# HYDROLOGIC INSTRUMENTATION FACILITY OF THE U.S. GEOLOGICAL SURVEY ANNUAL REPORT FOR FISCAL YEAR 1991

By Vito J. Latkovich

---

U.S. GEOLOGICAL SURVEY

Open-File Report 92-132


Stennis Space Center, Mississippi
1992

U.S. DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

---

For additional information,
write to:

Chief
Hydrologic Instrumentation Facility
U.S. Geological Survey
Building 2101
Stennis Space Center, MS 39529

Copies of this report can
be purchased from:

U.S. Geological Survey
Books and Open-File Reports Section
Federal Center
Box 25425
Denver, Colorado 80225

Contents

ILLUSTRATIONS

USE OF BRAND NAMES IN THIS REPORT IS FOR IDENTIFICATION PURPOSES ONLY AND DOES NOT CONSTITUTE ENDORSEMENT BY THE U.S. GEOLOGICAL SURVEY.

# HYDROLOGIC INSTRUMENTATION FACILITY
# OF THE
# U.S. GEOLOGICAL SURVEY
# ANNUAL REPORT FOR FISCAL YEAR 1991
# (October 1990 through September 1991)

## INTRODUCTION

The Hydrologic Instrumentation Facility (HIF) of the U.S. Geological Survey (USGS) has nationwide responsibility for all aspects of hydrologic field instrumentation in support of USGS data-collection programs. The HIF has 36,000 square feet of office, laboratory, and warehouse space at the John C. Stennis Space Center (SSC) on the Mississippi Gulf Coast, approximately 50 miles northeast of New Orleans, Louisiana. With the National Aeronautics and Space Administration (NASA) serving as host agency, 19 other Federal and State agencies located at SSC benefit from contractor-supplied technical and facility-support services and technology-exchange opportunities available at SSC.

The Instrumentation Committee (ICOM) serves the function of a senior advisory group for policy, projects and budget meeting periodically to provide the HIF with guidance on the instrumentation needs of the U.S. Geological Survey. The ICOM met at Tempe, Arizona, in February 1991 and at Denver, Colorado, in August 1991. Committee membership is listed in appendix I.

The Instrumentation Technical Advisory Subcommittee (ITAS), an advisory subcommittee of the ICOM, is composed of individuals involved in field-level data collection. This subcommittee makes recommendations to the ICOM concerning instrument needs and assists HIF staff with the formulation of functional requirements for new instrumentation. Resource persons from other organizational units are available to ITAS as requested by the subcommittee chairperson. The ITAS met in Denver, Colorado, in January 1991 and jointly with the ICOM in Denver in August of that year. Committee membership as of 9/30/91 is listed in appendix I.

A staff of 58 professional, technical, and clerical USGS personnel at the HIF are organized into five sections: Technical Services Section (TSS), Administrative Section (AS), Applications and Development Section (ADS), Test and Evaluation Section (TES), and Field Service and Supply Section (FSS). Organization of the HIF staff is shown in figure 1. In addition, to HIF personnel listed in figure 1, approximately nine on-site contractor employees worked on HIF projects during the year.

The primary purpose of this annual report is to inform Water Resources Division (WRD) personnel of progress made by the HIF in fulfilling its mission to improve instrumentation services to the Division. This report describes the activities of the HIF during fiscal year 1991 (FY91).

## Fiscal Year 1991 Overview

Fiscal Year 1991 was the twelfth year of operation for the HIF. Warehouse sales at HIF were $1.67 million--about $210,000 more than the average sales for previous years of operation.

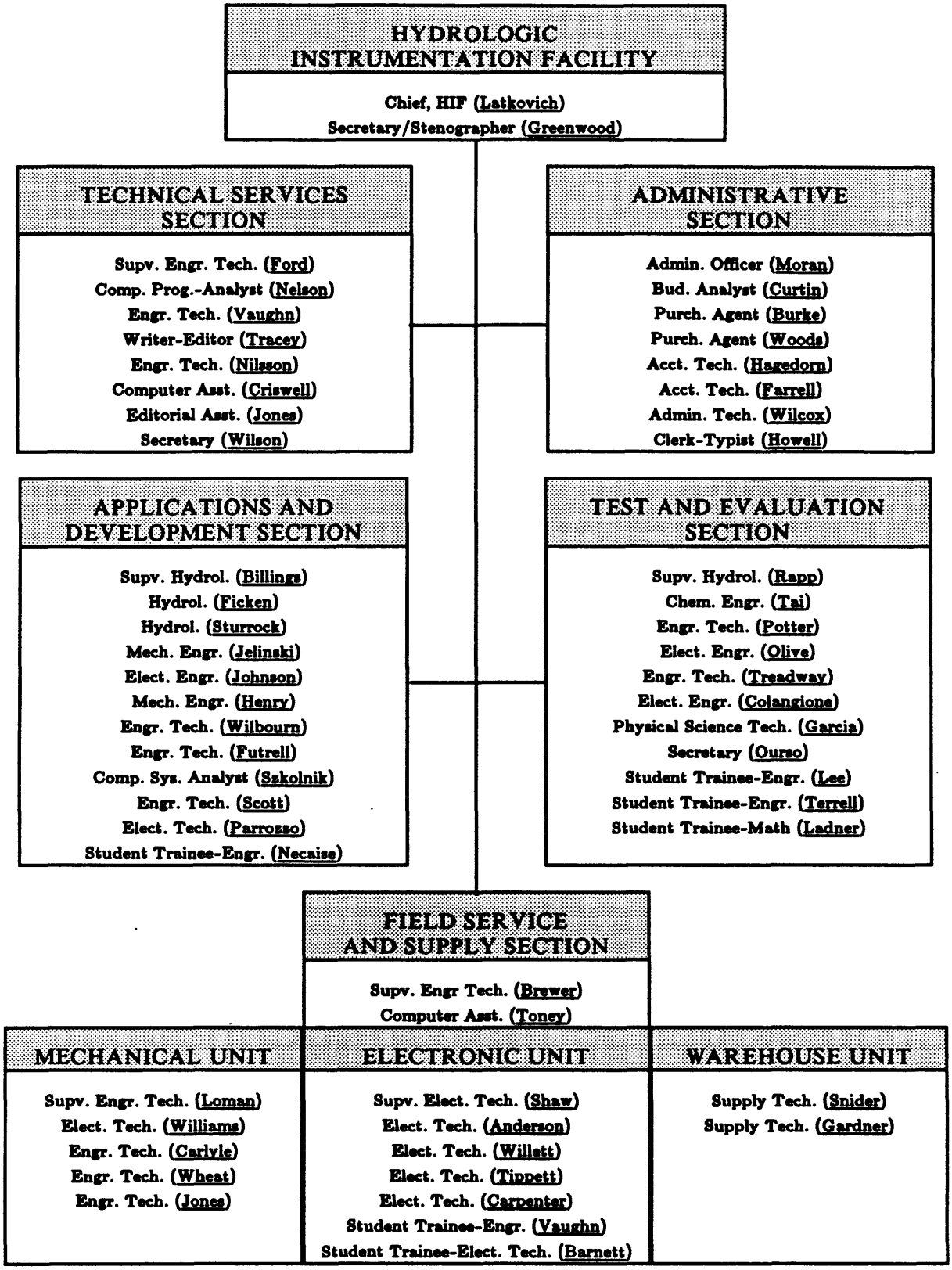


Figure 1.--Hydrologic Instrumentation Facility organization chart.

The reorganization of the HIF, which occurred as a result of the 1987 Management Review, has been in place for 4 years. Since the reorganization, the HIF has focused on two major objectives. First, the HIF strives to be more responsive to the wide variety of instrumentation needs and requirements from the field operation side. Second, the HIF works to make more use of commercially available products, by direct use or use after minor modification, before going into any research and development efforts. Field applications and technical support have ranged from advice and guidance given over the telephone to onsite visits to field sites by one or more HIF personnel for instrument installation and calibration and personnel training.

During FY91, HIF personnel visited 44 WRD offices, 28 of which were district and field offices (appendix II), and attended 33 professional and technical meetings (appendix III). Instrumentation briefings were presented at 8 WRD offices, and 14 presentations were made at professional and technical meetings. Visitors to the HIF included 107 Survey employees, 288 representatives from vendors, 27 representatives from various college and universities, 8 representatives from foreign governments, and numerous onsite agency, local government, and other Federal agency personnel. Fifteen vendors were visited by HIF personnel (appendix IV). The HIF hosted several conference and ad hoc committee meetings as well as training courses. Employees of the HIF are active in numerous professional and technical societies and associations.

The HIF continued its cooperation with the International Water Resources Program. Hydrologic instrumentation for the course "Techniques of Hydrologic Investigations for International Participants (THIIP)," which was held at the National Training Center, was provided by the HIF.

## Major Accomplishments for Fiscal Year 1991

- Completed formal field testing of Basic Data Recorders (BDR's) and Shaft Encoders (SE's) in four districts and at sites operated as part of the National Research Program.

- Completed formal field and laboratory testing and calibration of ultrasonic velocity meters (UVM's) and offered field assistance for newly installed units.

- Contracted with General Services Administration (GSA) to reorganize the Warehouse Unit and write new operating procedures.

- Contracted with GSA to study the feasibility of using a bar-code system for warehouse property control and recommend an implementation plan.

- Procured the following:

  - 211 data-collection platforms
  - 50 ultrasonic velocity meters
  - 137 extra transducers for UVM's
  - 75 pressure sensors (PS-2's)
  - 61,000 ft of UVM cable
  - 200 AA current meters
  - 1,500 AA current-meter bucketwheels
  - 500 pygmy-meter bucketwheels
  - 50 ESC 80 basic data recorders

- 75 CR10 data loggers
- 150 SM192 storage modules
- 40 R200 downhole recorders
- 80 436A encoders
- 50 BDR 301
- 50 436B encoders
- 30 keyboards for CR10 data loggers
- Numerous other items, such as waders, hip boots, wading rods, staff gages, and current-meter parts, required to maintain normal warehouse stock levels.

o Contracted for 20 lightweight ice augers.

o Conducted six instrumentation training courses at the HIF and in district offices.

o Continued support for National Trends Network collocation monitoring site program.

o Continued support for the National Hydrologic Benchmark Network Program.

o Serviced and rented 12 instruments used in the Hazardous-Waste Monitoring Support Program.

o Completed 209 new engineering drawings. Completed 30 new pieces of artwork in connection with the continuation of a project to create 3-dimensional and exploded 3-dimensional artwork of WRD field equipment for use in technical presentations and reports and in the WRD Instrumentation Catalog as replacements for the photographs currently in use.

o Completed the design and development of an extended-boom measuring crane.

o Awarded contract for prototype memory card reader/writer for the Environmental Scientific Corporation (ESC) BDR.

o Awarded contract for the prototype responder system for UVM's.

o Designed, developed, and installed two exhibits for the USGS National Center Visitors Center in Reston.

o Processed the following publications: 2 professional journal articles, 2 proceedings of meetings, 7 open-file reports, 12 technical information sheets, 6 abstracts, 31 HIF internal reports, and 3 manual reprints.

o Awarded contracts for hand-held and B-type personal field computers.

o Continued to provide National Institute of Standards and Technology-certified support for the Yucca Mountain Project (YMP) and provided calibration services as requested by the Project.

o Published and distributed new Operating Manual for the U.S. Geological Survey's Data-Collection System with the Geostationary Operational Environmental Satellite.

o Hosted a 3-week technical exchange visit by a three-man delegation from the People's Republic of China.

During FY91, the HIF rented the following:

- Analog-to-digital recorders (ADR's) ..... 10,963 units
- Monitors, flow-through ..... 58 units
- Minimonitors ..... 497 units
- DCP's ..... 486 units
- DCP shaft encoders ..... 412 units
- Data loggers ..... 829 units
- Data-logger storage modules ..... 617 units
- Special equipment ..... 90 items
- Hazardous-waste equipment ..... 12 items
- UVM's (5 units sold; 1 unit on loan) ..... 53 units
- Downhole recorders ..... 81 units
- Pressure sensor/recorder systems ..... 103 units

The 10 most active districts in procuring equipment and instrumentation from the HIF in FY91 were

1. Texas
2. Nevada
3. Indiana
4. California
5. Washington-Oregon
6. Iowa
7. Arizona
8. Colorado
9. Florida-(Miami Subdistrict)
10. Caribbean

For purposes of comparison the activities of the Field Service and Supply Section at HIF are listed below for 1987, 1990, and 1991. The list clearly indicates that activities have increased substantially in recent years.

| Item | 1987 | 1990 | 1991 |
|---|---|---|---|
| Work Orders | 963 | 2028 | 2079 |
| Minimonitor Repairs-Base Unit | 61 | NA | 423 |
| Minimonitor Repairs-Cables and Probes | 165 | NA | 1464 |
| DCP Repairs-Synergetics | - | 137* | 308* |
| DCP Repairs-Handar | - | 73* | 142* |

*Includes numerous Handar 524's that HIF repairs for WRD and other Federal agencies.

## Operational Actions

- HIF Institutes QIC/TQM.--HIF instituted a Quality Improvement Concepts (QIC) Program beginning in April 1991. The Branch of Quality Assurance is conducting the formal training sessions. As of September 30, 1991, the HIF had completed three 2-day training sessions, and the Quality Council and the Chief, HIF, had completed an additional 2-day "Orientation and Implementation Training" session. Twenty-seven HIF personnel are directly involved in the first iteration of the QIC Program. (For purposes of this report, QIC is synonymous with Total Quality Management or TQM.) The Quality Council has identified three distinct problem areas for team-solution efforts. Teams to deal with those problems have been selected.

- ICOM Ad Hoc Committee Evaluates HIF.--On February 12, 1991, the Instrumentation Committee (ICOM) assigned an ad hoc committee, composed of the District Chief in Pennsylvania, who serves as Chairman, and four ICOM members, to review (1) the principal functions of the HIF--are the existing functions needed in their entirety and (or) are other functions needed--and (2) how the HIF should be funded. The committee prepared a report which was presented to the ICOM on August 7, 1991, and subsequently approved for transmittal to the Senior Management Advisory Committee for the HIF. Action is pending on the resolution of the Ad Hoc/ICOM recommendations. The Ad Hoc committee reported that the HIF is needed and made recommendations as to how HIF should be funded and how those funds should be allocated and used.

- HIF Plans Bar Coding System.--On August 26, 1991, the HIF contracted with GSA to perform a feasibility study to determine if bar coding warehouse inventory and controlled property as well as individually controlled property is practical. If the project is feasible, the contractor will prepare the functional requirements document necessary for procuring bar- code hardware and software. The Chief, Technical Services Section, HIF, has been selected to chair the WRD Bar Code Standards and Coordination Committee.

- HIF Implementing New Warehouse Procedures and Operations.--On July 23, 1991, HIF contracted with GSA to evaluate warehouse operations, procedures, space utilization, security, and personnel. GSA warehouse personnel spent 1 week working with HIF warehouse personnel on shipping and receiving, operations, rearrangement of stock, utilization of available space, overall operating procedures, and development of additional security measures. A new set of warehouse operating procedures was submitted by GSA and is under final review by HIF personnel. HIF is also formulating new pricing and inventory control procedures. The latter work should be completed in FY92. These procedures will satisfy most of the recommendations of the Inspector General's Report of January 1991.

- HIF Will Institute New Equipment Tracking System.--The initial Equipment Tracking System (ETS) developed was inadequate to handle multiple-user inputs. A new ETS has been contracted with Sverdrup Technology and is scheduled to be completed and reach full operational status in the Spring of 1992. The new ETS program will allow for simultaneous multiple-user inputs and will be written in a language compatible with the present Hydrologic Instrumentation Facility-Computer Support System-I (HIF-CSS-I). It will also benefit the ETS component of HIF-CSS-II when completed. The bar-coding system will be an integral part of the ETS when completed and implemented.

- HIF Initiates New Electronic Data Logger Applications Team.--In August 1991, the HIF Electronic Data Logger Applications Team (EDAT) was established to handle field requests for assistance in applications of data loggers and related electronic instrumentation. The EDAT hopes to streamline the manner in which applications assistance is provided and to promote unity of action on the part of HIF personnel. Team members were selected from the various HIF sections so that all aspects of service, support, and applications are covered.

- HIF Develops New Field Coordination Capability.--The field coordination capability was bolstered by the following actions:

  - Sammy Wilbourn replaced Jack Hardee as primary HIF Field Coordinator and contact.

  - James Futrell was selected to be Alternate HIF Field Coordinator and contact.

  - HIF field coordination activity was transferred to the Applications and Development Section.

  - A new internal assistance process was put into action so that field coordination and assistance requests will be answered the day the request is received, if possible.

- HIF Establishes Technical Coordination Program.--In June 1991, HIF established a Technical Coordination Program, which is administered by a group made up of the Section Chiefs, Field Coordinator, second-line supervisors, ADS Procurement and Specification Specialist, and TES Quality Control and Acceptance Test Specialist. The group meets weekly to improve coordination among technical projects and to resolve problems within and between sections. The Chief, ADS, is the Chairman of this group which oversees all technical aspects and activities of the HIF.

## Personnel Actions

The following personnel actions occurred during FY91 or become effective in FY92:

- Sammy Wilbourn was selected to be the HIF Field Coordinator and Training Course Coordinator.

- James Futrell was selected to be Alternate Field Coordinator.

- Bobbie Brewer was selected to be Acting Chief, Field Service and Supply Section. He is also HIF's Safety and Radiation Safety Officer.

- James Ficken was transferred to the Test and Evaluation Section from the Applications and Development Section.

- Donna Criswell was transferred to the Field Service and Supply Section from the Technical Services Section. She is the HIF-CSS Administrator and will spend most of her time working directly with the Field Service and Supply Section.

- Richard Billings was selected to act as Assistant Chief, HIF. He will retain his position of Chief, Applications and Development Section.

- Debra Tracey was selected to be Editor, HIF Instrument News. She is the HIF Writer-Editor in the Technical Services Section.

## Planned Activities for Fiscal Year 1992

- Complete bar-code implementation for warehouse property control at the HIF.
- Complete reorganization of warehouse and implementation of new procedures and operations.
- Complete quality improvement concepts/total quality management (QIC/TQM) training course and implement the first team efforts toward solving designated problems.
- Award contract for the A-type personal field computer.
- Continue formal field tests of PS-2's to determine long-term drift and need for periodic recalibration.
- Purchase additional BDR's, SE's, UVM's, DCP's and PS-2's.
- Continue development of PFC software for laptop computers and begin development of hand-held computers.
- Conduct 10-12 instrumentation training courses at the HIF or in districts offices.
- Continue to research the need for and provide instrumentation support for National Research, National Water Quality Assessment, and Global Climate Change Programs.
- Continue to provide instrumentation support for the National Trends Network and Hydrologic Benchmark Network Programs.
- Procure a prototype broad-band acoustic doppler moving-boat measurement system and begin formal field tests.
- Complete strategy paper for dealing with field problems and complaints.
- Complete redesign and development of activating mechanism on the P61 and P63 water-quality samplers.
- Conduct informal evaluation tests of ground-water organic samplers and pumps, pH and conductivity probes and meters, submersible pressure transducers with SDI-12 output, WaterGage Model G2, and four-parameter water-quality monitors from GSA schedule contractors.
- Continue to work with the Office of Surface Water (OSW) in designing and developing bank-operated cableway systems.
- Complete the design, development, and installation of two exhibits for the USGS National Center. One will be a "hands-on" exhibit to get visitors involved in measuring water levels, gaging streamflow, and sensing water-quality constituents.

- Procure 20 ice augers.

- Award contract for fully digital, portable borehole geophysical logging systems with multiparameter probes and special menu-driven data-collection and analysis software.

## TECHNICAL SERVICES SECTION

The Technical Services Section (TSS) provides in-house technical support to other HIF sections. Drafting and graphics services are provided to create and maintain engineering drawings of WRD equipment. A computerized file of specifications for WRD equipment is maintained, and specifications for existing equipment are written. Assistance in the preparation of specifications is provided to the HIF staff during product development. Computer operation and support is provided in programming, training, and user assistance. TSS administers the HIF's warehouse management system (HIF-CSS). Editorial assistance is provided in the preparation of all HIF publications. In FY91, some drafting and computer operations were provided by contractors under the guidance of TSS.

### Engineering Documentation

Forty work requests were submitted to the drafting group; of these, 38 were completed. In FY91, 209 new drawings were completed. Thirty Engineering Change Requests (ECR's) were submitted during the year of which 20 have been completed. The microfilm drawing file and the index of drawings were routinely updated throughout the year as new or revised drawings were completed. Two hundred nine requests for copies of drawings and artwork were filled, which resulted in 1,735 copies being distributed. Thirty new pieces of artwork were created to replace photographs of WRD field equipment in the WRD Instrumentation Catalog. This artwork consisted of three-dimensional and exploded three-dimensional artwork such as that shown in figures 2 through 6.

### Computer Support

Computer support for both the Prime minicomputer and the 50 personal computers (PC's) at the HIF was provided throughout the year. Several training courses in Travel Manager and other software were presented to the HIF staff. The Local Area Network (LAN) connecting the various computers at the HIF was installed. The project to write a new version of HIF-CSS, which will be compatible with Distributed Information System-II (DIS-II), is continuing.

### Publications

Editorial support was provided to the HIF staff throughout the year. Work processed during the year included 2 professional journal articles, 2 proceedings of meetings, 7 Open-File Reports, 12 Technical Information Sheets, 6 abstracts, 31 HIF internal reports, and 3 manual reprints.

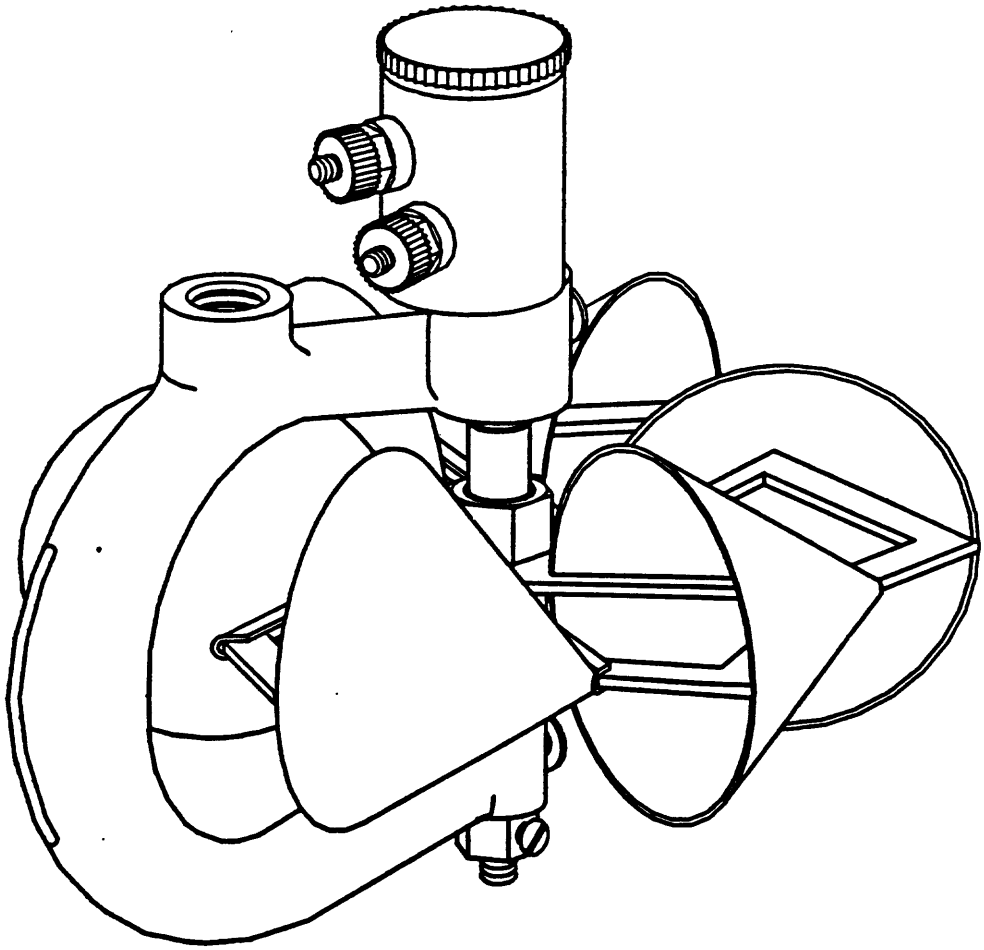

Figure 2.--AA Ice meter.

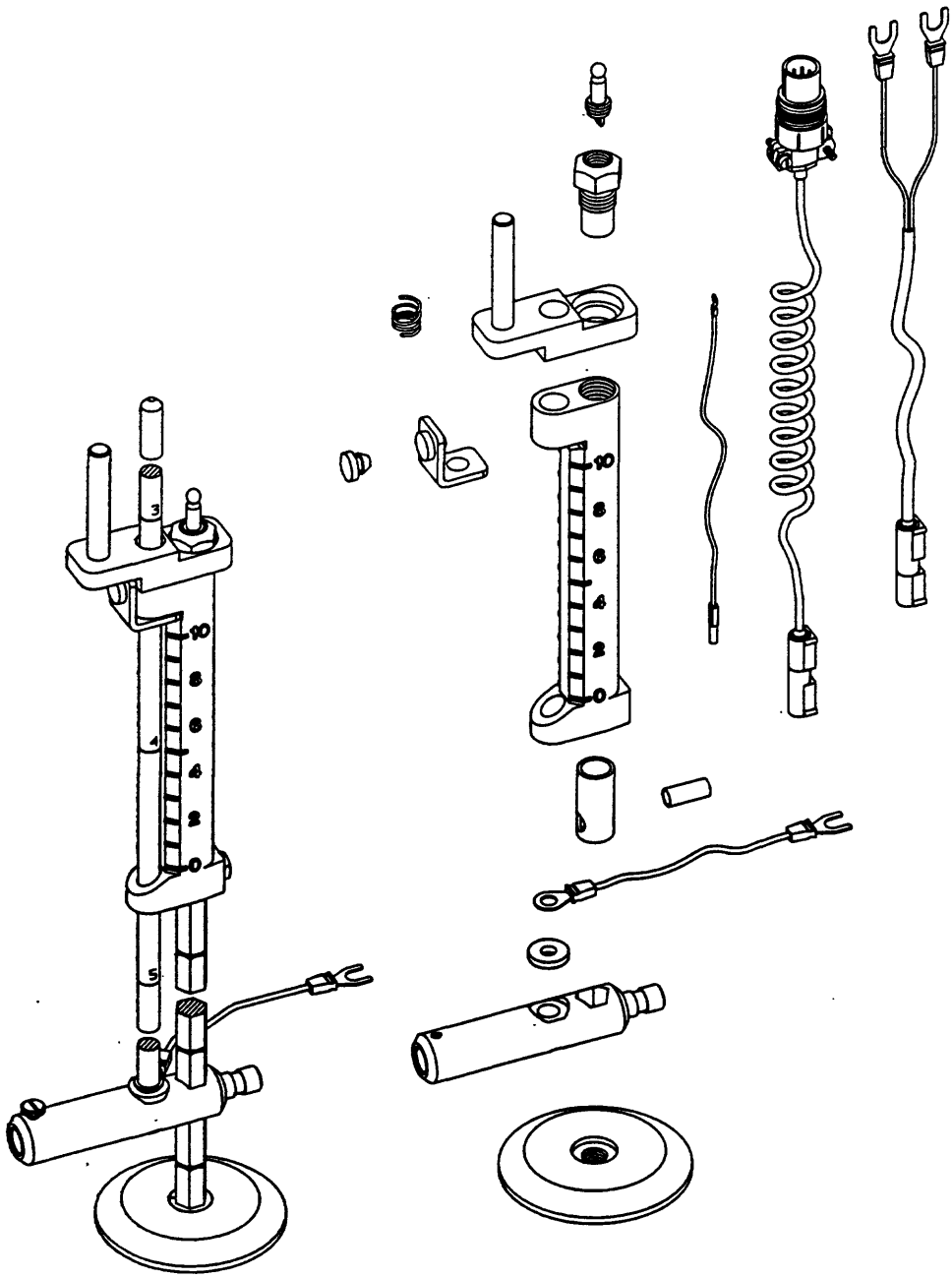

Figure 3.--Top-setting English wading rod.

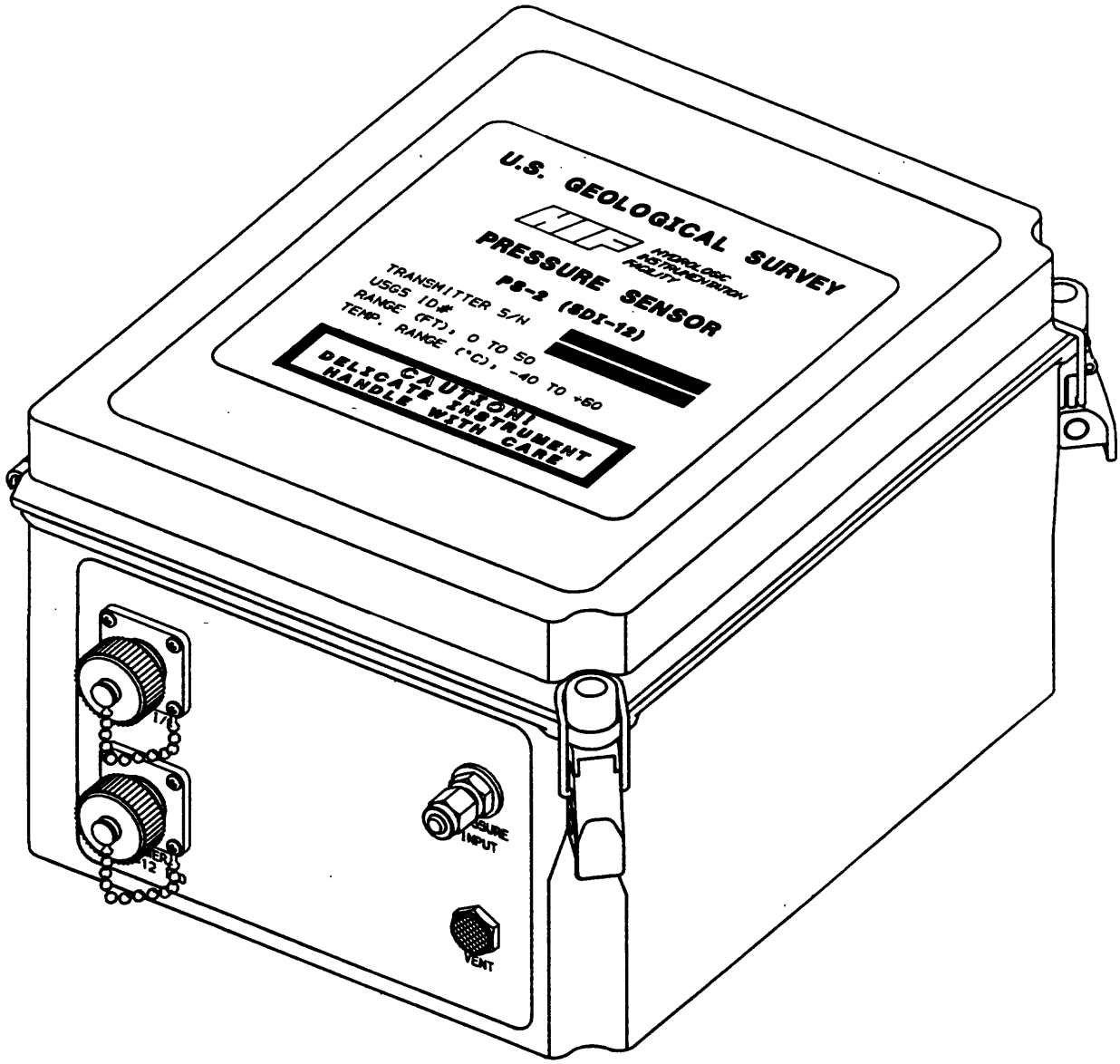


Figure 4.--Pressure sensor (PS-2).

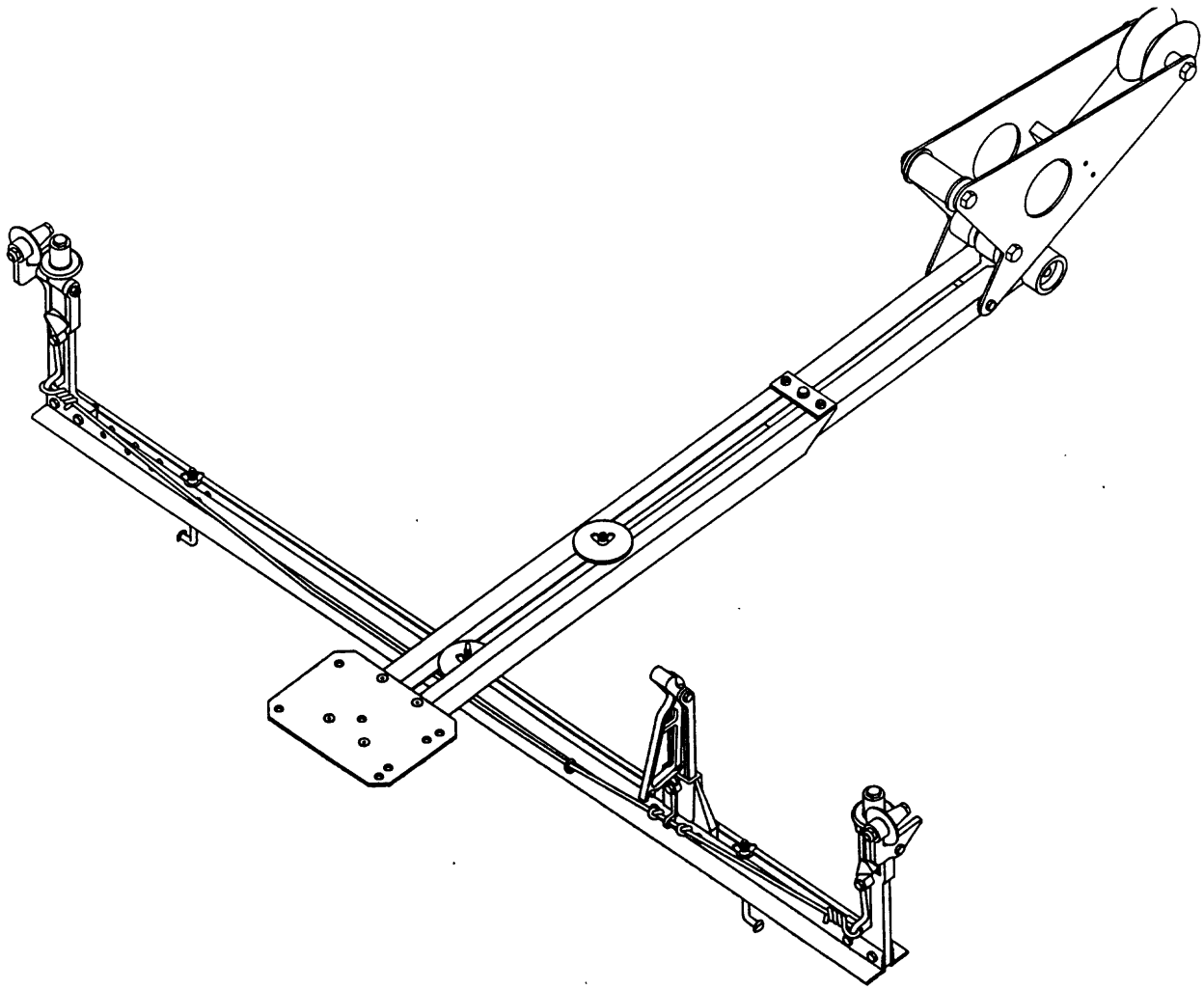

Figure 5.--Device for mounting sounding reel to a boat.

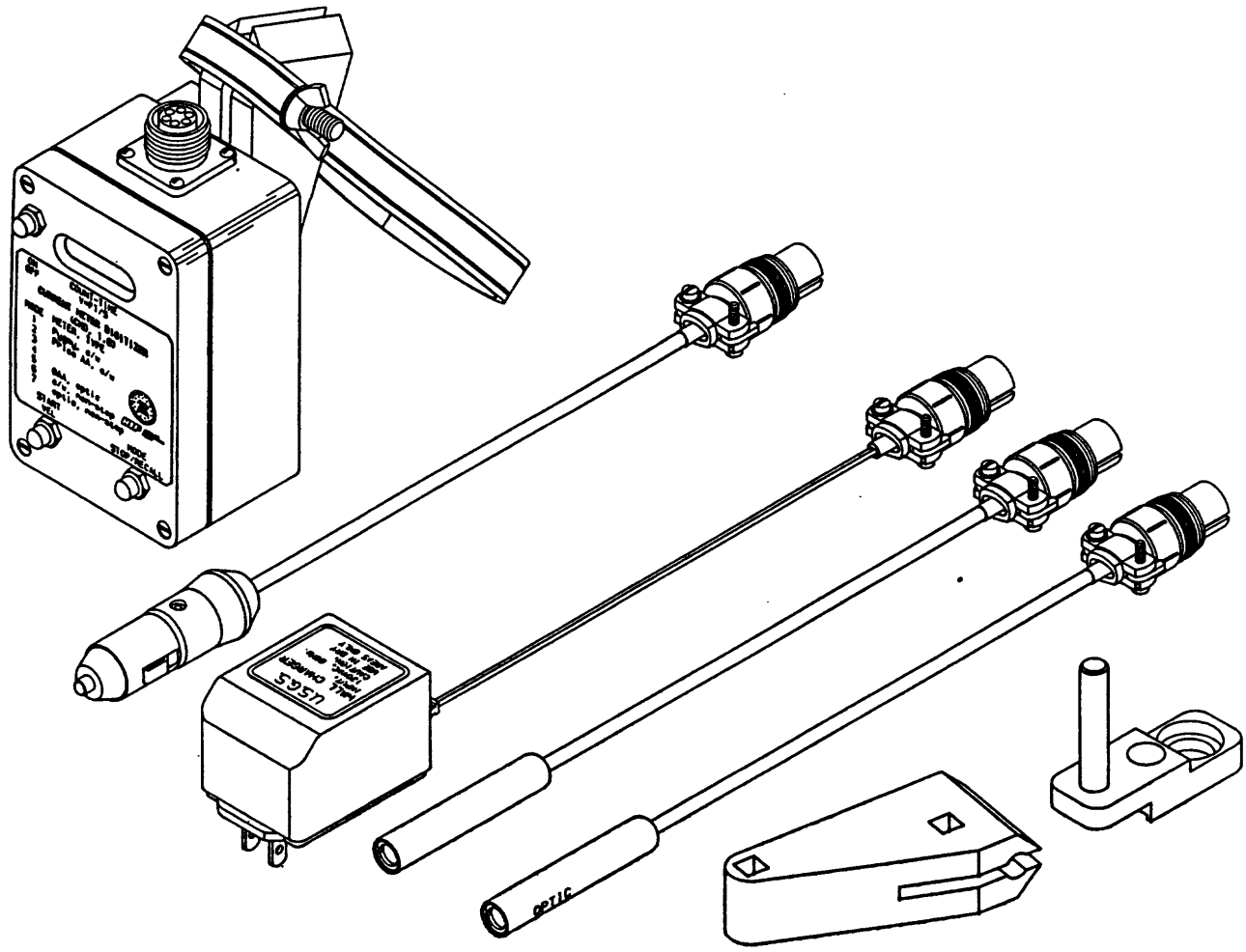

Figure 6.--Current meter digitizer (CMD).

## FIELD COORDINATION

Coordination of programs and activities at the HIF is the responsibility of the HIF Field Coordinator. Major duties of the Field Coordinator are to provide assistance and technical support to the field and to provide training in the application, operation, and maintenance of field instrumentation.

### Field Assistance and Technical Support

During FY91, the HIF received more than 1,000 requests for assistance in the application and support of field instrumentation. A total of about one man-year of effort, contributed by the Field Coordinator and personnel of the Applications and Development, Test and Evaluation, and Field Service and Supply Sections, was expended in responding to these requests. Assistance was provided in the following categories:

| Category | Number of requests | Percent of effort |
|---|---|---|
| Data logger/sensor systems | 25 | 54 |
| Data-collection platform systems | 10 | 21 |
| Water-quality monitor/sensor systems | 5 | 13 |
| Miscellaneous instrumentation | 40 | 8 |
| Availability of warehouse items | 20 | 4 |

### Electronic Data Logger Applications Team (EDAT)

The majority of field assistance and technical support effort was directed toward the application of data logger and sensor systems. During the last half of the year, such requests were received at the rate of about three per day. So that this increasing amount of work could be handled effectively, an Electronic Data Logger Applications Team (EDAT) was established.

All requests related to data logger systems are referred to the EDAT. The team also reviews warehouse orders for data-logger systems and contacts field personnel to verify that orders are suitable for intended applications and to determine whether technical support is needed. Support projects are broken down into work tasks which are then assigned to team members. Results of the individual efforts of team members on the various tasks are integrated into the data logger systems, and the systems are then tested for correctness and documented.

## HIF Training Program

The Field Coordinator served as an instructor at two Satellite Data-Collection Platform Installation and Operation courses in Phoenix, Arizona, and coordinated and participated in the following HIF-sponsored instrumentation courses:

- Operating and Troubleshooting Hydrologic Electronic Instrumentation (HIF and Salt Lake City, Utah)
- Basic Data Recorder Systems (HIF and Little Rock, Arkansas)
- Installation and Operation of Ultrasonic Velocity Meters (Miami, Florida)

## HIF QUALITY ASSURANCE

Quality assurance is a planned and systematic pattern of all actions necessary to provide confidence that adequate technical requirements are established for satisfactory product performance and that products and services conform to those requirements. Quality assurance activities are focused on the identification, correction, and prevention of conditions that adversely influence the acceptability of HIF products and services.

During the year, the HIF Quality Assurance Manager coordinated the following activities and training directed toward improved quality at the HIF.

- Met with the Chief, HIF, and personnel of the Branch of Quality Assurance (BQA), located in Denver, Colorado, on June 6, 1991, to discuss the pilot QIC/TQM program for the warehouse and other operations at the HIF.

- Formed Quality Council to develop HIF's QIC/TQM philosophy, to identify major quality projects, to charter and oversee teams that work on quality projects, and to monitor the progress of QIC/TQM at the HIF. Council met three times in FY91, identified three quality projects, and chartered three teams to work on those projects.

- Encouraged the development of Quality Assurance Procedures (QAPS's) and Standard Operating Procedures (SOP's) in all areas where they were needed. The need for such procedures has been emphasized as a result of the decision to incorporate the HIF Operating Manual into the Quality Assurance Manual. The Technical Services Section assumed responsibility for ensuring the standardization of QAP and SOP documents.

- Arranged for Sverdrup Technology, Inc. to present a program to HIF's senior staff and supervisors on the necessity for calibration of equipment used to repair and test instrumentation.

- Developed plan for implementing new computerized equipment tracking system in early FY92. Developed manual stock tracking system.

- Attended several Environmental Quality Control Joint Interservice Regional Support Group meetings, which involved all government agencies on the Mississippi Gulf Coast.

- Arranged for a guest speaker to address the HIF on the merits of recycling.

- Discussed training for HIF senior staff on Quality Improvement Concepts /Total Quality Management with the Chief, HIF, and the Assistant Chief Hydrologist for Operations.

- Began aggressive QIC/TQM training program to be taught by personnel of the WRD's Branch of Quality Assurance. Three sessions were held in FY91. Training sessions will continue until key HIF personnel have completed a 12-day course on the fundamentals of QIC/TQM.

## HIF SAFETY AND RADIATION SAFETY

Safety is an ongoing concern at the HIF. It is the policy of the HIF to comply with the safety and health standards of the Occupational Safety and Health Act of 1970. Management takes those standards seriously and makes every attempt to ensure safe and healthful working conditions for all HIF employees.

During the year, significant accomplishments by the HIF's Safety Manager included the following:

- Was elected to the Board of Directors for the SSC Safety & Health Council.
- Continued to work with USGS Headquarters personnel to develop a safe means of mercury disposal.
- Conducted quarterly safety inspections at the HIF.
- Reported no duty days lost from on-the-job injuries during the fiscal year.
- Attended the National Safety Conference in San Diego, California, April 14-19, 1991.

The HIF's Radiation Safety Officer arranged the following activities and training in efforts to improve the safety of personnel handling or exposed to radioactive materials at the HIF.

- Conducted radiation safety training for all HIF personnel who work around radiation sources.
- Accepted three radioactive-source transfers.
- Amended the NRC (Nuclear Regulatory Commission) license to allow for sources to remain in the borehole repair shop overnight on an emergency basis. HIF worked directly with NRC rather than through its consultant Dr. Roy Parker on this matter.

## ADMINISTRATIVE SERVICES SECTION

The Administrative Section (AS) is responsible for the formulation and execution of the budget, accounting, procurement, personnel, and office management necessary to support the operating needs of the HIF and Office of Surface Water Programs at SSC. The AS staff consists of nine employees: an administrative officer, a budget analyst, two accounting technicians, an administrative technician, two purchasing agents, and two clerk-typists.

In Fiscal Year 1991, the AS staff administered a budget of approximately $7.1 million. Much of this budget was generated as income to the Field Service and Supply Section, by the Analog-to-Digital Recorder Rental Program, the Water-Quality Monitor Program, the Borehole Equipment Support Project, and the Special Equipment Rental Program in the form of fees charged for services rendered, goods supplied, and equipment leased to WRD projects. ADS and TES operate with direct Federal program funding. Support of the Administrative Service Section is funded by assessment of the operating sections.

Approximately 6,000 documents were transmitted through AS for verification, processing, and monitoring. In addition, the AS staff processed about 400 documents for the Office of Surface Water programs at SSC.

In FY91, AS procured supplies and services totaling $5,331,113 as listed below:

Procurements submitted to Procurement and Contraccts -- 23 - $1,485,675
Procurements processed at HIF ---------- 1120 - $3,845,438

The AS provided administrative support for approximately 50 full-time employees, 6 part-time employees, and 1 intermittent employee. Eighty personnel actions for these employees were processed by the AS during the year. These included training documentation for HIF employees who attended approximately 40 training courses and job-related college-credit courses.

## APPLICATIONS AND DEVELOPMENT SECTION

The Applications and Development Section (ADS) is the WRD's principal engineering resource for developing, acquiring, and providing application support for field instrumentation and related software. With a staff of eleven scientists, engineers, and technicians, the section has experience and knowledge in the areas of surface-water hydrology, water chemistry, hydrometeorology, electrical and mechanical engineering, computer science, and technical support. The section's capabilities are augmented with contractor support in computer science.

Following prescribed procedures, the section provides new and modified field instrumentation products to the Division. First priority is placed on locating, procuring, and supporting the use of suitable standard or modified commercial products. When standard products are not available and vendor interest exists, development contracts are established, together with follow-on procurement and support programs. When no other source is available, products are developed, tested, and supported in house and manufactured under contract.

The section provides on-going technical support to field personnel in the application and use of instrumentation. Such support typically consists of providing consultation, specialized products and services, and training in the operation and maintenance of equipment. Approximately twenty-five percent of available technical staff-hours were committed to this effort during the year.

### Project status

There were 23 active projects in the Applications and Development Section in fiscal year 1991. Brief descriptions of the projects are listed below and the status of each project is described in more detail in individual project summaries that follow.

- Current Meter Technical Support (78-001-08).--A market search for new point-velocity current meters was conducted in support of the Office of Surface Water current-meter study.

- Evapotranspiration Instrumentation (78-005).--Technical support was provided to several major evapotranspiration studies.

- Water-Quality Instrumentation (80-003).--Development and evaluation of a self-cleaning in situ dissolved-oxygen sensor was performed and evaluation of a variety of other water-quality sensors was initiated.

- Ultrasonic Velocity Meter (81-014).--Design refinements were made to the ultrasonic velocity meter, and development of a "responder" version of the unit was initiated. Continuing support was provided for UVM field applications and a new UVM training facility was constructed at the HIF.

- Personal Field Computer (87-041).--A contract was awarded for hand-held field computers and contracts for laptop field computers were processed to the point of award. Personal Field Computer (PFC) software for use in laptop computers was developed.

- Acoustic Doppler Instrumentation (91-002).--A contract was awarded for the development of a broad-band acoustic Doppler current profiler with features optimized for hydrologic applications.

Fiscal Year 1991 Projects

| Number | Name | Chief | Period |
|---|---|---|---|
| 78-001-08 | Current-Meter Technical Support | Futrell | Oct. 1980 and continuing |
| 78-001-34 | Cable-Car Lock | Jelinski | Jan. 1987 to Oct. 1991 |
| 78-005 | Evapotranspiration Instrumentation | Sturrock | Oct. 1978 and continuing |
| 80-003 | Water-Quality Instrumentation | Ficken | Oct. 1980 to Oct. 1991 |
| 81-014 | Ultrasonic Velocity Meter (UVM) | Futrell | Jan. 1981 and continuing |
| 84-032 | R200 Downhole Recorder | Johnson | July 1984 to Oct. 1992 |
| 87-041 | Personal Field Computer (PFC) | Henry | Jan. 1987 and continuing |
| 87-042 | Basic Data Recorder Systems | Billings | July 1987 and continuing |
| 88-004 | Tilting-Weight Ice Meter | Jelinski | Oct. 1988 to Oct. 1991 |
| 88-005 | Pressure Sensors for Basic Data Recorders | Henry | Oct. 1988 and continuing |
| 89-002 | Scour-Measurement Instrumentation | Ficken | Oct. 1988 to Oct. 1991 |
| 89-003 | Portable Crane | Jelinski | Oct. 1989 to April 1991 |
| 89-004 | Large Tipping-Bucket Gage | Jelinski | Oct. 1989 to April 1991 |

| | | | |
|---|---|---|---|
| 89-005 | Pesticide Sampler | Jelinski | Jan. 1989 to Oct. 1991 |
| 89-006 | Minimonitor Interface | Johnson | Oct. 1988 to Oct. 1992 |
| 89-007 | Drive-Point Sampler | Jelinski | Jan. 1989 to July 1991 |
| 90-001 | Electrically Isolated Float-Wheel and Hub Assembly | Jelinski | Oct. 1989 to Oct. 1992 |
| 90-003 | P61 Sampler | Jelinski | April 1990 to Oct. 1991 |
| 90-004 | Hydrologic Benchmark Program | Sturrock | Oct. 1989 to Oct. 1992 |
| 91-001 | Gas-Purge Regulator Improvement | Jelinski | Jan. 1991 to Oct. 1992 |
| 91-002 | Acoustic Doppler Instrumentation | Henry | Oct. 1990 to Oct. 1992 |
| 91-003 | Bank-Operated Cableway | Jelinski | April 1991 to Oct. 1992 |
| 91-004 | Single-Channel Data Logger | Henry | July 1991 to Feb. 1992 |

## Current Meter Technical Support

PROJECT NUMBER.--ADS78-001-08

OBJECTIVE.--To provide technical support to the Office of Surface Water (OSW) current-meter study.

RESULTS LAST YEAR.--A standard rating was developed for the optical AA (OAA) current meter and installed in the current-meter digitizer. Field evaluations of a prototype low-velocity current-meter swivel were completed and a proposal to provide improvements to the prototype, including a seal to retain lubricating oil and an extended tailfin, was obtained. A market search for new point-velocity current meters was conducted, and a report was submitted to the OSW.

PLANS FOR NEXT YEAR.--A contract will be issued to complete the development of the low-velocity current-meter swivel. Technical support will be provided to the OSW current-meter study as requested.

## Cable-Car Lock

PROJECT NUMBER.--ADS78-001-34

OBJECTIVE.--Develop vandalproof locks to secure cable cars at remote gaging sites.

RESULTS LAST YEAR.--Field evaluations of a commercial lock (Cobralink®) with a HIF-designed tumbler shield were completed. Drawings for the lock shield were prepared and 50 shields were procured and placed in the warehouse. Due to the varying lengths of the locks, districts will purchase them directly from the manufacturer. An article on the locks and shields was printed in the *WRD Instrument News*.

PLANS FOR NEXT YEAR.--This project is complete.

## Evapotranspiration Instrumentation

PROJECT NUMBER.--ADS78-005

OBJECTIVE.--To develop and update instrumentation used to determine evaporation losses from lakes and vegetated surfaces.

RESULTS LAST YEAR.--A report on vapor pressure measurements was published in proceedings of the United States-People's Republic of China Bilateral Symposium on Droughts and Arid Region Hydrology. An interpretive report on evaporation from Williams Lake was submitted for publication in the Water Resources Research Journal and work on additional papers related to the Williams Lake study was performed. A colleague review of a report on evaporation from a seepage lake in central Florida was performed. The project chief attended the second annual Integrated Research Initiative (IRI) meeting.

PLANS FOR NEXT YEAR.--Laboratory tests of the ceramic wick psychrometers will be completed. Field evaluation of ceramic wick and non-ventilated capacitance sensor psychrometers will begin in the Idaho and Nevada Districts. Data analysis of evaporation losses at Cottonwood Lake (1982-1986) in south central North Dakota will begin. (A spin-off from this analysis will be a study of the temperature structure of the perma-frost layer below the lake bottom.)

## Water Quality Instrumentation

PROJECT NUMBER.--ADS80-003

OBJECTIVE.--To develop, update, and test water-quality instrumentation.

RESULTS LAST YEAR.--Three prototype Royce self-cleaning dissolved-oxygen (DO) sensor systems are being evaluated, two at the HIF and one on the Trinity River near Dallas, Texas. Initial results indicate that the sensors are able to produce good data under conditions that completely

facility was constructed and nine pH sensors (from four manufacturers) and four dissolved oxygen sensors (including two Royce systems) are being tested. A study of the use of minimonitor conductivity probes interfaced with a CR10 data logger was completed, and an informal report was prepared. A display was provided for the Fifth Federal Interagency Sedimentation Conference held in Las Vegas, Nevada, in March.

PLANS FOR NEXT YEAR.--Because the majority of future work involves testing and evaluation, this project has been canceled. Evaluation of pH and DO sensors will be continued by the HIF Test and Evaluation Section.

### Ultrasonic Velocity Meter

PROJECT NUMBER.--ADS81-014

OBJECTIVE.--To provide technical support to the WRD in establishing an operational data-collection capability based on the ultrasonic time-of-travel measurement technique.

RESULTS LAST YEAR.--Sixty UVM's are currently owned; an additional 30 were ordered. A change order was issued to the UVM contract to provide a number of minor modifications, including an improved data-acquisition scheme, elimination of the external 180-volt battery, and addition of input/output connectors. Kits were purchased to retrofit existing UVM's. A contract was issued for the development of a responder capability for the UVM. A UVM site was constructed at the HIF to support testing and calibration and to serve as a "hands-on" facility for training classes. Various assemblies and techniques for installing transducers were evaluated and documented.

PLANS FOR NEXT YEAR.--Thirty additional UVM's will be received, acceptance tested, and made available through the rental program. Retrofit kits will be installed on all UVM's in field service. Installation of a UVM at the HIF site will be completed. Calibration studies will be performed on the current UVM product and additional products will be purchased and evaluated at the site. Development of the UVM responder capability will be completed and field evaluation of the responder units will begin. UVM training courses will be conducted at the HIF.

### R200 Downhole Recorder

PROJECT NUMBER.--ADS84-032

OBJECTIVE.--To provide a recorder that can be placed inside a 2-inch well casing and can operate unattended for periods of up to 1 year recording daily average water levels or for shorter periods recording instantaneous water levels at fixed intervals of 5, 15, 30, or 60 minutes.

RESULTS LAST YEAR.--Problems with the R200 firmware and with the laptop version of the retriever software were corrected. Maintenance and repair of R200 units were turned over to the HIF repair and calibration shop. A commercial product was evaluated and found to be fundamentally acceptable

for use as a replacement for the existing USGS R200 units. Field requests for alternative versions of the R200 were discussed with the Instrumentation Committee.

PLANS FOR NEXT YEAR.--The retriever software will be rewritten and integrated into the PFC program. A survey of user demand for alternate versions of the R200 will be conducted and the results presented to the Instrumentation Committee for direction.

## Personal Field Computer

PROJECT NUMBER.--ADS87-041

OBJECTIVE.--To provide field computers and standardized software with which field personnel can service the variety of electronic data acquisition products used in the WRD's evolving data-collection network.

RESULTS LAST YEAR.--Specifications for field computers, which were submitted with a procurement requisition during the second quarter of FY90, were revised to bring them up to date technologically. Solicitations for field computers were issued and proposals were received and evaluated. A contract was issued for hand-held field computers and contracts for laptop field computers were processed to the point of award.

Development of a C-language version (2.0) of the Personal Field Computer (PFC) programs for use in laptop computers continued throughout the year and is nearing completion. The program supports the CR10, BDR 301, ESC 80, and 21X data loggers and includes an integrated personal computer version of the DECODES program and a plotting routine that operates on the standard-format data files produced by the DECODES program.

PLANS FOR NEXT YEAR.--Contracts will be awarded for the two types of laptop computers. Initial orders for laptop and hand-held computers will be placed, the products will be acceptance tested, and administration of the contracts by the HIF will proceed. PFC software, laptop version 2.0, will be released for use, and revision 2.01, with support added for DCP's, will be developed. PFC software, hand-held version 1.0, will be developed.

## Basic Data Recorder Systems

PROJECT NUMBER.--ADS87-042

OBJECTIVE.--To acquire a suitable data recorder system to replace the ADR.

RESULTS LAST YEAR.--A change order was issued to the ESC 80 BDR contract to modify the design for operation down to -40 °C. A program was initiated to make the ESC 80 BDR's compatible for use with an external modem and to correct a firmware problem that causes them to stop recording at the end of the year. A contract was issued to develop a memory-module enhancement for the ESC 80 BDR. Two BDR training courses were conducted, one at the Arkansas District and one at the HIF. Technical information sheets on BDR's and related instruments were prepared and submitted for publication.

PLANS FOR NEXT YEAR.--A program will be conducted to replace the firmware in the HIF BDR 301 rental units. Among other things, the new firmware will correct a problem that causes them to lose an hour of data during the transition from standard to daylight time. The BDR technical information sheets will be published. Additional BDR training courses will be taught.

## Tilting-Weight Ice Meter

PROJECT NUMBER.--ADS88-004

OBJECTIVE.--To provide harnesses, based on an ice-meter assembly built by the Maine Subdistrict, that allow the use of current meters and water samplers under ice cover through augered holes no larger than 8 inches in diameter.

RESULTS LAST YEAR.--Manufacturing drawings for the meter and yoke assembly were completed. The prototype harness was sent to the North Dakota District for evaluation and possible use during the next winter. The HIF is prepared to take orders for the harness assemblies.

PLANS FOR NEXT YEAR.--This project is complete.

## Pressure Sensors for Basic Data Recorders

PROJECT NUMBER.--ADS88-005

OBJECTIVE.--To acquire pressure sensor systems with SDI-12 outputs that can be used with basic data recorders and other SDI-12 data recorders and transmission products to replace manometer systems.

RESULTS LAST YEAR.--Forty pressure sensors (PS-2's), consisting of pressure transmitters procured under the contract installed in HIF-designed protective enclosures, were assembled, tested, and released for operational use. A change order to the contract was processed that would require that future units be delivered already assembled. Ninety-five units are now owned; 50 more have been ordered. A PS-2 user manual was prepared and submitted for publication. A Quality Assurance Procedure was written to assure that all steps required to prepare a PS-2 for release to the field are performed.

PLANS FOR NEXT YEAR.--The 50 PS-2 units on order will be received, assembled, tested, and released for operational service. Additional units will be ordered. The PS-2 vendor will be encouraged to place his product on the GSA schedule for procurement after the current contract expires (end of FY92).

## Scour-Measurement Instrumentation

PROJECT NUMBER.--ADS89-002

OBJECTIVE.--To provide technical support to the National Scour Program.

RESULTS LAST YEAR.--Lowrance model 3500 depth sounders were tested and found to operate satisfactorily in water as shallow as 0.8 foot. A feasibility scour measurement system, consisting of two Eagle Mach 1 sounders and an Ultrasonic Ranger interfaced with a CR10 data logger, was furnished to the North Carolina District. Development of a conductivity-type scour sensor resumed with the testing of new probe designs.

PLANS FOR NEXT YEAR.--Because the majority of future work involves testing and evaluation, this project has been canceled. The work will be performed by the HIF Test and Evaluation Section. Engineering support will be provided by ADS on an as-needed basis.

## Portable Crane

PROJECT NUMBER.--ADS89-003

OBJECTIVE.--To design a portable crane that is more versatile than types A and E cranes and has greater horizontal and vertical reach.

RESULTS LAST YEAR.--Final refinements were made to the design of the crane and its four-wheel base. Prototype testing was successfully completed and all drawings necessary to manufacture the units were prepared. The HIF is prepared to take orders for the cranes or to supply the drawings to districts who want to manufacture them elsewhere.

PLANS FOR NEXT YEAR.--This project is complete.

## Large Tipping-Bucket Gage

PROJECT NUMBER.--ADS89-004

OBJECTIVE.--To develop a tipping-bucket rain gage with a capacity of 2 liters per tip and a maximum flow rate of at least 2 gallons per minute to support highway runoff studies and other possible uses.

RESULTS LAST YEAR.--Drawings necessary to manufacture the gages were completed. The HIF is prepared to take orders for the units or to supply the drawings to districts who want to manufacture and calibrate them elsewhere.

PLANS FOR NEXT YEAR.--This project is complete.

## Pesticide Sampler

PROJECT NUMBER.--ADS89-005

OBJECTIVE.--To assist the National Water Quality Laboratory (NWQL) in the development of a field method for measuring volatile organic compounds in small-volume samples using a liquid-solid extraction technique; to develop equipment, as needed, to support the operational implementation of the method.

RESULTS LAST YEAR.--Field evaluations of the prototype sampler were performed by the NWQL during the year. No significant work was performed by HIF project personnel.

PLANS FOR NEXT YEAR.--NWQL personnel will be consulted regarding the outcome of field evaluations and their plans for the continued development of the sampler. Unless further support is indicated, this project is complete.

## Minimonitor Interface

PROJECT NUMBER.--ADS89-006

OBJECTIVE.--To redesign the water-quality minimonitor to support the acquisition of its data by recorders and transmission systems with SDI-12 or analog sensor interfaces.

RESULTS LAST YEAR.--The SDI-12 interface design was completed. Prototype interface hardware was about 80 percent complete and the software was about 70 percent complete. Work began on the layout of a final printer circuit board and the preparation of a user's manual.

PLANS FOR NEXT YEAR.--Due to other higher priorities, work was suspended on this project. The project will be completed on a low-priority basis.

## Drive-Point Sampler

PROJECT NUMBER.--ADS89-007

OBJECTIVE.--To develop and provide manufacturing documentation for a drive-point ground-water sampler for collecting samples to be analyzed for trace-organics and heavy-metals. The sampler is to have seven isolated, screened segments that can be individually sampled from the surface.

RESULTS LAST YEAR.--Drawings to support the manufacture of the sampler were completed and an article was printed in the *WRD Instrument News*. Orders for two additional samplers were filled. The HIF is prepared to take orders for the samplers or to supply the drawings to districts who want to manufacture them elsewhere.

PLANS FOR NEXT YEAR.--This project is complete.

## Electrically Isolated Float-Wheel and Hub Assembly

PROJECT NUMBER.--ADS90-001

OBJECTIVE.--To develop electrically isolated float-wheel and hub assemblies for use with shaft encoders that cannot have electrical contact with water.

RESULTS LAST YEAR.--One hundred plastic float wheels with metal hubs were released for use with the 436B smart shaft encoders. Laboratory evaluations of a one-piece plastic float wheel revealed a design problem.

PLANS FOR NEXT YEAR.--The design problem with the one-piece plastic float wheel will be corrected and a quantity of the units will be manufactured and placed under field evaluation.

## P61 Sampler

PROJECT NUMBER.--ADS90-003

OBJECTIVE.--To redesign the P61 sampler to provide improved sampling valve operation, reduce metallic oxide contamination of the water sample, and permit interchangeability of parts between sampler units.

RESULTS LAST YEAR.--The project chief attended a class on sediment sampling techniques. Data were transferred from the original P61 drawings to the MEDUSA computer-aided drafting (CAD) system. Several candidate designs for the pinch-tube operating mechanism were developed and tested although none proved to be workable.

PLANS FOR NEXT YEAR.--Work on this project is suspended pending the outcome of negotiations with the U.S. Army Corps of Engineers to move the sediment program to the Waterways Experiment Station (WES) in Vicksburg, Mississippi. If the program is ultimately moved to WES, this project will be canceled.

## Hydrologic Benchmark Program

PROJECT NUMBER.--ADS90-004

OBJECTIVE.--To provide support in the acquisition, testing, and calibration of instrumentation to be used in upgrading hydrologic benchmark sites.

RESULTS LAST YEAR.--No significant activities were performed during the year.

PLANS FOR NEXT YEAR.--Plans are to install the remaining 18 rain gages and 5 precipitation samplers during FY92.

## Gas-Purge Regulator Improvement

PROJECT NUMBER.--ADS91-001

OBJECTIVE.--To examine and, if practical, redesign the gas-purge regulator to reduce leaks and guard against improper purging.

RESULTS LAST YEAR.--Previous efforts to solve the problem were studied. It seems probable that the combination of changes resulting from these efforts has produced a reasonable solution but that these changes are not being incorporated into field units. New units assembled at the HIF that incorporate these changes do not show an excessive problem when tested for leaks.

PLANS FOR NEXT YEAR.--One or more battery-powered pressure source/regulator systems will be procured and evaluated for use as a viable alternative to the nitrogen tank system currently used.

## Acoustic Doppler Instrumentation

PROJECT NUMBER.--ADS91-002

OBJECTIVE.--To provide technical support to the WRD in establishing an operational capability for collecting current profiles and making real-time measurements of discharge in small-to-large streams and rivers using acoustic Doppler technology.

RESULTS LAST YEAR.--Specifications for a broad-band acoustic Doppler current profiler with features optimized for hydrologic applications were prepared and a contract was awarded to develop the system. The Office of Surface Water made arrangements for field evaluations of the system by the California and Florida Districts.

PLANS FOR NEXT YEAR.--The system will be delivered and placed under field evaluations. Contract arrangements will be made to refine the system as indicated by the results of these evaluations.

## Bank-Operated Cableway

PROJECT NUMBER.--ADS91-003

OBJECTIVE.--To develop an inexpensive cableway for streamgaging and sampling applications that can be operated remotely from the stream bank.

RESULTS LAST YEAR.--The North Carolina District wants to replace several of its conventional cableways (100 feet or less) with portable bank-operated systems. HIF was requested to develop a relatively simple transport mechanism that is manually operated and does not include meter proximity, depth, or angle sensors. Initial design work on this mechanism was performed.

PLANS FOR NEXT YEAR.--Design of the transport mechanism will be completed. A prototype will be fabricated, tested, and furnished to the district for field evaluation. Assistance will be provided to the district in the initial installation and use of the mechanism.

## Single-Channel Data Logger

PROJECT NUMBER.--ADS91-004

OBJECTIVE.--To conduct a market survey of simple data logger products that can replace ADR-based systems used to measure stage in cold-weather environments.

RESULTS LAST YEAR.--A market search for available candidate products was started.

PLANS FOR NEXT YEAR.--The market search will be completed, and the resulting information will be evaluated. A final report will be provided to the Instrumentation Committee for consideration and direction.

## TEST AND EVALUATION SECTION

The Test and Evaluation Section (TES) establishes minimum performance standards for instrumentation to ensure that WRD data-collection requirements are met and that legal and scientific credibility continues. TES writes acceptance standards, develops quality-control and test procedures that are written into procurement actions, and works closely with Survey offices and other Federal agencies to ensure that the evaluation criteria and calibration procedures used are in compliance with all applicable legal and operational requirements.

TES designs and conducts engineering tests and analyses of WRD-developed and commercial hydrologic instrumentation. A Qualified Products List (QPL) has been developed in accordance with Federal Acquisition Regulations as a guide to the procurement of commercial products that meet WRD requirements. Qualification tests have been conducted on water-level-sensing instrumentation and pH meters and electrodes. These products are on the published QPL. Field offices are encouraged to check with TES if procurement of unfamiliar instrumentation is being considered. In addition to the QPL, TES may be able to pass on experience from other Federal agencies. Field offices are encouraged to pass on information to TES regarding experience with new commercial instrumentation.

### Fiscal Year 1991 Project Highlights

- The test and Evaluation Section conducted acceptance tests on 164 new item shipments received by the warehouse last year. Approximately 81 percent passed all HIF requirements. Those products that did not meet one or more requirements were recommended to be returned for correction. TES conducted extensive acceptance tests on the new SDI-12 ultrasonic velocity meters (UVM). A few problems were found, and corrections were recommended. These acceptance tests are part of the quality-assurance (QA) program of the HIF. Eight used Price type AA and Pygmy meters were recalled from district offices for inspection as part of the QA program. This meter recall program helps establish the reliability of meters used by WRD.

- A number of commercial products were tested to determine that WRD and HIF operational requirements were met. Calibrations were performed on 105 of the HIF-built pressure-sensor systems (PSS). Acceptance tests were completed on Paroscientific SDI-12 nonsubmersible pressure sensor PS-2 shipments. Comparison PS-2 field tests were started in three districts. Preliminary calibration and temperature tests were run on four Design Analysis Associates model H300 SDI-12 submersible pressure transducers and one Fluid Data Systems WaterGage II.

- The final drafting of the GOES manual chapters on battery-power systems and antenna installations were completed. Phone inquiries concerning batteries, solar panels, controllers, and lightning protection were answered. Sessions on power systems were taught in HIF training courses during the year. *WRD Instrument News* articles were written on selecting and installing power systems.

- Proper grounding and lightning-protection procedures were taught in the HIF electronics troubleshooting classes. The Biddle Megger Null-Balance Earth Tester and Biddle Direct-Reading Ground-Resistance Testers were sent to NASA Calibration Laboratory. Testers are available for rent from HIF-CSS. *WRD Instrument News* articles were written on establishing proper grounding and lightning-protection systems.

- A journal article entitled "The use of standpipe to evaluate ground-water samplers" was published in the winter 1991 issue of *Ground Water Monitoring Review*.

- At the end of the year, HIF's warehouse had nine Enmet meters, eight HNU photoionization analyzers, seven Foxboro OVA-128 meters, and one Photovac GC with capillary column and oven. These instruments were serviced routinely and rented to WRD offices.

- The open-file report on the modified ISCO 2700 autosampler test results was approved for publication. The project is complete.

- More than 40 instruments and sensors were calibrated at NASA's John C. Stennis Space Center Standards and Calibration Laboratories for the Yucca Mountain Project (YMP).

- Environmental Systems Corporation (ESC) delivered an extended temperature model 80 (ETM80) that has an operating range of -40 to +60 °C and modem capability. This unit is currently being tested. An ESC 80 with a modem has been installed at the Pearl River stream site near the HIF. Data are successfully collected from the office by telephone. The seven WRD offices participating in the field tests reported successful data collection with all the Campbell and ESC BDR's and Handar water-level encoders. All offices, with the exception of Colorado, have completed their field tests. The available field comparison data have been tabulated and analyzed, and a draft open-file test report has been prepared.

- The Hydrolab Model H20 SDI-12 water-quality monitor laboratory tests are complete.

- TES continued the operation of the Mississippi District acid precipitation station at Stennis Space Center. The weekly rainwater samples were sent to the USGS laboratory in Ocala for analysis and the rainfall, pH, and conductivity data were sent to the district office.

- Four pH meters and 10 models of electrodes (2 of each) have been purchased and received, and the test plans prepared. A needs questionnaire was sent to District Instrument Coordinators and WQ Specialists for their input. All 44 districts replied. The revised HIF Specification of Procurement of pH Meters and pH Probes has been sent to Office of Water Quality for review.

## Project Status

There were 12 active projects in the Test and Evaluation Section in fiscal year 1991. Brief descriptions of these projects are listed below and accomplishments during the year and plans for fiscal year 1992 are described in the project summaries that follow.

| Number | Name | Chief | Period |
|---|---|---|---|
| 79-5410A | Quality Control of HIF Warehouse Procurements | Potter | July 1979 and continuing |
| 79-5410B | Test and Evaluation of Hydrologic Instrumentation | Treadway, Olive, Potter, and Colangione | July 1979 and continuing |
| 86-5410C | Test and Evaluation of Power Systems | Olive | Dec. 1985 and continuing |
| 87-5406A | Lightning and Transient Protection for Station Instrumentation | Olive | Jan. 1987 and continuing |
| 87-5413D | Ground-Water-Sampler Testing | Tai | March 1987 and continuing |
| 88-5413A | Hazardous-Waste Instrumentation Support | Tai | Oct. 1987 and continuing |
| 88-5413C | Toxic Autosampler Test | Tai | Sept. 1988 to Sept. 1991 |
| 89-5410A | Yucca Mountain Project | Treadway | March 1989 and continuing |
| 89-5410B | Basic Data Recorder System Tests | Colangione | May 1989 and continuing |
| 89-5413B | Submersible Water-Quality Monitor Tests | Tai | June 1989 and continuing |
| 90-5413A | Acid-Rain Data Collection | Tai and Garcia | Sept. 1989 and continuing |
| 91-5413A | Conductivity Meters, pH Meters, and pH Electrode Tests | Tai and Garcia | Jan. 1991 and continuing |

## Quality Control of Warehouse Procurements

PROJECT NUMBER.--TES79-5410A

OBJECTIVE.--To ensure that WRD-purchased instruments meet all contract specifications and that in-house assembled, fabricated, and repaired equipment meet WRD specifications before being stocked in the warehouse.

RESULTS LAST YEAR.--Of the 164 (fig. 7) shipments received and tested last year, 156 were accepted. Over the previous 9 years, 81 percent of the 1,074 new product shipments received were accepted. TES conducted extensive acceptance tests on the new SDI-12 ultrasonic velocity meters (UVM). A few problems were uncovered with the UVM's and corrections were recommended. The project chief assisted with the two UVM training courses. In conjunction with the Office of Surface Water district reviews, eight used Price Type AA and Pygmy meters were returned to the HIF. These meters were calibrated in the condition received, inspected, and then rebuilt. This meter recall program helps establish the reliability of current meters used by WRD.

PLANS FOR NEXT YEAR.--Plans for next year are to test all shipments of new and repaired items received by the warehouse, support the meter recall program, and assist in the teaching of various HIF training courses.

## Test and Evaluation of Hydrologic Instrumentation

PROJECT NUMBER.--TES79-5410B.

OBJECTIVE.--To test ADS prototype instruments and new commercial products to determine if WRD and HIF operational requirements are met.

RESULTS LAST YEAR.--Calibrations were performed on 105 of the HIF-built pressure-sensor systems (PSS). The PSS-1 uses the Paroscientific Digiquartz model 230G sensor and the PSS-2 uses the Setra model 270 sensor. Acceptance tests were completed on all Paroscientific SDI-12 non-submersible pressure sensor (PS-2) shipments. A PS-2 status report was prepared. Preliminary calibration and temperature tests were run on four Design Analysis Associates model H300 SDI-12 submersible pressure transducers and on one Fluid Data Systems WaterGage II. PS-2 and submersible pressure transducers field tests were started in the California, Pennsylvania, and Maine Districts. Performance will be compared to existing stage measuring devices. Tests on the new ESC BDR model ETM80 were started.

PLANS FOR NEXT YEAR.--TES will calibrate the PSS-1's, PSS-2's, and PS-2's returned from the districts. Field calibration procedures for pressure transducers will be developed and evaluated. TES will conduct tests and evaluation of new commercial products that appear to be direct replacements for manometers. TES will complete the three field tests and prepare the report. TES will also complete the ETM 80 field tests.

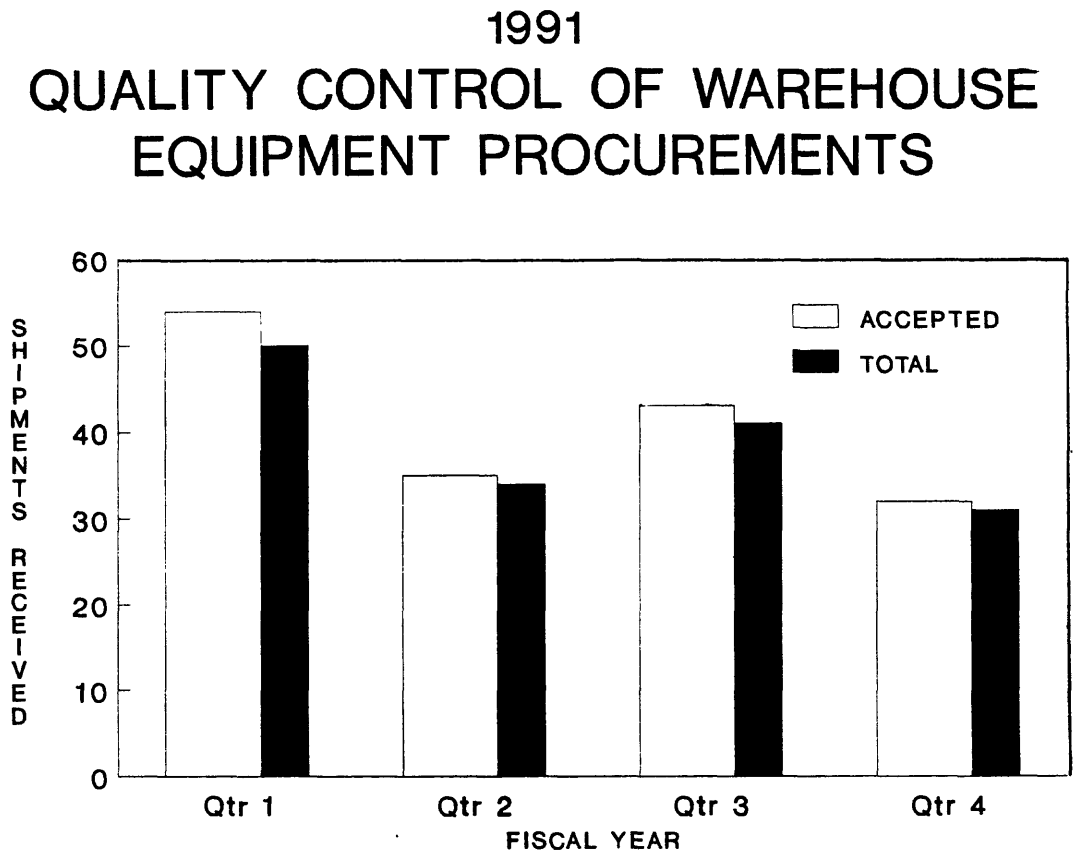


Figure 7.--Results of 1991 acceptance testing.

## Test and Evaluation of Power Systems

PROJECT NUMBER.--TES86-5410C

OBJECTIVE.--To investigate power-supply systems for field use.

RESULTS LAST YEAR.--The final drafting of the GOES manual chapters on battery-power systems and antenna installations were completed. Phone inquiries concerning batteries, solar panels, and controllers were answered. Sessions on power systems were taught in HIF training courses during the year. *WRD Instrument News* articles were written on selecting and installing power systems.

PLANS FOR NEXT YEAR.--TES will complete a survey of the average power-consumption requirements of typical gage houses so that a comprehensive, economical, solar-panel-controller system can be developed for use by WRD. TES will also review the battery solicitation and test procedures prior to their submission to the contracts office.

## Lightning and Transient Protection

PROJECT NUMBER.--TES87-5406A

OBJECTIVE.--To minimize damage from lightning and transient power surges at gaging stations.

RESULTS LAST YEAR.--Proper grounding and lightning-protection procedures were taught at the HIF electronics troubleshooting classes. Phone inquiries were answered on grounding and lightning protection. The Biddle Megger Null-Balance Earth Tester and Biddle Direct-Reading Ground-Resistance Tester were sent to NASA Calibration Laboratory. Testers are available for rent through HIF-CSS. *WRD Instrument News* articles were written on establishing proper grounding and lightning protection systems.

PLANS FOR NEXT YEAR.--TES will test the new DCP grounding-cable device and continue supporting requests for information on proper protection devices.

## Ground-Water-Sampler Testing

PROJECT NUMBER.--TES87-5413D.

OBJECTIVE.--To perform comparative tests of various sampling techniques to determine the effectiveness of water-sample collections of volatile organic compounds.

RESULTS LAST YEAR.--The journal article entitled "The use of standpipe to evaluate ground-water samplers" was published in the winter 1991 issue of *Ground Water Monitoring Review*. TES completed tests of the Grundfos pumping sampler and the Solinst VOA trap sampler. The Solinst sampler was sent to the South Carolina District for field tests in deep wells.

PLANS FOR NEXT YEAR.--TES will continue testing commercially available samplers and prepare a report on those tests.

### Hazardous-Waste Instrumentation Support

PROJECT NUMBER.--TES88-5413A

OBJECTIVE.--To support HIF's hazardous-waste instrumentation rental program.

RESULTS LAST YEAR.--At the end of the year, the HIF warehouse had nine Enmet meters, eight HNU photoionization analyzers, seven Foxboro OVA-128 meters, and one Photovac GC with capillary column and oven. These instruments were serviced routinely and rented to WRD district offices.

PLANS FOR NEXT YEAR.--TES will continue instrumentation support for the hazardous-waste program.

### Toxic Autosampler Test

PROJECT NUMBER.--TES88-5413C

OBJECTIVE.--To modify a commercially available autosampler for the collection of large-volume samples for analyses of trace organic compounds.

RESULTS LAST YEAR.--An open-file report was approved for publication.

PLANS FOR NEXT YEAR.--The project is complete.

### Yucca Mountain Project

PROJECT NUMBER.--TES89-5410A

OBJECTIVE.--To provide the Nevada Nuclear Waste Storage Yucca Mountain Project (YMP) with the required National Institute of Standards and Technology (NIST) calibration and test support.

RESULTS LAST YEAR.--Forty-three instruments and sensors were calibrated and returned to YMP.

PLANS FOR NEXT YEAR.--Calibration and test support will be provided for YMP, the Nevada District, and all districts that request NIST calibrations and products.

### Basic Data Recorder Systems Tests

PROJECT NUMBER.--TES89-5410B

OBJECTIVE.--To determine that each model BDR and encoder meets all WRD requirements.

RESULTS LAST YEAR.--Environmental Systems Corporation (ESC) has delivered an extended temperature model 80 (ETM80) that has an operating range of -40 to +60 °C and modem capability. This unit is currently under test. A modem ESC 80 has been installed at the Pearl River stream site near HIF. Data are successfully collected from the office by telephone. The seven WRD offices participating in the field tests reported successful data collection with all the Campbell and ESC BDR's and Handar water-level encoders. All offices, with the exception of Colorado, have completed their field tests. The available field comparison data have been tabulated and analyzed, and a draft open-file test report has been prepared.

PLANS FOR NEXT YEAR.--TES will continue to run long-term reliability tests on the BDR system to include testing of new SDI-12 sensors as they become available. Field tests of the Paroscientific SDI-12 pressure sensor and Design Analysis, Inc., submersible pressure transducer WaterLog model H-300 will be completed.

## Submersible Water-Quality Monitor Tests

PROJECT NUMBER.--TES89-5413B

OBJECTIVE.--To test the Hydrolab model H20 four-parameter water-quality monitor with the SDI-12 interface to verify that the manufacturer's specifications are met.

RESULTS LAST YEAR.--The H20 laboratory tests are complete.

PLANS FOR NEXT YEAR.--The preliminary results will be reported through EDOC and the *WRD Instrument News*. The field tests will be conducted at the Pearl River site near the HIF and in the Ohio District.

## Acid-Rain Data Collection

PROJECT NUMBER.--TES90-5413A

OBJECTIVE.--To collect weekly rainfall records and water samples, and to measure the pH and conductivity at the Mississippi District rainfall station at Stennis Space Center.

RESULTS LAST YEAR.--The weekly rainwater samples were collected and shipped to the USGS laboratory for analysis. Rainfall charts and water-quality data collected at the station were sent to the Mississippi District Office.

PLANS FOR NEXT YEAR.--This is a continuing project.

## pH Meter, pH Electrode and Conductivity Meter Test

PROJECT NUMBER.--TES91-5413A

OBJECTIVE.--To test and evaluate commercial pH meters, pH electrodes, and conductivity meters for general field use, and especially for the NAWQA Program.

RESULTS LAST YEAR.--Four pH meters and 10 models of electrodes (2 of each) were purchased and received, and the test plan was prepared. A needs questionnaire was sent to District Instrument Coordinators and Water Quality Specialists for their input. All 44 districts replied. A *WRD Instrument News* article was published in September 1991.

PLANS FOR NEXT YEAR.--Laboratory tests will be conducted and results published.

## FIELD SERVICE AND SUPPLY SECTION

The Field Service and Supply Section (FSS) operates a warehouse, provides repair and calibration services, initiates procurement actions to purchase equipment, monitors contracts, fills orders, and serves as technical liaison with the districts.

The FSS staff consists of five engineering technicians, five electronics technicians, two supply technicians, and a computer assistant. Section activities are supported by technical and administrative personnel in other HIF sections.

### Procurement

Seven contracts and 115 purchase orders were issued totaling $2,275,000 for warehouse items.

### Property Management

The FSS computer assistant tracks and accounts for rental property held in the district offices and the field with HIF-CSS, and tracks accountable property held by HIF employees with a personal computer INFO data base. Hydrologic Instrumentation Facility employee-held controlled property is valued at more than $1 million and the controlled rental-program property, frequently cycled through the HIF, is valued at more than $2 million.

### Equipment Rental Program

The equipment rental program, a major effort of the HIF, is operated by FSS. In most cases, equipment is sold to field offices; however, in the case of widely used recording and monitoring equipment, the HIF maintains a rental program for the field and is responsible for procurement and maintenance of the equipment. The rental program is divided into four major categories: recorders and timers, water-quality monitors, telemetry equipment, and special equipment.

### Repair and Calibration Services

Services provided include maintenance, repair, and calibration of district-owned and rental-program equipment. In the HIF Mechanical and Electronics Units, capabilities exist, either in-house or by contract, to repair, adjust, or calibrate virtually any type of Survey-owned equipment. Charges to field offices are assessed on a straight time-and-materials basis.

Activities for FY91 included the following:

Work orders completed--2,282.

Seventy-five flow-through modules, 423 minimonitors, 353 printed circuit boards, and 1,321 minimonitor sensors were repaired or serviced.

## Unit Activity Totals for FY91

| | | |
|---|---|---|
| Electronics Unit: | 2079 | Work orders received |
| | 2049 | Work orders completed |
| | 142 | Handar equipment serviced |
| | 308 | Synergetics DCP's serviced |
| | 174 | Individual Synergetics modules serviced |
| | 423 | Minimonitors serviced |
| | 353 | Minimonitor printed circuit cards serviced |
| | 12 | Minimonitor printed circuit cards fabricated |
| | 543 | Minimonitor pH probes serviced |
| | 275 | Minimonitor conductivity probes serviced |
| | 209 | Minimonitor temperature probes serviced |
| | 294 | Minimonitor dissolved oxygen probes serviced |
| | 143 | Minimonitor extension cables serviced |
| | 5 | Flow-through monitors serviced |
| | 75 | Flow-through signal conditioners serviced |
| | 82 | Flow-through probes serviced |
| | 6 | Flow-through power supplies serviced |
| | 11 | Flow-through panel meters serviced |
| | 73 | R200 downhole recorders serviced |
| | 472 | Equipment exchanges made |
| | $320,000 | Total income from above orders |
| Mechanical Unit: | 241 | Work orders received |
| | 233 | Work orders completed |
| | 102 | Work orders in mechanical shop |
| | 139 | Work orders in meter shop |
| | 176 | Work orders from field |
| | 62 | Work orders from HIF |
| | 8 | Work orders in progress (carryover) |
| | 4 | Work orders from other Federal agencies |
| Warehouse Unit: | 4,282 | Orders received and paperwork processed |
| | 4,153 | Orders filled |
| | $1,670,000 | Sales for FY91 |
| | $ 210,000 | Increase in sales over average year |
| | 2,320 | Work orders entered into HIF-CSS |
| | 44 | Other Federal agency orders entered into HIF-CSS |
| | 9 | Contracts awarded |
| | 76 | Procurements received and completed |

| | | |
|---|---|---|
| Analog-to-Digital Recorders Rental Program: | 1,050 | ADR's to contractor |
| | 934 | ADR's repaired |
| | 1,229 | Timers repaired |
| | 725 | ADR's in storage |
| | 313 | ADR's in warehouse |
| Borehole Equipment Support Project: | 66 | Work orders received |
| | 54 | Work orders completed |
| | 10 | New rentals |
| | 13 | Sales |
| | 30 | Loans or exchanges |
| | 29 | Repairs and (or) calibrations |
| | 5 | Terminations |
| | 2 | Field trips to service equipment |
| | 89 | Outgoing communications |

## Borehole Equipment Support Project

The Borehole Equipment Support Project (BESP) completed its third full year of operation administering the sale, rental, maintenance, and support of borehole geophysical logging systems. BESP work activity continues to diminish. There were 18 logger leases, two of which were short term. The year ended with only 13 loggers on lease. BESP's largest logger, located in Puerto Rico, and a logger in New York are scheduled for return.

- A general questionnaire concerning borehole equipment and the Borehole Equipment Support Project (BESP) was distributed to the Division. Not all responses were received by the end of the fiscal year. However, 45 responses received indicate interest in various parameters (natural gamma, SP, caliper, single-point resistance, multi-point resistance). PC-based loggers were another source of interest. A draft of preliminary specifications for PC-based logging equipment has been completed. Purchases of new logging equipment next fiscal year are possible when the specifications are finalized.

- The BESP was merged with the FSS Electronics Unit on September 30, 1991. This merger provides for continued support of field units with the limited, aging equipment currently in inventory. Considerations are being given to purchase or lease two more advanced technology loggers in FY92.

## Warehouse Activity

The HIF warehouse sells a significant volume of hydrologic instrumentation to other Federal agencies. This section responds to frequent calls from other Federal agencies regarding the whole range of instrumentation problems and possible solutions. Sales to other Federal agencies during the year totaled $161,000. Monthly warehouse sales for FY91 along with the maximum and mean monthly sales are shown in figure 8.

## Hydrologic Instrumentation Facility Computerized Support System (HIF-CSS)

The processing of field orders is supported by HIF-CSS, an interactive computerized support system. Sixty-four cost centers are registered to use HIF-CSS, with a total of 234 users allowed access to the field office functions. These functions include the ability to scan the computerized price list and place orders directly from interactive terminals, determine the status of previously placed orders, and retrieve numerous accounting reports by cost center. HIF-CSS also generates accounting documents, tracks inventory and procurement actions, and generates management reports used to improve future stocking and procurement decisions based on sales patterns. HIF-CSS automates the tracking of controlled property, eliminating the need for processing hard-copy property transfer forms for each transaction. Activities of the Hydrologic Instrumentation Facility-Computerized Support System for Fiscal year 1991 are presented in Table 1.

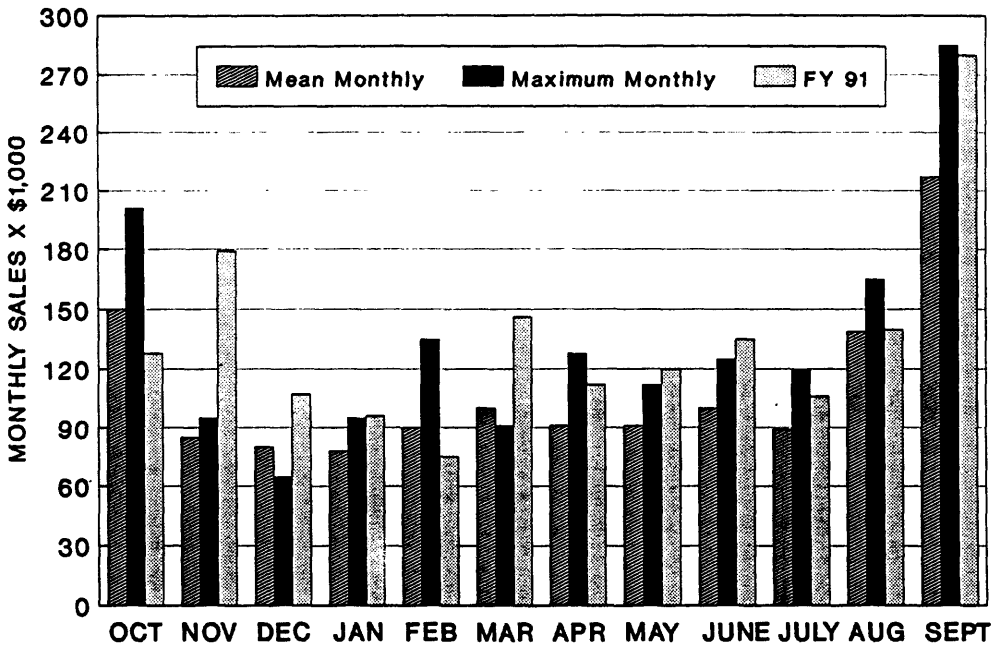


Figure 8.--Monthly warehouse sales for fiscal year 1991 and the maximum and mean monthly sales.

Table 1.--*Hydrologic Instrumentation Facility Computerized Support System Activity in fiscal year 1991*

| Activity | Quantity | Dollar value |
|---|---|---|
| TOTAL ORDERS: | | |
| Orders placed FY91 | 4,282 | $1,675,820.75 |
| Orders cancelled | - 129 | ( 29,777.95) |
| Total orders not cancelled FY91 | 4,153 | $1,646,042.80 |
| Refunds, FY91 | 103 | ( 24,711.53) |
| Net Sales, FY91 | | 1,621,331.27 |
| ORDERS, ITEMS IN STOCK: | | |
| Orders placed, items in stock | 2,965 | 1,233,555.90 |
| Orders cancelled | - 33 | ( 9,955.95) |
| Orders filled and shipped | 2,932 | $1,223,599.95 |
| Mean value per order: | | 417.32 |
| BACKORDERS: | | |
| Backorders placed FY91 | 1,317 | $ 442,264.85 |
| Backorders cancelled | 96 | 19,822.00 |
| FY91 backorders filled and shipped | 888 | 257,433.45 |
| Mean value per backorder: | | 289.90 |
| FY90 backorders filled and shipped during FY91 | 234 | 116,334.00 |
| FY89 backorders filled and shipped during FY91 | 2 | 570.00 |
| FY91 backorders remaining | 333 | 165,009.40 |
| FY90 backorders remaining | 14 | 8,690.00 |
| Older backorders remaining | 0 | 0.00 |
| Total backorders remaining in system | 347 | $ 173,699.40 |
| WAREHOUSE INVENTORY: | | |
| Warehouse inventory, October 1, 1991 | | $3,862,886.90 |

FSS maintains close liaison with field offices, is cognizant of equipment needs, and adds or deletes items to the inventory in response to field needs. About 900 catalog items are in the inventory. With the exception of some convenience items such as boots and waders, all items are built to Survey plans and specifications or require tight, quality-control procedures to ensure that Survey data-collection standards are met.

## Water-Quality Monitor Equipment

Flow-through monitor rental remained largely unchanged in FY91, while minimonitor demand declined slightly. Major expenses incurred in support of the water-quality monitor program included the fabrication of specific conductance, pH, temperature, and DO sensors and the purchase of extension cables.

## Special Equipment Rental Program

The Special Equipment Rental Program (SERP) received $32,878 from the rental of 97 pieces of equipment. No new equipment was purchased, but several pieces of equipment were returned to the manufacturer for repair.

SERP activities for the year included the sale of the Tokyo Keiki flowmeter. The loan of several cross-correlation ultrasonic flowmeters was made in FY91 to two districts. Equipment covered by the program included flowmeters, sediment samplers, data loggers, pipe thickness gages, precipitation gages, oscilloscopes, communications devices, and hazardous waste detection equipment.

During the year, approximately 20 inquiries concerning SERP were handled.

## Analog-to-Digital Recorders and Timers

A total of 1,830 recorders were repaired during FY91. At the end of FY91, 11,743 recorders, of which 460 were CR10's and 45 were BDR's, were in field service. The demand for recorders has continued to decrease. The cost of supporting the recorder program, including parts, labor, and contract services, was approximately $300,000. Figures 9 through 20 present results of the recorder and timer repair program.

Repair and maintenance activity in support of the recorder program was as follows:

| Description | Units repaired, modified, or refurbished | Units shipped to field |
|---|---|---|
| CR10 | 48 | 151 |
| Solid-state timer | 1,229 | 1,000 (approx.) |
| Fischer and Porter (F&P) ADR | 632 | 806 |
| Leupold and Stevens (L&S) ADR | 159 | 202 |
| F&P ADR with telekit | 34 | 27 |
| L&S ADR with Mod. A | 148 | 143 |
| L&S ADR with I/O | 77 | 97 |
| CSI BDR | 8 | 138 |
| ESC BDR | 9 | 54 |
| SDI-12 Encoders | 11 | 228 |
| TOTAL | 2,355 | 2,846 |

This activity is supported by FSS, the on-site contractor, and the Pearl River Work Activity Center. The Pearl River Work Activity Center is a nonprofit organization supported by the State of Mississippi to provide training and employment for physically and mentally handicapped citizens of Pearl River County, Mississippi.

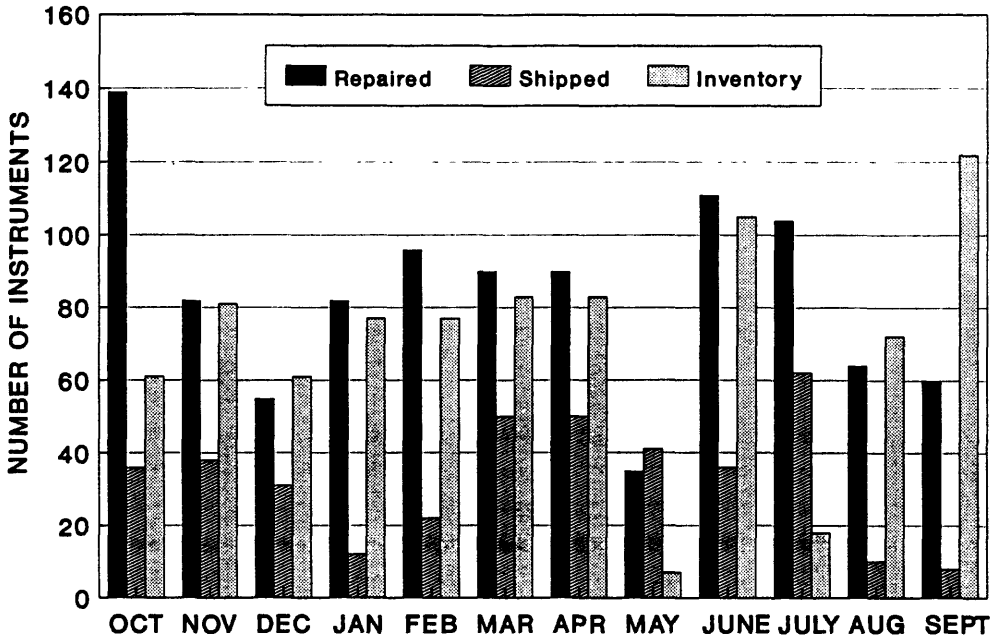


Figure 9.--Monthly summary of timer repair, shipment and inventory.

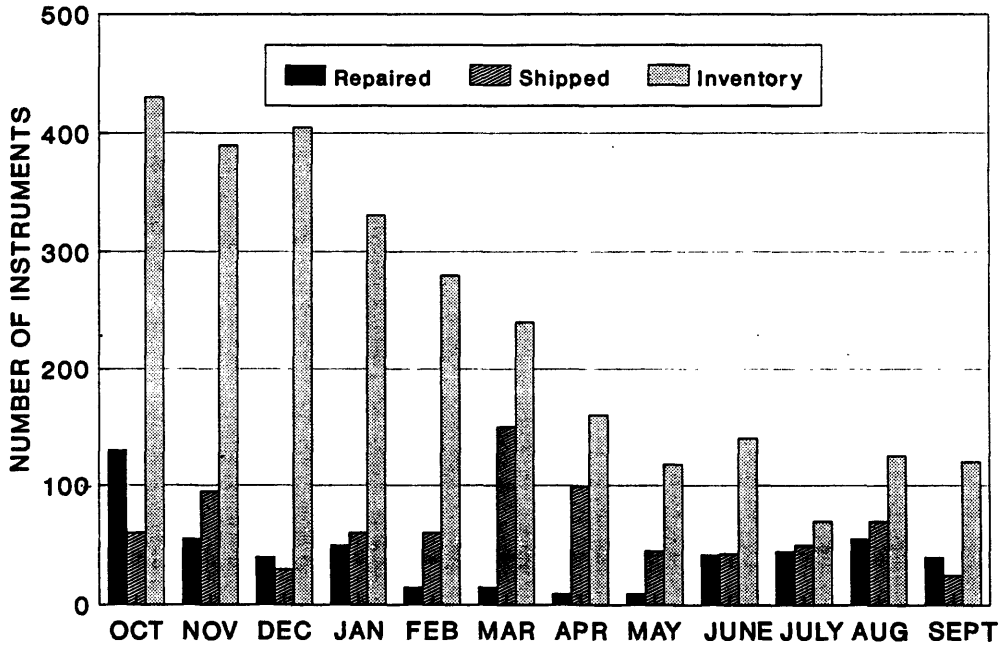


Figure 10.--Monthly summary of Fischer and Porter model 1542 repair, shipment, and inventory.

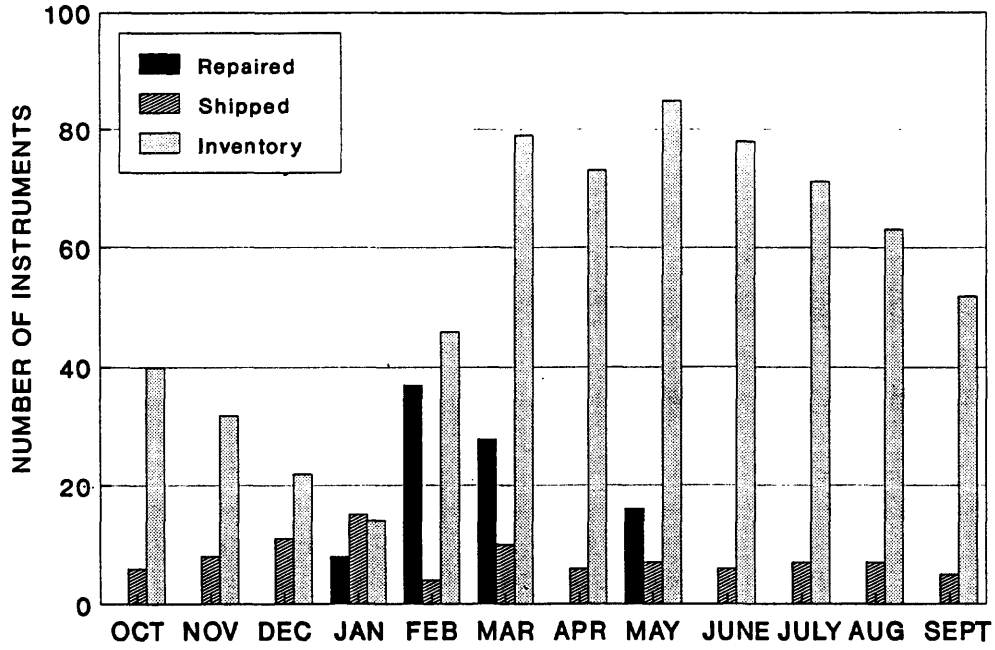


Figure 11.--Monthly summary of Leupold and Stevens 7000 analog-to-digital recorder with input-output repair, shipment and inventory.

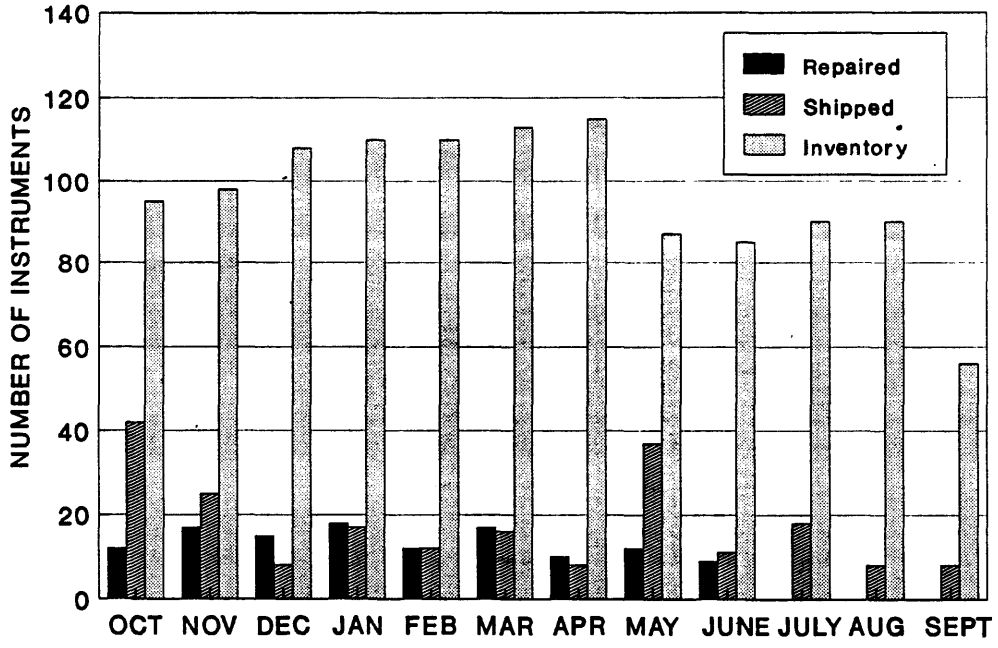


Figure 12.--Monthly summary of Leupold and Stevens 7000 repair, shipment and inventory.

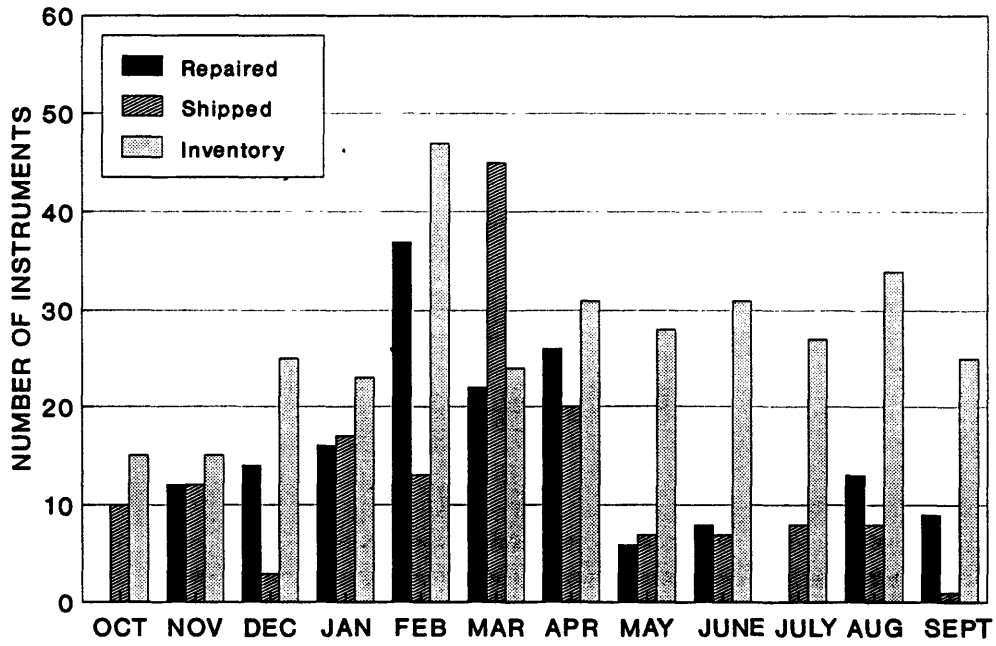


Figure 13.--Monthly summary of Leupold and Stevens 7000 analog-to-digital recorder with module A repair, shipment and inventory.

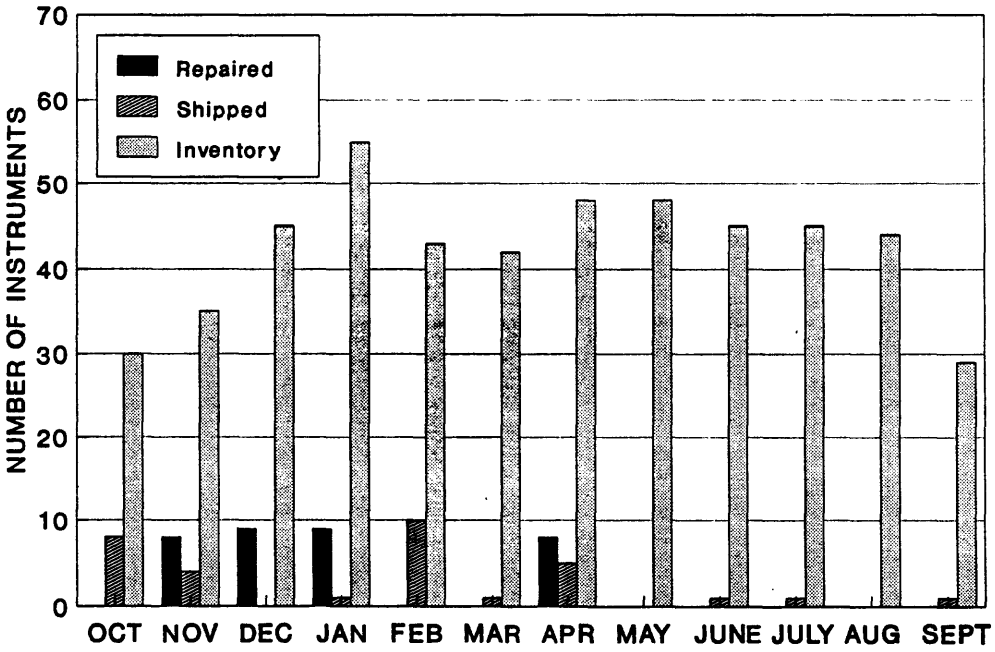


Figure 14.--Monthly summary of Fischer and Porter model 1542 with telekit repair, shipment and inventory.

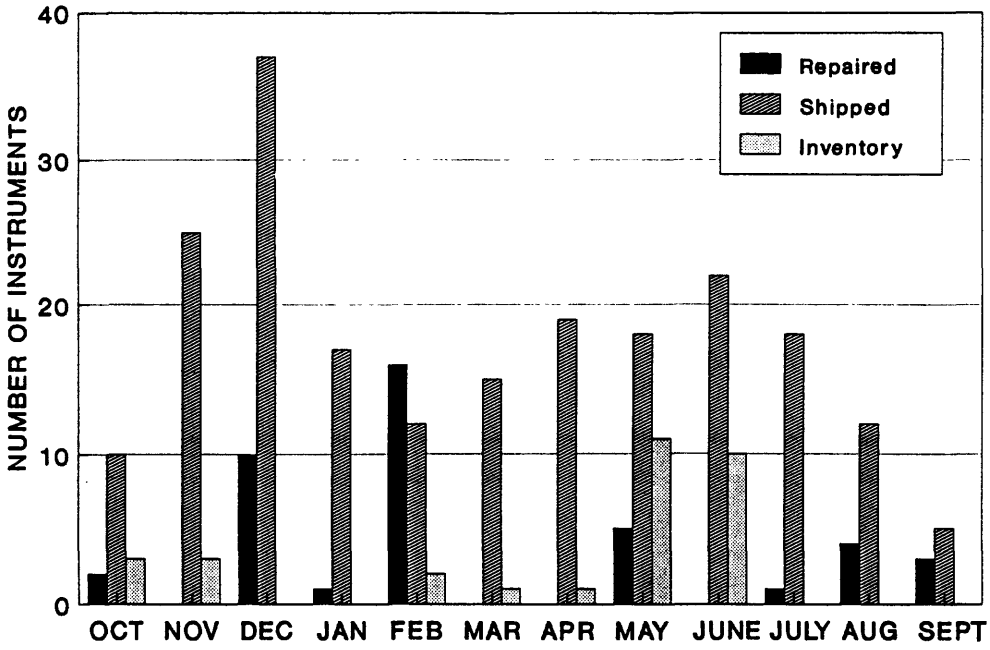


Figure 15.--Monthly summary of Campbell Scientific SM 192 storage module repair, shipment and inventory.

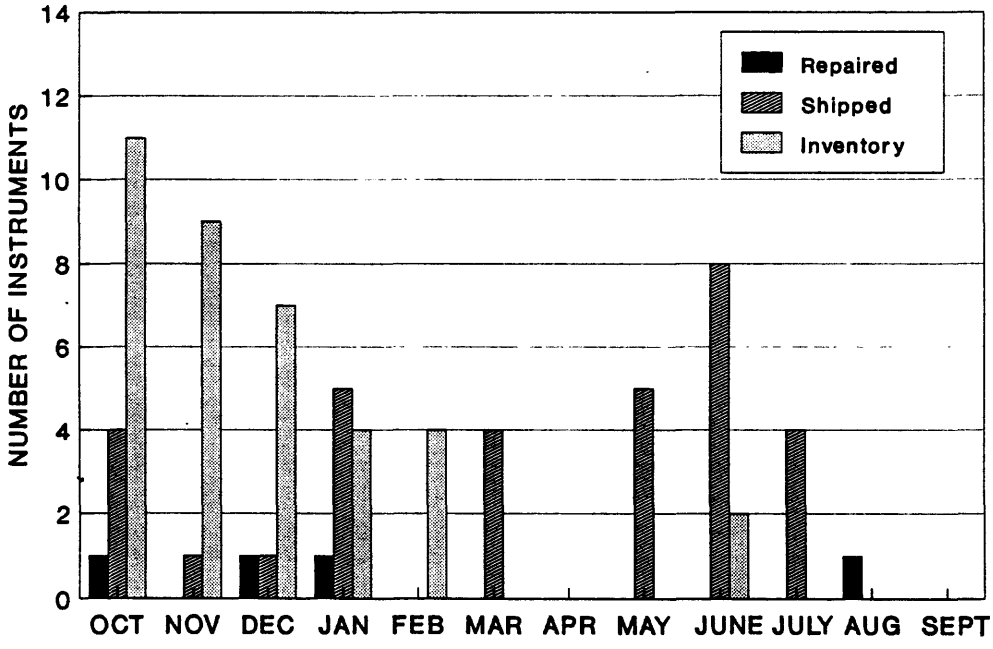


Figure 16.--Monthly summary of Campbell Scientific CR10 keyboard display pad repair, shipment and inventory.

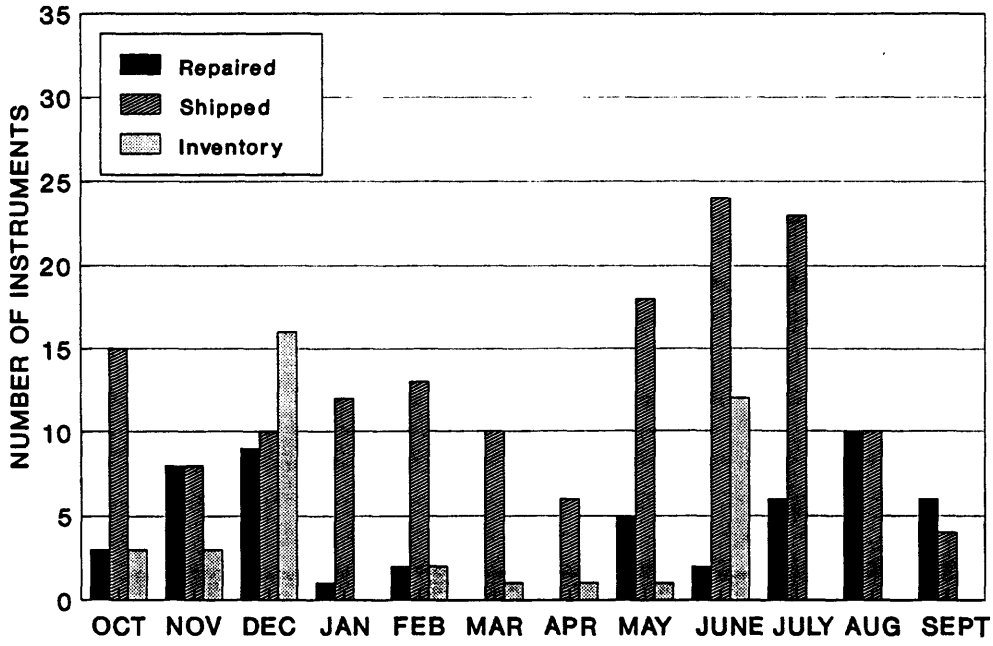


Figure 17.--Monthly summary of Campbell Scientific CR10 with wiring repair, shipment and inventory.

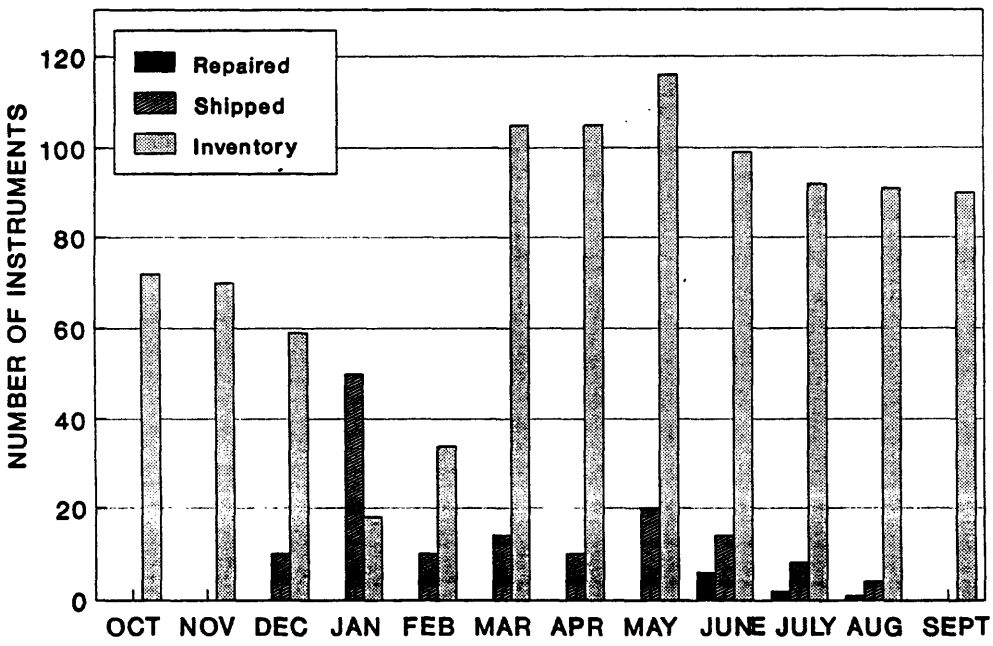


Figure 18.--Monthly summary of Campbell Scientific model 301 basic data recorder with junction box repair, shipment and inventory.

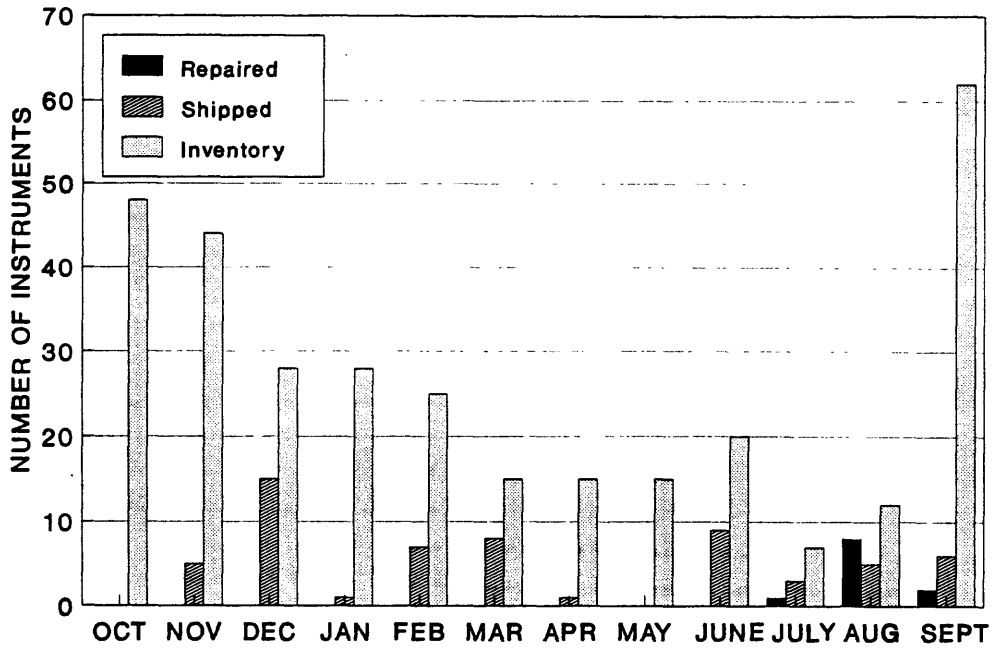


Figure 19.--Monthly summary of Environmental Systems Corporation model 80 basic data recorder with junction box repair, shipment and inventory.

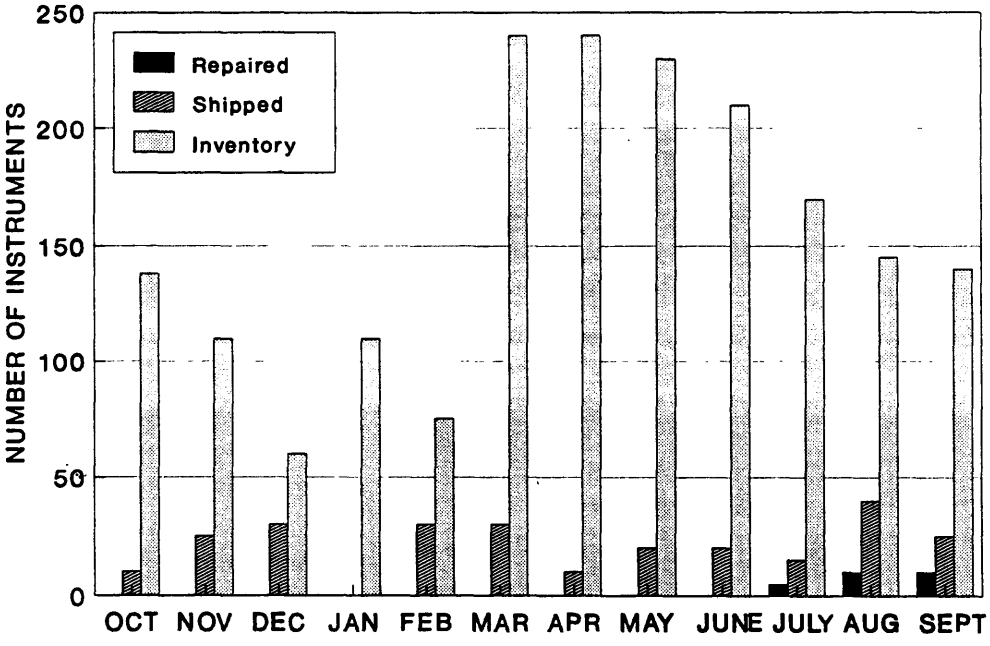


Figure 20.--Monthly summary of Handar shaft encoder model 436B repair, shipment and inventory.

## GLOSSARY OF ACRONYMS

| | |
|---|---|
| ADR | Analog-to-digital recorder |
| ADS | Applications and Development Section |
| AS | Administrative Services Section |
| BDR | Basic data recorder |
| BESP | Borehole Equipment Support Program |
| BQA | Branch of Quality Assurance |
| CMD | Current-meter digitizer |
| CR | Central Region |
| CSI | Campbell Scientific Incorporated |
| DCP | Data-collection platform |
| DIS-II | Distributed Information System-II |
| DO | Dissolved oxygen |
| ECR | Engineering change request |
| EDAT | Electronic Data Logger Applications Team |
| ESC | Environmental Scientific Corporation |
| ETS | Equipment Tracking System |
| ETM80 | Extended temperature model 80 |
| F&P | Fisher and Porter |
| FSS | Field Service and Supply Section |
| FY89 | Fiscal year 1989 |
| FY90 | Fiscal year 1990 |
| FY91 | Fiscal year 1991 |
| FY92 | Fiscal year 1992 |
| GC | Gas chromatograph |
| GOES | Geostationary Operational Environmental Satellite |
| GSA | General Services Administration |
| HIF | Hydrologic Instrumentation Facility |
| HIF-CSS | HIF Computerized Support System |
| I/O | Input-Output |
| ICOM | Instrumentation Committee |
| ITAS | Instrumentation Technical Advisory Subcommittee |
| L&S | Leupold and Stevens |
| LAN | Local Area Network |
| NASA | National Aeronautics and Space Administration |
| NIST | National Institute of Standards and Technology |
| NR | Northeastern Region |
| NRC | Nuclear Regulatory Commission |
| NWQL | National Water Quality Laboratory |
| OSW | Office of Surface Water |
| OWQ | Office of Water Quality |
| PC | Personal computer |
| PFC | Personal field computer |
| PS-2 | Pressure sensor |
| PSS | Pressure sensor system |
| QA | Quality assurance |
| QAP | Quality assurance procedure |
| QIC | Quality Improvement Concepts |
| QPL | Qualified products list |
| SDI-12 | Serial digital interface |
| SE | Shaft encoder |
| SERP | Specialized Equipment Rental Program |
| SOP | Standard operating procedure |

| | |
|---|---|
| SR | Southeastern Region |
| SSC | John C. Stennis Space Center |
| TES | Test and Evaluation Section |
| TQM | Total Quality Management |
| TSS | Technical Services Section |
| UVM | Ultrasonic velocity meter |
| USGS | United States Geological Survey |
| WR | Western Region |
| WRD | Water Resources Division |
| WES | Waterways Experiment Station |
| WSC | Water Survey of Canada |
| YMP | Yucca Mountain Project |

## APPENDIX I.--INSTRUMENTATION COMMITTEE AND INSTRUMENTATION TECHNICAL ADVISORY SUBCOMMITTEE MEMBERSHIP

The members of the Instrumentation Committee and their title or the offices they represent are listed below:

| | |
|---|---|
| William G. Shope, Jr. | Chief, Branch of Instrumentation |
| Vito J. Latkovich | Chief, Hydrologic Instrumentation Facility |
| John V. Skinner | St. Anthony Falls Hydraulic Laboratory Minneapolis, Minnesota |
| John M. Klein | District Chief, California |
| James E. Kircher | AARH/Midwest Programs |
| Derrill J. Cowing | Chief, Maine State Office |
| Michael W. Gaydos | AARH/Southeast Programs |
| Ernest D. Cobb | Office of Surface Water |
| Robert L. Laney | Office of Ground Water |
| Harold C. Mattraw | Office of Water Quality |
| John C. Briggs | Asst. Chief Hydrologist for Scientific Information Management |
| William N. Herkelrath | Regional Research, WR |

The members of the Instrumentation Technical Advisory Subcommittee (ITAS) and their title or the offices they represent are listed below:

| | |
|---|---|
| William J. Shope, Jr | Chief, Branch of Instrumentation |
| Vito J. Latkovich | Chief, Hydrologic Instrumentation Facility |
| Phillip W. Potter | HIF, Stennis Space Center, Mississippi |
| Wayne Rodman | YMP, Lakewood, Colorado |
| Sherman R. Ellis | NAWQA, Albuquerque, New Mexico |
| Robert L. Geomaat | CR, Oklahoma City, Oklahoma |
| Terrance E. Lamb | SR, Little Rock, Arkansas |
| William M. Woodham | SR, Tampa, Florida |
| Richard L. Kraus | WR, Medford, Oregon |
| Richard D. Hayes | WR, Carson City, Nevada |
| Max S. Katzenbach | NR, Columbus, Ohio |
| George M. Farlekas | NR, Trenton, New Jersey |
| Kathleen R. Wilke | CR, Lakewood, Colorado |

APPENDIX II.--DISTRICT, SUBDISTRICT, AND FIELD OFFICE VISITS

| Date | Office | Location | Personnel |
|---|---|---|---|
| Nov. 1990 | Field Office | Washington, North Carolina | P.W. Potter |
| Nov. 1990 | Headquarters | Reston, Virginia | R.H. Billings<br>C.T. Scott |
| Nov. 1990 | Project Office | Vancouver, Washington | J.C. Jelinski |
| Nov. 1990 | Regional Research, CR | Lakewood, Colorado | A.M. Sturrock |
| Dec. 1990 | Headquarters | Reston, Virginia | V.J. Latkovich |
| Jan. 1991 | Southeast Region | Atlanta, Georgia | D.C. Tracey |
| Feb. 1991 | Headquarters | Reston, Virginia | R.H. Billings<br>M.D. Szkolnik |
| March 1991* | Subdistrict Office | Knoxville, Tennessee | V.J. Latkovich<br>R.H. Billings |
| March 1991 | Field Sites | Mississippi District | J.C. Futrell<br>M.D. Szkolnik |
| March 1991 | Subdistrict Office | Miami, Florida | P.W. Potter |
| March 1991* | District Office | Columbus, Ohio | P.W. Potter |
| April 1991* | Central Region | Lakewood, Colorado | D.H. Rapp |
| April 1991* | Southeast Region | Atlanta, Georgia | D.H. Rapp |
| April 1991 | Headquarters | Reston, Virginia | R.H. Billings<br>R.A. Johnson<br>F.S. Henry |
| April 1991 | Subdistrict Office | Phoenix, Arizona | P.W. Potter<br>J. Hardee<br>E.J. Parrozzo |
| April 1991 | District Office | Salt Lake City, Utah | P.W. Potter<br>L.G. Colangione<br>C.T. Scott<br>A.S. Shaw |
| April 1991 | Central Region | Lakewood, Colorado and Field Sites | L.G. Colangione |
| April 1991 | District Office | Austin, Texas | L.G. Colangione |

| | | | |
|---|---|---|---|
| May 1991* | Headquarters | Reston, Virginia | D.Y. Tai |
| May 1991 | Subdistrict Office | Phoenix, Arizona | P.W. Potter<br>J. Hardee |
| May 1991 | District Office | Salt Lake City, Utah | C.T. Scott<br>L.G. Colangione |
| May 1991 | Headquarters | Reston, Virginia | E.L. Ford |
| May 1991* | District Office | Sacramento, California | V.J. Latkovich |
| May 1991 | Central Region | Lakewood, Colorado | R.H. Billings<br>R.A. Johnson<br>C.T. Scott<br>M.D. Szkolnik |
| May 1991 | Project Office | Minneapolis, Minnesota | V.J. Latkovich<br>J.C. Jelinski |
| June 1991 | District Office | Raleigh, North Carolina | J.C. Jelinski |
| June 1991* | District Office | Little Rock, Arkansas | R.A. Johnson<br>L.G. Colangione |
| June 1991 | Headquarters | Reston, Virginia | F.S. Henry |
| June 1991 | Project Office | Minneapolis, Minnesota | J.C. Jelinski<br>E.C. Vaughn |
| June 1991* | Central Region | Lakewood, Colorado | V.J. Latkovich<br>D.H. Rapp |
| June 1991 | District Office | Lawrence, Kansas | E.L. Ford |
| July 1991 | Subdistrict Office | Ithaca, New York | G.E. Loman |
| July 1991 | Subdistrict Office | Memphis, Tennessee | R.A. Johnson |
| July 1991 | District Office<br>District Office | Bismarck, North Dakota<br>Cheyenne, Wyoming | C.T. Scott |
| Aug. 1991 | Subdistrict Office | Miami, Florida | R.H. Billings |
| Aug. 1991 | Subdistrict Office | Nashville, Tennessee | J.C. Futrell<br>S.L. Wilbourn |
| Aug. 1991 | Field Office | Rochester, New York | E.J. Parrozzo |
| Aug. 1991 | District Office | Cheyenne, Wyoming | R.H. Billings |

| | | | |
|---|---|---|---|
| Aug. 1991 | Headquarters | Reston, Virginia | V.J. Latkovich |
| Aug. 1991 | Subdistrict Office | Lemoyne, Pennsylvania | V.J. Latkovich |
| Aug. 1991 | Subdistrict Office | Orlando, Florida | V.J. Latkovich |
| Sept. 1991 | Headquarters | Reston, Virginia | E.L. Ford |
| Sept. 1991 | District Office | Baton Rouge, Louisiana | R.H. Billings<br>J.C. Futrell |
| Sept. 1991 | Western Region | Menlo Park, California | V.J. Latkovich |

*HIF Presentations

APPENDIX III.---PROFESSIONAL AND TECHNICAL MEETINGS ATTENDED BY HIF PERSONNEL

| Date | Meeting | Attendee(s) |
|---|---|---|
| Oct. 1990* | ASCE Mississippi Section Fall Meeting Bay St. Louis, Mississippi | V.J. Latkovich |
| Oct. 1990 | Instrument Society of America 1990 Exhibition, New Orleans, Louisiana | Selected HIF personnel |
| Oct. 1990 | Southern Radio and Electronics Company Manufacturers Show and Exhibits New Orleans, Louisiana | Selected HIF personnel |
| Nov. 1990 | Implementing Bar Coding in Manufacturing and Distribution Operations, Atlanta, Georgia | E.L. Ford |
| Nov. 1990* | NR Data Chiefs and SW meeting Lancaster, Pennsylvania | R.H. Billings |
| Dec. 1990* | National Cooperative Highway Research Program, NRC, Ft. Collins, Colorado | V.J. Latkovich |
| Dec. 1990 | Data Relay Technical Subcommittee meeting Denver, Colorado | J. Hardee |
| Dec. 1990* | NY/New England District Data Sections meeting, Stockbridge, Massachusetts | V.J. Latkovich |
| Jan. 1991 | Measurement Science Conference, Anaheim, California | T.E. Olive |
| Jan. 1991 | Southeast Region System Administrators Meeting, Jackson, Mississippi | E.L. Ford |
| Jan. 1991 | Joint Interservice Regional Support Group South-2 Area, Biloxi, Mississippi | B.D. Brewer |
| Jan. 1991* | Instrumentation Technical Advisory Subcommittee Meeting, Lakewood, Colorado | V.J. Latkovich<br>R.H. Billings<br>P.W. Potter |
| Jan. 1991* | Office of Surface Water Meeting Atlanta, Georgia | V.J. Latkovich |
| Feb. 1991 | Current Meter Evaluation Advisory Committee Stennis Space Center, Mississippi | V.J. Latkovich<br>R.H. Billings |
| Feb. 1991* | Instrumentation Committee Meeting, Tempe, Arizona | V.J. Latkovich<br>R.H. Billings<br>D.H. Rapp |

| | | |
|---|---|---|
| Feb. 1991* | Sixth International ASCE Cold Regions Engineering Conference, W. Lebanon, New Hampshire | V.J. Latkovich |
| March 1991* | Fifth Federal Interagency Sedimentation Conference, Las Vegas, Nevada | V.J. Latkovich<br>J.H. Ficken |
| March 1991 | AIS Users Group Meeting, Reston, Virginia | B.L. Burke |
| March 1991 | Toxic Substances Hydrology Technical Meeting and SR QW Specialists Meeting, Monterey, California | D.Y. Tai |
| March 1991 | Joint Interservice Regional Support Group South-2 Area, Biloxi, Mississippi | B.D. Brewer |
| March 1991 | NASA Financial Management and Reporting Stennis Space Center, Mississippi | V.J. Latkovich<br>G.M. Moran |
| March 1991 | HIF-CSS Field Users Meeting Stennis Space Center, Mississippi | E.L. Ford<br>C.P. Nelson<br>D.E. Criswell |
| April 1991 | DOI FY 1991 Safety and Health Seminar San Diego, California | B.D. Brewer |
| April 1991* | Unsteady Flow Workshop Chapel Hill, North Carolina | R.H. Billings |
| May 1991 | Joint Interservice Regional Support Group South-2 Area, Biloxi, Mississippi | B.D. Brewer |
| June 1991* | Pressure-Transducer Packer Workshop Lakewood, Colorado | V.J. Latkovich<br>D.H. Rapp |
| July 1991 | American Society of Civil Engineers Biloxi, Mississippi | V.J. Latkovich |
| July 1991* | ASCE National Conference on Hydraulic Engineering, Nashville, Tennessee | V.J. Latkovich |
| July 1991 | Bar Code Committee meeting, Arvada, Colorado | E.L. Ford |
| July 1991 | Information Resources Management Conference Albuquerque, New Mexico | F.S. Henry |
| Aug. 1991* | Instrumentation Committee Meeting and Instrumentation Technical Advisory Subcommittee meetings, Denver, Colorado | V.J. Latkovich<br>R.H. Billings<br>D.H. Rapp<br>P.W. Potter |

| | | |
|---|---|---|
| Aug. 1991 | Current Meter Committee meeting, Denver, Colorado | R.H. Billings |
| Sept. 1991* | American Water Resources Association National Conference, New Orleans, Louisiana | D.H. Rapp |
| Sept. 1991 | American Water Resources Association Natonal Conference, New Orleans, Louisiana | V.J. Latkovich and selected HIF Staff |

*HIF Presentations

## APPENDIX IV.--VENDOR VISITS

HIF personnel visited the following vendors:

| Date | Vendor | Location | Personnel |
|---|---|---|---|
| Dec. 1990 | RD Instruments | San Diego, California | R.H. Billings<br>F.S. Henry |
| Dec. 1990 | Synergetics Company | Boulder, Colorado | J. Hardee |
| Feb. 1991 | Marsh McBirney | Frederick, Maryland | R.H. Billings |
| March 1991 | ESC, Incorporated | Knoxville, Tennessee | V.J. Latkovich<br>R.H. Billings |
| April 1991 | Foxboro Company | Houston, Texas | L.A. Garcia |
| April 1991 | Design Analysis<br>Campbell Scientific | Logan, Utah<br>Logan, Utah | L.G. Colangione |
| May 1991 | SCI, ESC, Handar, Omnidata, Sutron, DAA | Logan, Utah | R.H. Billings |
| June 1991 | Environmental Systems | Knoxville, Tennessee | E.J. Parrozzo |
| Aug. 1991 | Notestar, ITG, | New Brunswick, New Jersey | F.S. Henry |
| Sept. 1991 | Handar, | Sunnyvale, California | V.J. Latkovich |

## APPENDIX V.--REPORTS PREPARED BY HYDROLOGIC INSTRUMENTATION FACILITY PERSONNEL


Billings, R.H., 1985, An adaptable hydrologic data acquisition system: American Geophysical Union 1985 Fall Meeting, December 9-13, 1985, San Francisco, California, Proceedings.

Billings, R.H., and Latkovich, V.J., 1982, An adaptable hydrologic data acquisition system: International Symposium on Hydrometerology, Denver, Colorado, June 13-17, Proceedings.

----- 1984, Modular hydrologic data acquisition and real-time communications instrumentation: American Water Resources Association Symposium, Seattle, Washington, June 11-13, Proceedings.

*Brewer, B.D., ed., 1990 and 1991, WRD Instrument News: Hydrologic Instrumentation Facility, Nos. 49, 50, 51, 52, and 53.

Ciegler, J.C., 1984, Operating manual for the HIF-CSS, vol. I: users guide: U.S. Geological Survey Hydrologic Instrumentation Facility operating manual 9-84-01, 104 p.

----- 1985, Data element dictionary for the HIF-CSS: U.S. Geological Survey Hydrologic Instrumentation Facility operating manual 9-85-03, 162 p.

----- 1985, Operating manual for the HIF-CSS, vol. II: warehouse guide: U.S. Geological Survey Hydrologic Instrumentation Facility operating manual 9-85-01, 60 p.

----- 1985, Operating manual for the HIF-CSS, vol. III: administrators guide: U.S. Geological Survey Hydrologic Instrumentation Facility operating manual 9-85-04, 74 p.

----- 1985, Program descriptions for the HIF-CSS: U.S. Geological Survey Hydrologic Instrumentation Facility operating manual 9-85-02, 774 p.

----- 1985, Flowcharts for the HIF-CSS: U.S. Geological Survey Hydrologic Instrumentation Facility operating manual 9-85-05, 116 p.

Coon, W.F., and Futrell, J.C. II, 1986, Evaluation of wet-line depth-correction methods for cable-suspended current meters: U.S. Geological Survey Water-Resources Investigations Report 85-4329, 31 p.

Cordes, E.H., 1984, Ground-water instrumentation program: Second National Symposium and Exhibition on Ground-Water Instrumentation, Las Vegas, Nevada, April 2-4, Proceedings.

----- 1988, Operating manual for the R100 digital vibration-time totalizer: U.S. Geological Survey Open-File Report 88-454, 8 p.

Ficken, J.H., 1980, Troubleshooting probe problems on the USGS servo programmer with a conductivity meter: Reston, Va., U.S. Geological Survey WRD Bulletin, April-June 1980, p. 4.

----- 1985, Instrumentation for automatically monitoring sediment concentration and particle size - a progress report, *in* Glysson, G. Douglas, ed., Proceedings of the Advanced Seminar on Sedimentation, August 15-19, 1983, Denver, Colorado: U.S. Geological Survey Open-File Report 85-98, p. 14.

----- 1986, Instruments for measuring suspended sediment: Fourth Inter-agency Sedimentation Conference, Las Vegas, Nevada, 1986, Proceedings.

----- 1988, Recent development of downhole samplers for trace organics *in* Special Technical Publication 96 31988: American Society for Testing and Materials, Philadelphia, Pennsylvania, p. 253-257.

Ficken, J.H., and Rorabaugh, J.I., 1980, USGS Minimonitor: Reston, Va., U.S. Geological Survey WRD Bulletin, April-June 1980, p. 1.

Ficken, J.H., and Scott, C.T., 1980, Improved dissolved oxygen record on automatic water-quality monitors by installation of velocity tube in sample chamber: Reston, Va., U.S. Geological Survey WRD Bulletin, April-June 1980, p. 4.

----- 1984, Operating manual for the USGS Minimonitor: U.S. Geological Survey Hydrologic Instrumentation Facility operating manual 6-83-02, 71 p.

----- 1984, Feasibility of monitoring toxicity in streams: HIF technical report on file at Quality of Water Branch, Reston, Virginia, 21 p.

----- 1984, Operating manual for the ultrasonic ranger: U.S. Geological Hydrologic Instrumentation Facility operating manual 1-84-01, 15 p.

----- 1988, Operating manual for the U.S. Geological Survey Minimonitor, 1988 revised edition, punched-paper-tape model: U.S. Geological Survey Open-File Report 88-491, 76 p.

----- 1989, Operating manual for the U.S. Geological Survey minimonitor, 1988 revised edition, analog-voltage model: U.S. Geological Survey Open-File Report 89-403, 188 p.

Ficken, J.H., Sonntag, W.H., and Boettcher, A.J., 1985, Recent developments of downhole samplers for trace organics: Southeastern Region Water Quality Symposium, Jacksonville Beach, Florida, January 29 - February 1, Proceedings.

----- 1988, Recent developments in downhole samplers for organic and volatile compounds in ground water *in* U.S. Geological Survey program on toxic waste-ground-water contamination: Proceedings of the second technical meeting, Cape Cod, Massachusetts, October 21-25, 1985, Ragone, S.E., ed.: U.S. Geological Survey Open-File Report 86-481, p. F-5 - F-8.

Ficken, J.H., and Tai, D.Y., 1989, Activities of the U.S. Geological Survey's Hydrologic Instrumentation Facility in support of hazardous- and toxic-substances programs *in* U.S. Geological Survey Toxic Substances Hydrology Program -- Proceedings of the Technical Meeting, Phoenix, Arizona,

September 26-30, 1988, G.E. Mallard and S.E. Ragone, ed.: U.S. Geological Survey Water-Resources Investigations Report 88-4220, p. 625-631.

Ford, E.L., ed., 1989 through 1990, WRD Instrument News: Hydrologic Instrumentation Facility, Nos. 47 and 48.

Futrell, J.C. II, 1983, Operating manual for the modified P-61 sampler and the BP-76 control unit: U.S. Geological Survey Hydrologic Instrumentation Facility operating manual 4-83-01, 9 p.

----- 1985, Current meter digitizer: What's new about version 1.4: U.S. Geological Survey Hydrologic Instrumentation Facility operating manual 6-84-03, addendum, 5 p.

----- 1985, Operating the Kevlar line marking machine: Hydrologic Instrumentation Facility internal report, 31 p.

----- 1985, Prototype cable-car lock installation and removal: Hydrologic Instrumentation Facility instruction pamphlet, 4 p.

----- 1986, Ice metering system and ice chisels: Sixth International Northern Research Basins Symposium Proceedings, Houghton, Michigan.

----- 1987, Hydrologic Instrumentation Facility Technical Information Sheet for servicing of USGS sounding reel, 2 p.

----- 1987, Hydrologic Instrumentation Facility Technical Information Sheet for wading tag-line reel, 2 p.

----- 1987, Hydrologic Instrumentation Facility Technical Information Sheet for use of model II AA tail-fin assembly, 1 p.

----- 1987, Hydrologic Instrumentation Facility Technical Information Sheet for installation and use of the CMD adapter, 2 p.

----- 1987, Hydrologic Instrumentation Facility Technical Information Sheet for USGS ice chisel, 2 p.

----- 1988, Hydrologic Instrumentation Facility Technical Information Sheet for wire-weight gage reading instructions, 2 p.

----- 1989, Hydrologic Instrumentation Facility Technical Information Sheet for electric tape gage installation, 2 p.

----- 1989, Hydrologic Instrumentation Facility Technical Information Sheet for care and maintenance of optic-head meters, 16 p.

----- 1989, Hydrologic Instrumentation Facility Technical Information Sheet for P-Pygmy Current Meters, 2 p.

----- 1989, Hydrologic Instrumentation Facility Technical Information Sheet for wading tag-line reel, revision, 3 p.

*----- 1991, Hydrologic Instrumentation Facility Technical Information Sheet for the use of model II AA tail-fin assembly, revision, 1 p.

*Futrell, J.C., and Latorre, R., 1991, Preliminary design of low-velocity current-meter rating facility: Oceans 91 Conference of the Institute of Electrical and Electronics Engineers, Honolulu, Hawaii, October 1-3, Proceedings.

Hardee, J., 1983, Operating manual for the urban hydrology monitoring system: U.S. Geological Survey Hydrologic Instrumentation Facility operating manual 6-83-01, 41 p.

----- 1990, Hydrologic Instrumentation Facility Technical Information Sheet for standard orifice static tube, 4 p.

Healy, R.W., deVries, M.P., and Sturrock, A.M., Jr., 1987, Evapotranspiration and microclimate at a low-level radioactive-disposal site in northwestern Illinois: U.S. Geological Survey Open-File Report 86-301, Urbana, Illinois, 88 p.

----- 1989, Evapotranspiration and microclimate at a low-level radioactive-waste disposal site in northwestern Illinois: U.S. Geological Survey Water-Supply Paper 2327, 44 p.

Henry, F.S., Rickly, S.E., Vaughn, E.C., 1988, Hydrologic Instrumentation Facility Drafting Manual: Hydrologic Instrumentation Facility Internal Report, 182 p.

Holland, R.R., and Rapp, D.H., 1988, Results of qualification tests on water-level sensing instruments, 1986: U.S. Geological Survey Open-File Report 88-193, 34 p.

Hydrologic Instrumentation Facility, 1973, General and accessory hydrologic instrumentation: Hydrologic Instrumentation Facility unnumbered report, 16 p.

----- 1982, Environmental specifications for field monitoring equipment HIF-E-1: Hydrologic Instrumentation Facility specification, 36 p.

----- 1982, Power Study System: Hydrologic Instrumentation Facility internal report, 25 p.

----- 1983, Annual report 1981-82: Hydrologic Instrumentation Facility internal report, 104 p.

----- 1983, Specifications and guidelines for electrification of WRD gage-houses: Hydrologic Instrumentation Facility unnumbered report, 20 p.

----- 1984, Annual report 1983: Hydrologic Instrumentation Facility internal report, 129 p.

----- 1984, Instrumentation for today and tomorrow: The U.S. Geological Survey's Hydrologic Instrumentation Facility: Hydrologic Instrumentation Facility circular, 6 p.

----- 1985, Annual report 1984: Hydrologic Instrumentation Facility internal report, 129 p.

----- 1985, Annual report 1985: Hydrologic Instrumentation Facility internal report, 131 p.

----- 1986, Annual report 1986: Hydrologic Instrumentation Facility internal report, 114 p.

----- 1987, Annual report 1987: Hydrologic Instrumentation Facility internal report, 71 p.

----- 1988, Annual report 1988: Hydrologic Instrumentation Facility internal report, 54 p.

----- 1989, Annual report 1989: Hydrologic Instrumentation Facility internal report, 62 p.

*----- 1990, Annual report 1990: Hydrologic Instrumentation Facility internal report, 72 p.

----- 1988, WRD instrumentation catalog (revision): Hydrologic Instrumentation Facility internal report, 211 p.

----- 1990, The U.S. Geological Survey's Hydrologic Instrumentation Facility: Hydrologic Instrumentation Facility circular, 6 p.

Instrument Development Laboratory, 1983, Instrumentation for measuring and recording streamflow data at river-control structures: U.S. Geological Survey Open-File Report 83-872, 29 p.

----- 1984, Operating manual for installation of electrical power service: implementation guide: U.S. Geological Survey Hydrologic Instrumentation Facility operating manual 7-84-02, 24 p.

Jeffers, S.R., and Wagner, C.R., 1984, The Water Resources Division water-level recorder program - history and operation: U.S. Geological Survey Open-File Report 84-735, 16 p.

Jelinski, J.C., 1988, Hydrologic Instrumentation Facility Technical Information Sheet for installing a mercury overflow kit on the USGS screw-type manometer, 8 p.

----- 1989, Hydrologic Instrumentation Facility Technical Information Sheet for B-Connector Brass Bushing Retrofit Kit, 1 p.

Johnson, R.A., 1987, "The Series 310 Recorder," Proceedings of the 1987 American Geophysical Union Spring Meeting, May 18-22, 1987, Baltimore, Maryland, 1 p.

----- 1988, Hydrologic Instrumentation Facility Technical Information Sheet for the R200 downhole recorder, 4 p.

Johnson, R.A. and Rorabaugh, J.I., 1988, Operating manual for the R200 downhole recorder with Husky Hunter retriever: U.S. Geological Survey Open-File Report 88-455, 11 p.

----- 1988, Operating manual for the R200 downhole recorder with Tandy 102 retriever: U.S. Geological Survey Open-File Report 88-488, 113 p.

*Jones, J.C., Tracey, D.C., and Sorensen, F.W., eds., 1991, Operating manual for the U.S. Geological Survey's data-collection system with the geostationary operational environmental satellite: U.S. Geological Survey Open-File Report 91-99, 237 p.

Kilpatrick, F.A., Kaehrle, W.R., Hardee, J.H., Cordes, E.H., and Landers, M.N., 1985, Development and testing of highway storm-sewer flow measurement and recording system: U.S. Geological Survey Water Resources Investigations Report 85-4111, 98 p.

Knott, S.A., and Rapp, D. H., 1985, Specification for the procurement of in situ and field pH meters and pH electrodes: Hydrologic Instrumentation Facility specification HIF-P-08, 12 p.

Latkovich, V.J., 1983, Ground water monitoring system: International Association of Hydrologists-International Association of Hydrological Sciences Symposium paper, the Netherlands, May 1983.

----- 1985, Recent developments in hydrologic instrumentation: American Society of Civil Engineers Hydraulics Division Symposium, Orlando, Florida, August 13-16, Proceedings.

Latkovich, V.J., and Futrell, J.C. II, 1986, Recent developments in hydrologic instrumentation: American Water Resources Association Cold Regions Hydrology Symposium Proceedings, Fairbanks, Alaska.

Latkovich, V.J., Rorabaugh, J.I., Sharp, K.V., Cordes, E.H., and Jelinski, J.C., 1983, Ground-water monitoring system: International Symposium on Methods and Instrumentation for the Investigation of Ground-Water Systems, The Hague, Netherlands, Proceedings, 12 p.

Latkovich, V.J. and Shope, W.R., 1990, New hydrologic instrumentation in the U.S. Geological Survey: American Society of Civil Engineers, 6th International Cold Regions Engineering Specialty Conference, Hanover, New Hampshire, February 26-28, 1991, Proceedings.

Nichols, W.D. and Sturrock, A.M., 1988, Averaged hourly energy budget fluxes measured over cotton, alfalfa, and bare soil, at the Maricopa Agricultural Center, Maricopa, Arizona, June 11-12, 1988: paper, p. 31.

Olive, T.E., 1989, Results of qualification tests on water-level sensing instruments, 1987: U.S. Geological Survey Open-File Report 89-397, 37 p.

Parrozzo, E.J., 1990, Hydrologic Instrumentation Facility Technical Information Sheet for universal junction box, 4 p.

-----, 1990, Hydrologic Instrumentation Facility Technical Information Sheet for Campbell Scientific, Inc. Model 301 cable kit, 4 p.

-----, 1990, Hydrologic Instrumentation Facility Technical Information Sheet for Environmental Systems Corporation Model 80 cable kit, 4 p.

*-----, 1991, Hydrologic Instrumentation Facility Technical Information Sheet for installing electrical surge arrester, 5 p.

*-----, 1991, Hydrologic Instrumentation Facility Technical Information Sheet for Campbell Scientific, Inc. Model 301 cables, 4 p.

*-----, 1991, Hydrologic Instrumentation Facility Technical Information Sheet for Environmental Systems Corporation Model 80 cables, 4 p.

Rapp, D.H., 1982, Specification for procurement of water-level sensing instrumentation, specification number HIF-I-1: U.S. Geological Survey Open-File Report 82-89, 24 p.

----- 1983, HIF-I-1 Amendment-1, April 20, 1983, U.S. Geological Survey, Water Resources Division specification instrumentation, water-level sensing, 2 p.

----- 1985, Test facility for pressure transducer evaluation: Marine Technology Society Symposium Proceedings, New Orleans, Louisiana, May 1-3, 1985, p. 38-40.

----- 1986, U.S. Geological Survey's qualification program for water-level sensing instruments: Marine Data Systems International Symposium proceedings, New Orleans, Louisiana, p. 364-366.

*----- 1991, New serial digital interface for pressure sensors acquired by the U.S. Geological Survey: American Water Resources Association 27th Annual Conference Water Management of River Systems and Symposium, New Orleans, Louisiana, September 8-13, Proceedings.

Rapp, D.H., McDonald, B.L., and Hughes, R.M., 1985, Results of qualification tests on water-level sensing instruments: U.S. Geological Survey Open-File Report 85-199, 47 p.

----- 1985, Results of qualification tests on water-level sensing instruments, 1984-85: U.S. Geological Survey Open-File Report 85-489, 18 p.

Rapp, W.L., 1986, Operating manual for the miniservo-control tester: U.S. Geological Survey Open-File Report 85-690, 7 p.

Rathbun, R.E., and Tai, D.Y., 1988, Volatilization of benzene and eight alkyl-substituted benzene compounds from water: U.S. Geological Survey Water Supply Paper 2342, 24 p.

Rathbun, R.E., Stephens, D.W., Shultz, D.J., and Tai, D.Y., 1988, Fate of acetone in an outdoor model stream in southern, Mississippi, U.S.A. *in* Journal of Hydrology, 104, Amsterdam, p. 181-209.

Reddy, M.M., Liebermann, T.D., Jelinski, J.C., and Caine, T.N., 1983, Precipitation pH during summer storms on the Continental Divide in Central Colorado: National Atmospheric Deposition Program meeting, Knoxville, Tenn, November 6-10, 1983.

----- 1985, Variation in the pH during summer storms near the continental divide in central Colorado: February 1985, Artic and Alpine Research, v. 17, no. 1, p. 79-88.

Rickly, S.E., 1990, History of the applications and development section of the Hydrologic Instrumentation Facility, Stennis Space Center, Mississippi: U.S. Geological Survey Open-File Report 90-380, 66 p.

Rodman, W., 1985, Quality Assurance Manual: Hydrologic Instrumentation Facility, 129 p.

Rodman, W., ed., 1984 through 1988, WRD Instrument News: Hydrologic Instrumentation Facility, Nos. 24 through 29 and 32 through 46.

Rodman, W., and Wheat, J.T., 1985, Operating manual for the hydraulic power unit: U.S. Geological Survey Hydrologic Instrumentation Facility operating manual 2-85-02, 21 p.

Rorabaugh, J.I., 1979, Electromagnetic flowmeter interface: U.S. Geological Survey Hydrologic Instrumentation Facility unnumbered operating manual, 10 p.

----- 1980, Electronic times for analog-to-digital recorders: U.S. Geological Survey WRD Bulletin, April-June 1980, p. 2.

----- 1985, Operating manual for the USGS shaft encoder/interface: Hydrologic Instrumentation Facility operating manual 85-01, 7 p.

Rorabaugh, J.I., and Rapp, W.L., 1985, Operating manual for the USGS regulator: U.S. Geological Survey Hydrologic Instrumentation Facility operating manual 7-84-04, 17 p.

----- 1986, Operating manual for the digital data-collection system for flow-control structures: U.S. Geological Survey Open-File Report 85-691, 39 p.

Rosenberry, D.O., Sturrock, A.M., Scarborough, J.L., and Winter, T.C., 1988, Climatic data for Williams Lake, Hubbard County, Minnesota, 1982: U.S. Geological Survey Open-File Report 88-89, 43 p.

Rosenberry, D.O., Sturrock, A.M., and Winter, T.C., 1988, Climatic data for Williams Lake, Hubbard County, Minnesota, 1986: U.S. Geological Survey Open-File Report 88-304, 38 p.

Sasser, D.C., Sturrock, A.M., Jr., and Covay, K.J., Meteorological and microlysimeter data for a rice irrigation study in southwestern Louisiana, 1985 and 1986: state cooperator report, 37 p.

Schneider, V.R., and Futrell, J.C., II, 1984, Performance of ice meter and weight assemblies: U.S. Geological Survey Water-Resources Investigations Report 84-4035, 26 p.

Sharp, K.V., and Rapp, W.L., 1984, Operating manual for the current meter digitizer (software version 1.2): U.S. Geological Survey Hydrologic Instrumentation Facility operating manual 6-84-03, 8 p.

Sharp, K.V., Higgins, W.B., and Bartlett, W.P., Jr., Operating manual for the rechargeable 12-volt power system: implementation guide: U.S. Geological Survey Hydrologic Instrumentation Facility operating manual 7-83-01, 47 p.

*Snell, W.H., 1991, Hydrologic Instrumentation Facility Technical Information Sheet for the B-56 reel brake adjustment, 4 p.

Sturrock, A.M., Jr., 1984, Instrumentation for measuring lake and reservoir evaporation by the energy-budget and mass-transfer methods: U.S. Geological Survey Open-File Report 84-863, 21 p.

----- 1985, Measurement of the variation of atmospheric precipitation in Mississippi: Southeastern Region Water Quality Symposium, Jacksonville Beach, Florida, January 29 - February 1, Proceedings.

Sturrock, A.M., Jr., Buso, D.C., Diever, G.M., Engelbrecht, L.G., and Winter, T.C., 1984, Climatic data for Mirror Lake, West Thornton, New Hampshire, 1981-82: U.S. Geological Survey Open-File Report 84-816.

Sturrock, A.M., Jr., Buso, D.C., Scarborough, J.L., and Winter, T.C., 1986, Climatic data for Mirror Lake, West Thornton, New Hampshire, 1984: U.S. Geological Survey Open-File Report 86-134, 70 p.

----- 1988, Climatic data for Mirror Lake, West Thornton, New Hampshire, 1986: U.S. Geological Survey Open-File Report 88-494, 68 p.

----- 1988, Climatic data for Mirror Lake, West Thornton, New Hampshire, 1985: U.S. Geological Survey Open-File Report 87-682, 64 p.

Sturrock, A.M., Jr., and Jelinski, J.C., 1984, An instrument to automatically measure and record the magnitude, conductivity, pH, and temperature of precipitation during storms: Proceedings of 40th Eastern Snow Conference, Toronto, Canada, June 2-3, p. 102-105.

Sturrock, A.M., Hanson, B.A., Scarborough, J.L., and Winter, T.C., 1986, Climatic data for the Cottonwood Lake area, Stutsman County, North Dakota, 1982: U.S. Geological Survey Open-File Report 86-477, 24 p.

----- 1987, Climatic data for the Cottonwood Lake area, Stutsman County, North Dakota: U.S. Geological Survey Open-File Report 87-216, 28 p.

Sturrock, A.M., Jr., Rosenberry, D.O., Engelbrecht, L.G., Gothard, W.A., and Winter, T.C., 1984, Climatic data for Williams Lake, Hubbard County, Minnesota, 1983: U.S. Geological Survey Open-File Report 84-247.

Sturrock, A.M., Jr., Rosenberry, D.O., Scarborough, J.L., and Winter, T.C., 1986, Climatic data for Williams Lake, Hubbard County, Minnesota, 1984: U.S. Geological Survey Open-File Report 86-64, 63 p.

Sturrock, A.M., Jr., Rosenberry, D.O., and Winter, T.C., 1987, Climatic data for Williams Lake, Hubbard County, Minnesota, 1985: U.S. Geological Survey Open-File Report 86-607, 40 p.

*Sturrock, A.M., Jr., Nichols, W.D., 1991, Measurements of vapor pressure over natural vegetation at a high desert site in southeastern Arizona: United States-People's Republic of China Bilateral Symposium on Droughts and Arid-Region Hydrology, Tucson, Arizona, September 16-20, Proceedings.

Tai, D.Y., and Rathbun, R.E., 1988, Photolysis of Rhodamine-WT dye *in* Chemosphere, v. 17, no. 3: Pergamon Journals Ltd, Great Britain, p. 559-573.

Tai, D.Y., Turner, K.S., and Garcia, L.A., 1990, The use of a standpipe to evaluate ground-water samplers *in* Ground Water Monitoring Review, in press.

*Tai, D.Y., Jennings, M.E., White, K.D., and Garcia, L.A., 1991, Evaluation of a modified automatic sampler for the collection of water samples for analysis of trace organic compounds or suspended sediment: U.S. Geological Survey Open-File Report 91-469, 26 p.

Thibodeaux, K.G., and Futrell, J.C., II, 1987, The effects of vertical motion on the performance of current meters: U.S. Geological Survey Water-Resources Investigations Report 87-4147, 50 p.

*Tracey, D.C., ed., 1991, WRD Instrument News: Hydrologic Instrumentation Facility, No. 54.

Turner, K.S., 1987, "The establishment of a qualified products list for water-quality instrumentation and sensors," Proceedings of the American Water Resources Association Symposium on Monitoring, Modeling and Mediating Water Quality, May 17-20, 1987, Syracuse, New York, p. 269-275.

Wagner, C.R., 1982, Organization of instrumentation within the U.S. Geological Survey, Water Resources Division: International Symposium on Hydrometerology, American Water Resources Association, Denver, Colorado, June 13-17, 1982.

----- 1984, Instrumentation support of the U.S. Geological Survey Water Resources Division: Journal of Water Science and Technology, International Association of Water Pollution Research and Control Symposium, p. 117-128.

----- 1986, Organizational Aspects of Supporting Hydrometric Instrumentation, in Herschy, Reginal W., ed., New Technology In Hydrology: Boston, Adam Hilger Ltd, p. 67-81.

----- 1986, A systems approach to hydrologic data collection: Energy-Sources Technology Conference and Exhibition, February 23-27, 1986, American Society of Mechanical Engineers, New Orleans, Louisiana, 4 p.

----- 1986, Overview of the U.S. Geological Survey's Hydrologic Instrumentation Facility: Sixth International Northern Research Basins Symposium Proceedings, Houghton, Michigan, January 26 - February 2, 1986.

Wagner, C.R., and Jeffers, S.R., 1984, The Hydrologic Instrumentation Facility of the U.S. Geological Survey: U.S. Geological Survey Open-File Report 84-227, 18 p.

----- 1984, The Water Resources Division water level recorder rental program - history and operation: U.S. Geological Survey Open-File Report 84-735, 16 p.

Wagner, C.R., 1987, "Instrumentation support of the U.S. Geological Survey Water Resources Division," Proceedings of the American Water Resources Association Symposium on Monitoring, Modeling and Mediating Water Quality, May 17-20, 1987, Syracuse, New York, 8 p.

----- 1986, Annual Report 1986, Hydrologic Instrumentation Facility: Hydrologic Instrumentation Facility internal report, 114 p.

Wells, D.K., ed., 1985, Annual report 1985, Hydrologic Instrumentation Facility: Hydrologic Instrumentation Facility internal report, 60 p.

----- ed., 1985, Gulf Coast Hydroscience Center Projects and Activities, Gulf Coast Hydroscience Center, 21 p.

----- ed., 1985, WRD Instrument News: Hydrologic Instrumentation Facility, Nos. 30 and 31.

Wells, Frank, and Scott, Carl, 1985, Laboratory techniques, *in* McCutcheon, Steve C.and others, Water Quality and Streamflow Data for the West Fork Trinity River in Fort Worth, Texas: U.S.Geological Survey Water-Resources Investigations Report 84-4330, p. 19-20.

---

*Published in FY91