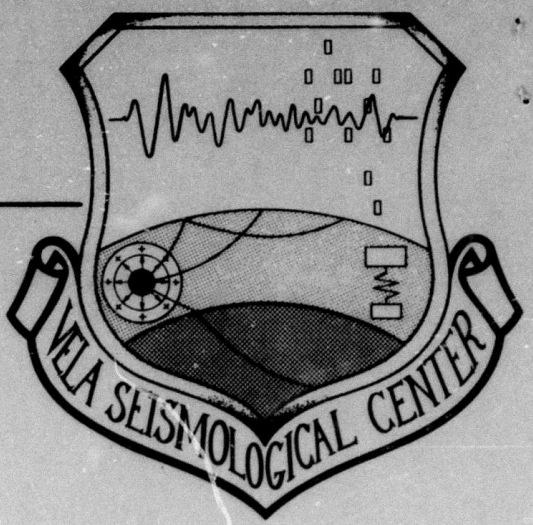
(12)

VSC-TR-83-4

SDAC FINAL REPORT
01 OCT 1980 TO 30 SEPT 1981



Paul Kovacs
Seismic Data Analysis Center
Teledyne Geotech
314 Montgomery Street
Alexandria, Virginia 22314

10 JAN 1983

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

Monitored By:
VELA Seismological Center
312 Montgomery Street
Alexandria, VA 22314

Sponsored by

The Defense Advanced Research Projects Agency (DARPA)

DARPA Order No. 2551

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER VSC-TR-83-4	2. GOVT ACCESSION NO. AD-A126	3. RECIPIENT'S CATALOG NUMBER 428
4. TITLE (and Subtitle) SDAC FINAL REPORT 01 OCTOBER 1980 TO 30 SEPTEMBER 1981		5. TYPE OF REPORT & PERIOD COVERED Technical
		6. PERFORMING ORG. REPORT NUMBER SDAC-TR-82-4
7. AUTHOR(s) Paul Kovacs		8. CONTRACT OR GRANT NUMBER(s) F33600-81-C-0279
9. PERFORMING ORGANIZATION NAME AND ADDRESS Teledyne Geotech 314 Montgomery Street Alexandria, Virginia 22314		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS VT/1706
11. CONTROLLING OFFICE NAME AND ADDRESS Defense Advanced Research Projects Agency 1400 Wilson Boulevard Arlington, Virginia 22209		12. REPORT DATE 01/10/83 13. NUMBER OF PAGES 47
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) VELA Seismological Center 312 Montgomery Street Alexandria, Virginia 22314		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)

SDAC
Final Report

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

The effort required to operate and maintain the Seismic Data Analysis Center during the fiscal year of 1981 is described in this report. Statistics concerning the operational effectiveness and the utilization of the systems at the Center are also given. The major activities associated with maintaining the operating systems, providing data services, and performing maintenance are discussed.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

The development effort and improvements made to the systems supporting the geophysical research include capabilites added to the Regional Event Location System and the Automatic Association program. Other tasks reported include the result of implementing a front end processor (called an intelligent line interface) to do real-time signal detection, the effects of altering the configuration of the detection systems, and the status of software developed to do interactive discrimination. A computer study was performed to determine a preferred system to accomplish the on-line data recording and support the data services activity.

SDAC FINAL REPORT

01 OCTOBER 1980 TO SEPTEMBER 1981

SEISMIC DATA ANALYSIS CENTER REPORT NO.: SDAC-TR-82-4

AFTAC Project Authorization No.:	VELA T/1706/B/AFLC
Project Title:	Seismic Data Analysis Center
ARPA Order No.:	2551
Name of Contractor:	TELEDYNE GEOTECH
Contract No.:	F33600-81-C-0279
Date of Contract:	01 October 1980
Amount of Contract:	$2,917,636
Contract Expiration Date:	30 September 1981
Project Manager:	Robert Van Nostrand (703) 836-3882

P. O. Box 334, Alexandria, Virginia 22313

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

ABSTRACT

The effort required to operate and maintain the Seismic Data Analysis Center during the fiscal year of 1981 is described in this report. Statistics concerning the operational effectiveness and the utilization of the systems at the Center are also given. The major activities associated with maintaining the operating systems, providing data services, and performing maintenance are discussed.

The development effort and improvements made to the systems supporting the geophysical research include capabilites added to the Regional Event Location System and the Automatic Association program. Other tasks reported include the result of implementing a front end processor (called an intelligent line interface) to do real-time signal detection, the effects of altering the configuration of the detection systems, and the status of software developed to do interactive discrimination. A computer study was performed to determine a preferred system to accomplish the on-line data recording and support the data services activity.

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

LIST OF FIGURES

LIST OF TABLES

I. INTRODUCTION

The Seismic Data Analysis Center (SDAC) completed its 13th year of operation in 1981. Major systems and operational requirements have changed during the years in response to research requirements and budget limitations. Work accomplished during the fiscal year 1981 changed some of the operational systems but not to the same extent as in previous years. The modifications to the systems and their status at the SDAC are provided in this report along with the summaries of operational statistics of the major computer systems. Other activities including programming support, data services, and maintenance are reviewed, and pertinent new computer programs and changes to operating systems are described. Hardware problems and configuration changes are identified and summarized.

The development and results of the Data Management tasks were, for the most part, characterized by completing programs begun during previous years. The programming and system support was heavily oriented toward the geophysical aspect of the systems. Previous years have seen most of the time spent evaluating and selecting hardware systems and integrating various peripherals. Programming emphasis was placed on the operating systems and on developing drivers and on handlers for some of the devices.

II. SUMMARY

Few changes were made in the operation of the systems, the most significant being that the VAX was brought to an operational state. Routine backups and user assistance were assigned to the operational personnel.

System programmers continued supporting the IBM 360's by cataloging programs, helping users, and occasionally assisting in trouble shooting during maintenance periods.

Some new equipment was added to the DEC systems, i.e., disk drives and tape units. The disk drives caused considerable problems because of design problems in the controller shared between the 11/70 and VAX. Determining and correcting this deficiency was a major activity of the maintenance staff during the year.

Data Services developed a major data set to support the International Data Collection Experiment and began a much needed inventory of all of the seismograms available at the facility. Other contractors and agencies were provided data as they have been in the past, seismicity files were kept current, and a continuous throughput of A/D conversions was maintained.

Development of the data management system continued from work started in previous contracts. The Regional Event Location System (RELS) was functioning in a limited geophysical sense by the end of the contract. The capabilities in the basic structure that allow geophysical applications to be included were implemented. A location program for regional events was integrated and improvements were made to the magnitude computations. Both the phase arrival queue display and the waveform display were developed. Tests on scrolling the waveform display showed that eight traces could be scanned at a rate of 30 times real time.

The detection processor was moved from the DEC 11/70 to the VAX. The 11/70 version of the program used all of that computer's memory, so that any input or processing change desired for the program were

difficult to make. By moving it to the VAX, the program was also able to provide a detection list that is immediately accessible for post DP processing, Automatic Association, and other analysis.

A computer study was performed to determine a suitable replacement for the aging IBM systems. The goal of the study was to recommend a system capable of supporting data services and recording the continuous on-line data.

Development of the in-line or front-end detector continued, with most of the effort spent selecting a suitable detection algorithm for these micro processors.

Many improvements were made to the Automatic Association program which dramatically increased the accuracy of this process. Now few true events are missed and fewer false events are determined. The improvements were made by adding later phase logic, allowing the formation of regional events, and screening events for logical groupings of stations.

Only a limited amount of work was accomplished on the Interactive Discrimination program during this contract. Some improvements were made, but the process remained as a batch program because the necessary software structure within RELS was not developed enough to integrate this subsystem into the VAX research system.

Operational Overview

A photograph showing the VAX and 11/70 is provided in Figure 1. These systems occupy about one fifth of the computer room area. The remaining floor space is occupied by the IBM systems.

Figure 2 shows the real-time data flow during the contract period. Note that detection processor resides in the 11/70, this was the case for most of the contract period, but in late 1981, this process was moved to the VAX.

Figure 1. - Photo of Computer Room

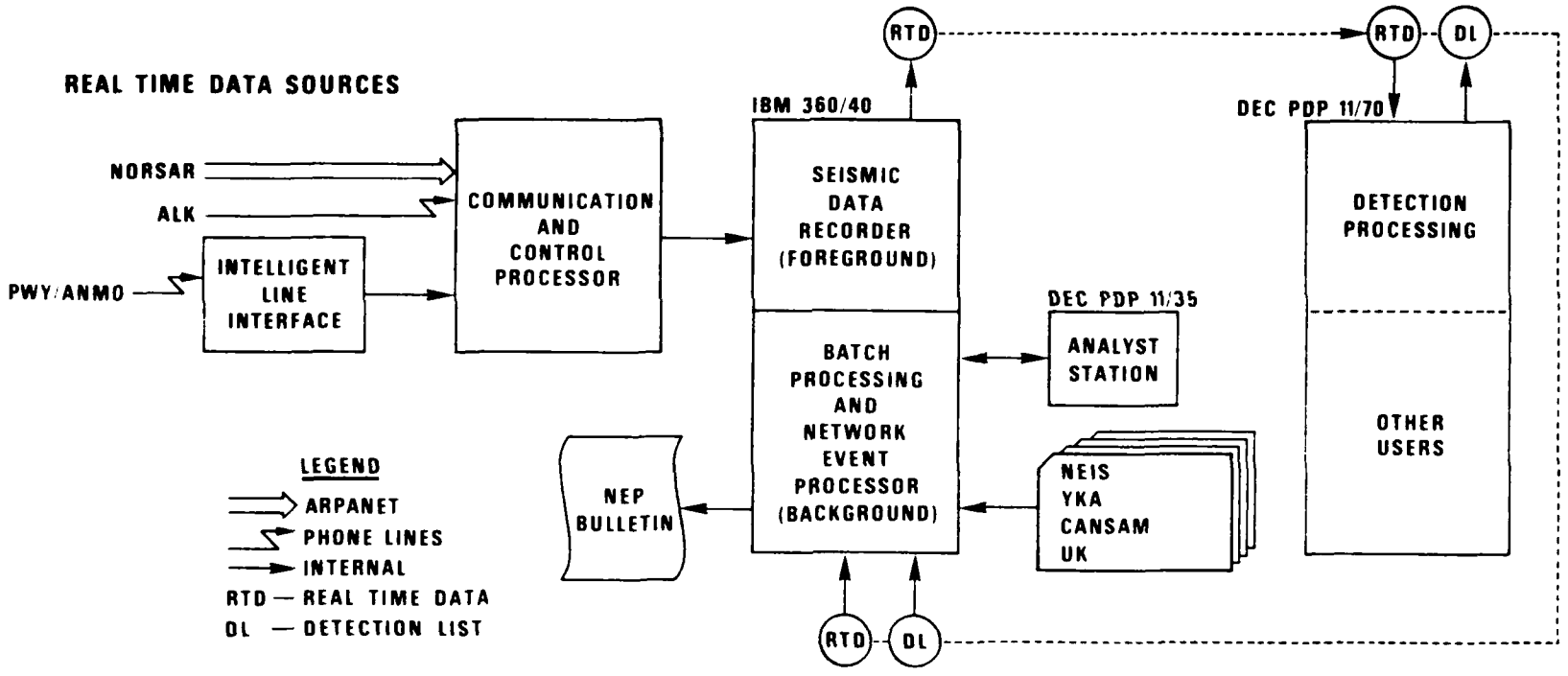


Figure 2. - Real-Time Data Flow

III. OPERATIONS

The operational statistics gathered throughout the year are tabulated in this chapter. The most troublesome operational problem was the communication link to Norway. This data path was rerouted to use the military line at Fort Detrick and the commercial line operated by C&P at Arlington. This reconfiguration resulted in a very high error rate and required corrective action by other agencies. Detailed statistics of the transmission quality of the data were routinely given to the Project Officer and are not included this report.

In general, all of the systems showed a reasonable degree of reliability. The CCP was monitored hourly throughout the year and its downtime amounted to less than three percent. Month by month down times for this system and the reasons for the failures are given in Table I.

As noted previously, the real-time data stream was recorded in a foreground partition on the IBM 360/40 and the resources of the remainder of the system were used for other processing. The requirements for recording the on-line data stream were: 1) mandatory data recording between the hours of 0000 and 0800 GMT and, 2) recording maximum possible amount of data during the remainder of the day. During the year, 80.1 hours of data were lost during the mandatory recording time; the reasons for the lost data, by month, and a summary of the causes are presented in Table IIa. Table IIb shows the use of the background partition of the IBM 360/40 in hours per month.

The IBM 360/44 operated the TS44 system 80% of the time. Other uses of the system are shown in Table IIIa on a month by month basis; Table IIIb gives the number of TS44 runs for each month of the year.

Tables IV and V show the hourly usage of the PDP 11/70 and VAX 11/780 respectively. These tables reflect the login time of the noted uses by month. Totals for each month and for the year of each of the uses are also given. The low numbers for the beginning of the year indicate the excessive downtime during the installation of the additional disk drives. Also, some accounting data for these months were lost.

TABLE I

CCP Downtime In Hours

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
System Crashes	1.2	.6	1.5	2.5	.2	-	-	-	.4	1.0	-	-	7.4
System Testing	-	-	12.3	43.2	24.3	.2	3.8	-	-	-	3.5	3.1	90.4
Investigating	.7	.8	.7	.5	-	-	-	-	-	-	-	-	2.7
P M	-	6.8	15.0	-	20.7	7.6	1.1	14.3	-	-	-	-	65.5
Power Failure	-	1.5	.7	-	-	1.9	.1	.5	2.5	-	-	-	7.2
Operations	-	-	-	6.0	-	-	-	-	-	46.1*	-	-	52.1
Total Downtime	1.9	9.7	30.2	52.2	45.2	9.7	5.0	14.8	2.9	47.1	3.5	3.1	225.3
Total Possible Recording Hours	744	720	744	744	672	744	720	744	720	744	744	720	8760
Total Hours of Recording	742.1	710.3	713.8	691.8	626.8	734.3	715.0	729.2	717.1	696.9	740.5	716.9	8534.7
Total % Recording Experience	99	99	96	93	93	98	99	98	99	93	99	99	97.1

* Unable to load Operating System using the Tenex Network

TABLE IIa

Recording Downtime In Hours (FG Partition)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
System Crashes	1.1	1.6	1.5	1.3	.7	3.3	1.2	2.1	2.3	1.3	.5	-	16.9
Power Failures	1.3	1.2	.7	.7	-	.4	.1	-	1.5	-	-	-	5.9
Investigating	-	-	.7	-	-	-	-	-	-	-	-	-	.7
Testing	-	-	12.3	-	4.7	-	-	-	-	-	.1	-	17.1
P/M	-	-	15.0	-	-	.2	1.6	.2	2.0	3.1	-	.1	22.2
Operations	-	-	-	-	-	-	-	-	-	17.3*	-	-	17.3
Total Downtime	2.4	2.8	30.2	2.0	5.4	3.9	2.9	2.3	5.8	21.7	.6	.1	80.1
Total Mandatory Recording Hours**	248	240	248	248	224	248	240	248	240	248	248	240	2920.0
Total Hours	245.6	237.2	217.8	246.0	218.6	244.1	237.1	245.7	234.2	226.3	247.4	239.9	2839.9
% Recording	99	99	88	99	97	98	99	99	97	91	99	99	97

* Unable to initialize Operating System using the Tenex Network
** Mandatory recording hours are between 0000 and 0800 GMT.

TABLE IIb

40B Background Partition Utilization In Hours

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Downtime	8.0	9.4	37.3	20.9	68.5	34.5	50.4	41.2	68.8	84.8	67.2	23.2	514.2
Operations	5.0	1.5	3.4	4.9	3.6	5.9	14.3	15.7	23.6	42.8	53.0	75.0	248.7
DP Testing	41.4	18.3	15.6	-	-	-	-	-	-	-		-	75.3
NEP	125.2	93.3	190.0	209.0	216.0	193.4	42.5	231.0	207.0	207.0	235.0	191.5	2340.9
Data Services	7.2	-	4.0	-	-	-	2.8	11.5	4.3	7.6	10.3	17.4	65.1
Documentation	-	.4	1.6	-	-	-	-	-	-	-	-	-	2.0
Systems	-	-	-	21.9	13.1	19.3	3.7	1.2	.5	.5	6.8	1.3	68.3
VSC	-	-	-	-	13.0	15.1	5.1	.3	.1	.1	.8	.2	34.7
NEP Classified	-	-	-	-	-	-	-	-	-	-	-	146.2	146.2
Idle	557.2	597.1	492.1	487.3	357.8	475.8	401.2	443.1	415.7	401.2	370.9	265.2	5264.6
Total Available Hours	744	720	744	744	672	744	720	744	720	744	744	720	8760

TABLE IIIa

Distribution Of 360/44 Block Time (In Hours)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	% of Total
DOS	18.5	18.5	6.5	241.5	14.0	16.7	12.2	26.6	2.5	4.0	5.0	3.4	369.4	4
Classified	5.5	7.0	1.0	2.0	16.0	13.6	17.3	5.4	36.2	1.5	2.0	6.7	114.2	1
TS44	539.8	501.0	649.5	443.5	556.0	663.6	598.4	672.0	468.8	665.3	614.9	646.2	7019.0	80
Automatic Assoc	31.0	46.0	46.5	5.5	-	-	-	-	-	-	-	-	131.0	1
Downtime	54.2	147.5	23.0	38.5	86.0	48.1	33.1	38.9	206.2	65.7	38.1	63.0	842.3	10
NEP	61.0	-	-	-	-	-	-	-	-	-	-	-	61.0	1
NEP-Classified	32.0	-	-	-	-	-	-	-	-	-	-	-	32.0	-
Systems	-	-	10.5	13.0	-	2.0	-	1.1	.2	-	.3	.7	27.8	-
Online Recorder	-	-	7.0	-	-	-	59.0	-	6.1	7.5	83.7	-	163.3	2
Total Hours Operating	689.8	572.5	721.0	705.5	586.0	695.9	686.9	705.1	513.8	678.3	705.9	657	7917.7	
% of Total Hours Available Monthly	93	80	97	95	87	94	95	95	71	91	95	91		

TABLE IIIb

Distribution Of 360/44 Block Time Of TS44 (In Runs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	% of Total
Data Services	2302	1759	1680	1372	1713	1866	2126	1763	1707	1760	2154	3046	23248	47
Systems	1125	709	790	521	869	933	978	828	913	693	608	685	9652	20
Operations	273	237	338	474	286	375	261	289	355	255	228	213	3584	7
Real-Time	2	-	-	15	7	21	14	5	-	-	1	-	65	-
Batch Programming	560	295	193	105	171	197	101	98	235	227	104	237	2535	5
Research	820	546	552	486	1206	1226	703	645	555	544	872	460	8615	17
VSC	143	35	42	37	69	161	195	84	78	221	245	258	1568	3
Ensco	-	-	-	-	-	2	-	-	-	-	-	-	2	-
Total Runs	5225	3581	3595	3010	4321	4781	4378	3712	3843	3700	4212	4899	49257	

TABLE IV

PDP 11/70 Usage In Hours

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul*	Aug	Sep	Total
SDAC Research	3.1	4.4	4.5	1.4	5.9	239.8	76.9	76.2	183.9	-	132.8	351.7	1080.6
Data Services	.8	.7	.9	.9	82.5	42.4	1.8	-	46.9	-	50.0	141.4	368.3
Operations	115.1	68.0	123.5	52.7	537.2	845.1	1012.6	1003.1	778.7	-	475.7	584.6	5596.3
SDAC Sys Prog.	27.5	31.0	20.3	12.9	59.0	436.2	388.2	357.5	201.4	-	229.4	175.4	1938.8
Real-Time Prog	75.9	40.8	30.2	11.9	449.9	477.4	297.4	202.6	254.9	-	293.3	312.7	2447.0
Documentation	15.0	5.5	19.8	20.1	148.8	436.8	425.5	380.2	235.9	-	209.0	326.3	2222.9
VSC	10.1	33.4	14.9	5.4	164.6	319.8	185.3	58.0	32.7	-	196.5	413.0	1433.7
S3	9.8	2.5	3.1	2.1	58.3	123.2	88.8	115.1	166.2	-	49.7	82.7	701.5
SDAC Batch Prog.	-	-	5.4	15.3	314.9	191.2	247.4	181.1	230.7	-	150.3	411.9	1748.2
Ensco	-	-	-	-	33.9	141.3	131.0	169.1	48.4	-	223.4	262.3	1009.4
Detector Proces.	-	-	-	-	-	-	-	-	-	-	152.4	144.7	297.1
Totals	257.3	186.3	222.6	122.7	1855.0	3253.2	2854.9	2542.9	2179.7		2162.5	3206.7	18843.8

* Statistics for July were lost because of problems with the accounting file.

TABLE V

PDP VAX/11-780 Usage In Hours

	Oct	Nov	Dec	Jan*	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
ILI	1.7	-	-	-	-	-	-	-	-	-	-	-	1.7
Automatic Assoc	6.1	.1	135.0	-	55.6	160.4	271.0	172.7	249.2	230.2	266.5	148.8	1695.6
Interactive Discrim.	.6	-	118.3	-	82.4	107.5	232.6	43.1	184.7	173.2	198.1	27.1	1167.6
RELS	2.3	21.7	-	-	70.3	346.1	719.2	358.8	342.5	290.1	436.8	187.0	2774.8
Systems	1.0	.4	168.4	-	36.4	216.7	453.7	208.3	299.3	17.4	63.9	74.5	1540.[illegible]
VSC	.2	-	-	-	-	131.6	59.0	19.5	146.9	81.5	1.3	2.9	442.9
S3	-	-	.8	-	-	-	-	-	-	-	-	-	.8
Real-Time Progam	-	-	124.4	-	9.9	4.5	54.5	1.5	149.1	223.1	.2	47.3	614.6
Documentation	-	-	-	-	-	.9	.3	-	-	-	-	-	1.2
Operations	-	-	-	-	-	11.9	.9	22.9	6.1	9.8	17.1	76.4	145.1
Ensco	-	-	-	-	-	-	-	35.8	143.0	118.4	67.5	58.3	423.[illegible]
Data Services	-	-	-	-	-	-	-	18.8	31.8	28.5	23.4	18.2	120.[illegible]
Research	-	-	-	-	-	-	-	2.7	69.5	63.4	39.9	45.7	221.[illegible]
Totals	11.9	22.2	546.9	-	254.6	979.6	1791.3	884.1	1622.1	1235.6	1114.7	686.2	9149.[illegible]

* Statistics for January were lost because of problems with the accounting file.

IV. SOFTWARE MAINTENANCE AND SUPPORT

CCP

The installation of the hardware to make the bus structure of the CCP fully redundant was completed and the software was modified to support this configuration. The modifications involved changes to the system's I/O tables and the configuration variables. Operationally, both the hardware and the software performed according to specifications. The system has been sucessfully run using hardware configurations of the "F" I/O bus, the "E" I/O bus, and combinations of both.

Changes in the CCP code to support the new ARPANET protocols were made. The new ARPANET protocol changed from a 32 bit to a 96 bit Host/IMP leader format. Several problems were encountered during the implementation. The most significant and the most difficult problem was an error in the routine that does leader translation on the incoming data stream. The actual problem was never found but the system was made to work by inserting a small amount of code in the on-line program to accomplish the same logical function as performed by the translation routine.

The network loader program was also modified to support the new 96 bit host IMP leader formats. Several problems arose with this change as well. A portion of the password sent from the system at the University of Southern California was lost during the modificatitons. To correct this problem, debugging assistance was provided to personnel there.

The CCP paper tape punch program also needed conversion because of the protocol changes. This work was done using the off-line CCP system.

The protocol change resulted in errors in the block transfers to PAFB. Initial analysis of the problem indicated that one error was in the Network Control Program which handles the data stream sent to the 360/44 from the CCP. The error was in the CCP's message acknowledgement module which was calling the checksum subroutine with the wrong entry point.

DPS

During the previous contract period the detection processor was moved

from the old IBM 360/40 to the DEC 11/70 and the real-time data recording was moved to the same system, with the event processing (the Network Event Processor) running as a foreground job. Improvements to this recording system, referred to as the Seismic Data Recorder (SDR), continued during this contract period.

Two programs were written to allow the SDR to process the NORSAR detection and EPX data. The programs provided velocity and azimuth information and initialized the NORSAR beam information for subsequent input.

Other improvements to the SDR include:

- implementing the time/tape file,
- providing more printer information to aid in the monitoring of program execution and to indicate on the operator console the data content of the output tape,
- adding a sophisticated data gap detection algorithm to minimize data loss,
- correcting the blockage of the input data stream during I/O to the operator's console, and
- correcting a bug in one of the diagnostic routines.

A program was also written for the 11/70 which modeled combinations of data received by the SDR from the CCP. This allowed offline verification of the time logic in the SDR.

NEP

The only work done on this system was to make minor corrections to the later phase processing algorithms and to configure the operation of the system so that it will run without using the IBM 2311 disk drives.

360/44

Numerous programs were written, modified, or corrected during the contract period. This section lists the programs with a brief description of their purpose and what was done to them. The end of this section gives a summary of the programs that were cataloged.

- NEWSDCS - written to convert MCK SDCS tapes to subset format
- NA2SEIS - written to convert NOAA epicenter data to SEISFILE format
- SROHNME - written to convert SDCS-HNME tapes to three component SP SRO format
- PINESRO - written to extract and convert PWY data from DPS tapes into SRO format
- SROMCK - written to convert MCK SDCS tapes into SRO format
- HNMEFIX - written to correct DOY errors found in some of the HNME-SDCS tapes
- SRO3SUB - modified version of program SROPLOT that will write SUBSET format of IDCE three component SP SRO tapes written during the International Data Collection Experiment
- SROTIM - QC program written to do a record time sequence check of the SRO three component SP tapes
- PINEBIS - written to extract PWY data from the station processor tapes and write SRO format three component SP output tapes
- GAINR - subroutine corrected to properly convert a 32 bit integer into the SRO gain range format
- SRO3SUB - modified to process 18,000 data points per channel of SRO three component and SRO day tape data
- SRO3DP - written to convert three component SRO data to DPS format
- SRODISC - program which subsets SRO and SRO three component data was modified to allow for the inclusion of a comment to identify the seismogram being written; the comment field was added to an existing parameter card
- SHORT1 - Seisfile edit program was written to convert the Soviet K value, which is a measure of energy release to magnitude
- SROSSN - convert new SRO format Day tapes with up to 18,000 data points/channel
- SRODWW - written to provide the user with a formatted listing of the Network Log, Station Logs, and the Data Logs contained on the Day tape

- SRODISC - program modification that sets the default value for the counts/millimicron parameter to one for subset formated data written from the SRO Day tapes
- DEPRPT - written to process Seisfile tapes and produce a report of events by geographic region and depth
- IXTAPE - modified by changing the raw tape input routine used from INTAPE, which will read a maximum of 7,280 bytes, to IXTAPE, which will read any size record
- CHNGCOM - written to allow users to change the comment field contained in a subset tape header
- YKATOSUB - modified to process a new format for Yellow Knife Array station tapes
- FLNNAM - correction to the program used to determine the seismic region given the coordinates of an event (the error involved a round-off mistake)
- OKIN - written to subset up to 60,000 continuous data points for up to seven channels of 200 Hz hydroacoustic data
- SFSCAAN - written to scan the IBM Scientific Subroutine Package tape for a specific subroutine
- COHERE - modified to include the subroutine TAPER on the coherency program used in conjunction with the Digitizer acceptance test
- ADEDIT - written to verify the proper structure of the A/D tapes written by the Kinemetrics system
- SUBBLX - written to copy and merge Subset tapes containing unusually large numbers of points per channel
- STNTAPE - written to format station processor tapes into an intermediate format used by the program which merges data into the data already contained on DPS/SDR data tapes
- KINSUB - modified to handle 1000 Hertz data for a single special run
- STNTAPE - converts station processor log tapes to DPS format in order to analyze the data using the NEP system
- STNTAP2 - written to produce a DPS format tape from individual channels on the station processor log tapes; individual channels can be selected but output data can not be merged with an existing data tape

The following four programs were written to support the Data Services seismogram inventory project.

a) CNVSUB - This is modified version of the program SUBSETQC. This program writes to tape the information contained in each subset tape seismogram header record.

b) BLK400 - This program is used to reblock card image tapes made from the cards used to control and A/D conversions. It also does some checking of card sequence codes.

c) FIVECD - Information contained on the "five-card-tape" produced by BLK400 is converted to inventory format using this program.

d) SEISED - This program has two modes: EDIT or LIST. If the EDIT mode is selected, the program lists errors detected on the seismogram inventory tape. If the LIST mode is selected, the program prints a formatted listing with headers, page numbers, etc.

The following programs were catalogued:

Name	Description
ADEDIT	Edits Kinemetrics A/D tapes
ARCHSIZE	Lists user's archive directory
DEPRPT	Lists events by region/depth
FILENAME	Polar coord. to region access routine
FLNNAM	Determines seismic waves and numbers
NEWDCQC	QC's McKinney station tapes
NSSBEAM	Beams, subsets, and plots DPS tapes
OKIN	Subsets 0 System data tapes
OLDDCQC	QC's SDCS station tapes
OLDSDCS	Subsets SDCS station tapes
PINEFIX	Reformats PWY stations tape into
SRODISC	Subsets old SRO Day tapes
SRODWW	Lists SRO Day tape logs
SROHNME	Three component SRO tapes
SROLP	Subsets SRO LP data
SROSP	Subsets SRO SP data
SROSSN	Subsets SRO Day tapes

PDP-11/70

Routine system maintenance and work continued throughout the year. Numerous programs and commands were corrected, catalogued, or improved. Considerable effort was spent in isolating problems causing random interrupts and with the boards (DZ11's) that interface the computer to the terminals used throughout the facility. Some operational

improvements were obtained after soliciting help from DEC, exchanging the DZ11's with those in the VAX, and developing software debugging tools, but the random interrupt messages and excessive system failures continued at an unacceptable rate.

A new operational release of the UNIX system, version 7, was installed; the main changes in this system include:

- having the Tektronix terminals handle the control software in the hardware itself,
- a fix for the endless EOF problem when reading tapes under certain conditions,
- updating the system parameters, and
- enabling all of the DZ communications interface boards.

In addition to installing the new UNIX system, the following errors in the UNIX kernel were corrected:

- the memory parity interrupt vector was changed to the correct value,
- a problem in a routine to process text data having to do with levels of parenthesis was corrected,
- a bug in a routine which could destroy the system swap area was fixed, and
- two errors in a routine doing save/restore operations of the floating point registers was corrected.

The UNIX support modules were modified to fix the C optimizer supplied with the Version 7 distribution tape and new versions of the following commands were installed to correct the indicated problems or improve performance:

"time" - a bug involving the printing of null characters was corrected,

"su" - modifications were made to allow the command parser to properly read startup files; this command now logs each invocation to maintain audit trails of its use,

"print" - the set of programs dealing with line printers and spooling were recompiled so that the ownership of

demon resource locking files would be properly set,

"login" - the login command was modified to set up the terminal type at login time,

"stty" - the Tektronix distribution of this command was installed to permit more hardware control of the device,

"ac" - the Duke University version of the connect time accounting program was installed to correct several errors in the previous version,

"help" - provides basic information about the commands and programs available on the system, including what they do, resources required, and where the documentation is located,

"bboard" - used for posting information,

"netstat" - reinstalled to correct an error; the program would fail whenever there were open network connections,

"sa" - was modified to do accounting by groups as well as by login ID's,

"cron" - was written to maintain the accounting files by way of entries into a special file,

"ld" - installed to correct problems which would occur when loading very large programs,

"fcheck" - was modified to make its output clearer,

"logic" - installed to warn logged-on users that the system is coming down for a given reason,

"fsck" - installed to allow interactive repair of damaged file systems,

"pfe" - installed to examine a core dump of a user program to determine what kind of floating exception (overflow, underflow, divide by zero, etc.) actually occurred,

"finger" - installed to display user information,

"ex","vi" and "csh" - were re-installed because of discrepancies between source and binary,

"newgrp" - modified to require that the group password be given before allowing a user's current group affiliation to occur, and

"lock" - was modified to be invoked only by the root to

prevent the occurrence of accidental 'locking' of the system.

The MTX tape handlers and the TROFF/NROFF terminal translation tables for the spinwriter were installed.

Errors were corrected in the NETSTAT program, the Calcomp plotter routines, and the program that converts IBM floating point numbers to PDP floating point numbers.

There were several major software systems installed, primarily to support the seismic application. These systems are summarized in the following paragraphs.

A plot package 'Graphpak' was obtained from Lincoln Labs and installed on the system. This package is very much like the Calcomp support routines available on the 360's.

A new version of the 'Quick and Dirty Plotter' was obtained from Lincoln Labs and installed on the system.

The latest version of the Signal Display Package from Lincoln Labs and the Vrije Universiteit (sic) Pascal compiler and libraries were installed.

The INGRES database management system from the University of California at Berkeley was installed.

The following application programs/packages were installed on the UNIX system along with the Help and Programmer Manual informa- tion concerning them:

- XPREDICT - computes travel/arrival times for body/surface seismic phases,
- SUBSETIN - reads and converts to Wave-Form Data Base Format a SDAC Subset tape,
- SUBSETOUT - reads Wave-Form Data Base Format and write a SDAC Subset tape, and
- DIGIT - supports the digitizer.

VAX-11/780

Support for the VAX involved updates to the operating system necessitated by new releases of system software or by changes to the hardware configuration.

System Improvements

Version 2.0 of the VMS operating system was installed by updating version 1.6. Installation of 2.0 required an update to the terminal, disk, and the array processor drivers.

The line printer previously configured on the PDP 15/50 was installed and made available to the users via the VMS spooling routines.

An incremental backup procedure that uses a disk as the backup medium was installed.

The IMSL subroutines have been installed and successfully tested.

The Core Graphics package from George Washington University was installed.

A problem was corrected in the macro routine that converts IBM floating point numbers to VAX floating point number. The routine was computing negative values incorrectly.

User Support

The application program SEISPOOL was installed. SEISPOOL provides a means for users to read subset tape as input to 'spool' a seismogram to disk for processing.

Investigations of the C compiler supplied by Interactive System indicated that it was not meant to be compatible with the VAX FORTRAN run-time library routines, and that you do not call C routines from FORTRAN for the purpose of doing 'I/O'. The use of C language was not recommended on this system.

Configuration Changes

Additional disk drives were added to the system and configured such that both the VAX and 11/70 could access them through a single controller. After considerable effort, involving hardware, software and vendor support, it was determined that design errors in the controller prevented this configuration. Another controller was installed so that each system had independent access to the disk, and the concept of the shared configuration was abandonded.

Miscellaneous

Problems with the Detection Processor on the VAX were corrected. These problems included the loss of NORSAR detections, and differences between the VAX version of DP and the 11/70 version.

A review of available accounting packages for the VAX was made. The only commercially supported VAX accounting/billing systems available are Signal Technology's PACS system and RAXCO's Rabbit-1 system. Based on cost estimates and the limited features provided by both systems, it was decided that the current method of accounting was adequate.

PDP-11/40

The SYSGEN of RSX-11M was completed and correct system execution was verified. The FORTRAN IV plus compiler was added; however, tape input and output from FORTRAN were found to be unreliable. Corrections to the I/O programs were received from DEC and installed in the system.

V. MAINTENANCE

Maintenance of the computer systems, environmental equipment, and other hardware used to support the data libraries is performed by Geotech personnel and suppliers under contract to Geotech. The total maintenance cost is split about evenly between Geotech and these contractors. Geotech personnel maintain the CCP, timing systems, modems, and the ARPANET interfaces associated with the real-time data collection and monitoring systems. The NEP graphics system, composed of a DEC PDP-11/35 computer, an Evans and Sutherland Picture System, an Ann Arbor alphanumeric terminal, two Pertec Disk Drives, and an interface to the IBM 360/40 are also maintained by Geotech personnel, as well as other computer systems and/or peripherals including four Kennedy tape drives and a controller, a Pertec disk, 192K words of core memory, a Versatec printer plotter and its interface, and a Calcomp plotter on the DEC PDP-11/70. A DEC PDP-11/40 with an A/D converter card, a RP04 disk drive, a Kennedy tape drive, analog filters, analog tape drives, test equipment, A/D conversion components in the analog laboratory, the tape evaluator, numerous film viewers, and reproduction equipment used throughout the laboratory are also maintained by Geotech.

Contract maintenance was obtained from suppliers for the equipment shown below:

Supplier	Equipment
IBM	360/40, 360/44, and unit record
FABRITEC	360/40B memory
DEC	PDP-11/70, VAX 11/780
MEMOREX	disk drives (five on the 360/40B)
CALCOMP	disk drives (five on the 360/44)
CDI	five 1030 Teleterm terminals
WILLARD	air-conditioners
SYSTEM INDUSTRIES	five 300 M byte disk drives and two controllers
MISC	after hours maintenance, typewriters, and calibration of test equipment.

The time spent on the various systems by SDAC maintenance personnel is summarized in Table VI. The hours noted do not include the time spent for duties such as ordering parts, designing components for special systems, planning for future systems, and obtaining budgeting information for proposals or system alternatives. The time shown is for actual repair or maintenance to the indicated system and is an estimate of the downtime for the system itself.

The following sections in this chapter give specific details concerning the repairs of the systems maintained by SDAC maintenance personnel.

TABLE VI

SDAC Maintenance

System	Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Totals	
	PM	Rpr	PM	Rpr	PM	Rpr	PM	Rpr	PM	Rpr	PM	Rpr	PM	Rpr	PM	Rpr	PM	Rpr	PM	Rpr	PM	Rpr	PM	Rpr	PM	Rpr
Analyst Station	16.0	4.0	16.0	7.0	16.0	-	16.0	6.0	16.0	-	8.0	-	8.0	6.0	8.0	12.0	8.0	14.0	8.0	12.0	8.0	15.0	8.0	11.5	136.0	87.5
Analog	4.0	20.0	4.0	16.0	4.0	-	4.0	24.0	4.0	24.0	4.0	60.0	4.0	24.0	4.0	-	4.0	-	4.0	20.0	4.0	4.0	4.0	-	48.0	189.0
CCP	2.0	-	2.0	6.0	2.0	24.0	2.0	2.0	2.0	22.0	2.0	5.0	2.0	24.0	2.0	-	2.0	1.5	2.0	2.0	2.0	6.0	2.0	-	24.0	92.5
Plotters	4.0	6.0	4.0	5.0	4.0	-	4.0	-	4.0	-	4.0	6.0	4.0	-	4.0	-	4.0	-	4.0	-	4.0	-	4.0	-	48.0	17.0
Terminals	-	6.0	-	-	-	-	-	-	-	21.0	-	-	-	20.0	-	20.0	-	9.0	-	-	-	-	-	-	-	76.0
VAX - 11/780	-	-	-	-	-	-	2.0	-	-	-	-	10.0	-	-	-	1.0	-	4.0	-	2.0	-	2.0	-	-	2.0	19.0
11/40	8.0	12.0	2.0	-	2.0	6.0	2.0	32.0	2.0	16.0	4.0	-	4.0	10.0	4.0	-	4.0	12.0	4.0	10.0	4.0	4.0	4.0	-	44.0	102.0
11/70	-	-	-	-	-	4.0	-	11.0	-	24.0	2.0	6.0	-	-	-	1.5	-	6.0	-	2.0	-	-	4.0	2.0	6.0	160.0
Miscel-laneous	-	16.0	-	30.0	-	34.0	-	30.0	-	-	-	-	-	6.0	-	6.0	-	-	-	5.0	-	4.0	-	4.0	-	175.0
Totals	34.0	64.0	28.0	64.0	28.0	68.0	30.0	102.0	28.0	107.0	24.0	87.0	22.0	90.0	22.0	40.5	22.0	46.5	22.0	53.0	22.0	35.0	26.0	17.5	308.0	774.5

PM - Preventive Maintenance
Rpr - Repairs

Analog

The analog equipment underwent extensive overhaul and repair. The major components or subsystems that were affected include: the time code reader, the Kinemetrics system, the Pertec digital tape drive, the B-system tape head interface, and modifications to Kinemetrics system by putting analog cables in parallel with the oscillograph recorder.

A new Bell & Howell analog tape drive was installed and modified to use with the B-system analog tapes. Six new Kronhite filters were also added to the analog system.

Two Krohnhite analog filters were modified to increase the power supply reliability and a faulty power supply on another analog filter was corrected.

General repairs were made to the Kinemetrics A-D system, its digital tape drive, and to the Oscillograph recorder used for hardcopy output. Also the time-code reader on the analog tape transport was repaired.

11/40

A 16 channel analog-to-digital card was installed on this system. This card also has a 2-channel digital-to-analog output which may be connected to an X,Y display unit for graphic output.

The 11/40 equipment rack was reconfigured to allow for the installation of additional memory and repairs were made to a five volt power supply and to a power supply connector.

The system also required repairs to the Plessey memory module, the Kennedy 9100 tape drive, the RP04 disk drive, and the RP11 disk control unit.

11/70

The problem of the DZ interface causing some of the terminals to stop perfirming on the 11/70 required support from DEC field service. They conducted extensive tests on the device but were unable to isolate any problems.

This system was augmented with two new disk drives and the controller was modified to support the new drives as DEC RM05 drives instead of RP04 drives. This change was performed in order to maintain compatibility with the VMS Operating System running on the VAX 11/780.

The 128 KB MOS memory, a 9-slot backplane, and several DZ11 interface boards were installed.

Repairs were made to some of the DZ11 terminal interface modules, and a defective Plessey memory module was replaced. Alignment and calibration was performed to the Kennedy tape drive units and the Pertec cartridge disk drive.

Analyst Station

The Pertec disk drives caused most of the problems on this system. Problems with the power supply were corrected and positioning of the servo timer was made. Other repairs to this system include the memory modules and the data tablet used for cursor display on the E & S system.

The NEP system was repositioned in the computer room to comply with security requirements.

CCP

The components of the CCP requiring maintenance are named below. In several cases, the off-line CCP was used for trouble shooting and repair, thus minimizing downtime of the on-line system.

Two host interface cards were installed in the bus to complete the system upgrade. A defective host interface card connected to the 360/40 was replaced. Repairs were made to a processor bus and a serial interface card used for a terminal was replaced with a spare.

Repairs were made to the Remex paper tape punch electronics, a power supply, a display terminal, and a BSLI serial interface card. A defective HLC interface card and a HLC/DMA device (CCP to IMP connection) was replaced.

Plotters

Repairs were made frequently to both of the old Calcomp plotters on the 360/44.

Terminals

Numerous lines were installed for terminal access to both the VAX and 11/70. All areas of the facility were affected, including those of other contractors and VSC. These installations were the major activity in support of the terminals.

Repairs were made to nearly all of the terminals. Alignment was performed on a Tektronix terminal, and the terminal switching panel was moved into a new cabinet; also one Pennywhistle Modem was repaired.

Two terminal interface multiplexors were removed from the VAX-11/780 and installed on the PDP-11/70 system.

VAX-11/780

The VAX suffered a major failure in the hardware module interfacing the CPU to the disk drive. The result of this failure was the loss of the bootstrap logic contained on the disk.

A Plessey line printer Unibus interface card was connected to the Model 2410 line printer that was used with the PDP-15.

Numerous defective logic boards in the array processor were sent to the vendor for testing and repairs.

Repairs were made to the line printer, its interface logic card, and the direct memory interface device. The DL11 terminal interface card was replaced to help with a software test. Repairs were made on the A-D interface logic card on the VAX 11/780.

Miscellaneous

Monitoring of the line voltage in the computer room for a one month period did not show a direct correlation between power surges/sags/spikes and the interruptions of the 360/44, VAX and 11/70 computers. The IBM

customer engineers commented that their experience had been the same; however, when line voltage conditioners were added to sites, many problems were cleared up.

The batteries for the time-of-day clocks were cleaned and serviced, and repairs were made to the oscilloscope configured with the timing system. Repairs were also made to the GTCO datatizer unit and the cursor control switch it uses.

VI. DATA SERVICES

The SDAC has libraries of data, bulletins, and literature to support the research effort of those participating in the VELA project. It is the function of data services to maintain these libraries and extract data as requested by the Project Office, Geotech's research staff, other VSC contractors, and any agency or institution contribu- ting to the VELA program and approved by the Project Office.

Requests vary to simple copies of data to complex searches through seismicity lists to identify a particular class of data. In some cases, it is necessary to predict arrival times to sites that may be operational during the event of interest, examine the quality of predicted signals, then extract it from any of the types of storage media - film, or analog and digital tapes. The number of such requests totaled 257 throughout the contract period.

There were very few request for LASA data during this contract, but a significant number of requests for NORSAR data did occur. The NORSAR request included extracts of event lists, data selected for some NTS events, and data copies of a general nature. Data from CPO and TFO were distributed to support regional event studies and enhance other data sets. Minor requests for data recorded at the Yellow Knife array and the Iranian long period array were satisfied; distance computations for events to YKA were requested. Data for a specific date were needed in the case of ILPA.

Data from the Long Range Seismic Measurement program were also requested. Site descriptions and calibration information were provided as well as digital time segments. Most time series data requests were for selected sites for certain NTS events, but data from other shots were supplied as well.

Data from the Seismological Research Observatories were requested more than data from any of the other data collection systems. The requests were for both short and long period time segments from NTS events, events in a particular region, events recorded by particular sites, and events within specified distances for certain sites. The requests usually resulted in producing SUBSET tapes. Epicenter searches were also required to support

this data collection and reduction effort.

Other kinds of data requests included providing copies of discrimination parameter tapes, direct writes of the Special Data Collection System analog tapes, a tape copy of the GNOME data set.

Searches of event lists were made for various event and station criteria. Of interest were events from the Missouri-Kansas border, South Africa, the Lake Baikal region, the South Indian Ocean, the St. Lawrence region for events within the United States, and events near the Kurile, Kamchatka, and Aleutian Islands. A list of events within 15 degrees of 11 deepwell sites was also provided.

A/D conversions were made for the shots PILEDIVER, PIRANHA, DUMONT. A request to digitize O-system data was also satisfied; this task required modification to some of the A/D support programs.

Miscellaneous other requests included determining the calibration factor for sites that are not commonly used, verifying data sent to the facility from the National Seismic Station at the Cumberland Plateau Observatory, modifying the search program QUERY to summarize event searchers, and developing the capability to recover data from the Stiegler's Gorge array.

International Data Collection Experiment

Data Services involvement with IDCE data was to assemble, reformat as necessary, and transmit to users the US contribution to the 1 through 15 October 1980 International Data Collection Experiment (IDCE), sometimes referred to as the Common Data Base Experiment (CDBE).

The task was to convert all data sources to SRO format. Since SRO and ASRO comprised about two thirds of the data, the principal task become to convert the remainder to SRO format. This conversion was straightforward at most sites. CPO required as much time as all the others combined because it was necessary to change from one gain range format to another.

A/D Conversion Effort

There were 2113 digital seismograms obtained from analog tape using

the analog-to-digital conversion system at the Center. A re-run rate of 24 percent was necessary to correct erroneous output. These errors were caused by operator error, hardware failure, or an inade- quate description of the data request. The most frequent errors were caused by the operators, especially when switching from one system configuration or request to another. In general, the operation of the equipment is labor intensive and only the most careful operation results in a low error rate.

Outside User Support

The following individuals representing the indicated agencies received data or related information from data services during the year.

Name	Agency
Dr. Frode Ringdal	NORSAR
Dr. Peter W. Rogers	Lawrence Livermore Laboratories
Lee Woodie	Pacific Sierra Research
Dr. Antonio Rovelli	Instituto Nazionale di Geofisica, Rome, Italy
Dr. Robert Hart	Sierra Geophysics
Dale Breding	Sandia
G. G. Sorrells	Tyledyne Geotech, Garland, Texas
Roberto Scarpa	Observatorio Vesuviano, Naples, Italy
Joseph T. Beardwood, III	Institute for Defense Analyses
Monsour Niazi	Lawrence Livermore Laboratories
Dr. Eystein S. Husebye	NORSAR
Prof. Ta-liang Teng	University of Southern California
Dr. Ramon Cabre, S. J.	Observatorio San Calixto, Bolivia
Prof. Charles A. Langston	Pennsylvania State University
Dr. Robert North	Lincoln Laboratory
Dr. Joseph Mills, Jr.	Lawrence Livermore Laboratories
Dr. Michael Tiberio	Lincoln Laboratory
Prof. J. W. Schlue	New Mexico Institute of Mining and Technology
Dr. Ilkka Noponen	ENSCO
Dr. Gary M. Lundquist	Sierra Geophysics Inc.
Steve Gruverman	Lincoln Laboratory
Dr. Tom Goforth	Southern Methodist University
Prof. G. A. Bollinger	Virginia Polytechnical Institute
Dr. Karl Veith	Teledyne Geotech, Garland, Texas
Ms. Billie Kimball	Teledyne Geotech, Garland, Texas
Mr. Dave Lambert	Systems, Science and Software
Prof. Robert B. Herrmann	St. Louis University
Dr. James Murdock	Alburquerque Seismological Lab
Ms. Lish Bache	System, Science & Software
Prof. Robert P. Meyer	University of Wisconsin
J. Murphy	Systems, Science and Software
M. Zibres	USGS, Golden, Colorado
Dr. John Savino	Systems, Science & Software
J. Swanson	Teledyne Geotech, Garland, Texas
W. Farrell	Systems, Science & Software
Dr. Marvin Weinstein	Underwater Systems

Seismicity File Maintenance

Seismicity files were routinely updated during the contract period. The ISC epicenter files were brought up to date for the years 1971 through 1978.

A collation of the 1973-1975 Soviet epicenter list with other sources of epicenter information was produced.

Seismological Research Library

A data base containing references and, in some cases, abstracts of documents relevant to the VELA effort was established on the PDP 11/70. A system developed by Bell Labs is used to establish and maintain the material in this data base. Programs "mkey" and "inv" developed by Bell Labs are used to create keywords and indexes; "hunt" is used to read the information from the database.

The data base was updated with available computer readable information for some 18,000 documents in the VESIAC Library.

Seismic Data Index

A program to manipulate and maintain some of the digital tape library lists on the VAX was developed. It permits interactive review and modification of these data.

Data Inventory

Work was begun late in the contract to compile an inventory of all segments of seismic waveform data which are available at the SDAC. Significant progress was made in obtaining data from the A/D tapes made on the PDP-15 and tapes extracted from digital tapes. A/D tapes made on the CDC 1604 and CDC 160A were not added to the inventory before the end of the contract.

VII. SDAC DATA MANAGEMENT RESEARCH

Regional Event Location

The implementation of the Regional Event Location System was begun during the previous contract period (fiscal year 1980) when the system was procured and installed. The basic function of this system is to analyze data from events occuring at regional distance of about 20 degrees. At these closer distances, the data volume increases because higher sampling rates are used. The general characteristics of the design are that more data are put on-line, newer, faster, and more modern display devices are used, and a development framework is established that permits easier program and system modifications so that various studies can be performed and the system modified based on the needs of the researchers. Researchers, system programmers, engineers, and technicians were required to continue the development of this task.

Application

Two separate developments of Bruce Julian's location program have been carried out during the last three years. Several additions have been added to the program: three crustal parameters, correlation of travel time residuals, improved method of determining confidence ellipsoids, and the use of three component azimuth data. These modifications have been merged into one subroutine named LOK.

The statistical model for correlating residuals between various stations in the location group for program LOK involves three parameters: station variance, distance fall-off rate, and a zero distance spike function. These parameters are estimated by maximizing the likelihood function of the covariance matrix, using nearly 200 residual elements. The optimum values for the three parameters are used in conditioning the covariance matrix and will provide a more accurate definition of the confidence ellipsoids. The LONGSHOT data have been used to determine the distance decay rate of correlation between stations and the variance of residuals, by maximum likelihood.

Two other location programs, SIMUL and LOCATION, were merged into one program in order to combine the matrix solution techniques of the

two programs.

Programs for surface and body wave magnitude calculations were converted from the IBM 360/44 to the VAX-11/780 and programs to fit distance and distance-depth dependent coefficients to travel time tables were completed.

System

Task initialization and termination routines were combined with the task controller and command interpreter and several RELS support subroutines were implemented. A directory and program library structure for the RELS programs were developed and command files and command symbols were established to aid the users.

The sensor information file was implemented to provide frequency response information and I/O routines to use these files were developed for general use.

The SAQ display and scroll capability were implemented and the coding of the error files was completed. The maintenance routines to update and service these files were started late in the contract period.

A small waveform test data base of Alaskan data was built and a waveform display of eight traces was developed. Slewing of eight traces appears irregular and a speed of 30 times real-time appear to be the upper limit; however, when fewer traces are displayed, smoother slew and higher speeds are possible.

Hardware

A major graphics system was purchased from Vector Automation and installed during the contract period proceding this report. Several items of this subsystem were not functioning correctly and were corrected during the development of the application system.

Several errors in the processor board were noted and eventually corrected. Numerous attempts to correct the boards were necessary because other changes to the system were being made and other errors were introduced as corrections were made. Several updates to the Vector

Automation version of GCORE were also received, each corrected certain errors noted during the development.

The parallel interface never quite performed to specification regarding speed; however, by making changes to both the system and hardware, the speed of the device was improved considerably and its performance was considered acceptable. The long overdue hard-copy device was finally installed; it too had problems that were eventually resolved.

It was finally determined that additional memory would be required to overcome other timing and processing constraints. This add-on will be considered during future work.

Detection Processing

This task involved defining the data bases used by RELS and other systems being developed by contractors to VSC. Numerous revisions to a document entitled Data Base Specification were made as versions were submitted to the Project Office and coordinated with all of the contractors. After obtaining a general acceptance of the document, utility type software was developed to provide standard interface modules to read and write data into the various files.

ILI Detection Processing

Signal detection algorithms that have low computing requirements were investigated with the intent of installing one of them in the micro processor front end comprising the ILI. The candidates were the Veith Detector, a detector based on Walsh Transform, and the standard STA/LTA. After considerable evaluation and some tests the STA/LTA detector was chosen and implemented in the system. The implementation also required software changes to the Message Interface Controller and other interface devices.

Other support for this task included design and fabrication of a front panel and installing debug and other support software on the VAX to facilitate the program development.

Automatic Association

Numerous improvements and enhancements were made to the Automatic Association program during the year which dramatically increased the accuracy of the events it made and reduced the number of false events it had made using previous versions of the program. The most significant of these changes are summarized in the following paragraphs.

The quality of AA's summary bulletin was improved by incorporating an algorithm which checks delcared events for certain characteristics of good events. If an event does not have any of these characteristics it is rejected and the corresponding arrivals are free for later association.

A "superloop" was added to AA. This loop is identical with normal execution with the exception that events with less than six associations are not saved in this loop. The purpose of this is to prevent small, possibly false, events from trapping signal detections that belong to a larger, real event. AA then does its usual processing. The "superloop" causes AA to take longer for execution, but event generation is aborted in the "Find Initial Arrival" stage, thus saving the time required to run HYPO.

The multiple locations determined by TRIX only, rather than QFIX, are used throughout AA. This implementation permits making regional events in Alaska, which was impossible with QFIX, and which appear frequently in the analyst's bulletin.

The screening of events by station clustering was improved by studying the processing results from several different days and altering some of the values of the association parameters.

An arrival or detection record was expanded so that it could be associated to more than one event.

A program was written to construct a new data grid to use the same area coverage as the land/water, seismic activity, AI grid on NEP, rather than one degree coverage from pole to equator.

The station constants file was enlarged to hold 300 station entries instead of 200.

Comparison of the AA output with an analyst on the data for October 2, 1980, showed that AA generated every conceivable event it could have from the PAQ, and, in addition, only 10 bad events were made, three of which were made using what were determined to be pP phases.

An evaluation of the AA using 9-10 October 1980 data showed that AA makes as many events as is possible; however, for large events there is a tendency for some arrivals to be segmented out, forming a small false event. Later phase logic was included into AA to correct this problem. It was also noted that to process a typical full day's data takes about 30 minutes CPU time on the VAX.

Technical report TR 81-9 describing what AA does and how it does it, entitled "A Functional Description of Teledyne Geotech's Automatic Association Program" was written.

Incoherent Beamforming

This task was classified. The results can be found in VSC-TR 82-22 entitled Seismic Detection by Incoherent Beamforming (U).

Detection Experiment

This task was to move the code for the detector software running on the 11/70 using the UNIX operating system to the VAX computer using the VMS operating system. Minor incompatibilities between the two FORTRAN compilers were found and corrected. The tape and disk I/O routines were modified for VMS, and the C-language EBCDIC to ASCII translation routine was replaced with a MACRO routine.

To support this processing, it was necessary to move the program that makes SAQ tapes from the disk file output by the detector. The detector was run on four hours of data selected from 1 April 1979 and the results were checked using the PAQ comparison program against the operational version of DP running on the 11/70. The data was given to the analyst who successfully analyzed it using the Network Event

Processor System.

Interactive Discrimination

The DISE program has been augmented to include hypocenter cross-sections, clustering of events, histogram plots, and scaling of variables to remove magnitude bias. This program remained a stand-alone program at the end of the contract because the RELS development had not progressed far enough to allow it to be integrated into the interactive portion of the system.

Design work was initiated on the waveform utilization functions of an expanded DISE program. The Pearce algorithm for focal mechanism solutions was converted to VAX FORTRAN and sucessfully run on test cases, with output identical to previous runs on the IBM 360/44. An algorithm was coded to display the results of this program as fault-plane nodal lines on a standard focal sphere projection.