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Final Report
31 March 1982

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Itek 82-8466-1

NASA-CR-167629

# Feasibility Evaluation and Study of Adapting the Attitude Reference System to the Orbiter Camera Payload System's Large Format Camera

Final rept.

Prepared for
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS 77058

Under Contract No. NAS9-16562


(NASA-CR-167629) FEASIBILITY EVALUATION AND STUDY OF ADAPTING THE ATTITUDE REFERENCE SYSTEM TO THE ORBITER CAMERA PAYLOAD SYSTEM'S LARGE FORMAT CAMERA Final Report (Itek Corp.) 165 p HC A07/MF A01 CSCL 22B G3/18 N82-33420 Unclas 27750



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82-045

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# 1. INTRODUCTION

Accurate line of sight (LOS) pointing information for the LFC is a desirable addition to provide a mapping capability for the Orbital Camera Payload System (OCPS) when ground control points are not available. Through the use of stellar imagery collected by a pair of cameras whose optical axes are structurally related to the LFC optical axis, such pointing information is made available. This study has been performed to develop a design concept that will implement such a system.

A straightforward approach to an Attitude Reference System (ARS) involves two ballistic lenses mounted at right angles to each other and to the terrain viewing lens. All three lenses must be structurally related so that after calibration, the angular relationships are preserved to arc-seconds tolerance. A dual-platen film transport interfaced with appropriate supply and takeup spools is required to collect exposures and manage film useage. Shutters which can be synchronized to the terrain camera exposure to milliseconds accuracy complete the basic package.

While several approaches are possible, the use of available and suitable Government Furnished Equipment (GFE) is particularly attractive from a cost and schedule viewpoint. Such an approach to an ARS was described in an internally funded Itek paper "Conceptual Overview of Photographic Attitude Reference Package (PARP) for Large Format Camera (LFC)", dated February 1981. This study program has reinforced the validity of the approach, with minor conceptual changes.

Referring to Figure 1-1 (General Configuration: ARS Module for NASA LFC Camera), GFE components include:

1. A pair of shutters of the "barn door" type.
2. A pair of 6-in. focal length f/2.8 lenses.
3. A dual-platen film transport with a station for auxiliary data display.
4. One film cassette and spare parts for a second plus several spools.

These GFE components are assembled into an ARS by means of the following new-design hardware, to be provided as a part of the ARS Hardware Implementation phase:

1. A housing which provides the means of structurally relating the lenses and the film transport.
2. Cassette brackets and film chutes which provide the means of attaching the supply and takeup cassettes to the housing and the light tight film passageways.
3. Shutter Housings which provide the means of attaching the shutters in front of the lenses, and the baffles ahead of the shutters. This housing also completes the enclosure of the lens providing the surface area to mount thermal control components.
4. Baffles which reduce the possibility of non-imaging light rays striking the entrance pupil and lowering detectability of dim stars.
5. A Sun Sensor Module (not shown in the figure) which inhibits shutter openings when the sun is in the field of view
6. A Support Structure which provides the attachment means between the ARS and the LFC.

7. An Electronics Assembly which houses the bulk of the circuitry to run the ARS. (While many of the mechanisms have been identified as GFE, the circuitry to control them is generally of new design).

8. The Environmental Enclosure which consists of several insulating blankets.

The major subassemblies, and key components within them are listed on Fig. 1-2 (ARS Hardware Family Tree). Each subassembly is addressed in the body of this report.

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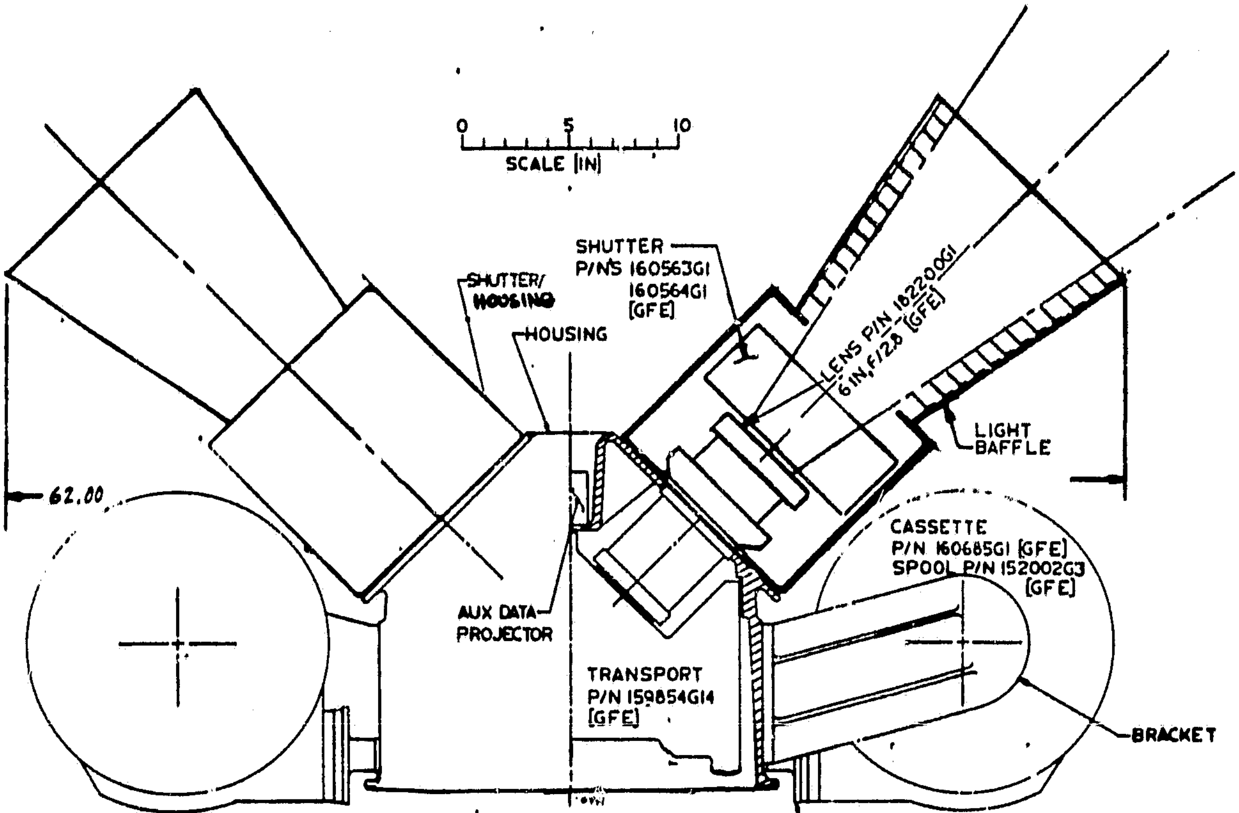
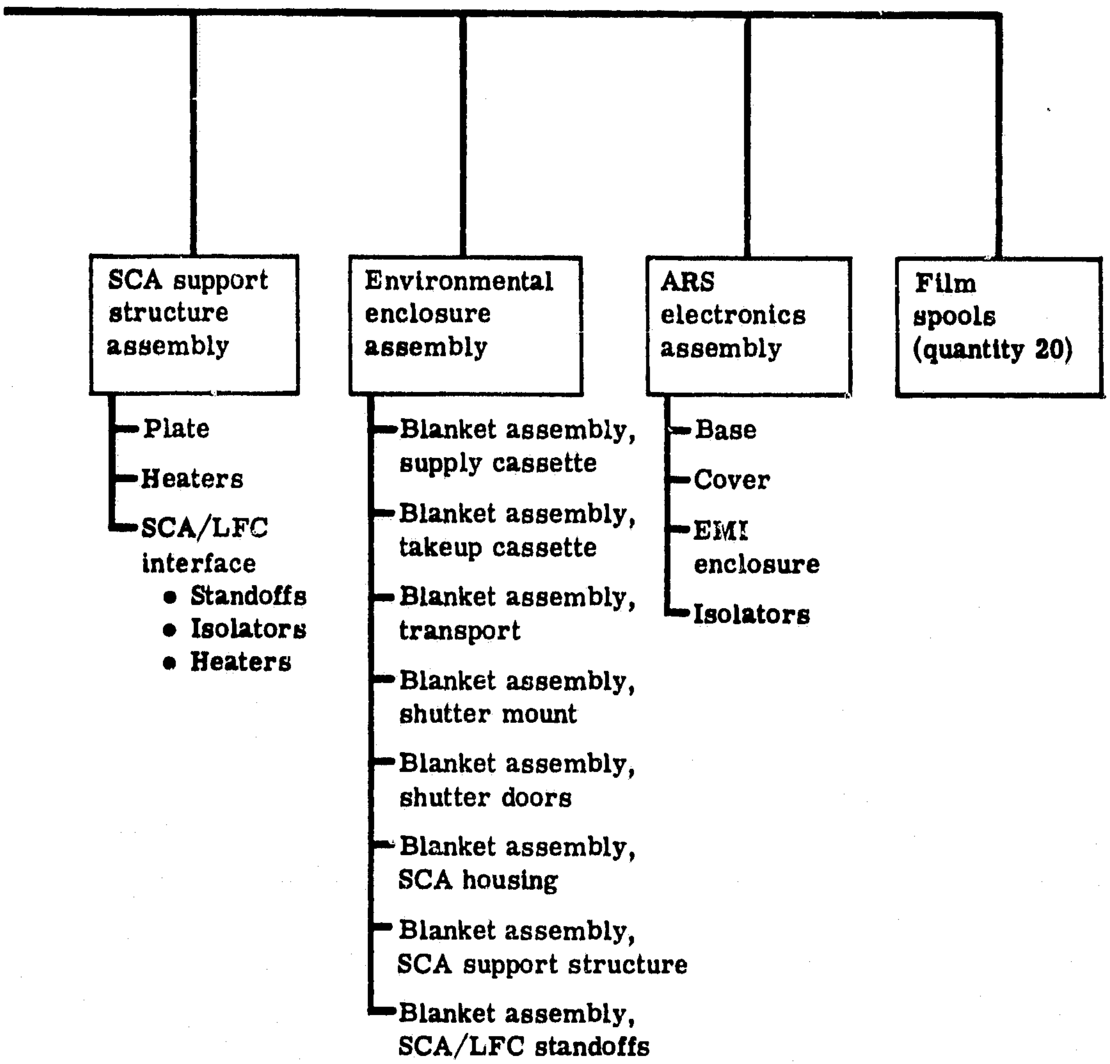



FIG GENERAL CONFIGURATION
ARS Module for
NASA LFC CAMERA


SCA support structure assembly
Plate
Heaters
SCA/LFC interface
• Standoffs
• Isolators
• Heaters
Environmental enclosure assembly
Blanket assembly, supply cassette
Blanket assembly, takeup cassette
Blanket assembly, transport
Blanket assembly, shutter mount
Blanket assembly, shutter doors
Blanket assembly, SCA housing
Blanket assembly, SCA support structure
Blanket assembly, SCA/LFC standoffs
ARS electronics assembly
Base
Cover
EMI enclosure
Isolators
Film spools (quantity 20)

# 2. PRIMARY CONSIDERATIONS

## 2.1 LOCATION AND FIELD OF VIEW

The location of the ARS with respect to the LFC is indicated on drawing 920003 (see Fig.2-1). The vertical distance between the top (the side near the ARS) of the LFC camera support structure and the plane of the SCA lens optical axes is 13.38 inches. Projections of the two SCA optical axes back through their focal planes intersect at a point 30.62 inches from the LFC optical axis.

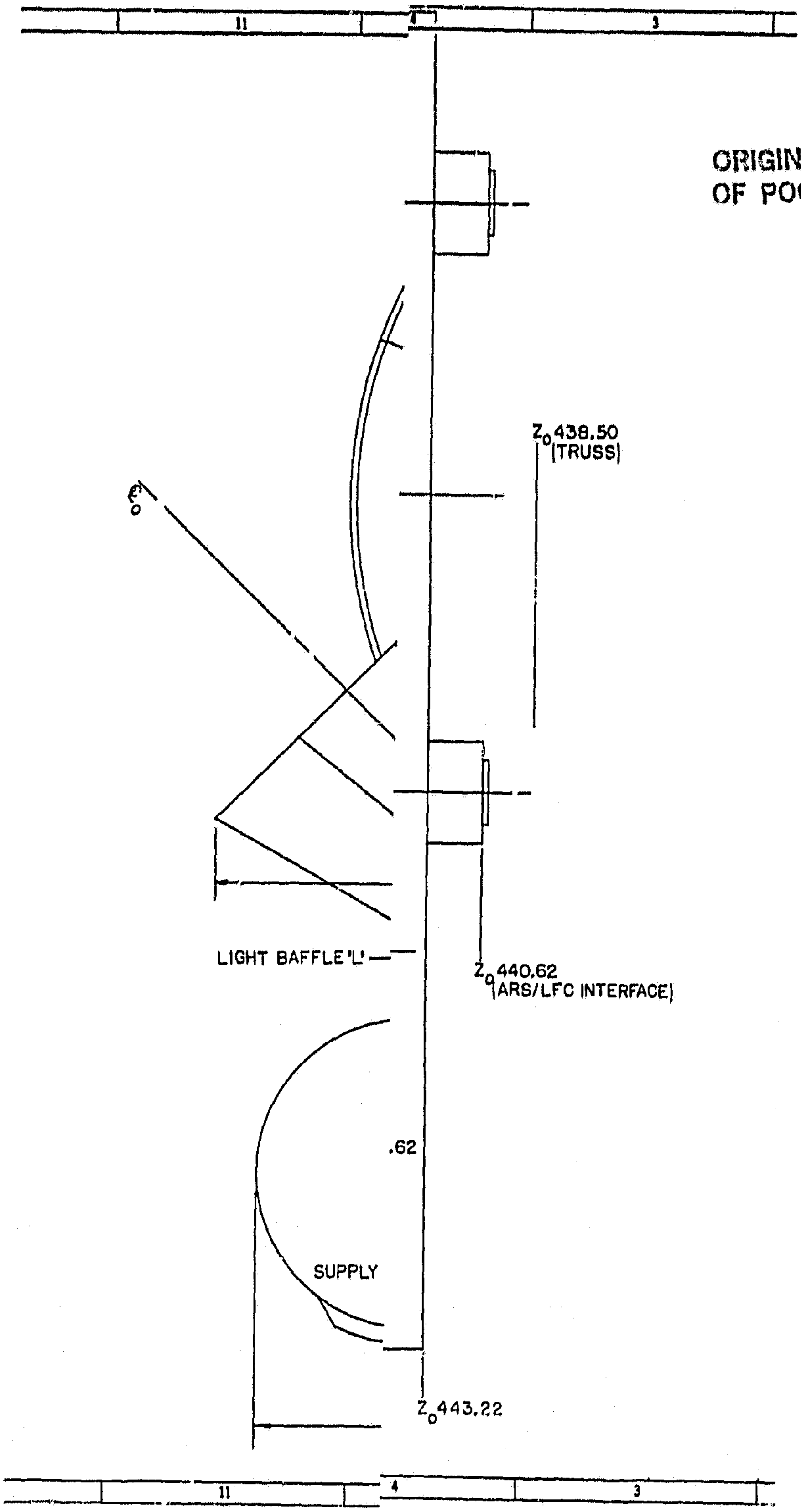
The angular relationship of the SCA to the LFC is constrained to one of four positions, as the LFC will always be oriented with its LOF reference along the orbiter line of flight while the SCA can be mounted in whichever of the four $90^{\circ}$ incremental positions provide it with the best field of view.

The field of view (FOV) of each SCA lens has a maximum value in the XY plane of $\pm 15^{\circ}$ as determined by 3.25 inch maximum useable format and a 6 inch focal length lens. Refer to Figure 2-2, ARS FOV Limits in XY plane and drawing 920000, the ARS Field of View study (Fig 2-3). This X, Y plane FOV will provide the basic limits for an avoidance envelope with the shuttle. For missions where such an envelope is not available, modifications to the ARS baffles can reduce the envelope by reducing the maximum image format of the SCA.

In the Z direction, the FOV is limited to $9.6^{\circ}$ in + Z due to a baffle plate that limits the FOV to imaging rays which pass not closer to the earth's surface than 50 nautical miles (see the section on baffles) and to $12.9^{\circ}$ in - Z due to the maximum possible image format on a piece of 70 mm film.

The location of the OCPS with the STS has been defined in the Z direction as $Z_0$ 438.5 for a mounting surface. The X and Y coordinates of $X_0$ 578.0 and $Y_0$ 42.3 have been assumed for the purpose of the field of view study. This assumption is derived from the transmittal of two drawings form NASA JSC to Itek to be used as study baselines (identified only by title, they are "Looking aft from $X_0$ 578" and LFC Mounting (on MPESS)").

The X, Y, and Z locations are not necessarily limited to those values given. A study of the FOV in three dimensions should be made for any location to ascertain the desirability of that location, the best orientation for the ARS, and any constraints on neighboring payloads.



11
4
3
$Z_0$ 438.50
(TRUSS)
LIGHT BAFFLE 'L'
$Z_0$ 440.62
(ARS/LFC INTERFACE)
.62
SUPPLY
$Z_0$ 443.22
11
4
3

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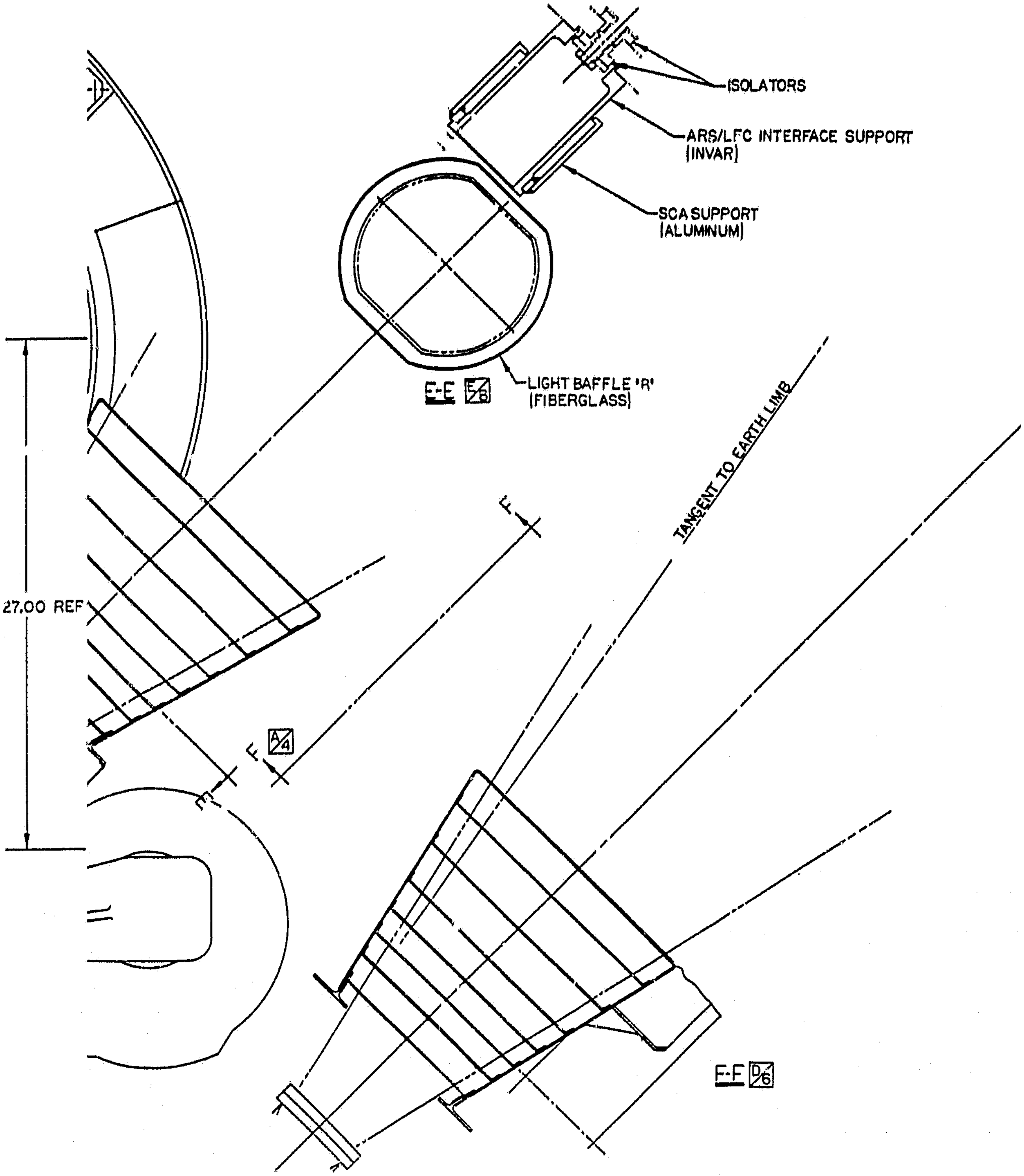

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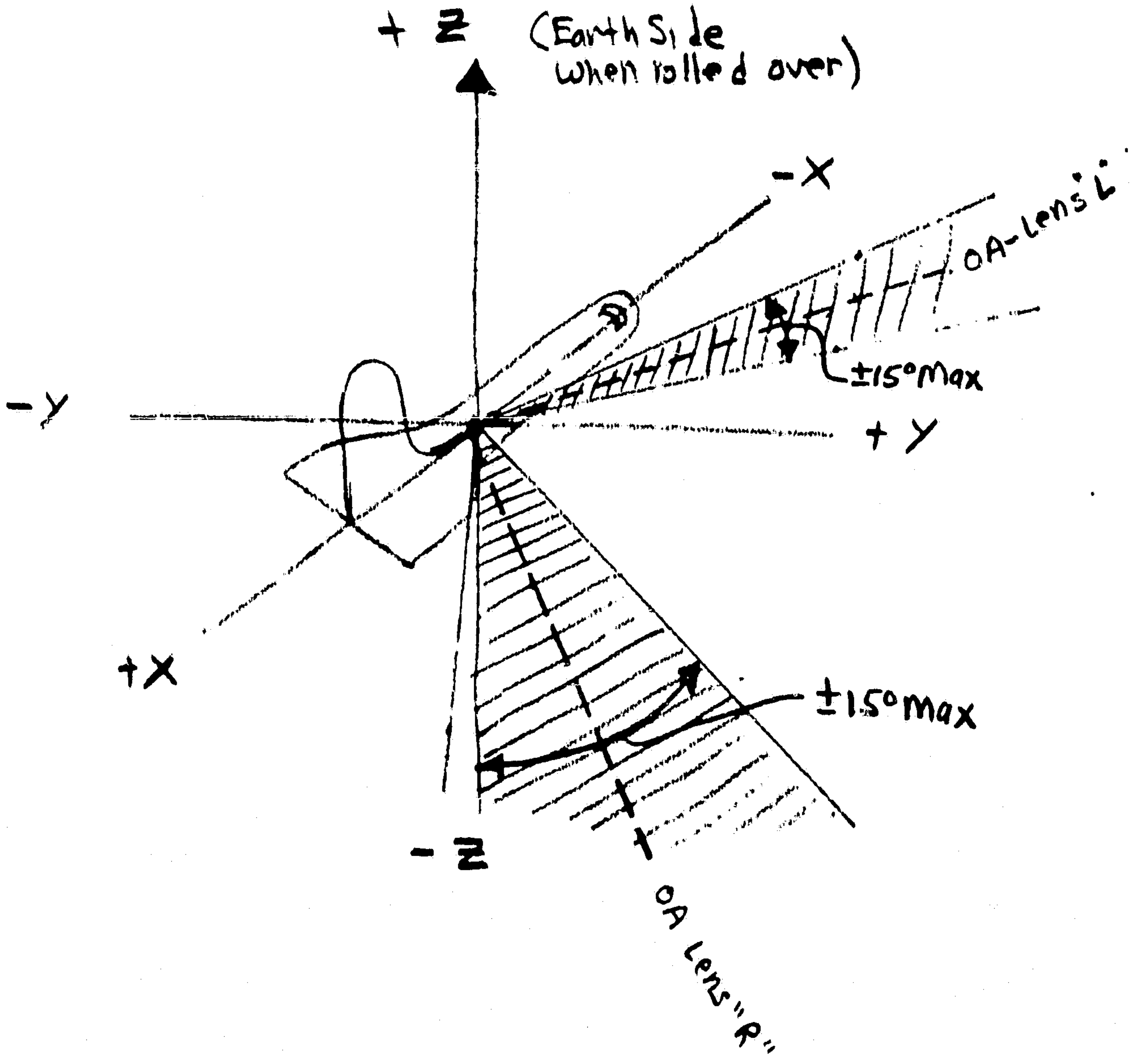


Fig. 2-2

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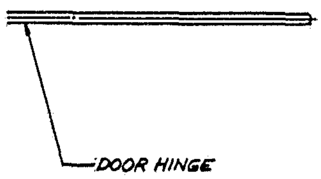
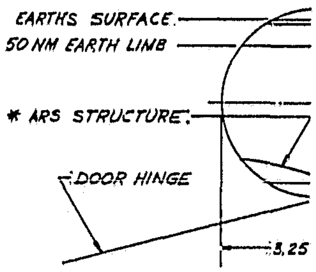



NM ABOVE EARTH

)




FOCAL PL
SCALE

* STRUCTURE TO L

## 2.2 ARS FORMAT

The ARS Format is dictated primarily by the layout of the GFE film transport and the GFE lenses.

The transport is so configured that the nominal position of the two lenses optical axes as they impinge on the film is 5.92 inches apart. Further, the lenses constrain the maximum image format to be cut by a 3.25 inch circle. The resultant format is depicted in fig 2-4 (ARS Format).

Between the two image formats is an auxiliary data (AUX DATA) area in which LED character generators print out data in human readable characters. The data so printed is depicted in the detail of fig 2-4, referenced above and includes:

- Station L CE Mismatch in milliseconds, which represents the time difference between an LFC center of exposure and the corresponding ARS Left looking camera center of exposure,
- Station R CE Mismatch in milliseconds, which represents the time difference between and LFC center of exposure and the corresponding ARS Right looking camera center of exposure and,
- LFC Frame Number which represents the LFC frame number corresponding to this ARS frame.

The relationship of an ARS frame to GMT is developed by adding the mismatch to the LFC CE time, found on the LFC AUX DATA presentation.

Within the Image format is the Mask reseau grid, reseau S/N and station indicator (R for right hand or L for left hand - - - - for a starboard mount, looking out, station L is forward and R is aft). Among the reseau, the central reseau is encircled, for reference and use as an origin. Four "crow's feet" are also included among the reseau as a quick check on orientation. The frame cannot be flipped or rotated in any combination of maneuvers that cannot be quickly spotted by checking these "Crows Feet". Refer to figure 2-5 (ARS Mask and Reseau).

| BY: | | TITLE: ARS FORMAT | PAGE: |
|---|---|---|---|
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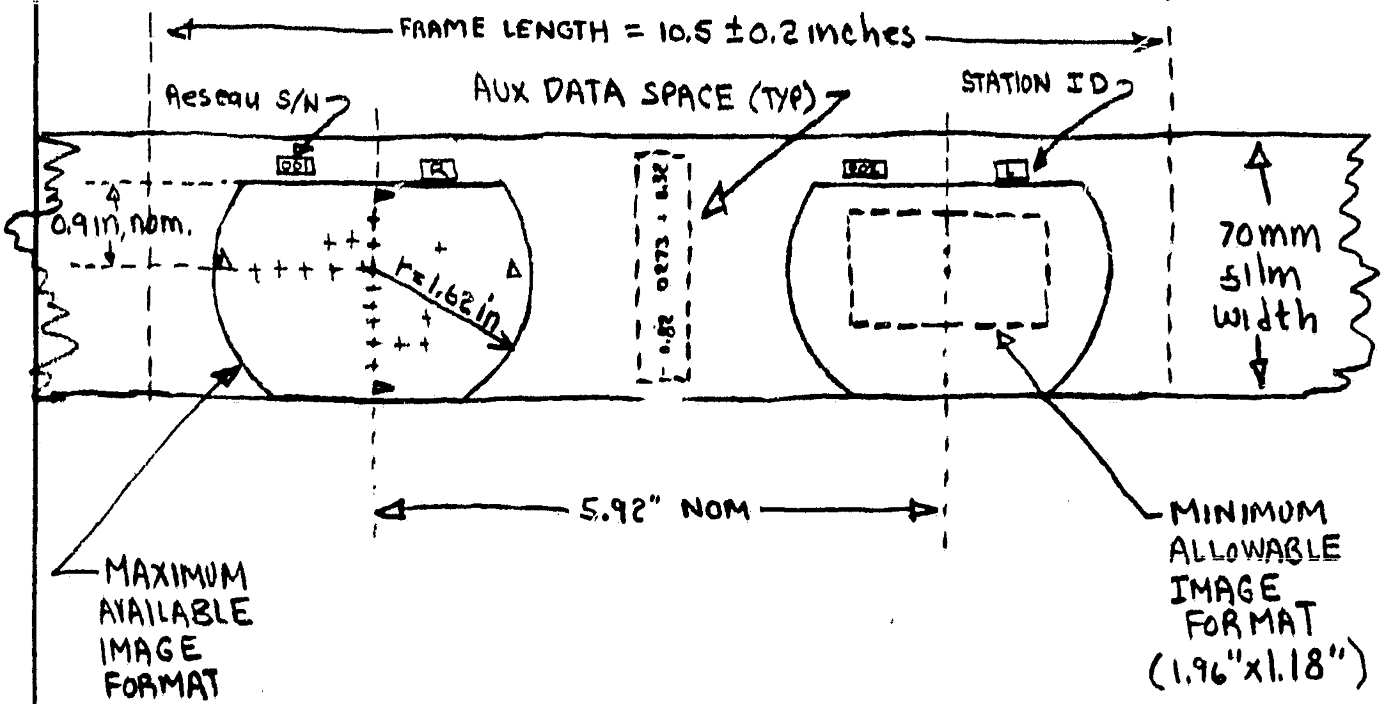
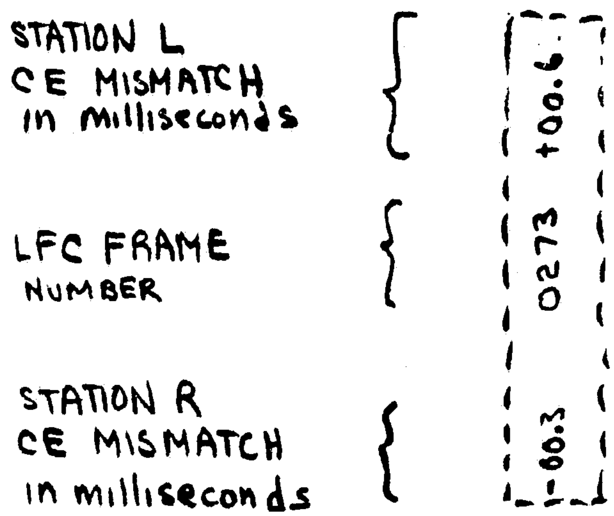



ARS FORMAT: Original Negative Emulsion Down




DETAIL OF AUX DATA AREA

Fig. 2-4. ARS Format

| BY: | | TITLE: ARS MASK + RESEAU | PAGE: Fig 2-5 |
|---|---|---|---|
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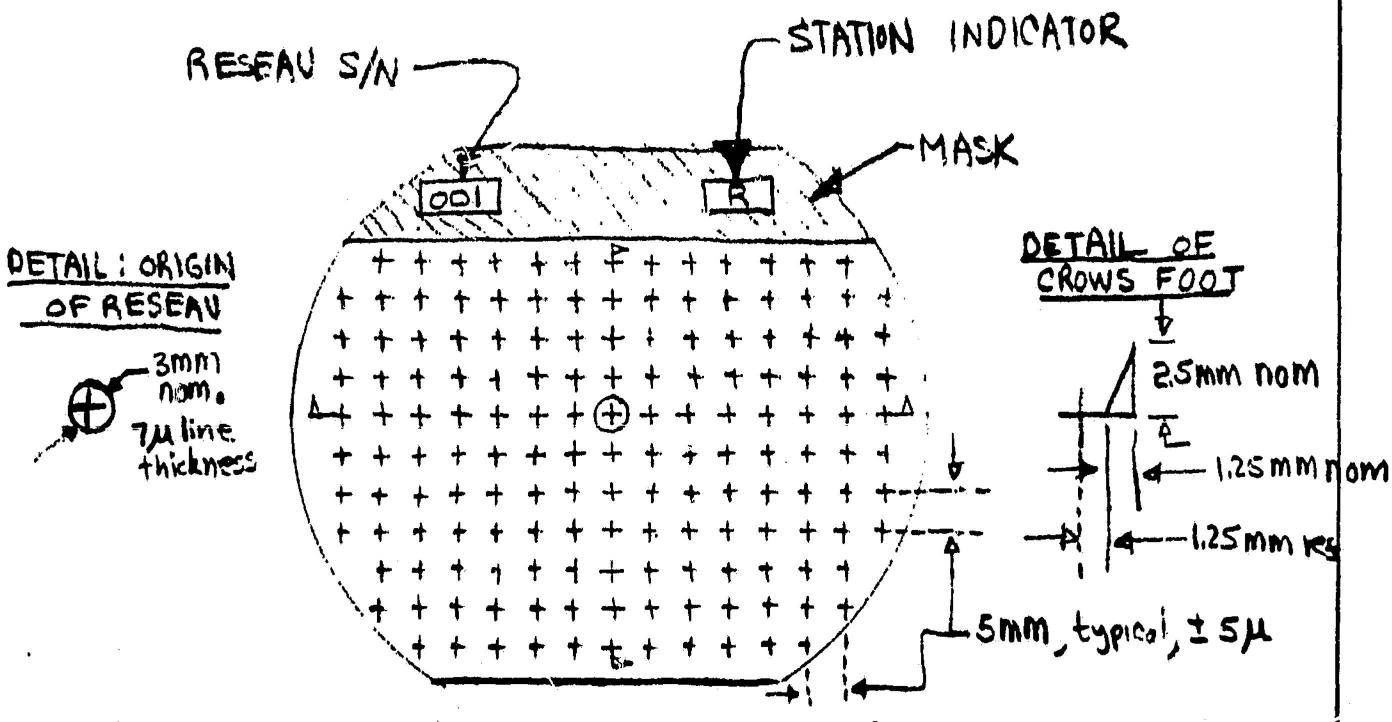
(As is viewed on Original Negative, emulsion down)




NOTES

Reseau crossline length: 2.5 ± 0.1 mm

Reseau line width: 7 ± 1 micron

Reseau grid, mask (shaded area), serial number and other indicators are to be applied to rear lens element outboard surface via evaporative metal process, using inconel or chrome at a thickness of ≤5 micro-inches and a minimum density> 2.0

Reseau grid spacing 5 mm ± 0.005 mm as measured @ 72°F

Line parallelism: 5 microns runout over length/width of grid
Line straightness: 5 microns over length/width of grid. (Line means the locus of all intersections of crosses in a straight line.)

Orthogonality of individual crosslines and lines joining the crossline intersections shall be within 2 arc minutes, measured as runout over the length/width of the grid pattern

Overcoat optical surfaces with $MgF_2$

## 2.3 ARS BAFFLES (EXTERNAL)

The function of the external baffles used on the ARS is to reduce the likelihood of non image forming rays falling onto the outside surface of the lenses first elements. Even though these rays might strike the lenses at angles beyond their angular field of view, and do not arrive at the image plane as proper image forming rays, their presence leads to scattered light within the lens and a general lessening of the ability to detect a dim star in the image plane.

The baffles under consideration for usage on the ARS also serve to restrict the camera field of view so as not to include those rays passing within 50 nautical miles or less of the earth's surface. 50 nautical miles was chosen as a low altitude cutoff to limit problems due to atmospheric path radiance effects (see following caculations).

The ideal baffle design for the OCPS would approach 100 inches each, which greatly exceeds the available packaging envelope. Certain tradeoffs are possible, and have been considered in the baffle approach. First, the SCA baffles have been scoped to provide a maximum useable image area, being limited only by the 3.25 inch diameter of the final lens element, the 70 mm film pressed across that element, and the line of sight (LOS) cutoff at 50 nm above the earth's surface. As practical considerations cause the baffles size to be reduced, vignetting of the beam at the periphery of the format may be allowed. Further reductions will cause the format to be reduced as outer rays are completely cutoff. The final baffle configuration will be arrived at during detailed design phases of the hardware program and will result in a useable format greater than the minimum detailed under the "Format" section of this report, and likely less than the maximum.

The baffles will be fiberglass, will attach as shown in layout 920003 (attached to this study), will feature attachment points to the SCA support structure, and will be designed so that bolt on extensions may be added on missions having more space available.

Attachments: Analysis: Determination of allowable LOS approach to Earth for 5th magnitude star detection (Austin McKenney)

Memo: Comments on FOV and baffling for Project 8466 (W. C. Britton)

References:

Study L/O 920003 (attached)

A. McKenney

# DETERMINATION OF ALLOWABLE LOS APPROACH TO EARTH FOR 5th MAGNITUDE STAR DETECTION

The problem of viewing a 5th magnitude star through the upper earth's atmosphere was investigated by extrapolating atmospheric path radiance data obtained from the Scat III atmospheric modeling program. Assuming that the stars being viewed are in the 5-10 K $^{o}K$ color temp. range the stellar irradiance at the lens pupil is (in the 0.5-0.7 micron band)

$$H \approx 2.5 \times 10^{-10} \text{ Watt m}^{-2} \ \mu^{-1}$$

The atmospheric path radiance for a LOS that comes within 40 nm of the earth (see fig. 1); based on extrapolation of Scat III data is

$$R_{atm} = 12.5 \times 10^{-4} \text{ Watt m}^{-2} \ \mu^{-1}$$

The ratio of the image intensity (power density) of the star to that from the atmospheric path is

$$\frac{I_{star}}{I_{atm}} \approx \frac{H\ (\pi D^2)\ 4F\#^2}{R_{atm}\ A_{star}}$$

The exposure time for the star image is $d/V_s$ where d= effective star image diameter & $V_s$= star image velocity at the focal plane. Assuming the net exposure time (i.e. time shutter is open) is $t_{ex} \geq d/V_s$, then the ratio of the stellar exposure to that due to the atmospheric path is

$$\frac{E_{star}}{E_{atm}} = \frac{4H\ F\#^2\ D^2}{R_{atm}\ dV_s\ tex}$$

Assuming a film gamma of $\nu$, the density difference between the star and the atmospheric path is

$$\Delta D = \nu \log \left(\frac{4HF\#^2 D^2}{R_{atm}\ dV_s\ tex}\right)$$

For a 6-inch focal length the image velocity at the focal plane reaches a maximum value of about 160 microns/sec.

Assuming $d = 10$ microns

$$t_{ex} \approx 4d/V_s = \frac{4(10\mu)}{160\ \mu/sec} \approx 0.25\ sec$$

$$F\# \approx 3$$

$$D \approx 2\ in\ (50 \times 10^3\ microns)$$

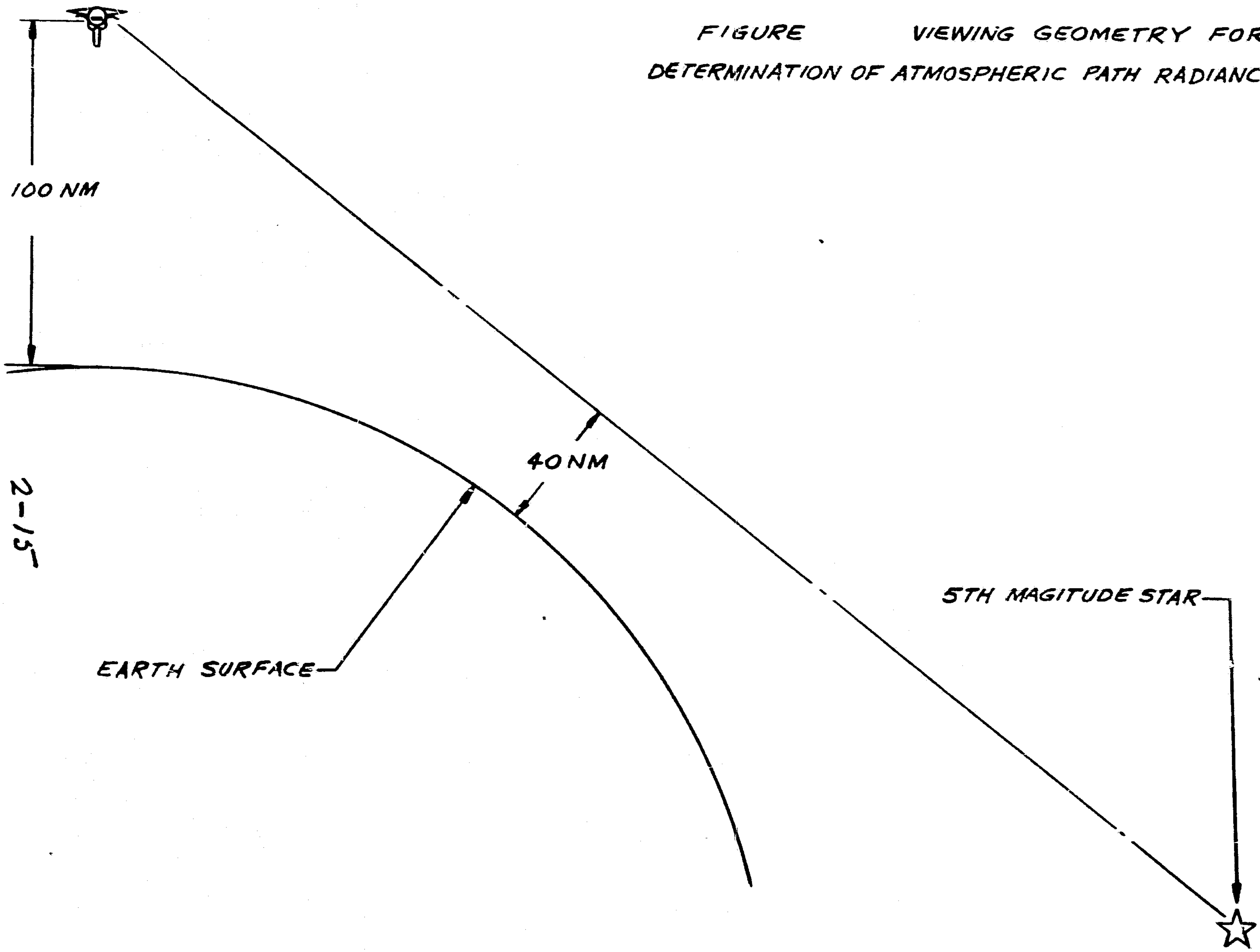
$$\nu \approx 1$$

$$V_s = 160\ microns/sec$$

$$\Delta D \approx 1.7.\ (E_{star}/E_{atm} \approx 45)$$

Therefore, it should be possible to detect a 5th magnitude star through the atmosphere at a 40 nm closest approach. One note of caution, the extrapolation to determine the atmospheric path radiance indicates an order of magnitude variation with a 10 mile change in altitude. The value given above was based on conservative assumptions, but none the less, extrapolation over the range required for this case is a somewhat risky business. However, if the planned line of sight is substantially above 40 nm closest approach, it can probably be safely assumed that the above conclusion is valid.

FIGURE VIEWING GEOMETRY FOR DETERMINATION OF ATMOSPHERIC PATH RADIANCE



# Memorandum



Report 1

To: Ernest W. Pigeon ✓  Date: March 1, 1982

From: William C. Britton

Subject: Comments on field-of-view and baffling for project 8466 report.

The two ARS (S-190) lenses will be mounted so that the axial ray of each is oriented to be perpendicular to the nadir-zenith axis with respect to the earth. At the planned operational altitude of 100 nautical miles, the earth's limb and earth glow are only 13.65 and 10.6 degrees below the axial line-of-sight of the lenses. In order to image a sufficient number of stars for positioning accuracy, an effort is made to obtain good imagery to 9.6 degrees below the optical axes. At that look angle, the earth glow is approximately 1/100 of the earth glow at the 10.6 degree angle, corresponding to 50 and 40 nautical miles above the earth, respectively.

The difference between 10.6 and 9.6 is only 1.0 degree and a baffle to eliminate the glow at 10.6 degrees and transmit unvignetted the starlight to the lens aperture would require a baffle more than 100 inches long. Since this would protrude well beyond the requested package volume, it will be necessary to reduce the baffle size and improve the veiling glare characteristics within the lens. In the ARS usage, some improvements can be made without total disassembly of the lens.

Since the shutter will now be in front of the lens, the space between elements 3 and 4 can be used for the installation of both an aperture stop (to replace the Waterhouse stop) and additional baffles. Another location for additional control is between elements 7 and 8 where baffles can be inserted that are shaped like the image format. This baffle will not only trap out-of-field light but also absorb light reflected from the film and the mask that defines the image format.

The above-mentioned mask deserves more study. Frequently, the mask is an evaporated metal coating which has reflectivity above 50%. It may be advisable to eliminate the mask entirely inasmuch as the edges of the format are not important to the function of the cameras - - the reseau pattern and several tick marks will provide all of the necessary orientation and angular field information that is needed.

The 9.6 - degree format edge position occurs at only one place (A) in the film plane as shown in Figure 1. At $B_1$ and $B_2$, the earth's limb and glow are about 1/3 degree lower in the field-of-view; therefore, the image will be a little above the 9.6-degree-line at $B_1$ and $B_2$.

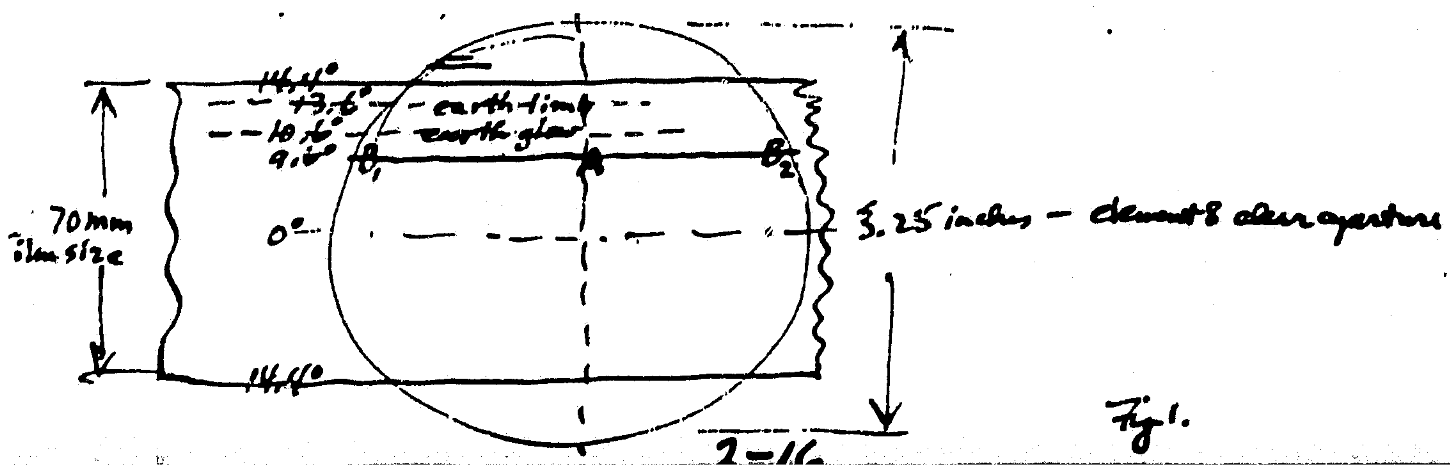



Fig. 1.

The "horizon" image will be a softly curving line connecting $B_1$, A and $B_2$. Therefore, the stars to the left and right of the look-ahead, or axial, point will likely be less affected by the earth glow.

On the other side of the axis, there appears to be no reason to limit the field-of-view with either masks or baffles. Let the film be the edge of the field and provide reseau crosses to the extremes of the clear aperture of element 8.

The external baffle design will be irregular in length and cross-section reflecting the shape of the image format. It will range from 31 to 50 inches from the camera focal place. Of necessity, it will provide for the mounting of the shutter in front of the lens. The baffle will extend further and will be truncated both for fitting in the allowed volume of the shuttle section and for eliminating sections that are not needed. The field-of-view envelope should be defined at regular distances in front of the lens and the external baffle designed to not intrude except as intended to block out the earth glow. This "envelope of avoidance" will also serve to guide the placement of the two camera systems so that LFC and shuttle appurtenances do not intrude or reflect unwanted radiation into the camera systems.

Some baffles between the lens and shutter may be necessary to trap and absorb unwanted radiation. It is generally advisable to make the baffles deep---from inside edge to bottom of the trough---so that light entrapment is maximized. Also, the edges of the baffles should not be contiguous to the field-of-view since it is impossible to fabricate totally absorbent edges, even if razor blades are used. A row of knife edges with barely adequate absorbing paint usually deteriorates to a row of glinting edges. Fewer baffles are better.

/md

cc M. Egdall
M. Kahan
C. King
W. Knapp
D. Womble

## 3. FUNCTIONAL COMPONENTS

The ARS is defined in layout drawing 920003 (Fig.2-1) and in Fig.1-2 (ARS Hardware Family Tree). The sections that follow discuss each of the functional subassemblies in turn.

## 3.1 SHUTTER ASSEMBLIES "A" & "B"

The Shutter Assemblies for the "A" & "B" lenses are identical except that they are opposite hand as shown in Figure 3-1. The shutter consists mainly of two doors that are driven in opposite directions by motor powered steel bands. In the assembly, the shutter motor drives the following:

1. A tachometer directly.
2. First shutter door and a commutator pot through gearing.
3. Second shutter door and a microswitch cam through crossed steel bands.

The doors contain electro-luminescent panels and heaters on their inside surfaces. The purpose of these panels is to illuminate the lens reseau marks, causing them to be exposed on film prior to stellar exposure and to provide a low level film exposure or "pre-fogging" which assures that the density of the subsequent stellar photograph will be adequate. The shutters are mounted in housings that surround the lenses and are secured to the ARS housing. Figure 3-2, Functional Diagram, shows the position of the shutters relative to the lenses.

The doors are opened and closed on receipt of an exposure command whose center is coincident with the LFC exposure. The effective film exposure thus obtained is of 200 milliseconds duration. Outer surfaces of the doors contain thermal blankets to protect the shutter from hostile outside environment. Additional thermal blankets around the shutters will protect the drive components as well.

The following is a summary of the steps that are proposed for the update of the two GFE shutter assemblies, as received, into ARS shutter assemblies:

## SHUTTER ASSEMBLIES - "L" & "R"

(1) Receive units and spare parts as GFE

(2) Inspect

(3) Electrical test

Component level check of pots, motors, tachometers, heaters, electroluminescent panels & switches.

(4) Remove lower tubular portion of assembly and discard. Disassemble all shafts and bearings. Obtain new bearings from GFE stores, send out for relube. NOTE: One shutter does <u>not</u> have flex lead from stationary portion to moving doors. Remove thermal blankets and associated brackets.

(5) Design interface between shutters and new mount housing. Reconfigure thermal blanket and brackets as required, and design new mount housing to interface with Shutters and Transport housing.

(6) Manufacture mount housings, newly configured thermal blankets and brackets.

(7) Reassemble shutters, installing new bearings. Add flex leads in one shutter assembly. Install new thermal blankets/brackets. Possibly install new motors, tachometers and switches.

(8) Electrical test - same as above

(9) Inspect as shutters "L" and "R"

(10) Integrate with ARS, debug.

Shutter Control (refer to diagram Fig. 3-3)

The ARS shutters L & R are controlled to produce a CE which is synchronous to the LFC CE to within ± .005 seconds. The approach to this control is as follows:

On the System Timing and Control (ST&C) section of the ARS Electronics Assembly, a Microprocessor based system computes ahead of time, using LFC generated signals, the LFC CE. When an exposure of the LFC is about to occur, a Shutter Position Profile Command and a Feed Forward signal are generated at times calculated to result in coincident CE's. The Feed Forward signal is used to reduce the position error in the shutter response during the open and close intervals.

The commands generated within the ST&C are applied to the Shutter Servo Preamp card on which compensation, gain and other servo system parameters are controlled. Two servo power amplifiers mounted on the Electronics assembly Heat Sink provide direct control of the shutter motors. Shutter feedback signals are routed to the Shutter Servo Preamp Card, and include a tach, and a pot from each shutter. Several microswitch generated signals are available from each shutter which may be utilized as TM data to determine the following conditions: Shutter Closed, Not Closed, Not Open, Open. A commutator signal is available which provides a switch closure type gate signal whose duration is 200 milliseconds and whose center has been mechanically aligned to be coincident with the shutter CE.

Temperature sensors, heater elements and thermostats are available for thermal conditioning, and a setpoint of TBD°C will be maintained.

Electroluminescent Panels on the shutters will be controlled by a switched 400Hz supply housed within the ARS Electronics Assembly.

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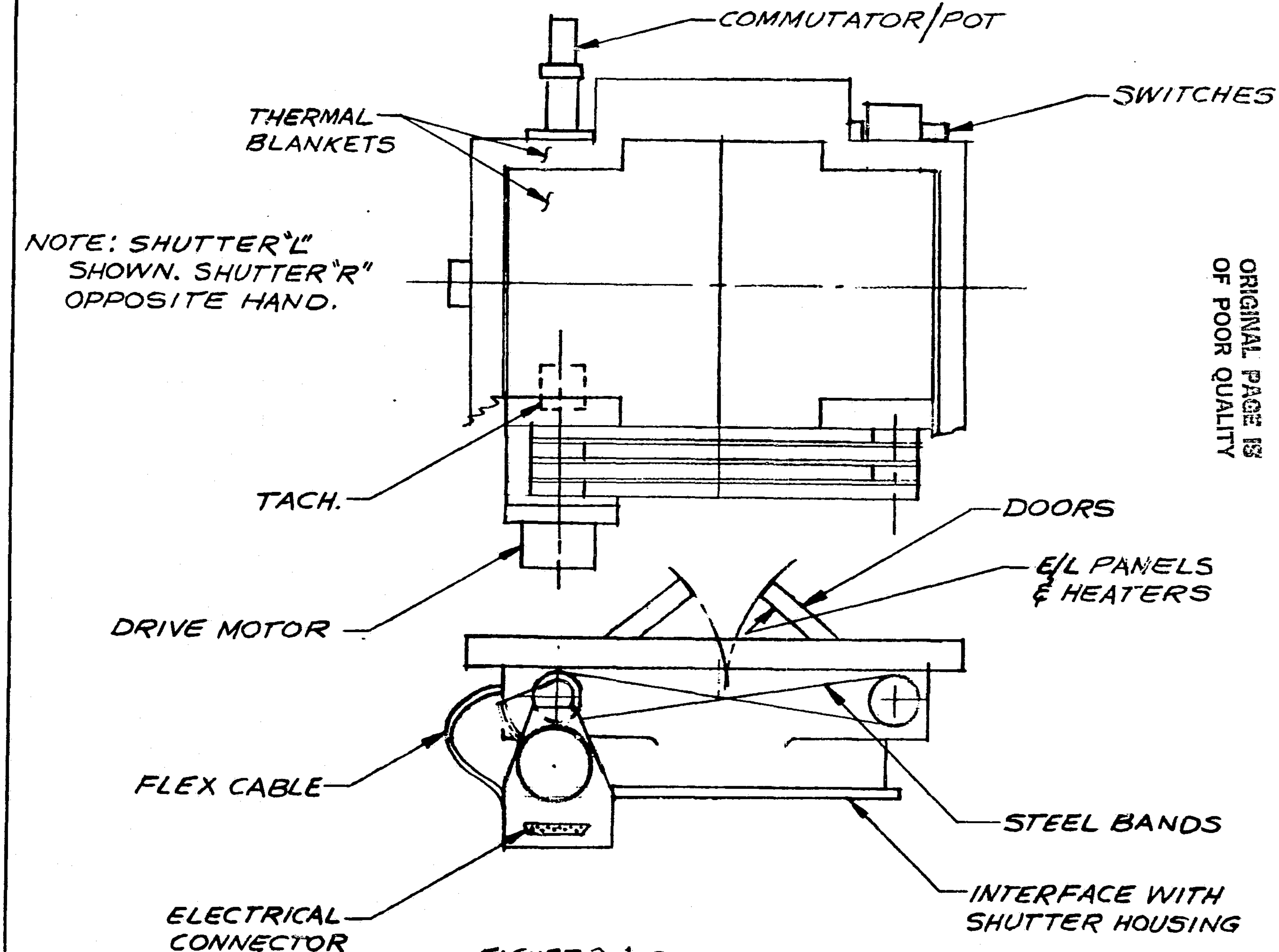


FIGURE 3-1. SHUTTER ASSEMBLY

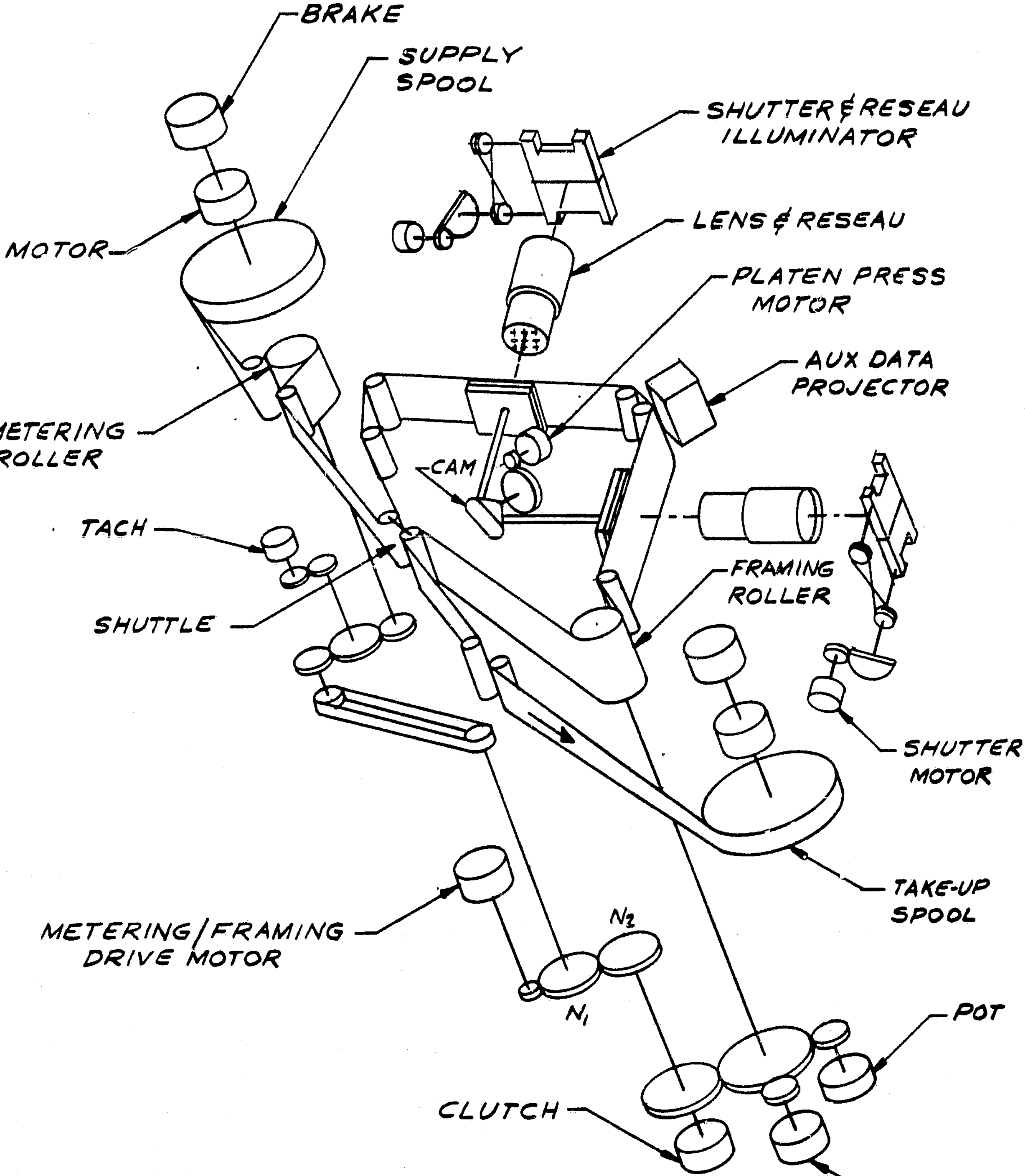


FIGURE 3-2. SCA FUNCTIONAL DIAGRAM

| BY: RP | TITLE: SCA SHUTTER CONTROL (2 REQ'D) | PAGE: Fig 3-3 |
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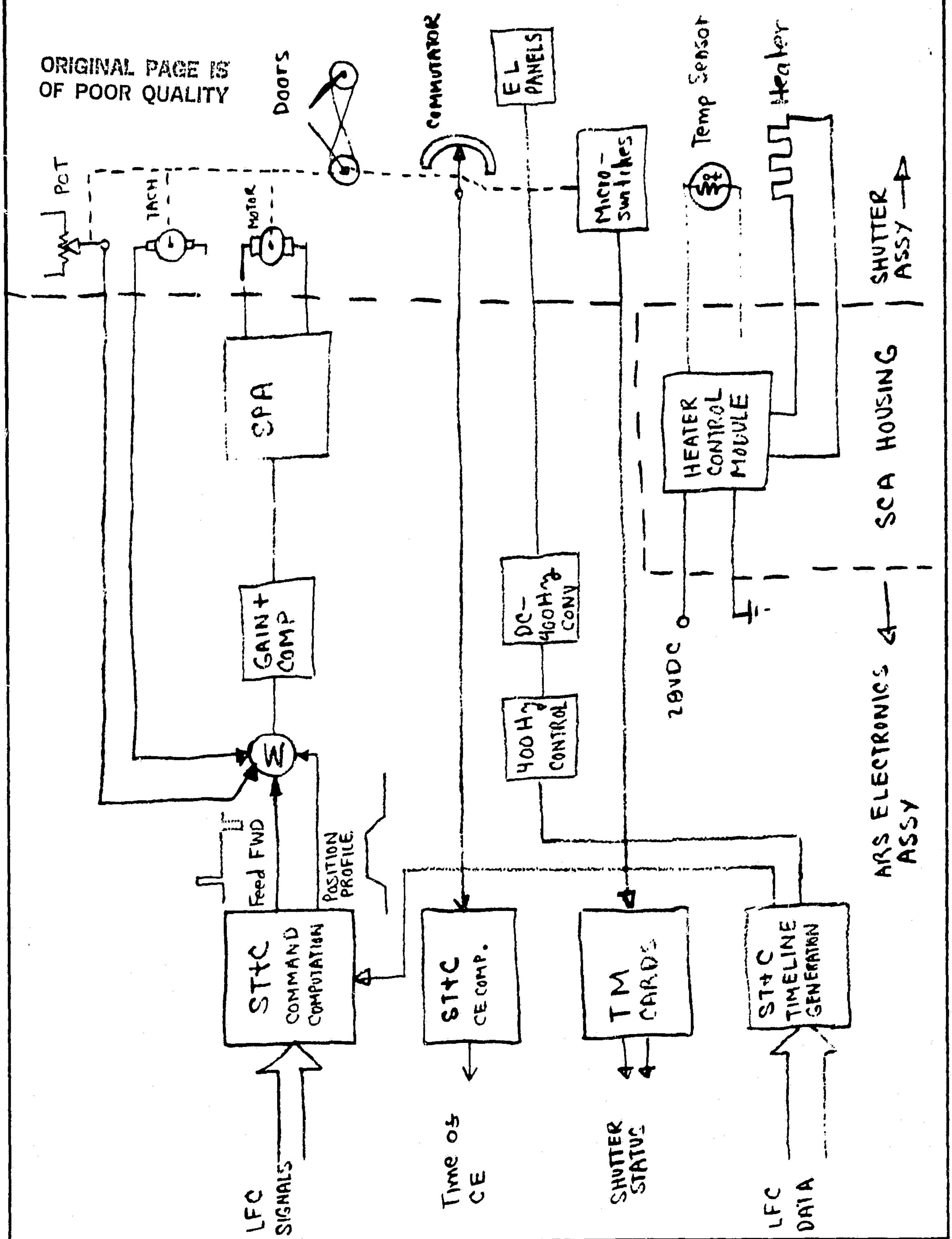

## 3.2 SUN SENSOR ASSEMBLY

In its useage, the ARS will likely encounter the situation in which the SCA shutters are commanded open at a time when the disc of the Sun is in the field of view of one of the SCA lenses. The collecting area of the approximately 2 inch diameter aperture will result in the energy density of the Sun's image at the focal plane being 1350 times the density at the surface of the first lens element. This is derived by taking the ratio of the size of the 2 inch aperture to that of the Sun's image (area ratio) and multiplying by an 85% measured transmission.

A thermal model of the focal plane indicates excessive temperature rise over a 0.05 inch diameter spot during the 0.2 second effective exposure time.

In order to preclude the possibility of damage to the film, the platen and the reseau, a sun sensor has been added to the SCA design concept. Referring to Fig. 3-4, Sun Sensor Assembly, ports machined in the housing provide a field of view for a Left (L) and a Right (R) photodiode. As the Sun enters the field of view of a photodiode, the electronics module will develop a signal which will provide a disable command to the appropriate shutter servo power amplifier. In order that the sun not be allowed to enter the field of view of an SCA lens whose shutter is already open, the Sun Sensor ports will be slightly larger in field of view than the SCA Line of Sight in the 0.3 seconds total (actual) exposure time. Since the angular rate is $360^{\circ}$ per 90 minutes, an oversize of $0.02^{\circ}$ minimum in all directions is required.

The interior surfaces of the ports will be treated to minimize reflections into the photodiodes from a sun or a reflected (from some shuttle borne surface) sun not in the SCA field of view proper. The detection threshold will be set to require a direct sun in the field of view to produce a disable output.

In order to provide for the possibility of operation without the Sun Sensor, its interfacing circuitry will be designed such that an open line (i.e., sensor not plugged in) will be interpreted as a valid enable level to the shutter servo power amplifiers.

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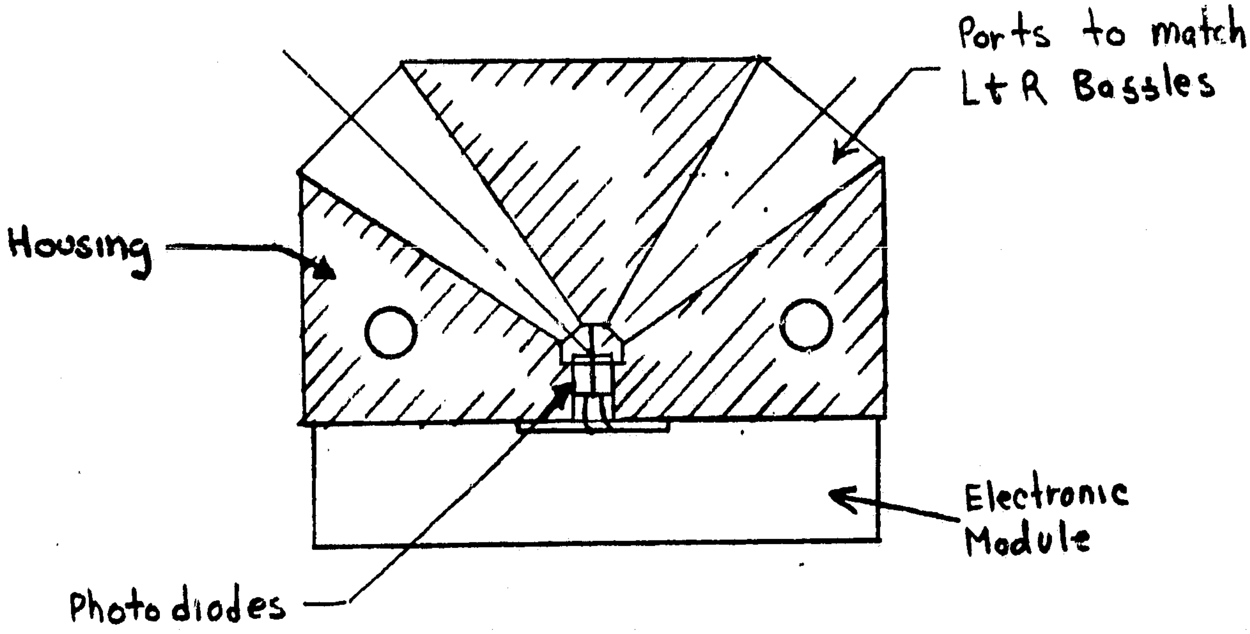



Fig. 3-4. Sun Sensor

## 3.3 LENSES

The lenses to be used for the ARS will be modified GFE S-190 lenses of 6 inch focal length and f/2.8 relative aperture. The basic lens design was used for both the S-190 and the AMPS lens delivered to NASA in the mid 1970's and is shown in Figure 3-5.

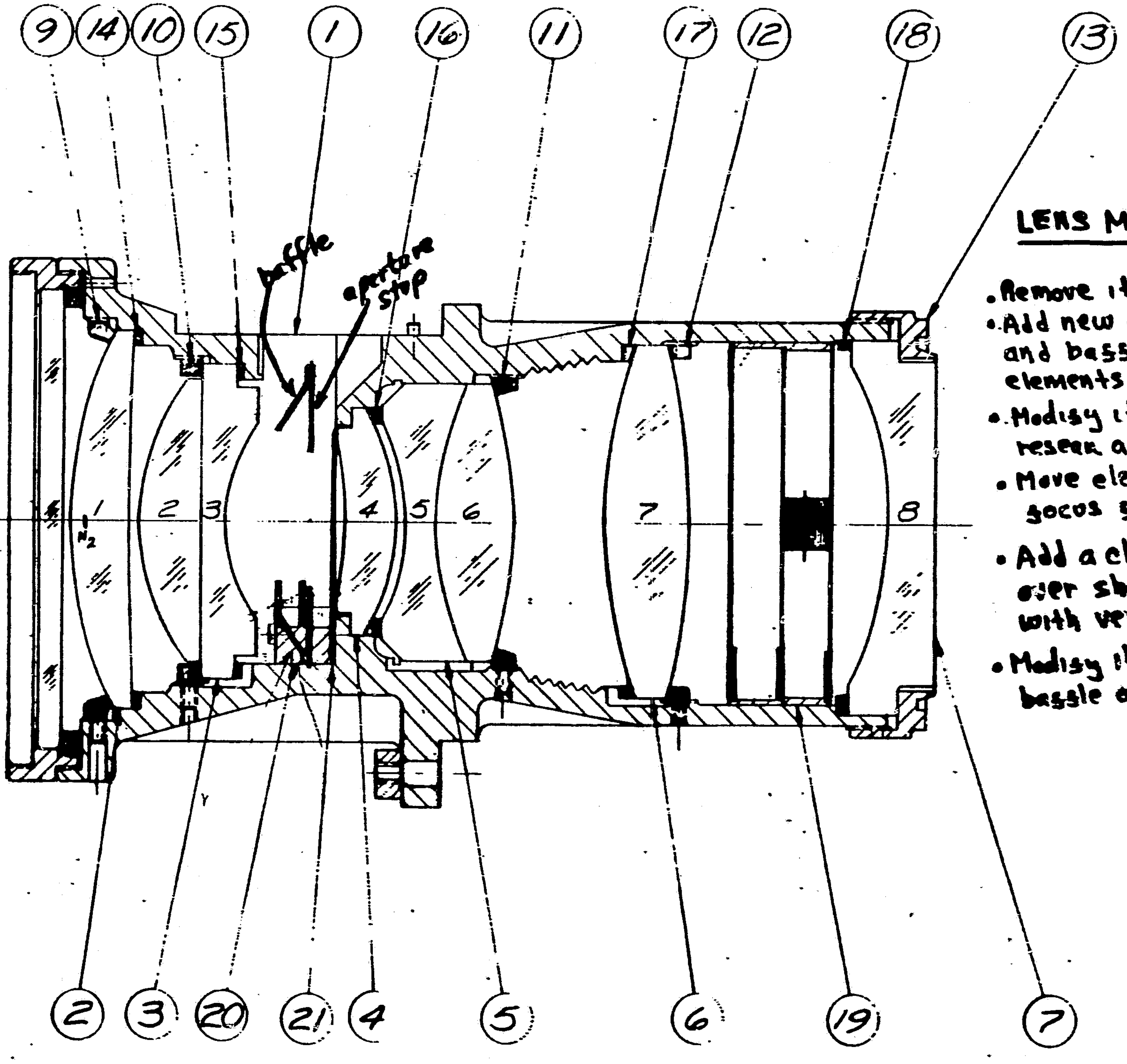
The modifications and refurbishment will be as follows:

(1) Rework of the reseau element (No.8) to provide a pattern with crosses at 5 mm intervals as indicated in Figure of the Format section of this report.

(2) Reposition element no. 7 in order to effect best focus on the rear surface of element no. 8 under anticipated operational conditions. This "tuning" was used in both the S-190 and AMPS program to properly focus the lenses for both chromatic focus (based on spectral filter transmission) and for temperatures and pressures of operation.

(3) Design, fabricate and install an aperture stop in the airspace between elements 3 and 4, from which the waterhouse stop and the shutter have been removed. This will insure that the lens operates at the f/number for which it is optically corrected and that any stray light that enters the lens aperture will be more completely under control. An additional aperture may be used as a baffle to decrease stray light.

(4) An inspection of the lens to detect and correct blemishes that might detract from the lens performance. One such item is a light leak around the edges of element 8 at the reseau surface.




## LENS MODS

- Remove items 20 & 21
- Add new aperture stop and baffle between elements 3+4
- Modify item 7: new screen and mask
- Move element 7: re-focus for vacuum
- Add a closure plate over shutter opening with vent/filter
- Modify item 13: new baffle opening shape

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Figure 3-5. GFE Lens

(5) Design and fabrication/ application of a mask on the reseau surface to limit the field of imagery and to prevent stray light from exposing film in an unwanted way.

(6) Design and fabrication of new auxiliary baffles between elements 7 and 8 to further control stray light.

Following is a description of the work flow anticipated for adaption of the GFE lenses to SCA use:

S-190 lens assemblies

(1) Receive units from government, unpack and store.

(2) Inspect units for integrity, cleanliness.

(3) Clean lenses of all foreign material and re-inspect. Do not disassemble.

(4) Design and fabricate adapter plate for mounting lenses on optical test bench.

(5) Visually evaluate quality of lenses on lens bench and measure focal lengths, including chromatic shifts. Compare to original data.

(6) Select two lenses to be used for ARS.

(7) Review filters for suitability for ARS. If any are spectrally suitable, test these in conjunction with the selected lenses to insure wavefront quality. Also test interferometrically.

(8) Design and fab internal baffles and aperture stop for insertion into space between elements 3 and 4.

(9) Determine new position of element 7 for correct focus of system under operational conditions and for correct spectral range as defined by film and filter combination.

(10) Modify spacers between 6 and 7, and 7 and 8, to insure correct focus for the system at the reseau surface.

(11) Modify baffles between elements 7 and 8.

(12) Re-design reseau and mask pattern.

(13) Remove present reseau and mask on element 8 and send out for application of new reseau and mask.

(14) Edge paint element 8 to insure zero light-leaks.

(15) Reassemble lens elements 7 and 8, and their associated baffles.

(16) Calculate shift of focus between Itek laboratory conditions (Lexington temperature and pressure) and operational conditions. Calculate necessary shift of focus for collimator to compensate for the focal shift of the lens. Adjust the collimator accordingly. Figure the scale between collimator and ARS lens focal lengths to apply to resolution calculations.

(17) Test the reassembled lens for accurate focus across field and for maximum quality of image.

(18) Measure distortion on four semi-diagonals to insure compliance with specification.

(19) If necessary, iterate focus, resolution and distortion measurements with air-space adjustments and positioning of elements 7 and 8.

(20) When visually satisfactory, make photographic exposures on film held against reseau surface of element 8.

(21) If photographically acceptable, disassemble element 8, epoxy retaining ring of element 7, reassemble element 8 and re-photograph. If acceptable, epoxy retaining ring of element 8.

## 3.4 TRANSPORT ASSEMBLY

The Film Transport Assembly, as shown in Figure 3-6, is used to perform the following:

1. Pull film from the supply cassette.
2. Meter the correct length of film to the platens through the continuously moving supply shuttle.
3. Press the film against the reseau elements of both lenses and the Auxiliary data head for film exposure, then retract pressure pads for film framing.
4. Pull (frame) the exposed film from the platens and store it in the continuously moving takeup shuttle, for removal by the takeup cassette drive.

The transport is mounted in the SCA Housing Assembly and consists of several sub assemblies:

1. Metering and Framing Drives

These drives consist of two gear and belt driven film rollers that are rubber coated with adjacent pinch rollers to assure there will be no film slippage. One motor drives the metering and framing rollers, coupling to the framing roller intermittently by means of an electric clutch. The metering drive pulls fresh film into the transport for photography. The framing drive pulls the exposed film out after photography. An electric brake prevents the framing roller from rotating after a frame. A potentiometer on one of the shafts gives framing roller rotation positior [illegible] achometer near the metering roller provides the means to control the [illegible] of film that is metered into the assembly. The exploded [illegible] of Fig. 3-2 shows the essential components.

2. Shuttle

The metering drive provides fresh film to the supply side of the moving shuttle which consists of two film rollers mounted on a linear track with a travel of approximately 5.25 inches. The framing drive fills the takeup side of the moving shuttle with exposed film to be removed by the Takeup Cassette. Switches placed along the travel of the shuttle provide status signals used in the control of the metering and framing systems.

3. Platen Press Assembly

The drive consists of cams and springs, that are motor driven through gearing, with switches for platen pressure control. This assembly operates as follows:

a. Motor driven platen cams wind up a torsion spring and compress[redacted] platen springs as the platens are displaced in unison.

b. Two foam-rubber coated platens 90° apart are driven in this manner to press the film against each lens reseau element. This assures that the film will always be at the focal plane during photography. Film is also pressed against the auxiliary data recording head.

c. When the exposure is complete, the motor is disabled and the energy stored in the torsion spring reverses the cams allowing the platen springs to retract the platens.

4. Auxiliary Data Assembly

This assembly is located in an area between the two Platen Press Assemblies. It consists of seven-segment numerical displays that are illuminated immediately after the main exposure occurs, contact printing the displays onto the film.

A GFE film transport assembly will be modified to perform all these functions. The basic modifications are:

1. Redesign of metering and framing drives, shuttle travel.
2. Redesign of the Aux Data module to provide numeric print-out on film.
3. Redesign of mounting brackets and relocation of electrical component boards.

The following is a summary of the steps that will be taken in converting the GFE transport, as received, into the SCA transport assembly:

1. Receive unit and spare parts as GFE.
2. Inspect
3. Electrical checkout :
   Component level check of pots (except Sin/Cos pot) tachometer, and switches. The unit is partially disassembled.
4. Disassemble all rollers and gear/belt drives. Remove metering clutch, Sin/Cos pot rubber rollers, Platen press assy and star-wheel and follower. Obtain new bearings from GFE stores and send out for re-lube. Obtain new Platen press and Motor/Gear assemblies from GFE stores, partially dis-assemble and send bearings out for re-lube.
5. Design new metering gear drive without clutch. Design new framing drive gearing, with clutch, brake and potentiometer, utilizing components from GFE stores, replacing existing star-wheel. Design new Aux data printer, interface with new housing and new brackets for elect. components. Elongate shuttle from present 3.5" travel to required 5.25" travel. See Fig 3-64, Shuttle Modification.
6. Manufacture new metering and framing drive shafts, gears, housings, also Aux data printer, shuttle rods, brackets, housing interface, electrical component brackets.

7. Reassemble the transport, installing new bearings, new rubber rollers (from GFE stores), new shafts, gearing, clutch, brake, potentiometers, motor/gear and platen press assemblies, Aux data printer, shuttle parts, housing interface parts and brackets for elec. components.
8. Electrical checkout - component level check of potentiometers, tachometer, clutch, brake motors, Aux data, switches.
9. Inspect
10. Integrate with ARS, debug.

SCA Transport Control

The transport can be broken down into 4 sections for the purpose of control discussion. These sections are:

(1) The Metering System

(2) The Framing System

(3) The Platen Press System

(4) The Aux Data System

1. The Metering System (See Fig. 3-7)

The Metering System is a servo controlled film metering roller and shuttle combination. The electronics involved are contained in the ARS Electronics Assembly while the actuating and feedback elements are physically a part of the transport.

Within the Electronics Assembly, the System Timing and Control system generates a velocity command, $V_F$, and applies it to the transport servo preamp. $V_F$ has 3 possible modes:

(1) $V_F$ = 0ips in standby mode

(2) $V_F$ = 1.4 ips in calibrate mode

(3) $V_F$ = 10.5 inches per cycle in test or operate mode (A cycle is $t_c$ seconds, where $t_c = 1.5 \times \frac{1 - \text{overlap}}{V/h}$.

(Overlap and V/h are LFC commands).

On the transport servo preamp card, the $V_F$ command is applied to a preamp/compensation circuit, summed with feedback from a film velocity tachometer and the error signal drives a servo power amplifier (SPA) whose output powers the motor.

As the Metering System operates, filling the supply side of the shuttle, the framing system normally operates to empty the shuttle at the same average rate, 10.5 inches per cycle. Microswitches on the shuttle (see Fig. 3-8) provide feedback to modify the $V_F$ command thereby accommodating small inaccuracies of command or response. Another microswitch is used to sense a limit condition and inhibit further metering until such time as a framing cycle is initiated. Actuation of this last switch is a regular part of a calibration cycle.

There is no "STOW" condition required for the ARS transport, as the shuttle is fully captured in any position.

2. The Framing System (See Fig. 3-9)

The Framing System consists of a roller which is driven from the metering system motor via a clutch and gear ratio. The gear ratio is set to result in a framing rate which is nominally twice the metering rate. Since the average framing rate must exactly equal the average metering rate, the time spent framing will therefore be nominally 50% of the ARS operating time in Test and Operate Modes.

When the framing roller is not clutched into the metering drive train, a brake is actuated to prevent film slippage.

The System Timing and Control (ST&C) system will generate a Frame Enable condition which will affect the following:

(1) Release the framing roller brake

(2) Wait 0.05 sec., nominal.

(3) Engage the framing roller clutch.

During the course of a framing cycle, if the Shuttle should momentarily reach a near empty condition (supply side) shuttle switch S4 will disengage the framing roller clutch. As the shuttle recovers, S5 will re-engage the clutch.

The effects of the Framing System on the Metering System servo will be a part of that servo's design.

3. The Platen Press System (See Fig. 3-10)

The Platen Press System is a servo controlled actuator in which the controlled parameter is motor current, or torque.

The ST&C generates a "CLAMP" command which causes a current to be circulated through the press motor. The motor torque thereby developed causes the presses to advance, as described under the description of the mechanism, and clamp the film to the three platens which are the rear surface of element 8 in each lens and the aux data window. As the presses, which are constructed from a type of closed cell sponge material, begin to deflect into the clamped condition, a microswitch is actuated which causes a reduction in the motor current. The motor remains in a stalled condition for the duration of the "clamp" command which is expected to range from a minimum of 1.25 seconds in Operate to 300 seconds or more in Calibrate. When the "clamp" command is returned to zero, the motor current goes to zero and torsion springs return the presses to the "released" condition.

There are heater elements and sensors on the presses for temperature control, and a switch available for TM which indicates "clamped" or "not clamped".

4. The Aux Data System

The Aux Data System is comprised of an array of seven-segment displays in the Aux Data Projector in the Transport (See Fig. 3-6 Film Transport Assembly).

The technical specification calls out a mandatory presentation of "IRIG-B time" which has been elaborated upon to consist of 12 digits, 3 spaces and one decimal point.

The Aux Data Processor card in the ARS Electronics Assembly will either generate the desired time output from the IRIG B Code or by processing LFC data, and will condition it and store it for ARS useage. The ST&C will generate a pulse to initiate the exposure, and the Aux Data Processor will generate the timing and strobing to expose each character.

The Aux Data Projector will include limited electronics to receive BCD encoded data and character strobes and to drive an array of seven segment displays.

The concept will be very similar to that used in the LFC Aux Data system except that there will be no translation of film while characters are being printed.

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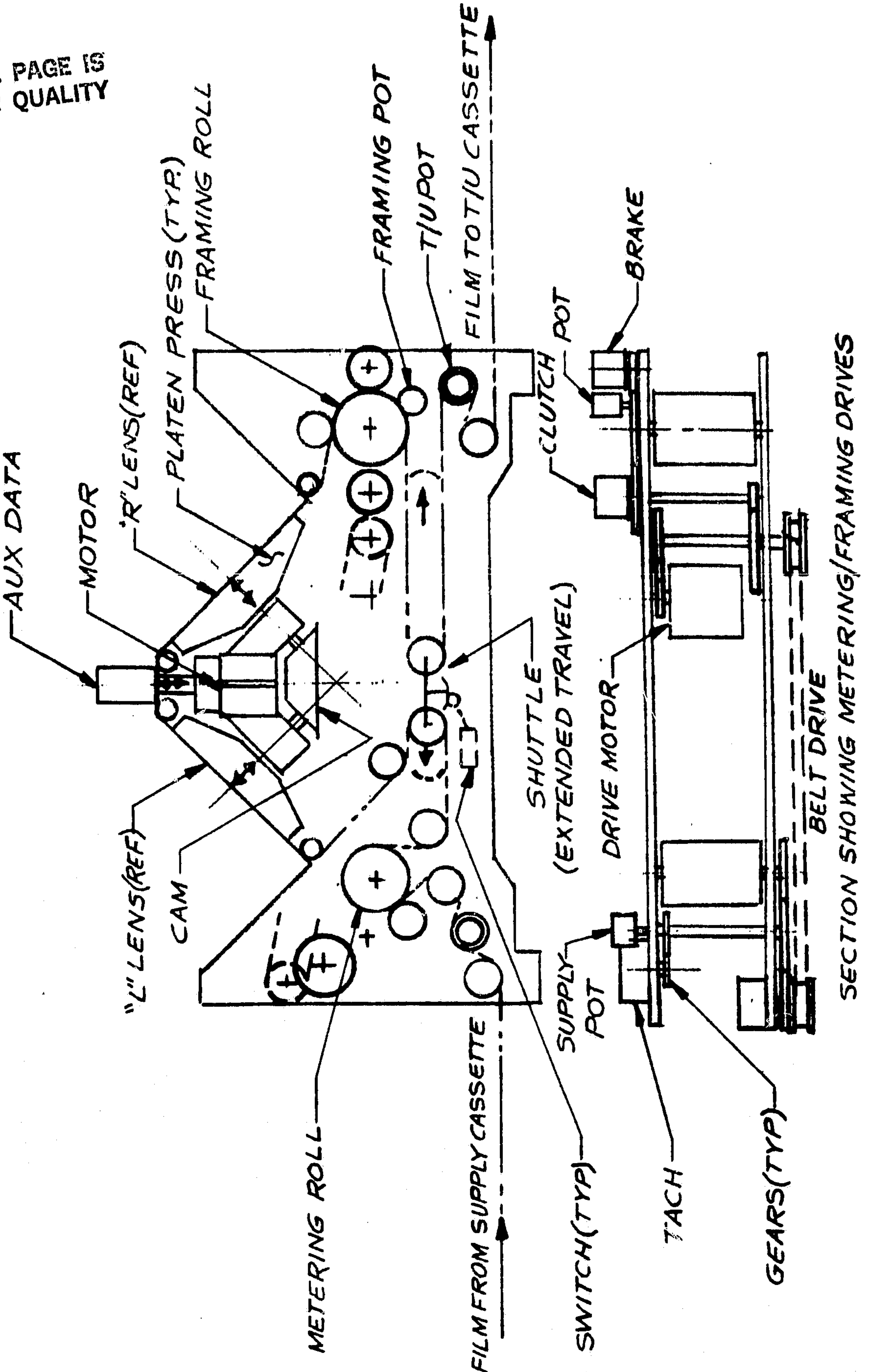


FIGURE 3-6. TRANSPORT ASSEMBLY

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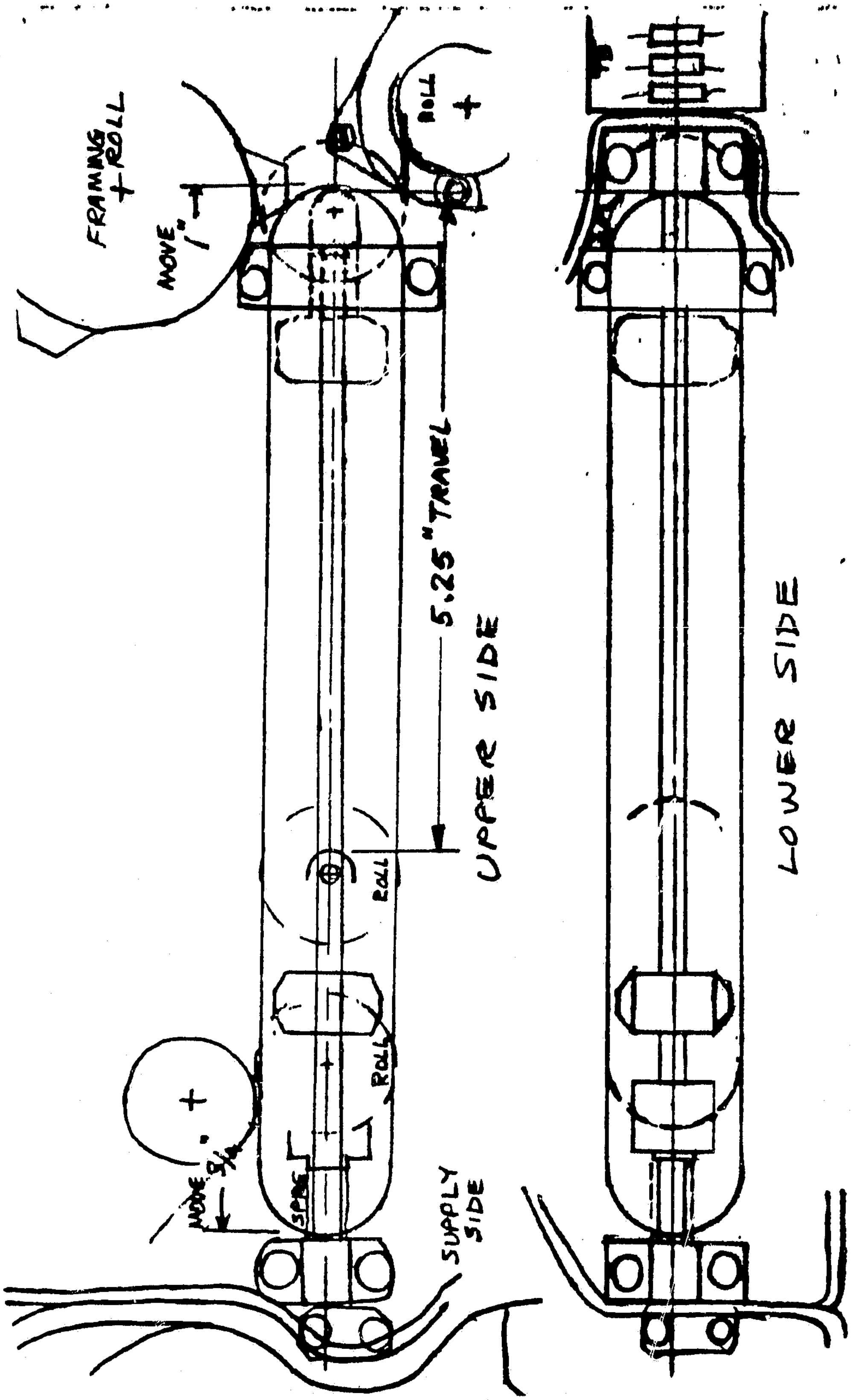


Fig. 3-6A SHUTTLE MODIFICATION

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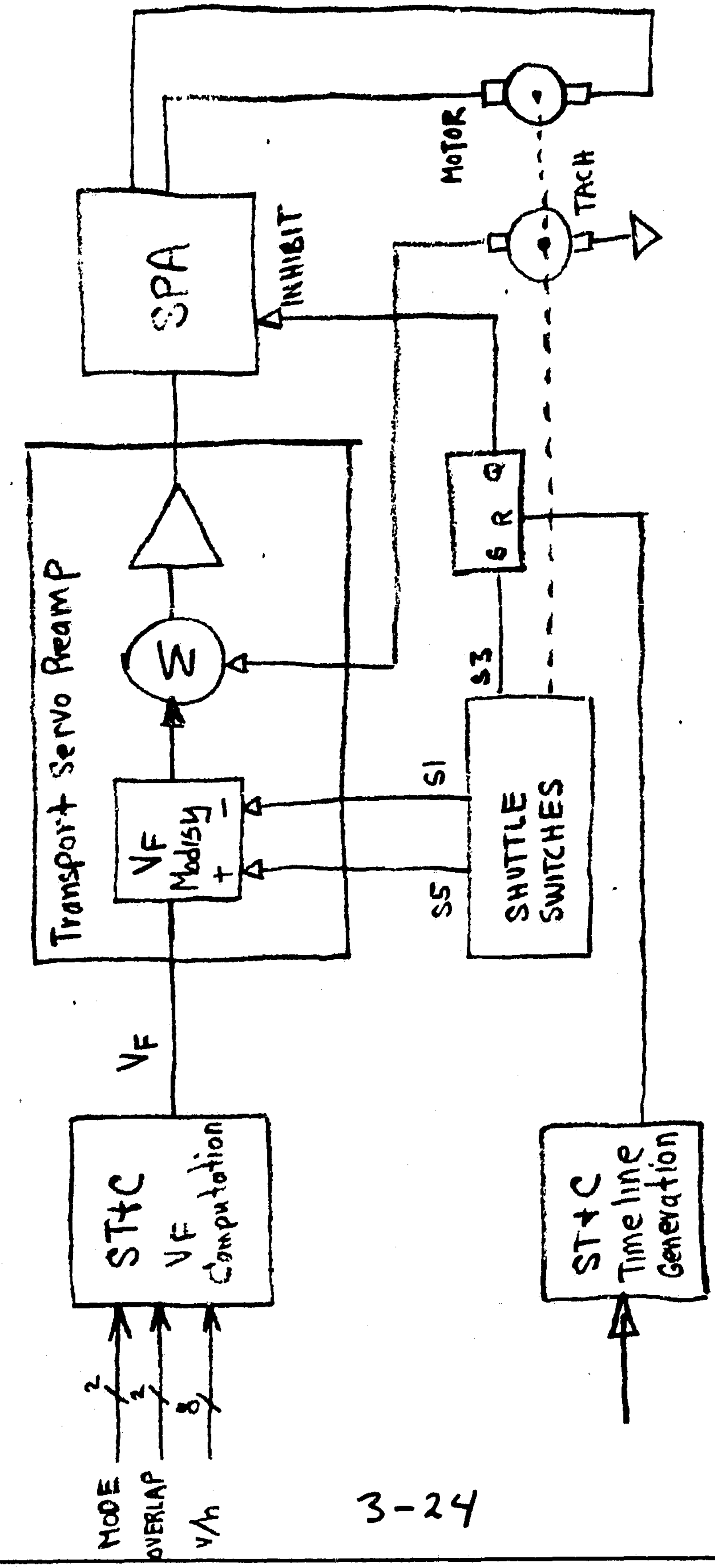

| BY: EP | | TITLE: SHUTTLE SWITCHES | PAGE: Fig 3-8 |
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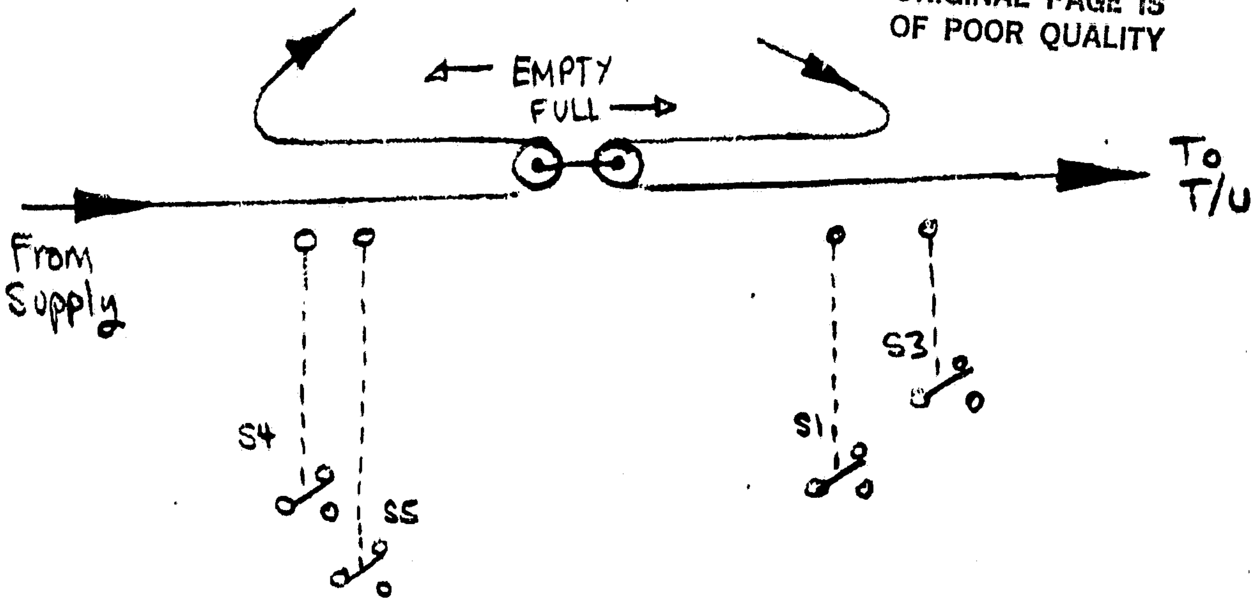



* SET S4 1/8" from bottom (empty side). Action disables framing clutch

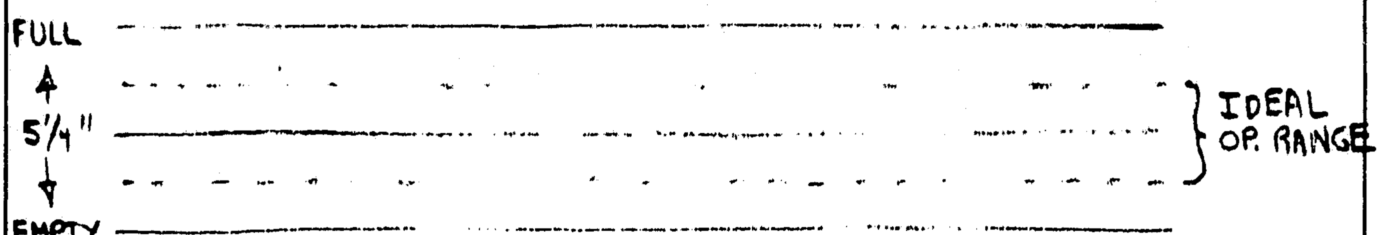
SET S5 3/4" from bottom. resets a disabled clutch. sets a latch for +Δ velocity

SET S1 3/4" from top. Action sets a latch to −Δ Velocity

* SET S3 1/8" from top. Action sets latch to disable metering. Frame Enable resets this latch

SHUTTLE CAPACITY (AFTER MOD) = 10½" (5¼" SPAN)

NOMINAL TRAVEL DURING OPERATION = 2 5/8" SPAN




* S3 + S4 must not be overridable mechanically.
~~(ACTUATOR MUST EXTEND AT LEAST 1/8")~~

| BY: gP | | TITLE: Framing control | PAGE: Fig 3-7 |
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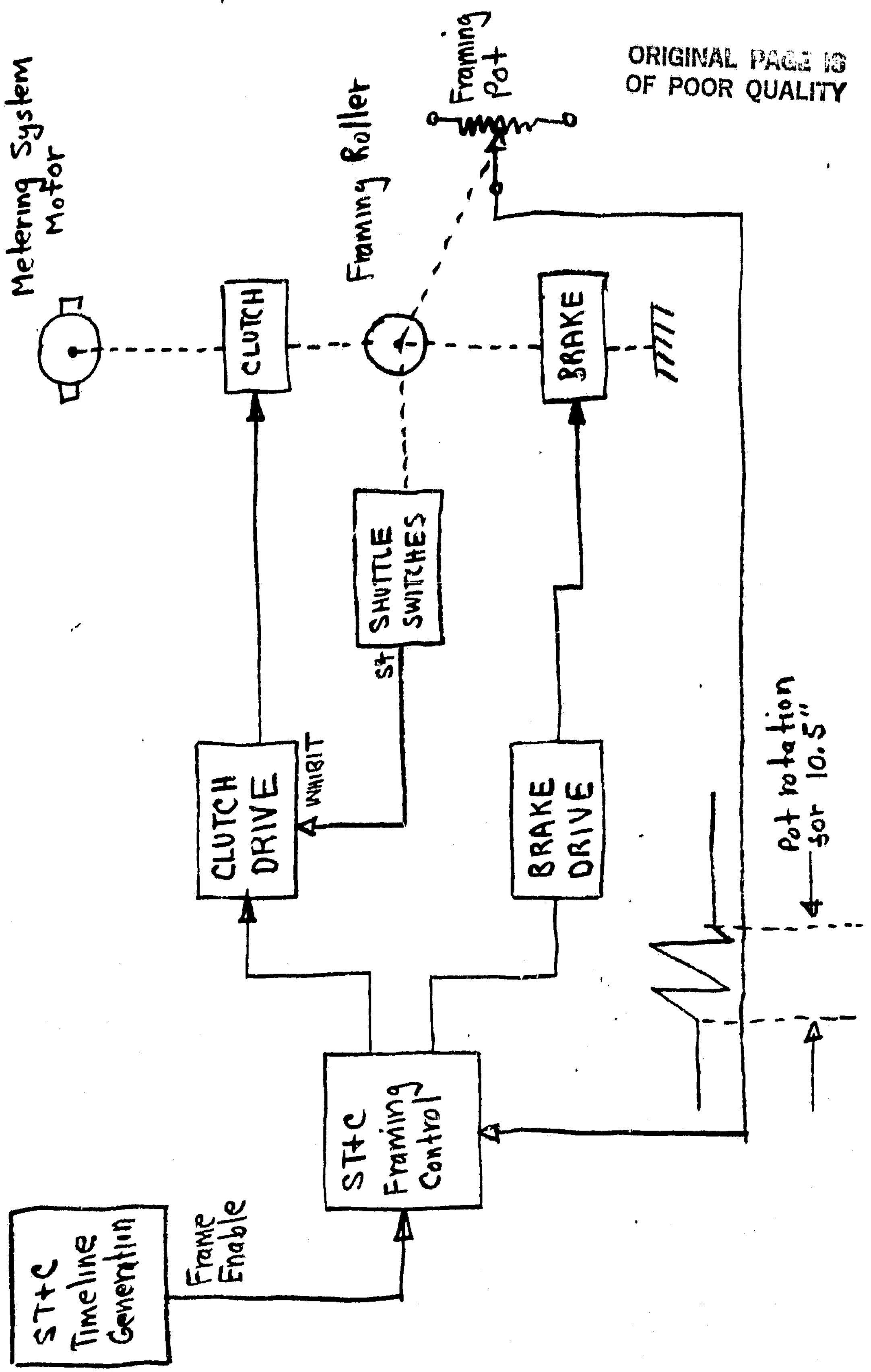

| BY: [signature] | | TITLE: Platen Press Control | PAGE: Fig 3-10 |
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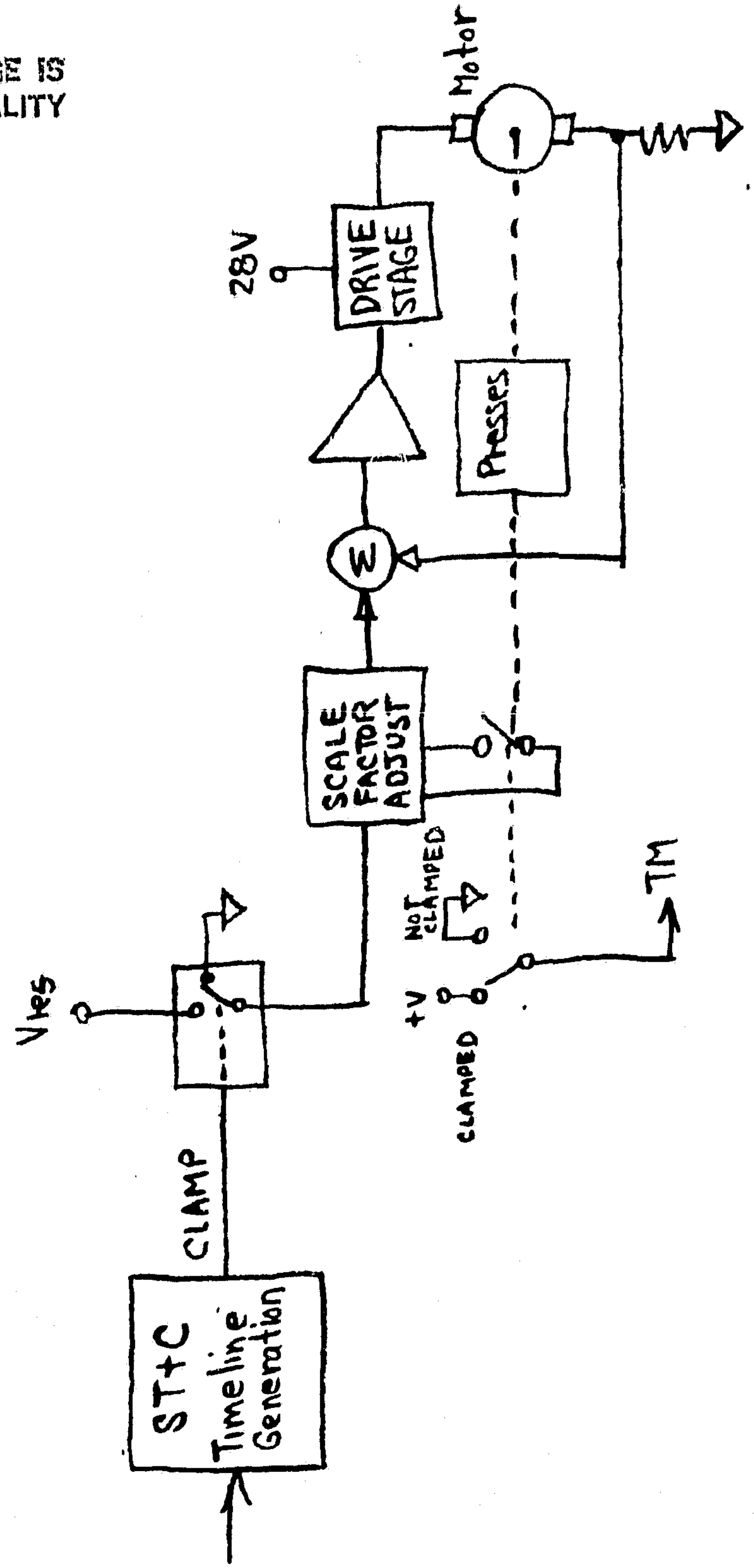

## 3.5 SUPPLY AND TAKEUP FILM CASSETTE ASSEMBLY

The film cassettes for Supply and Takeup are identical units as shown in Figure 3-11. Film is stored on the spool which is held in the assembly by means of a large spanner nut securing the spool to the drive assembly. The film radius is sensed by a "puck-arm" which drives a potentiometer providing position feedback to the spool drive servo, thus maintaining constant film tension from full to empty spool. The spool drive provides back torque on the Supply cassette to maintain tension, whereas the drive on the takeup cassette provides the torque to wind the film on the takeup spool. A "dip stick" provides the means of checking film load without opening the cassette. A cap covers the entrance fitting when the "dip stick" is not in use. Dual offset film rollers center the film in the exit/entry chute of the cassette regardless of film radius. A cover with a labyrinth light seal provides access to the film spool. The cover is held on by means of a threaded knob that is safety wired. A light seal device (see Fig 3-12) will be designed to fit in the exit/entry chute to prevent stray light from entering the cassette when it is not connected to the ARS. Film exit/entry chute extensions will be designed to interface between existing chutes and the ARS housing. An electrical connector in the side of the housing provides an interface with the ARS electrical system. The cassettes will be mounted to the ARS housing by means of brackets that will be fastened to the rear of the cassette housings.

The following are summaries of the steps that are proposed for the conversion of the two GFE assemblies, as received, into Supply and Takeup film cassette assemblies for the ARS.

## SUPPLY CASSETTE

(1) Receive unit and spare parts from Govt.

(2) Inspect

(3) Electrical Checkout

Component level check of potentiometer, motor and brake.

(4) Dis-assemble rollers and Drive Assembly. Obtain new bearings from GFE stores, send out for re-lube.

(5) Design new light seal and interface film chute to transport housing. Design new thicker (extended capacity) spool flanges. Design new bracket to support the assembly.

(6) Manufacture the above.

(7) Reassemble, installing new bearings and possibly new motor, potentiometer and brake (from GFE stores). Mount on new support bracket.

(8) Repeat electrical checkout as in step (3).

(9) Inspect as Supply Cassette

(10) Integrate with ARS, debug.

## TAKEUP CASSETTE

(1) Receive spare parts from Govt.

(2) Inspect

(3) Electrical Checkout

Component level check of motor and brake.

(4) Obtain new bearings from GFE stores, send out for re-lube.

(5) Design new light seal and interface film chute to transport housing (same as supply) Design bracket to support the assembly.

(6) Machine housing from casting in stores and manufacture light seal, film chute and bracket.

(7) Reassemble, installing new bearings, new sensor arm assembly (from GFE stores) and new motor, potentiometer, brake, and all other necessary parts. Mount on new bracket.

(8) Electrical checkout.

Component level check of potentiometer, motor and brake as installed.

(9) Inspect as Takeup Cassette.

(10) Integrate with ARS, debug.

## SUPPLY AND TAKEUP CASSETTE CONTROL

The Supply and Takeup Cassettes have identical control electronics which have been GFE'ed. These are identified as assembly 157006.

A "puck arm" measures the radius of the film wrapped onto the spool and sets the wiper position of a pot. The voltage developed at the wiper is applied to an amplifier which develops a current output. This current plus a bias current flows through the motor producing a torque at the spool hub. The torque divided by the spool radius produces the ultimate film tension. See Figure 3-13 for a block diagram.

The amplifier scale factor can be varied by means of a select in test resistor for various film tensions. A likely choice is 2 pounds film tension.

An electrically actuated brake prevents the spools from unwinding when power is off. The application of power deactivates the brake and activates the tension control. There is no command interface.

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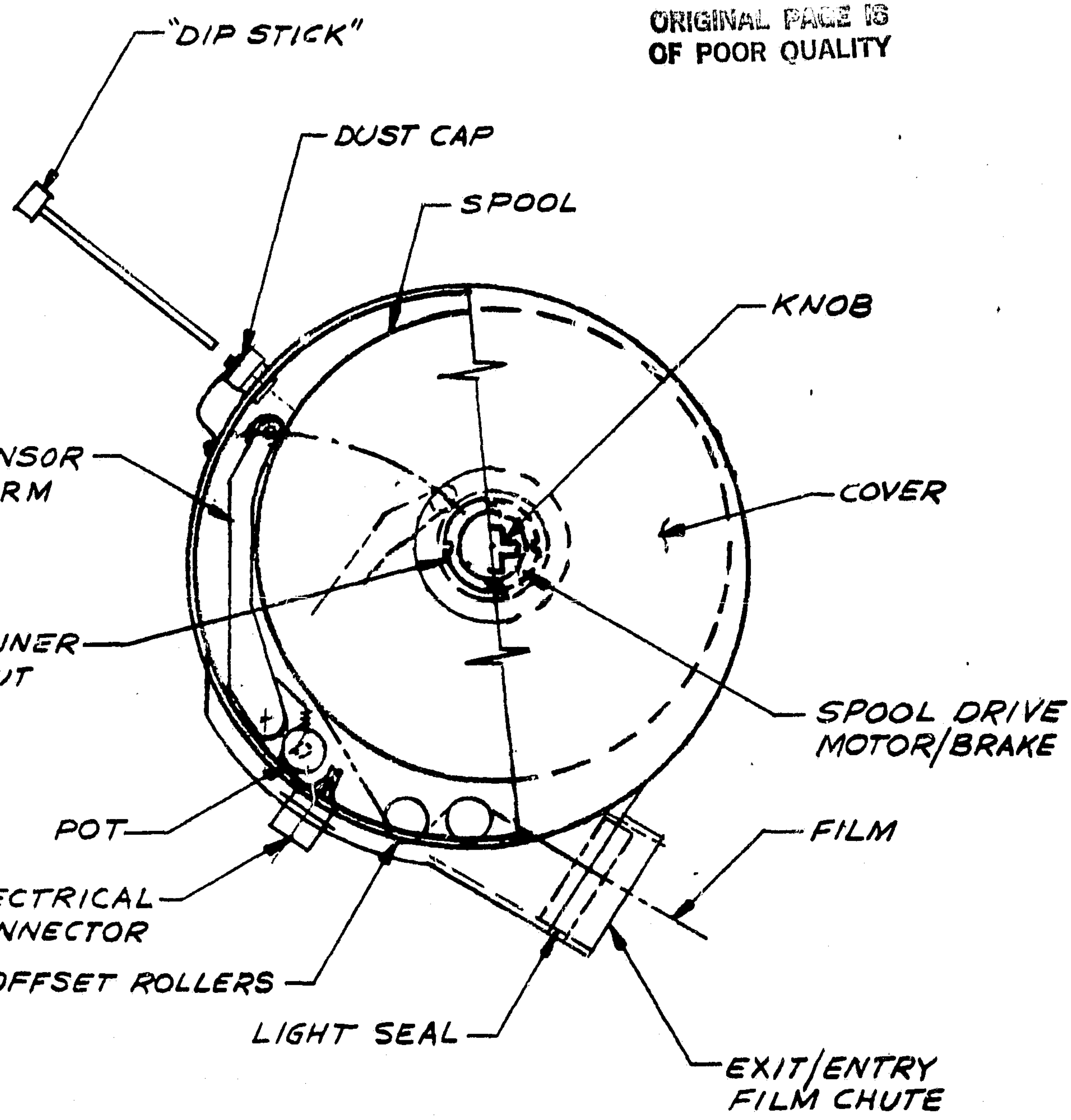


FIGURE 3-11. SUPPLY & TAKE-UP FILM CASSETTES

| BY: | | TITLE: | PAGE: Fig 3-12 |
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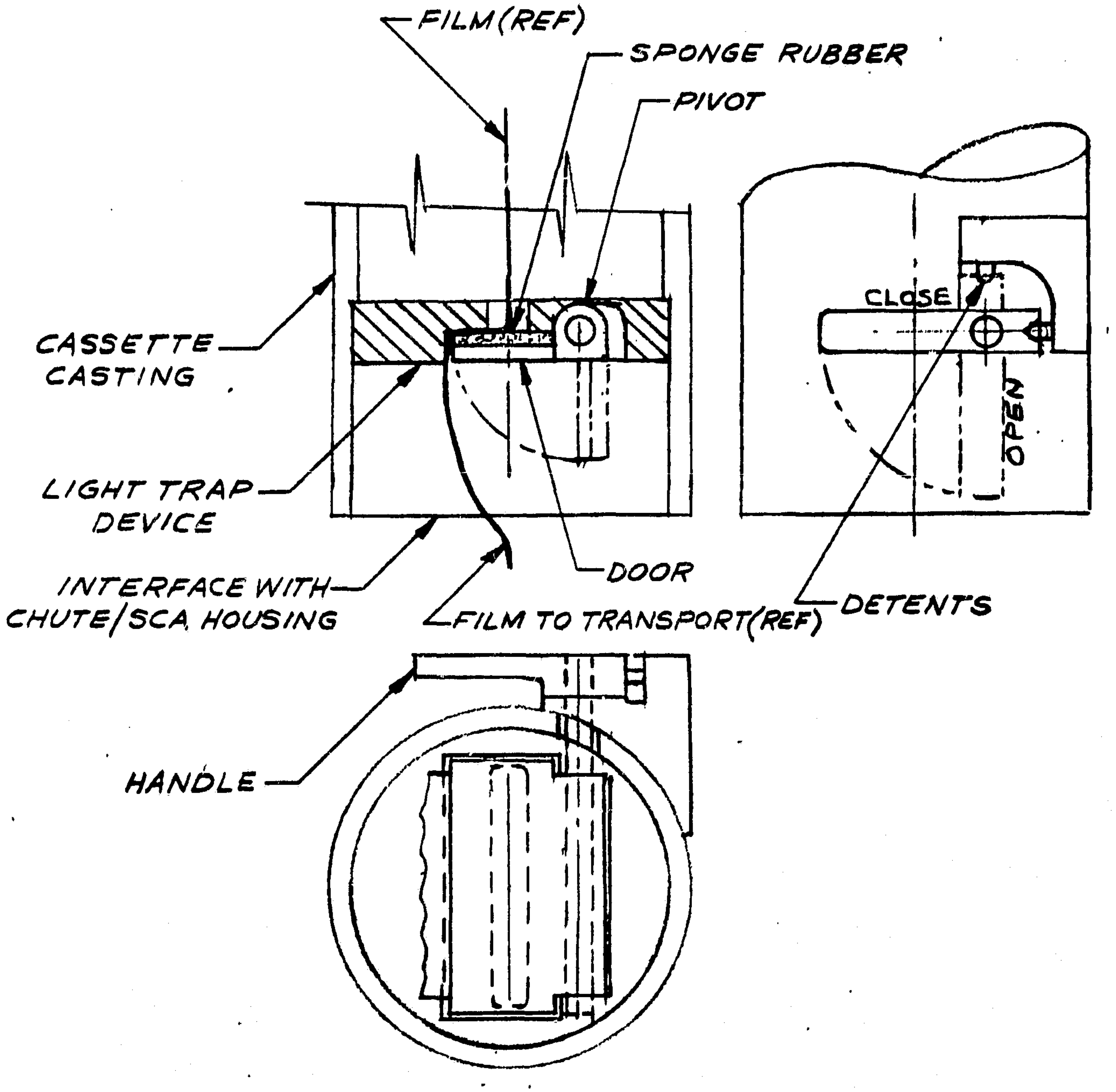


FIGURE 3-12. CASSETTE LIGHT SEAL

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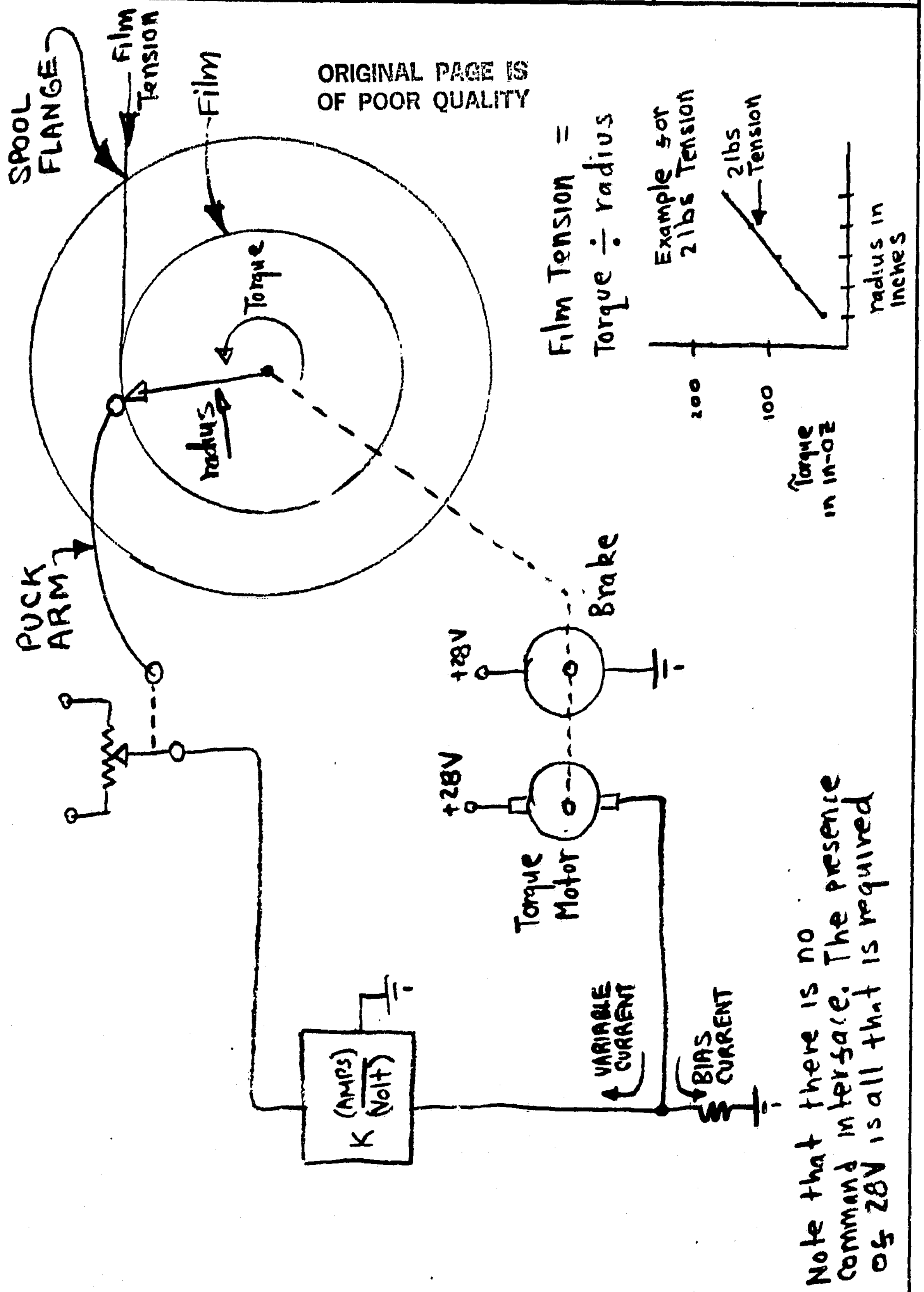


Fig. 3-13. Cassette Control

## 3.6 SCA Housing Assembly

A new housing assembly as shown in Figure 3-14 will be designed to do the following:

1. Contain the film transport assembly
2. Provide a mounting for lenses "L" and "R"
3. Provide a mounting for shutter mount housings "L" and "R"
4. Interface with film chute extensions from supply and takeup cassettes
5. Interface with support brackets for supply and take-up cassettes
6. Provide interface with electrical "J" Box and pneumatic line
7. Interface with SCA support structure

The housing will be a light tight structure incorporating heater strips and thermal insulation and will provide a rigid, thermally controlled structure for the mounting of all the critical assemblies of the ARS. It will provide access for testing the entire film transport system from supply to take-up prior to installation of lenses and shutters. Once the film transport system has been checked out, lenses and shutters can be assembled to it and integrated testing can be performed. An air-tight cover plate will permit access to components inside the housing. During operation a slight pressure will be maintained inside the housing to reduce static marking of the film. Nitrogen, cycled from the LFC during operation, will be brought to the housing assembly by a pneumatic line. Suitable venting will be incorporated in the design to assure adequate pressure equalization during lift-off and landing.

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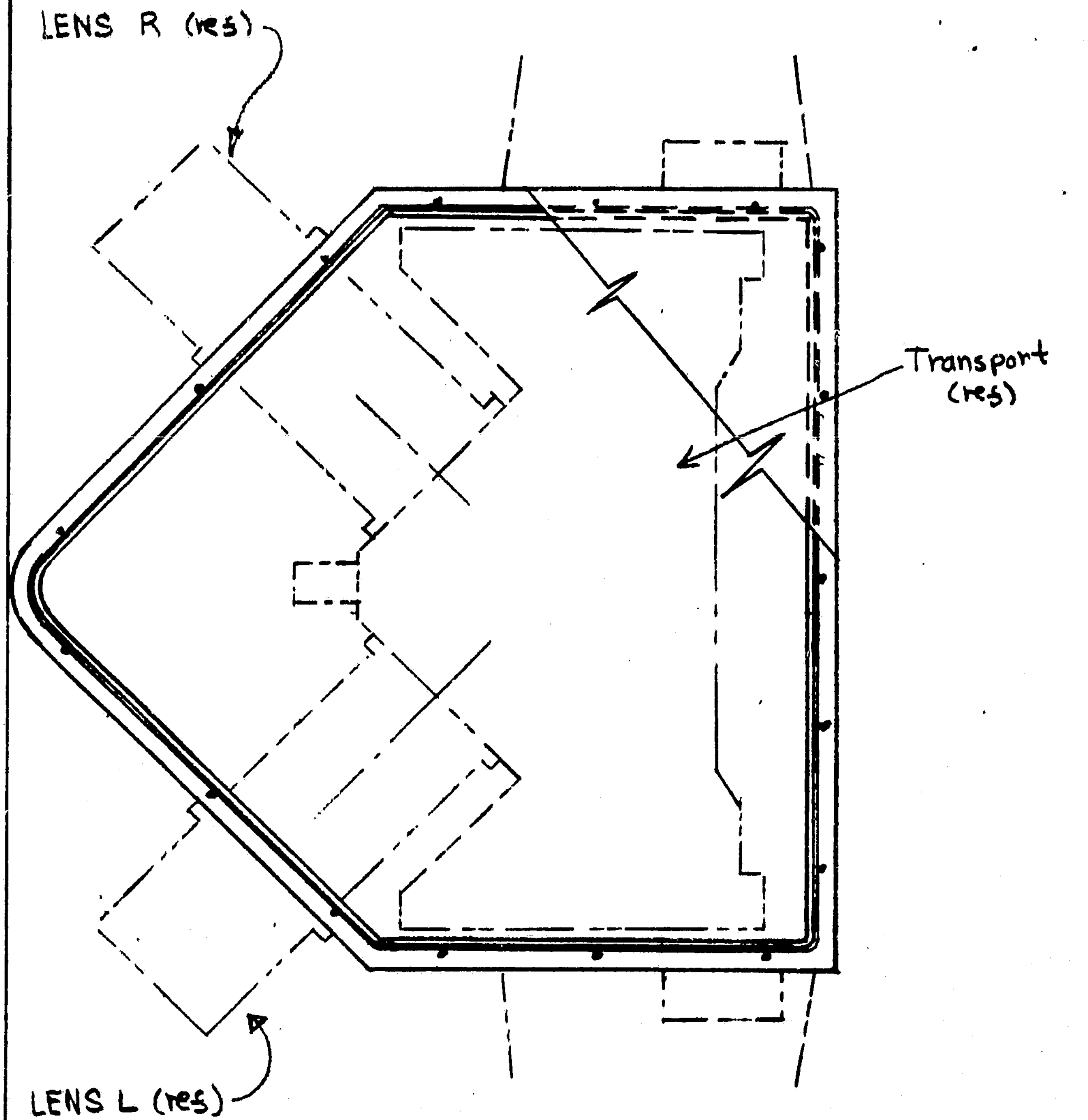


Fig. 3-14. SCA Housing

## 3.7 SCA SUPPORT STRUCTURE

The SCA support structure provides the interface between the LFC and the SCA. It will be designed to mount on the LFC camera bolts. The structure will be an aluminum weldment as shown in Figure 3-15 with invar interface fittings to minimize effects of thermal gradients. Aluminum was chosen as the structure material so that it's thermal coefficient would match that of the LFC camera support structure to which it is attached. The inside diameter will clear the LFC environmental enclosure and there will be open areas adjacent to each interface point to permit access to the LFC electrical connector, regardless of LFC position within the structure. The LFC line of flight can be in any one of four positions.

The SCA Housing Assembly, containing most of the essential subassemblies of the ARS, will be mounted on top of the structure. Two sides of the structure are beveled to prevent interference with two light weight baffles that are installed on the SCA shutter housings.

All outer surfaces of the SCA support structure will be covered by an insulation blanket to minimize effects of the thermal gradients.

Thermal blankets will be located on the structure to prevent excessive thermal gradients which can cause one side of the structure holding the SCA to grow more than the other side, minimizing angular position errors that must be kept within budget limits for the SCA to perform properly.

The total SCA weight, excluding the electronics assembly, will be approximately 280 lbs. with a CG in the -Y- direction approximately 14 inches from LFC centerline. It is imperative that the SCA be rigidly attached to the LFC and that the SCA structure preserve the system knee angle. For these reasons, a reinforced box section was chosen as the structural form of the SCA support structure to bridge the gap from the SCA system to the LFC interface. Preliminary calculations indicate that this SCA structure configuration will limit the static angular deflection of the SCA system in a 1 g field to less than 5 arc seconds.

An analysis of the LFC vibration isolators, with the addition of the SCA, has shown that two of the four existing isolators may remain the same. The two remaining isolators must be stiffened by a factor of approximately 1.7 in order to maintain the present isolator natural frequencies and static deflections. This may be possible by altering dimensions slightly in existing isolator grommets to reduce elastomer thickness and thereby increase stiffness, without changing the durometer of the elastomer. The present LFC isolator grommet material is Viton-A flurocarbon elastomer with a duromteter of 70-75.

Knee Angle Stability

Once the STS has arrived on station and the LFC/SCA has been calibrated there, photographically, thermal gradients provide the source of error which will affect the relative pointing angles.

The SCA support structure will be designed to minimize effects of thermal gradients on this pointing angle of the SCA with respect to the LFC, or Knee angle. Height of all members of the support structure are equal and the structure is approximately symmetrical except for the section supporting the SCA. These features coupled with the use of heater strips will help to minimize angular errors caused by uneven temperature distributions over the structure. In addition, insulation blankets will cover the SCA and its support structure to prevent the occurrence of wide temperature variations in the structure that can affect the knee angle. Aluminum was chosen as the material for the SCA support structure so that it's thermal coefficient of linear expansion would match that of its interface, the LFC camera support structure with attachment points twenty-seven inches apart. Thus the two structures will expand and contract together, assuming minimal thermal gradients between them. The attachment fittings are made of INVAR, with a low thermal coefficient of expansion. This will ensure minimum angular deflection resulting from fitting-to-fitting temperature differences. Preliminary calculations indicate the SCA knee angle variations can be kept below two arc seconds with thermal gradients side to side of approximately $1^{o}$F. Allowable thermal/structural contributions via knee angle variations are three arc seconds or less. The temperature control system will be designed for $\pm 1^{o}$F set point accuracy.

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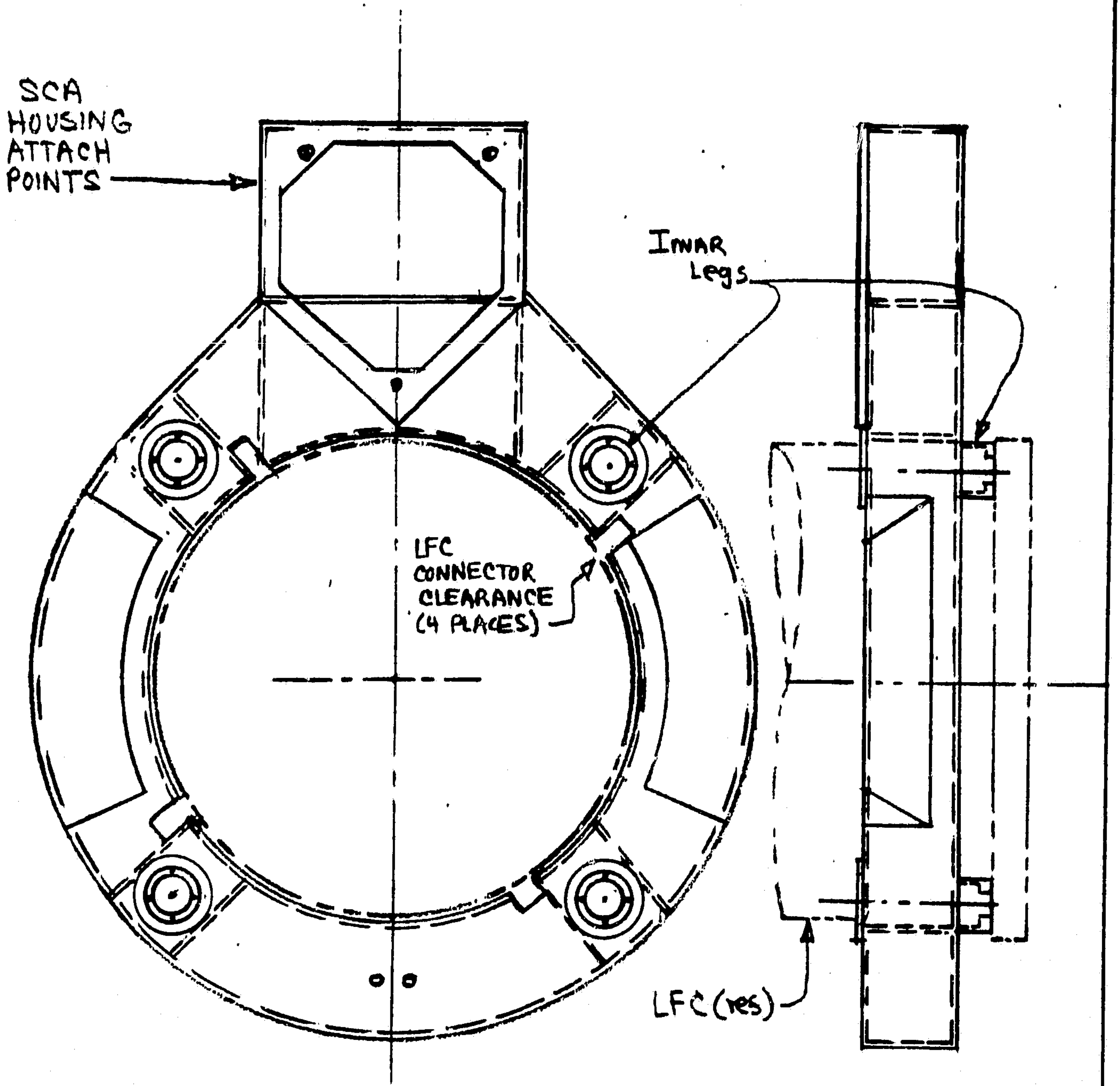


Fig. 3-15. SCA Support Structure

G.G.
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## 3.8 Thermal Control System

The ARS thermal control design must meet the SCA pointing stability requirements while exposed to the orbital and STS bay radiation environments. The design must also be compatible with the LFC camera system. Thermal control will be similar to that employed on the LFC system, utilizing a combination of passive thermal techniques and thermostatically controlled heater zones. The following paragraphs will describe the boundary conditions, requirements, the baseline thermal design, and the thermal analytical model used in the design tradeoffs.

I. Thermal Boundary Conditions

Since the ARS shares the same support structure as the LFC, it will basically see the same orbital environments. These include solar, albedo, and earth flux exposure in the 185Km to 600Km altitude range, the STS bay radiation environment, and radiant interchange with neighboring payloads. The current plan is to analyze the same orbital conditions (with appropriate modifications) as previously utilized in the LFC thermal design effort.

II. Requirements

The most strigent thermal control requirement is maintenance of mechanical alignment (budgeted at ± 3 arc seconds) between stellar to stellar and stellar to LFC lines of sight. Initial assessments indicate the ARS aluminum support structure will require temperature control to approximately ± 1$^{o}$F to maintain stellar to LFC alignment. Temperature control of the structure for stellar to stellar alignment are more relaxed. Employment of a thermal control system similar to that of LFC has been investigated and appears to be a viable approach in maintaining stability to these levels.

III. Baseline Thermal Control (refer to Fig 3-16 Thermal Control Features)

ACTIVE HEATER CONTROL

The axis stability requirements dictate a uniform temperature environment for the ARS and close temperature control between the ARS and the LFC. Multizoned, thermostatically controlled heaters will be used to achieve the required temperature stability. The baseline design has one zone on the main camera housing, three zones on the aluminum support structure, one zone on each shutter housing, and one zone on each shutter assembly. Two zones for the separate electronics package will bring the total number to ten. The temperature setpoints will be finalized in the design phase but will likely be maintained near the LFC support structure ring setpoint of 19.5$^{O}$ (67.1$^{O}$F). This would minimize ARS support structure top-to-bottom gradients resulting from differing adjacent setpoints. To conserve energy, the electronics enclosure setpoint will be - 15$^{O}$C (5$^{O}$F). The control on setpoint will be within the required $\pm$ 1$^{O}$F on zones effecting axis stability. A preliminary estimate of ARS heater power is 90 watts for cold orbital conditions (Orbit C, B = 52$^{O}$, from the LFC Thermal Analysis Report). The nominal orbit (Orbit A) heater power is estimated at 36 watts.

INSULATION

The entire ARS outer surface area, except for the sun shades (baffles), will be covered with thermal insultation. Its purpose is to attentuate external temperature oscillations and to conserve thermal control power. The blanket construction will be similar to the LFC insulation system. The two materials, fiberglass for attenuation of launch and entry thermal loads, and MLI (Multi-Layer Insulation) for orbital conditions, will be enclosed in a dacron fine-mesh netting. The insulation blankets will be constructed to conform to each components' shape and can be removed at hook and pile fasteners. The external netting will confine fiberglass particles and support the thermal control coating. See Fig

THERMAL CONTROL COATINGS

All insulation surfaces which are exposed to solar loading will have a thermal control coating. The coating will attenuate these solar loads and provide a more stable temperature environment for camera components. The baseline thermal design specifies the LFC thermal control coating, Chemglaze A276 white paint ($\alpha_s/\varepsilon$ = .44/.87). Thermal analyses under solar orbital conditions will determine the paint's adequacy in maintaining surfaces below setpoint temperature. This insures positive heater control under all orbital conditions.

IV Analytical Model

The ARS and LFC are mechanically, optically, and thermally linked to each other. Therefore, the ARS thermal analytical model will be constructed and added to the existing LFC thermal model. This combined model will be utilized to assess the ARS thermal control under the required operating conditions. Internal optical elements and cell structures will be modelled in sufficient detail to assess optical performances (temperature level excursions and gradients). Attention will be given to components, mechanisms, and heat dissipating items that are key to the camera's operation.

A major effort will be to supply system temperature data under nominal and worst case conditions to the NASTRAN model to insure pointing errors are within the stability requirements of ± 3 arc seconds. The model will also be utilized to make final adjustments, as required, in setpoint temperatures, heater zones, insulation, and thermal control coating properties.

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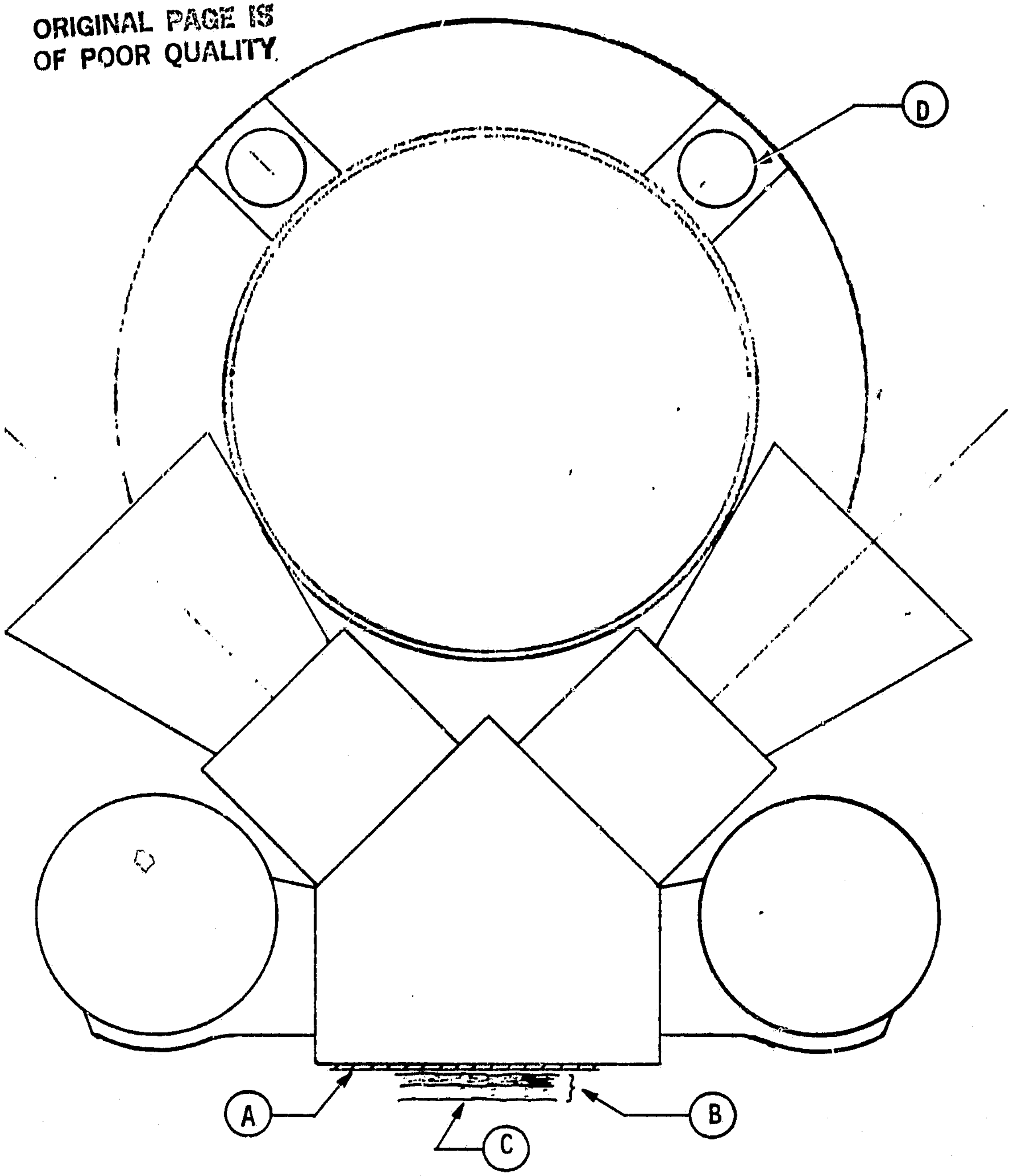


Fig. 3-16

THERMAL CONTROL FEATURES

A HEATER, TYPICAL, CONTROLLED AT SETPOINT ± 1°F
8 ZONES, KAPTON ETCHED FOIL DESIGN

B INSULATION, OVER ENTIRE ARS STRUCTURE, 1/2" FIBERGLASS, 1/2" MLI
DACRON NETTING OUTER LAYER

C THERMAL CONTROL SURFACE, CHEMGLAZE A276, WHITE PAINT, $\alpha_s/\varepsilon$ = .44/.87

D INVAR STRUCTURE SUPPORTS TO MINIMIZE POINTING ERRORS

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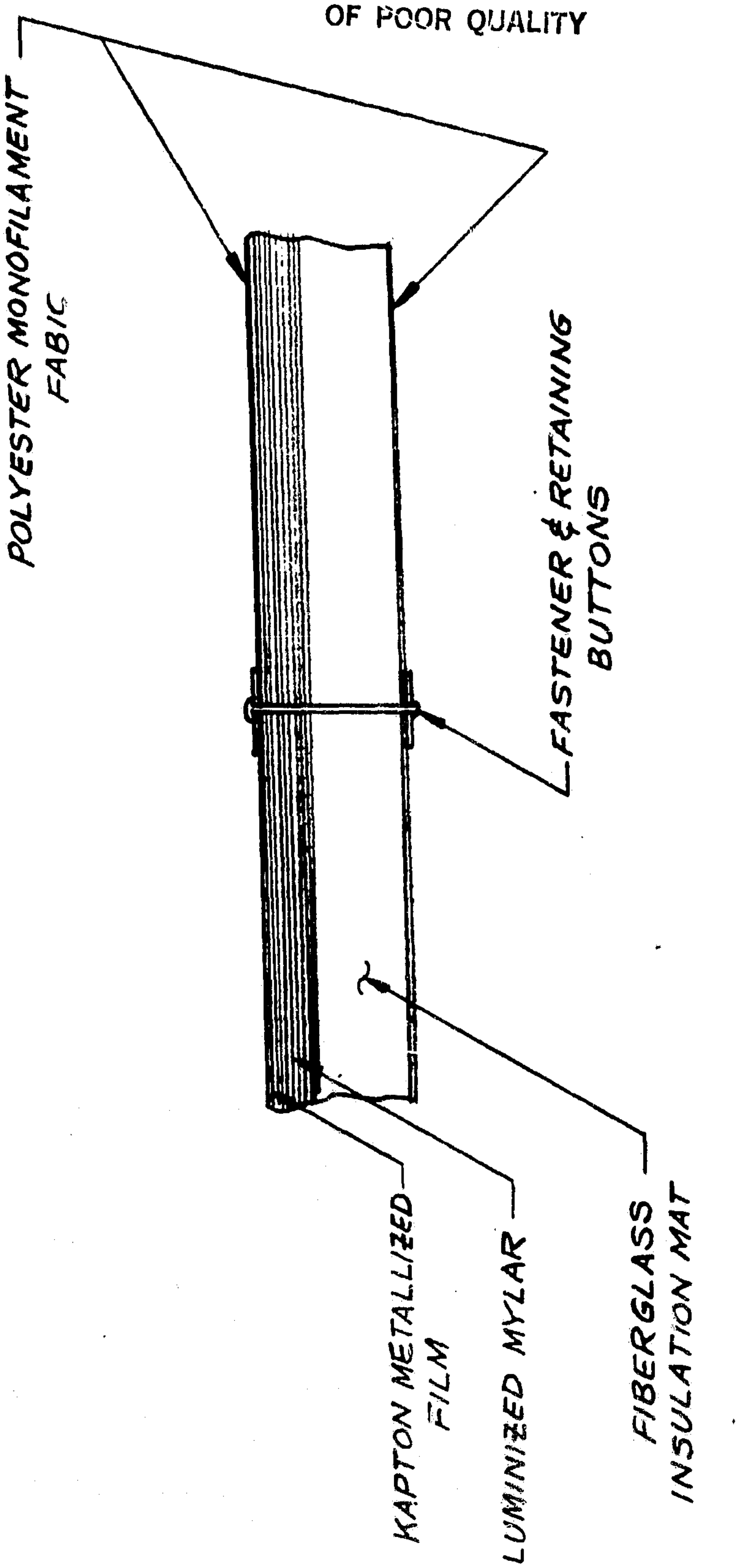



FIGURE 3-17 ENVIRONMENTAL ENCLOSURE, TYPICAL CROSS SECTION

## 3.9 ARS ELECTRONICS ASSEMBLY

The ARS Electronics Assembly will utilize the same basic design as did the LFC Camera Electronics Assembly. By doing this, a design with proven structural, thermal and EMI characteristics is made available at a great cost savings. There will be substantial volume available within the ARS enclosure to accomodate all remotely locatable electronics for the SCA as well as providing space for future expansion. Many of the detailed parts drawings produced for the LFC program will be used with no change for the ARS program, but some will change in whole or in part. Typical of those that will not change are:

- The Thermal Enclosure
- The Card Rack sheet metal parts
- The Enclosure and Cover
- The basic Heat Sink

Those that will change include:

- The Printed Wiring Boards (PWB) will be new
- The back plane wiring will change

Refer to the ARS Electronics family tree (Fig.3-18) for a listing of features included in the ARS Electronics Assembly. Some components appear there on a branch called SCA. These are items which need to be located close to the point of useage. Those features which can be remotely located have been placed in the ARS Electronics assembly proper.

Many of the functional characteristics of the various PWB's have been reviewed under the area affected, such as the shutter servos, but a brief recap is included below along with the Electronics Assembly description.

The ARS Electronics Assembly will consist of an EMI Enclosure, which

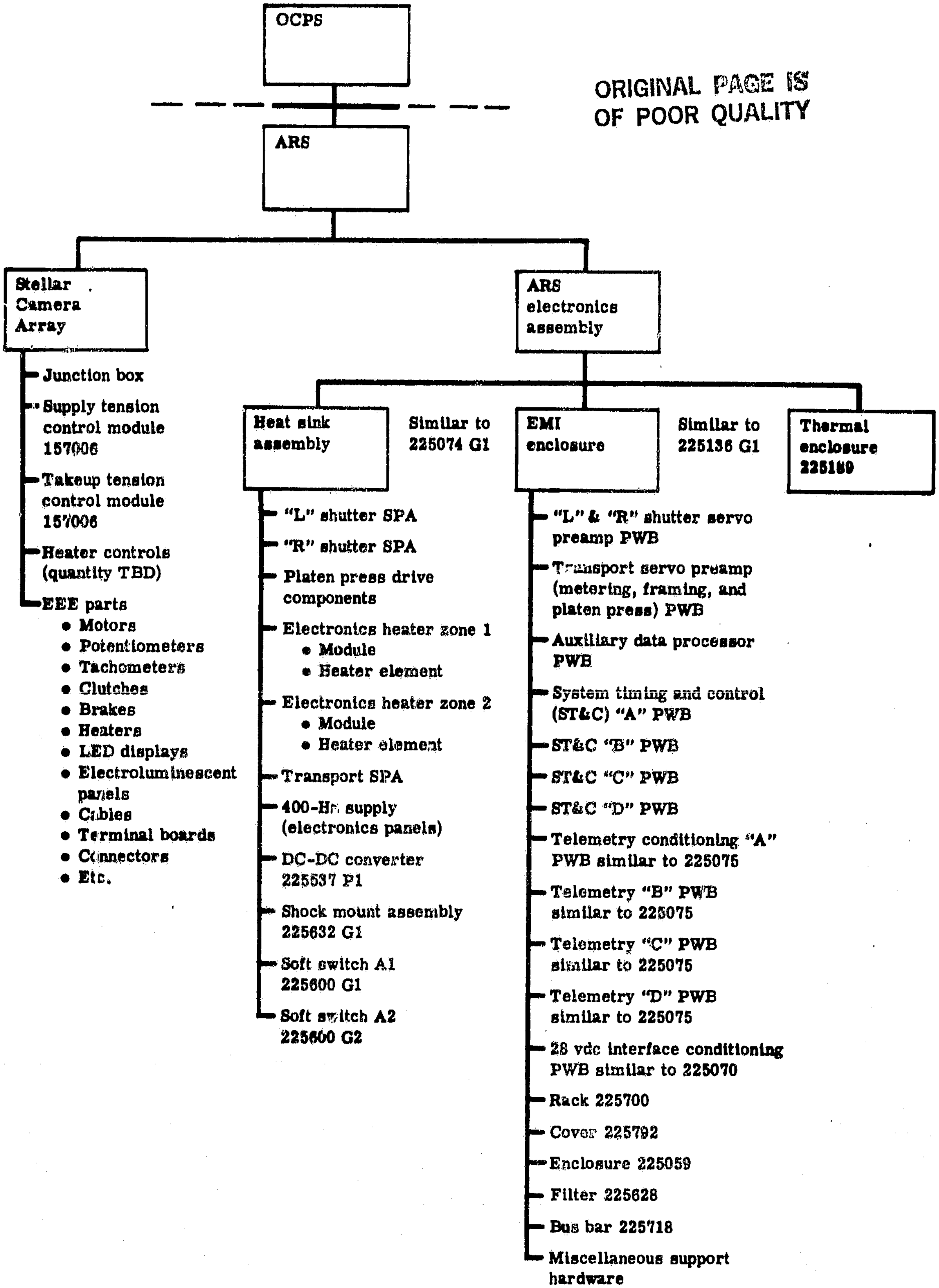
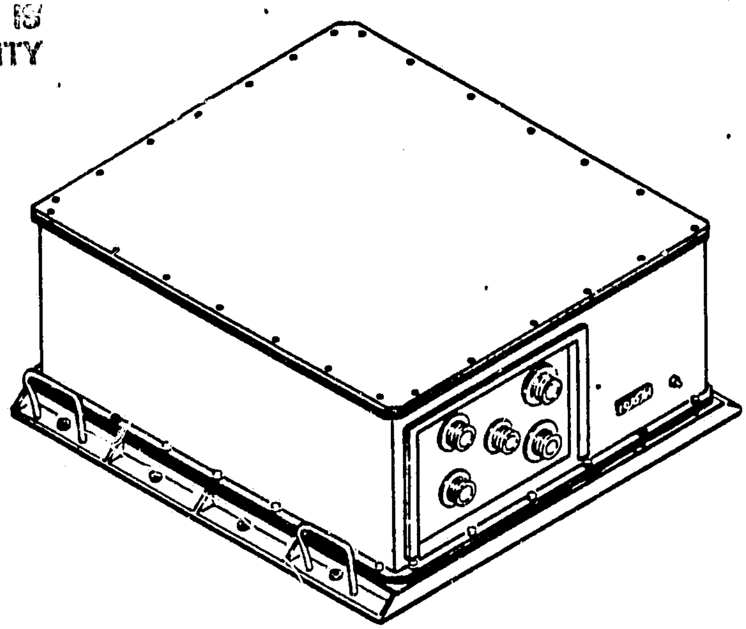



Fig. 3-18 — ARS electronics family tree

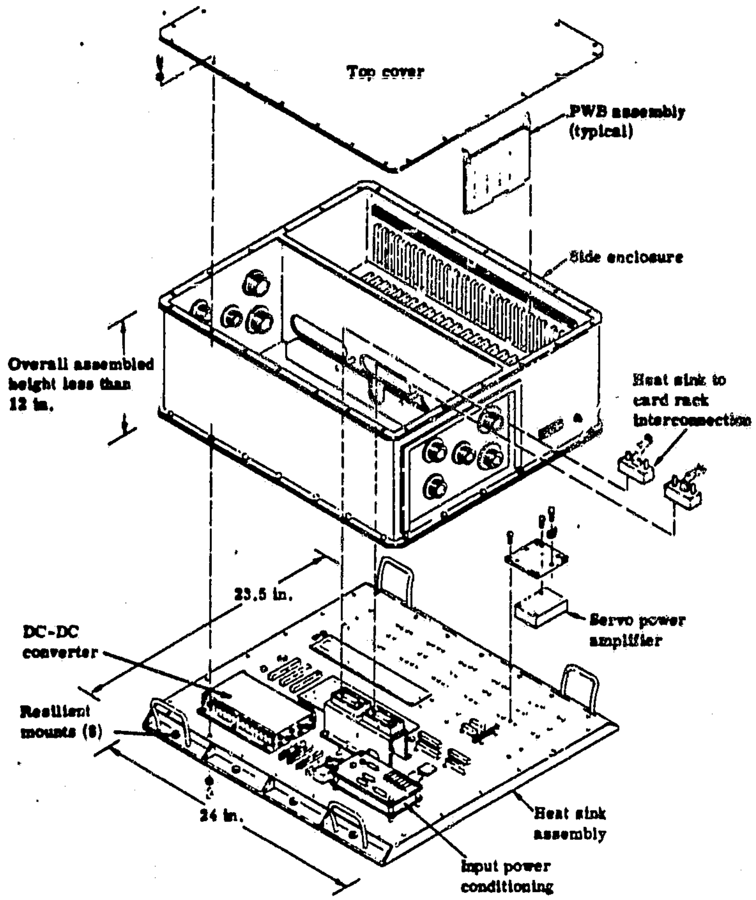
is a box structure containing a card rack full of PWB's, back plane wiring and interface connectors, a Heat Sink Assembly which is an aluminum plate that forms the base of the Electronics Assembly, has vibration isolators and handles, and which houses all the major heat dissipating components within the Electronics Assembly, and a Thermal Enclosure which is a fiberglass box that covers the EMI enclosure and provides a thermal shroud for the enclosure. Figure 3-19, Electronics Assembly, includes views of the unit assembled, and exploded to illustrate the concept and the maintainability features of this approach. The figure does not include the Thermal Enclosure.

## FUNCTIONAL CHARACTERISTICS OF THE PWB's

1. A & B Shutter Servo Preamp. This PWB houses the gain and compensation circuitry for both shutter servos. Isolation circuitry is housed on this board to separate signal and power grounds. Commands are originated in the ST&C (System Timing and Control) area, and the output of this card is applied to two servo power amplified (SPA's) to drive the shutter motors.
2. Transport Servo Preamp. This PWB houses the gain and compensation circuitry for the Metering motor and the platen press motor. If any circuitry beyond that contained within the ST&C is required to control Framing, it will reside on this PWB as well. Commands are originated within the ST&C, and outputs are applied to an SPA and drive transistors.
3. Aux Data Processor - This board will receive the LFC Frame Count signal from the LFC interface, and the two CE mismatch signals from the ST&C, will format and buffer and store that data to be compatible with the SCA Aux Data Printer, and will output the data upon command from the ST&C.



(a) Electronics assembly assembled




(b) Electronics assembly exploded view

Fig. 3-19 Electronics assembly

4. System Timing and Control (ST&C) - This is a four board set which includes a micro processor based computational system to accomplish the following tasks:

   a. Develop a Metering Roller servo film velocity command based on mode, v/h and LFC overlap.

   b. Generate the commands to control the Framing Roller brake and clutch, starting a frame in accordance with the "Timeline" and ending it after 10.5 inches of film has been framed, as ascertained from position feedback information.

   c. Produce a variety of outputs in accordance with a "Timeline" for either the Test/operate mode, or the Calibrate mode. (see Figs 3-20, 3-21 + ARS profiles). These outputs include:

      - Electroluminescent Panel control
      - Platen Press Control
      - Aux Data Control (print)

   d. Monitoring LFC parameters, predict a forthcoming exposure and create an ARS shutter position profile command to synchronize the ARS/LFC centers of exposure (CE's).

   e. Observing the shutter responses, compute CE mismatch data for the two SCA cameras versus the LFC and forward this data to the AUX Data Processor PWB.

Other minor ST&C tasks may develop as the design matures.

5. TM Conditioning - ARS response signals which are considered significant enough to provide for monitoring during flight are conditioned by the four TM conditioning PWB's, A,B,D or D, to be interfaced to an FMDM as either DIL or AID signals (refer to JSC-07700, Volume XIV). These

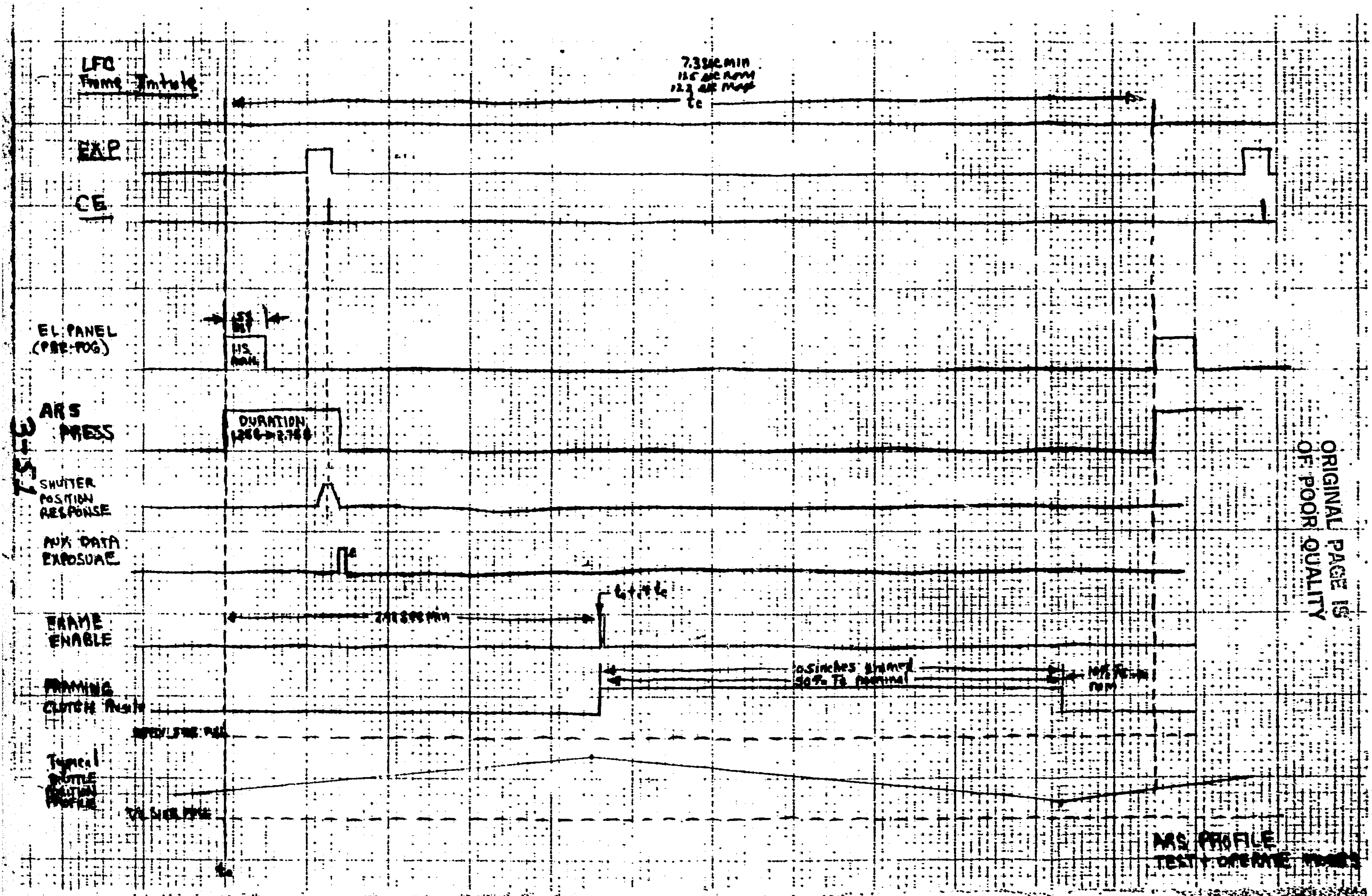



Fig. 3-20. ARS Profile, Test and Operate Modes

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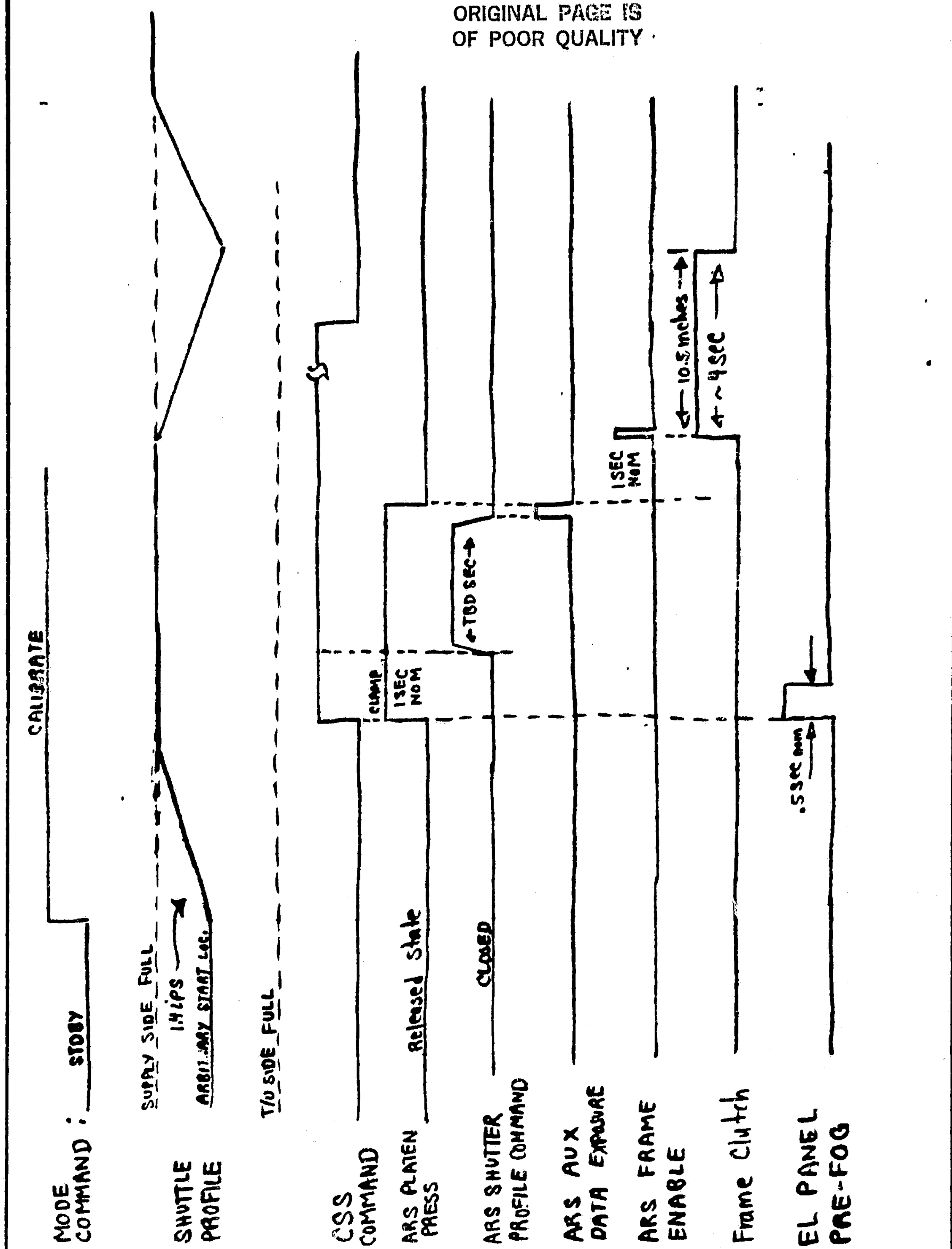

four cards are identical in layout to their LFC counterparts, although specific scaling will vary. These four cards will allow for a maximum of 32 analog and 16 digital TM signals, which will be outputted via the ARS Electronics assembly connector J4 for direct FMDM interface. Pin limiting at this connector of 85 lines will restrict the maximum TM capabilities to less than the full TM card potential. A list of TM functions will be agreed upon at CDR.

6. 28 VDC Interface Card - This card will be similar to its LFC counterpart and is used in controlling the ARS 28VDC power interface.

## HEAT SINK COMPONENT FUNCTIONAL DISCUSSIONS

1. Servo Power Amplifiers (SPA's) - The SPA's are Inland Servo Power amplifiers produced under a specification developed on the LFC program. They provide for either current or voltage control of the motors, have adjustment means for scale factor and current limit and may be disabled by a TTL signal.
2. Heaters, Z1 and Z2 - As with the LFC, the Electronics assembly features temperature control in two zones with a setpoint of +5$^{\circ}$F.
3. Drive Components - Certain actuators, such as the platen press, are driven by power Darlington transistors. Where the power dissipation is calculated to be excessive for PWB mounting, these will be located on the Heat Sink assembly.
4. 400Hz Control and Supply - The Electroluminescent panels contained within the shutter assemblies require AC excitation. A 28VDC to 400 Hz AC converter will be used together with a control consisting of a relay or semiconductor actuated 28VDC on/off switch.

5. DC-DC Converter - This is a Powercube unit of identical specification as the unit used within the LFC, and provides the ARS with the secondary voltages needed for operation.

6. Soft Switch A1 and A2 - These components are as used on the LFC and control the 28VDC/ARS interface.

7. Shock Mount Assembly - A direct lift from LFC. The LFC Electronics assembly featuring these isolators successfully passed vibration testing.

## POWER DISSIPATION/ENERGY

A detailed power dissipation estimate will be available at CDR.

Current estimates for power dissipation are for a heater power of 88 Watts average for a cold orbit, and an additonal 55 Watts average for the functional components of the ARS in the Operate, Test or Calibrate modes.

For energy calculations, use an average of 93 Watts in Standby Mode times the mission duration, plus an additional 50 Watts times the operate, test and calibrate cumulative durations. Based on a five day mission at 160 nm, circular, and 60% overlap with a 30 minute calibrate cycle, the total energy for the ARS is estimated at less than 12 kwh.

## 3.10 WEIGHTS AND C.G.'s

Based on the design concept, the ARS total weight estimate is 356.1 pounds, of which 287.7 pounds is attributable to the SCA and therefore attaches to the LFC. The remaining 68.4 pounds is in the ARS electronics, which are remotely located. See Table 3-1, attached. The weight estimate at this time contains no contingencies.

The approximate C.G. locations for the SCA are presented in Table 3-2.

TABLE 3-1 ARS WEIGHT SUMMARY

| | WT-LB |
|---|---|
| Cassette Assembly - supply (with film) | 36.5 |
| Cassette Assembly - Take-up | 23.5 |
| Transport Assembly | 14.3 |
| Shutter Assembly L | 10.75 |
| Shutter Assembly R | 10.75 |
| Lens Assembly L | 10. |
| Lens Assembly R | 10. |
| Baffle Assembly L | 6.2 |
| Baffle Assembly R | 6.2 |
| SCA Support Structure | 118. |
| Housing Assembly & J Box | [illegible]5.5 |
| Environmental enclosure (blankets | 6. |
| Pneumatic Supply Line | 2. |
| SCA cable set | 8. |
| Total weight mounted on LFC | 287.7 LB |
| ARS electronics (LFC STYLE) | 68.4 LB |
| Total ARS weight | 356.1 LB |

## TABLE 3-2 C.G. LOCATIONS

Approximate C.G. Locations (Without Electronics Ass'y)

Y - direction
- SCA alone: 14 inches inboard from LFC vertical centerline.
- LFC/SCA: 3.5 inches inboard from LFC vertical centerline.

Z - direction
- SCA alone: 12.2 inches above LFC/STS interface ($Z_c$ 438.5)
- LFC/SCA: 5.8 inches above LFC/STS interface ($Z_c$ 438.5)

X - direction
- SCA alone: $\pm$0.7 inch from LFC centerline (Full supply +, full take-up)
- LFC/SCA: 1.0 inch from LFC centerline toward ARS take-up with full ARS/LFC supply spools. 0.6 inch toward ARS take-up with full ARS/LFC take-up spools.

## 3.11 FILM MARKING

Cosmetic considerations for stellar imaging are different from those for terrain imaging.

In terrain imagery, the scene content is rich and varied both in spatial frequency content and in density range. Many film marks due to manufacturing, handling and processing are lost in the scene content and only very gross marks, such as serious scratches or static discharge marks are noticeable. Also, the graininess of the film may be less noticeable due to the useage of slow, high resolution emulsions such as 3414.

In stellar imagery, with a prefogged background, the scene content is more uniform and very slight markings stand out and are easily discernable. Further, coarser films are used in the quest for more sensitivity to dim stars, and processing is optimized to regain every bit of energy which impinged on the film. As a result, stellar imagery contains a fair amount of markings such as bands or mottling from pressure effects, granularity from the film, specks from "dirt", streaks from processing and so forth.

In order that stars may be distinguished apart from the other markings, techniques are used which generate a "track". A star image will produce a "track", all of them will produce similar "tracks", and they may thereby be differentiated from other effects. Even a very dim star will produce a track which is readily spotted. The mechanism used on the ARS to produce a track is that of the pitch inherent in the shuttle when it is maintaining the Z axis vertical posture for normal picture taking. This will produce a 36 μ long track during the 200 MS effective exposure time. The measured track will be longer by the addition of the star image blur circle of approximately 10 μ. For cases in which an Inertial mode will be used, the mode should be prefaced by some period of rotation to produce a track in order to spot the dimmest stars.

The ARS will be designed and adjusted to produce a minimum of film marking and that minimum to be compatible with a ready location of stars of the fifth magnitude. However, cosmetic criterion on a level used with ground imagery should not be applied in critiquing the output. Rather, the satisfaction of the film reader in locating stars must be the final consideration.

# 4. GFE MODIFICATIONS

## 4.1 GFE Modifications other than LFC Modifications

Modifications to GFE components of the SCA have been discussed under the appropriate headings throughout.

## 4.2 MODIFICATIONS REQUIRED FOR THE LFC

The LFC, as received from the Government will require modifications to allow interface with the ARS. See Fig. 4-1 LFC Mods. These will include modifications in the areas of:

1. The Camera Electronics Assembly
2. The Camera Support Structure
3. The Environmental Enclosure

In all cases, the modifications will allow either stand alone LFC missions or integrated LFC/ARS missions. As a result of the LFC changes, certain documentation will also be affected including:

1. Drawings of the LFC and the components modified
2. ICD's describing the LFC
3. Test Procedures
4. The O & M manual
5. The CEI specifications

Modifications to GFE other than LFC have been discussed as encountered.

1. Modifications to the LFC Camera Electronics Assy.

Two types of modifications are required. The first are those required for ARS interface, and the second are a group of LFC improvements.

ARS Interface Modifications

The LFC Electronics Assembly will be restructured by changing connector J5 from a groundtest connector to the ARS interface connector. As such, it will supply power and commands to the ARS. ARS TM will not interface with the LFC Electronics assembly but will go directly to the orbiter. Signals and test features previously available at the

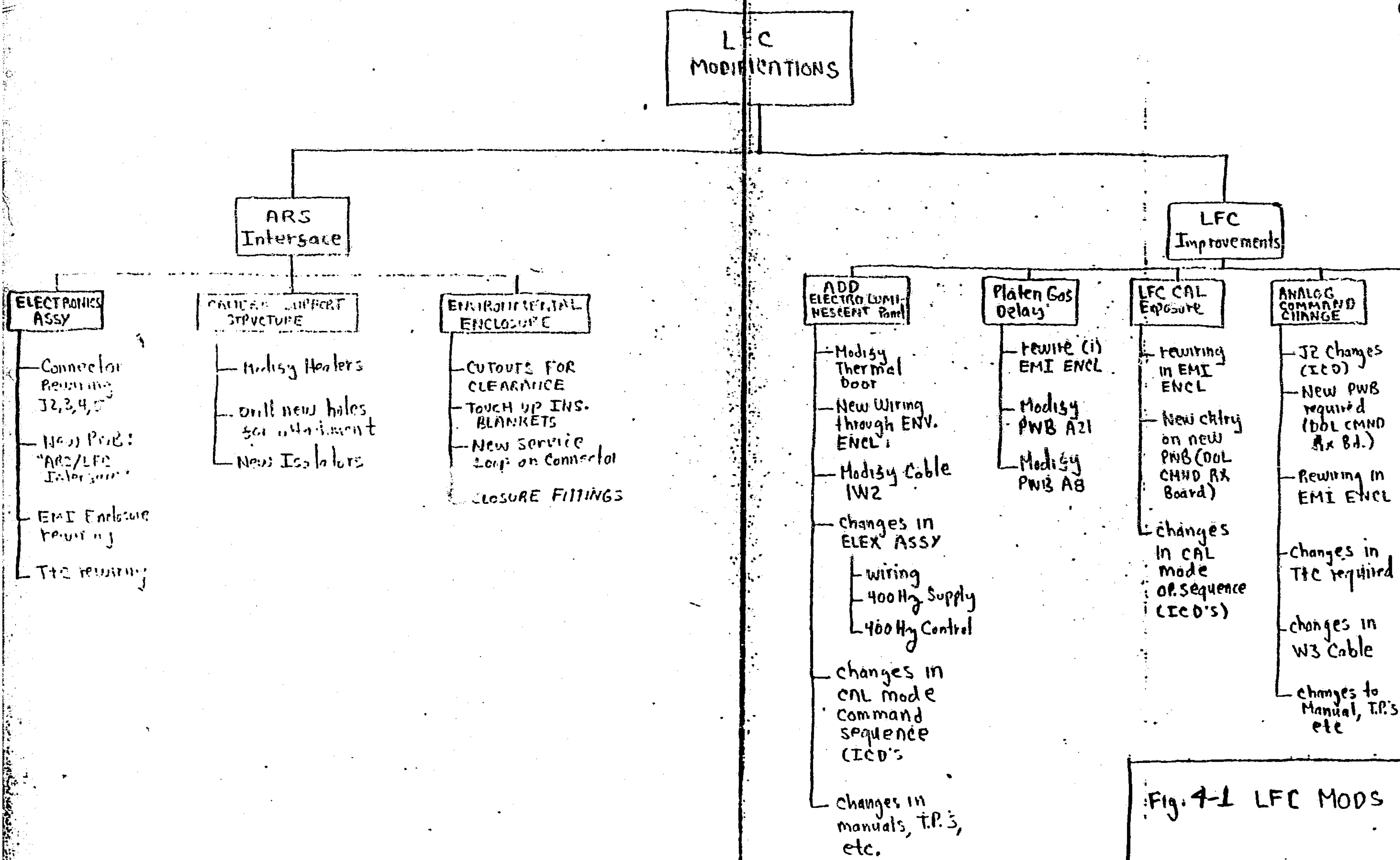


Fig. 4-1 LFC MODS

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J5 connector will be re-routed to J3 & J4 (for output data) and J2 (for input commands), or deleted. Some TM output previously available at J3 & J4 will be considered for deletion to provide space for the J5 signals. See the accompanying "Role of J5 in LFC/ARS Interface" for a suggested redistribution.

For the needs of the ARS interface, all commands from the LFC are available with minor modifications to existing PWB's. However, due to uncertain line length between ARS and LFC electronics packages, an interface PWB should be added to the LFC to provide line drivers/ receivers. See Fig. 4-2 (LFC/ARS Interface PWB).

The two bit mode command will not be the same as the LFC Mode Command as described in ICD-SLD-47-000001-803 paragraph 3.3.2, but will consist of the internal LFC signals "Call" and "MPE". If "MPE" is high, the mode is "not standby". If "Call" is high, it is "calibrate". Otherwise it is "Test" or "Operate". Since the ARS is slaved to the LFC, there is no need to differentiate Test from Operate.

The overlap command requires a PWB mod on A5 to bring out signals.

LFC IMPROVEMENTS

Several LFC product improvements have been called for in the Technical Specification from NASA.

1. LFC Analog Command Change - This requires a 5 Bit digital word be used for v/h interface to the orbiter. The coding is TBD, but will not be linear and implies a lookup table. Further a three bit code is required for the exposure command whose coding has been specified and which will also require a lookup table.

A new LFC PWB is required for this change, and demands are put on J2 of the LFC. See Fig. 4-3 (v/h and Exp DOL Cmnd Rx PWB) amd Fig. (J2 connector discussion). Extensive enclosure rewiring is generated due to this change and test procedure, manual and ICD changes

THE ROLE OF J5 IN LFC/ARS INTERFACE

- J5 is now "LFC GND TEST" CONNECTOR
  - M8372305R2255N
    (55-#20AWG Connections)
  - Present population

    13* Analog Signals using 35 pins

    4 Digital Signals using 6 pins

    3 Test Commands using 8 pins

    49 pins used

    6 pins available

    * 28 VDC operate is unbuffered, other 12 are buffered
  - Redistribution plan:
    - Delete notation "Flag" - all TM is same
    - Weed out less usable LFC TM:

      DISCARD - "Supply Spool Velocity"
      "Takeup Spool Velocity"
      "LFC Internal Pressure"
      "Supply Spool Radius"
      "Frame Count MSB"
      "Frame Count LSB"
      } Analog

      This frees up 6 Analog Channels
    - Spares currently available

      Suitable for Analog: 5

      Suitable for Digital: 4

J 5 (continued)

- Adding available spares to deleted TM allows us to accomodate all the J5 Digital signals and 11 of the J5 Analog signals.
- Delete 2 low use J5 signals (Analog)
  - T/U spool radius
  - Filter Changer Motor current
- Move Test commands to J2

  Delete Reseau Inh and Fiducial Inh

Summary

Delete 6 low useage Analog TM signals
and 2 low useage Analog test points (gnd)

Move all J5 lines to J2, J3, and J4

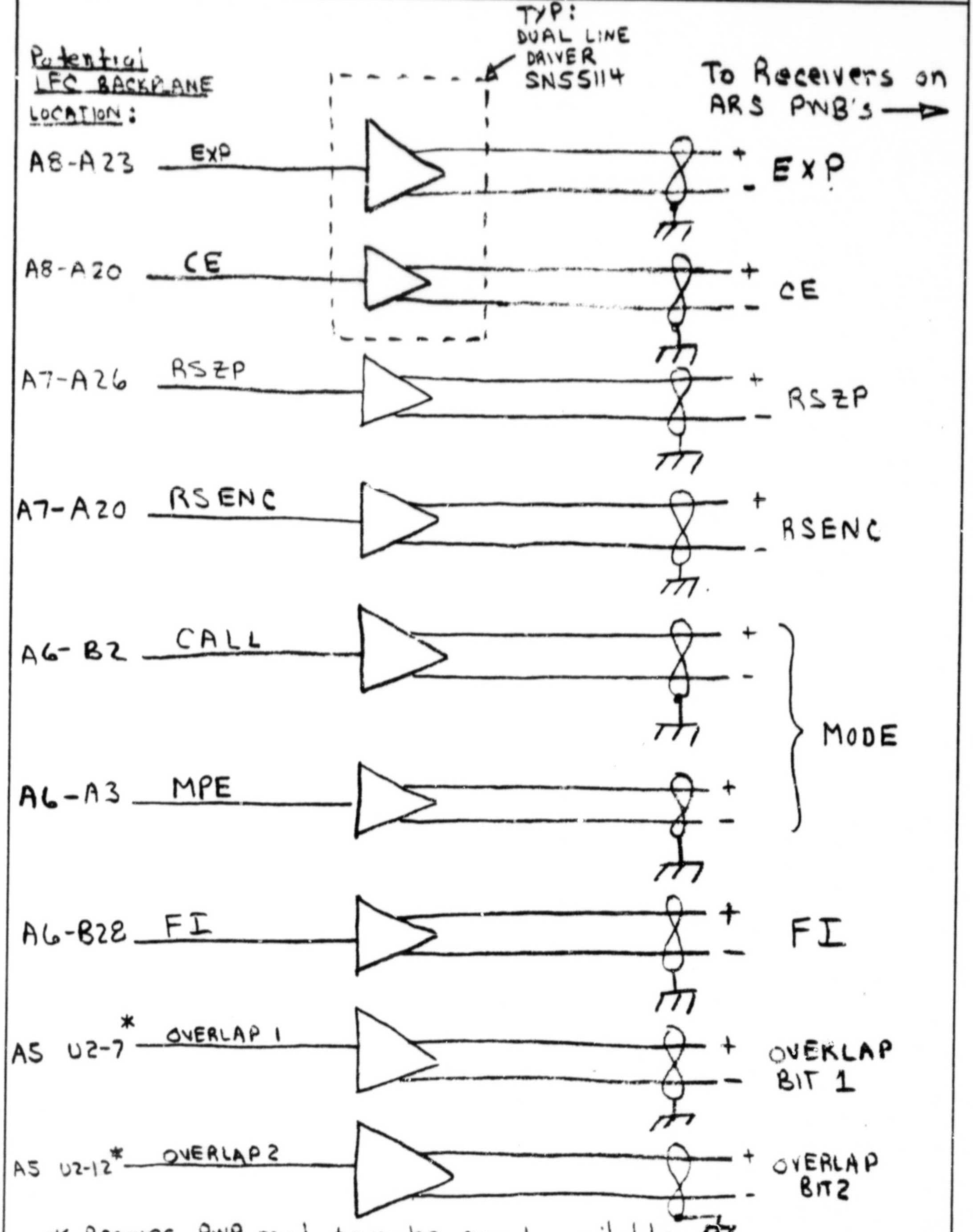
Resultant: J5 is free for ARS interface
J3 and J4 are full 100% (no room for ARS TM)

THE ROLE OF J5 IN LFC/ARS INTERFACE

The following LFC/ARS Interfaces will be made via the LFC J5 connector (capacity 55 pins):

| | | |
|---|---|---|
| Power: | +28 VDC | 4 pins |
| | 28 VDC RET | 4 pins |
| | FI | 3 pins (TSP) |
| Commands: (From LFC to ARS) | RS ENC | 3 pins (TSP) |
| | RS ZP | 3 pins |
| | EXP | 3 pins |
| | CE | 3 pins |
| | MODE (2 Bits), OVERLAP (2 Bits) | 6 pins (TS5C) |
| | CSS | 3 pins |
| | $\overline{\text{SRCK}}$ | 3 pins |
| | MSR out | 3 pins |
| | AX STR, $\overline{\text{AX STR}}$ | 3 pins |
| | $\overline{\text{MCLR}}$ | 3 pins |
| | $\overline{\text{FRSP}}$ | 3 pins |
| | LFC SIG RET | 2 pins |
| | v/h | 3 pins (Analog TSP) |
| FEEDBACK (From ARS to LFC) | N<O FLAG | 3 pins (Delay LFC Exposure) |
| | | 55 Pins |

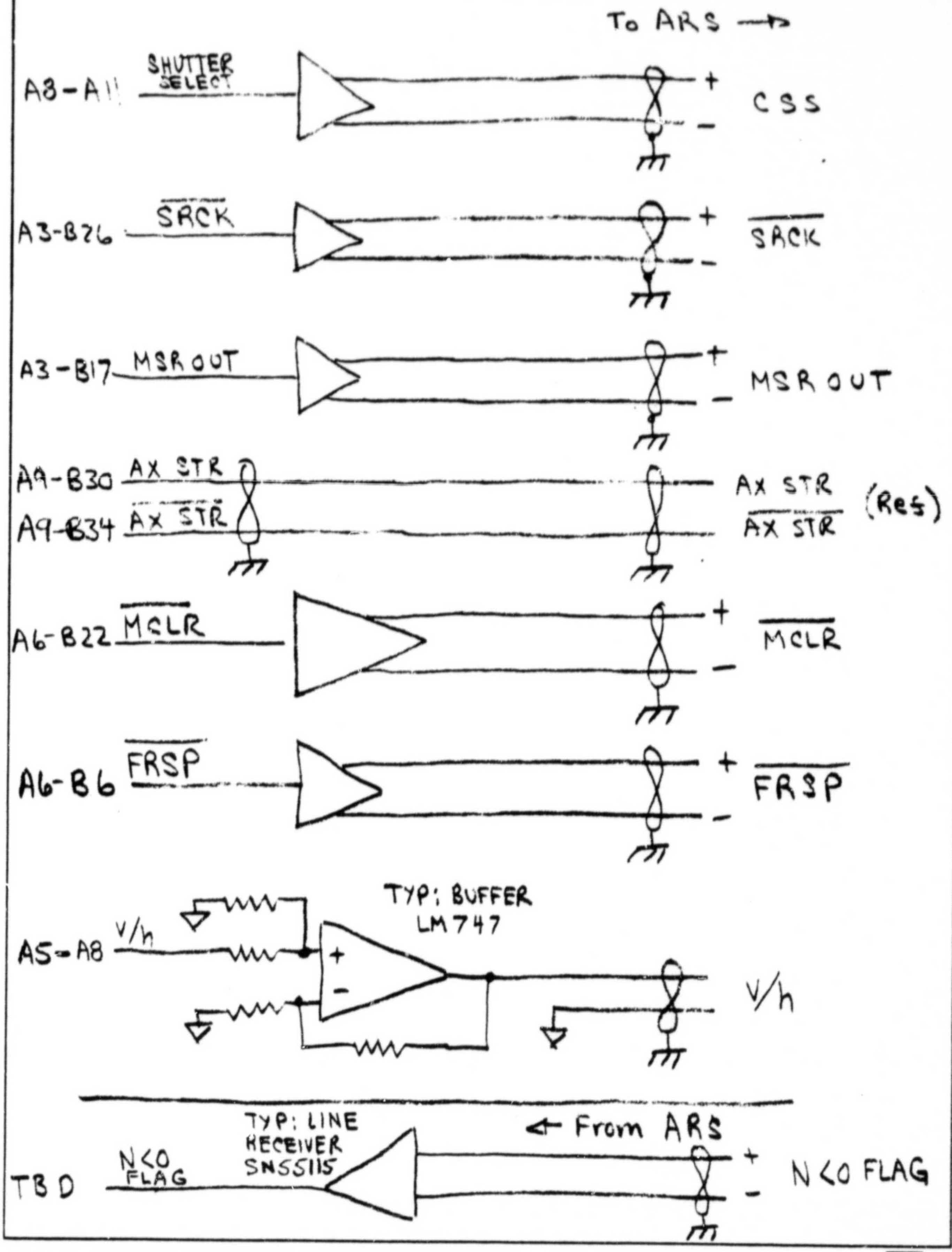
| | | | |
|---|---|---|---|
| BY: SP | | TITLE: LFC/ARS Intersace PWB | PAGE: Fig 4-2(1) |
| DEPT: | DATE: 3/20 | | PROJECT: ARS |




* Requires PWB mod to make signal available

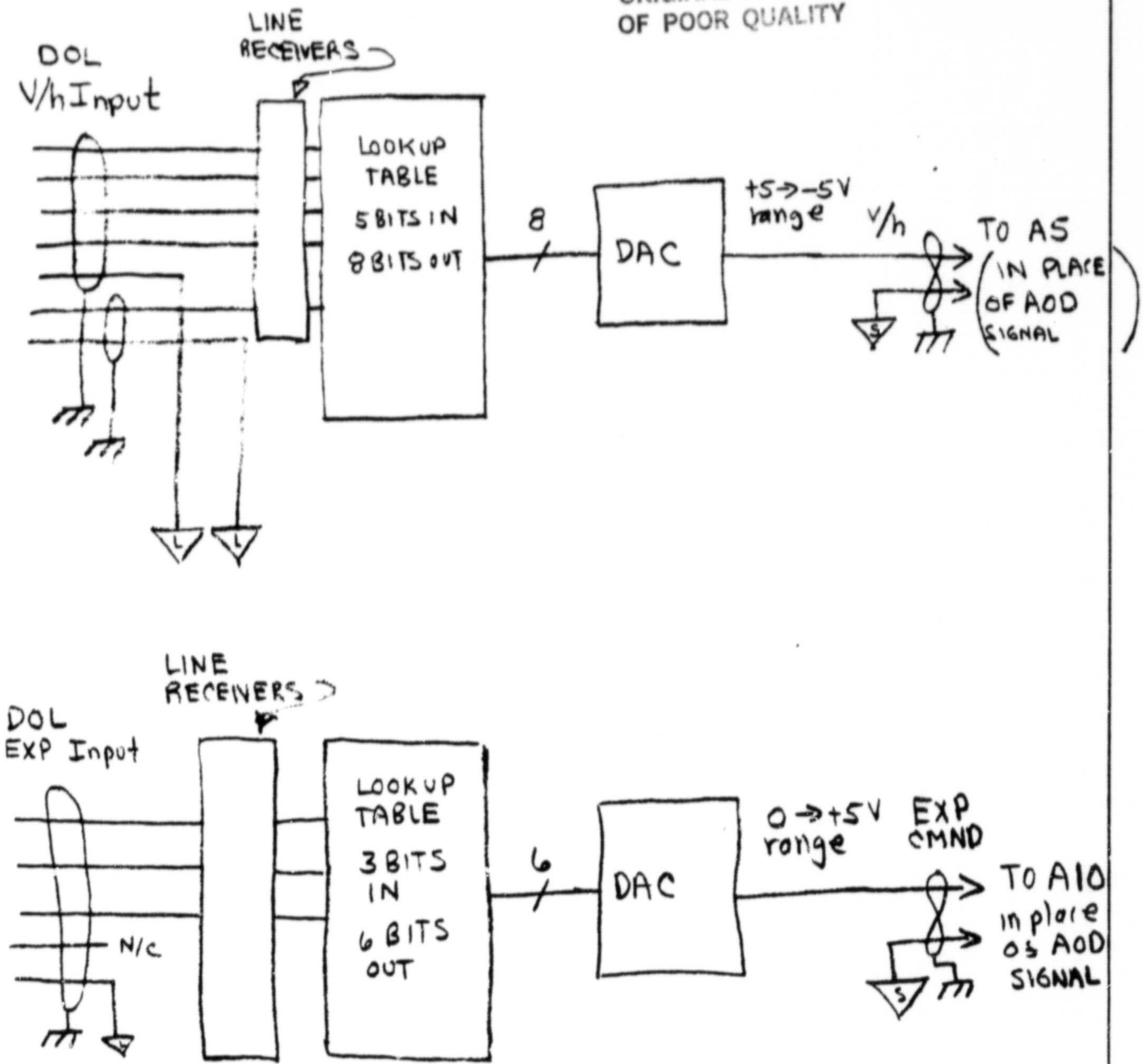
② 

| BY: SP | | TITLE: LFC / ARS Interface PWB (CONT) | PAGE: Fig 4-2 (2) |
|---|---|---|---|
| DEPT: | DATE: 3/20 | | PROJECT: ARS |



| BY: | | TITLE: V/h and Exp DOL COMMAND Receiver PWB | PAGE: Fig 4-3 |
|---|---|---|---|
| DEPT: | DATE: | | PROJECT: |






LINE Receivers involve 10 R+C's
and 2-½ IC sections
for each line

DAC's involve ~ 2 IC's + 6 R+C's each

By: E. Pigeon

Title: J2 Connector Discussion

Date: 3/20/82

Figure:

- This carries commands into the LFC
- M8372306R22-41N

  27 #20 pins

  14 #16 pins

  41 total pins
- Current useage = 30 pins
- Changes anticipated:

  - Add FMC Inhibit (+3 pins)
  - Delete v/h Analog (-3 pins)
  - Add v/h DOL (+9 pins)

    (5 bits: IXTS5C
    +IXTSP)
  - Delete Exp Analog (- 3 pins)
  - Add Exp DOL (+ 5 pins)

    (3 bits: IXTS5C)

    one unused)

Net adder: 11 pins

Resultant: J2 full

will be required.

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2. Platen Gas Solenoid Delay

This requires implementation of certain NASA generated DCN's which affect PWB's A21, A8 and enclosure wiring. This is not an extensive rework.

Itek suggests one slight deviation from the proposed change, which will also be incorporated as a product improvement in two other areas of board A8.

The area for this deviation is a one shot created as shown on the bottom of DCN 63383 (ref Tech Spec attachments). A pull up resistor at U2 pin 6 is recommended to insure that the step at U14-1 will be large enough to reach logic "0".

3. LFC Calibrate Exposure Incorporation - In CAL mode, CSS currently controls the open time of the capping shutter by means of interconnections on board A8. This change requires generation of a TBD second pulse at the leading edge of CSS which will replace CSS in function. To do this, since A8 is already fairly busy, will require circuitry addition on the new DOL command receiver board to receive CSS, generate a pulse and transmit it to A8 in place of the old CSS. No changes will be required on A8. See Fig. (Mod: calibrate exposure).

4. Provide an inhibit for the FMC function while on the PAD - The FMC inhibit signal was formerly provided via J5, which has been restructured for ARS interface. FMC inhibit can be added to J2 to be available to flight level interconnections. It can be reconfigured to a DOL signal, and received and conditioned on the new DOL Receiver card. See Fig. 4-4 (Mod: Calibrate Exposure).

5. Electroluminescent (EL) Panels for the LFC - To add and utilize EL panels on the LFC requires many changes:

   a. Add the material to the inside of the door

   b. Wire from the material to the Environmental Enclosure connector

   c. Modify the cable running from the Environmental Enclosure to the

| BY: | | TITLE: MOD: CALIBRATE EXPOSURE | PAGE: Fig 4-4. |
|---|---|---|---|
| DEPT: | DATE: | | PROJECT: |

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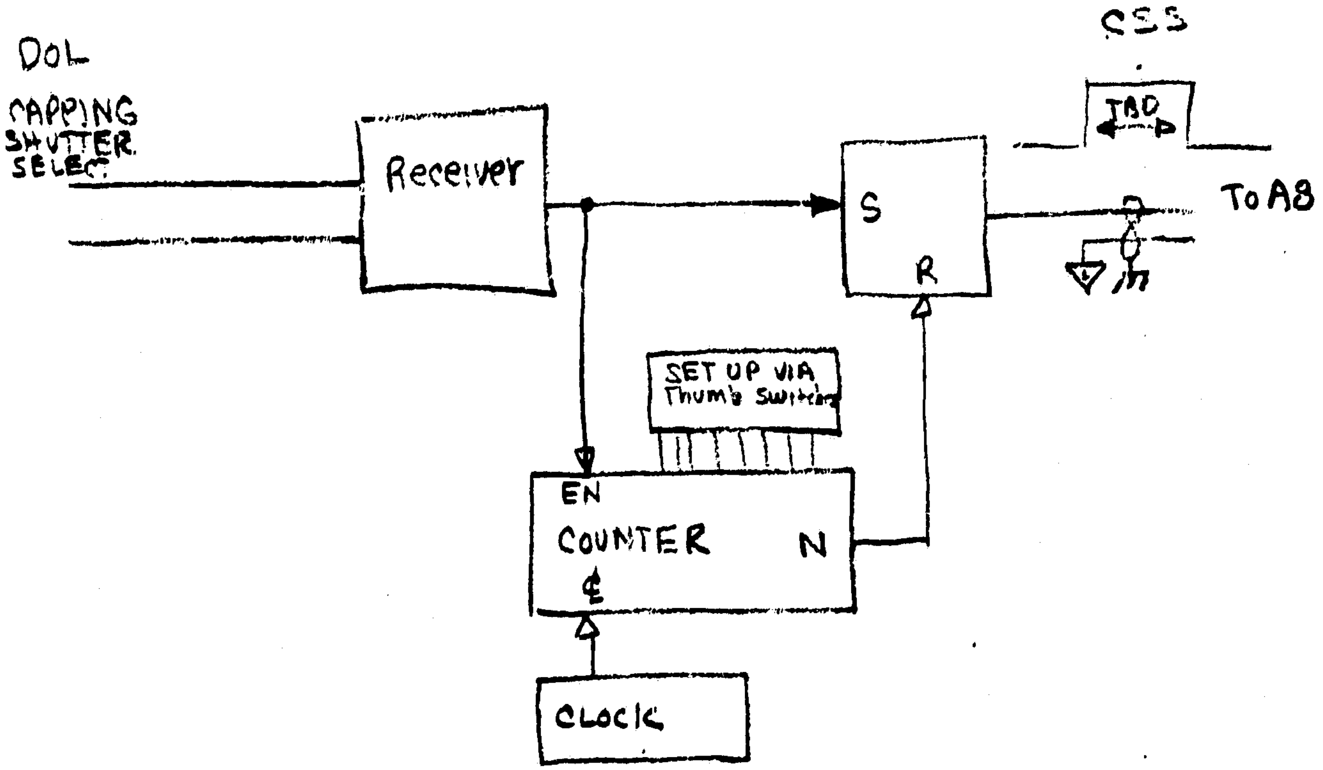
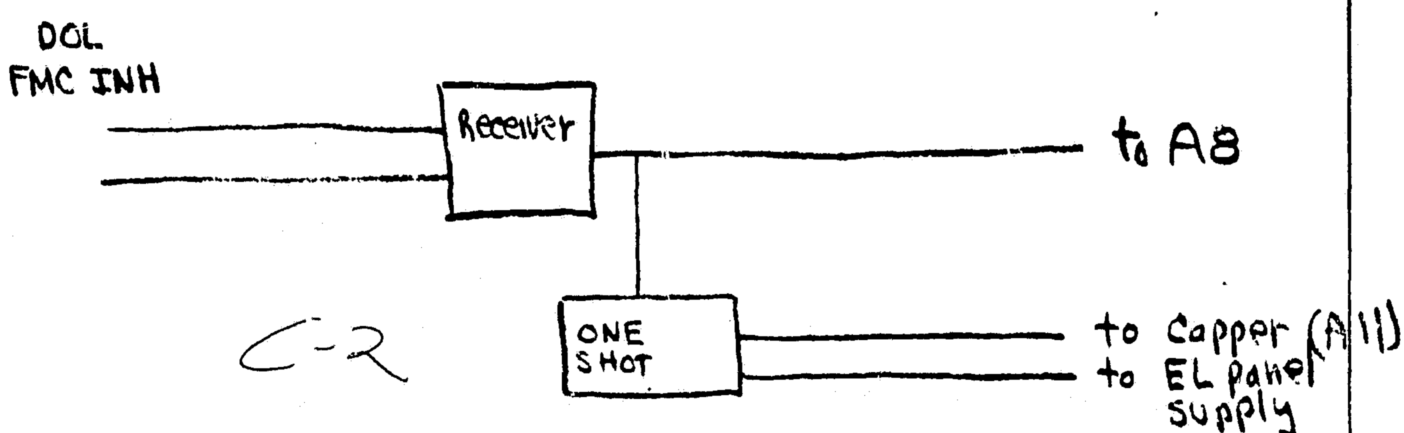



This circuitry to be added to the new PWB required by the DOL command change (V/n + Exp)




C-2

d. Within the Electronics assembly

- provide a 400 Hz supply which maybe turned off and on by a TTL signal
- provide the wiring needed throughout the box
- provide a change on A11 to actuate the capper by FMC Inhibit

Refer to Fig. "EL Panel Calibrate Sequence" for a discussion for the timeline.

# EL PANEL CALIBRATE SEQUENCE

## Old Sequence

Switch from STDBY→CAL opens thermal door.

Magazine prepares for exposure

Rotary shutter stops in full open position

CSS Command creates exposure

CSS END cycles exposed film out and sets up camera for next CSS.

## Required New Sequence

Camera is in STDBY

New command (FMC INH) will cause following:

- Capping shutter opens for TBD seconds
- 400 Hz powers EL panel for TBD seconds

CAL cycle is initiated as above but for <u>one photo only</u>

STDBY is commanded and door closes

cycle may be repeated

For this to be implemented, the capping shutter servo must be "alive" in STDBY to receive commands, as must the 400 Hz system.

## Modifications to the Camera Support Structure and the Environmental Enclosure

These modifications are mechanical in nature and are presented in the following discussion:

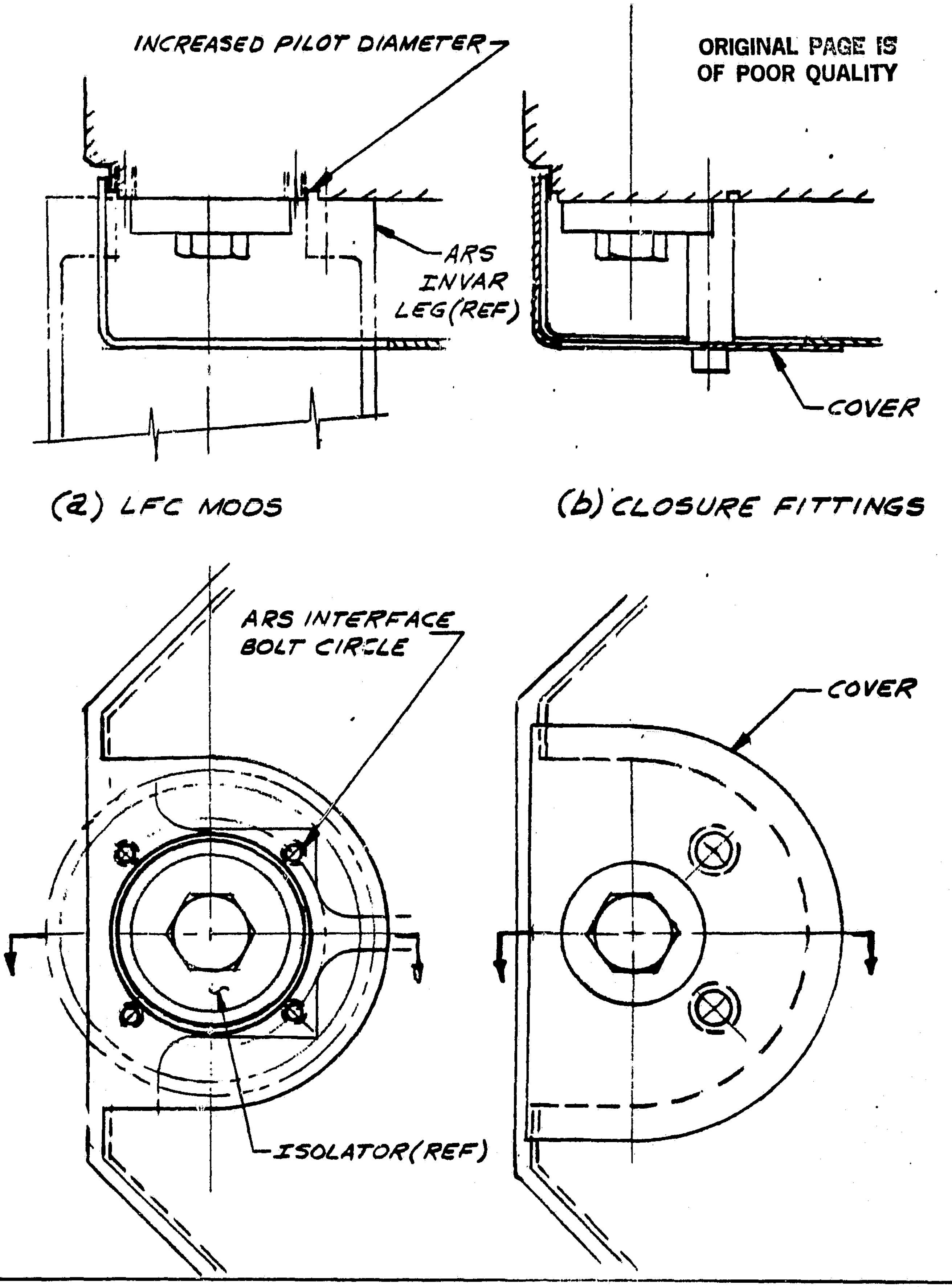
LFC Modifications - Mechanical - The ARS Support Structure will be designed to interface mechanically with the LFC at four points.. These interface points will be adjacent to the LFC interface with the STS structure and will consist of several new tapped holes in a circle around each of the four isolators in the LFC camera support structure. Figure 4-5 a shows the modification to the LFC at these points and the ARS interface fitting. New isolators will be designed to take the new loadings imposed by the addition of the ARS. In addition, the fiberglass LFC environmental enclosure will be cut away locally to permit the ARS fittings to be attached to the LFC. New closure fittings shown in Figure b will be designed to fit over the portions of the enclosure that are reworked to accomodate stand-alone LFC missions. The LFC heater strips and thermal insulation will require rework to accomodate the new interface.

The ARS Housing assembly will require nitrogen from the LFC to maintain a slight ambient pressure in the film transport. To accomplish this, a pneumatic bleed line will be run from the LFC Pressure Control System to the housing. This bleed line will either be connected to the exhaust port of the valve that vents the LFC platen to vacuum during photography or to the LFC internal pressure.

In order to provide access to the Environmental Enclosure electrical connector when mated with the ARS, a new and longer cable service loop will be provided to allow the connector to be removed from its bracket and be installed on an auxiliary bracket on the STC support structure.

| BY: | | TITLE: Mechanical LFC Modisications | PAGE: Fig 4-5 |
|---|---|---|---|
| DEPT: | DATE: | | PROJECT: |





## 5. GROUND SUPPORT EQUIPMENT (GSE)

Most items of GSE required to accomplish the goals of an ARS Hardware Implementation phase are available as Government Furnished Equipment (GFE). There are, however, some items that must be designed and built up new, and some that must be modified from the "as-received" condition.

Figure 5-1 is a "Family Tree" presentation of GSE items anticipated listed by area of first useage. Those marked with a single asterisk are GFE, no change. Two asterisks imply GFE, changes are required and no asterisk implies a new item to be designed and built under the ARS Hardware phase. The lists of Fig. 5-1 reiterate new and modified items.

New GSE Items (to be designed and built during the ARS Hardware Phase)

ARS Assembly and Maintainance Dolly Adapter An adapter plate will be made which will adapt the dolly from the Apollo 24 inch Pan OB camera to useage in assembling and debugging certain aspects of the ARS.

Protective Cover Set Protective covers will be designed and built for:

- Both ends of each baffle
- The film chute openings of each cassette
- The exposed shutter for the case in which a baffle has been removed from the SCA
- The exposed port on the SCA Housing left when a cassette is removed
- All electrical connectors
- The $GN_2$ port

Lens Adapter Plate  A plate for mounting lenses on an optical test bench for the required performance measurements.

Lens Assembly Holding Fixture  A fixture for holding the lens during modifications required.

Handling Sling  A slinp similar to the sling already supplied as part of the LFC project to provide interface between the SCA and a hoist or crane.

TM Breakout Box  All ARS TM will be routed through one cable.  This box interfaces with that cable and presents all TM points at patch panel locations.

Cable Set  Five cables are required for ARS interconnections and are supplied as GSE.

$GN_2$ Line  A pneumatic connection to the LFC is required.  The line is supplied as GSE.

EMI Breakout Box  EMI testing requires injection of signals in series with various ARS lines.  This box provides that capability.

Vibration Fixture  The vibration test requires interface of the shaker to the OCPS.  The interfacing structure is a massive piece.  The structure used to test the LFC is not large enough to hold the LFC/ARS. A new fixture, or possibly adapters to a fixture used on another program is required.

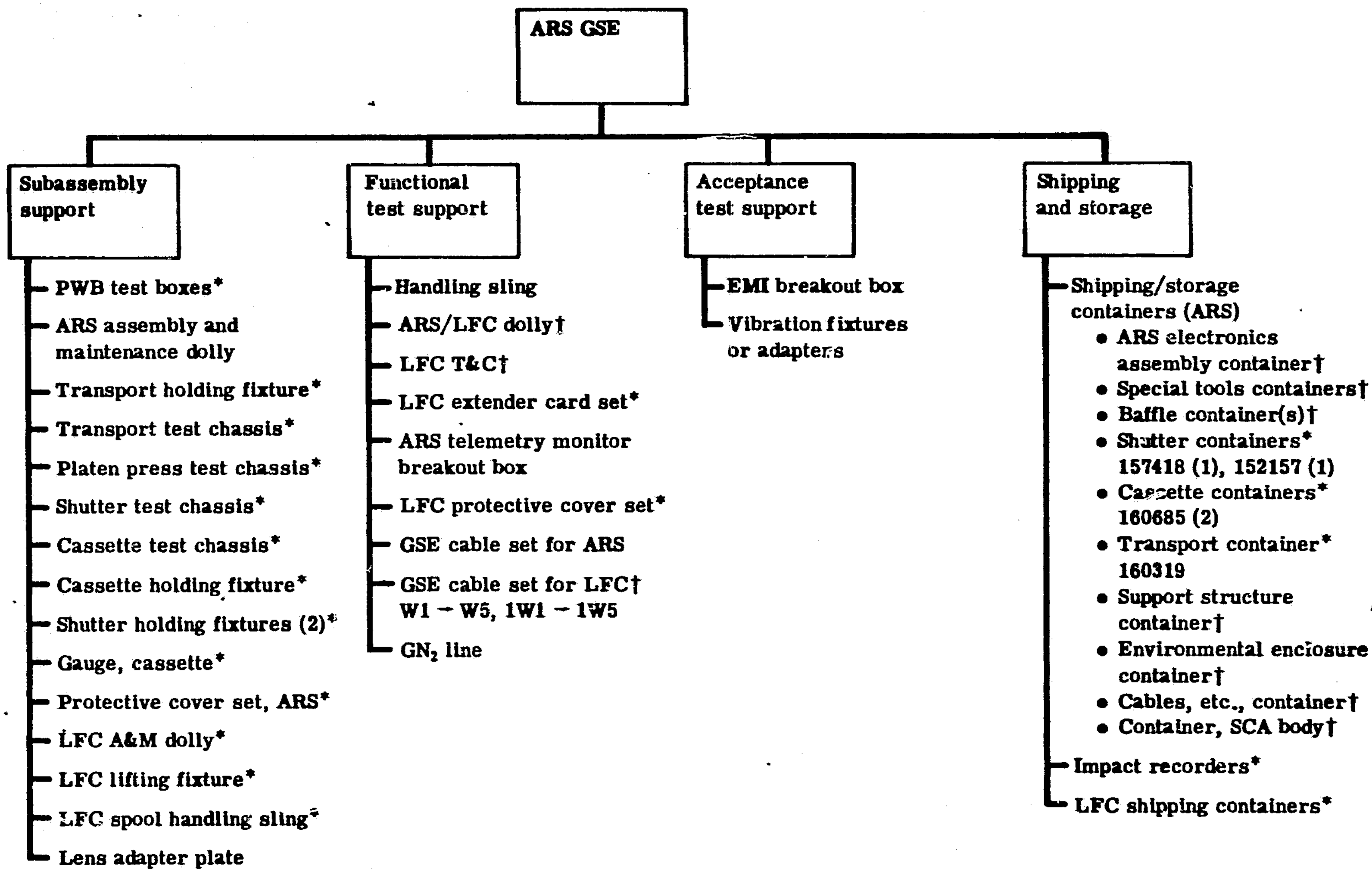
Modified GSE Items

ARS/LFC Dolly  The LFC dolly, must be modified to prevent inadvertant rotation of the mounting plate while the ARS is installed.  It must also be reviewed for structural strength considering the new load.  Reinforcing pieces may be required.

LFC T & C There will be substantial rewiring required due to interface changes. A new circuit card is required to accomodate v/h hand exposure command changes.

LFC Cable Set Additional runs are required due to new commands and general ARS interface

Shipping Containers NASA will supply surplus containers of appropriate dimensions. These must be modified with inserts to hold the hardware and then painted.




* GFE GSE used as is
† Modified GFE GSE
Items appear under phase of first usage

Fig. 5-1 — ARS ground support equipment family tree

## 6. ICD CHANGES

A family of ICD's for the OCPS was developed on the LFC program. Because no particular mission has been identified, these ICD's define the interface only on the OCPS side, with the exception of the Environmental ICD.

The addition of the ARS to the OCPS will require updating of the ICD's, which now describe only the LFC and the GSA (Gas Supply Assembly). Since not all missions will require an ARS, the ICD's must be modified to describe two possibilities:

(1) The LFC and GSA as a standalone payload

(2) The LFC/ARS/GSA as a combined payload

The required ICD updates will be affected by incorporation of DCN's to be generated during the ARS Hardware Phase. A brief overview of the changes to be expected is presented in the following paragraphs.

The OCPS ICD set consists of the following documents:

| | |
|---|---|
| SLD-47-000001-801 | Interface Control Document Orbiter Camera Payload System - Functional |
| SLD-47-000001-802 | Interface Control Document Orbiter Camera Payload System - MEchanical |
| SLD-47-000001-803 | Interface Control Document Orbiter Camera Payload System - Electrical |
| SLD-47-000001-804 | Interface Control Document Orbiter Camera Payload System - Environmental |
| SLD-47-000001-805 | Interface Control Document Orbiter Camera Payload System - Film Spool and Spooling |
| SLD-47-000001-806 | Interface Control Document Orbiter Camera Payload System - Installation |

| | |
|---|---|
| SLD-47-000001-808 | Interface Control Document Orbiter Camera Payload System - Gas Supply Assembly |
| SLD-47-000001-901 | Interface Control Document Orbiter Camera Payload System - BTE and Ground Handling Equipment |
| SLD-47-000001-902 | Interface Control Document Orbiter Camera Payload System - Launch and Recovery Facilities |

Functional (SLD-47-000001-801)

The Functional ICD establishes the interfaces for system modes and sequences, operator commands, flags, telemetry and additional test points.

System Modes. There are no new system modes. The description of those that alread exist will be expanded to include details of ARS activities.

Sequences. Sequence descriptions will be expanded to include ARS operations. The Calibrate Sequence will change, even for the LFC. An FMC Inhibit Sequence will be described.

Operator Commands. A new command, FMC Inhibit, will be described. New requirements for utilizing the Calibrate Command will be described.

Flags. New flags may be created for the ARS, and if so, they will be described.

Telemetry (TM). Some existing LFC Telemetry will be deleted. Some former LFC "Additional Test Points" will be upgraded to TM status. The ARS TM will be defined.

Additional Test Points. These, as a category, will be deleted.

Miscellaneous Topics. Film types will be expanded to include ARS films, if not already mentioned. The Pneumatic Interface will be expanded, as required, to describe the ARS interface.

Mechanical (SLD-47-000001-802)

The Mechanical ICD establishes the interfaces for attachment points, envelope and mass properties.

Attachment Points. The Camera/STS attachment points do not change with the addition of the ARS. The ICD will be expanded to include data on LFC/ARS attachment. Note that the ARS is attached to the LFC after the LFC is attached to the STS. The ARS Electronics Assembly Attachment is identical to the LFC Electronics Assembly Attachment and will be so noted.

Envelope. The ICD will be expanded to include the envelope for a combined LFC/ARS, including an avoidance envelope for the ARS camera field of views. Again, the ARS Electronics Assembly envelope is identical to the LFC Electronics Assembly envelope and will be so stated.

Mass Properties. The ICD will be updated to include weight, center of gravity and mass moment of inertia data for the LFC/ARS system.

Electrical (SLD-47-000001-803)

The Electrical ICD establishes the interfaces for power, command, and TM data, and for grounding.

Power. Power utilization, average and peak, will be updated to include an LFC/ARS interface.

Commands. The command section will be updated to include FMC Inhibit, to include a 5 bit digital V/h command and a 3 bit digital exposure command.

TM Data (& Flags & Additional Test Points). This area shall be updated to delete certain LFC TM signals, add new LFC TM signals, add ARS Flags and TM signals and delete LFC Additional Test Points. Channel identification of LFC TM may change.

Connector Pin Assignment Figures. There will be extensive changes on LFC connectors J2, J3, J4 and J5 to effect an ARS interface. ARS connector interface information will be added to the ICD.

Grounding. The grounding scheme will be expanded to indicate the ARS.

Environmental (SLD-47-000001-804)

The Environmental ICD establishes the interface for thermal, pressure, vibration, shock and nuclear radiation environments. These environments are the shuttle environment, and no change is anticipated.

Film Spool and Spooling (SLD-47-000001-805)

This ICD is a new ICD and will be written to describe spools and spooling for the LFC and the ARS.

Installation (SLD-47-000001-806)

This ICD establishes installation requirements. It will be expanded to include ARS addition and current OCPS installation philosophies.

Gas Supply Assembly (GSA) (SLD-47-000001-807)

This ICD establishes all interface considerations for the GSA. No change is anticipated.

BTE and Ground Handling Equipment (SLD-47-000001-901)

This document establishes the interface for OCPS Bench Test Equipment (BTE) and Ground Handling Equipment.

It will be updated to include ARS related items including cables, pneumatic lines, lifting fixtures, handling dollies, etc. The T&C console section will be updated to include ARS related features. Interconnecting diagrams will be expanded to include the ARS. Shipping containers for the ARS will be described.

Launch and Recovery Facilities (SLD-47-000001-902)

This document establishes the OCPS Launch & recovery facility interfaces. Diagrams indicating cabling and T&C features will be updated to include ARS items. The bulk of this ICD will not be affected.

## 7. Command Sequencing

The OCPS command interface was designed around a scenario in which astronaut-originated commands were entered via the GPC into the data bus to be intercepted and passed to the LFC by an FMDM. As the scope of OCPS activities has widened, it has become more and more apparent that an "autonomous" OCPS command system is required to fully exploit the possibilities of any given mission. Without such a capability, the OCPS will be restricted to operation only when a dedicated crew member is available, and the likelihood of the coincidence of such time with target availability is not always high. Once a target timeline has been established, OCPS commands will need to be generated within about plus or minus 10 seconds of the scheduled time. There may be as many as two commands a minute over a twenty minute duration of every revolution (90 minutes) around the clock. Due to the rotation of the earth with respect to the orbital plane, a given target may not be repeated in a mission, especially at low latitudes. Clearly, efficient useage of the OCPS demands dedicated attention to avoid the loss of potential targets. The need for dedicated attention is best met by an "autonomous" command system capable of accepting a full mission command load, of being updated from the ground, and of outputting appropriate OCPS commands versus GMT.

Beyond the benefits in lessened Astronaut involvement, additional benefits are available if a serial input/output (SI/O) interface is established for the OCPS. Currently, the LFC requires 11 bits of parallel digital commands, two analog commands and an IRIGB interface. The ARS hardware phase may include LFC modifications which would expand this command requirement to 20 bits of parallel digital commands, no analog commands and an IRIG-B interface. These changes provide a more difficult interface (more DOL requirements from the MDM or FMDM) and also exhaust the LFC spare command pins, making future modifications more difficult. The expansion of the OCPS to include the NASA PANOB's would add up to an additional 28 parallel digital command lines, further complicating interface.

A command sequencing feature could be added to the OCPS which would have an SI/O interface with an orbiter MDM (available as a unique payload requirement). This feature could include power switching, A to D conversion of V/h and exposure commands, and the appropriate commands to run the LFC (with its ARS, if used) and the two PAN OB's. Once loaded with a full command set, the Command Sequencer (CS) would need no further command services from the STS until an update was deemed appropriate (updates might be called for at 12 hour intervals or longer), and the OCPS would run autonomously collecting exposures at the appropriate GMT. The command interface for the OCPS would be reduced from a possible 48 DOL signals to one SI/O interface. An IRIG-B GMT interface and a power interface is needed in either approach.

The design and development of the CS is straightforward and it can be housed within the ARS Electronics Assembly.

A Command Sequencer was described during the LFC program in Itek Document 9555-79-629 entitled "A Feasibility Study to Fulfill the Requirements of Mission Planning, Command Generation and Data Handling for the NASA Sponsored OCPS/EOCPS Systems". Section 5 of that document outlined both a command and data handling system.

The data handling is the more complex problem, and is not a part of this discussion. A brief recap and update of the command generation system is included below.

Command Word, Time Tag, Command Update

By taking advantage of some commonality in the command set, a command word capable of addressing the entire OCPS (LFC, ARS and dual PAN OB's) can be structured from 45 bits of data. This 45 bits contains 8 bits for V/h, more than that currently anticipated for an updated LFC. A BCD format time tag covering the range from day of year to second can be represented by 30 bits. Combining the time tag with the command word results in a 75 bit minimum command update. To allow for expansion, an additional 5 bits in the command word will result in an 80 bit Command Update.

Command Set

Recent mission planning studies carried out at Itek on other programs have indicated that a Command Update may be required for every second LFC frame on the long term average. This allows for short bursts over island groups and exposure changes over a longer run. Since the maximum LFC frame capacity is about 2500, a Command Set for an entire mission needs to contain a minimum of 1250 Command Updates. To provide for extended capabilities, 1600 Command Updates should be provided in the Command Set.

Loading the Command Sequencer

The Command Sequencer would be addressed by the MDM SI/O bus, which transmits information in batches called "transactions" of 32-16 data bit words each. In each transaction, word number one would be used as a "Load Control" word and the remaining 31 words would be available for data. In this manner 258 SI/O transactions would be required to fill an entire 1600 Command Update set, or closer to 200 for the 1250 update set.

As transactions are received by the CS, the SI/O Receiver (see Fig. 7-1. , Block Diagram: Command Sequencer) strips out the data portion of the MDM words and sends it to the Load Control. The Load Control examines the first word of each transaction and applies the Command Updates to a static RAM for temporary storage. After the last Command Update has been received and stored in the RAM, the Load Control transfers the complete Command Set to an Electrically Erasable PROM (EEPROM). This "ping-pong" routine is required due to the long erase/ write cycle required by the EEPROM (10 - 20 MS per byte). The EEPROM is used to insure retention of the command set if power is interrupted. A Command Set must be structured such that the Command Updates are sequentially arranged.

Command Sequencing

After a full load, the Command Update first in line is moved by the Program Counter so that the Time Tag portion is applied to the Time Tag Comparator and the Command Word portion is available for loading into the Command Word Register. The Comparator will send a local signal to the Command Register whenever the Time Tag is equal to or less than the decoded GMT value. The comparator also addresses the Program Counter and causes the next Command Update to be shifted into position.

Command Output

The Command Word REgister block contains line drivers and commands are applied in parallel fashion to the LFC and the two PAN OB's.

## Optional Features

A power switching capability can be added to apply main power to the three cameras either upon receipt of a hardwired command from the Aft Flight Deck Standard Switch Panel or at an appropriate GMT. Power to some portions of the Command Sequencer would need to be always on for this option.

A Real Time Command (RTC) feature can be added by structuring the Load Control to recognize an RTC from the data in the first word of a transaction and to apply that RTC directly to the Command Word Register. In this manner, some astronaut interface could be maintained if desired.

Other experiments can be commanded by expanding the Command Sequencer. Once the basic task is undertaken, the size of the memory is not a main driver in packaging or cost considerations.

## Real Estate Required

For the Command Sequencer described, memories having 2K x 8 bit bytes per Integrated Circuit would be used. These are available at -883B level. The entire memory should require one Printed Wiring Board (PWB) of the size proposed for the ARS hardware implementation. SI/O receiving and Load Control should require an additional one PWB and could be implemented using microprocessor based circuitry. GMT receiving, Time Tag Comparison and Program Counting would account for another one PWB, also using a microprocessor based system. The Command Word Register/Line Driver and D/A Converter Section would use up a fourth board. Within the proposed ARS Electronics Assembly, there is space for 32 PWB's, 12 used up for the ARS itself. Four more would pose no problem.

Summary

An "autonomous" Command Sequencer can be provided for the OCPS through the addition of four PWB's to the proposed ARS Electronics Assembly. A simpler wired STS → OCPS interface would be had as a result, as one SI/O interface would replace as many as 45 separate DOL command interfaces (or more if needed) for a full-up OCPS. Real Estate requirements are low using modern memory technology and micro-processor-based control.

The addition of a Command Sequencer is not currently a part of any proposed contract. In order to obtain the most cost effective implementation of such a scheme, it should be made a part of the ARS hardware implementation phase before PDR.

| BY: | | TITLE: BLOCK DIAGRAM: COMMAND SEQUENCER | PAGE: Fig 7-1 |
|---|---|---|---|
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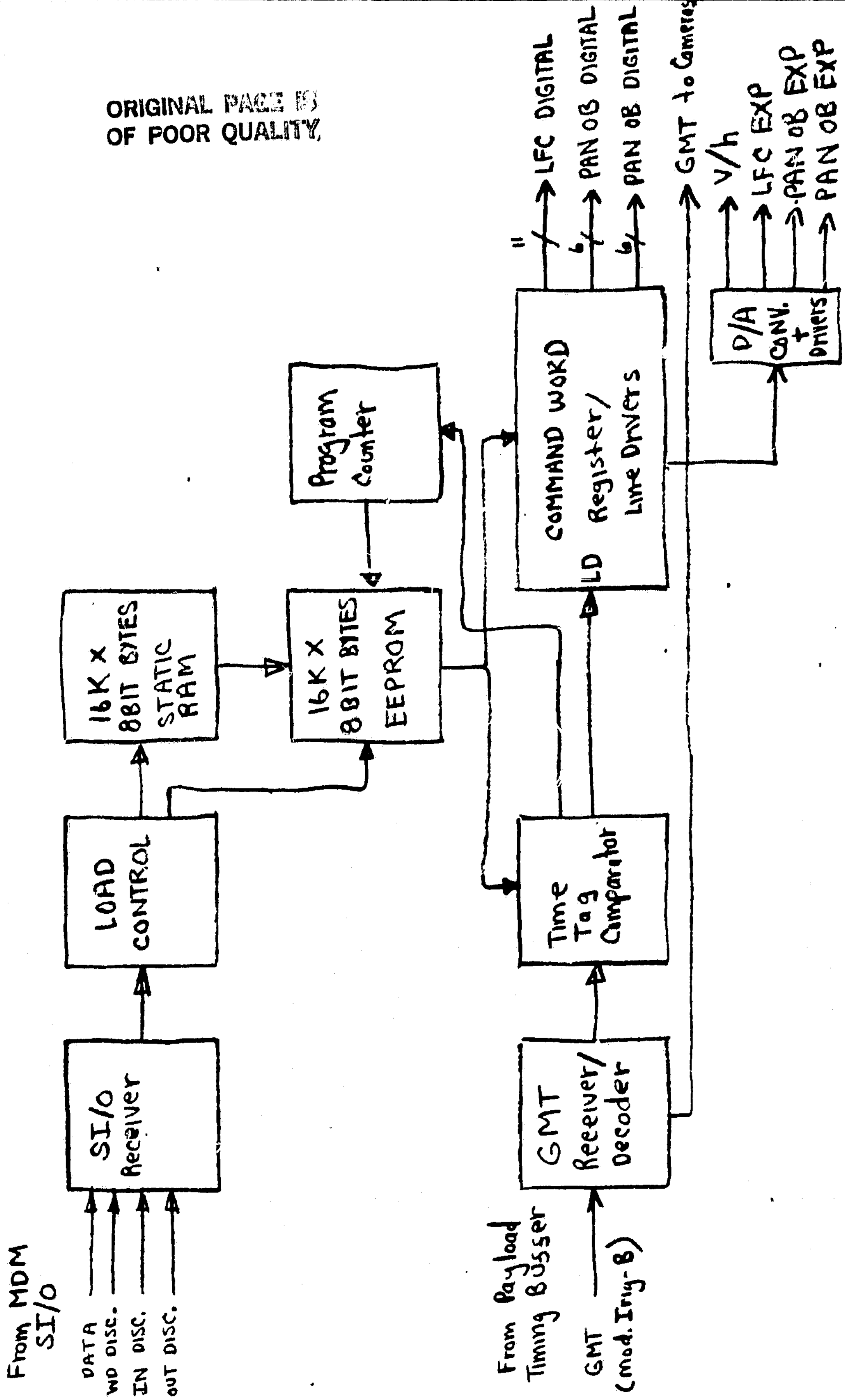


Fig. 7-1. Command Sequencer

# 8. PROGRAM PLAN

A Management Plan for the ARS program is available under separate cover. Within that plan are detailed program schedules, a Work Breakdown Structure (WBS), a WBS dictionary, organizational structure and more. For ready reference, a summary schedule is included within this report as Figure 8-1.

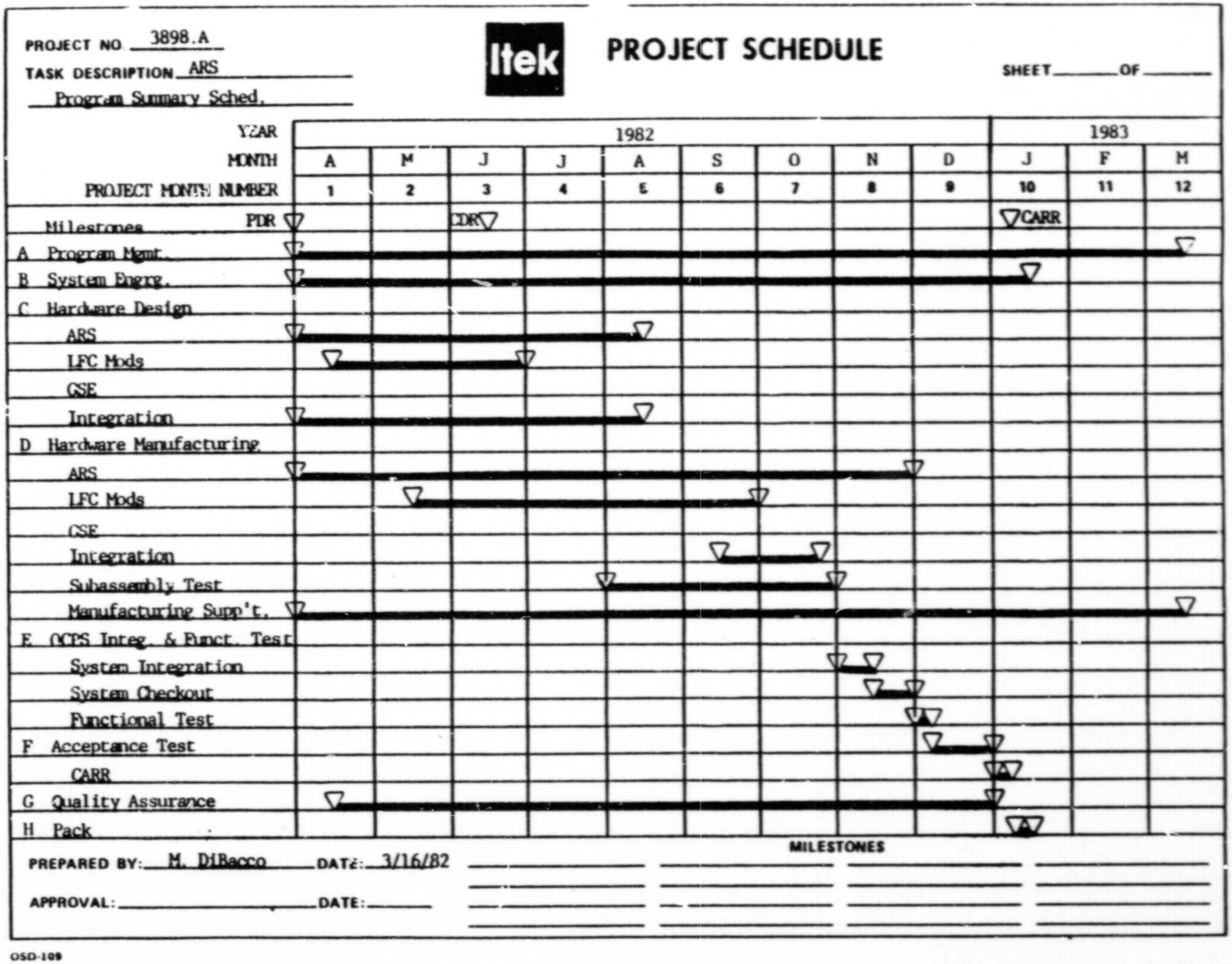


Figure 8-1. Program Summary Schedule

# 9. ACCEPTANCE TEST PLAN

A detailed acceptance Test Plan (ATP) is included as a part of the hardware phase effort. It is due in preliminary form at CDR, and in final form 30 days later. The ARS ATP will be created as an addendum to the OCPS ATP prepared under contract NAS9-15671. Some modifications to the original ATP will be required to make it compatable with the addendum.

Sections 1 through 3 will remain nearly intact, with allowances for new item numbers and names. In section 4, the ARS Test Flow (see Fig 9-1) will replace Figures 2 and 3 for ARS discussions. On the ARS Test Flow, the subassembly tests and the System Functional tests (non-acceptance level) will replace the verification phase of the LFC test flow. These tests will provide for Acceptance Test Phase readiness and will provide some of the calibration data for the Acceptance Data Package (ADP). The System Functional and Acceptance test phases will be run with the integrated LFC/ARS, but the tests to be conducted will be of ARS performance.

Following is an over-view of the tests to be run as acceptance tests:

System Functional

As described in the original ATP paragraph 4.3.1 and expanded upon in Fig. (ARS Test Flow).

Vibration Testing

As described in the original ATP paragraph 4.6.1 for the integrated LFC/SCA. The ARS electronics will be tested to a different curve as described in the ARS Tech/Spec page 5-6 (Para. 5.3.2.1)

Abbreviated Functional

As described in the original ATP paragraphs 4.6.2.2 (system checkout test)

Thermal Vacuum Test

As described in the original ATP paragraph 4.6.2 and the following sub-paragraphs but with the following modifications:

- Resolution will not be measured during this test, and photographic parameters shall be taken to consist of format presentation, and film marking characteristics.
- Exposure to environment will be 120 hours.
- The timeline of figure 4 will be modified to satisfy the ARS Tech Spec paragraph 5.3.2.2 requirements and the 5 day exposure.
- Paragraphs 4.6.2.3, 4.6.2.3.1 and 4.6.2.3.2 will be deleted as non-applicable.
- Paragraph 4.6.2.4 will be deferred to later
- Paragraph 4.6.2.7 will be included only if the ARS requires OCPS $GN_2$ at either full (high) pressure, 30 psig or 2 psig.

EMI/EMC Test

As described in the original ATP paragraph 4.3.3.

Post Environmental System Functional

As described in the original ATP paragraph 4.6.2.4.

Mass Properties

As described in the ARS Tech Spec paragraph 5.3.1

The following tests referenced in the original ATP will be deleted as non-applicable, or shifted to lower level (non-acceptance) testing:

Paragraph 4.4 and sub paragraphs Lens Acceptance moved to subassembly test level.

Paragraph 4.4.1 modified to agree with ARS Tech Spec paragraphs 5.2.1.4, 3.2.1.1.11.

Paragraph 4.4.2 modified to agree with ARS Tech Spec paragraphs 5.2.1.4, 3.2.1.1.12.

Paragraph 4.43 deleted.

Paragraph 4.4.4 modified to agree with ARS Tech Spec paragraph 3.2.1.2.4.4.

Paragraph 4.4.5 deleted

Paragraph 4.4.6 modified to an inspection per ARS Tech Spec paragraph 3.2.1.2.4.5

Paragraph 4.5 and subparagraphs - deleted.

## TEST AND CHECKOUT CONSOLE ACCEPTANCE

The T & C shall be tested per the original ATP paragraph 4.8.

Figures and Tables

Pages 19 thru 24 of the original ATP will be removed and replaced, where applicable, with appropriate ARS related tables and figures.

Attachments

The original ATP, Itek document 9555-78-007 rev. A, is attached for reference.

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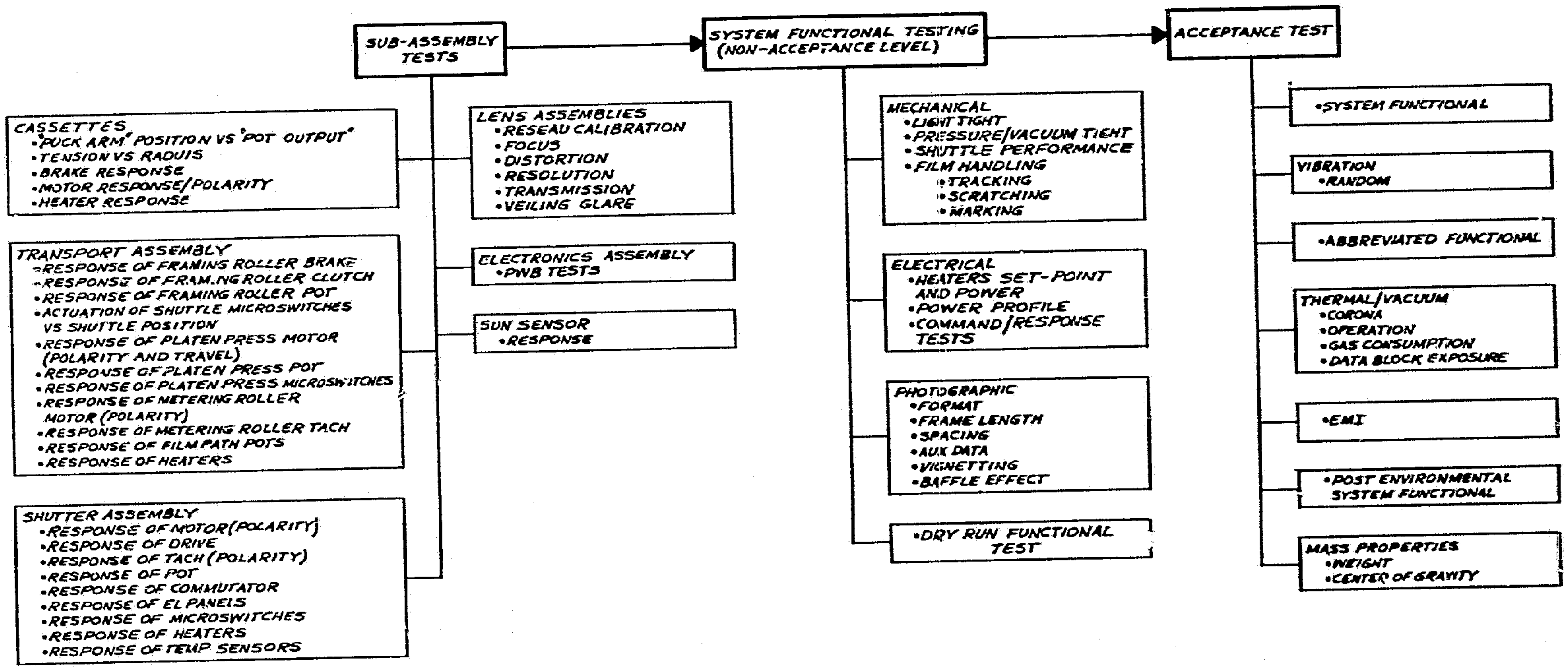


Fig. 9-1 — ARS test flow

DOCUMENT NO. 9555-78-007

Rev: A DATE: 9 April 1979



# ORBITER CAMERA PAYLOAD SYSTEM

## ACCEPTANCE TEST PLAN

CONTRACT NO.
NAS9- 15671

DRL = T-1418 LINE ITEM #8
DRD # TM-098T

Approved by: ______________________
James I. Brownlee
JSC Contracting Officer
Houston, TX 77058
Code Ident. A83

Approved Date: ______________________

Approved by: [signature]
Robert R. Heath
Itek Corp.
Lexington, MA 02173
Code Ident. 92208

Approved Date: 4/19/79

9-5

REVISION STATUS

| REVISION | DESCRIPTION |
|---|---|
| O | Initial Release |
| A | Changes made in the following: |
| | Paragraphs 1.2, 4.6, 4.6.2, 4.6.2.2 & 4.6.2.3 |
| | Thermal Vacuum Test Matrix |
| | Subsystem Integration Test Flow - Fig. 2 |
| | Project Schedule - System Level Tests |
| | |
| | Add the following: |
| | Paragraphs 4.6.2.3.1 & 4.6.2.3.2 |
| | Figure 4 |
| | |
| | Delete the following: |
| | Paragraphs 4.3.2, 4.3.4, 4.3.4.1, 4.3.4.2 & 4.7 |

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# ACCEPTANCE TEST PLAN FOR ORBITER CAMERA PAYLOAD SYSTEM (OCPS)

## 1. INTRODUCTION

### 1.1 Scope

This Acceptance Test Plan is submitted as the defining document for testing the Large Format Camera and Ground Support Equipment. The primary objective of the entire test program is to demonstrate the ability of the flight hardware to meet the technical requirements of the Contract End Item Specification, 225000.

This document presents information in accordance with Item #8 of the Data Requirements List.

### 1.2 Test Item Nomenclature and Identification

The flight hardware consists of one Orbiter Camera Payload System designed to be a precision cartographic camera for producing wide-field imagery of the earth's surface.

The major components of the OCPS and its supporting equipment are as follows:

1. Large Format Camera, P/N 225000
   a. Lens Cone Assembly, P/N 225130
   b. Film Magazine Assembly, P/N 225038
   c. Camera Electronics Assembly, P/N 225085
   d. Environmental Enclosure, P/N 225294
   e. Interconnecting Cables, P/N 225241-225246

2. Checkout and Support Equipment
   a. Electrical Test & Checkout Unit, P/N 225800
   b. T&C Cable Set, P/N TBD
   c. Focal Plane Calibration Fixture, P/N 225808
   d. Film Thickness Adjustment Fixture, P/N 225812

## 2.0 APPLICABLE DOCUMENTS

The following documents form a part of this plan:

| | | |
|---|---|---|
| NASA | Exhibit A to Contract NAS9-15671 | Statement of Work for the Orbiter Camera Payload System |
| | SLD-47-00000-801 through 902 | OCPS Interface Control Documents |
| | SLP 2104 | Payload Accommodation Handbook |
| ITEK | ES225363 | Cartographic Lens Test Plan |
| | 9555-78-009 | S, R, Q & M Plan |
| | 9555-78-010 | OCPS Certification Plan |
| | 225000 | C.E.I. Specification |

## 3.0 TEST REQUIREMENTS

### 3.1 General

#### 3.1.1 Safety Standards

Itek Safety bulletins covering all of the common hazards associated with industrial processes and testing are posted in all appropriate fabrication and test areas. In addition, trained first aid teams, kept current to offset personnel turnover, are available at each facility in which test operations will take place. The program Safety Requirements are delineated in the S, R, Q & M Plan, 9555-78-009.

#### 3.1.2 Hazardous Operations or Situations

At the present time there are no hazardous operations not covered by a standard Itek safety bulletin, identified in the Test Plan. In the event that any hazardous conditions become evident during the generation of specific test procedures, such conditions will be described and incorporated in this plan and in the test procedures to which they apply, together with appropriate special precautionary procedures.

#### 3.1.3 Test Procedures, Analysis, and Reporting

##### 3.1.3.1 Test Procedures

Test procedures used for testing of the LFC will be general engineering procedures. These will be used for all integration tests at either the subsystem or system level and will be written so that they may be properly employed by senior technicians or engineering personnel. The following specific items will be included:

1. Exact location and designation of test points.
2. Discrete steps indicating points in the sequence at which data is to be recorded. The acceptable parameters of such data will be clearly indicated in quantitative terms.
3. Electrical waveshapes, environmental or power profiles, and the like will be shown graphically, with sufficient detail and accuracy to preclude misinterpretation of requirements.

3.1.3.1.1 Generation

A test procedure will be generated for each discrete test required by this plan. Each test procedure will be clearly identified as to project relationship, level of testing (system, subsystem), and type of test (verification, acceptance).

3.1.3.1.2 Contents

1. Scope/Purpose. The extent of testing, specific applicability of the procedure, and its purpose will be clearly stated.

2. Applicable Documents. Reference will be made in this plan to the appropriate Contract End Item Specification (CEIS), and any other document affecting or governing the test covered by the procedure. Order of precedence in the case of conflict will be stated.

3. Requirements. The following requirements will be stated in specific terms:

   a. Test conditions. Environmental values (e.g., temperature, pressure, relative humidity), special facility requirements (e.g., screen room, clean room, power requirements, etc.), and any other conditions required during the test will be specified.

   b. Test Equipment. All equipment items required for successful conduct and recording of the test, including test stands, jigs, fixtures, and other GSE, will be specifically identified by part number, drawing number, or other positive means of identification. Test circuits, breakout boxes, and the like will be identified by controlled schematics.

4. Test Preparation. Test preparation will include appropriate data sheet entries, test equipment setup and connection, initial control settings, and other preparatory operations required prior to starting the actual test.

NOTE

Precautions to be observed regarding safety of personnel and equipment will be included as the first information item in this area.

5. Data Sheet (s). One or more test data sheets will be provided as part of each test procedure. The sheet(s) will make provision for the following:

   a. Test article identification, by nomenclature and serial number.

   b. Test equipment calibration due dates.

   c. Data entries for direct recording of quantitative data obtained. Each of these entries will reference the paragraph or procedural step directing the recording of the data item.

   d. Indication of supporting data to be attached.

   e. Signature/date entries for signatures of test conductor and the contractor quality assurance representative.

6. Supporting Data. Any and all data required to substantiate test results will be appended to the test data sheet. Supporting data may include recorder tracings, waveshape photographs, resolution data sheets, and the like. All such data will be identified as to the test procedure to which it pertains, and the recorder channel, sensor identification, camera station, or other qualifying information.

3.1.3.1.3 Responsibility

The following responsibilities are assigned regarding test procedures:

1. Generation. OCPS test manager.

2. Review and Approval. Chief engineer and quality assurance representative.

3. Witnessing Tests, Data Verification. Test engineer and quality assurance representative.

3.1.3.2 Data Analysis

The majority of data to be generated during the OCPS Test Program will provide a direct indication of conformance or nonconformance with specific requirements. In cases where some method of analysis is required to convert raw data to conclusive test information, the method of analysis will be shown or described on the test data sheet. The raw data will be maintained at the contractor facility; summarized data derived by analysis will be included in the appropriate test report.

3.1.3.3 Retest

Retest of the LFC system may be required whenever one of the following occurs during the original test.

1. Required test conditions were not met.

2. Test data indicates that the article under test does not conform to specified limits.

Evaluation and corrective action, including necessary design changes shall be completed and approved before retest is attempted. The extent of retest necessary will be determined by a review of the failure.

Failure reporting, analysis and corrective action shall be in accord with DRL items 15 and 16. Reference S., R., Q & M plan, 9555-78-009.

3.1.3.4 Test Reporting

Results of tests performed in accordance with Appendix A of the C.E.I. Specification, 225000 will be reported as an acceptance data package as required by Item 20 of the D.R.L.

3.1.4 Disposition of Test Articles

Test articles (Contract End Items) will be delivered in accordance with contractual requirements.

3.1.5 Test Standards

3.1.5.1 Acceptance and Rejection Criteria

Acceptance criteria will be established by parametric tolerances specified in the CEI Specification, 225000.

Deviations from these tolerances will result in rejection, subject to allowable adjustment, repair, rework, or maintenance operations stated in Section 3.1.5.2 below.

3.1.5.2 Allowable Adjustment, Repair, Rework, or Maintenance Operations

Subject operations will be conducted only as specified in the following paragraphs, and the circumstances and conditions surrounding such operations will be recorded in the Q. A. Log Book in sufficient detail to establish that the limitations outlined herein have been maintained.

3.1.5.2.1 Adjustment

Prior to commencement of acceptance testing, an appropriate system alignment and debug procedure will be completed. Malfunction or out-of-limits operation during testing will be corrected by adjustment only when it can be established that the anomaly was caused directly by an out-of-adjustment situation rather than a component or sub-system failure. Additionally, the following limitations are placed on adjustments: Adjustments will be limited to those provided or inherent in the design of the circuit, subsystem, or mechanical linkage. Adjustments which involve the addition of circuit or mechanical components to the article under test or which tend to change the electrical or mechanical configuration of the test article during testing, will not be permitted without formal ECN or RSA activity.

3.1.5.2.2 Repair

A failed assembly, subassembly, or part may be replaced during testing, subject to the provisions of paragraph 3.1.3.3, Retest. The repair action will be recorded in the appropriate assembly log book with a copy of the repair, substitution authorization, (RSA) notice as described in the S. R. Q & M plan.

3.1.5.2.3 Rework

Reworked parts may be used, providing that test article configuration is not changed thereby. All rework action will be recorded in the assembly log book with a copy of the RSA.

3.1.5.2.4 Maintenance

Routine maintenance to the extent that would be required during normal operation of the test article (cleaning, lubrication, exchange of desiccant, etc) will be completed prior to the commencement of any test series.

3.1.5.3 Failure of Government-Furnished Property

Failures or operational anomalies caused by failure of the Government-furnished property will not constitute a failure of the CEI equipment under test..

3.2 Performance Specifications

The performance specifications of the test items (para. 1.2) will be as delineated in Section 3.1 of the CEI Specifications, 225000.

4.0 TEST PHILOSOPHY

4.1 General

Subsystems will be tested by means of a series of engineering level tests. Acceptance tests will be conducted at three discrete levels of assembly.

1. Cartographic Lens Acceptance
2. Subassembly Calibration
3. Integrated L.F.C.

In addition to the L.F.C. acceptance the Flight Support Structure, P/N 225240, and the Test and Checkout Console, P/N 225800 will undergo acceptance testing as described in paragraphs 4.7 and 4.8 of this document.

4.2 Test Flow

Figure 2 illustrates the OCPS integration cycle, beginning at the assembly level, and the series of verification tests to be performed prior to the system acceptance program. During the manufacturing cycle, subassembly tests may be performed at the discretion of the project management to facilitate the overall test objectives and schedules. Figure 3 illustrates the test and data flow of the OCPS acceptance program in order to satisfy the requirements of the C.E.I. Specification document, 250000.

4.3 Verification Testing

The verification tests will be conducted with the use of engineering test procedures. These tests are virtually a "dry-run" of the tests performed during acceptance and therefore facilitate a problem-free acceptance program. Additionally these tests provide data for design verification.

4.3.1 System Functional Test

The system functional test consists of a complete electrical test in which all commands are exercised and all functional responses are monitored for the entire system.

4.3.2 DELETED

4.3.3 System EMC/EMI Test

The system EMC/EMI test consists of installing the LFC within Itek's screen room and submitting the system to the tests prescribed by the applicable sections of MIL-STD-461, as modified by NASA document, S1-E-0002A, to ensure that the specifications of conducted and radiated emittance and susceptibility are met. The tests to be performed are as follows:

1. Conducted Emission, CE01, 10HZ To 20KHZ, Fig. 13A
2. Conducted Emission, CE03, 20KH2 to 50 MHZ, Fig. 15A
3. DC Power Bus Transients, TT01, Spec. Reqt.
4. Radiated Emission,Electric Field,RE02, 14KHZ - 10GHZ, Narrowband, Fig. 21A
5. Radiated Emisson, Electric Field, RE02, 14KHZ - 10GHZ, Broadband, Fig. 22A
6. Conducted Susceptibility, CS01, 30HZ - 50 KHZ, Fig. 17A
7. Conducted Susceptibility, CS02, 50KHZ - 400 MHZ

8. DC Power Bus Transients, CS06, $\pm$ 56 volts

9. Radiated Susceptibility, Electric Field, RS03, 14KHZ to 10GHZ

— 4.3.4 DELETED

— 4.3.4.1 DELETED

— 4.3.4.2 DELETED

## 4.4 Cartographic Lens Acceptance Test

This series of tests will provide the data necessary to establish accordance with the C.E.I. specification 225000 as it relates to the Lens Performance. They form a part of the overall lens test program as described in the Cartographic Lens Test Plan, ES 225363

### 4.4.1 Static Resolution Test

This test consists of exposing an array of low contrast (2.4:1), twelfth root of two, targets onto 3414 film stationed at the focal plane. The targets are strategically placed to ensure full format coverage. Reference, Fig. 1. Three frames of data shall be obtained from which the area weighted average resolution (AWAR) and the specified field point resolution shall be obtained. The resolution reported will be an average of three Itek qualified readers and shall meet or exceed the requirements of the C.E.I. specification, 225000, paragraph 3.1.3.7.2. This test shall be performed with the Wratten 12 spectral filter and the antivignetting filter in place.

### 4.4.2 Radial Distortion

This test is comprised of exposing a precise reticle at the same field positions described by Figure 1. Kodak type 3414 film shall be evacuated onto a glass platen containing a 1 centimeter grid system. Either before or after exposing the reticles but while the film is still evacuated onto the platen, the grid system will be imaged onto the film. The coordinates of this imaged grid will be used during the distortion data analysis to account for film changes due to processing.

The data shall be analyzed to report the lens radial distortion and point of best symmetry. The performance criteria shall be as specified in paragraph 3.1.3.8.2 of the C.E.I. specification, 225000.

### 4.4.3 Principal Point of Autocollimation

The principal point of autocollimation shall be determined by conventional photo-optical means. An autocollimator reticle shall be imaged on Kodak type 3414 film situated at the focal plane. In addition to the reticle the lens fiducial system shall be imaged onto the film.

The X-Y coordinates of the principal point and the fiducials shall be determined from the processed film.

An analysis of the fiducial locations shall be performed to locate the center of format. The center of format shall be the intersection of the mid-format fiducials on both major axes.

A further analysis of the data shall be performed to ensure that the center of format, the principal point of autocollimation and the principal point of symmetry (Ref. paragraph 4.4.2) lie within a thirty micron diameter circle.

In order to accomodate this requirement, the fiducial mask can be adjusted along the X and Y planes. If this is necessary a repeat verification frame of data will be exposed after placement of the fiducial mask.

4.4.4 Lens Transmission Test

This test shall be performed with a reflective collimator fitted with a diffuser in its focal plane. A calibrated Lambertian light source will be used to illuminate the collimator.

The ratio of transmittance will be determined by comparing the brightness of the source, the brightness of the source reflected by the collimator and the brightness of the source transmitted from the collimator through the LFC lens system.

A radiometer shall be used as the measuring device throughout the range of 350 to 1000 nanometers. Data from this test will be used to prove requirements of C.E.I. specification, 225000, paragraph 3.1.3.5.

4.4.5 Relative Illumination

This test is similar to the transmission test except for the additional measurements across the format. In this test comparison readings are made between off axis ( ± 10°, ± 25°, ± 35°) and on axis (0°) image positions.

To simulate the solid angle acceptance of film, a cosine head attachment with a small aperture is used with the radiometer.

Measurements will be performed for the spectral range of 580 to 720 nanometers.

Data from this test will be used to prove requirements of C.E.I. specification, 225000, paragraph 3.1.3.4 have been met.

4.4.6 Veiling Glare

This test method is designed to photograph through the LFC lens a test field consisting of a bright surface containing a black spot whose luminance is not greater than one-hundredth of the bright surface luminance.

The photograph shall be made by placing a film holder containing a 3414 film at the LFC focal plane to capture the black spot image

The densitometry of the processed film shall be examined to report the percentage of veiling glare as a ratio of illuminances of the bright surface to the black spot in accordance with the requirements of paragraph 3.1.3.6 of C.E.I. specification, 225000.

4.5 Subassembly Acceptance Tests

This series of tests will provide calibration data necessary to establish accordance with the C.E.I. specification, 225000 as it relates to specific subassemblies.

4.5.1 Platen Flatness Calibration

This test will be performed at the magazine assembly level in two steps. Step one consists in measuring the surface flatness of the platen using standard inspection techniques and electronic height gauge indicators capable of detecting $\pm$ 0.0001 inch height deviations. Step two consists of evacuating a 9.5 inch by 18 inch piece of Kodak type 3414 film onto the platen and repeating surface flatness measurements in step one.

The tabulated data will be used to substantiate the requirements of C.E.I. specification, 225000, paragraph 3.1.3.14.

4.5.2 Exposure Sensor Calibration

This test will be performed on the exposure sensor assembly. A variable density solar light source will be presented across the field of view of the sensor while recording the sensor's electrical output. This test will be performed in two steps.

Step one consists in presenting to the sensor a discrete density for one integration cycle (15 seconds). The density levels used will simulate the expected brightness range of LFC operation, i.e. 600 to 5000 foot-lamberts. A calibration curve of output versus brightness will be generated.

Step two entails a variation of densities presented to the sensor during one integration cycle while monitoring its output to verify that the signal output is equivalent to the minimum brightness presented during the integration cycle.

The data from this test will be used to verify the requirements of the C.E.I. specification, paragraph 3.1.3.15.

4.6 System Level Acceptance Tests

This series of tests will be performed on the Large Format Camera to obtain data necessary to prove compliance with the C.E.I. specification 225000. It is comprised of three major tests, i.e.

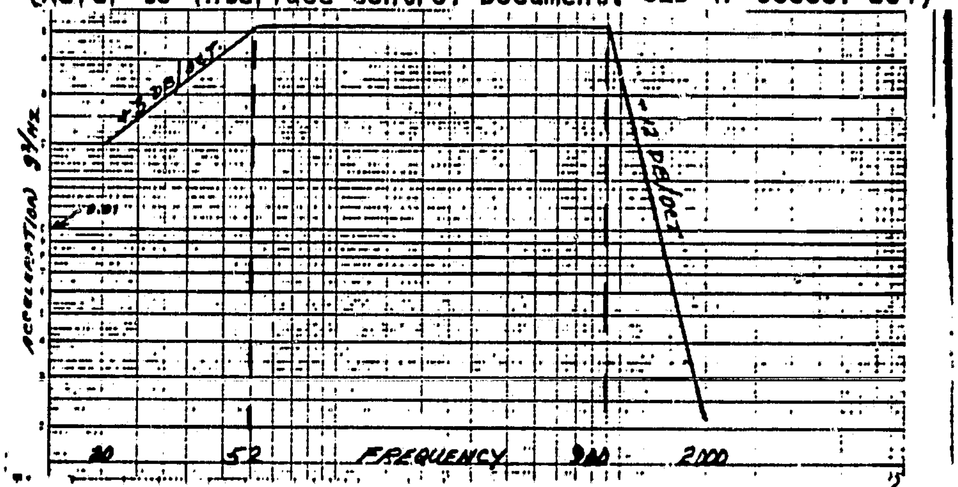
1. Vibration
2. Thermal/Vacuum
3. Mass Properties

At the conclusion of the Vibration Test, the system will undergo a system checkout test. The purpose of this test will be to verify the system integrity after exposure to the vibration environment.

Prior to the start of these tests, NASA will be notified that the camera system is ready for customer acceptance.

4.6.1 Vibration Test

The vibration test consists of installing the LFC into its vibration test fixture, attaching control and response accelerometers at the predetermined locations on the LFC and its fixture, and then subjecting the system to a random vibration test per MIL-STD-810B, method 514, in which the following curve applies (Refer to interface Control Document, SLD-47-000001-804)




| Frequency, Hz | Acceleration Density, $g^2$/Hz |
|---|---|
| 10 to 52 | 0.020 |
| 52 to 900 | 0.053 |
| 900 to 2,000 | 0.0022 |

Composite = 7.78g rms.

The duration of this applied vibration shall be 1 minute in each of the three major axes.

During this test, response accelerometers shall be located at the areas which were previously analyzed to exhibit resonant points within the frequency band of 5 to 200 Hz. These accelerometers will be used to determine if a resonance occurs.

A resonance will be considered to exist if the acceleration response is at least 2.5 times the input acceleration.

When a resonance occurs, the acceleration density at the resonant frequency will be applied for a maximum of 5 minutes with all other frequency inputs equalized to zero g.

4.6.2 Thermal Vacuum Test

This test is a single-setup test in which all photographic, electrical, thermal, and mechanical parameters are functionally tested. The acceptance test will be a 72 hour exposure to an appropriate thermal-vacuum environment. During the test, a complete spool of Kodak type 3414 film (4,000 ft.) will be transported by the LFC.

Table 1 provides a summary of the thermal-vacuum environment versus the discrete tests which comprise this part of the acceptance. During the conduct of these tests, all the electrical status indicators and telemetry signals will be monitored to ensure that the system is operating satisfactorily.
Figure 4 is a profile of the shroud temperature versus time duration.

At the conclusion of the test, the system will be returned to ambient conditions, and the entire spool of film will be retrieved and processed. The processed film will be evaluated to verify that the resolution specifications have been met, that the auxiliary data presentations are correct, that the frame format is correct, and that there are no deleterious markings on the film.

4.6.2.1 Temperature Evaluation Test

The purpose of this test is to functionally demonstrate that the temperature sensing and heater control circuits maintain the LFC at the thermal set point within 1°C while in a simulated operational environment.

4.6.2.2 System Checkout Test

This test is a simplified version of the Full System Functional Test and is an indicator of the health and status of the system. Its purpose is to verify the major functions of each subsystem as they interact with one another. The intended purpose of this test is to verify, within a relatively short period of time, that the LFC is functioning properly and is ready to undergo either a complete parametric evaluation as delineated in the Full System Functional Test or some other system level examination.

4.6.2.3 Forward Motion Compensation Test

The purpose of this test is to demonstrate that the FMC performance requirements as specified in paragraph 3.1.3.9 of the C.E.I. Specification are satisfied within a simulated operational environment.
This test consists of two parts, i.e. a Zero FMC Test in which the FMC mechanism is non-operational and a Nominal FMC Test in which the FMC is allowed to operate normally.

— 4.6.2.3.1 Zero F.M.C. Test

This test will consist of a special camera mode of operation in which all subsystems are operating with the exception of the FMC which will be commanded to a stopped position. The Rotary Shutter will be operated at a 6-millisecond exposure rate while acquiring ten consecutive exposures of the twelfth root of two target at three field points, i.e., +9.5 degrees, +35 degrees, and -35 degrees. The results of these ten exposures will then be averaged. The resultant average is to be used as the comparative baseline with the nominal F.M.C. test.

— 4.6.2.3.2 Nominal F.M.C. Test

This test consists of exposing ten consecutive frames with a moving twelfth Root of two target whose motion has been set to be consistent with the camera's FMC velocity. Exposures will be made at a 6-millisecond effective shutter speed. All other subsystems of the camera will be operating under nominal conditions consistent with the 6-millisecond exposure rate.

The results of these ten exposures will be averaged and will become the data point for comparison with the zero F.M.C. test. In addition to the 6-millisecond exposure, a series of dynamic resolution tests will be conducted in which ten consecutive exposures are made for the minimum, nominal, and maximum condition of v/H at each of the three field positions. For each term of this test matrix, the average resolution will be computed.

For purpose of information only, an additional ten frames of resolution will be obtained at an effective exposure of 32 milliseconds with maximum v/H.

4.6.2.4 Full System Functional Test

This test is the major electro-mechanical interface test in which every functional parameter of the OCPS is verified. Every mode of operation will be tested while the timing and synchronization of the subsystem is analyzed for proper operation. All telemetry and status indicators will be monit red for amplitude and duration during this test.

4.6.2.5 Data Presentation Test

This test is designed to exercise, in an orderly sequence, each of the auxiliary data displays. The flight parameter data will be updated by the T&C to enable each of the LED segments and, therefore, prove their ability to function within this simulated operational environment.

4.6.2.6 Film Usage Test

This test is designed to transport film for the prescribed maximum periods of operation and is primarily used within this test as a "filler" test to ensure that the targeted cumulative frame count is met. This test will be conducted at the test director's discretion. All normal telemetry signals and status indicators will be monitored during this test.

4.6.2.7 Gas Consumption Test

Prior to evacuating the space chamber, all external pneumatic connections will be leak tested to ensure faulty connections do not contribute to the determination of leaks within the LFC. Upon completion of this check, the gas supply will be removed and weighed with a high resolution load cell. The gas supply will then be reinstalled and tested for a leak-free connection.

The space chamber will then be evacuated to less than 1 torr pressure for a 16-hour period of time during which the LFC will be pressurized to 2 psia. The LFC will not be operated, so any consumption of gas will be directly attributable to leakage.

At the end of this test, the gas supply will again be weighed. The delta between the two weight determinations will be used in computing the LFC leakage rate.

At the conclusion of the thermal vacuum test, the gas supply will again be weighed. The resultant weight difference will be used to compute the actual gas consumption rate. As an aid in determining the consumption rate per operate sequence, the weight of the gas supply bottle will be recorded on a daily basis.

4.6.3 Mass Properties

The LFC will be weighed to determine the overall flight system weight. The flight support structure, P/N 225240 and the Large Format Camera, P/N 225000 will be weighed individually.

The center of gravity will be empirically determined for the longitudinal axis of the LFC and analytically determined for the remaining two orthogonal axes. The moments of inertia will be calculated.

4.7 DELETED

4.8 Test & Checkout Console Acceptance Test

During the manufacture of the console, there will be inspection points and subassembly tests to ensure the built-in integrity of the unit. Upon completion of manufacture, a series of pre-use checks will be performed including verification of all voltages at the output connectors.

The acceptance test of the T & C console is a virtual acceptance, i.e., it will be used during the LFC verification test program and, therefore, will have been completely exercized and proven satisfactory prior to it's use within the LFC acceptance program.

5.0 ACCEPTANCE DATA

In compliance with item 20 of the Data Requirements List, Exhibit A, the acceptance data package shall be compiled to show proof of meeting the requirements of Appendix A of the C.E.I. specification 225000.

This package of data shall be forwarded to the JSC technical monitor two weeks prior to the acceptance review.

The data package will then be finalized upon completion of the acceptance review.

— Thermal Vacuum
Test Matrix

| Elapsed Time | Vacuum X10$^{-5}$ TORR | Shroud Temp. F° | Buss Voltage | Test Description | Cumulative Frames |
|---|---|---|---|---|---|
| 0 | - | 70 | 32 | -- | 30 |
| 10 | 5.0 | 0 | 32 | -- | 30 |
| 20 | 5.0 | 0 | 32 | T1 | 870 |
| 30 | 5.0 | -40 | 28 | T2A | 870 |
| 46 | 5.0 | 0 | 28 | -- | 870 |
| 50 | 5.0 | 0 | 28 | T2B | 1740 |
| 59 | 5.0 | 25 | 26 | -- | 1740 |
| 68 | 5.0 | 25 | 24 | T3 | 2570 |
| 72 | - | 70 | 24 | -- | 2700 |

T1 Tests

- Temp. Evaluation
- Full Functional
- FMC Test
- Film Usage

T2A Test

- Temp Evaluation

T2B Test

- FMC Test
- Data Presentation Test
- Film Usage
- Temp. Evaluation

T3 Tests

- Full Functional
- FMC Tests
- Temp. Evaluation
- Film Usage

# LFC SEMIDIAGONAL & TARGET PLACEMENT REFERENCE

## (STATIC RESOLUTION)

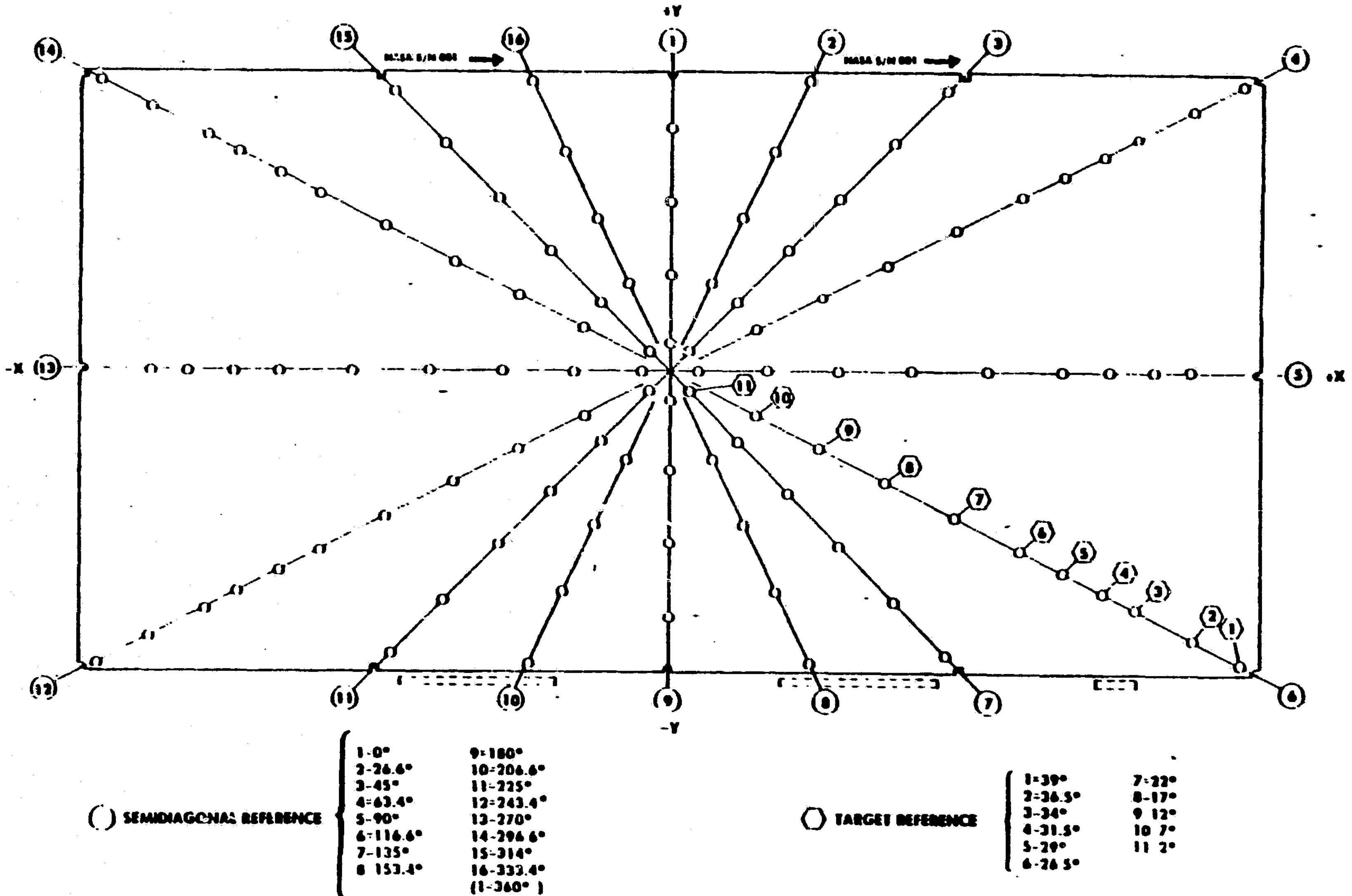



Figure 1 - LFC Semidiagonal and Resolution Target Placement Reference (For static resolution and distortion measurement)

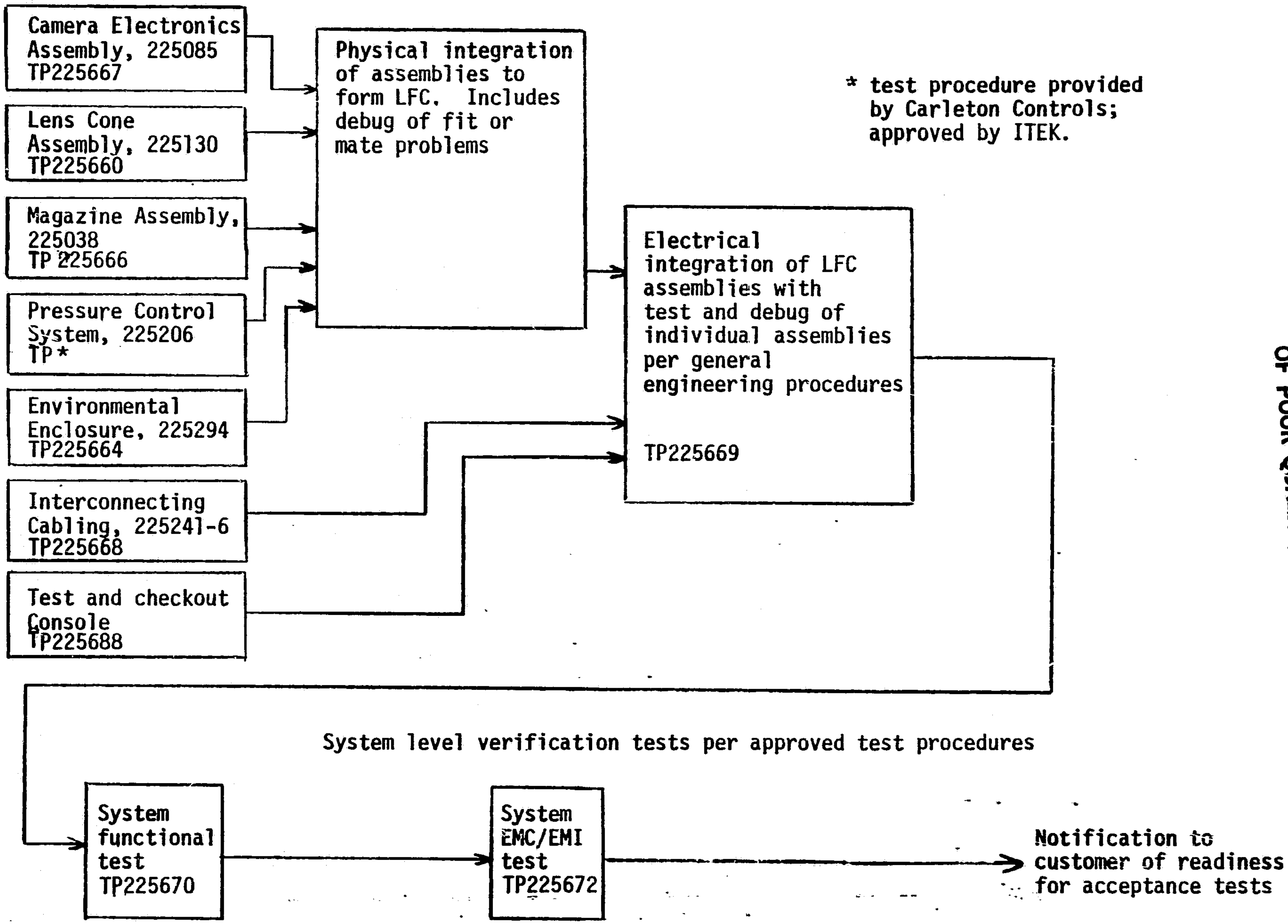



Fig. 2 ---Subsystem integration test flow

ACCEPTANCE TESTING & DATA FLOW

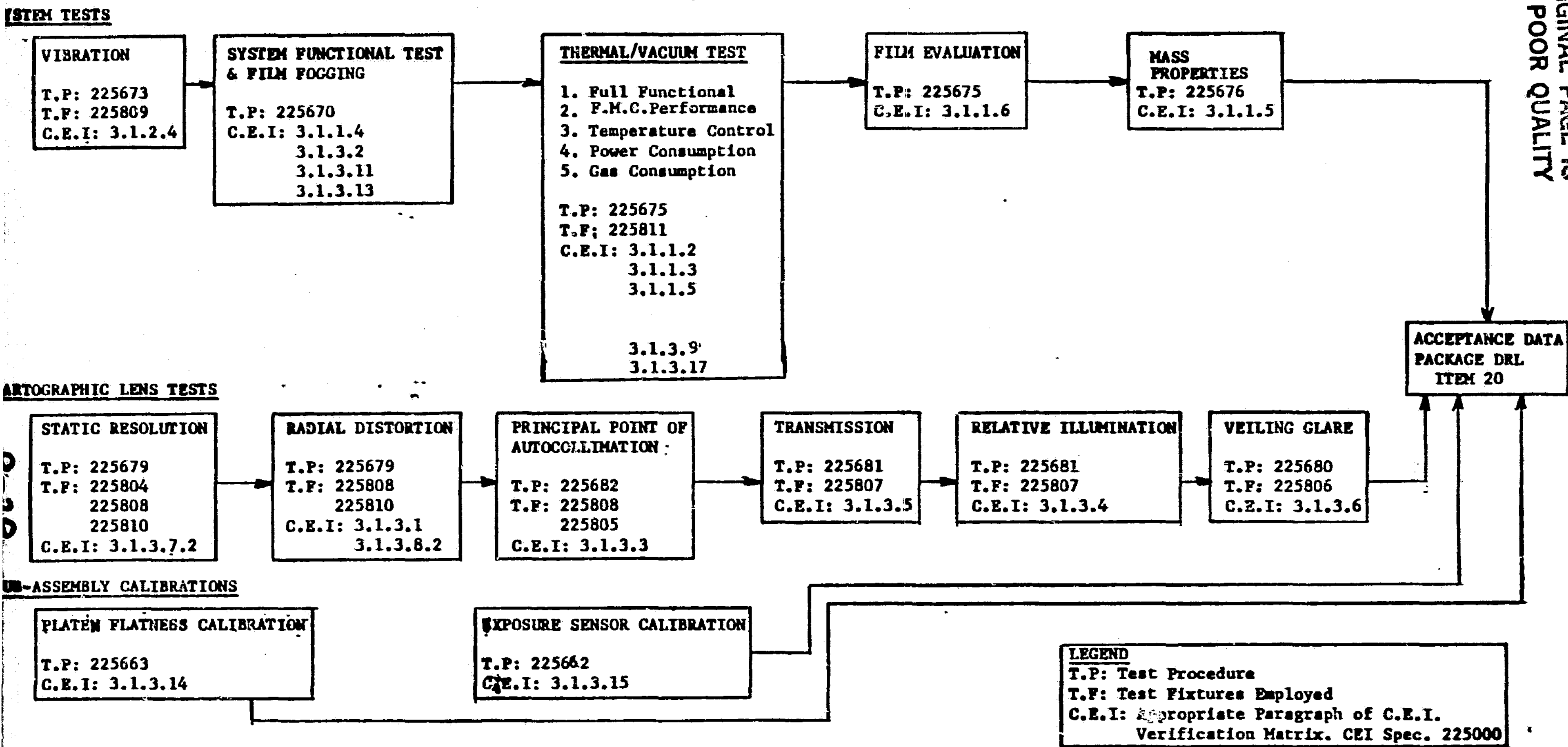



FIGURE 3

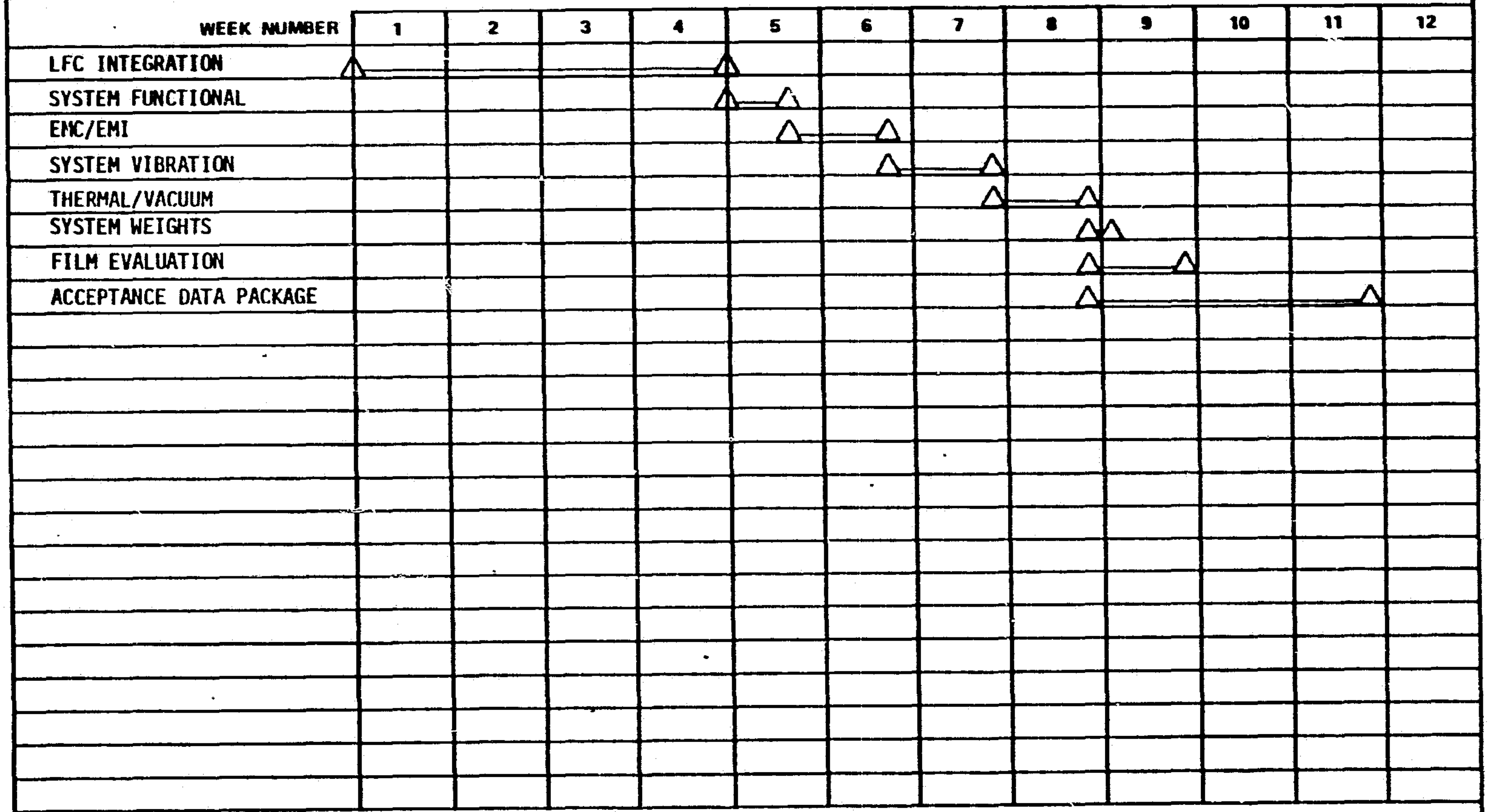
PROJECT NO. 9555

TASK DESCRIPTION SYSTEM LEVEL TESTS

Itek

# PROJECT SCHEDULE

SHEET 23 OF 23




OSD-109

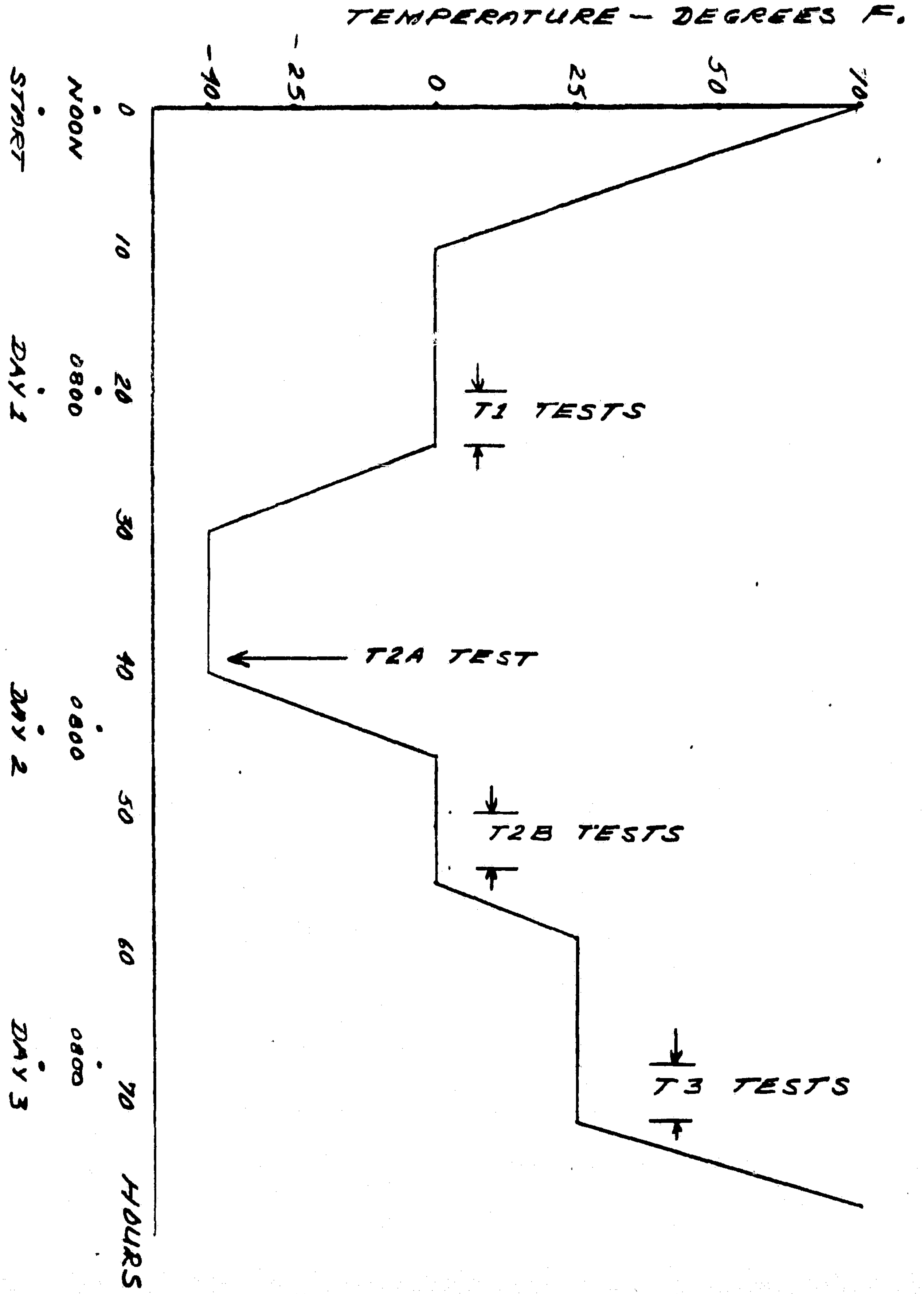

TEMPERATURE — DEGREES F.
70
50
25
0
-25
-40
0
10
20
30
40
50
60
70
HOURS
NOON
START
0800
DAY 1
0800
DAY 2
0800
DAY 3
T1 TESTS
T2A TEST
T2B TESTS
T3 TESTS

FIGURE 4

## 10. LONG LEAD PROCUREMENT ITEMS

The preliminary ARS program schedule has been constructed using procurement cycles of up to 12 weeks as normal. Items requiring potentially more than 12 weeks, therefore, must be treated as Long Lead Items and be identified and ordered within the first two weeks of the Hardware Phase startup. Using the Itek lead time chart, updated as of 1/25/82, the following items have been identified as having Long Lead Status for the ARS program:

- Capacitors
- Connectors
- Integrated Circuits
- Power Supplies
- Relays
- Wirewound Resistors
- Transistors
- Temperature Controls
- Fabricated Gears
- Large Machining

Based on anticipated useage of common parts, the following lists for early procurement have been generated:

- Capacitors
- Connectors
- Linear I.C.'s
- Relays
- Wirewound Resistors
- Transistors
- Temperature Controls

With the exception of temperature controls, all items are multiple source, most having MS or slash number identifications. Yet to be generated is a listing of likely digital I.C.'s.

The ARS program schedule has been shaped to accommodate expected lead times for fabricated gears, Invar components, and large machining where applicable.

A list of digital integrated circuits has not yet been prepared. These circuits will be identified, as far as practicable, within the first two weeks of the hardware phase and ordered. Device types utilized on the LFC will take first precedence, but some new devices in the area of the Microprocessor based ST&C will be encountered.

The Long Lead Item list will be continuously updated as required.

# Memorandum

ERL-82-25

Itek

To: Distribution

Date: January 25, 1982

From: E.R. Landers ERL

Subject: LEAD TIME CHART - 1ST QUARTER 1982

The current economic condition continues to be reflected in the downward trend of lead times for most electronic components, especially those used in commercial application. A lengthening trend for these items is not expected until year end or into 1983.

However, increased defense spending, and therefore military demand, is creating some shortages on typical Mil-Spec items. Connectors especially will bottom out early this year and become increasingly extended through the balance of the year. Lead time on semiconductors (JAN-TX) is now considerably shorter than last year with a stretch-out not expected until the 3rd and 4th quarters of 1982.

The list of qualified manufacturers having QPL status on individual electronic components is continuing to dwindle with some items limited to one (1) or two (2) sources. This situation is contributing to some current random shortages and unavailability and it is expected to have a greater impact during the latter part of this year and 1983.

In general, lead time for most industrial products has shortened considerably during 1982 with inventories being reduced at all levels of distribution.

Large optical glass lead time, except for special types, has eased appreciably, especially from Schott. Eight weeks from Duryea, PA and twelve from Germany are occurring. Corning fused silica has also eased, but ULE is holding steady.

Backlog in many fabrication and machine houses is being consumed rapidly.

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DISTRIBUTION:

| | | | | |
|---|---|---|---|---|
| Purchasing | M. Burnett | W. Gratz | W. Knapp | D. Oliver |
| R. Aldrich | P. Campoli | W. Hannan | E. Kopf | E. Pelkey |
| F. Anderson | R. Collins | P. Hannon | R. Larson | P. Phinney |
| W. Anderson | J. Coughlin | J. Hardy | J. Lilley | R. Plante |
| A. Aube | R. Delaney | H. Harlow | A. MacEachern (10) | D. Quimby |
| W.H. Barnes | J. Fiorilla | W. Harney | A. MacGovern | W. Reusch |
| W.P. Barnes | R. Forkey | R. Heath | P. Mailhot | J. Rezendes (5) |
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| M. Berg | S. Golder | C. Jacobson | C. Morser | T. Woo |
| W. Bradley | N. Goralnick | R. Jones | G. Mulford | G. Wood |
| | | | M. N[illegible]x | |

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# LEAD TIME CHART

The lead times listed herein reflect industry reports and Itek/OSD experience which will permit routine economical procurement.

Small quantities of many standard commercial and military catalog items are available from local distributor inventories in less time.

All items listed in the OSD Hardware Standards Manual (except those in Section III) are maintained in inventory in the Building #9 Storeroom (Ext. 5204).

*Attachment "A" lists individual items which should be considered extremely critical.

## PURCHASED PARTS

| DESCRIPTION | DELIVERY | DESCRIPTION | DELIVERY |
|---|---|---|---|
| *Bearings | 8-60 Weeks | Film (Special) | 6 Weeks |
| Cables & Harnesses | 6-12 Weeks | Gages | 2-6 Weeks |
| *Capacitors | 4-20 Weeks | Glass (Optical)(Small) | 4-6 Weeks |
| Circuit Boards | | *Glass (Optical)(Large) | 8-26 Weeks |
| Single/Double Sided | | Hybrid Circuits | 16-40 Weeks |
| Design | 3-6 Weeks | Insulation Sleeving | 2-8 Weeks |
| Fabrication | 4-8 Weeks | *Integrated Circuits | 4-20 Weeks |
| Multi-Layer | | Lasers | 8-20 Weeks |
| Design | 4-8 Weeks | **Metals (Warehouse) | 3-7 Days |
| Fabrication | 6-12 Weeks | Metals (Mill Run) | 16-26 Weeks |
| Flexible | | Meters | 6-12 Weeks |
| Design | 3-6 Weeks | Motors (Fractional DC) | 8-16 Weeks |
| Fabrication | 4-12 Weeks | Motors (AC) | 8-16 Weeks |
| Circuit Board Assembly | 2-4 Weeks | Motors, Torque | 10-16 Weeks |
| Circuit Breakers | 4-12 Weeks | Mounts | 8-16 Weeks |
| Connectors | 16-40 Weeks | PMT (Photomultiplier Tubes) | 6-10 Weeks |
| Crystals, Filter | 10-20 Weeks | | |
| Cutting Tools | 1-5 Weeks | Plastics | 4-10 Weeks |
| Encoders | 10 Weeks | Potentiometers | 6-16 Weeks |
| Encoders (Hi-Rel) | 20-24 Weeks | Power Supplies | 8-26 Weeks |
| *Fasteners | 1-6 Weeks | Relays | 6-26 Weeks |
| Fiber Optics | 8-16 Weeks | *Resistors | 4-20 Weeks |
| | | *Semiconductors | 4-16 Weeks |
| | | Solenoids | 8-16 Weeks |

**Can be as long as 2 weeks if sawcut or burned.

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## PURCHASED PARTS

| DESCRIPTION | DELIVERY | DESCRIPTION | DELIVERY |
|---|---|---|---|
| Switches | 4-16 Weeks | Transformers | 6-12 Weeks |
| Temperature Controls | 6-16 Weeks | Tubes (Electronic) | 3-6 Weeks |
| Terminals | 2-8 Weeks | CRT Image Tubes | 4-10 Weeks |
| Test Equipment (Electronic) | 4-8 Weeks | Wire | 4-12 Weeks |

## FABRICATIONS

| DESCRIPTION | DELIVERY | DESCRIPTION | DELIVERY |
|---|---|---|---|
| Ball Screw Assembly | 20-40 Weeks | Machining (Beryl)(Sm) | 12-14 Weeks |
| Castings (Sm-New)(Raw) | 8-10 Weeks | Machining (Beryl)(Med) | 12-14 Weeks |
| Castings (Med-New) | 8-10 Weeks | Machining (Beryl)(Lge) | 20-24 Weeks |
| Castings (Lge-New) | 10-12 Weeks | Mirrors (Small) | 8-12 Weeks |
| Castings (Repeat-Sm-Med) | 4-6 Weeks | Mirrors (Large) | 12-16 Weeks |
| Castings (Repeat-Lge) | 6-8 Weeks | Nameplates | 5-6 Weeks |
| Castings (Investments) | 10-12 Weeks | Processing: | |
| Castings (Stainless Steel) | 10-12 Weeks | Anodize | 3-7 Days |
| | | Engrave | 1-2 Weeks |
| Thin Wall Castings (Inv) | 12 Weeks | Heat Treatment | 3-5 Days |
| Fiberglass | 8 Weeks | Painting | 1-3 Weeks |
| Tooling for above | 4 Weeks | Passivate | 3-6 Days |
| Forgings (Stainless) | 10-12 Weeks | Plating | 3-6 Days |
| Gears | 12-16 Weeks | Precious Metal Plating | 3-7 Days |
| Grinding | 2-4 Weeks | Sheet Metal (Small) | 6 Weeks |
| Honeycomb Construction | 12-16 Weeks | Sheet Metal (Medium) | 8 Weeks |
| Lenses (Small) | 8-12 Weeks | Sheet Metal (Large) | 12-14 Weeks |
| Lenses (Large) | 10-14 Weeks | Springs | 4-6 Weeks |
| *Machining (Small) | 6 Weeks | Structures (Aircraft type) | 12-14 Weeks |
| *Machining (Medium) | 8 Weeks | Welding | 1-2 Weeks |
| **Machining (Large) | 12-16 Weeks | Welding (E.B.) | 4-8 Weeks |
| | | Welded Frames | 8-12 Weeks |
| | | Windows (Optical)(Large) (Fab only) | 14-20 Weeks |

* In some cases, a 3-4 week delivery can be obtained from a few shops.

**Most machine shops with large equipment including NC are still heavily committed; however quick turn-around service is available from some shops.

## ATTACHMENT "A"

## CRITICAL ITEMS

| ITEM | COMMENTS |
|---|---|
| BEARINGS | Delivery of miniature and precision bearings is from 8 to 40 weeks. Special large diameter types have increased to 46-60 weeks. |
| CAPACITORS | |
| A) Ceramic | 4-16 Weeks |
| B) Electrolytic | 4-12 Weeks |
| C) Film | 6-12 Weeks |
| D) Mica | 8-16 Weeks |
| E) Paper | 8-16 Weeks |
| F) Trimming | 4-20 Weeks |
| CONNECTORS | All manufacturers of high reliability MIL-Spec/SCD connectors are quoting 16-40 weeks. |
| FASTENERS | Non-standard hardware running 6-12 weeks, specifically stainless steel. |
| GLASS (LARGE) | |
| INTEGRATED CIRCUITS (DIGITAL) | |
| A) D.T.L. | 4-8 Weeks |
| B) E.C.L. | 4-16 Weeks |
| C) T.T.L. (Standard) | 4-20 Weeks |
| D) T.T.L. (Schottky) | 8-20 Weeks |
| E) T.T.L. (Low Power Schottky) | 8-20 Weeks |
| F) C.M.O.S. | 8-20 Weeks |

ATTACHMENT "A"

CRITICAL ITEMS (CONTINUED)

| ITEM | COMMENTS |
| --- | --- |
| INTEGRATED CIRCUITS (LINEAR) | |
| A) OP-AMPS | 6-16 Weeks |
| B) Voltage Regulator | 6-16 Weeks |
| C) Data Converters | 8-12 Weeks |
| D) Sample and Hold | 6-16 Weeks |
| LIGHT EMITTING DIODES | 4-10 Weeks |
| OPTO ISOLATORS | 6-12 Weeks |
| MEMORY I.C.'s | |
| A) BiPolar | 6-16 Weeks |
| B) C.C.D.'s | 4-10 Weeks |
| C) M.O.S. (Rams) | 8-20 Weeks |
| D) Rams (1K, 4K) | 8-20 Weeks |
| E) Rams (16K) | 8-20 Weeks |
| F) Proms | 6-12 Weeks |
| G) E Proms | 6-12 Weeks |
| RESISTORS, FIXED | |
| A) Compositions | 4-16 Weeks |
| B) Carbon & Carbon Film | 4-12 Weeks |
| C) Metal Film | 4-16 Weeks |
| D) Wire wound | 4-12 Weeks |
| E) Special Fixed Value/Tol | 6-16 Weeks |
| RESISTORS, VARIABLE | |
| A) Precision | 8-16 Weeks |
| B) Non-Precision | 8-12 Weeks |
| C) Trimmers | 8-12 Weeks |

# ATTACHMENT "A"

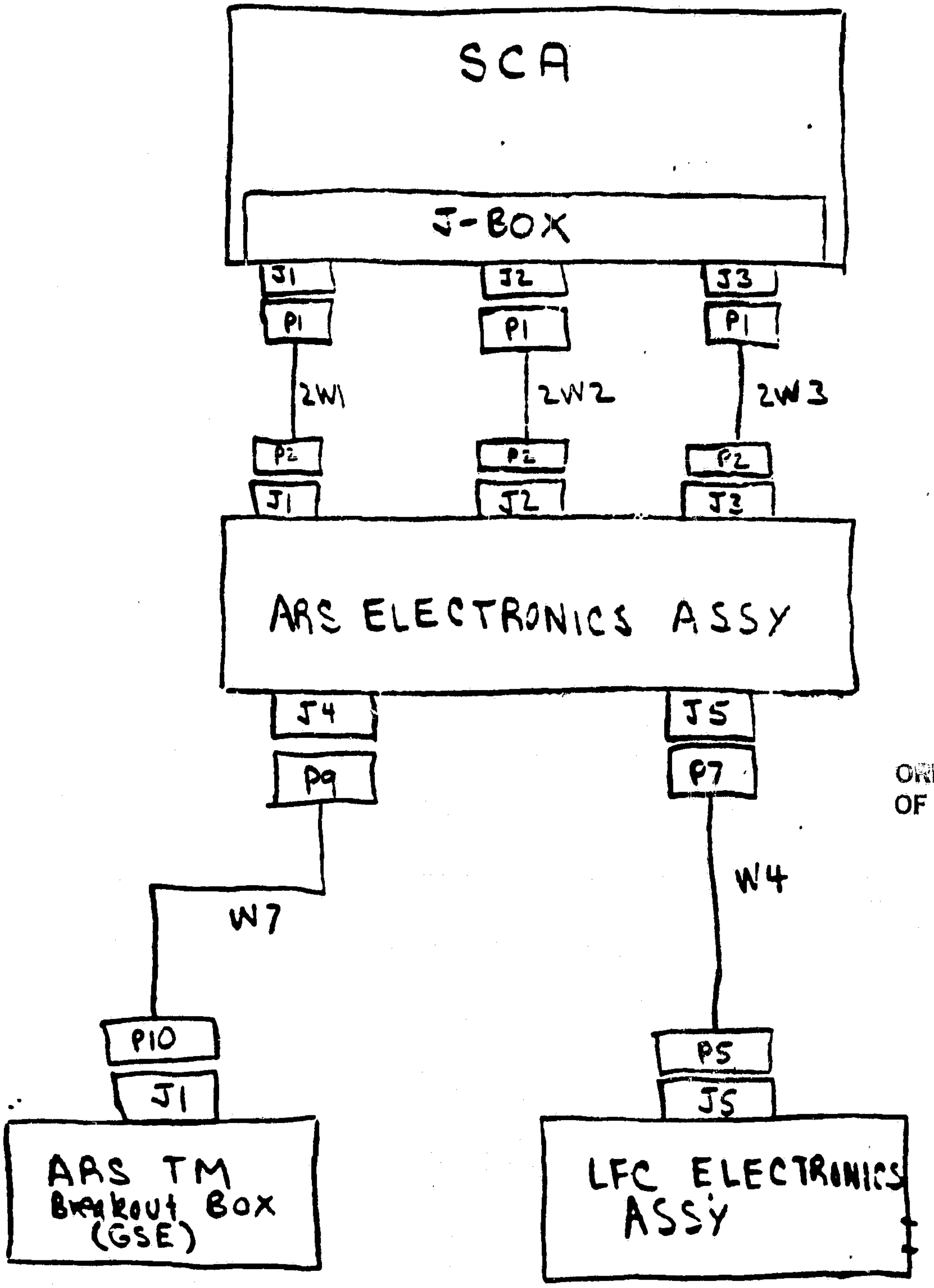
## CRITICAL ITEMS (CONTINUED)

| ITEM | COMMENTS |
|---|---|
| SEMICONDUCTORS | |
| A) F.E.T.'s | 4-8 Weeks |
| B) Power Rectifiers | 4-8 Weeks |
| C) Power Transistors | 4-8 Weeks |
| D) S.C.R.'s & Triacs | 4-8 Weeks |
| E) Transistors | 4-18 Weeks |
| F) Switching Diodes | 4-8 Weeks |
| G) Zeners | 4-8 Weeks |
| OTHER RAW MATERIALS | 400 Series Stainless Steel continues to present problems on availability.<br><br>Steel Plate or other items that require "Flame Cutting", such as Rings, etc., are still requiring 4-10 working days from local service centers. |
| SPECIFICATION CONTROL DRAWINGS | New requirements released on SCD's still require up to 3-4 weeks engineering review by vendors prior to quoting prices.<br><br>Testing in accordance with MIL-Spec/SCD requirements will extend lead times. |
| **PLASTICS** | |
| Noryl (Flame retarded) | 4-10 Weeks |
| PVC Plate Type I (1" thick and over.) | 4-6 Weeks |
| Rulon | 6-8 Weeks |
| Lexan (over ½" diameter) | 4-6 Weeks |

Connectors

At the present state of the design concept, GFE connectors have been located for all needs within the SCA. Other connectors throughout the ARS have been identified and limited quantities of all but one are in hand. A list of ARS interface connectors is included for NASA reference in planning shuttle/OCPS application interfaces. The one connector not on hand for Itek needs is an M83723-06-R22-55N.

| BY: | | TITLE: ARS Interface Connectors | PAGE: |
|---|---|---|---|
| DEPT: | DATE: 3/9/82 | | PROJECT: |



BY: | TITLE: | PAGE:
DEPT: | DATE: | PROJECT:

- W4 will be a GFE'ed item from the LFC
- LFC ELEX J5 is already on equipment
- ARS ELEX J5 is not on hand
- We have 3 pieces each of a back-up connector set:

  154861 P55
  158362 P29

- we should order:

  158362 P15 - 1 piece
  158362 P26 - 1 piece
  158362 P17 - 2 pieces

  from Bendix, to latest rev.

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| BY: | | TITLE: ARS Intersore Connectors | PAGE: |
|---|---|---|---|
| DEPT: | DATE: 3/5/82 | | PROJECT: |

| USED | | CONNECTOR | QTY ON HAND |
|---|---|---|---|
| J-BOX | J1 | 154861 P51 | 3 |
| | J2 | 154861 P44 | 3 |
| | J3 | 154861 P15 | 3 |
| 2W1 | P1 | 158362 P1 | 3 |
| | P2 | 158362 P4 | 3 |
| 2W2 | P1 | 158362 P15 | 2 |
| | P2 | 158362 P16 | 3 |
| 2W3 | P1 | 158362 P7 | 3 |
| | P2 | 158362 P26 | 2 |
| ARS ELECTRONICS ASS'Y | J1 | 154861 P33 | 3 |
| | J2 | 154861 P21 | 3 |
| | J3 | 154861 P45 | 3 |
| | J4 | 154861 P39 | 3 |
| | J5 | M83723-06-R22-55 N | 0 |
| W7 | P9 | 158362 P2 | 3 |
| | P10 | 158362 P17 | 1 |
| ARS TM Breakout Box | J1 | 154861 P42 | 3 |
| W4 | P7 | PVA 6R22B55SNS | 0 |
| | P5 | PVA6R22B55PNS | 0 |
| LFC ELEX | J5 | M83723-05-R22-55N | 0 |

## LONG LEAD ELECTRONIC PARTS

Following is a list of parts likely to be long lead items which would be suitable for use in the ARS program.

The inclusion of a part on any of these lists is not a statement of its useage.

A combination of early procurement of these parts and the committment to their use where practical will result in fewer potential schedule problems.

| CIRCUIT TYPE | DASH NO. OR EQUIV. | ESTIMATED USEAGE | TOTAL |
|---|---|---|---|
| General Purpose | M38510/10102BCX | Tm Bds - 4 @ x 4 = | 16 |
| OP AMP (dual) | | Servo Bds 6 @ x 2 = | 12 |
| (  A747) | | ST&C 4 @ x 4 = | 16 |
| | | LFC Mods | 4 |
| | | Extras | 12 |
| | | | 60 |
| General Purpose | LM119J/883B | Servo's 4 @ x 2 = | 8 |
| dual comparators | or 225679 screening | Extras | 6 |
| (LM119D) | | ST&C Bds 4 @ x 4 = | 16 |
| | | | 30 |
| +10V Ref. | AD5815H/883B | Servo Cards 1 @ x 2 | 2 |
| | | Extras | 2 |
| | | | 4 |
| Temp Sensor | AD590MF/883B | Various Zones | 12 |
| | | Extras | 6 |
| | | | 18 |
| D/A Conv | DAC 20-883AQ | ST&C Outputs | 2 |
| | | LFC Mods | 2 |
| | | Extras | 2 |
| | | | 6 |
| Analog Switches | DG172AP/883B | Various | 6 |
| | | Extras | 3 |
| | | | 9 |
| | DG181AA/883B | Various | 6 |
| | or M38510/11101BCX | Extras | 3 |
| | | | 9 |
| OP10 Isolator | JANTXV4N24A | Various | 12 |
| | | Extras | 6 |
| | | | 18 |

| CIRCUIT TYPE | DASH NO. OR EQUIV. | | ESTIMATED USEAGE | TOTAL |
|---|---|---|---|---|
| OP Amp | LM108AH/883B or | | Various | 6 |
| | M38510/10104 BCX | | Extras | 3 |
| Line Drivers/ | 55114 | M38510/10403BEX | | 16 |
| Receivers | 55115 | M38510/10404BEX | | 16 |
| Drivers | UHD500 (SPRAGUE) | | | 12 |
| FET, dual | 225597 | | | 16 |

CAPACITORS, LONG LEAD POTENTIAL

| | | QTY REC. |
|---|---|---|
| Tantalum | 22 f 35V<br>M39003/01-2306 | 50 |
| Ceramic | .01 f 200V<br>M39014/02-1218 | 100 |
| CERAMIC | .1 f 200V<br>M39014/02-1230 | 200 |

**TRANSISTORS**

| | |
|---|---|
| JAN TXV 2N4399 | 10 |
| JAN TXV 2N6384 | 10 |
| JAN TXV 2N2222A | 25 |
| JAN TXV 2N4150 | 10 |
| JAN TXV 2N6058 | 10 |
| JAN TXV 2N6350 | 10 |
| JAN TXV 2N2907A | 15 |

Resistors, Wire Wound

| | | |
|---|---|---|
| RER 65 F1R01R | 1Ω, 10W | 5 |
| RER 65 F2R49R | 2.49Ω,10W | 10 |
| RER 75 F40R2R | 40.2Ω,30W | 5 |
| RER 70 F14RPR | 14Ω,20W | 5 |
| RER 65 FR750R | 0.75Ω,10W | 5 |

Temperature Controls

| | |
|---|---|
| 3 C2-54 (Oven Industries) | 12 |

Long Lead Digital I.C.'s

TBD