2.2 FUTURE ENVIRONMENTAL MEASUREMENT OPPORTUNITIES WITH HIAPER, THE NEW NSF/NCAR RESEARCH PLATFORM

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1. INTRODUCTION

At the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, work is now taking place to bring on-line the High-Performance Instrumented Airborne Platform for Environmental Research (HIAPER). This advanced research platform is a Gulfstream V (G-V) business jet that will undergo modification in order to serve the environmental research needs of the U.S. National Science Foundation (NSF) for the next several decades.

After completion, HIAPER will be maintained and operated for NSF by the Research Aviation Facility (RAF) of NCAR's Atmospheric Technology Division (ATD).

2. BACKGROUND

2.1 *Project History*

In December 2001, the University Corporation for Atmospheric Research (UCAR; the university consortium responsible for managing NCAR for NSF) awarded a contract to Gulfstream Aerospace Corporation for production of the basic HIAPER airframe. Contract award followed a multi-year, community-wide effort to clearly define the requirements for HIAPER, select a contractor, and secure NSF funding for the project. Under the terms of the contract, Gulfstream has partnered with Lockheed Martin, and Lockheed will perform the required modifications to prepare the aircraft for environmental research.

In fiscal year 2002, the U.S. Congress appropriated $35 million for HIAPER, and it was this allocation – combined with $21 million awarded in preceding years for the project – that allowed for the aircraft purchase through NSF's Major Research Equipment and Facilities Construction (MREFC) fund. At the time of completion, it is expected that the development of HIAPER and associated new research instrumentation will have cost just over $81 million.

Management and oversight of the aircraft acquisition and modification effort is the responsibility of the HIAPER Project Office at NCAR. Scientific community oversight and guidance for this acquisition are provided by the HIAPER Advisory Committee (HAC). This group of university researchers and representatives of NCAR, NSF, NASA, and NOAA is charged with ensuring ongoing and effective community involvement in critical aspects of the HIAPER acquisition. The HAC, which is advisory to the NCAR director, has played an instrumental role throughout the project execution to date, including reviewing the vendor award decision, participating in engineering design review and modification decision discussions, and aiding in planning for the HIAPER Community Instrumentation Workshop.

Production of the "green" (basic) HIAPER airframe was completed in June 2002. A picture of the completed "green" aircraft is shown in Figure 1 below.

Figure 1. The "green" (basic) HIAPER airframe, a Gulfstream V (G-V) business jet.

Following issuance of the Certificate of Airworthiness (COA), the aircraft was transferred to Lockheed Martin's modification facility in Greenville, South Carolina where it will reside for the majority of the upcoming two-year engineering design and modification period. The fully modified

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G-V will be delivered to UCAR and NCAR in October 2004, and infrastructure integration work by NCAR staff will immediately follow delivery for a period of approximately nine months. At present, it is planned that the first research deployment of HIAPER will take place in June 2005.

2.2 *Aircraft Capabilities*

As originally envisioned by the user community, the NSF/NCAR G-V will allow investigators to carry payloads to a higher altitude in a shorter period of time and will also allow for mission deployments that cover a longer range. With a scientific payload of approximately 2,700 kg, HIAPER will be able to climb to an altitude of 12,497 m in approximately 22 min. The maximum certified altitude for the aircraft is 15,545 m. The G-V will be capable of covering a range of over 11,200 km and will have a maximum flight duration of just under 14 hrs. This combination of performance attributes will make it possible for investigators to engage in a variety of Earth system research missions, including atmospheric studies in and near the tropopause and global studies of various geophysical phenomena covering a quarter of the globe in a single research flight.

2.3 *Planned Modifications*

Modifications to be made to the new NSF/NCAR G-V by Gulfstream and Lockheed Martin to prepare the aircraft for use in environmental research include installation of the following:

- Three hard points beneath each wing for carrying wing pods and other sensors, with each hard point to have a maximum carrying capacity of 680 kg (it should be noted, however, that it is not intended to deploy the maximum of 680 kg on each of the six wing hard points simultaneously)
- Three 52.6-cm diameter optical ports on the fuselage centerline (two down and one upward looking, with one down and one upward looking port co-aligned vertically) for remote sensing instrumentation
- Several aperture plates and fuselage hard points for the installation of inlets, antennas, other small instruments, and possibly small external instrumentation fairings
- Forward fuselage nose pads for the installation of state parameter sensors (e.g., temperature, dewpoint, and humidity sensors) and a research pitot-static system
- Interior cabin attachment points for equipment racks and seats
- Research power equipment and power and data signal wiring
- Chemical exhaust system in the main cabin and a pump exhaust system in the aircraft baggage compartment

Following delivery of the modified aircraft to UCAR and NCAR in October 2004, NCAR staff will begin integration of the following infrastructure components into the aircraft:

- Data acquisition system and associated data recording and display software
- Research intercommunication system (ICS)
- Research equipment racks
- Satellite communications (SATCOM) system

3. OVERVIEW OF NSF-LED COMMUNITY INSTRUMENTATION WORKSHOP FOR HIAPER

An important aspect of the HIAPER project is the need to fully engage the scientific community in the development of new instrumentation for the aircraft. Of the approximately $81 million budgeted for the project, NSF has targeted $12.5 million for the development of new research instrumentation. These funds are to be awarded competitively through a NSF proposal and review process.

In order to initiate discussions with a broad section of the scientific community regarding the type of measurements that should be made using HIAPER and the types of instrumentation that should be considered for development and deployment, a NSF-led Community Instrumentation Workshop for HIAPER was held at NCAR from 4-6 November 2002. The following three primary goals were established in advance for this workshop:

1. Identify the science thrusts and types of measurements that will need to be made in the near and mid-term with this platform;
2. Ensure that the broad research community has a clear understanding of the HIAPER airframe and its basic infrastructure; and
3. Discuss the NSF Announcement of Opportunity (AO) process, schedule, and estimated funding level for proposals to build instrumentation for HIAPER.

The workshop was attended by a large number of personnel from universities, government laboratories, and private industry. During the morning of the opening day of the workshop, background information on the HIAPER project and a general overview of the aircraft's capabilities and plans for modification were presented by a number of NSF and NCAR staff members. The remainder of the first day consisted of talks by seven invited speakers with expertise in the fields of new technologic opportunities, the "heterogeneous" atmosphere (aerosol physics and chemistry and cloud microphysics), gas phase chemistry and biogeochemistry, radiation and climate, the middle and upper atmosphere, large scale dynamics, and the earth sciences (ocean and terrestrial remote sensing, etc.). These invited presentations by recognized experts in the above fields helped to lay the groundwork for discussions during the next one-and-a-half days of the workshop about the environmental areas in which observations from the HIAPER research platform may be of the greatest benefit.

The second day of the workshop began with an invited speaker panel discussion period, followed by a town hall session in which workshop participants were able to contribute their own thoughts regarding critical measurement areas in which HIAPER could have an impact. During the afternoon of the second day, two parallel focus group discussion periods were conducted in which targeted discussions regarding major research areas instrumentation priorities and HIAPER instrumentation design and development considerations were held. The second day concluded with a HIAPER engineering preview session, in which brief presentations by NCAR staff were given on the following: sampling on HIAPER (airflow results and options for probes, inlets, plumbing, pumps, and exhaust); wing pod and equipment rack designs; the next generation data system and new data display and dissemination possibilities for the G-V; HIAPER engineering limitations, operational considerations, and certification issues.

The workshop concluded on the third day with a presentation of summary reports from the focus group moderators, a summary of the workshop conclusions and outcomes, final discussion of the NSF AO for HIAPER instrumentation funds, and an open discussion of new topics.

In general, the HIAPER Community Instrumentation Workshop provided the participants with a valuable opportunity to discuss the environmental measurements that should be made with this new platform and to share ideas regarding new technologies and approaches to instrumentation design that should be considered in developing new instrumentation for HIAPER. These discussions will be essential in developing the NSF/NCAR G-V as a leading edge platform that will be of maximum benefit to the environmental research community in the years to come.

4. ACKNOWLEDGMENTS

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