EXPERIMENTAL PROGRAM

The Boeing Company is currently working in conjunction with the Collins Air Transport Division of Rockwell International Corporation (See their license: FCC File Number 0718-EX-PL-88) to perform Installation and Check Out (I&CO) of Collins prototype equipment on Company controlled aircraft. This equipment is to be used in the proposed Aeronautical Mobile Satellite Service. No "For Hire" communications are to be provided during any testing by The Boeing Company.

Low Gain Data System

Initially, the equipment will be transmitting data only, at the 600 and 1200 bawd A-BSKT modes. Our objective is to perform I & CO of the Collins equipment on Company controlled aircraft, communicating with similar modems installed at the COMSAT Earth Station in Southburry, CN. and Santa Paula, CA (These installations will be licensed by COMSAT). In addition, the SITA data network operates ground earth stations at Perth, Australia, and at Wier, Canada and the KDD data network operates a ground station in Ibaraki, Japan.

High Gain Data System

In the future we plan to add a high gain antenna to the system. The Collins antenna pointing algorithms will have been evaluated by Collins prior to installation on Company controlled aircraft.

High Gain Voice System

In 1991, Collins plans to add digitized voice capability to the system, using the 21 kb/sec (10.5 kbaud) A-QPSK modulation. This system will also use the high gain antenna. The modem algorithms will have been evaluated by Collins prior to incorporation on Company controlled aircraft.

Other Data Rates

Other data rates have been suggested for use in a future Aeronautical Satellite System. Depending on the likelihood of being implemented in a final system, modems for these data rates may be developed and evaluated by Collins and installed and checked out by The Boeing Company.

PARTICULARS OF OPERATION

Transmiter Characteristics

Desired Transmit Frequency Band: 1626.5-1660.5 MHz.

(Actual operational frequencies and schedules will be coordinated with INMARSAT and COMSAT.)

Maximum RH Output: 60 Watts = 17.8 dBW (Peak)

Ant. Gain (Low): Hemispherical coverage, 0 to +5 dBi
Ant. Gain (High): Electronically Steered Array, +12 to +15 dBi

Maximum EIRP (Low Gain Antenna): 17.8 + 5 = 22.8 dBW (Peak)
Maximum EIRP (High Gain Antenna): 17.8 + 16 = 33.8 dBW (Peak)

Emission Types

Type	Modulating Signal		
84OHG1D	A-BPSK	600 baud	(600 bits/sec)
1K68G1D	A-BPSK	1200 baud	(1200 bits/sec)
3K36G1D	A-BPSK	2400 baud	(2400 bits/sec)
4K80G1D	A-QPSK	2400 baud	(4800 bits/sec)
6K00G1D	A-QPSK	3.00 kbaud	(6000 bits/sec)
10K5G1D	A-QPSK	5.25 kbaud	(10.5 kbits/sec)
21K0G1D	A-QPSK	10.5 kbaud	(21.0 kbits/sec)

Modulation Method

A-BPSK (Aviation Binary Phase Shift Keying) is a form of differentially encoded BPSK in which alternate modulation symbols are transmitted in notational in-phase and quadrature channels. Details on A-BPSK can be found in "Differential Detection with Integrated Interference and Frequency Uncertainty," Jack H. Wintes, IEEE Transactions on Communications, January 1984, Vol. COM-32, No. 1, pp. 25-33. A-QPSK (Aviation Quadrature Phase Shift Keying) is a particular form of Offset QPSK. Details on A-QPSK can be found in "MSK and O-QPSK Modulation," S. A. Gronemeyer, IEEE Transaction on Communications, August 1976, Vol. COM-24, pp. 809-820; and in "Quatrinary Transmission over Satellite Channels with Cascaded Non-Linear Elements and Adjacent Channel Interference," Russel J. F. Fang, IEEE Transactions on Communications, May 1981, Vol. COM-29, No. 5, pp. 567-581.

Necessary Bandwidth Calculations

The SATCOM system uses a raised cosine transmit filter to limit bandwidth. A-BPSK signals use 40% raised cosine, and A-QPSK signals use 100% raised cosine filtering. The resulting bandwidth is calculated as:

$$Bk = 1/T\ (1+r)$$

where $1/T$ = rate of symbol transmission in symbols/sec
r = rolloff factor

for 600 baud, A-BPSK (r=0.4), Bn = 0.840 kHz
for 1200 baud, A-BPSK (r=0.4), Bn = 1.680 kHz
for 2400 baud, A-BPSK (r=0.4), Bn = 3.360 kHz

for 2400 baud, A-QPSK (r=1.0), Bn = 4.800 kHz
for 3000 baud, A-QPSK (r=1.0), Bn = 6.000 kHz
for 5250 baud, A-QPSK (r=1.0), Bn = 10.50 kHz
for 10.5 kbaud, A-QPSK (r=1.0), Bn = 21.00 kHz

Transmitting Equipment Type

The transmitting equipment will be developed by the Collins Air Transport Division of Rockwell, and will be designed to meet the are requirements of the System Definition Manual for the INMARSAT Aeronautical Service.

Station Identification Provisions

Transmissions will contain a 24 bit ICAO code which is unique for each station.

Directional antenna

The high gain antenna to be used is electronically steered to track the satellite. Half power beam width will be less than 30 degrees.

Antenna Mounting

Fixed Transmitters:

Mounted on the roof of the buildings indicated at each of the Fixed Transmitter locations.

Mobile Transmitters:

Mounted to the top surface of various test aircraft (747-400, 757, 767, and others - see Illustrations 1 and 2)

Fixed Transmitter Locations

Site 1: Building Number: 9-120
Address: East Marginal Way South
State: WA
County: King
City: Seattle
Coordinates: Lat. 473015 N, Long. 1221730 W

Site 2: Building Number: 40-30
Address: Casino Road
State: WA
County: Snohomish
City: Everett
Coordinates: Lat. 475539 N, Long. 1221629 W

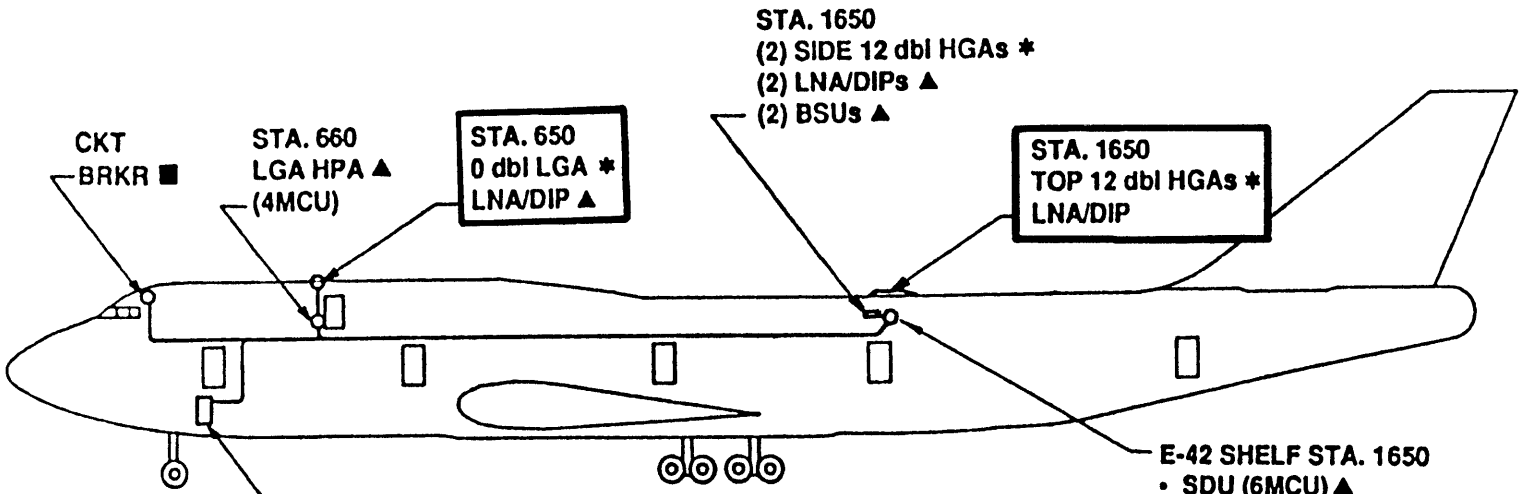
Site 3: Building Number: 10-63
Address: Garden Ave. N.
State: WA
County: King
City: Renton
Coordinates: Lat. 472954 N, Long. 1221200 W

Mobile Transmitter Locations

1. On aircraft on the ground at each of the above locations.

2. On aircraft in the air typically within a 250 mile radius, but occasionally up to a 500 mile radius of Site 1.

747-400 SATCOM SYSTEM PROVISIONS

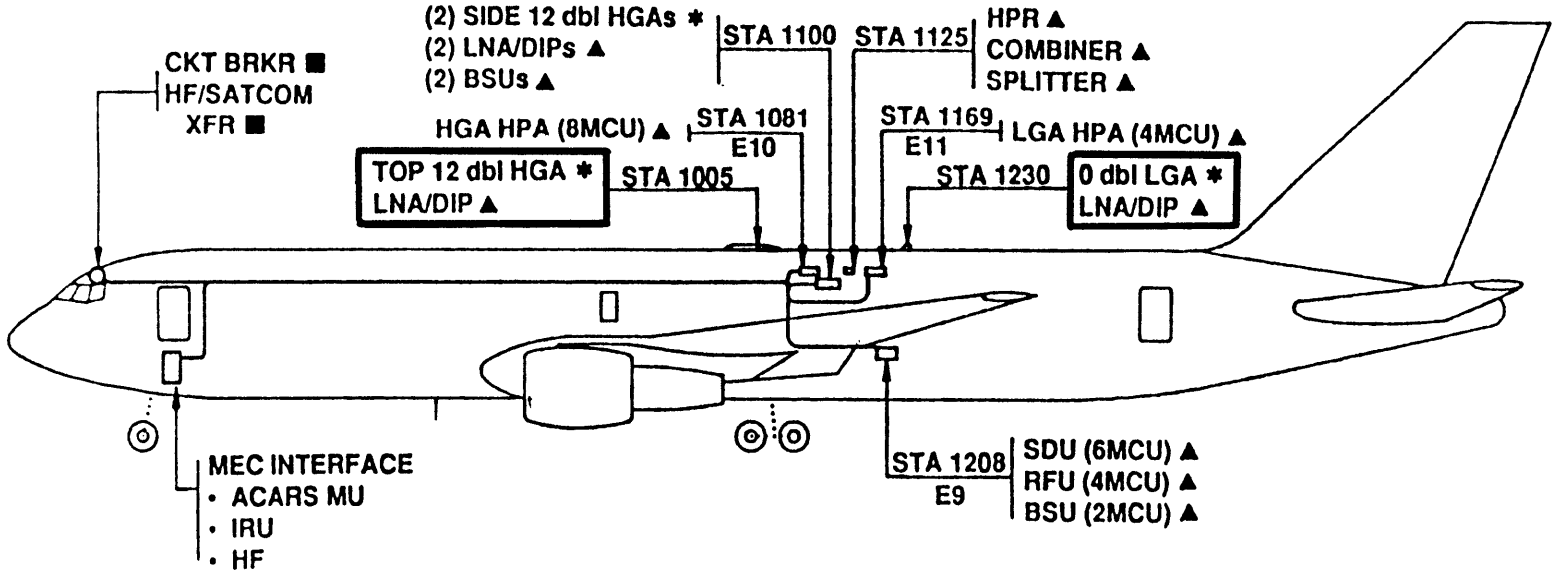


NOTE:
* PARTIAL PROVISIONS - STRUCTURAL DOUBLER INSTALLATION
Δ SPACE PROVISIONS - NO TRAY OR BRACKET
▲ MOUNTING PROVISIONS - TRAY OR BRACKET INSTALLED
■ EQUIPMENT INSTALLED

ILLUSTRATION 1

EXHIBIT 1

767-200 / -300 SATCOM SYSTEM PROVISIONS



NOTE:
* PARTIAL PROVISIONS - STRUCTURAL DOUBLER INSTALLATION
△ SPACE PROVISIONS - NO TRAY OR BRACKET
▲ MOUNTING PROVISIONS - TRAY OR BRACKET INSTALLED
■ EQUIPMENT INSTALLED

EXHIBIT 1
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ILLUSTRATION 2