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Cambridge, MA. 02138

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TITLE OF PROPOSED PROJECT **Acquisition of New GPS Equipment for the UNAVCO Community Pool in Support of Current and Emerging Solid-Earth Sciences Research Applications**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PREPROPOSAL NO., IF APPLICABLE
$ **375,250**	**36** months	**06/01/02**	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

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By signing and submitting this proposal, the individual applicant or the authorized official of the applicant institution is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), as set forth in Grant Proposal Guide (GPG), NSF 02-2. Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

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The undersigned certifies, to the best of his or her knowledge and belief, that:

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AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **James L Davis**	**Electronic Signature**	**Jan 15 2002 4:24PM**

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PROJECT SUMMARY

New GPS Equipment for the UNAVCO Community Pool in Support of Current and Emerging Solid-Earth Sciences Research Applications

This proposal addresses the rapidly approaching need to upgrade the UNAVCO community Global Positioning System (GPS) receiver pool, critical for high-precision GPS campaign-style measurements to support solid-Earth sciences research. Annual reports submitted by UNAVCO to the NSF EAR Instrumentation and Facilities (I&F) Program document the extensive use of the pool by many investigators, as well as the diverse research applications supported. To summarize, the scientific applications of campaign-style GPS measurements have grown in recent years to include plate motions and deformation within boundary zones, earthquake processes, continental dynamics, active tectonics, geomorphology, volcanology, polar studies including glaciology, sea level change, and atmospheric sensing, amongst many others.

A similar equipment request was included in the successful 1999 UNAVCO community and facility proposal. The range of topics to be covered in such a large proposal, however, prevented a sufficient justification for an upgrade to the pool to be fully developed. The EAR-I&F Panel declined that part of the budget request and encouraged the community to re-submit the equipment request under separate cover. Since 1999, community use of pool campaign equipment has increased more than 50% (282 receiver months in FY99 vs. 443 receiver months in FY01) because of new investigators and new applications. In addition, the capability of new-generation GPS receivers has improved and the price of GPS equipment has declined. These trends and the continued aging of the current UNAVCO pool of GPS equipment make it timely to submit this new equipment request.

The 24 NSF-EAR receivers in the pool are on average seven years old, out of production, and spare parts are no longer available. Plans must be made for refurbishment and upgrade to the pool in the near future or the community will loose significant equipment availability due to attrition from the rigors of field surveys. Current generation GPS receivers also have several improved features including improved data quality, reduced power consumption, smaller size, and increased memory that make them desirable to the UNAVCO community. A state-of-the-art receiver pool is necessary to ensure the UNAVCO Facility's continued leadership in geodetic GPS technology for campaign applications on behalf of the community.

The main uses of the UNAVCO equipment pool continue to be traditional millimeter-level positioning for inference of crustal deformation and studies in earthquake processes. GPS campaigns involve data collection for several days per survey point, with multiple receivers, often over large, multi-country regions, and 24 new receivers are requested to maintain this capability. An additional six receivers with added capability are also requested to support newer, emerging kinematic, rapid static, and real-time kinematic applications that require centimeter-level precision but with many more points surveyed in a much shorter time frame. This equipment will support projects related to active tectonics, geomorphology, ice dynamics, and mapping, as well as other more traditional campaign applications.

The proposed 30 receiver purchase will be spread over three years to reduce the initial investment required by the I&F program and to ensure a continuum in age and capability of equipment in the pool. As new equipment is introduced into the pool over the three-year period, the older pool receivers will be made available to NSF-EAR funded research projects for use in permanent GPS installations. This approach results in a direct and significant cost savings for the EAR Division, and the I&F Program specifically.

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For font size and page formatting specifications, see GPG section II.C.

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

PROJECT DESCRIPTION

1. INTRODUCTION

This proposal addresses the rapidly approaching need to upgrade the UNAVCO[1] community Global Positioning System (GPS) receiver pool, critical for high-precision GPS campaign measurements to support Earth sciences related research. UNAVCO was originally formed in 1984 around the concept of sharing a small number of scarce and very expensive GPS receivers. Even though the price of receivers has decreased ten to twenty-fold in the meantime, equipment sharing through a centralized pool remains a very valid concept for the precise-GPS research community. Many institutions and Principal Investigators (PIs) using GPS have neither the technical ability nor desire to maintain equipment for the occasional field or teaching application and look to the UNAVCO Facility for access to equipment and associated technical support. Maintaining, scheduling, deploying, and purchasing campaign GPS equipment on behalf of the community continues to be one of the most important functions of the UNAVCO Facility. Previous UNAVCO annual reports to the National Science Foundation (NSF) Earth Sciences Division (EAR) Instrumentation and Facilities (I&F) Program document the application of UNAVCO pool equipment and associated scientific results (http://www.unavco.ucar.edu/aboutus/publications/publications.html). The following section of this proposal provides statistics on the current status of the UNAVCO pool, including usage rates by the community. Figure 1-1 shows several of the many recent campaign applications of the UNAVCO receiver pool.

Figure 1-1. Rapid static survey of raised marine terraces to measure fault-related folding in California's Northern Channel Islands (left); vertical control benchmark for the Mississippi Delta project used to document Holocene sea-level change (upper right); Mt. Erebus, Antarctica volcano deformation campaign network site at Hooper's Shoulder (lower right).

The UNAVCO community pool of standardized GPS receivers and the ancillary equipment required to make precise GPS measurements was built up by a series of university-led proposals that included

[1] UNAVCO was formerly the University NAVSTAR Consortium but is now UNAVCO, Inc., the submitting organization for this proposal.

institutional cost sharing and a commensurate time share (e.g., 50%-50%) between that institution and the UNAVCO pool. This approach resulted in a fairly substantial community pool being developed over time, but one that required extensive time management and repeated shipping of receivers between the Facility, individual projects, and owner institutions. With the large infusion of GPS equipment associated with the NSF Academic Research Infrastructure (ARI) award to the University Corporation for Atmospheric Research (UCAR) on behalf of the UNAVCO community in 1995, the concept of time sharing equipment was abandoned as overly inefficient for both the Facility and individual participating institutions. Negotiations were undertaken with universities that time-shared equipment with UNAVCO to divide the equipment permanently between the institution or the pool on a pro-rata basis consistent with the original time-share agreement, e.g., if a university had six receivers in the pool half time, they received three receivers for permanent, full-time use as did the pool.

Based on the substantial quantity discount achieved through bulk purchase of GPS receivers under the multi-institution ARI award, both the participating individual institutions and the community pool received a substantial infusion of new state-of-the art GPS equipment. Since this happened in 1995, however, there have been significant improvements in GPS receiver performance and the current pool, while heavily used, is becoming outdated and difficult to repair due to scarcity of repair parts. Also, half of the existing pool pre-dates the 1995 purchase and many of those receivers are approaching ten years of age. The only additions to the pool in the subsequent years have been through contributions by other programs, such as the NSF Office of Polar Programs (OPP). Table 1-1 provides a summary of the current UNAVCO GPS receiver pool. This proposal is specifically to replace the 24 aging NSF-EAR receivers in the pool, and to purchase an additional six systems to meet future demand and emerging applications.

Table 1-1. Current UNAVCO GPS receiver pool

NSF-EAR Receivers		
Receiver Type	**Quantity**	**Average Age**
Trimble 4000 SSE	14	8 years
Trimble 4000 SSi	10	6 years
Total NSF-EAR	**24**	**7 years**
NSF-OPP Receivers		
Receiver Type	**Quantity**	**Average Age**
Trimble 4000 SSE	1	7 years
Trimble 4000 SSi	7	4 years
Trimble 4700	3	3 years
Total NSF-OPP	**11**	**4 years**
Other Receivers		
Receiver Type	**Quantity**	**Average Age**
Ashtech Z12	2 (UNAVCO)	4 years
Trimble 4000 SSi	6 (NSF-ATM)	5 years
Trimble 4700	1 (American Mt. Everest Expedition)	1 year
Trimble 4800	3 (American Mt. Everest Expedition)	4 years
Total Other	**12**	**4 years**
Total Pool		
	Quantity	**Average Age**
	47	**6 years**

Plans must be made for refurbishment and upgrade to the pool in the near future or the community will loose significant capability in terms of both equipment availability and performance. An additional motivation for looking at upgrades to the community pool is the plan to have a campaign-style pool of 100 receivers available to the community in connection with the Plate Boundary Observatory (PBO). These GPS systems will be used to conduct focused, local, short-term projects and to densify permanently installed networks where the research goals dictate a higher spatial density for measurements and for

rapid response after earthquakes and volcanic events. The plan spelled out in this proposal to identify, test, purchase and maintain new equipment for the community pool is an excellent precursor activity to developing a PBO-dedicated pool in the FY2003 time frame.

Finally, an issue that must be addressed up-front in this proposal is that of cost sharing. The NSF-EAR I&F Program has a long-standing policy of requiring an institutional cost share for equipment purchases. While this concept can work for individual universities because of the availability of private and/or state funds, the requirement is problematic for UNAVCO, Inc. UNAVCO, Inc., the submitting entity for this proposal, has collected a very modest amount of private funds to date but barely enough to meet outstanding legal and organizational costs associated with creating the corporation. The only option would be to attempt a community-wide GPS receiver purchase and ask the participating universities to "contribute" a portion of their cost share, a mechanism which history has shown to be very unpopular and divisive within the community. Based on these circumstances, this proposal is submitted requesting that the I&F cost-share requirement be waived. We believe the benefits of a shared pool of GPS equipment to the Earth sciences research community, and therefore to the EAR program, are substantial and we will present other ways of achieving cost advantages and off-sets to compensate for the lack of institutional cost share.

The equipment will be maintained and supported on behalf of the GPS research community by the UNAVCO Facility in Boulder, Colorado. The previous UNAVCO Facility and community proposal submitted via UCAR and funded under a four-year award (EAR-9910789) clearly spells out the responsibility of the UNAVCO Facility in supporting and maintaining a pool of GPS equipment on behalf of the NSF-funded solid-Earth sciences community. The UNAVCO Facility is funded under that award to maintain, test, calibrate, repair, and ship the UNAVCO pool equipment in support of both NSF-funded and community research initiatives. That same community proposal submitted in July of 1999 requested funds for replacements to the UNAVCO pool of GPS equipment. The EAR-I&F Panel requested that a separate proposal regarding pool equipment be submitted. This proposal is responsive to that request.

2. BENEFITS OF AN UPGRADED RECEIVER POOL

Maintaining a Healthy Pool. The most urgent reason to upgrade the UNAVCO receiver pool is that the existing pool is shrinking due to the normal attrition associated with field use, while receiver demand has increased more than 50% since 1999. The rigors of field surveys damage approximately 10% of the UNAVCO pool receivers per year, and receiver repair has been an important UNAVCO role in maintaining the pool in top operational condition. Trimble 4000 SSE spare parts, however, are unavailable commercially and the UNAVCO stockpile is depleted. The Trimble 4000 SSi receiver and spare components have been out of production since 2000, but UNAVCO has continued repairing damaged receivers using stockpiled spare parts. As these supplies are depleted it is necessary to cannibalize receivers to extend the life of the remaining receivers in the pool. The direct, immediate impact of this is a reduced ability to support campaign projects in the future. Figure 2-1 and Table 2-1 illustrate the FY2002 receiver requests as of January 10, 2002. Additional requests are received throughout the year and are projected based on FY2001 data, when over 30% of project requests for the year were received after January.

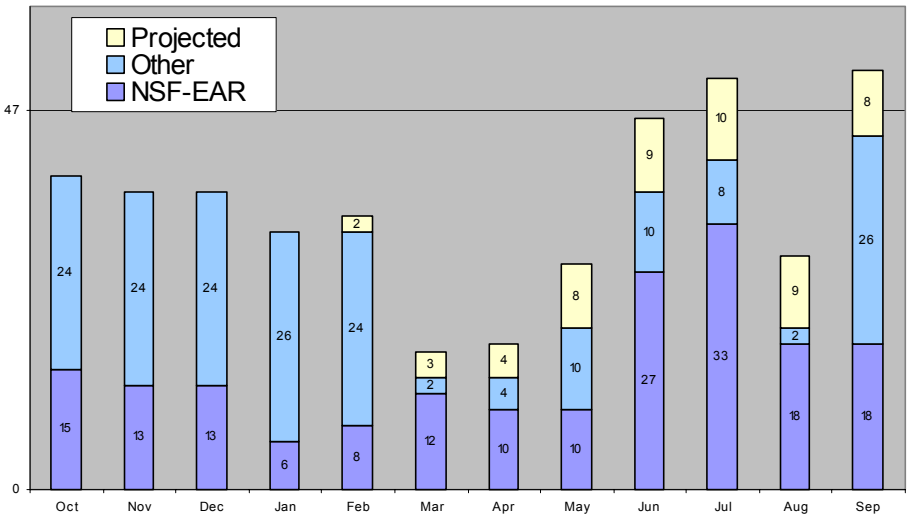

Figure 2-1. Current receiver schedule as of January 10, and projected receiver demand for FY2002 (24 of the 47 receivers in the pool are contributed by NSF-EAR).

Table 2-1. Receiver requests for FY2002 as of January 10, 2002

Award	Title/Investigator	# Receivers, Dates
NSF EAR-9903183	Vertical Movement in the Southern Alps Constrained by GPS and Absolute Gravity/P. Molnar	3, Oct-Sep03
NSF EAR-0003740	Collaborative Research: Geodynamics of the Eastern California Shear Zone/T. Dixon	2, Oct
Cooperative Agreement	GPS Support to the NSF Office of Polar Programs Supplement to NSF EAR-9903413	24, Oct-Feb
NSF EAR-0003621	Nazca- South America Convergence and Continental Growth in the Central Andes/T. Dixon	10, Oct-Dec
NSF EAR-0073769	GPS Observations and Numerical Modeling of a Rapid Shear Zone in Irian Jaya, Indonesia/R. McCaffrey	3, Jan-Apr
Internal MIT	MIT Field Geophysics/T. Herring	2, Jan
NSF EAR-0083752	Rio Grande Biocomplexity Incubation/D. McDonnell	2, Feb-Mar
NSF BNS-9910545	Chunchucmil Regional Economy Program; Phase II/B. Dahlen	2, Mar-Apr
NSF EAR-0106238	Collaborative Research: Active Deformation Of The Central And Northern Dead Sea Fault/R. Reilinger	4, Mar-May
Private	American Mt. Everest Expedition/D. Mencin	2, Apr-Jun
NSF OPP-9818251	Collaborative Research: Glacial Valley Profile Evolution/R. Anderson	6, May-Jul
NSF EAR-0106824	Mechanisms of Postseismic and Interseismic Deformation, Southern Alaska/J. Freymueller	3, May-Sep
NSF OPP-0095088	Collaborative Research: Spatial and Temporal Variability of Ground Temperature and Thaw, Northern Alaska/F. Nelson	2, May-Sep
NSF EAR (proposed)	Collaborative Research: Retreating-Trench, Extension, And Accretion Tectonics (RETREAT): A Multidisciplinary Study Of The Northern Apennines/R. Bennett	15, Jun-Jul
NSF-EAR (proposed)	Collaborative Research; Monitoring Surface Deformation At Torfajokull And Hekla Volcanoes, Southern Iceland/T. Dixon	6, Jun-Aug
NSF EAR-9909730	Present-Day Kinematics And Dynamics Of The Eastern Mediterranean/Caucasus/R. Reilinger	6, Jul-Sep
Cooperative Agreement	GPS Support to the NSF Office of Polar Programs Supplement to NSF EAR-9903413	24, Sep-Feb03

Upgrade to a State-of-the-Art Pool. The Trimble 4000 SSi receiver, the workhorse of the UNAVCO pool, was first introduced in 1995. Since then, GPS technology for geodetic applications has improved dramatically through two generations of new equipment. For example, the Trimble line of receivers progressed to the 4700/4800 series (1997-2000) and is now based on the 5700 system introduced in 2001. Other geodetic GPS manufacturers such as Ashtech have a similar progression of products. Current generation GPS receivers have several improved features such as improved data quality, reduced power consumption, smaller size, and increased memory that make them desirable to the UNAVCO community, and the UNAVCO Facility is already supporting community purchases and technical support questions related to this new equipment. A state-of-the-art receiver pool will ensure the UNAVCO Facility's continued leadership in geodetic GPS technology for campaign applications.

Improved Features and Functionality. Table 2-2 highlights the features of newer equipment that are of significance to campaign data collection. Reduced power consumption results in a decrease in the batteries and solar panels required, significantly increasing field portability to remote sites. This can result in significant cost savings to all projects and especially those relying on light aircraft transport to remote field locations.

Increased receiver memory allows data collection for up to a year without data downloads, and allows for higher data logging rates without frequent downloads. Increased memory may eliminate data downloading visits to a site during a campaign, resulting in significant travel and staff time savings. The combination of low power consumption and high memory capacity is particularly well suited to semi-continuous applications in remote locations.

New equipment is also more compact, and a complete receiver-antenna-battery system can now be carried in a single suitcase-sized transport case instead of the two cases required for pool systems as illustrated in Figure 2-2. Eliminating the need for periodic data downloads, and the reduction in bulk and weight are especially important in reducing field costs and logistical complexity for GPS sites only accessible by aircraft.

Table 2-2. Features of current pool vs. new generation geodetic GPS receivers

Feature	Current Pool Receivers (Trimble 4000 SSi)	Current Generation Receivers
power consumption	12 W	3-5 W
data logging memory	10 Mb (internal)	100+ Mb (removable commercial PC card)
weight, with battery for 24 hour survey	37.3 kg (82 lb)	14.5 kg (32 lb)
battery location	external	internal and/or external
size	6.3 cu. ft., 2 pcs.	2.0 cu. ft., 1 pc.
real-time kinematic radio option	external	internal or external
cost	$12-25K	$8-12K

Figure 2-2. Current UNAVCO pool campaign system (left) vs. a modern GPS campaign system (right). The modern system is less than half the size and weight of the current UNAVCO pool systems.

Improved Data Quality. Newer GPS receivers provide better signal tracking, especially on the weaker L2 GPS signal. Figure 2-3 illustrates the occurrence of cycle-slips (breaks in signal tracking) in data from a Trimble 4000 SSi and a newer generation 4700 receiver during a period of increased solar activity and ionospheric disturbance. Both receivers used a chokering antenna. As can be seen from the figure, the newer generation 4700 receiver provides significantly better L2 tracking as indicated by the lack of cycle-slips (loss of lock). UNAVCO will conduct a thorough data quality evaluation and comparison as part of the proposed equipment pool upgrade.

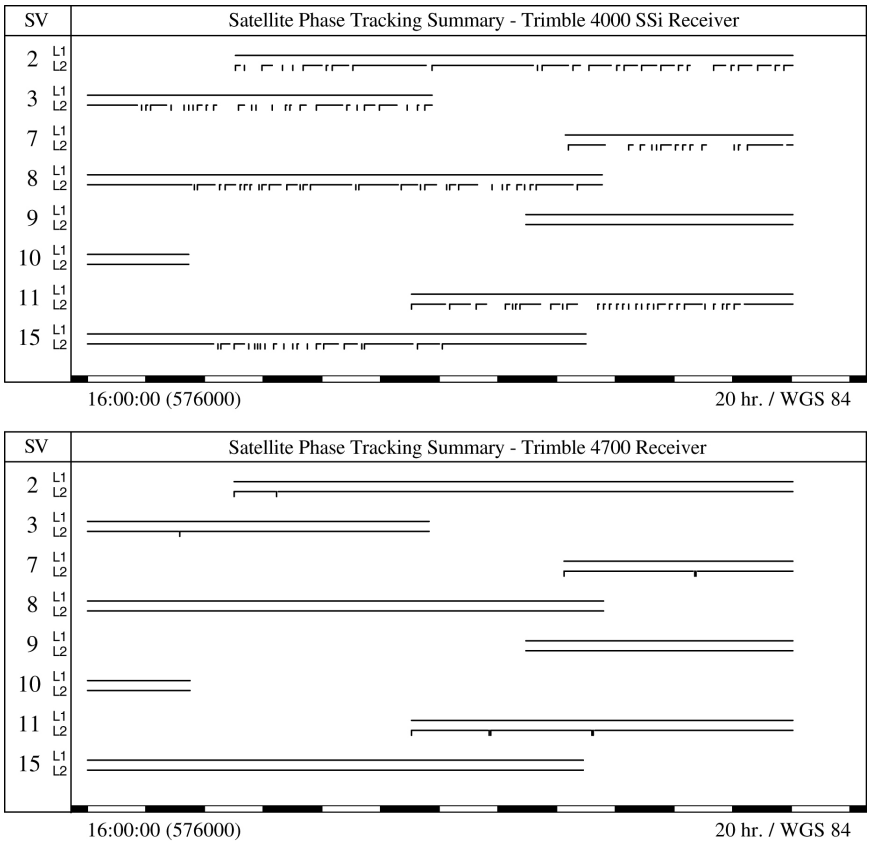

Figure 2-3. Satellite tracking summary for a Trimble 4000 (upper) vs. 4700 receiver (lower) illustrates the improved tracking capability of newer generation GPS receivers. Note the significant increase in L2 cycle-slips (vertical ticks indicating loss of lock) and data gaps on the older Trimble 4000 receiver.

Improved Antenna Performance. The trend in GPS antenna technology is to make more compact antennas while improving performance. Manufacturers claim their newer antenna elements have improved phase center stability and the groundplanes are as effective as the chokering design in reducing multipath. UNAVCO continues to evaluate data quality issues from various antenna designs, and rigorous antenna testing would be a significant part of evaluating and selecting the appropriate GPS system for the UNAVCO pool. Table 2-3 illustrates performance differences between the Trimble chokering and new Zephyr Geodetic antennas, as claimed by the manufacturer. As seen from the table, the newer antenna offers comparable performance and significant weight reduction.

Table 2-3. Features of chokering vs. new generation geodetic GPS antenna

Feature	**Chokering**	**Trimble Zephyr Geodetic**
L1 phase multipath	7.0 mm RMS	8.8 mm RMS
code multipath (L1/L2)	0.25/0.28 m RMS	0.26/0.32 m RMS
phase center variation deviation	0.2 mm RMS	0.2 mm RMS
% observables (10-90 deg)	97%	99%
diameter	38 cm	34 cm
weight	4.5 kg	1.0 kg

Cost. GPS receiver systems have come down slightly in cost since the UNAVCO ARI purchase in 1995. The more significant issue affecting cost is negotiating quantity discounts. UNAVCO is much more likely to negotiate favorable receiver pricing as part of a bulk receiver pool upgrade. UNAVCO community members also benefit from such a volume discount, as they have in the years after the 1995 ARI and 2000 SuomiNet Major Research Infrastructure (MRI) purchases based on quantity discounts available through the Facility.

3. REVIEW OF COMMUNITY GPS REQUIREMENTS

The geodetic GPS community continues to utilize the UNAVCO equipment pool for a wide variety of PI-based projects. Experienced investigators are supported as "agents", where they receive equipment but little technical support from UNAVCO. Those with less experience or larger and more complex projects continue to rely upon UNAVCO engineers for training and field support.

Campaign Measurements. The main use of the UNAVCO equipment pool continues to be traditional millimeter-level precision crustal deformation GPS campaigns involving data collection for several days per survey point. For such projects the UNAVCO pool is either the sole source of GPS equipment or it is used to augment equipment owned by the PI institution. A new equipment pool will ensure UNAVCO's continued ability to support such projects with current technology. Examples of several ongoing, multi-year campaigns supported by NSF and the UNAVCO pool include New Zealand Southern Alps Vertical Movement (P. Molnar), Irian Jaya Rapid Shear Zone (R. McCaffrey), Central and Northern Dead Sea Fault Zone (R. Reilinger), Southern Alaska Post and Inter-Seismic Deformation (J. Freymueller), and Dynamics of the Eastern Mediterranean (R. Reilinger).

Kinematic, Rapid Static, and Real Time Kinematic (RTK) Applications. Over the past several years, UNAVCO has experienced a considerable increase in requests for centimeter-level precision GPS surveying support for projects involving active tectonics, geomorphology, ice dynamics, and mapping. These projects require the same state-of-the-art dual frequency GPS receivers as the traditional geophysical applications, but the data collection periods tend to be on the order of minutes to hours per point. Typically many points are surveyed in a day and field portability of the GPS equipment becomes a significant factor. The current UNAVCO pool Trimble 4000 SSi receivers are bulky and cumbersome for such applications. Current generation receivers, which are smaller, lighter, require fewer batteries, and are technically advanced will enhance UNAVCO's ability to support such projects without a sacrifice in data quality for traditional campaign style surveys. Examples of several past and ongoing projects using these rapid data collection techniques include: Iceberg Lake, Alaska Topography Mapping (R. Anderson); Channel Islands, California Fault-Related Folding (N. Pinter); and Rio Grande/Sevilleta, New Mexico Digital Elevation Mapping (D. McDonnell).

Semi-Permanent Applications. High memory receivers now provide the UNAVCO community with the ability to utilize semi-permanent stations for sub-millimeter applications, where continuous data are desired but there is no need to retrieve the data in real-time. Receivers may be set out for several weeks, and up to a year in some cases, before requiring data download. Currently UNAVCO does not have the ability to support such applications because the receiver pool is memory-limited to 10Mb (less than two weeks of data collection between downloads). With new, high memory GPS receivers UNAVCO will be able to support this emerging application of GPS. Examples of applications where this is important include measuring post-earthquake response and volcano monitoring. NSF-OPP-funded receivers with extended memory are being used this year in Antarctica to measure deformation of Mt. Erebus, and the motion (tidal, rotation, and displacement) of Iceberg C-16 which calved off the Ross Ice Shelf in March 2000.

4. PROPOSED RECEIVER PURCHASE PLAN

Equipment Specification. All major community purchases of GPS equipment such as the 1995 ARI and 2000 SuomiNet MRI projects started with development of a detailed equipment

specification. The general primary requirements for receiver and antenna performance are shown in Table 4-1. Since the newer receiver technology does not support a "one size fits all" strategy we have identified several primary applications including semi-continuous operation, campaign occupations, kinematic measurements, and real-time kinematic applications. All of these applications share major system specifications but also have certain unique requirements as seen in Table 4-2. Twenty four receivers are requested to replace the existing pool, and an additional six systems are requested to support kinematic applications as discussed in Section 6, EQUIPMENT REQUEST.

Table 4-1. General performance requirements for GPS pool receiver and antenna systems

Feature	**Minimum Requirement**	**Desired**
observables	L1/ L2 pseudorange, L1/L2 phase, AS techniques	WAAS
channels	12 L1, 12 L2	all-in-view
tracking	0-90 degrees	
logging rate	0.5 – 300 sec	
I/O ports	2 I/O ports	+2 pwr ports
power	<5 W	<3 W
power ports	2 12 VDC power ports	internal battery
battery	12 VDC power port	
data logging	6 mo. @ 60 sec, removable memory	1 yr. @ 30 sec
data format	translator to RINEX	RINEX, BINEX option
external devices	data collector, met station compatible	display and meta-data entry on receiver
antenna	L1/L2, separate from receiver, 30m cable w/o external amplifier, stable and known gain pattern	chokering compatible, compact antenna available
carrying case	1 for receiver + antenna	
weight	<20 kg complete system	
environmental	-40 C to +65 C, 100% humidity fully sealed, 1 m drop	

Table 4-2. Functional requirements for GPS pool receivers

Function	**Qty. Rqd.**	**Notes**
campaign, semi-continuous surveys	24	all systems purchased under this proposal would be standardized for campaign surveys and semi-continuous applications
+kinematic surveys	4	additional equipment required includes compact antennas, backpacks, and hand-held controllers
+kinematic, RTK surveys and stake-out	2	additional equipment required includes base and rover radios, compact antennas, backpacks, and hand-held controllers

Equipment Testing. Once the system specification is finalized it will be sent to the major GPS vendors with a request for both a technical and cost proposal detailing how their system meets the system specification and providing a cost structure for quantity purchases. Upon receipt of those proposals, they will be reviewed for compliance with the specifications. For those found in compliance, the vendors will be requested to provide equipment for testing at the UNAVCO Facility. All equipment submitted will be tested under a rigorous plan to ensure that all data quality and receiver functionality requirements are met with an emphasis on data quality, minimal loss of data, low power consumption, ease of use, and lifetime cost of operations and maintenance. Based on these test results, a recommendation for purchase will be made by the Facility to UNAVCO, Inc.

The difficult part of any GPS receiver testing is a potential trade-off between performance and price. In previous UNAVCO receiver testing, a statistical analysis tool was used to appropriately weight various performance parameters against price to develop a final recommended receiver purchase. The evaluation criteria and relative weights could include, for example, technical performance (40%), price (30%), timely delivery (20%), and general organization of the vendor (10%). For the technical criteria such as observations per cycle slip or short baseline residual troposphere, each receiver/antenna pair would receive a normalized score based on the mean and standard deviation of all scores for a particular test.

Vendor Selection. Once the testing procedure outlined above is complete, the UNAVCO Facility will make a GPS receiver recommendation to UNAVCO, Inc. based on a combination of price and performance criteria. UNAVCO, Inc. will independently vet this recommendation with other community leaders well versed in GPS equipment requirements and capability. Based on the outcome of this external review, UNAVCO, Inc. will move forward with purchase of the equipment as recommended by the Facility and/or modified by community input. The winning vendor will be required to submit a First Article to the Facility for acceptance testing before large-scale shipment commences. Upon receipt of production quantities of equipment, the Facility will implement an internal test and acceptance plan to check everything from inventory lists of materials to individual receiver/antenna performance.

Use of Existing Pool Equipment. The older GPS receivers in the community pool after new equipment is purchased are proposed to be placed into permanent installations where they tend to operate more reliably and for longer periods of time than when used repeatedly for campaigns. This strategy of using older receivers that still meet all data quality requirements has been used successfully in the past. Under the 1995 ARI purchase, ten Trimble SSE systems were made available to support EAR-I&F-funded projects in central Asia and Nepal which resulted in a direct cost savings on the order of $120,000 to the I&F program. UNAVCO also supports approximately 90 permanent stations that use the Trimble 4000 receiver, and since spare parts are no longer available, several of the current pool receivers can be used as spares to extend the life of these existing stations for continued use by the community.

Ancillary Equipment. In the case of the hundreds of pieces of ancillary equipment such as tripods, batteries, and computers, the current equipment will be maintained and only partially replaced under this proposal. Table 4-3 provides a summary of the currently available ancillary equipment and how much new equipment will be required to adequately support the pool.

Table 4-3 – Ancillary equipment required

Ancillary Equipment	Current	Additional Requested	Total Required
tribrachs	31	0	30
optical plummets	31	0	30
data download PC	5	10	15
tripods	35	0	30
batteries	(expendable)	30	30
memory cards	0	30	30
pocket PCs for receiver configuration	0	15	15
spare antenna cables	0	30	30
solar panels	15	0	0

5. EQUIPMENT SUPPORT PLAN

Once a decision has been made for the new pool receivers, UNAVCO, Inc. and the UNAVCO Facility will jointly apply standard procedure to purchase, deploy, support, and repair this equipment. Upon receipt at the UNAVCO Facility, all new GPS receivers are checked for damage, verified for features and options, and tested for proper operation and acceptable data quality. The receivers are inventoried in the UNAVCO equipment database, tagged with property identification numbers, and listed as insured capital equipment before becoming part of the community pool. In this case, equipment will be tagged to UNAVCO, Inc. but will be insured by UCAR, probably under the existing umbrella equipment policy that covers all pool equipment.

Once the equipment is in the pool, it is available for community use by request via the on-line support request form on the UNAVCO Facility Web page (www.unavco.ucar.edu). Projects with programmatic support (NSF-EAR and NSF-OPP) receive top priority, and community projects are supported on a resource-available basis. UNAVCO will continue to offer training, field engineering support, and data archiving services associated with the use of this pool equipment including extensive web-based support. Prior to any equipment loan, the project PI signs an Agent Agreement and assumes all responsibility for the equipment while in field. Upon return to UNAVCO after the project, the equipment is checked for damage and tested for proper operation and acceptable data quality. Damaged equipment is repaired, and the user institution is billed for any substantial damage. The Facility cleans, calibrates, and makes minor repairs to the equipment at no cost to the user.

As with the 1995 ARI and 2000 SuomiNet MRI purchases, UNAVCO will be a service depot for community GPS equipment purchased through this proposal. This service will include specially trained repair technicians and dedicated Line Replacement Unit receivers that would be available to the community on temporary loan while their equipment is in for repair, allowing minimal disruption to critical fieldwork in the event of equipment failure. UNAVCO is currently an authorized repair depot for both Ashtech and Trimble receivers.

6. EQUIPMENT REQUEST

Previous sections of this proposal have documented how the UNAVCO equipment pool has been built up over the years, as well as the current strengths and weaknesses of the pool. The primary reasons for requesting an infusion of new equipment into the UNAVCO pool come down to:

- increasing age of the pool (Table 1-1)
- increasing difficulty and cost of maintaining the current pool
- increased operating capability of new generation equipment (Table 2-2)
- improved data quality associated with new generation equipment (Figure 2-3)
- demand outstripping availability during the peak survey season (Figure 2-1 and Table 2-1)

The equipment testing and new quantity pricing that will come out of a new group purchase will also benefit future purchases, whether by individual universities or a large group purchase for the PBO campaign pool. Costs will be reduced while data collection capability is enhanced.

Table 6-1 summarizes the receivers and ancillary equipment being requested under this proposal. Also shown is the number of existing pool receivers that will become available for support of permanent installations over the next four years. The goal of spreading this request over three years is to reduce the initial investment to be made by the I&F program and to ensure a continuum in age and capability of equipment in the pool.

This proposal will support 30 new generation receivers to be purchased to replace the Trimble 4000 SSE's and SSi's over the next several years. The oldest GPS receivers in the pool (14 Trimble 4000 SSE's) will immediately be made available to NSF-EAR funded research projects for use in permanent GPS installations. This will result in direct cost savings of ~$100,000 to the I&F Program. The somewhat newer Trimble 4000 SSi's including a pool of chokering antennas will remain in the pool for campaign applications for the next few years. As the SSi's are transitioned out of the pool in future years, they will also be made available to EAR-funded projects for permanent installation, saving the I&F Program an additional ~$80,000. The current ancillary equipment will be maintained for as long a useful lifetime as possible, with an initial infusion to meet immediate needs and then new purchases as replacements are needed.

Table 6-1. Three-year phased request for equipment upgrades to the UNAVCO pool

Equipment Requested	FY2002	FY2003	FY2004	FY2005
GPS receivers	**10**	**10**	**10**	
Data download PCs	**5**	**5**	**5**	
Configuration PCs	**5**	**5**	**5**	
Memory cards	**10**	**10**	**10**	
Batteries	**10**	**10**	**10**	
Spare antenna cables	**10**	**10**	**10**	
Existing pool receivers made available to permanent stations	**4 SSE**	**10 SSE**	**5 SSi**	**5 SSi**

Bjorn L. Johns
UNAVCO Special Projects Group Manager
3340 Mitchell Lane
Boulder, CO 80301
Tel: 303-497-8034; Fax: 303-497-8028
E-mail: bjorn@unavco.ucar.edu
URL: http://www.unavco.ucar.edu

a. Professional Preparation:

University of California	Mechanical/Aeronautical Engineering	B.S. 1987
University of Colorado	Aerospace Engineering Sciences	M.S. 1993

b. Appointments:

2000-Present	UNAVCO Special Projects Group Manager
1996-2000	UNAVCO Antarctic Support Manager
1993-1996	UNAVCO Geodetic Engineer
1988-1991	Naval Aviation Depot, U.S. Navy

c. Publications

None

d. Synergistic Activities

The UNAVCO Facility provides equipment, technical, development and testing, archiving, and education and outreach support to the solid Earth sciences research community using GPS. The use of GPS has grown amongst a wide and diverse community of Earth scientists in large part because of the capability represented by the Facility and the UNAVCO community. Bjorn Johns has managed UNAVCO campaign support since 2000.

e. Collaborators and Advisors

None

Wayne S. Shiver
UNAVCO Facility Manager
3340 Mitchell Lane
Boulder, CO 80301
Tel: 303-497-8042; Fax: 303-497-8028
E-mail: shiver@unavco.ucar.edu
URL: http://www.unavco.ucar.edu

a. Professional Preparation

University of North Carolina	Geology	B.S. 1972
Naval Postgraduate School	Oceanography and Meteorology	M.S. 1977

b. Appointments

1994-Present	UNAVCO Facility Manager
1990-1994	Assistant to the President, University Corporation for Atmospheric Research
1988-1990	Senior Program Manager, Science Applications International Corporation
1985-1988	Executive Officer, Naval Environmental Prediction Research Facility
1981-1985	Program Manager, Sippican Ocean Systems, Inc.
1972-1981	US Naval Officer

c. Publications

None

d. Synergistic Activities

The UNAVCO Facility provides equipment, technical, development and testing, archiving, and education and outreach support to the solid Earth sciences research community using GPS. The use of GPS has grown amongst a wide and diverse community of Earth scientists in large part because of the capability represented by the Facility and the UNAVCO community. Wayne Shiver has served as the Facility Manager since 1994.

e. Collaborators and Advisors

Proposal Collaborators:
Jim Davis, Smithsonian Astrophysical Observatory
Tom Herring, MIT, UNAVCO Scientific Director

SUMMARY PROPOSAL BUDGET YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **UNAVCO, Inc.**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Bjorn Johns**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Bjorn Johns - none**	**0.00**	**0.00**	**0.00**	$ **0**	$
2. **Wayne Shiver - none**	**0.00**	**0.00**	**0.00**	**0**	
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**2**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**0.00**	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**0.00**	**0.00**	**0.00**	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**0**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**0**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**0**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **Standard GPS Systems (10)** **$ 100,000**					
TOTAL EQUIPMENT				**100,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**5,750**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**2,000**	
TOTAL OTHER DIRECT COSTS				**7,750**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**107,750**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **(Rate: , Base:)**					
TOTAL INDIRECT COSTS (F&A)				**0**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**107,750**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **107,750**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Bjorn Johns**

ORG. REP. NAME*: **James Davis**

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INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET YEAR 2

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **UNAVCO, Inc.**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Bjorn Johns**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Bjorn Johns - none**	**0.00**	**0.00**	**0.00**	$ **0**	$
2. **Wayne Shiver - none**	**0.00**	**0.00**	**0.00**	**0**	
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**2**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**0.00**	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**0.00**	**0.00**	**0.00**	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**0**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**0**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**0**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
Kinematic GPS Systems (4) $ **60,000**					
RTK Survey System (2) **40,000**					
Standard GPS Systems (4) **40,000**					
TOTAL EQUIPMENT				**140,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**11,750**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**2,000**	
TOTAL OTHER DIRECT COSTS				**13,750**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**153,750**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **(Rate: , Base:)**					
TOTAL INDIRECT COSTS (F&A)				**0**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**153,750**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **153,750**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Bjorn Johns**

ORG. REP. NAME*: **James Davis**

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 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **UNAVCO, Inc.**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Bjorn Johns**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Bjorn Johns - none**	**0.00**	**0.00**	**0.00**	$ **0**	$
2. **Wayne Shiver - none**	**0.00**	**0.00**	**0.00**	**0**	
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**2**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**0.00**	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**0.00**	**0.00**	**0.00**	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**0**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**0**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**0**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **Standard GPS Systems (10)** **$ 100,000**					
TOTAL EQUIPMENT				**100,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**11,750**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**2,000**	
TOTAL OTHER DIRECT COSTS				**13,750**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**113,750**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **(Rate: , Base:)**					
TOTAL INDIRECT COSTS (F&A)				**0**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**113,750**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **113,750**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Bjorn Johns**

ORG. REP. NAME*: **James Davis**

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Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
UNAVCO, Inc.

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Bjorn Johns

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Bjorn Johns - none**	**0.00**	**0.00**	**0.00**	$ **0**	$
2. **Wayne Shiver - none**	**0.00**	**0.00**	**0.00**	**0**	
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**2**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**0.00**	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**0.00**	**0.00**	**0.00**	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**0**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**0**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**0**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **$ 340,000**					
TOTAL EQUIPMENT				**340,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**29,250**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**6,000**	
TOTAL OTHER DIRECT COSTS				**35,250**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**375,250**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**0**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**375,250**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **375,250**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Bjorn Johns

ORG. REP. NAME*
James Davis

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INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

BUDGET JUSTIFICATION

Section 6 of the Project Description of this proposal identifies the specific equipment being requested to augment the UNAVCO GPS pool. As noted in that discussion, funds are requested to be spread over a three year period in order to reduce the cost impact on the NSF EAR Instrumentation and Facilities (I&F) Program, ensure a phased-in addition of new equipment to the pool, and allow a gradual release of current pool receivers for use in EAR-funded GPS projects requesting equipment for permanent GPS installations. Also as previously discussed, UNAVCO, Inc. is requesting a waiver to the EAR-I&F cost share requirement due to the extremely limited private funds available to the corporation (a few thousand dollars) and there being no other practical way to generate a private cost share match.

As shown in Table 1-1, funds are being requested for a total of 30 GPS receivers (10/year for 3 years), 30 personal computers for data downloading and receiver configuration, and various memory cards, batteries and spare cables required to maintain the pool of ancillary equipment. Table 1-1 shows an inventory of the items being requested as well as the best current estimate of pricing for each item including an annual funding request and three year total. The estimate of $10k per receiver is based on current quotes for similarly configured receiver systems, while allowing for the possibility of the added expense of chokering antennas for some of the systems if deemed necessary by the user community. If reduced pricing is achieved for receivers in the first year procurement, the second and third year funding requests will be reduced proportionately. Pricing for ancillary equipment is based on current purchase prices that are not expected to change in the near future. Under the current mode of NSF-EAR funding of UNAVCO, Inc. activities, there is no overhead applied to equipment.

The equipment requested through this proposal will be maintained and supported on behalf of the GPS research community by the UNAVCO Facility in Boulder, Colorado, which is administered as a program within the University Corporation for Atmospheric Research (UCAR). The previous UNAVCO Facility and community proposal submitted via UCAR and funded under a four-year award (EAR-9910789) clearly spells out the responsibility of the UNAVCO Facility in supporting and maintaining a pool of GPS equipment on behalf of the NSF-funded solid-Earth sciences community. The UNAVCO Facility is funded under that award to maintain, test, calibrate, repair, and ship the UNAVCO pool equipment in support of both NSF-funded and community research initiatives. Given ownership of the equipment by UNAVCO, Inc. and maintenance of the equipment at the UNAVCO Facility, funds for additional insurance to cover against losses are included in Table 1-1.

Table 1-1. Summary budget request for UNAVCO pool equipment

	FY2002		FY2003		FY2004		
	Qty	Cost($)	Qty	Cost($)	Qty	Cost($)	Total $ Requested
Equipment							
Standard GPS Systems ($10,000 ea.)	10	100,000	4	40,000	10	100,000	260,000
Kinematic GPS Systems ($15,000 ea.)			4	60,000			30,000
RTK Survey System (2 receivers @ $40,000)			2	40,000			40,000
Data download computers ($1200 ea)			5	6,000	5	6,000	12,000
Receiver configuration computer ($500 ea.)	5	2,500	5	2,500	5	2,500	7,500
Spare antenna cables ($250 ea.)	5	1,250	5	1,250	5	1,250	3,750
Memory cards ($150 ea)	10	1,500	10	1,500	10	1,500	4,500
Batteries ($50 ea.)		500		500		500	1,500
Total Equipment		105,750		151,750		111,750	359,250
Purchased Services							
Receiver Insurance ($200/receiver)		2,000		2,000		2,000	6,000
Total Purchased Services		2,000		2,000		2,000	6,000
Total		**107,750**		**153,750**		**113,750**	**375,250**

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Bjorn L. Johns | Other agencies (including NSF) to which this proposal has been/will be submitted: NSF

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: New GPS Equipment for the UNAVCO Community Pool in Support of Current and Emerging Solid-Earth Sciences Research Applications

Source of Support: NSF

Total Award Amount: $375,250 Total Award Period Covered: 06/01/2002 – 06/01/2005

Location of Project: Boulder, CO USA

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 0

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title

Source of Support: NSF

Total Award Amount: Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Wayne S. Shiver	Other agencies (including NSF) to which this proposal has been/will be NSF

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Support of UNAVCO and Related Activities

Source of Support: NSF EAR-9903413, SPO#2

Total Award Amount: $8,832,037 Total Award Period Covered: 1/15/1999 – 9/30/2004

Location of Project: Boulder, CO, USA

Person-Months Per Year Committed to the Project. Cal: 7.0 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Support for UNAVCO, Inc. and Pre-Plate Boundary Observatory (PBO)/ Planning Activities

Source of Support: NSF

Total Award Amount: $283,092 Total Award Period Covered: 10/01/2001 – 04/01/2002

Location of Project: Boulder, CO USA

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 0

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Pre-EarthScope/Pre-Plate Boundary Observatory GPS Backbone Network Reconnaissance and Support

Source of Support: NSF

Total Award Amount: $497,387 Total Award Period Covered 02/01/2002 – 02/01/2003

Location of Project Boulder, CO USA

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 0

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Borehole Strainmeter Permitting and Personnel: A Pre-EarthScope Proposal

Source of Support: NSF

Total Award Amount: $154,897 Total Award Period Covered: 06/01/2002 – 06/01/2003

Location of Project: Boulder, CO USA

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 0

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: New GPS Equipment for the UNAVCO Community Pool in Support of Current and Emerging Solid-Earth Sciences Research Applications

Source of Support: NSF

Total Award Amount: $375,250 Total Award Period Covered: 06/01/2002 – 06/01/2005

Location of Project: Boulder, CO USA

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 0

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

FACILITIES, EQUIPMENT & OTHER RESOURCES

FACILITIES: Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. USE additional pages as necessary.

Laboratory:

Clinical:

Animal:

Computer:

Office:

Other: **The activities outlined within this proposal will be supported by the full capability of the UNAVCO Facility in Boulder, Colorado. The Facility is a $3 million per year, multi-agency funded Global Positioning System (GPS) support facility that includes over 25 full time staff, a pool of over 45 GPS receivers and ancillary equipment, laboratories for technology testing and development, and an extensive archive of**

MAJOR EQUIPMENT: List the most important items available for this project and, as appropriate identifying the location and pertinent capabilities of each.

OTHER RESOURCES: Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual arrangements with other organizations.

Continuation Page:

OTHER FACILITIES (continued):

precise GPS data available through a relational database system. Staff at the Facility include electrical and mechanical engineers, software programmers, computer engineers, systems administrators, and significant financial and contracts management capability. The Facility maintains multiple on-line, relational database systems for the capture and presentation of project information and data and has recently developed a Geographical Information Systems (GIS) capability to support project planning. The Facility supports individual Principal Investigator GPS-based projects, plays a key role in maintaining the global infrastructure required for precise GPS applications, and provides administrative and logistics support for major community meetings and workshops. Funds to support the Facility are obtained through peer review of multi-year proposals to the National Science Foundation and the National Aeronautics and Space Administration.