TELEDYNE, INC.
UED EARTH SCIENCES DIVISION

214 NORTH THIRTIETH STREET | BILLINGS, MONTANA | TELEPHONE: 406-245-6332

10 December 1965

AFTAC/VELA Seismological Center
300 North Washington Street
Alexandria, Virginia 22313

Attention: Major Jack T. Pantall, Jr.

Dear Major Pantall:

Transmitted herewith is our Quarterly Progress Report (No. 616-1265-2065) for 1 September 1965 through 30 November 1965, for the LASA Contract No. AF 33(657)-14104.

Very truly yours,

Dean B. Rabenstine

Dean B. Rabenstine
Associate Manager
LASA Data Center

DBR/mac

Enclosures

LASA
OPERATIONS AND MAINTENANCE

QUARTERLY PROGRESS REPORT

1 SEPTEMBER 1965 THRU 30 NOVEMBER 1965

Prepared for

AIR FORCE TECHNICAL APPLICATIONS CENTER

Washington, D. C.

10 December 1965

By

EARTH SCIENCES DIVISION

TELEDYNE, INC.

Under

Project VELA UNIFORM

Sponsored By

ADVANCED RESEARCH PROJECTS AGENCY

Nuclear Test Detection Office

ARPA Order No. 599

OPERATION AND MAINTENANCE OF LASA

QUARTERLY PROGRESS REPORT

1 SEPTEMBER 1965 THRU 30 NOVEMBER 1965

REPORT NO. 616-1265-2065

AFTAC Project No.:	VELA T/5071/ASD(32)
Project Title:	LASA
ARPA Order No.:	599
ARPA Program Code No.:	5810
Name of Contractor:	EARTH SCIENCES DIVISION TELEDYNE, INC.
Contract No.:	AF 33(657)-14104 S/A #3
Date of Contract:	1 June 1965
Amount of Contract:	$547,886
Contract Expiration Date:	31 May 1966
Project Manager:	Dean B. Rabenstine (406) 245-6332

P. O. Box 1964, Billings, Montana

AVAILABILITY

Qualified Users May Request Copies of This Document From:

Defense Documentation Center
Cameron Station
Alexandria, Virginia 22314

TABLE OF CONTENTS

INTRODUCTION

This is the second Quarterly Progress Report of the LASA Operations and Maintenance Contract, and covers the period of 1 September 1965 thru 30 November 1965.

The major areas of effort during this period were: (1) routine maintenance of the signal acquisition system; (2) initiation of analog recording and visual analysis at the LASA Data Center; and (3) engineering work on the standby power system.

1. DISCUSSION OF PROGRESS

1.1 Failure Statistics

The component failure statistics for the quarter ending 30 November 1965 can be found on Figures 1-3. Monthly maintenance was performed on twenty one subarrays during the month of November. Forty five field trips were made as a result of the diagnosis at the LASA Data Center maintenance monitor. Fifty four repairs and/or adjustments were made during these trips.

With the exception of the component failures listed in Figures 1-3, the field repairs consisted mainly of amplifier adjustments. As is evident, actual component failures during the quarter were minimal as compared to components requiring adjustment. This points out a weakness of the currently used failure stastic system which is geared to reflect only component failures. Records of all adjustments are kept on the equipment history cards, but are not reflected in the summary tables. It may be necessary to modify the statistic collection system in order to reflect these adjustments.

Since 1 November 1965 failure statistics have also been gathered in the LRSM punched card format. This is being done at the request of AFTAC and is on a trial basis. These statistics also reflect only component failures and not adjustments.

1.2 Analog Recording Section

1.2.1 Operating Procedures -

Procedures of operation have continued in the analog section essentially as outlined in the October 1965 Monthly Report. At the approval of AFTAC, however, analysis is now limited to the period of digital tape recording. This procedure, which commenced 1 December 1965, permits more time for quality control, routine maintenance, and more detailed analysis of events studied.

1.2.2 Additional Equipment -

1.2.2.1 Installation of the Lincoln Laboratory's 24 channel digital to analog converter and 20 channel develocorder was completed on 23 November 1965.

1.2.2.2 At the same time that the above equipment was being installed, a temporary attenuator panel was also installed, in order to permit some magnification control on both develocorders.

NOVEMBER MAINTENANCE STATISTICS

Failure data in the following tables was compiled from information obtained from the "Component Failure Sheets".

AMPLIFIER RA-5 FAILURE											
	LINE DRIVER STAGES					I. F. STAGES	FEED BACK BRIDGE	SIGNAL BRIDGE			
MONTH	Q-1	Q-2	Q-5	Q-10	Q-11	Q-2	T1	CR-1	CR-2	Y1	Y2
June	100	76	1	0	0	0	0	4	4	0	0
July	185	181	0	0	0	10	0	0	0	0	0
Aug.	150	150	0	3	3	21	0	0	0	0	0
Sept.	0	0	0	0	0	0	0	0	0	0	0
Oct.	6	6	0	2	2	4	1	1	1	2	2
Nov.	1	1	0	0	0	0	0	1	1	1	1
TOTAL	442	414	1	5	5	35	1	6	6	3	3

AMPLIFIER RA-5 FAILURE		
	BATTERY	SLIDER RESISTOR (ON AMP. PANEL)
MONTH	B-3	40K. OHM
June	1	8
July	0	15
Aug.	1	1
Sept.	0	2
Oct.	0	3
Nov.	0	5
TOTAL	2	34

Figure 1

WHV PROTECTOR BOARD FAILURE				
	SIGNAL CIRCUIT		POWER CIRCUIT	
MONTH	R1 and/or R2	CR-1 and/or CR-2	R-5	CR-3
June	82	1	75	2
July	181	20	165	0
Aug.	171	43	158	6
Sept.	2	6	2	2
Oct.	0	0	0	0
Nov.	0	6	0	1
TOTAL	436	76	400	11

Figure 2

SEISMOMETER HS-10-1 FAILURES								
MONTH	STICKING MASS	CENTER FREQ. OFF	OPEN DATA COIL	OPEN CAL. COIL	TOP SEAL LEAKAGE	SIGNAL DIST'D	CABLE DAMAGE	LO GAIN
June	1	1	0	0	0	2	0	0
July	0	0	0	0	0	0	0	0
Aug.	0	0	1 *	0	1**	0	0	0
Sept.	0	0	0	0	0	0	0	0
Oct.	0	0	0	0	1	0	1	1
Nov.	0	[illegible]	0	0	0	1	0	0
TOTAL	1	1	1	0	2	3	1	1

* Lost in well
** Original Texas Instrument installation

Figure 3

On 2 December 1965 magnification checks were made on the develocorders, and the galvanometers were adjusted to give equal calibration amplitude on all traces. The attenuation controls, recently installed, were adjusted to give a 250K gain on all data traces at the 10X magnification of the develocorder screen. This gain appears to be a reasonable value for the recording of 18 channels of data due to the high microseismic background noise which has been prevalent at the LASA array since recording was commenced. If the recorded data could be reduced to 11 channels per develocorder the gain could be increased considerably without detrimental effects.

1.2.2.3 5400 Timing System -

Due to the high sensitivity of the Geotech Model 15925 Time Encoder to power line noise, a Geotech Model 5400 Timing System was acquired GFE and installed. The crystal output of this unit is used to provide a controlled 60 cps driving signal to the Time Encoder. The entire timing system is operated from four heavy duty 12 volt wet cell batteries to permit complete independence from local power sources. This system, which has been in operation since 20 November 1965, seems to require considerable time to stabilize. However, as of the first week of December it has operated within acceptable tolerances.

1.2.2.4 Develocorder Overflow Sensors-

The develocorder overflow sensor unit mentioned in the October Monthly Report was expanded to the second develocorder and additional sensors were installed under the floor in the analog area. This modification has proven quite worthwhile as it has prevented numerous overflows of the film wash water and waste chemicals.

1.2.2.5 Water Softener -

Photographic chemicals, especially the developer, when prepared with tap water produced a solid precipitate of fine particles. The concentration became such that it, on two occasions, clogged the line from reservoir tank to the process unit, with a resultant loss of record. Tests were made which indicated that soft water from commercial "softeners" eliminated the problem. On 3 December 1965 a water softening unit was installed on a rental basis to provide treated water for both the mixing of chemicals and the washing of film.

1.2.2.6 Water Filter System -

After the float valve on the develocorder water reservoir clogged numerous times due to solid particles in the water system, a cellulose type filter was placed in the main water line in the operations area. The filter apparently has eliminated this source of trouble.

1.2.3 Epicenter Determinations -

Epicenter locations were originally made graphically with a map of the LASA array having a scale of 1" = 4 miles. This proved to be a rather time consuming process. In November, Lincoln Laboratory prepared for the LASA Data Center a set of tables utilizing various tripartite combinations of subarrays. From the various arrival times of a signal at three subarrays the tables provide epicentral distance in degrees, station to epicenter azimuth, longitude and latitude, apparent velocity and theoretical P-O travel time in seconds. The tables have proved to be a valuable aid in time saved; however, experience has indicated that locations should be made with at least two tripartite combinations for verification. Locations are still made graphically when the tables are not applicable.

1.2.4 Analog Tape Recording Level -

When analog tape recording was commenced at the LASA Data Center the recording oscillators were set at 6 volts peak-to-peak to provide 40% ± modulation. On 5 November 1965 this was adjusted to 8 volts peak-to-peak to insure the recording of the calibration signal without distortion.

1.2.5 Digital Tape Recording -

As of 1 December 1965 the digital recording section commenced operation on a three shift basis. The 0800 to 1700 MST (1500 Z to 2400 Z) period, Monday through Friday, is devoted to system maintenance and tape duplication. On-line recording is performed between the hours of 1700 and 0700 MST (0000 Z to 1400 Z) Wednesday through Sunday.

During the period from 10 November to 8 December 1965 digital tapes for the SDL were requested for approximately thirty events. This is an approximate average of two events per day.

1.3 <u>Engineering Staff Activities</u>

1.3.1 Standby Power System -

Standby power system problems and their

solutions were discussed in the Monthly Report for September 1965. To summarize:

1.3.1.1 Battery Charger Ripple -

A 6 to 8 volt (peak-to-peak) charger ripple is decreased to 0.4 volts by adding a 5 mhy choke coil in series with a 0.3 mhy choke in the output curcuit.

1.3.1.2 DC to AC Inverter -

1.3.1.2.1 Tripping of the inverter's circuit breaker, by turning on the charger, is eliminated by increasing the voltage rating of a zener diode in a surge-protection circuit from 33 to 36 volts.

1.3.1.2.2 The inverter's output voltage fluctuated by 10% when the battery voltage was less than 27. Increasing the inverter's input filter capacitance from 15,000 to 36,000 mfd reduced the initiating battery voltage to 25.8.

1.3.1.2.3 It was proposed to insert a 8 mhy choke between the battery and the seismic amplifiers, to further reduce ripple in the amplifier power.

1.3.2 Subsequent Engineering -

1.3.2.1 Battery Charger -

Adding the 5 mhy choke caused a small fluctuation at about 3 cps in the charger output current and voltage when the current was high. It was large enough to be objectionable in the second charger test. The output was stabilized by increasing a capacitance in the current-limiting circuit from 1,000 mfd to 15,000 mfd.

Current and voltage test and adjustment procedures have been established.

1.3.2.2 Inverter -

1.3.2.2.1 It was learned that the output fluctuation was more directly associated with output than with batter voltage. A control circuit inserts a dropping resistor into the output voltage when the battery voltage exceeds a present value. An additional, adjustable, 3 or 4 ohm resistor added to the original 2 ohm fixed resistor allows operating on a high-voltage tap of the output transformer, with the contemplated fixed load. The resistance is adjusted to give an output near 140 volts with the charger voltage at equalize level and 130 volts at float level. Any change in load would require readjustment. In normal operation, the resistance limits the output voltage. During a power failure, the resistance is shorted before the output drops to the point where it begins to fluctuate. The output increases about 10 volts, and does not drop to the fluctuation level until the battery voltage becomes very low. Adjustment procedures are being tested.

1.3.2.2.2 The inverter has a protection circuit designed to trip its circuit breaker if the output load becomes excessive or if the battery voltage becomes very low. If it should trip during a prolonged power failure, the subarray would be inoperative until someone could reset it manually. If it did not trip, the battery could be completely drained, requiring an excessive charging time. To prevent these possibilities, a cut-out relay has been added to turn the inverter off when the battery voltage drops below 22. After the charger comes on, the relay closes at a voltage around 27. The photographs of the installations are in Figure 4. Adjustment procedures are being tested.

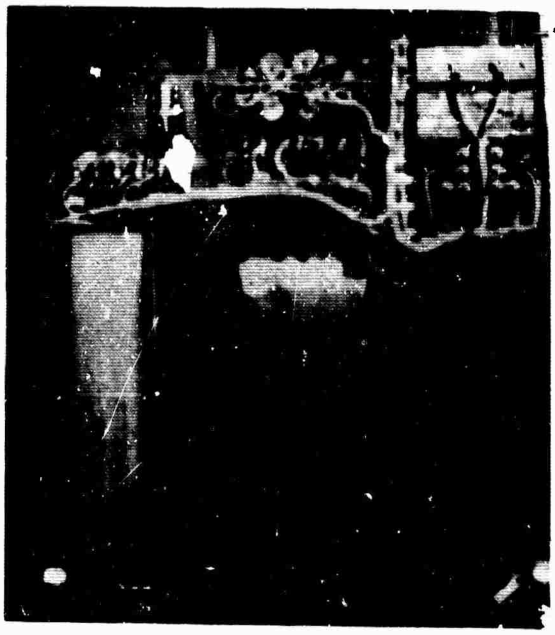
1.3.2.3 Amplifier Power -

Installation of the 8 mhy choke in the power circuit was found to be impractical because of excessive voltage drop. In fact, the present voltage loss is too high for proper operation at low battery voltages. Therefore, a 130 ohm resistor in series with the power line to each subarray leg will be removed.

1.3.3 Performance Test at MIT -

MIT and Teledyne personnel ran six tests with the equipment loads simulated by resistive elements connected to the Sola constant-voltage transformers. The battery was fully charged and the inverter warmed up one hour before each test. The charger was then turned off and the battery allowed to run down. Readings of voltages and power were taken every 15 minutes until the inverter cut off.

In the first test, the inverter cut off after 9-1/4 hours while output fluctuation began after 8-1/4 hours. The time to fluctuation and to cut out decreased approximately two hours in subsequent tests (although the average battery voltage was higher). It is possible that the battery may require a very long time to fully recover from such a severe discharge. The battery was charged for four hours at the

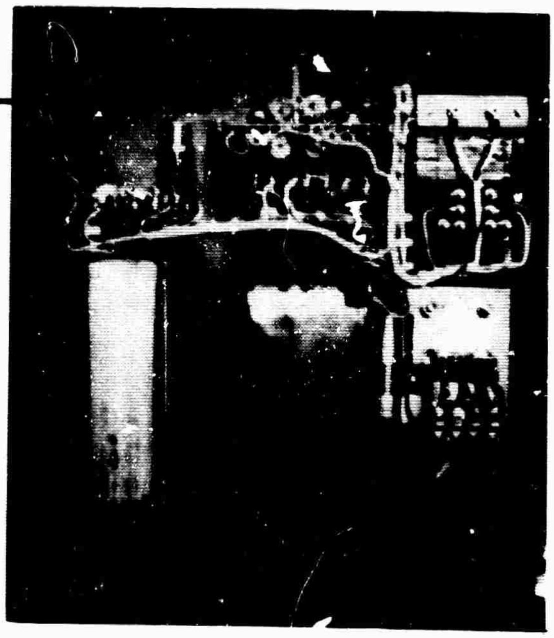


– INPUT surge-protection zener

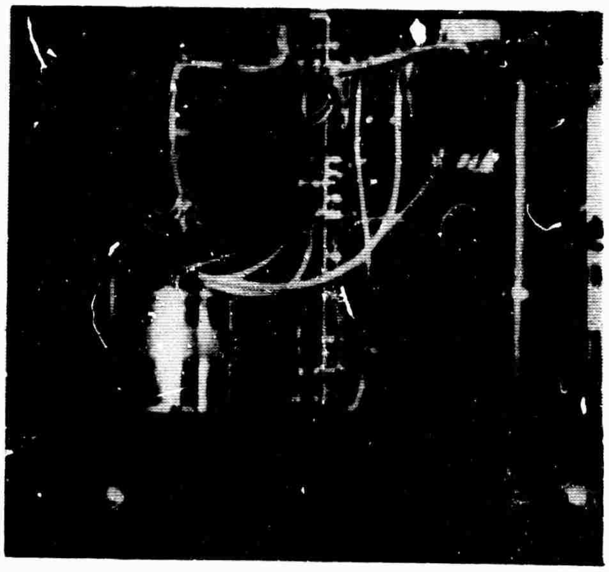
1. Before modification

REAR VIEWS

Output resistance control –



2. With low-battery-voltage protection circuit installed



- Resistance

FRONT VIEW

Showing increased input filter capacitance and output dropping resistance

- Capacitance

AC-DC INVERTER MODIFICATIONS

Figure 4

equalize voltage (31.4 volts) before the final test. No difference in operation was noted. A second battery, charger, and inverter are being prepared for another operating test.

1.3.4 Analog Recording System for LASA Data Center -

The equipment cabinets, the pin selector boards, and the chassis for the filter-amplifiers and the summing amplifiers have been received at the Maintenance Center in Miles City. The pin selector boards are in the process of being assembled and wired. The assembly and wiring of the filter-amplifier cards is nearly completed. Installation at the LASA Data Center is now scheduled for early January 1966.

1.3.5 Engineering Manual -

The accumulation of data and specifications for this manual are complete. Schematics for the various components are nearly finished and the text, with the exception of the latest battery charger and inverter modifications, is in rough form. Completion of the rough form text and editing will be accomplished early in December.

1.4 <u>Field Vehicles</u>

During this quarter, three new field vehicles have been received and outfitted, and have proven to be more efficient than the previous units. Maintenance costs have been reduced considerably because these are new vehicles.

A Bombardier snow vehicle has been requisitioned and delivery is expected during the first week in December. This vehicle will allow the maintenance crews to get to any site or borehole in most any adverse weather conditions. This snow vehicle will prove even more valuable in the spring when extremely muddy conditions are encountered, as it will be able to travel along prescribed access routes without damage to the landowners' fields. The repair costs to other field vehicles should be at a minimum, as they will not be required to travel when the snow vehicle can be used.

1.5 <u>Land Department Activities</u>

1.5.1 Mr. William J. Killen requested removal of WHV fences on his property (Subarray C4-6). The fences on this property are being removed and replaced with marker posts as on other properties in problem areas.

1.5.2 Compiled data and initiated an estimate report on future costs connected with renewal and re-permitting of all permits on the LASA project. Included are names and mailing addresses of LASA landowners and corrected land descriptions

1.5.3 Prior business commitments by the landowners have prevented scheduling the field trip for reinspection and evaluation of Angela Coop. State Grazing District lands located on Subarrays AO and B4. It is anticipated that this meeting will be held in the near future and no major problems with the landowners are prevalent at this time.

1.5.4 Coordinated with the contractor during repairs to cable trench washouts and access roads on several subarrays. These repairs are generally of a minor nature and are being accomplished jointly with the grading and contouring portion of the Long Period Vault installation on all subarrays.

1.5.5 Settled damage claims and obtained signed releases from the following landowners. (Damages due to installation phase of the LASA project.)

1. Mathers Brothers Ranch.
2. Jacob and Martha Hirsch.
3. Gladys I. Harvey.
4. Ed and Neva Vaughn.

1.5.6 Obtained renewals on all Texas Instruments Company's original permits that were assigned to Teledyne, Inc., on 29 June 1965. The renewals were required on all locations on Subarrays F3 and B1.

1.5.7 Currently negotiating settlement of damage claims with the following landowners. (Damages due to installation phase of the LASA project.)

1. Angela Coop. State Grazing District.
2. Herman and Ferdinand Ohlhauser.

1.5.8 Verified staking locations of Long Period Vault locations on all subarrays.

1.6 <u>Recording Trailer</u>

A recording van was transferred from Pasadena to

Miles City and reworked to operate on Subarray C3 during and after the "Long Shot" test. This trailer was operated on a 24 hour, 7 day per week basis until 24 November 1965. It was then shut down and is now on standby at the same location (C3). This work was done under the general direction of A. M. Rubenstine of IDA.

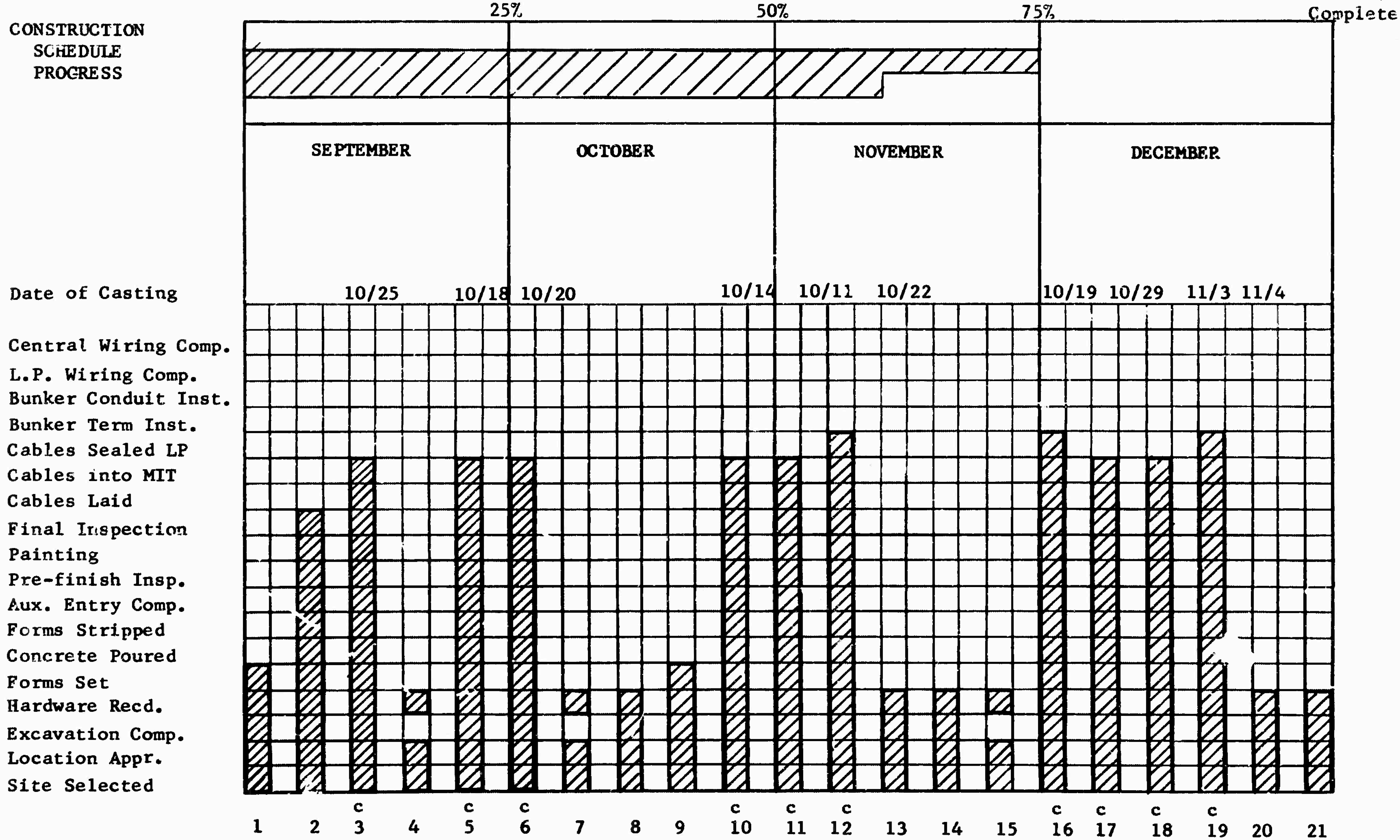
Signals were tapped out of the Subarray C3 SEM unit at the unfiltered access. The signal from the No. 10 sensor was filtered in a pass band around 12 cps, and the signals from the No. 71, No. 73, and No. 75 sensors were filtered in a pass band around 6 cps. All signals were recorded on both film and magnetic tape at three different levels each.

1.7 WHV Fences

All but twelve of the WHV fences have been removed and marker posts have been installed in areas where removal was requested. Future removal of WHV fences will have to be postponed until the ground thaws in the spring.

2. LONG PERIOD SEISMOMETER INSTALLATION

Figure 5 shows progress made as of 1 December 1965.



PROGRESS, LASA LP

Figure 5

3. SUMMARY OF CURRENT PROBLEMS

The following are existing problem areas under study or that have solutions under test or soon to be implemented:

3.1 Standby Power System

One unit has been tested and installed in the field. Another unit is under test, and if satisfactory without further modification, the regular schedule of installation will be implemented.

3.2 60 cps System Noise Pickup (before MIT low-pass filter)

This problem has been reduced somewhat by the battery charger modifications. Further testing has indicated an improvement is made by eliminating the 130 ohm resistor in the DC power line to the amplifiers, thus raising the voltage and allowing the zeners on the outside amplifiers to conduct.

3.3 Amplifier Gain Adjustments

The elimination of the 130 ohm resistor in the DC power lines to the amplifiers will require readjusting gains on some amplifiers. The gains will have to be readjusted in some instances to comply with closer tolerances requested by the LASA Data Center.

4. FUTURE PLANS

Tentative plans for work to be performed during the next quarter are as follows:

4.1 Continue installing weather stripping on CTH doors during monthly maintenance.

4.2 Continue study of 60 cps noise pickup and intermittent amplifier operations.

4.3 Implement in the field, standby power supply modifications and any other solutions that may be found to the above problems.

4.4 Locate and map the balance of the underground cables in the CTH areas. (Nine complete as of 1 December 1965.)

4.5 Operate recording van upon request.

4.6 Perform monthly maintenance operations.

4.7 Complete fabrication and installation of Analog Recording System for the LASA Data Center.

4.8 Remove 130 ohm resistors from CTH cards to increase voltage and insure more stable operation. (This will be modification #12, and is now complete on Sites B1 and D2.)

4.9 Upon completion of the installation of the filter system and selector pinboard panels in the analog section, consideration should be given to a systematic analysis of the microseismic noise level of the LASA array.

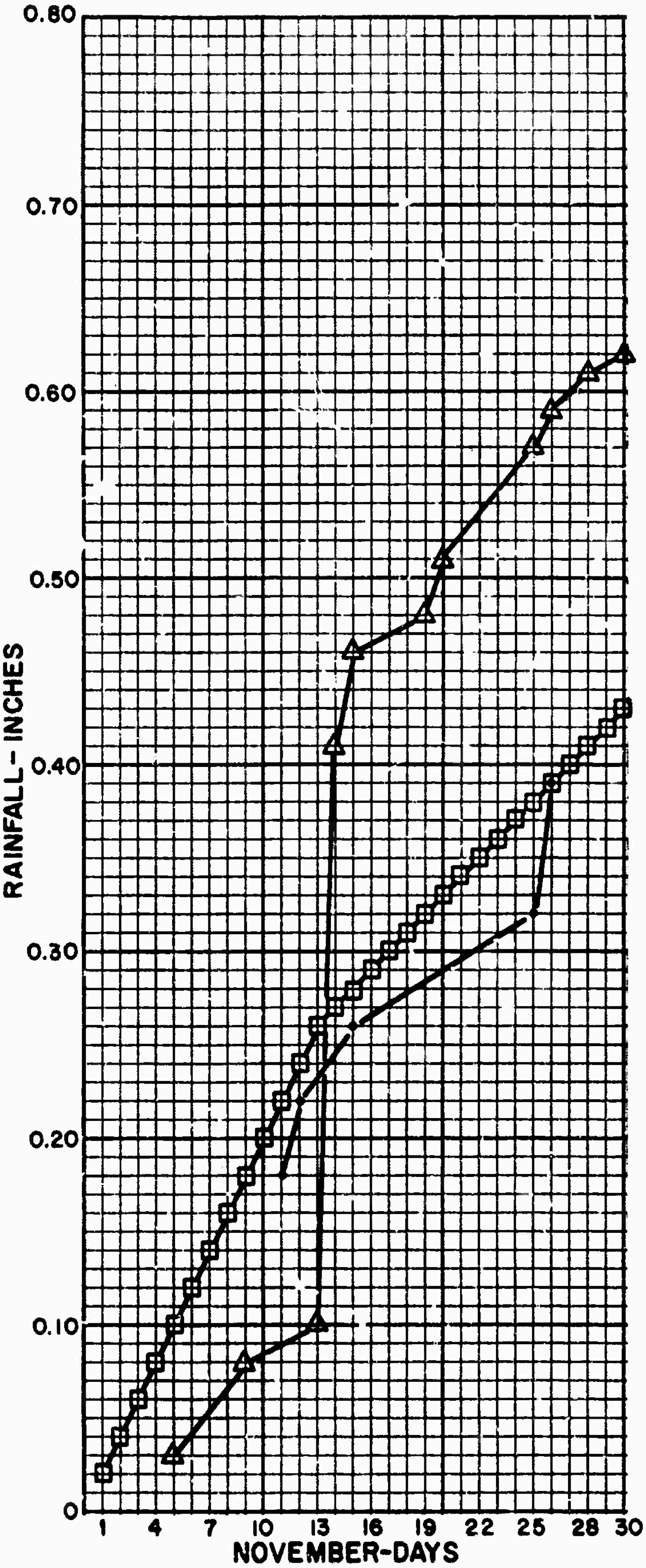
5. FINANCIAL STATUS

The financial status of the contract as of 30 November 1965 is as follows:

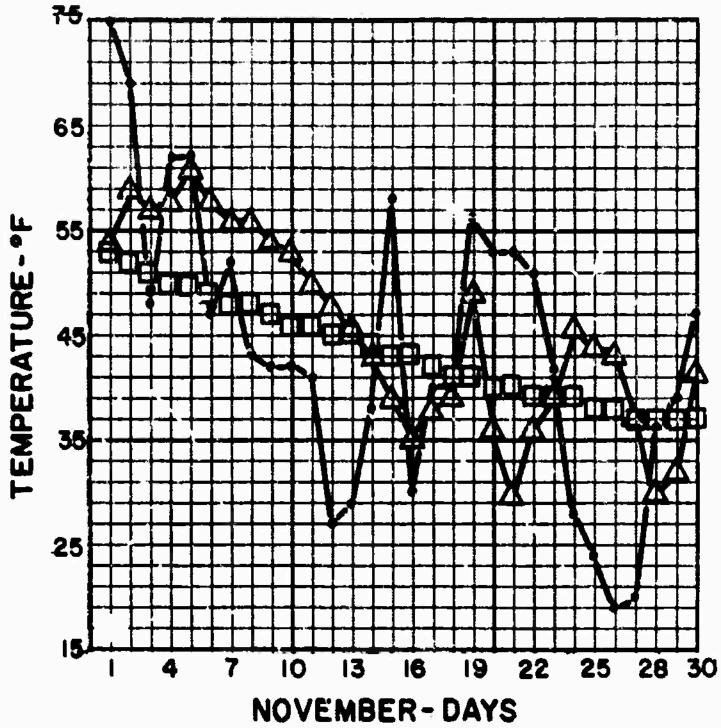
Total authorized cost excluding fee	$547,886
Actual cost expended and committed	269,409
Total unexpended cost	$278,477

The above cost figure includes the expenditure of labor in the amount of 105.9 man-months.

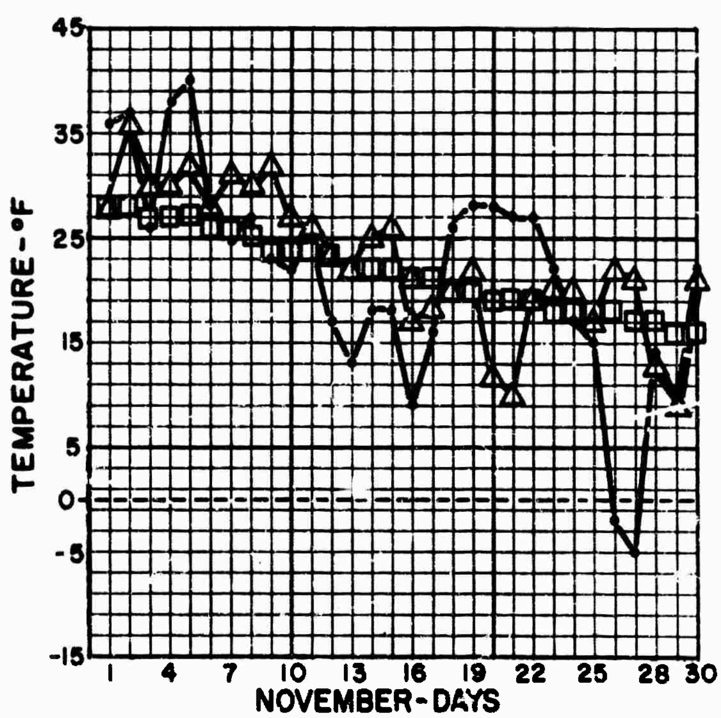
There is no reason to expect at this time that there will be an overrun of the authorized cost in completion of the tasks currently assigned.



CUMULATIVE RAINFALL



DAILY HIGH TEMPERATURE



DAILY LOW TEMPERATURE

LEGEND

- • DAILY - NOVEMBER, '65
- △ 3 YR. AVG. '62, '63, '64.
- □ 30 YR. AVG. '30-'60.

LASA WEATHER STATISTICS (NOVEMBER)

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)	2a. REPORT SECURITY CLASSIFICATION
Earth Sciences Division Tel dyne, Inc. Bil ngs, Montana	Unclassified
	2b. GROUP

3. REPORT TITLE

LASA

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Quarterly Progress Report, 1 September 1965 thru 30 November 1965.

5. AUTHOR(S) (Last name, first name, initial)
Rabenstine, Dean B.
Associate Manager
LASA Data Center

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
10 December 1965	22	0

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
AF 33(657)-14104 S/A #3	616-1265-2065
b. PROJECT NO. VELA T/5071/ASD(32)	
c. ARPA Order No. 599	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d. ARPA Program Code No. 5810	

10. AVAILABILITY/LIMITATION NOTICES
Qualified users may request copies of this document from DDC.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Adva ce Research Projects Agency Nuclear Test Detection Office Washington, D. C.

13. ABSTRACT This is the second Quarterly Progress Report of the LASA Operations and Maintenance Contract, and covers the period of 1 September 1965 thru 30 November 1965.

The major areas of effort during this period were: (1) routine maintenance of the signal acquisition system; (2) initiation of analog recording and visual analysis at the LASA Data Center; and (3) engineering work on the standby power system.

DD FORM 1 JAN 64 1473

Unclassified
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Seismology						
LASA						
Arrays						
System Maintenance						

INSTRUCTIONS

1. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization *(corporate author)* issuing the report.

2*a*. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2*b*. GROUP: Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.

7*a*. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7*b*. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8*a*. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8*b*, 8*c*, & 8*d*. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9*a*. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9*b*. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers *(either by the originator or by the sponsor)*, also enter this number(s).

10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

(1) "Qualified requesters may obtain copies of this report from DDC."

(2) "Foreign announcement and dissemination of this report by DDC is not authorized."

(3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through
____ ."

(4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through
____ ."

(5) "All distribution of this report is controlled. Qualified DDC users shall request through
____ ."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring *(paying for)* the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as *(TS)*, *(S)*, *(C)*, or *(U)*.

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.