

General Purpose & Description

These "radio station" installations are required to accomplish FAA certification, commissioning and satellite access approval from INMARSAT (International Maritime Satellite Organization) for the MD-11 installation of Satellite communications. Ninety-five percent of the MD-11 customers have bought Satcom provisions. On June 3, 1991, Douglas Aircraft received a request for proposal from three airlines for complete installation on the MD-11. In response DAC submitted a Statement of Work outlining DAC responsibilities which include performing satellite communications testing both on a test bench and on the aircraft.

The fixed base equipment will be installed at Douglas Aircraft Company, 3855 Lakewood Blvd., Long Beach, CA, on the roof of Building 36 (see Figure 1). It will operate in the Marine and Aeronautical Mobile Satellite Service band of frequencies providing voice and data communications. Ground communications services will be provided by COMSAT, British Telecom International, KDD and other INMARSAT signatories. The fixed base facility will be utilized primarily for developmental and INMARSAT access approval testing from January 1992 through the first quarter of 1993. The mobile installation installed on the MD-11 will be used for developmental testing INMARSAT access approval and FAA certification in 1992-1993. Figure 2 shows the location of the antennas and peripheral equipment on the MD-11. Note there may be two installations. All technical requirements are fully defined by Aeronautical Radio Incorporated (ARINC) characteristic 741 and the INMARSAT System Definition Manual.

Spectrum Planning Information

Transmitter Frequency Band

The bands comprising 1626.5 to 1660.5 MHz will be used. This includes both Marine and Aeronautical Satellite bands. Although the aeronautical band may be sufficient it is conceivable INMARSAT may dictate we utilize frequencies in the Marine band as well. Specific operating frequencies will be coordinated with INMARSAT, in cooperation with COMSAT, British Telecom International, KDD and other INMARSAT signatories.

RF Power Output

The maximum power output of the equipment will be 60 Watts per carrier.

$$P_o = 60 \text{ Watts} = 17.8 \text{ dBW}$$

Antenna

Both installations will employ the high gain top mounted phased array antenna as described in ARINC characteristic 741. This antenna provides a peak gain (G_A) of 12 dBic with a half power beam width nominally 30 degrees.

EIRP

The maximum Equivalent Isotropic Radiated Power will be:

$$\begin{aligned} \text{EIRP} &= P_o + G_A \\ \text{EIRP} &= 17.8 + 12 \\ \text{EIRP} &= 29.8 \text{ (Peak)} \\ &\text{or} \\ \text{EIRP} &= 950 \text{ Watts (Peak)} \end{aligned}$$

DAC FACILITIES

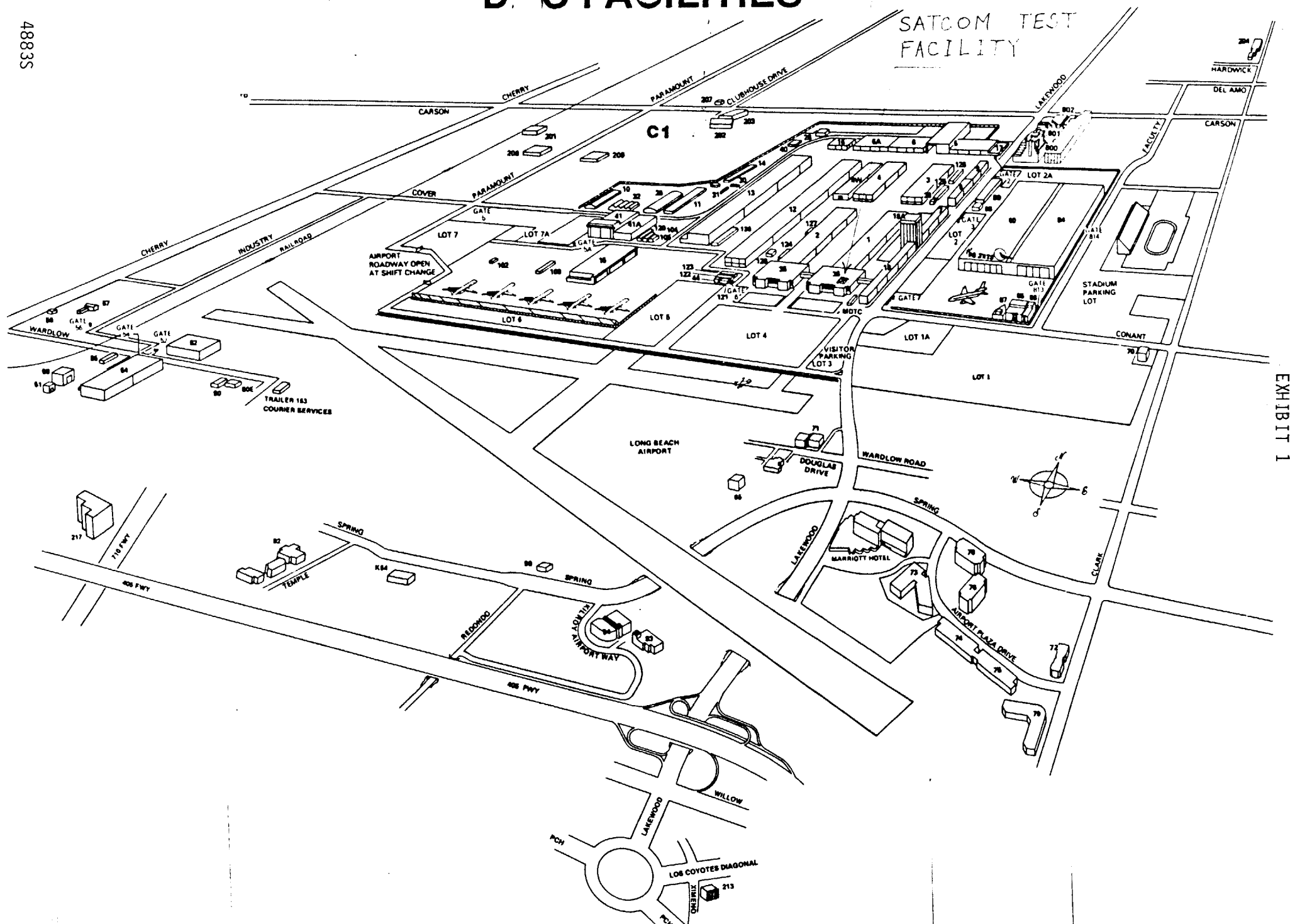


Figure 1: Location of Radio Station

Top-Mounted High Gain SATCOM Antenna

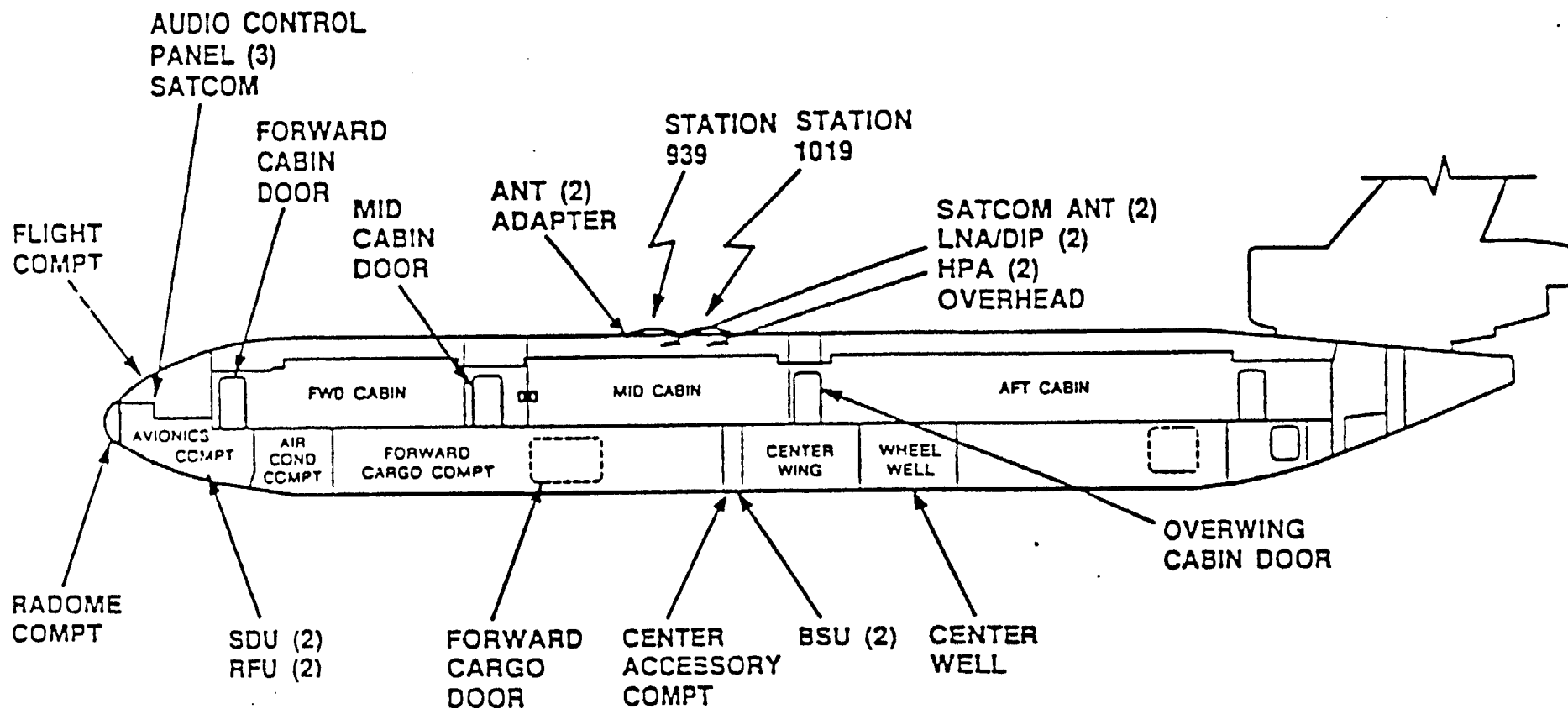


EXHIBIT 1

Figure 2: MD-11 Installation

EXHIBIT 1
(continued)

Emission Types

<u>Emission Type*</u>	<u>Modulation Type</u>	<u>Symbol Rate</u>	<u>Rate 1/2 Convolutionally Encoded Rate</u>
840HG1D	A-BPSK	600 baud	600 b/sec
1K68G1D	A-BPSK	1200 baud	1200 b/sec
3K36G1D	A-BPSK	2400 baud	2400 b/sec
4K80G1D	A-QPSK	2400 baud	4800 b/sec
6K00G1D	A-QPSK	3.0 k baud	6000 b/sec
10K0G1D	A-QPSK	5.25 k baud	10.5 kb/sec
21K0G1D	A-QPSK	10.5 k baud	21.0 kb/sec
21K0G1E	A-QPSK	10.5 k baud	21.0 kb/sec
21K0G1W	A-QPSK	10.5 k baud	21.0 kb/sec

*Emission types are as defined in FCC rulemaking reports Section 2.201. Initially the nature of the signals modulating the main carrier (second to last digit) will be 1 (a single channel...). Upgrades in the system to occur in 1992 will change the second to last character of all emissions to 7 (two or more channels...).

Also note the ungraded system will be capable of transmitting up to six independent carriers simultaneously in a variety of emission type combinations. The initial system will only transmit one carrier (i.e., one emission type at a time).

Modulation Methods

<u>Type</u>	<u>Description</u>
A-QPSK	Aviation Quadrature Phase Shift Keying uses a specific form of Offset-QPSK where the modulation filtering is optimized for satellite communication in aviation applications. (Reference: "Quaternary Transmission over Satellite Channels with Cascaded Non-Linear Elements and Adjacent Channel Interference" by Russel Fang in IEEE Transactions on Communications, May 1991, Vol. COM-29, No. 5, pp 567-581.
A-BPSK	Aviation Binary Phase Shift Keying uses a specific form of differentially encoded BPSK where in phase and quadrature channels are used to transmit alternate symbols. (Reference's "Differential Detection With Intersymbol Interference and Frequency Uncertainty" by J. H. Winters in IEEE Transactions on Communications, January 1984 Vol. Com-32, No. 1, pp 25-33.)

Necessary Bandwidth

Radiated bandwidth from the equipment is controlled by the use of raised cosine filters in the transmitter. The A-QPSK signals are subjected to a 100% raised cosine filter. A 40% raised cosine filter is used for the A-BPSK signals.

The associated necessary bandwidth calculation is:

$$BW = 1/T(1+r)$$

Where $1/T$ is the symbol transmission rate in symbols per second and r is the rolloff factor.

EXHIBIT 1
(continued)

<u>Symbol Rate</u> <u>Baud</u>	<u>Modulation</u> <u>Type</u>	<u>Rolloff</u> <u>(r)</u>	<u>Bandwidth</u> <u>(BW)</u>
600	A-BPSK	0.4	0.840 kHz
1200	A-BPSK	0.4	1.680 kHz
2400	A-BPSK	0.4	3.360 kHz
2400	A-QPSK	1.0	4.800 kHz
3000	A-QPSK	1.0	6.000 kHz
5250	A-QPSK	1.0	10.50 kHz
10.5k	A-QPSK	1.0	21.00 kHz

Site Data

The fixed station is located at Douglas Aircraft Company, 3855 Lakewood Blvd., Long Beach, California, on the roof of Building 36. The Antenna, High Power Amplifier and Diplexer/Low Noise Amplifier will be mounted to a 6'X 8' aluminum/plywood assembly which will be attached to a positioner table. In all possible orientations the antenna will be less than 4 ft above the existing structure. The positioner is mounted approximately 4 stories above the ground (i.e., Building 36 is 3 stories and the positioner is on the roof). All remote control functions are located approximately 10 ft below the positioner.

The mobile installation (see Figure 2) will be operated in the vicinity of Long Beach and Yuma AZ.

Technical Description

Figure 3 and 4 shows block diagrams for the fixed base and mobile systems respectively. The initial fixed base system will consist of the following equipment:

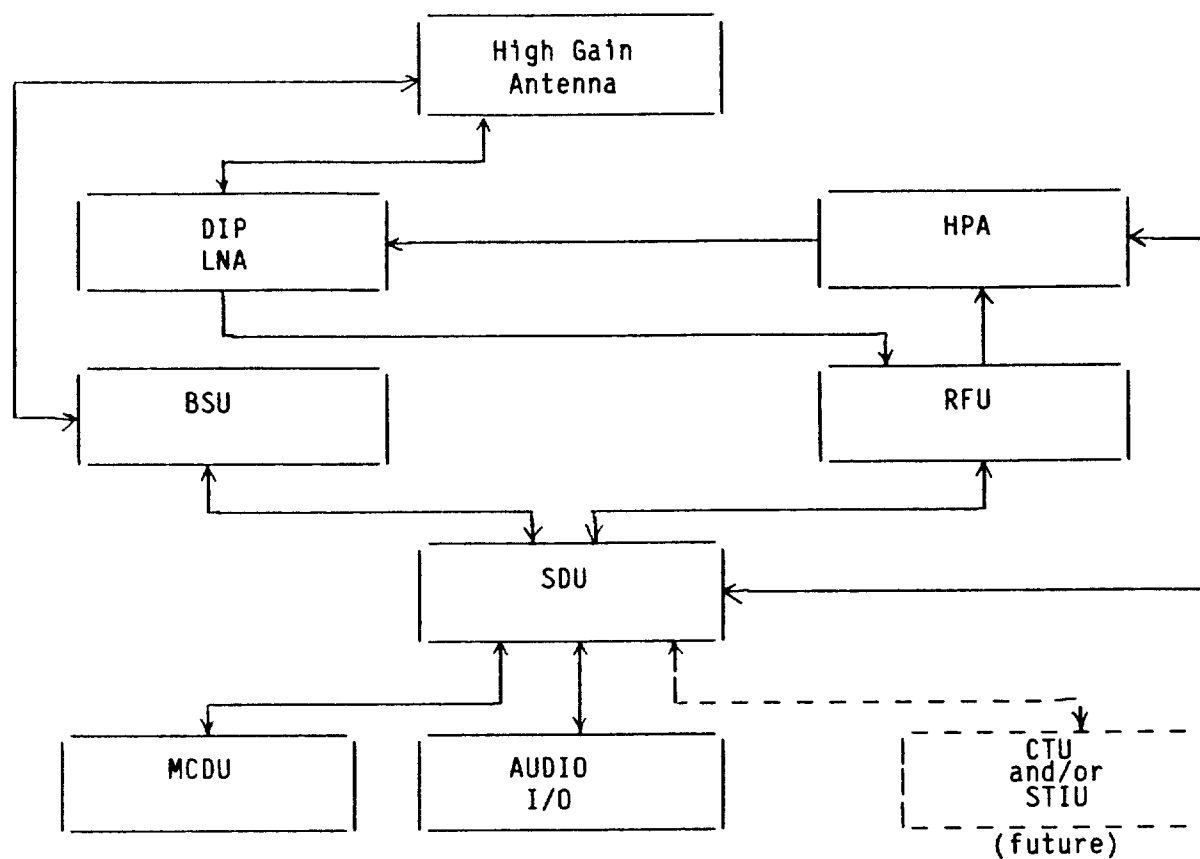
<u>Quantity</u>	<u>Description</u>	<u>Manufacturer</u>	<u>Part Number</u>
1	Satellite Data Unit (SDU)	HI/Racal Avionics	81567A01A
1	Radio Frequency Unit (RFU)	HI/Racal Avionics	81568A02A
1	High Power Amplifier (HPA)	HI/Racal Avionics	81569A01A
1	Telephone Set	Global Wolfberg	400-0123-113
1	High Gain Antenna (HGA)	Canadian Marconi	100-602-066-001
1	Beam Steering Unit (BSU)	Canadian Marconi	100-602-076-001
1	Diplexer Low Noise Amp (Dip/LNA)	Canadian Marconi	100-602-073-001

The installation also includes a bench, wiring harness, connectors associated trays, cooling fans, brackets etc.

Alternate configurations to follow later in 1992 will utilize the following equipment:

<u>Quantity</u>	<u>Description</u>	<u>Manufacturer</u>	<u>Part Number</u>
1	Satellite Data Unit 901	Collins	622-8851-001
1	Radio Frequency Unit 900	Collins	622-8849-001
1	High Power Amplifier 900	Collins	622-8850-001
1	High Gain Antenna (HGA)	Canadian Marconi	100-602-066-001
1	Beam Steering Unit (BSU)	Canadian Marconi	100-602-076-001
1	Diplexer Low Noise Amp (Dip/LNA)	Canadian Marconi	100-602-073-001
1	Multi Function Control Display Unit	Honeywell	
1	Satellite Telecommunications Interface Unit	Collins/Honeywell/others unknown	
1	Cabin Telephone Unit	Collins/Honeywell/others unknown	

EXHIBIT 1



See Acronyms and Abbreviations (last page)

Figure 4: Satellite Communications - MD-11 Installation
(Potentially Two Systems Per Airplane)

EXHIBIT 1
(continued)

Other alternate equipment may also be utilized.

The MD-11 installation will utilize the following equipment:

<u>Quantity</u>	<u>Description</u>	<u>Manufacturer</u>	<u>Part Number</u>
2	Satellite Data Unit 906	Collins	822-0309-001
2	Satellite Data Unit	Honeywell	7516100-90XXX
2	Radio Frequency Unit 900	Collins	622-8849-100
2	Radio Frequency Unit	Honeywell	7516240-90XX
2	High Power Amplifier	Collins	622-9252-001
2	High Power Amplifier 901	Honeywell	7516250-90XX
2	High Gain Antenna	Canadian Marconi	100-602-066-001
2	Beam Steering Unit	Canadian Marconi	100-602-076-001
2	Diplexer Low Noise Amp	Canadian Marconi	100-602-073-001
2	Satellite Telecommunication Interface Unit	Collins/Honeywell/others unknown	
2	Cabin Telephone Unit	Collins/Honeywell/others unknown	

EXHIBIT 1
(continued)

ACRONYM AND ABBREVIATIONS DEFINITIONS:

ARINC	Aeronautical Radio Inc.
BFE	Buyer Furnished Equipment
BSU	Beam Steering Unit
CMC	Canadian Marconi Company
CTU	Cabin Telecommunications Unit
DIP	Diplexer
HI	Honeywell
HPA	High Power Amplifier
I/O	Input/Output
LNA	Low Noise Amplifier
MCDU	Multifunction Control Display Unit
SDU	Satellite Data Unit
RFU	Radio Frequency Unit
SATCOM	Satellite Communications
SFE	Supplier Furnished Equipment
STIU	Satellite Telecommunications Interface Unit
INMARSAT	International Maritime Satellite Organization