

LOM 30, 1971  
 Royal Norwegian Council for  
 Scientific and Industrial Research  
 May 15, 1971  
 PROGRESS REPORT  
 NORSAR Phase 3  
 1st QUARTER 1971  
 LOM 30, 1971  
 Robert Major, USAF



**NORWEGIAN SEISMIC ARRAY**

**NORSAR**

P. O. Box 51. 2007 Kjeller - Norway

NTNF/NORSAR  
P.O.Box 51  
2007 Kjeller  
Norway

NORSAR Report No. 13  
Budget Bureau No. 22-R0293

PROGRESS REPORT  
NORSAR Phase 3  
1st QUARTER 1971

Status per 31 March 1971

The NORSAR project has been sponsored by the United States of America under the overall direction of the Advanced Research Projects Agency and the Technical Management of the Electronic Systems Division, Air Force Systems Command.

ARPA Order No. 800

Program Code No. 1F10

Name of Contractor : Royal Norwegian Council for  
Scientific and Industrial Research

Date of Contract : May 15, 1970

Amount of Contract : \$ 1.300.883,-

Contract No. : F19628-70-C-0283

Contract Termination Date : June 30, 1972

Project Supervisor : Robert Major, NTNF

Project Manager : Per Tveitane (temporary)

Title of Contract : Norwegian Seismic Array (NORSAR)  
Phase 3

FOREWORD

This report covers the period 1 Jan - 31 March 1971. The period is characterized by the finishing of equipment installations, and consequent starting-up of the complete system. IBM still has major work in progress with the system, but, following operational completion, scheduled operation is performed by the regular NORSAR staff.



## INTRODUCTION

At the beginning of the report period, all equipment, including SLEMs had been installed. There remained, however, installation of some parts in 4 SLEMs, testing and acceptance of these SLEMs. 20 SLEMs were previously accepted.

Equipment and system tests were carried on, and improvements to both soft- and hardware continued.

The system was considered operationally completed by the end of February, as reflected by the system Acceptance-Tests 22 - 26 Feb.

No major problems were encountered in the period.

## 2 ADMINISTRATION AND SUPPORT

2.1 After finishing the indoor installation in the 2 new Moelven huts (NTNF financed), which were added to the existing chain in December, the office facilities are adequate. A canteen building erected by KCIN in the fall, was rented by the project and used as temporary office, mainly for IBM.

2.2 Government furnished property registration continues according to regulations laid down by DET 16 AFCMC (AFLC). Regular visits are in this connection made to subarrays.

## 3 CONTRACTS

3.1 The contract for rent and maintenance of communication lines and associated equipment is still being negotiated. This contract must be seen in connection with the NDRE/NTA Phase 2 contract. This contract has been audited, and some discussions are going on regarding certain points (e.g. length of cables), which have relevance to the new contract. A fixed price contract is eventually expected.

- 3.2 Non-standard IBM-delivered equipment (SPS, EOC, etc) is being maintained by IBM-Norway according to a special agreement ("Service by call, time and material" basis).
- 3.3 The support contract between KCIN and NORSAR for rent of housing and other services, is held up pending an agreement on certain unit prices. The Audit Office has been consulted on the subject. A fixed price contract is expected.
- 3.4 The field maintenance contract between NORATOM-NORCONTROL A/S and NORSAR is not signed, pending consent of Contracting Officer.

#### 4 PERSONNEL

- 4.1 The Project Manager left the project 15 January. The Operation Manager is temporarily acting as Project Manager. There is still a vacancy for a mathematician/physicist; a suitable candidate has proved hard to find. All other positions have been filled in the period.
- 4.2 Visitors:

Dr. S. Eklund, Director, International Atomic Energy Agency, Vienna, paid a brief visit to NORSAR 17 March. He was accompanied by Mr. Eriksen, Director of the Atomic Research Institute at Kjeller.

Seismologists Hjortenbergs, Denmark, and Pirhonen, Finland, worked at NDPC parts of the period.

IBM had 15 persons at NDPC the full period, plus 3 persons part of the period.

5            INSTALLATION, OPERATION AND MAINTENANCE

5.1        SLEM Integration

By the end of 1970, 20 of the 24 SLEMs had been officially accepted. The remaining 4 were not accepted due to faulty components. At the arrival from USA of new (repaired) A/D converters, tests were made, minor problems in one SLEM solved, and all 4 remaining SLEMs accepted during January.

5.2        NDPC Activities

Following the completion of installations, the NDPC activities were oriented towards normal operation of the system. Personnel took up work with their assigned fields, such as DP, EP, AM & C, Event Summary work, etc. To a very large extent, the time was spent debugging and improving procedures and performance. With this work going on parallel to IBM's divers activities, limited machine time was available, and strict priority rules had to be established.

5.3        ISRSPS System Acceptance

Acceptance tests for the Integrated Seismic Research Signal Processing System were performed during the week of February 22 - 26. For details concerning these tests, see IBM FSD REF 112.

5.4        Special studies

Following the installation of the environmental chamber at the Maintenance Center, seismometer frequency/temperature studies continued on a more regular base. A report of the investigations will be issued by the subcontractor for field maintenance.

Certain improvements to electronic equipment have been suggested, and partly tested and carried out:

- a. An equalizing network for the SP seismometer natural frequency was installed and tested at subarray 05C, channels 01 and 02. The results appear to be very good; compensated natural frequency output being very close to nominal value. However, the network is comparatively expensive to install, and also involves considerable program changes.
- b. A noise filter for the CTV battery monitor is installed.
- c. Tests have been carried out with an LPV pressure monitoring circuit. This was initiated by pressure fluctuations in the vault due to insufficiently closed lid.
- d. A modification to the line B-loop circuitry has been carried out, enabling NDPC personnel to distinguish between faulty input to the CTV modem (NORSAR responsibility) and faults in modem or line (NTA responsibility).
- e. Improvements of the control of the NDPC TOD is accomplished.
- f. A mechanical noise suppression device (glass insulation) has been installed at some SP sites where the noise from high tension power lines in the area was excessive.
- g. A simple modification to the telephone system has been carried out at some CTVs, to prevent coupling between WHV lines and the NTA network, due to high tension power lines in the area.



6 DATA COMMUNICATION LINES

Data lines are in general of sufficient quality to ensure good performance. However, error bursts, probably due to switching in the NTA network, and breaks in transmission occur. In the case of the error bursts and short breaks (up to a few seconds) the reasons are very difficult to find. Breaks (sometimes announced) may involve 8, 12, or all subarrays, due to the grouping of lines in carrier systems (2 groups containing 8 and 12 lines each, 2 subarrays having direct lines to Lillestrøm near the NDPC).

7 FIELD MAINTENANCE AND MAINTENANCE CENTER ACTIVITIES

After completion of installation in the beginning of the period, great efforts were put into adjusting the field work to the AM&C. It soon became clear that the present arrangement of subcontracting the field maintenance was impractical and cumbersome. This led to some discussions about a reorganization of the activity after the expiration of the present subcontract.

The Maintenance Center at Kjeller has been completed, including reassembly of the 3 Moelven huts brought in from subarrays. In this house the environmental chamber is installed.

In the basement of the MC building, a "silent" working table is installed in the seismometer test room. The table has proved valuable for LP seismometer work.

With recent supplements of instruments and tools, the supplies are considered sufficient.

8

## RESEARCH AND DEVELOPMENT

The research group is involved in the daily operation of the NORSAR array and participates especially in system development, processing parameters updating, Event Processor output analysis and debugging. These tasks were given top priority in the reporting period, as NORSAR became fully operational in March. The completion of the array software system although not perfect yet, is considered the most important occasion in the NORSAR project since 1968. When more experience is gained in proper operation of the system, system evaluation and research will, of course, be emphasized.

Analysis of long period data represent an essential part of the research activity at NDPC. This work got a flying start as a very comprehensive software package for analysis of the above type of seismic waves, developed by Texas Instrument (TI), was transferred to NORSAR in March. Moreover, E. Husebye and F. Ringdal spent four weeks, Feb 24 - Mar 23, at SAAC, Alexandria, USA, receiving training in formal usage of the above analysis package. Work has started on implementing this software in the NORSAR off-line processing system.

From geological surveys it is obvious that the crustal structure in the NORSAR area is rather complex, and this hypothesis is confirmed by analysis of seismic waves recorded by the array. P-signals from individual events show unpredictable variations from one subarray to another. This is reflected in the positions of minima in the amplitude spectra, and may be interpreted in terms of interferences of multiple arrivals which have partly been generated by anomalous geological structures in the siting area.

Corresponding results are obtained by time domain analysis, as relatively large but consistent travel time anomalies and error location vectors are observed. We also have some indications of signal variations occurring within a subarray, although in this case data available for analysis have been scarce.

So far our analysis have been restricted to interim NORSAR data, that is events recorded by one single sensor in each of 18 subarrays. The results obtained so far will be summarized in a special report. However, the above type of analysis will be extended and also comprise signals recorded by the complete array. Special attention will be given to spectral analysis for performance evaluation on the array and subarray level. This kind of data will also be used for discrimination research purposes.

H. Bungum, E. Husebye and F. Ringdal participated in a seismic array seminar arranged in Karlsruhe Jan 24 - 26, 1971.

9

EXPENDITURES IN THE PERIOD 1 JAN - 31 MAR 1971

1. Operation and Maintenance			
1.1 Data Processing Center	\$	60.725	
1.2 Field Installations	\$	57.160	
1.3 Data Communications	\$	295	\$ 118.180
2. Research & Development			\$ 12.725
3. Administration & Support			<u>\$ 17.940</u>
		Total Approx.	\$ 148.845 =====

## LIST OF ACRONYMS

in order of appearance.

- NTNF - Norges Teknisk-Naturvitenskapelige Forskningsråd (Royal Norwegian Council for Scientific and Industrial Research).
- NORSAR - Norwegian Seismic Array
- ARPA - Advanced Research Projects Agency
- IBM - International Business Machines
- SLEM - Short and Long Period Electronic Module
- KCIN - Kjeller Computer Installation
- DET 16 AFCMC (AFLC) - Detachment 16 Air Force Contract Maintenance Center (Air Force Logistic Command)
- NDRE - Norwegian Defense Research Establishment
- NTA - Norwegian Telegraph Administration
- SPS - Special Processing System
- EOS - Experimental Operations Console
- NDPC - NORSAR Data Processing Center
- A/D - Analog to Digital
- DP - Detection Process(or)
- EP - Event Process(or)
- AM&C - Array Monitoring and Control
- IBM FSD - IBM Federal Systems Division
- SP - Short Period
- CTV - Central Terminal Vault
- TOD - Time of Day
- WHV - Well Head Vault
- LP - Long Period