Bendix

Aerospace Systems Division

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| Preliminary Isotope Heater Locations and Masking Pattern<br>PSEP Central Station | NO. EATM-10 | REV. NO. |
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| | DATE 12-16-68 | |

R. Mely

Prepared by: R. J. Simms

R. J. Simms
PSEP Thermal Supervisor

Approved by: Kai Hsi

Kai Hsi
PSEP Manager

## 1.0 INTRODUCTION

A series of parametric thermal studies have been carried out to determine within the limits described below, the optimum locations for the two heaters and the optimum masking pattern. The studies were limited to four possible heater locations as determined from the overall mechanical layout. Of the four possible heater locations, one was always used in conjunction with one of the other three as shown in Figure 1. Thus, heater No. 1 remains in the front right corner while the location of heater No. 2 is varied.

## 2.0 SUMMARY

A unique masking pattern has been found for each of the three configurations. With these masking patterns and the assumptions discussed below, the day/night temperature swings for all three configurations were found to be within the specified limits of +140F to -65F.

## 3.0 DISCUSSION

An analytical model consisting of the isotope heaters, the sunshield radiator and the thermal plate was constructed for machine computation. The first series of computer runs utilized no masking other than that caused by the PSE and the heaters themselves. The thermal dissipation of the Central Station electronics was assumed to be 35.8 watts (55 watt regulator, no dump) and the heater power was 15 watts each. The night time heat leak was assumed to be 5 watts and the day time heat leak to be zero. The results of the runs were plotted and are shown in Figures 2 through 4.

The purpose of the runs was to determine the optimum masking pattern for each configuration. By masking only those areas that are relatively cool it is possible to move the day/night temperature swing to within specification without seriously increasing the temperature gradients across the sunshield radiator and thermal plate.

## 4.0 RESULTS

The machine computed results indicate that the following masking patterns are required:

a. Configuration I (Figure 2)

The masking should be placed in either the rear right-or left-hand corners in the areas where the temperatures are 95F or less. However, there are no electronics components located under the right rear corner. Therefore, the masking will be located there.

b. Configuration II (Figure 3)

In this configuration, only the rear right-hand corner is suitable for masking. Thus, the masking pattern will be the same as configuration I.

c. Configuration III (Figure 4)

In this configuration, the coolest temperatures occur along a fairly narrow trough within the loop formed by the 100F contour. However, the PCU is located beneath the left-hand portion of the 100F contour. Therefore, the masking will be located along the right-hand portion of the 100F contour away from the PCU.

In each configuration, the radiating area (second-surface mirrors) was varied from 2.25 $ft^2$ to 2.60 $ft^2$ (324 to 375 1" x 1" second-surface mirrors). These areas yielded the following thermal plate day/night temperatures and temperature swings:

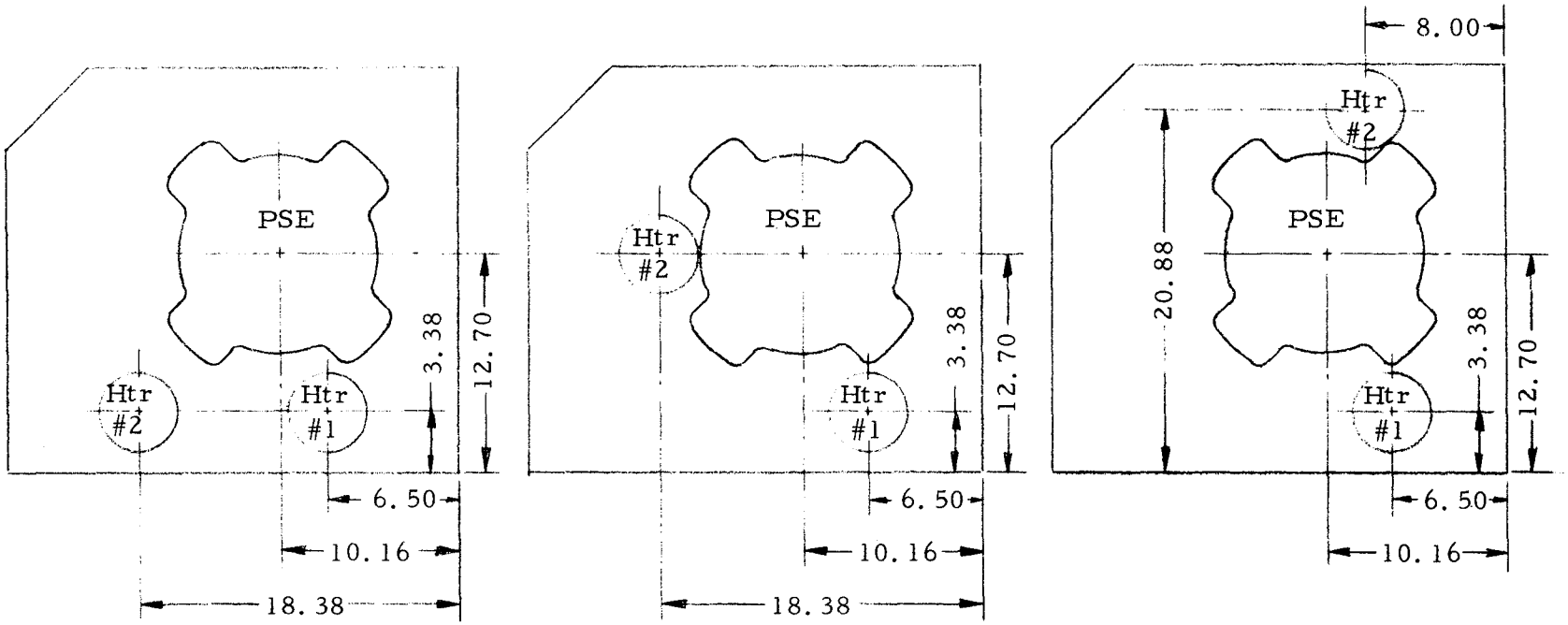
| Radiator Area ($ft^2$) | Configuration I Thermal Plate Temp(F) | | | Configuration II Thermal Plate Temp(F) | | | Configuration III Thermal Plate Temp(F) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Day | Night | Swing | Day | Night | Swing | Day | Night | Swing |
| 2.25 | 161 | -49 | 210 | 159 | -39 | 198 | 157 | -40 | 197 |
| 2.42 | --- | --- | --- | 145 | -48 | 193 | --- | --- | --- |
| 2.60 | 130 | -55 | 185 | 134 | -55 | 189 | 133 | -54 | 187 |

The day/night temperature profiles of the thermal plate for each of the three configurations with 2.60 $ft^2$ of second-surface mirror area are shown in Figures 5 through 7.

## 5.0 CONCLUSIONS

The PSEP thermal performance specifies a maximum thermal plate temperature of 140F and a minimum of -65F. The results of this analysis show that any of the three configurations with the proper masking pattern and radiator area will satisfy the specified requirement within the framework of the assumptions given above.

Additional work must be done to include the new 30 watt regulator, additional heat leak at night resulting from newly designed thermal isolators and thicker sunshield skin. For the present, however, it is recommended that the second-surface mirror area be reduced to obtain 140F day-time average thermal plate temperature (approximately 2.5 $ft^2$ in the present analysis). This will raise the night-time average thermal plate temperature which in turn will permit a greater heat leak to be tolerated without exceeding the -65F lower limit.




Configuration I

Heater Positions 1 , 2

Configuration II

Heater Positions 1 , 2A

Configuration III

Heater Positions 1 , 2B

Figure 1. Heater Positions for Parametric Study



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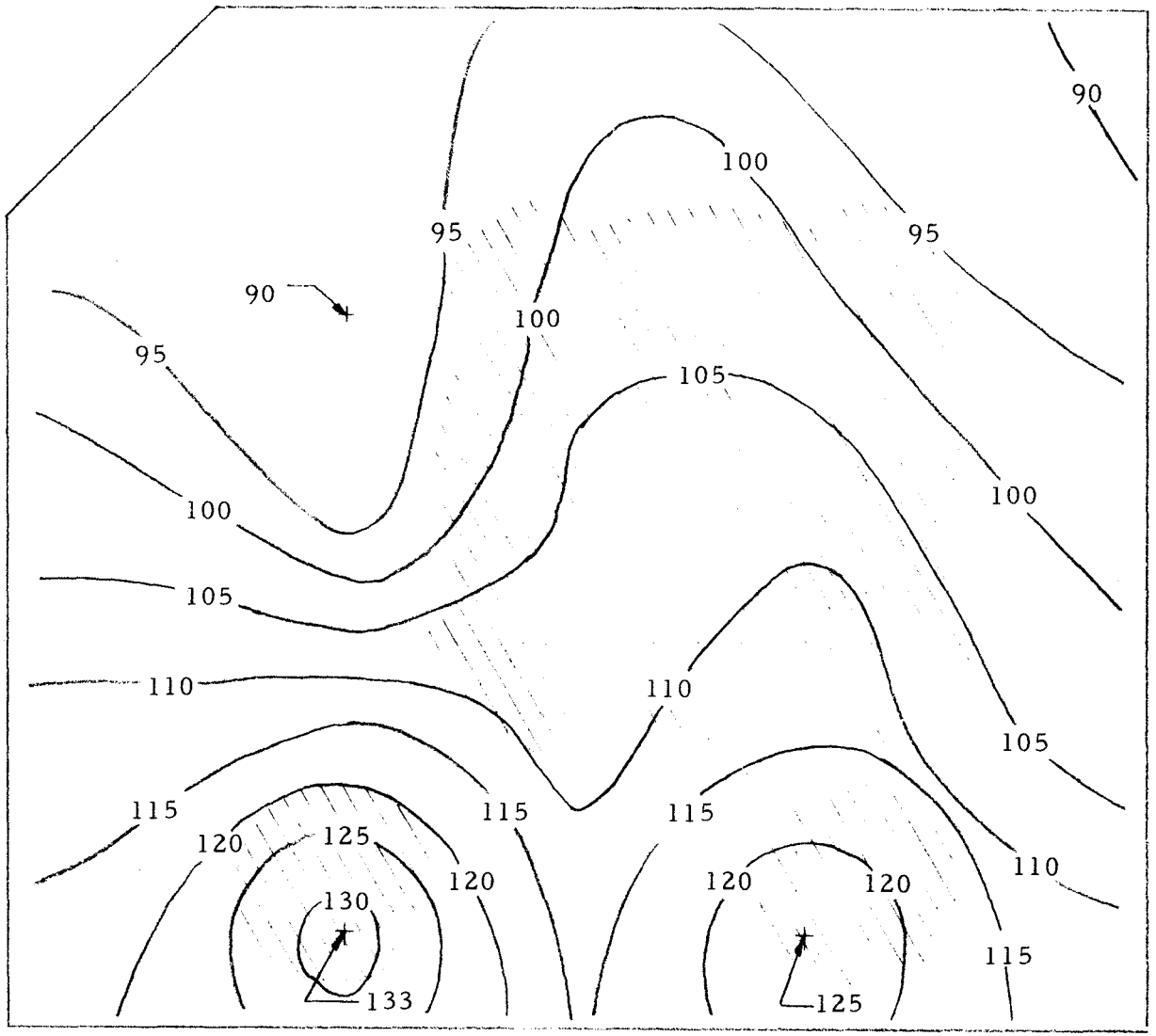


Figure 2. Sunshield Top Temperature Profile (F) at Lunar Noon Configuration I
$\overline{T}$ = 105 F; $\Delta T$ = 43 F (133-90); Second Surface Mirror Area = 3.04 $ft^2$



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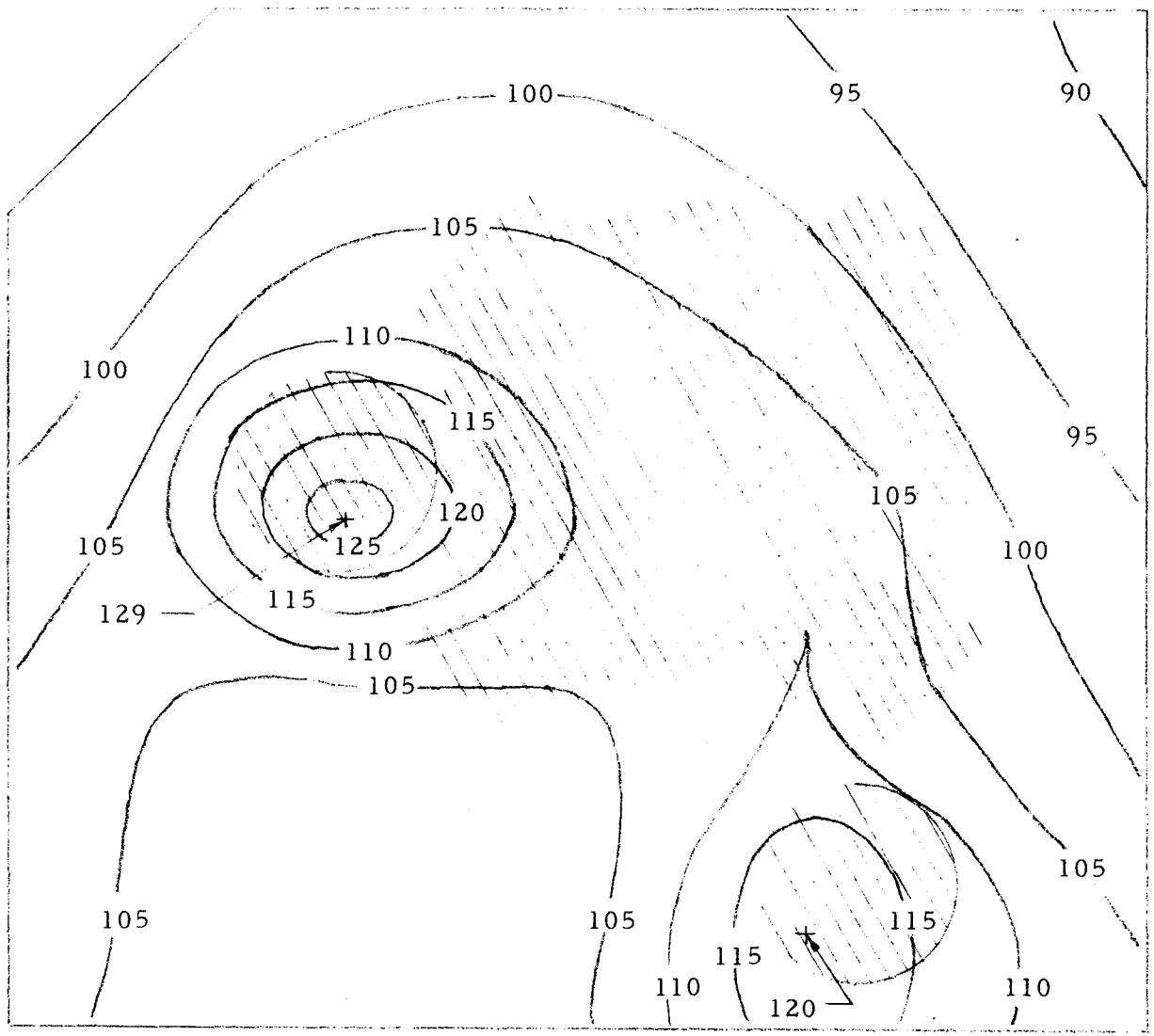


Figure 3. Sunshield Top Temperature Profile (F) at Lunar Noon--Configuration II
$\overline{T}$ = 104 F; $\Delta T$ = 39 F (129-90); Second Surface Mirror Area = 3.04 $ft^2$



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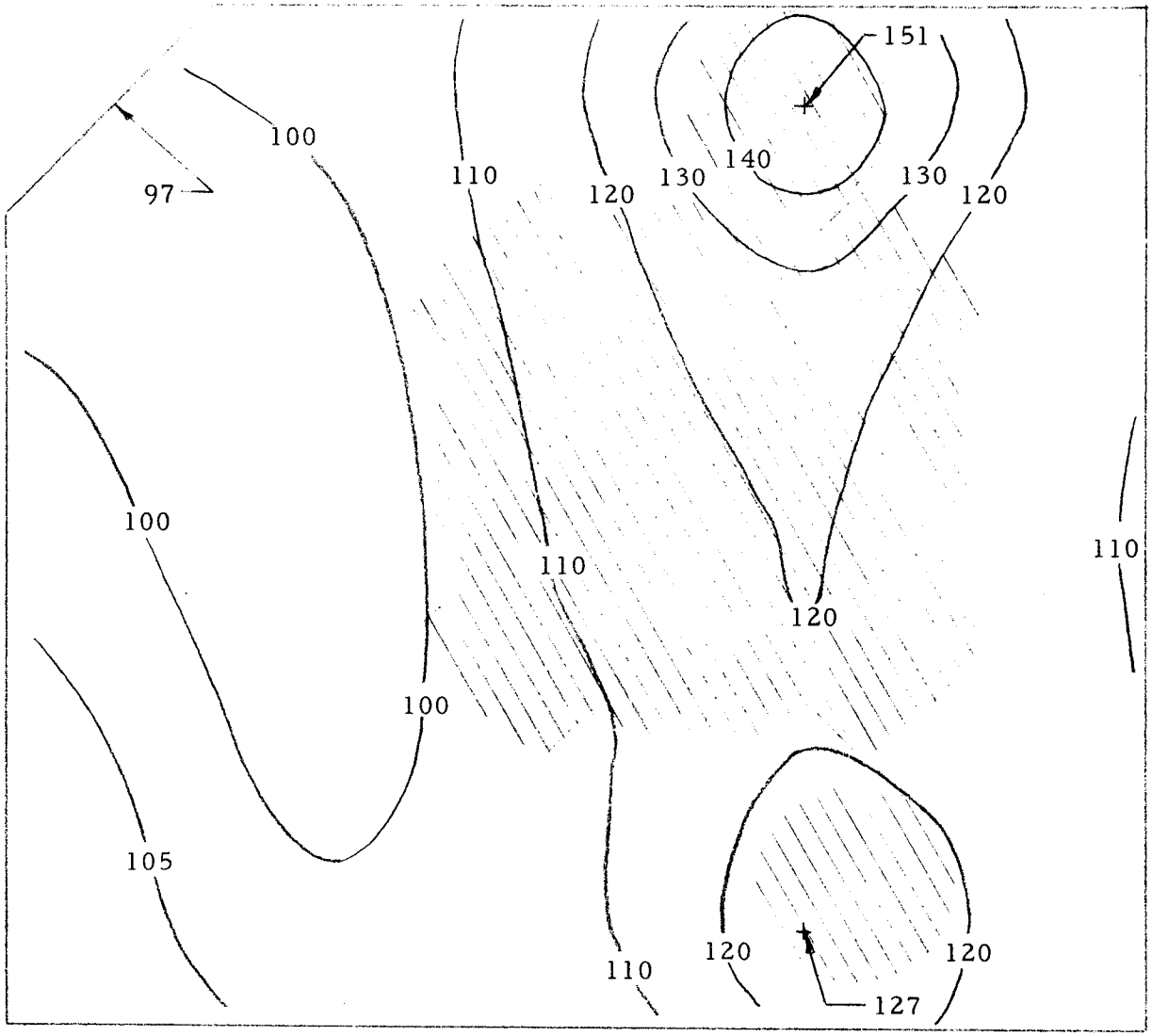


Figure 4. Sunshield Top Temperature Profile (F) at Lunar Noon--Configuration III
$\overline{T}$ = 111 F; $\Delta T$ = 54 F (151-97); Second Surface Mirror Area = 2.97 $ft^2$



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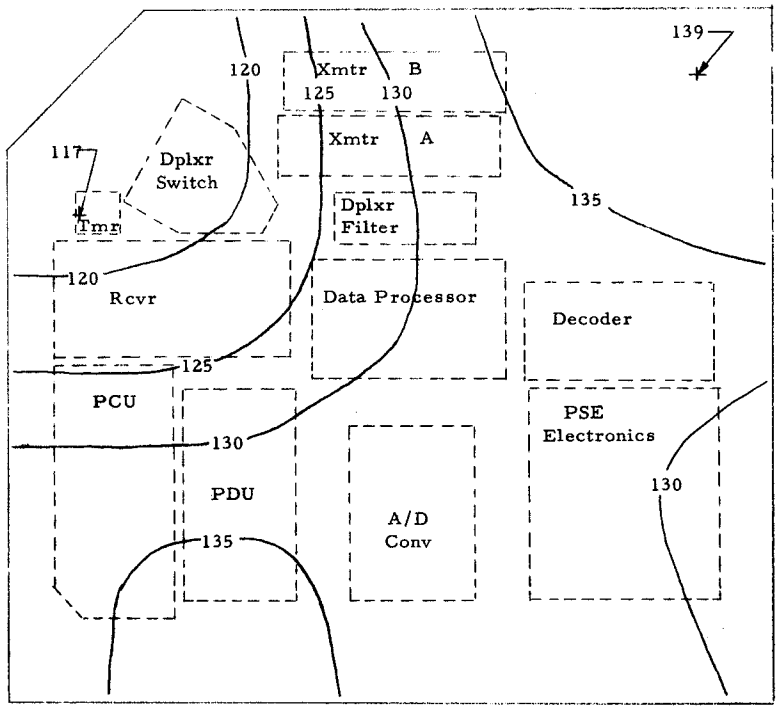
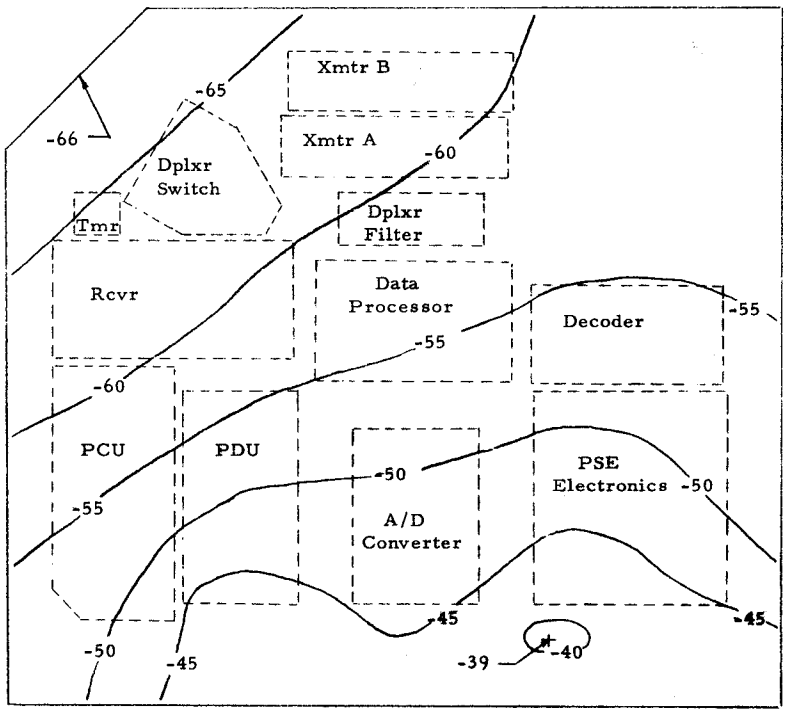
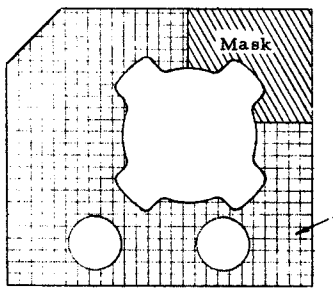



Lunar Noon $\bar{T}$ = 130 F $\Delta T$ = 22 F (139 - 117)




Lunar Night $\bar{T}$ = -55 F $\Delta T$ = 27 F [ -39 - (-66)]

**Day/Night Temperature Swing**
**185 F**




**Configuration I**
**Sunshield**
**With Masking Pattern**
**(Reference Only)**

**Second Surface Mirror Area**
**2.60 Ft$^2$**

**Figure 5**

**Thermal Plate Temperature Profiles (F)**
**Configuration I With Masking**

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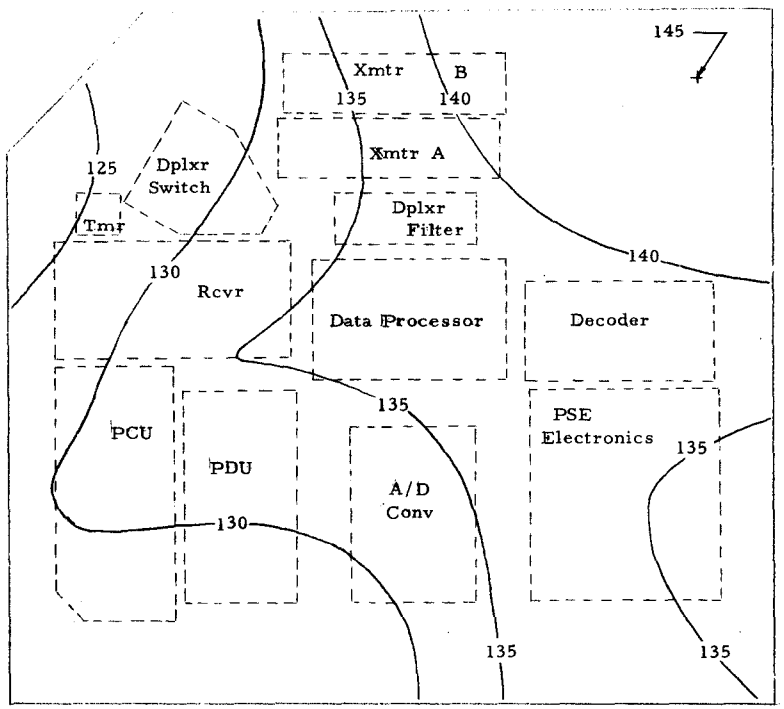
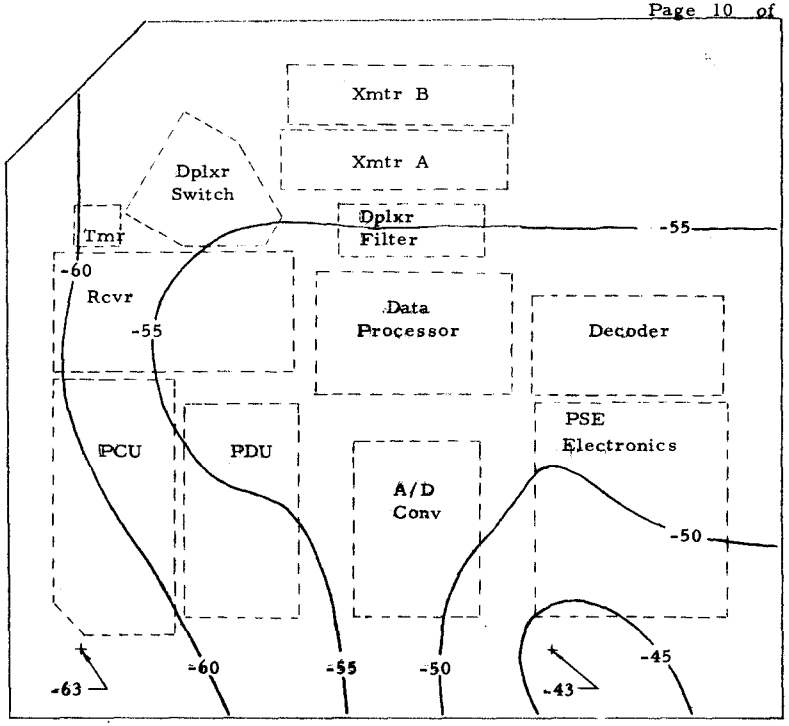
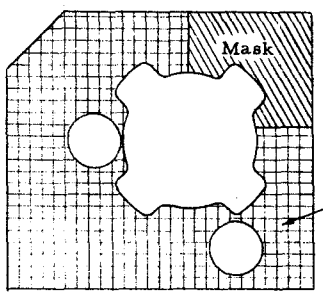



Lunar Noon $\bar{T}$ = 134 F $\Delta T$ = 20 F (146 - 125)




Lunar Night $\bar{T}$ = -55 F $\Delta T$ = 20 F [-43 - (-63)]

Day/Night Temperature Swing
189 F




Configuration II
Sunshield
With Masking Pattern
(Reference Only)

Second Surface
Mirror Area
2.60 $Ft^2$

Figure 6

Thermal Plate Temperature Profiles (F)
Configuration II With Masking

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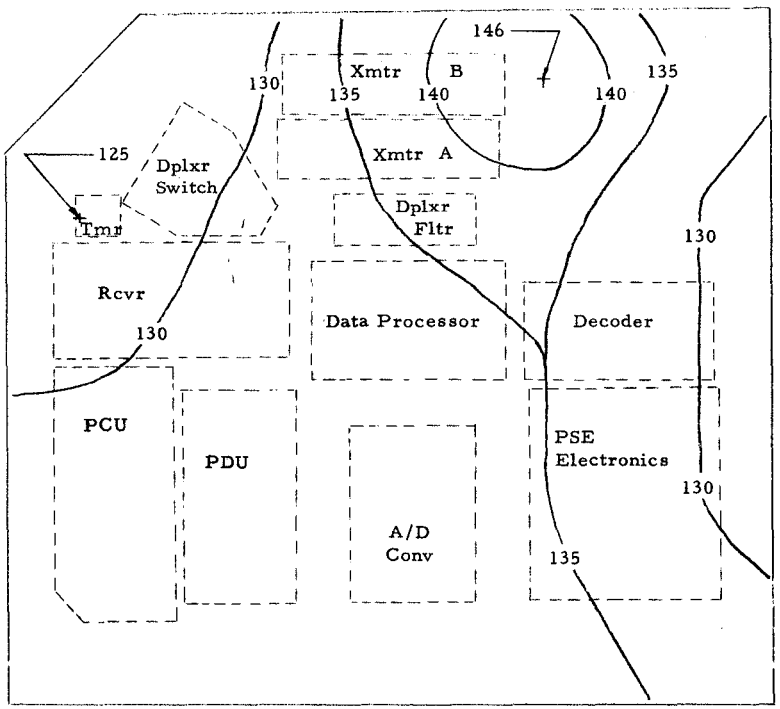
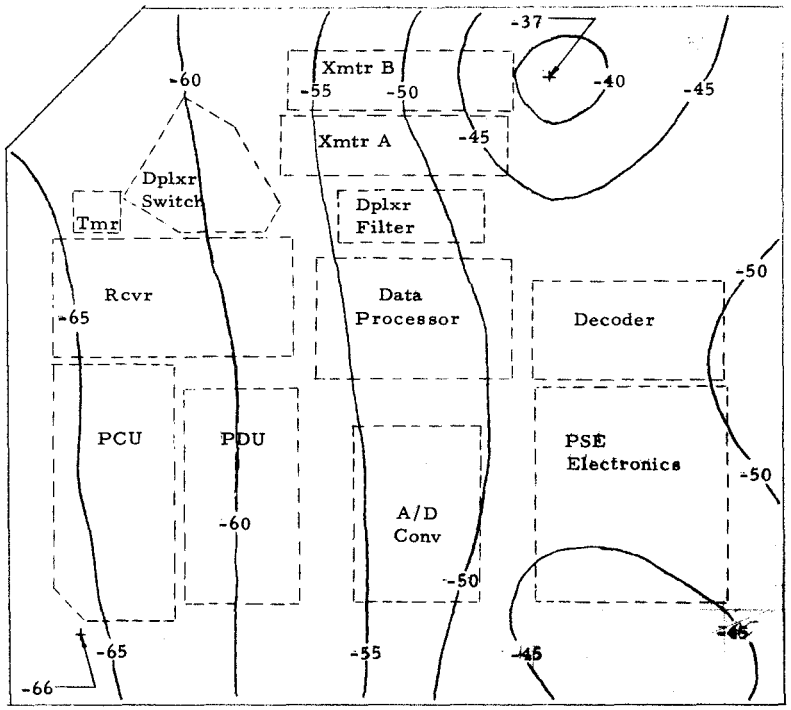
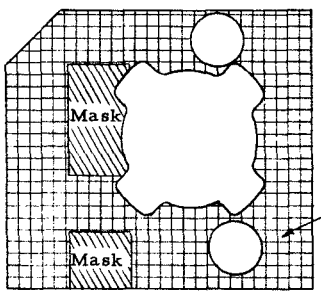



Lunar Noon $\bar{T}$ = 133 F $\Delta T$ = 21 F (146 - 125)




Lunar Night $\bar{T}$ = -54 F $\Delta T$ = 29 F [-37 - (-66)]

Day/Night Temperature Swing
187 F




Configuration III
Sunshield
With Masking Pattern
(Reference Only)

Second Surface
Mirror Area
2.60 $Ft^2$

**Figure 7**

**Thermal Plate Temperature Profiles (F)**
**Configuration III With Masking**

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