 11 - continuous - accelerometer

FILMS AND FILTERS

AERIAL FILMS

Aerial films designed for reconnaissance and space application require characteristics which differ from conventional films. Aerial films must withstand the influence of environment, the requirements of system designs, and the handling from film manufacture through the duplication stages. Advances in emulsion making technology have made possible aerial films having a broad range of sensitivity, speed, and definition. Aerial color films are subjected to the same environment and design requirements as are black and white films. However, aerial color films have more critical exposure and color balance requirements. These special photographic characteristics are combined with a dimensionally stable Estar base to provide added dimensional stability. In the CORONA system, three primary black and white film types are used: 3404 (3414), 3400, and 3401. Three color film types have been experimentally used: SO-121, SO-180, and SO-242. All these emulsions have special characteristics and applications. Each is individually described in the following text.

PANORAMIC CAMERA FILMS

High Definition Aerial 3404 film has high contrast, high definition, extremely fine grain, and extended red sensitivity. The 3404 emulsion is coated on a 2.5-mil Estar base for use in cameras specifically designed for extremely high altitude stable platform photography. In the earliest missions, [redacted] used variable spray processing conditions for 3404 film. This three-level (primary, intermediate, and full) processing provided sensitometric responses separated by 1/2 f/stop. Beginning with mission 1104, however, a single level viscous process has been used. This "dual-gamma" sensitometric response effectively produces as wide an exposure latitude as the former three-level process as well as a lower D_{max} for more advantageous duplicating. On July 1970 Eastman Kodak replaced 3404 with 3414 film. The 3414 emulsion characteristics are similar to the 3404 emulsion with the exception of spectral response and film speed.

		3404	3414
Resolving power:	100:1 T.O.C.	671	704
	1.7:1 T.O.C.	221	272
AEI speed		3.4	5.0

SO-242 AERIAL COLOR FILM

SO-242 Aerial Color Film is an Ektachrome type reversal emulsion with a filter coating which is equivalent to a Wratten no. 2B filter. The very high definition feature of SO-242 makes it ideal for high acuity/high altitude photographic systems. The emulsion orientation is stacked such that the green sensitive layer is on top followed by the red and the bottom blue sensitive layer. Overcoating the emulsion layers is the filter layer for modifying the incident illumination. These filter and emulsion layers, together with an anti-curl backing layer, are coated on a 2.5-mil Estar base. The film speed has been designed to be compatible with the black and white 3404 and 3414 films as normally used, i.e., slit widths set for the black and white primary films for given mission parameters are also correct for the SO-242 film.

SO-242 mission 1108, December 1969, Williams Air Force Base

SO-121 AERO EKTACHROME FILM

SO-121 Aero Ektachrome film is a reversal material having fine grain characteristics capable of high definition suitable for high altitude photography. The SO-121 emulsion orientation is such that the green sensitive layer is on top, the blue sensitive layer in the middle, and the red sensitive layer on the bottom. One unique characteristic of this film is the absence of the yellow filter layer that is found in other color films. There is some overlap in sensitivity in the blue-green region. The green sensitive layer has mor than the normal amount of blue sensitivity. As a result this material generally does not reproduce blues well in that they tend to be blue-green in color. The three emulsions are coated on standard 2.5-mil Estar base material with a cle gel anticurl backing. The speed of this film had previously been in the neighborhood of 10-12. However, recent adjustments to the film by Eastman Kodak have lowered the speed in an effort to improve the film image quality.

Resolving power: T.O.C. 1,000:1 = 172 cycles per millimeter
1.7:1 = 63 cycles per millimeter

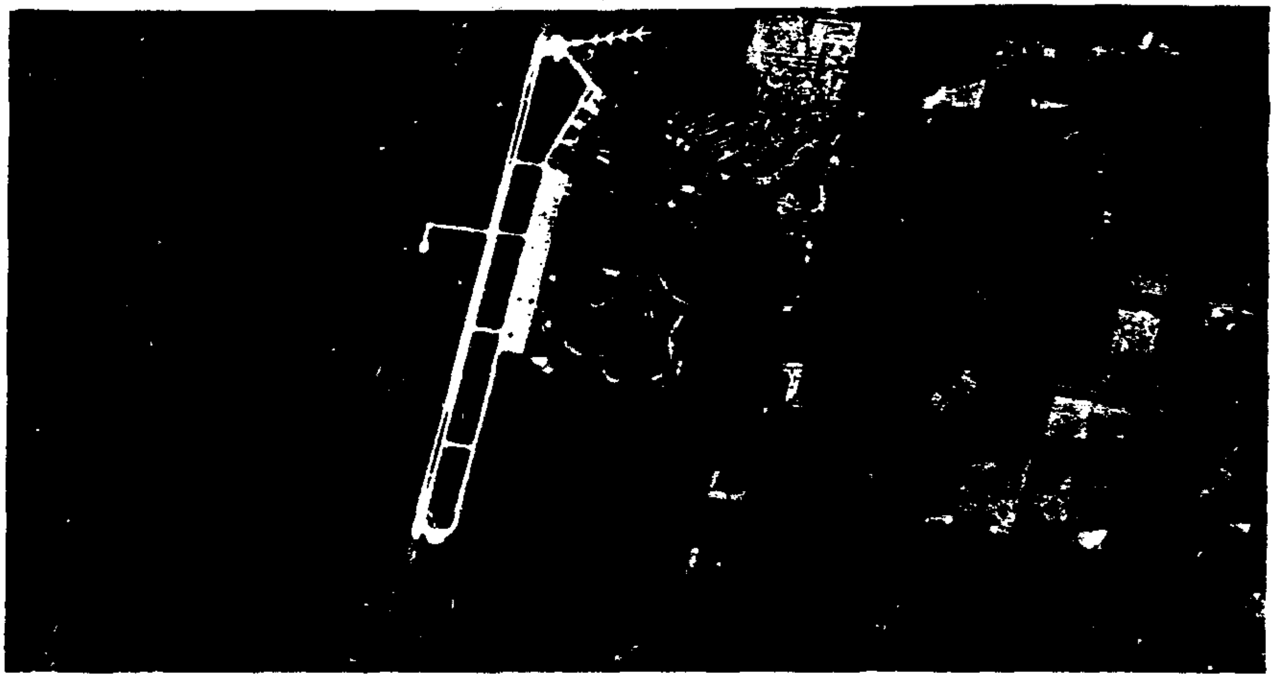
AEI: 5.0 to 8.0

SO-180 EKTACHROME INFRARED AERIAL FILM

SO-180 Ektachrome Infrared Aerial film is a color reversal film. The tripak emulsion consists of a green sensitive layer, a red sensitive layer, and a near infrared layer. The emulsion is coated on the 2.5-mil Estar base with a clear gel anticurl backing. The spectral sensitivity of SO-180, enables the recording of objects that have reflectances in the near infrared. The film construction is such that the infrared sensitive layer records as red, the red sensitive layer as green, and the green sensitive layer as blue. To compensat for this inherent blue sensitivity of all three layers, the SO-180 must be supplemented with a minus-blue (Wratten 12 or 15) filter with short wavelength cutoff in the 500-nanometer region. The cyan layer is designed to be slower than the other two layers because targets of interest for this material reflect comparatively more energy in the near infrared region than the green and red Therefore, its prime value is in the detection of changes in the 700-900 nanometer region that are not visually discernible.

Resolving power: T.O.C. 1,000:1 = 65 cycles per millimeter
1.7:1 = 35 cycles per millimeter

AEI: 18.0



SO-121 mission 1105, November 1969, Clinton Sherman AFB

SO-180 mission 1104, August 1968, Lompoc, California

DISIC —INDEX CAMERA FILM

Panotomic-X Aerial, 3400 is a moderate speed panchromatic sensitive emulsion having high contrast and extended red sensitivity. For added dimensional stability the 3400 emulsion is coated on the 2.5-mil Estar base material. [redacted] has a three-level process for 3400, providing 2/3-stop increments between each process. The film from DISIC, though, is processed in the single level processor using the Drape processor.

Resolving power: 1,000:1 = 184 cycles per millimeter
1.7:1 = 73 cycles per millimeter

AEI: 23.9

DISIC —STELLAR CAMERA FILM

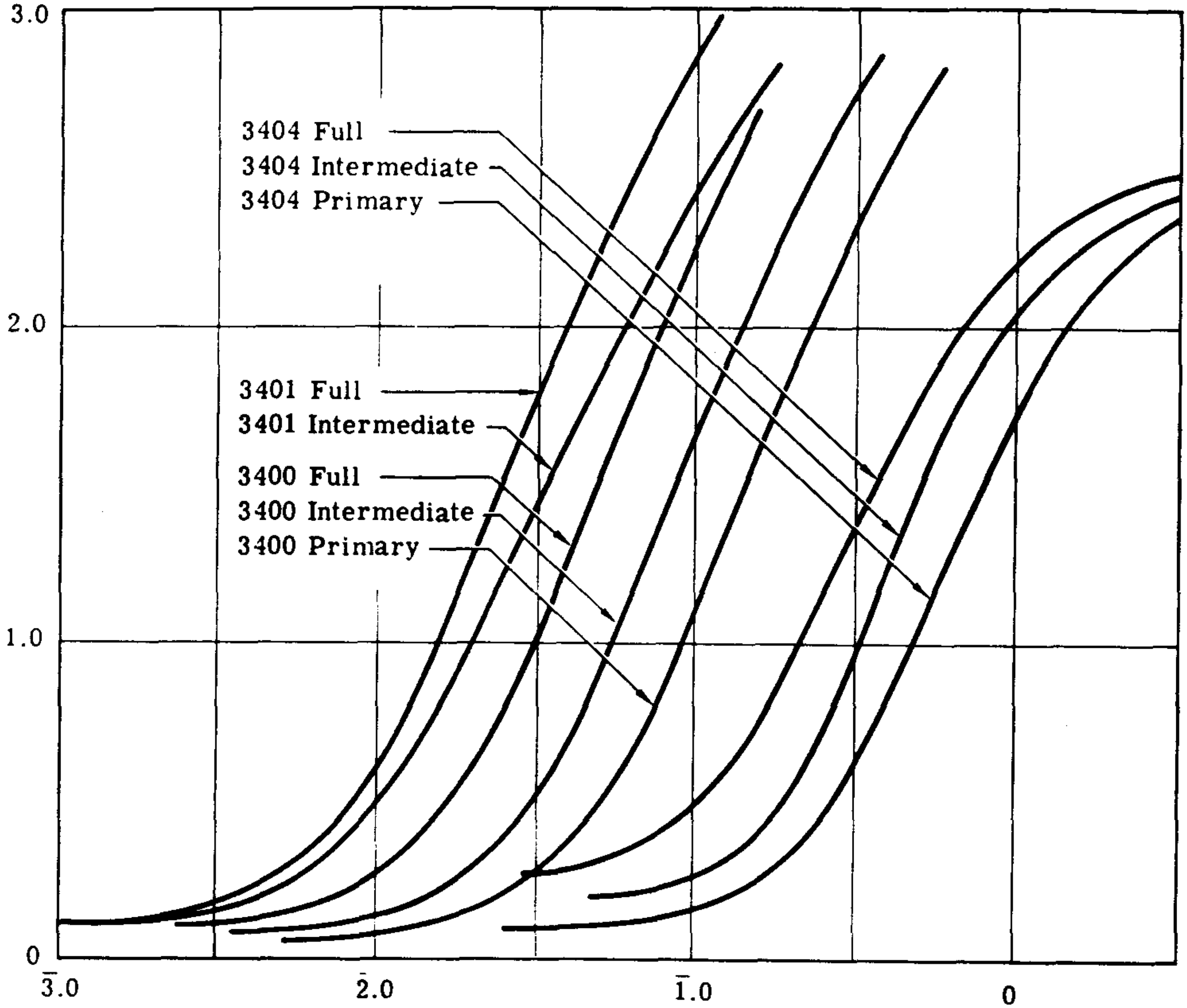
Plus-X Aerial, 3401 is a fast, high contrast, relatively coarse grain film emulsion and with records stellar images with a $1\frac{1}{2}$-second exposure at f/2.8 This film is panchromatic with extended red sensitivity. This film is coated on a 2.5-mil Estar base which has a green antihalation pelloid backing. The films reciprocity characteristics are such that it operates at peak efficiency with expose times on the order of that used in the stellar cameras. This material is processed in the Trenton processor at a single level development.

Resolving power: 1,000:1 = 109 cycles per millimeter
1.7:1 = 43 cycles per millimeter

AEI: 60.0

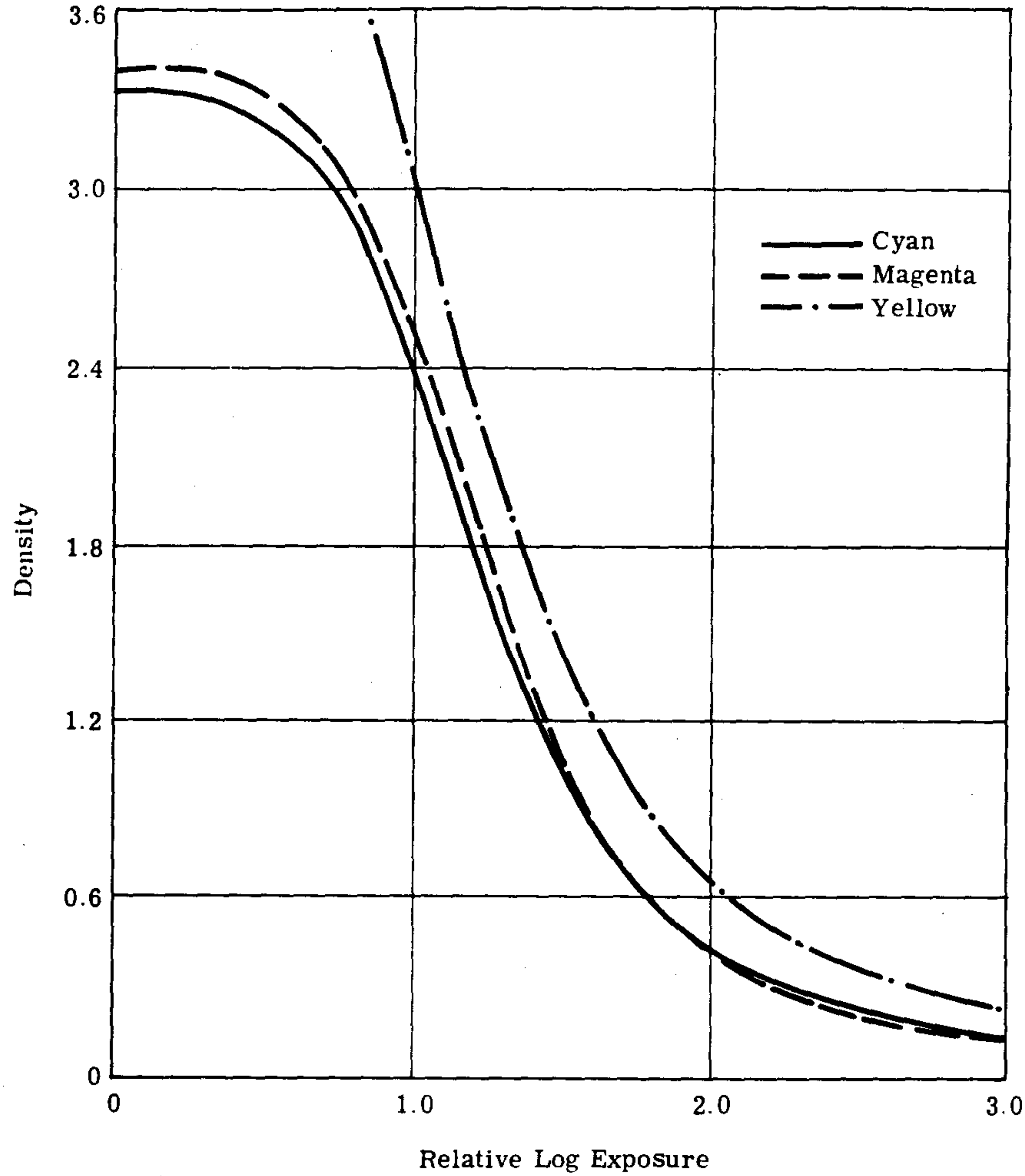
SENSITOMETRIC CURVES FOR TRENTON SPRAY PROCESSING

3404 Index Camera Film
3401 Stellar Camera Film
3404 Panoramic Camera Film

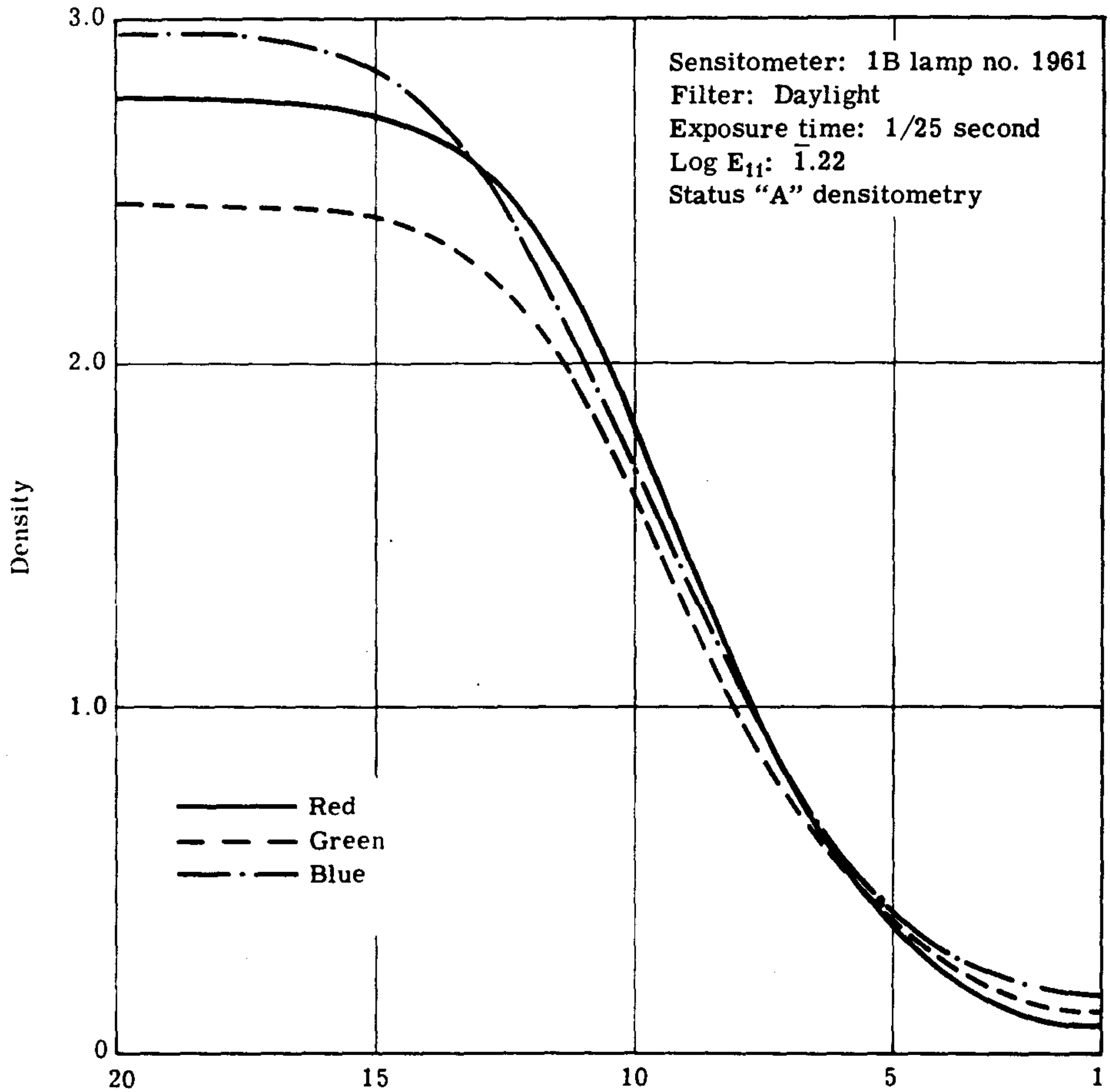


Absolute Log Exposure

SENSITOMETRIC CURVE FROM MAIN CAMERA MATERIAL SO-121

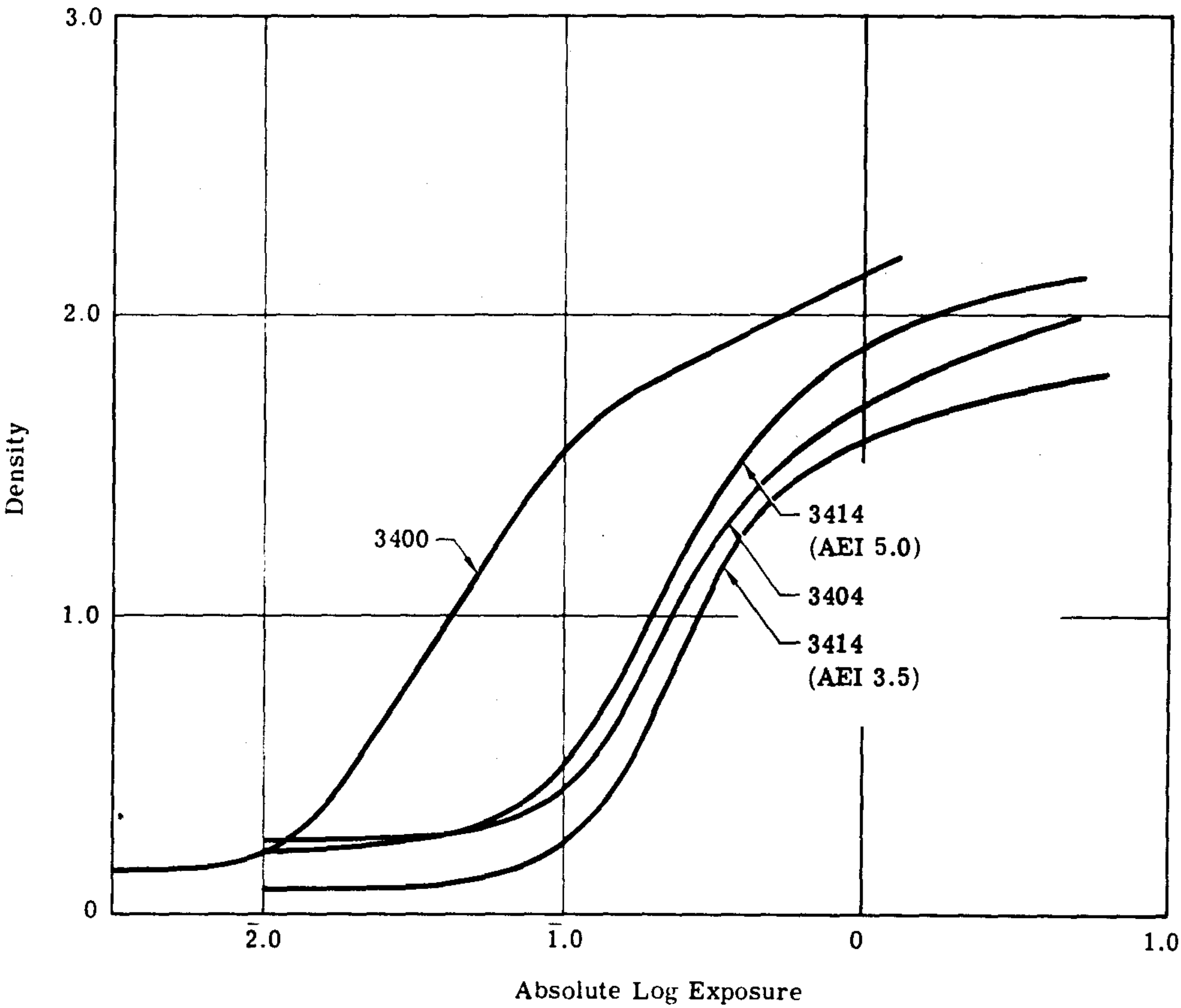


SENSITOMETRIC CURVES FOR SO-242

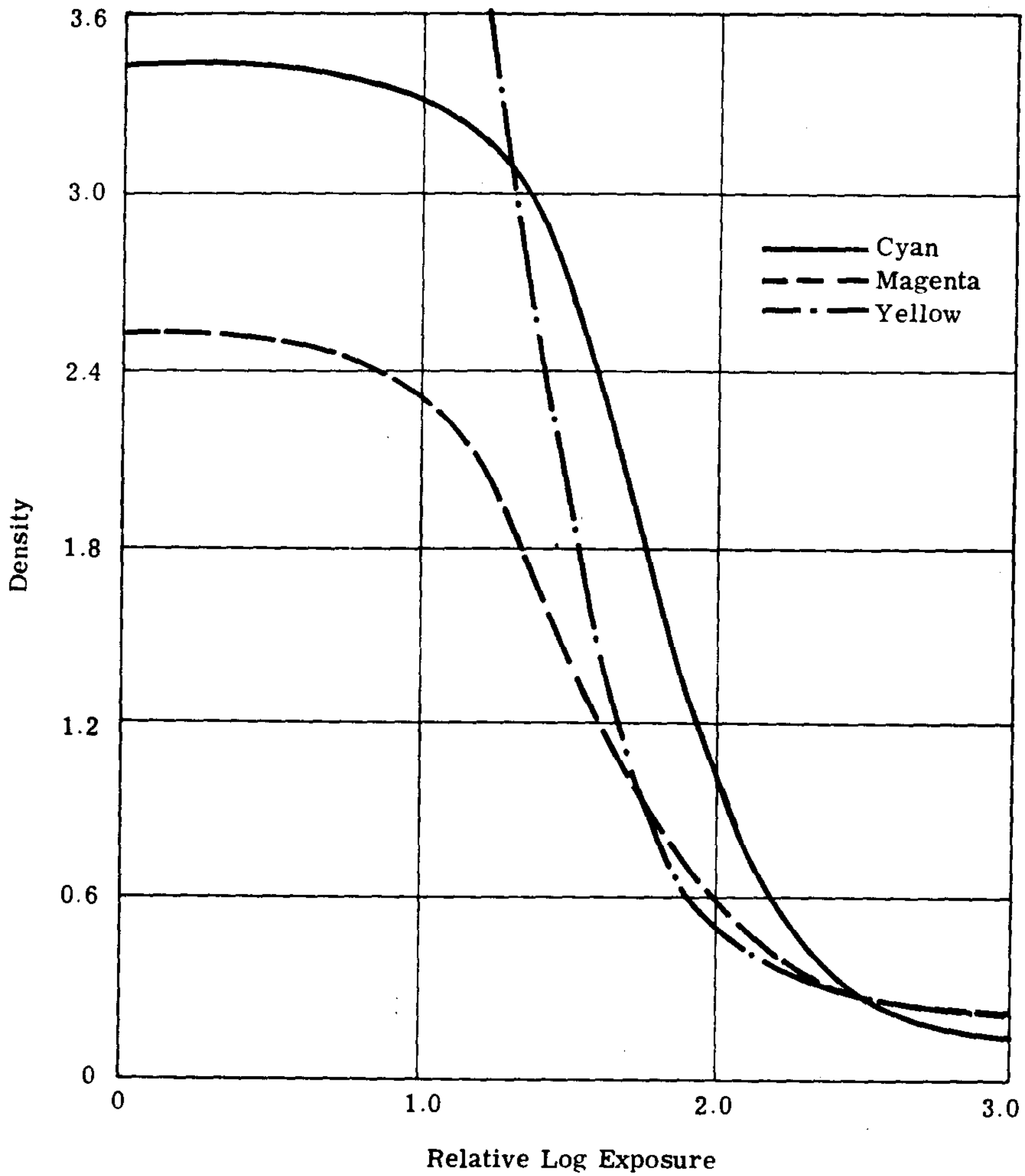


SENSITOMETRIC CURVES FOR YARDLEIGH VISCOUS PROCESSING

3400 Index Camera Film
3404 Panoramic Camera Film
3414 Panoramic Camera Film

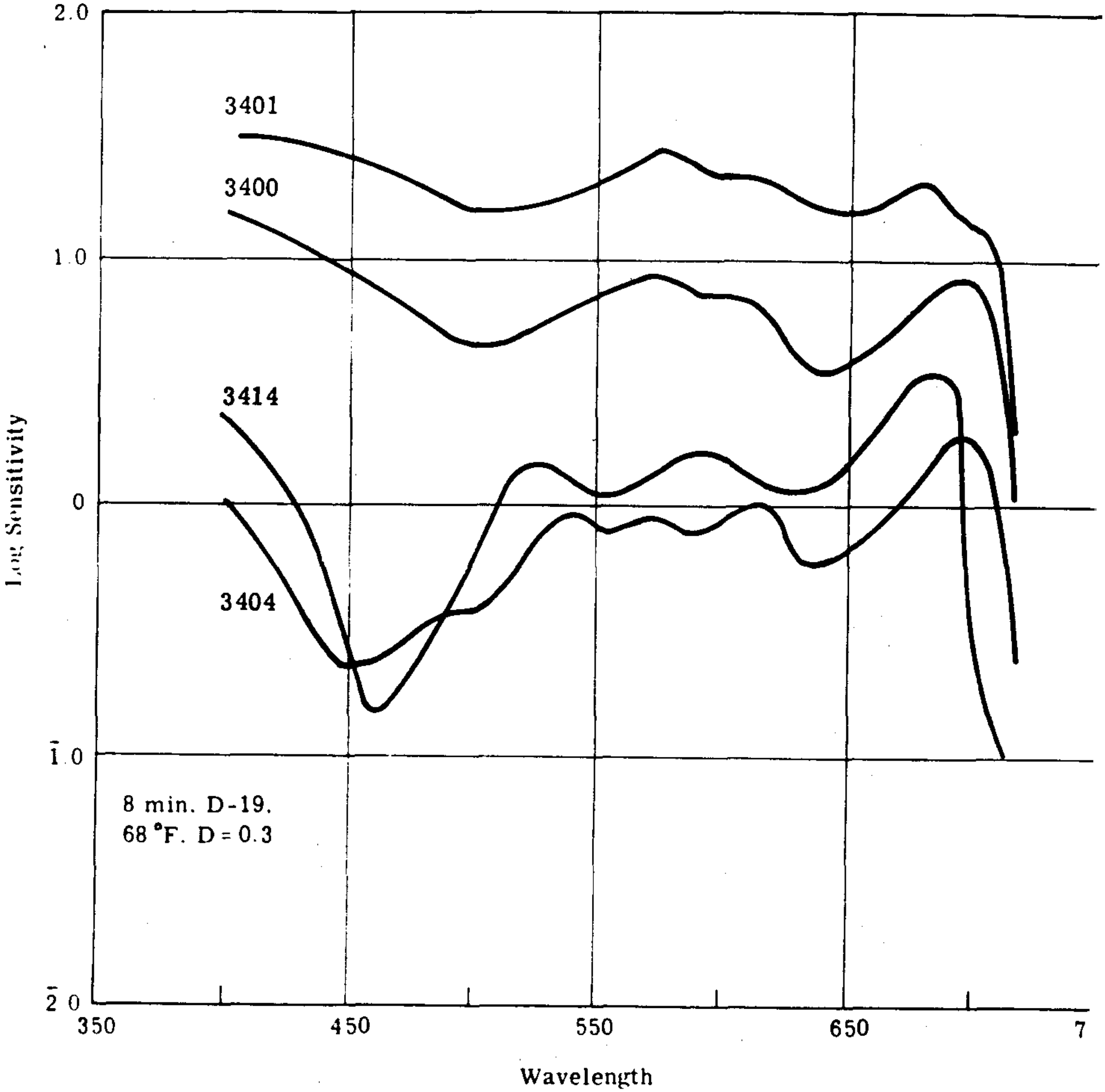


SENSITOMETRIC CURVE FROM MAIN CAMERA MATERIAL
SO-180

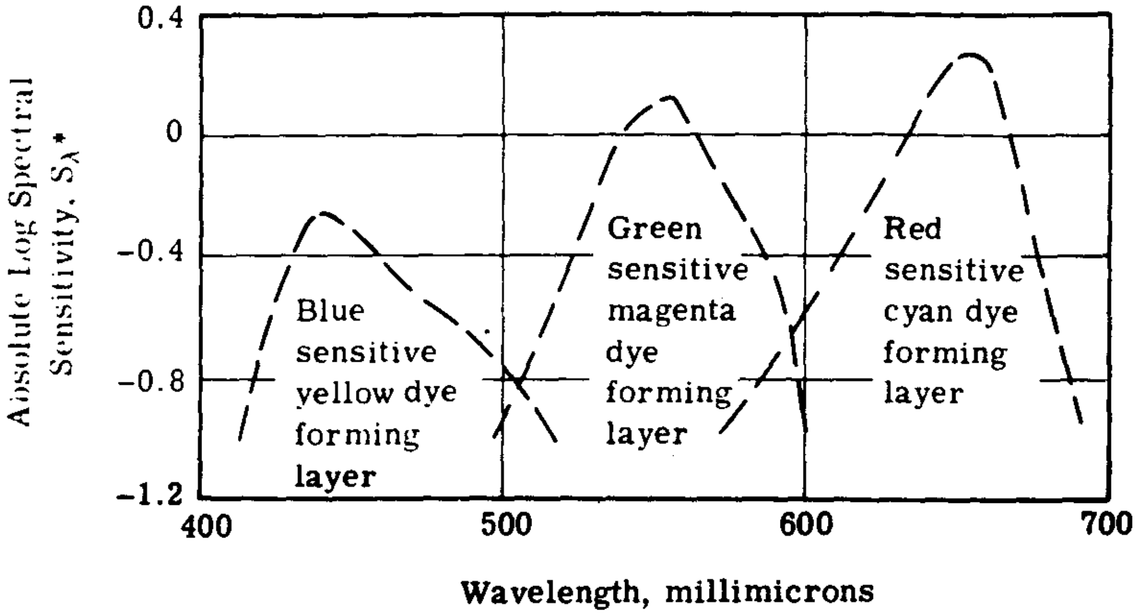


SPECTRAL SENSITIVITY

Kodak Panatomic-X Aerial Film 3400
Kodak Plus-X Aerial Film 3401
Kodak High Definition Aerial Film 3404
Kodak High Definition Aerial Film 3414

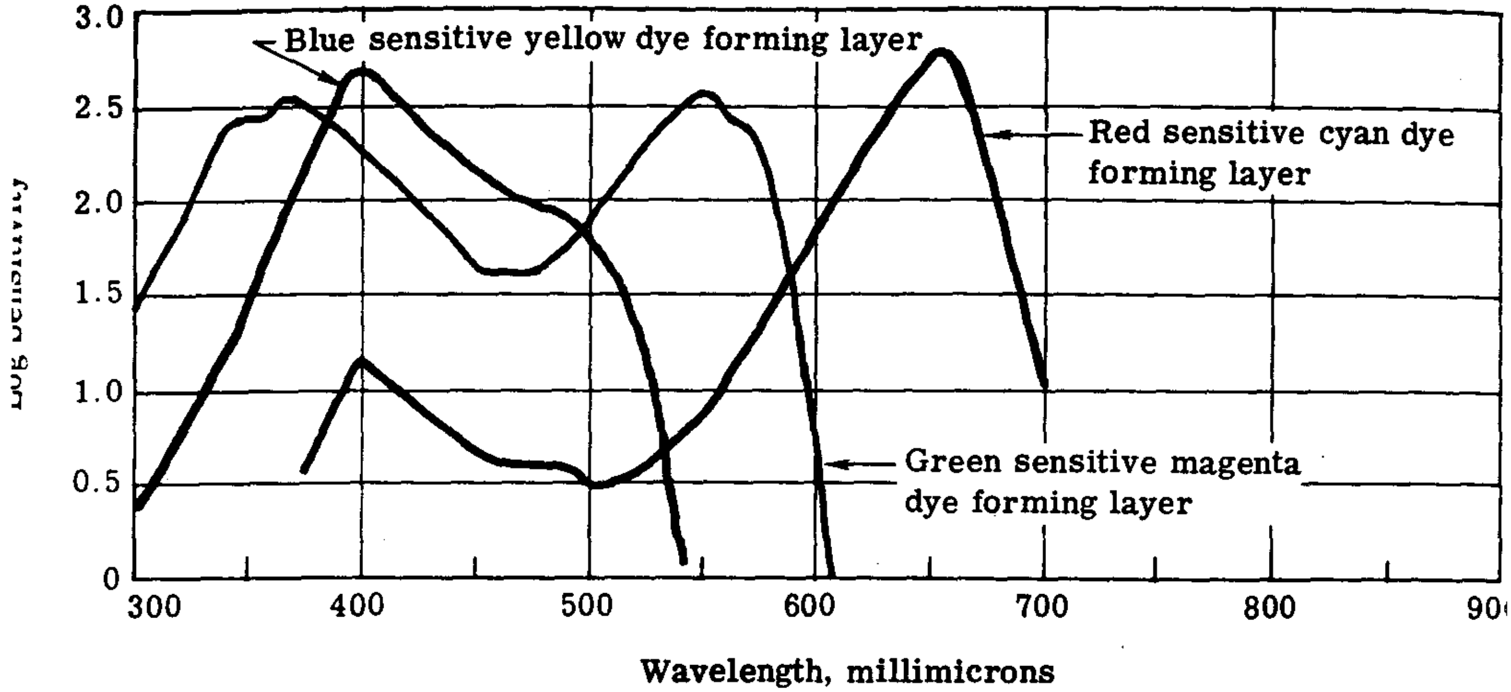


ABSOLUTE SPECTRAL SENSITIVITY OF SO-242 FILM

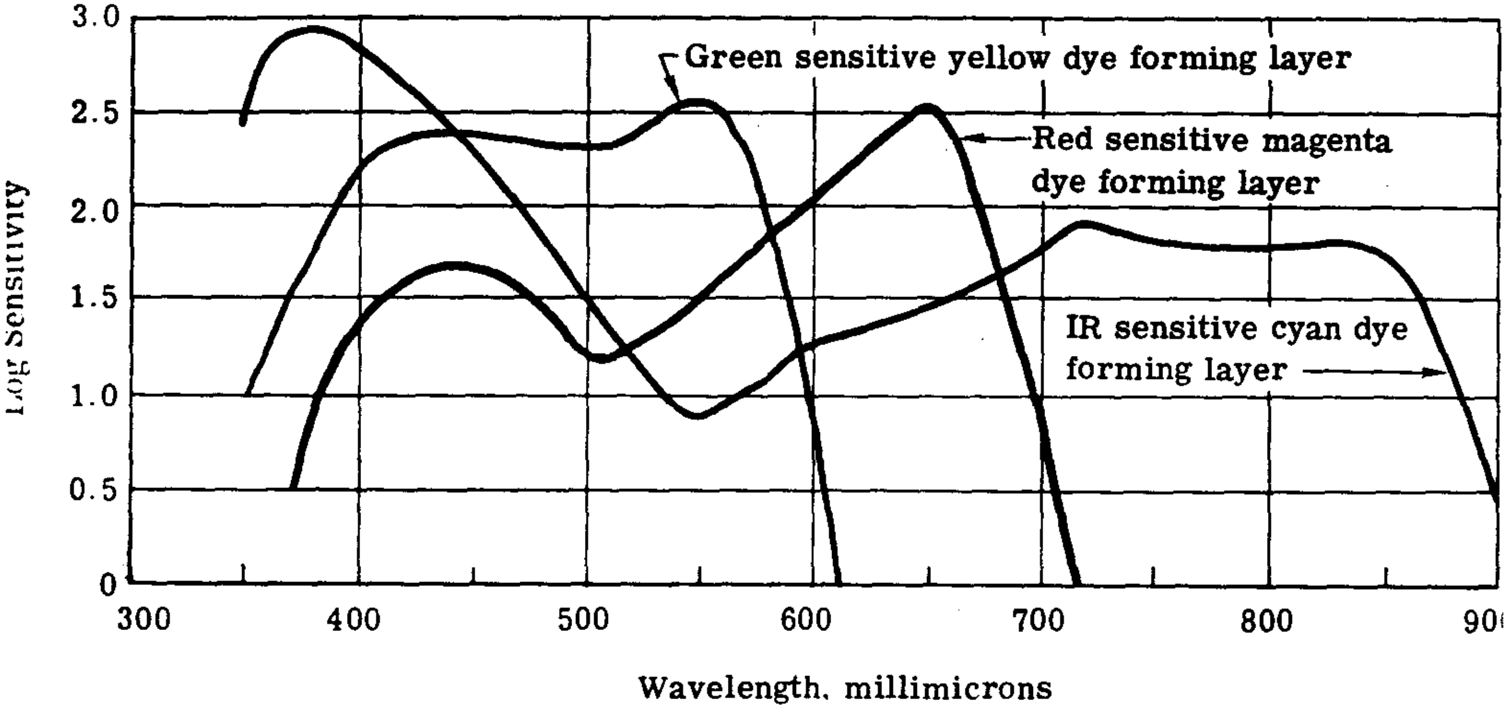


* $S\lambda = 1/E\lambda$, where $E\lambda$ is energy (ergs/cm^2) of monochromatic light of wave length, λ, required to reduce the dye image density in individual dye layers to an equivalent neutral density of 1.0 above minimum density.

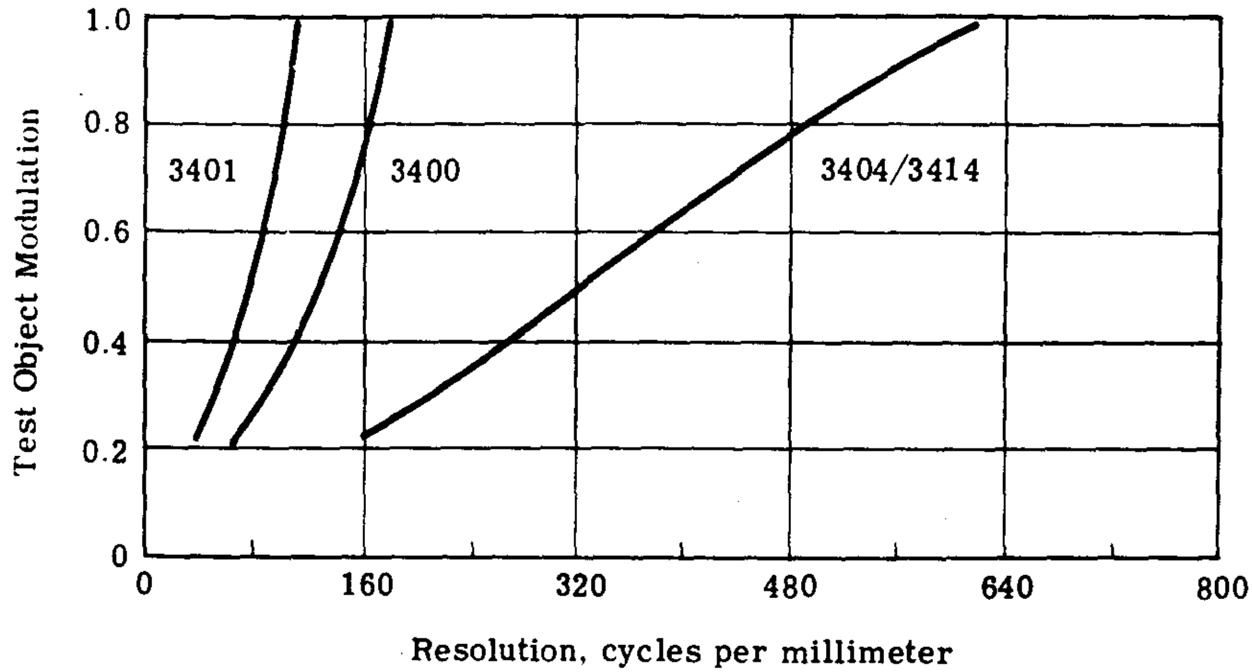
SPECTRAL SENSITIVITY SO-121



SPECTRAL SENSITIVITY SO-180



TEST OBJECT CONTRAST VERSUS RESOLUTION



FILTERS

Eastman Kodak manufactures a wide variety of gelatin filters for use in almost all fields of pictorial and scientific photography. Most of the filters are 0.004-inch gelatin that have been coated with a lacquer for protection. A few of the filters are available in glass only, and most of the gelatin filters are available cemented between glass. There are four main classes of filters: Wratten, color correction, and photometric and light balancing.

The Wratten filters are available in approximately 100 different spectral colors. They range from almost clear to saturated colors visually representing most wavelengths and some cases combinations of wavelengths in the spectrum. This class of filters includes the haze cutting filters used by CORONA. The color correction filters are used to adjust the color balance for color films with both ground and aerial photography. These filters, unlike the Wratten filters, are not saturated but are pastel in color. The photometric and light balancing filters are used to change the color temperature of a light source to match that required for a particular color film sensitivity. These filters, though, are not generally employed in aerial reconnaissance.

Filters are required for most aerial reconnaissance systems in order to counteract the contrast reduction effects from the bluish haze light. The spectral filters commonly employed are Wratten gelatin filters and are yellow to red in color. Generally, the deeper red the filter, the greater the haze cutting ability, and hence, the higher the contrast. There is a tradeoff though that must be considered in selecting the best filter for any given camera. The redder the filter, the higher the filter factor which in turn makes longer exposure times necessary. Thus, filters are chosen that provide the best contrast without too much image smear. These considerations are then incorporated into the lens design so that performance can be optimized for that region of the spectrum.

The polarizing filters are also coated on 0.005-inch quartz but are made by Polacoat. The dye molecules for the polarizer coating are deposited on the charged glass substrate and become oriented with respect to the charge. In order to have maximum effect on the polarized component of the atmosphere the axis of polarization must be aligned with the sun/target/camera plane. The coating, therefore, must take into account the predicted solar position during the mission. The filter used on mission 1102, for example, had the axis of polarization at a 20-degree angle to the flight line.

An in-flight focus-adjust capability can be introduced into the CORONA system by using filters of different thicknesses in the primary and alternate positions. A 0.001-inch focal shift is obtained with a 0.003-inch filter thickness difference. This can be done with either a 0.004-inch gelatin/ 0.007-inch glass combination or with a 0.037-inch glass/0.040-inch glass combination.

MAIN PANORAMIC CAMERA FILTERS

The haze cutting filters for J-3 consist of either a Wratten 21, 23A, or 25. Operational conditions and specific lens types govern the choice of specific filter for a mission. A third generation Petzval lens, for example, is designed for a Wratten 25 filter. However, for a winter mission, where the exposure time would be long, total system performance could be enhanced by using a Wratten 23A filter with an appropriate reduction in exposure time due to the lower filter factor.

J-3 has a filter switching mechanism that allows the mission to be flown with two filters per camera. The primary filter position is generally used for most of the mission, the alternate filter can be commanded into position on real time or automatically with a material change detector (MCD) on the film. This is particularly useful when a split film load is flown. The change in filter factor can be accommodated by changing the exposure slits. There are a variety of special filters that have been used for specific purposes, and these are described later in this text.

DISIC — INDEX CAMERA FILTER

The higher f/no. of this system requires that the filter factor be low. The Wratten 12 filter is used, having a factor of 1.5. In order to maintain the precision geodetic characteristics of the camera, the filter is an integral part of the system, and therefore a filter changing mechanism is not employed. The Wratten 12 filter is yellow in color and has the widest bandpass of all filters on CORONA.

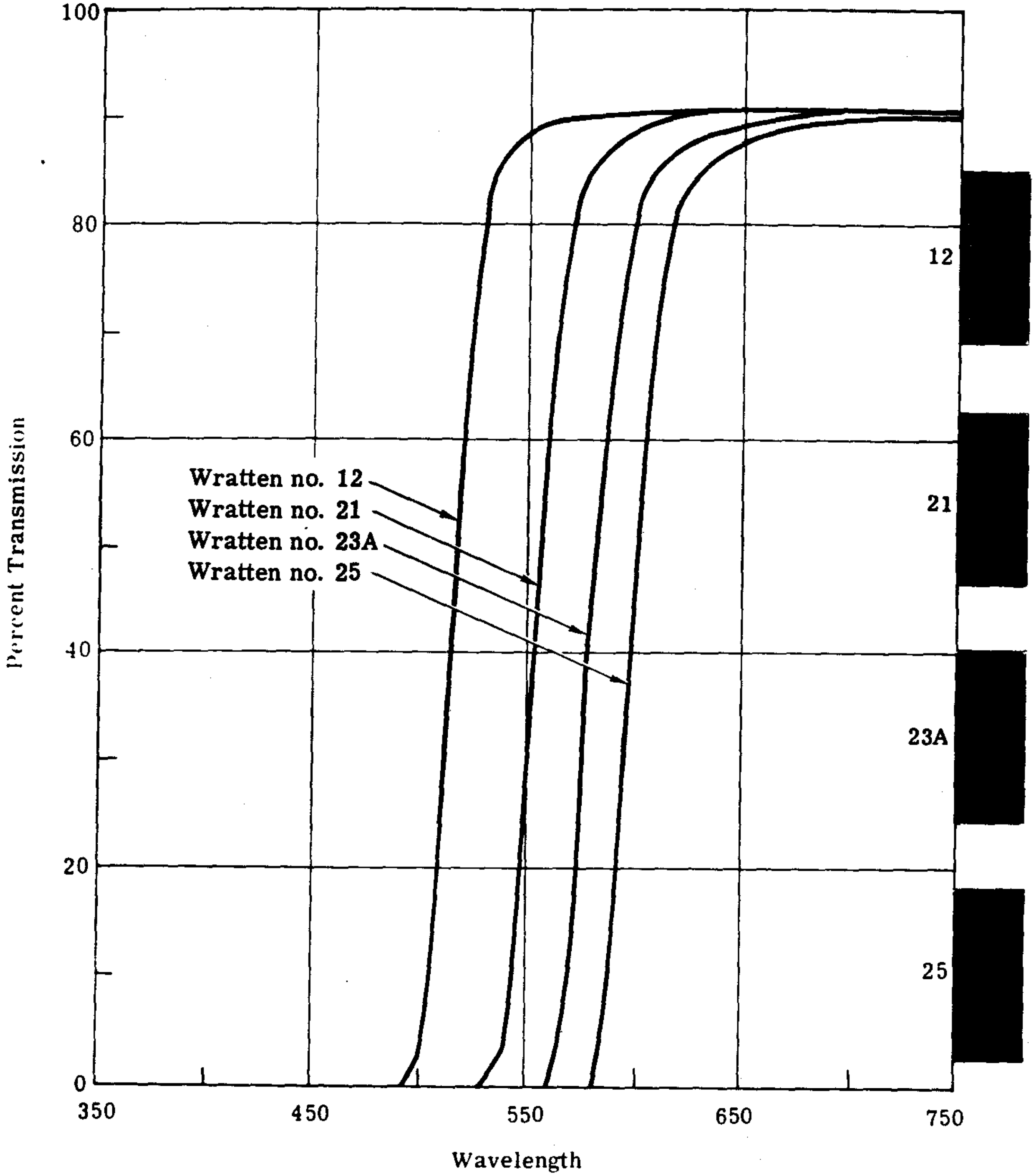
DISIC — STELLAR CAMERA

The purposes of the stellar portion of DISIC is to provide interlocking photographs of star patterns with the terrain photography. There are no requirements for filters on these lenses.

HORIZON OPTICS

The main purpose of the horizon optics is to obtain a clear horizon image for determination of vehicle attitude. The filter employed is a glass mounted Wratten 25 filter. By using a glass filter it is not necessary to change the filter through the testing cycle as with the main panoramic cameras. The lens/filter combination is tested and calibrated as an integral unit in order to maintain geodetic accuracy. Although there is no filter changing mechanism, there is provision for higher speed films on split load missions. There is a filter arm that contains a neutral density filter that can be put in front of the lens. However, the glass Wratten 25 cannot itself be removed. This provides satisfactory calibrated imagery for higher speed black and white films although there is no provision for obtaining correct color balance with color films in the horizon images.

FILTERS USED WITH PANORAMIC CAMERA AND DISIC



SPECIAL PURPOSE FILTERS FOR PANORAMIC CAMERAS

Filters for special photographic techniques have been fabricated for use in the alternate filter position of J-3. These filters fall into either one of two categories of substrate: gelatin and glass.

The filters used for color film, SO-121 and SO-180, are composite color correction filters in a gelatin support that have a metal Inconel overcoating. These are fabricated by Eastman Kodak and are tailored for the particular film batch-mission conditions that they will encounter.

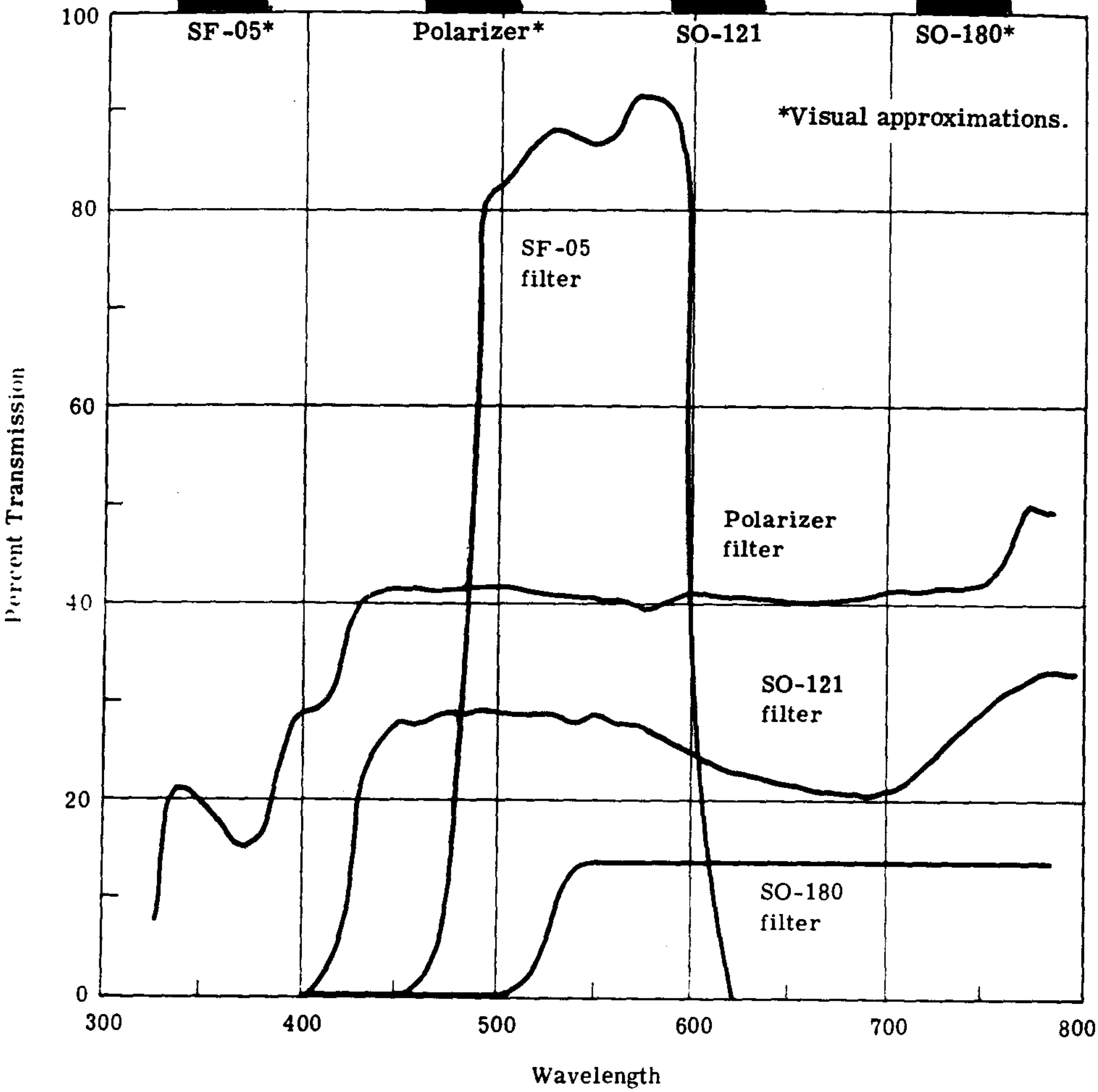
SO-121 must be used with at least two different filters in order to obtain high quality color. In order to maintain high quality performance, though, only one filter can be used; thus the composite coating serves both functions well. One of the components is a light yellow filter (Wratten 25) and is used for reducing the blue effects of the haze. However, this haze reduction technique gives an overall yellow cast that must be compensated with a blue color correction component, i.e., 20CCB. Color films are higher speed than 3404 and would therefore require smaller exposure slits. However, the slit sizes available for a mission are not large enough to encompass the latitude of both color and black and white. A neutral density coating is added to the filter to effectively reduce the speed of the color film to the point that it is the same as the 3404 with its primary filter. In order to acquire color photography in areas not accessible by tracking stations the effective speed must be made exactly the same as the primary film/filter combination so that the automatic slit sequencing can be used for both films. Generally a Wratten 21 filter is used on the AFT-looking camera and a Wratten 25 on the FWD-looking camera. The filter factor difference is 50 percent and is accounted for in the preflight slit selection. It is therefore necessary to know which camera the color film is to be used on prior to flight so that the correct amount of neutral density can be added.

There are two special techniques that can be used on J-3 that require filters not available from Eastman Kodak: bi-color and polarization. The bi-color technique calls for a green filter similar to the Wratten 57. However, dye filters characteristically have high filter factors in the green portion of the spectrum. Satisfactory green filters are made by OCLI through a metal deposition technique. employing thin quartz as the substrate. In order to avoid the problem of refocusing the camera for the alternate filter the glass thickness was chosen to be the same as the gelatin filters, 0.005 inch. These bi-color filters appear visually similar to a bright Wratten 57 and have a filter factor of 2.8.

The polarizing filters are also coated on 0.005-inch quartz but are made by Polacoat. The dye molecules for the polarizer coating are deposited on the charged glass substrate and become oriented with respect to the charge. In order to have maximum effect on the polarized component of the atmosphere the axis of polarization must be aligned with the sun/target/camera plane. The coating, therefore, must take into account the predicted solar position durin the mission. The filter used on mission 1102, for example, had the axis of polarization at a 20-degree angle to the flight line.

SPECIAL FILTERS FOR PANORAMIC CAMERA

[redacted] [redacted] [redacted] [redacted]



KODAK WRATTEN PHOTOMETRIC FILTERS

78

78 A

78 AA

78 B

78 C

86

86 A

86 B

86 C

KODAK LIGHT BALANCING FILTERS

80 A | 80 B

80 C | 80 D

81 | 81 A

81 B | 81 C

81 D | 81 EF

82 | 82 A

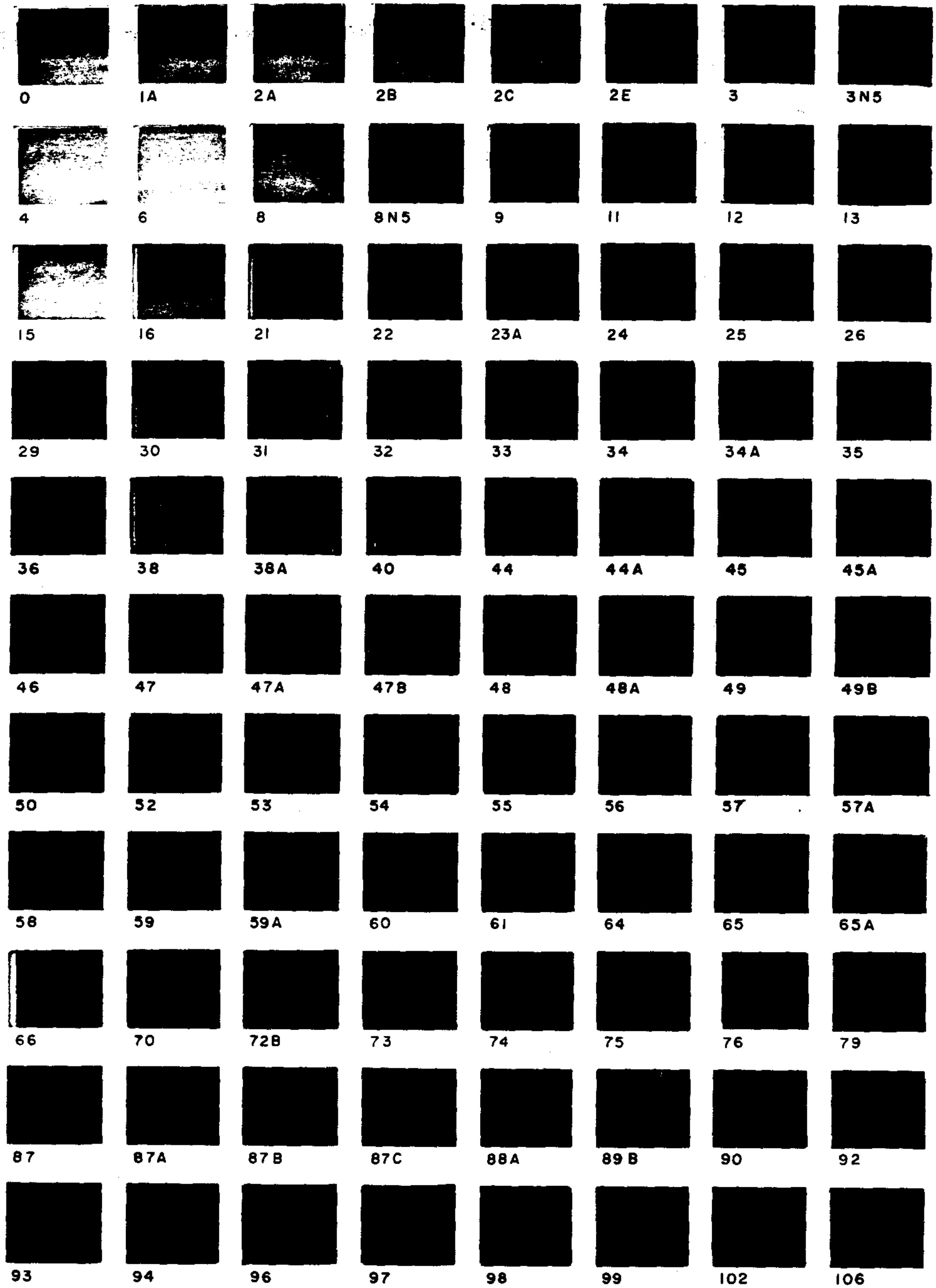
82 B | 82 C

85 | 85 B

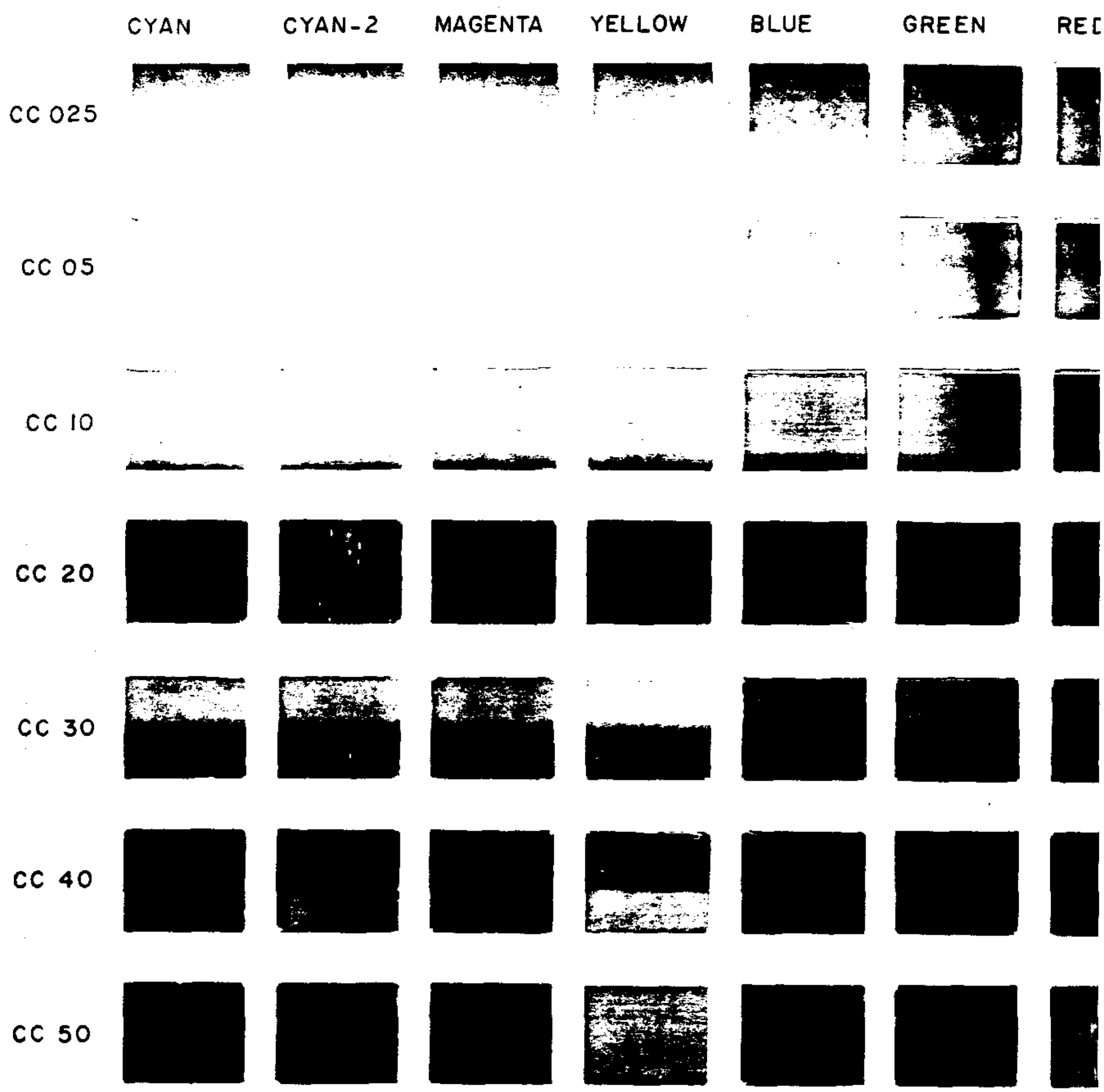
85 C | 85 N3

85 N6

KODAK WRATTEN GELATIN FILTERS



KODAK COLOR COMPENSATING FILTERS



OPERATIONS