# M-SAT PHASE A EXTENSION

## CANADIAN DEMONSTRATION SPACECRAFT

REPORT AND BASELINE PERFORMANCE

DOCUMENT ADDENDUM

TASK 2 M-SAT

L-SAT - NO DND

PAYLOAD

OPERATIONAL MISSION

REPORT REF. NO. DOC-CR-SP-82-004-B

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APPENDIX

## 1.0 PURPOSE

The purpose of this document is to define the performance of a Canadian Operational M-SAT Spacecraft launched on an Ariane IV launch vehicle and carrying only a commercial mobile transponder.

A conservative transfer orbit weight has been taken for Ariane IV and to facilitate comparisons with the baseline the same power amplifier design and efficiency has been assumed.

This volume is an addendum to the main Phase A report. Some sections of the report are essentially unchanged in which case reference is made to the Phase A report.

## 2.0 APPLICABLE DOCUMENTS

The following documents are applicable to and form part of this report. In general, only those sections are applicable which are specifically referenced herein, however, the documents provide considerable background material which is essential for understanding the satellite system.

(1) M-SAT Canadian Demonstration Spacecraft Report and Baseline Performance Document, Volumes I and II.

Report Ref. # : DOC-CR-SP-81-047-A
Contract # : OST-00133
Contract File #: 15ST 36100-0-0768

(2) M-SAT PHASE A EXTENSION, TASK 1 CANADIAN DEMONSTRATION SPACECRAFT - L-SAT BUS, ADDENDUM TO PHASE A REPORT.

REPORT REF. # : DOC-CR-SP-82-004-B
CONTRACT # : OST81-00181
CONTRACT FILE #: 15ST36001-1-3040

## 3.0 SYSTEM DESCRIPTION

### 3.1 System Concept

A Canadian Operational M-SAT spacecraft must provide reliable and dependable radio telephone service to mobile users over all of Canada. An initial operational system would be launched in the early 1990's and would have to provide service to about the year 2000 when the number of mobile users in Canada is expected to reach about 125,000.

The required launch configuration is an L-SAT bus on an Ariane IV launch vehicle. A 50 foot antenna aperture has been chosen as this is approximately the optimum size to generate a single line of beams across Canada.

The communication system is unchanged from the baseline, and is described by figure 3.4-1 (a) of the Phase A report except that the backhaul frequency band is changed to 14/12 GHz.

### 3.2 Coverage Pattern

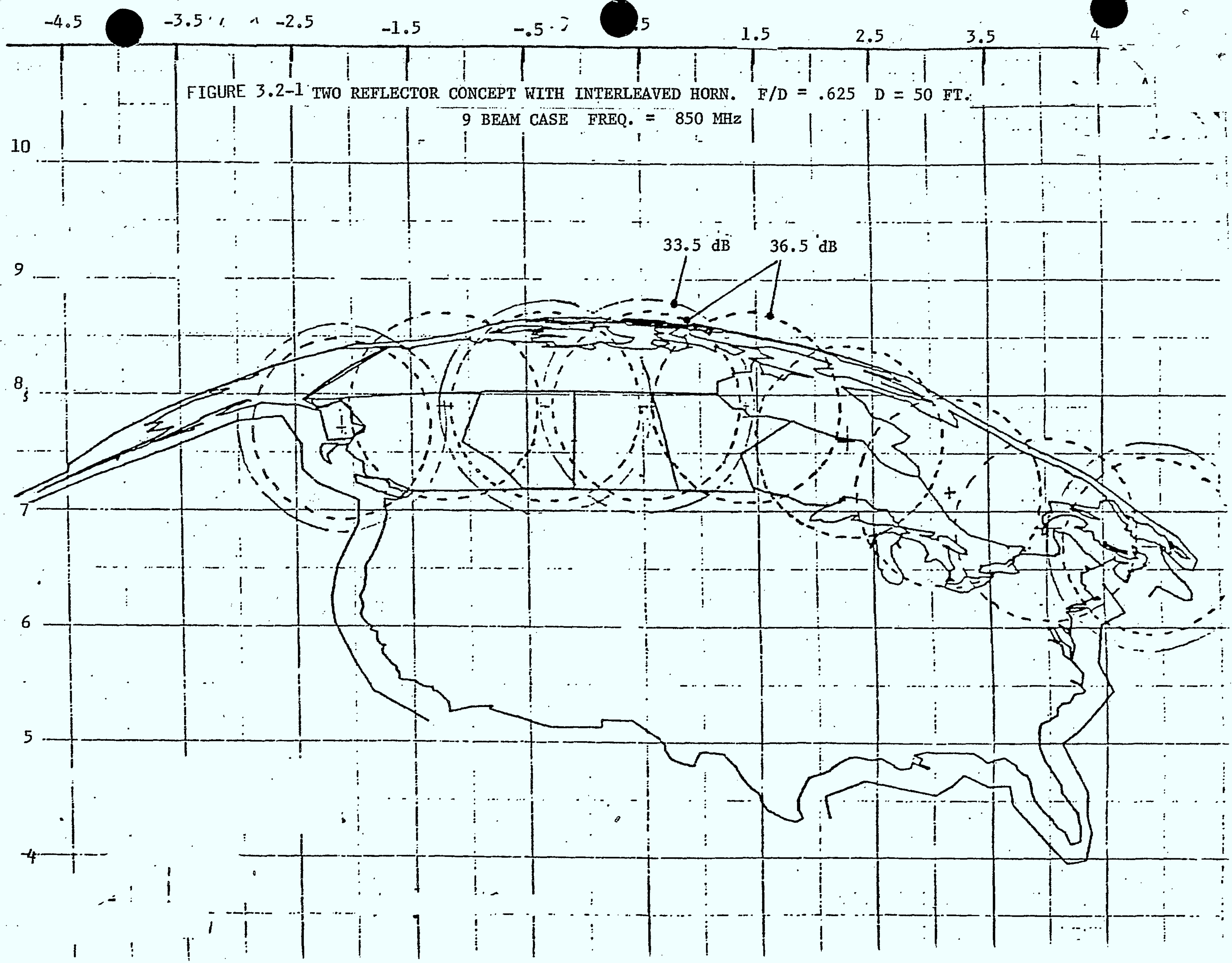
The coverage pattern is shown in Figure 3.2-1 with nine beams provided to cover Canada. This is accomplished by using two antennas with odd numbered beams in one antenna and even numbered beams in the other. This provides a high antenna edge gain due to the high cross-over level.

### 3.3 Frequency Plan

The high UHF frequency band is assumed to be the same as for the baseline, namely 866-870 MHz on the downlink and 821-825 MHz on the uplink. The available band is divided into three subbands. Each subband is used three times to make up the nine beams.

The polarization is right hand circular on both the uplink and downlink, identical to that used in the baseline.

FIGURE 3.2-1 TWO REFLECTOR CONCEPT WITH INTERLEAVED HORN. F/D = .625 D = 50 FT.
9 BEAM CASE FREQ. = 850 MHz



## 3.0 SYSTEM DESCRIPTION (CONT'D)

### 3.4 Traffic Capability

Table 3.4-1 summarizes the number of assignable channels for the complete spacecraft in both sunlight and eclipse and gives an estimate of the number of users that can be supported on the basis of 10% blockage and .0125 erlong per user. The number of users in sunlight is 135,000 assuming LPC.

This exceeds the Woods-Gordon projection of 124,000 (Figure 3.4-1) in the year 2000. Further optimization in the space and ground segment should increase the channel capability still more, provided LPC or other high efficiency modulation technique is selected for the system.

## TABLE 3.4-1 OPERATIONAL MODEL-USER ESTIMATE

| | TOTAL CHANNELS | TOTAL ERLONGS (10% BLOCKAGE) | TOTAL USERS (.0125 ERLONG/USER) |
|---|---|---|---|
| **Sunlight** | | | |
| NBFM | 359 | 398 | 31,840 |
| PELPC | 1,479 | 1,643 | 131,440 |
| **Eclipse** | | | |
| NBFM | 101 | 107 | 8,560 |
| PELPC | 445 | 494 | 39,520 |

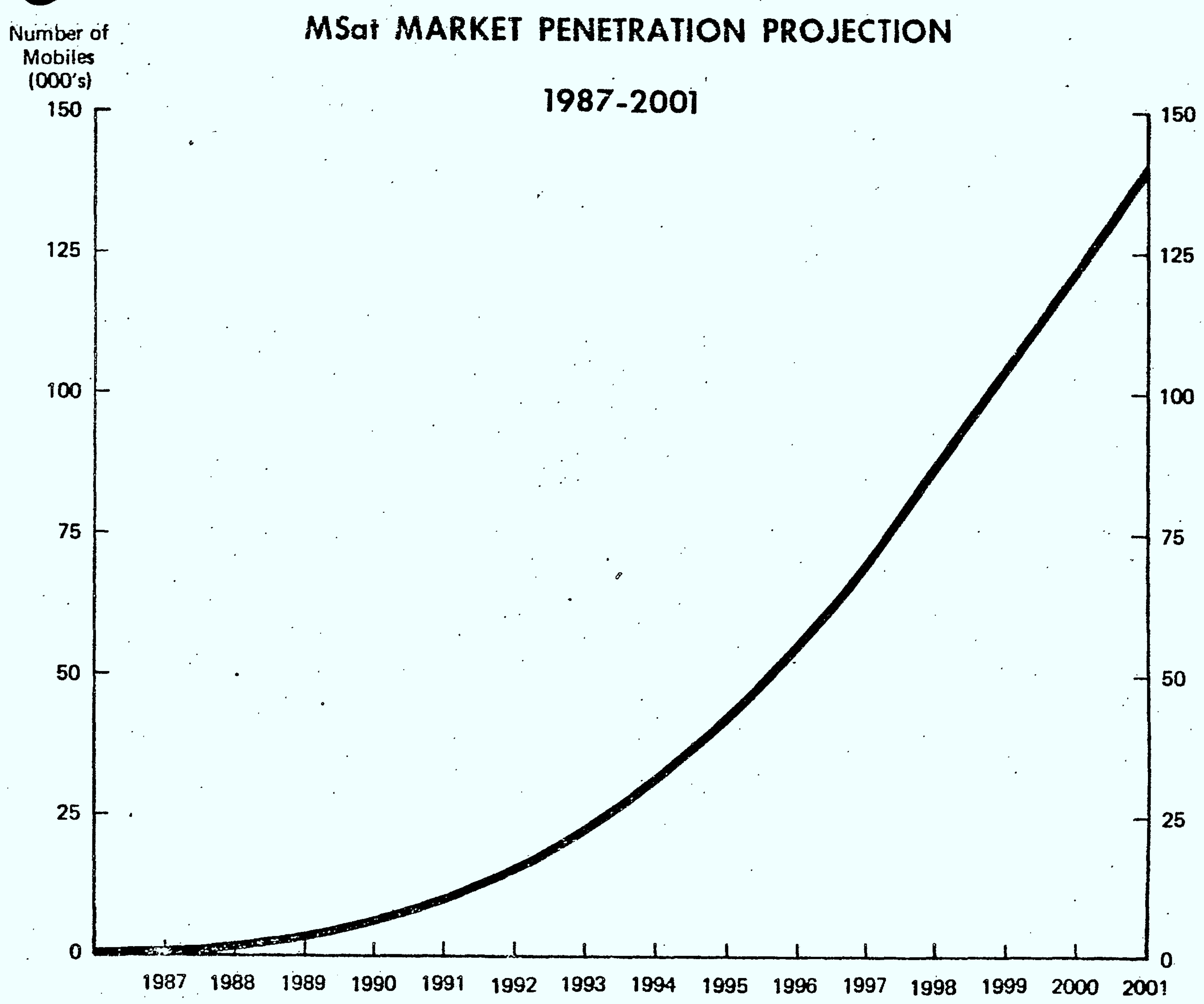



FIGURE 3.4-1 WOODS GORDON MARKET PROJECTION FOR M-SAT

## 3.0 SYSTEM DESCRIPTION (CONT'D)

### 3.5 Demographic Distribution

A breakdown of the number of users in each beam is made on the basis of the map of Figure 3.5-1. In the overlap region the locations of the boundaries between the beams have been selected generally to conform to provincial boundaries. In other cases they have been positioned in an attempt to optimize the number of users in any one beam. The estimated number of users in each beam is given in Table 3.5-1 based on the user population given in the baseline requirements document. The estimated number of channels is given for this population as well as for double the population totalling 140,000 users.

The present design has aimed at servicing the higher user population except that the individual beams would be limited to less than the maximum required in the east central beams. By limiting each beam to a maximum of 266 channels, then the total requirement is 1367 channels which is less than the number of channels that the spacecraft can support. The total user population that can be serviced with 1479 channels (see Table 4.3-1 ) is about 135,000 which is less than the total number of 140,000 users because two beams are not fully serviced. If the number of channels per beam were increased, the total number of channels would decrease with a resulting decrease in the total number of users.

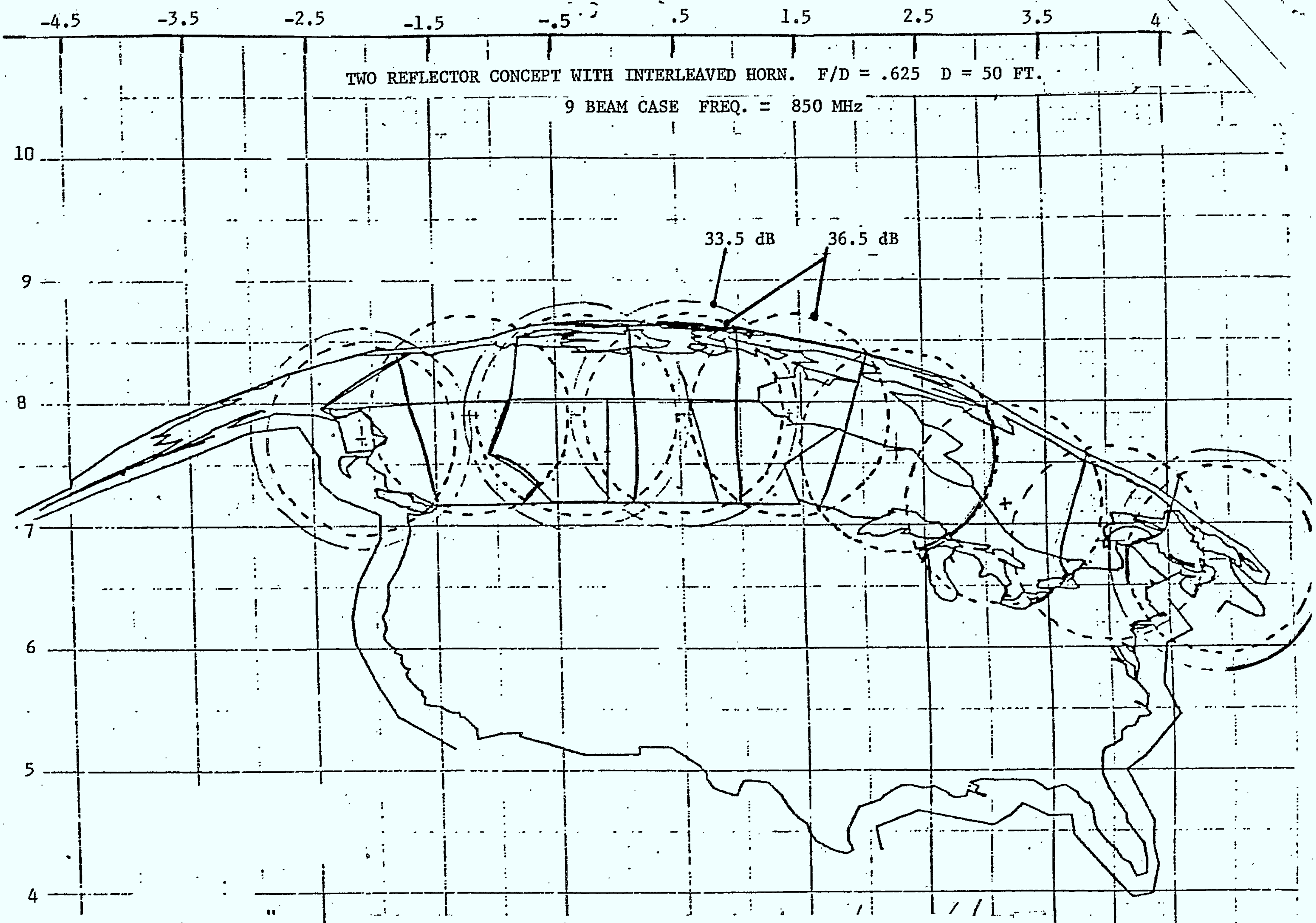



FIGURE 3.5-1 ASSUMED DIVIDING LINES BETWEEN ADJACENT BEAMS

TABLE 3.5-1 ASSUMED DISTRIBUTION OF USER POPULATION

| | | 70,000 USERS | | | 140,000 USERS | | |
|---|---|---|---|---|---|---|---|
| | No. of Users | Beam Total | Erlong Per Beam X .0125 | Ch/Beam 10% Blockage | Beam Total | Erlong Per Beam X .0125 | Ch/Beam 10% Blockage |
| **Beam 1** | | | | | | | |
| BC | 4446 | 4510 | 56.4 | 57 | | | |
| Yukon | 64 | | | | 9020 | 112.8 | 106 |
| **Beam 2** | | | | | | | |
| BC | 4000 | | | | | | |
| Yukon | 70 | 4110 | 51.4 | 53 | 8220 | 102.8 | 97 |
| NWT | 40 | | | | | | |
| **Beam 3** | | | | | | | |
| ALTA | 5090 | | | | | | |
| SASK | 1425 | 6545 | 81.8 | 79 | 13090 | 163.6 | 150 |
| NWT | 30 | | | | | | |
| **Beam 4** | | | | | | | |
| SASK | 4000 | | | | | | |
| MAN | 839 | 4869 | 60.9 | 61 | 9738 | 121.7 | 114 |
| NWT | 30 | | | | | | |
| **Beam 5** | | | | | | | |
| MAN | 2000 | | | | | | |
| ONT | 1000 | 3661 | 38.3 | 41 | 6122 | 76.5 | 74 |
| NWT | 61 | | | | | | |
| **Beam 6** | | | | | | | |
| ONT | 3000 | | | | | | |
| QUE | 300 | 3400 | 42.5 | 45 | 6800 | 85.0 | 82 |
| NWT | 100 | | | | | | |
| **Beam 7** | | | | | | | |
| ONT | 14077 | | | | | | |
| QUE | 700 | 14895 | 186.2 | 170 | 29790 | 372.4 | 335 |
| NFLD | 118 | | | | | | |
| **Beam 8** | | | | | | | |
| ONT | 2000 | 19239 | 240.5 | 217 | 38478 | 481.0 | 434 |
| QUE | 17039 | | | | | | |
| NFLD | 200 | | | | | | |
| **Beam 9** | | | | | | | |
| NFLD | 3000 | | | | | | |
| NB | 3200 | 9371 | 117.1 | 110 | 18742 | 234.3 | 212 |
| NS | 2787 | | | | | | |
| PEI | 384 | | | | | | |
| TOTAL | | 70000 | | | 140000 | | 1604 (1367 with max. 266) |

## 4.0 TRADE-OFF STUDIES

### 4.1 Two Reflectors Versus One

This trade-off was performed for the high UHF only demonstration model and is described in the addendum to the Phase A report. The conclusion was that the lower gain of the one antenna system and the requirement for a phase and gain imbalance allowance absorbed all the mass recovered by having only one antenna so that the two configurations had practically the same traffic capability. In addition, the two reflector configuration, by eliminating the transponder beam forming network, avoided the risks and costs associated with phase and amplitude control of the power amplifiers and low noise amplifiers.

Finally, the two reflector version uses smaller power amplifiers thus minimizing the amplifier design and thermal dissipation problem. For these reasons, the two reflector configuration was chosen for the high UHF only demonstration model. All the reasons are equally valid for the operational system and the two reflector configuration has been selected.

### 4.2 Reflector Diameter

The choice in aperture diameter is between three sizes;

a) a repeat of the 30 foot aperture used for the demonstration model,

b) an increase to the maximum diameter (about 50 feet), which is optimum for a single line of beams to cover Canada, and,

c) an increase to the minimum diameter (about 83 feet), which will provide two rows of beams across Canada.

To minimize the heat dissipation problem it is necessary to maximize the antenna gain. For this reason the 30 foot diameter is considered too small. The largest diameter (~83 feet) would provide the highest No. of users. However, the bus designers, BAe, have found a problem with stowage of the feed array and question the capability of the AOCS subsystem to stabilize and accurately point such a large antenna. For this reason the 50 foot diameter has been chosen for this configuration study. Table 4.2-1 summarizes the essential features of the three antenna diameters.

TABLE 4.2-1 COMPARISON OF SPACECRAFT WITH THREE ANTENNA DIAMETERS

| | | | |
|---|---|---|---|
| Aperture Diameter | 30 foot | 50 foot | 83 foot |
| Number of Rows | One | One | Two |
| Number of Beams | 6 | 9 | 24 |
| Calculated Antenna Gain | 33.5 | 36.5 | 39.0 |
| Beam Forming Network (With 2 Reflectors) | No | No | Yes |
| Problem Areas: | | | |
| • Stowage | No | No | Yes |
| • AOCS | No | No | Yes |
| • Thermal | Yes | Yes | No |
| • Power | Yes | No | No |

4.0 TRADE-OFF STUDIES (CONT'D)

## 4.3 Number of Antenna Beams

The high UHF antenna gain has been determined for coverage optimized for both nine and ten beams. To obtain ten beams in the same space, the horns must be made smaller thus increasing the spill over. The net result is that the edge gain with nine beams is 0.5 dB higher than with ten beams. The coverage patterns for the ten beam antenna along with the required horn dimension is given in Figure 4.3-1. The coverage pattern for the nine beam antenna is given in Figure 3.2-1 and the feed assembly in Figure 6.1-1.

The number of beams is not selected on the basis of net antenna gain but rather on the basis of number of channels per beam and the total number of channels.

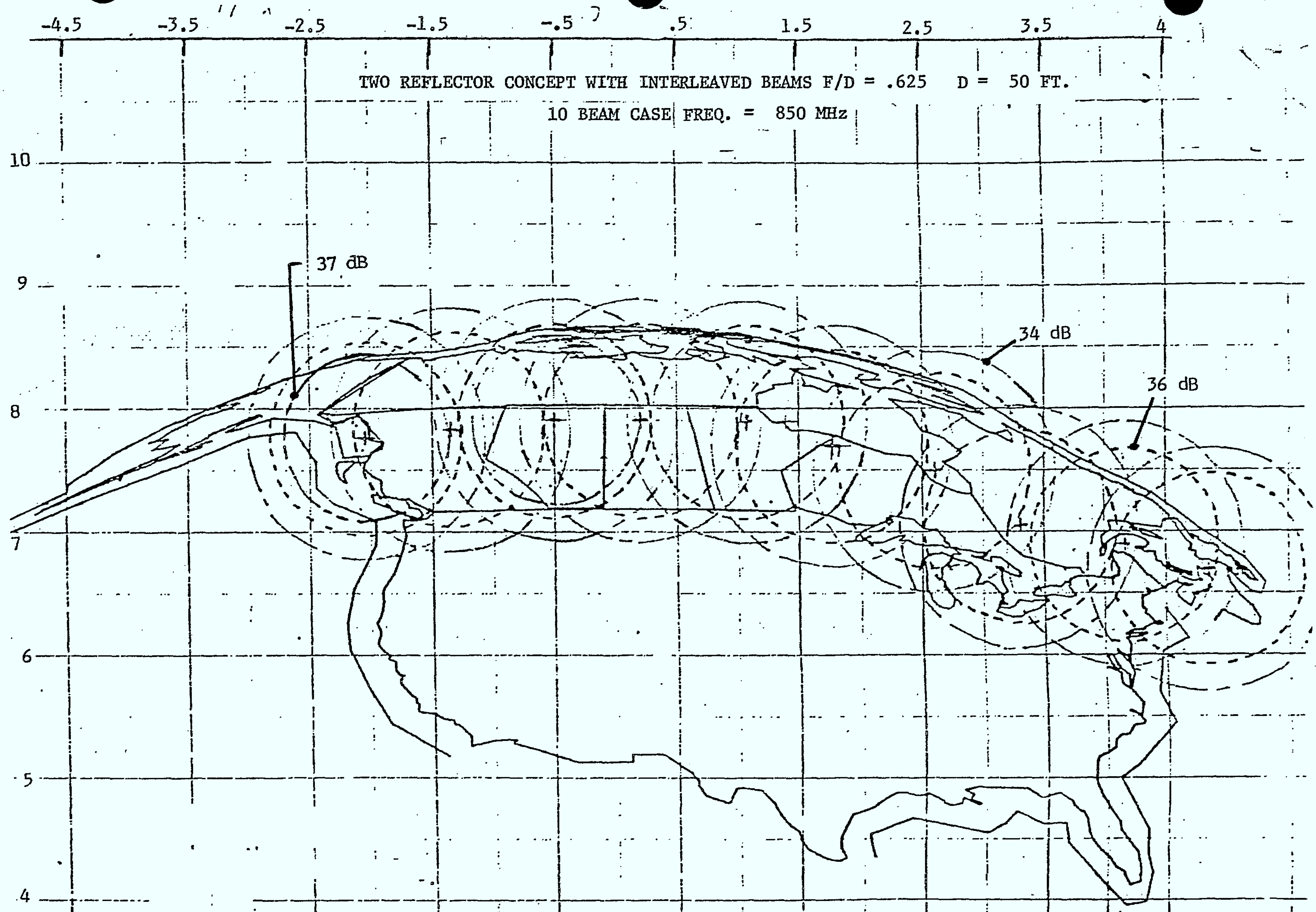



FIGURE 4.3-1 THE TEN BEAM ANTENNA COVERAGE PATTERN USING TWO 50 FOOT REFLECTORS WITH INTERLEAVED SINGLE HORN BEAMS

4.0 TRADE-OFF STUDIES (CONT'D)

## 4.4 Traffic Capability

The calculation of the number of channels for both narrow band FM and pitch excited LPC is shown in Table 4.3-1 for the nine beam antenna and Table 4.3-2 for the ten beam antenna. There is no unique solution. Larger power amplifiers could be used which would increase the number of channels per beam but would also increase the zero traffic power drain and thus reduce the total number of channels that can be supported by the spacecraft. The power amplifier size could also be reduced but number of assignable channels in each amplifier must be at least one tenth of the assignable channels for the complete spacecraft. The optimum is to have the power amplifier somewhat larger than the minimum described above so that there is some capability of demographically distributing the channels.

The antenna gain is 36 dB for the nine beam and 35.5 dB for the ten beam antenna which includes an allowance for the cable connection to the transponder. A pointing allowance of 1.6 dB is used which is larger than the demonstration model to allow for the higher gain slope of the smaller beam.

The power amplifier efficiency is taken as 27% which is the same as that used for the demonstration model. The conversion from active channels to assignable channels due to voice activation is made using the approximate formula;

$$N_{ACT} = 6 + 0.40625 \times N_{ASS} \qquad N_{ASS} > 10$$

$$N_{ACT} = N_{ASS} \qquad N_{ASS} \leq 10$$

## TABLE 4.3-1 CALCULATION OF CHANNEL CAPACITY FOR THE NINE BEAM ANTENNA CONFIGURATION

| | | NBFM | PELPC |
|---|---|---|---|
| Antenna Diameter | m | 15.2 | 15.2 |
| | ft | 50 | 50 |
| Number of Beams | $N_B$ | 9 | 9 |
| Edge EIRP/Channel | dBw | 39.7 | 33.7 |
| Antenna Gain | dB | 36.0 | 36.0 |
| Pointing Error Loss | dB | 1.6 | 1.6 |
| Transponder RF Power/Ch | dBw | 5.3 | -0.7 |
| Output Circuit Loss | dB | 1.3 | 1.3 |
| HPA RF Power/Channel | dBw | 6.6 | 0.6 |
| | watts | 4.57 | 1.15 |
| Max. Conversion Eff. (0.3 X 0.9) | | .27 | .27 |
| Voice Activation | | yes | yes |
| Max. Number of Active Ch/Beam | $N_{BA}$ | 24* | 114 |
| Max. Number of Assignable Ch/Beam | $N_{APB}$ | 44* | 266 |
| Total Number of Active Channels | $N_{TA}$ | 152 | 607 |
| Total Number of Assignable Channels | $N_{ASS}$ | 359 | 1479 |
| Max. RF Power Per Amp. | watts | 109.7 | 131.0 |
| Max. DC Power Per Amp. | watts | 422.9 | 484.8 |
| Max. DC Power for 9 Amps. | watts | 2961 | 2961 |
| Remainder of Transponder | watts | 83 | 83 |
| Total DC Power for Transponder | watts | 3044 | 3044 |
| Number of Active Cahnnels in Eclipse | | 47 | 187 |
| Number of Assignable channels in Eclipse | | 101 | 445 |
| Total DC Power in Eclipse | watts | 1633 | 1633 |
| Unit Weight of HPA and EPC | Kg | 8.5 | 8.5 |
| Total Weight of 16 (HPA and EPC)s | Kg | 136.3 | 136.3 |
| Total Frequency Band | MHz | 4 | 4 |
| Channel Spacing | KHz | 30 | 5 |
| Number of Subbands | | 3 | 3 |
| Maximum Channels Per Subband | | 44 | 266 |

* Limited by the 4 MHz Frequency Band

## TABLE 4.3-2 CALCULATION OF CHANNEL CAPACITY FOR THE TEN BEAM ANTENNA CONFIGURATION

| | | NBFM | PELPC |
|---|---|---|---|
| Antenna Diameter | m | 15.2 | 15.2 |
| | ft | 50 | 50 |
| Number of Beams | $N_B$ | 10 | 10 |
| Edge EIRP/Channel | dBw | 39.7 | 33.7 |
| Antenna Gain | dB | 35.5 | 35.5 |
| Pointing Error Loss | dB | 1.6 | 1.6 |
| Transponder RF Power/Ch | dBw | 5.8 | -0.2 |
| Output Circuit Loss | dB | 1.3 | 1.3 |
| HPA RF Power/Channel | dBw | 7.1 | 1.1 |
| | watts | 5.13 | 1.29 |
| Max. Conversion Eff (0.3 X 0.9) | | .27 | .27 |
| Voice Activation | | yes | yes |
| Maximum Number of Active Ch/Beam | $N_{BA}$ | 23 | 92 |
| Maximum Number of Assignable Ch/Beam | $N_{APB}$ | 42 | 211 |
| Total Number of Active Channels | $N_{TA}$ | 136 | 540 |
| Total Number of Assignable Channels | $N_{ASS}$ | 320 | 1314 |
| Maximum RF Power Per Amp. | watts | 117.9 | 118.5 |
| Maximum DC Power Per Amp. | watts | 436.9 | 438.9 |
| Maximum DC Power for 10 Amps. | watts | 2961 | 2961 |
| Remainder of Transponder | watts | 83 | 83 |
| Total DC Power to Transponder | watts | 3044 | 3044 |
| Number of Active Channels in Eclipse | | 42 | 187 |
| Number of Assignable Channels in Eclipse | | 88 | 445 |
| Total DC Power in Eclipse | | 1633 | 1633 |
| Unit Weight of HPA and EPC | Kg | 7.76 | 7.76 |
| Total Weight of 18 (HPA & EPC)s | Kg | 139.7 | 139.7 |
| Total Frequency Band | MHz | 4 | 4 |
| Channel Spacing | KHz | 30 | 5 |
| Number of Subbands | | 3 | 3 |
| Width of Subband | MHz | 1.333 | 1.333 |
| Maximum Channels/Subband | | 44 | 266 |

## 4.0 TRADE-OFF STUDIES (CONT'D)

### 4.4 Traffic Capability (Cont'd)

In comparing the nine and ten beam configurations it is seen that both the number of channels per beam and the total number of channels is larger for the nine beam antenna due to the higher antenna gain. This is realized with a small increase in the size of the individual amplifiers. However, the number of amplifiers has been reduced by two giving a small net drecrease in the overall transponder weight. On the negative side, an odd number of beams requiring nine amplifiers on the one side and seven amplifiers on the other is a non symmetric arrangement requiring two layouts, two thermal analyses, etc.

Because of the higher channel capacity, the nine beam version has been chosen as optimum. An eight beam configuration might provide still higher antenna gain by reducing still more the spill-over loss. Such an arrangement would provide maximum traffic capacity and a symmetric arrangement.

## 5.0 SPACE SEGMENT DESCRIPTION

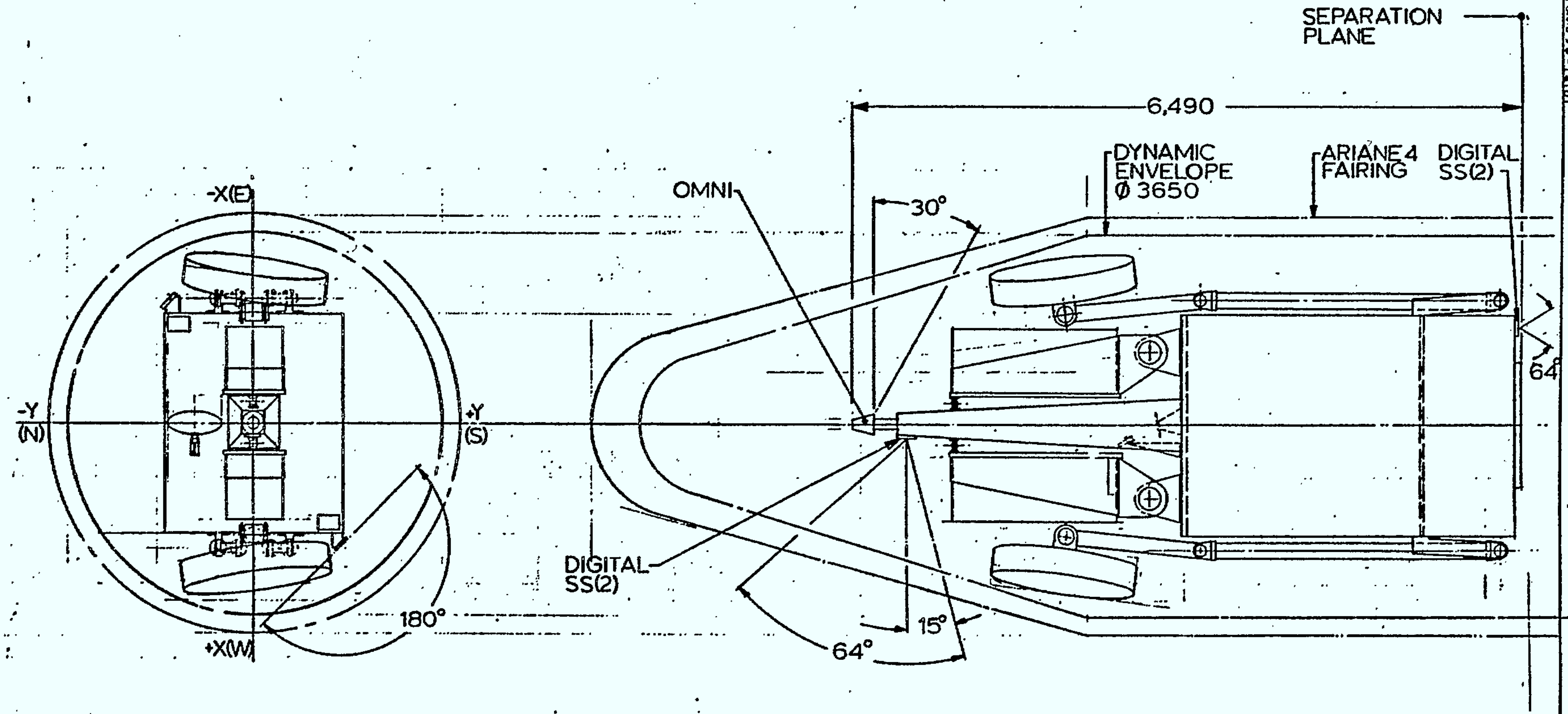
### 5.1 General

The high UHF only, operational M-SAT spacecraft has been configured utilizing the BAe L-SAT bus and two 50 foot reflectors with a single horn per beam providing nine beams over Canada.

The description of the overall spacecraft design configuration, designated AX-5, is provided in Section 4.0 of this report. For this configuration, the basic L-SAT bus required a significant number of modifications to accomodate the increased power, weight and dissipation of the payload. These modifications are detailed in Section 6.0.

### 5.2 Launch Vehicle Interface

Because of weight and volume constraints, the spacecraft is not compatible with the Ariane III launch vehicle but is compatible with the Ariane IV. The stowed configuration, as shown in drawing number 2612596, will fit either within the dedicated "short" 9.1 m fairing or within the upper position of the dual launch SPELDA "unsymmetrical configuraiton" system. As shown in Section 7.0, the spacecraft weight is well within the capability of the Ariane IV launch vehicle.




ASP

☐ FLIGHT
☒ NON FLIGHT

DIMENSIONS IN MILLIMETRES

CONCEPT/LAYOUT

Spar Aerospace Limited

SPAR

5010-A

C.WICKINS

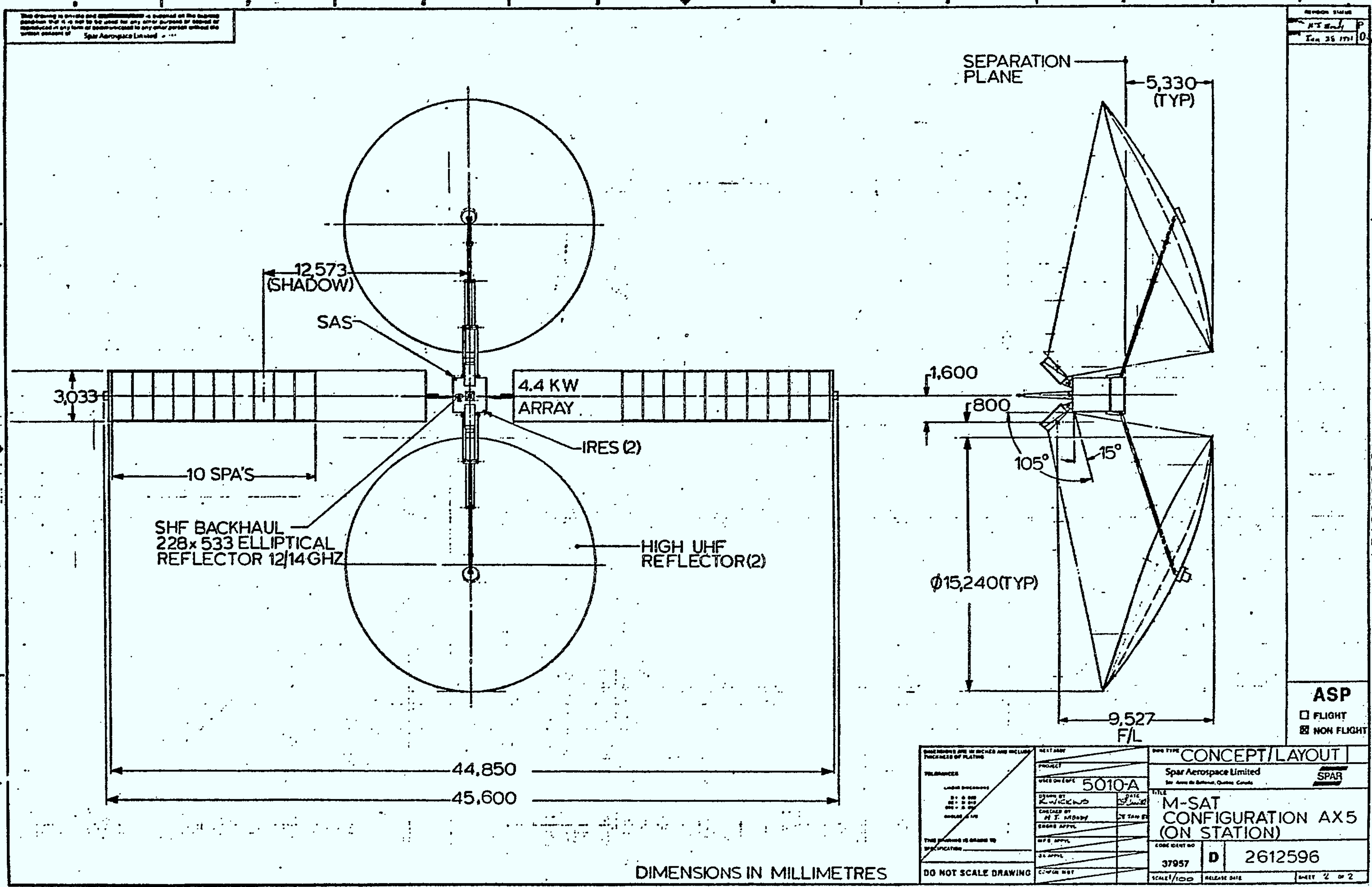
M.J. Moody

M-SAT CONFIGURATION AX5 (LAUNCH)

37957 D 2612596

DO NOT SCALE DRAWING

SCALE 1/20


SEPARATION PLANE
5,330 (TYP)
12,573 (SHADOW)
SAS
3,033
4.4 KW ARRAY
1,600
800
105°
15°
IRES (2)
10 SPA'S
SHF BACKHAUL
228x 533 ELLIPTICAL
REFLECTOR 12/14 GHZ
HIGH UHF
REFLECTOR(2)
ϕ15,240(TYP)
9,527
F/L
44,850
45,600
DIMENSIONS IN MILLIMETRES
ASP
FLIGHT
NON FLIGHT
CONCEPT/LAYOUT
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SPAR
5010-A
M-SAT
CONFIGURATION AX5
(ON STATION)
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2612596
DO NOT SCALE DRAWING

5.0 SPACE SEGMENT DESCRIPTION (CONT'D)

5.3 Mission Scenario

For a dedicated Ariane IV launch, the mission sequence is identical with that of the Ariane III launch described in Section 5.3 of the main M-SAT Baseline Performance Document. The spacecraft antenna deployment sequence would differ however, and would be as follows:

- Reflector boom deployments
- Reflector orientations
- Reflector deployments
- Feed array assembly deployeamnts

For a dual Ariane IV launch, the mission sequence would be as follows:

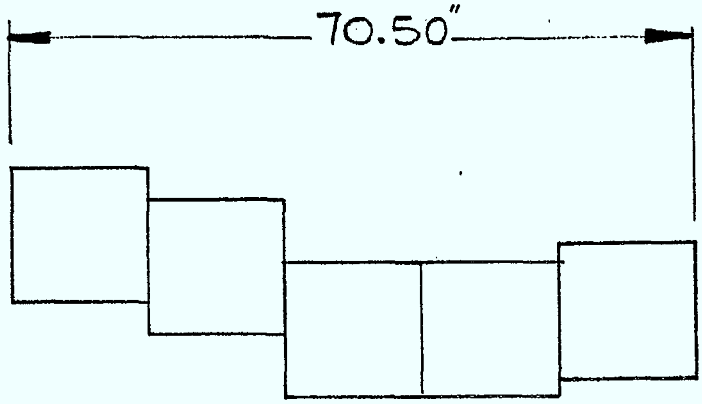
- Ignition of first stage engines
- Lift-off
- End of vertical ascent, tiltover
- Maximum thrust
- First stage burnout and separation
- Second stage ignition
- Fairing jettison
- Second stage burnout and separation
- Third stage ignition
- Third stage thrust cut off
- 2 spacecraft/third stage orientation
- Upper spacecraft separation
- (upper SPELDA separation)
- (lower spacecraft separation)
- Acquire ground station tracking
- Attain 3 axis stabilized mode
- Deploy solar arrays (partial)
- Attitude trim for apogee motor fire
- Apogee motor burn
- Sun acquisition
- Earth acquisition
- North-South inclination corrections
- East-West drift to station
- Spacecraft deployments
- On station operations

## 6.0 SUBSYSTEM DESCRIPTIONS

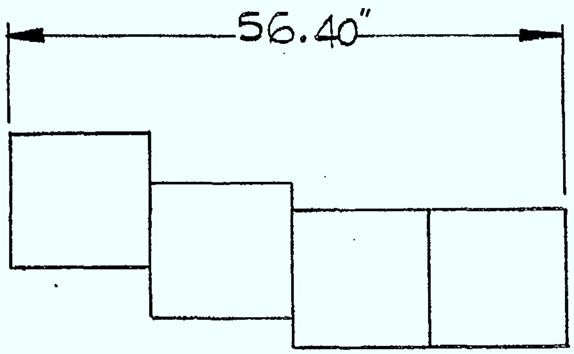
### 6.1 Antenna Subsystem

The antenna subsystem consists of two high UHF antennas with 15.2 meter aperture diameter and a 14/12 GHz elliptical aperture antenna for the backhaul. The high UHF antennas use the Lockheed wrap-rib design similar to, but larger than, the 9.1 meter antenna used in the baseline. Two antennas are used, one providing five beams and the other providing four beams using a single horn feed for each beam. The beams from the two antennas are interleaved so that odd numbered beams are provided by one antenna and even numbered beams by the other. The two feed assemblies are shown in Figure 6.1-1. The antenna pattern provided by the two antennas is given in Figure 3.2-1.

The backhaul antenna at 14/12 GHz is an elliptical aperture reflector with an offset focal point feed. The 12 GHz transmit beam is horizontally polarized while the 14 GHz receive beam is vertically polarized. Including feed loss but without pointing error, the net receive gain in the Canadian land mass is 24.5 dB while the transmit gain is 26.7 dB. This antenna is more fully described in the addendum to the M-SAT Phase A report.




(a) FEED ASSEMBLY FOR ODD NUMBERED BEAMS




(b) FEED ASSEMBLY FOR EVEN NUMBERED BEAMS

FIGURE 6.1-1 FEED HORN ASSEMBLIES FOR THE TWO ANTENNAS

## 6.0 SUBSYSTEM DESCRIPTIONS CONT'D)

### 6.2 Transponder Subsystem

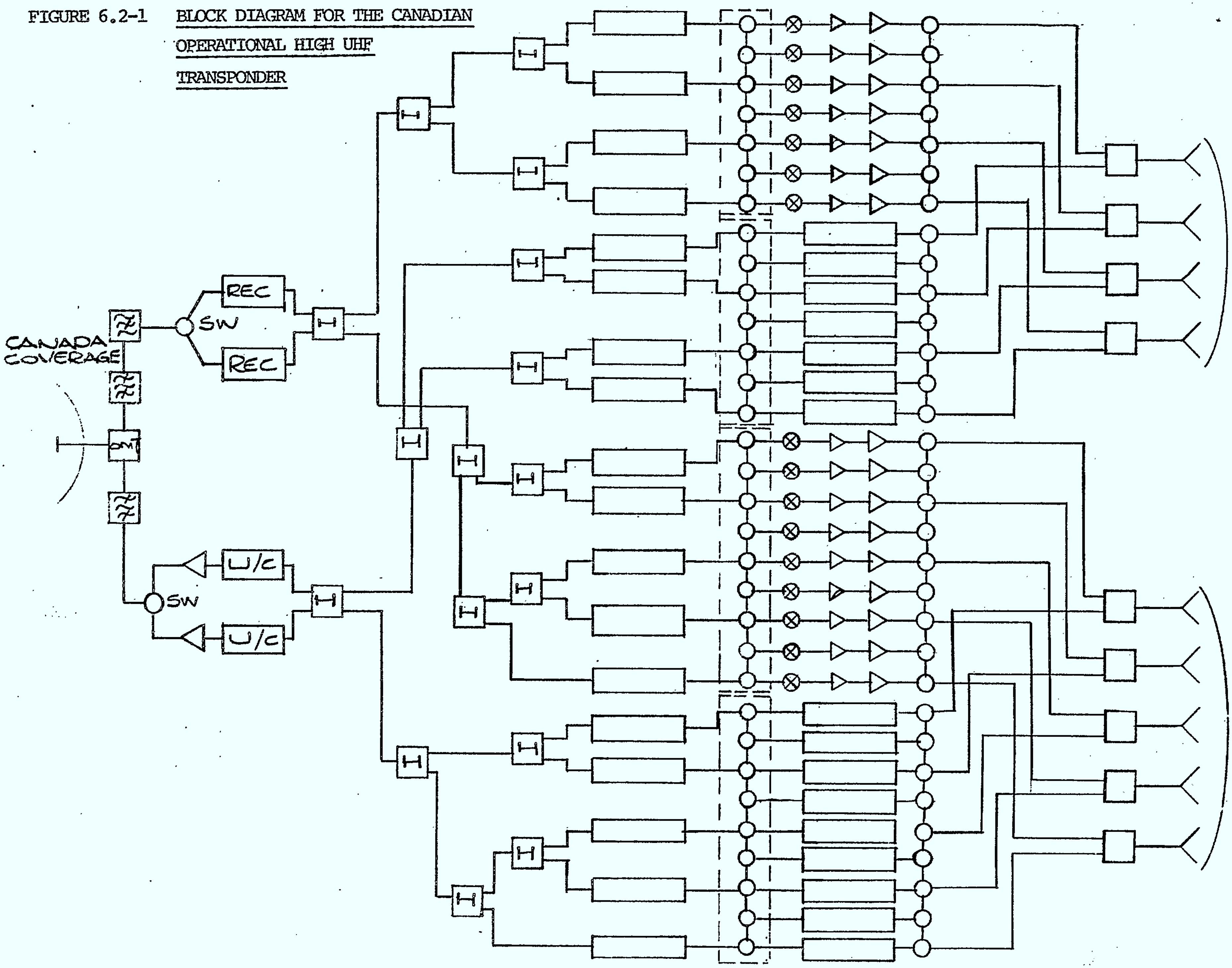
The transponder block diagram is shown in Figure 6.2-1. There are nine beams with a single horn for each beam. Since no beam forming network is required, each amplifier carries signals for only one beam and nine active amplifiers are required for the nine beams. The transponder is divided in two halves for mounting on the north and south panels. Redundant power amplifiers and low noise amplifiers are provided on each panel for a total of 16 in all. These are connected in an open ring redundancy scheme on each panel. Except for the backhaul, there are no signal interconnections between panels.

Because there is no beam forming network, there is no requirements on phase and amplitude stability or control. This simplifies the transponder design, the design of many components as well as the complexity of integration and test.

The transponder is a double conversion type similar to that selected for the baseline demonstration model. This allows the use of all the UHF bandwidth without having to subtract bandwidth for filter guard bands. It seems fairly certain that bandwidth will be a restriction at least in an operational system so the double conversion transponder is used.

The backhaul frequency has been changed from the military band at 7/8 GHz. 14/12 GHz has been selected for the purpose of providing weight and power estimates. This is the same band selected for the earlier operational system design but the trade-off performed then is only partially valid. A single all Canada backhaul beam is used requiring one redundant transmitter and one redundant receiver. All the frequency segments in the UHF bands are stacked in frequency and translated to the 14/12 GHz band for transmission to/from the gateway stations.

FIGURE 6.2-1 BLOCK DIAGRAM FOR THE CANADIAN OPERATIONAL HIGH UHF TRANSPONDER



6.0 SYSTEM DESCRIPTIONS (CONT'D)

6.2 Transponder Subsystem (Cont'd)

The detailed frequency plan is given in Table 6.2-1. In the forward path, the 14 GHz receive signal is translated to an IF frequency in the vicinity of 350 MHz where the band is separated into nine segments for the nine UHF beams. The nine frequency segments are then translated by different local oscillator frequencies to the appropriate location in the 866-870 MHz band. In the return path, the uplink signals at 821-825 MHz are translated to an IF frequency in the region of 450 MHz where the frequency segments are multiplexed together and translated to 12 GHz for transmission to the gateway station. The local oscillator frequencies are all harmonically related with a separation of 8 MHz and controlled from a master oscillator.

TABLE 6.2-1(a) DETAILED FREQUENCY PLAN (FORWARD PATH)

| BACKHAUL FREQUENCY UPLINK FREQUENCY | FORWARD IF FREQUENCY | FORWARD L.O. | DOWNLINK FREQUENCY | PANEL LOCATION |
|---|---|---|---|---|
| 14042.00-14043.33 | 322.00-323.33 | 544 | 866.00-867.33 | North |
| 14051.33-14052.67 | 331.33-332.67 | 536 | 867.33-868.67 | South |
| 14060.67-14062.00 | 340.67-342.00 | 528 | 868.67-870.00 | North |
| 14066.00-14067.33 | 346.00-347.33 | 520 | 866.00-867.33 | South |
| 14075.33-14076.67 | 355.33-356.67 | 512 | 867.33-868.67 | North |
| 14084.67-14086.00 | 364.67-366.00 | 504 | 868.67-820.00 | South |
| 14090.00-14091.33 | 370.00-371.33 | 496 | 866.00-867.33 | North |
| 14099.33-14100.67 | 379.33-380.67 | 488 | 867.33-868.67 | South |
| 14108.67-14110.00 | 388.67-390.00 | 480 | 868.67-870.00 | North |

TRANSLATION 13720.00

## TABLE 6.2-1(b) DETAILED FREQUENCY PLAN (RETURN PATH)

| BEAM NO. | UPLINK FREQUENCY | RETURN L.O. | RETURN IF FREQUENCY | BACKHAUL DOWNLINK FREQUENCY | PANEL LOCATION |
|---|---|---|---|---|---|
| 1 | 821.00-822.33 | 440 | 381.00-382.33 | 11741.00-11742.33 | North |
| 2 | 822.33-823.67 | 432 | 390.33-391.67 | 11750.33-11751.67 | South |
| 3 | 823.67-825.00 | 424 | 399.67-401.00 | 11759.67-11761.00 | North |
| 4 | 821.00-822.33 | 416 | 405.00-406.33 | 11650.00-11766.33 | South |
| 5 | 822.33-823.67 | 408 | 414.33-415.67 | 11774.33-11775.67 | North |
| 6 | 823.67-825.00 | 400 | 423.67-425.00 | 11783.67-11785.00 | South |
| 7 | 821.00-822.33 | 392 | 429.00-430.33 | 11789.00-11790.33 | North |
| 8 | 822.33-823.67 | 384 | 438.33-439.67 | 11798.33-11799.67 | South |
| 9 | 823.67-825.00 | 376 | 447.67-449.00 | 11807.67-11809.00 | North |

TRANSLATION 11360.00

6.0 SUBSYSTEM DESCRIPTIONS (CONT'D)

## 6.3 Bus Changes

### 6.3.1 General

A complete detailed description of the L-SAT bus subsystem is provided in Sections 6.3 through 6.8 of the Canadian Demonstration Baseline Performance Document. For this operational configuration, a large number of modifications were necessary to accomodate the increased power, weight and dissipations of the payload.

The bus changes noted herein are expected to result in an overall bus mass increase of approximately 240 Kg, with excellent prospects for significant savings as the configuration is refined.

Bus changes, listed by subsystem, are as follows.

### 6.3.2 TT&C

No major modifications are envisioned in this sub-system. The omni look angle for this configuration is adequate.

### 6.2.3 ACS

Look angles for the SAS and IRES are adequate, and solar torques are within the present L-SAT wheel capability.

### 6.3.4 Propulsion

An increase in fuel capacity of 530.6 Kg is required for this configuration. This is achieved by inserting a cylindrical plug into each tank. This is a standard L-SAT modification to match Ariane IV capability. The larger tanks fit within the current L-SAT thrust tube.

6.0 SUBSYSTEM DESCRIPTIONS (CONT'D)

6.3 Bus Changes (Cont'd)

6.3.5 Power Subsystem

6.3.5.1 Solar Arrays

The number of solar array SPA's is doubled from 5/side to 10/side for this configuration. Solar array span is increased from 30m to 45m tip-to-tip, and the blank inner panels are retained. Total power available to the bus/payload combination from this array is approximately 4.4 kw.

6.3.5.2 Batteries

This configuration will require one additional Ni-H batteries for a total complement of three.

The total power subsystem mass increase is estimated to be 103 Kg. A potential weight saving of 20 Kg may be achieved by 1990 with 50 AHr batteries.

6.3.6 Thermal Subsystem

This configuration makes use of crossed heat pipes for additional thermal rejection capacity, and some cool running (low dissipation) items are mounted internally away from the north/south panels. A maximum thermal dissipation capacity of 3.0 Kw will be available with this configuration at equinox. A worst case capacity of 2600W will be available at any time, distributed as approximately 1600 watts on the shadowed panel and 1000 watts on the sunlit panel. A total weight penalty of 18 Kg is expected.

6.3.7 Structure

The present L-SAT structure with approximately 10 Kg of additional stiffening will support this configuration. A slightly more efficient structure would result if the reflector boom attachments are moved up to the lower floor.

## 7.0 SPACECRAFT SYSTEM BUDGETS

### 7.1 Spacecraft Mass and Power Budgets

The spacecraft level mass budget is given in Table 7.1-1. The solar array consists of 20 SPA's (10 on each side) which have been extended to the maximum amount permissible leaving the inboard sections without solar cells. This minimizes the problem of solar array shadowing from the antenna though shadowing still occurs.

This is the maximum solar array considered practical with a 50 foot reflector. Because of this, the full weight capability of the Ariane IV launch vehicle is not used and a sizeable weight margin remains.

The eclipse capability is also augmented to 2272 watts requiring three nickel hydrogen batteries. This gives an eclipse capability which is comfortably above the 25% minimum.

This power summary is given in Table 7.1-2.

## TABLE 7.1-1 HIGH UHF OPERATIONAL MODEL (L-SAT WITH ARIANE IV LAUNCH)

### WEIGHT SUMMARY (Kg)

| | | | |
|---|---|---|---|
| Subsystem | | | |
| Repeaters | | | |
| Hugh UHF | 187.0 | 187.0 | |
| L-Band Repeater | - | - | |
| DRP & EPIRB | - | - | |
| Antennas | | 212.6 | |
| High UHF | 194.4 | | |
| Backhaul | - | | |
| L-Band | 2.7 | | |
| DRP & EPIRB | - | | |
| Central Support Tower | 15.5 | | |
| Platform | | 999.5 | |
| Structure | 229.5 | | |
| Thermal | 67.4 | | |
| Attitude (AOCS) | 88.3 | | |
| Power (3 Batteries) | 437.3 | | |
| TT&C | 21.6 | | |
| Propulsion | 125.4 | | |
| Balance | 30.0 | | |
| Spacecraft Dry Mass | | 1399.1 | |
| Fuel and Residual | | 1742.3 | |
| Adaptor | | 65.0 | |
| Margin | | 293.6 | (21%) |
| Launch Capability | | 3500.0 | |

## TABLE 7.1-2 HIGH UHF ONLY OPERATIONAL MODEL - TWO REFLECTORS

### (POWER SUMMARY)

| | ON STATION POWER REQUIREMENTS | |
|---|---|---|
| | Sunlight | Eclipse |
| Payload (High UHF) | 3044 | 1633 |
| Platform | | |
| Structure | - | - |
| Thermal | 232.0 | 99.2 |
| AOCS (Incl. SADAPTA) | 116.6 | 116.6 |
| Power (Incl. Harness) | 61.0 | 46.0 |
| TT&C | 29.1 | 29.1 |
| Propulsion | - | - |
| Sub Total | 438.7 | 290.9 |
| Misc. Losses | | |
| ELI Loss | 22.8 | 22.8 |
| Battery Charging | 262.5 | - |
| Shunt Dump Loss | 240.5 | - |
| BDR Loss | - | 169.3 |
| Sub Total | 525.8 | 192.1 |
| Total Required | 4008.5 | 2116.0 |
| Available | 4390.0 | 2272.5 |
| Margin | 381.5 | 156.5 |
| | (9.5%) | (7.4%) |

## 7.0 SPACECRAFT SYSTEM BUDGETS (CONT'D)

### 7.2 Payload Mass and Power Breakdown

The transponder weight and power breakdown is given in Table 7.2-1. The total UHF repeater mass is 187.0 Kg and the power is 83 watts for everything except the high power amplifiers. The power taken by the final high power amplifiers is given in Table 3.4-1 as 2961 watts. The items with item numbers are generally identical in weight and power to the baseline. The main exceptions are the power amplifiers which have been resized and the frequency synthesizer which has been increased in site and separated into two units.

The antenna and tower elements including associated tie-down and deployment mechanisms are listed in Table 7.2-2. The total weight of these items is 212.6 Kg.

## TABLE 7.2-1 MASS AND POWER BREAKDOWN OF THE HIGH UHF REPEATER

| | | Quantity | Unit Mass (Kg) | Total (Kg) | Power (w) |
|---|---|---|---|---|---|
| 115 | REC BSF | 1 | .23 | .23 | - |
| 116 | REC BPF | 1 | .23 | .23 | - |
| 117 | REC ISO | 1 | .07 | .07 | - |
| 118 | REC Ferrite SW | 1 | .07 | .07 | - |
| 119 | Preamp Red | 1 | 0.9 | .90 | 1.0 |
| 401 | SHF/UHF D/C Red | 1 | .54 | .54 | 3.6 |
| 404/ 412 | Redundant SW | 4 sets | .25 | 1.0 | 1.6 |
| 402 | UHF D/C Non Red | 16 | 0.2 | 3.2 | 23.0 |
| 406 | UHF PA&EPC | 16 | 8.52 | 136.3 | Per Table |
| 407/ 409 | Red Switch | 4 sets of 8 | 0.14 | 4.5 | - |
| 408 | Duplexer | 10 | .68 | 6.8 | - |
| 410 | UHF Preamp | 16 | .18 | 2.9 | 3.5 |
| 414 | UHF D/C Non Red | 16 | .15 | 2.4 | 3.7 |
| 415 | UHF/SHF D/C Red | 2 | .45 | .9 | 0.8 |
| 416 | SHF TWTA 10w | 2 | 3.0 | 6.0 | 35.0 |
| 417 | W/G SW | 2 | .64 | 1.3 | - |
| | Output BPF | 2 | .36 | .72 | - |
| | Output Isolator | 2 | .07 | .14 | - |
| 418 | Frequency Synth. Red | 2 | 1.9 | 3.8 | 6.8 |
| 419 | PWR, Tlm. & Cmd | 2 | 1.5 | 3.0 | 2.0 |
| | Brackets and Hardware | 1 set | 1.5 | 1.5 | - |
| | Cable of Wire Harness | 1 set | 9.0 | 9.0 | - |
| | Master Oscillator (Redundant) | 1 | 1.5 | 1.5 | 2.0 |
| | Total | | | 187.0 | 83.0 |

## TABLE 7.2-2 ANTENNA MASS BREAKDOWN

| Unit Name | Quantity | Unit Mass | Total Mass |
|---|---|---|---|
| Reflector (50 foot aperture) | 2 | 43.1 | 86.2 |
| Deployment Boom | 2 | 31.3 | 62.6 |
| GFEC with Hinges and spring dampers | | | |
| Reflector Tie-Down | 2 | 2.5 | 5.0 |
| Feed Horn Assembly | 2 | 13.8 | 27.6 |
| Feed Deployment Mechanism | 2 | 2.0 | 4.0 |
| Feed Coax Lines | Set | | 6.0 |
| Feed Tie-Down | 2 | 0.5 | 1.0 |
| Feed Thermal Blankets | Set | | 2.0 Kg |
| Total High UHF Antenna | | | 194.4 |
| Central Support Tower | 1 | | 15.5 |
| Backhaul Antenna | 1 | | 2.7 |
| Total | | | 212.6 |

7.0 SPACECRAFT SYSTEM BUDGETS (CONT'D)

### 7.3 Bus Mass and Power Breakdown

The bus mass and power breakdown is fully described in Section 7.0 of the final Phase A report. Changes to the bus subsystems are described in Section 6.3 of this report including weight increments. The estimate of power requirements for the bus are given in Section 7.1.

## 8.0 PARAMETRIC VARIATION

### 8.1 General

The requirement is to add the L-band capability and a low UHF payload described in Section 6.0. This is accomplished using the L-band quad helix and a dual band feed on one of the 50 foot reflectors to provide the low UHF receive function. The power required for these services is subtracted from the high UHF payload which slightly reduces the number of available channels though the size of the high UHF power amplifiers is not reduced. The weight additions were taken from the large available margin.

### 8.2 Transponder Description

The transponder block diagram is given in Figure 8.2-1. It includes the L-band transponder with a quad helix antenna and the low UHF receiver with a feed assembly for the 50 foot reflector. The low UHF is connected directly into the IF combiner without frequency translation. The L-band is translated down to the IF band and combined with the high UHF band in the IF combiner so as to use the same backhaul. The detailed frequency plan is given in Table 8.2-1.

FIGURE 8.2-1 BLOCK DIAGRAM OF THE HIGH UHF TRANSPONDER WITH L-BAND AND LOW UHF ADDED

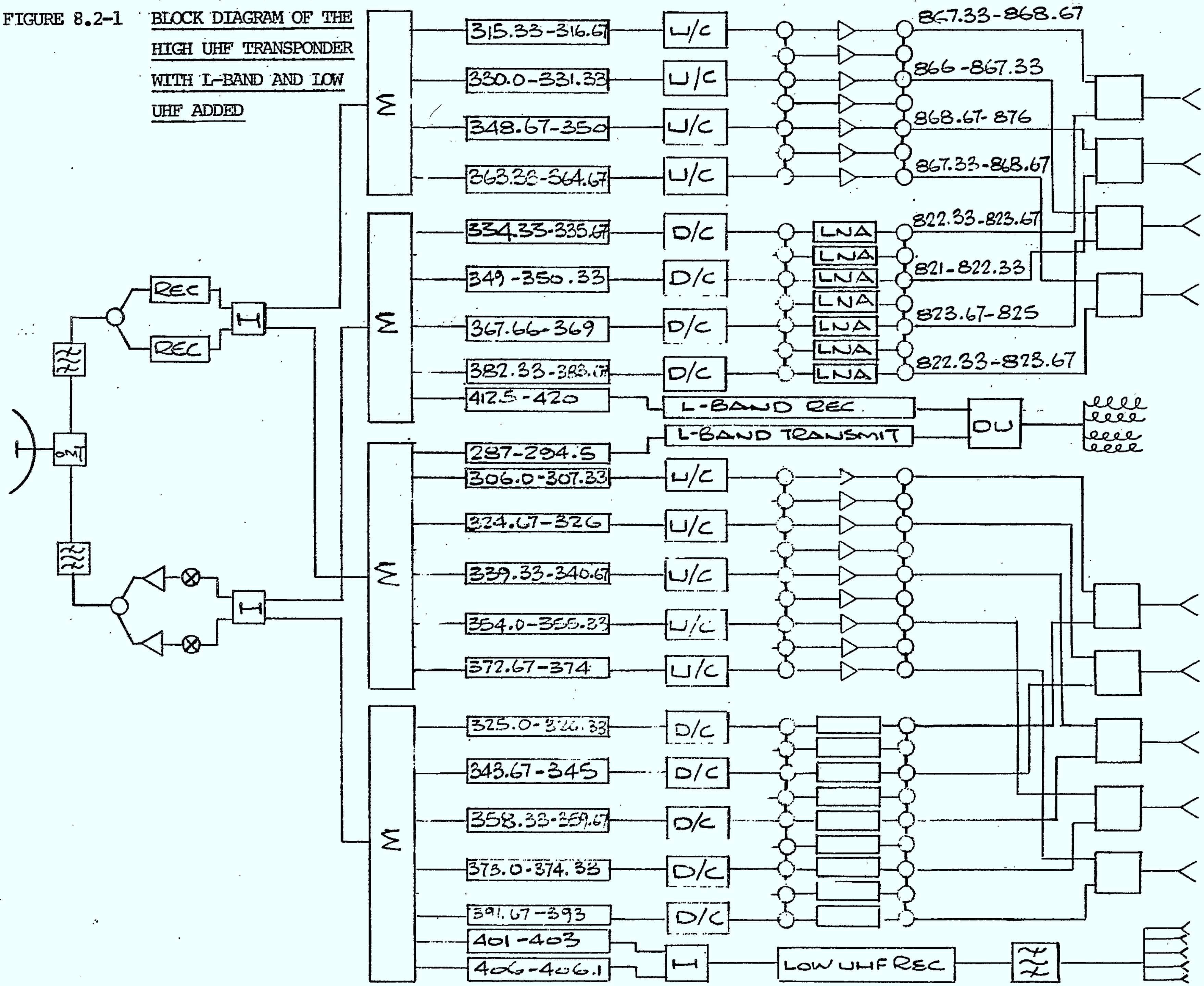


TABLE 8.2-1 FREQUENCY PLAN OF THE TRANSPONDER INCLUDING L-BAND AND LOW UHF

| UPLINK (MHz) | L.O. (MHz) | IF BAND (MHz) | L.O. (MHz) | DOWNLINK (MHz) |
|---|---|---|---|---|
| FORWARD LINK | | | | |
| 14007-14094 | 13720 | 287.00-294.50 | 580 | 1535.00-1542.50 |
| | | 306.00-307.33 | 560 | 866.00-867.33 |
| | | 315.33-316.67 | 552 | 867.33-868.67 |
| | | 324.67-326.00 | 544 | 868.67-870.00 |
| | | 330.00-331.33 | 536 | 866.00-867.33 |
| | | 339.33-340.67 | 528 | 867.33-868.67 |
| | | 348.67-350.00 | 520 | 868.67-870.00 |
| | | 354.00-355.33 | 512 | 866.00-867.33 |
| | | 363.33-364.67 | 504 | 867.33-868.67 |
| | | 372.67-374.00 | 496 | 868.67-870.00 |
| RETURN LINK | | | | |
| 821.00-822.33 | 496 | 325.00-326.33 | 11400 | 11719.67-11820.00 |
| 822.33-823.67 | 488 | 334.33-335.67 | | |
| 823.67-825.00 | 480 | 343.67-345.00 | | |
| 821.00-822.33 | 472 | 349.00-350.33 | | |
| 822.33-823.67 | 464 | 358.33-359.67 | | |
| 823.67-825.00 | 456 | 367.67-369.00 | | |
| 821.00-822.33 | 448 | 373.00-374.33 | | |
| 822.33-823.67 | 440 | 382.33-383.67 | | |
| 823.67-825.00 | 432 | 391.67-393.00 | | |
| 401.00-403.00 | - | 401.00-403.00 | DRP's | |
| 406.00-406.10 | - | 406.0-406.1 | EPIRB's | |
| 1636.50-1644.00 | 1224 | 412.50-420.00 | L-Band | |

## 8.3 L-BAND ANTENNA AND LOW UHF ANTENNA FEED

A dual band feed is being used for the low UHF receive function at 401-406 MHz. The dual band feed is much larger than the feed for the high UHF only but it will stow in the Ariane IV shroud with only a single deployment mechanism. The dual band feed is required on only one of the two high UHF antennas. The low UHF has been added to the antenna with the four high UHF beam since this results in the smallest overall feed dimensions. A sketch of the dual band feed assuming horn radiators for the low UHF as well as for the high UHF is shown in Figure 8.3-1. A representative but not fully optimized antenna coverage pattern is shown in Figure 8.3-2 giving a minimum antenna gain of about 23 dB without losses.

The quad helix has been retained for the L-band antenna. This is because of the extensions to the north and south panel. The quad helix can be mounted directly on the antenna panel while the L-band reflector must be mounted on a pedestal so that it can project above the north panel extension.

## 8.4 Calculation of Traffic Capacity

The calculation of the total number of channels is given in Table 8.4-1. The size and weight of the power amplifiers is unchanged from that given in Section 7.0, however, the total number of channels for the whole spacecraft, both during sunlight and eclipse, is reduced. In Table 8.4-2, the number of channels for both narrow band FM and pitch excited LPC are converted to the number of users that can be supported using the standard conditions of 10% blockage and .0125 erlong per user.

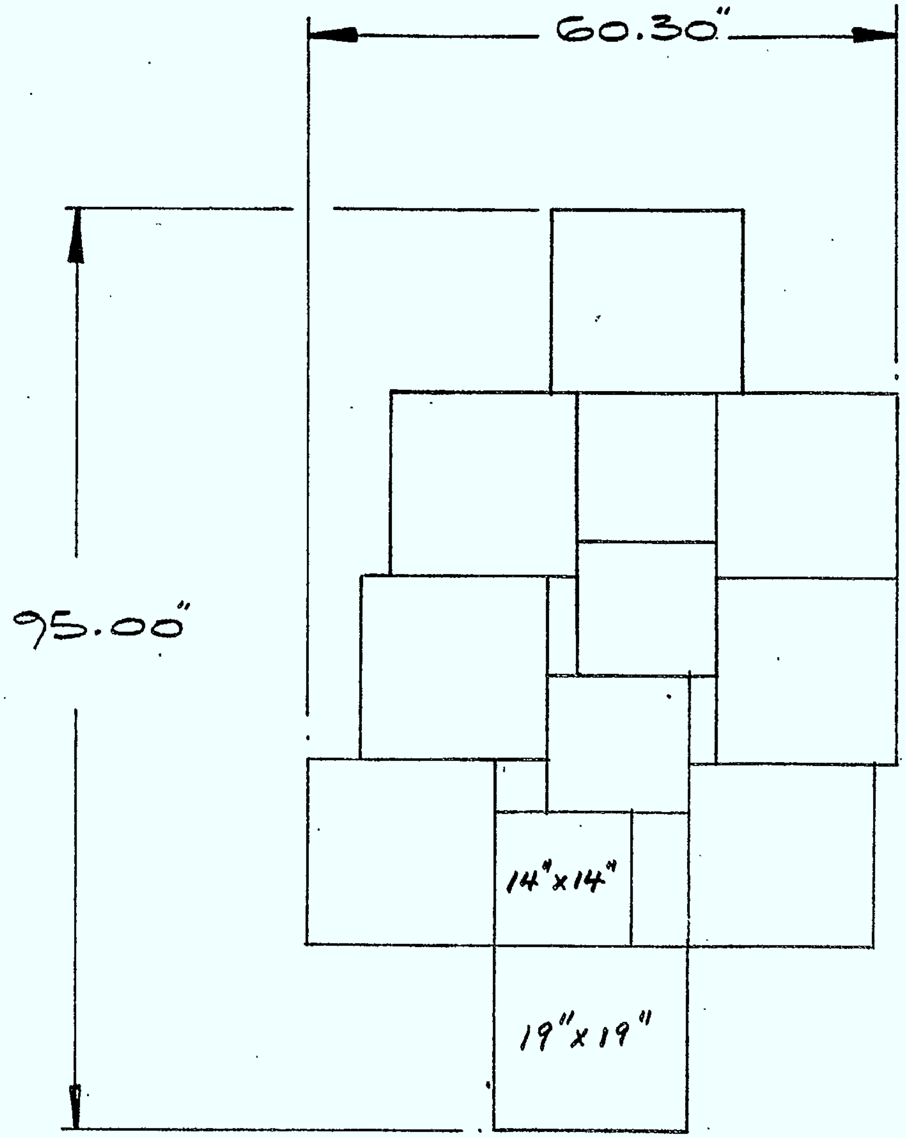
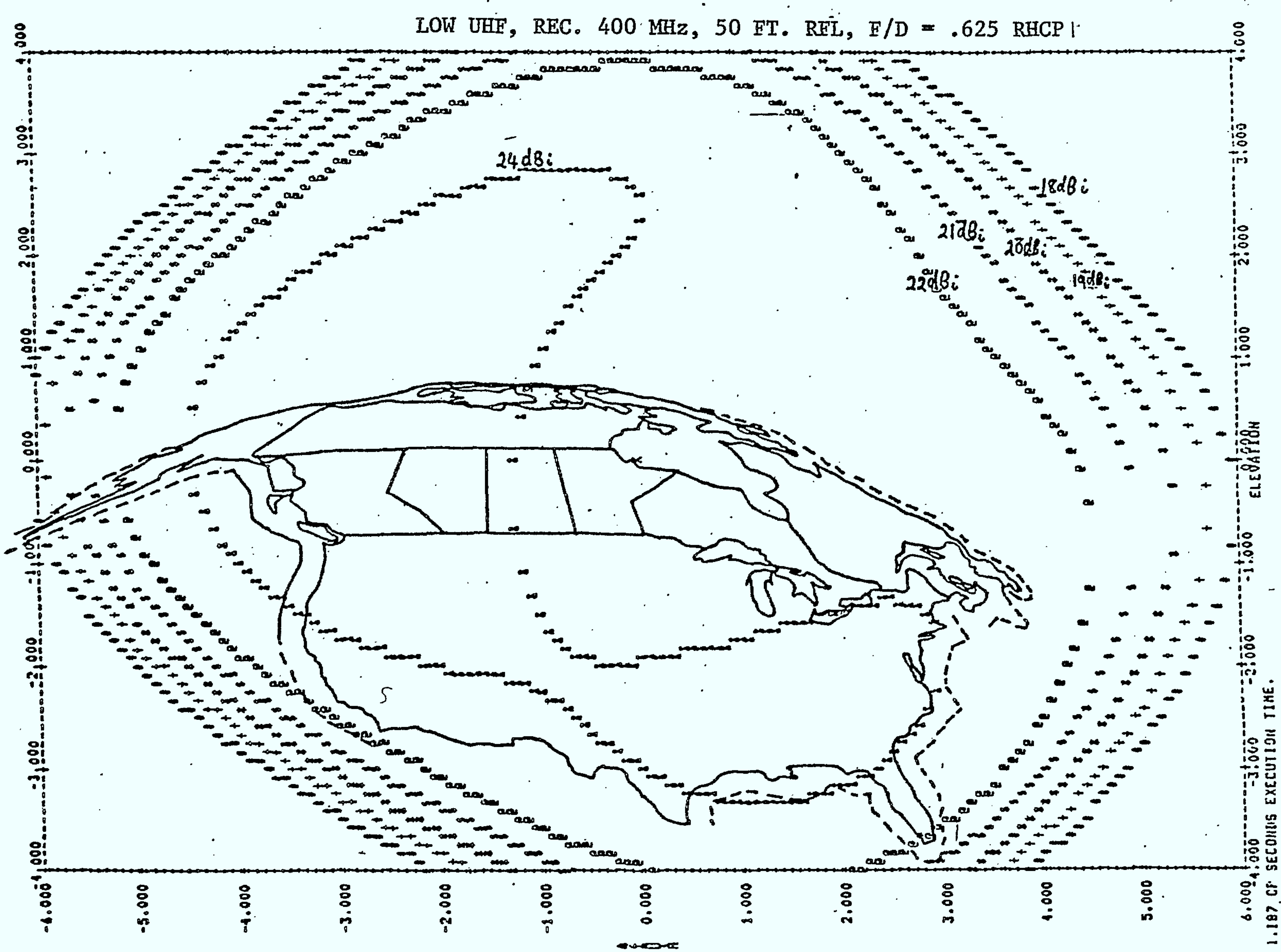



FIGURE 8.3-1 DUAL BAND FEED FOR HIGH UHF AND 400 MHz RECEIVE

FIGURE 8.3-2 400 MHz ANTENNA PATTERN FOR THE 8 LOW UHF HORNS OF FIGURE 8.3-1



## TABLE 8.4-1 CALCULATION OF CHANNEL CAPACITY WITH L-BAND AND LOW UHF ON BOARD

| | | NBFM | PELPC |
|---|---|---|---|
| Antenna Diameter | m | 15.2 | 15.2 |
| | ft | 50.0 | 50.0 |
| Number of Beams | $N_B$ | 9 | 9 |
| Edge EIRP of Channel | dBw | 39.7 | 33.7 |
| Antenna Edge Gain | dB | 36.0 | 36.0 |
| Pointing Error Loss | dB | 1.6 | 1.6 |
| Transponder RF Power/Channel | dBw | 5.3 | -0.7 |
| Output Circuit Loss | dB | 1.3 | 1.3 |
| HPA RF Power/Channel | dBw | 6.6 | 0.6 |
| | watts | 4.57 | 1.15 |
| Maximum Conversion Eff. (0.3 X 0.9) | | .27 | .27 |
| Voice Activation | | yes | yes |
| Maximum Number of Active Ch/Beam | $N_{BA}$ | 24* | 114 |
| Maximum Number os Assignable Ch/Beam | $N_{APB}$ | 44* | 266 |
| Total Number of Active Channels | $N_{TA}$ | 148 | 590 |
| Total Number of Assignable Channels | $N_{ASS}$ | 349 | 1438 |
| Maximum RF Power Per Amp. | watts | 109.7 | 130.9 |
| Maximum DC Power Per Amp. | watts | 422.9 | 484.8 |
| Maximum DC Power for 10 Amps. | watts | 2901 | 2901 |
| Remainder of Transponder | watts | 83 | 83 |
| Total DC Power to Transponder | watts | 2984 | 2984 |
| Number of Active Channels in Eclipse | | 42 | 169 |
| No. of Assignable Channels in Eclipse | | 88 | 401 |
| Total DC Power in Eclipse | watts | 1573 | 1573 |
| Unit Wt. of HPA & EPC | Kg | 8.5 | 8.5 |
| Total Wt. of 16 (HPA & EPC)s | Kg | 136.3 | 136.3 |

* Limited by the Assumed Frequency Band of 4 MHz

TABLE 8.4-2 USER ESTIMATE FOR THE OPERATIONAL MODEL WITH L-BAND AND LOW UHF RECEIVE ON BOARD

| | TOTAL CHANNELS | TOTAL ERLONGS (10% BLOCKAGE) | TOTAL NUMBER OF USERS (.0125 ERLONG/USER) |
|---|---|---|---|
| SUNLIGHT | | | |
| NBFM | 349 | 387 | 30960 |
| PELPC | 1438 | 1597 | 127760 |
| ECLIPSE | | | |
| NBFM | 88 | 92 | 7360 |
| PELPC | 401 | 445 | 35600 |

8.0 PARAMETRIC VARIATION (CONT'D)

## 8.5 Spacecraft Configuration

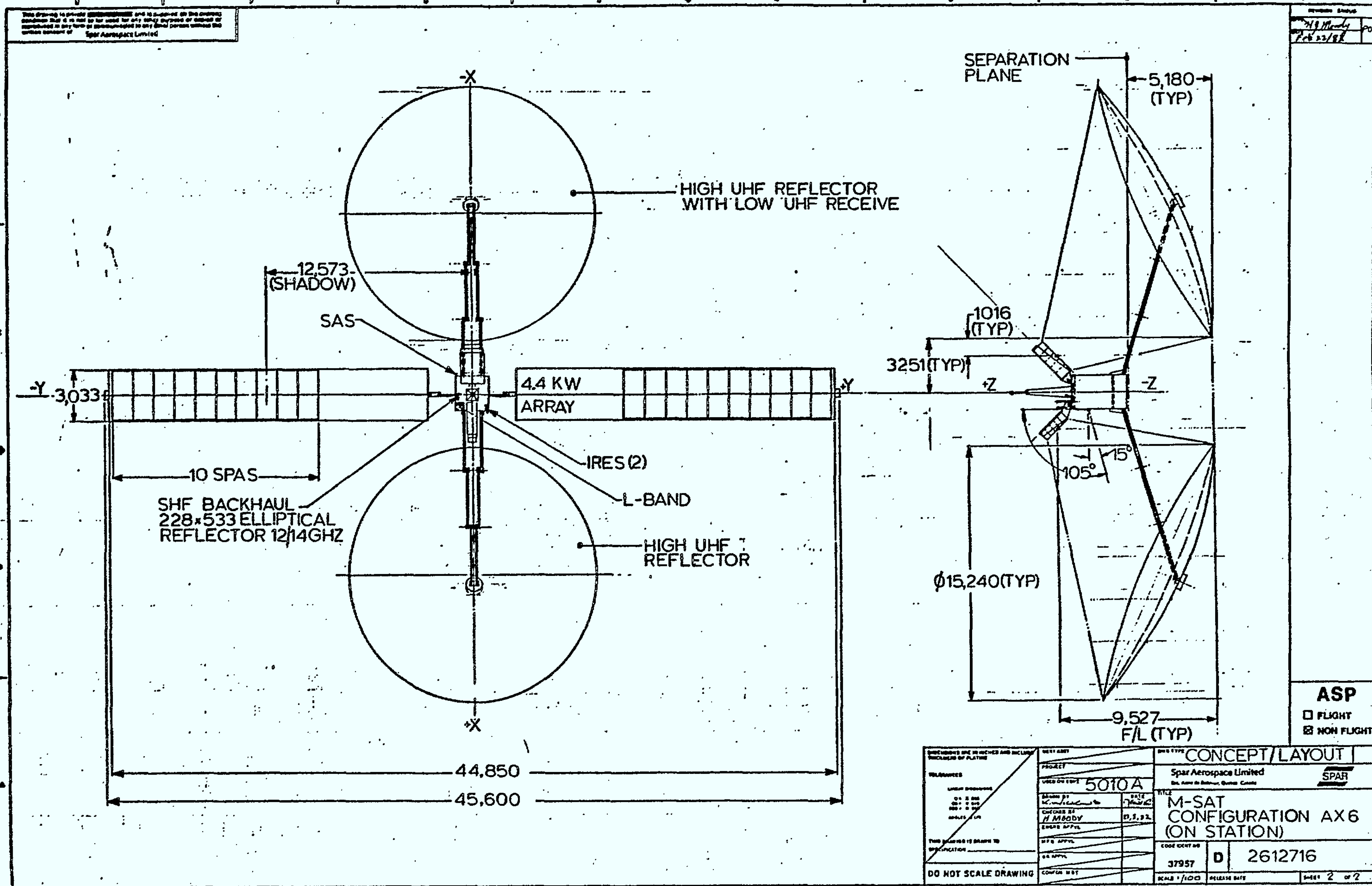
This configuration is illustrated in the deployed (on station) mode and in the stowed (launch) mode in drawing number 2612716.

Configuration AX-6 retains the two 9.15 meter aperture reflectors and two solar arrays with 10 SPA's per side used on configuration AX-5. The reflectors are of the Lockheed wrap-rib type with identical attachemnts, booms and deployment mechanisms.

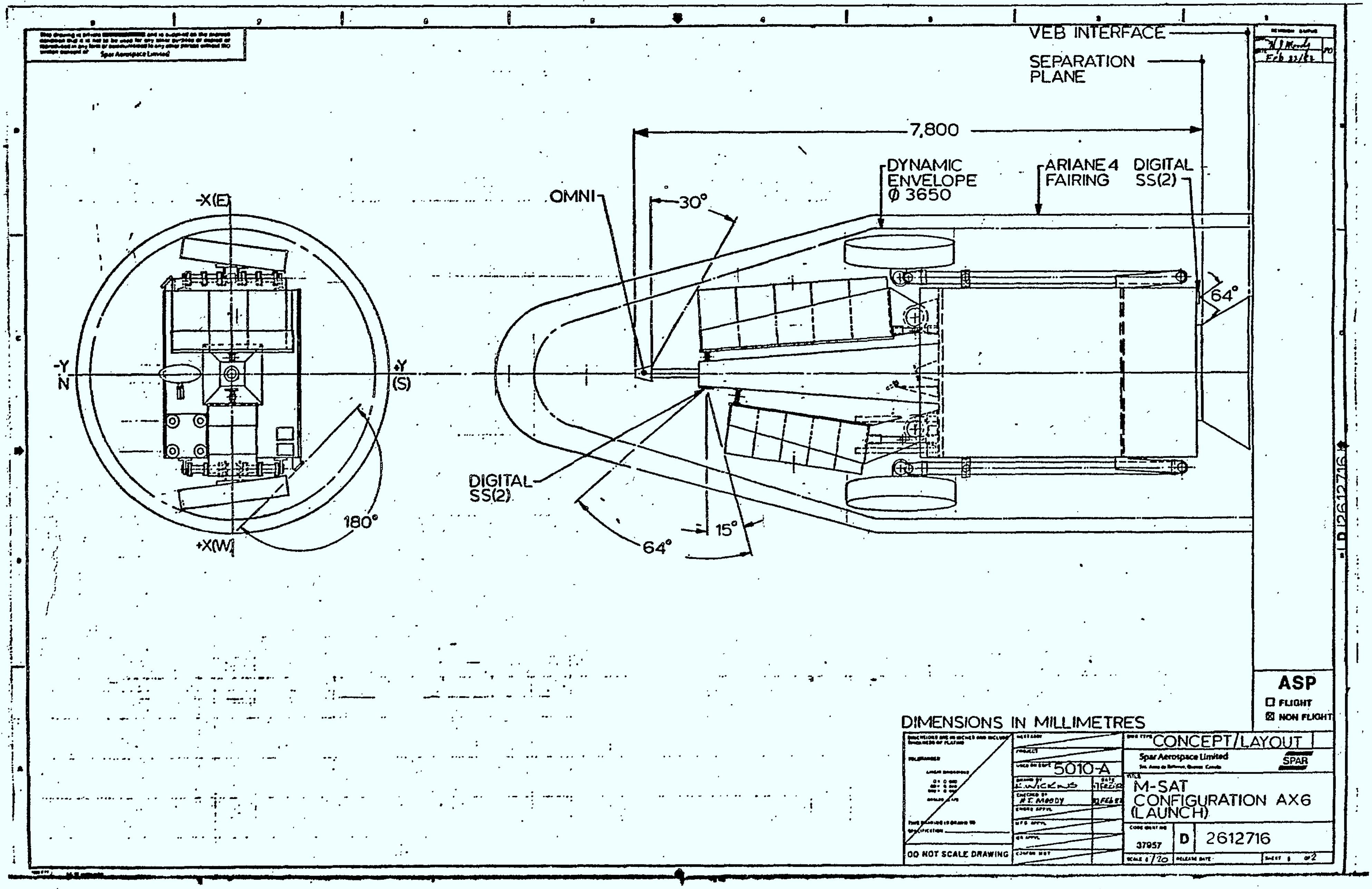
Two independant feed assemblies are attached to the east side and west side of the earth facing deck, and are stowed against an enlarged tower. The feeds are rotated in one plane for deployment. The east feed assembly incorporates four high-UHF receive/transmit horns serving four separate beams, and eight low-UHF receive-only horns serving a single Canada-wide receive beam. The west feed assembly incorporates five high-UHF receive/transmit horns serving five separate beams.

The SHF downlink antenna with a single-feed elliptical reflector is retained from configuration AX-5. An L-band quad helix, similar to that used on the baseline M-SAT configuration 7A, is mounted on the earth facing deck of the spacecraft.

Earth and sun sensor locations remain essentially unchanged from configuration AX-5, the stowed configuration is designed to fit within the Ariane IV short fairing dynamic envelope, and can be modified to fit within the "Ariane IV dual launch SPELDA unsymmetrical configuration" upper fairing.



-X
+X
-Y
+Y
+Z
-Z
HIGH UHF REFLECTOR
WITH LOW UHF RECEIVE
12,573
(SHADOW)
SAS
3,033
4.4 KW
ARRAY
10 SPAS
IRES (2)
L-BAND
SHF BACKHAUL
228×533 ELLIPTICAL
REFLECTOR 12/14GHZ
HIGH UHF
REFLECTOR
44,850
45,600
SEPARATION
PLANE
5,180
(TYP)
1016
(TYP)
3251(TYP)
15°
105°
ϕ15,240(TYP)
9,527
F/L (TYP)
ASP
FLIGHT
NON FLIGHT
CONCEPT/LAYOUT
Spar Aerospace Limited
SPAR
5010A
H MOODY
M-SAT
CONFIGURATION AX6
(ON STATION)
37957
D
2612716
DO NOT SCALE DRAWING
SCALE 1/100
SHEET 2 OF 2


VEB INTERFACE
SEPARATION PLANE
7,800
DYNAMIC ENVELOPE Ø 3650
ARIANE 4 FAIRING
DIGITAL SS(2)
OMNI
30°
64°
-X(E)
-Y N
+Y (S)
+X(W)
180°
DIGITAL SS(2)
15°
64°
D 2612716
ASP
FLIGHT
NON FLIGHT
DIMENSIONS IN MILLIMETRES
DO NOT SCALE DRAWING
5010-A
CONCEPT/LAYOUT
Spar Aerospace Limited
SPAR
M-SAT
CONFIGURATION AX6
(LAUNCH)
37957
D
2612716

8.0 PARAMETRIC VARIATION (CONT'D)

8.6 Mass and Power Budgets

The spacecraft level mass and power budgets are given in Table 8.6-1 and 8.6-2 respecitvely. The weight budget is based on the Ariane IV launch capability of 3500 Kg and the power is supplied by 20 SPA's arranged in two assemblies of 10 SPA's each. The power margin is maintained at 10% and the weight margin is still very comfortable.

The weight and power estimates for the L-band repeater are given in Table 8.6-3. These are in addition to the high UHF repeater which is unchanged in weight from that given in Section 7.0. The antenna mass breakdown is given in Table 8.6-4 including changes to the high UHF antenna as well as additions of the L-band antenna and low UHF feed.

## TABLE 8.6-1 WEIGHT SUMMARY FOR THE OPTIONAL M-SAT

## INCLUDING L-BAND AND LOW UHF RECEIVE

| | | |
|---|---|---|
| Repeaters | | 194.5 |
| High UHF Repeater | 187.0 | |
| L-Band Repeater | 6.67 | |
| Low UHF Receiver | 0.84 | |
| Antennas and Tower | | 279.5 |
| High UHF (Includes Dual Band Feed) | 248.6 | |
| Backhaul Antenna | 2.7 | |
| L-Band Antenna | 3.2 | |
| Support Tower | 25.0 | |
| Platform | | 999.5 |
| Structure | 229.5 | |
| Thermal | 67.4 | |
| Attitude (AOCS) | 88.3 | |
| Power | 437.3 | |
| TT&C | 21.6 | |
| Propulsion | 125.4 | |
| Balance | 30.0 | |
| Spacecraft Dry Mass | | 1473.5 |
| Fuel and Residuals (7 Years) | | 1742.3 |
| Adaptor | | 65.0 |
| Margin | | 219.2 |
| Launch Capability | | 3500.0 |

## TABLE 8.6-2 POWER SUMMARY FOR THE OPTIONAL M-SAT

| | ON STATION POWER REQUIREMENTS | |
|---|---|---|
| | SUNLIGHT | ECLIPSE |
| Payload | | |
| High UHF | 2984 | 1573 |
| L-Band | 58.6 | 58.6 |
| Low UHF Receiver | 1.4 | 1.4 |
| Sub Total | 3044 | 1633 |
| Platform | | |
| Structure | - | - |
| Thermal | 232.0 | 99.2 |
| AOCS (Incl.SADAPTA) | 116.6 | 116.6 |
| Power (Incl.Harness) | 61.0 | 46.0 |
| TT&C | 29.1 | 29.1 |
| Propulsion | - | - |
| Sub Total | 438.7 | 290.9 |
| Misc. Losses | | |
| ELI Loss | 22.8 | 22.8 |
| Battery Charging | 262.5 | - |
| Shunt Dump Loss | 240.5 | - |
| BDR Loss | - | 169.3 |
| Sub Total | 525.8 | 192.1 |
| Total Required | 4008.5 | 2116.0 |
| Available | 4390.0 | 2272.5 |
| Margin | 381.5 | 156.5 |

TABLE 8.6-3 WEIGHT AND POWER SUMMARY OF PAYLOAD ADITIONS

| Item No. | Item | Quantity | Unit Weight (Kg) | Weight (Kg) | Power (Watts) |
|---|---|---|---|---|---|
| | L-Band | | | | |
| 306 | Duplexer | 1 | .68 | .68 | |
| 302 | Driver Amp. | 2 | .28 | .56 | 2.4 |
| 303 | Power Amp. | 2 | 1.82 | 3.64 | 55.0 |
| 304 | Tx Red SW | 1 | .09 | .09 | |
| 305 | Tx BSF | 1 | .23 | .23 | |
| 307 | Rx BSF | 1 | .32 | .32 | |
| 308 | Rx Red SW | 1 | .09 | .09 | |
| 309 | Preamp. - D/C | 1 | .28 | .28 | .75 |
| 301 | U/C - Amp. | 1 | .28 | .28 | 0.4 |
| | Brackets and Cabling | set | .50 | .50 | |
| | (L.O. Derived from High UHF) | | | | |
| | Total | | | 6.67 Kg | 58.6 watts |
| | Low UHF Receiver | | | | |
| 102 | Rx Red SW | 1 | .09 | .09 | |
| 103 | Beam (Redundant) | 1 | .27 | .27 | 0.6 |
| 111 | UHF Return | 1 | .28 | .28 | 0.8 |
| | Misc. | set | .20 | .20 | |
| | Total | | | .84 | 1.4 |

TABLE 8.6-4 ANTENNA WEIGHTS FOR CONFIGURATION AX-6

| ITEM | | QUANTITY | WEIGHT (Kg) | TOTAL (Kg) |
|---|---|---|---|---|
| High UHF Antenna | | | | 248.6 |
| (Including Dual Band Feed) | | | | |
| Reflector, 50 Ft Aperture | | 2 | 86.2 | |
| Deployment Boom, Hinges and Spring Dampers | | 2 | 62.6 | |
| Reflector Tie-Downs, Brackets and Pyros | | 2 | 5.0 | |
| Low/High UHF Feed | - Horn Array | 1 | 57.3 | |
| | - Deployment | 1 | 4.5 | |
| | - Coax | 1 set | 8.2 | |
| | - Tie-Down | 1 | 2.1 | |
| | - Thermal | 1 | 3.0 | |
| High UHF Feed | - Horn Array | 1 | 12.8 | |
| | - Deployment | 1 | 2.0 | |
| | - Coax | 1 set | 3.4 | |
| | - Tie-Down | 1 | 0.5 | |
| | - Thermal | 1 | 1.0 | |
| Central Support Tower | | 1 | | 25.0 |
| Backhaul Antenna | | 1 | | 2.7 |
| L-Band Quad Helix | | 1 | | 3.2 |
| Total | | | | 279.5 |

# APPENDIX

Tentative subsystem specifications for the payload and bus subsystems have been included in Volume II of the Phase A report. The following is a list of the subsystem specificaitons and an indication of the extent of the modification required for the configuration described in this report.

| | | |
|---|---|---|
| 1. | Canadian Military Transponder Spec. | Delete |
| 2. | Maritime Mobile Transponder Spec. | Minor Modifications |
| 3. | Commercial Mobile Transponder Spec. | Minor Modifications |
| 4. | Canadian Military Antenna Spec. | Delete |
| 5. | Maritime Mobile Antenna Spec. | Unchanged |
| 6. | Commercial Mobile Antenna Spec. | Minor Modifications |
| 7. | L-SAT TT&C Subsystem Spec. | Unchanged |
| 8. | L-SAT Power Subsystem Spec. | Minor Modifications |
| 9. | L-SAT AOCS Specification | Unchanged |
| 10. | Sturcture Subsystem Spec. | Minor Modifications |
| 11. | L-SAT Thermal Subsystem Spec. | Minor Modifications |
| 12. | L-SAT Combined Propulsion Spec. | Minor Modifications |
| 13. | L-SAT Solar Array Spec. | Minor Modifications |
| 14. | L-SAT Electrical Distribution Spec. | Minor Modifications |