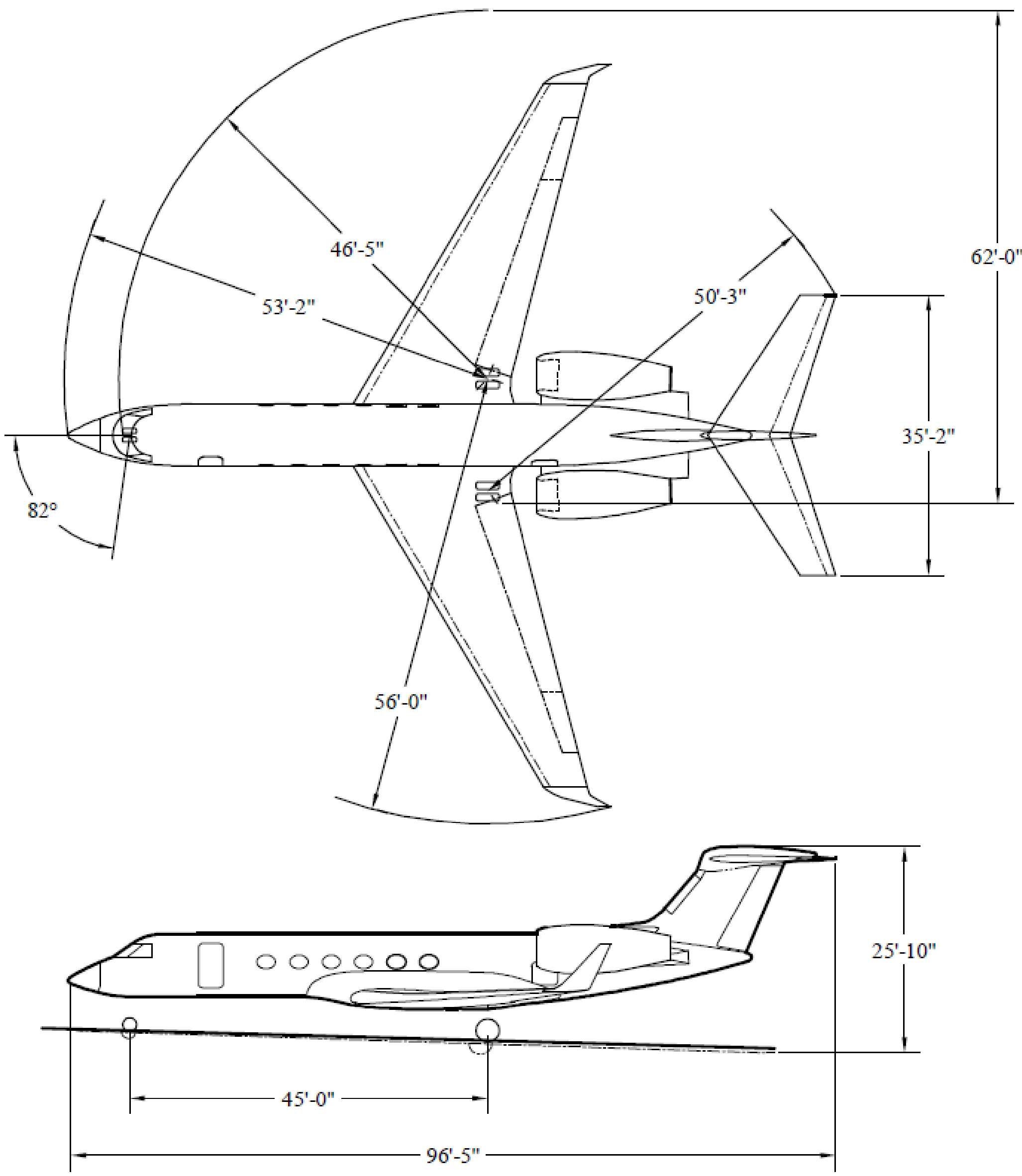
Chapter 2 Basic GV Specifications

2.1 General View

The NSF/NCAR GV aircraft is a Gulfstream Aerospace Corporation (GAC) Gulfstream V aircraft certified in the transport category and specially modified to perform environmental research missions. The aircraft is powered by two Rolls-Royce Deutschland GmbH BR710A1-10 turbofan engines.

A dimensional drawing of the GV is shown in Figure 2.1below.



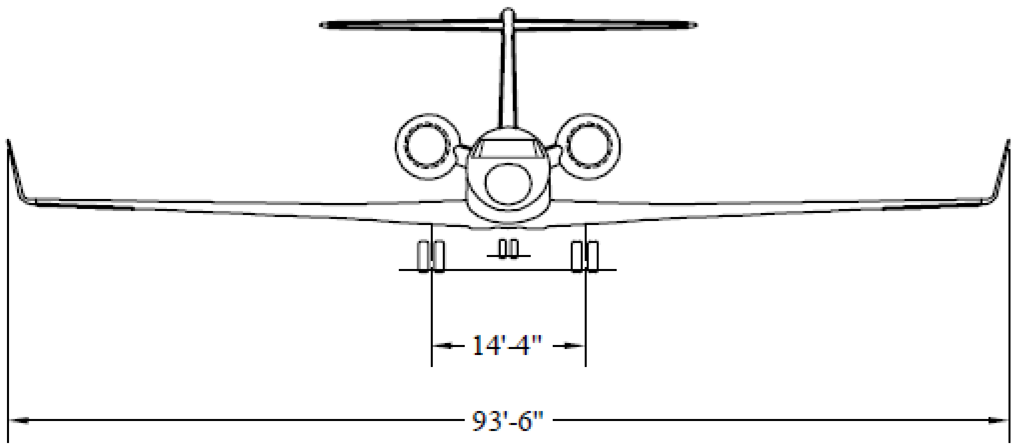


Figure 2.1: Top, side and front dimensional views of the GV.

2.2 Cabin Layout

The basic configuration of the GV cabin is as shown in Figure 1.2 below. The aircraft is equipped with a galley and a lavatory in the aft section of the main cabin and with the proper survival and safety equipment, which use will be explained to the investigators in detail in pre-project safety briefings for each approved research project. The research mission power rack is located in the forward section of the cabin immediately across from the main crew entry door. Floor stations L2 - L5 and R2 - R5 (Figure 2.2) can accommodate either an operator seat or an equipment rack. Stations L1, R1 and L6 can only accommodate an instrumentation rack. Note that the rack in position L6 has an operator seat in front of it facing aft, so the rack should be configured to have the controls on the forward facing side and tension straps aligned accordingly. The rack in position R6 is a permanently installed Aircraft Data System (ADS) rack and the seat P12 is permanently assigned to a RAF technician operating the ADS. Note also that not all of the floor stations have equal access to the Inter Communication System (ICS, see also Aircraft operations conducted by UCAR/NCAR personnel are insured – to the extent of the policy coverage – for legal liability arising from third-party claims.

This coverage extends to instrumentation installed on the aircraft as part of NSF-approved flight operations. UCAR also is insured for legal liability involving operation of motor vehicles and general liability hazards.

All UCAR/NCAR staff members are covered by the UCAR Travel Accident Policy as stated in the UCAR Benefits Manual.

Non-UCAR staff should check with their home institution for workers compensation coverage, medical and life insurance coverage, for possible insurance exceptions related to flying in a public aircraft operation.

Appendix A, Station Locations on page 89) with only floor stations P9, P10, P12 (ADS operator), R4 and R5 being equipped with full cockpit communication capability. The rest of the stations have a listen-only capability with the cockpit and full communication capability to the rest of the cabin.

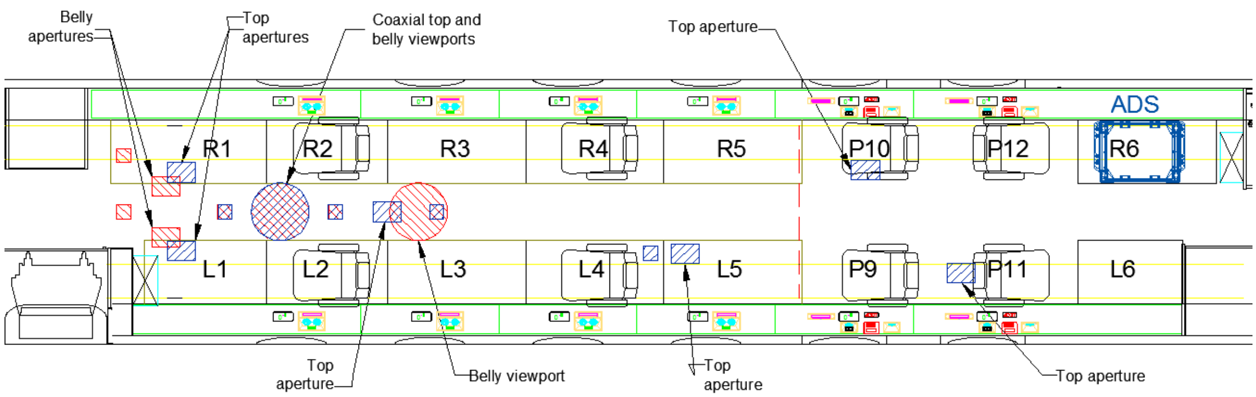


Figure 2.2: GV cabin configuration. Floor stations P9-12 are emergency exits and can only contain seats. Floor stations L1, R1 and L6 can only contain racks. Stations P12 and R6 are permanently assigned to ADS and ADS operator.

Secondary power distribution boxes (SPDB) and secondary signal distribution boxes (SSDB) are located throughout the aircraft cabin for the provision of power to research equipment (see Section 2.3) and for the transmission of signals to and from instrumentation. Additionally, cabin interior attachment points have been installed on the floor and ceiling of the aircraft for the installation of equipment racks and instrumentation. Utilization of the upper attach rail may allow increased overturning moment for the equipment racks but does not allow increased weight over that specified in Section 2.3. Additionally, upper attach points are not available at all floor stations. Passenger service units (PSUs) situated on the upper section of the aircraft cabin walls contain reading lights, oxygen boxes, and “No Smoking/Fasten Seat Belts” signs. Figure 2.3 shows a cross section of the GV cabin, with the locations of seats relative to the power and signal wiring trays, SPDBs and SSDBs, PSUs, return air duct, and upper attachment (railing) depicted. Figure 2.4 and Figure 2.5 show the GV galley and lavatory, respectively.

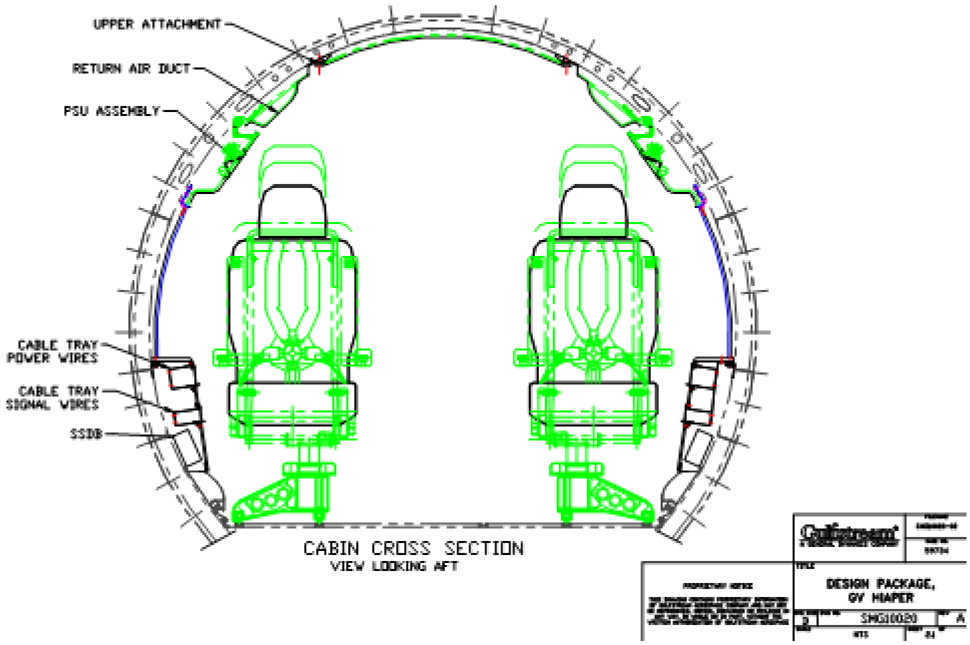


Figure 2.3: GV cabin cross section with seats in position (looking aft).

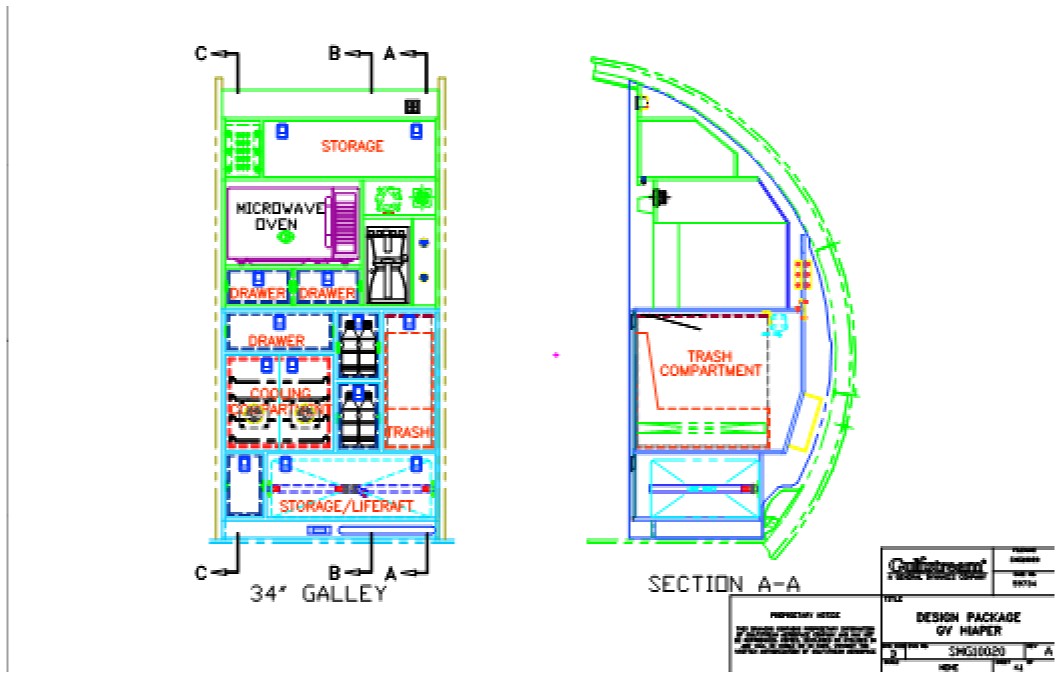


Figure 2.4: GV galley (front view).

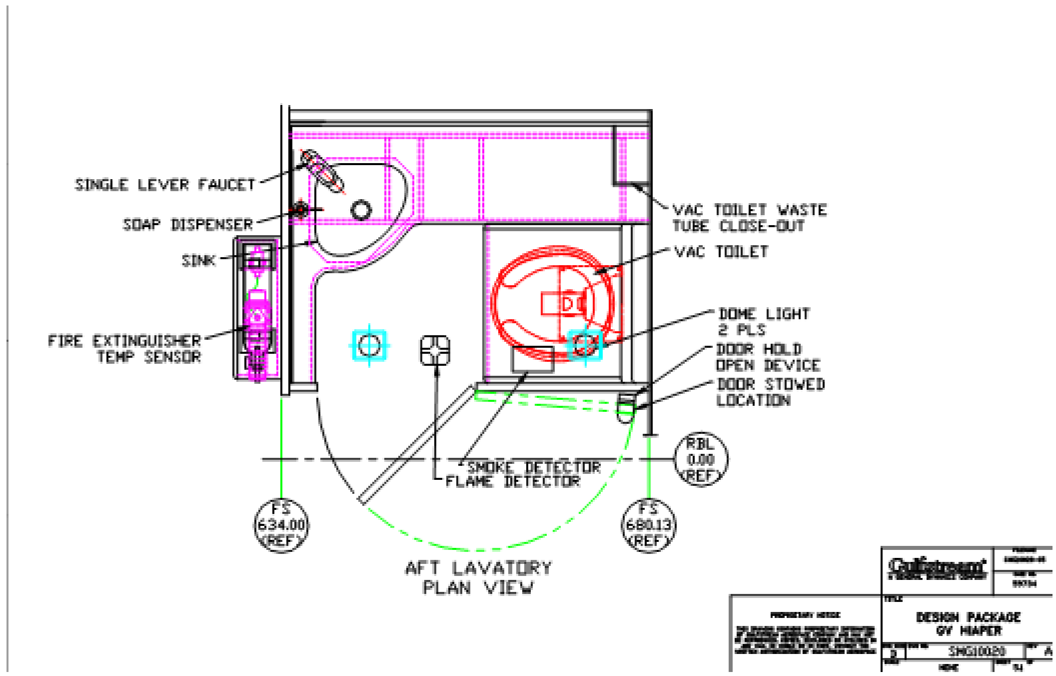


Figure 2.5: GV lavatory (plan view)

2.3 Weight and Balance

The NSF/NCAR GV aircraft is certified for operation at the following gross weights:

Category	Weight (lbs)
Maximum Ramp Gross Weight	90,900
Maximum Takeoff Gross Weight	90,500
Maximum Landing Gross Weight	75,300
Maximum Zero Fuel Weight	54,500

Table 2.1: GV operational gross weights

The following table provides loading information for the aircraft:

Category	Weight (lbs)
Operating Weight Empty	46,200
Fuel Capacity, Maximum	41,300
Payload w/ Maximum Fuel	3,400
Fuel Capacity w/ Maximum Payload	36,400
Payload, Maximum	8,300

Table 2.2: GV loading information

RAF will determine the aircraft zero fuel center of gravity (CG) either by weighing the aircraft or by numerical computation of the configuration prior to each mission to ensure the aircraft center of gravity is within the approved GV envelope.

***Note:** While the GV cabin has space to install up to 10 equipment racks in the forward cabin, installing more than 7 racks in the forward cabin may cause the CG to shift forward of the optimal position and require placement of ballast in the baggage compartment. This in turn impacts the ability to carry luggage or spares, reduces the available fuel load and negatively impacts the aircraft range and practical ceiling. Installation of 7 or more racks at the maximum rack weight may cause the CG to move out of bounds and result in a payload being incompatible with the GV.*

2.4 Cabin Pressurization

The aircraft pressurization system can automatically maintain a cabin altitude of sea level at an aircraft altitude of 11,000 feet to a cabin altitude of 6,000 feet at an aircraft altitude of 51,000 feet. The system can also be operated manually. A warning is displayed if cabin altitude exceeds 8,000 feet. The pressure safety relief valve is set for a +10.48 psi and -0.25 psi pressure differential.

Note: some instruments rely upon a stable ambient pressure to maintain operation of internal pressure or flow controllers. Please keep in mind that the GV cabin pressure will change during the flight, approximately tracking the outside ambient pressure but with a lag and minimum pressure platoeing at approximately 840 hPa (Figure 2.6).

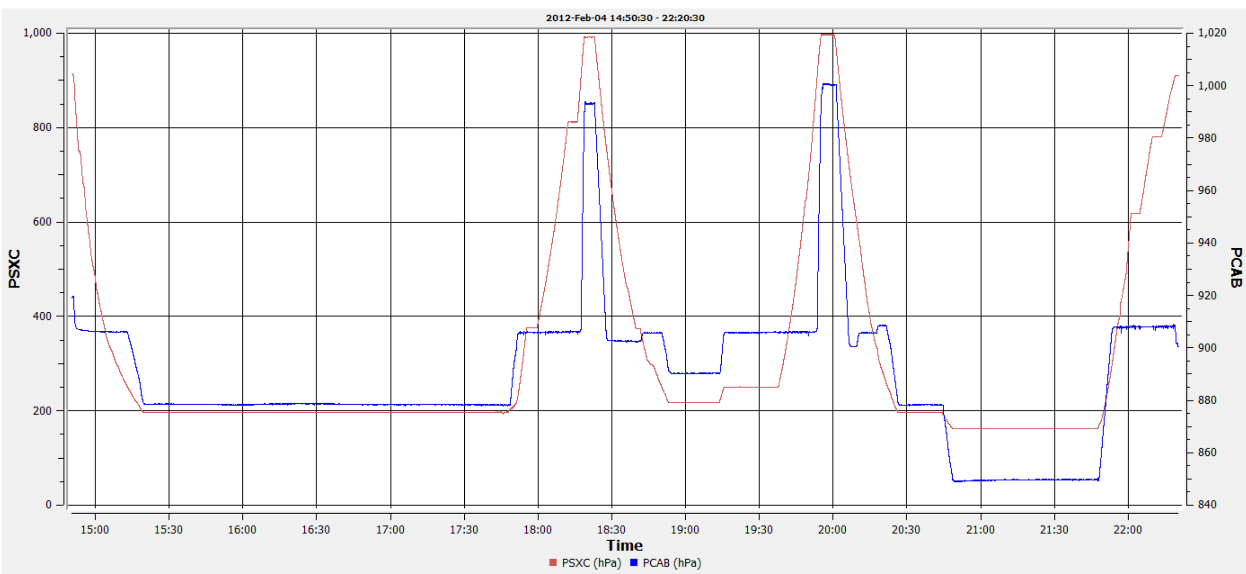


Figure 2.6: A representative profile of cabin pressure and ambient pressure during a typical GV flight. PSXC is the ambient atmospheric pressure; PCAB is the GV internal cabin pressure.

2.5 Aircraft Systems

The aircraft is equipped with the following standard equipment. These systems meet the latest requirements for high-density air traffic and all weather operations, including

Minimum Navigation Performance (MNP) and Reduced Vertical Separation Minimums (RVSM). Controls for the equipment are provided on the flight deck.

Note: *The frequency ranges of the navigation, radio, and radar units are also given in the following sections. Investigators are cautioned to engineer their equipment to utilize frequencies other than those specified for the various GV systems in order to prevent interference with aircraft equipment. For any equipment that will transmit any RF signal the investigators are advised to contact RAF to ensure compatibility with the GV prior to fabrication of such equipment.*

2.5.1 Integrated Flight Management System (FMS)

The GV is equipped with a FMS that integrates flight instrument displays and flight planning, navigation, and performance management utilities. The FMS consists of integrated displays and navigation, performance, guidance, and sensor systems. Equipment includes dual flight and navigation display cathode ray tube (CRT) systems, dual integrated avionics computers, dual flight guidance computers, a single Data Loader, and a PC Data Loader Port. Primary sensors consist of three Micro Air Data Computers (MADC) and three Inertial Reference Systems (IRS).

The FMS provides interfaces to the following:

- Navigation systems
- Inertial Reference Systems (IRS)
- Lateral Navigation (LNAV)
- Vertical Navigation (VNAV)
- Area Navigation (RNAV)
- Flight Planning
- Navigation Data Base Storage
- Autopilot
- Auto-throttle
- Stability Augmentation
- Performance Management
- Air Data
- Guidance

2.5.2 High Frequency (HF) Communications

Dual HF transceivers provide 99 user-programmable preset channels and 280,000 discrete operating frequencies covering the 2.0000 – 29.9999 MHz range in 100 Hz increments.

2.5.3 Very High Frequency (VHF) Communications

Dual VHF Communications transceivers provide AM voice communication in the frequency range of 118.0 – 136.975 MHz in 8.33 kHz increments for a total of 1360 separate channels.

Note: *The use of radio frequencies for scientific purposes (i.e., other than routine contact by the air crew with the Federal Aviation Administration Air Traffic Control [FAA ATC]) requires that NCAR apply for authorization in advance of the project. It is* *important that needs for radio communications are clearly defined by investigators in the GV Facility Request Form.*

2.5.4 VHF Navigation (VHFNAV), Instrument Landing System (ILS), and Marker Beacon

Dual VHFNAV systems provide Omni-directional Range (VOR) and ILS capabilities for the crew. The ILS is made up of the Localizer, Glide Slope, and Marker Beacon. The ILS functions are used to provide range, azimuth, and vertical input to align the aircraft with the landing runway. Both Navigation receivers operate in a frequency range of 108.0 MHz – 117.95 MHz spaced 50 kHz apart. The Localizers (LOC) operate in the frequency range of 108 – 112 MHz, and the Glide Slope (GS) receivers operate in the frequency range of 329.3 – 335.0 MHz. These frequency ranges provide 200 VOR channels and 40 Localizer channels. The Marker Beacon antenna is optimally tuned to receive signals at 75 MHz at an input impedance of 50 ohms.

2.5.5 Automatic Direction Finder (ADF)

Dual solid state ADF's provide bearing and audio output information that pertain to a selected ground station. The bearing and audio information are routed to the aircraft's navigation and intercommunication systems, respectively. The ADF can also be used for reception of voice or continuous wave (CW) transmissions. Both ADF receivers operate in frequency ranges of 190.0 – 1799.0 kHz and 2179.0 – 2185.0 kHz, tunable in 0.5 kHz increments.

2.5.6 Global Positioning System (GPS)

The GPS consists of two identical Global Navigation System Sensor Units (GNSSUs) and a single antenna for each sensor. Data from these sensors are provided to the Flight Management Control System for very accurate worldwide navigation capabilities. The GPS uses the Department of Defense (DOD) space-based satellite system to determine a three-dimensional aircraft position that consists of longitude, latitude, and altitude. The GNSSU is a twelve-channel GPS receiver that receives L1 transmissions (centered at 1575.42 +/-10 MHz) from the NAVSTAR GPS satellite constellation.

2.5.7 Distance Measuring Equipment (DME)

The DME system consists of two complete, independent and redundant systems. These units provide distance, time to station, ground speed, and station identification information for use by other aircraft systems. Each DME can track as many as three ground stations at the same time. Channel 1 of either DME is normally paired with the on-side VOR (manually tuned), and the data are directly displayed to the flight crew. Channels 2 and 3 are used by the Flight Management System for multi-sensor navigation and are automatically tuned. Both DME receiver functions operate in the L-band frequency range of 962 – 1213 MHz, and the transmitter functions operate in a frequency range of 1025 – 1150 MHz. The DME receiver operates 63 MHz above or below the transmitter frequency.

2.5.8 Air Traffic Control (ATC)

Dual solid state ATC systems provide Mode A and Mode C identification replies to Air Traffic Control Radar Beacon System (ATCRBS) interrogators for tracking, identification, and altitude reporting. Mode A provides coded aircraft identification and Mode C provides aircraft altitude information. The ATC transducers receive interrogation pulses on a frequency of 1030 MHz and, in response to all valid interrogations, transmit coded replies on a frequency of 1090 MHz.

2.5.9 Traffic Collision Avoidance System (TCAS)

One TCAS 2000 (ACAS II/Change7) system and controls is installed in the GV to provide the flight crew with notifications of the presence of other transponder equipped traffic in the vicinity that may present a collision hazard. The TCAS/ACAS can track up to 50 airplanes simultaneously. The system provides aural alerts in the cockpit to the presence of traffic and visual plots on cockpit displays of the relative location of other airplanes and visual cues for evasive maneuvers are provided to the flight crew if collision is imminent. If both converging airplanes are equipped with TCAS/ACAS and mode S transponders, the systems mutually coordinate evasive maneuvers to ensure diverging flight paths. Both TCAS antennae on the GV operate at a transmit frequency of 1030 MHz and a receive frequency of 1090 MHz. The antennae have a nominal impedance of 50 Ohms.

2.5.10 Color Weather Radar

The Primus Weather Radar system installed in the GV is a lightweight X-band digital radar designed for weather detection and ground mapping. The primary purpose of the system is to detect storms along the flight path and to give the pilot a visual color indication of the storms' rainfall and turbulence content. After proper evaluation of radar images, the pilot can chart a course to avoid storm areas. In the weather detection mode, target returns are displayed as one of five video levels (0, 1, 2, 3, and 4). Level 0 is shown as a black screen which indicates weak or no returns. Levels 1, 2, 3, and 4 are shown as green, yellow, red, and magenta, respectively, with increasing number indicating progressively stronger returns. Areas of potentially hazardous turbulence are shown as gray white. In the ground-mapping mode, video levels of increasing reflectivity are displayed as black, cyan (sky blue), yellow, and magenta. The weather radar system transmits and receives on a frequency of 9375 (+/-25) MHz (X-band radio frequency).

2.5.11 Radio Altimeter (RAD ALT)

The RAD ALT system consists of two complete and separate systems. The purpose of the RAD ALT system is to provide the flight crew with an accurate above ground level (AGL) altitude indication during low level flight. The range of the RAD ALT system is

-20 to +2500 feet AGL. The radio altimeter antennae have an input impedance of 50 Ohms and operate within a low frequency range of 4200 – 4400 MHz.

2.5.12 Emergency Locator Transmitter (ELT)

One ELT System is installed in the aircraft. This system, an Artex C406-2 series ELT, is a third generation ELT that transmits at 121.5, 243.0, and 406 MHz. The system is capable of transmitting both aircraft position and aircraft identification.

2.5.13 Enhanced Ground Proximity Warning System (GPWS)

The GPWS provides wind shear detection and alerting. GPWS also provides advanced ground proximity warning with increased terrain-ahead awareness. These features help prevent accidents caused by Controlled Flight into Terrain (CFIT). The GPWS monitors the various sensor inputs for deviations that exceed predetermined parameters. The GPWS produces visual and audible warnings to notify the flight crew when any of the parameters are exceeded. The major feature of the enhanced GPWS is the incorporation of terrain awareness and display functions. The terrain awareness alerting algorithms in the GPWS computer continuously compute an advisory level and a warning level clearance envelope ahead of the aircraft. If the boundaries of these envelopes conflict with terrain elevation data in the terrain database, an alert or warning is issued.

2.5.14 Intercommunications System (ICS)

The cockpit ICS delivered with the GV was modified and expanded prior to delivery of the aircraft to NCAR to provide communications capabilities for crew members in the main cabin. The GV ICS consists of hardware components manufactured by ATS Orbitz and includes three Audio Control Panels (ACPs) in the cockpit (for the two pilots and one flight observer) and five ACPs and three Interphone Control Panels (ICPs) in the main cabin (see Aircraft operations conducted by UCAR/NCAR personnel are insured – to the extent of the policy coverage – for legal liability arising from third-party claims.

This coverage extends to instrumentation installed on the aircraft as part of NSF-approved flight operations. UCAR also is insured for legal liability involving operation of motor vehicles and general liability hazards.

All UCAR/NCAR staff members are covered by the UCAR Travel Accident Policy as stated in the UCAR Benefits Manual.

Non-UCAR staff should check with their home institution for workers compensation coverage, medical and life insurance coverage, for possible insurance exceptions related to flying in a public aircraft operation.

Appendix A, Station Locations on page 89). Additionally, one ICP is located in the aircraft baggage compartment. One intercommunications jack is provided in the fuselage nose exterior, and one is also provided in the tail compartment for use by the aircraft mechanics. Each of the ACPs in the GV main cabin provides investigators with the capability to communicate with other members of the flight crew (including the pilots) and to communicate outside of the aircraft using either one of the GV VHF radios (selected by the pilots) or the SATCOM systems. ICPs provide investigators with the capability to communicate with flight crew members in the main cabin only.

Instruction in the use of the GV ICS is provided to investigators by RAF personnel during preparation for aircraft field deployments.

2.5.15 Satellite Communications (SATCOM) Systems

Iridium and Inmarsat SATCOM systems are both available on the NSF/NCAR GV. An AirCell ST 3100 Iridium system is installed on the aircraft. The SATCOM system is an Inmarsat Classic and SwiftBroadband (SBB) system. Incorporating the Thrane & Thrane Aviator 700 SATCOM System, utilizing the I-4 Salletile Network. The operating frequency range for the Iridium system is 1621.35 – 1626.5 MHz. The Inmarsat system transmits in a frequency range of 1626.5 – 1660.5 MHz and receives in a frequency range of 1530 – 1559 MHz.

The AirCell Iridium SATCOM system provides worldwide voice and data communications. RS-232 support built into the AirCell cabin-mounted equipment supplies the capability for Internet dial-up connection at a maximum data transmission rate of 2.4 kilobits per second (kbps).

The Thrane & Thrane Aviator 700 SBB Inmarsat system provides global voice and PC modem data capabilities using the Inmarsat SBB service. Data transfers at rates up to 64kbps for circuit switched, ISDN. Up to 128kbps packet switched/streaming (Billed per minute based on the requested amount of bandwidth) and up 432 kbps background Always-on IP data, single shared channel (Billed per megabyte based on the actual amount of data sent and received) are possible using the Inmarsat SBB service.

Note: *Due to the high cost of satellite data communications, only EOL computers onboard the GV are allowed internet access. All user systems are only allowed access to the Local Area Network (LAN) onboard the GV. Systems requiring access to the Internet must be identified to the EOL/RAF staff in advance of the project and will be allowed to connect only after a thorough examination by the EOL system administrators.*

The Internet Relay Chat can be made available on all systems including instrument computers. This system does not connect to the Internet directly but goes through the ADS server. Please see Section 5.4 for more details.

Instruction in the use of the GV SATCOM systems and additional materials describing the capabilities of the two systems is provided to investigators by RAF personnel during preparation for aircraft field deployments.

2.5.16 Airborne Flight Information System (AFIS)

The Honeywell AFIS installed on the GV is a tool for the communication of necessary flight information to the pilots using a VHF datalink. Information transmitted to the aircraft is displayed for the flight crew on the cockpit displays of the FMS. The AFIS may be used to access Automatic Terminal Information Service (ATIS) products and the digital version of an Air Traffic Control (ATC) clearance. Additionally, AFIS can be used to have a previously computed flight plan transmitted directly to the GV FMS. In flight, the AFIS can be utilized to gain access to such information as the latest terminal weather, ATC flow reports, Significant Meteorological Conditions (SIGMETS), NEXRAD graphical images, and Terminal Weather Information for Pilots (TWIP). The GV pilots can also use the AFIS to transmit messages.