LEVEL II

AD A059244

. . . . . contributing to man's understanding of the environment World

TR 78-13

TECHNICAL REPORT NO. 78-13

SEMIANNUAL REPORT, PROJECT T/4703 SPECIAL DATA COLLECTION SYSTEMS

APRIL 1978 THROUGH SEPTEMBER 1978

APPROVED FOR PUBLIC RELEASE.
DISTRIBUTION UNLIMITED.

TELEDYNE GEOTECH

LEVEL II

12

TECHNICAL REPORT NO. 78-13

SEMIANNUAL REPORT, PROJECT T/4703 SPECIAL DATA COLLECTION SYSTEMS APRIL 1978 THROUGH SEPTEMBER 1978

by

John R. Sherwin
and
George C. Kraus

Sponsored by

Advanced Research Projects Agency
ARPA Order No. 2897

This research was supported by the Advanced Research Projects Agency of the Department of Defense and was monitored by AFTAC/VSC, Patrick Air Force Base FL 32925, under Contract F08606-78-C-0011.

TELEDYNE GEOTECH
3401 Shiloh Road
Garland, Texas 75041

29 December 1978

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: 78-13

2. GOVT ACCESSION NO.:

3. RECIPIENT'S CATALOG NUMBER: (9)

4. TITLE (and Subtitle): Semiannual Report, Project T/4703 (6) Special Data Collection Systems (Project T/4703) April 1978 through September 1978

5. TYPE OF REPORT & PERIOD COVERED: Semiannual Report, (3) Apri[illegible] Sept[illegible]78,

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s): (10) John R. Sherwin and George C. Kraus

8. CONTRACT OR GRANT NUMBER(s): (15) F08606-78-C-0011, ARPA Order-2897

9. PERFORMING ORGANIZATION NAME AND ADDRESS: Teledyne Industries, Geotech Division, 3401 Shiloh Road, Garland, Texas 75041 - 405 770

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: T/4703/B/ETR

11. CONTROLLING OFFICE NAME AND ADDRESS: Air Force Technical Applications Center, Alexandria, Virginia 22314

12. REPORT DATE: (11) 29 Sept[illegible]978

13. NUMBER OF PAGES: 16

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): (14) TR-78-13 (12) 17p.

15. SECURITY CLASS. (of this report): UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release. Distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Seismic Recording Systems
Seismic
Long-Range Seismic Measurements Program
VELA-Uniform
SDCS

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The work performed under Project T/4703, Special Data Collection Systems, during the period from April 1978 through September 1978 is described. The present program is an extension of the program which began in 1973 under Contract F08606-74-C-0013. (begun)

At the start of this period SDCS systems remained in operation at four sites. These were Island Falls, Maine; Gasbuggy, New Mexico; Rio Blanco, Colorado; (over)

DD FORM 1 JAN 73 1473 A EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

405770 JOB

and Houlton, Maine. The first two sites record short-period data on analog tape only; the Rio Blanco configuration is the same except that data are also recorded on the digital recorder. At Houlton, both short-period and long-period data from a KS36000 system are recorded on analog and digital recorders. The remaining seven SDCS units remained in an inactive status.

Operations at all sites continued with only minor, routine problems until late August when all except Rio Blanco were closed. Equipment from these sites was returned to Garland, Texas, for refurbishing and preparation for redeployment in October, 1978, at sites designated by the Project Office.

A special project to collect high-frequency data at a site near McKinney, Texas, was begun in May. In the first phase of operations, data were collected from both the KS36000 vertical and a standard vertical instrument in the high-frequency passband. These data are being analyzed at Southern Methodist University (SMU) to determine whether the KS36000 operates properly at this frequency. Phase two, which began in mid-September and will be continued through December, will collect one channel of high-frequency data and three channels of intermediate period data from the KS36000 to determine the potential usefulness of such seismographs in detection of events at relatively close distances up to 650 km.

Another special project was approved and work was just beginning at the end of the reporting period. Under this program, a borehole package will be developed for a recently developed low-cost short-period seismometer. In addition, techniques will be developed to use lightweight plastic pipe to case shallow boreholes suitable for this instrument. These tasks will be followed by tasks to evaluate both instrument operation and borehole performance. SDCS equipment will be used as necessary to support this program.

1473B

CONTENTS

ILLUSTRATIONS

SEMIANNUAL REPORT, PROJECT T/4703
SPECIAL DATA COLLECTION SYSTEMS
APRIL 1978 THROUGH SEPTEMBER 1978

1. INTRODUCTION

The Special Data Collection System (SDCS) program, Project T/4703, is a continuation of work begun under the Long-Range Seismic Measurement (LRSM) program in 1960. This work is directed toward advancing the seismic detection, identification and location techniques necessary to detect and identify underground nuclear explosions.

This work describes the work performed under the SDCS program during the period from April 1978 through September 1978 and is submitted in accordance with Sequence No. A004 of the Contract Data Requirements List. This research was supported by the Advanced Research Projects Agency of the Department of Defense and was monitored by AFTAC/VSC, Patrick Air Force Base FL 32925, under Contract No. F08606-78-C-0011.

2. FIELD OPERATIONS

2.1 GENERAL

The basic instrumentation for the SDCS program consists of eleven units of the Portable Seismograph System, Geotech Model 19282. This system includes three-component short-period and three-component long-period seismographs recording on slow-speed FM magnetic tape, plus necessary calibration, timing, and support equipment. The system is designed for quick deployment by a qualified electronic technician and is capable of recording laboratory quality data. Other instrumentation assigned to the program inventory provides versatility and increased operating capability of the basic portable system. Examples of such instrumentation include three Model 36000 borehole seismograph systems (KS36000) and five digital data recording systems.

At the beginning of this report period, four SDCS units were collecting data. These sites and basic instrumentation are as follows:

Team	Site and Designator	Instrumentation
51	Island Falls, Maine (IF-ME)	Surface SP, Analog
53	Gasbuggy, New Mexico (GB-NM)	Surface SP, Analog
56	Rio Blanco, Colorado (RB-CO)	Surface SP, Analog and Digital Recording
58	Houlton, Maine (HN-ME)	KS36000, 40 m depth SP & LP Components, Analog and Digital Recording

One unit, Team 57, was located at Gold Meadows, Nevada (GQ-NV) and remained in an inactive status through the period in anticipation of future data collection operation at the Nevada Test Site (NTS). Another unit, Team 59, was enroute to Garland, Texas, from Red Lake, Ontario, Canada, where operations had recently concluded. Teams 52 and 60 were being checked out after having recently been operational in the field and Teams 50, 54, and 55 were maintained in storage at Geotech's Garland, Texas, facility.

2.2 FIELD LOCATIONS

The function of each SDCS is to record high quality seismic data. However, each location differs from the others in the equipment utilized, the data recorded and the environmental conditions under which it is operated. Figure 1 is a map showing the locations of the sites occupied during the April through September 1978 period. Figure 2 is a map showing the more recent SDCS site locations on the NTS. The following paragraphs summarize the site activities at each SDCS location during this report period.

2.2.1 Team 51, Island Falls, Maine (IF-ME)

Data recording continued virtually uninterrupted from the start of report period until the station was closed on 23 August 1978. Data recording of the three-component short-period data was in analog mode only as no power was available for digital system operations. Except for site access problems during the winter months (by snowmobile only) no unusual operation problems were encountered. The system was returned to Garland, Texas, on 05 September 1978 and was placed in storage.

2.2.2 Team 53, Gasbuggy, New Mexico (GB-NM)

Data recording of three-component short-period signals in an analog format continued until the station was closed on 23 August 1978. Digital system operation was not possible as no commercial power was available. Some data were lost when the site was inaccessible due to muddy roads caused by snow and rain. High noise level at the site during this period was caused by increased cultural activity (logging trucks, well drilling, plowing and seeding) in the immediate area.

2.2.3 Team 56, Rio Blanco, Colorado (RB-CO)

Analog and digital recording of three-component short-period data from a surface vault continued through most of the report period. On several occasions data recording was interrupted due to failures caused by lightning strikes. The digital system was inoperative from 28 August 1978 through the end of September 1978, due to lightning damage and lack of spare parts. The poor reception of radio time signals from WWV continues to be a problem at this location. Various antenna locations and configurations have been tried but no solution has been found.

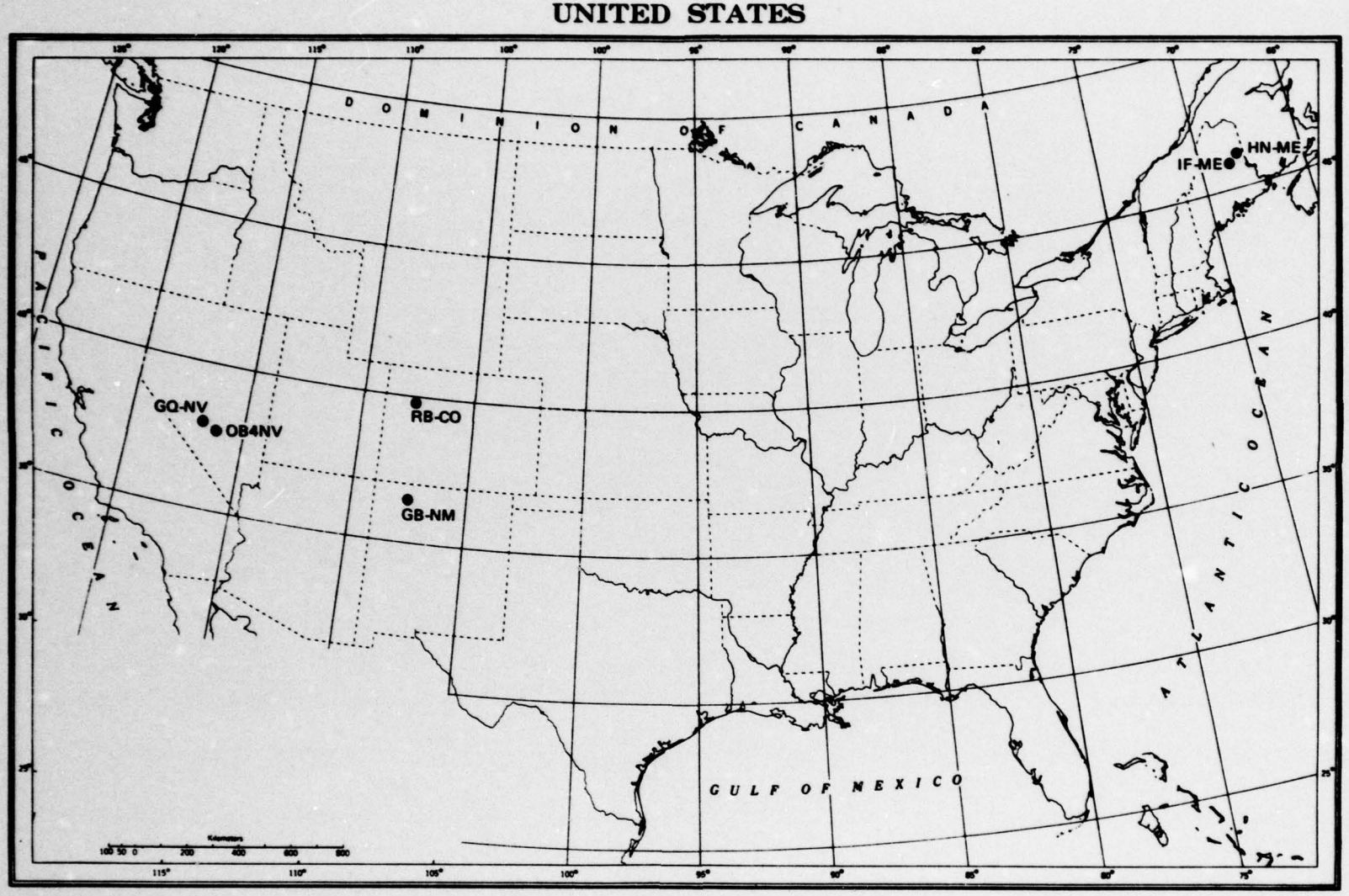

Figure 1. Sites occupied during the period April - September, 1978

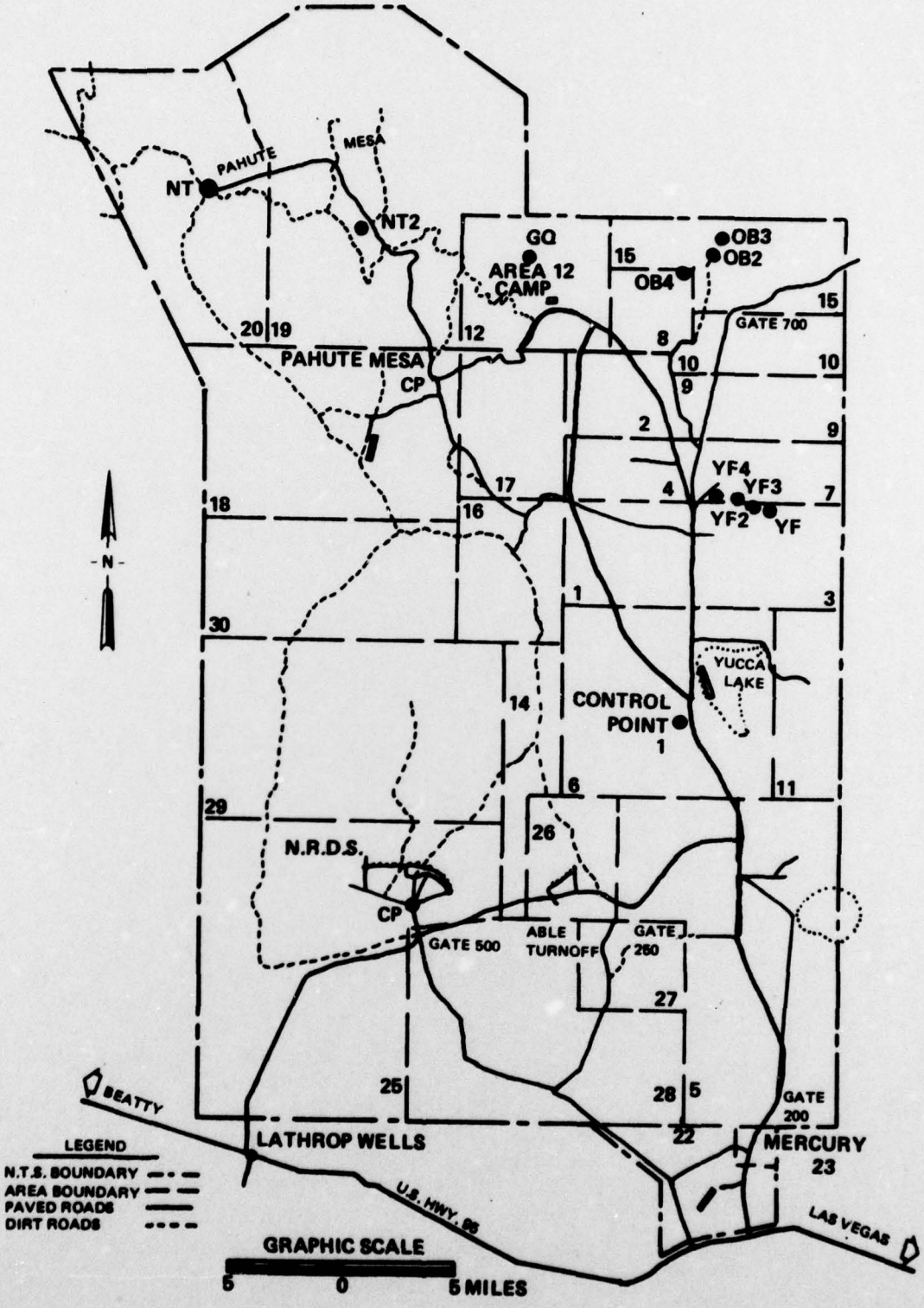

Figure 2. SDCS site locations on the Nevada test site

2.2.4 Team 57

2.2.4.1 Gold Meadows, Nevada (GQ-NV)

The three-component short-period analog equipment from Team 57 remained on site in an inactive status. Site operations had been discontinued in December, 1977, when heavy snow prevented site access. The equipment was retrieved and moved to a new location on the NTS on 22 September 1978. Deeply rutted roads made retrieval of the equipment very difficult.

2.2.4.2 Oak Springs Butte 4, Nevada (OB4NV)

Team 57 equipment was moved to the site location on 22 September 1978. The coordinates of the new site on the NTS in Area 8 are:

37° 13' 10" N

116° 03' 41" W

Elevation 1524 meters or 5000 feet

Additional equipment will enable three-component short-period data to be recorded in both analog and digital modes. This site was intended to be located at the OB2NV location which was occupied previously but cultural activity in the area made the area too noisy. The new site is still on the Climax Stock but as far away as practical from the noise sources. Data recording at OB4NV is expected to start in October, 1978.

2.2.5 Team 58, Houlton, Maine (HN-ME)

Data recording of three-component short-period and three-component long-period data from a Model 36000 borehole seismometer in both analog and digital formats continued through much of the period. Digital recording stopped on 23 August and analog recording was discontinued on 29 August 1978. The operator departed the site on 31 August and arrived in Garland, Texas, on 5 September 1978.

The site was left with the recorder building intact, the borehole dry and locked, and the surface vault intact. Under the terms of the lease agreement, Geotech retains the option to reoccupy this site until 1986 when all rights to the borehole revert to the landowner. Lease fees are payable only during those periods that the site is occupied. When the site was closed, Weston Observatory of Boston College requested permission to use the building and the surface vault to install seismic equipment as part of a large monitoring network. The landowner was notified and Weston Observatory personnel were instructed to make any necessary arrangement with the landowner.

After returning to Geotech's Garland facility the equipment was reconfigured to a standard system and readied for deployment to the Project Rulison area in western Colorado. All equipment associated with the KS36000, such as filters, amplifiers, and special wiring, were removed from the system; standard short-period seismometers and amplifiers were installed and tested. A small, used camper trailer was obtained for use as a field operations building in lieu of purchasing a temporary building. The use of the trailer will provide for greater mobility for systems with digital recording capability. Deployment to the Rulison, Colorado, area is expected in October 1978.

2.2.6 Team 59, Red Lake, Ontario (RK-ON)

Site operations were completed on 30 March 1978, and the team departed the site on 01 April 1978, arriving at Geotech's Garland, Texas, facilities on 04 April 1978. Site clean up was subcontracted to local personnel as a heavy snow cover prevented a complete site clean-up. The site clean-up was completed to the satisfaction of the Province of Ontario, Ministry of Natural Resources in June 1978.

In September, 1978, Team 59 was readied for deployment to a field site in the Battle Mountain area of northern Nevada. Again, a small, used camper trailer was obtained to be used as an instrumentation shelter. Actual deployment of the equipment is expected in October, 1978.

2.2.7 Team 60

Units of Team 60 equipment were used in special studies operations at the McKinney, Texas (MCK) site in a cooperative program with Southern Methodist University (SMU). SDCS equipment required for this program included one short-period seismometer, one amplifier with a special filter, the digital recording system, and the timing system. The remaining Team 60 units were used in the checkout of equipment returned from the field.

3. ENGINEERING SUPPORT

3.1 GENERAL

The engineering support function in Garland routinely provides for control of government property and replacement or repair of parts for SDCS operations. In addition, changes to system hardware are developed to improve operation or to correct deficiencies. In the following paragraphs, engineering support activities during this period are discussed.

3.2 DIGITAL RECORDING SYSTEMS

Two of the SDCS digital recording systems were routinely operated at sites throughout the period and the remaining three units (formerly assigned to the RK-ON and NTS sites) were set up in the Garland laboratory. No major problems were encountered in operating these systems.

3.2.1 Special System Modifications

One of the DDS-1103 systems was modified for a special studies program at McKinney, Texas (see paragraph 5 below). The standard configuration of this system specifies an INTERRUPT mode of operation where four channels are sampled at the input pulse rate and the remaining four channels are sampled at one-twentieth of that rate. For normal operation, the input scan pulses are at a rate of 20 pps, resulting in SP sampling at 20 sps and LP sampling at 1 sps. This special application required that one channel be sampled at 60 sps for high frequency (HF) data and at least three channels be sampled at one-tenth that rate or 6 sps for intermediate period (IP) data. A modification was developed which required a few wiring changes to achieve this configuration. Also, the number of zero-filled bytes in the header was adjusted in order to assure that the INTERRUPT mode record would be completed in an integral number of seconds.

After modifying the system, a test tape was recorded and later analyzed; all data channels were properly recorded. This modification demonstrated that the DDS-1103 system can be modified relatively quickly for special requirements.

3.2.2 Increased Operating Time

A problem resulting from using the digital recording system is the requirement for a daily tape change. The SDCS operator therefore cannot take a day off without losing digital data. Several alternate approaches were considered to resolve this problem. Reduction of the approximate 1900 ft per day tape usage would require a decrease in the sampling rate or a change in the INTERRUPT mode of operation, such as elimination of the low gain (fourth) SP channel. Such changes would be easily implemented but could require changes in the software used for processing the data. An alternative approach was to supply the teams with thinner tape (1.0 mil) which can be supplied on standard reels in 3600 ft lengths instead of the usual 2400 ft tapes. The 3600 ft tapes run

for about 45 hours and would allow the operator to take a day off. This approach is cost effective because the cost of a new tape is more than offset by the savings in labor and transportation. When data processing personnel at the Seismic Data Analysis Center (SDAC) reported that there would be no particular problem in handling the tapes, several cases were purchased on a trial basis. In June, each of the SDCS operators started using one of these tapes per week and have reported no problems with them. Also, all reported that the weekly day off was very helpful.

3.3 CHECKOUT OF SDCS UNITS RETURNED FROM THE FIELD

As part of the engineering support function, SDCS units returned from the field are thoroughly tested in preparation for future assignments. During this period, Teams 51, 52, and 53 (which had been assigned to sites IF-ME, TQ-MS and GB-NM) were checked and returned to the warehouse. These units are three of the six older type systems on hand and use photocell amplifiers instead of the solid state amplifiers in the newer units. Among the five newer units, Teams 58 (HN-ME) and 59 (RK-ON) were checked and readied for redeployment. Selected components from Team 60, formerly assigned at OB2NV, were configured for use at the McKinney, Texas station.

At the end of this reporting period, ten of the SDCS portable units were either in storage and ready for future operation (Teams 51-55) or in the process of being set up in the field (Teams 56 through 60). Team 50, which is the original engineering model system, should not be considered available for any future operation. The short-period seismometers originally assigned to this team were transferred to another government organization and much of the remaining equipment is non-standard; this unit has not been operated as a system since 1973. Remaining Team 50 equipment will be used primarily as a source of ready spare parts for the other ten operational units.

3.4 KS36000 SYSTEMS

The SDCS program has three KS36000 Borehole Seismometer Systems assigned. At the end of this period, system S/N X001 which had been operated at the HN-ME site, was being checked and repaired as necessary. When repairs and final checkout are completed, this system will be returned to the warehouse along with the other two units; all units will be maintained in a readiness condition for deployment on relatively short notice.

3.5 GOVERNMENT PROPERTY SURVEY

In April, the annual survey of government property assigned to the contract was conducted by government representatives. Categories checked included maintenance, utilization, and a spot check of the physical inventory. With a few minor exceptions, all was found to be in order.

4. DATA PROCESSING

The data processing tasks under this contract include routine analog tape quality control and special playouts of data as required. Digital tape quality control and event processing tasks are performed in Alexandria, Virginia, under the SDAC Contract.

4.1 DATA PROCESSING AT GARLAND

4.1.1 Magnetic Tape Playouts on 16-mm Film

The requirement to play out magnetic tape from selected SDCS operations continued during this period. In general, playouts were made from those stations not equipped with digital recorders (and others as requested) and were used by SDAC personnel for preliminary analysis and selection of data segments for detailed computer analysis. The playouts are made using the SDCS facilities in Garland. The film recorder operates at six times normal short-period (SP) film speed (180 mm/min) and the tapes are reproduced at 20 times real-time (0.6 ips). The resulting film presentation is a compression of the SP data by 3.33 as compared to normal SP films and the resolution has been found to be adequate.

During this period, playouts were routinely made of the data from IF-ME and GB-NM. In addition, portions of most tapes from RB-CO and HN-ME were played out (approx. 24 hour-segments), primarily for quality control checks of the field data. All film data were reviewed in Garland and a brief log containing information relative to the processing was prepared. Films, tapes, and all logs were then routinely sent to the SDAC for storage and processing.

By the end of the period, routine production of films had been completed for all tapes for those teams requiring playouts. It is not planned that full-coverage films will be produced during the next reporting period because all sites to be operated under the extended program will have the digital recorders.

4.1.2 Quality Control of the Analog Tapes at Garland

The quality control (QC) function has received continued emphasis during this period. Film playouts were made for those sites not specifically required for the SDAC analysis effort, such as HN-ME. These playouts cover the last one or two days of each ten-day magnetic tape and are analyzed to identify problems at each site. These procedures have assured production of high quality data and will be continued.

4.2 DATA PROCESSING AT THE SDAC

The SDAC at Alexandria, Virginia, provides all digital tape QC and data analysis support for this program under the SDAC contract. In addition, digital tapes for use at the SDCS sites are provided by the SDAC. At the end of the reporting period, SDAC personnel had reported that the supply of recycled tapes had been exhausted. For continued operation of five digital systems under the contract extension, either a supply of tapes must be located or new ones may be purchased.

During this reporting period, there were no routine QC reports generated by the SDAC. However, there have been no problems reported in using the data. Routine QC reporting should be resumed during the extended program because more recorders will be in operation.

5. SPECIAL PROJECTS

5.1 COLLECT HIGH FREQUENCY DATA

In the previous period, there was considerable interest in the possiblity that high-frequency (HF) seismographs might be useful to collect data for discriminating between earthquakes and explosions at near-regional distances of 150 to 650 km. There was also a need to investigate the potential usefulness of intermediate-period (IP) data. A proposal was submitted outlining a program to collect such data in a cooperative effort with Southern Methodist University (SMU) at their KS36000 site near McKinney, Texas. The SDCS program would provide special filters and collect the data and SMU would provide the KS36000 broadband outputs, would process the data, and write a report.

The program was divided into two phases. First HF data were to be collected from both a KS36000 HF vertical seismograph and from a conventional (inertial) HF seismograph to determine whether the KS36000 performs properly in the HF passband. In the second phase, data were to be collected from a single HF KS36000 vertical channel and from the three-component KS system through IP filters. For both phases, data were to be recorded on digital tape.

When approval to begin was received in May, components for several special filters were ordered. Needed equipment from SDCS Team 60 was gathered and checked, and the digital recorder was modified from its standard configuration. A set of temporary filters was built for the KS channel (HFZ) in order to start data collection operations before the special filters were available. The equipment was installed and the first phase of operation began in late June. During July, processing routines were developed at Geotech to reformat the 9-track field tape to the 7-track format compatible with the SMU computer facility. SMU personnel developed routines to demultiplex the 7-track data and the first processing runs were completed in early August. It was then determined that the response of the HFZ (KS) channel and the surface channel (HFZ-5) were not adequately matched at frequencies above 7 Hz to complete the comparison tests. Therefore, the newly completed set of filters was installed in the KS system on 15 August. Data collection for the first phase continued until 15 September when phase two began; phase two operations are scheduled through December with the extended program.

By the end of the reporting period, only limited data processing had been completed at SMU. However, preliminary reports indicated that (1) microseisms at 2 to 3 Hz obscured many small signals and (2) signal level on the KS channel was considerably lower than the surface signal for small, high-frequency events. Further processing will be done and a detailed report will be made by SMU during the next period.

5.2 DEVELOPMENT OF A NEW BOREHOLE SEISMOMETER

In August, a Task Change Proposal (P-3144) was submitted outlining a program to develop a borehole package for a low cost short-period seismometer (Model 43830) recently introduced by Teledyne Geotech. The goal of this program would be to provide an instrument to replace the Model 23900 now used by the government, and to evaluate boreholes cased with lightweight plastic pipe. The proposed system would provide a more rugged, lower cost instrument which could be installed in relatively inexpensive boreholes in areas not easily accessible to the large drilling rigs now required.

In late September, approval was received to begin work on this program as a special project under the SDCS program. At the end of the reporting period, engineering assignments had been released to design both the filter and the borehole packaging components, but work had not begun. Present plans call for the use of several items of SDCS equipment during the evaluation phase. Items being considered are a standard short-period surface seismograph for control, an analog recording facility, and calibration equipment.