



NCAR

NSF / NCAR Gulfstream V

INVESTIGATOR'S HANDBOOK



Research Aviation Facility, Earth Observing Laboratory
National Center for Atmospheric Research
Boulder, Colorado, USA

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Introduction

History

The GV aircraft was made available for research in February, 2005 concluding an extensive two year program of adding research infrastructure modifications to a stock GV. This program was named High altitude Instrumented Airborne Platform for Environmental Research (HIAPER). After completion of this program the aircraft became known as NSF/NCAR GV but sometimes is still referred to as HIAPER in the community.

Current status

The Gulfstream V (GV) aircraft represents a high performance platform that will serve the environmental research needs of the National Science Foundation (NSF) for the next several decades. The capability offered by the GV to carry fairly large, manned payloads to high altitudes and over long distances make it an attractive research vehicle for in-depth studies of the troposphere and lower stratosphere and for remote sensing studies of the Earth's surface or upper atmosphere.

The GV is maintained and operated on behalf of NSF by the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, USA. The Research Aviation Facility (RAF) within NCAR's Earth Observing Laboratory (EOL) manages the support and deployment of the aircraft, and the GV itself is based at Rocky Mountain Metropolitan Airport (RMMA) in Broomfield, Colorado.

This Investigator's Handbook is intended to serve investigators as a reference guide for the NSF/NCAR GV. As such, information is included on the following: basic aircraft specifications; research systems specifications including information on structural modifications, standard instrumentation racks, the research power system, and the data acquisition system and displays; aircraft performance characteristics and considerations; flight operations; integration of investigator equipment packages; EOL standard instrumentation; and aircraft request procedures and project support services.

Investigators who are either considering requesting the use of the GV or who have already been awarded project support with this facility are strongly encouraged to review this handbook and to structure their programs and payloads to the operational guidelines and integration requirements outlined in this document.

While this handbook has been intended to be as comprehensive as possible, it is anticipated that other, more project specific, questions will arise as investigators make plans to utilize the GV. Investigators are invited and encouraged to work closely with NCAR/EOL staff while making preparations for research deployment of the aircraft. The list of key contact personnel given on Page 9 of this document will aid investigators in contacting those individuals within EOL who can be of assistance with particular issues as they arise. General questions regarding the GV should be addressed to either the EOL Director's Office (303-497-2040) or the RAF Facility Manager (303-497-1032).

Key Personnel Contact Information at NCAR/EOL

Earth Observing Laboratory (EOL) Directorate

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List of Acronyms/Definitions

| | |
|--------|---|
| ACAS | Aircraft Collision Avoidance System |
| ACP | Audio Control Panel |
| A/D | Analog to Digital |
| ADADS | Aircraft Data Acquisition and Display System |
| ADF | Automatic Direction Finder |
| ADS | Airborne or Aircraft Data System |
| AEROS | Airborne Environment Research Observing System |
| AFIS | Airborne Flight Information System |
| AGL | Above Ground Level |
| ALT | Altitude |
| ANSI | American National Standards Institute |
| APA | Airport Pressure Altitude |
| APU | Auxiliary Power Unit |
| ARINC | Air Radio Incorporated |
| ASCII | American Standard Code for Information Interchanges |
| ATC | Air Traffic Control |
| ATCRBS | Air Traffic Control Radar Beacon System |
| ATIS | Automatic Terminal Information Service |
| BL | Buttline (in inches) |
| CDS | Computing Data and Software |
| CFIT | Controlled Flight Into Terrain |
| CG | Center of Gravity |
| COTS | Commercially Available Off The Shelf |
| CRT | Cathode Ray Tube |
| CW | Continuous Wave |
| DER | Designated Engineering Representative |
| DFS | Design and Fabrication Services |
| DME | Distance Measuring Equipment |
| DMT | Droplet Measurement Technologies, Inc. |
| DOD | Department of Defense |
| DSM | Data Sampling Module |

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| EDO | Extended Data Out |
| EIA | Electronics Industry Association |
| ELT | Emergency Locator Transmitter |
| EOL | Earth Observing Laboratory |
| FAA | Federal Aviation Administration |
| FAC | Facilities Allocation Committee |
| FAR | Federal Aviation Regulation |
| FIFO | First In First Out |
| FMCS | Flight Management Control System |
| FMS | Flight Management System |
| FPS | Field Project Services |
| GAC | Gulfstream Aerospace Corporation |
| GNSSU | Global Navigation System Sensor Unit |
| GPS | Global Position Sensor, Global Positioning System |
| GPWS | Ground Proximity Warning System |
| GS | Glide Slope |
| GTW | Gross Takeoff Weight |
| GV | Gulfstream V Aircraft |
| GVFS | GV Fuselage Station |
| HDLC | High Level Data Link Control |
| HF | High Frequency Communications |
| HIAPER | High altitude Instrumented Airborne Platform for Environmental Research |
| HSD | High Speed Data |
| ICP | Interphone Control Panel |
| ICS | Intercommunications System |
| IDG | Integrated Drive Generator |
| ILS | Instrument Landing System |
| I/O | Input / Output |
| IRIG | Inter Range Communication Group |
| IRS | Inertial Reference System |
| IRU | Inertial Reference Unit |

| | |
|---------|---|
| ISA | International Standard Atmosphere |
| KCAS | Knots Calibrated Air Speed |
| KTAS | Knots True Air Speed |
| LAN | Local Area Network |
| LAOF | Lower Atmospheric Observing Facilities |
| LBL | Left Buttline (in inches) |
| LEO | Low Earth Orbiting |
| LOC | Localizers |
| LNAV | Lateral Navigation Localizers |
| MADC | Micro Air Data Computers |
| MMO | Maximum Operating Mach Number |
| MNP | Minimum Navigation Performance |
| MPDB | Main Power Distribution Box |
| MSL | Standard Atmosphere |
| NACA | National Advisory Committee on Aeronautics |
| NATO | North Atlantic Treaty Organization |
| NCAR | National Center for Atmospheric Research |
| NEMA | National Electrical Manufacturers Association |
| netCDF | Network Compact Data Format |
| NM | Nautical Mile |
| NEXRAD | Next Generation Radar |
| NSF | National Science Foundation |
| NTP | Network Time Protocol |
| PCI | Peripheral Component Interconnect |
| PI | Principal Investigator |
| PIC | Pilot In Command |
| PMS | Particle Measuring System |
| PPS | Pulse Per Second |
| PSI | Passenger Service Units |
| RAD ALT | Radio Altimeter |
| RAF | Research Aviation Facility |
| RBL | Right Buttline (in inches) |

| | |
|---------|--|
| RDP | Research Data Program |
| RNAV | Area Navigation |
| RVSM | Reduced Vertical Separation Minimum |
| SATCOM | Communications Satellite |
| SIGMETS | Significant Meteorological Conditions |
| SOD | Scientific Overview Document |
| SPDB | Secondary Power Distribution Box |
| SPDDB | Secondary Power Distribution Drop Box |
| SQL | Structured Query Language |
| SSDB | Secondary Signal Distribution Box |
| TAS | True Airspeed |
| TCAS | Traffic Collision Avoidance System |
| TWIP | Terminal Weather Information for Pilots |
| UDP/IP | User Datagram Protocol/Internet Protocol |
| UPS | Uninterruptible Power Supply |
| USAF | United States Air Force |
| VDC | Voltage From Direct Current |
| VHFNAV | Very High Frequency Navigation System |
| VHF | Very High Frequency Communications |
| VME | VersaModule Eurocard Bus |
| VNAV | Vertical Navigation |
| VOR | Omnidirectional Range |
| VSR | Stall Reference Speed |
| WL | Waterline (in inches) |
| WOW | Weight-On-Wheels |

Chapter 1 Requesting the Aircraft and Instrumentation

1.1 Aircraft Requests

EOL manages and operates the majority of NSF's Lower Atmospheric Observing Facilities (LAOF) and makes them available on a competitive basis to qualified researchers from universities, NCAR, and other government agencies. Deployment decisions for each facility are driven by the scientific merit of the proposed use, the capabilities of a specific facility to carry out the proposed observations, and availability of the facility for the requested time period. The NSF/NCAR GV is part of the LAOF group. Correspondingly, proposed usages of the aircraft for research are eligible for NSF deployment pool funding support.

Procedures for requesting use of the GV and other NSF-supported facilities are outlined in the NSF Lower Atmospheric Observing Facilities User Guide. This document may be directly retrieved on-line at [www.eol.ucar.edu/deployment/request-info /UserGuide.pdf](http://www.eol.ucar.edu/deployment/request-info/UserGuide.pdf).

1.2 Project Support Services

Investigators interested in requesting usage of the NSF/NCAR GV for support of their research program can expect comprehensive, end-to-end field project support from EOL. Personnel within the Field Project Services (FPS) and Computing, Data and Software (CDS) facilities and the RAF are available to provide assistance at all stages of a project's lifecycle, from the early planning phase, through the deployment period, and extending out beyond the final data processing and distribution phase.

The sections below provide more detailed information about the specific types of programmatic support provided by EOL staff members.

1.2.1 Basic and Specialized Research Instrumentation

Several basic and specialized instrument packages can be made available to GV users upon request. Standard instruments available on the aircraft are described in the RAF Standard Instrumentation Manual document. EOL personnel assume responsibility for installing and maintaining these instruments. In addition, EOL staff members will help investigators with the installation of user-supplied instrumentation on the GV. All user-furnished equipment will need to comply with specified EOL design and interface requirements. Requirements for the integration of investigator equipment packages are detailed in Chapter 5 of this handbook.

RAF personnel supervise the installation of user-supplied equipment on the GV in order to ensure compatibility with existing aircraft operations and instrumentation systems and to ensure that all safety of flight and engineering requirements are met.

EOL/RAF staff members provide in-flight oversight of equipment operation. However, this does not normally include the operation of user-supplied instrumentation. If investigators will require EOL personnel to provide in-flight sensor operation assistance, this requirement must be identified on the aircraft request form available from EOL FPS.

1.2.2 *Engineering Support*

EOL can provide aeronautical, mechanical, and electrical engineering support services to investigators in order to ensure that user-supplied equipment meets all design and fabrication requirements set forth for the GV (see Chapter 5 of this handbook). Requests for such assistance must be clearly identified on the aircraft request form and should also be discussed with EOL personnel during the pre-project planning phase.

Specific questions about aeronautical, mechanical, and electrical engineering support services available within EOL should be addressed to RAF Aeronautical Engineering, the EOL/DFS Manager, and the RAF Electrical Engineer respectively.

1.2.3 *Operational and Scientific Support*

A RAF Project Manager is assigned to each GV program to serve as a point of contact for platform investigators and to work with them to plan the most effective scientific experiment possible. Based on his/her knowledge of the program's scientific requirements, the Project Manager may assist in defining particular sensors for the instrumentation package, the design of flight profiles, or the most applicable data processing techniques. At a minimum, EOL staff members are normally responsible for project planning (in close cooperation with project investigators), conduct of project operations, quality control oversight for EOL-supported sensors, oversight of data system performance, EOL data processing, and final EOL data delivery to the user. Delivery of user (non-EOL) data is normally not a responsibility of EOL personnel. More in-depth scientific participation is dependent on the specific needs and wishes of the requesting scientists and should be discussed with EOL scientists at the time the aircraft request form is submitted. For general information about RAF project management services, investigators should contact the leader of the RAF Scientific Project Management Group.

Project principal investigators are required to guide and participate in the in-flight conduct of research. This may be done through delegation to another qualified member of the investigator's group or through delegation to a qualified member of the RAF support team. In all such cases, it is necessary for the principal investigator and the investigator's group to visit the RAF prior to the start of the field program to receive orientation and training in the safe operations of instrumentation and any associated data recording equipment. Project investigators normally participate in the instrumentation flight tests, which are conducted prior to the scientific field phase of the program.

A mission scientist is normally required on the GV to perform in-flight mission coordination and to handle communications with pilots, scientific crew members, and ground support personnel. Because the mission scientist communicates directly with the pilots during flight operations, specialized training in cockpit and flight procedures/protocol is required. The RAF pilots will provide this training to project investigators who wish to serve as mission scientists, provided there are no impediments (e.g., language barriers) to the investigator being able to communicate effectively. Alternatively, EOL can supply a trained mission scientist. It should be noted

that mission scientists are normally not in a position to operate cabin instrumentation during flight.

The RAF pilots work with investigators and with the assigned RAF GV Project Manager to plan missions, obtain air traffic control flight clearances, and to address special requests pertaining to flight operations. Requests for diplomatic clearances, which are required when operating in most foreign countries, are initiated by EOL personnel after project approval.