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SEMI-ANNUAL REPORT, PROJECT T/4703
SPECIAL DATA COLLECTION SYSTEMS
JANUARY THROUGH JUNE 1975

John R. Sherwin

Teledyne Geotech

Prepared for:

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30 June 1975

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SEMIANNUAL REPORT, PROJECT T/4705
SPECIAL DATA COLLECTION SYSTEM

January through June 1975

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The work performed under Project T/4703, Special Data Collection Systems, during the period from 1 January through 30 June 1975 is described. In addition, a summary of work done under this contract since its inception in August 1973 is presented.

Five SDCS systems were deployed in February and March to sites in the Continental U.S. and Canada which had been previously occupied. Sites at

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20. Abstract (Continued)

Houlton, Maine; Red Lake, Ontario; and Whitehorse, Youkon, are standard units; the site at Cumberland Plateau Observatory uses that station's SP array on its SP input; and the site at Franklin, West Virginia, uses a Model 36000 Borehole Seismometer System. The five stations have routinely collected seismic data on a continuous basis since setup operations were complete. The operational problems encountered were primarily associated with start-up of the equipment and experience level of operators; operations at present are largely routine with a minimum of data outage. Data analysis tasks for the program are being done at the SDAC in Alexandria, Virginia. Forty-six requests for event reports have been received since March, and the reports are in various stages of completion.

One special project was completed during this period. Its purpose was to study several geophysical methods of locating existing shallow tunnels. A report, AL-75-1, Tunnel Detection by Magnetometer, Active Seismic and Radon Decay Methods, was published and distributed in June. A follow-on report describing an overseas field operation will be released in July.

TECHNICAL REPORT NO. 75-5

SEMI-ANNUAL REPORT, PROJECT T/4703
SPECIAL DATA COLLECTION SYSTEMS
January through June 1975

by

John R. Sherwin

Sponsored by

Advanced Research Projects Agency

ARPA Order Nos. 2551 and 2897

TELEDYNE GEOTECH
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16

30 June 1975

IDENTIFICATION

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ARPA Order Nos.	2551 and 2897
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Effective Date of Contract	01 August 1973
Contract Expiration Date	30 June 1976
Date of Report	30 June 1975
Contract No.	F08606-74-C-0013
Program Manager	B.B. Leichliter (214) 271-2561, ext. 215
Short Title of Work	Special Data Collection Systems
Amount of Contract	$735,020
Contract Period covered by this Report	1 January through 30 June 1975

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SEMI-ANNUAL REPORT, PROJECT T/4703
SPECIAL DATA COLLECTION SYSTEMS
January through June 1975

1. INTRODUCTION

The Special Data Collection System (SDCS) program, Project T/4703, is a continuation of work begun under the Long Range Seismic Measurements (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. In addition to this effort, the SDCS program has historically included other special tasks (as its name implies) related to the primary program. Included are such items as an instrument development program and deep-borehole noise studies.

This report describes the work performed under the SDCS program during the period from January through June 1975. Also included is a brief description of work done since the inception of the contract in August 1973. This report is submitted in accordance with Sequence No. A004 of the Contract Data Requirements List, as amended under Modification P00005, 2 January 1975. This research was supported by the Advanced Research Projects Agency of the Department of Defense and was monitored by AFTAC/VSC, Alexandria, Virginia, 22314, under Contract No. F08606-74-C-0013.

2. SUMMARY OF OPERATIONS PRIOR TO JANUARY 1975

The following paragraphs are included in this semi-annual report in order to fully document work done prior to this reporting period when semi-annual reporting was not required. Work under Contract C-0013 began on 1 August 1973 and was a continuation of the work performed under Contract F08606-73-C-0008. The original statement of work included two main tasks - primary data collection and special studies.

2.1 PRIMARY DATA COLLECTION

This task was primarily directed toward maintaining of the eleven SDCS portable seismograph systems in an operationally ready condition in anticipation of a field deployment. Work done included the following:

a) Maintenance of SDCS test equipment and adequate spare parts inventory;

b) Maintenance of a laboratory area with adequate test equipment to support SDCS operations and special studies;

c) Routine maintenance of eleven vehicles (pickup trucks) and other related equipment;

d) Record keeping and handling associated with control of government property.

One of the major accomplishments under this task was a complete evaluation of the government property assigned to the program and transferred from prior contracts. As a result, over 250 items of accountable equipment were declared surplus and were ultimately disposed of through normal channels. Among those items declared surplus were two recording vans with related equipment used during the LRSM program. One of these vans had been on location near Fairbanks, Alaska, and the other had been in storage at the Garland plant.

Work under this task continued until 30 June 1974. At this time, the originally planned deployment of the SDCS units had not materialized so the available funding was transferred to other programs. Prior to this, those SDCS units not being used elsewhere for special projects were inventoried, placed in large crates, and stored in the controlled warehouse at Garland. During the period from July through December 1974, virtually no work was done under this primary data collection task.

2.2 SPECIAL STUDIES

2.2.1 Deep Borehole Operation of Model 36000 Seismometer System

Work under this task involved modification of the Model 36000 for operation at the pressures and temperatures which would be encountered in boreholes at depths of 3,000 m (10,000 ft). Also included was the operation of the modified instrument at the deep borehole site near Pinedale, Wyoming (PI2WY). This work began in November 1973 with the modification of one instrument. Field operations at PI2WY began in late April 1974 and continued until 2 January 1975. A complete discussion of this program plus results of extensive data analysis are contained in Technical Report 75-2, Deep Borehole Operation of the Model 36000 Borehole Seismometer System.

2.2.2 Other Studies

The SDCS program also continued its support of other programs as directed by the Project Office. Equipment, including a mobile recording van plus several components of one SDCS portable system, remained on loan at a site near McKinney, Texas, under contract C-0052, in support of a study to Suppress Pressure Generated Earth Noise.

The program also provided one Model 36000 system to USGS, Albuquerque Seismological Center, (ASC) for tests from February through August 1974, and provided minimal support to install and repair the system as necessary.

Two proposals for other special studies were submitted to the Project Office for consideration. P-2231, Laser Strain Study, which involved operation of an SDCS unit to record data from an existing laser strain meter installed in a mine area near Boulder, Colorado. The second proposal was TCP-2284, Ultra Long-Period Array Studies at TFO, which outlined a program to use the TFO long-period array data in a study of atmospherically generated ultra long-period noise. Neither proposal was approved.

3. FIELD OPERATIONS

3.1 GENERAL

The original operational concept of the portable Seismograph System, Model 19282 and 19282A, was that it was to be a complete system (LP and SP), self-contained, designed for quick reaction time, and capable of being set up and operated by one man. Normally, the system was deployed for only brief operational periods up to two months and was then returned to inactive status in Garland until needed again. The present deployment represents a significant departure from the original concept in that the systems are to be operational for about 12 months. Also, non-standard systems are being used at two of the sites. Therefore, some departures from normal SDCS operations were made, both in the field operations and in the support function in Garland. Generally, the procedures adopted are similar to those used when the LRSM program was active. In the following paragraphs, the present operations are described.

3.2 PREPARATIONS FOR DEPLOYMENT

On 17 December 1974, a change order was received from the client officially authorizing work to prepare five SDCS units for a deployment of about one year.

The sites selected (discussed in detail below) and SDCS teams assigned for the deployment were:

a) Franklin, West Virginia (FN-WV) T-56

b) Cumberland Plateau Observatory (CPO) T-57

c) Houlton, Maine (HN-ME) T-58

d) Red Lake, Ontario (RK-ON) T-59

e) Whitehorse, Yukon (WH2YK) T-60

Work on the systems began immediately and continued through January 1975. Systems for the sites at HN-ME, RK-ON, AND WH2YK were completed first, followed by the system for the CPO site. The system for FN-WV, where a Model 36000 system was to be installed, represented a significant departure from normal SDCS operations and equipment, and required more time to complete preparations.

Because this deployment was projected to cover an extended operational period, departure from normal SDCS operations were made. First, power companies at all sites except RK-ON were contacted and arrangements were made to install commercial power. Two 3-KW diesel generators were ordered for the RK-ON site where power is not available. Lease arrangements were made to occupy the FN-WV, HN-ME, RK-ON, and WH2YK sites. Also, new pickup trucks were ordered under the same lease-type arrangement used for this program for several years. Finally, the decision was made to house the SDCS units in small portable-type buildings in order to protect men and equipment for the extended deployment. This was not necessary at CPO where permission was received to set up the SDCS recording equipment in the station's Central Recording Building. At the other sites, buildings with floor dimensions of 8 by 10 feet were procured locally and were carried to the sites. At HN-ME, RK-ON, and WH2YK, the standard SDCS equipment was installed as usual, except that the normal housing (dolly) was not used. At FN-WV, only a few components of the basic SDCS system are used (such as recorder, calibrator, timer, etc.). Most of this equipment plus the additional equipment required for operation of the Model 36000 system, was installed in two equipment racks. All buildings have small but adequate areas for spare parts storage and routine equipment maintenance.

On 21 January, a meeting was held with the client concerning facilities and equipment at CPO. At that time final decisions were made to install SDCS long-period instruments in an existing tank vault, to use CPO short-period data (including the 19-element vertical array), and to install the remaining SDCS equipment in available space at the observatory's central recording building.

3.3 DEPLOYMENT OF THE SDCS TEAMS

On 17 January, a second change order was received authorizing deployment of the five SDCS teams. Due to the special requirements resulting from the semi-permanent nature of the operation and for personnel safety in the extreme cold, two-man teams were assigned for set up of each site. Figure 1 is a map showing the sites occupied during this report period, and Table 1 summarizes the operations at the sites during deployment and set up phases. The following paragraphs describe operations at each site.

3.3.1 Franklin, West Virginia (FN-WV), Team 56

The FN-WV site was originally occupied under the short-period deep-hole program, Project VT/1139, in 1964. The site has two cased boreholes - one shallow reference hole 15 m (50 ft) deep, and a deep borehole 3827 m (12,557 ft) deep known as the Sponangle No. 1. Both boreholes are cased to the bottom with 7-inch API steel casing. At the termination of VT/1139, the deep borehole was plugged in accordance with the terms of the lease and the laws of the State of West Virginia.

The FN-WV site was selected for operation of the Model 36000 Borehole Seismometer System which had been used during prior tests at Pinedale, Wyoming. Accordingly, the site was visited in late January. A lease was arranged with the landowner and arrangements were made with a local driller to re-enter the hole to the 160 m (525 ft) level. Due to delays in receiving an approved re-drilling permit from the West Virginia Bureau of Mines, Oil and Gas Division, the drilling was not completed until 31 March.

Final setup began on 10 April with the orientation check by Sperry-Sun of the holelock installed at 150 m (492 ft). The Model 36000 was installed and levelled on 11 April. After allowing for settling of the instruments, the LP horizontals remained very noisy at a level about ten times greater than the

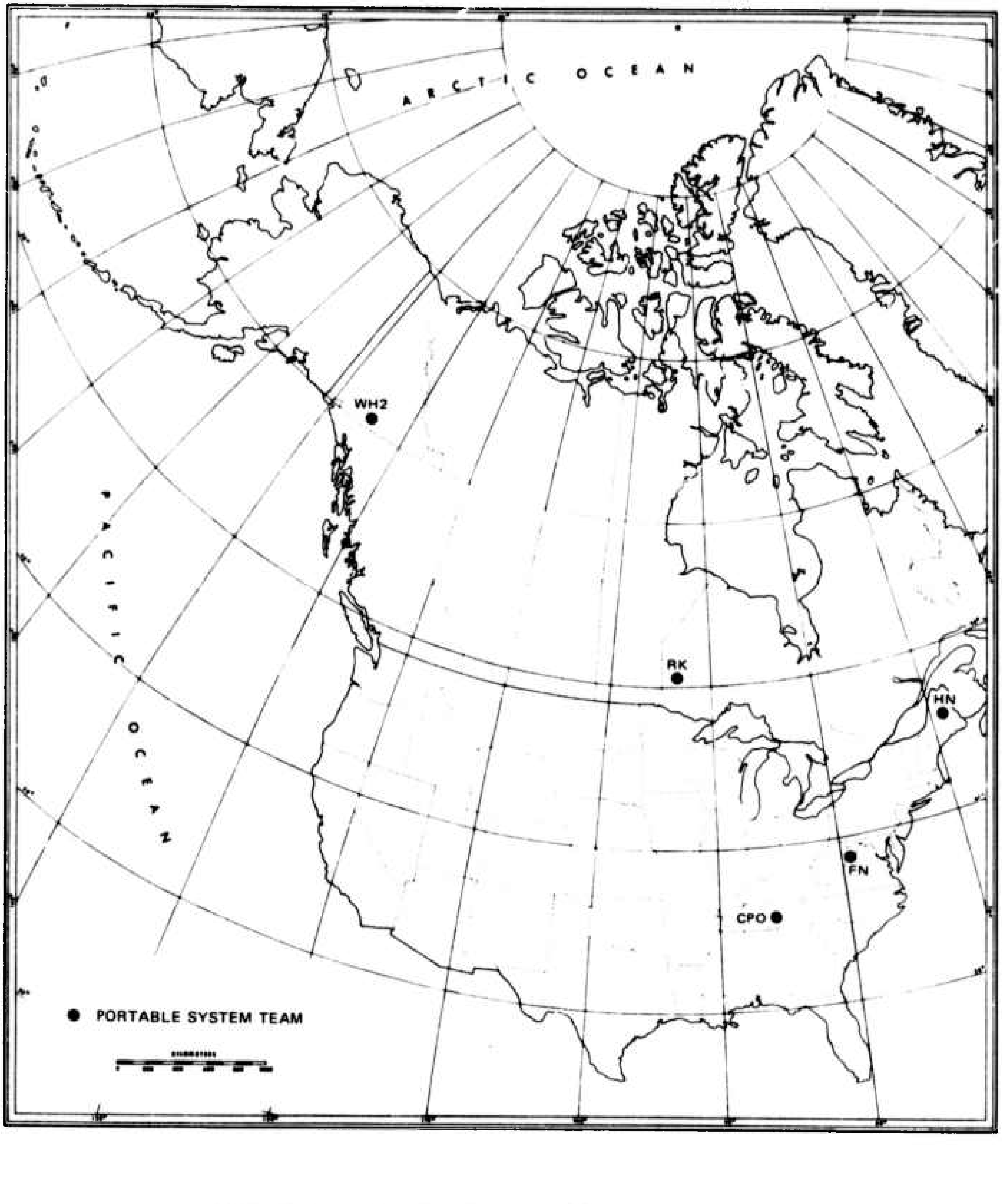

Figure 1. Site locations for SDCS operations during the period from January through July 1975

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Table 1. Summary of operations at five SDCS sites

Site	Date of Departure	Arrival On Site	Set up Complete	Comments
FN-WV	20 March 75	24 March 75	27 May 75	Borehole redrilling to 525 ft depth completed 31 March. First installation at 150 m produced noisy LPH data. Instrument moved to shallow hole (10 m) on 23 May.
CPO	8 Feb 75	9 Feb 75	14 Mar 75	LP vault retrofit required. No significant problems.
HN-ME	30 Jan 75	5 Feb 75	20 Feb 75	Set up performed in deep snow and extreme cold. Data quality degraded 20 Feb - 23 March by noise and spikes due to ground loops and other grounding problems. Intermittent noise problems, expecially on LP's, due to moisture in vaults.
RK-ON	25 Jan 75	3 Feb 75	10 Mar 75	Set up performed in snow and extreme cold. Generators required for set-up operation not received in Red Lake until early March. No other significant problems encountered. Bunker will require maintenance in summer.
WH2YK	25 Jan 75	5 Feb 75	18 Feb 75	Set up performed in snow and extreme cold. Use of bunker for shelter prior to delivery of portable building allowed rapid set up. No installation or operational problems encountered.

LP vertical level. Several attempts to locate the source and reduce this noise were made but were unsuccessful. On 30 April, tests were conducted which indicated that the well casing was not adequately constrained. Apparently, the drilling mud which had filled the annulus between the 7-in API casing and the 9-5/8-in API surface casing had settled out to a point that the 7-in casing was left free-standing.

A project recommendation (P-2478) was prepared and submitted to the Project Office on 15 May 1975. It was recommended that 1) the Model 36000 be moved to the shallow hole; 2) it be returned to operation to determine if recordings were unsatisfactory at this shallow depth; and 3) the deep borehole be cemented from the 300 m (1000 ft) level to the surface. Accordingly, the Model 36000 was moved to the shallow hole during the period from 22 to 24 May. Setup calibrations were completed on 27 May and the station was considered fully operational. Subsequent operations have indicated that the horizontal noise level has decreased significantly, but horizontal LP instruments remain about twice as noisy as the vertical channel. This additional noise could be due to convection cell activity in the water covering the instrument or it could be caused by operation too near the surface. In any case, the operating magnifications of the LP instruments at FN-WV are three to five times higher than at other SDCS sites and no further plans have been made to cement the 7-inch casing in the deep borehole.

When the instrument was moved to the shallow hole, the holelock orientation could not be checked visually due to water in the hole. It was decided that the cost of an additional Sperry-Sun survey was not justified since the shallow hole operation could be a short term one. As a result, the orientation of the Model 36000 horizontal instruments is not accurately known. Using signals from a known source, it appears that the actual orientation is about 316 degrees for the radial channels, and 46 degrees for the transverse channels instead of the required 99 degrees and 189 degrees. The orientation will be checked as soon as a tool ordered by the Project Office is received.

3.3.2 Cumberland Plateau Observatory (CPO), Team 57

The Cumberland Plateau Observatory (CPO) has been in operation since December 1962. At the present time, it is being operated by the USGS. The primary instrumentation at CPO is a 19-element short-period vertical array with two SP horizontal instruments and a three-component LP system. Figure 2 shows the configuration of the CPO array. The USGS data requirements are minimal and data are recorded on film only. Because the array could provide excellent SP vertical data for this experiment, at a very low cost, CPO was selected as one of the SDCS sites.

All operations at CPO were fully coordinated through the USGS by the Project Office. The present SDCS operation represents a cooperative program with SDCS personnel providing assistance as required to maintain the SP instrumentation. An initial evaluation of the LP operations indicated that substantial improvements would be required to achieve optimum operational levels. It was, therefore, decided that SDCS LP instrumentation would be installed for this experiment.

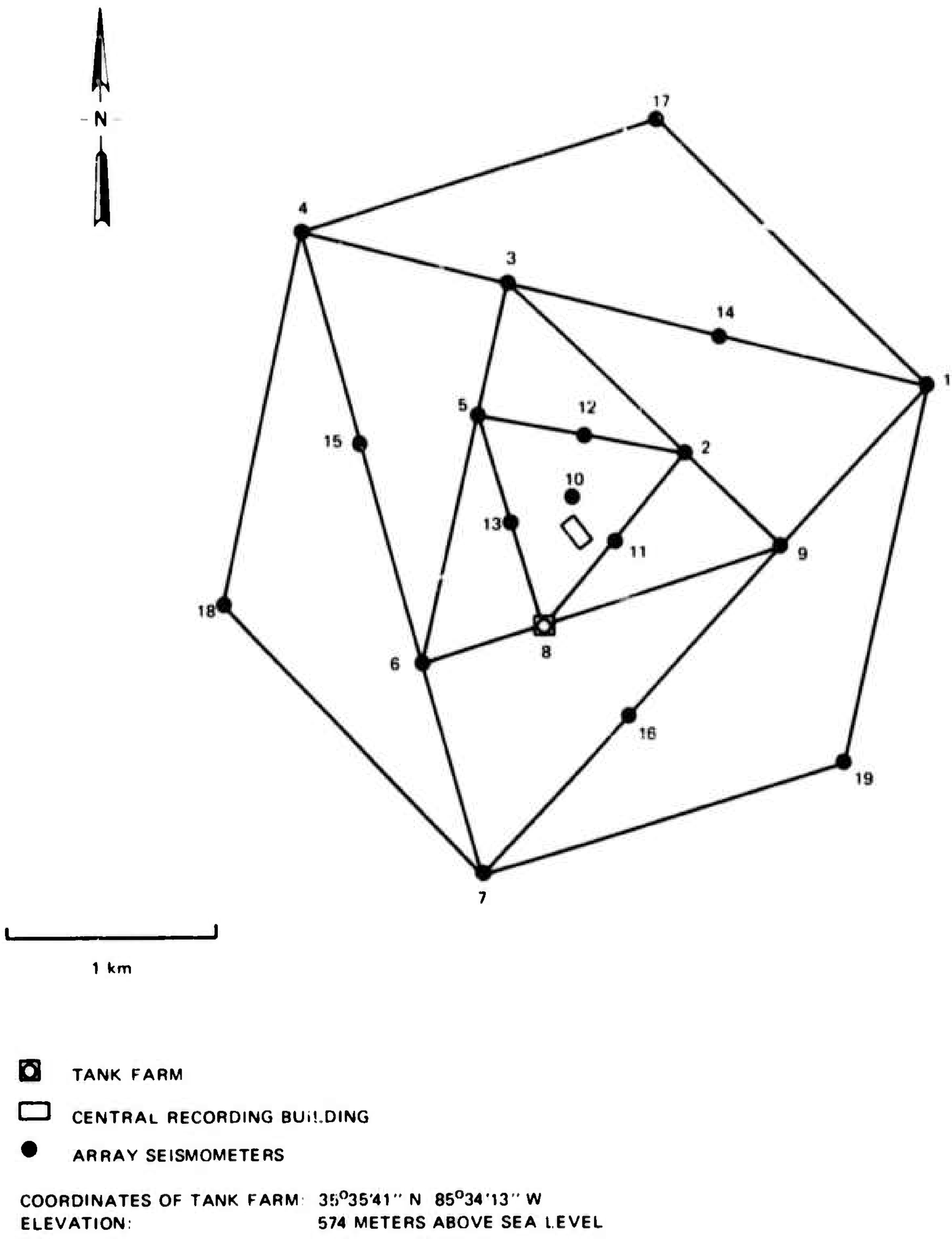

Figure 2. Orientation and configuration of the CPO array

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The SDCS operator and a helper arrived on site on 9 February and routine operations began on 14 March. Extensive retrofit of the existing tank vault and retainer wall used for the LP seismometers was required. At this station, the normal SDCS instrument channels are replaced by the CPO channels; and the SP vertical channel is the total summation of the SP array. All horizontal instruments at the site, including the SDCS LP seismometers, are oriented North and East rather than radial and transverse as at the other SDCS sites.

At the end of the reporting period, both the SDCS and the CPO equipment continued to operate with a minimum of data outages. The SDCS operator has assisted CPO personnel in completing maintenance of all array instruments enabling the recording of all 19 elements in the sum. Also calibration coils were installed on those SP instruments requiring them and calibration circuits were repaired as necessary to provide accurate calibrations.

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

The HN-ME site is the same location occupied for the RIO BLANCO experiment in May 1973. The present site is an alternate location selected in 1973 when the original HN-ME site could not be permitted. The location change is well within the location tolerance limits (across the road) and was not of sufficient magnitude to warrant a change to the HN2ME site designator. The HN-ME site was an LRSM van site from August 1962 to February 1971 and was a portable systems site in November 1971 for the CANNKIN experiment.

For the present operation, the standard portable system equipment and operator arrived on site on 5 February. Site setup and calibrations were delayed by heavy snowfall and extreme cold. Setup could not be started until the instrument and personnel shelter was on site. Routine operations officially began on 20 February. However, data quality was poor until 23 March when high level noise and spiking was eliminated by careful grounding techniques. Moisture in the temporary wooden vaults housing the seismometers is a continuing problem at this site. This moisture causes occasional noise and calibration crosstalk and necessitates frequent LP seismometer mass recentering and entering of the vault to dry the instruments. This condition is now being corrected.

The original HN-ME site is particularly attractive for the present SDCS experiment because it has a 7-5/8-in API cased borehole 46 m (150 ft) deep which was drilled for the vertical strain seismometer test program in 1969 under Project VT/8704. This borehole would provide adequate depth for a Model 36000 system and would improve the detection capability of the site significantly. The land is involved in litigation which was to be settled by June 1975. At the time of this writing, an August date is probably more likely and tentative negotiations between the two parties for a lease have been started. The present plan is to move to this site as soon as possible and to install the Model 36000 system. The additional components required for the system including the Model 36000 seismometer are approximately 95 percent complete at this time.

3.3.4 Red Lake, Ontario, Canada (RK-ON), Team 59

The site at Red Lake has also been occupied several times. It was an LRSM van site from June 1963 to August 1970, and was a portable system site for CANNIKIN in 1971 and for RIO BLANCO in 1973. The site lease has been maintained on a yearly basis from the Ontario Department of Lands and Forests. The site has tank vaults installed inside a bunker and is an excellent site except that commercial power is not available. For the present operation, two 3.0 KW diesel generators are installed in an auxiliary shelter. These units were purchased in anticipation of installation of the digital recording system installation discussed later in this report.

Set-up for this experiment began when the standard portable system arrived on site 3 February. Full operation did not begin until 10 March due to shipping delays for the generators. No particular difficulties were encountered in the equipment set-up or in subsequent operations at RK-ON. However, the bunker which is built with logs and earth fill is collapsing due to rot. Repairs are planned for July 1975.

3.3.5 Whitehorse, Yukon, Canada (WH2YK), Team 60

Like HN-ME and RK-ON, the Whitehorse site has been occupied several times. It was an LRSM van site from October 1966 to October 1969 and a portable systems site for the CANNIKIN and RIO BLANCO experiments in 1971 and 1973. The site has a bunker with tank vaults and commercial power. Since occupying this site in 1973, responsibility for the land at this site changed from one Canadian governmental agency to another. As a result, the local official allowed re-occupation of the site on 12 February 1975 under the condition that he would receive an official letter explaining our purpose and the authority by which we were operating in Canada. Such a letter was sent on 21 March 1975 with the coordination and approval of the Project Office. On April 25, final official approval to occupy the site until April 1976 was received from the Yukon Territorial Government.

The portable system equipment arrived on site on 5 February and set-up operations were completed with little difficulty on 18 February. The only operational problem at this site has been the lack of consistent reception of adequate radio time signals from WWV or WWVH. As a result, there have been times when the SDCS timer could not be checked and significant timing errors have occurred. A tuneable receiver will be sent to the site in August in order to use Canadian broadcasts of time signals on frequencies other than the 5, 10, 15, and 25 MHz channels to which the SDCS receiver is fixed-tuned.

3.4 DESCRIPTION OF OPERATION SYSTEMS

3.4.1 Portable Seismograph System, Model 19282 and 19282A

This system is comprised of lightweight, suitcase-enclosed units which can be transported by air as excess baggage and carried to an operating site in a station wagon or light truck. A typical portable system is shown in figure 3 and consists primarily of a three-component short-period and a three-component long-period seismograph which are normally operated to record 6 high-gain data

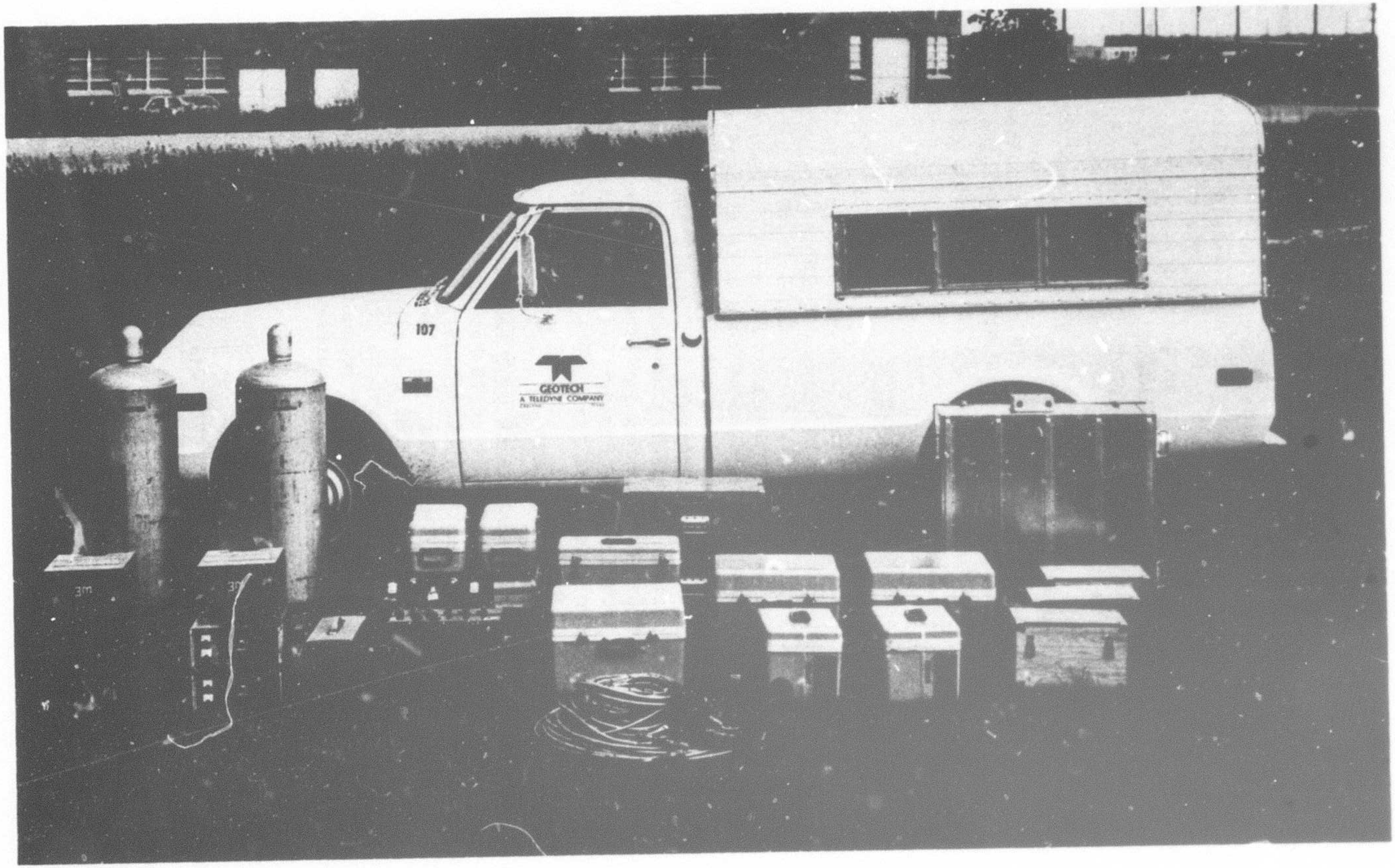

Figure 3. Portable system equipment

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channels and 6 low-gain data channels. Figure 4 is a drawing showing a typical installation.

The system (refer to block diagram, figure 5) operates in the following manner. Earth motion, detected by the seismometers, is transformed into an analog signal voltage which is transmitted through the seismometer cabling to the vault lightning protector. The signal voltage is then transmitted via the field cable to the station lightning protector and then to the station terminal for distribution into the central recording station. At the central recording station, the signals are amplified and recorded on magnetic tape. Timing and power are also located inside the central recording station. An accessory and control unit contains the system calibration and test equipment.

Although the Model 19282 and 19282A systems produce basically the same data, there are slight differences in the equipment complement. The systems have been modified slightly over the years and table 2 shows the various components in the present system configuration. In general, the 19282A systems are easier to set up and maintain, primarily because the equipment is newer and also because the 2-Kg LP seismometers are much easier to handle. The 19282A systems are being used for the present experiment at the Houlton, Maine (HN-ME), Red Lake, Ontario (RK-ON), and Whitehorse, Yukon (WH2YK) sites.

3.4.2 System at Cumberland Plateau Observatory (CPO)

The portable system at CPO has been modified to accept the CPO short-period data in place of the standard SDCS SP units. The CPO SP system consists of a 19-element array of Johnson-Matheson (J-M) SP Vertical Seismometers, Model 6480, and two J-M Horizontal Seismometers, Model 7515. Data amplification is provided by Phototube Amplifiers, Model 4300, with 3 Hz galvos and Bandpass Filters, Model 6824-1. For the SDCS operation, the normal CPO summation circuitry is bypassed and formation of the total vertical array summation (ΣSPZ) is provided by a Summation Module, Model 23404. The three channels of SP data are then routed to the normal SP channel inputs to the SDCS magnetic tape system. Other components of the CPO SDCS installation are standard with the exception that the LP seismometers are in one of the tank farm vaults approximately 1/2 Km from the central recording building (CRB). The normal 20 m data cable was replaced by Spiral-4 between the vaults and the CRB.

3.4.3 System at Franklin, West Virginia (FN-WV)

The system at FN-WV uses only the recording and calibration components from a standard portable system. At this site, SP and LP data are obtained from a Borehole Seismometer System, Model 36000, which is installed in a shallow borehole at a depth of 10 m (33 ft). The broadband outputs from the three channels of the Model 36000 are appropriately filtered with a prototype filter unit to provide three channels of SP and three channels of LP data. Figure 6 is a block diagram of a typical data channel.

3.4.4 Amplitude and Phase Responses of the Various Systems

Parameters for the various components of the six types of systems being operated were used to compute the theoretical amplitude and phase responses. Appendix 1 contains the computed amplitude and phase data. Figures 7 and 8

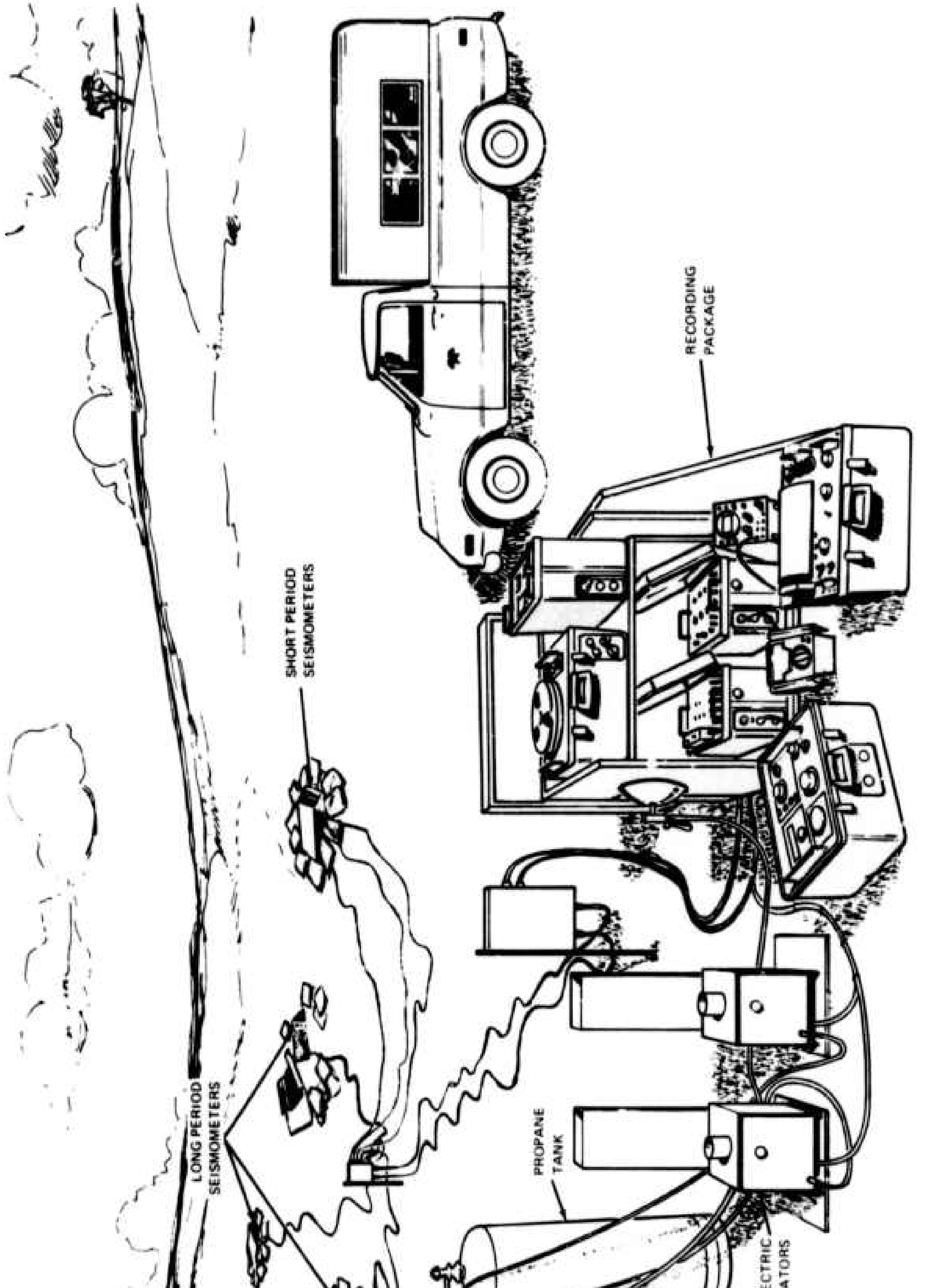

Figure 4. Typical portable system site layout

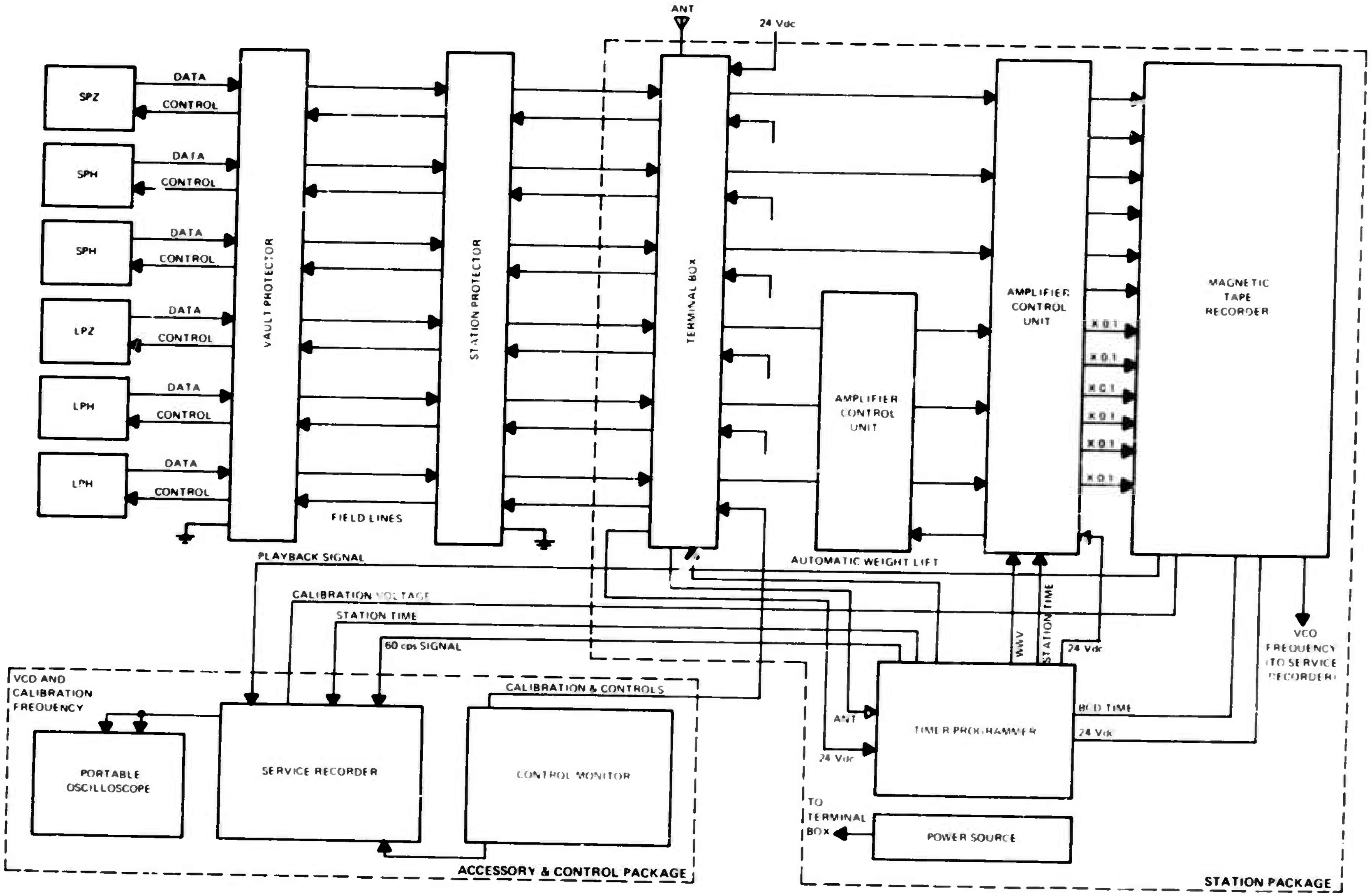

Figure 5. Block diagram, Portable Seismograph System, Model 19282 and 19282A

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Table 2. Major equipment complement of portable seismograph system

Item	Description	19282 Sys. (T50-55)	19282A (T56-60)
1	SP Seismometer, V and H	18300	18300
2	LP Seismometer, Vertical	7505A (10Kg mass)	SL-210 (2Kg mass)
3	LP Seismometer, Horizontal	8700C (10Kg mass)	SL-220 (2Kg mass)
4	Vault Protector	20164	20164
5	Station Protector	20165	20165
6	Station Terminal	20166	20166
7	Amplifier-Control Unit, SP	23927 (photocell amplifiers)	29460 (Solid state amplifiers)
8	Amplifier Control Unit, LP	29470 (Solid state amplifiers)	29470 (Solid state amplifiers)
9	Magnetic Tage Recorder (0.03 ips, 14 ch)	19429	19429
10	Timer Programmer	19754	19754
11	Control Monitor (calibrator)	19823	19823
12	Service Recorder	19820	19820
13	Auxiliary Recorder	None	31550
14	Power Sources		
	a) Thermoelectric Generator (2 ea)	3M-515	3M-515
	b) Battery (4 ea)	Any 12V automotive	Any 12V automotive
	c) Battery charger (2 ea)	21160A	21160A

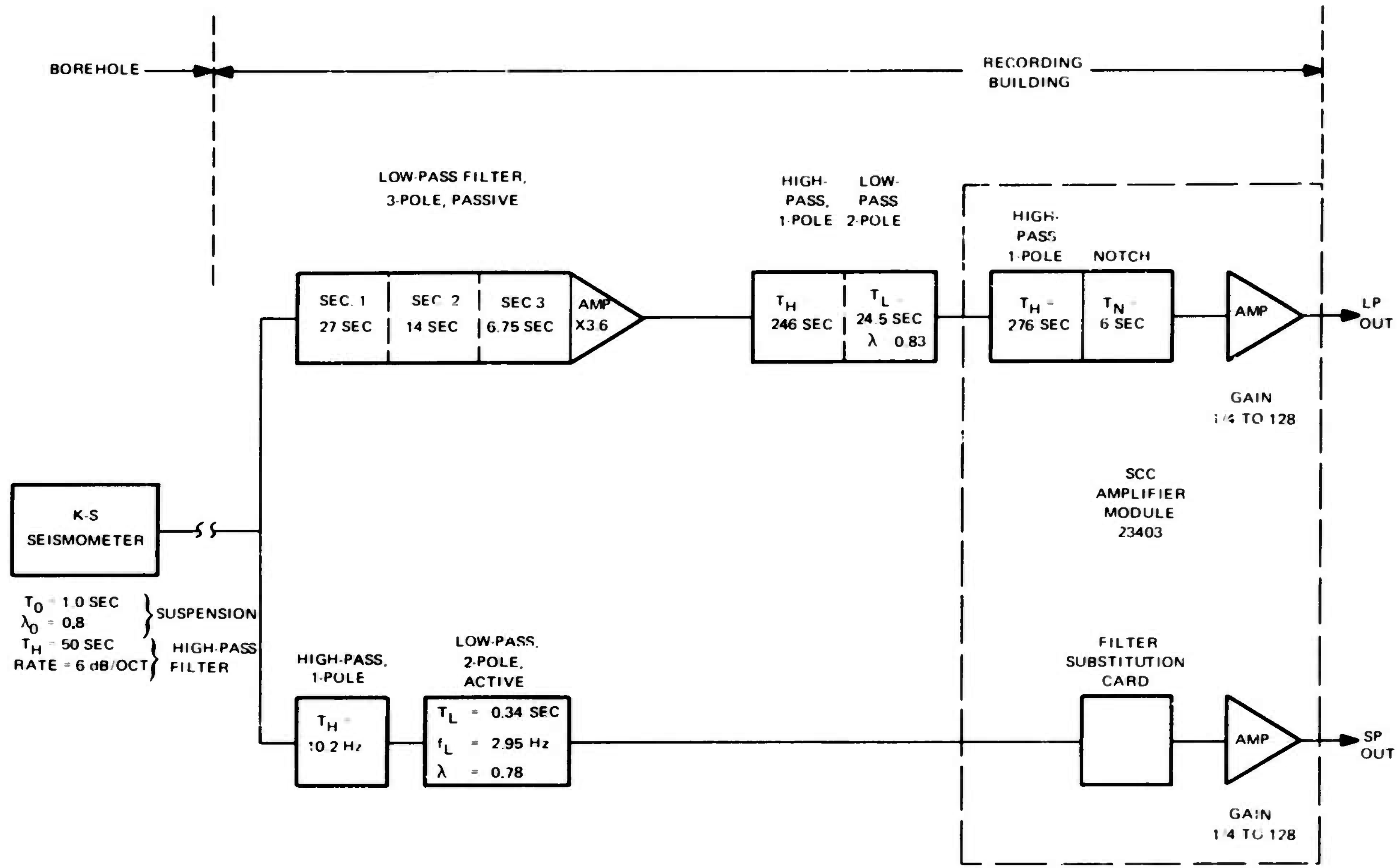

Figure 6. Typical filter amplifier circuit for Model 36000 data channels at Franklin, West Virginia

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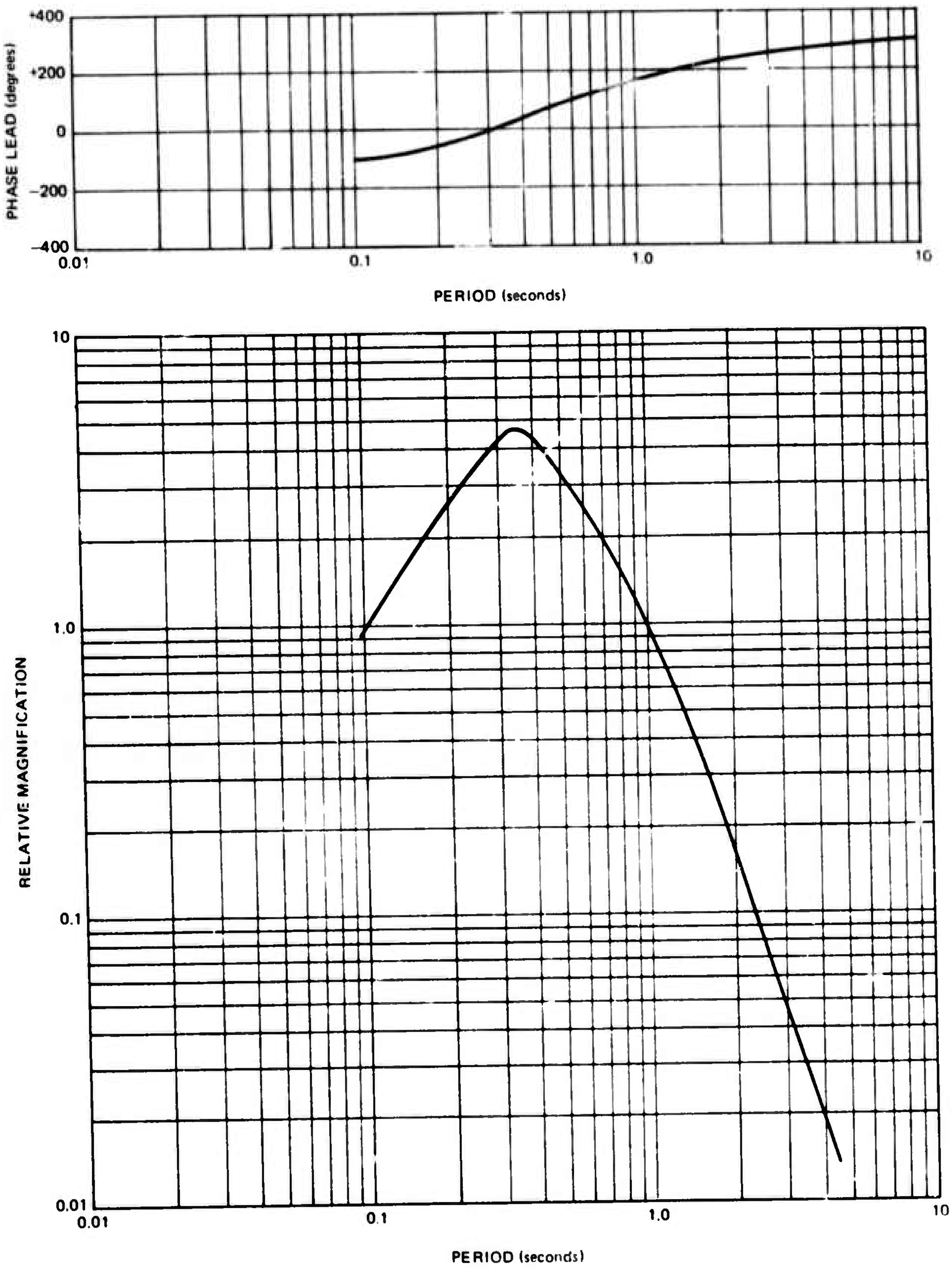

Figure 7. Theoretical amplitude and phase responses of the short-period seismographs in the Portable Seismograph System, Model 19282A, as used at sites HN-ME, RK-ON, and WH2YK

G 8243

are plots of these data applicable to the standard SDCS units at HN-ME, RK-ON, and WH2YK. Figure 9 is a plot of the CPO SP system response and figures 10 and 11 are applicable to the FN-WV system.

Users of SDCS data should be aware of two areas of potential error in applying amplitude (and phase) response corrections. First, the actual amplitude response data plotted on SDCS logs is subject to considerable reading error, primarily because it is read from Helicorder paper records. The Helicorder has a highly variable frequency response at the higher frequencies which depends on such parameters as paper type, pen heat, and pen pressure. As a result, users should be cautious in applying response corrections based on field measurements. The second problem area concerns the SP data and is related to tape speed. The high frequency limit (cutoff) for the 0.03 ips SDCS magnetic tape recordings is normally 5.0 Hz maximum in real time for the full-bandpass filters normally used in FM reproducing machines. A full-bandpass filter at 5 Hz (or its equivalent for an accelerated playback) will affect SDCS SP data at the higher frequencies. Therefore, the amplitude and phase responses for SP data should be corrected for the response of the playback system used.

3.5 SYSTEM CHANGES AND IMPROVEMENTS

3.5.1 Operational Changes

During this reporting period, two changes were made in the operation of the system at the request of SDAC personnel who are performing routine analysis of the SDCS data.

The first change was an increase in the background level recorded on magnetic tape for all high-gain channels. The SP average background level specification was changed from "50 to 100 mV" (p-p) to "100 to 200 mV" (p-p), and the LP average background level specification was changed from "100 ± 50 mV" (p-p) to "200 ± 100 mV" (p-p). This change was accomplished at all sites during the week of 28 April. Reports from the SDAC indicate that these higher levels greatly improve the signal-to-noise ratio of the recordings and facilitate data analysis.

The second change involves a change in the SDCS magnetic tape recording format. Channel #1 was originally used to record the standard dc time program from the Model 19000 timer along with the WWV signal. The original intent of this channel was for reading station time corrections. Because the Model 19000 timer has been shown to be reasonably accurate, and because the IRIG time program (BCD time) is recorded on Channel #14, it was decided that Channel #1 could be put to better use. Therefore, LPT low-gain data replaced the original station time data on channel #1 at all stations as follows:

FN-WV	At site start-up
HN-ME	27 May 1975
CPO	27 May 1975
RK-ON	29 May 1975
WH2YK	28 May 1975

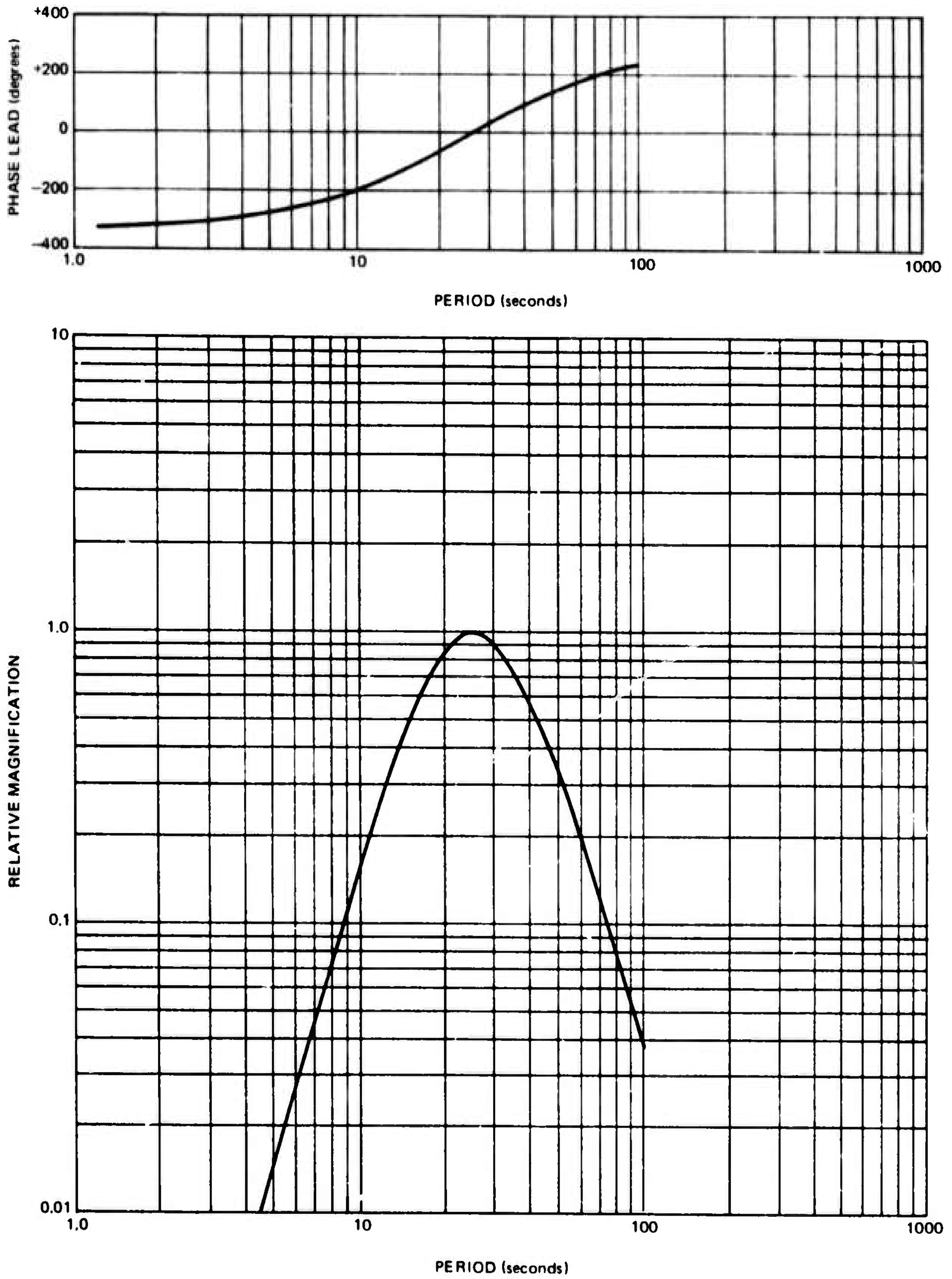

Figure 8. Theoretical amplitude and phase responses of the long-period seismographs in the Portable Seismograph System, Model 19282A, as used at sites CPO, HN-ME, RK-ON, and WH2YK

G 8244

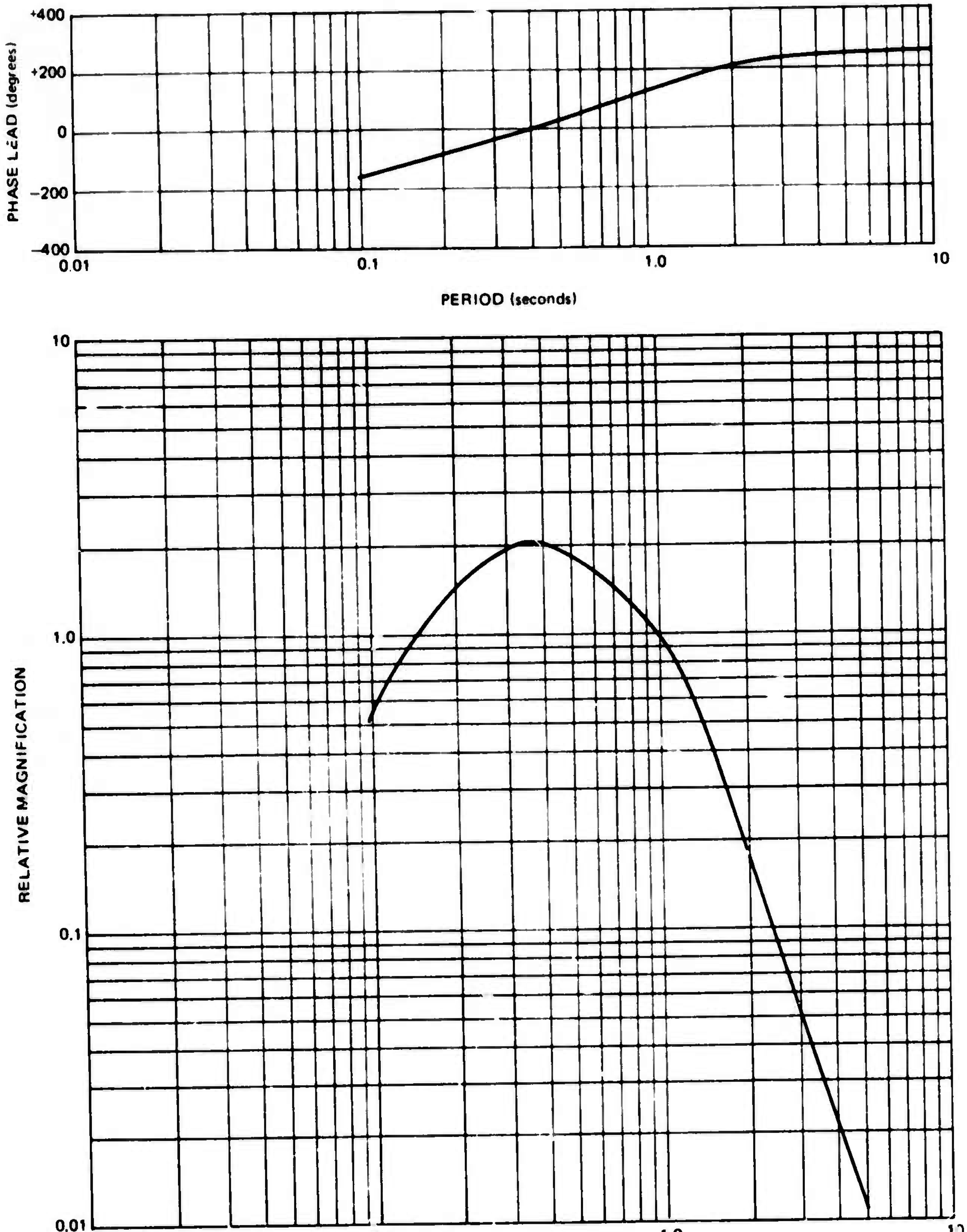

Figure 9. Theoretical amplitude and phase responses of the short-period seismographs at the Cumberland Plateau Observatory

G 8245

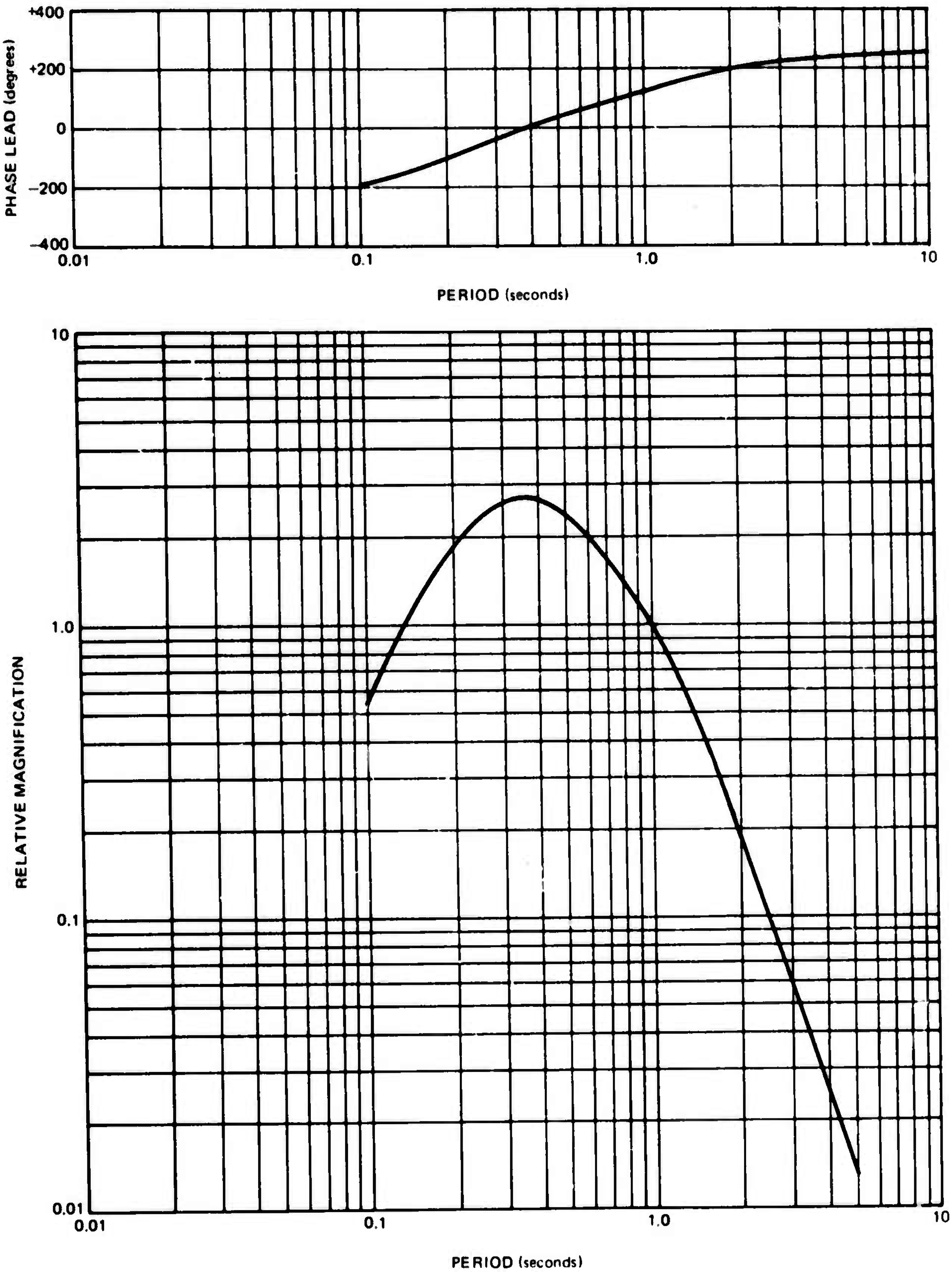

Figure 10. Theoretical amplitude and phase responses of the Model 36000 short-period seismographs at Franklin, West Virginia

G 8201A

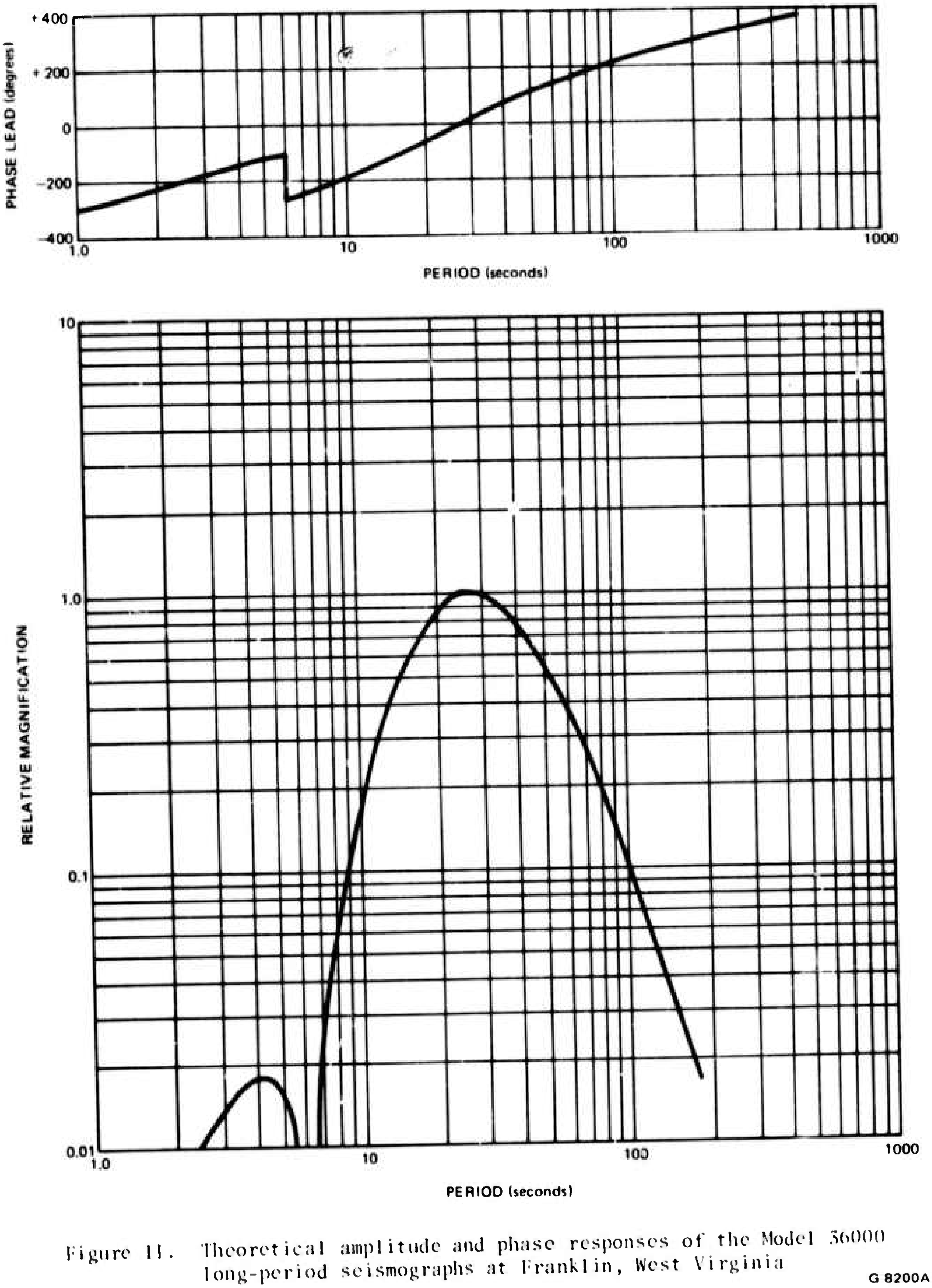

Figure 11. Theoretical amplitude and phase responses of the Model 36000 long-period seismographs at Franklin, West Virginia

G 8200A

3.5.2 Digital Recording Systems

It has long been recognized that SDCS data could be processed quicker and easier if it were recorded in digital format. Recent advances in digital data acquisition systems have made such an upgrading of the SDCS system possible. In the proposal for the present operations, two systems were suggested as options which would satisfy SDCS requirements. After further study of system specifications and price comparisons, a Digital Recording System, Model DDS-1103 from Kinnemetrics, Inc., was recommended in a letter to the Project Office on 28 January.

When verbal approval to buy five DDS-1103 systems was received from the Government in late March 1975, work began immediately on a performance specification for the system, which included particular options, system operating parameters, and modifications to the basic unit which would be required. Appendix 2 contains these specifications. The initial order for five systems to the Geotech specifications was placed with Kinnemetrics in late April and was finalized after minor specification modifications on 20 May 1975. At that time, delivery of the first two units was promised by late August and the remaining three by late September.

In addition to the five basic systems, several items of equipment will be required to interface between the SDCS units and the recorders. These include:

a) Anti-alias filters for analog data;

b) Interface unit between Model 19000 timer in SDCS and digital system to provide 1) time of day, 2) clock data, and 3) start/stop commands;

c) System for on-site evaluation of the recorded data and for verification of proper system operation by the SDCS operator.

As of the close of the reporting period, the anti-alias filters had been designed and drafting work was in process to produce the necessary documentation. Also, work has begun on other interface equipment. It is expected that the required components will be on hand by the time the first systems are received from Kinnemetrics.

Upon arrival, the DDS-1103 systems and required interface equipment will be acceptance tested in Garland. Following successful completion of the tests, the first system will be sent to the CPO site, and installed. The SDCS operator will be trained to operate the system on site. Other systems will be installed at the remaining sites as they become available.

4. DATA PROCESSING

The data processing for this program has been divided into two parts; tape quality control which is performed at our Garland office; and data analysis, which is performed at the Seismic Data Analysis Center (SDAC) in Alexandria, Virginia.

4.1 TAPE QUALITY CONTROL AT GARLAND

The quality control procedures are an integral part of the SDCS operation and are very important for successful field operations. This is true primarily because the SDCS operators do not have continuous visual recordings by which problems can be noted and corrected. This function is, therefore, being performed at Garland for better program control and for timely notification of operators of problems.

4.1.1 Procedures for Magnetic Tape Critiques

Every magnetic tape from the field is carefully checked in detail to maintain high standards of data quality and to test the validity of established operational procedures. Items which are checked are accuracy and completeness of documentation, calibration signal levels, background levels, dc offsets, tape system noise level, tape speed, and general data quality. Appropriate visual (paper) playouts are made of selected data samples and sent to the field operator along with a summary sheet of the critique. These procedures have been very effective in maintaining data quality.

When the critique is complete, the magnetic-tape, logs, and a copy of the critique are forwarded to the SDAC within two working days. This assures that the data analysis task will be delayed a minimum amount of time. By the end of this reporting period, magnetic tapes through 25 June had been critiqued for all stations except RK-ON and had been forwarded to the SDAC. The RK-ON tapes usually arrive about one week later than those from other stations due to slow mail service. The RK-ON tapes have been critiqued through 19 June.

4.1.2 Data Processing Equipment at Garland

Due to the continuing decline in the requirements for extensive data processing at Garland, the quantity of data processing equipment has been considerably reduced during this contract. Three of the four one-inch FM magnetic tape systems formerly assigned have been declared surplus. Also, several items of specialized equipment associated with the former LRSM data processing effort have been declared surplus. As a result, the system has been reduced from 14 equipment racks to five with several auxiliary items stored for possible future use. In addition, the facility has been moved to a smaller area. Much of the former versatility of this system, of course, is gone but there have been few occasions in the last five years when it has been required. With the transfer of normal SDCS data analysis to the SDAC, there will be even fewer instances of need of these capabilities.

The present system retains the capability for the following:

a) Playout of one-inch FM magnetic tapes;

b) Recording on 7-inch wide oscillograph ("pink paper");

c) Reading of IRIG format time (BCD);

d) Reproduction from one-inch magnetic tape for off-line digitizing;

e) Other functions associated with the above.

In addition, the following operations are possible by bringing in stored equipment:

a) Playout of 1/2-inch FM magnetic tapes (for visual recordings and digitizing);

b) Recordings on 9-inch wide oscillograph (permanent photographic recordings);

c) Recordings on 16mm film.

4.2 DATA ANALYSIS AT THE SDAC

The bulk of the data processing task is being performed at the SDAC in Alexandria, Virginia. Procedures have been established to process the data and generate reports on specific events as requested by the client. These procedures include:

a) Receiving, cataloging, and storage of SDCS field tape;

b) Preparation of composite records of events as requested;

c) Digitizing of the composite record; and

d) Generation of a memorandum report for each event, consisting of a summary sheet of basic event information plus visual playouts of the digital tapes.

When conversion to the Kinnemetrics DDS-1103 digital systems is completed in the field, the SDAC will assume the duties of quality control of the SDCS field tapes. Routine reports will be supplied to the Garland office for review and correction of field problems.

To date, requests to prepare 46 event reports have been received. Figure 12 is an estimated status of reports as of the end of the reporting period. In addition to the SDCS station seismograms, each report also contains available LP and SP data from LASA, NORSAR, and ALPA. A summary of published data concerning the epicenter of the reported event and station-residual are also contained in the SDCS event report.

The average percentage completion of these reports is considerably below a desirable level because of two problems. First, the data quality from the SDCS units was relatively poor during February and March. As a result, considerable time was spent in working around the various field problems.

DATE 1 JULY 1975

SDCS REPORT STATUS

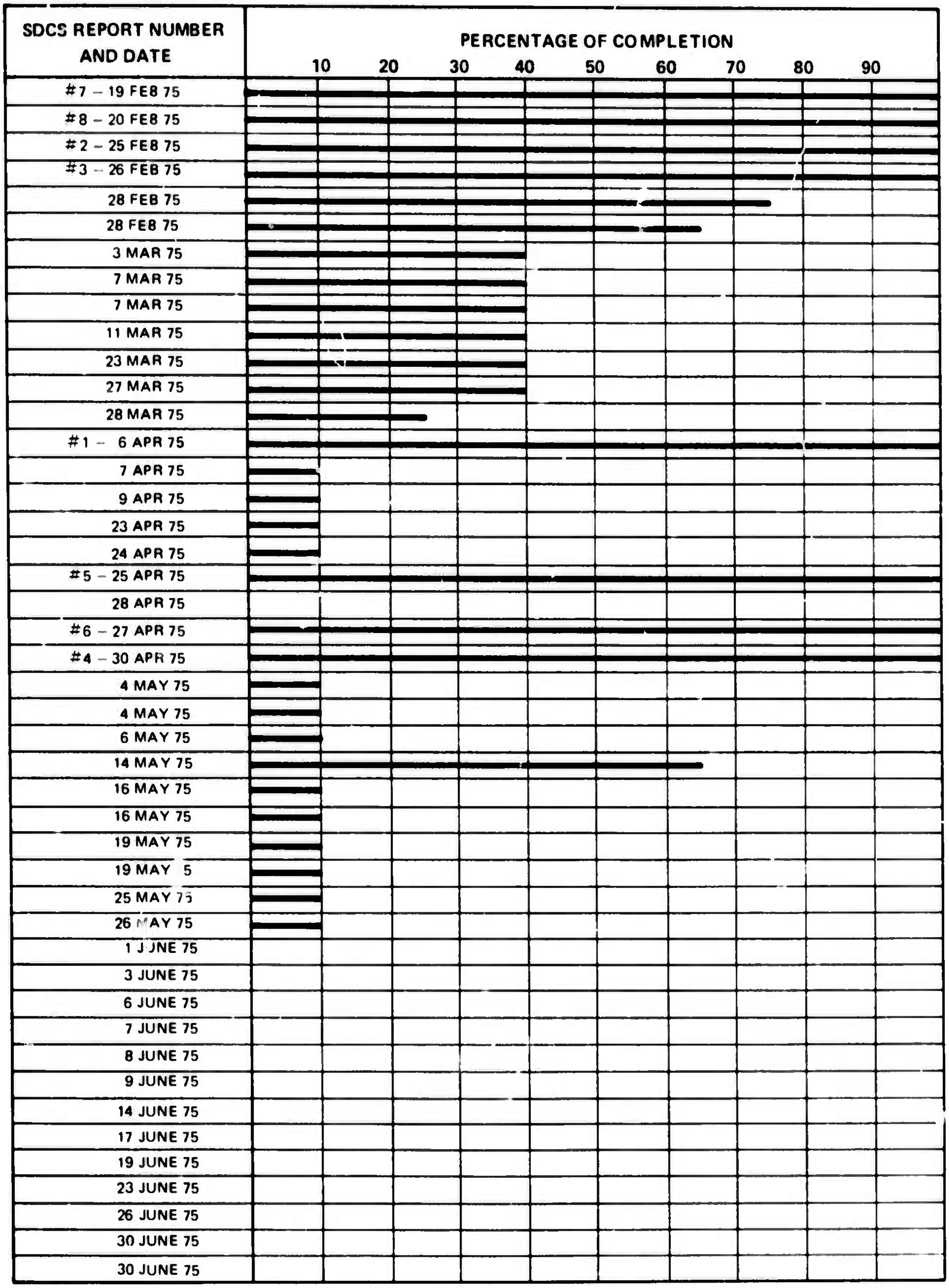

Figure 12. Status of SDCS event reports at the SDAC, as of 1 July 1975

A second problem has been that more time than expected was required to write programs necessary to put the SDCS data into a publishable format. It is expected that the event report backlog will be considerably reduced within the next two months. Data quality from the SDCS sites has greatly improved as operators have regained lost experience and as operations have settled into routine status. Also, the necessary programs have been written at the SDAC for the routine analysis and report generation has been simplified.

5. SUPPORT EQUIPMENT

The support equipment for the SDCS program includes one recording van, generators, trailer, and vehicles used during data collection operations. Table 3 lists the equipment available at the end of this report period.

5.1 RECORDING VAN

Only one Recording Van, Model 8513 remains assigned to the contract. This unit was on loan to Contract C-0052 at McKinney, Texas, until early June when it was returned to the Garland plant. The van and related equipment are now on standby status. There is a possibility that the unit can be put to use for a deep borehole test during the next reporting period.

5.2 GENERATORS

The three generators assigned to this program include one 3 KW Kohler unit on standby in Garland and two 3 KW Onan units assigned to the RK-ON site. The Onan units have performed relatively well as far as the engines are concerned. However, the generators of both units failed and required warranty repair by the Onan representative at Winnipeg. At the end of this period, both units had been returned to the RK-ON site.

5.3 VEHICLES

The vehicles assigned to this program are a 2-1/2 ton truck, eleven 3/4 ton pickups and a utility trailer. Those vehicles on standby in Garland are driven periodically and preventive maintenance measures are taken in order to maintain them in a ready status.

5.3.1 2-1/2 Ton Truck

The 1966 Ford, Model F-800, truck is used to move the Model 8513 recording van to field locations. The unit is presently on standby status at Garland. Unit usage has been low because no van movements (except the move of the van from McKinney) have been required. Operating costs have been low and this vehicle will be maintained as long as the Model 8513 van remains assigned to the program.

5.3.2 Utility Trailer

The Krueger utility trailer was again utilized infrequently during the report period, but low operation and maintenance costs have made it an economical unit to retain.

5.3.3 3/4 Ton Pickup Trucks

As previously mentioned, new 1975 Ford 3/4 ton pickups were leased for the present SDCS operations primarily because most of the 1967 and 1968 Chevrolet units were not considered reliable enough for a one-year program. These new

Table 3. Available vehicles, vans, and generators

Vehicles	Unit No.	Approx. Mileage as of 6-30-75	Miles Driven since June 1974
Prime Mover, 2-1/2 ton Ford	212-098	55519	119
Pickup, 3/4 ton Chevrolet (1967)	212-101	88477	7067
Pickup, 3/4 ton Chevrolet (1967)	212-102	78432	10738
Pickup, 3/4 ton Chevrolet (1967)	212-103	67057	5542
Pickup, 3/4 ton Chevrolet (1967)	212-104	89900	12845
Pickup, 3/4 ton Chevrolet (1968)	212-107	58200	2009
Pickup, 3/4 ton Chevrolet (1968)	212-108	80119	3572
Pickup, 3/4 ton Ford (1975)	011-110	7171	7171
Pickup, 3/4 ton Ford (1975)	011-111	16282	16282
Pickup, 3/4 ton Ford (1975)	011-112	7233	7233
Pickup, 3/4 ton Ford (1975)	011-113	9136	9136
Pickup, 3/4 ton Ford (1975)	011-114	5632	5632
			87,346

Trailers	Unit No.	Location
Krueger	235-015	Geotech/Garland
Vans		
Model 8513	208	Geotech/Garland
Generators		
3KW Kohler (gasoline)	320841	Geotech/Garland
3KW Onan (diesel)	897069	RK-ON
3KW Onan (diesel)	897078	RK-ON

trucks replaced two 1967 and three 1968 model units which had very high mileage and/or serious mechanical problems. Of the four 1967 and two 1968 units remaining, only two still have the enclosed bed (camper top) to provide shelter for normal SDCS operations. Four camper tops were removed and scrapped during this period because they were no longer serviceable. The new Ford trucks have new enclosures. Operation of the new Ford vehicles has been satisfactory and minor repairs necessary have generally been covered by warranty. The remaining six Chevrolet units continue to perform satisfactorily and will probably be adequate in the event that a short-term deployment of other SDCS units is desired.

6. SPECIAL PROJECTS

6.1 GENERAL

During this reporting period, a report on deep borehole tests was completed as discussed paragraph 2.2.1 above. In addition, a shallow tunnel detection study was carried out during this period.

6.2 SHALLOW TUNNEL DETECTION STUDY

The shallow tunnel detection study was done at the request of the Project Office and began in late December 1974. The purpose was to study several geophysical methods of locating existing shallow tunnels. Planning and coordination for the study was done in December and field experiments were conducted in January and February. Of the methods considered, significant experimentation was directed toward seismic and magnetic techniques and both types of data were collected near existing railroad tunnels. A final report, AL-75-1, Tunnel Location by Magnetometer, Active Seismic and Radon Decay Methods, was published and distributed in June.

As a result of these studies, a magnetometer experiment was approved and completed at an overseas site during April. The effectiveness of the method was demonstrated and resident personnel were instructed in operation of the equipment and interpretation of the data. A second report covering this portion of the study had been completed by the end of June and distribution is scheduled for July 1975.

APPENDIX 1

Theoretical amplitude and frequency response data
for SDCS operations - January-June 1975

TOTAL SYSTEM RESPONSES

VELOCITY TRANSDUCER OUTPUT DE-COUPLED CALCULATED

6 DB LOW CUT FILTER AT .100 HZ
6 DB HIGH CUT FILTER AT 20.400 HZ
12 DB HIGH CUT FILTER AT 2.950 HZ WITH .3850 DAMPING
6 DB HIGH CUT FILTER AT 51.400 HZ

FREQ	PER	AMPT	ANGT
.1000	10.0000	.0009	305.5
.1500	6.6667	.0034	289.4
.2000	5.0000	.0088	277.4
.2500	4.0000	.0178	267.8
.3000	3.3333	.0316	259.4
.4000	2.5000	.0771	244.5
.5000	2.0000	.1525	230.6
.6000	1.6667	.2628	217.0
.8000	1.2500	.5866	190.3
1.0000	1.0000	1.0000	165.3
1.5000	.6667	2.0895	117.5
2.0000	.5000	3.2244	82.1
2.5000	4000	4.2717	47.7
3.0000	.3333	4.6296	13.8
4.0000	.2500	3.5691	-33.7
5.0000	.2000	2.5807	-58.1
6.0000	.1667	1.9848	-72.9
8.0000	.1250	1.3372	-91.9
10.0000	.1000	.9901	-105.1

TOTAL SYSTEM RESPONSES

VELOCITY TRANSDUCER OUTPUT DE-COUPLED CALCULATED

12	DB	HIGH	CUT	FILTER	AT	.033 HZ	WITH	.6418	DAMPING
6	DB	LOW	CUT	FILTER	AT	.005 HZ			
6	DB	HIGH	CUT	FILTER	AT	.126 HZ			
12	DB	HIGH	CUT	FILTER	AT	.041 HZ	WITH	.8290	DAMPING

FREQ	PER	AMPT	ANGT
.0100	100.0000	.0401	231.7
.0125	80.0000	.0807	209.8
.0167	59.9880	.1915	175.0
.0200	50.0000	.3192	147.7
.0250	40.0000	.55[illegible]8	106.9
.0333	30.0030	.9008	41.8
.0400	25.0000	1.0000	-4.8
.0500	20.0000	.8820	-62.5
.0571	17.5009	.7203	-95.2
.0667	14.9993	.5173	-129.7
.0800	12.5000	.3175	-165.1
.1000	10.0000	.1598	-201.0
.1250	8.0000	.0758	-230.3
.1667	5.9999	.0274	-260.5
.2000	5.0000	.0140	-276.1
.2500	4.0000	.0061	-292.1
.3333	3.0000	.0020	-308.6
.4000	2.5000	.0010	-316.9
.5000	2.0000	.0004	-325.4
.5714	1.7500	.0002	-329.7
.6667	1.5000	.0001	-334.0
.8000	1.2500	.0001	-338.3

TOTAL SYSTEM RESPONSES

VELOCITY TRANSDUCER - GALVO COMBINATION COUPLED CALCULATED
6 DB LOW CUT FILTER AT .010 HZ
12 DB HIGH CUT FILTER AT 10.000 HZ WITH .7070 DAMPING

FREQ	PER	AMPT	ANGT
.1000	10.0000	.0013	265.1
.1500	6.6667	.0044	257.7
.2000	5.0000	.0106	251.2
.2500	4.0000	.0211	244.8
.3000	3.3333	.0369	238.3
.4000	2.5000	.0905	224.8
.5000	2.0000	.1814	209.8
.6000	1.6667	.3153	193.3
.8000	1.2500	.6701	157.8
1.0000	1.0000	1.0000	126.2
1.5000	.6667	1.5231	74.7
2.0000	.5000	1.8600	40.6
2.5000	.4000	2.0304	12.4
3.0000	.3333	2.0318	-11.6
4.0000	.2500	1.7663	-48.4
5.0000	.2000	1.4494	-74.7
6.0000	.1667	1.1848	-95.2
8.0000	.1250	.7969	-127.5
10.0000	.1000	.5338	-152.5

36<

TOTAL SYSTEM RESPONSES

NO TRANSDUCER - FILTER RESPONSES ONLY
12 DB LOW CUT FILTER AT 1.000 HZ WITH .8000 DAMPING
6 DB LOW CUT FILTER AT .020 HZ
6 DB HIGH CUT FILTER AT 7.950 HZ
6 DB HIGH CUT FILTER AT 16.000 HZ
6 DB LOW CUT FILTER AT 10.150 HZ
12 DB HIGH CUT FILTER AT 2.950 HZ WITH .7820 DAMPING

FREQ	PER	AMPT	ANGT
.1000	10.0000	.0016	267.4
.1500	6.6667	.0056	256.8
.2000	5.0000	.0132	247.9
.2500	4.0000	.0255	239.8
.3000	3.3333	.0437	231.9
.4000	2.5000	.1007	216.8
.5000	2.0000	.1888	202.0
.6000	1.6667	.3087	187.4
.8000	1.2500	.6270	159.4
1.0000	1.0000	1.0000	133.9
1.5000	.6667	1.8599	81.8
2.0000	.5000	2.4241	42.0
2.5000	.4000	2.6786	9.6
3.0000	.3333	2.6877	-17.6
4.0000	.2500	2.3246	-60.4
5.0000	.2000	1.8487	-92.3
6.0000	.1667	1.4360	-117.3
8.0000	.1250	.8648	-154.6
10.0000	.1000	.5343	-182.0

TOTAL SYSTEM RESPONSES

```
 NO TRANSDUCER  -  FILTER RESPONSES ONLY
12  DB   LOW  CUT  FILTER  AT   1.000  HZ   WITH   .8000 DAMPING
 6  DB   LOW  CUT  FILTER  AT    .020  HZ
 6  DB  HIGH  CUT  FILTER  AT    .037  HZ
 6  DB  HIGH  CUT  FILTER  AT    .071  HZ
 6  DB  HIGH  CUT  FILTER  AT    .148  HZ
 6  DB   LOW  CUT  FILTER  AT    .004  HZ
12  DB  HIGH  CUT  FILTER  AT    .041  HZ   WITH   .8290 DAMPING
 6  DB   LOW  CUT  FILTER  AT    .004  HZ
FILTER NOTCH       READ FROM CARDS
```

FREQ	PER	AMPT	ANGT
.0100	100.0000	.1010	220.7
.0125	80.0000	.1857	191.5
.0167	59.9880	.3685	149.7
.0200	50.0000	.5298	120.3
.0250	40.0000	.7523	80.9
.0333	30.0030	.9736	25.3
.0400	25.0000	1.0000	-11.9
.0500	20.0000	.8799	-57.9
.0571	17.5009	.7480	-84.9
.0667	14.9993	.5730	-115.1
.0800	12.5000	.3749	-149.0
.1000	10.0000	.1866	-187.7
.1250	8.0000	.0695	-223.3
.1667	5.9999	0	-265.2
.2000	5.0000	.0207	-109.7
.2500	4.0000	.0193	-138.0
.3333	3.0000	.0150	-172.8
.4000	2.5000	.0112	-194.3
.5000	2.0000	.0071	-220.8
.5714	1.7500	.0052	-236.8
.6667	1.5000	.0035	-255.6
.8000	1.2500	.0021	-279.1

APPENDIX 2

Performance Specifications for an eight-channel
Digital Data Acquisition System
Drawing No. 990-41503-01-01

APPLICATION		REVISIONS				
NEXT ASSY.	USED ON	LTR	ECN NO.	DESCRIPTION	DATE	APPROVED

990–

PERFORMANCE SPECIFICATION FOR AN EIGHT-CHANNEL DIGITAL DATA ACQUISITION SYSTEM

The system described in this specification is to be a Kinemetrics DDS-1103 with various options and modifications. The intent of this specification is to describe the performance of the modified system so that the original system can be modified to meet this specification with a minimum amount of modification and cost.

1. Multiplexer

a.	Number of channels	8
b.	Input voltage range	±10 V
c.	Input impedance	2000 megohms
d.	Accuracy	0.005% F. S.
e.	Common mode rejection	80 dB @ 1 kHz
f.	Crosstalk	-80 dB
g.	Source impedance	1000 ohms
h.	Off channel capacitance	7 pf/channel
i.	Input leakage (off channel)	100 pA/channel
j.	Over voltage limit	±15 V

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	CONT.		
TOLERANCES	DRAWN	JACKIE	AMM 75
FRACTIONS ± DECIMALS ± ANGLES ±	CHECKED	JRS	20 AM 75
	PROTO.		
	1ST. PROD.		
MATERIAL	PROD.		
	GEOTECH APPVL.		
FINISH	OTHER APPVL.		

TELEDYNE GEOTECH
3401 SHILOH ROAD / GARLAND, TEXAS 75040

TITLE: PERFORMANCE SPECIFICATION FOR AN EIGHT-CHANNEL DIGITAL DATA ACQUISITION SYSTEM

SIZE	CODE IDENT. NO.	DWG. NO.
A	99019	990– 41503-01-01
SCALE		SHEET 1 OF 6

k.	Rate (binary)	$>$ 40 kHz
l.	Channel-to-channel skew (binary)	$<$ 25 µsec
m.	Addressing (internal)	Switch selectable

n. Normal mode of operation, four channels sampled twenty times a second. On the twentieth sample all eight channels are sampled. A switch will be provided to change from the normal mode to sequential mode where all channels are sampled at the same rate.

o.	Sampling rate	Set by external start pulse rate
p.	Pulse zero level	0 V +0.25 V
q.	Pulse one level	4.5V ±1.0 V
r.	Max pulse duration	10 µsec
s.	Min pulse duration	3 µsec
t.	Start transition	Negative going
u.	Load at "START PULSE" input	4 ea TTL loads

v. Upon receiving a start pulse the multiplexer will make one scan of the applicable channels at the maximum multiplexer rate. In normal mode, four channels for nineteen scans and eight channels on the twentieth scan. If in the sequential mode, all eight channels will be scanned each start pulse.

2. <u>Sample and Hold Amplifier</u>

a.	Accuracy	0.01% F. S.
b.	Aperature	$<$ 50 nsec
c.	Hold decay	±15 µV/msec
d.	Gain	+1
e.	Sampling time	5 µsec

3. Analog-to-Digital Converter

a. Accuracy	$\pm$0.02% F. S.
b. Conversion time	7 μsec
c. Temperature coefficient	$\pm$5 PPM/^{o}C
d. Quantizing error	$\pm$1/2 LSB
e. Quantizing resolution	1 part in 4096
f. Number of binary bits	12
g. Output code	Offset binary

Volts	Output code
+9.9951	1111 1111 1111
+0.0000	1000 0000 0000
-10.000	0000 0000 0000

4. Memory

a. Type	MOS
b. Full cycle rate	5 MHz (max)
c. Size	2048 words by 8 bits

5. Digital Clock

The system is to be supplied with signals from an external digital clock. See attachment Section 2.10 and table 2.13, 2.14 for details of clock input line definitions and logic levels. Thirty lines will be used for the clock. The year will be input as one digit in the header constants.

6. Controls, front panel

a. Select analog channel to be displayed on monitor
b. Select normal mode or sequential mode per paragraph 1 n above.
c. START, STOP, CLEAR, and END-OF-FILE (EOF) control switches

d. 4-digit header information

7. Front Panel Displays or Indicators

a. Digital display of input channel voltage for selected channel — 3 digits plus sign

b. End-of-Tape indicator

c. System error indicators

d. A front panel switch should be provided to shut off displays and indicators

8. Controls, rear panel

a. START, STOP, CLEAR, and EOF

b. EOT and error output levels

c. Tape transport busy signal

d. End record — A control line is to be provided to externally cause a record to be ended, the data written on the tape, and an end-of-record gap to be written. This is to be used to end a record before the memory is full. The signal may cause the entire memory to be written or just the portion that has been filled; in either case the system will be cleared and be ready to start a new record.

An alternative to the above would be to provide a control that could be used to designate the number of characters to be recorded and when that number is reached, automatically write the data and start a new record.

e. Any other outputs and controls normally included in the DDS 1103 (see attachment Section 2.11).

f. Connectors

Analog data
Start scan
Clock data input

9. Tape Transport (IBM Compatible)

a. Recording mode — NRZI

b. Type — Synchronous

c.	Tape speed	25 ips
d.	Density	800 bpi
e.	Number of tracks	9
f.	Record length	2048 tape bytes
g.	Tape reel size	10-1/2 in.
h.	Tape length	2400 ft
i.	Tape length (continued)	Tape length required to record for 24 hr on one reel at the sampling rates specified in paragraph 1 for eight channels

j. The tape transport is to be equipped with the necessary heads and electronics for Read-after-Write operation. A signal from each tape track and a data available signal are to be provided so that a tape character can be loaded in an external register. The signals provided are to be TTL compatible (see attachment). The signals are to be available on a printed circuit type connector.

10. Data Format

As specified in Kinemetrics Drawing No. 102029 with external digital clock data recorded in the area labeled EXTERNAL DIGITAL DATA. See attachment for details of clock input line definitions and logic levels.

11. Power Requirements

a.	Voltage	105 to 125 Vac
b.	Frequency	48 to 400 Hz
c.	Power	
	Data System	175 W
	Tape transport	400 W

12. Environment (sheltered equipment)

a.	Temperature	
	Data system	0-70°C operating
	Tape transport	5-45°C operating -20 to +60°C storage
b.	Humidity	10 to 90% without condensation
c.	Shock and vibration	Under normal operating conditions, sheltered equipment is not expected to be subject to damaging shock or

	vibration. The equipment must withstand shock and vibration incurred during shipment and handling by common carrier when packed in its normal shipping container.
d. Altitude	
Operating	0-5000 ft
Shipping	0-50,000 ft
e. Shipping (continued)	In transit the equipment should withstand changes in barometric pressure resulting from altitude changes from 0 to 50,000 ft without damage

13. <u>Physical Characteristics</u>

a. Width	23 in.
b. Height	55 in.
c. Depth	25 in.
d. Weight	225 lb max The physical characteristics are for a system having all the components mounted in a rack cabinet. All system cables are to be supplied with the equipment.

2.10 EXTERNAL DIGITAL DATA (Optional) J14-J15

These input lines are provided to accept external digital data that are DTL/TTL compatible and will be recorded first into memory, then onto tape either once per record as part of the Header data or after each scan of the analog multiplexer. This programming capability is provided for on J16. For binary coded 9 track transport data systems 32 bits are provided and recorded while BCD coded data systems provide for 36 bits. For 7 track tape transports the binary coded data systems provide 24 bits to be recorded.

Logic 1 level = +4-1/2 volts ($\pm$1 volt).

Logic 0 level = 0 volts (+.25 volt.)

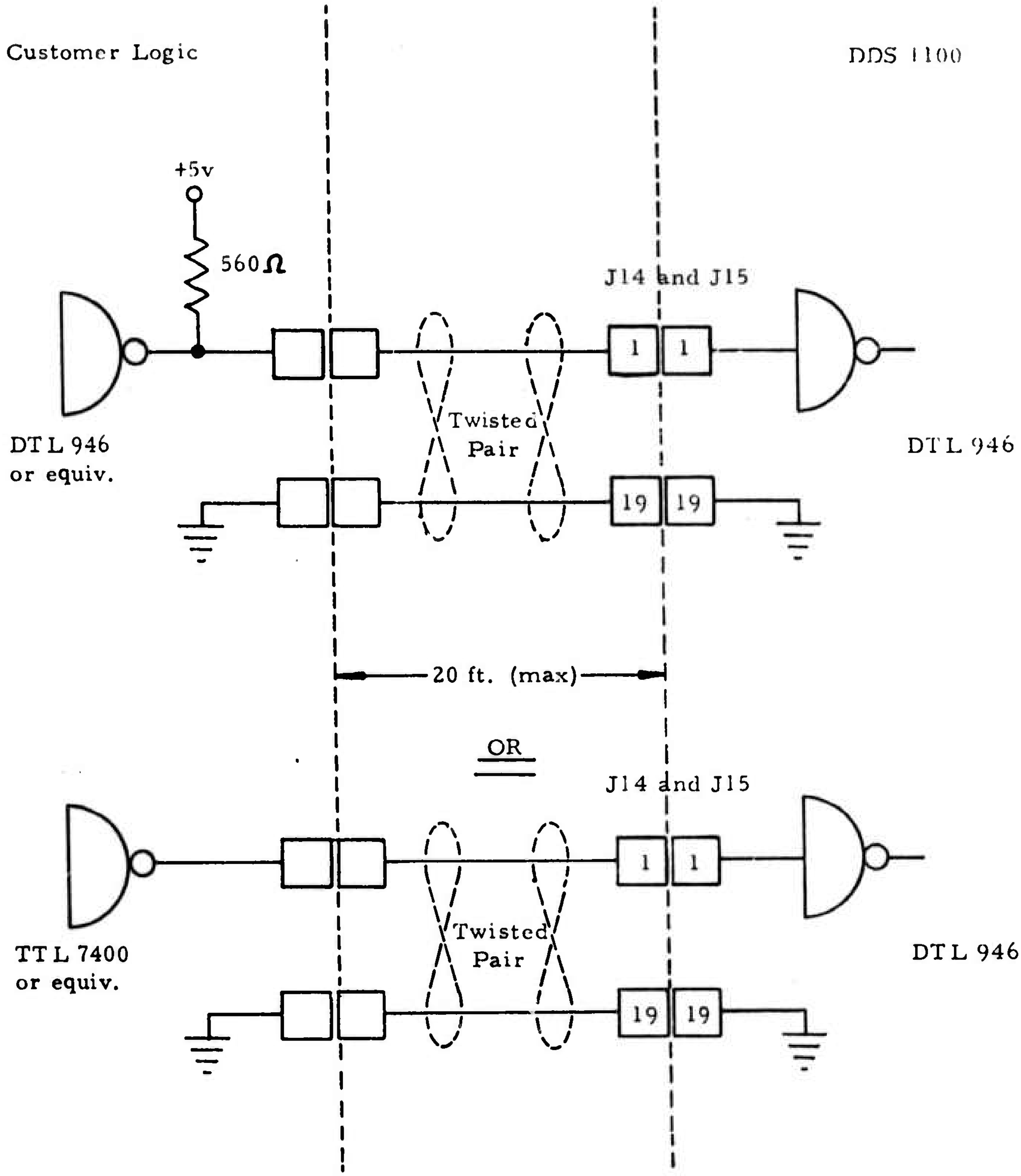

Figure 2.2

EXTERNAL DIGITAL DATA INTERFACE

J14

EXTERNAL DIGITAL DATA
(Optional)

Connector Pin	Signal		Connector Pin	Signal		
1	DATA	X1	19	DIGITAL	RETURN	1
2	"	X2	20	"	"	2
3	"	X3	21	"	"	3
4	"	X4	22	"	"	4
5	"	X5	23	"	"	5
6	"	X6	24	"	"	6
7	"	X7 **	25	"	"	7 **
8	"	X8 **	26	"	"	8 **
9	"	X9	27	"	"	9
10	"	X10	28	"	"	10
11	"	X11	29	"	"	11
12	"	X12	30	"	"	12
13	"	X13	31	"	"	13
14	"	X14	32	"	"	14
15	"	X15 **	33	"	"	15 **
16	"	X16 **	34	"	"	16 **
17	"	X17	35	"	"	17
18	"	X18	36	"	"	18

Use twisted pair (see interface example).

** Not provided for 7 track tape transport binary systems.

Table 2.13

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J15

EXTERNAL DIGITAL DATA
(Optional)

Connector Pin	Signal	Connector Pin	Signal
1	DATA X19	19	DIGITAL RETURN 19
2	" X20	20	" " 20
3	" X21	21	" " 21
4	" X22	22	" " 22
5	" X23 **	23	" " 23 *
6	" X24 **	24	" " 24 *
7	" X25	25	" " 25
8	" X26	26	" " 26
9	" X27	27	" " 27
10	" X28	28	" " 28
11	" X29	29	" " 29
12	" X30	30	" " 30
13	" X31 **	31	" " 31 **
14	" X32 **	32	" " 32 **
15	" X33 *	33	" " 33 *
16	" X34 *	34	" " 34 *
17	" X35 *	35	" " 35 *
18	" X36 *	36	" " 36 *

Use twisted pair (see interface example).

* BCD systems only.
** Not provided for 7 track tape transport binary systems.

Table 2.14

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2.11 DATA SYSTEM I/O CONTROL LINES J16

J16-1 EXTERNAL CLOCK may be furnished to the system by applying the DTL/TTL compatible signal to J16 and selecting EXT on the front panel rotary switch.

J16-2 SCAN FREQUENCY OUT is the product of the BASE FREQ rotary switch and the BASE FREQ MULTIPLIER rotary switch located on the front panel. This signal may be applied to external frequency dividers and returned to the system via Scan Frequency In connection. Normally, this signal should be jumpered at J16-2 to J16-3.

J16-3 SCAN FREQUENCY IN is the clock signal that controls the rate of the Analog Multiplexer. A DTL/TTL compatible pulse on this line initiates the Analog Multiplexer to begin scanning through the number of analog channels selected via the front panel thumbwheel switches, the system internally completes the entire scan at 40 KHz rate.

J16-4 EXTERNAL DATA ALERT is associated with the optional External Digital Data feature. When this line is at a logic "1" (+5 volts) level all input External Digital Data must be stabilized within two microseconds from the time the Alert signal rises from a logic "0" (0 volts) level to a logic "1" level. The source of this internal signal is a TTL 7404 inverter and is capable of driving 10 TTL loads.

J16-5 RECORDING is an internal logic DTL/TTL compatible output line associated with the optional data compression mode (threshold). It may be used to determine when the data system is recording data (busy) after a threshold signal has been generated either internal or external. Busy level is approximately 5 volts and not busy is zero volts. The source of this signal is a DTL 930 and is capable of driving 4 DTL loads.

J16-6 EXTERNAL THRESHOLD is a DTL/TTL compatible input line

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associated with the optional data compression mode. The front panel mode switch must be set to EXT THRES for this line to be effective. When the RECORDING line (J16-5) is not busy a pulse on this line will cause the digital clock to be recorded followed by the analog to digital data. Normally, this line should be at a ±5 volt level and a pulse shall be a negative going to zero volts and returned to +5 volts. This line includes a 1000 ohm pull-up resistor to +5 volts for an open collector application. Pulses on this line are ineffective as long as the RECORDING line is at +5 volts.

J16-7 STOP RECORDING is a DTL/TTL compatible input line associated with the optional data compression mode. Normally this line should be at a +5 volt level and a pulse shall be a negative going to zero volts and returned to +5 volts. This line includes a 1000 ohm pull-up resistor to +5 volts for an open collector application. A pulse on this line when the RECORDING line is at +5 volts will cause the analog multiplexer to stop scanning at the end of the next completed scan.

J16-8 TAPE BUSY is a buffered DTL/TTL compatible output line indicating the status of the tape transport. When the tape is busy the line will be at +5 volts and when not busy it will be at zero volts. The source of this signal is a TTL 7400 and is capable of driving 10 TTL loads.

J16-9 AUTO EOF is a DTL/TTL compatible input line that includes a 1000 ohm pull-up resistor to +5 volts for an open collector application. An End-Of-File will be recorded on tape for each pulse on this line. Before generating a pulse it is important to monitor the tape busy line. A pulse should be generated only when the TAPE BUSY line is at zero volts. The pulse shall be a negative going signal to zero volts and returned to the normally +5 volt level.

J16-10 REMOTE AUTO EOF DISABLE is associated with the optional

RECORDS counter and control logic. With the RECORDS option the system will automatically write an EOF (End-Of-File) mark on tape upon completion of recording the programmed number of records. To inhibit the AUTO EOF ground J16-10 by jumpering it to J16-27. If the system does not include the RECORDS option this line is ineffective. This line is DTL/TTL compatible and includes a 1000 ohm pull-up resistor to +5 volts for an open collector or other switching application.

J16-11 END-OF-TAPE (EOT) is a buffered output of the EOT circuit as sensed from the tape transport. When EOT is detected this line rises from a logic "0" (0 volts) to a logic "1" level and holds until CLEAR is depressed (local or remote). The source of this internal signal is TTL 7404 inverter and is capable of driving 10 TTL loads.

J16-12 INHIBIT WRITE MEMORY is a DTL/TTL compatible input line with a 1000 ohm pull-up resistor to +5 volts for an open collector or other switching applications. This line is normally at the +5 volt level. However, when zero volts is applied the memory write lines are disabled. The general application of this line is for data editing and should be used in conjunction with monitoring the optional analog to digital converter output provided at rear panel connector J9.

J16-13 ERROR is a buffered output of the error detection circuitry. When an error is detected this line will rise from a logic "0" (0 volts) to a logic "1" level and holds until CLEAR is depressed (local or remote). The source of this internal signal is a TTL 7404 inverter and is capable of driving 10 TTL loads.

** CAUTION **

DO NOT apply any foreign voltage to the EOT or ERROR lines other than the input o[illegible] standard DTL/TTL circuit or equivalent, as permanent damage may result.

J16-14 INHIBIT SCAN COUNTER is an optional DTL/TTL compatible line with a 1000 ohm pull-up resistor to +5 volts for open collector or other switching applications. This line is normally at the +5 volts level and is associated with the data compression (threshold) mode. It is used to inhibit the front panel SCAN thumbwheel switches for data editing.

J16-15 REMOTE START parallels the function of the START switch located on the front panel. To remotely start the system, apply the signal lead to the digital ground return. Contact bounce, if a switch is used, is of little consequence and contact need only be made for 10 microseconds without regard to rise or fall times. The DTL/TTL compatible signal must remain "true" (0 volts) for at least 5 microseconds. This line includes a 1000 ohm pull-up resistor to +5 volts for an open collector or other switching application.

** CAUTION **

DO NOT apply any other voltage to this control line as permanent damage may result. Use only the ground line that is made available.

J16-16 REMOTE STOP is identical to the REMOTE START function above except that it parallels the function of the STOP switch.

J16-17 REMOTE CLEAR is identical to the REMOTE START function above except that it parallels the function of the CLEAR switch.

J16-18 REMOTE MULTIPLEXER SCAN DISABLE is a unique line that gates the Analog Multiplexer Scan Rate Clock (SCAN FREQ IN). When this DTL/TTL compatible line is connected to digital ground provided, it will disable the Analog Multiplexer from starting its scan, thus making the system quiescent during this period of time regardless of the SCAN FREQ IN clock signal. This method of system interruption should not be confused with the STOP switch (local or remote) function. The STOP switch may be depressed during this time and the system will perform the functions attributed to the STOP switch. This line includes a 1000 ohm pull-up resistor to +5 volts for an open collector or other switching application.

J16-30 DIGITAL RETURN for J16-31. This line must be connected to either J16-32 or J16-34.

J16-31 START EXT DATA is an optional input control signal that initiates recording of the External Digital Data. This input line must be connected to either J16-33 or J16-35.

J16-32 DIGITAL RETURN for J16-33. This line must be connected to J16-30 only if J16-33 is connected to J16-31.

J16-33 SEDA is an optional output control signal that when jumpered to J16-31 will cause the external digital data to be recorded after each scan of the analog multiplexer.

J16-34 DIGITAL RETURN for J16-35. This line must be connected to J16-30 only if J16-35 is connected to J16-31.

J16-35 SR16B is an optional output control signal that when jumpered to J16-31 will cause the external digital data to be recorded after the header data has been recorded. Thus, the external digital data will be recorded only once per tape record.

J16-36 REMOTE RECORD COUNTER DISABLE is associated with the optional RECORDS thumbwheel switches located on the front panel. By applying this DTL/TTL compatible signal line to digital ground return line the output of the Record Counters is disabled. If this optional line is utilized it must be grounded during the entire recording period from START to STOP, not just momentarily. This line includes a 1000 ohm pull-up resistor to +5 volts for an open collector or other switching application.

** NOTE **

Any J16 control lines not utilized may be ignored and left disconnected without system degradation, except SCAN FREQ OUT must directly or indirectly be connected to SCAN FREQ IN.

J16

REMOTE CONTROLS
REAR PANEL

Connector Pin	Signal	Connector Pin	Signal
1	EXT CLK	19	DIGITAL GND
2	SCAN FREQ OUT	20	" "
3	SCAN FREQ IN	21	" "
4	EXT DATA ALERT	22	" "
5	RECORDING	23	" "
6	EXT THRESHOLD	24	" "
7	STOP RECORDING	25	" "
8	TAPE BUSY	26	" "
9	AUTO EOF	27	+5 volt (REF) 0.5 amp max
10	DISABLE AUTO EOF	28	
11	EOT	29	
12	INHIBIT WRITE MEMORY	30	DIGITAL GND
13	ERROR	31	START EXT DATA
14	INHIBIT SCAN COUNTER	32	DIGITAL GND
15	REMOTE START	33	SEDA (after Mux)
16	REMOTE STOP	34	DIGITAL GND
17	REMOTE CLEAR	35	SR16B (After Header)
18	MULTIPLEXER SCAN DISABLE	36	DISABLE RECORDS CTR.

Table 2.15

RECORDED ONCE PER RECORD

9 TRACK	CHANNELS SELECTED		HEADER CONSTANTS				EXTERNAL DIGITAL DATA				1ST SAMPLE		2ND SAMPLE			1019TH SAMPLE	
PARITY	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
0	1	1	1	1	1	1	X8	X16	X24	X32	0	2^7	0	2^7		0	2^7
1	1	1	1	1	1	1	X7	X15	X23	X31	0	2^6	0	2^6		0	2^6
2	1	1	1	1	1	1	X6	X14	X22	X30	0	2^5	0	2^5		0	2^5
3	1	1	1	1	1	1	X5	X13	X21	X29	0	2^4	0	2^4		0	2^4
4	80	8	8000	800	80	8	X4	X12	X20	X28	2^{11}	2^3	2^{11}	2^3	ETC.	2^{11}	2^3
5	40	4	4000	400	40	4	X3	X11	X19	X27	2^{10}	2^2	2^{10}	2^2		2^{10}	2^2
6	20	2	2000	200	20	2	X2	X10	X18	X26	2^9	2^1	2^9	2^1		2^9	2^1
7	10	1	1000	100	10	1	X1	X9	X17	X25	2^8	2^0	2^8	2^0		2^8	2^0
	1	2	3	4	5	6	7	8	9	10	11	12	13	14		2047	2048

INTER RECORD GAP OR BEGINNING OF TAPE (left of byte 1); INTER RECORD GAP (right of byte 2048)

TAPE CHARACTERS (BYTES)

TAPE MOTION ←

Notes:
1. 2048 characters per record.
2. Data format not physical data location on tape (EBCDIC coding).
3. 2^0 is the LSB.

SYM	ITEM NO	QTY REQD	IDENTIFYING NO.	DESCRIPTION	MATERIAL	SPECIFICATION

LIST OF MATERIAL

NEXT ASSY | USED ON
APPLICATION
FINISH
SPEC.
DIMENSIONS ARE IN INCHES TOL .XX ± .01, .XXX ± .005, FRACT ± 1/32, ANG ± 0°30'

UNLESS OTHERWISE SPECIFIED
HOLE TOLERANCES
.040 TO .128 + .002 .001
.136 TO .228 + .003 .001
.234 TO 1/2 + .004 .001
33/64 TO 3/4 + .005 .001
MACH. FINISH 125 OR BETTER
BREAK SHARP EDGES .010
REMOVE ALL BURRS
DIMS APPLY AFTER FINISH
DIMENSIONS ARE PER MIL-STD-8
IDENTIFY PER MIL STD 130
DO NOT SCALE DRAWING

CONTR NO.
DRAWN [signature]
CHECK
ELEC.
MECH.
DESIGN D R. Juil
APPR.
APPROVED
APPROVED

KINEMETRICS, INC.

TAPE FORMAT - TYPICAL STD. BINARY WITH EXTERNAL DIGITAL DATA-HEADER DATA

SIZE C | CODE IDENT NO | 102029 | A
SCALE — | WEIGHT | SHEET 1 OF 1

10232