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# **Antenna and Radome Loss Measurements** for MFMR and PMIS

by

K. R. Carver

**Project Director** 

with

Appendix on MFMR/PMIS Computer (Tograms

by.

Wm. K. Cooper **Project Engineer** 

PA 00817

prepared for NASA Johnson Space Center contract No. NAS-9-95451 May, 1975

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#### ACKNOWLEDGMENT

Special thanks are extended to Bill Cooper who took charge of developing the entire software package and spent many sleepless nights bringing a complex concept into a practical reality usable in real-time data reduction. It was this feature that transformed an aluminum bucket into a useful tool for scientific/engineering measurement.

Grateful acknowledgement is made to Morrie Drexler and Cecil Post for coordinating a myriad of mechanical details in the construction of the bucket and associated antenna and radome positioners. Dennis Henry provided yeoman service in managing an unending procession of administrative and economic details, as well as working through a numerical analysis of the Fresnel field interaction between a horn and a surrounding bucket. It was this exercise that led to the final bucket dimensions.

Hank Schubert, Dick Lara, and Arun Pattni deserve special recognition for a truly outstanding job as night operators and for responding wherever help was needed. Lou Snow, Bobby Stout and Bronson Woods also were instrumental in taking care of several details before and during the measurement period.

In the final report preparation, Cecil Post took charge of preparing final versions of all figures and photographs. Mary Lou Kearns provided special assistance in preparing the Appendix. Jane Johnson deserves special thanks for typing the manuscript and enduring many intervening changes by the author.

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AGC	-	Automatic Gain Control
AIL		Airborne Instruments Laboratory
EMI	-	Electromagnetic Interference
JSC	-	Johnson Space Center
LC-36	-	Launch Complex 36
$LN_2$	-	Liquid Nitrogen
LRC	-	Langley Research Center
MFMR	-	Multifrequency Microwave Radiometer
NASA	-	National Aeronautics and Space Administration
NMSU	-	New Mexico State University
PCM	-	Pulse Coded Modulation
PMIS		Passive Microwave Imaging System
PSL		Physical Science Laboratory
RACF	-	Radiometer Antenna Calibration Facility
SMR		Small Missile Range
UHF	-	Ultra High Frequency
VHF		Very High Frequency
VSWR		Voltage Standing Wave Ratio

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#### CHAPTER I

#### SUMMARY

#### 1.0 INTRODUCTION

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The two principal objectives of this report are (1) to describe the NMSU/PSL Radiometer Antenna Calibration Facility (RACF) and (2) to summarize the antenna and radome loss measurements made on the Passive Microwave Imaging System (PMIS) and the Multifrequency Microwave Radiometer (MFMR) during January and February of 1975. This chapter summarizes the major features of the facility, points out highlights of the PMIS/MFMR loss measurements, and makes several recommendations for future measurements.

#### 1.1 NMSU/PSL Radiometer Antenna Calibration Facility

The physical facility used at PSL for the loss calibration of antennas and radomes consists of a large reflecting bucket and an electronic equipment building, both located at A-Mountain, approximately 5 km east of the New Mexico State University. The bucket is at an altitude of 1.46 km above MSL and is an aluminum foil covered wooden truncated inverted pyramid with dimensions as shown in Fig. 2-7. The purpose of the bucket is to block thermal emission from surrounding terrain and from near-horizon atmospheric sources. Thus, the thermal emission incident on the antenna is ideally isothermal and equal to the zenith sky temperature at the frequency of interest.

In addition to the physical plant, an extensive data reduction program has been written for PMIS and MFMR, with separate software components tailored to the PCM output format used in the NASA P-3A earth resources aircraft. This is discussed further in Chapter III and the Appendix. The bucket is similar to an enclosure at Table Mountain, California used previously by NASA. However, the timely availability of PSL support personnel and a real-time data reduction capability make the RACF more useful as a radiometer test bed.

#### 1.2 Highlights of Test Results

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It is shown conclusively in Chapter VI: that the bucket technique provides sufficient accuracy and repeatability for the loss values to be used in an aircraft radiometric measurement mission when the radiometer aircraft mockup exhibits sufficient fidelity to the actual aircraft situation. An extensive error analysis for PMIS and MFMR (Secs. 5.5 and 6.7) establishes the following:

1. For PMIS (10.69 GHz) the total uncertainty (sum of random plus systematic errors) in the antenna loss is  $\pm$  0.022 and  $\pm$  0.039 for the vertical and horizontal channels respectively. The total uncertainty in the radome loss is  $\pm$  0.014 and  $\pm$  0.039 for the vertical and horizontal channels. This would correspond to a total uncertainty in the measured brightness temperature (in flight) of  $\pm$  5.2 K and  $\pm$  5.7 K for the vertical and horizontal channels respectively.

2. For MFMR, L-Band (1.4135 GHz), the bulkhead and associated absorber were not sufficiently good replicas of the actual aircraft situation, with the result that the mutual coupling between the AIL array and the radome was so strong that the measured values of the radome loss were virtually meaningless. However, as explained in Sec. 6.6, a constant value of  $L_R \approx 1.09$  is a reasonable choice. The antenna loss values were typically  $L_A \approx 1.36$  (essentially independent of pitch angle) when the PSL-furnished X-Band absorber was in place on the bulkhead. However, this

material is virtually transparent at L-Band and thus does not simulate the actual aircraft situation where an L-Band absorbing material is used. Thus, in the flight situation, it may be expected that  $L_A > 1.36$  for pitch angles near 0° or 180°, since the relatively hot absorber will contribute noise power through the antenna sidelobes. In the absence of accurate near-field <u>in situ</u> patterns for the AIL array, it is difficult to see how the effect of the absorber can be estimated, short of new improved measurements.

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3. For MFMR,  $K_u$ , K,  $K_a$ -Bands (18.0, 22.05 and 37.0 GHz), the antenna loss is less than the radome loss and both losses depend much more on the pitch and roll angles than was the case at L-Band. The antenna loss is slightly higher in Channel 1 than in Channel 2 and generally rises as the pitch angle approaches 180° when the horns are nearest the bulkhead (c.f. Figs. 6-2, 6-3, and 6-4). However, as explained in Sec. 6.5), the exact values of  $L_A$  and the slope  $dL_A/d\theta_O$  depend critically on the fidelity of the mockup used, the exact shape of the absorber used on the bulkhead, etc.

The radome loss at  $K_u$ , K, and  $K_a$ -Bands also depends critically on both pitch and roll angles, as shown in Figs. 6-5 - 6-10. The jagged nature of these loss graphs is not due to errors in the measurement (the repeatability was much better than this), but seems to stem from resonant scattering between the horns and radome material or radome resonant thickness effects (especially at  $K_a$ -Band).

Thus, it may be stated that the <u>precision</u> of measurement was good, but the <u>accuracy</u> was poor, since the antenna system furnished was an insufficiently good replica of the antenna system used. The MFMR error budget is discussed at considerable length in Sec. 6.7.

1.3 Recommendations

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As a result of the measurement program, several major recommendations can be made:

 Future tests of the MFMR should be made with a much better replica of the aircraft bulkhead, including the same absorber that would be used in flight operations, along with any other significant structural features such as weather radars, etc.

2. Measurements of the input vs. pitch angle at L,  $K_u$ , K, and  $K_p$ -Bands should be made, with and without the radome.

3. A study of the MFMR pitch and roll positioning repeatability should be made.

4. If the  $K_u$ , K, and  $K_a$ -Band channels are to be used for skyward viewing, the horns should be located at a roll angle of 180°, rather than 0°. This would obviate the critical dependence on the exact bulkhead geometry.

5. Greater attention should be paid to reducing PCM noise and long-term instability in the PMIS receivers, particularly the horizontal channel.

#### CHAPTER II

#### ANTENNA LOSS MEASUREMENT TECHNIQUES

#### 2.0 INTRODUCTION

The temperature calibration of a radiometer system normally proceeds in two parts: (1) the calibration of the connecting waveguide, front end, etc., by use of known reference load temperatures, and (2) the calibration of the antenna and radome loss. The purpose of the NMSU/PSL Radiometer Antenna Calibration Facility is to measure the antenna and radome loss by using a calibrated radiometer receiver and a known source brightness temperature.

This facility differs by comparison to many other past calibration efforts, in that relatively large aircraft and satelliteborne radiometer systems, including automatic positioners and radomes, may be accommodated. Also, the bucket technique employed is easily adaptable to multi-frequency use since radiosonde support is locally available on a timely and convenient basis. The genesis of this effort was the requirement to periodically calibrate the NASA JSC Passive Microwave Imaging System (PMIS) at 10.69 GHz and the Multifrequency Microwave Radiometer (MFMR) at 1.4, 18, 22.05, and 37 GHz. These systems are complicated by a variety of requirements for beam scanning, polarization switching, multiplexed data handling and subsequent data reduction.

In response to the need for near real-time data reduction, PSL has developed an extensive set of software packages to handle the PCM encoded radiometer and housekeeping data, both for PMIS and MFMR. These make use of a PCM decommutation device and an IBM System 7 computer which transfers the stripped data from the magnetic tape to an IBM System 370 Computer for processing. This will be described in more detail in Chapter 3.

#### 2.1 Definitions

The antenna loss of a receiving antenna is defined as

$$L_{A} = \frac{P_{capt}}{P_{del}}$$
(2-1)

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P<sub>capt</sub> = power incident on and captured by antenna P<sub>del</sub> = power delivered to load

Since the received or captured power includes both incidence and re-radiation effects, it follows that

$$P_{capt} = P_{del} + P_{J}$$
(2-2)

where

$$P_{\tau}$$
 = power lost as Joule heating

Thus

$$L_{A} = 1 + \frac{P_{J}}{P_{del}}$$
(2-3)

so that  $1 \leq L_A < \infty$ .

A radome inserted between an antenna and an incident field will introduce an <u>insertion loss</u>

$$L_{R} = \frac{P_{B}}{P_{A}}$$
(2-5)

6

(2-4)

where

 $P_{A}$  = power received before radome insertion

 $P_{p}$  = power received after radome insertion

It is observed that  $P_B > P_A$  if the radome does not interact with the near-field distribution of the antenna, since radome dielectric materials have non-zero a.c. conductivities. Thus,

$$1 \leq L_{\rm p} < \infty$$
 (2-6)

Since antennas and radomes are lossy networks, it is clear that they will introduce a small amount of their own noise power, even when no external wave is incident. Generalizing to a twoport network, as in Fig. 2-1, we may solve for the apparent antenna brightness temperature, i.e.

$$T_{B}^{\prime} = (1 - \frac{1}{L}) T_{A} + \frac{T_{S}}{L}$$
(2-7)

where it is assumed that an unpolarized random noise signal of equivalent temperature  $T_S$  is incident on an isothermal antenna at thermometric temperature  $T_A$  and of loss L. The first term in (2-7) is the component of the apparent brightness temperature due to the self-generated noise in the antenna and the second term is due to the absorption attenuated equivalent temperature, or received noise power. If the incident brightness temperature distribution is  $T_{sky}$  ( $\theta, \phi$ ) and the antenna gain pattern is G( $\theta, \phi$ ), then the second term of (2-7) is

$$\frac{\mathbf{T}_{S}}{\mathbf{L}} = \frac{1}{4\pi} \iint_{\mathbf{A}\pi} \mathbf{T}_{\mathbf{S}\mathbf{k}\mathbf{y}}(\theta,\phi) \ \mathbf{G}(\theta,\phi) \,\mathrm{d}\Omega \tag{2-8}$$



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### 2.2 Directivity/Gain Technique

It has been unofficially estimated by NBS that both the gain and directivity of moderate to high gain antennas can be measured, using the near-field sampling technique [Kerns, 1970], to an accuracy of 0.1 dB (at the 3  $\sigma$  point) throughout the frequency range L to K<sub>a</sub>-Band. This is assumed to be the state of the art. We wish to examine the effect of such gain and directivity measurement errors on the radiometer antenna temperature uncertainty.

The power gain of an antenna is related to its directivity by

$$G = \frac{D}{L_A}$$
(2-9)

where

G = power gain (dimensionless) D = directivity (dimensionless) $L_A = antenna loss$ 

We next calculate the effect of systematic and independent errors  $\Delta G$ ,  $\Delta D$  on the insertion loss error  $\Delta L^*$ . From (2-9)

$$L_{A} = \frac{D}{G}$$
 (2-10)

Differentiating and using the worst case formula,

$$\Delta L_{A} = \frac{1}{G} \Delta D + \frac{D}{G^{2}} \Delta G \qquad (2-11)$$

"It is assumed that there is zero systematic error.

which can be written as

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$$\Delta L_{A} = \frac{1}{G} (\Delta D + L \Delta G)$$
 (2-12)

It is next assumed that G and D are independent random variables, normally distributed with zero mean so that  $\overline{L} = L_A$ . Letting  $\sigma_L^2$ ,  $\sigma_G^2$ ,  $\sigma_D^2$  be the variances of L, G and D respectively, we can determine  $\sigma_L^2$  by the familiar quadrature formula, i.e.,

$$\sigma_{\rm L}^2 = \left[\frac{\partial {\rm L}_{\rm A}}{\partial {\rm G}}\right]^2 \sigma_{\rm G}^2 + \left[\frac{\partial {\rm L}_{\rm A}}{\partial {\rm D}}\right]^2 \sigma_{\rm D}^2$$
(2-13)

which yields

$$\sigma_{\rm L} = \frac{1}{G} \sqrt{\sigma_{\rm D}^2 + L_{\rm A}^2 \sigma_{\rm G}^2}$$
(2-14)

Since the errors are normally distributed we can express the 3  $\sigma$  error as

$$3\sigma_{\rm L} = \frac{3}{G} \sqrt{\sigma_{\rm D}^2 + L_{\rm A}^2 \sigma G^2}$$
 (2-15)

The incremental errors  $\sigma_L$ ,  $\sigma_G$ , and  $\sigma_D$  can be related to their corresponding decibel errors by

$$\delta L(dB) = 10 \log (L + 3\sigma_L) - 10 \log L = 10 \log \left(1 + \frac{3\sigma_L}{L}\right)$$
 (2-16)

If it is assumed that  $\delta D(dB) = \delta G(dB)$ , then it can be shown that

$$\delta L(dB) = 10 \log \left[ 1 + \sqrt{2} (10^{\frac{\delta D}{10}} - 1) \right]$$
 (2-17)

When  $\delta D = \delta G = 0.1 \, dB$ , (9a) yields

$$\delta L = 0.14 \, dB$$
 (2-18)

For example, when  $L_A = 1 \text{ dB}$ ,  $3\sigma_L = 0.041$ .

We next consider the effect of the insertion loss error on the apparent antenna temperature,  $T_R$ . The noise temperature  $T_R$ at the terminals of an antenna is composed of two parts: (1) the integrated brightness temperature  $T_S$ , diminished by the antenna loss and (2) the emissive temperature of the lossy antenna structure itself.

Eqn. (2-7) can be written as

$$T_{B} = \frac{T_{S} - T_{A}}{L_{A}} + T_{A}$$
(2-19)

Assuming that  ${\tt T}_{\rm S}$  and  ${\tt T}_{\rm A}$  are known, the effect of a random error  $\sigma_{\rm L}$  on  ${\tt T}_{\rm B}$  is given by

$$\sigma_{\mathrm{T}_{\mathrm{B}}} = (\mathrm{T}_{\mathrm{A}} - \mathrm{T}_{\mathrm{S}}) \frac{\sigma_{\mathrm{L}}}{\mathrm{L}_{\mathrm{A}}^{2}}$$
(2-20)

Assuming that the insertion loss uncertainty is entirely caused by the random  $\delta G = \delta D = 0.1$  errors (typifying the state of the art), eqns. (2-16), (2-17) and (2-20) can be used to calculate  $\sigma_{TB}$ . For example, a 1 dB insertion loss ( $L_A = 1.259$ ) corresponds to  $\delta L = 0.14$  dB ( $3\sigma_L = 0.041$ ). Assuming  $T_S = 10$  K\* and  $T_A = 300$  K,

$$\sigma_{\rm T_B} = (300 - 10.0) \frac{0.041}{1.259^2} = 7.5 \text{ K}$$
 (2-21)

For antennas with low insertion loss such as scalar horns,  $L_A \approx 1$ and a 0.14 dB insertion loss error would correspond to  $L_A = 1 \pm 0.032$ .

This would be a typical figure for the antenna looking at the cold sky.

However, since  $L_A \geq 1$ , the effective  $3\sigma_L = \frac{0.032}{2} = 0.016$ , corresponding to  $\sigma_{T_B} = 4.6$  K. Using this approach, we obtain the curve of Fig. 2-2 which plots the antenna temperature uncertainty vs. the insertion loss for two assumed values of G, D measurement error.

The preceding results demonstrate that in the calibration procedures where the measured insertion loss is used to deduce the integrated brightness temperature, relatively small errors in insertion loss can cause unacceptably high antenna temperature errors. In particular, when the insertion loss is inferred from the D/G ratio, independent random errors of 0.1 dB in the measurement of D and G correspond to temperature errors of 5 - 9 K for typical values of insertion loss.

Thus, single-frequency direct measurement techniques are not yet sufficiently accurate for the determination of the insertion loss in a microwave radiometric calibration situation. In addition, this method suffers from the disadvantage that an extremely large near-field sampling device would be required for large radome-covered radiometer systems such as PMIS or MFMR, and that to date no such large system has been built.

#### 2.3 Cryoload Technique

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A second technique which is usable for smaller antennas such as horns makes use of a  $LN_2$  cooled microwave absorbing hohlraum or cooled blackbody enclosure, as shown in Fig. 2-3. If the horn views an isothermal brightness distribution  $T_S$  in a perfectly absorbing (and emitting) medium, then solving for  $L_a$  from (2-7).



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$$L_{A} = \frac{T_{A} - T_{S}}{T_{A} - T_{B}}$$
(2-22)

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LA	= antenna loss
r <sub>A</sub>	= thermometric temp. of antenna (K)
	(assumed here to be isothermal)
rs	= brightness temp. of cryoload (K)
r,	= uncorrected brightness temperature
2	measured by radiometer (K)

Blume and Swift [1972] of NASA LRC have used this technique to calibrate the loss of an S-Band horn and have achieved an absolute accuracy of + 1 K.

The technique has the advantage of being inexpensive and accurate for relatively small antennas (diameters less than 6'), but as yet no isothermal cryoloads have been developed which are large enough to accommodate such large radiometer antennas/radome systems as PMIS or MFMR where 30 m<sup>3</sup> volumes are encountered.

#### 2.4 Bucket Technique

#### 2.4.1 Theory

It is clear from (2-22) that the antenna thermometric temperature  $(T_A)$  must differ substantially from the integrated source brightness temperature  $(T_S)$  in order for  $L_A$  to be measured with acceptable accuracies. The bucket technique achieves this by placing the antenna in a large reflecting enclosure which blocks thermal emission from surrounding terrain, thus allowing the antenna to receive atmospheric noise only. The equivalent sky temperature can be calculated from radiosonde data by calculating the radiative transfer of an assumed 2.7 K cosmic background temperature through a clear atmosphere with both water and oxygen resonant molecular constituents [Paris, 1971]. This technique is shown in Fig. 2-4.

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$$T_{S} = \frac{\int \iint T_{sky}(\theta, \phi, f) \quad D(\theta, \phi, f) \quad F(f) \quad d\Omega \quad df}{4\pi \int F(f) \quad df}$$
(2-23)

where

 $T_S$  = integrated antenna brighness temp. (K)  $T_{sky}$  = sky brightness temp. distribution (K) F = spectral transfer function of radiometer system (Hz<sup>-1</sup>)  $\Delta f$  = bandwidth (Hz)

If the bandwidth is much smaller than the pressure-broadened spectral widths of the  $H_2^0$  and  $0_2^2$  emission lines and if the antenna pattern is independent of frequency across the bandwidth, then (2-23) reduces to

$$T_{S} = \frac{1}{4\pi} \iint_{4\pi} T_{Sky}(\theta, \phi, f_{o}) D (\theta, \phi, f_{o}) d\Omega \qquad (2-24)$$

where  $f_0$  is the center frequency. If the sky temperature distribution is essentially constant across the main beam and first few sidelobes of the antenna in the bucket, then (2-24) reduces to

$$T_{S} = T_{sky} (f_{o})$$
(2-25)

which is the form used in all subsequent calculations.



Fig. 2-4. Bucket technique for loss measurements.



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#### 2.4.2 Errors due to Bucket Emissivity

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It is apparent that (2-25) implies that the antenna in the bucket is assumed to be surrounded by an isothermal brightness temperature distribution, i.e., the bucket has a net zero emissivity. Also, it is tacitly assumed that the bucket is large enough so that there is no mutual coupling between the test antenna and the bucket. Assuming an emissivity of .001 for aluminum, the bucket brightness temperature would be [Carver,1973]

$$T_{BK} = e T_A = (.001)(290) = .29 K$$
 (17)

Assuming that the main beam views a 10 K sky and a 95% bucket efficiency\*, the contribution from the sky plus bucket would be

$$T_{B} = n T_{sky} + (1 - n) (T_{BK} + T_{sky})$$
$$= T_{sky} + (1 - n) T_{BK}$$
$$= 10 + (.05) (.29)$$
$$= 10.01 K$$

Thus the error in neglecting the emissive temperature of the bucket walls is only .01 K. Even under severe oxidation conditions in which the emissivity might increase by a factor of 10, the error is still less than 0.2 K.

The bucket efficiency  $\eta$  is the percent power received by the antenna which is not reflected by the bucket.

#### 2.4.3 Bucket Shape Criteria

How large does the bucket need to be in order to avoid first order mutual coupling effects? The answer to this depends on the near-field distribution of the worst-case antenna(s) being used, i.e., the antenna(s) having the strongest fields near the bucket walls. For the case of PMIS/MFMR, the L-Band array and the X-Band array are electrically closest. These near-field distributions can be estimated using Hansen's [1964] calculated curves for uniform and tapered distribution horns, and setting a criterion that the distance from the antenna to any bucket wall should be large enough so that the near field reflected power is at least 30 dB below the main beam on-axis power at the same distance.

#### 2.4.4 Bucket Effect on Antenna Pattern - An X-Band Experiment

A small model bucket was built using this approach, scaled for use with an X-Band standard gain horn, and with dimensions shown in Fig. 2-5. The power patterns of the horn in free space and inside the bucket are compared in Fig. 2-6 where it is seen that the effect of the bucket is to eliminate sidelobes beyond the bucket shadow boundaries and to introduce a distortion to the free-space pattern. The horn is relatively large in comparison to the bucket so that the perturbation is most likely due to the phase interference of multiply edge-diffracted rays and the unreflected incident rays.

#### 2.4.5 Description of Full Scale Bucket

The full-scale bucket was made much larger than any antenna to be put in it, so that no appreciable perturbations in the lit-zone pattern is expected. Dimensions are given in Fig. 2-7 along with sketches of the antenna positioner and PMIS/MFMR systems.



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The bucket is an aluminum foil covered wooden truncated and inverted pyramid, with a reinforced concrete base pad. It is located about 9 km east of the NMSU campus at an altitude of 1.46 km on "A" Mountain. The photographs of Fig. 2-8 - 2-11 show phases of the bucket construction. Equipment access is through a 3 m x 6 m door, as shown in Fig. 2-12, with special lifting rigs available for the PMIS and MFMR antenna and radome systems, as shown in Figs. 2-13 - 2-16. Personnel access is through a small removable door on the south side. Antenna/radome mockups are mounted on a Scientific-Atlanta az over el positioner affixed to the top of a steel support tower, with center-of-gravity maintained on the tower axis by use of counterbalance assemblies.

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Electronic and control equipment is housed in a large temperature controlled concrete block building (see Fig. 2-17) about 15 m south of the bucket with an interconnecting cableway. During operations, a weather station is used to give temperature, relative humidity, pressure, wind speed and wind direction. An all-weather gravel road permits truck transport of equipment to the facility.



Mig. 2-8 Pre-fabrication and Painting Bucket Parts (12 Nov. 1974)



Fig. 2-9 Cementing Aluminum Foil to Bucket Interior Surface (13 Nov. 1974)

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Fig. 2-10 Bucket Assembly Underway (14 Nov. 1975)



Fig. 2-11 South Face of Bucket Showing Braces and Rigging to Sustain 100 mph Wind (Jan. 1975)


Fig. 2-12 PMIS in Position for Test -Main Bucket Door Open (Jan. 1975)



Fig. 2-13 PMIS in Mockup on Sling and Handling Dolly (6 Feb. 1975)

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Fig. 2-14 MFMR Radome in Handling Sling (20 Feb. 1975)



Fig. 2-15 Mounting MFMR Radome (20 Feb. 1975)

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Fig. 2-16 Mounting PMIS - Note Counter Weight (24 Jan. 1975)



Fig. 2-17 PMIS Equipment Setup (Dec. 1974)



Fig. 2-18 MFMR with Absorber Mounted for Test (Feb. 1975)

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### CHAPTER III

### ANTENNA/RADOME DATA REDUCTION TECHNIQUES

#### 3.0 INTRODUCTION

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This chapter discusses the theoretical framework for the inference of antenna and radome loss as well as the practical techniques used for the PMIS and MFMR systems.

It is worth repeating that the loss values  $L_A$  and  $L_R$  are used in establishing the <u>absolute accuracy</u> of an integrated radiometer (antenna plus receiver) and that the need for these values must be established by the user. How accurate must the inferred brightness temperatures be? At present, accuracies of  $\pm 1$  K are considered to be very good with receiver sensitivities between 0.1 K and 1.0 K achievable using integration times ranging from 100 - 1000 milliseconds. But can a user establish a need for a  $\pm 1$  K accuracy? Will  $\pm 3$  K suffice? This is a difficult question, having to do with the adequacy of radiative transfer models, the availability of sufficient ground truth in controlled areas, aircraft/spacecraft platform stability, etc.

It is clear, however, that <u>relative</u> loss values are extremely important. In the case of PMIS, there are 44 beam positions, electronically scanned, and it is necessary to establish the loss value of a given beam position relative to its adjacent beam positions with maximum precision. For MFMR, the <u>variation</u> in loss with pitch angle change is of greater immediate importance than the absolute value of those losses.

# 3.1 Theoretical Foundation for Loss Calculations

A calibrated radiometer viewing an isothermal source  $T_s$  indicates an uncorrected brightness temperature  $T_p$ ' which is

greater than  $T_S$ , due to the added emissive contributions of the intervening waveguide, antenna, and radome. Considering first the radiative transfer when there is no radome (Fig. 3-la), we have [Kraus, 1966]

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${}^{T}B$	=	uncorrected brightness temp. measured
_		by radiometer (K)
$\mathbf{T}_{\mathbf{S}}$	=	sky brightness temp. (K)
TA	=	antenna kinetic temp. (K)
T <sub>W</sub>	=	waveguide kinetic temp. (K)
LA	=	antenna loss (L <sub>A</sub> > l)
$L_w$	=	waveguide loss $(L_M > 1)$

It is assumed that the waveguide loss is known from laboratory measurements. Solving for  ${\rm L}_{\rm A}$  ,

$$I_{A} = \frac{T_{A} - T_{S}}{T_{A} + (L_{W} - 1)T_{W} - L_{W}T_{B}^{*}}$$
(3-2)

Turning now to the radome loss  ${\rm L}^{}_{\rm R}$  (Fig. 3-lb), the radiative transfer equation is

$$T_{B}^{*} = (1 - \frac{1}{L_{W}})T_{W} + \frac{1}{L_{W}} \left\{ (1 - \frac{1}{L_{A}})T_{A} + \frac{1}{L_{A}} \left[ (1 - \frac{1}{L_{R}})T_{R} - \frac{T_{S}}{L_{R}} \right] \right\} (3-3)$$



Fig. 3-1. Radiometer, waveguide and antenna (without and with radome).

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Solving for L<sub>R</sub>,

$$L_{R} = \frac{T_{R} - T_{S}}{T_{R} + T_{A}(L_{A} - 1) + T_{W}L_{A}(L_{W} - 1) - L_{A}L_{W}T_{B}^{T}}$$
(3-4)

The coupled equations (3-2) and (3-4) form the basis for the measurement of the antenna loss and radome loss. It is assumed that the  $L_A$  value in (3-4) is the same as that calculated in (3-2), i.e., there is no mutual coupling between radome and antenna.

The thermometric temperatures of the antenna, radome and waveguide structures are read by imbedded thermistors. The sky brightness temperature is calculated by techniques described in Chap. IV and the uncorrected brightness temperature  $T_B^*$  is that indicated by the calibrated radiometer.

In practice, both random and systematic errors are introduced into (3-2) and (3-4) with concomitant effects on both precision and accuracy. These are discussed in detail in Chaps. V and VI.

### 3.2 PMIS/MFMR Data Systems

Both PMIS and MFMR are operated on a Lockheed P-3A aircraft, along with other remote sensors such as multi-spectral optical scanners, etc., with all electronic data being recorded on magnetic tape in PCM format. Thus, the output of both PMIS and MFMR is in PCM counts with integration times of 100 ms being typical during flight operations. However, an integration time of 1 minute was used during the loss calibration tests so that an improved sensitivity would be obtained. The sensitivity of the radiometer is continuously monitored by the use of two internally generated equivalent temperatures known as the <u>calibrate</u> and <u>baseline</u> modes, with corresponding PCM counts  $C_C$  and  $C_B$ , respectively. Assuming the radiometer is linear, the uncorrected brightness temperature is given by

$$T_{B}^{\prime} = T_{1}^{\prime} + \Delta T \frac{\overline{C}_{A}^{\prime} - \overline{C}_{B}^{\prime}}{\overline{C}_{C}^{\prime} - \overline{C}_{B}^{\prime}}$$
(3-5)

where

 $T_1 \& \Delta T = \text{constants to be determined (K)}$  $\overline{C}_A = \text{one minute average of data counts}$  $\overline{C}_B = \text{one minute average of baseline counts}$  $\overline{C}_C = \text{one minute average of calibrate counts}$ 

as shown in Fig. 3-2.

 $T_1$  and AT are determined by connecting known noise temperatures to the radiometer input port and by computing the best linear regression fit to the resulting data, or if only a hot and cold load are available, by solving two equations and two unknowns. Figs. 3-3 and 3-4 show the calibration history of  $T_1$  and AT for the PMIS vertically and horizontally polarized channels, over the Jan. 20 - Feb. 6, 1975 time period. The horizontal channel shows much more long-term instability than the vertical, which was the basis for recurring difficulties in data reduction. Fig. 3-5 shows a similar history of  $T_1$  and AT for MFMR, comparing the initial calibration on Feb. 8, 1975 to the final calibration on Feb. 21, 1975. The K-Band (22.05 GHz) receiver was not working



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Fig. 3-3. PMIS calibration repeatability - vertical polarization.



Fig. 3-4. PMIS calibration repeatability - horizontal polarization.

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# Fig. 3-5. MFMR calibration history.

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on Feb. 21, so that only an initial set of values are shown. The apparent downward drift in the  $T_1$  value for  $K_u$ -Band was caused by not allowing sufficient warmup time before calibration.

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In addition to the PCM counts corresponding to the radiometric data, both PMIS and MFMR software require the monitoring of other housekeeping data, such as antenna, radome and waveguide thermistors, AGC voltages, electronics enclosure temperatures, etc. These data are multiplexed and recorded on magnetic tape for subsequent processing, as shown in Fig. 3-6. Data tapes recorded at the bucket site are brought to the computer facility at the PSL building on campus. Data on the tapes are then decommutated, and transferred to storage addresses within the IBM 370 computer, all of this being under control of the IBM SYSTEM 7 process controler.

Data reduction then proceeds under three phases of software: PMIS/MFMR -1, 2, and 3 as shown in Fig. 3-6. Phase 1 strips and sorts data from the tape, calculates means and standard deviations and prints significant data in counts, as shown in Figs. 3-7, 3-8. Phase 2 converts radiometric housekeeping data into appropriate engineering units, as shown in Figs. 3-9, 3-10. Phase III then calculates loss values and associated standard deviations by using eqns. (3-2) and (3-4), and prints the results as shown in Figs. 3-11, 3-12.

The detailed instructions for the reduction of PMIS and MFMR data tapes are given in the Appendix. The software written for this purpose is extremely complex and powerful. However, it must be complemented by a parallel intervention of the project engineer and programmer in order to monitor the health of the various components of the PMIS/MFMR systems and to properly intermesh the  $L_{h}$  values (eqn. 3-2) into the computation of  $L_{p}$  (eqn. 3-4).



NUMBER OF DATA CYCLES = 288 CONTROL CODE = FFFF0000 LOGID = P040 START TIME = 1 HOURS 37 MINUTES 8.10 SECONDS FND TIME = 1 HOURS 38 MINUTES 30.01 SECONDS HIGH DISK ADDRESS OF THIS DATA SET = 116649 HIGHEST ADDRESS OF DATA USED = 116499 HIGH ADDRESS AT THE END OF LAST JOB = 116499 HALE BEAM STEP RATE = 0 FRAME PULSE = 1 SCAN MANUAL = 1 BEAM POSITION = 22 V/H RATIO = 66 VALID DATA WORD = 605

PCM COUNT	PCN COUNT SQUARED	NUMBER OF FULL CYCLES	CAL COUNT	CAL COUNT Squared	NUMBER OF	BASE LINE COUNT	BASE LINE Souared	NUMBER OF FLEMENTS
210236	162108306	273	VERTICAL 46257	POLARIZATION 10917019 DOLARIZATION	196	5701	200977	162
0	G	) 0		) 0	0	996970	53929660	18431

Fig. 3-7 PMIS-1 Sample Output.

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Fig. 3-8 MFMR-1 Sample Output,

NUMBER OF DATA CYCLES IN FILE = 222 VALID DATA = 00000245 LOGID = M003 START TIME = 2 HOURS 45 MINUTES 46.03 SECONDS END TIME = 2 HOURS 46 MINUTES 46.06 SECONDS HIGH DISK ADDRESS OF THIS DATA SET = 255399 HIG/EST APCPESS OF DATA USED = 243249 HIGH ADDRESS AT THE END DF LAST JOB = 252249

AND OF WE DAND DADIONETED OF 1 $-$ 071 AND OF THE COMMENTS -	764876
AAR OF KO-BENE FRUIDWEIGK CHOIT = 810 MAR DE THE PROPARES =	100010
AVG OF KU-BAND RADIOMETER CH.2 = 873 AVG OF THE SOUARES =	763024
AVG OF KA-BANC RADIOMETER CH.1 = 793 AVG OF THE SQUARES =	628989
AVG OF KA-BAND RADIOMETER CH.2 = 789 AVG OF THE SQUARES =	623214
AVG OF K- BAND RADICHETER CH.1 = 868 AVG OF THE SQUARES =	754663
AVG OF K- BAND RADIOMETER CH.2 = 909 AVG OF THE SQUARES =	826376
AVG OF L- BAND RADIOMETER = 779 AVG OF THE SOUARES =	605675

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015K	RAW	DESCRIPTION	CHANNEL	DISK ENG	INEFRING	UNITS	FORMAT	IDP OR EDP
ADDRESS	COUNT		NUMBER	ADDRESS				SUBSCRIPT
508000	325	BEAM POSITION	3- 1-D	508050	22		1	1
508001	66	V/H PATIO	3- 2-0	508051	66		I	?
508002	214052	VERT POLARIZATION	3- 3-D	508052	770.4392	AVG CTS	F	3
508003	0	HORIZ POLARIZATION	3- 4-0	508052*	*******	AVG CTS	F	4
508004	605	VALID DATA CODE	3- 5-D	508054	00000250	CTS	1	5
508005	165023318	STD VERTICAL	3-22-D	508055	5.7097		F	6
508006	0	STD HORIZONTAL	3-23-0	508056	0.0		F	1
508007	109185	ANTENNA THEPMISTOR 1	3-41-4	508057	4. 9896	DFG C	F	6
503008	111871	ANTENNA THERMISTOR 2	3-42-A	508058	4.2549	DEG C	F	9
508009	74554	AVE OF 4 ANT TEMPS	3-43-A	508059	16.4990	DEG C	F	10
508010	2°6721	RADOME THERMISTOR 1	3-44-A	508060	-70.9019	DFG C	F	11
508011	297819	RADOME THERMISTOR 2	3-45-A	508061	-12.3959	DEG C	F	12
508012	298704	AVE OF 4 RADOME TEMPS	3-46-A	508062	-73.6000	DEG C	F	13
508713	295176	BOMP BAY THERMISTOP 1	3-47-A	508033	-68.8000	DEG C	F	14
508014	296364	BOMB BAY THERMISTOR 2	3-48-A	508064	-70.4162	DFG C	F	15
509015	296176	AVE OF 4 BOMB BAY TEMP	S 3-49-A	506065	-70.1604	DFG C	F	16
508016	61742	HORIZ WAVE GUIDE "FMP	3-57-A	508066	21.8767	DEG C	F	17
508017	68329	VERT WAVE GUIDE T. AP	3-51-A	508067	19.1333	DEG C	F	18
508018	1331	HORIZ HOT LOAD TEMP	3-52-A	508068	167.3197	DEG C	F	19
508010	262646	VERT HOT LOAD : CHP	3-53-A	508069	130.0541	DEG C	F	20
. 508020	0	HORIZ WARM LOAD TEMP	3-54-A	508070	89.5239	DEG C	F	21
508021	246989	VERT WARM LOAD TEMP	3-55-A	508071	60.7170	DEG C	F	22
508022	1373	HORIZ PARAMETRIC AMP T	MP 3-56-A	508072	93.4742	DEG C	F	23
508023	55178	VERT PARAMETRIC AMP TE	MP 3-57-A	508073	54.9325	DEG C	F	24
508024	1417	HORIZ ENCLOSURE TEMP	3-58-A	508074	93.4406	DEG C	F	25
508025	54869	VERT ENCLOSURE TEMP	3-59-A	508075	55.0974	DEG C	F	26
508026	116840	ELECT ENCLOSURE TEMP	3-60-A	508076	35.3007	DEG C	F	27
508027	294	NO. OF DATA CYCLES					t	28
508028	FFFF0000	CONTROL CODE					Z	29
508029	-672074512	LOG ID	= P040	0			4	20
508030	95952960	START TIME	= 1 1	HOURS 37 MI	NUTES 8	.10 SECON	DS I	31
1165756400	96518148	END TIME	= 1 1	HOURS 38 MI	NUTES 30	.01 SECON	DS I	32

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Fig. 3-9 PMIS-2 Sample Output

C CDUMT     C MAM     C CDUMT     C MAM     C CDUMT     C CDUMT       1     A76     KU-RAND BACTOMETER CH 1     2A-1-A     R.76646E 02 AVG CTS       2     B77     KU-RAND BACTOMETER CH 1     2A-1-A     R.7350F 02 AVG CTS       3     763     KA-BADD RADIOMETER CH 1     2A-1-A     R.7304F 02 AVG CTS       4     779     KA-BADD RADIOMETER CH 1     2A-2-A     B.7380F 02 AVG CTS       5     R6H     K-SAND RADIOMETER CH 1     2A-2-A     R.9090F 02 AVG CTS       6     000     K-SAND RADIOMETER CH 1     2A-2-A     R.9090F 02 AVG CTS       6     000     R-SAND RADIOMETER CH 1     2A-2-A     R.9090F 02 AVG CTS       7     T78     L-JAND RADIOMETER CH 1     2A-2-A     R.9090F 02 AVG CTS       6     000     RCAND RADIOMETER CH 1     2A-2-A     R.9090F 02 AVG CTS       7     T78     L-JAND RADIOMETER CH 1     2A-2-A     R.71901C 02 AVG CTS       7     T78     L-JAND RADIOMETER CH 1     2A-2-A     R.71901C 02 AVG CTS       11     120807     KA     MATERNA TEMP     2A-4-A </th <th></th> <th>DAU</th> <th></th> <th>CONCOL EVETEN</th> <th></th> <th>C (1 A A)</th> <th></th> <th></th>		DAU		CONCOL EVETEN		C (1 A A)		
1   276   KU-RAND QACTONTER CH 1   24-1-4   7.76046 02 AVG CTS     1   077   KU-RAND QACTONTER CH 1   24-1-4   7.40046 02 AVG CTS     1   777   KU-RAND QACTONTER CH 1   24-1-4   7.40046 02 AVG CTS     1   779   KU-RAND PADTONTER CH 2   24-1-4   7.40046 02 AVG CTS     1   770   KU-RAND PADTONTER CH 2   24-1-4   7.40046 02 AVG CTS     1   700   K-ANN PADTONTER CH 2   24-2-4   7.40046 02 AVG CTS     1   700   K-ANN PADTONTER CH 2   24-2-4   7.40046 02 AVG CTS     1   127807   KU-9AND COLD REFT FMP   24-2-4   7.40046 02 AVG CTS     1   127807   KU-9AND COLD REFT FMP   24-2-4   7.40046 02 AVG CTS     1   127807   KU 9440 07018 FT FMP   24-2-4   7.40047 02 DEG K     1   121525   KU 9440 07018 FT FMP   24-6-4   7.270477 02 DEG K     1   121525   KU 9440 07018 FF FMP   24-16-4   7.270477 02 DEG K     1   121525   KU 9440 07018 FF F   7.40-70 70 20 DEG K   7.71467 02 DEG K     1   1295970   KA 6472 WAF GUIDF TEMP	•	COUNT	•	3E430F 3T51FT WEVO	•		•	
1   776   KU-BAND BALTOMETER CH 1   2A-1-A   R.7664E 02 AVG CTS     2   D73   KU-BAND BALTOMETER CH 1   2A-2-A   H.7303F 02 AVG CTS     3   T73   KA-BAND BALTOMETER CH 1   2A-13-A   T.3303F 02 AVG CTS     4   T79   KA-BAND BALTOMETER CH 1   2A-25-A   H.6867F 02 AVG CTS     5   REH   K-BAND BALTOMETER CH 1   2A-25-A   H.6867F 02 AVG CTS     6   T70   L-IAND PALTOMETER CH 2   2A-27-A   T.7181F 02 AGG CTS     7   T0   L-IAND PALTOMETER CH 2   2A-3-A   J.7181F 02 AGG CTS     8   129297   KU   MATENNA TEMP   2A-4-A   J.811F 02 PLS K     10   121525   KU   MATENNA TEMP   2A-4-A   J.811F 02 PLS K     11   12090   KU   SHITCH TEMP   2A-4-A   J.811F 02 PLS K     12   113399   KU   CH IA MAY GUIDE TEMP   2A-4-A   J.8107 07 0165 K     12   113979   KU   CH IA MAY GUIDE TEMP   2A-4-A   J.8207F 07 00 VILTS     12   113979   KU CH IA MAY GUIDE TEMP   2A-4-A   J.8207F 07 00 VILTS     12	•	11110141	•		•	51	•	0.4113
1   776   KU-BAND BADIGMETER CH 1   2.4-2-A   B.7350F 02 AVG CTS     3   763   KA-BAND BADIGMETER CH 2   2.4-2-A   H.7350F 02 AVG CTS     4   779   KA-BAND PADIGMETER CH 2   2.4-14-A   H.7305F 02 AVG CTS     5   86H   K-BAND PADIGMETER CH 2   2.4-14-A   H.6905F 02 AVG CTS     6   900   K-BAND PADIGMETER CH 2   2.4-24-A   H.6905F 02 AVG CTS     7   778   L-iAND PADIGMETER CH 2   2.4-24-A   H.6905F 02 AVG CTS     8   199287   KU-4ND CHA BET TEMP.   2.4-24-A   H.8181F 02 CTS   KU     9   132880   KU   MTT MT TEPP   2.4-4-A   H.8181F 02 CTS   KU     10   121525   KU   ANT CHA REF TEMP.   2.4-4-A   H.8181F 02 CTS   KU     11   12093   KU   CH-1 MAY GUIDE TEMP.   2.4-4-A   H.8181F 02 CTS   KU     12   113397   KU   CH-1 MAY GUIDE TEMP.   2.4-4-A   H.710F 02 DEG K     13   116411   KU CAAMA ATEMA TEMP.   2.4-15-A   H.710F 02 DEG K     14   1350787   KU CAAMA ATEMA TEMP.   2.4-17-A </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>								
2     BT2     KU-HAND PADIOMETER (H 1     2A-2-A     B.T200F 02 AVG CTS       3     T73     KA-HAND PADIOMETER (H 1     2A-13-A     T.930F 02 AVG CTS       4     T79     KA-HAND PADIOMETER (H 1     2A-13-A     T.930F 02 AVG CTS       5     BEH     K-SAND PADIOMETER (H 1     2A-25-A     9.090AF 02 AVG CTS       6     ON     K-SAND PADIOMETER (H 1     2A-25-A     9.090AF 02 AVG CTS       7     T78     L-JANP PADIOMETER (H 1     2A-25-A     9.090AF 02 AVG CTS       8     1292AF     KU-SAND (ATTER (H 1)     2A-3-A     J.1199E 07 MCG CTS       8     1292AF     KU-SAND (ATTER (H 1)     2A-3-A     J.811F 02 TES K       10     121525     KU (H ATTER (T HP)     2A-3-A     J.811F 02 TES K       11     120080     KU (H ATTER (T HP)     2A-4-A     J.811F 02 TES K       11     120295     KU (H ATTER (T HP)     2A-4-A     J.820FF 02 OFG K       12     113397     KU (H ATTER (T HP)     2A-4-A     J.820FF 02 OFG K       12     113040     KU (H ATTER (F HP)     2A-4-A     J.820FF 02 OFG K<	1.	P76		KU-BAND RADIOMETER CH 1		24-1-4		8.7664E 02 AVG CTS
3.   763.   KA-BAND PADITWETER CH 2   2A-14-A.   7.9305 02 AVG CTS     5.   R6H.   K-BAND PADITWETER CH 2   2A-14-A.   7.9305 02 AVG CTS     6.   900   K-BAND PADITWETER CH 2   2A-25-A.   8.6687 02 AVG CTS     7.   778.   L-JAND PADITWETER   2A-25-A.   7.90967 02 AVG CTS     9.03067 02 AVG CTS   2A-25-A.   7.1996 02 PTG K   4.000067 02 AVG CTS     1.1   120287 KU - AND PADITWETER   2A-3-A.   3.8115 02 PTG K     1.1   120908 KU SWITCH TEMP   2A-5-A.   3.22175 02 PTG K     1.1   120908 KU SWITCH TEMP   2A-6-A.   2.22175 02 PTG K     1.2   113097 KU CH HAVF GUIDE TEMP   2A-6-A.   2.22175 02 PTG K     1.3   116411 KW CH CH.2 WAVE GUIDE TEMP   2A-6-A.   2.20176 02 PTG K     1.4   135028 KU-SAHD AGC VULTAGE   2A-9-A.   2.00067 02 VHT5     1.3   116411 KW CH.2 WAVE GUIDE TEMP.   2A-17-A.   7.73067 02 PTG K     1.4   135028 KA CH-1 WAVE GUIDE TEMP.   2A-17-A.   7.71067 02 PTG K     1.5   120559 KA CH-1 WAVE GUIDE TEMP.   2A-17-A.   7.27167 02 PTG K     1.6   124640 KA CH-2 WAVE	2.	877	-	KU-BAND RADIOMETER CH 2	-	24-2-4		8.7350F 02 AVG CTS
4.   7P7   KA-BAND BADITWETER CH 1   2A-25-A   6.6667 02 AVG CTS     5.   R64 K-MAND FADITWETEP CH 1   2A-25-A   6.6667 02 AVG CTS     7.   T78 L-INNP BADITWETEP CH 2   2A-27-A   7.7921E 02 AVG CTS     8.   129283 KU-4AND COLD REF TEMP   2A-3-A   7.7931E 02 AVG CTS     8.   129283 KU-4AND COLD REF TEMP   2A-3-A   7.71931E 02 AVG CTS     10.   121525 KH ANTEWA TEMP   2A-4-A   3.8131F 02 PEG K     11.   132080 KU   HOT DFF TEMP   2A-6-A   2.217F C2 DFG K     11.   132078 KU CH.1 MAVE GUIDE TEMP   2A-6-A   2.37367 02 DFG K     11.   132078 KU CH.1 MAVE GUIDE TEMP   2A-6-A   2.370627 02 DFG K     13.16411 KU CH.2 MAVE GUIDE TEMP.   2A-15-A   2.71067 02 DFG K     13.129554 KA-BAND GOLD REF. TEMP.   2A-15-A   3.7307 72 OFG K     14.   132078 KA ANTENNA TEMP.   2A-17-A   3.7307 72 OFG K     15.   129597 KA ANTENNA TEMP.   2A-17-A   3.7307 72 OFG K     16.   129690 KK CH.1 MAVE GUIDE TEMP.   2A-17-A   3.7307 72 OFG K     17.   121063 KA ANTENNA TEMP.   2A-17-A   3.7307 72 OFG K	з.	793		KA-BAND BADIOMETER CH 1		24-13-A		7.9303F 07 AVG CTS
5   864   K=9ANP PADITMETER   CH 2   2A=25=A   6.667T   02 AVG CTS     7   778   L=JANP PADITMETER   2A=27=A   7.7121E   02 AVG CTS     8   129283   KU=9ANP COLP REF TEMP   2A=37=A   7.7121E   02 AVG CTS     9   132880   KU   HPT PF TEMP   2A=4A   3.8131F 02 PTG K     10   121525   KU   ANTEWA TEMP   2A=4A   3.8131F 02 PTG K     11   132098   KU   CH.1 MAVF GUIDF TEMP   2A=4A   3.7807F 02 PTG K     11   132097   KU   CH.1 MAVF GUIDF TEMP   2A=4A   2.7622F 02 PTG K     12   113367   KU-BAND AGT VNLTAGE   2A=4D=A   2.7622F 02 PTG K     13   116411   KU -BAND AGT VNLTAGE   2A=1A=A   2.77367F 02 PTG K     14   135028   KU-BAND AGT VNLTAGE   2A=1A=A   2.73767F 02 PTG K     14   136050   KA   HOT PFF. TEMP.   2A=16=A   2.73767F 02 PTG K     15   120957   KA   SMITCH TEMP   2A=1A=A   2.73716 02 PTG K     11   113680   KA   CH1 PAVF GUIDF TEMP. <t< td=""><td>4 .</td><td>789</td><td></td><td>KA-BAND RADIDMETER CH 2</td><td></td><td>24-14-A</td><td></td><td>1.99455 02 AVG CTS</td></t<>	4 .	789		KA-BAND RADIDMETER CH 2		24-14-A		1.99455 02 AVG CTS
6   909   K=9AND CACIFMETEP   CH 2   ZA=ZA=A   7.000AF   102 AVG CTS     8   129283   KU=9AND COLD REF TEMP.   ZA=ZA=A   7.782LE 02 AVG CTS     9   132800   KU   HOT DFF TEMP.   ZA=A=A   7.782LE 02 AVG CTS     9   132800   KU   HOT DFF TEMP.   ZA=A=A   7.780LF 02 PTG K     11   132090   KU   SUTFMAR   ZA=A=A   7.780LF 02 PTG K     12   133973   KU   HI MAYE GUIDE TEMP.   ZA=A=A   7.780LF 02 PTG K     13   116411   KU   CH.2 MAYE GUIDE TEMP.   ZA=A=A   7.780LF 02 PTG K     13   116411   KU   CH.2 MAYE GUIDE TEMP.   ZA=15-A   Z.7140F 02 DTG K     15   129554   KA=ABAD COLD REF. TEMP.   ZA=15-A   Z.7140F 02 DTG K     16   174660   KA   ANTENNA TEMP.   ZA=17-A   Z.77316F 02 DTG K     17   121063   KA   CH.2 MAYE GUIDE TEMP.   ZA=17-A   Z.77316F 02 DTG K     17   121063   KA   CH.2 MAYE GUIDT TEMP.   ZA=17-A   Z.77316F 02 DTG K     1116055   KA   CH.2 MAY	5.	868		K-BAND PADIOMETER CH 1		2A-25-A		8.6867F 02 AVG CTS
7.   778   L-14NP PADIOWETER   24-37-A   7.71921E 02 AVG CY K     8.   137880   KU-94NP COLP REF TEMP.   24-3-A   7.1192E 02 NG K     13.12925   KU   ANT PEMP   24-3-A   7.1192E 02 NG K     11.   132098   KU   SWITCH TEMP   24-5-A   7.1501 02 NG K     12.   113397   KU   CH.1 MAVF GUIDE TEMP   24-5-A   7.37677 02 NEG K     12.   113397   KU   CH.1 MAVF GUIDE TEMP   24-7-A   7.37677 02 NEG K     13.   116411   KU   CH.2 WAVE GUIDE TEMP   24-15-A   7.7167 02 NEG K     14.   135078   KU-9AND GG VNLTAGE   24-17-A   7.37676 02 NEG K     15.   129554   KA-8AND COLD REF. TEMP.   24-16-A   7.37076 02 NEG K     16.   174660   KA   HOT PEF. TEMP.   24-16-A   7.37076 02 NEG K     17.   121063   KA   GUIDF TEMP.   24-16-A   7.37076 02 NEG K     18.   129597   KA   GHTFNA TEMP.   24-16-A   7.37076 02 NEG K     18.   120597   KA   GHTFNA TEMP.   24-16-A   7.37076 02 NEG K	6.	იი		K-BAND RADIOMETER CH 2		24-26-A		9.0906F 02 AVC CTS
8   129287   KU-AND CDLD REF TEMP.   2A-3-A   2.71996 02 DEG K     10   121257   KU   ANTENNA TEMP   2A-5-A   3.8131F 02 DEG K     11   132080   KU   SWITCH TEMP   2A-6-A   3.8131F 02 DEG K     11   132098   KU   SWITCH TEMP   2A-6-A   3.217F 22 DFG K     12   1133078   KU   CH-1 MAYE GUIDE TEMP   2A-6-A   3.2317F 22 DFG K     13   116641   KU   CH-2 MAVE GUIDE TEMP   2A-8-A   2.90607 C2 V017S     15   129554   KA-BAND GCLO REF. TEMP.   2A-16-A   3.8317F 22 DEG K     17   121063   KA   ANTENNA TEMP.   2A-16-A   3.7375F 02 DEG K     18   129590   KA   CH-1 HAVE GUIDF TEMP.   2A-21-A   2.37736F 02 DEG K     19   118655   KA   CH-1 HAVE GUIDF TEMP.   2A-21-A   2.3773F 02 DEG K     21   103041   KA-8AND AGF VDITAGE   2A-21-A   2.3773F 02 DEG K     23   13393   K   HOT REF. TEMP.   2A-21-A   2.3773F 02 DEG K     23   131339   K   HOT REF. TEMP.   2A-27-A<	7.	778		L-BAND PACIOMETER		24-37-1		7.7921E 02 AVG CTS
9   132880   KU   HTT DFF TEMP   2A-4-A   38131F 02 PEG K     10   121525   KU   SWITCH TEMP   2A-5-A   2.75060F 02 PEG K     11   132098   KU   SWITCH TEMP   2A-6-A   2.75667 02 PEG K     12   1133073   KU   CH-1 MAVE GUIDE TEMP   2A-6-A   2.7662F 02 PEG K     12   113578   KU-0AAD AGC VULIAGE   2.409A7   2.70647 02 PEG K     14   135028   KU-0AAD AGC VULIAGE   2.409A7   2.77647 02 PEG K     15   129554   KA-BAND GCLD REF. TEMP.   2A-16-A   3.8007F 02 DEG K     16   174660   KA   HOT PFF. TEMP.   2A-16-A   3.7357F 02 DEG K     17   120687   KA   GHTFMATEMP.   2A-21-A   2.7714F 02 DEG K     20   120687   KA   CH-2 WAVE GUIDT TEMP.   2A-27-A   2.7114F 02 PEG K     21   103041   KA-6AND AGC VULTAGE   2A-27-A   2.7114F 02 PEG K     22   120697   K   HOT RFF. TEMP.   2A-20-A   2.7751F 02 DEG K     23   131337   K   HOT RFF. TEMP.   2A-27-A   2.71514F 02	8.	129382		KU-9AND COLD REF TEMP.		24-3-4		2.7199E 02 DEG K
10.   121255.   KU   ΑΝΤΕΡΜΑ   24-5-4   2.7500F   02 PEG K     11.   132098   KU   CH-1 MAVF GUIDE TEMP   24-6-A   3.221FC C2 DEG K     13.   116411   KU   CH-2 MAVE GUIDE TEMP   24-8-A   2.0960F C2 DEG K     13.   116411   KU   CH-2 MAVE GUIDE TEMP   24-8-A   2.0960F C2 DEG K     14.   135028   KU-BAMO AGC VULTAGE   24-9-A   2.0960F C2 DEG K     15.   129554   KA-BAND COLD REF. TEMP.   24-16-A   3.620F C2 DEG K     17.   121063   KA   ANTENNA TEMP.   24-17-A   2.7736F C2 DEG K     19.   118655   KA   CH-1 WAVE GUIDE TEMP.   24-17-A   2.7736F C2 DEG K     19.   118655   KA   CH-1 WAVE GUIDE TEMP.   24-21-A   2.3979F C0 VOLTS     21.   103041   KA-6AND AGE VDLTAGE   24-21-A   2.3979F C0 VOLTS   22     22.   120680   K   ANTENNA TEMP.   24-27-A   2.7146F C2 DEG K     23.   131329   K   HOT REF. TEMP.   24-27-A   2.7579F C2 DEG K     24.   1205957   K<	9.	132880		KU HOT PEF TEMP		20-4-0		3.8131F 02 PES K
11 . 12098 . KU SWITCH TEMP . 2A-6-A 2.2217F C2 DFG K 12 . 113997 . KU CH-1 WAYE GUIDE TEMP 2A-8-A 2.7862F C2 DEG K 13 . 116411 . KU CH-2 WAYE GUIDE TEMP 2A-8-A 2.7862F C2 DEG K 14 . 135028 . KU-BAND AGC VNLTAGE 2A-9-A 2.7862F C2 DEG K 15 . 129554 . KA-BAND CLD REF. TEMP. 2A-15-A 2.7164F C2 DEG K 16 . 174860 . KA HAT PFF. TEMP. 2A-16-A 7.8207F C2 DEG K 17 . 121053 . KA ANTENNA TEMP. 2A-16-A 7.8207F C2 DEG K 18 . 129570 . KA SWITCH TEMP. 2A-10-A 7.7736F C2 DFG K 19 . 118685 . KA CH-1 WAYE GUIDE TEMP. 2A-10-A 7.7736F C2 DFG K 20 . 12008P . KA CH-2 WAYE GUIDE TEMP. 2A-10-A 7.7736F C2 DFG K 21 . 103041 . KA-8AND AGC VOLTAGE 2A-27-A 2.77714F C2 DFG K 22 . 120400 . K-9AND COLD REF. TEMP. 2A-20-A 2.7774F C2 DFG K 23 . 11333 . K HOT REF. TEMP. 2A-20-A 2.7774F C2 DFG K 24 . 120557 . K ANTENNA TEMP. 2A-20-A 2.7774F C2 DFG K 25 . 121540 . K-9AND COLD PEF TEMP. 2A-20-A 2.7774F C2 DFG K 26 . 120597 . K ANTENNA TEMP. 2A-20-A 2.7774F C2 DFG K 27 . 119074 . K CH-2 WAYE GUIDE TEMP. 2A-20-A 2.7774F C2 DFG K 28 . 127657 . K ANTENNA TEMP. 2A-20-A 2.7774F C2 DFG K 29 . 135344 . L-RAND AGC VOLTAGE 2A-20-A 2.7774F C2 DFG K 29 . 135344 . L-RAND AGC VOLTAGF 2A-30-A 2.77579F C2 DFG K 29 . 127658 . K-BAND AGC VOLTAGF 2A-30-A 2.77579F C2 DFG K 29 . 127654 . L-BAND AGC VOLTAGF 2A-30-A 2.77579F C2 DFG K 29 . 127654 . L-RAND AGC VOLTAGF 2A-30-A 2.776379 D2 DFG K 20 . 15124 . L HOT REF. TEMP. 2A-40-A 3.8129F 00 VOLTS 29 . 127654 . L-RAND AGC VOLTAGF 2A-30-A 2.7783F D2 DFG K 20 . 15124 . L HOT REF. TEMP. 2A-40-A 3.8129F 00 VOLTS 29 . 107214 . L MAYE GUIDE TEMP. 2A-40-A 3.8129F 00 VOLTS 29 . 127664 . L-RAND AGC VOLTAGE 2A-37-A 2.7083F 02 DFG K 20 . 15124 . L HOT REF. TEMP. 2A-40-A 3.8129F 02 DFG K 20 . 15124 . L HOT REF. TEMP. 2A-40-A 3.8129F 02 DFG K 21 . 107214 . L MAYE GUIDE TEMP. 2A-40-A 3.8129F 02 DFG K 24 . 160753 . L-RAND AGC VOLTAGE 2A-40-A 3.8129F 02 DFG K 34 . 106735 . L-RAND AGC VOLTAGE 2A-40-A 3.8129F 02 DFG K 35 . 130243 . L-RAND AGC VOLTAGE 2A-40-A 2.71800F 02 DFG K 36 . 0 . RADUME THEPMISTOP NO.1	10 .	121925	•	ΚΠ ΑΝΤΕΝΝΆ ΤΕΜΡ		24-5-4	•	2.7560F 02 PEG K
12.   1133973   KU   CH.1 WAVE GUIDE TEMP.   2A-7-A   7,734,27   02 DEG K     13.   116411   KU   CH.2 WAVE GUIDE TEMP.   2A-9-A   2.796427   02 DEG K     15.   129554   KA-BAND COLD REF. TEMP.   2A-15-A   2.796427   02 DEG K     15.   129554   KA-BAND COLD REF. TEMP.   2A-16-A   3.82077   02 DEG K     16.   174660   KA   ANTEMT EMP.   2A-16-A   3.73577   02 DEG K     17.   120685   KA   CH.1 WAVE GUIDE TEMP.   2A-16-A   3.73776   02 DEG K     19.   113665   KA   CH.1 WAVE GUIDE TEMP.   2A-16-A   3.73776   02 DEG K     20.   120089   KA   CH.2 WAVE GUIDE TEMP.   2A-21-A   3.39797   02 VDITS     21.   103041   KA-BAND AGC VDITAGE   2A-21-A   2.39797   02 VDITS     22.   128400   K-HANN TEMP.   2A-21-A   3.61827   02 DEG K     23.   131333   K   HOT REF. TEMP.   2A-21-A   3.2187607   02 DEG K     24.   1205973   K   ANTENNA TEMP.<	11.	132098		KU SWITCH TEMP		21-6-1	•	3.23175 C2 DEG K
13   116411   • KU   CH 2 WAVE GUIDE TFMP   2A-8-A   2.7862F   02 OEG K     14   135028   • KU-BAND AGC VOLTAGE   2A-9-A   2.9969F   02 VOLTS     15   129554   • KA-BAND COLD REF. TFMP   2A-15-A   2.7140F   02 OEG K     16   124860   • KA   HPT PFF. TEMP   2A-15-A   2.7140F   02 OEG K     16   129570   • KA   SWITCH TEMP   2A-16-A   3.735FF   02 OEG K     19   118685   • KA   CH-1 WAVE GUIDF TEMP   2A-19-A   2.7774F   02 OEG K     20   12008P   • KA   CH-2 WAVE GUIDF TEMP   2A-20-A   2.7774F   02 OEG K     21   103041   • K-BAND COLD PEF. TEMP   2A-27-A   2.7714F   02 DEG K     22   128400   · K-BAND COLD PEF. TEMP   2A-27-A   2.7774F   02 DEG K     23   131333   · K   HOT REF. TEMP   2A-20-A   3.7226F   02 DEG K     24   127050   K   SHITCH TEMP   2A-30-A   3.7226F   02 DEG K     24   131333   · K   HOT REF. TEMP <t< td=""><td>12 .</td><td>113399</td><td></td><td>KU CH.1 WAVE GUIDE TEMP</td><td></td><td>2 A-7-A</td><td>•</td><td>7.7362F 02 PEG K</td></t<>	12 .	113399		KU CH.1 WAVE GUIDE TEMP		2 A-7-A	•	7.7362F 02 PEG K
14   135028   KU-BAND AGC VOLTAGE   24-96.0   200007 00 VOLTS     15   129554   KA-BAND COLD REF. TEMP.   2A-15-A   2.71405 02 DEG K     16   174860   KA   HOT PEF. TEMP.   2A-16-A   2.7736F 02 DEG K     17   121063   KA   ANTENNA TEMP.   2A-17-A   2.7736F 02 DEG K     18   120587   KA   CH.2 WAVE GUIDF TEMP.   2A-17-A   2.7736F 02 DEG K     20   120087   KA   CH.2 WAVE GUIDF TEMP.   2A-20-A   2.7736F 02 DEG K     21   103041   KA-BAND AGC VOLTAGE   2A-21-A   2.3079F 00 VOLTS     22   128400   K-94ND COLD PEF. TEMP.   2A-21-A   2.318127 O PEG K     23   131337   K   HOT REF. TEMP.   2A-21-A   2.31744F 02 PEG K     24   120557   K   ANTENNA TEMP.   2A-21-A   2.7579F 02 DEG K     24   117894   K   CH.1 WAVE GUIDT TEMP.   2A-30-A   2.7579F 02 DEG K     25   121560   K   SHITCH TEMP.   2A-30-A   2.7579F 02 DEG K     26   127558   K-BAMD AGC VOLTAGE   2A-40-A   3.8129	13 .	116411		KU CH.2 WAVE GUIDE TEMP	•	2 A-8-A		2.7862F 02 DEG K
15   129554   KA-BAND COLD REF. TEMP.   2A-15-A   2.7140F 02 DEG K     16   17.121063   KA   ANTENNA TEMP.   2A-16-A   3.7357F 02 DEG K     18   1205P7   KA   SWITCH TEMP.   2A-16-A   3.7357F 02 DEG K     19   118685   KA   CH-1 WAVE GUIDF TEMP.   2A-17-A   2.77746 02 DEG K     20   120089   KA   CH-2 WAVE GUIDF TEMP.   2A-20-A   2.7774F 02 DEG K     21   103041   KA CH-2 WAVE GUIDF TEMP.   2A-27-A   2.7174F 02 DEG K     23   131379   K   HOT REF. TEMP.   2A-27-A   2.7174F 02 DEG K     24   120557   K   ANTENNA TEMP.   2A-27-A   2.7174F 02 DEG K     24   120557   K   MATENNA TEMP.   2A-27-A   2.7174F 02 DEG K     25   131670   K   SHITH TEMP.   2A-27-A   2.77647 02 DEG K     26   127658   K-BAND GOLD REF. TEMP.   2A-27-A   2.77647 02 DEG K     27   1190P4   K   CH-2 WAVE GUIDT TEMP.   2A-27-A   2.7579F 02 DEG K     27   1190P4   K   CH-2 WAVE GUIDT TEMP.	14 .	135028	٠	KU-BAND AGE VOLTAGE		20-9-0		2.9969F 00 VALTS
16.   17.4060.KA   HOT PFF. TEMP.   2A-16-A.   7.8207F D2 DEG K     17.   121063   KA   ANTENNA TEMP.   2A-17-A.   2.7736F D2 DEG K     18.   1295PD.KA   SWITCH TEMP.   2A-18-A.   3.2357F D2 DEG K     19.   118685.KA   CH.L WAVE GUIDF TEMP.   2A-20-A.   2.7774F D2 DEG K     20.   12008P.KA   CH.2 WAVE GUIDF TEMP.   2A-20-A.   2.77714F D2 DEG K     21.   103041   KA-8AND AGC VDLTAGE   2A-21-A.   2.3979F D0 VDLTS     22.   128400.K-9AND AGC VDLTAGE   2A-21-A.   2.37714F D2 DEG K     23.   131339.K   HOT REF. TEMP.   2A-21-A.   2.3979F D2 DEG K     24.   120557.K   ANTENNA TEMP.   2A-20-A.   2.7744F D2 PEG K     24.   120557.K   ANTENNA TEMP.   2A-31-A.   2.8527F D2 DEG K     25.   121560.K   SHITCH TEMP.   2A-30-A.   3.7579F D2 DEG K     26.   117899.K   CH.2 WAVE GUIDT TEMP.   2A-37-A.   2.8527F D2 DEG K     27.   1190P4.K   CH.2 WAVE GUIDT TEMP.   2A-43-A.   3.2829F D2 DEG K     27.   135344.L-BAND CDLD REF. TEMP.	15 .	129554	٠	KA-BAND COLD REF. TFMP.	•	24-15-4	-	2.7140F 02 DEG K
17.   121063   « Δ ΑΝΤΕΝΝΆ ΤΕΜΡ,   2Δ-18-Δ   2.7776 F 02 DEG K     18.   1295P0   « Δ SWITCH TEMP,   2Δ-18-Δ   3.235F 02 DEG K     20.   12008P   « Δ CH.1 WAVE GUIDF TEMP,   2Δ-0-Δ   2.7774F 02 DEG K     21.   103041   « Δ - 40AN ΔG VOLTAGE   2Δ-20-Δ   2.37776 00 VOLTS     22.   129400   « -40AND COLD #FF. TEMP,   2Δ-27-Δ   2.7118F 02 DEG K     23.   131339   κ   HOT REF. TEMP,   2Δ-27-Δ   2.7118F 02 DEG K     24.   120559   κ   ANTENNA TEMP,   2Δ-27-Δ   2.7174F 02 DEG K     25.   121560   K   SWITCH TEMP,   2Δ-27-Δ   2.7736F 02 DEG K     25.   121560   K   SWITCH TEMP,   2Δ-37-Δ   2.7579F 02 DEG K     26.   127658   K-BAND AGC VOLTAGE   2Δ-37-Δ   2.7579F 02 DEG K     27.   1190P4   K   CH-1 WAVE GUIDF TEMP,   2Δ-37-Δ   2.7579F 02 DEG K     27.   119344   L   HAND COLD REF. TEMP,   2Δ-37-Δ   2.7579F 02 DEG K     28.   127658   K-BAND AGC VOLTAGE   2Δ-40-Δ   2.8892F 00 VOLT K <td>16 .</td> <td>174860</td> <td>٠</td> <td>KA HOT PEE. TEMP.</td> <td></td> <td>ZA-16-A</td> <td>•</td> <td>3.8207F 02 DEG K</td>	16 .	174860	٠	KA HOT PEE. TEMP.		ZA-16-A	•	3.8207F 02 DEG K
18   1295P0   KA   SWITCH TEMP.   2A-19-A   3,235TF 02 DEG K     19   118665   KA   CH.1 WAVE GUIDF TEMP.   2A-19-A   2,7774F 02 DEG K     20   12008P   KA   CH.2 WAVE GUIDF TEMP.   2A-20-A   2,7734F 02 DEG K     21   103041   KA-BAND AGF VDLTAGE   2A-27-A   2,7734F 02 DEG K     22   128600   K-MAND COLD FFF. TEMP.   2A-27-A   2,7174F 02 DEG K     23   131339   K   HOT REF. TEMP.   2A-27-A   2,7744F 02 DEG K     24   120559   K   ANTFNNA TEMP.   2A-30-A   3,2126F 02 DEG K     25   121506   K   SNITCH TEMP.   2A-30-A   3,2126F 02 DEG K     26   117899   K   CH.1 WAVE GUIDF TEMP.   2A-30-A   2,7579F 02 DEG K     26   127658   K-BAND AGC VOLTAGE   2A-30-A   2,8527F 00 VOLTS     27   135374   L-BAND COLD REF. TEMP.   2A-40-A   3,8139F 02 DEG K     20   155124   L   HOT REF. TEMP.   2A-40-A   3,8199F 02 DEG K     21   127656   K-BAND COLD REF. TEMP.   2A-40-A   3,8129	17 .	121063	•	KA ANTENNA TEMP,		24-17-4	٠	2.7736F 02 0FG K
19   118685 . KA   CH-1 WAVE GUIDF TEMP.   2A-20-A   2.7774F 02 DEG K     20   120089 . KA   CH.2 WAVE GUIDF TEMP.   2A-21-A   2.3979F 00 V0LTS     21   103041 . KA-BAND AGG V0LTAGE   2A-21-A   2.3979F 00 V0LTS     22   128480 . K-HAND COLD FFF. TEMP.   2A-21-A   2.3979F 00 V0LTS     23   131339 . K   HOT RFF. TEMP.   2A-27-A   3.618FP 02 DEG K     24   120559 . K   HOT RFF. TEMP.   2A-27-A   2.7744F 02 DEG K     25   17160 . K   SHITCH TEMP.   2A-30-A   3.3226F 02 DEG K     24   120597 . K   CH.1 WAVE GUIDF TEMP.   2A-37-A   2.87579F 02 DEG K     27   1190P4 . K   CH.2 WAVE GUIDF TEMP.   2A-37-A   2.8122F 00 V0LTS     29   1353F4 . L-BAND COLD RFF. TEMP.   2A-40-A   3.8129F 02 DFG K     31   116456 . L   ANTFNNA TEMP.   2A-40-A   3.8129F 02 DFG K     32   127600 . L   SWITCH TFMP.   2A-42-A   2.8703F 02 DFG K     34   116735 . L-RAND AGC V0LTAGE   2A-42-A   3.8129F 02 DFG K     35   130243 . L-BAND FILTFP TEMP.   2A-46-A   3.2409F 02 DFG K	18 .	129580		KA SWITCH TEMP.	•	24-18-4	٠	3.2357P 02 DEG K
20 . 120089 . KA CH.2 WAVE GUIDE TEMP. 20-20-A . 2.7751F 02 PEG K 21 . 109041 . KA-GAMD AGE VDLTAGE . 20-21-A . 2.3979F 00 VDLTS 22 . 128480 . K-94ND COLD PEF. TEMP 2A-21-A . 2.3979F 00 VDLTS 23 . 131337 . K HOT REE. TEMP 2A-28-A . 3.6182F 02 DEG K 24 . 120559 . K ANTENNA TEMP 2A-29-A . 2.7744F 02 PEG K 25 . 121560 . K SNITCH TEMP 2A-29-A . 2.7744F 02 PEG K 26 . 117899 . K CH.1 WAVE GUIDE TEMP 2A-31-A . 2.7579F 02 DEG K 27 . 1190P4 . K CH.2 WAVE GUIDE TEMP 2A-31-A . 2.7579F 02 DEG K 28 . 127658 . K-BAND AGE VOLTAGE . 2A-33-A . 2.6322F 00 VOLTS 29 . 135364 . L-BAND COLD REE. TEMP 2A-30-A . 3.6129F 02 DEG K 31 . 116456 . L ANTENNA TEMP 2A-40-A . 3.6129F 02 DEG K 33 . 107214 . L HOT GEF. TEMP 2A-40-A . 3.28129F 02 DEG K 34 . 116735 . L-BAND AGE VOLTAGE . 2A-44-A . 3.2889F 02 DEG K 35 . 1302431 . L-BAND FILTEP TEMP 2A-40-A . 3.28129F 02 DEG K 36 . 116735 . L-BAND AGE VOLTAGE . 2A-42-A . 3.2789F 02 DEG K 36 . 116735 . L-BAND AGE VOLTAGE . 2A-45-A . 3.2809F 02 DEG K 37 . 0 . NO15 . 2A-42-A . 3.2809F 02 DEG K 36 . 116735 . L-BAND FILTEP TEMP 2A-46-A . 3.2820F 02 DEG K 37 . 0 . NO15 . 2A-45-A . 3.2800F 02 DEG K 37 . 0 . NO15 . 2A-45-A . 3.2800F 02 DEG K 38 . 0 . NO15 . 2A-45-A . 3.2800F 02 DEG K 39 . 0 . NO15 . 2A-45-A . 3.2800F 02 DEG K 34 . 0 . NO15 . 2A-45-A . 3.2800F 02 DEG K 35 . 1302431 . L-BAND FILTEP TEMP 2A-46-A . 3.2800F 02 DEG K 36 . 0 . NO15 . 2A-45-A . 2.1800F 02 DEG K 37 . 0 . NO15 . 2A-45-A . 2.1800F 02 DEG K 38 . 0 . NO15 . 2A-45-A . 2.1800F 02 DEG K 39 . 0 . NO15 . 2A-45-A . 2.1800F 02 DEG K 34 . 57200 . MODE F POLAPIZATION SWITCH . 2B-1-A . 2.5100F 02 DEG K 37 . 0 . NO15 . 2A-45-A . 2.1800F 02 DEG K 37 . ADDWE THEPWISTER NO17 . 20-57-A . 3.1800F 02 DEG K 38 . 0 . NO15 . 2A-45-A . 2.5100F 02 DEG K 39 . 0 . NO15 . 2A-45-A . 2.5100F 02 DEG K 41 . 57200 . MODE F POLAPIZATION SWITCH . 2A-1-A . 2.5145 D0 COUNTS 45 . 623734 . 51GMA KA-BAND CH.2 . 2A-1-A . 2.5145F 00 COUNTS 46 . 623734 . 51GMA KA-BAND CH.2 . 2A-1-A . 2.5145F 00 COUNTS 47	19 .	118685	٠	KA CH.1 WAVE GUIDE TEMP.	٠	24-19-A	٠	2.77745 02 DEG K
21   103041   KA-GAND AGT VOLTAGE   24-21-A   2.3979F 00 VOLTS     22   1284880   K-44ND COLD FF. TEMP.   2A-27-A   2.7118E 02 PFG K     23   131339   K   HOT RFF. TEMP.   2A-27-A   2.7744F 02 PEG K     24   120557   K   ANTENNA TEMP.   2A-28-A   3.6182F 02 DEG K     25   117899   K   CH.1 MAVE GUIDI TEMP.   2A-30-A   3.726F 02 DEG K     26   117899   K   CH.1 MAVE GUIDI TEMP.   2A-31-A   2.7579F 02 DEG K     27   1190P4   K   CH.2 WAVE GUIDT TEMP.   2A-39-A   2.7083F 02 DEG K     27   1193544   L-BAND AGC VOITAGE   2A-39-A   2.7083F 02 DEG K     20   1276578   K   CH.7 NA TEMP.   2A-42-A   3.8129F 02 DEG K     21   116456   L   ANTENA TEMP.   2A-42-A   3.8129F 02 DEG K     23   107214   L   MAYE GUIDT TEMP.   2A-42-A   3.8129F 02 DEG K     24   16735   L-RAND AFC VOLTAGE   2A-42-A   3.2389F 07 PEG K     24   116735   L-RAND AFC VOLTAGE   2A-42-A   3.2409F 02 DEG	20 .	120082	•	KA CH.2 WAVE GUIDE TEMP.	٠	21-20-1	•	2.7751F 02 DFG K
22.   128480 . K-HAND COLD FFF. TEMP.   .24-27-4 . 2.7118E 02 0FG K     23.   131339 . K   HOT REF. TEMP.   .24-28-4 . 3.8182F 02 0FG K     24.   120559 . K   ANTFRNA TEMP.   .24-28-4 . 3.8182F 02 0FG K     25.   131500 . K   SMITCH TEMP.   .24-29-4 . 2.7744F D2 0FG K     26.   117899 . K   CH.1 WAVE GUIDT TEMP.   .24-30-4 . 2.7579F D2 DEG K     27.   119004 . K   CH.2 WAVE GUIDF TEMP.   .24-37-4 . 2.8127F D2 DEG K     28.   127658 . K-BAND AGC VNITAGE   .24-33-4 . 2.8129F D2 DEG K     29.   135364 . L-BAND COLD REF. TEMP.   .24-41-4 . 3.8129F D2 DEG K     20.   125124 . L   HOT REF. TEMP.   .24-41-4 . 3.2389F D2 DEG K     31.   116456 . L   ANTENNA TEMP.   .24-42-A . 3.2389F D2 DEG K     32.   107214 . L   WAVE GUIDF TEMP.   .24-42-A . 3.2389F D2 DEG K     34.   116735 . L-BAND FILTFP TEMP.   .24-45-A . 2.5909E D0 VNLTS     35.   130243 . L-BAND FILTFP TEMP.   .24-46-A . 3.2430F D2 DEG K     37.   0 .   ND.4 . 28-54-A . 2.1800F D2 DEG K     38.   0 .   ND.4 . 28-54-A . 2.1800F D2 DEG K     37.   0 . ND.4 . 28-54-A . 2.1800F D2 DEG K	21.	103041	٠	KA-BAND AGC VOLTAGE	•	24-21-4		2,3979F 00 VOLTS
23.   131339.   K   HOT REF. TEMP.   2A-28-A.   3.6182F 02 DEG K     24.   120559.   K   ANTENNA TEMP.   2A-29-A.   2.7744F 02 DEG K     25.   121560.   K   SNITCH TEMP.   2A-31-A.   2.7579F 02 DEG K     26.   117899.   K   CH-1 MAVE GUIDT TEMP.   2A-31-A.   2.7579F 02 DEG K     26.   127658.   K-BAND AGC VNITAF   2A-33-A.   2.8127F 00 VNITS     29.   135344.   L-BAND COLD REF. TEMP.   2A-39-A.   2.7683F 02 DEG K     20.   155124.   L   HOT REF. TEMP.   2A-40-A.   3.8129F 02 DEG K     31.   116456.   L   ANTENNA TEMP.   2A-40-A.   3.8129F 02 DEG K     32.   127600.   L   WHTCH TEMP.   2A-40-A.   3.2380F 02 DEG K     33.   107214.   HAVE GUIDF TEMP.   2A-42-A.   3.2380F 02 DEG K     34.   116735.   L-BAND AGC VNITAGE   2A-42-A.   3.2793E 02 DEG K     35.   130243.   L-BAND FILTEP TEMP.   2A-46-A.   3.24235C 02 DEG K     36.   0.   N3.4   24-57-A.   2.1800F 02 DEG K </td <td>22.</td> <td>128480</td> <td>٠</td> <td>K-HAND COLD PEE. TEMP.</td> <td>•</td> <td>21-27-1</td> <td>•</td> <td>2.7118E 02 PEG K</td>	22.	128480	٠	K-HAND COLD PEE. TEMP.	•	21-27-1	•	2.7118E 02 PEG K
24   120559   K   ANTERNA TEMP.   2A-39-A   2.7744F   D2 DEG K     25   121560   K   SWITCH TEMP.   2A-31-A   3.226F   D2 DEG K     26   117899   K   CH-1 WAVE GUIDL TEMP.   2A-31-A   3.7579F   D2 DEG K     27   1190P4   K   CH-2 WAVE GUIDF TEMP.   2A-32-A   2.7579F   D2 DEG K     28   127658   K-BAND AGC VDITAGF   2A-39-A   2.7083F   D2 DEG K     29   135364   L-BAND COLD REF. TEMP.   2A-40-A   3.8129F   D2 DEG K     31   116456   L   ANTENNA TEMP.   2A-40-A   3.2189F   D2 DEG K     32   127600   L   SUTCH TEMP.   2A-40-A   3.2189F   D2 DEG K     33   107214   L   WAVE GUIDF TEMP.   2A-40-A   3.2189F   D2 DEG K     34   116735   L-BAND FILTP TEMP.   2A-40-A   3.2209E D2 DEG K   C     35   130243   L-BAND FILTP TEMP.   2A-40-A   3.2423E D2 DEG K   C     36   116725   RADOME FILTP TEMP.   2A-40-A   2.27973E D2 DEG K<	23.	131339	•	K HOT REF. TEMP.	٠	24-28-4		3.8182F 02 056 K
25.   121560   K   SWITCH TEMP.   2A-30-A   3.2226F   02 0FG K     26.   117899   K   CH.1 HAVE GUIDT TEMP.   2A-31-A   2.7579F   02 DEG K     27.   1190P4   K   CH.2 MAVE GUIDF TEMP.   2A-32-A   2.7579F   02 DEG K     28.   127658   K-BAND AGC VOLTAGE   2A-30-A   2.7083F   02 DEG K     29.   135124   L   HON REF. TEMP.   2A-40-A   3.8129F   02 OLG K     31.   116456   L   HOT REF. TEMP.   2A-40-A   3.8129F   02 DEG K     32.   107214   L   HOT FEMP.   2A-40-A   3.2389F   02 DEG K     33.   107214   L   WAVE GUIDF TEMP.   2A-40-A   3.2389F   02 DEG K     34.   116735   L-BAND AGC VOLTAGE   2A-42-A   2.7610F   02 DEG K     35.   130243   L-BAND AGC VOLTAGE   2A-42-A   2.7800F   02 DEG K     37.   0   N0.4   28-56-A   2.1800F   02 DEG K     38.   0   N0.4   28-56-A   2.1800F   02 DEG K	24 .	120559	٠	K ANTENNA TEMP.		21-29-1	٠	2.77445 02 PEG K
26.   117899.   K   CH.1 WAVE GUIDE TEMP.   2A-31-A   2.7579F D2 DEG K     27.   1190P4.   K   CH.2 WAVE GUIDE TEMP.   2A-31-A   2.8527F D0 VDLTS     29.   135364.   L-BAND COLD REF. TEMP.   2A-39-A   2.7579F D2 DEG K     20.   125124.   L   HOT REF. TEMP.   2A-40-A   3.8129F D2 DEG K     31.   116656.   L   ANTENNA TEMP.   2A-41-A   2.7677F D2 DEG K     32.   127600.   L   SWITCH TEMP.   2A-40-A   3.8129F D2 DEG K     32.   127600.   L   WHTCH TEMP.   2A-42-A   3.2389F D2 DEG K     33.   107214.   WAVE GUIDE TEMP.   2A-42-A   3.2389F D2 DEG K     34.   116735.   L-BAND ACC VOLTAGE   2A-46-A   3.2423E C2 DEG K     35.   130243.   L-BAND FILTEP TEMP.   2A-46-A   3.2423E C2 DEG K     36.   0   RADDME THEPMISTOR NO.1   24-51-A   2.1800F 02 DEG K     37.   0   N0.4   28-56-A   2.1800F 02 DEG K     39.   0   N0.4   28-57-A   2.1800F 02 DEG K     39. <td< td=""><td>25 🔹</td><td>1?1560</td><td>٠</td><td>K SWITCH TEMP.</td><td>٠</td><td>24-30-4</td><td>٠</td><td>3.2326F CZ DEG K</td></td<>	25 🔹	1?1560	٠	K SWITCH TEMP.	٠	24-30-4	٠	3.2326F CZ DEG K
27 .   1190P4 . K   CH.2 WAVE GUIDF TEMP   . 2A-32-A . 2.7579F 02 DEG K     28 .   127658 . K-BAND AGC VOLTAGE   . 2A-33-A . 2.8122F 00 VOLTS     29 .   135364 . L-BAND COLD REF. TEMP.   . 2A-39-A . 2.7083F 02 DEG K     30 .   135124 . L   HOT REF. TEMP.   . 2A-39-A . 2.7083F 02 DEG K     31 .   116456 . L   ANTFNA TEMP.   . 2A-40-A . 3.8129F 02 DEG K     32 .   127600 . L   SWITCH TEMP.   . 2A-40-A . 3.2389F 02 DEG K     33 .   107214 . L   WAVE GUIDF TEMP.   . 2A-42-A . 3.2389F 02 DEG K     34 .   116735 . L-BAND AGC VOLTAGE   . 2A-42-A . 3.2389F 02 DEG K     35 .   130243 . L-BAND FILTEP TEMP.   . 2A-46-A . 3.2439F 02 DEG K     36 .   0 . RADDWE THEPWISTOP NO.1   . 24-61-A . 2.7973F 02 DEG K     37 .   0 .   NO.4   . 28-56-A . 2.1800F 02 DEG K     38 .   0 .   NO.4   . 28-56-A . 2.1800F 02 DEG K     39 .   0 .   NO.4   . 28-56-A . 2.1800F 02 DEG K     40 .   7 PADOME THEPMISTOR NO.7   . 28-56-A . 2.1800F 02 DEG K     41 .   57200 . MODE F POLAPIZATION ANGLE   . 28-60-A . 1.5917F 01 C MUNG K     42 . 25844 . ANTENNA ELEVATION ANGLE   . 28-6	26 .	117899		K CH.1 WAVE GUIDE TEMP.		2∧→31-∆	•	2.7579F D2 DEG K
28.   127658.   K-BAND AGC VOLTAGE   24-33-A.   2.8527E 00 VOLTS     29.   135364.   L-BAND COLD REF. TEMP.   2A-40-A.   3.8139F 02 DEG K     31.   116456.   L. HOT REF. TEMP.   2A-40-A.   3.8139F 02 DEG K     32.   127600.   L. SWITCH TEMP.   2A-40-A.   3.2389F 02 DEG K     33.   107214.   L. WAVE GUIDE TEMP.   2A-42-A.   3.2389F 02 DEG K     34.   116735.   L-BAND AGC VOLTAGE   2A-42-A.   3.2389F 02 DEG K     34.   116735.   L-BAND FILTEP TEMP.   2A-42-A.   3.2389F 02 DEG K     35.   130243.   L-BAND FILTEP TEMP.   2A-46-A.   3.2423E C2 DEG K     76.   D. RADOME THEPMISTOR NO.1   24-51-A.   2.1800F 02 DEG K     77.   O.   NO.4   28-56-A.   2.1800F 02 DEG K     78.   O.   NO.4   28-56-A.   2.1800F 02 DEG K     79.   O.   NO.6   28-56-A.   2.1800F 02 DEG K     79.   O.   NO.6   28-56-A.   2.1800F 02 DEG K     741.   5720F   MDDE F. PDLAPIZATION ANGLE   28-60-A.   1.5912F 01 COUNTS	27 .	119094	•	K CH.2 WAVE GUIDE TEMP	٠	24-22-4	•	2.7579E C2 DEG K
29 .   135374 .   L-BAND COLD REF. TEMP.   .24-39-4   2.7083f 02 DEG K     30 .   135124 .   HOT REF. TEMP.   .24-40-4   .38139F 02 DEG K     31 .   116656 .   ANTENNA TEMP.   .24-40-4   .2.7083f 02 DEG K     32 .   127600 .   L   SWITCH TEMP.   .24-40-4   .2.7010F 02 DEG K     33 .   107214 .   WAVE GUIDE TEMP.   .24-40-4   .2.7973F 02 DEG K     34 .   116735 .   L-BAND AGC VOLTAGE   .24-46-4   .2.7973F 02 DEG K     35 .   130243 .   L-BAND FILTEP TEMP.   .24-46-4   .2.423E C2 DEG K     36 .   D .   ND.4   .24-56-4   .2.423E C2 DEG K     37 .   O .   ND.4   .24-56-4   .2.4300F 02 DEG K     38 .   O .   ND.4   .28-56-4   .2.1800F 02 DEG K     39 .   O .   ND.6   .28-56-4   .2.1800F 02 DEG K     40 .   .   PADOME THEPMISTOR ND.7   .28-67-4   .2.1800F 02 DEG K     41 .   5720P .   MODE F. PDLAPIZATION ANGLE   .28-67-4   .2.1800F 02 DEG K     42 .   25844 .   ANTENNA ELEVATION ANGLE   .2	28.	127658	•	K-BAND AGE VOLTAGE	٠	24-33-1	•	2+8122E 00 VELTS
20.   125124.   L   HOT RFF. TEMP.   . 24-40-A.   3.8129F 02 DFG K     31.   116456.   L   ANTENNA TEMP.   . 2A-40-A.   3.2389F 02 DEG K     32.   127600.   L   SWITCH TEMP.   . 2A-42-A.   3.2389F 02 DEG K     33.   107214.   L   WAVE GUIDF TEMP.   . 2A-42-A.   3.2389F 02 DEG K     34.   116735.   L-BAND AGE VOLTAGE   . 2A-42-A.   2.7973F 02 DEG K     34.   116735.   L-BAND FILTFP TEMP.   . 2A-46-A.   3.2289F 02 DEG K     35.   130243.   L-BAND AGE VOLTAGE   . 2A-46-A.   3.2289F 02 DEG K     36.   D.   RADUME THEPMISTOP NJ.I.   . 2A-46-A.   3.2200F 02 DEG K     37.   D.   ND.4   . 20-51-A.   . 1800F 02 DEG K     38.   D.   ND.4   . 28-57-A.   . 1800F 02 DEG K     39.   D.   ND.4   . 28-57-A.   . 1800F 02 DEG K     40.   J. PADOME THEPMISTOR ND.7   . 28-57-A.   . 1800F 02 DEG K     41.   57200.   MDE F PDLAPIZATION ANGLE   . 28-57-A.   . 1800F 02 DEG K     42.   25844.   A	29.	135364	٠	L-BAND COLD REF. TEMP.	•	24-39-4	•	2.7083F 02 DEG K
31.   116656.L   ANTENNA TEMP.   2A-61-A.   2.7610F 02 DEG K     32.   127600.L   SWITCH TEMP.   2A-42-A.   3.2389F 02 DEG K     33.   107214.L   WAVE GUIDE TEMP.   2A-42-A.   3.2389F 02 DEG K     34.   116735.L-BAND AGC VDLTAGE   2A-45-A.   2.5909E 00 VDLTS     35.   130243.L-BAND FILTEP TEMP.   2A-46-A.   3.2400F 02 DEG K     76.   0.   RADUME THERMISTOR NO.I   29-51-A.   7.1800F 02 DEG K     37.   0.   NJ.4   28-56-A.   2.1800F 02 DEG K     38.   0.   NJ.4   28-56-A.   2.1800F 02 DEG K     39.   0.   NJ.4   28-56-A.   2.1800F 02 DEG K     40.   1.57200.MDDE E PEDLAPIZATION NO.F   28-57-A.   2.1800F 02 DEG K     41.   57200.MDDE E PEDLAPIZATION ANGLE   28-60-A.   1.59325 D2 AVG DEG K     42.   25944.ANTENNA #LEVATION ANGLE   2A-1-A.   1.2517F 01 COUNTS     43.   768652.SIGMA KU-BAND CH.1   2A-1-A.   1.2517F 01 COUNTS     44.   763005.SIGMA KA-BAND CH.1   2A-1-A.   1.2517F 01 COUNTS     45.   627324.SIGMA K-BAND CH.1 <t< td=""><td>- 20 •</td><td>135124</td><td>•</td><td>L HOT REF. TEMP.</td><td>•</td><td>2A-40-A</td><td>•</td><td>3.8139F 02 DFG K</td></t<>	- 20 •	135124	•	L HOT REF. TEMP.	•	2A-40-A	•	3.8139F 02 DFG K
32   127600   L   SWITCH TEMP.   24-42-A   3.2389F 02 DEG K     33   107214   L   WAVE GUIDE TEMP.   24-45-A   2.7973E 02 DEG K     34   116735   L-BAND AGE VOLTAGE   24-45-A   2.7973E 02 DEG K     35   130243   L-BAND FILTEP TEMP.   24-45-A   2.5909E 00 VOLTS     35   130243   L-BAND FILTEP TEMP.   24-46-A   3.2243E C2 DEG K     76   0   RADDME THEPMISTOR NO.1   24-51-A   2.1800F 02 DEG K     37   0   N0.4   28-54-A   2.1800F 02 DEG K     38   0   N0.5   24-55-A   2.1800F 02 DEG K     29   0   N0.6   28-56-A   7.1800F 02 DEG K     40   7   PADOME THEPMISTUR ND.7   28-57-A   2.1800F 02 DEG K     41   5720C   MODE E POLAPIZATION SWITCH   28-67-A   2.1800F 02 DEG K     42   25844   ANTENNA FLEVATION SWITCH   28-67-A   2.1800F 02 DEG K     43   768652   SIGMA KU-BAND CH.1   2A-1-A   1.5932F 02 C00FG     44   762055   SIGMA KU-BAND CH.2   2A-1-A   2.5145F D0 C00I	31 .	116456	•	L ANTENNA TEMP.	٠	ZA-41-A	٠	2.7810F 02 DEG K
33   107214 • L   WAVE GUIDE TEMP.   22-45-A • 2.7973E 02 PEG K     34   116735 • L-BAND AGC VOLTAGE   22-45-A • 2.5909E 00 VOLTS     35   130243 • L-BAND FILTEP TEMP.   24-45-A • 3.223E 02 DEG K     76   0 • RADOME THEPWISTOP NO.I   24-46-A • 3.243E 02 DEG K     77   0 • NO.4   29-51-A • 7.1800E 02 DEG K     78   0 • NO.4   29-55-A • 2.1800F 02 DEG K     79   0 • NO.6   28-56-A • 2.1800F 02 DEG K     40 • 7 • PADOME THEPMISTUR NO.7   28-67-A • 2.1800F 02 DEG K     41 • 57200 • MODE £ POLAPIZATION SWITCH   28-67-A • 2.1800F 02 DEG K     42 • 25844 • ANTENNA ÉLEVATION ANGLE   28-60-A • 1.5932F 01 COUNTS     43 • 768652 • SIGMA KU-BAND CH.1   28-60-A • 1.5932F 01 COUNTS     44 • 763005 • SIGMA KU-BAND CH.2   2A-14-A • 1.2517F 01 COUNTS     45 • 627911 • SIGMA KA-BAND CH.2   2A-12-A • 7.5114E 00 COUNTS     46 • 627326 • SIGMA K-BAND CH.2   2A-12-A • 2.51657 F 01 COUNTS     47 • 754547 • SIGMA K-BAND CH.2   2A-25-A • 2.51657 F 00 COUNTS     48 • 826405 • SIGMA K-BAND CH.2   2A-26-A • 2.5567E C0 COUNTS     47 • 754547 • SIGMA K-BAND CH.2   2A-26-A • 2.5567E C0 COUNTS     48 • 826405 • SIGMA K-BAND CH.2   2A-27-A • 3.6288F 00 COUNTS <tr< td=""><td>32 .</td><td>127600</td><td>٠</td><td>L SWITCH TEMP.</td><td>٠</td><td>24-42-A</td><td>٠</td><td>3.2389F 07 TEG K</td></tr<>	32 .	127600	٠	L SWITCH TEMP.	٠	24-42-A	٠	3.2389F 07 TEG K
34   116755   L-MANE ARE VIOLINGE   24-45-A   2.5909E DO VOLTS     35   130243   L-BAND FILTEP TEMP.   24-45-A   3.2423E CZ OEG K     37   O   N0.4   24-51-A   2.1800F 02 DEG K     37   O   N0.4   28-54-A   2.1800F 02 DEG K     38   O   N0.4   28-54-A   2.1800F 02 DEG K     39   O   N0.6   28-56-A   2.1800F 02 DEG K     40   O   PADOME THEPMISTUR NO.7   28-57-A   2.1800F 02 DEG K     41   57200   MODE E POLAPIZATION SWITCH   28-7-A   2.1800F 02 DEG K     42   25844   ANTENNA FLEVATION ANGLE   28-67-A   2.1800F 02 DEG K     43   768652   SIGMA KU-BAND CH-1   28-7-A   2.6000f 02 CUNTS     44   763005   SIGMA KU-BAND CH-2   24-13-A   1.6557E CO COUNTS     45   628734   SIGMA KA-BAND CH-2   24-13-A   2.51455 DO COUNTS     46   623734   SIGMA KA-BAND CH-2   24-13-A   2.51455 DO COUNTS     47   754547   SIGMA K-BAND CH-2   24-25-A   5.34025 NO COUNTS     47 <td>33 .</td> <td>107214</td> <td>•</td> <td>L NAVE GUIDE TEMP,</td> <td>٠</td> <td>20-43-0</td> <td>٠</td> <td>2.7973F 02 DEG K</td>	33 .	107214	•	L NAVE GUIDE TEMP,	٠	20-43-0	٠	2.7973F 02 DEG K
33   130243   L-0ADD FILTP THPP.   24-46-4   322436 C2 056 K     26   0   RADDME THEPMISTOP NO.I   29-51-A   2.1800F 02 DFC K     37   0   NJ.4   28-54-A   2.1800F 02 DFC K     38   0   NJ.4   28-56-A   2.1800F 02 DFC K     40   3   PADOME THEPMISTUR NO.7   28-57-A   2.1800F 02 DFC K     40   3   PADOME THEPMISTUR NO.7   28-57-A   2.1800F 02 DFC K     41   57200   MDE E PDLAPIZATION ANGLE   28-10-A   2.6000F 02 DFC K     42   25844   ANTENNA #LEVATION ANGLE   28-60-A   1.59325 02 AVG DFG     42   25844   ANTENNA #LEVATION ANGLE   2A-1-A   1.2517F 01 COUNTS     43   768052   SIGMA KU-BAND CH-1   2A-1-A   1.5517F 01 COUNTS     44   763005   SIGMA KA-BAND CH-2   2A-14-A   2.5145E 00 COUNTS     45   623734   SIGMA K-BAND CH-1   2A-25-A   5.51455   C0 COUNTS     46   623734   SIGMA K-BAND CH-2   2A-25-A   5.3402F N0 CUUNTS     47   754567   SIGMA K-BAND CH-2   2A-25-A   5.3602	54 .	116735	٠	L-HAND AND AND TAGE	٠	24-45-4	•	2.5909E 00 VOLTS
37   0   N0.4   24-51-4   2.1800F 02 DF6 K     38   0   N1.4   28-54-4   2.1800F 02 DF6 K     29   0   N0.4   28-56-4   2.1800F 02 DF6 K     40   1   PADOME THEMAISTON ND.7   28-57-4   2.1800F 02 DF6 K     41   57200   MDDE E POLAPIZATION SWITCH   28-60-4   7.1800F 02 DE6 K     42   25844   ANTENNA FLEVATION ANGLE   28-60-4   1.5932F 02 AVG DE6     42   25844   ANTENNA FLEVATION ANGLE   28-60-4   1.5932F 02 AVG DE6     43   768652   SIGMA KU-BAND CH.1   24-14-4   1.2517F 01 COUNTS     44   763005   SIGMA KU-BAND CH.2   24-14-4   2.5145E 00 COUNTS     44   763005   SIGMA KA-BAND CH.2   24-14-4   2.5145E 00 COUNTS     45   623734   SIGMA KA-BAND CH.2   24-14-4   2.5145E 00 COUNTS     46   623734   SIGMA K-BAND CH.2   24-25-4   2.5567E C0 COUNTS     47   754547   SIGMA K-BAND CH.2   24-26-A   2.5567E G0 COUNTS     47   516-5619   SIGMA L BAND   24-37-A   3.6288F 00 COUNTS	37 .	1 3 0 2 4 3	•	E-DAND FILIFY JEMP.	•	24-46-4	e	3.2423E CZ DEG K
38.   0.   NU.4   20-94-4   2.1800F 02 NEG K     29.   0.   NU.6   28-56-4   2.1800F 02 NEG K     40.   7.   PADOME THERMISTUR ND.7   28-56-4   2.1800F 02 NEG K     41.   57200   MODE F. POLAPIZATION SWITCH   28-67-4   2.1800F 02 NEG K     42.   25844   ANTENNA HERVITON SWITCH   28-60-4   1.5932F 02 AVG DEG     43.   768652   SIGMA KU-BAND CH.1   2A-1-4   1.5932F 02 AVG DEG     44.   763005   SIGMA KU-BAND CH.1   2A-2-4   7.5114E 00 COUNTS     44.   763005   SIGMA KU-BAND CH.2   2A-2-4   7.5114E 00 COUNTS     45.   628911   SIGMA KA-BAND CH.2   2A-14-A   3.65145F 00 COUNTS     46.   623736   SIGMA K-BAND CH.2   2A-14-A   2.5145F 00 COUNTS     47.   754547   SIGMA K-BAND CH.2   2A-14-A   2.5145F 00 COUNTS     47.   754547   SIGMA K-BAND CH.2   2A-225-A   5.3402F 00 COUNTS     47.   754547   SIGMA K-BAND CH.2   2A-26-A   2.5567E CO COUNTS     47.   561   SIGMA L BAND   2A-37-A   3.6288F	20.		•	REDUME THEREIST.A Met*1	٠	29-51-6	•	2.1800E 02 DFG K
37   0   NU-5   2495-A   2.1800F 02 DEG K     29   0   NU-6   28-56-A   7.1800F 02 DEG K     40   7   PADOME THEPMISTUR ND-7   20-57-A   2.1800F 02 DEG K     41   57200   MODE E POLAPIZATION SWITCH   28-67-A   2.1800F 02 DEG K     42   25844   ANTENNA ELEVATION ANGLE   28-67-A   1.5932E 02 AVG DEG     43   768652   SIGMA KU-BAND CH.1   2A-1A   1.2517F 01 COUNTS     44   763055   SIGMA KU-BAND CH.2   2A-2A   7.5114E 00 COUNTS     45   628011   SIGMA KU-BAND CH.2   2A-1A   3.6557E CO COUNTS     46   623236   SIGMA KA-BAND CH.2   2A-14-A   3.5145E DO COUNTS     47   754547   SIGMA K-BAND CH.2   2A-14-A   3.5145E DO COUNTS     47   754547   SIGMA K-BAND CH.2   2A-26-A   2.5567E GO COUNTS     48   826405   SIGMA L BAND   2A-37-A   3.6288F D0 COUNTS     50   220   51   51   51   51   51     52   4003   51   51   51   51   51 <td< td=""><td>20</td><td>0</td><td>•</td><td>· N</td><td>•</td><td>28-54-6</td><td>•</td><td>2. LOOP OZ MEG K</td></td<>	20	0	•	· N	•	28-54-6	•	2. LOOP OZ MEG K
40   0   PADOME THEPMISTUR ND.7   28-57-4   2.1800F 02 DEG K     41   57200   MODE E POLAPIZATION SWITCH   28-57-4   2.1800F 02 DEG K     42   25844   ANTENNA FLEVATION ANGLE   28-60-4   1.5932E 02 AVG DEG     43   768652   SIGMA KU-BAND CH.1   24-14-4   1.2517F 01 COUNTS     44   763005   SIGMA KU-BAND CH.1   24-13-4   1.6557E 02 COUNTS     45   628701   SIGMA KA-BAND CH.1   24-13-4   1.6557E 00 COUNTS     46   623734   SIGMA KA-BAND CH.2   24-14-4   2.5145E DO COUNTS     47   754547   SIGMA KA-BAND CH.2   24-14-4   2.5145E DO COUNTS     47   754547   SIGMA K-BAND CH.2   24-25-A   5.3402E NO COUNTS     48   826405   SIGMA K-BAND CH.2   24-25-A   5.3402E NO COUNTS     49   605619   SIGMA K-BAND CH.2   24-25-A   3.6288E DD COUNTS     50   220   SIGMA L BAND   24-37-A   3.6288E DD COUNTS     51   561   571   170661400   3.6288E DD COUNTS     52   170661400   3.1186200   3.1186200   3.11	30 .	0		NU - 7	•	24-95-6	•	2.1800F 02 146 K
41.   57200.   MODE & PILAPIZATION SWICH   28-3744.   2.18000 02 CDF     42.   25844.   ANTENNA #LEVATION ANGLE   28-60-4.   1.59320 02 AVG DEG     43.   768652.   SIGMA KU-BAND CH.1   2A-1-4.   1.25176 01 COUNTS     44.   763005.   SIGMA KU-BAND CH.1   2A-1-4.   1.25176 01 COUNTS     45.   628711.   SIGMA KU-BAND CH.2   2A-24.   7.51140 00 COUNTS     46.   623734.   SIGMA KA-BAND CH.2   2A-14-A.   3.65577 CO COUNTS     47.   754547.   SIGMA KA-BAND CH.2   2A-14-A.   2.51455 DO COUNTS     47.   754547.   SIGMA K-BAND CH.2   2A-255A.   5.34025 CO COUNTS     48.   826405.   SIGMA K-BAND CH.2   2A-255A.   5.34025 CO COUNTS     49.   605619.   SIGMA K-BAND CH.2   2A-255A.   3.62885 DO COUNTS     50.   220.   .   .   3.62885 DO COUNTS     51.   561.   .   .   3.62885 DO COUNTS     52.   MOO3.   .   .   .   3.62885 DO COUNTS     53.   17066190.   .   .   .   .	· · ·		•	DADONE THERMISTON NO 7	•	24-36-8	•	2.1309F C2 0F5 K
42   25844   ANTENNA «LEVATION ANGLE   28-60-A   1.59320   02 AVG DEG     43   768652   SIGMA KU-BAND CH.1   2A-1-A   1.2517F O1 COUNTS     44   763005   SIGMA KU-BAND CH.1   2A-1-A   1.2517F O1 COUNTS     45   628011   SIGMA KU-BAND CH.1   2A-2-A   2.5114E OD COUNTS     45   628011   SIGMA KA-BAND CH.1   2A-2-A   2.5145E OD COUNTS     46   623736   SIGMA KA-BAND CH.2   2A-14-A   2.5145E OD COUNTS     47   754547   SIGMA K-BAND CH.2   2A-25-A   5.3402E CO COUNTS     47   754547   SIGMA K-BAND CH.2   2A-26-A   2.5567E GO COUNTS     47   605619   SIGMA K-BAND CH.2   2A-26-A   2.5567E GO COUNTS     49   605619   SIGMA L BAND   2A-37-A   3.6288F OD COUNTS     50   220   .   .   3.6288F OD COUNTS     51   561   .   .   .   3.6288F OD COUNTS     52   100619PO   .   .   .   3.6288F OD COUNTS     53   1706619PO   .   .   .   . <td< td=""><td>40 4</td><td>67200</td><td>•</td><td>MODE &amp; DOLADIZATION SHITCH</td><td>•</td><td>29-97-4</td><td>٠</td><td>2.1800F 02 0EG K</td></td<>	40 4	67200	•	MODE & DOLADIZATION SHITCH	•	29-97-4	٠	2.1800F 02 0EG K
43.   768662.   SIGMA KU-BAND CH.1   .28-014.   1.2517F OI COUNTS     44.   763005.   SIGMA KU-BAND CH.1   .24-1-A   1.2517F OI COUNTS     45.   628911.   SIGMA KA-BAND CH.1   .24-1-A   1.6557F CO COUNTS     46.   633736.   SIGMA KA-BAND CH.1   .24-14-A   .25145F DO COUNTS     47.   754547.   SIGMA KA-BAND CH.1   .24-25-A   .5145F DO COUNTS     47.   754547.   SIGMA KA-BAND CH.2   .24-26-A   .25165F DO COUNTS     47.   754547.   SIGMA K-BAND CH.2   .24-26-A   .25165F DO COUNTS     47.   754547.   SIGMA K-BAND CH.2   .24-26-A   .25567E CO COUNTS     49.   605619.   SIGMA L BAND   .24-26-A   .3.6788F DO COUNTS     50.   .220.   .   .24-37-A   .3.6788F DO COUNTS     51.   .5f1.   .   .24-37-A   .3.6788F DO COUNTS     52.   .4003.   .   .24-37-A   .3.6788F DO COUNTS     53.   .5f1.   .   .   .24-37-A   .3.6788F DO COUNTS     53.   .170661970.   .   .   .3.6788F DO COUNTS	41.	25944	•	ANTEMNA CLEMATION ANDLE	•	20-140	•	2 50205 07 4005
44   763005   \$1600 F + 31000 F + 2000 F + 2000F + 200	42 .	769653	•	STOWA WILDAND CU 1	•	28761-0	•	1.5932* 02 405 086
45.   62AP011.   SIGMA KA-BAND CH.1   22413-4.   3.6557E CO COUNTS     46.   623734.   SIGMA KA-BAND CH.1   22413-4.   3.6557E CO COUNTS     47.   754547.   SIGMA KA-BAND CH.1   24-25-4.   5.3402E CO COUNTS     48.   826405.   SIGMA K-BAND CH.2   24-25-4.   5.3402E CO COUNTS     49.   605619.   SIGMA K-BAND CH.2   24-26-4.   2.5567E CO COUNTS     50.   220.   .   .   3.6288E DO COUNTS     51.   561.   .   .   .   3.6288E DO COUNTS     52.   MOO3.   .   .   .   .   .     53.   17066190.   .   .   .   .   .     54.   171186200.   .   .   .   .   .	44 .	767005	•	STGMA KU-BAND CH.2	•	2 3-1-4	•	7 61165 00 COUNTS
46   623734   51GMA KA-BAND CH.2   24-14-A   25145F DO COUNTS     47   754547   51GMA KA-BAND CH.2   24-14-A   25145F DO COUNTS     47   754547   51GMA K-BAND CH.1   24-25-A   53402F CO COUNTS     48   826405   51GMA K-BAND CH.2   24-26-A   2.5567E GO COUNTS     49   605619   51GMA L BAND   24-37-A   3.6288F DO COUNTS     50   220   51   561   561     51   561   57   10063   53     52   M003   53   1706619C0   54	45	628911		SIGMA KA-BAND CH.1	•	24-2-4	*	3 65675 00 COUNTS
47.   754547   SIGMA K-BAND CH.1   24-25-A   543402F (O COUNTS     48.   826405   SIGMA K-BAND CH.2   24-25-A   543402F (O COUNTS     49.   605619   SIGMA L BAND   24-25-A   2.5567E CO COUNTS     50.   220.   .   .   3.6288F DO COUNTS     51.   581.   .   .   .     52.   MO03.   .   .   .     53.   170661900.   .   .   .     54.   171186200.   .   .   .	46	623234	-	SIGMA KA-BAND CH.2	1	20-14-1	•	2.51455 DO COUNTS
48.   826405.   SIGMA K-BAND CH.2   2A-26-A.   2.5567E CO COUNTS     49.   605619.   SIGMA L BAND   .2A-26-A.   2.5567E CO COUNTS     50.   220.   .2A-26-A.   3.6288F DO COUNTS     51.   51.   51.   .2A-26-A.   3.6288F DO COUNTS     52.   MO03.   .36288F DO COUNTS   .36288F DO COUNTS     53.   170661900.   .36288F DO COUNTS   .36288F DO COUNTS	47	754547	-	SIGMA K-BAND CH.1		74-75-		5.3402E 00 COUNTS
49 . 605619 . SIGMA E BAND . 20-37-4 . 3.62885 00 COUNTS 50 . 220 . 51 . 581 . 52 . 4003 . 53 . 170661940 . 54 . 171186200 .	48	826405	-	SIGMA K-BAND CH. 2	-	20-26-4	:	2.5567E CO COUNTS
50 . 220 . 51 . 581 . 52 . MOO3 . 53 . 170661970 . 54 . 171186270 .	49	605619	Ţ	STGMA L BAND	•	20-37-4	•	3.62885 00 COUNTS
51 . 581 . 52 . MOO3 . 57 . 17061900 . 54 . 171186200 .	50	220	Ĩ	• • • •	•		•	2 T 1 T 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
52 . 4003 . 52 . 170661900 . 54 . 171186200 .	51	5.61						
57 . 170661900 . 54 . 171186200 .	52	4003	7					
54 . 171186200 .	57	170661900						
	54 .	171186200						

Fig. 3-10 MFMR-2 Sample Output.

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LOGID = MOO3 VALID DATA CODE = 00000245 START TIME = 2 HOURS 45 MINUTES 46.03 SECONDS END TIME = 2 HOURS 46 MINUTES 46.06 SECONDS PAW TOTAL DATA FOR THIS FILE STARTS AT DISK ADDRESS 242500 ENGINEERING DATA FOR THIS FILE STARTS AT DISK ADDRESS 242500

LOGID = P040 VALID DATA CODE = 0000024E START TIME = 4 HOURS 10 MINUTES 20.19 SECONDS PHIS2 DISK ADDRESS = 146500 END TIME = 4 HOURS 11 MINUTES 20.09 SECONDS

.

DISK ADDRESS OF ANTENNA LOSS DATA IS 509050

BEAM POSITION IS

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RADOME LOSS ( 1

	SKY темр (к)	4N7 LASS LA	{K}	SIGMA TR (K)	Fa Fuzz Azuuma	SIGMA LR	RADDME L DSS (DR)
VERT	5.00	1.68	134.0129	8.5660	1.1129	-0.0801	0.4645
Horz	5.00	0.00	292.0999	0.0		0.0	0.0000

Fig. 3-11 PMIS-3 Sample Output.

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					ANTENN	A LOSS									
			SK Y Temp	TB		51G4A	ANT.	SIGMA	ANT.						
			(K)	(K)	1	(K)	14	LA	(DA)						
		K ()-	1 6.17	57.	65	5.8100	1.1132	0.0272	9.46	55					
		κΔ-	2 0+10 1 10-91	59.	.93	5.8049 4.9573	1.1210	J+0272	0.49	12					
		К А-	2 10.91	58.	47	5.1687	1.1144	0.0263	C.47	03					
		×-1	12.16	45.	48	5.7641	1.0836	0.0267	0.34	48					
		4-2	13.16	<del>,</del> 43.	27	5.5761	1.0777	0.0257	0.32	51					
		L I	4.29	90.	.46	5.2219	1.2661	0,0380	1.35	48					

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# Fig. 3-12 MFMR-3 Sample Output.

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#### CHAPTER IV

### ESTIMATION OF SKY BRIGHTNESS TEMPERATURES

### 4.0 INTRODUCTION

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Eqn. (2-23) and its special case (2-25) form the basis for estimating the isothermal brightness temperature seen by the antenna. The purpose of the bucket is to equate this temperature to the sky brightness temperature at zenith.

The calculation of this temperature using the spherical shell model of Paris [1971] depends on the availability of contemporary radiosonde data at the bucket site in clear sky conditions, and it assumes negligible random fluctuations (within-the-hour). In practice, however, logistic considerations make it difficult to obtain soundings at the exact desired time and/or place. These and other factors can introduce systematic errors in  $T_{sky}$  which become greatest at the water resonance frequency of 22.235 GHz.

This chapter discusses the general technique and pitfalls involved in this approach.

## 4.1 Theoretical Background

The low-level noise power emanating from the atmosphere in the microwave spectrum results primarily from absorption and re-radiation by water and oxygen molecular constituents with an extremely weak cosmic background ( $T_{cosmic} = 2.7$  K), believed by many cosmologists to be due to radiation from the remnants of a diffuse expanding primiordal fireball. Superimposed on this are occasional localized radio objects such as the sun, the galactic center and various point sources. Almost all of these, however, have flux densities which decrease rapidly with increasing frequency and may be safely ignored at X-Band and above. At 1.4 GHz it is possible to detect solar radiation with only moderate gain antennas, so that mid-day calibration measurements should be avoided at L-Band.

For PMIS and MFMR, the task of primary concern is the modelling of radiative transfer within the atmosphere. The model constructed by Paris [1971] uses concentric spherical shells to describe the radiative transfer, as shown in Fig. 4-1. The equation of radiative transfer through one shell (shown in inset) is

$$T_{B\Delta Z} = T_{BO} e^{-\alpha \Delta Z} \sec^{\theta} + T(1 - e^{-\alpha \Delta Z} \sec^{\theta})$$
(4-1)

where

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T <sub>BO</sub>	=	incident brightness temperature (K)
т	=	mean thermodynamic temperature (K)
T <sub>BAZ</sub>	Ξ	transmitted brightness temperature (K)
α	=	volume absorption coefficient $(m^{-1})$
∆ <b>Z</b>	=	thickness of shell (m)
θ	=	angle from zenith (rad)

By summing over a sufficient number of shells (with thickness equal to or less than 30 mb pressure), the total incident brightness temperature can be computed for any station altitude or pressure.

The volume absorption coefficient  $\alpha$  is due to absorption by both water and oxygen and is modified to include pressure broadening effects using the model of Van Vleck and Weisskopf [1945]. The necessary input data for (4-1) are taken from radiosonde profiles of air temperature (T), pressure (p) and relative humidity (R.H), which are then converted to more useful forms.





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It is necessary to include sounding data to 10 mb in order to accurately assess the sky temperature at 22 GHz where <u>total</u> precipitable water is of great importance.

Unfortunately, however, many soundings are terminated at 300 mb so that it is necessary to simulate profiles above this level. This simulated tropopause effect is shown in Table 4-1.

Table 4-1									
Simulated Tropopause Data									
Pressure (mb)	Air Temp. (°C)	Dew Pt. Temp. (°C)							
000	<b>CO. O</b>	70.0							
200	-60.0	-70.0							
100	-65.0	-75.0							
50	-62,0	-72.0							
10	-52.0	-62.0							

It has been found through computer simulation that these numbers are not critical, even at 22 GHz, but that <u>some</u> reasonable simulation must be made.

# 4.2 Local Topography

The radiometer calibration facility is located approximately 7 km east of the NMSU campus in Las Cruces, and is at an altitude of 4816' (1.468 km), as shown in Fig. 4-2. Most of the regular soundings (daily, at 0200 MST) are taken at White Sands Missile Range WSD site, although other soundings are taken occasionally at the SMR, LC-36 and Airport sites shown. Between the WSD site and the A-Mtn. bucket site is the Organ Mountain range with some peaks rising to 9000' (2.743 km).



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Can the regular soundings at WSD be used to adequately estimate the sky temperature at the bucket site? The answer is a qualified yes, with the proviso that clear sky conditions be prevailing, that the WSD sounding be within 3 hours of the measurement, and that the wind be predominantly westerly. This technique has evolved as the result of systematic study of the correlation between sounding data in the area, and of the correlation between total precipitable water  $(W_{p})$  and the sky temperature T<sub>sky</sub>. For example, Fig. 4-3 compares contemporary soundings at A-Mtn. and WSMR at 0200 MST on Feb. 12, 1975, and shows a higher temperature and slightly higher humidity on the WSMR side of the mountains. The effect of this difference on the T<sub>sky</sub> spectrum is shown in Fig. 4-4, where the sensitivity to total precipitable water at K-Band becomes immediately apparent.

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These data are referenced to an average A-Mtn. surface pressure of 850 mb. The effect of smaller pressures (higher altitudes) is shown in Fig. 4-5 in the T<sub>sky</sub> spectrum. As the pressure broadening decreases, water and oxygen line shapes become more distinct, and the 2.7 K asymptotic value is approached at lower frequencies.

The correlation between the zenith sky temperature and total precipitable water  $(W_p)$  is shown in Fig. 4-6 for 18, 22 and 37 GHz. The total precipitable water is found by integrating from the atmospheric top (10 mb) to the station pressure of 850 mb, using sounding data and standard meteorological expressions. At 18 and 37 GHz the computed zenith sky temperature is closely correlated to the indicated linear fits with slopes of 0.28° and 0.38° per mm respectively. At 22 GHz the slope of 2°/mm is much steeper and the correlation is not as good, with one point departing 2.5 K from the standard curve. The points shown on this scattergram were computed from sounding data in the winter time period



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Fig. 4-4. Calculated sky temperature spectrum versus frequency from radiosonde data.

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Nov. 1, 1974 to Feb. 20, 1975. A histogram showing the distribution of 22.05 GHz temperatures is shown in Fig. 4-7 and indicates the most recurrent temperatures to be in the 14-17 K range [Carver, Cooper and Paris, 1975].

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Even under clear sky conditions, the zenith sky temperature can vary widely over a period of several days, as shown in Fig. 4-8, which compares A-Mtn. temperatures to WSMR (WSD) values in the Feb. 12-14, 1975 time period. Excursions over 10 K are evident at 22 GHz (WSD) in a little less than two hours.

Since 22 GHz is the most difficult frequency from the standpoint of prediction, a key question is whether the zenith sky temperature can be estimated with sufficient accuracy using only total precipitable water (W<sub>p</sub>) as a basis. Fogarty [1975] has very recently reported on the correlation between 22.2 GHz measured zenith temperatures and surface dew point temperatures over the Oct. 1972 - Nov. 1974 time period for a Brazilian coastal zone site 850m above MSL. He observed large seasonal, daily and even hourly variations in the zenith attenuation with typical clear sky values of 0.64 dB in the winter and 1.70 dB in the summer, corresponding to 40 K - 88 K temperature variations respectively. He concludes that, contrary to previous recommendations [Sullivan, 1971], the prediction of zenith sky temperature by surface dew point temperature or total precipitable water is much less accurate than by use of the "tipping" method, wherein the sky temperature is observed at various angles and calculated by slope techniques. The difficulty with Fogarty's assertion is that no explanations are offered to explain how he

lculates total precipitable water, although it is apparent that  $\therefore$  is <u>not</u> the total integrated W<sub>D</sub> used in the Paris approach.





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Fig. 4-8. Comparison of computed sky temperature versus time.

It is believed that the proper use of radiosonde profiles with an adequate radiative transfer model leads to an acceptable correlation between the zenith sky brightness temperature and  $W_p$ , as indicated in Fig. 4-6. Clearly, a direct calculation of  $T_{sky}$ using the SKYTEMP program written by Paris with timely sounding data from A-Mtn offers the most accurate means of estimation. However, on-site soundings are relatively expensive and logistically difficult so that it is desirable to use the regular 0200 WSD soundings where possible.

By comparing the integrated  $W_p$  values from several coordinated soundings from Las Cruces Airport, Small Missile Range, and Launch Complex - 36, it has been found that for clear sky conditions and prevailing westerly winds, the  $W_p$  value is about 1/2 mm higher on the east side of the Organ Mountains (see Fig. 4-2), so that from Fig. 4-6,  $T_{sky}$  should be higher on the west side of the mountains. This is confirmed in Fig. 4-8 where A-Mtn. and WSD temperatures are compared, with the brightness temperatures on the A-Mtn. side being consistently cooler.

## 4.3 Variation with Zenith Angle

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Fig. 4-9 shows the variation in the computed  $T_{sky}$  values at 18, 37, and 22.05 GHz with angle from zenith. Both A-Mtn. and WSD curves (Feb. 12, 1975; 0200 MST) are shown. The greatest slopes are found at 22 GHz, although the variation is negligible over the 5° beamwidth of the scalar horn used. Thus the assumption that  $T_s = T_{sky}(0^\circ)$ , as in eqn. 2-25, is a good one when a reflect-ing bucket enclosure is used to block emissive radiation from surrounding terrain.


# 4.4 Errors in Tsky

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An extensive analysis of systematic errors in  $T_{sky}$  using radiosonde data has been prepared by Paris (1975] especially for the PMIS/MFMR measurement program. His analysis assumes that the sounding is contemporary with the radiometric measurement and is taken at the A-Mtn. site and that random errors can be ignored. These error values are repeated in Table 4-2.

<u>Table 4-2</u>						
Systematic Errors in T <sub>sky</sub> (after Paris, 1975)						
Frequency (GHz)	ΔT <sub>sky</sub> (K)					
1.4135 10.69 18.00 22.05	0.27 0.40 0.82 3.04					
37.00	1.84					

#### CHAPTER V

#### PMIS LOSS MEASUREMENTS

#### 5.0 INTRODUCTION

The PMIS radiometer operates at 10.69 GHz as a dualpolarized imaging sensor using a planar phased array of crossed slots. The beam is scanned through 44 discrete positions on a conical surface and has a typical beamwidth of 2° corresponding to a gain of 35 dBi. Horizontally and vertically polarized components of incident radiation are processed by separate radiometers with beam switching and data initial data processing under control of a dedicated computer. In flight, integration times are variable and controlled by a feedback network. A radome covers the array when it is used on the P-3A aircraft.

In the calibration testing phase, the radiometer's intrinsic integration time was fixed (- 120 ms) with an effective integration time of 1 minute being provided by computer processing of data tapes. The objective of the test was to provide antenna loss  $(L_A)$  values for all 44 beam positions for both vertical and horizontal channels, and radome loss  $(L_R)$  values for both radomes supplied, at each of the 44 positions. This totals to 264 separate loss measurements. Tests were run at night, normally from midnight to dawn, so that the regular 0200 MST radiosonde sounding from WSD could be used to calculate the sky brightness temperature.

#### 5.1 Mechanical Positioning Technique

The PMIS array and associated radiometers were mounted in a plywood bomb-bay mockup which was in turn affixed to an

azimuth-over-elevation antenna positioner, as shown in Fig. 2-16. The positioner was set (according to a table in the operator logbook) so that electronic beam steering was compensated, giving a beam always pointed toward the zenith.

A counterbalance assembly was used so that the center of gravity was nearly on the elevation axis. Angular setting errors of the positioner are negligible.

#### 5.2 Radiometer Receiver Calibration

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Both horizontal and vertical radiometer receivers were laboratory calibrated by the use of an X-Band waveguide variable temperature cold load, as shown in Fig. 5-1. A matched waveguide load is immersed in a cryobath whose temperature can be varied from approximately 50 K - 250 K. This source of thermal noise causes an equivalent noise temperature  $T_f$  to appear at the A-A' waveguide flange connected to the radiometer receiver. Thermistors (one is shown) are used to monitor temperatures along the waveguide. Corrections are made for waveguide absorption and internal emission, as well as mismatch corrections, in arriving at the A-A' flange temperature.

This reference load has not to date been calibrated by NBS and it would be desirable to have this done. However, it is instructive to consider possible sources of error in order to arrive at a total systematic uncertainty in the flange temperature. These errors result primarily from inaccuracies in the cryobath temperature ( $\pm$  .2 K), and flange mismatch (misalignment) errors ( $\pm$  .5 K) with the resulting estimate of a  $\pm$  1 K overall systematic error.



Fig. 5-1. Symbolic diagram of X-Band reference cold load for PMIS receiver calibration.

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In practice, the apparent flange temperature  $T_{\rm f}$  (equated to  $T_{\rm B}^*$ ) in 25 K steps from 100 K to 200 K, which is the normal operating range of the receiver. As the cryoflask mixing is changed, short-term local temperature gradients develop around the matched load so that  $T_{\rm f}$  requires several minutes (typically 10 min.) to stabilize after making a 25 K change. An equation of the form

$$T_{fi} = T'_{Bi} = T_1 + (\Delta T)X_i$$
 (5-1)

where

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$$x_{i} = \frac{\overline{c}_{A} - \overline{c}_{B}}{\overline{c}_{C} - \overline{c}_{B}}$$
(5-2)

is used to solve for the calibration constants  $T_1$  and  $\Delta T$  by using standard regression techniques to find the best straight line fit to (5-1).  $T_{fi}$  assumes approximate values 100 K, 125 K, 150 K, 175 K and 200 K, and is read from the (827) address of the Varian computer.

The  $T_1$  and  $\Delta T$  "constants" varied slightly, due to receiver post-detection instabilities, as shown in Figs. 3-3 and 3-4. The horizontal receiver showed about 3 times the drift of the vertical receiver and generally provided a continuum of difficulties. A further source of difficulty in receiver calibration was a high level of PCM noise, which was corrected only near the end of the measurement program.

On Jan. 27, the horizontal receiver failed completely, so that all subsequent data from both horizontally and vertically polarized channels were taken using the vertical receiver frontend.

5.3 PMIS Data Flow

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Each of the 264 loss values were measured independently several times so that a reduction in the uncertainty was made possible by averaging. The number of independent measurement sets is shown in Table 5-1.

<u>Table 5-1</u>								
Number o	Number of Independent Loss Measurement Sets							
Loss	Polarization	Number of Sets (N <sub>S</sub> )						
Antenna	Vert.	7						
Radome #1	Horiz. Vert.	7 3 4						
Radome #2	Vert. Horiz.	- 3 4						

The mean loss value for each set was then computed according to

$$\overline{L}^{\overline{M}} = \frac{1}{N_{S}} \sum_{i=1}^{N_{S}} L_{i}^{M}$$
(5-3)

where the superscript refers to the beam position number and  $N_S$  is the number of sets. The standard deviation of the set was computed according to

$$\sigma^{M} = \left\{ \frac{1}{N_{S} - 1} \sum_{i=1}^{N_{S}} (L_{i}^{M} - \overline{L}^{M})^{2} \right\}^{1/2}$$
(5-4)

It was found that the noise  $\sigma^{M}$  was still too high using this procedure, particularly for the horizontal channel. To reduce the noise further, a three-point convolution process was used, wherein a loss value for beam M is averaged in a weighted sense with values of its two neighbors M-1, M+1. The weighting function is chosen as the standard deviation, so that  $L^{M}$  values having high (noisy)  $\sigma^{M}$  values count less than those with more repeatable values (low  $\sigma^{M}$ ), i.e., the final quoted loss value is

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$$L^{M} = \frac{M+1}{\sum_{\substack{M=1\\M+1\\M-1}}^{M+1} (\sigma^{N})^{-1} L^{N}} (5-5)$$

As an example, the antenna loss (horizontally polarized case) for beam position 4 is derived from measured data listed in Table 5-2.

#### Table 5-2

	- 10		Loss Va	lue Ave	raging	Technic	que		<b></b>		
Ream				Measure							
Position	ĩ	2	3	4	5	6	7		σ <sup>M</sup>	LM	
•	1								<u> </u>		,
•											
3	1.514	1.488	1.559	1.567	1.576	1.611	1.584	1.557	.04		
→ <b>4</b>	1.509	1.531	1.532	1.563	1.570	1.611	1.570	1.554	.04	1.560	
5	1.553	1.538	1.635	1.579	1.504	1.633	1.559	1.572	.05		
•	<b>I</b>										
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Then

$$L^{4} = \frac{\frac{1.557}{.04} + \frac{1.554}{.04} + \frac{1.572}{.05}}{\frac{1}{.04} + \frac{1}{.04} + \frac{1}{.05}} = 1.560$$

This smoothing process essentially borrows statistical information from neighboring beams and is equivalent to convolution of average loss values  $\overline{L^{M}}$  with a three-beam weighted pulse function.

#### 5.4 PMIS Antenna and Radome Loss Values

The final loss values, as derived by this technique, are tabulated in Table 5-3 and illustrated graphically in Figs. 5-2, 5-3 and 5-4.

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# Table 5-3

PMIS Loss	Summary
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Position	Antenna	a Loss	Radome	l Loss	Radome	2 Loss
	Vert.	Horiz.	Vert.	Horiz.	Vert.	Horiz.
1	1.672	1.555	1.083	1.130	1.064	1.125
2	1.677	1.557	1.083	1.134	1.063	1.127
3	1.679	1.558	1.083	1.136	1.060	1.129
4	1.679	1.560	1.082	1.137	1.059	1.131
5	1.682	1.572	1.080	1.138	1.057	1.133
6	1.685	1.585	1.079	1.138	1.056	1.134
7	1.681	1.585	1.077	1.139	1.055	1.135
8	1.677	1.586	1.077	1.139	1.055	1.135
9	1.669	1.589	1.076	1.139	1.055	1.134
10	1.667	1.595	1.074	1.139	1.054	1.134
11	1.664	1.604	1.072	1.139	1.053	1.132
12	1.666	1.614	1.069	1.139	1.052	1.130
13	1.664	1.634	1.067	1.138	1.051	1.128
14	1.661	1.641	1.066	1.138	1.050	1.127
15	1.657	1.642	1.066	1.138	1.050	1.125
16	1.655	1.638	1.066	1.137	1.050	1.125
17	1.650	1.642	1.066	1.137	1.049	1.124
18	1.646	1.649	1.066	1.136	1.048	1.124
19	1.646	1.646	1.067	1.134	1.048	1.123
20	1.645	1.640	1.067	1.132	1.048	1.122
21	1.644	1.638	1.068	1.130	1.048	1.121
22	1.641	1.637	1.070	1.126	1.048	1.120
23	1,639	1.645	1.071	1.123	1.048	1.118
24	1.639	1.641	1.071	1.119	1.049	1.116
25	1.643	1.656	1.072	1.116	1.048	1.114
26	1.644	1.655	1.071	1.112	1.048	1.111
27	1.646	1.659	1.071	1.109	1.047	1.108
28	1.649	1.661	1.069	1,106	1.047	1.106
29	1,658	1.660	1.068	1.104	1.046	1.105
30	1.662	1.662	1.066	1.105	1.046	1.106
31	1.664	1.651	1.065	1.110	1.046	1.108
32	1.665	1.635	1.065	1.119	1.046	1.111
33	1.667	1.624	1.066	1.125	1.047	1.113
34	1.672	1.615	1.067	1.129	1.048	1.115
35	1.675	1,604	1.068	1.131	1.049	1.117
36	1.679	1.594	1.071	1.132	1.050	1.118
37	1.684	1.592	1.073	1.134	1.052	1.119
38	1.680	1.585	1.075	1,135	1.054	1.120
39	1,684	1.579	1.078	1.136	1.056	1.121
40	1,688	1.570	1.080	1.136	1.057	1.121
41	1,686	1.562	1.080	1,135	1.058	1.122
<u>4</u> 2	1,681	1,552	1,079	1,133	1.059	1.122
43	1,681	1.552	1.076	1,126	1,059	1.122
44	1,601	1.547	1.075	1,116	1.059	1.122

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Fig. 5-2. PMIS antenna loss versus beam position.



Fig. 5-3. PMIS radome 1 loss versus beam position.



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Fig. 5-4. PMIS radome 2 loss versus beam position.

#### 5.5 FMIS Error Budget

#### 5.5.1 Theoretical Background

In experimental measurements, errors may be divided into three classes:

#### 1. Blunders

These errors are due to human mistakes, and all measurement programs suffer from them. Incorrect reading of meters, computer card punching mistakes, careless mating of waveguide flanges, etc., typify these blunders. In most cases, these errors will eventually be discovered and corrected.

#### 2. Systematic Errors

Systematic errors relate to the <u>accuracy</u> of a measurement and stem from incorrectly calibrated instruments, human meter reading error (e.g., meter parallax), or such environmental conditions as strong magnetic fields interacting with meter movements. Systematic errors will thus cause a measured value to be consistently high or low from the absolute value. Instrument calibration and the careful use of these instruments as recommended by the manufacturer will minimize these errors.

If a quantity is deduced from its relationship  $f = f(X_1, X_2, X_3, \ldots, X_n)$  on n independently measured quantities  $(X_1, X_2, X_3, \ldots, X_n)$ , then the <u>worst case</u> systematic error (accuracy) in f is

$$\Delta \mathbf{f} = \sum_{i=1}^{n} \left| \frac{\partial \mathbf{f}}{\partial \mathbf{X}_{i}} \right| \Delta \mathbf{X}_{i}$$
(5-6)

where  $\Delta X_i$  is the accuracy of the measured quantity  $X_i$ .

#### 3. Random Errors

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Random errors control the <u>precision</u> of a measurement or the number of significant figures that may be quoted. Such errors are noise-related and may stem from short-term gaussian noise or shot noise or they may be caused by the relatively long-term gain instability of an amplifier. If the variances  $\sigma_1^2$  of the quantities  $X_i$  (see above) are known, then the variance of the quantity f is given by the quadrature relationship

$$\sigma_{f}^{2} = \sum_{i=1}^{n} \left( \frac{\partial f}{\partial X_{i}} \right)^{2} \sigma_{i}^{2}$$
(5-7)

#### 5.5.2 PMIS Antenna Loss Errors

For PMIS, the waveguide and antenna are considered as a unit so that (3-2) reduces to

$$L_{A} = \frac{T_{A} - T_{S}}{T_{A} - T_{B}}$$
(5-8)

1. Random Error

It can be shown that the random fluctuations in the antenna temperature ( $\sigma_{T}$ ) and in the sky temperature ( $\sigma_{T}$ ) at X-Band are  $\Gamma_{S}$  two to three orders of magnitude smaller than the fluctuations in the uncorrected brightness temperature. Thus, from (5-7),

$$\sigma_{L_{A}} = \frac{\partial L_{A}}{\partial T_{B}^{\dagger}} \sigma_{T_{B}} = \frac{T_{A} - T_{S}}{(T_{A} - T_{B}^{\dagger})^{2}} \sigma_{T_{B}}$$
(5-9)

The uncorrected brightness temperature is computed by

$$T'_{B} = T_{1} + (\Delta T)X \qquad \text{where } X = \frac{\overline{C}_{A} - \overline{C}_{B}}{\overline{C}_{C} - \overline{C}_{B}} \qquad (5-10)$$

where  $T_1$  and  $\Delta T$  are constants established by laboratory calibration and X is the PCM count ratio. Thus,

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$$\sigma_{\rm T_B} = [\sigma_{\rm T_1}^2 + x^2 \sigma_{\Delta \rm T}^2 + (\Delta \rm T)^2 \sigma_{\rm X}^2]^{1/2}$$
(5-11)

The noise process responsible for  $\sigma_x$  is short-term (within-theminute fluctuations) and originates from the receiver front-end, from antenna phase shifters and from the residual PCM transients. It has been found that with a one-minute integration time,

$$(\Delta T)\sigma_{\chi} = \begin{cases} 0.07 \text{ K} & (\text{vertical}) \\ 0.22 \text{ K} & (\text{horizontal}) \end{cases} (typically) (5-12) \end{cases}$$

Electuations in  $T_1$  and  $\Delta T$  originate from medium-term (within-theweek) gain instability as influenced by the synchronous demodulator in the receiver rear end. Repeated laboratory calibrations during the PMIS loss measurement period at A-Mountain established that

$$\sigma_{\rm T1} = \begin{cases} 1.60 \text{ K} & (\text{vertical}) \\ 3.00 \text{ K} & (\text{horizontal}) \end{cases}$$
(5-13)  
$$\sigma_{\Delta \rm T} = \begin{cases} 0.29 \text{ K} & (\text{vertical}) \\ 1.05 \text{ K} & (\text{horizontal}) \end{cases}$$
(5-14)

as being typical. Using X = 3.50 (a maximum) and substituting 5-12, 5-13 and 5-14 into 5-11,

$$\sigma_{\rm T_B} = \begin{cases} 1.90 \text{ K} & (\text{vertical}) \\ 4.70 \text{ K} & (\text{horizontal}) \end{cases}$$
(5-15)

Under typical conditions,

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 $T_{A} = 288 \text{ K}$   $T_{S} = 5 \text{ K}$   $T_{B} = 120 \text{ K}$   $L_{A} = 1.684$ (5-16)

Substituting 5-15 and 5-16 into 5-9,

$$\sigma_{\rm L} = \begin{cases} 0.019 & (vertical) \\ 0.047 & (horizontal) \end{cases}$$
(5-17)

The three-point convolution process used to borrow statistical information from neighboring beam positions decreases the noise on  $L_{A}$  by 58%, giving a final random error

 $\overline{\sigma_{L}}_{A} = \begin{cases} 0.010 \quad (vertical) \\ 0.027 \quad (horizontal) \end{cases}$ (total random error) (5-18)

#### 2. Systematic Error

The major source of systematic, or calibration error is the inaccuracy of the laboratory standard X-Band cooled load. Other errors, considerably smaller, include the accuracy of the sky temperature and of the antenna kinetic temperature.

The worst case systematic error may be calculated by

$$\Delta L_{A} = \frac{1}{T_{A} - T_{S}} \Delta T_{S} + \frac{T_{B}^{\dagger} - T_{S}}{(T_{A} - T_{B}^{\dagger})^{2}} \Delta T_{A} + \frac{T_{A} - T_{S}}{(T_{A} - T_{B}^{\dagger})^{2}} \Delta T_{B}^{\dagger}$$
(5-19)

It is estimated that:

 $\Delta T_{n} = \pm 0.2 \text{ K}$  (limited by accuracy of thermistors)

 $\Delta T_S = \pm 0.4 \text{ K}$  (limited by accuracy of knowledge in  $H_2^0$ vapor volume absorption coefficient in accuracy of radiosonde instruments see Section 4.4.

 $\Delta T_{B}^{*} = \pm 1.0 \text{ K}$  (See Section 5-2)

Substituting 5-16 and 5-20 into 5-19,

$\Delta L_A = \pm$	(0.0014	÷	0.0008	÷	0.0100)	(5-21)
	sky temp. error		ant. temp. error		ref. cold load error	

or

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 $\Delta L_{A} = \pm 0.012$  (total systematic error for vert. and horiz.)

#### 3. Total Uncertainty

The total uncertainty is found by adding the random and systematic error, i.e.

$$\varepsilon_{\mathrm{LA}} = \pm (\sigma_{\mathrm{LA}} + |\Delta_{\mathrm{LA}}|) \tag{5-22}$$

or

$$\varepsilon_{\text{LA}} = \begin{cases} + 0.022 & (\text{vertical}) \\ + 0.039 & (\text{horizontal}) \end{cases}$$
(5-23)

#### 5.5.3 PMIS Radome Loss Errors

Since the waveguide loss is subsumed within the antenna loss for PMIS, (3-4) reduces to

$$L_{R} = \frac{T_{R} - T_{S}}{T_{R} + T_{A}(L_{A} - 1) - L_{A}T_{B}}$$
(5-24)

#### 1. Random Error

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It can be demonstrated that random fluctuations in the brightness temperature have a negligible effect on (5-24) in comparison to the contribution from the noise on  $L_A$  as computed from (5-18). Also, random fluctuations in the sky temperature and the radome temperature have a negligible effect on  $L_R$ . Thus, carrying out the indicated operations of (5-7), using (5-24),

$$\sigma_{\mathbf{L}_{\mathbf{R}}} \approx \frac{\mathbf{T}_{\mathbf{R}} - \mathbf{T}_{\mathbf{S}}}{(\mathbf{T}_{\mathbf{A}} - \mathbf{T}_{\mathbf{B}}')\mathbf{L}_{\mathbf{A}}^{2}} \sigma_{\mathbf{L}_{\mathbf{A}}}$$
(5-25)

which, under typical conditions, reduces to

$$\sigma_{L_{R}} = 0.6 \sigma_{L_{A}}$$
(5-26)

#### 2. Systematic Error

It may likewise be shown that the systematic error in L<sub>R</sub> is, under typical conditions, given by

$$\Delta L_{R} \simeq 0.6 \ \Delta L_{A} \tag{5-27}$$

#### 3. Total Uncertainty

It follows from (5-26) and (5-27) that the total uncertainty in the radome loss is

$$\varepsilon_{L_R} \approx 0.5 \varepsilon_{L_A}$$
 (5-28)

which, using (5-23), yields

$$\varepsilon_{L_{R}} = \frac{\pm 0.014 \quad (vertical)}{\pm 0.039 \quad (horizontal)}$$
(5-29)

## 5.6 Effect of Errors in $L_A$ , $L_R$ on PMIS User

What is the significance of these errors in the measured values from the viewpoint of the PMIS data user? In flight, the antenna may be viewing a ground target or possibly a sky target; furthermore, it is covered by a radome so that (5-24) holds, except that  $T_S$  now represents the target (or scene) brightness temperature, and it is  $T_S$  that the user wishes to measure. Solving for  $T_S$  from (5-24),

$$T_{S} = L_{A}L_{R}T_{B} - L_{R}(L_{A} - 1)T_{A} - (L_{R} - 1)T_{R}$$
(5-30)

#### 5.6.1 Random Errors

Even though there were random errors in the <u>measured</u> values of  $L_A$  and  $L_R$ , the values themselves do not fluctuate. Thus, we may say that we know these values only to a certain precision. However, there is an appreciable random noise-caused error in  $T_B^1$  (more commonly known as the receiver sensitivity), typically 1 K over a short period of time. Long-term receiver instability may cause this value to become much higher over a period of hours. Fluctuations in  $T_A$  and  $T_R$  are negligible. Applying (5-7) to (5-30), the variance in the source brightness temperature is

$$\sigma_{T_{S}}^{2} = [L_{R}(T_{A} - T_{B}^{\prime})]^{2} \sigma_{L_{A}}^{2} + [L_{A}T_{B}^{\prime} - (L_{A} - 1)T_{A} - T_{R}]^{2} \sigma_{L_{R}}^{2} + (L_{A}L_{R})^{2} \sigma_{T_{B}}^{2}$$
(5-31)

Assuming a source brightness temperature of 200 K, antenna and radome temperatures of 288 K and 293 K respectively and antenna and radome losses of 1.684 and 1.100, the uncorrected brightness temperature  $T_B'$  would be 241 K. The corresponding variances are

$$\sigma_{L_{A}}^{2} = \begin{cases} (0.010)^{2} & \text{vertical} \\ (0.027)^{2} & \text{horizontal} \end{cases}$$

$$\sigma_{T_{B}}^{2} = \begin{cases} (1)^{2} & \text{vertical} \\ (1)^{2} & \text{horizontal} \end{cases}$$

$$\sigma_{L_{R}}^{2} = \begin{cases} (0.006)^{2} & \text{vertical} \\ (0.016)^{2} & \text{horizontal} \end{cases}$$
(5-32)

Substituting these figures into (5-31),

$$\sigma_{T_{S}}^{2} = \begin{cases} 0.94 + 0.25 + 3.43 & (vertical) \\ 1.95 + 1.81 + 3.43 & (horizontal) \end{cases}$$
antenna radome receiver noise imprecision imprecision

or

$$\sigma_{\rm T_S} = \begin{cases} 2.2 \text{ K} & (\text{vertical}) \\ 2.7 \text{ K} & (\text{horizontal}) \end{cases}$$
(5-34)

These values specify the <u>precision</u> with which a measured source brightness temperature may be quoted. They are larger than the receiver noise related system sensitivity because of the imprecision of the loss numbers. If the statistical fluctuations in  $T_S$  are assumed to be normally distributed, then there is a probability of 68% that the measured value of  $T_S$  will be within  $\pm \sigma$  of the mean. If the random error in  $L_A$  and  $L_R$  were reduced to zero, then  $\sigma_{T_S} = 1.9$  K which is then the tangential sensitivity of the radiometer system.

#### 5.6.2 Systematic Errors

The systematic error, or accuracy, associated with  $T_S$  is computed by using (5-6) and (5-30) in a worst case sense, yielding

$$\Delta \mathbf{T}_{S} = \left| \mathbf{L}_{R} (\mathbf{T}_{A} - \mathbf{T}_{B}^{*}) \right| \Delta \mathbf{L}_{A} + \left| \mathbf{L}_{A} (-\mathbf{T}_{A} + \mathbf{T}_{B}^{*}) + (\mathbf{T}_{A} - \mathbf{T}_{R}) \right| \Delta \mathbf{L}_{R}$$
$$+ \mathbf{L}_{A} \mathbf{L}_{R} \Delta \mathbf{T}_{B}^{*} \qquad (5-35)$$

The accuracies involved are

$$\Delta L_{A} = \pm 0.012$$

$$\Delta L_{R} = \pm 0.007$$
(5-36)
$$\Delta T_{B}^{*} = \pm 1 K$$

so that, using the same constants as before,

$$\Delta T_{S} = \pm \begin{bmatrix} 0.62 \\ antenna \\ loss \\ inaccuracy \\ inacuracy \\ inacuracy \\ inaccuracy \\ inaccuracy \\ inaccuracy \\ inaccu$$

or

$$\Delta T_{\rm S} = \pm 3 \ {\rm K}$$
 (5-39)

This means that the measured source brightness mean temperature  $T_s$  is within  $\pm$  3 K of the true value.

### 5.6.3 Total Uncertainty

The total uncertainty in  ${\rm T}_{\rm S}$  is found by adding the random and systematic errors, i.e.,

$$\varepsilon_{\mathrm{T}_{\mathrm{S}}} = \pm (|\Delta \mathrm{T}_{\mathrm{S}}| + \sigma_{\mathrm{TS}})$$
 (5-40)

 $\mathbf{or}$ 

$$\varepsilon_{\rm TS} = \pm \begin{cases} 5.2 \text{ K} & (\text{vertical}) \\ 5.7 \text{ K} & (\text{horizontal}) \end{cases}$$
(5-41)

#### CHAPTER VI

#### MFMR LOSS MEASUREMENTS

#### 6.0 INTRODUCTION

*2* - 1

The MFMR operates at L-Band (1.4135 GHz), K, -Band (18.0 GHz), K-Band (22.05 GHz) and K<sub>a</sub>-Band (37.0 GHz) with fixed beam antennas so that radiometric profiles in the flight direction are provided. The L-Band antenna is a linearly polarized stripline array, manufactured by AIL, with a 16° beamwidth and a beam In order to obtain both vertically and efficiency of 95%. horizontally components of incident radiation at L-Band, the entire antenna assembly is mechanically rotated through a roll angle of 90°. The K, K<sub>u</sub>, and K<sub>a</sub>-Band antennas are dual-polarized scalar horns, with simultaneous vertical and horizontal outputs to two radiometer channels for each band. 3 dB beamwidths are 4.0° at K<sub>u</sub>, 4.3° at K and 4.5° at K<sub>a</sub>-Bands. The seven channels all use Hach [1968] radiometers with 100 ms integration times (in flight) and bandwidths of 27, 200, 200 and 500 MHz at L,  $K_{\mu}$ , K and Ka-Bands respectively. Radiometric outputs and housekeeping data are all PCM encoded in a similar format to that used by PMIS.

All antennas and radiometers are mounted on a positioning ring so that both roll (0° or 90°) or pitch (0° to 180°) motions are mechanically controlled.

#### 6.1 Mounting Configuration

Fig. 2-18 shows the MFMR on the antenna positioner and tower inside the bucket. During the measurement sequence, the antenna positioner was set to compensate for MFMR pitch motions so that the beam was always pointing toward zenith. However, this caused the position of the antennas relative to the bucket walls to change considerably, as shown in Fig. 2-7, with the antennas being very close to the top of the bucket when the pitch was 90°. It will be shown later that this displacement had no measurable effect on the loss values.

In flight, microwave absorber is placed on the aircraft bulkhead for two principal reasons: (1) the L-Band array is so close to the bulkhead for a pitch of 0° that mutual coupling between antenna and radome via bulkhead reflections must be eliminated, and (2) when the K<sub>u</sub>, K and K<sub>a</sub>-Band horns are pointing skyward and viewing a cold and constant sky, considerable radiometric variations may occur in flight due to the backlobes viewing a variable terrain brightness temperature, unless this effect is artifically removed by causing the sidelobes and backlobes to view a relatively hot absorbing bulkhead. The absorber used is Emerson and Cuming flat Eccosorb, tuned for use at L-Band.

In testing at A-Mtn, however, the Eccosorb was not furnished and PSL used its own available absorber, the pyramidal material seen in Fig. 2-18. Unfortunately, this absorber is designed for use at X-Band and above and is essentially transparent at L-Band. The result is that all L-Band tests were with a non-absorbing bulkhead and thus did not simulate flight conditions. This situation will be discussed in detail in Sec. 6.5.4.

#### 6.2 Radiometer Receiver Calibration

Each of the seven radiometer receivers was calibrated by the use of laboratory standard hot loads and cold loads. From (5-1), letting  $T'_{Bi} = (T_h, T_c)$  and solving 2 simultaneous eqns. for the 2 unknown calibration constants.

$$F_{1} = \frac{T_{c}X_{h} - T_{h}X_{c}}{X_{h} - X_{c}}$$
(6-1)

$$\Delta T = \frac{T_h - T_c}{X_h - X_c}$$
(6-2)

where X refers to the count ratio (see eqn. 5-2) and the subscripts h and c refer to hot and cold.

During the testing phase, laboratory calibrations were done twice: (1) at the beginning of the MFMR tests on Feb. 8, 1975 and (2) at the end of the MFMR tests on Feb. 21, 1975. Table 6-1 and Fig. 6-1 compare these constants over this period of time. No final calibration at K-Band was possible since the receiver failed during the intervening time.

Table 6-1									
	MFMR Laboratory Calibration Summary								
Band	Initial Cal. (2-8-75) T <sub>l</sub> (K) AT (K)	Final Cal. (2-21-75) T <sub>l</sub> (K) AT (K)							
Ku-1	329.87 -54.24	325.51* -54.48*							
K <sub>u</sub> −2	327.65 -54.22	323.11* -55.39*							
K <sub>a</sub> -1	330.57 -58.73	330.25 -58.17							
K <sub>a</sub> -2	331.14 -60.02	331.05 -59.89							
K-1	329.64 -56.67	** **							
к-2	328.61 -50.20	** **							
L	323.33 -51.15	323.84 -50.93							

NOTES:

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\* Final K<sub>u</sub>-Band calibration may be slightly inaccurate since there was insufficient equipment warmup time.

\*\* K-Band receiver was not operating at the time of final

calibration.



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K-2

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2/21/75

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6.3 MFMR Data Flow

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Loss values were measured at roll angles of 0° and 90° for the following pitch angles: 0°, 5°, 10°, 15°, 20°, 25°, 30°, 35°, '0°, 45°, 50°, 60°, 70°, 80°, 90°, 100°, 110°, 120°, 130°, 140°, 150°, 160°, 165°, 170°, 175° and 180°. In flight, a 0° pitch angle has all antenna beams directed toward nadir, with the L-Band array nearest the bulkhead and the horns nearest the radome nose. A 180° pitch angle corresponds to the zenith direction, with the horns nearest the bulkhead and the L-Band array nearest the nose.

This arrangement thus requires 364 antenna loss measurements plus 364 more for each of the two radomes supplied, giving a total of 1092 measurements required. Most of these loss values were measured independently twice (and subsequently averaged), so that roughly 2000 measured values were processed.

Due to an unforeseen interaction between the L-Band antenna and the radome, the radome loss values measured at that frequency are not valid, although an approximate value of  $L_R \simeq 1.09$ (independent of pitch angle) can be used. This is discussed in detail in Sec. 6.6.

Antenna and radome loss values were calculated by the use of eqns. (3-2) and (3-4), with the sky brightness temperature  $(T_s)$  estimated using the algorithm discussed in Chap. 4. The uncorrected brightness temperature  $T_B^1$  measured for each beam position was a 1-minute average. The 100 ms. integration time rms noise level (std. deviation) was monitored for each channel and a threshold, receiver sensitivity level of 6 K was established. This corresponds to a sensitivity of 0.25 K when referred to a 1-minute integration time.  $T_B^1$  values noisier than this were discarded.

## 6.4 MFMR Antenna and Radome Loss Values (K<sub>u</sub>, K, K<sub>a</sub>-Bands)

The 980 final loss values, as derived by this technique, are tabulated in Tables 6-2, 6-3 and 6-4. The antenna loss values are plotted vs. pitch angle in Figs. 6-2, 6-3 and 6-4. Corresponding radome loss values for both radomes are plotted in Figs. 6-5 - 6-10.

All of these loss measurements were made with PSL-furnished absorber in place on the bulkhead. The rise in  $L_A$  as the pitch angle approaches 180° (for a roll of 0°) is due to an increasing contribution to the apparent source brightness distribution  $T_s$ as the horns come closer to the hot absorbing material. For a roll of 90°, this distance change with pitch angle is much less so that the effect is less pronounced. Radome losses are generally higher near 0° or 180° for a roll of 0° and are occasionally quite high from 170° - 180° since the antennas are looking straight up and into the radome fairing-bulkhead interface, with the resulting likelihood of strong mutual coupling.

It should be emphasized that the jagged nature of the loss graphs for  $L_R$  is <u>not</u> due to errors in the measurement method, since these values were easily repeatable from one measurement set to the next under identical circumstances. Rather, this behavior stems from either resonant scattering between the horns and radome or resonant thickness effects (especially at  $K_a$ -Band) of the radome material.

# 6.5 Interaction Mechanisms between the MFMR Horns and the Aircraft Bulkhead

6.5.1 Introduction

As mentioned previously, it was observed that the antenna

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Table	6-2
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MFMR ANTENNA LOSS (L<sub>A</sub>)

	$ROLL = 0^{\circ}$						$ROLL = 90^{\circ}$							
PITCH	L	к <sub>u</sub> -1	к <sub>и</sub> -2	K-1	К-2	K <sub>a</sub> -1	K <sub>a</sub> -2	L	к <sub>u</sub> -1	Ku-2	K-1	К—2	K <sub>a</sub> -1	к <sub>а</sub> -2
0 <sup>0</sup>	1.365	1.123	1.119	1.096	1.082	1.124	1.111	1.369	1.136	1.140	1.105	1.098	1.129	1.114
5°	1.366	1.122	1.119	1.092*	1.080*	1.123	1.110	1.365	1.135	1.141	1.104*	1.098*	1.128	1.113
10 <sup>0</sup>	1.365	1.122	1.118	1.086	1.078	1.123	1.111	1.363	1.136	1.139	1.103	1.098	1.129	1.113
15 <sup>0</sup>	1.364	1.122	1.118	1.085*	1.077*	1.121	1,109	1.362	1.136	1.1.1	1.103*	1.098*	1.129	1.114
20 <sup>0</sup>	1.363	1.122	1.117	1.083	1.077	1.122	1.109	1.362	1.136	1.142	1.102	1.098	1.129	1.113
25 <sup>0</sup>	1.363	1.122	1.117	1.083*	1.078*	1.122	1.109	1.363	1.137	1.142	1.102*	1.097*	1.130	1.115
30 <sup>0</sup>	1.361	1.122	1.117	1.083	1.078	1.122	1.110	1.362	1.138	1.143	1.102	1.096	1.130	1.115
35 <sup>0</sup>	1.361	1.123	1.118	1.087*	1.081*	1.122	1.110	1.363	1.140	1.144	1.100*	1.095*	1.130	1.115
40 <sup>0</sup>	1.362	1.123	1.118	1.089*	1.082*	1.121	1.109	1.363	1.141	1.144	1.099*	1.094*	1.131	1.116
45 <sup>0</sup>	1.361	1.125	1.119	1.089*	1.084*	1.122	1.109	1.364	1.141	1.144	1.098*	1.093*	1.131	1.117
50 <sup>0</sup>	1.362	1.127	1.121	1.091*	1.086*	1.122	1.110	1.363	1.143	1.146	1.097*	1.092*	1.132	1.117
60 <sup>0</sup>	1.360	1.135	1.129	1.094*	1.089*	1.125	1.113	1.365	1.145	1.146	1.096*	1.090*	1.133	1.120
70 <sup>0</sup>	1.360	1.142	1.134	1.098*	1.092*	1.127	1.115	1.365	1.147	1.148	1.094*	1.089*	1.135	1.121
Ś0 <sup>0</sup>	1.361	1.150	1.143	1.101*	1.096*	1.131	1.119	1.367	1.146	1.148	1.092*	1.088*	1.136	1.122
90 <sup>0</sup>	1.360	1.159	1.153	1.103	1.097	1.133	1.121	1.367	1.146	1.148	1.090	1.087	.137	1.123
100 <sup>0</sup>	1.360	1.168	1.162	1.108*	1.102*	1.137	1.127	1.369	1.145	1.147	1.089*	1.085*	.137	1.124
1100	1.360	1.175	1.168	1.111*	1.105*	1.141	1.130	1.367	1.142	1.145	1.088*	1.084*	1.139	1.125
120 <sup>0</sup>	1.360	1.185	1.175	1.114*	1.109*	1.144	1.133	1.362	1.138	1.143	1.087*	1.082*	1.138	1.124
130 <sup>0</sup>	1.360	1.192	1.181	1.118*	1.111*	1.146	1.136	1.365	1.135	1.141	1.085*	1.080*	1.140	1.126
140 <sup>0</sup>	1.360	1.197	1.187	1.121*	1.115*	1.149	1.139	1.362	1.133	1.139	1.083*	1.079*	1.141	1.126
150 <sup>0</sup>	1.361	1.201	1.193	1,124	1.116	1.151	1.141	1.365	1.131	1.138	1.081	1.077	1.141	1.127
160 <sup>0</sup>	1.362	1.204	1.198	1.132	1.124	1,156	1.147	1.365	1.131	1.139	1.082	1.076	1.147	1.131
165 <sup>0</sup>	1.362	1.206	1.201	1.133*	1.125*	1.160	1.150	1.366	1.133	1.141	1.0837	1.078*	1.151	1.135
170 <sup>0</sup>	1.363	1.211	1.204	1.135*	1.126	1.164	1.154	1.367	1.134	1.143	1.084	1.080	1.156	1.140
175 <sup>0</sup>	1.365	1.216	1.208	1.136	1.127	1.167	1.156	1.372	1.136	1.144	1.085	1.079	1.159	1.144
180 <sup>0</sup>	1.366	1.228	1.219			1.173	1.160	1.376	1.138	1.147			1.163	1.148

\*Interpolated Data

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Table (	б-	3
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	M	FMR	·:
RADOME	1	LOSS	(L <sub>R</sub> )

	$ROLL = 0^{\circ}$								ROL], = 90 <sup>0</sup>							
рітсн	L	K <sub>u</sub> -1	K <sub>u</sub> -2	K1	K-2	K <sub>a</sub> -1	к <u>а</u> -2	L	к <sub>0</sub> -1	к <sub>и</sub> -2	K-1	K-2	K1	К <sub>а</sub> -2		
0 <sup>0</sup>		1.458	1.300	1.221	1.217	1.548	1.521		1.172	1.161	1.370	1.293	1.539	1.574		
5 <sup>0</sup>		1.403	1.276	1.204	1.198	1.535	1.512		1.170	1.160	1.245	1.212	1.568	1.591		
10 <sup>0</sup>		1.364	1.252	1.205	1.190	1.538	1.531		1.169	1,160	1.244	1.213	1.561	1.578		
15 <sup>0</sup>		1.350	1.242	1.191	1.176	1.543	1.549	ļ	1.171	1.159	1.248	1.223	1.559	1.555		
20 <sup>0</sup>		1.325	1.234	1.198	1.183	1,522	1.536		1.173	1.161	1.246	1.220	1.566	1.545		
25 <sup>0</sup>		1.298	1.223	1.226	1.209	1.495	1.504		1.173	1.162	1.221	1,199	1.566	1.536		
30 <sup>0</sup>		1,274	1.216	1.232	1.212	1.503	1.527	Į	1.180	1.165	1.216	1.193	1.566	1.530		
35 <sup>0</sup>		1.246	1.208	1.205	1.185	1.513	1.542	Ì	1.192	1.170	1.207	1.187	1.539	1.512		
40 <sup>0</sup>		1,240	1.206	1.201*	1.182*	1.486	1.512		1.198	1.176	1.202*	1.183*	1.489	1.463		
45 <sup>0</sup>		1.230	1.194	1.198*	1.178*	1.477	1.506	1	1.212	1.184	1.197*	1.178*	1.483	1.458		
50 <sup>0</sup>		1.222	1.186	1.194*	1.175*	1.472	1,496		1,205	1.181	1.192*	1.174*	1.474	1.450		
60 <sup>0</sup>		1.214	1.177	1.191*	1.171*	1.502	1.518		1.192	1.174	1.186*	1.169*	1.494	1.481		
70 <sup>0</sup>		1,214	1.193	1.187*	1.168*	1.450	1.466		1.195	1.186	1.181*	1,165*	1.463	1.440		
80 <sup>0</sup>		1.217	1.209	1.184*	1.164*	1.478	1.487		1.206	1.204	1.176*	1.160*	1.468	1.454		
90 <sup>0</sup>		1,215	1.207	1.180	1,161	1.454	1.461		1.189	1.175	1.171	1.156	1.449	1.436		
100 <sup>0</sup>		1.211	1.204	1.189*	1.170*	1.426	1.429	]	1.193	1.177	1.178*	1,161*	1.435	1.425		
110 <sup>0</sup>		1.206	1.199	1.196*	1.179*	1.412	1.414		1.207	1,188	1.184*	1.166*	1.420	1.413		
120 <sup>0</sup>		1.202	1.194	1.205*	1.189*	1.338	1.340		1.195	1.176	1.191*	1.171*	1.338	1.342		
130 <sup>0</sup>		1.208	1.198	1.214*	1.198*	1.354	1.359		1.171	1.160	1.198*	1.175*	1.331	1.332		
140 <sup>0</sup>		1.214	1.205	1.223*	1.207*	1.357	1.360		1.163	1.156	1.204*	1.180*	1.345	1.343		
150 <sup>0</sup>		1,207	1,205	1.234	1.216	1.362	1.359		1.165	1.156	1.211	1.185	1.367	1.364		
160 <sup>0</sup>		1.292	1.278	1.342	1.325	1.440	1,460		1,177	1.163	1.271	1.244	1.401	1.386		
165 <sup>0</sup>		1.378	1.359	1.420	1.419	1.486	1.534	]	1.190	1.172	1.383	1.346	1.409	1.381		
170 <sup>0</sup>	-	1.379	1.388	1.446	1.419	1.552	1.582	ł	1.195	1.175	1.417	1.376	1.445	1.404		
175 <sup>0</sup>		1.412	1.416	1.620	1.595	1.683	1.770	1	1.252	1.209	1.528	1.463	1.791	1.698		
180 <sup>0</sup>		1.366	1,323			1.838	1.922	1	6.880	6.605			9.473	10.551		

\*Interpolated Data

NOTE: L-Band data missing because of mutual interaction effects between radome and antenna.

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Table 6-4

MFMR

RADDME 2 LOSS (L<sub>R</sub>)

	$ROLL = 0^{\circ}$								$ROLL = 90^{\circ}$							
PITCH	L	K <sub>u</sub> -1	K <sub>u</sub> -2	K-1	K-2	K <sub>a</sub> -1	K <sub>a</sub> -2		L	K1	K2	K-1	K-2	К1	K <sub>a</sub> -2	
00		1.536	1.357	1.241	1.228	1.520	1.454	Ι		1.220	1.196	1.287	1.224	1.480	1.537	
5 <sup>0</sup>		1.475	1.329	1.228	1.216	1.577	1.517			1.214	1,193	1.217	1,188	1.463	1.509	
10 <sup>0</sup>		1.426	1.290	1.231	1.208	1.601	1.560			1.207	1.187	1.228	1,198	1.478	1.511	
15 <sup>0</sup>		1.408	1.280	1.230	1.207	1.595	1.575			1.194	1.182	1.239	1.213	1.495	1.513	
20 <sup>0</sup>		1.394	1.278	1.232	1.208	1.571	1.560			1.185	1.177	1.237	1.211	1.494	1.495	
25 <sup>0</sup>		1.367	1.263	1.219	1.199	1.544	1.545	IJ		1.180	1.178	1.237	1.211	1.487	1.478	
30 <sup>0</sup>		1.339	1,250	1.212	1.194	1.547	1.559			1.180	1.176	1.236	1.210	1.486	1.469	
35 <sup>0</sup>		1.301	1.237	1.210	1.191	1.531	1.543			1.185	1.180	1.229	1.206	1.486	1.467	
40 <sup>0</sup>		1.291	1.239	1.214	1.198	1.569	1.571			1.191*	1.185*	1.223*	1.202*	1.481*	1.463*	
45 <sup>0</sup>		1,278	1.229	1.189	1.174	1.515	1.519			1.197*	1.190*	1.218*	1.199*	1.476*	1.460*	
50 <sup>0</sup>		1.229	1.194	1.153	1.138	1.482	1.487			1.203*	1.195*	1.212*	1,195*	1.471*	1.456*	
60 <sup>0</sup>		1.229	1.214	1.157	1.142	1.459	1.461			1.208*	1.200*	1.206*	1.192*	1.465*	1.452*	
70 <sup>0</sup>		1.235	1,225	1.162	1.146	1.512	1.504			1 <b>.21</b> 4*	1.205*	1.200*	1.188*	1.460*	1.448*	
80 <sup>0</sup>		1.239	1.231	1.171	1,156	1.463	1.460			1.220*	1.210*	1.195*	1,185*	1.455*	1.445*	
90 <sup>0</sup>		1.248	1.240	1.205	1.192	1.457	1.452			1.226	1.215	1.189	1.181	1.450	1.441	
700 <sub>0</sub>		1.250	1.243	1.205	1.199	1.479	1.468			1.223*	1.212#	1.193*	1.182*	1.450*	1.440*	
110 <sup>0</sup>		1.249	1.245	1.199	1.183	1.508	1.523			1.220*	1.209*	1.195*	1.183*	1.450*	1.439*	
120 <sup>0</sup>		1.253	1.246	1.211	1.190	1.522	1.527			1.217*	1.206*	1.199*	1.184*	1.451*	1.438*	
130 <sup>0</sup>		1.265	1.256	1.219	1.195	1.516	1.518	11		1.214*	1.202*	1.202*	1.184*	1.451*	1.437*	
140 <sup>0</sup>		1.237	1.230	1,186	1.173	1.425	1.447			1.211*	1.199*	1.206*	1.185*	1.452*	1.436*	
150 <sup>0</sup>		1.232	1.235	1.197	1,189	1.402	1.419			1.208	1.196	1.212	1.186	1.452	1.435	
160 <sup>0</sup>		1.280	1.279	1.306	1.299	1.492	1.546			1.222	1.202	1.243	1.220	1.436	1.397	
165 <sup>0</sup>		1.345	1.358	1.432	1.435	1.451	1.490			1.228	1.205	1,287	1.254	1.393	1.366	
170 <sup>0</sup>		1.377	1.404	1.504	1.511	1.427	1.489			1.238	1.209	1.294	1.263	1.468	1.403	
175 <sup>0</sup>		1.418	1.469	1.749	1.766	1.577	1.664	$\ $		1.282	1.254	1.411	1.346	1.885	1.720	
180 <sup>0</sup>		1.359	1.422	1.713	1.738	1.690	1.774			1.319	1.290	1.313	<b>1.26</b> 1	1.924	1.879	

\*Interpolated Data

NOTE: L-Band data missing because of mutual interaction effects between radome and antenna.

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Fig. 6-2. MFMR antenna loss versus pitch angle -- Ku-Band.



Fig. 6-3. MFMR antenna loss versus pitch angle -- K-Band.



Fig. 6-4. MFMR antenna loss versus pitch angle --  $K_a$ -Band.












loss  $L_A$  at  $K_u$ -Band (and to a lesser extent, at K and  $K_a$ -Bands) rose monotonically with pitch angle increasing beyond 60° (when the roll was 0°) when the absorber was in place on the mockup bulkhead of the aircraft. When the absorber was removed, the antenna loss was essentially independent of pitch angle both at  $K_u$  and  $K_a$ -bands (no measurement at K-Band were made without absorber). It is the intention of Sec. 6.5 tc show a mechanism of interaction between the bulkhead and the horn and to suggest further measurements which could improve the accuracy of the loss numbers applied to use in the operational situation on the P-3 aircraft. Comments are restricted mostly to the  $K_u$ -Band horn, but the approach can be generalized.

## 6.5.2 Near-field Patterns of Circular Horns

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Assuming the scalar K,-Band horn has 25 dB sidelobes, the circular Taylor distributions for near-field given by Hansen [1964] for a 10 wavelength diameter aperture can be used by rescaling to the diameter of the K,-Band horn (36 cm). Fig. 15 (p. 29) of Hansen lists several field patterns for a  $10\lambda$  diameter horn in free space. Let R be the distance to field point from the horn phase center (taken to be in the center of the mouth of the horn). Hansen defines  $\Delta = \frac{R}{2D^2/\lambda}$  and plots field patterns for  $\Delta = 0.0375$ , 0.05, 0.075, 0.125, 0.25 and  $\infty$ . We are interested in the smallest two of these. Fig. 6-11 is a general plot of the power pattern (dB) for  $\Delta = 0.0375$  (R = 58 cm., 0.05 (79 cm.) and  $\infty$  (far-field) with the abscissa X = ka sin  $\theta = \frac{\pi D}{\lambda} \sin \theta = 10\pi \sin \theta$ . Since the K<sub>1</sub>-Band horn has a diameter of 21.7 $\lambda$  at 18 GHz, Fig. 6-11 can be rescaled to this diameter, producing the graph of Fig. 6-12. According to Hansen, a typical circular Taylor design would require a monotonic aperture distribution with the power density at the edge of the horn lown about 8 dB from its value on axis. This produces the aperture distribution curve at a radius of 18 cm shown in Fig. 6-12.



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Fig. 6-ll. Fresnel and far-field patterns for 25 dB circular Taylor distribution.

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Fig. 6-12. Fresnel and far-field patterns.

The on-axis power density oscillates with distance from the phase center, assumed here to be at or very near the horn mouth. Fig. 6-13 is extrapolated from Hansen's data and plots the on-axis power in dB vs. distance. The variation out to about 200 cm is  $\pm$  1 dB and can be seen to fluctuate most rapidly out to 50 cm from the horn. Beyond about 175 cm, the  $1/R^2$  far-field behavior begins to predominate.

# 6.5.3 Geometry of Horn Relative to Bulkhead

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Fig. 6-14 shows the geometrical relationship of the horn relative to the absorber-covered bulkhead, for pitch angles of 180° (when horn is looking at zenith) and at 100° (slightly up from the aircraft flight vector). The distance from the horn phase center varies from about 38 cm (closest approach at  $\theta = 180^{\circ}$ ) to about 81 cm (farthest approach at  $\theta = 70^{\circ}$ ) so that the near field pattern evaluated at the distance to the absorber must be a function of angle from horn axis as well as radius. To a first approximation, all near field patterns have the same on-axis gain level, and can therefore be normalized to 0 dB.

## 6.5.4 Contribution of Absorber to Brightness Temperature

The near-field curves of Fig. 6-12 make two assumptions:

- 1) The horn is in free space
- 2) Edge diffracted rays are negligible

In reality, however, the horn is near a number of metallic surfaces, some of them very close. Furthermore, the approximate -8 dB edge taper introduces the possibility of strong near-field interaction between the horn and the mounting ring, L-Band antenna and receiver enclosures. It has been shown in a series of papers by Peters, et. al. [1966, 1975] that a Fourier transformation of an aperture distribution which is assumed to be zero outside the



AXIAL DISTANCE FROM HORN MOUTH (Cm)

Fig. 6-13. On axis power density versus axial distance from horn mouth.



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Fig. 6-14. Positions relative to bulkhead - MFMR.

aperture of a horn (i.e., neglecting induced line sources at the horn edges) is satisfactory to predict the far-field shape of the main beam and the first few sidelobes, but fails to predict the level and structure of the far sidelobes and backlobes, either in the E-plane or in the H-plane. Typically, aperture integration methods which neglect the geometrically-diffracted rays from the edge give good agreement with measured results out to about 5 or 6 times the HPBW, when in the far field.

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Thus, in the near-field, a similar behavior can be expected so that the patterns of Fig. 6-12 may be considerably broader below about -20 dB, than shown. In addition, the <u>in situ</u> patterns may exhibit considerable asymmetry.

Can this near-field perturbed behavior, including edge diffracted rays, contribute to an increased antenna brightness temperature resulting from the 290 K absorbing wall? The answer is yes, and that it can be explained in terms of a broadened near-zone pattern behavior. The antenna brightness temperature is given by

$$T_{A} = \frac{1}{4\pi} \iint_{A_{\pi}} T_{B}(\theta, \phi) G(\theta, \phi) d\Omega$$
 (6-3)

where  $T_B$  is the source brightness temperature distribution (consisting of both the sky temperature and absorber temperature), G is the antenna gain pattern, and  $d\Omega = \sin \theta \ d\theta \ d\phi$  in a spherical coordinate system. This formula does not explicitly consider the distance from the antenna to the radiating surface. Normally, in the far-field,  $G(\theta, \phi)$  is independent of distance R from the antenna. However, in the near-field, the gain is a strong function of distance, i.e.

$$G = G[\theta, \phi, R(\theta, \phi)]$$
(6-4)

as shown in Figs. 6-11 and 6-12. A rough approximation to the  $K_u$ -Band Brightness distribution (in the bucket) is shown in Fig. 6-15. Also shown are the far-field and estimated near-field patterns of the  $K_u$ -Band horns, when the horn axis is at a pitch angle of 100° and a roll of 0°. In this situation, the phase center of the horn is approximately 71 cm from the nearest approach of the absorber. Edge diffraction from the horn and interaction with the adjacent  $K_a$  and K-Band horns and the L-Band array may appreciably broaden and distort the near-field patterns from those shown in Fig. 6-12, leading to the dashed pattern (estimated) shown in Fig. 6-15 (top).

Denoting the pitch angle of the horn axis as  $\theta_0$ , eqn. (1) may be rewritten more explicitly as

$$T_{A}(\theta_{O}) = \frac{1}{4\pi} \iint_{4\pi} T_{B}(\theta', \phi')G(\theta_{O} - \phi', \phi_{O} - \phi) \sin \theta' d\theta' d\phi' \quad (6-5)$$

where the roll position is  $\phi_0$  ( $\phi_0 = 0^\circ, 90^\circ$ ) and ( $\theta', \phi'$ ) are the (pitch, roll) angles measured from the main beam position. This is recognized as the familiar convolution integral, and leads to an antenna temperature profile of the form shown in Fig. 6-15 (bottom). No scale units are placed on the ordinate since the function  $G(\theta_0 - \theta', \phi_0 - \phi')$  is not known exactly enough to carry out the integration in (6-5). However, the gradual rise of the antenna temperature from 90° to 180° is due to the increasing contribution from the relatively hot absorber as  $\theta_0$  is increased.

If the shape of the absorbing surface or its distance to the horn  $R(\theta_0, \phi_0)$  is changed by only a few cm, the near-field pattern of the horn can change appreciably so that the slope

 $\frac{dT_A}{d\theta_o}$  in the near-zenith region (Fig. 6-15) may likewise change. Thus it is of considerable importance that the mockup aircraft bulkhead be as faithful a replica of the actual aircraft bulkhead





as possible, especially when the "calibrated" antenna is to be used for near-zenith observation.

When the absorber is removed, however, this critical relationship no longer exists and the antenna loss becomes nearly independent of pitch angle, as shown in Fig. 6-16 for Channel 1 at  $K_u$ -Band. Similar behavior was observed at  $K_a$ -Band; no data without absorber was available at K-Band since the receiver failed during that measurement sequence.

# 6.5.5 Conclusions

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When the absorber is used on the aircraft bulkhead, the MFMR  $K_u$ , K and K-Band loss values (both antenna and radome) measured at A-Mountain in February, 1975 are of questionable validity since the mockup and absorber used differ from the operational configuration. The complex nature of the interaction between the horn antennas, the sky temperature and the absorber temperature make it almost insuperably difficult to calculate the slope of the antenna loss  $\frac{dL_A}{d\theta_O}$  and therefore the values of radome loss. Future measurements should be taken with a much better bulkhead replica and should use the same absorber type and shape used in flight.

## 6.6 MFMR Antenna and Radome Loss Values (L-Band)

Table 5-1 lists the antenna loss values for the AIL L-Band antenna and shows that the loss (~1.34 dB) is essentially independent of pitch or roll so long as there is no radome present or L-Band absorber on the bulkhead.

The fact that the X-Band absorber has no effect at L-Band is illustrated in Fig. 6-17 for  $L_A$  measured values, both with and without absorber.





angle -- L-Band.

It was found that this non-absorbing bulkhead produced a strong interaction between the L-Band antenna and the radome because of multiple internal reflections off the bulkhead. This effect is clearly evident in Fig. 6-18 where the uncorrected brightness temperature is plotted vs. pitch angle, both for radome (#2) on and off. When  $T_{\rm B}^{*}$  (radome on) exceeds  $T_{\rm B}^{*}$ (radome off), the radome loss is greater than unity, but otherwise (0°  $\leq \theta_{0} < 5^{\circ}$ ; 90°  $\leq \theta_{0} < 165^{\circ}$ ) the radome loss would appear to be less than unity, an absurd result. Moreover, it is clear that the radome loss at L-Band should be essentially independent of pitch angle  $\theta_{o}$ . The same effect is observed for the Aerojet L-Band array, as shown in Fig. 6-19, although the radome on temperature is consistently higher than the radome off temperature. This unstable behavior is again caused by internal scatter by the radome and is further evidenced in Fig. 6-20 where the VSWR of the Aerojet L-Band array is compared for both radome on and radome The peak mismatch at  $_{0}$ =5° agrees with the peak in T<sub>B</sub> at off.  $\theta_{c}=5^{\circ}$  in Fig. 6-19.

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A partial correction of  $T_B$  due to the mismatch loss can be made even though it is not sufficient to describe the more general effect of redistributed antenna currents on the array. Thus, the radome loss would be estimated by

$$L_{R} = \frac{T_{on}}{T_{off}} \left[ \frac{1 - |r_{on}|^{2}}{1 - |r_{off}|^{2}} \right]$$
(6-6)

where  $T_{on}$  and  $T_{off}$  refer to the curves of Fig. 6-19 and the bracketed quantity is the mismatch loss correction. |F| is the magnitude of the voltage reflection coefficient and is related to the VSWR curves of Fig. 6-20 by

$$|\Gamma| = \frac{VSWR - 1}{VSWR + 1}$$
(6-7)

After  $L_R$  is computed for all pitch angles  $\theta_O$  and averaged, a value





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$$L_R \approx 1.09 \ (0.38 \ dB) \ (6-8)$$

is obtained. It is suggested that this figure be used until new loss measurements (with a good L-Band absorber) become available.

Since L-Band Eccosorb <u>is</u> being used in flight and must certainly contribute to the apparent source temperature, it is clear that this loss component was excluded from these measurements and that the  $L_A$  values in Table 6-1 for L-Band are too low. Furthermore,  $L_A$  (with absorber in place) would become even higher as  $\theta_0 \rightarrow 0^\circ$  and the near-zone antenna pattern begins to intercept the absorber.

## 6.7 MFMR Error Budget

The general theory follows that used for PMIS, as discussed in Sec. 5.5.1.

## 1. Random Error

It can be shown that the standard deviations of the antenna and radome losses are given by

$$\sigma_{L_{A}} = \frac{(T_{A} - T_{S})L_{W}}{[T_{A} + T_{W}(L_{W} - 1) - L_{W}T_{B}^{\dagger}]^{2}} \sigma_{T_{B}}$$
(6-9)

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$${}^{\sigma}L_{R} = \frac{(T_{R} - T_{S})L_{A}}{[T_{R} + T_{A}(L_{A} - 1) + T_{W}L_{A}(L_{W} - 1) - L_{A}L_{W}T_{B}^{\dagger}]^{2}} {}^{\sigma}T_{B}$$
(6-10)

Under typical circumstances at K<sub>u</sub>, K, and K-Bands, T<sub>S</sub> = 13 K, T<sub>A</sub> = 288 K, T<sub>R</sub> = 290 K, T<sub>B</sub><sup>i</sup> = 42 K,  $\sigma_{TB}$  = 0.25 K, L<sub>W</sub> = 1.05, L<sub>A</sub> = 1.065 and L<sub>R</sub> = 1.30. Using these values in (6-9) and (6-10),

$$\sigma_{L_{A}} \simeq \sigma_{L_{R}} \simeq 0.001 \tag{6-11}$$

# 2. Systematic Error

Systematic errors in the antenna loss arise primarily from inaccuracies in (1) the apparent sky temperature,  $\Delta T_s$  and (2) the receiver calibration,  $\Delta T_B^i$ . Systematic errors in the radome loss arise from not only  $\Delta T_s$  and  $\Delta T_B^i$  but in addition, any systematic error  $\Delta L_A$  in the antenna loss. The worst case systematic errors may be calculated from

$$\Delta \mathbf{L}_{\mathbf{A}} = \frac{\mathbf{L}_{\mathbf{A}}}{\mathbf{T}_{\mathbf{A}} - \mathbf{T}_{\mathbf{S}}} \Delta \mathbf{T}_{\mathbf{S}} + \frac{\mathbf{L}_{\mathbf{A}} \mathbf{L}_{\mathbf{W}}}{\mathbf{D}_{\mathbf{A}}} \Delta \mathbf{T}_{\mathbf{B}}^{\dagger}$$
(6-12)

and

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$$\Delta \mathbf{L}_{\mathbf{R}} = \frac{1}{D_{\mathbf{R}}} \left\{ \Delta \mathbf{T}_{\mathbf{S}} + \mathbf{L}_{\mathbf{R}} \mathbf{L}_{\mathbf{A}} \mathbf{L}_{\mathbf{W}} \Delta \mathbf{T}_{\mathbf{B}}^{\dagger} + \mathbf{L}_{\mathbf{R}} D_{\mathbf{A}} \Delta \mathbf{L}_{\mathbf{A}} \right\}$$
(6-13)

where

$$D_{A} = T_{A} + T_{W}(L_{W} - 1) - L_{W}T_{B}^{T}$$
 (6-14)

$$D_{R} = T_{R} + T_{A}(L_{A} - 1) + T_{W}L_{A}(L_{W} - 1) - L_{A}L_{W}T_{B}^{\dagger}$$
(6-15)

Using the assumed constants in 6.7.1-1,

$$\Delta L_{A} = 0.004 \ \Delta T_{S} + 0.004 \ \Delta T_{B}^{\dagger}$$
(6-16)

and

$$\Delta L_{R} = 0.004 \ \Delta T_{S} + 0.005 \ \Delta T_{B}^{*} + \Delta L_{A}$$
 (6-17)

The accuracy of the receiver calibration,  $\Delta T_B^*$ , is related to the calibration of the reference hot and cold loads and again it is assumed that

$$\Delta T_{\rm B}^1 = \pm 1 \, {\rm K}$$
 (6-18)

The accuracy of the <u>apparent</u> sky temperature,  $\Delta T_g$ , depends not only on the adequacy of the Paris model for estimating the sky noise component, but also it depends very critically on the fidelity of the aircraft bulkhead mockup and its absorber geometry. Table 4-2 lists the systematic error in the sky noise component. However, there is apparently no way of estimating the systematic error due to the poor replication of the aircraft bulkhead environment in the mockup furnished. This becomes particularly critical at the pitch angles (0° - 20°, 160° - 180°) where good loss data is most needed. It is easily conceivable that a total systematic error  $\Delta T_g = \pm 10$  K could be encountered in such a circumstance, thus yielding

$$\Delta L_{a} = \pm 0.04 \tag{6-19}$$

$$\Delta L_{p} = \pm 0.09 \tag{6-20}$$

as a possible systematic error.

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This situation clearly leads to unacceptably high accuracy errors in the brightness temperature and can be improved only after a better replica of the aircraft bulkhead has been furnished.

#### CHAPTER VII

#### BUCKET PERFORMANCE TESTS

## 7.0 INTRODUCTION

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Several questions arise when evaluating the performance of the bucket and this chapter discusses the most obvious of these, e.g.

1. Does antenna location change within the bucket affect the observed brightness temperature?

2. How does one know that the effective emissivity of the bucket doesn't change over a period of many months or years?

3. Does electromagnetic interference (EMI) affect operation in the bucket?

# 7.1 Effect of Antenna Location Change

It can be quite naturally suspected that the bucket, being a partially closed metal box, might have resonances associated with it. Clearly, as shown in Fig. 2-6, if the bucket is too small there are observable effects on even the "lit zone" portion of the antenna pattern.

There is, however, clear evidence at L,  $K_u$  and  $K_a$ -Bands that location change within the bucket has a negligible effect. Figs. 7-1 and 7-2 compare the antenna loss vs. pitch angle at  $K_u$ -2 and  $K_a$ -1-Bands, with and without absorber on the bulkhead. Two conclusions are immediate: (1) the rise in  $L_A$  with increasing  $\theta_o$ (with absorber) is due to an increased noise contribution from the absorber (see also Sec. 6.5) and (2) when there is no absorber





Fig. 7-2. MFMR antenna loss versus pitch angle -- Ka-Band.

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on the bulkhead, the flat loss curve indicates that raising the horns from a mid-bucket position (at  $\theta_0 = 0^\circ$  or  $180^\circ$  as in Fig. 2-7) to a position very high in the bucket has a negligible effect.

In early May, 1975 a similar experiment was conducted at L-Band using the S-194 radiometer receiver and a standard gain horn. The horn was connected to the receiver through about 6 m of flexible coaxial cable so that it could be easily positioned at various locations within the bucket. The tests were conducted in mid-afternoon so that the sun was radiometrically visible by pointing the horn toward the southwest corner of the bucket. Thus, some of the variation in  $T_B^i$  was due to the sun intercepting various portions of the antenna pattern.

Even under these adverse conditions, however, a movement of the horn from near the bucket floor to near the top produced only a 1.7 K change. Pointing the horn directly toward the north wall of the bucket produced only a 3.9 K change.

It may be concluded that if the radiometer has a reasonably low sidelobe level (say, below -25 dB), there is virtually no dependence of the observed brightness temperature on antenna location within the bucket.

## 7.2 Long-Term Bucket Emissivity Changes

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It has been pointed out in Sec. 2.4.2 that from a theoretical viewpoint even the most pessimistic of changes in the bucket emissivity or shape would not be observable by any modern radiometer.

Nonetheless, certain baseline performance checks have been made at X,  $K_u$ , and  $K_a$ -Bands to produce an eventual verification that the bucket characteristics are stable over a period of months or years. The idea behind the verification check is that

if a calibrated radiometer in the bucket views a known source temperature  $T_S$ , then any change in the apparent loss  $L_A$  would be due to a change in the emissivity or shape of the bucket.

## 7.2.1 X-Band Measurements

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At X-Band, the sky temperature is typically 5 K and can be calculated (using radiosonde data) to an accuracy of  $\pm$  0.4 K. To ensure that the antenna characteristics would not change, an X-Band standard gain horn (Scientific-Atlanta Model 21-8.4) was used and was mounted on the centerline of the bucket with the horn mouth 3/96 m above the floor, as shown in Fig. 7-3. The E-plane was oriented east-west.

In order to bring the antenna brightness temperature within the normal operating range of the radiometer, an HP-Model X382 precision attenuator was inserted between the horn and the radiometer (the PMIS vertical channel was used). The attenuator was set at 1.0, 1.2, 1.4 and 1.6 dB (four 1-minute averages each) and the corresponding values of  $T'_B$  noted (74.15, 82.78, 89.67, and 97.87 K respectively). The sky temperature  $T_s$  was 4.9 K on the night of measurement (2-6-75), so that for the 1 dB setting,

$$L_A = \frac{T_A - T_S}{T_A - T_B} = \frac{296 - 4.9}{296 - 74} = 1.312 (1.18 \text{ dB})$$
 (7-1)

which leaves 0.18 dB as the antenna loss of the X-Band horn. Continuing in this fashion, the graph of Fig. 7-4 is obtained, in which the uncorrected brightness temperature  $T_B^*$  is plotted vs. the total loss in dB. The measured points give a slope of 4.0 K/0.1 dB and the calculated slope (obtained by adding 0.18 dB to the attenuator setting and using  $T_{sky} = 4.9$  K) gives 4.8 K/0.1 dB. The difference in slope may be attributed to using the calibration constants  $T_1$ ,  $\Delta T$  outside of their 100 K - 200 K intended range.



Fig. 7-3. Bucket calibration at X-Band.



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If the emissivity of the bucket were to degrade, then  $T_s = k T_{sky}$ where k (>1) is the degradation factor. The uncorrected brightness temperature is then given (from 2-7) by

$$T_{B}^{\dagger} = T_{A}^{\dagger} + \frac{kT_{sky} - T_{A}}{L_{A}}$$
(7-2)

where all quantities except k are now known. It is straightforward to show that a change of  $L_A$  (by attenuation setting) from 1.5 dB to 1.6 dB causes a change in  $\Delta T_B^{\dagger}$  given by

$$\Delta T_{\rm B}^{\prime} = \frac{T_{\rm A}^{\prime} - kT_{\rm Sky}}{L_{\rm A}^{2}} (.033)$$
(7-3)

where  $L_A$  is the median value,  $L_A = 1.429$ . Therefore,

ΔT<sub>B</sub> (7-4)

For example, when  $T_A = 296$  K (thermistor reading) and  $T_{sky} = 4.9$  K, and assuming k = 1,

$$\Delta T_{\rm B}' = 4.7 \text{ K/0.1 dB}$$
(7-5)

If, due to bucket corrosion, deformations, etc. k were to double, then  $\Delta T_B^1 = 4.6 \text{ K/0.1 dB}$ . Extending this to a 1.0 dB change in  $L_h$ , a 1 K <u>difference</u> in slope would be observed.

Clearly, a change in bucket emissivity is indistinguishable from a systematic error in  $T_{sky}$ . Therefore, it is imperative in constructing a history of the bucket performance that  $T_{sky}$  be accurately assessed from sounding data.

# 7.2.,2 L, K<sub>u</sub>, K<sub>a</sub>-Band Measurements

Similar bucket performance tests were conducted at L,  $K_u$  and  $K_a$ -Bands except that a 183 cm diameter microwave absorbing disk was suspended 6 m above the MFMR antenna assembly as shown in Fig. 7-5. The purpose of the disk was to present a known hot brightness temperature which subtended most of the antenna beam solid angle [Kraus and Carver, 1974] and thereby reduce the systematic error in the apparent sky brightness temperature. The disk was held rigidly in place by a quadrupod arrangement of four aluminum spars and the absorber temperature was averaged from the readings of eight thermistors embedded at various locations across the disk.

Five one-minute averages were recorded for each of the five channels, with a pitch angle of 180° in all cases. The roll angle was set to 0°, then to 180° and then back to 0°, with the results as shown in Fig. 7-6. The sky temperatures (2-18-75) at L, K<sub>u</sub> and K<sub>a</sub>-Bands were 4.3 K, 6.3 K and 11.1 K respectively. The average disk temperature was 288.5 K. It is clear that the high T<sup>1</sup><sub>B</sub> values indicate that the main beam of each antenna was viewing primarily the disk and that errors in T<sub>sky</sub> would be of negligible importance in determining the repeatability of the experiment.

However, the lack of repeatability of the  $T_B^{\prime}$  in the two measurements for a roll of 0° indicates that the mechanical repositioning accuracy of the antennas was poor. The roll angle settings were carried out using hand positioning of the ring (by LEC/HASD personnel) and the lack of repeatability may have been due to personnel fatigue and consequent carelessness or it may have been an inherent problem in the MFMR positioning system. Until this problem is corrected, it is not reasonable to expect that these results can be repeated.



Fig. 7-5. Absorbing disk located above MFMR antenna assembly.



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REQUENCY	PITCH = 180 <sup>0</sup> , ROLL = 0 <sup>0</sup>		PITCH = 180 <sup>0</sup> , ROLL = 90 <sup>0</sup>
	NO. 1	NO.2	
K <sub>u</sub> • GH. 1	174.9K	168.8K	221.9K
K <sub>u</sub> -CH. 2	176.6K	170.2K	223.3K
K <sub>a</sub> - CH. 1	191.1K	184.9K	197.9K
К <sub>а</sub> - СН. 2	193.8K	187.2K	197.9K
L	188.1K	187.4K	181.9K

Fig. 7-6. L,  $K_u$ ,  $K_a$  bucket verification tests.

7.3 <u>EMI</u>

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Systematic spectrum surveillance tests were conducted throughout the VHF-UHF bands to identify and record interfering RF signals that could possibly be detected by the radiometer IF circuitry. These tests made use of the HP 8550 series spectrum analyzer with various Yagi and log periodic antennas. The antennas were placed in and near the bucket and were pointed in different directions.

The only interfering signal that seemed to be correlated with the radiometer output was a 150 MHz sporadically actuated carrier from a state police repeater tower located approximately 600 m northeast of the bucket. This signal level occasionally exceeded an input power level of -20 dBm when a moderately directive three-element Yagi was pointed directly toward the repeater tower.

No power line interference or ignition noise was observable at the radiometer output.
### APPENDIX

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### PMIS & MFMR RADIOMETER PROGRAMS

#### INTRODUCTION

Two separate sets of program procedures are given here: one for the PMIS series of programs, and one for the MFMR series of programs. Although some repetition is entailed, the procedures for both series are written as separate modules, designed to be used independently of each other without cross-referencing.

To facilitate use of the procedures, a reference index is provided for each series of programs. The pagination style is a key to the series of programs (FMIS or MFMR), the program within the series (PMIS 1, PMIS 2, SKYTEMP program used with PMIS data, etc.). For example: P1.1 denotes page 1 of the PMIS 1 program procedures; PS.1 is page ' of the SKYTEMP program as used in the PMIS series; and, P3.1 is page 1 of PMIS 3 program procedures. In like fashion, the prefix "M" indicates a page of the MFMR procedures writeup.

# PMIS PROGRAMS - REFERENCE INDEX

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PROGRAM PROCEDURE TO REDUCE PMIS DATA TAPES

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TO L	OAD AND EXECUTE THE SYSTEM-7 PROGRAM, PROCEED AS FOLLOWS:
(1)	RUN U-ZERO TAPE (LOAD UNIT ADDRESS = X'0000')
(2)	LOAD IPL PROGRAM FROM DISK (LOAD UNIT ADDRESS = X'0002')
	*** IPOO A ENTER CONTROL STATEMENT
(3)	CYCLE HOST ATTACH SWITCH TO (ENABLE AND IPL) AND THEN TO (ENABLE);
	IT MUST REMAIN ON (ENABLE) FOR REMAINDER OF PROGRAM EXE- CUTION.
(4)	SET DISK PROGRAM "DATA SET NAME" BY FOLLOWING R(EFER) STATEMENT:
	R JOBLIB, F2,, PCMUSER
(5)	L(QAD) PCM PROGRAM INTO CORE BY FOLLOWING L(OAD) STATEMENT:
	L PCM01B

# PROGRAM PROCEDURE TO REDUCE PMIS DATA TAPES

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Notes: "PA are given : by hand-dr:	MIS" is the name of the program and of the radiometer being tested; procedures in large type, while explanatory comments are given in smaller type enclosed awn brackets, thus: for benefit of one who is unfamiliar with the System-7].
PRIO	R TO LOADING THE SYSTEM-7 PCM PROGRAM: PERFORM CHECKOUT OF ALL PCM HARDWARE AND TAPE(S).
, TOL	OAD AND EXECUTE THE SYSTEM-7 PROGRAM, PROCEED AS FOLLOWS:
(1)	RUN U-ZERO TAPE (LOAD UNIT ADDRESS = X'0000')
]	U-ZERO, the tape to IPL the computer, is a small, blue punch tape kept right by the computer; put Address switches on 0000 (Addresses are con- trol switches on front of computer; there are 4 Address switches, thus <u>each</u> Address switch is set on 0, as indicated by the four zeros in step (1), above.
ູ່ (2)	LOAD IPL PROGRAM FROM DISK (LOAD UNIT ADDRESS = X'0002')
1	IPL denotes "Initial Program Load". Leave the first 3 Address switches on zero, move the right hand Address switch to setting of 2.
	*** IPOO A ENTER CONTROL STATEMENT
}	the above is a statement that the computer sends back to you after you have done step (2)
(3)	CYCLE HOST ATTACH SWITCH TO (ENABLE AND IPL) AND THEN TO (ENABLE) WHERE IT MUST REMAIN FOR THE REMAINDER OF PROGRAM EXECUTION.
- - - -	the Host attach switch is another control switch on the front of the computer; switch it to "Off" (that's down), then up to "Enable and IPL" and back to center position, which is "Enable"; it must stay on "Enable" all the time you're transferring data from Sys7 to Sys370 - this is done in order to establish a linkage with the System-370.
(4)	SET DISK PROGRAM "DATA SET NAME" BY FOLLOWING R(EFER) STATEMENT:
1	Step (4) tells you to type an "R", that is, "Reference Statement", on the control typewriter. The statement to be typed, is as follows, be- low (be sure to leave a space between the "R" and the "J").
ļ	R JOBLIB, F2, , PCMUSER
(5)	L(OAD) PCM PROGRAM INTO CORE BY FOLLOWING L(OAD) STATEMENT:
1	after typing the statement of step (4)'s instruction, execute step (5) by typing the following statement, below. Leave a space between "L" and "P".
1	L PCM01B
THE WILL SYST	SYSTEM-/ IS NOW PREPARED TO ACCEPT LINKUP WITH THE SYSTEM-3/U AND . REMAIN IN A WAIT STATE UNTIL PMISL PROGRAM IS EXECUTED BY THE TEM-370.
	page P.1a

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ec Sa PRENNIP (2) BIT SHUCHESNIZCE D TIME CODE RENDER Anvex Type Recerence VARIABLE FILTOR 3 SCOPE (9) MULTIPLEXIE OF POOR QUALITY ORIGINAL PCM INTERTICE PCM MONITOR (8  $(\mathbf{D})$ Telemetry Playback Console (G) PWR ON 16-BIT Z LOND YRUN  $(\mathcal{D})$ () PWR ON @ TURN ON TURN ON SETTING @ MPHOS 250 ] LPASS 2300] (B) PURON WORD 159 (9) THEN ON TIMENIG LEVEL MONITOR T SET 3.5 UP-D MOX 2.5 UP-D MOX 2.5 UP-D MON (9) PUR ON BW=.1 Center Deviation Meter 5) TURN ON FSET RGD TIMES 4 PRESS TO RESET ERACA TEMASLE COMES

COMMENTS ON SYSTEM-7 PROGRAM

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## PAGE 1

STMT		SOURCE STATEMENT	ť	DOS ASM/7	(36)	0A-TX-011) V1M2	12/10/74
2 3 4 5 6 7 8 9 10	***********	PCMOIO PROGRAM SI PURPOSE; INPUT (M (A OR B) PROPER S TRANSFER FLAG IS (VALID-DAT	PECIFICATIONS: (FMR) OR (PMIS) ), DETERMINE TY SEOUENCE OF (T) R TOGGLED BUFF( PRESENT, AND S FA-FLAG) DROPS.	) DATA INT (PE (MFMR) (ME-WORD-3 ER AT (TIN SIGNAL (EN	FD A 648 WO OR (PMIS) 3-FLAG) AND 4E-WORD-3) J MD-OF-FILE)	ORD BUFFERS , CHECK FOR {FID} FORMS, IF (VALID DATA) WHEN	00000070 00000040 00000050 00000060 00000070 00000080 00000090 00000990 00000110
11	34	BUFFER FORMAT;					00000120
12	λ;		te cendt and			100001 0171	00000130
13	72	HEADER	(8-WORD5) DISI	00001	CODE MOND	(0000) DATA	00000140
14	774 					(PPPP) EUP	00000150
12	**					(66861 603	00003180
10	-/- -/-			100023	10610 2-CH		00000170
18	*			(0003)	10610 2-084	ARS (EBCDIC)	00000190
19	*			(0004)	TIME-WORD1		00000200
20	*			(0005)	TIME-WORD2		00000210
21	<del>de</del>			(0006)	TIME-WORD3	(QUEUE XFR)	00000220
22	str.			(0007)	BLANK		00000230
23	*						00000240
24	ų,	FRAME NU	JMBER (1)	(0008)	SYNC1		00000250
25	*			(0007)	SYNC2		00000260
26	*	DATALL	(30 WORDS)	(0010)	DATA		00000270
27	*			THOU			00000280
28	*			(0039)	DATA		00000290
29	<b>X</b> t						00000300
30	*	F ID1		(0040)	UIOL (FID (	CHK, SET TYPE)	00000310
31	*	0 A T A 1 0		100/11	0474		00000320
52	* *	UATA12	ITSI MOKO21	(UU41) Tunii	UATA		00000330
22	۲۲ ال			101471			00000340
24	*			(0101)	UATA		00000300
36	*	FRAME N	JMBER (2)	(0158) 7	THRU (0169)	SYNC (TIME CHK)	00000370
_		,			· · · •		

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## EXAMPLE OF PRINTOUT FROM CONTROL TYPEWRITER - PMIS DATA RUN

The following System-7 messages will be executed by the System-7 when the System-370/System-7 linkup occurs, as indicated by the statement "S370 is ready to accept data". Responses typed by the operator on the control typewriter are indicated by enclosure in a box.

\*\*\* IPOO A ENTER CONTROL STATEMENT R JOBLIB, F2,, PCMUSER L PCM01B S370 IS READY TO ACCEPT DATA ENTER OPTIONS BY TYPEWRITER (REQUEST): REQ (LOG) TO ENTER LOG-ID WORD THEN (OSC) OR (RUN). REQ (OSC) TO RUN SIMULATED PCM DATA. REQ (RUN) TO RUN PCM DATA. REQ (EOF) MARK FILE AND IGNORE DATA. THIS IS NORMALLY AUTOMATIC BY VALID-DATA-FLAG DROP. REQ (EOJ) TO SIGNAL TERMINATE JOB. NOTE--NEW FILES MAY BE OPENED BY (LOG)/(OSC) OR (RUN) REQUESTS AFTER AN (EOF) REQUEST. OR1: LOG ENTER 4-DIGIT (HEX) LOGBOOK(ID) WORD P019 REQUEST (OSC) OR (RUN) TO PREP FOR PCM DATA OAL RUN ENTER PCM DATA EOF PROCEDURES EXECUTED see following page, "Notes on Control Typewriter Printout e overflow occurred PMIS Data Run" job was started again at selected place on tape ORI: RUN <-ENTER PCM DATA EOF PROCEDURES EXECUTED EOF PROCEDURES EXECUTED OR1: E0J \_\_\_\_\_ end of last tape; end of job was requested S7/S370 LINK TERMINATED

NOTES ON CONTROL TYPEWRITER PRINTOUT - PMIS DATA RUN

#### Explanation of Terms

LOG ID = name of the tape (4-digit word). The first digit must be either "P" or "M" in order for the computer to recognize data as being either PMIS or MFMR data. OSC = running oscillator to de-bug tape. PCM = pulse code modulation. VDC = Test Id. number (name of file). The Test Id. is the "valid data" code, or word. EOF = end of file. EOJ = end of job.

#### Overflow

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When overflow occurs, as it did during the processing of PMIS tape F019 (indicated by arrow on "Example of Printout from Control Typewriter -PMIS Data Run" on the previous page), determination of where to re-start the job is made by: counting EOF's; and, by checking the time on the time code reader and the time code on the log. The tape is then backed up to the selected point, and the job is started again.

Although whole files are not lost prior to overflow (<u>all</u> files are lost afterward), it is possible to lose 25 data cycles, spread throughout the files, out of the job. There are 640 words per data cycle.

When data overflows: a bell rings; EOF messages cease to print out; and, the control typewriter skips lines where the messages would have been.

#### Valid-Data-Flag Drop

The twenty-second word of each PCM data cy is the "valid data word" (VDC). The high-order bit of this word is the "Valid-Data-Flag". The valid-data-flag is one (1) during each file and is zero (0) between files.

The System-7 program monitors the valid-data-flag and executes an endof-file procedure each time the valid-data-flag drops, i.e., goes from 1 to 0. The PMIS 1 and MFMR 1 programs also monitor the value of the entire validdata-word; in case the System-7 fails to execute an end-of-file procedure any time the VDC changes, the PMIS 1 and MFMR 1 programs will do so.

# PMIS 1 PROGRAM CARD SETUP

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The PMIS 1 program is executed by running the following setup on the System-370:

			a a manual to ma			18.
1*						17
/ DUMP	(Job Step - D	isk Disk) (opt	ons/)	<u>el 16 4</u>		
/ // EXEC EN	103H (Job-3	Step - Disk-Dump)				
		4 V - 14 - 14 - 14 - 14 - 14 - 14 - 14 -				N. May 1
361.94	6 -67,47 36 B	55.57 -64.07	"71 4	AT card	tional .	in PMISI)
/ EXECTEN	103B (PMIS 2	brogram - optional in	PMIS1)	cara - op	cronar i	12
	to an anna 10 Marshow		2473	and at the		The states
A. A.	A CARLENS AND			<b>的</b> 这些"你们"	Server and	
T	99	Disk Addres	s Card	(optiona	1)	18.
S EXEC E	MOCA (PMIS 1	2)		525 ° X - X - X		9.
22 TOTENT	Transit (Optional	) . 0. 02000, 03200				8.
1 DUNCT	N合地E・11111111			1.74	A 53	7
17 65551	OYD801+M*935*			• • • •		6
. 27 PAIRE	Krither opzicał an	935				4
2774005M	_843035•X.501.					.3
AN ADDEN	1 2729319715061					2
27 JITS F	*MISI CPOPER+4100	)•P•14305#PHI31				1.
LOG NO.	JOB NAME	PMIS 1 @0	FUND	14305	w.o	PMIS 1
REQUESTOR_	Cooper		_ cc4	100 B	EGIN	
DATE	TIME	APPROX RUN TIME		E	ND	
TAPE DR.	TAPE NAM	E & DATE CREATED	w	TAPE LOC.	II DIAK	
	the second s	the second se			DISK	VOLSER NO.
280					335	VOLSER NO.
280 281					335	VOLSER NO.
280 281 282					335	VOLSER NO.
280 281 282 283					335	VOLSER NO.
280 281 282 283 PUNCH		2701 SEL	REAL	ALLOCATION	335	VOLSER NO.
280 281 282 283 PUNCH FORMS 1	2 4	2701 SEL.	REAL	ALLOCATION	335	VOLSER NO.
280 281 282 283 PUNCH FORMS 1 SPECIAL	2 4	2701 SEL.	REAL stem	ALLOCATION	335 375	VOLSER NO. DREOOL
280 281 282 283 PUNCH FORMS 1 SPECIAL CARRIAGE TA	2 4	2701 SEL. COMMENTS Sy Run I	REAL stem Th Fo	ALLOCATION -7 Tr. regrou	335 37 205 205 4 205 4 205 4 205 205 205 205 205 205 205 205 205 205	VOLSER NO. DRE001

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### PMIS 1 FROGRAM CARD SETUP & PROGRAM OPTIONS

#### PMIS 1 Program Card Setup

#### 1. Phase 1

The example of a "PMIS 1 Program Card Setup" given on the previous page actually includes three separate programs, PMIS 1, PMIS 2, and Job-Step Disk-Dump, all executed by the PMIS 1 program setup. When the three programs are thus used, PMIS 1, PMIS 2, and Job-Step Disk-Dump are the first, second, and third phases, respectively, of a single job.

By removing the PMIS 2 cards numbered 12, 13, and 14, PMIS 1 can be run as a separate job.

#### 2. Phase 2

PMIS 2 may also be run singly, by choice. However, if certain values must be changed in PMIS 2 data run previously, there is no option; PMIS 2 <u>must</u> be executed as a separate job (see PMIS 2 writeup and card setup).

#### 3. Job-Step Disk-Dump

When PMIS 2 (or PMIS 1, if PMIS 2 was not included in the job setup) has processed all of the data on the disk, control is turned over to Job-Step Disk-Dump (cards #15 and #16). Job-Step Disk-Dump prints all of the data cycles that were dumped into the disk by PMIS 1.

This job step also computes the amount of run cime for the entire program and prints this time on the SYSLOG and on the printer, thus must be included in all foreground PMIS and MFMR programs. Disk Dump dumps the disk only if it is enabled by following the // EXEC EMO3H card (#15) with the dump card (#16). If no dump is desired, follow the // EXEC EMO3H with the /\* card (#17).

#### Optional Control Cards - PMIS 1 (First Phase)

1.

Card No. 8, the UPSI card, is optional. It contains a string of eight binary digits.

The binary value of the seven low-order bits of this string is the number of data cycles which will be dumped onto the disk each time a new Test Id. is established, i.e., the number of data cycles dumped per file. Note: the last data cycle of each file (Test) is not under the control of the // UPSI card and is always placed (dumped) on the disk.

The high-order bit is a flag to determine whether or not the diagnostic is to be printed from PMIS 1 (Phase 1 of the example, "PMIS 1 Program Card Setup"). If the high-order UPSI bit is 1, the full printout is obtained; if the high-order bit is zero, or if there is no UPSI card, Phase 1 printout is suppressed.

page P1.2

## PMIS 1 PROGRAM CARD SETUP & PROGRAM OPTIONS

### Optional Control Cards - PMIS (First Phase), continued

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2.

Card 10, "Disk Address" card, must be used with great caution. Its misuse can destroy all data on the disk, since it updates, i.e., <u>changes</u> the disk directory. On the card shown in the PMIS 1 program setup, each word has the value "99", which is the starting address. This initializes the disk and causes it to start loading data at the beginning of the disk file.

Format of Disk Address Card (when used in PMIS 1): 3110.

- a. First word, HIGHØN: the highest disk address that PMIS 1 or MFMR 1 has operated on up to a given instant;
- b. Second word, HIGHOFF: the highest disk address that PMIS 2 or MFMR 2 has operated on up to the same given instant;
- c. Third word, JØBEND: the highest disk address that the last PMIS 1 or MFMR 1 job has operated on up to the time it was terminated.

Note: the disk control is set up such that both PMIS 1 and PMIS 2 can operate simultaneously in different partitions of the computer. And, if PMIS 1 is in process of executing while PMIS 2 is also in the process of executing, then PMIS 2 has to know exactly where PMIS 1 is. Three variables are transmitted through the disk so that these two programs can communicate with one another; these variables are HIGH $\phi$ N, HIGH $\phi$ FF, and J $\phi$ BEND.

#### Optional Control Cards - PMIS 2 (Second Phase)

Cards numbered 12 and 13, the "// EXEC EMO3B" and the "T1 and  $\Delta$ T" cards, respectively, are optional in the PMIS 1 program. Inclusion of these cards causes the PMIS 2 program to be executed in the PMIS 1 program (see example of PMIS 1 program card setup). However, the T1 and  $\Delta$ T card is optional, and it can be included only if the values of T1 and  $\Delta$ T are known prior to execution of the job. If omitted, the values used will be those that were used the last time the PMIS 2 program was executed.

Format of T1 and  $\Delta$ T Data Card: 4Fl0.4. Words are: T1 vertical;  $\Delta$ T vertical; T1 horizontal; and,  $\Delta$ T horizontal, respectively.

If it should later become necessary to change the values of T1 and  $\Delta T$  in data that were run previously, this is done by re-running PMIS 2 as a single phase (see PMIS 2 writeup).

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### PMIS 2 PROGRAM

When the EOJ instruction is issued at the System-7 terminal, the linkage between the System-370 and the System-7 is terminated, and program PMIS 1 (the first phase of the job) ends and turns control over to the second phase (PMIS 2 program).

PMIS 2 retrieves the raw data placed on disk DRZJO1 by PMIS 1 and computes the engineering units; it then places these results on the disk, prints them out, and punches a card for each file (Test). These cards are referred to as "PMIS 2 cards" (see example).

The "PMIS 2 card" will be used in the PMIS 3 program (see example of PMIS 3 program card setup).

	Data Address	Contraction of the second seco	i lst word of file		Beam Position			Valid Data Word		(DT JSBI)	<u>)</u>		의 > Loe Id (A format				<u></u>	Ci 💙 Start Time		4		?f				ent dons			Ŷſ	0.		Di Nnorrected Sky		Brightness	11 Temp Vert			Ĵ			Incorrected Chr.		- / brightness	Temp Horiz	<u>ار میں میں میں میں میں م</u>			<b>-</b>		_	
/	000	36) 001 34		) i i D ) L	9 D 9 H 1 1	2 00 ""	0	0 0 14 15 1 1	0 10	0		ייי ייי ו	:2 1	0	0 C 24 ~	- <b> </b> r	- F 00 27 24 1 1	3. Ma 16 123	2	-4   08 C	( .			- 1 - 1 - 1 - 1		: 2 1 1		7. C 0( 24		1) - - 15 - 1	- - - - - - -	0(	0 0 6 1 [		) () .) 54 ( ) 1		1 - 51 ! - 1	00 5959	0 50 M	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	9 1	101	00		01	0	0	0	00	0	) (
	2 2 3	2 2	2	22	22	2		· · ? ?	2	2	2 2	2	21	22	22	2	2 2	2	2	2 2	22	2 2	2	2 2	ż	2 2	2 2	2 2	2 2	2	2	23	22	2	2 2	2 2	2 2	2 2	2 2	2	22	2	2	2	2.	2 2	2	2	22		2 :
	33	3	3	33	33	3 3	3	3 <b>3</b>	3	3	3 1	3	3 ;	33	3 :	3	33	3	33	3	3	3	3	33	3		3	3	Ì	3	3	3 :	3	ł	2 3	3 3	3	3	3	3	33	3	3 1	13	3	33	;	3	33		3 :
	44	44	44	44	44	44	4	1.1	4	ţ	d 1	4	4 /	14	41	4	44	4	4 6	1	4.	<b>i</b> 4	4	44	4	41	4 4	4 :	14	4 1	44	1	44	વં	44	4 4	11	44	4 4	4	4 4	14	4 4	14	4	4 4	14	4	44	4	4
i	55	5 3	55	5	5 5	5 5	5	រំ ។	;	•	5 5	5 5	5 !	5 S	5 (	i 5	5 5	i	53	j 5	5 '	5 5	i 5	5 9	•	5	55	5 3	5	5 :	55	5	Ş	÷	53	j	; Pj	4) M]	55 [5]	5	5 S 2	55 C	5 ( 1.3	55 77	đ	55	5	5	55	ļ	5 '
	Řů	2	56	65	16	66	6	66	6	6	6 (	; G	6 1	85	ų i	6	6 9	6 6	ß (	10	8 (	66	6 6	<b>8</b> 6	i Ç	ſ, ,	5 F	51	5 5	G	66	5	63	5	6	5 [	56 51	6 ŝ 10.	) 6 ک	6 8	6 ( 0	66 6	6 ( • f	į 6	6 م	6 6 'O'	; 6 0;	<b>1</b> 6	6 9	I	5
	71	77	77	11	11	17	1	17	1	7	7	1	7	11	1.	11	77	11	7	17	7	77	17	71	17	1	17	1	11	7	11	7	17	1	11	1	'n	้ำ	ī	ñ	īī	บ	11	11	1	11	17	7	11	ļ	1
	38	88	88	8 P	88	88	8 8	88	8 8		8 (	38	8 /	88	8 1	8 8	88	3 8	8 (	58	8	8	3 R	3 8	3 3	<b>8</b> i	88	8	8	8	8	8	88	8	88	8 (	88	83	9	9	8 (	88	8 9	38	8	88	8 8	8	88	.	3
	99 12	9 9 3 4	99 56	99 78	9 9 9 19	99 11 12 14 16	9	9 9 14 e	9 5 16	9	9 9 18 1	9 9 9 59	9 ! 21 :	99 2223	9 { 24 2	9 9 5 26	ן זי ג	9 9 879	9 : 19 1	5 E 1- 37	; ::::	9 9 29 3	39 5%	2 4 U	: 9 a 29	3 ! 49 {	99 1147	43.	9 9 1. 13	9 546-	9 9 6 4	149	9 9 24 4	9	9 53 54	9 9 55 5	9 9 8 57	9 9 58 19	9 ( 9 (	99	9 ( 53 6	9 9 4 ជ	9 ( 65 m	9 11 - 1	: 9% 8	9.9 123	9 <u>5</u>	9	99	9	) 4

"PMIS 2 CARD" OUTPUT BY PMIS 2 PROGRAM

Note: the Log Id., above, is the name of the tape. The first digit must be either "P" or "M" in order for the computer to recognize data as being either PMIS or MFMR data. The Valid Data Word (or Valid Data Code, VDC) is the Test Id. number (name of file).

### PMIS 2 PROGRAM

When PMIS 2 has processed all of the data on the disk, control is turned over to Job-Step Disk-Dump. This is the last job step of the three-phase job illustrated by the PMIS 1 Program Card Setup. Job-Step Disk-Dump prints all of the data cycles that were dumped into the disk by PMIS 1.

Note: the last data cycle of each file (Test) is not under the control of the // UPSI card and is always placed on the disk.

Job-Step Disk-Dump is described in "PMIS 1 Program Card Setup & Program Options" under "PMIS 1 Program Card Setup".

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### PMIS 2 PROGRAM - USAGE AS SINGLE-PHASE JOB

Whenever it becomes necessary to re-run PMIS 2 program at a later time with new values of Tl and AT, PMIS 2 must be executed as a single-phase job.

The PMIS 2 program card setup may include or omit optional control cards as follows:

- 1. <u>as Phase 2 of a three-phase job setup</u>. For optional inclusion in this setup, as shown in "PMIS 1 Program Card Setup":
  - a. T1 and AT card (if such values are known prior to program execution).
- as a separate, single-phase job to obtain PMIS 2 data not previously run (where the Test, or file, has been processed by PMIS 1, and PMIS 2 program was not included in the job setup). Optional inclusion in this setup, as shown in "PMIS 2 Program Card Setup":

a. Ti and AT Card;

- b. Disk Address Card, 2110 format
- 3. <u>as a separate, single-phase job to change existing PMIS 2 data</u> <u>by re-running it with new values of T1 and AT</u>. Inclusion in this setup, as shown in "PMIS 2 Program Card Setup", is not optional. It is:
  - a. mandatory that the T1 and  $\Delta T$  card, with new, changed values of T1 and  $\Delta T$ , be included in setup;
  - b. mandatory that the Disk Address card, 2110 format, be included in the setup.

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### PMIS 2 PROGRAM CARD SETUP

The PMIS 2 program is executed as a separate, single-phase job by running the following setup on the System-370:

48 ?\* ----99 "Disk Address Card" - 2110 format 99 1. Mandatory in PMIS 2 as single-phase program re-run with new values of T1 & AT. Optional in PMIS 2 single-phase program except in above re-runs. 2. -64,07 "T1 and AT Card" 361.96 -67.47 365.57 1. Mandatory in PMIS 2 as single-phase program re-run with new values of T1 & AT. 2. Optional except in re-runs, as above. XEC EMOSE F FF F F ZZ EXTENT SYSDOL.DRZODI, 1.0.03000,00800 . . . . . .... 之后加克 的函称,可打了11 1.767.001 2/ A3356 292001 - N\* 335\* SZ PALCE (KUNI DEZÓDI ÚN 335 -2/ UMB PHISE COOPER, 4100, P. 14305; FMISE JOB NAME PMIS 2 DO FUND 14305 W.O. PMIS 2 LOG NO. W. COOPER TEL 383 CC 4100 BEGIN\_ REQUESTOR ..... \_ APPROX RUN TIME \_\_ END DATE TIME ..... VOLSER NO. w TAPE LOC. DISK TAPE NAME & DATE CREATED TAPE DR. 335 Dreool 280 281 282 283 REAL ALLOCATION \_ 2701 SEL .... PUNCH\_ COMMENTS FORMS 2 4 1 SPECIAL \_\_\_\_\_ CARRIAGE TAPE \_\_\_\_\_ 950 Rev. 8-74 PMIS 2 PROGRAM - SETUP FOR SEPARATE, SINGLE-PHASE JOB

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page P2.4

### PMIS 2 PROGRAM - USAGE AS SINGLE-PHASE JOB

#### PMIS 2 Card Setup. Control Cards

When the PMIS 2 program must be re-run with values of T1 and  $\Delta T$  that are different from those used previously on a particular set of files (Tests):

- a. the PMIS 2 program must be executed as a separate job;
- b. a T1 and AT card punched with the new values of T1 and AT must be included in the card setup; and,
- c. a Disk Address card punched in the 2110 format must be included in the card setup.

#### 1. T1 and AT Card

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Card Format: 4F10.4.

Words are: T1 vertical; AT vertical; T1 horizontal; and, AT horizontal, respectively.

#### 2. Disk Address Card

The disk address card is used to tell the program what values of HIGH $\phi$ FF and J $\phi$ BEND to use for this run. Unlike the Disk Address card used in PMIS 1, the 2I10 format card used in PMIS 2 overrides the disk directory instead of updating it.

Format (when used in PMIS 2 program): 2110. Words: HIGH¢FF; and, J¢BEND, respectively.

- a. The first word, HIGHOFF, is -1+ the disk address of the first file to be recomputed. HIGHOFF is the highest address which PMIS 2 or MFMR 2 has operated on up to that time.
- b. The second word, J $\phi$ BEND, is 149+ the disk address of the last file to be recomputed. J $\phi$ BEND is the highest disk address PMIS 1 or MFMR 1 has operated on at the time the last job was ended.

Note: if PMIS 2 encounters MFMR data, such data are bypassel. Disk directory usage and the usage of HIGHØN and HIGHØFF values proceed as if these data had been used.

## NOTES ON CONVERSION TO ENGINEERING UNITS IN THE PMIS 2 PROGRAM

#### HOUSEKEEPING DATA

PMIS 2 converts the housekeeping data to engineering units by means of a table-look-up subroutine that performs linear interpolation between the closest two points. These tables are derived from tables A, B, C, D, E, and F for PMIS Temperature Calibration as per TM1353, Appendix K, pages 1-4.

#### UNCORRECTED SKY BRIGHTNESS TEMPERATURE, T'B

The uncorrected sky brightness temperature is computed according to the formula:

$$\Gamma'_B = T_1 + \Delta T \frac{\overline{C}_A - \overline{C}_B}{\overline{C}_C - \overline{C}_B}$$
,

where:

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 $T_1$  and  $\Delta T$  are the Y intercept and slope provided on the  $T_1$ ,  $\Delta T$  card;

 $\overline{C}_{\!\!A}$  is the average value of the counts when the radiometer is in the operate mode;

 $\overline{C}_B$  is the average of the base line counts; and,

 $\overline{C}_{C}$  is the average of the calibrate counts.

STANDARD DEVIATION OF THE UNCORRECTED SKY BRIGHTNESS TEMPERATURE,  $\sigma_{\rm T}$ 

The standard deviation of the uncorrected sky brightness temperature is computed according to the formula:

$$\sigma_{\mathrm{T}} = \frac{|\Delta \mathrm{T}|}{(\overline{\mathrm{C}}_{\mathrm{C}} - \overline{\mathrm{C}}_{\mathrm{B}})^{2}} \sqrt{(\overline{\mathrm{C}}_{\mathrm{C}} - \overline{\mathrm{C}}_{\mathrm{B}})^{2} \sigma_{\mathrm{A}}^{2} + (\overline{\mathrm{C}}_{\mathrm{A}} - \overline{\mathrm{C}}_{\mathrm{C}})^{2} \sigma_{\mathrm{B}}^{2} + (\overline{\mathrm{C}}_{\mathrm{A}} - \overline{\mathrm{C}}_{\mathrm{B}})^{2} \sigma_{\mathrm{C}}^{2}},$$

where:

 $\sigma_A$  = standard deviation of data counts;

 $\sigma_{\rm R}$  = standard deviation of baseline counts; and,

 $\sigma_{\rm C}$  = standard deviation of calibrate counts.

page P2.6

## NOTES ON CONVERSION TO ENGINEERING UNITS IN THE PMIS 2 PROGRAM

cont'd

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### STANDARD DEVIATION OF THE UNCORRECTED SKY BRIGHTNESS TEMPERATURE, $\sigma_{T}$

A standard deviation of zero in any of the data is an indicator of hardware trouble. Therefore, if  $\sigma_A$ ,  $\sigma_B$ , or  $\sigma_C$  is zero,  $\sigma_T$  is flagged by changing its sign. A negative value of  $\sigma_T$  is thus an indicator of bad data; and, since this sign propagates through all subsequent calculations of antenna loss and radome loss, it automatically flags these calculations also.

### SKYTEMP PROGRAM

Before the antenna loss program (PMIS 3) can be executed, it is necessary to run program SKYTEMP with meteorological data taken on the same day as that of the PMIS data.

The input data cards for SKYTEMP are of two types: (1) the header card; and (2) pressure, temperature, and dew point (PTD) cards.

The Header Card, followed by the PTD cards, must fit the following formats:

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#### 80 COLUMN PUNCH CARD FORMAT

1). SKYTEMP header card

Card format: 3E12.1, 3X, 5A4

The Log Id. word in the header card must be the same as the Log Id. word on the first data tape for that date, i.e., for the first data tape to be associated with the particular meteorological data.

The sky temperature may be computed at any number of frequencies by specifying the start frequency, the frequency increment, and the stop frequency. If only one frequency is desired, ensure that stop frequency value is smaller than that for start frequency by leaving stop frequency blank (see header cards in example of SKYTEMP program setup); increment field may also be left blank.

2). PTD Data Cards

Card format: 3F10.1.

Wherever dew point data are missing, -99.0 should be punched in that field of the PTD data card(s). (See PTD cards in example of SKY-TEMP program card setup.)

page PS.1

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# SKYTEMP PROGRAM CARD SETUP

	SKYTEMP PRO	)GRAM CARD SETU	5			
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### SKYTEMP PROGRAM

Each time a sky temperature data set is computed, the program punches a card (the "SKYTEMP Card") which is used by PMIS 3 as input data. One SKY-TEMP card is punched for each sounding at each frequency requested. Normally, two soundings, at times spanning the time at which the radiometer measurement was run, are used.

The form of the SKYTEMP card is as follows:

 $\left[ \right]$ 

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"SKYTEMP CARD" OUTPUT BY SKYTEMP FOR INPUT TO PMIS 3 PROGRAM

Note: the "0.0" punched in card columns 51, 52, and 53, above, has no significance in the PMIS program (the field is still used in the MFMR program, however).

## PMIS 3 ANTENNA LOSS FACTOR - RADOME LOSS FACTOR

PMIS 3 is the program that computes the antenna loss factors and the radome loss factor.

Antenna loss is computed according to the formula:

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$$L_{ant} = \frac{T_{ant} - T'_B}{T_{ant} - T_{sky}}$$

where 
$$T_{ant} = \frac{T_8 + T_9 + 4 T_{10}}{6} + 273.1$$
°K,

the average of the six antenna thermistor readings.

 $T'_B$  is the uncorrected sky brightness temperature from PMIS 2 calculations.  $T_{\rm sky}$  is the sky temperature from SKYTEMP.

Radome loss is computed according to the formula:

$$L_{R} = \frac{T_{BR}^{*} - T_{ant} (1 - L_{ant}) - T_{R} L_{ant}}{T_{skvR} L_{ant} - T_{R} L_{ant}}$$

#### where:

 $T^{\prime}BR$  is the uncorrected sky brightness temperature from PMIS 2 taken with the radome on;

Tant is as above with radome on; and,

Lant is the value computed above with the radome off.

 $T_{\rm Sky_R}$  is the sky temperature from SKYTEMP at the time of the  $T^*_{\rm BR}$  measurement.

TR is the average of six radome temperatures.

$$T_{\rm R} = \frac{T_{11} + T_{12} + 4 T_{13}}{6} + 273.1 {}^{\rm o}{\rm K}$$

The standard deviation of the antenna loss is computed according to the formula:

$$\sigma_{LA} = -\frac{L_A \sigma'_T}{T'_{BR} - T_A}$$

where  $\sigma^{\prime}{}_{T}$  is the standard deviation of  $T^{\prime}{}_{BR}.$ 

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The standard deviation of the radome loss is computed according to the formula:

$$\sigma_{LR} = \frac{L_R L_A \sigma_T}{T_{BR}^* L_A - T_A (L_A - 1) - T_R},$$

where  $T_{\mathbf{R}}$  is the kinetic temperature of the radome.

## PMIS 3 PROGRAM - "RADOME IS OFF" CARD SETUP

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A PMIS 3 "Radome Is Off" job is run by executing the following program on the System-370:

	OT (and fint								10
IN E	of lend of jet	files)							18.
		2.	Fact of the			Sec. O.S.	. Strattering	1	
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1456 PM	15 2 card - 2nd	i Data Set	. 4 C 13.	0.1355	001		STRAIL		13.
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	F. E.C.		No. of the owner of the owner of the owner of the owner of the owner of the owner of the owner of the owner own		1				
(ABAC	5.30 04 FEB.10	30 MSTP040	10.49998	19 (	1.0	Second	SKYT	EMP	10.
N	1 1180		0		1	card -	0530 H	rs.	
1/	6.45 N4 FEB. 08	EBO MSTP040	10.4999E	09 0	. u	First S	OZ30	1P hrs.	9.
1454	50 22 584 PO	0 3 59 51	. 4 0 36.	0.1291	763	E 03 0.29	37297E	03	8.
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rze DI R	L FNAME. 111111					• • 76	166.		4
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ភា ព្រះ	PMISS COOPER+41	00-P-14805:	20130					ور ما دانون به	
	1								/
LOG NO.	JOB NAME	PMIS 3	(	D FU	ND .	14305	w.o	MIS3	
05005070	Cooper		.383		4	100			
REQUESTO	R			CC		E	BEGIN		
	TIME	APPF	TOX RUN TIME		1		ND		
TAP2 DR.	ТАРЕ	NAME & DATE CH	TEATED		W	TAPE LOC.	DISK	VOLSER	NO.
280							335	DREO	01
281									
282									
283							1		
PUNCH		2701 SEI			REAL	ALLOCATION		1	
FORMS	1 2 4	2701 366.	COMMENTS			ALLOCATION			
CONVIS SPEC	ι <u>4</u>								
CARDUAGE	TADE								
CARRIAGE	TAPE							950 Re	v. 8-74

### PMIS 3 PROGRAM

#### Card Setup - "Radome Is Off"

Any number of data sets may be stacked behind the initial data control cards. The first data set of each job setup must use the SKYTEMP cards, but a /\* card replaces the SKYTEMP cards in succeeding sets thus stacked.

#### Data Cards

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- The first data card after the // EXEC EM03C is the "Radome Is Off" card (card #7).
- 2. Card #8 is the PMIS 2 card punched by the PMIS 2 program and used to tell PMIS 3 where to retrieve the uncorrected sky brightness and the thermistor temperatures. The format of the PMIS 2 card (given in the PMIS 2 writeup) is repeated here for your convenience:



### PMIS 3 PROGRAM

### Data Cards, "Radome Is Off", cont'd

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3. Cards #9 and #10 are the SKYTEMP cards. One SKYTEMP card is punched by the SKYTEMP program for each sounding at each frequency requested. Normally, two soundings, at times spanning the time at which the radiometer measurement was run, are used. If only one sounding is used, the second SKYTEMP card is left blank. Note that two cards are required, i.e., a blank card must be used to represent the second SKY-TEMP card.

The sounding must be taken on the same day as the radiometer measurement, and the LOG ID on the SKYTEMP card must be repunched to match the LOG ID on the first PMIS 2 card. Failure to observe these rules will produce unpredictable results.

The format of the SKYTEMP card (given in the SKYTEMP writeup) is repeated here for your convenience:



"SKYTEMP CARD" OUTPUT BY SKYTEMP FOR INPUT TO PMIS 3 PROGRAM

Each time PMIS 3 is executed for a "Radome Is Off" job, the program punches a "Radome Is On" card for use later when a PMIS 3 "Radome Is On" job is run.

PMIS 3 PROGRAM - "RADOME IS ON" CARD SETUP Any number of these data sets may be stacked with one /\* card separating data sets. To execute PMIS 3 when the "Radome Is On", run the following program: EOJ (end of job) EOF (end of file(s)) Blank card in place of second SKYTEMP card (only one sounding is being used here) 10.4999E 09 0.0 First SKYTEMP card 04 FEB. 10230 MSTP040 0 36. 0.1291763E 03 0.2937297E 03. 1 3 59 51. 22 P1140 145450 PMIS 2 card RADIME IS ON ALTISSVE D. TESEGE NO ALDSSHE D. 3775DE DO IDSKADE 700 22 EXTENT RYPG01.TR2001.1.0.03000.00790 • **.**74 - 001 22 前 111 日柏昭和14月14日 // A225N SY2001-X\*335\* ZZ PRISE MOUNT DRZ001 DN 335 22 JOB 24153 CODPER-4100-P.143051PMIS3 LOG NO. \_\_\_\_\_ JOB NAME PMIS 3 PD FUND 14305 W.D. PMIS 3 REQUESTOR W. COOPER TEL 383 CC 4100 BEGIN -DATE \_ TIME \_\_\_\_ APPROX RUN TIME \_\_ END TAPE DR. TAPE NAME & DATE CREATED w TAPE LOC. VOLSER NO. DISK 280 335 DREOOL 281 282 283 PUNCH. 2701 SEL.\_ REAL ALLOCATION COMMENTS FORMS 1 2 4 SPECIAL \_\_\_ CARRIAGE TAPE 950 Rev. 8-74

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### PMIS 3 PROGRAM

#### Card Setup, "Radome Is On"

The same card setup is used as for the "Radome Is Off" job, except that the "Radome Is On" card will now be the first data card in each data set. Any number of data sets may be stacked behind the initial data control cards. The first data set of each job setup must use the SKYTEMP cards, but a /\* card replaces the SKYTEMP cards in succeeding data sets. Radome on and off sets may be intermixed in the same job deck.

The LOG ID of the first PMIS 2 card is checked against the LOG ID on the SKYTEMP cards.

#### "Radome Is On" Data Card

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The "Radome Is On" card contains the antenna loss values needed when computing the radome loss.

RADOME IS ON ALOSSY= 0.16869E 00 ALOSSH= 0.37750E 00 IDSKAD= ્રો - 1 0.000000 000000000 80, D8 00 00ď 1 n a 00000 in n 328, 31 522 53 34 15 38 57 38 29 49-41 42 43 44 45 48 . 2 3 4 5 5 7 8 5 10 H 12 17 14 15 19 17 18 19 20 27 22 23 24 2 त रेफ्स म 25 हो 51 51 60 हा दर ही 66 65 हा का लेंग This is an average of the ALOSSV 2222222 values taken from several "Radome 2222 222222 222222 Is On" cards. C. <del>. . . . . . .</del> 33 3333333 33333333 بيدنج ك ا 44 & #444 This is an average of ALOSSH values taken from 5555 3 355 the same cards used to obtain the average ALOSSV. Tailininininini This is the disk address taken from one of the same cards used to obtain the average values of ALOSSV and ALOSSH. 

"RADOME IS ON" CARD - OUTPUT BY PMIS 3 "RADOME IS OFF" JOB

Values punched in the "Radome Is On" card are: antenna loss vertical, antenna loss horizontal, and, disk address, respectively.

The disk address on the "Radome Is On" card is used only to check the beam position, and it is therefore possible to use the average of several antenna losses on this card, giving the disk address of one.

# MFMR PROGRAMS - REFERENCE INDEX

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# MFMR 3 PROGRAM

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# PROGRAM PROCEDURE TO REDUCE MFMR DATA TAPES

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PRIOR TO LOADING THE SYSTEM-7 PCM PROGRAM:									
PERFORM CHECKOUT OF ALL PCM HARDWARE AND TAPE(S).									
TO LOAD AND EXECUTE THE SYSTEM-7 PROGRAM, PROCEED AS FOLLOWS:									
(1) RUN U-ZERO TAPE (LOAD UNIT ADDRESS = X'0000')									
(2) LOAD IPL PROGRAM FROM DISK (LOAD UNIT ADDRESS = X'0002')									
*** IPOO A ENTER CONTROL STATEMENT									
(3) CYCLE HOST ATTACH SWITCH TO (ENABLE AND IPL) AND THEN TO (ENABLE):									
IT MUST REMAIN ON (ENABLE) FOR REMAINDER OF PROGRAM EXECUTION.									
(4) SET DISK PROGRAM "DATA SET NAME" BY FOLLOWING R(EFER)									
STATEMENT:									
R JOBLIB, F2,, PCMUSER									
(5) L(OAD) PCM PROGRAM INTO CORE BY FOLLOWING L(OAD) STATEMENT:									
L PCMO1B									
THE SYSTEM-7 IS NOW PREPARED TO ACCEPT LINKUP WITH THE SYSTEM-370									
AND WILL REMAIN IN A WAIT STATE UNTIL MFMR 1 PROGRAM IS EXECUTED									
BY THE SYSTEM-370.									

page M.1

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## PROGRAM PROCEDURE TO REDUCE MFMR DATA TAPES

Ĵ,

"MFMR" is the name of the program and of the radiometer being tested; procedures Botes: are given in large type, while explanatory comments are given in smaller type enclosed by hand-drawn brackets, thus: for benefit of one who is unfamiliar with the System-7. PRIOR TO LOADING THE SYSTEM-7 PCM PROGRAM: PERFORM CHECKOUT OF ALL PCM HARDWARE AND TAPE(S). TO LOAD AND EXECUTE THE SYSTEM-7 PROGRAM, PROCEED AS FOLLOWS: (1)RUN U-ZERO TAPE (LOAD UNIT ADDRESS = X'0000') U-ZERO, the tape to IPL the computer, is a small, blue punch tape kept right by the computer; put Address switches on 0000 (Addresses are control switches on front of computer; there are 4 Address switches, thus each Address switch is set on 0, as indicated by the four zeros in step (1), above. LOAD IPL PROGRAM FROM DISK (LOAD UNIT ADDRESS = X'0002') (2)IPL denotes "Initial Program Load". Leave the first 3 Address switches on zero, move the right hand Address switch to setting of  $\overline{2}$ . \*\*\* IPOO A ENTER CONTROL STATEMENT the above is a statement that the computer sends back to you after you have done step (2). CYCLE HOST ATTACH SWITCH TO (ENABLE AND IPL) AND THEN TO (ENABLE) (3) WHERE IT MUST REMAIN FOR THE REMAINDER OF PROGRAM EXECUTION. the Host attach switch is another contro switch on the front of the computer; switch it to "Off" (that's down), then up to "Enable and IPL" and back to center position, which is "Enable"; it must stay on "Enable" all the time you're transferring data from Sys.-7 to Sys.-370 - this is done in order to establish a linkage with the System-370. (4) SET DISK PROGRAM "DATA SET NAME" BY FOLLOWING R(EFER) STATEMENT: step (4) tells you to type an "R", that is, "Reference Statement", on the control typewriter. The statement to be typed, is as follows, below (be sure to leave a space between the "R" and the "J"): R JOBLIB, F2, PCMUSER L(OAD) PCM PROGRAM INTO CORE BY FOLLOWING L(OAD) STATEMENT: (5) after typing the statement of step (4)'s instruction, execute step (5) by typing the following statement, below. Leave a space between "L" and "P". L PCM01B THE SYSTEM-7 IS NOW PREPARED TO ACCEPT LINKUP WITH THE SYSTEM-370 AND WILL REMAIN IN A WAIT STATE UNTIL MEMR 1 PROGRAM IS EXECUTED BY THE SYSTEM-370.

PREAMINE 2 רווויבד אוויב רבכיייטבית BIT SHUCHECNIZCULD VARIABLE TIMECODE REIDER FILTOR 3 SCOPE (J) MULTIPECKER PCNI JUDEFFICE MONITER (  $(\mathbf{I})$ Telemetry Playback Console (6) PUR ON 16-Br; [2]  $(\mathcal{D})$ LOAD YRUN (2) TURN ON () PWRON (3) TURN ON SETTING @ HPASS 250 ] L LPASS 2300] B PURON WORD 159 (9) THEN ON TIMENTS LEVEC MONIFOR T SET 3.5 UP-D MAX 310 UP-D NEM 2.5 URP NEM (9) PUR ON BW=.1 Center Deviation Meter 6) TURN ON SET RGD TIMES + PRESS TO RESET ERA ON FENASSE COMES

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COMMENTS ON SYSTEM-7 PROGRAM

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STMT		SOURCE STATE	EMENT	DOS	ASM/7	(36)	DA-TX-011)	142	12/10/74	
234567890	*****	PCMOIO PROGRAM SPECIFICATIONS: PURPOSE; INPUT (MEMR) OR (PMIS) DATA INTO A 649 WORD BUFFERS (A OR B), DETERMINE TYPE (MEMR) OR (PMIS), CHECK FOR PROPER SEQUENCE OF (TIME-WORD-3-FLAG) AND (FID) FORMS, TRANSFER TOGGLED BUFFER AT (TIME-WORD-3) IF (VALID DATA) FLAG IS PRESENT, AND SIGNAL (END-OF-FILE) WHEN (VALID-DATA-FLAG) DROPS.								
11	*	BUFFER FO	DR MA T :						00000120	
12	×:								00000130	
12	**		HEADER (8-WORDS) DIS	SP [(	00001	CODE WORD	(0000) DAT/	<b>A</b>	00000140	
14	*		•				(FFFF) EOF		00000150	
15	372	S P				<b>D 1 1 1 1 1</b>	(EEEE) EOJ		00000160	
16	ᅏ	P IC				BLANK			00000170	
10	л 	82		<u>د</u> (	00021	LOGIO 2-CH/	AKS LEBLUIL/	2 N	00000180	
18	ېد بد	)B AI		10	10031	LUGIU 2-CAA	WES LEBODICI	,	00000190	
20	*	Q m		11	0004) 2005)	TIME-WORD1			00000200	
20	**	UA A			00021	TIME-WORD2	Loughe ver	• •	00000210	
22	 #2	E E			00007		INVEUS AFF	1	00000220	
26	÷.	TY IS		• •	0007	DEANN			00000220	
25	110		ERAME NUMBER (1)		10081	SYNCI			00000240	
25	*			- i	00001	SYNC2	-		0000000000	
26	*		DATA11 (30 WORDS)	i i		ΠΑΤΑ	•		00000270	
27	#			•	THEY				00000280	
28	*		•	{(	0039)	DATA			00000290	
29	34								00000300	
30	ホ		FID1 ·····	: ((	0040)	DID1 (FID (	CHK, SET TYP	PE)	00000310	
31	*						• • • •		00000320	
32	#		DATA12 (127 WORDS)	()	0041)	DATA			00000330	
33	×			-	THRU				00000340	
34	¥			1	(0167)	DATA			00000350	
35	*								00000360	
36	*		FRAME NUMBER (2)	()	0158)	THRU (0169)	SYNC (TIME	СНКЈ	00000370	

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## EXAMPLE OF PRINTOUT FROM CONTROL TYPEWRITER - MFMR DATA RUN

The following System-7 messages will be executed by the System-7 when the System-370/System-7 linkup occurs, as indicated by the statement "S370 is ready to accept data". Responses typed by the operator on the control typewriter are indicated by enclosure in a box.

```
*** IPOO A ENTER CONTROL STATEMENT
R JOBLIB, F2, , PCMUSER
L PCM01B
S370 IS READY TO ACCEPT DATA
ENTER OPTIONS BY TYPEWRITER (REQUEST):
REQ (LOG) TO ENTER LOG-ID WORD THEN (OSC) OR (RUN).
REQ (OSC) TO RUN SIMULATED PCM DATA.
REQ (RUN) TO RUN PCM DATA.
                                      THIS IS NORMALLY
REQ (EOF) MARK FILE AND IGNORE DATA.
          AUT/MATIC BY VALID-DATA-FLAG DROP.
REQ (EOJ) TO SIGNAL TERMINATE JOB.
NOTE--NEW FILES MAY BE OPENED BY (LOG)/(OSC) OR (RUN) REQUESTS
AFTER AN (EOF) REQUEST.
OR 1: LOG
ENTER 4-DIGIT (HEX) LOGBOOK(ID) WORD
M019
REQUEST (OSC) OR (RUN) TO PREP FOR PCM DATA
OR 1: RUN
ENTER PCM DATA
EOF PROCEDURES EXECUTED
EOF PROCEDURES EXECUTED
EOF PROCEDURES EXECUTED
EOF PROCEDURES EXECUTED
EOF PROCEDURES EXECUTED
EOF PROCEDURES EXECUTED
EOF PROCEDURES EXECUTED
EOF PROCEDURES EXECUTED
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EOF PROCEDURES EXECUTED
EOF PROCEDURES EXECUTED
EOF PROCEDURES EXECUTED
                                         see following page, "Notes on
                                         Control Typewriter Printout -
           coverflow occurred MFMR Data Run"
                         job was started again at selected place on tape
OR 1: RUN
ENTER PCM DATA
EOF PROCEDURES EXECUTED
EOF PROCEDURES EXECUTED
ORI: EOJ <--- end of last tape; and of job was requested
S7/S370 LINK TERMINATED
```
NOTES ON CONTROL TYPEWRITER PRINTOUT - MFMR DATA RUN

#### Explanation of Terms

LOG ID = name of the tape (4-digit word). The first digit must be either "M" or "P" in order for the computer to recognize data as being either MFMR or PMIS data. OSC = running oscillator to de-bug tape. PCM = pulse code modulation. VDC = Test Id. number (name of file). The Test Id. is the "valid data" code, or word. EOF = end of file. EOJ = end of job.

#### **Overflow**

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When overflow occurs, as it did during the processing of MFMR tape MO19 (indicated by arrow on "Example of Printout from Control Typewriter -MFMR Data Kun" on the previous page), determination of where to re-start the job is made by: counting EOF's; and, by checking the time on the time code reader and the time code on the log. The tape is then backed up to the selected point, and the job is started again.

Although whole files are not lost prior to overflow (<u>all</u> files are lost afterward), it is possible to lose 25 data cycles, spread throughout the files, out of the job. There are 640 words per data cycle.

When data overflows: a bell rings; EOF messages cease to print out; and, the control typewriter skips lines where the messages would have been.

#### Valid-Data-Flag Drop

The twenty-second word of each PCM data cycle is the "valid data word" (VDC). The high-order bit of this word is the "Valid-Data Flag". The valid-data-flag is one (1) during each file and is zero (0) between files.

The System-7 program monitors the valid-data-flag and executes an endof-file procedure each time the valid-data-flag trops, i.e., goes from 1 to 0. The MFMR 1 and PMIS 1 programs also monitor the value of the entire validdata-word; in case the System-7 fails to execute an end-of-file procedure any time the VDC changes, the MFMR 1 and PMIS 1 programs will do so.

MFMR	1	PROGRAM	CARD	SETUR
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The MFMR 1 program is executed by running the following setup on the System-370:

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	Constant of the second se	99 <b>"</b>	Disk Addre	255 C 27	rd"	(cption#	, , ,	
PT EXEC	EMOSD (MEMR	1)				<i>r</i>	an a far an an an an an an an an an an an an an	9
I TIPST	10000011 Cope	ional)			anna chraite a	1807 Martin Fair Scotland Scotland Scotland	·	8
A EXTEN	T SYSDO1.DR200	1.1.0.0300	0.00800					
/ TOLEL	FNAME 1111111					• .76.	/001	6
ASSGN	SYS001 . X*335*							5
ASSGN	SYG032+X 201	UN 330						4
TOSGN	SYS031-X*200*	99						2
I ATR M	FMR1 COUPER.41	00-P-14305	I MEMRI					1
LOG NO	JOB NAME	MFMR	1	@/D	FUND _	14305	_w.o/	MFMR 1
REQUESTOR_	Cooper		TEL <u>383</u>	C	c <u>41</u>	00 BI	EGIN	
DATE	TIME	API	PROX RUN TIME			El	ND	
TAPE DR.	TAPE N	AME & DATE O	REATED		w	TAPE LOC.	DISK	VOLSER NO.
280							335	DRZ001
281								
282								
283								
PUNCH		2701 SEL.			REAL	ALLOCATION		
FORMS 1 SPECIAL	2 4		COMMENTS	Syst	tem	7 Trai	nsfer	-
CARRIAGE TA	PE		- Run	In	Foreg	around	4	950 Rev. 8-74

### MFMR 1 PROGRAM CARD SETUP & PROGRAM OPTIONS

#### MFMR 1 Program Card Setup

#### 1. Phase 1

The example of a "MFMR 1 Program Card Setup" given on the previous page actually includes three separate programs, MFMR 1, MFMR 2, and Job-Step Disk-Dump, all executed by the MFMR 1 program setup. When the three programs are thus used, MFMR 1, MFMR 2, and Job-Step Disk-Dump are the first, second, and third phases, respectively, of a single job.

By removing the MFMR 2 cards numbered 12 and 13, MFMR 1 can be run as a separate job.

#### 2. Phase 2

MFMR 2 may also be run as a separate job.

#### 3. Job-Step Disk-Dump

When MFMR 2 (or MFMR 1, if MFMR 2 was not included 'n the job setup) has processed all of the data on the disk, control is turned over to Job-Step Disk-Dump (cards #14 and #15). Job-Step Disk-Dump prints all of the data cycles that were dumped into the disk by MFMR 1.

This job step also computes the amount of run time for the entire program and prints this time on the SYSLOG and on the printer, thus must be included in all foreground MFMR and PMIS programs. Disk Dump dumps the disk only if it is enabled by following the // EXEC EMO3H card (#14) with the dump card (#15). If no dump is desired, follow the // EXEC EMO3H with the /\* card (#16).

#### Optional Control Cards - MFMa 1 (First Phase)

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Card No. 8, the UPSI card, is optional. It contains a string of eight binary digits.

The binary value of the seven low-order bits of this string is the number of data cycles which will be dumped onto the disk each time a new Test Id. is established, i.e., the number of data cycles dumped per file. Note: the last data cycle of each file (Test) is not under the control of the // UPSI card and is always placed (dumped) on the disk.

The high-order bit is a flag to determine whether or not the diagnostic is to be printed from MFMR 1 (Phase 1 of the example, "MFMR 1 Program Card Setup"). If the high-order UPSI bit is 1, the full printout is obtained; if the high-order bit is zero, or if there is no UPSI card, Phase 1 printout is suppressed.

### MFMR 1 PROGRAM CARD SETUP & PROGRAM OPTIONS

#### Optional Control Cards - MFMR 1 (First Phase), cont'd

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2. Card 10, "Disk Address" card, must be used with great caution. Its misuse can destroy all data on the disk, since it updates, i.e., <u>changes</u> the disk directory. On the card shown in the MFMR 1 program setup, each word has the value "99", which is the starting address. This initializes the disk and causes it to start loading data at the beginning of the disk file.

Format of Disk Address Card (when used in MFMR 1): 3110.

- a. First word, HIGHON: the highest disk address that MFMR 1 or PMIS 1 has operated on up to a given instant;
- b. Second word, HIGHØFF: the highest disk address that MFMR 2 or PMIS 2 has operated on up to the same given instant;
- c. Third word, JØBEND: the highest disk address that the last MFMR 1 or PMIS 1 job has operated on up to the time it was terminated.

Note: the disk control is set up such that both MFMR 1 and MFMR 2 can operate simultaneously in different partitions of the computer. And, if MFMR 1 is in process of executing while MFMR 2 is also in the process of executing, then MFMR 2 has to know exactly where MFMR 1 is. Three variables are transmitted through the disk so that these two programs can communicate with one another; these variables are HIGH $\phi$ N, HIGH $\phi$ FF, and J $\phi$ BEND.

#### Optional Control Cards - MFMR 2 (Second Phase)

3. Cards numbered 12 and 13, the // EXEC EM03E and the /\* cards, respectively, are optional in the MFMR 1 program. Inclusion of these cards causes the MFMR 2 program to be executed in the MFMR 1 program job (see example of MFMR 1 program card setup).

When the MFMR 2 program has not been included in a MFMR 1 job and must be run at a later time, MFMR 2 is executed as a separate job (ref. "MFMR 2 Program - Usage as a Single-Phase Job").

If it becomes necessary to re-run MFMR 2 data that were run previously, the MFMR 2 program must be executed as a separate job (ref. "MFMR 2 Program - Usage as a Single-Phase Job").

When the EOJ instruction is issued at the System-7 terminal, the linkage between the System-370 and the System-7 is terminated, and program MFMR 1 (the first phase of the job) ends and turns control over to the second phase (MFMR 2 program).

MFMR 2 retrieves the raw data placed on disk DRZ001 by MFMR 1 and computes the engineering units; it then places these results on the disk, prints them out, and punches a card for each file (Test). These cards are referred to as "MFMR 2 Cards" (see example).

The MFMR 2 card will be used in the MFMR 3 program (see example of MFMR 3 program card setup).



"MFMR 2 CARD" OUTPUT BY MFMR 2 PROGRAM

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<u>Note</u>: the Log Id., above, is the name of the tape. The first digit must be either "M" or "P" in order for the computer to recognize data as being either MFMR or PMIS data. The Valid Data Word (or Valid Data Code, VDC) is the Test Id. number (name of file).

When MFMR 2 has processed all of the data on the disk, control is turned over to Job-Step Disk-Dump. This is the last job step of the three-phase job illustrated by the MFMR 1 Program Card Setup. Job-Step Disk-Dump prints all of the data cycles that were dumped into the disk by MFMR 1. Note: the last data cycle of each file (Test) is not under the control of the // UPSI card and is always placed (dumped) on the disk.

Job-Step Disk-Dump also computes the amount of run time for the entire program and prints this time on the SYSLOG and on the printer, thus must be included in all foreground MFMR and PMIS programs. Disk Dump dumps the disk only if it is enabled by following the // EXEC EMO3H card with the dump card. If no dump is desired, follow the // EXEC EMO3H with the /\* card.

## MFMR 2 PROGRAM - USAGE AS SINGLE-PHASE JOB

#### MFMR 2 Card Setup. Single-Phase Job.

The MFMR 2 program may or may not be run as the second phase of the threephase MFMR 1 job as shown in the MFMR 1 program card setup; its inclusion is optional. However, if the MFMR 2 data are to be obtained at a later time, or if it should become necessary to re-run MFMR 2 data, the MFMR 2 program must be executed as a separate, single-phase job.

- Run MFMR 2 as a separate, single-phase job to obtain MFMR 2 data not previously run (where the Test, or file, has been processed by MFMR 1, and MFMR 2 program was not included in the job setup) as follows:
  - a. with card #7, "Disk Address" card <u>omitted</u>, run the job shown in the "MFMR 2 Program Card Setup".
- 2. Run MFMR 2 as a separate, single-phase job to change existing MFMR 2 data by re-running it as follows:
  - a. run the job shown in the "MFMR 2 Program Card Setup"; and,
  - b. include card #7, "Disk Address" card, 2110 format.

#### Disk Address Card

The disk address card is used to tell the program what values of HIGH $\phi$ FF and J $\phi$ LEND to use for this run. Unlike the Disk Address card used in MFMR <sup>1</sup>, the 2110 format card used in MFMR 2 overrides the disk directory instead of updating it.

Format (when used in MFMR 2 program): 2110. Words: HIGHØFF, and, JØBEND, respectively.

- a. The first word, HIGHOFF, is -1+ the disk address of the first file to be recomputed. HIGHOFF is the highest address which MFMR 2 or PMIS 2 has operated on up to that time.
- b. The second word, J $\phi$ BEND, is 149+ the disk address of the last file to be recomputed. J $\phi$ BEND is the highest disk address MFMR 1 or PMIS 1 has operated on at the time the last job was ended.

Note: if MFMR 2 encounters PMIS data, such data are bypassed. Disk directory usage and the usage of HIGH $\phi$ N and HIGH $\phi$ FF values proceed as if these data had been used.

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The MFMR 2 program is executed as a separate, single-phase job by running the following setup on the System-370:

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MFMR 2 PROGRAM ~ SETUP FOR SEPARATE, SINGLE-PHASE JOB

page M2.4

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### SKYTMFMR PROGRAM

Before the loss program (MFMR 3) can be executed, it is necessary to run program SKYTMFMR with meteorological data taken on the same day as that of the MFMR data.

The input data cards for SKYTMFMR are of two types: (1) the header card; and (2) pressure, temperature, and dew point (PTD) cards.

The header card, followed by the PTD cards, must fit the following formats:



CARD FORMATS - HEADER CARD, PTD CARDS

1). SKYTMFMR Header Card

Card format: 39X, 5A4

The Log Id. word in the header card must be the same as the Log Id. word on the first data tape for that date, i.e., for the first data tape to be associated with the particular meteorological data.

2). PTD Data Cards

Card format: 3F10.1.

Wherever dew point data are missing, -99.0 should be punched in that field of the PTD data card(s). (See PTD cards in example of SKYTMFMR program card setup.)

page MS.1

# SKYTMFMR PROGRAM CARD SETUP

Any number of these data sets may be stacked with one /\* card separating data sets. Note that two consecutive /\* cards terminates the program.

In order to run program SKYTMFMR, execute the following statements on the System-370:

End of Job (50)

and the second second

\* End of All Files in this Job (EOF)

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SKYTMFMR PROGRAM

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Each time a sky temperature data set is computed, the program punches four cards (the "SKYTEMP Cards") which are used by MFMR 3 as input data. One SKYTEMP card is punched for each sounding at each frequency requested.

Following is an example of the card format and the four SKYTEMP cards:



"SKYTEMP CARDS" OUTPUT BY SKYTMFMR FOR INPUT TO MFMR 3 PROGRAM

page MS.3

# MFMR 3 UNCORRECTED SKY BRIGHTNESS TEMPERATURE ANTENNA LOSS FACTOR - RADOME LOSS FACTOR

MFMR 3 is the program that computes the uncorrected sky brightness temperature, the antenna loss factors, and the radome loss factor.

#### UNCORRECTED SKY BRIGHTNESS TEMPERATURE, T'B

The uncorrected sky brightness temperature is computed according to the formula:

$$\mathbf{T'_B} = \mathbf{T_1} + \Delta \mathbf{T} \frac{\overline{\mathbf{C}_A} - \overline{\mathbf{C}_B}}{\overline{\mathbf{C}_C} - \overline{\mathbf{C}_B}} ,$$

where:

 $T_1$  and  $\Delta T$  are the Y intercept and slope provided on the  $T_1$  and  $\Delta T$  cards;

 $\overline{C}_A$  is the average value of the counts when the radiometer is in the operate mode;

 $\overline{C}_{B}$  is the average of the base line counts; and,

 $\overline{C}_{C}$  is the average of the calibrate counts.

#### STANDARD DEVIATION OF THE UNCORRECTED SKY BRIGHTNESS TEMPERATURE, JTR

The standard deviation of the uncorrected sky brightness temperature is computed according to the formula:

$$\sigma_{\mathrm{TB}} = \frac{|\Delta \mathrm{T}|}{(\overline{\mathrm{C}}_{\mathrm{C}} - \overline{\mathrm{C}}_{\mathrm{B}})^2} \sqrt{(\overline{\mathrm{C}}_{\mathrm{C}} - \overline{\mathrm{C}}_{\mathrm{B}})^2 \sigma_{\mathrm{A}}^2 + (\overline{\mathrm{C}}_{\mathrm{A}} - \overline{\mathrm{C}}_{\mathrm{C}})^2 \sigma_{\mathrm{B}}^2 + (\overline{\mathrm{C}}_{\mathrm{A}} - \overline{\mathrm{C}}_{\mathrm{B}})^2 \sigma_{\mathrm{C}}^2},$$

where:

 $\sigma_A$  = standard deviation of data counts;

 $\sigma_{\rm B}$  = standard deviation of baseline counts; and,

 $\sigma_{\rm C}$  = standard deviation of calibrate counts.

A standard deviation of zero in any of the data is an indicator of hardware trouble. Therefore, if  $\sigma_A$ ,  $\sigma_B$ , or  $\sigma_C$  is zero,  $\sigma_T$  is flagged by changing its sign. A negative value of  $\sigma_T$  is thus an indicator of bad data; and, since this sign propagates through all subsequent calculations of antenna loss and radome loss, it automatically flags these calculations also.

# MFMR 3 ANTENNA LOSS FACTOR - RADOME LOSS FACTOR

#### ANTENNA LOSS

Antenna loss is computed according to the formula:

$$L_{A} = \frac{T_{S} - T_{A}}{T'_{B} L_{W} - T_{W} (L_{W} - 1) - T_{A}}$$

where:

,

1

Ts is the sky temperature in <sup>O</sup>K;

 $T_A$  is the kinetic antenna temperature in  ${}^{O}K$ ;

T'B is the uncorrected sky brightness temperature in <sup>OK</sup>;

Ly is the wave guide loss; and,

Tw is the wave guide temperature in <sup>O</sup>K.

#### STANDARD DEVIATION OF ANTENNA LOSS

The standard deviation of the antenna loss is computed according to the formula:

$$\sigma_{LA} = \frac{L_A L_W \sigma_{TB}}{T'_B L_W + T_W (1 - L_W) - T_A}$$

#### RADOME LOSS

The radome loss is computed according to the formula:

$$L_R = \frac{T_S - T_R}{T_B L_A L_W - T_A (L_A - 1) - T_R - T_W (L_W - 1) L_A}$$

where  $T_{\rm R}$  is the temperature of the radome  $^{\rm O}K$  (average of 5 radome thermistors).

#### STANDARD DEVIATION OF RADOME LOSS

The standard deviation of the radome loss is computed according to the formula:

$$\sigma_{LR} = \frac{-L_R L_A \sigma_{LA}}{T'_B L_A L_W - T_A (L_A - 1) - T_R}$$

# MFMR 3 PROGRAM - "RADOME IS OFF" CARD SETUP

A MFMR 3 "Radome Is Off" job is run by executing the following program on the System-370:

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#### Card Setup - "Radome Is Off"

Any number of data sets may be stacked behind the initial data control cards. The first data set of each job setup <u>must</u> use: the OPR, CAL, and BASE cards; the Tl and  $\Delta T$  cards; and, the SKYTEMP cards. A /\* card may be used to truncate succeeding data sets in any one of three places: after the OPR card; after the BASE card; or, after the  $\Delta T$  card.

#### Data Cards

Type

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- The first data card after the // EXEC EMO3F is the "Radome Is Off" card (card #7).
- 2. Cards #8, #9, #10 are the MFMR 2 OPR, CAL, and BASE cards punched by the MFMR 2 program and used to tell MFMR 3 where to retrieve the engineering data. The format (given in less detail in the MFMR 2 writeup) and an example of each of the MFMR 2 cards is shown below:



HEST	MUTU MUUU22A 169087268	169611896 300100 NFMR2	ASSOUND
CAL	MUTO 00000229 168349824	168874116 299950 MFARE	00000229
UPR	M010 0000022E 171729480	172254336 300700 AFMR2	00000220
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"MFMR 2 CARDS" OUTPUT BY MFMR 2 FOR INPUT TO MFMR 3 PROGRAM

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Program Name

# Data Cards, "Radome Is Off", cont'd

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 Cards #11 and #12 are the T1 and ∆T cards required for the uncorrected sky brightness calculations.

Formats for these cards are as follows:

CH-2 CH-2 CH-1 K CH-2 KA CH-1 CH-1 KA ' KU KU M Ч F Ē Ľ F Ч Ë H 10000 門武计师作

T1 CARD FOR INPUT TO MFMR 3 PROGRAM

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### Data Cards, "Radome Is Off", cont'd

#### continued

Format for the AT card is as follows:

СН-1	СН-2	СН-1	СН-2	СН- <b>1</b>	сн-2	
KU	KU	KA	KA	K (	K 0	Ц
ΔT	$\Delta T$	$\Delta T$	$\Delta T$	$\Delta T$	$\Delta T$	$\Delta T'$



AT CARD FOR INPUT TO MFMR 3 PROGRAM

#### Data Cards, "Radome Is Off", cont'd

4.

Cards #13, #14, #15, and #16 are the SKYTEMP cards. One SKYTEMP card is punched by the SKYTMFMR program for each sounding at each of the four MFMR frequencies. Note that four cards are required: one card for each frequency in the correct order, i.e., 18, 37, 22, and 1.4 GHz, respectively.

The sounding must be taken on the same day as the radiometer measurement, and the Log Id. on the SKYTEMP cards must be repunched to match the Log Id. on the first MFMR 2 card. Failure to observe these rules will produce unpredictable results.

The format of the SKYTEMP cards (given in the SKYTEMP written) is repeated here for your convenience:



Each time MFMR 3 is executed for a "Radome Is Off" job, the program punches a "Radome Is On" card for use later when a MFMR 3 "Radome Is On" job is run.

# MFMR 3 PROGRAM - "RADOME IS ON" CARD SETUP

A MFMR 3 "Radome Is On" job is run by executing the following program on the System-370:

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FOF (	(end of All Files.)						
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Z SENTEN	T SYT001-DRZ001-1-0-0	3000,00800					-7
ZZ DI EL ZZ GROGN	FN4ME+*111111			1.76	PQ1		2.
Z PAUSE	MOUNT DR2001 DN 335						`
C UP N	FNFS COCFEF+4100+F+14	ISUSINEMES					
LOG NO.	JOB NAME MEN	1R 3 00	FUND _	14305	_w.o	MFMR 3	_
REQUERTOR	Win Couper	TEL 1383		100			
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283 PUNCH FORMS 1 SPECIA CARRIAGE T/	2701 2 4 L APE	SELCOMMENTS	REAL	ALLOCATION		950 Rev. 8-7	4
283 PUNCH FORMS 1 SPECIA CARRIAGE T/	2701 2 4 L APE		REAL	ALLOCATION		950 Rev. 8-7	4
283 PUNCH FORMS 1 SPECIA CARRIAGE T	2701 2 4 L APE	ORIGINA OF POOL	REAL	ALLOCATION		950 Rev. 8-7	4
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#### Card Setup, "Radome Is On"

The same card setup is used as for the "Radome Is Off" job, except that the "Radome Is On" card will now be the first data card in each data set. Any number of data sets may be stacked behind the initial data control cards. The first data set of each job setup must use: the OPR, CAL, and BASE cards; the Tl and  $\Delta T$  cards; and, the SKYTEMP cards. A /\* card may be used to truncate succeeding data sets in any one of three places: after the OPR card; after the BASE card; or, after the  $\Delta T$  card.

#### "Radome Is On" Data Card

The "Radome Is On" card (example follows) contains the Log Id., the valid data code (VDC), the disk address, and the encoded antenna elevation angle of the disk data set that contains the antenna loss values needed when computing the radome loss.



"RADOME IS UN" CARD - OUTPUT BY MFMR 3 "RADOME IS OFF" JOB

The Disk Address on the "Radome Is On" card is used to access engineering data, and it is therefore not possible to avarage several antenna losses (as in PMIS 3) through manipulation of the data deck.

#### REFERENCES

- Blume, H-J. C. and C. T. Swift, "S-Band Radiometer Remote Sensing of Sea Surface Temperatures," Proc. 1972 URSI/USNC Conference, Williamsburg, Va., Dec. 12-15, 1972 (USNC-URSI, Nat'l. Acad. Sciences, 2101 Constitution Ave., N. W., Washington, D. C. 20418).
- Carver, K. R., "Remote Sensing Using Microwave Radiometry," Proc. 1973 IEEE Southeast-Con, Louisville, Ky., April 30 -May 2, 1973 (IEEE, 345 E. 47th St., New York, N. Y. 10017).
- Carver, K. R., Wm. Cooper and J. F. Paris, "Local Variations in Radiometric Sky Temperature Using Radiosonde Data," Proc. 1975 URSI/USNC Conference, Urbana, Ill., June 2-5, 1975.
- Fogarty, Wm. G., "Total Atmospheric Absorption at 22.2 GHz." IEEE Trans. Ant. and Prop., AP-23, May, 1975, pp. 441-444.
- Hach, J.-P., "A very Sensitive Airborne Microwave Radiometer Using Two Reference Temperatures," <u>IEE Trans. Micro. Theory</u> and Techniques, MTT-16, September, 1968, pp. 629-636.
- Hansen, R. C., <u>Microwave Scanning Antennas</u>, Vol. I, Academic Press (New York), 1964, pp. 24-46.
- Kerns, D. M., "Correction of Near-Field Antenna Measurements Made With an Arbitrary But Known Measuring Antenna," Electronics Letters, Vol. 6, No. 11, May 28, 1970.

Kraus, J. D., <u>Radio Astronomy</u>, McGraw-Hill Book Co. (New York), 1966, p. 261.

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#### REFERENCES (Continued)

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1

- Kraus, J. D. and K. R. Carver, <u>Electromagnetics</u>, 2nd ed., McGraw-Hill Book Co. (New York), 1974, pp. 621-622.
- Mentzer, C. A., L. Peters, and R. C. Rudduck, <u>IEEE Trans. Antennas</u> and Prop., AP. 23, March, 1975, pp. 153-159.
- Paris, J. F., "A Program for Computing the Brightness Temperature of a Clear Atmosphere from Radiosonde Data," Tech. Rept. LEC/HASD No. 6490.21.068, Lockheed Electronics Co., Inc., Aerospace Systems Div., Houston, 1971.
- Paris, J. F., "Sky Brightness Temperature Error Analysis for Microwave Sensor Calibration," Job Order 75-415, Lockheed Electronics Co., Inc., Aerospace Systems Division, Houston, Feb., 1975.
- Sullivan, W. T., "Variations in Frequency and Intensity of 1.35 centimeter H<sub>2</sub>0 Emission Profiles in Galatic HII Regions," <u>Astrophys. J.</u>, vol. 116, 1971, pp. 321-332.
- Van Vleck, J. H. and V. H. Weisskopf, "On the Shape of Collision -Broadened Lines," Rev. Mod. Phys., vol. 17, 1945, pp. 227-236.

Yu, J. S., R. C. Rudduck and L. Peters, <u>IEEE Trans. Antennas and</u> Prop., AP-14, March, 1966, pp. 138-149.