

31 December 1970 no. 10

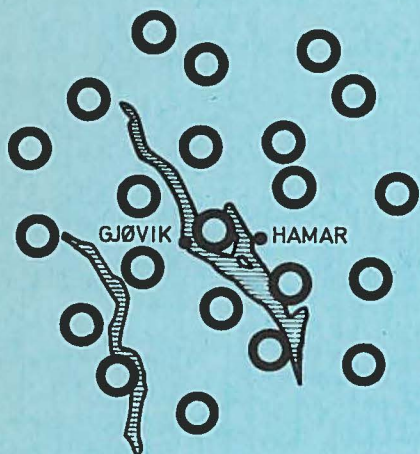
Royal Norwegian Council for Scientific and Industrial Research

Royal Norwegian Council for Scientific and Industrial Research  
May 15, 1970  
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P. 19628-70-C-0281

10

PROGRESS REPORT  
NORSAR Phase 3  
4th QUARTER 1970

Director WNTF  
Eivind Austr, WNTF



OSLO ●  
● DATA CENTER

NORWEGIAN SEISMIC ARRAY

# NORSAR

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NORSAR Report No. 10

10

PROGRESS REPORT  
NORSAR Phase 3  
4th QUARTER 1970

Status per 31 december 1970

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.

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. : F 19628-70-C-0283

Contract Termination Date : June 30, 1972

Project Supervisor : Robert Major, Director NTNF

Project Manager : Eivind Sætre, NTNF

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

FOREWORD

This report covers the period 1 Oct to 31 Dec 1970. In the period, there is a close connection between Phase II and Phase III, with gradual transfer of activities to Phase III as Phase II is brought towards its finish. For this reason, some of the points in the report are associated also with Phase II. As it is impractical to draw clear lines between the two phases with respect to implementation, relevant points are included also in this report.

1. INTRODUCTION

Great efforts have been made this quarter in order to have the remaining thirteen SLEMs installed and tested.

Modification to all SLEMs have been accomplished, including modification and retesting of the nine previously installed.

Data communication lines between NORSAR DPC and the subarrays have all been tested and brought up to specifications.

Data modems at the DPC have been installed.

Activities in connection with establishing the NORSAR Maintenance Center have continued and the remaining tasks are expected accomplished in February 1971.

The contract for Phase 2 between Norwegian Defence Research Establishment (NDRE) and Electronic Systems Division (ESD) expired 1 November 1970.

Support of SLEM integration and check-out has been provided continuously by NDPC.

2. ADMINISTRATION AND SUPPORT

2.1 In order to meet the initial need for office facilities two Moelven huts have been added to the existing chain. The work related to this installation was accomplished in December. The two new huts are financed by NTNf.

2.2 CONTRACTS

2.2.1 Maintenance of data communication lines with associated equipment will be an NTA responsibility.

In this connection a contract is being prepared for period 1 November 1970 - 30 June 1971.

2.2.2 The Special Processing System (SPS) and the Experimental Operations Console (EOC) will be maintained by IBM/Norway. Minor problems have to be solved before a contract can be signed for period 1 January 71 - 30 June 71.

- 2.2.3 A support contract between KCIN and NORSAR covering the period 1 September 1970 - 30 June 71 is being negotiated. Certain differences of opinion exist with respect to interpretation of "Contract Clauses".
- 2.2.4 The contract between NORATOM-NORCONTROL A/S and NORSAR for field maintenance, period 1 July 70 - 30 June 71, has not been signed, pending consent of Contracting Officer.
- 2.3 In order to meet the requirement set forth in Armed Service Procurement Regulations (ASPR) Appendix C, the administration group has been engaged in activities related to registration of US Government owned property. This involves certain new procedures compared to the previously established ones.
- 2.4 PERSONNEL  
The personnel situation is unchanged since last report dated 31 October 1970. However, one programmer and two computer operators will be hired 1 January 71. A second programmer is engaged from 1 February 1971. This leaves two vacancies (consultant programmer and physicist) in the personnel plan.  
Dr. A.K. Ibrahim, NTNF scholarship, left by end of 1970, after working at NORSAR from September 1970.

3. OPERATION AND MAINTENANCE - GENERAL PROGRESS

3.1 SLEM INTEGRATION

Last progress report dated 31 October 1970 stated that nine SLEMs had been installed during the period. A combined modification and retesting effort for the nine SLEMs in the field and at the NDPC was undertaken.

All units were modified and retested, mainly due to "missing numbers". This work was completed at the end of October.

During November the remaining 13 SLEMs were installed in the subarray CTVs. An abbreviated test procedure had to be

implemented in order to accomplish all SLEM installations before winter conditions created access problems.

Twenty of the twenty-four SLEMs were accepted by the end of October.

The other four units had outstanding problems, e.g., faulty A/D converters.

These converters were sent back to USA for repair, and will be installed early January 1971.

Activities mentioned above were covered by IBM, Philco/Ford, Noratom-Norcontrol A/S and A/S Norconsult (Teleplan A/S). The two representatives from Philco-Ford returned to USA 22 October 1970.

### 3.2 NDPC ACTIVITIES

3.2.1 All Twenty-two data modems interfacing the SPS and the subarray modems have been installed.

3.2.2 Support of SLEM integration and check-out has been provided continuously by NDPC. Some contention for computer time has been experienced since program development by IBM demands much computer time. Physicist O. Steinert has been oriented towards assuming the tasks of array maintenance and control.

### 3.3 SPECIAL STUDIES

3.3.1 Studies are being carried out on SP seismometer frequency temperature problem.

3.3.2 Some investigations have been made of possible improvement of the system, e.g., SP natural frequency compensation, certain monitor functions, etc.

Investigations are continuing on small scale.

## 4. DATA COMMUNICATION LINES

All data lines between NDPC and the subarray CTVs have been tested by the Norwegian Telegraph Administration (NTA) and brought up to specifications.

A report dealing with these activities will be submitted to NORSAR by NTA.

5. NORSAR MAINTENANCE CENTER ACTIVITIES

Reference is made to last Progress Report item 3.3, 3.4, and 3.5 dated 31 October 1970.

5.1 The Moelven huts have been moved from the subarrays and reassembling is going on. The task related to these activities will be accomplished medio February 1971.

5.2 INSTALLATION AT THE MAINTENANCE CENTER (MC)

5.2.1 Installation of "Silent" working table and a special seismometer test room is under way.

5.2.2 Installation of facilities for chemical cleaning of parts is accomplished.

5.2.3 Installation of temperature and humidity chamber is expected to be ready during February 1971.

5.3 Purchase order for test instruments and tools is placed.

5.4 Establishment of a data communication line between NDPC and NORSAR MC is accomplished.

5.5 A data modem and the two spare SLEMs have been installed.

6. MISCELLANEOUS

6.1 Per 31 December 18 IBM employees are engaged at NORSAR DPC.

6.2 Dr. Hjortenbergt, Geodætisk Institutt, København, visited NORSAR for 2 weeks in November 1970.

7. RESEARCH AND DEVELOPMENT

7.1 NORSAR OFF-LINE DATA PROCESSING

The research group will have the responsibility for operating the routine data analysis or Event Processor (EP). We have studied the relevant software documentation, and also participated in IBM's debugging and test runs of the EP



package. We do not foresee any severe problems in the SP analysis after the IBM NORSAR contract expires.

#### 7.2 ERRORS IN ARRIVAL TIME MEASUREMENTS

The relative subarray arrival times are measured through a cross-correlation iteration technique. The method is parameterized, and henceforth the precision of the final steering delays depends on specified signal length, window positioning, bandpass filter and SNR. We have investigated this problem, and the results obtained are presented in NORSAR Technical Report No. 3.

#### 7.3 VERTICAL AND LATERAL INHOMOGENEITIES IN THE EARTH

Travel time derivatives represent a powerful tool in investigating problems of the above types. In our case, we have used bulletin data from the Fennoscandinavian network for direct DT/DA measurements, and the final results in terms of vertical and lateral discontinuities in the mantle, are presented in NORSAR Technical Report No. 6.

#### 7.3 OPTIMIZING THE ON-LINE DETECTION ALGORITHM

The parameterized detection algorithm declares an event when:

$$\frac{STA(T)}{LTA(T)} \geq THR$$

for  $Q$  out of  $Q'$  successive values of  $T$ .  $STA$  is the short term linear power estimate,  $LTA$  is the long term linear power estimate, and  $THR$  is the specified threshold value. The problems at hand are to increase the number of detections while the false alarm rate remains constant. Preliminary results indicate that proper values for the parameters  $STA$  window length  $T$ ,  $Q$  and  $Q'$  are (12,1,1), but the values (18,2,2) and (24,3,3) could also be acceptable. This is under the assumption of a 6 dsec  $STA$  sampling interval, and a 1.0-3.4 Hz bandpass prefiltering.

#### 7.4 DETECTION PROCESSOR FILTERING PROBLEMS

Substantial signal enhancement at NORSAR is obtained by recursive bandpass filtering. However, the choice of filter is somewhat problematic due to regional and time varying

background noise. Some of our results here can be summarized as follows:

- SNR at NORSAR is generally speaking at high frequencies as compared to LASA.
- The SNR is primarily dependent upon the lower half power point of the filter, i.e. where it cuts off the low frequent noise.

This means that the choice of bandpass filter is critical for effective noise suppression. This problem may possibly be circumvented by introducing a sloping filter which is inverse to the noise, i.e. with a falloff of about 12 dB/oct. This has been suggested by IBM/SAAC, and their results initiated a further investigation on our part. Our preliminary results indicate that the best choice is a combination of a sloping and a bandpass filter, since the 12 dB/oct prefiltering tends to give a large acceptable area in filter space for each event.

#### 7.5 SCIENTIFIC MEETINGS

Talks given by NORSAR staff members at seismological meetings in Stockholm (Aug 1970) and Luxembourg (Sept 1970) have been summarized in technical reports (see ref. list).

#### 7.6 REFERENCE LIST

NORSAR Report No. 3

Errors in Time Delay Measurements

H. Bungum and E.S. Husebye

NORSAR Report No. 4

The NORSAR Array and Preliminary Results of Data Analysis,

H. Bungum, E.S. Husebye and F. Ringdal

NORSAR Report No. 5

Vertical and Lateral Inhomogeneities in the Earth's Deep Mantle

E.S. Husebye, R. Kanestrøm and R. Rud

NORSAR Report No. 6

Observations of Vertical and Lateral P-Velocity  
Anomalies in the Earth's Mantle Using the Fennoscandinavian  
Continental Array

E.S. Husebye, R. Kanestrøm and R. Rud

NORSAR Report No. 7

The Norwegian Seismic Array

E.S. Husebye

NORSAR Report No. 8

Seismic Arrays and Data Handling Problems

E.S. Husebye and H. Bungum

8. EXPENDITURES IN THE PERIOD 1 OCTOBER - 31 DECEMBER 1970

1.	Operation and Maintenance		
	1.1 Data Processing Center	\$ 93.371	
	1.2 Field Installations	\$ 49.428	
	1.3 Data Communication	\$ 630	\$ 143.429
2.	Research and Development		\$ 8.604
3.	Administration and Support		<u>\$ 19.661</u>
		Total approx.	<u><u>\$ 171.694</u></u>