University of Texas Institute for Geophysics Technical Report No. 149

Table of Contents

List of Figures

List of Tables

List of Attachments

Executive Summary

Overview:

Airborne research platforms are uniquely suited to study the earth's processes in remote regions. As a research vessel traverses the world's oceans, an airborne research platform is well suited to study the interior regions of Antarctica.

The Support Office for Aerogeophysical Research (SOAR) is a facility of the National Science Foundation's Office of Polar Programs whose mission is to make airborne geophysical observations available to the broad research community of geology, glaciology and other sciences.

This facility grew out of science programs funded by the National Science Foundation beginning in 1989. The instrumented aircraft presently used by SOAR was also used for the site survey at the McMurdo Dome drill site and to collect ice thickness data across the West Antarctic ice streams. The support of these science programs and the increasing number of requests for access to an aircraft led to the concept of an aerogeophysical facility.

SOAR is a multi-institutional facility. The institutions with major responsibilities are the Institute for Geophysics at the University of Texas at Austin, Lamont-Doherty Earth Observatory of Columbia University and the Geophysics Branch of the U.S. Geological Survey. The central office of the SOAR facility is located in Austin.

This report summarizes the 1995/96 goals and accomplishments of the SOAR facility, its second year of operation and future facility plans.

History:

SOAR was chartered on August 1, 1994 via a cooperative agreement between the National Science Foundation and the University of Texas at Austin. The facility goal stated in the agreement is to "develop, maintain and operate a suite of geophysical systems aboard a Twin Otter Aircraft in support of research in Antarctica for five years."

In 1994, SOAR assembled a staff, designed the laboratory areas and prepared to deploy personnel and equipment for the 1994/95 Antarctic summer field season. Most of the equipment, staff and experience for SOAR came from the science projects of the previous few years. Some new equipment was added, most notably real-time Global Positioning System navigation for the survey aircraft.

SOAR executed a compressed but successful 1994/95 field season based out of Byrd Surface Camp in Marie Byrd Land, Antarctica. SOAR completed 32 survey flights, acquiring over 18,000 km of geophysical profiling. The primary science project supported was the West Antarctic Ice Sheet (WAIS) aerogeophysics program of the University of Texas Institute for Geophysics, Lamont-Doherty Earth Observatory and the United States Geological Survey. The data acquired during the 1994/95 and 1995/96 seasons also included the preliminary site selection information for the deep ice coring site at the West Antarctic ice divide. Details of the goals, accomplishments, finances and timetable of the 1994/95 field season can be found in the SOAR Annual Report for 1994/95.

Second Year Review:

Operations and Experiments:

The experimental goal for SOAR is to meet the needs of the client science projects by providing simultaneous airborne observations of gravity, magnetics, ice-surface topography and subglacial topography. For the 1995/96 field season the science project clients were WAIS and the University of Wisconsin-Madison (UW). The 1995/96 season was planned to be long due to the short initial season of 1994/95. Eighty flights were anticipated. Eighty-eight survey flights were completed including 81 original survey flights and seven survey reflights covering lines of poor data quality obtained in either the 1994/95 or 1995/96 season. A total of 49,000 kilometers of data was acquired. This extremely productive field season was the result of hard work from all parties and exceptionally good weather.

The 1995/96 flights covered two geographic areas surveyed in distinct phases (Figure 1). The first phase completed the Byrd Subglacial Basin (BSB) area of the WAIS project in 44 survey flights (Figure 2). The second phase covered an area requested by both the WAIS and the UW projects. This target, called the Whitmore Accommodation Zone (WAZ), required 37 survey flights (Figure 3). Representatives from WAIS and UW were in the field to perform quality checks of the data.

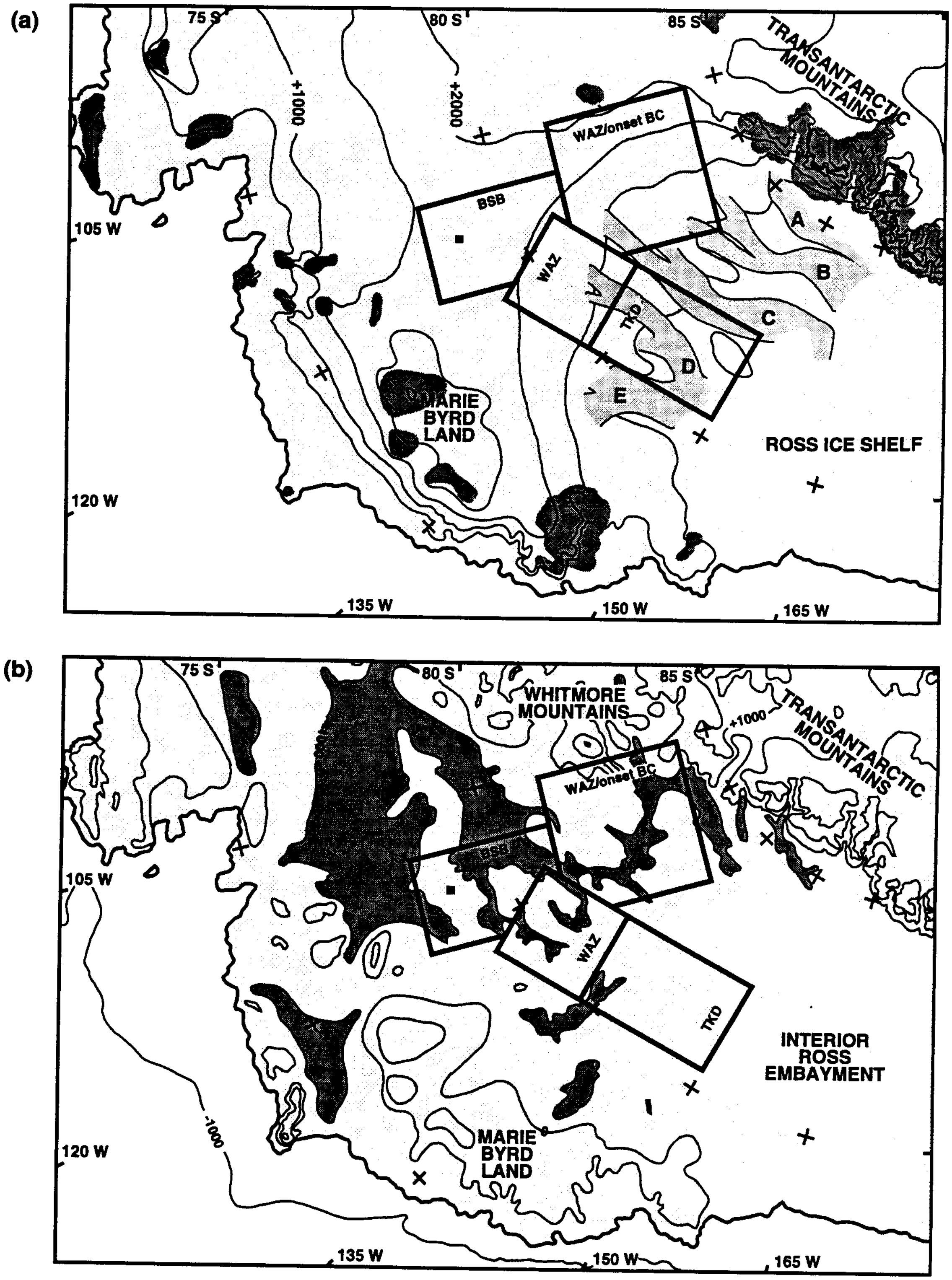


Figure 1 - SOAR survey targets shown on the surface and bedrock topography of West Antarctica. The three targets are outlined with blocks: [1] **BSB** (Byrd Subglacial Basin) [2] **WAZ** (Whitmore Accommodation Zone) [3] **TKD** (trunk of ice stream D). The previously completed CASERTZ work is marked **WAZ/onset BC**. A small square marks the proposed WAISCORES deep-drilling site. Siple Dome, on the ridge between ice streams C and D, is the current site for the WAISCORES drilling effort. (a) Survey targets on the ice surface. (b) Survey targets on the bedrock topography.

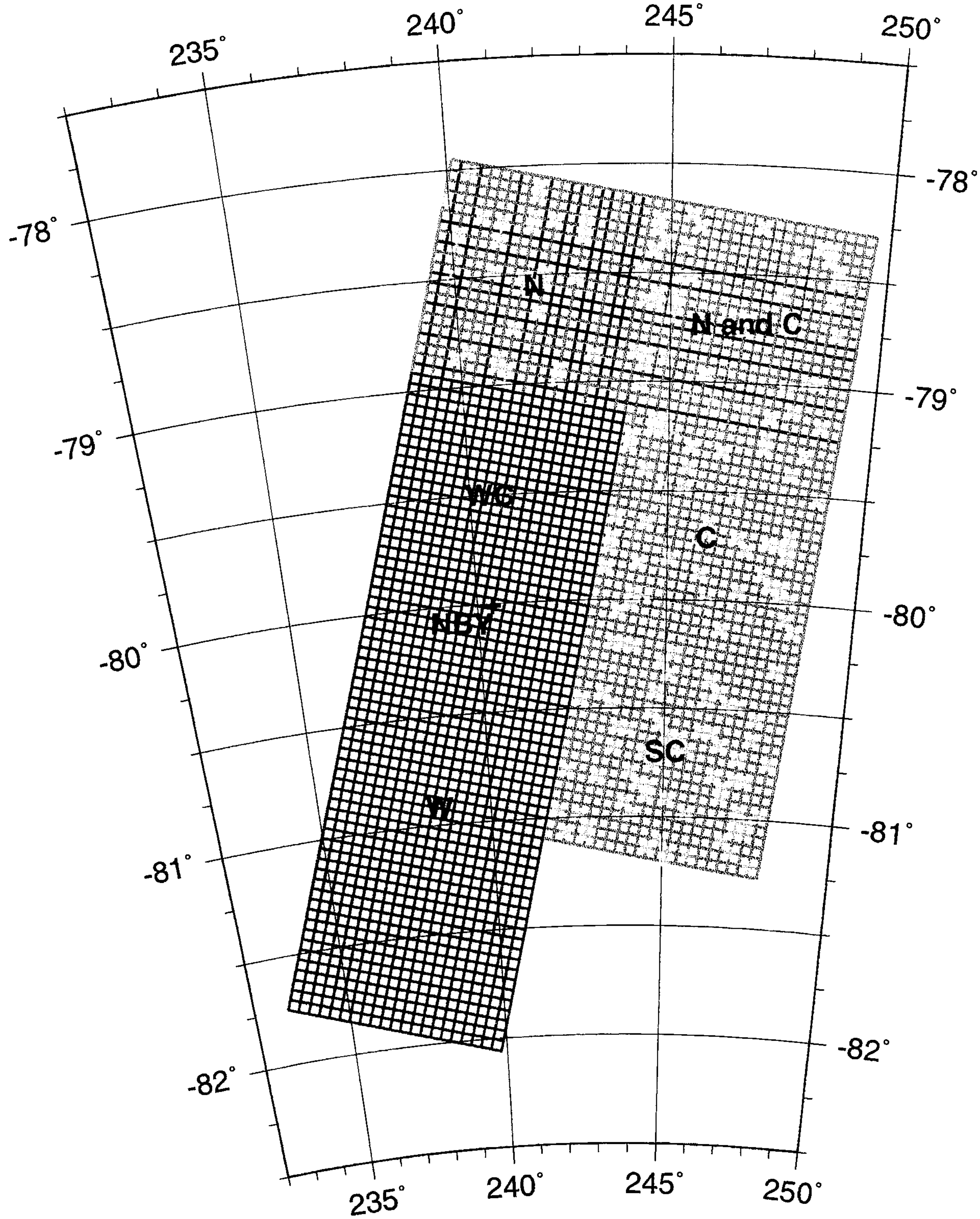


Figure 2 - SOAR survey coverage of the **BSB** target area during 1994/95 and 1995/96 field seasons. Lines shown in purple and blue are BSB lines left over from the 1994/95 season which were added to those planned for the 1995/96 season. The colored survey lines were flown during the 1995/96 season. Each completed profile is augmented by a run-in and run-out that is not shown.

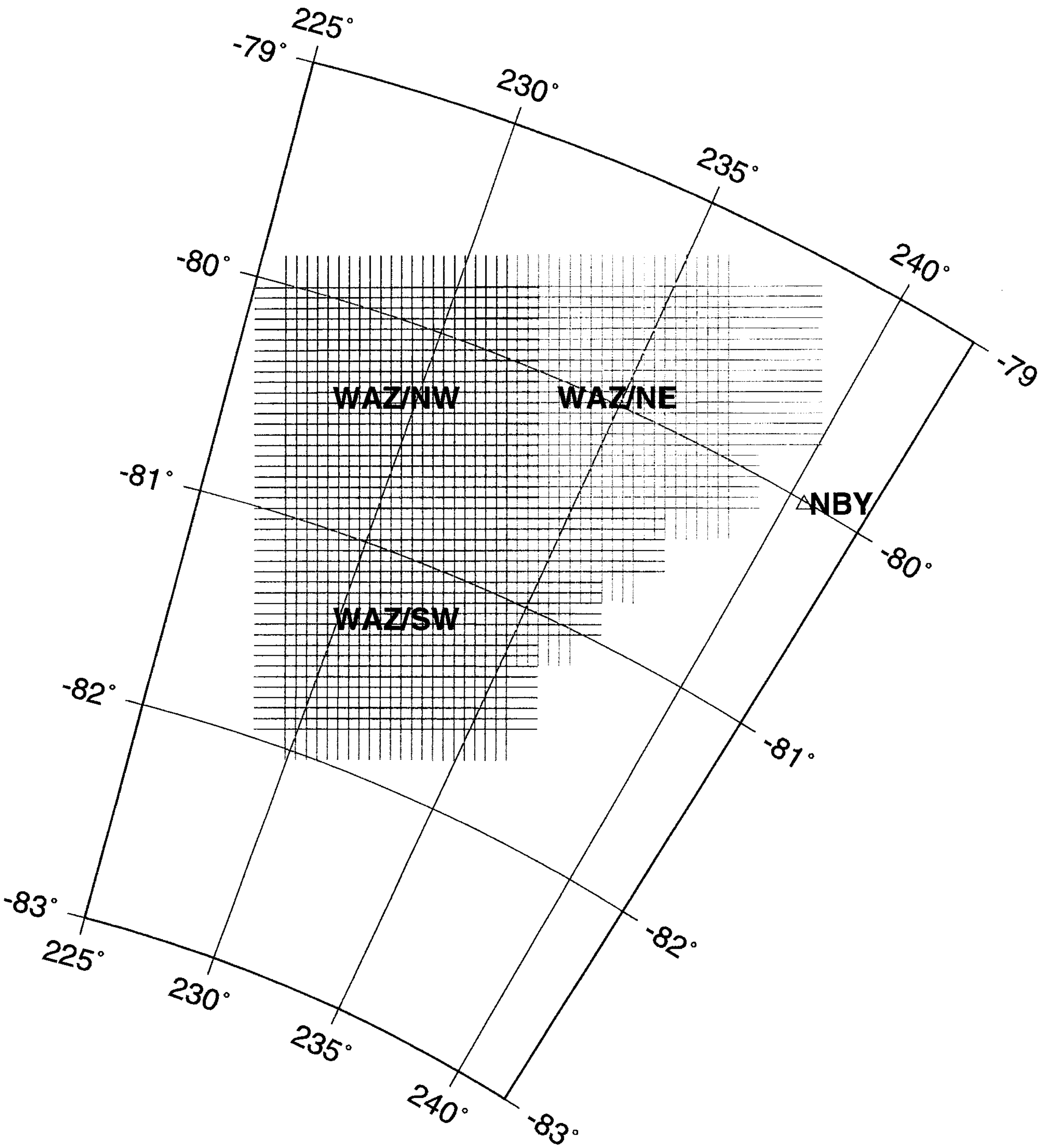


Figure 3 - SOAR survey coverage of the **WAZ** target area during 1995/96 field season. Run-ins and run-outs are shown on this figure.

All geographic goals for the 1995/96 season were accomplished and the overall data quality was excellent.

Technology

The technical goal of the facility is to prepare, configure and operate the geophysical and positioning systems aboard the survey aircraft to obtain the highest quality observations consistent with simultaneous operation of these systems. The geophysical instrument suite consists of a gravimeter, magnetometer, laser altimeter and ice-penetrating radar. The positioning suite consists of GPS receivers for navigation, GPS receivers for post-processed positioning (allowing differential carrier phase positioning), an inertial navigation system and a precision pressure altimeter. The geophysical measurements are time stamped with GPS time. Ground based instrumentation consists of base station magnetometers and GPS receivers. Ground computing facilities are utilized to download and quality check each flight's data within a few hours of landing.

Various improvements were made to the aircraft and ground systems since the 1994/95 field season. The field computer networks were upgraded through higher performance hardware and more efficient software. As a result the download, breakout and quality control (QC) processes were accelerated so that the QC products could be delivered less than two hours after a flight landed. Changes to the geophysical instruments included instrument software upgrades, calibration and tuning. The emphasis was on reliability for the longer 1995/96 season. Six test flights were required and all systems worked extremely well throughout the season.

One test flight was dedicated to testing real-time differential GPS (DGPS) in the differential mode with corrections successfully transmitted from the ground base at Byrd. Limitations in the broadcast range prevented the operational implementation of the DGPS system. The results of that flight test will be used to guide further work on DGPS for the coming year.

Logistics

The SOAR facility has large and diverse logistical requirements. In handling these, SOAR was assisted by several organizations. The major needs and assisting organizations were:

- Aircraft Support -- operation and maintenance of the Twin Otter survey aircraft. Aircraft and services were contracted by Antarctic Support Associates (ASA) from Kenn Borek Air, Ltd.

- Field Support -- provided by ASA and the Naval Support Force Antarctica (NSFA) on-site at Byrd.

- Scientific Equipment Support -- the airborne gravimeter was supplied by the Naval Oceanographic Office (NAVOCEANO) and GPS receivers supplied by the University Navigation Consortium (UNAVCO) and the National Aeronautics and Space Administration (NASA).

- Cargo Support -- provided by a variety of groups involved in the transport of SOAR equipment coordinated by Lee Degalen for the NSF at Port Hueneme, California.

To meet its aircraft support needs SOAR requires exclusive use of the specially configured Twin Otter from the beginning of instrument installation to the conclusion of flight operations. Field preparation of the aircraft required 18 days this season, including five test flights prior to regular survey flying. With the exception of one week of survey operations lost to an engine malfunction, the aircraft was reliable.

Field support consists of services provided principally for operation of the field camp. A special SOAR requirement is voice and data communication with North America. Communications were successfully established early in the season. The field camp and other field support proceeded smoothly throughout the season.

External support supplying the GPS receivers and gravimeter is required because of the expense of these instruments and the demand for their use by other research groups. UNAVCO supplied Turborogue GPS receivers. NASA supplied Ashtech GPS receivers through a loan agreement with another science project based at Byrd (S-173, Principal Investigator: R. Bindschadler). SOAR requires the two different types of GPS receivers to ensure reliability. This year one of each type was carried in the survey aircraft. The gravimeter, a Bell Aerospace BGM-3, was supplied by NAVOCEANO. There was no backup for this device due to its expense.

Because of the need to transport a complete systems integration laboratory, a computing facility and the equipment necessary to operate the survey aircraft, SOAR requires a large amount of cargo. A total of 14,842 pounds of cargo was transported to Antarctica in six shipments in addition to some items of handcarry. The shipping effort went very well this season with all items arriving as needed.

As always, the gravimeter had special requirements, including an escort. This year, as last, the gravimeter and its SOAR escort returned to North America aboard a New York Air National Guard LC-130. This arrangement went quite smoothly and the Air Guard crews were very helpful.

Personnel

The core staff of SOAR has stabilized at two directors, technical coordinator, science coordinator, research engineer, installation engineer, senior systems analyst, systems analyst and administrative assistant. All these persons were with SOAR last year. The length of SOAR appointments for the year varied between three and eleven months. This was the last year with SOAR for the technical director, Keith Najmulski. His replacement, Tom Richter, was hired in October and participated in the entire 1995/96 field season.

Prior to field deployment, three temporary workers were hired to assist in preparations. For the actual field deployment five additional persons were hired and two were supplied by the United States Geological Survey to augment the core staff in the field. These personnel included one acting director, two senior systems analysts, one systems analyst, one geophysical field technician and two geophysical field assistants.

Oversight Committee

The SOAR oversight committee was formed in 1995 and consists of:

- Robert Bindschadler (glaciologist), Goddard Space Flight Center, NASA.
- Terry Wilson (polar earth science), Department of Geology and Mineralogy, The Ohio State University.
- Terry McConnell (aerogeophysical operations), SCINTREX, Concord, Ontario.

The oversight committee met in August 1995 to advise the facility on long and short-term policies. Their primary recommendation to SOAR was to concentrate on data acquisition for the next two years but to develop data reduction and map production services in later years.

Finances

Expenditures for SOAR during its second year (May 1, 1995 to April 30, 1996) are anticipated to be $891,925. This compares to $915,000 budgeted. The difference is primarily funding allocated for the real-time differential GPS that has not yet been spent.

Future Plans

This section reviews issues and plans for SOAR in the upcoming years. Each general topic is fully described in the appendices.

Operations and Experiments

The objective for SOAR for the 1996/97 field season is to complete the surveying over the trunk of ice stream D (TKD) for the WAIS and UW projects begun in 1995/96 (Figure 1). The base camp for this will be established at Siple Dome. It is anticipated that 72 flights will be required with field operations beginning in late October and extending through early January. Thirteen to fourteen SOAR personnel and two aircrews will be required to support this work.

The SOAR facility is presently uncommitted for the field seasons after 1996/97. A workshop was convened at NSF headquarters in March 1996 for investigators wishing to submit proposals to use the SOAR facility. SOAR anticipates the submission of several science proposals for use of the facility by the June 1996 deadline.

Technology

SOAR has several technical upgrades and additional capabilities planned for next year. Upgrades are planned for the data acquisition system and laboratory computer facilities as well as for the geophysical and navigation instrumentation. These improvements include: extending the data acquisition software and hardware for better in-flight quality control; establishing a stable laboratory computer network for more efficient data distribution; completion of the DGPS implementation; and improvement of the sampling speed and depth capabilities of the radar digitizer. In addition, SOAR plans to purchase three geodetic GPS receivers for dedicated use.

Logistics

Future plans for SOAR logistics are guided by the desire to enhance existing arrangements and support new SOAR requirements. Important items planned for aircraft support are the early field arrival of the survey aircraft next season, the use of two aircrews, a plan for quick delivery of aircraft spares and the use of a high-frequency (HF) receiver aboard the Twin-Otter to receive DGPS corrections. The plans for field support include early field arrival and pull-out, ATS (or better) voice and data communications and an HF radio tower and antenna optimized and dedicated to the DGPS. For technical support the gravity meter and UNAVCO's geodetic GPS receivers will again be needed. This year the gravity meter will require retrograde to the U.S. a month earlier than was required for the last two seasons. Other cargo requirements this year should be about the same as last year.

Personnel and Finances

To support these technical improvements and the increasing commitments by SOAR for proposal planning and client services (i.e., data distribution) the amount of core personnel support needs to be increased. No present core personnel are on full-year appointments. To accomplish our objectives, full-year support has been budgeted for the science coordinator, research engineer and systems analyst. Two months of support have been added for laboratory activities of the installation engineer and one month for the director's activities in the field.

To reduce administrative costs, a software support contract is being implemented to generate quality control products and archives in the field. This will eliminate the need to hire augmented systems analysts.

Vision for the Future

Longer term technical upgrades being planned are:

1. Implement a coherent receiving capability for the present NSF/TUD ice-penetrating radar.

2. Implement the capability to provide data reduction and map production services for science clients.

Appendix A: Experiments

SOAR Annual Report

1995/96

This appendix reviews the experimental goals, plans, accomplishments, outstanding issues and future plans of the facility.

Goals:

The overall experimental goal of SOAR is to meet the scientific needs of its client science projects by providing simultaneous observations of gravity, magnetics, ice-surface topography and subglacial topography.

Presently, SOAR has two clients: WAIS (West Antarctic Ice Sheet) and the University of Wisconsin-Madison (UW). The WAIS investigators are D.D. Blankenship, R.E. Bell, J.C. Behrendt and C.A. Finn. The UW-Madison investigator is C.R. Bentley.

The WAIS investigators require aerogeophysical data in three adjacent regions of central West Antarctica (see Figure 1). The regions are:

- **BSB**: the ice divide which overlays the Byrd Subglacial Basin.
- **WAZ**: the onset of ice stream D which overlies the lithospheric "accommodation" zone between the Byrd Subglacial Basin and the Interior Ross Embayment.
- **TKD**: the trunk of ice stream D in the Interior Ross Embayment.

The UW-Madison study area is a subset of the WAZ and TKD regions. A portion of the data collected in these two regions will be used jointly by WAIS and UW-Madison.

The science objectives of these researchers requires SOAR to complete an aerogeophysical survey of a 200,000 square kilometer region using an orthogonal survey grid with a 5.3 kilometer line spacing. This work is proposed to span three field seasons.

Plans:

During the 1995/96 field season, SOAR's objective was to complete the BSB survey begun during the 1994/95 season and the entire WAZ survey.

To allow for completion of the TKD work during the 1996/97 field season, all surveying over the WAZ region had to be completed during the 1995/96 season so that the base-of-operations could be relocated to Siple Dome. This relocation is necessary because of limitations on aircraft range. Siple Dome is favorably placed to allow efficient access to the TKD survey region.

Accomplishments:

- Completion of the BSB Survey The 1994/95 field season consisted of 32 flights within the BSB area. During the first half of the 1995/96 field season, 44 flights within BSB completed the BSB portion of the WAIS project. Tables A.2 and A.3 summarize the data quality obtained for the 1995/96 portion of the BSB survey.

- Completion of WAZ The entire WAZ survey was flown from Byrd Surface Camp and completed during the 1995/96 season in 37 flights. All survey flights requiring a Byrd base were completed during the 1995/96 season. To complete the survey over the TKD region during the 1996/97 season the base of flight operations will be moved from Byrd Surface Camp to Siple Dome.

- Reflights To optimize the data quality over the BSB and WAZ regions each transect was ranked in case time for reflights was available. Ultimately seven reflights were accomplished over the highest-priority transects.

- Technical Interchange with Science Representatives A representative from UW-Madison visited the facility prior to the field season to become familiar with SOAR's technical capabilities and data acquisition scheme. During this one-week visit, Neal Lord met with the facility's technical staff for detailed exchange of information.

- Client Participation in Experiment Design WAIS and UW-Madison provided technical representatives to participate in SOAR's Experiment Design and Flight Support (EDS) group prior to deployment. The EDS group successfully merged the requirements of all of the science projects into a single integrated experiment plan. During the field season, EDS participants from both science clients monitored the experiment's progress.

- Science Observer in Field UW-Madison provided an observer in the field during the WAZ portion of data collection.

- SOAR at 1995 Spring AGU The facility was represented at the American Geophysical Union (AGU) Spring 1995 Convention in Baltimore, Maryland. SOAR occupied an exhibitor's booth for two days, displaying information from the previous year's deployment and providing an informal forum for discussion of the facility's capabilities and plans.

• Data Distribution to WAIS Investigators for 1994/95 SOAR completed distribution of data from the 1994/95 field season to the WAIS investigators. The data products provided to WAIS included raw digital data and hardcopy quality control plots. These data were distributed approximately nine months after data collection. The SOAR objective of six months was not met.

• Workshop A workshop chaired by S. Anandakrishnan was sponsored by the SOAR oversight committee at NSF headquarters on March 18 and 19, 1996. The SOAR co-directors as well as the technical and science coordinators were in attendance. The purpose of the workshop was to inform the thirty-five participants of SOAR's capabilities, to solicit input on SOAR data reduction development and to provide an environment for planning future experiments.

Issues to Address:

• Relocation of Base-of-Operations The upcoming 1996/97 field season will use Siple Dome as a base-of-operations. The science support provided at Byrd Surface Camp will have to be duplicated at Siple Dome.

• Completion of TKD (Enhanced Field Season) During the 1996/97 field season SOAR is due to complete work in the TKD area. Successful completion of this project will require up to 72 flights (assuming 66 flights with 10% reflights). These flights are best completed prior to January 1, 1997 due to late season fog conditions in this region.

• Data Distribution SOAR must distribute data to the WAIS and UW-Madison projects in a timely fashion during the spring of 1996. Data for both WAIS and UW-Madison was collected during the 1995/96 field season. Distribution of data products for the two science projects is targeted for six months after the end of field operations.

• Communication of Facility Capabilities to the Polar Community The facility support of the WAIS and UW-Madison projects concludes after the 1996/97 field season. SOAR must assist in proposal preparation for science projects to cover the remaining years of the Cooperative Agreement.

• Data Reduction The long-term plan for the facility is to provide reduced data products to science projects. Data products are to include transect and map products, in addition to the raw data product presently provided. Production of these reduced products will require increased resources within the facility, including both computer resources and personnel.

Future Targets:

- The TKD survey work will be conducted during the 1996/97 field season from a Siple Dome base-of-operations.

- SOAR plans on conducting an enhanced 72-flight field season during the 1996/97 austral summer. Beginning with an October 27, 1996 put-in to Siple Dome, four and one-half weeks will be required for setup and testing, including an estimated eight days for testing of an upgraded DSU and real-time differential GPS. Aircraft delivery to the field site is targeted to occur on November 6, 1996. Three survey flights per day will be conducted over an approximately 32 day period beginning November 29, 1996 and concluding on December 31, 1996. This survey period takes into account approximately one-third bad-weather days and one day off for the Christmas holiday. Take-down and packing will occur over a one week period, ending with pull-out on January 8, 1997. Thirteen to fourteen SOAR personnel and two flight crews will be required to support this work.

- SOAR will target distribution of the data collected during the 1995/96 season by August 1, 1996. A distribution of the raw archival data is targeted for an earlier delivery date of June 1, 1996.

- SOAR will communicate its capabilities to the polar community and will assist in proposal preparation by potential science clients. Beginning at the workshop held at NSF Headquarters in March, 1996, SOAR began cultivating interest within the community for use of the facility during the 1997/98 and 1998/99 seasons.

- Future users of the facility desire data products in a form beyond the currently distributed raw product. SOAR needs to prepare to produce these reduced data products. Costs for these products will be negotiated with NSF.

Table A.1
Flight Operations Summary

Flight Number	Date (NZDT)	Start Time (NZDT)	Duration (h:mm)	Flight Lines*	Comments
T01	25 Nov 95	08:54	0:23	-	Antenna Test Flight
T02	29 Nov 95	09:00	3:20	-	Radar Test Flight
T03	7 Dec 95	14:08	2:02	-	Full Test
T04	9 Dec 95	14:42	3:53	-	Full Test (S-173 Recon.)
T05	10 Dec 95	15:18	3:28	-	Full Test (Volcano Reflight)
F01	11 Dec 95	14:05	3:16	4/4	Start BSB
F02	12 Dec 95	01:07	3:39	4/4	
F03	13 Dec 95	01:12	3:58	4/4	
F04	13 Dec 95	07:39	3:48	4/4	
F05	13 Dec 95	14:05	4:02	4/4	
F06	14 Dec 95	01:23	3:41	4/4	
F07	14 Dec 95	14:26	3:19	5/4	No Autopilot, One Generator
F08	15 Dec 95	07:54	3:58	5/5	
F09	15 Dec 95	14:01	2:52	4/4	
F10	16 Dec 95	01:38	3:44	4/3	Weather/Icing
F11	16 Dec 95	14:05	4:14	5/5	
F12	17 Dec 95	01:11	4:01	5/5	
F13	17 Dec 95	14:04	3:26	4/4	
F14	18 Dec 95	01:14	3:25	4/4	
F15	18 Dec 95	13:59	3:49	5/4	
F16	19 Dec 95	14:01	4:09	4/4	
F17	20 Dec 95	01:16	4:14	5/5	
F18	20 Dec 95	14:03	4:08	5/4	
F19	21 Dec 95	01:17	3:49	5/3	
F20	21 Dec 95	07:45	4:35	5/5	
F21	21 Dec 95	14:02	4:00	5/5	
F22	22 Dec 95	01:26	3:51	5/5	
F23	22 Dec 95	13:59	3:46	4/3	
F24	23 Dec 95	01:05	4:16	5/5	
F25	23 Dec 95	08:09	4:15	5/5	
F26	23 Dec 95	14:11	3:53	3/3	
F27	24 Dec 95	01:07	3:51	4/3	
F28	24 Dec 95	07:37	4:05	4/4	
F29	26 Dec 95	07:45	3:40	3/3	
F30	26 Dec 95	14:03	3:46	5/4	Weather/Icing

Note: Flight Lines are shown as number planned/number flown.

Table A.1
Flight Operations Summary, Continued

Flight Number	Date (NZDT)	Start Time (NZDT)	Duration (h:mm)	Flight Lines*	Comments
F31	27 Dec 95	01:15	4:00	5/4	
F32	27 Dec 95	07:45	3:19	5/4	
F33	27 Dec 95	14:00	4:06	5/4	
F34	28 Dec 95	01:00	4:00	4/4	
F35	28 Dec 95	07:48	4:13	5/5	
F36	28 Dec 95	14:05	4:16	5/4	
F37	29 Dec 95	01:38	3:54	4/4	
F38	29 Dec 95	07:41	1:15	5/0	DSU Problems
F39	29 Dec 95	14:03	3:52	4/4	
F40	30 Dec 95	01:25	3:27	4/4	
F41	30 Dec 95	07:35	4:24	5/5	
F42	30 Dec 95	14:02	3:16	4/4	
F43	31 Dec 95	01:14	3:58	4/4	
F44	31 Dec 95	07:55	4:06	5/4	Finish BSB
F45	2 Jan 96	08:57	3:43	5/5	BSB Reflight
F46	2 Jan 96	14:13	2:48	4/4	BSB Reflight
F47	3 Jan 96	01:27	4:20	4/5	Start WAZ
F48	3 Jan 96	14:00	4:01	5/4	
F49	4 Jan 96	08:03	4:14	5/5	
F50	4 Jan 96	13:59	3:47	4/4	
F51	5 Jan 96	01:04	3:53	4/4	
F52	5 Jan 96	13:58	4:17	4/3	
F53	6 Jan 96	01:09	3:57	4/4	
F54	6 Jan 96	13:59	3:35	4/4	
F55	7 Jan 96	01:07	3:45	4/4	
F56	7 Jan 96	14:01	3:24	3/3	
F57	8 Jan 96	01:08	3:39	3/3	
	9 Jan 96				Aircraft Inoperable
	10 Jan 96				Aircraft Inoperable
	11 Jan 96				Aircraft Inoperable
	12 Jan 96				Aircraft Inoperable
	13 Jan 96				Aircraft Inoperable
	14 Jan 96				Aircraft Inoperable
F58	15 Jan 96	07:37	4:18	3/3	
F59	15 Jan 96	13:59	4:11	4/4	
F60	16 Jan 96	01:06	4:14	4/4	

Note: Flight Lines are shown as number planned/number flown.

Table A.1
Flight Operations Summary, Continued

Flight Number	Date (NZDT)	Start Time (NZDT)	Duration (h:mm)	Flight Lines*	Comments
F61	16 Jan 96	07:48	3:12	3/3	
F62	16 Jan 96	14:00	3:57	4/4	
F63	17 Jan 96	01:08	3:44	4/4	
F64	17 Jan 96	07:31	4:12	4/4	
F65	17 Jan 96	13:55	4:25	4/4	
F66	18 Jan 96	01:04	4:10	4/4	
F67	18 Jan 96	07:42	4:04	3/3	
F68	18 Jan 96	14:08	4:20	4/4	
F69	19 Jan 96	01:25	3:40	3/3	
F70	19 Jan 96	07:43	3:48	3/3	
F71	19 Jan 96	14:12	4:05	4/4	
F72	20 Jan 96	01:09	3:36	3/3	
F73	20 Jan 96	07:46	3:59	4/4	
F74	20 Jan 96	13:31	2:52	4/2	Poor Byrd Weather
F75	21 Jan 96	01:39	4:08	4/4	
F76	21 Jan 96	07:34	4:07	4/4	
F77	21 Jan 96	13:26	4:10	3/3	
F78	22 Jan 96	01:45	3:50	4/4	
F79	22 Jan 96	07.47	3:58	4/4	
F80	22 Jan 96	13:36	3:52	3/3	
F81	23 Jan 96	01:40	3:53	4/4	
F82	23 Jan 96	07:36	3:57	4/4	
F83	23 Jan 96	13:35	3:51	3/3	Finish WAZ
F84	24 Jan 96	01:40	3:45	4/4	BSB Reflight
F85	24 Jan 96	07:53	3:43	5/5	BSB Reflight
F86	24 Jan 96	13:32	3:59	4/4	WAZ Reflight
F87	25 Jan 96	01:44	3:39	4/4	BSB Reflight
F88	25 Jan 96	07:35	4:32	5/5	BSB Reflight
T06	26 Jan 96	14:22	1:30	-	DGPS Flight Test

Note: Flight Lines are shown as number planned/number flown.

Table A.2a - Data Quality Summary, Geophysical Systems
(1995/96 SOAR field season; BSB target)

	Gravity								Magnetics							
	N		C	WC		W			N		C	WC		W		
Line #	x	y	y	x	y	x	(x)	y	x	y	y	x	y	x	(x)	y
1				G	G	G	E	E				G	E	E	E	E
2	G	G	G	E	G	E	G	E	E	E	E	E	G	E	E	E
3			E	E	E	G	G	G			E	E	E	E	E	E
4		G		G	G	G	E	E		E		E	E	E	E	E
5	E	G	G	G	G	G	G	E	G	E	E	E	G	E	E	E
6			G	G	E	E	E	G			E	E	E	E	E	E
7	G		E	G	E	G	E	G	G		E	E	E	E	E	E
8	G	G	X	G	E	E	G	G	E	E	E	E	G	E	E	E
9			E	G	E	G	G	G			E	E	E	E	E	E
10	G		E	G	G	G	G	G	G		E	E	E	E	E	G
11	E	G		E	G	G	G	G	E	E		E	E	G	E	E
12		G	E	E	G	G	G	G		E	E	E	E	E	E	G
13		G	E	G	G	G	E	G		E	E	E	E	E	E	G
14	G	G		E	E	G	G	G	E	E		E	E	E	E	E
15				G	E	G	G	G				E	E	E	E	E
16	G	G	E	G	G	G	G	G	E	E	E	E	E	E	E	E
17		G		E	G	G	G	G		E		E	G	E	G	E
18				G	E	G	G	G				E	E	E	E	E
19		G		G	G	E	G	G		E		E	E	E	E	G
20		G		E	G	G	E	E		E		E	E	E	E	E
21		G		G	E	G	G	E		E		E	E	E	E	G
22		G		G	E	G	-	E		E		E	E	E	-	G

	Ice-Penetrating Radar								Laser Altimeter							
	N		C	WC		W			N		C	WC		W		
Line #	x	y	y	x	y	x	(x)	y	x	y	y	x	y	x	(x)	y
1				E	E	G	G	E				E	E	E	E	E
2	G	G	E	G	E	G	G	E	E	E	E	G	E	E	E	E
3			E	E	E	G	G	E			E	E	E	E	E	E
4		G		E	E	G	E	E		E		E	E	E	E	E
5	G	E	G	E	E	G	E	E	E	E	G	G	E	E	E	E
6			E	E	E	G	E	E			E	E	E	E	E	G
7	E		E	E	E	G	E	E	E		G	E	E	E	E	E
8	E	E	G	E	E	G	E	E	E	E	X	E	E	E	E	E
9			E	E	E	G	E	E			E	E	E	E	E	E
10	G		E	E	E	G	E	E	E		G	E	E	E	E	E
11	G	G		E	E	G	E	E	E	E		E	G	E	E	E
12		E	G	E	E	E	E	E		E	E	E	E	E	E	E
13		G	G	E	E	G	E	E		E	E	E	E	E	E	E
14	E	E		E	E	G	E	E	E	G		E	E	E	E	E
15				E	E	G	E	G				E	E	E	E	E
16	G	E	G	G	E	G	E	E		E	E	E	E	E	E	E
17		E		G	E	G	E	G		G		E	E	E	E	E
18				G	E	G	E	G				E	E	E	E	E
19		E		G	E	G	E	G		E		G	E	E	G	E
20		E		E	E	G	E	G		E		E	G	E	E	E
21		E		G	E	E	E	G		E		E	E	E	E	E
22		E		E	E	E	-	G		E		E	G	E	-	E

Note: E - excellent, G - good, X - bad; (blank) - flown in 1994/95
Ny, Cx, WCx, WCy and Wx are approximately 143 line-km.
Nx, Cy and Wy are approximately 254 line-km
(x) = Summary for Wx/X23-Wx/X43 (Line # + 22)

Table A.2b - Data Quality Summary, Geophysical Systems (1995/96 SOAR field season; WAZ target)

	Gravity						Magnetics					
	NE		NW		SW		NE		NW		SW	
Line #	x	y	x	y	x	y	x	y	x	y	x	y
1	G	G	G	G	E	E	E	E	E	E	E	E
2	E	G	E	E	E	G	E	E	E	E	E	E
3	E	G	E	G	E	E	E	E	E	E	E	E
4	E	G	G	G	G	G	E	E	E	E	E	E
5	G	E	E	E	E	G	E	E	E	E	E	E
6	E	E	G	E	E	G	E	E	E	E	E	E
7	E	G	E	G	G	E	E	E	E	E	E	E
8	E	G	E	E	G	E	E	E	E	E	E	E
9	E	G	G	E	E	E	E	E	E	E	E	E
10	G	E	X	G	E	G	E	E	E	E	E	E
11	E	E	E	G	G	E	E	E	E	E	E	E
12	E	G	E	G	E	E	E	E	E	E	E	E
13	G	E	G	E	E	G	E	E	E	E	E	E
14	E	E	G	G	E	E	E	E	E	E	E	E
15	E	E	G	G	G	G	E	E	E	E	E	E
16	E	E	G	G	E	G	E	E	E	E	E	E
17	G	E	G	G	G	G	E	E	E	E	E	E
18	G	G	E	E	G	E	E	E	E	E	E	E
19	G	E	G	E	G	E	E	E	E	E	E	E
20	G	E	E	E	G	G	E	E	E	E	E	E
21	X	E	E	E	G	E	E	E	E	E	E	E
22	G	E	E	G	G	G	E	E	E	G	E	E

	Ice-Penetrating Radar						Laser Altimeter					
	NE		NW		SW		NE		NW		SW	
Line #	x	y	x	y	x	y	x	y	x	y	x	y
1	G	G	G	E	E	E	E	E	G	E	E	E
2	E	G	E	E	E	E	E	E	G	E	E	G
3	E	G	G	E	E	E	G	E	E	E	G	E
4	E	E	G	E	E	E	E	E	G	E	E	E
5	E	G	E	E	E	E	E	E	G	E	E	E
6	E	G	E	E	E	E	E	E	E	G	E	E
7	E	E	E	E	E	E	E	E	G	E	E	E
8	E	E	E	E	E	E	E	E	G	E	E	E
9	E	E	E	E	E	E	E	E	E	G	G	E
10	E	E	E	E	E	G	E	G	G	X	E	E
11	E	E	E	E	E	E	E	E	G	E	E	E
12	E	E	E	E	G	E	E	E	E	E	E	E
13	E	E	G	E	E	E	E	E	E	E	E	E
14	E	E	E	E	E	G	E	E	E	E	G	E
15	E	E	E	E	E	E	E	E	E	E	E	E
16	E	E	E	E	G	E	E	E	E	E	E	E
17	E	E	E	E	G	E	E	E	E	E	E	E
18	E	E	E	E	G	E	E	E	E	E	E	E
19	E	E	G	E	E	E	E	E	E	E	E	E
20	E	E	G	E	E	E	E	E	E	E	E	E
21	E	E	E	E	E	E	E	E	E	E	E	E
22	E	E	E	E	G	E	E	E	E	G	E	E

Note: E - excellent, G - good, X -bad
All NE, NW and SW lines are approximately 143 line-km.

Table A.3a - Data Quality Summary, Positioning Systems
(1995/96 SOAR field season; BSB target)

	Geodetic GPS								Inertial Navigation							
	N		C	WC		W			N		C	WC		W		
Line #	x	y	y	x	y	x	(x)	y	x	y	y	x	y	x	(x)	y
1				E	E	G	G	E				E	E	E	E	E
2	G	G	E	G	E	G	G	E	G	E	E	E	E	E	E	E
3			E	E	E	G	G	E			G	E	E	E	E	E
4		G		E	E	G	E	E		E		E	E	E	E	E
5	G	E	G	E	E	G	E	E	G	E	E	E	E	E	E	G
6			E	E	E	G	E	E			G	E	E	E	E	G
7	E		E	E	E	G	E	G	G		E	E	E	E	E	E
8	G	G	G	E	E	G	E	E	G	E	E	E	E	E	E	E
9			E	E	E	G	E	E			E	E	E	E	E	E
10	G		E	E	E	G	E	E	G		E	E	E	E	E	E
11	G	G		E	E	G	E	E	G	E		E	E	G	E	E
12		E	E	E	E	E	E	E		E	E	E	E	E	E	E
13		G	E	E	E	G	E	E		G	G	E	E	E	E	E
14	E	E		E	E	G	E	E	G	E		E	E	E	E	E
15				E	E	G	E	G				E	E	E	E	G
16	G	E	E	G	E	G	E	E	G	G	G	E	E	E	E	E
17		E		G	E	G	E	G		E		E	E	E	E	E
18				G	E	G	E	G				E	E	E	E	E
19		E		G	E	G	E	G		G		E	E	E	E	E
20		E		E	E	G	E	G		E		E	E	E	G	E
21		E		G	E	E	E	G		E		E	E	E	G	E
22		E		E	E	E	-	G		G		E	E	E	-	E

	Pressure Altimetry								Weather							
	N		C	WC		W			N		C	WC		W		
Line #	x	y	y	x	y	x	(x)	y	x	y	y	x	y	x	(x)	y
1				E	E	E	E	E				G	E	E	E	E
2	E	E	E	E	E	E	E	E	G	E	E	G	E	E	E	E
3			E	E	E	E	E	E			E	E	E	E	E	E
4	E			E	E	E	E	E		E		E	E	E	E	E
5	E	E	E	E	E	E	E	E	G	G	G	G	E	E	E	E
6			E	E	E	E	E	E			G	E	E	E	E	G
7		E	E	E	E	E	E	E	E		G	E	E	E	E	E
8	E	E	E	E	E	E	E	E	G	E	G	G	G	E	E	E
9			E	E	E	E	E	E			G	E	E	E	E	E
10		E	E	E	E	E	E	E	E		G	E	E	E	E	E
11	E	E		E	E	E	E	E	E	G		G	X	E	E	E
12	E		E	E	E	E	E	E		G	E	E	E	E	E	E
13	E		E	E	E	E	E	E		G	E	E	E	E	E	E
14	E	E		E	E	E	E	E	G	G		E	G	E	E	E
15				E	E	E	E	E				E	G	E	E	G
16	E		E	E	E	E	E	G	E	E	E	G	E	G	E	E
17	E			E	E	E	E	E		G		E	G	E	G	E
18				E	E	E	E	E				E	G	E	G	E
19	E			E	E	E	E	E		G		G	E	E	G	E
20	E			E	E	E	E	E		G		E	G	E	E	E
21	E			E	E	E	E	E		E		E	G	E	E	E
22	E			E	E	E	-	E		G		G	G	E	-	E

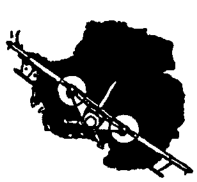
Note: E - excellent, G - good, X - bad; (blank) - flown in 1994/95
Ny, Cx, WCx, WCy and Wx are approximately 143 line-km.
Nx, Cy and Wy are approximately 254 line-km
(x) = Summary for Wx/X23-Wx/X43 (Line #+ 22)

Table A.3b - Data Quality Summary, Positioning Systems (1995/96 SOAR field season; WAZ target)

	Geodetic GPS						Inertial Navigation					
	NE		NW		SW		NE		NW		SW	
Line #	x	y	x	y	x	y	x	y	x	y	x	y
1	E	E	E	E	E	G	E	G	E	E	E	E
2	E	E	E	G	E	E	E	E	E	E	E	E
3	E	E	G	E	E	G	E	E	E	E	E	E
4	E	E	E	E	E	G	E	E	E	E	E	E
5	E	E	E	E	E	E	E	E	E	E	E	E
6	E	E	G	E	E	G	E	E	E	E	E	E
7	E	E	E	E	E	E	G	E	E	E	E	E
8	E	E	E	E	E	E	E	E	E	E	E	E
9	E	E	G	E	E	E	E	E	E	E	E	E
10	E	E	E	G	E	E	E	E	E	E	E	E
11	E	E	E	X	E	E	E	E	E	E	E	E
12	E	E	E	E	E	G	E	E	E	E	E	E
13	E	E	E	E	E	E	E	E	E	E	E	E
14	E	E	E	X	E	E	E	E	E	E	E	E
15	E	E	E	E	E	G	E	E	E	E	E	E
16	E	E	E	E	E	E	E	E	E	E	E	E
17	G	E	E	E	G	E	E	E	E	G	E	E
18	E	E	E	E	G	G	E	E	E	E	E	E
19	E	E	E	E	E	E	E	E	E	E	E	E
20	G	E	E	G	G	E	E	E	E	E	E	E
21	E	E	E	G	G	G	E	E	E	E	E	E
22	E	E	G	E	E	E	E	E	E	G	E	E

	Pressure Altimetry						Weather					
	NE		NW		SW		NE		NW		SW	
Line #	x	y	x	y	x	y	x	y	x	y	x	y
1	E	E	E	E	E	E	E	E	G	E	E	G
2	E	E	E	E	E	E	E	E	G	G	E	G
3	E	E	E	E	E	E	E	E	E	E	G	E
4	E	E	E	E	E	E	E	G	G	E	E	G
5	E	E	E	E	E	E	E	E	G	E	E	E
6	E	E	E	E	E	E	G	E	E	G	G	E
7	E	E	E	E	E	E	E	E	G	E	E	E
8	E	E	E	E	E	E	E	E	G	E	E	E
9	E	E	E	E	E	E	G	E	E	G	G	E
10	E	E	E	E	E	E	E	G	G	G	E	E
11	E	E	E	E	E	E	E	E	G	E	E	E
12	E	E	E	E	E	E	G	E	G	E	E	E
13	E	E	E	E	E	E	E	G	E	E	G	E
14	E	E	E	E	E	E	G	E	E	E	G	E
15	E	E	E	E	E	E	E	E	E	G	E	E
16	E	E	E	E	E	E	E	E	E	E	E	G
17	E	E	E	E	E	E	E	E	E	E	E	E
18	E	E	E	E	E	E	E	E	E	G	E	E
19	E	E	E	E	E	E	E	E	E	E	G	G
20	E	E	E	E	E	E	E	E	E	E	E	G
21	E	E	E	E	E	E	E	E	E	E	E	E
22	E	E	E	G	E	E	E	E	G	E	G	G

Note: E - excellent, G - good, X - bad
All NE, NW and SW lines are approximately 143 line-km.



Appendix B: Technology

SOAR Annual Report

1995/96

This appendix focuses on the facility's technical goals, plans, accomplishments, outstanding issues and future targets.

Goals:

The SOAR technical goal is to prepare, configure and operate the geophysical and positioning systems aboard the survey aircraft to obtain the highest quality observations consistent with simultaneous operation of these systems. The geophysical observations are gravity, magnetics, laser altimetry and ice-penetrating radar sounding. The positioning observations are GPS (including post-processed differential pseudorange and carrier-phase positioning), precision pressure altimetry and inertial navigation.

Plans:

The technical plan for the second year of facility operations included completion of unfinished components from the first year and some new ones. These components included the following efforts.

- Implementation of a field computing facility and associated software systems capable of:
    - Downloading data from a survey flight within 1.5 hours,
    - Performing quality control for each geophysical and positioning system for a flight in less than four hours, and
    - Archiving digital field notes, quality control products and data at all processing levels in a well defined hierarchy on a variety of media.

- Improvements to the computing facility were planned for year two. Major targets were to upgrade the workstations and peripherals for the field data reduction network and to add portable computers to the office network.

- Repair and refurbishment of the ice-penetrating radar, its digitizer unit and aircraft racking systems. The year two plan included upgrading the digitizer stacking unit (DSU) to digitize and stack all 12,000 sweeps generated each second by the NSF/TUD radar system. The other major refurbishment item was to obtain time and frequency domain test equipment for the 1995/96 field-season preparation.

- Complete the implementation of an accurate and reliable real-time differential GPS (DGPS) navigation system for the survey aircraft. Specifically required to finish this system were acquisition of the ground-based radio transmitter and implementation of the transceiver portion of the DGPS navigation system for the 1995/96 field season.

• Implement in-flight data monitoring software for the data acquisition system and add computers to the airborne laptop network.

Accomplishments:

Computer Facilities

Improvements to the computing facilities prior to and during the 1995/96 field season allowed the download, breakout and archiving of survey data to be more efficient. Production of quality control products was also enhanced. Highlights of the computer facility upgrades included:

• Workstation Upgrades. The field quality control and archiving network was upgraded to SPARC 5 machines this year. This upgrade, replacing SPARC 2 machines, was accomplished through a new purchase and rentals. The increase in computing capability was most evident in the production of radar quality control products in the field.

• Enhanced On-line Storage Capability. The overall data storage capacity was enhanced by the acquisition of larger hard drives and an automated tape stacking unit. The increase in on-line storage allowed more efficient use of network resources. The automated stacker allowed unattended data archival overnight, optimizing use of the limited personnel resources in the field.

• Increased Spares. A more complete suite of computer spares was assembled prior to deployment. This consisted of spare internal hard disks, power supplies and interface cards.

• Network Administration. An increase in network efficiency allowed the turn-around time of quality control products to be reduced. By fine-tuning several steps in the download, breakout and quality control software subsystems the time period from the end of a survey flight to delivery of the final quality control product was reduced from four hours to less than two hours.

• Other Computer Enhancements. Two additional portable computers were added to the field office network. This increased access to the network and was needed for experiment planning and logistics database applications.

The GPS data download procedures from the aircraft were changed this season. High-capacity removable media was used to replace the earlier ethernet link. This reduced offload time to a fraction of that required for the link.

Data Acquisition System.

A real-time display of geophysical data during acquisition was added for each operator station in the aircraft.

A second GPS time receiver and a software upgrade for the existing receiver were obtained. The software upgrade allowed the receiver to operate in dynamic mode providing improved timing during flight operations. This capability was demonstrated with the new receiver prior to deployment to the field.

Real-Time Differential GPS.

An HF transceiver was obtained to transmit differential corrections from the base to the aircraft. This capability was demonstrated in the field.

The software in the navigation DGPS was upgraded to include the capability to navigate based on a Lambert Conformal grid projection. This projection was used in the second half of the season for the WAZ area of operations.

The serial data stream from the DGPS was added to the raw data recorded, the inflight data displays and the quality control plots produced for each flight.

Test Flight 6 was dedicated to testing the DGPS system in real-time differential mode. An Ashtech GPS receiver at the Byrd base generated differential corrections which were transmitted on the HF frequency of 3.0 Mhz. The corrections were received aboard the aircraft. The experiment was successful as the differential corrections were received and decoded by the aircraft DGPS unit. Two aspects of the overall system performance remain unsatisfactory. The range at which corrections are received is inadequate and a tracking problem in the DGPS limits its accuracy to about 50 meters.

Repair/Refurbishment

A set of dual frequency aircraft GPS antennas were obtained for use aboard the Twin Otter. Last year ground survey antennas had to be modified for use on the aircraft. The aircraft style antennas are smaller, lighter, more rugged and require less setup time than the ground antennas for this aircraft installation.

Independently powered GPS antenna splitters were obtained. Normally a GPS receiver will power its own antenna and different types of receivers often use different voltages. By using antenna splitters with an independent power source, multiple types of GPS receivers can be attached to one antenna. This year SOAR had four different types of GPS receivers onboard the aircraft attached to either of two antennas.

The magnetometer sensors and laser altimeters were returned to their respective factories for calibration and refurbishment. This increased the accuracy and signal to noise ratio of both instruments.

A function generator and time-domain reflectometer were acquired to test the radar receiver and cables both before and after installation aboard the aircraft. Since the radar splits its outgoing and incoming power into two antennas it is crucial to measure and match the cables and antennas when the system is installed in the aircraft. The major antenna cables are removed from the Twin-Otter after each field season and must be reinstalled each year.

Issues To Address:

To achieve future experimental objectives the following technical issues need to be addressed:

- *Data Acquisition System.* The largest unimplemented feature of the data acquisition system is the in-flight quality control software. This improvement will allow equipment malfunctions to be recognized sooner.

- *Computer Facilities.* More workstations are required for data distribution and data reduction in the laboratory.

    In order to provide quick data distribution services and begin developing a data reduction capability, a network of computers dedicated to these tasks and not taken to the field is necessary.

    It was difficult and time consuming to find and hire personnel to provide quality control and archival products in the field. This recruitment effort interfered with the technical upgrades to the SOAR systems. A multi-year subcontract for these services would avoid inefficiency of the hiring and training of short-term systems analysts.

- *Real-Time Differential GPS.* The DGPS system tested in the field during the 1995/96 season is not yet suitable for long-range precise aircraft navigation. Further development and testing will be required.

  The range problem requires better antenna installations on both the aircraft and base station as well as an increase in the transmitted power. A vertically polarized antenna which directs its energy horizontally and at least two kilowatts of output power for the base transmitter will be needed. An item to be investigated is whether an existing HF radio aboard the survey aircraft can be used to receive the DGPS correction data.

  The DGPS exhibited a tracking problem on most flights this season. The system would not guide steadily, exhibiting an oscillatory guidance with a range of 30 to 100 meters and a period of 10 to 15 seconds. This problem will have to be resolved in consultation with the manufacturer.

- *Repair/Refurbishment.* The current DSU does not capture every sweep of the ice-penetrating radar. Currently only every other sweep is recorded. Also the current DSU does not have sufficient memory depth to record the entire return echo of the radar when maximum time resolution data is acquired. To improve the quality of data recorded from the radar the DSU must be upgraded.

- *Geodetic GPS Receivers.* SOAR currently does not own any Ashtech geodetic GPS receivers. SOAR needs to obtain three to reduce reliance on loaned receivers (see Logistics/Technical Support appendix).

- *Coherent Radar.* In order to meet developing needs of the research community the ice-penetrating radar should have a coherent detection and stacking capability. The current radar and DSU do not support coherent detection but can be appropriately modified. Planning will have to be initiated in order to implement it within the next few years. This project is estimated to require 1.5 years from start to completion including time in Antarctica for testing with a cost of about $250,000. This effort should start in the spring of 1997 for field testing in the 1998/99 field season. The initial funding will be requested next year.

Future Plans

The future technical plans for SOAR are to:

1. Extend acquisition software and hardware for better inflight quality control.
2. Establish a stable laboratory computing network.
3. Complete the implementation of an effective real-time DGPS capability.
4. Improve the sampling speed and depth of the radar digitizer.

On a longer schedule than the projects listed above is to implement a coherent detection capability for the NSF/TUD radar.

Appendix C: Logistics

SOAR Annual Report

1995/96

This appendix details the logistical support aspects of the facility's 1995/96 field season. It is divided into the following sections:

I. Aircraft Support - facility interactions with the aircraft contractor Kenn Borek Air, Ltd.

II. Field Support - facility interactions with Antarctic Support Associates (ASA) and the Naval Support Force Antarctica (NSFA).

III. Technical Support - facility interactions with organizations directly providing equipment and service to SOAR, specifically, the University Navigation Consortium (UNAVCO), the Naval Oceanographic Office (NAVOCEANO) and the National Aeronautics and Space Administration (NASA).

IV. Cargo Support - facility interactions with NSF and ASA cargo systems.

I. Aircraft Support

The Twin Otter survey aircraft, flight crew and maintenance support in the field were provided by Kenn Borek Air, Ltd. of Calgary, Canada. This section discusses the facility's goals, plans, accomplishments, issues to be addressed and future targets as they pertain to the interactions with this contractor and the survey aircraft.

Goals:

SOAR's principle aircraft support goal is to receive the survey aircraft from the contractor, optimized to SOAR's specifications for use as an aerogeophysical platform, and after configuration and testing by SOAR personnel, operate it reliably in the field during the survey period.

Plans:

To meet its aircraft support goals for the 1995/96 field season the following activities were planned:

- Replacement of the strut system for the NSF/TUD radar antennas,
- Implementation of a permanent radar cable installation for the survey aircraft,
- Obtaining on-site spares of the critical contractor-supplied systems and implementation of a plan for quick delivery of a replacement inertial navigation system,
- Utilizing a flight crew of three and four to five instrument operators to complete an 80 flight season with the survey aircraft on-site from mid-November through early January,
- Scheduling the aircraft to be delivered to the SOAR field site directly from Calgary, and
- Pre-deployment visit to Calgary by the Technical Coordinator and Research Engineer to verify SOAR specifications including fabrications and aircraft modifications.

Accomplishments:

This section focuses on the aircraft support accomplishments during the second year of the facility operations.

- The NSF/TUD strut system was refurbished by Ken Borek Air, Ltd. The relaminated struts were installed on the aircraft in the field and performed satisfactorily.

- Prior to deployment, two SOAR personnel made a two-day Calgary visit beginning on October 11, 1995. This visit focused on the installation of signal cables in the wings for the ice-penetrating radar. Installation of these cables while the aircraft was still at the contractor's site was an improvement over previous cable installation in McMurdo. While at the contractor's facility confirmation and testing of contractor-supplied devices and other cabling was also performed.

- The aircraft arrived at Byrd on November 17, 1995. The aircraft configuration and testing (including five test flights) were completed in 18 days. This year the configuration/test phase took less time than last year (21 days last year including three test flights).

- Two full flight crews were provided in the field to support flight operations. Flight operations began on December 11, 1995 and continued until January 26, 1996. Double flight crews and good weather allowed virtually around-the-clock survey operations. Eighty-eight survey flights were completed in 339 hours of flight operations (Table A.1).

- The aircraft autopilot malfunctioned early in the season and required several flights to be repaired and properly tuned.

- During a one week period the aircraft was inoperable due to a failure of an engine fuel control unit. The major source of the delay was obtaining parts for the repair. This down-period occurred during the survey flight operations. This maintenance delay had the potential to prevent the survey target from being met. However, very favorable weather and an increased flight rate allowed the survey target to be completed.

- During the survey flights, contractor-supplied instrumentation critical to data collection experienced intermittent failures. These systems were the DAI (Data Acquisition Interface) and the autopilot. Failure of the DAI renders the laser measurements useless and an outage of the autopilot seriously compromises the gravity system.

Issues To Address:

- The possibility of prolonged aircraft inavailability due to mechanical failures must be reduced. A contractor plan must be in place for dealing with such occurrences.

- No plan for a replacement inertial navigation system is in place. On-site spares for the DAI and the autopilot and arrangements for quick delivery of a replacement inertial navigation unit must be developed.

- This season the survey aircraft was used for open-field applications prior to use as a survey aircraft. This reduces the amount of configuration that can be performed in North America and increases both the configuration and testing required in the field, ultimately delaying flight operations. Dedication of the aircraft to SOAR at the start of the field season would alleviate this delay. The relatively early start of the upcoming field season will also necessitate direct delivery of the aircraft to the field site.

- A set of spare radar antennas needs to be obtained. Presently the radar antennas have no backup in case of damage. A second set of antennas exists, but their mounts need to be modified for compatibility with the present strut system.

- The capability to receive HF transmissions of the DGPS correction data needs to be incorporated into the survey aircraft.

Future Targets:

To address the outstanding issues detailed above, a number of aircraft-support targets have been developed for the next field season. They are:

- Obtaining on-site spares of the critical contractor supplied systems and implementing a plan for a quick delivery of replacement aircraft parts (See Table C.1, Equipment Supplied by Kenn Borek Air, Ltd.). Of special interest are available spares for the DAI and INS.

- Modification of a second set of radar antennas for use on the existing Twin Otter platform. These antennas currently exist at the facility, but require modification to their mountings for use with the current mounting system aboard the Twin Otter.

- Two flight crews (four pilots) must be on-hand to support SOAR survey flights, along with six SOAR instrument operators to complete a 72 flight season lasting from late October 1996 to early January 1997. The planned flight rate is three survey flights per day.

- Delivery of the Twin Otter to the SOAR field camp directly from the contractor facility in Calgary, Canada.

- Pre-deployment site visit to Kenn Borek Air, Ltd. by SOAR personnel to inspect aircraft fabrications and modifications and to verify SOAR specifications (see Table C.1).

- Install a new HF antenna and receiver or enable an existing HF radio to receive the DGPS corrections and relay them to the DGPS aboard the aircraft.

Table C.1, Equipment Supplied by Kenn Borek Air, Ltd.

GPS positioning * - CA code with latitude and longitude [+/-0.1 minute] available over an RS-232 port.

Inertial Navigation *- Litton LT-92R or equivalent with all raw binary output available over an RS-232 port.

Pressure Altitude * - 0.5 m pitot boom and Paroscientific 1015a or equivalent with pressure [+/-0.1 mbar] over a range of 600-1100 mbar available over an RS-232 port.

Outside Air Temperature * - temperature [+/-1° C] over a range of -40° to +25°C available over an RS-232 port.

Autopilot † - roll, pitch and pressure altitude stabilized with all controls available to both pilot and copilot.

Antenna system refurbishment and cable raceway in wings - for user-supplied radar antennas to be mounted beneath wings; includes flight preparation/relamination of user supplied antennas and struts.

Securing mechanisms and viewing window - for the "bird" containing the magnetometer sensor that is to be towed on a 30 m retractable cable and laser range finder which is mounted in viewport.

Data Acquisition Interface † - to allow recording of avionics data by user acquisition system.

Auxiliary Power Unit † - 28V at 10 kW.

Intercom† - four operator headsets with push-to-talk and cockpit isolation features.

HF Radio with audio line output and antenna† - to receive DGPS correction signal.

* Engineering diagrams and manuals must be available in the field for these avionics systems.

† Spare parts, engineering diagrams and manuals must be available in the field for these systems

II. Field Support

Field support includes services provided by ASA and NSFA to the facility principally for operations of the field camp. This section focuses on these services.

Goals:

The goals of the SOAR field support efforts primarily are to ensure that the field camp is set up to optimize configuration and operation of the survey aircraft, and secondarily to minimize the time and resources necessary for field site setup and maintenance.

Plans:

The SOAR field support plan for the 1995/96 field season focused on ensuring that adequate services and communications were available for efficient aircraft configuration and safe flight operations. The plan included:

- Occupying a field site at Byrd Surface Camp, Antarctica by mid-November 1995 and departing this field site by the first week of February 1996.
- Establishing high-quality voice and data communications links from Byrd Surface Camp to North America and McMurdo before the beginning of field operations.
- Establishing flight following activities with hourly updates from three locations during flight operations.
- Establishing two alternate landing sites with fuel caches positioned between 75 km and 200 km from the Byrd Surface Camp field site.
- Implementing the capability at Byrd Surface Camp to receive satellite weather photographs for central West Antarctica.
- Erecting a DGPS transmission tower at Byrd Surface Camp capable of broadcasting a 3 to 4 Mhz signal to a range of 300 km.

Accomplishments:

The major field support accomplishments are given below.

- Byrd Surface Camp was occupied by SOAR personnel from November 13, 1995 through January 29, 1996. The "science" jamesway erected last year was in good shape and required very little work to be made operational. The amenities installed last year to support the planning, maintenance and survey environment (work benches, bookshelves, etc.) were still in-place. The only facilities maintenance activities necessary were to restore the jamesway from its winter-over state. After the completion of flight operations on January 26 one week was required for deconfiguring the aircraft and packing equipment.

- Prior to beginning the configuration of the Twin Otter for survey flying, the aircraft was used to put in a fuel cache.

- An ATS satellite communications system was chosen by ASA to provide voice and data communications with North America for the Byrd Surface Camp field site. This system worked well and supported a minimal but adequate level of communications with North America.

- ASA provided a camp manager, a cook, one or two general field assistants, a mechanic, and a weather observer. NSFA provided a medical corpsman. Diligent work by the ASA and NSFA camp personnel allowed the camp to run smoothly throughout this field season.

- An HF packet system was installed between the Byrd Surface Camp and McMurdo weather offices by McMurdo Information Systems personnel. This system aided the flight following effort by allowing more timely access to forecasts provided by McMurdo for the survey time period and areas. Support for on-site weather images could not be supplied.

Issues to Address:

To improve the efficiency of aircraft configuration and flight operations, as well as to ensure that flight operations are conducted safely, a number of issues need to be addressed. These are listed below.

- Voice and data communications links to North America continue to be important to the operation of the survey aircraft due to the highly technical nature of the facility's suite of geophysical, positioning and computing systems. Reliable voice and data communications links must be established at SOAR field sites. These links should be installed prior to the arrival of SOAR field personnel. The volume of traffic supported should be increased to 10 Mbyte/day to allow quality control products to be evaluated by SOAR personnel in North America.

- Flight-following capability is critical for safe operation of the survey aircraft. This consists of a weather observer at a radio tuned to the survey aircraft frequency from one hour prior to take off of a flight until the flight lands. The around-the-clock nature of SOAR field operations necessitates that twenty-four hour flight following be provided, both at the base camp and at alternate landing sites, if possible.

- The SOAR differential GPS navigation system requires an appropriate transmission tower and antenna for differential corrections at the next field site. (see Technical Appendix). The 1995/96 installation proved inadequate for our needs. Close cooperation will be required for a successful implementation.

Future Targets:

To address these outstanding issues, SOAR intends to request the following:

- ATS (or better) voice and data communications links be established at the field site prior to the arrival of SOAR field personnel.

- Flight following capability with hourly updates from three locations during flight operations. Any nearby ASA-supported field camps must monitor radio traffic 24 hours per day.

- Two alternate landing sites with fuel caches positioned at least 75 km and no more than

200 km away from the base field site.

- A DGPS radio tower capable of broadcasting a 2-3 Mhz signal to a range of 300 km located at the base field site.

III. Technical Support

This appendix covers the interactions of the facility with other organizations which provided technical support. The technical support was provided for the gravity meter and the geodetic GPS receivers.

A. Gravity Meter

Goal:

The goal of SOAR is to secure reliable access to a state-of-the-art gravity meter designed for airborne applications.

Plans and Accomplishments:

Efforts this year focused on establishing a long-term relationship with the Naval Oceanographic Office (NAVOCEANO) of the U.S. Navy (USN). The data acquired by the NAVOCEANO BGM-3 appears to be very good. Free-air gravity quality-control plots produced in the field show very close agreement with data collected last year.

Issues to Address and Future Targets:

SOAR must continue to work with the NSF/ONR Gravimeter Coordination Committee to establish a formal relationship between the USN and NSF to facilitate the use of Navy equipment for academic research projects. A BGM-3 Loan Agreement must be formalized to allow reliable access to this unique resource.

B. GPS Systems for Precise Positioning

GPS technology is utilized by SOAR in two different ways: as a real-time tool to allow accurate airborne navigation along a pre-determined flight path, and to precisely determine the aircraft's position for post-mission data reduction. This section addresses this latter use of GPS, as a precise geodetic positioning system.

Goals:

The goal of SOAR for precise positioning is to gain reliable access to the GPS equipment best suited for routine sub-meter positioning of the survey aircraft.

Plans and Accomplishments:

SOAR again this year utilized both Ashtech Z-12 and Turborogue GPS receivers. For reliability and redundancy two receiver types operated in parallel both in the aircraft and on the ground. Multiple receivers of each type were used to prevent data loss due to individual receiver failure.

- UNAVCO provided four Turborogues for facility use. Two complete systems were delivered to SOAR in September, providing time to train SOAR personnel in their operation. An additional two systems were delivered to SOAR directly from UNAVCO personnel in McMurdo.

- Bill Krabill of NASA/Wallops Flight Facility - Observational Science Branch provided two Ashtech Z-12's to the facility for use during the field season. These two had been issued to the R. Bindschadler's S-173 science group at Byrd. After S-173 had completed its field work, SOAR was allowed to take over operation of the Ashtechs and return them to NASA.

Issues to Address:

- The facility will continue to require access to Tubrorogue GPS receivers in future field seasons. UNAVCO is the ideal organization for supplying this equipment as well as field support. SOAR recommends that Polar Programs continue to support UNAVCO to ensure access to state-of-the-art GPS positioning capability.

- We cannot rely on the availability of the NASA Ashtech receivers. Because of recent price reductions it has become cost effective for SOAR to acquire these.

Future Targets:

- SOAR encourages Polar Programs to continue fostering a formal relationship with UNAVCO to ensure access to well-maintained equipment and excellent field support.

- To ensure that its GPS needs are met, SOAR should purchase three Ashtech Z-12 GPS receivers.

IV. Cargo Support

This section reviews the cargo support provided to the facility by ASA. A significant quantity of cargo must be moved annually from the SOAR central office in Austin, Texas, to the field site in a timely manner. Much of this equipment must be returned to North America quickly so that data distribution activities can begin soon after the field season.

Goals:

The SOAR cargo goal is to move equipment to the field site in a manner which supports the timetable for configuring and operating the survey aircraft and associated ground support facilities.

Plans:

The facility's plan for the 1995/96 field season was to:

- Have the equipment necessary to set-up the survey aircraft on-site at Byrd Surface Camp before mid-November 1995 and to have all other equipment at the field site before the arrival of the survey aircraft at the end of November;

- Reduce the amount of SOAR handcarry to and from the field; and

- Transport the gravimeter from North America to Byrd Surface Camp with a SOAR escort. The escort is required to ensure that continuous power is supplied to the meter and to repair any failures during transport.

Accomplishments:

The facility cargo movements during the 1995/96 field season are outlined here.

Cargo deployment accomplishments are shown below in two tables. Table C.2 describes the amount of cargo in each of the six SOAR 1995/96 shipments. Table C.3 describes the timing of each of these cargo shipments.

In addition to the cargo denoted in the Tables C.2 and C.3, certain items were required to be hand carried from North America to Antarctica because of their late availability, critical importance or immediate need upon arrival. SOAR personnel hand carried 26 pieces (1,708 lbs) down to McMurdo, and 13 pieces (629 lbs) to North America on the return trip.

Table C.2: Cargo Summary

Shipment Number	Number of Pieces	Total Weight (lbs)	Volume (ft^3)
1	13	3120	386
2	12	2441	237
3	11	2857	246
4	13	3142	263
5	11	2433	244
6	5	849	73

Table C.3: Cargo Timetable

		Arrival Date			
Shipment Number	Date Depart Austin, TX	Port Hueneme, CA	Christchurch, NZ	McMurdo, Antarctica	Byrd Surface Camp
1	28 Sep 95	7 Oct 95	19 Oct 95	28 Oct 95	5 Nov 95
2	3 Oct 95	11 Oct 95	20 Oct 95	28 Oct 95	13 Nov 95
3	10 Oct 95	19 Oct 95	24 Oct 95	28 Oct 95	16 Nov 95
4	17 Oct 95	25 Oct 95	31 Oct 95	4 Nov 95	16 Nov 95
5	24 Oct 95	2 Nov 95	8 Nov 95	18 Nov 95	21 Nov 95
6	31 Oct 95	6 Nov 95	18 Nov 95	27 Nov 95	1 Dec 95

The gravimeter used for the SOAR 1995/96 field season was a BGM-3 gravimeter which, including its shipping container, weighed 330 pounds. The complete system included four additional boxes totaling 340 pounds for a total gravimeter weight of 670 pounds. Lee Degalen of NSF with the assistance of ASA arranged transportation of the gravimeter aboard an Air Force C-141 aircraft from North America to McMurdo. Brian Stone of ASA and NSF personnel in McMurdo arranged for its return via an LC-130 aircraft of the 109th New York Air National Guard.

Issues to Address and Future Targets:

To optimize resources during the next field season the following issues/targets must be addressed.

- The amount of SOAR hand carry to and from field-sites in Antarctica is large. This is an inconvenience for the cargo system and the risk of equipment loss and damage is high. SOAR will continue to try to reduce the volume of handcarry.
- The amount of paper documents carried to and from, and produced in, the field by SOAR is large and creates a logistical burden. To address this SOAR will investigate transporting and creating documents on electronic media.
- Transport of the gravity meter back to North America via the New York Air National Guard will not be possible in a timely manner if the field season ends in early January as anticipated. An alternate means of transportation needs to be found to avoid an expensive delay in returning this device.
- Shipping containers need to be acquired to replace broken and damaged ones.

Appendix D: Personnel

SOAR Annual Report

1995/96

This appendix covers the goals, plans, accomplishments, outstanding issues and future targets for SOAR personnel.

Goals:

The SOAR personnel goals are to staff the facility with a stable core of highly qualified technical people and to maintain a flexible management structure that allows the core personnel to be easily augmented during periods of peak activity.

Plans:

The personnel plan for the second year of SOAR activities focused on the following:

- Augmenting the core personnel with sufficient personnel to accommodate the field preparation schedule and to allow for high production (3 flights per day) flight operations in the field; and

- Operating with a management structure composed of groups with specifically defined scopes under the direction of a management team made up of the directors and coordinators. Laboratory groups were to include:

  o Geophysical and Navigation Systems (GAN),

  o Network Operation and Data Management (NOD), and

  o Logistics and Information Management (LIM).

  In addition to LIM and NOD, field groups were to include:

  o Experimental Design and Flight Support (EDS),

  o Flight Operations (FOP), and

  o Base Operations (BOP).

Accomplishments:

Upon conclusion of the Cooperative Agreement in 1994, Don Blankenship and Robin Bell assumed their responsibilities as directors of SOAR. The core technical staff personnel are summarized below.

Co-director - Don Blankenship (Ph.D., 1989, Geophysics, University of Wisconsin-Madison) has 11 austral summers of field experience in Antarctica, seven as chief scientist including the Corridor Aerogeophysics of the Southern and Eastern Ross Transect Zone (CASERTZ) surveys and the 1994/95 and 1995/96 SOAR field seasons. His efforts there have concentrated on aerogeophysics and seismology.

Co-director - Robin Bell (Ph.D., 1989, Geophysics, Columbia University) has spent three austral summers in Antarctica as chief scientist for the CASERTZ surveys and two austral summers doing long-range aerogeophysics over the Weddell Sea. Her work has been in marine and airborne geophysics with an emphasis on gravity measurements.

Technical Coordinator - Keith Najmulski (B.S., 1988, Electrical Engineering and Engineering Physics, Ohio State University) has extensive polar field experience including six seasons in Antarctica and two in Greenland. He coordinated technical activities for all three CASERTZ field seasons and was field leader for the 1994/95 and 1995/96 SOAR field seasons. He left SOAR this year to pursue a graduate degree.

New Technical Coordinator - Tom Richter (M.S., 1993, Electrical and Computer Engineering, University of Texas at Austin) brings aeronautical and engineering experience useful to SOAR. He was a pilot and an operational test director of aircraft systems for the U.S. Navy. He has been with the University of Texas since 1991, working on a variety of electrical, electronic and software systems for research programs. His training included participation in the 1995/96 field season.

Science Coordinator - Jeff Williams (M.S., 1995, Geophysics, University of Texas at El Paso) joined SOAR shortly before its first field season. His background included advanced studies in applied geophysics and experience as a U.S. Air Force officer and test director for airborne life-support systems. The Science Coordinator's primary responsibilities include interaction with SOAR science clients and data distribution. He has participated in both SOAR field seasons.

Research Engineer - Matt Peters (Ph.D., 1994, Electrical Engineering, Ohio State University) joined SOAR immediately upon completion of his Ph.D. at Ohio State University. His doctoral research focus was on antennas and wave propagation for airborne applications. One of the early engineers on the CASERTZ project, he assisted in field preparations and participated in two CASERTZ field seasons. Peters has participated in both SOAR field programs and has primary operational responsibility for geophysical systems.

Senior Systems Analyst - Scott Kempf (M.S., 1992, Computer Science, University of Wisconsin-Madison) also moved to SOAR from CASERTZ where he had spent a year programming database applications for underway geophysics. His background at the University of Wisconsin includes experience in systems architecture, programming tools and assembly language applications as well as six years as a network administrator. His primary responsibilities include software development for data acquisition and data distribution.

Systems Analyst - John Gerboc (M.S., 1991, Systems Science, State University of New York at Binghamton) joined SOAR prior to its first field season. His previous experience was in software development for vision and airborne systems. While a software engineer at IBM Federal Systems Division he participated in a number of aircraft based field projects. While with SOAR, he has participated in both field programs with operational responsibility for data acquisition and data distribution.

Installation Engineer - Ken Griffiths (B.S., 1968, Electrical Engineering, Duke University) is a Research Engineer with the Institute for Geophysics who acts as installation engineer for SOAR. Griffiths has participated in more than ninety marine, land and airborne geophysical field programs including two CASERTZ field seasons. Ken has both developmental and operational responsibilities for geophysical and navigational systems. He has participated in both SOAR field programs.

Administrative Assistant - Wilbert King (B.S., 1995, Economics, University of Texas at Austin) was selected from a wide variety of candidates for this position because of his familiarity with computer oriented administration. He has substantial experience with the management of administrative databases as well as University of Texas budgeting. His primary SOAR responsibility is information management.

The core personnel for SOAR were augmented by the following persons for the field deployment. These are summarized below.

Acting Director (augmented) - Carol Finn (Ph.D., 1988, Geophysics, University of Colorado-Boulder) is a geophysicist at the Geophysics Branch of the USGS with extensive aerogeophysics experience in both North America and Japan. She serves as the administrator of the SOAR subcontract to the USGS. She was a participant in the 1990/91 German/Italian and 1992/93 CASERTZ aerogeophysics programs as well as the SOAR field programs.

Senior Systems Analyst (augmented) - Mark Maybee (Ph.D., 1994, Computer Science, University of Colorado-Boulder) was recruited to assist in field networking, data management and systems integration. His background includes over ten years of research experience in software engineering as well as substantial systems programming experience. He participated in both SOAR field programs.

Senior Systems Analyst (augmented) - Dwight Melcher (B.S., 1986, Applied Mathematics and Computer Science) was also recruited to assist in field networking, data management and systems integration. He has over nine years experience with UNIX, programming languages and system administration.

Systems Analyst (augmented) - Eric Robison was also recruited to assist in field networking, data management and systems integration. He has over seven years experience as a systems and network administrator.

Installation Engineer (augmented) - Don McNair, a retired geophysical technician at the Geophysics Branch of the USGS with over twenty years of geophysical field experience, was contracted for both SOAR field seasons.

Field Assistant (augmented) - Vicki Langenheim (M.S., 1989, Geology, University of California at Berkeley) is a geophysicist with the USGS where she uses potential field data to solve tectonic problems. Her primary SOAR responsibility was quality control for navigation systems.

Field Assistant (augmented) - Jennifer Eigenbrode (B.S., 1994, Geology, James Madison University) had most recently worked for the USGS Geophysics Branch. She has both geophysics and geology field experience. During the SOAR field season her responsibilities included potential field data acquisition.

Issues to Address and Future Targets:

The core personnel objectives for SOAR were largely met in the first year. Issues remaining to be addressed and future personnel targets are:

- Recruitment of computer systems personnel to augment core personnel in the field was difficult this year. Maybee was known from last year but it took significant effort to recruit Melcher and Robison. The accelerated training schedule required for these new employees was inefficient. A target for next year is to implement a multi-year contract for systems analyst services to generate quality control and archival products in the field. This would enhance personnel continuity and quality of these products from year to year.

- With additional science clients seeking help from the facility the administrative load has been increasing. In response to this, SOAR has increased the time period of the science coordinator's, system analyst's and administrative assistant's appointments.

- To achieve SOAR's planned technical upgrades the time periods of the research engineer and installation engineer appointments have been increased.

- As in past seasons an augmented installation engineer will be hired for the first part of the field season to assist in preparation of the equipment on-site.

- At present Scott Kempf and Matt Peters share appointments between SOAR and UTIG science projects. Conflicts can arise especially with SOAR field preparation and data distribution. SOAR needs to evaluate changing the balance of their tasks and possibly hiring a new "core" person.

- The time period of the appointment of a co-director who goes to the field for SOAR should be increased to encompass the field time (one month should be sufficient).

Appendix E: Oversight Committee

SOAR Annual Report

1995/96

This appendix reviews the results and findings of the first meeting of SOAR's Oversight Committee.

Goals:

The charter for the SOAR Oversight Committee lies in the Cooperative Agreement established between the University of Texas at Austin and the National Science Foundation, Office of Polar Programs (NSF/OPP). In it the facility was asked to establish an external oversight committee tasked with "defining broad areas of scientific interest and keeping abreast of technological developments."

Plans:

The committee is to meet annually and is intended to represent the interests of the polar earth science, glaciology, general earth science, aerogeophysical operations communities. The facility co-directors, the NSF/OPP Program Officer and a U.S. Antarctic Program Operations Manager are all to be represented at committee meetings.

Accomplishments:

The first meeting of the SOAR Oversight Committee was held at the SOAR central facility in Austin, Texas on August 29 through 30, 1995. The members of the committee were:

- *Robert Bindschadler* (glaciologist), Goddard Space Flight Center, NASA,
- *Terry Wilson* (polar earth science), Department of Geology and Mineralogy, The Ohio State University, and
- *Terry McConnell* (aerogeophysical operations), SCINTREX, Concord, Ontario.

(Scheduling conflicts did not allow the fourth committee candidate to attend this first meeting.) The National Science Foundation was represented by Scott Borg, NSF/OPP. The facility co-directors were also present.

Among the topics discussed by the Committee were:

- A review of SOAR's origins, and an overview of the facility,
- A review of the facilities Year 1 activities,
- Data Distribution and Data Product Policies,
- The Oversight Committee mandate,
- Technical Improvements, and
- UW-Madison interaction with SOAR.

Issues to Address:

Fourth Oversight Committee Member A four-member committee is specified in the Cooperative Agreement. Formally adding a fourth committee member should be accomplished prior to the next committee meeting.

Data Product Policy The committee set a goal for both a short-term and a long-term data distribution policy. The short-term policy goal recommends that during Years 2 and 3 of SOAR's existence, the emphasis should be on collecting as much data as possible to demonstrate SOAR's capabilities and to provide case history data sets to assist with publicizing these capabilities. During this Year 2 and 3 time period, the facility's data product would be the raw data from the aircraft.

However, based on the notion that the long-term success of the facility is dependent upon the ability to provide user-friendly products to its clients, the committee recommended that data collected by the facility be made available to the end-users in the form of reduced data products.

Data Distribution Policy A basic data distribution policy for the facility was stated as follows:

1. NSF owns all data collected.
2. All instruments shall be turned on and data acquired on all survey flights.

3. Any Principal Investigator who submits a proposal to utilize less than all data streams will be made aware that the remaining data streams will be made available for use by PI's submitting separate proposals acceptable to the NSF.

Finally, the committee identified three phases of data use and distribution. These phases are summarized below:

Phase I **Start**	**Phase II** **0 to 2 Years**	**Phase III** **After 2 Years**
Proposals submitted to NSF to utilize one or more data streams.	NSF/SOAR to keep data streams confidential.	Approximately two years after data acquisition has been completed, all data will become available to the public. Exact timing will be determined by NSF.
If one or more data streams are not included in a funded and about to be flown project, NSF reserves the right to, over the next two years, fund other PI's to use the unstudied data streams(s).	All requests for data must go through the NSF.	SOAR and/or NSF can give data to anyone for the cost of duplication.

Future Targets:

SOAR Workshop. The committee proposed that a workshop be held in March 1996 to aid in the generation of NSF-funded project proposals utilizing the facility and to solicit opinions on SOAR data reduction. The proposed workshop title is "Aerogeophysical Opportunities in Geology and Glaciology". Scientists from the glaciology and polar earth science communities are the target audience.

Oversight Committee Mandate. The committee stated its mandate as consisting of three parts: to provide a vision for the future of SOAR, to provide policy assistance to the co-directors and to provide proposals for SOAR improvements.

1. Vision for the future of SOAR. Four targets were specified. SOAR should:
    - Concentrate on acquiring data for Years 2 and 3.
    - Develop data reduction and map production services in Years 4 and 5.

- Make software developed by the facility freely available to the public.

- Provide a "defined service" for which outside suggestions for improvement are to be accepted for review and possible implementation.

2. Assist the co-directors with policy decisions on an on-going basis.

3. Provide concrete proposals for improvements to SOAR's capabilities and services.

Technical Improvements. The committee approved specific technical improvements to the SOAR radar. The prioritized improvements are:

1. Upgrading the Digitizer/Stacking Unit (DSU).

2 Calibration of the radar signal.

3 Adding coherent capability to the current NSF/TUD radar system.

Next Meeting. Funds need to be allocated for the next meeting of the oversight committee, scheduled to take place in Austin during the summer of 1996.

Appendix F: Finances

SOAR Annual Report

1995/96

This appendix covers the plans, accomplishments and future targets for SOAR finances.

Goals:

The financial goal of SOAR is to support the core staff and physical plant necessary to prepare, configure and operate a geophysical aircraft in Antarctica for a five year period. These activities are to be undertaken for the lowest cost consistent with the data volume and data quality specified in the facility's experimental tasking.

Plans and Accomplishments:

The plans and accomplishments for the second year of SOAR operations are outlined in Attachment F.1 which presents the initial budget estimates and their reconciliation as of the end of April, 1996. The expenditures are in line with the estimates. The $23,000 under-expenditure in Year 2 represents DGPS hardware which was requested but not acquired in that year. These acquisitions were deferred to Year 3 to allow SOAR to complete higher-priority technical developments for the 1995/96 field season.

Issues to Address and Future Targets:

The financial issues resulting in the Year 3 budget targets given in Attachment F.2 are:

- The need for a field subcontract to support field production of data archival and quality control products as described in the Technology Appendix. The cost is estimated to be approximately equal to what would be necessary to hire augmented systems analysts to produce these products.

- The need for additional engineering support to execute the technical upgrades described in the Technology Appendix.

- The need for additional administrative and computer personnel support to execute the proposal planning and data distribution projects described in the Experiments Appendix.

- The permanent equipment requirements described in the Technology Appendix.

All other budget targets are similar to those for Years 1 and 2.

Attachment F.1
Year 2 Budget Reconciliation - Institute for Geophysics
05/01/95 - 04/30/96

		Months	Budgeted	Projected Expenditures*
A.	Senior Personnel			
	1. D. D. Blankenship	4.0		
B.	Other Personnel			
	2. Technical Coordinator	9.0		
	Science Coordinator	11.0		
	Research Engineer	11.0		
	Senior Systems Analyst	9.0		
	Systems Analyst	11.0		
	Installation Engineer	3.0		
	Augmented Installation Engineer	2.0		
	Augmented Research Engineer	5.5		
	Augmented Senior Systems Analyst	5.5		
	Augmented Systems Analyst	5.5		
	5. Administrative Assistant	6.0		
	Total Salaries		285,446	303,094
C.	Fringe Benefits		81,352	53,625
	Total Salaries & Fringe Benefits		366,798	356,719
D.	Permanent Equipment			
	1. GPS Transceiver		25,000	
	2. Shipping Containers		6,000	
	3. Time and Frequency Domain Analyzers		15,000	
	4. 2 In-flight Monitor Computers		12,000	
	5. 2 Portable Computers (ION Network)		9,000	
	6. Workstation (RAV Network)		14,000	
	Total Permanent Equipment		81,000	51,395
E.	Travel			
	1. Domestic			
	4 R/T Austin-Golden, CO (Denver)		5,274	
	8 Days Per Diem		1,040	
	4 R/T to Austin, TX		2,800	
	8 Days Per Diem		1040	
	2 R/T Austin-Calgary		2,484	
	6 Days Per Diem		756	
	2. Foreign			
	66 Days Per Diem, Christchurch		8,624	
	Total Travel		22,018	20,955
G.	Other Direct Costs			
	1. Materials and Supplies:			
	Field Supplies		4,022	
	Electronics		10,070	
	4. Computer Services		16,600	
	5. Sub-Contracts			
	USGS		31,971	
	LDEO		88,269	
	6. Other:			
	Shipping		18,100	
	Insurance		16,100	
	11 Physicals		6,828	
	Repair/Refurbishment		45,000	
	Copying		805	
	Communications		3,217	
	Lease Payments		92,100	
	Total Other Direct Costs		333,082	352,641
H.	**Total Direct Costs**		802,898	781,710
I.	Indirect Costs			
	22% Excluding Equipment, **Sub-Contracts and Lease Payments**		112,102	110,215
J.	**Total Costs**		915,000	891,925

*Includes costs from year 1 marked for payment with year 2 funds.

Attachment F.1
Year 2 Budget Reconciliation - Lamont-Doherty Earth Observatory
05/01/95- 04/30/96

		Months	**Budgeted**	**Projected Expenditures**
A.	Senior Personnel			
	1. R.E. Bell, Associate Research Scientist	4.0		
B.	Other Personnel			
	5. Administrative Assistant, B. Hautau	3.0		
	Total Salaries		27,896	27,896
C.	Fringe Benefits @33.5%		9,345	9,345
	Total Salaries & Fringe Benefits		37,241	37,241
D.	Permanent Equipment*			
	1. Macintosh Quadra 950		2,782	
	Total Permanent Equipment		2,782	2,198
E	Travel			
	1. Domestic			
	2 R/T New York-Golden, CO (Denver)	2,560		
	10 Days Per Diem		1,080	
	4 R/T New York - Austin, TX		4,304	
	21 Days Per Diem		1,890	
	Misc. Ground Transportation		166	
	Total Travel		10,000	5,898
G.	Other Direct Costs			
	1. Materials and Supplies		300	
	2. Computer Services *		2,500	
	6. Other:			
	Shipping		500	
	Copying		200	
	Communications		6,000	
	Total Other Direct Costs		9,500	5,491
H	Total Direct Costs		59,523	50,828
I	**Indirect Costs 2nd year MTDC =x53%**		28,747	25,774
J.	**Total Costs**		88,269	76,602

* Not subject to indirect costs.

Attachment F.1
Year 2 Budget Reconciliation - USGS/Geophysics Branch
05/01/95- 04/30/96

		Months	Budgeted	Projected Expenditures
A.	Senior Personnel			
	1. C. A. Finn		N/C	
B.	Other Personnel			
	2. Electronics Technician, J. Bradley	1.5		
	Field Assistant	4.0		
	Total Salaries		17,121	17,121
C.	Fringe Benefits		N/C	
	Total Salaries & Fringe Benefits		17,121	17,121
D.	Permanent Equipment			
	1. Computer Tape Drive		3,000	
	Total Permanent Equipment		3,000	3,000
E	Travel			
	1. Domestic			
	2 R/T CO - Austin, TX		1,500	
	2. Foreign			
	13 Days Per Diem, Christchurch		1,050	
	Total Travel		2,550	2,550
G.	Other Direct Costs			
	1. Materials and Supplies			
	Field Supplies		800	
	Electronics		1,200	
	6. Other:			
	Shipping		1,500	
	Physical Exam		1,200	
	Repair/Refurbishment		4,600	
	Total Other Direct Costs		9,300	9,300
H	Total Direct Costs		31,971	31,971
I	**Indirect Costs**		N/C	
J.	**Total Costs**		31,971	31,971

Attachment F.2
Year 3 Budget Estimate - Institute for Geophysics
05/01/96- 04/30/97

			Months	
A.	Senior Personnel			
	1.	D. D. Blankenship	5.0	
B.	Other Personnel			
	2.	Technical Coordinator	9.0	
		Science Coordinator	12.0	
		Senior Research Engineer/ Installation Engineer	5.0	
		Research Engineer	12.0	
		Senior Systems Analyst	9.0	
		Systems Analyst	12.0	
		Augmented Installation Engineer	2.0	
	5.	Administrative Assistant	8.0	
		Total Salaries		261,809
C.	Fringe Benefits			67,526
		Total Salaries & Fringe Benefits		329,335
D.	Permanent Equipment			
	1.	(3) Geodetic GPS Receivers		54,000
	2.	DSU Upgrade Hardware		35,000
	3.	Shipping Containers		6,000
	4.	Workstation (RAV Network)		8,500
	5.	Tape Drive and Printer (RAV Network)		2,800
		Total Permanent Equipment		106,300
E.	Travel			
	1.	Domestic		
		4 R/T Austin-Golden, CO (Denver)		1,200
		8 Days Per Diem		560
		2 R/T Austin-Calgary		2,200
		6 Days Per Diem		840
		4 R/T Austin-Bay St. Louis		1600
		8 Days Per Diem		960
		4 R/T (various)-Austin oversight committee meeting		2,400
		8 Days Per Diem		960
		2 R/T Austin- Washington D.C.		1,000
		4 Days Per Diem		560
	2.	Foreign		
		48 Days Per Diem, Christchurch		5,760
		Total Travel		18,040
G.	Other Direct Costs			
	1.	Materials and Supplies:		
		Field Supplies		4,250
		Electronics		10,800
	5.	Sub-Contracts		
		USGS		33,700
		LDEO		87,473
		Field Quality Control and Data Archival		96,400
	6.	Other:		
		Computer Leasing		9,000
		Shipping		19,100
		Insurance		16,900
		8 Physicals		5,200
		Repair/Refurbishment		46,100
		Copying		850
		Communications		3,400
		Lease Payments		94,400
		Total Other Direct Costs		427,573
H.	Total Direct Costs			881,248
I.	**Indirect Costs**			
	22% Excluding Equipment, Sub-Contracts and Lease Payments			107,355
J.	**Total Costs**			988,603

Attachment F.2
Year 3 Budget Estimate - Lamont-Doherty Earth Observatory
05/01/96- 04/30/97

		Months	
A.	Senior Personnel		
	1. R.E. Bell, Associate Research Scientist	4.0	
B.	Other Personnel		
	5. Administrative Assistant,	3.0	
	Total Salaries		29,311
C.	Fringe Benefits @33.5%		9,819
	Total Salaries & Fringe Benefits		39,130
D.	Permanent Equipment*		
	1. Macintosh Powerbook		2500
	Total Permanent Equipment		2500
E.	Travel		
	1. Domestic		
	2 R/T New York-Golden, CO (Denver)		2,720
	10 Days Per Diem		1,150
	4 R/T New York - Austin, TX		4,352
	21 Days Per Diem		2,121
	Misc. Ground Transportation		150
	Total Travel		10,493
G.	Other Direct Costs		
	1. Materials and Supplies		350
	2. Computer Services *		2,700
	6. Other:		
	Shipping		550
	Copying and Communications		3,250
	Total Other Direct Costs		6,850
H.	Total Direct Costs		58,973
I.	**Indirect Costs**		
	1st year MTDC = 60,327 x 53%		28,500
J.	**Total Costs**		87,473

* Not subject to indirect costs.

Attachment F.2
Year 3 Budget Estimate - USGS/Geophysics Branch
05/01/96 - 04/30/97

		Months	
A.	Senior Personnel		
	1. C. A. Finn		N/C
B.	Other Personnel		
	2. Electronics Technician,		
	J. Bradley	1.5	
	Field Assistant	4.0	
	Total Salaries		18,319
C.	Fringe Benefits		N/C
	Total Salaries & Fringe Benefits		18,319
D.	Permanent Equipment		
	Total Permanent Equipment		0
E	Travel		
	1. Domestic		
	2 R/T CO - Austin, TX		1,500
	2. Foreign		
	13 Days Per Diem, Christchurch		1,050
	Total Travel		2,550
G.	Other Direct Costs		
	1. Materials and Supplies		
	Field Supplies		800
	Electronics		1,200
	6. Other:		
	Shipping		2,000
	Physical Exam		1,200
	Repair/Refurbishment		7,600
	Total Other Direct Costs		12,800
H	Total Direct Costs		33,669
I	**Indirect Costs**		N/C
J.	**Total Costs**		33,669

Attachment F.3
Total Expenditures- Institute for Geophysics
08/01/94 - 04/30/96

	Budgeted	Projected Expenditures
A. Senior Personnel		
B. Other Personnel		
Total Salaries	422,127	451,188
C. Fringe Benefits	119,648	95,345
Total Salaries & Fringe Benefits	541,775	546,533
D. Permanent Equipment		
Total Permanent Equipment	188,800	159,195
E. Travel		
Total Travel	38,118	37,055
G. Other Direct Costs		
1. Materials and supplies	28,092	
4. Computer Services	33,100	
5. Sub-Contracts		
USGS	62,821	
LDEO	187,068	
6. Other:	315,042	
Total Other Direct Costs	626,123	627,581
H. Total Direct Costs	1,394,816	1,370,364
I. **Indirect Costs**		
22% Excluding Equipment, Sub-Contracts and Lease Payments	186,259	187,636
J. **Total Costs**	1,581,075	1,558,000

Attachment F.3
Total Expenditures - Lamont-Doherty Earth Observatory
08/01/94 - 04/30/96

		Budgeted	Projected Expenditures
A.	Senior Personnel		
B.	Other Personnel		
	Total Salaries	62,393	56,363
C.	Fringe Benefits @33.5%	20,900	18,881
	Total Salaries & Fringe Benefits	83,293	75,244
D.	Permanent Equipment*		
	Total Permanent Equipment	6,782	6,209
E.	Travel		
	Total Travel	20,000	11,544
G.	Other Direct Costs		
	Total Other Direct Costs	16,275	14,894
H.	Total Direct Costs	126,350	107,891
I.	**Indirect Costs**	60,719	52,566
J.	**Total Costs**	187,068	160,457

* Not subject to indirect costs.

Total Expenditures - USGS/Geophysics Branch
08/01/94 - 04/30/96

		Months	Budgeted	Projected Expenditures
A.	Senior Personnel			
B.	Other Personnel			
	Total Salaries		32,621	32,621
C.	Fringe Benefits		N/C	
	Total Salaries & Fringe Benefits		32,621	32,621
D.	Permanent Equipment			
	Total Permanent Equipment		5,500	5,500
E.	Travel			
	Total Travel		5,100	5,100
G.	Other Direct Costs			
	1. Materials and Supplies			
	6. Other:			
	Total Other Direct Costs		19,600	19,600
H.	Total Direct Costs		31,971	31,971
I.	**Indirect Costs**		N/C	
J.	**Total Costs**		62,821	62,821

Appendix G: Cooperative Agreement

SOAR Annual Report

1995/96

This appendix contains the five-year Cooperative Agreement between the National Science Foundation Office of Polar Programs and the University of Texas at Austin creating the Support Office for Aerogeophysical Research.

COOPERATIVE AGREEMENT NO. OPP-9319379

PARTIES:	**National Science Foundation** **and** **The University of Texas at Austin**
TITLE:	**Support Office for Aerogeophysical Research (SOAR)**
AMOUNT:	**$3,734,824**
EFFECTIVE DATE:	**August 1, 1994**
EXPIRATION DATE:	**July 31, 1999**
AUTHORITY:	This agreement is awarded under the authority of the National Science Foundation Act (42 U.S.C. 1861 et seq.) and the Federal Grant and Cooperative Agreement Act (31 U.S.C. 6301 et seq.)

This Cooperative Agreement is entered into between the United States of America, hereinafter called the "Government," represented by the National Science Foundation, hereinafter called the "Foundation" or "NSF," and The University of Texas at Austin, hereinafter called the "Awardee".

NSF Program Official:

Scott G. Borg
Office of Polar Programs
Telephone (703) 306-1033
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NSF Grant and Agreement Official:

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TABLE OF CONTENTS TO

COOPERATIVE AGREEMENT OPP-9319379

I. SPECIAL CONDITIONS

Article 1. Statement of Purpose and General Responsibilities

A. The Support Office for Aerogeophysical Research (SOAR), hereinafter called the "Facility," is a research facility for aerogeophysical work in Antarctica. The goal of the Facility is to develop, maintain and operate a suite of geophysical systems aboard a Twin Otter Aircraft in support of research in Antarctica for five years. The Facility has the capability of collecting and reducing ice penetrating radar, laser altimetry, magnetics and gravity data sets in addition to GPS navigation information. The Facility data product will be a well organized data set under a spatially based hierarchy described in Attachment I. Data is to be made available to the general research community according to NSF policies (see Article 2.D.4 and Article 11.B.(1) (b).

B. The Facility will be housed at the Institute for Geophysics at the University of Texas at Austin.

C. The Awardee will manage joint aerogeophysical projects under the terms and conditions of this Cooperative Agreement and an Annual Program Plan in accordance with the awardee's proposal dated July 12, 1993, revised budget dated July 7, 1994 and revised cover page dated August 22, 1994 An Annual Program Plan is to be developed in consultation with the NSF Program Official in accordance with Article 2.

D. The National Science Foundation through its Polar Earth Sciences Program will provide general project oversight, monitoring, coordination and evaluation to help assure appropriate project performance and administration.

Article 2. Scope of Work and Specific Responsibilities of Awardee

A. The Awardee will ensure that the Office of Polar Programs' scientific and other programmatic needs are effectively integrated with NSF needs as well as the needs of the national and, where appropriate, the international scientific community. All work shall be performed in accordance with this Agreement and an Annual Program Plan.

B. The Awardee shall be responsible for the activities and projects agreed upon in the Annual Program Plan. The Awardee shall establish the facilities, organization, and staffing, as well as perform the supervisory functions of scheduling, planning, budgeting, resource allocation, fiscal control, contracting, and administration necessary to fulfill the requirements of the program delineated in this Agreement and in the Annual Program Plan.

C. The Awardee shall establish the means whereby it will control the business functions of the Facility and its tasks such as, but not limited to: schedule and budget development; fiscal control, reporting, accountability, and strategic planning; and selection and subcontracting for the Facility.

D. The Facility will be used to support the Office of Polar Program sponsored aerogeophysical research in Antarctica. The projects to be supported involve the need for high quality, integrated, geographically based ice thickness, surface elevation, magnetics and gravity data sets from continental Antarctica. The following elements are integral components of the overall Awardee responsibilities:

(1) **Facility Capability**: The basic Facility will provide approximately 55 survey flights per year operating from a single base camp over approximately a 3.5 month field season. The Facility will collect ice penetrating radar, laser altimetry, magnetics and gravity data sets in addition to GPS navigation information. The personnel required to maintain this effort will be 5 facility personnel supported approximately 9 months per year augmented by temporary personnel. The Facility will include the flexibility to expand the number f lights and bases of operations with appropriately increased funding levels. As the number of science groups supported by the Facility expands, increased management expenses will also be budgeted. The Facility staff will operate the platform exclusively during this initial period of five years.

(2) **Facility Management**: The operating structure of the facility will be a Management Team consisting of two co-directors, a technical coordinator and a scientific coordinator. The co-directors are responsible for scientific guidance and technical direction of the facility. The technical coordinator will be responsible for day-to-day management of the facility and will serve as the point of contact for NSF/Operations, U.S. Antarctic Program contractors, facility contractors and sub-contractors. The scientific coordinator will be responsible for evaluating and maintaining data quality and will serve as the point of contact for collaborating investigators.

(3) **Community Interaction**: Optimum use of this community facility requires that survey design and other planning be accomplished prior to funding and scheduling of any work. During the pre-proposal phase, the Facility will be responsible for ascertaining its capabilities and limitations with respect to the proposed work, including, but not limited to, data accuracy and resolution, the design of field experiments and data management considerations. This interaction should begin no later than 60 days prior to proposal submission. The pre-proposal interaction will ensure that the investigator's specific goals can be met, that the proposed project is technically feasible, and that the project could be accommodated with uncommitted facility time. The Awardee will maintain an ongoing dialogue with NSF to allow adequate planning of future work. After notification by NSF of science project funding, the Awardee, NSF and investigators will develop plans for budgeting and project implementation. Scheduling of the aircraft will be the responsibility of the Facility Management Team in consultation with NSF. The collaborating investigator and other users of the facility may provide a representative on site during data acquisition but this representative will not be used to supplement the technical personnel either abroad the aircraft or in a ground support role. The facility personnel will be solely responsible for field operations.

(4) **Data Products and Data Policy**: The Facility product will be a well organized data set of contiguous transacts under a spatially based hierarchy (see Attachment I). Following the field season the data requested in each proposal will be gathered into its spatial hierarchy and sent by the Awardee to the collaborating investigator; this task will be completed within six months following the end of data acquisition. Each investigator may process this data to meet his/her specific objectives. The facility will also collaborate with users who do not wish to reduce their own data. The budgets for this reduction including staffing, computer resources and any associated software development will be negotiated directly with NSF. Approximately two years after acquisition of a geographically contiguous data set is completed for a science project, the data will be available for release to the general community contingent on the approval of the NSF Program Official.

(5) **Scientific Oversight**: The Facility will establish an external oversight committee tasked with defining broad areas of scientific interest and keeping abreast of technological developments. The external oversight committee, representing both the earth science and glaciology communities, will meet at least once annually and may visit the Facility annually. This committee will consist of four members; one representing the polar earth science community, one representing the polar glaciology community, one member with technical expertise in aerogeophysical operations, and one member from the general earth science community. The Facility Co-Directors will be present at all oversight committee meetings. NSF will be represented at oversight committee meetings by the NSF Program Officer, or a designated representative, and an NSF Operations Manager from the U.S. Antarctic Program. The Awardee will negotiate costs to support the activities of the oversight committee directly with the Office of Polar Programs.

(6) **Technical Development**: The Facility will pursue appropriate technical development to enhance its ability to accomplish its scientific goals. Development of capabilities beyond those required to accomplish these goals will be considered directly by NSF in consultation with the Facility Management Team and oversight committee.

(7) **Facility Administration**: The Awardee will identify points of contact to ensure close communication between the Awardee, the NSF Program Official and the NSF Grants and Agreements Official. These points of contact will be the Director of the Office of Sponsored Projects, the Office of Accounting and the Assistant to the Director of the Institute for Geophysics. Their particular responsibilities will include implementation and monitoring of Articles 8, 13 and 15 outlined below. The Awardee will also be responsible for providing a centralized location with proximal laboratories and office space of sufficient size and stability to allow facility personnel both to accomplish the tasks outlined in this article and to interact effectively with collaborators, subcontractors and other Facility visitors. The Awardee will maintain its commitment to the matching salary support outlined in the budget justification of the attached budget estimates.

Article 3. Period of Performance

This Agreement shall be effective for 60 months -- from August 1, 1994 through July 31, 1999.

Article 4. Contractual Arrangement

The Foundation authorizes the Awardee to enter into the proposed contractual arrangements with Lamont-Doherty Earth Observatory and the U.S. Geological Survey, and to fund such arrangements with agreement funds up to the amount indicated in the approved budget. Such contractual arrangements should contain appropriate provisions consistent with the applicable agreement general terms and conditions and any special conditions included in this Agreement.

Article 5. Antarctic Clause

Neither Article 5, Expenditures for Related Projects," of GC-1 nor Article 3, "Programs of Related Projects," of FDP-II may be applied to agreements from NSF's Office of Polar Programs relating to the U.S. Antarctic Program.

This agreement is subject to the Antarctic Conservation Act, 16 U.S.C. 2401 ("ACA"). Unless authorized by regulation or permit, violation of the ACA may result in civil or criminal fines up to $10,000, imprisonment for up to one year, and where appropriate, administrative sanctions up to and including debarment. Please refer to the USAP Personnel Manual for general guidance.

Article 6. Allotment of Funds

A. The total estimated cost of this Agreement from its effective date through expiration is $3,734,824.

B. For purposes of payment of cost, pursuant to the terms outlined in Article 6, the total amount currently allotted by the Government to this Agreement is $666,075. This allotment covers the initial 9-month period of performance through April 30, 1995.

Article 7. Funding Schedule and Review

A. Contingent on the availability of funds, and the acceptance of the Annual Progress Report and Annual Program Plan, NSF expects to provide funding at the following approximate levels:

Fiscal Year	Approximate Funding Level	Period of Performance
1995	$785,895	12 months
1996	$742,886	12 months
1997	$755,820	12 months
1998	$784,148	15 months

B. Under normal circumstances, data organization and management activities continue after data acquisition and are performed concurrently with planning and preparation for the next field season. In light of this, and because of the schedule in year one, an additional three months has been added to the period of performance of the final fiscal year. This will allow completion of the required organization, management and distribution of data from the final field season.

C. The actual level of continued NSF support for years 2 through 5 will be negotiated annually with the Awardee and will depend upon an annual review of progress, which may include a site visit, and the availability of funds. Continuation is dependent on NSF decisions to fund peer reviewed science proposals requiring the Facility. Should NSF decide to terminate the Facility, NSF and the Awardee will negotiate support to complete all projects in progress at that time. In the event that the anticipated level of NSF support cannot be awarded because of budgetary constraints, NSF and the Awardee will negotiate a change in the scope of Facility activities. The Facility will be reviewed after the third year of this agreement (after completion of the third field season) as described in this Article 7.D below. The review will determine if the Awardee is meeting the stated goals and objectives in order to determine if an aerogeophysical facility should be continued beyond the five year period under this Agreement.

D. A formal review of the Facility will be conducted prior to April 30, 1997. The purpose is to determine if the Facility is meeting the stated goals and objectives of this Agreement in order for NSF to determine if an aerogeophysical capability should be continued beyond the five year term of this Agreement. If this capability is to continue, this review will also be used by NSF to determine how continued work should be competed. The review is to be scheduled as not to jeopardize field operations to acquire data. The review process can include observations of NSF or reviewers from any time during the performance prior to the formal review. The review panel will be selected by NSF. The Awardee will negotiate costs to support the activities of the review panel directly with the Office of Polar Programs.

Article 8. Limitation of Funds

NSF shall not be obligated to reimburse the Awardee for costs incurred in excess of the amount currently allotted to the Agreement. The Awardee shall not be obligated to continue performance under this Agreement or incur costs in excess of said amounts unless and until the NSF Grants and Agreements Officer notifies the Awardee in writing that the amount allotted to the Agreement has been increased and specifies in such notice a revised allotment which constitutes the amount allotted for performance under this Agreement.

Article 9. Indirect Costs

The amount granted includes an indirect cost allowance at the following rate: 22% off campus rate. This modified total direct costs consists of all salaries and wages, fringe benefits, materials and supplies, services, travel and subagreements and subcontracts up to $25,000 of each subagreement or subcontracts. Equipment, capital expenditures, charges for patient care and tuition remission, rental costs, scholarships, and fellowships as well as the portion of each subagreement and subcontract in excess of $25,000 shall be excluded from the modified total direct costs.

Article 10. NSF Responsibilities

A. NSF involvement must be consistent with the general scope of work as set forth in this Agreement.

B. Performance under this Cooperative Agreement shall be subject to the general oversight and monitoring of the NSF Program Official cited on the Agreement's cover page. This NSF involvement may include, but is not limited to, the following:

1. provide advice, especially with regard to integration and coordination with NSF's Office of Polar Program activities, including:

   (a) negotiate support for science project interaction with the Facility, including definition of annual tasking and deliverables;
   (b) negotiate for twin otter support and other resources required to implement field work in Antarctica under the Annual Program Plan;
   (c) enforce and support the policy for release of data to the general research community. This policy is that approximately two years after acquisition of a geographically contiguous data set is completed for a science project, the data will be available for release to the general community. The NSF Program Official will be responsible for determining the date of completion of data acquisition for specific projects and for approving the release of data.

C. The NSF Program Official does not have the authority to and may not:

(1) request additional work outside the general scope of the Agreement;

(2) issue instructions which constitute a change as defined in Article 8 of GC-1;

(3) cause an increase or decrease in the estimated cost or time required for performance under the Agreement; or

(4) change the expressed terms and conditions of the Agreement.

D. If, in the opinion of the Awardee, any instructions or requests issued by the NSF Program Official are within one of the categories as defined in 10.C (1) through (4) above, the Awardee shall not proceed, but shall notify the NSF Grants and Agreements Officer and request, if appropriate, modification of the Agreement in accordance with Article 38, "Changes -- Limitation of Funds," of the attached Cooperative Agreement General Conditions.

E. Unless stated otherwise, all NSF approvals, authorizations, notifications and instructions required pursuant to the terms of this Cooperative Agreement must be set forth in writing by the NSF Grants and Agreements Officer.

Article 11. Awardee Reporting Requirements

A. The Awardee shall provide the NSF Program Official with annual program report detailing the prior year's effort by March 1st of each year (normally five (5) copies will be sent). This will also serve as the Awardee's request for continued support. The documentation will usually include, but is not necessary limited to the following:

(1) summary of accomplishments, future plans, and discussion of major change in direction/pace.

(2) a financial report containing the following information:

(a) a budget explanation by major project and major function for the current fiscal year and the preceding fiscal year;

(b) 4-column table (use Form 1030 budget categories) containing actual expenditures, project estimates to end of the current fiscal year, and total expenditures (actual plus projected costs). This information should also be supplied for subcontracts;

(c) a statement of funds estimated to remain unobligated at the end of the current award year;

(d) a proposed program plan in accordance with this agreement and a proposed budget for the next award year in accordance with NSF Form 1030.

B. The Awardees' staff will meet, as necessary, with NSF staff to review the relevant operations of the Facility and to exchange views, ideas, and information concerning the Facility and the Polar Earth Sciences Program.

C. The reports and plans shall be sent in the specified number of copies to the following destination:

No. of Copies	Addressee
5	National Science Foundation Office of Polar Programs, Room 755 Polar Earth Sciences Program Attn.: NSF Program Official

Article 12. Acknowledgment of NSF Support and Reports from Users

In accordance with Article 20, "Publication" of the GC-1 Grant General Conditions, appropriate acknowledgment of NSF's support should be included in reports or publication based on work performed under this Agreement.

Article 13. Key Personnel

The Facility will be under the direction of a Management Team. The following individuals are considered to be essential to the work being performed. Any change in these individuals, or any significant change in the level of effort of the individuals, under this Agreement shall require the prior written approval of the NSF Grants and Agreements Officer.

Personnel	Title	Level of Effort
Donald D. Blankenship	Scientific Director	4 months/year
Robin E. Bell	Scientific Director	4 months/year
Keith A. Najmulski	Technical Coordinator	9 months/year
TBD	Scientific Coordinator	9 months/year

Article 14. Prior Approval and Notification Requirements

In addition to the prior approval requirements as set forth in Article 2 of the GC-1 General Conditions, prior written approval by the NSF Program Official is required for equipment purchases over $15,000, which were not identified in the approved budget, and the reprogramming of funds over $30,000.

Article 15. Permanent Equipment

Title to all equipment purchased and/or fabricated with Government funds under this Agreement shall passed directly to the Government from the vendor. Within 30 days from the date of delivery by the vendor, the Awardee shall furnish the Foundation Property Management Officer with a full description of the equipment, including model and serial number, acquisition cost (including transportation charges), and the date of acquisition. The Awardee shall be responsible for property control over Government equipment until such time as it is delivered to an agent of the Foundation. Upon expiration of the Agreement, disposition of the equipment will be determined by the Foundation in consultation with the Awardee.

Article 16. Order of Precedence

Any inconsistency in this Cooperative Agreement shall be resolved by giving precedence in the following order: (a) the Special Conditions; and (b) the General Conditions.

II. General Conditions

The following General Conditions attached hereto shall apply to this Cooperative Agreement and are incorporated herein:

1. **Grant General Conditions**, GC-1 (5/94)

2. **Cooperative Agreement General Conditions**, NSF CA-1 (5/94), which is amended as follows:

   Delete Article 41, "GC-1 Deletions" in its entirety and substitute the following in lieu thereof.

41. GC-1 Deletions

The following articles in GC-1, Grant General Conditions, are not applicable to this Cooperative Agreement:

4. No-Cost Extensions
5. Expenditures for Related Projects
33. Resolution of Conflicting Conditions (GC-1)
40. Resolution of Conflicting Conditions (CA-1)

IN WITNESS WHEREOF, the parties have executed Cooperative Agreement No. OPP-9319379 "Support Office for Aerogeophysical Research (SOAR)."

UNITED STATES OF AMERICA:

(Signature)

Aaron R. Asrael
Grants and Agreements Officer
(Name and Title)

8/31/94
(Date)

NATIONAL SCIENCE FOUNDATION
Arlington, VA

ACCEPTANCE:

X
(Signature)

STEPHEN A. MONTI
VICE PROVOST
(Name and Title)

SEP 27 1994
(Date)

UNIVERSITY OF TEXAS
Austin, TX

Attachment I

The data stream from each of the aircraft's independent geophysical and navigation systems is collected by a central acquisition computer. A similar system is used to collect base station observations. These acquisition computers, upon recognizing a packet from a particular system, tag it with an identifier and the time from a master clock. This packet is then written in the order of its arrival to an archival medium. At the completion of a flight, these multiplexed data structures both for the aircraft and the base station are demultiplexed and recombined into a hierarchical file structure. This file structure contains a continuous data stream for each aircraft system along each transect and a continuous data stream for each base-station system for the entire flight period. At the completion of the field season the large radar data stream is separated from the other aircraft streams and all transects are spatially gathered. The data streams requested for each proposal/investigator are then archived for distribution.