Royal Norwegian Council for Scientific and Industrial Research

TECHNICAL REPORT

Field Maintenance Report
1 July - 31 December 1970

1 October 1972

NORWEGIAN SEISMIC ARRAY

NORSAR

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FOREWORD

This report covers the NORSAR field activity for the period 1 July - 31 December 1970. Although scheduled as a Field Maintenance Report, it deals mainly with the delayed equipment installation and check-out. The report is prepared by the sub-contractor for field work, NORATOM-NORCONSULT A/S.

C O N T E N T S

NORSAR PHASE III - FIELD OPERATION AND MAINTENANCE 1 JULY TO 31 DECEMBER 1970.

ABSTRACT

This report covers the field operation and maintenance (FO & M) during the period 1 July to 31 December 1970, the first part of the phase III of NORSAR, and succeeds Technical Report "NORSAR Phase 2 - Field Operation and Maintenance, 1 June 1969 to 30 June 1970", later referred to as (1), and also Technical Report "NORSAR Phase 2 - Special Tasks", later referred to as (2), which actually fills in (1), and together with it completes the phase 2 O&M activities.

1. INTRODUCTION

Phase III of NORSAR was meant to be the operational phase of the completed system. The installation works,however, were not finished by the end of phase II and the FO&M tasks during the first part of phase III, covered in this report, were therefore mainly concentrated on installation and check-out works, as in the past period.
Reference is made to Technical Report "NORSAR Phase III - Operations 1 July to 31 December 1970", later referred to as (3), which gives more details of these installations.

1.1. FO&M Tasks.

The activities were mainly concentrated around the installations and check-out of the Seismic Short & Long period Electronics Modules (SLEM) and various tasks connected with these installations.
The SLEM which constitutes the central, coordinating part of each Subarray is installed in the DS rack in the Central Terminal Vault (CTV). For further details refer to (3).

Some theoretical training in operation and service of the SLEM was conducted for the FO&M staff and others at the end of phase II, and the first units were received and checked, and also one trial installation was carried out. For further details of these activities refer to (1).

The greater part of the SLEM integration into the system however, were conducted during and throughout the period reported herein.
Other tasks were installation and check-out of the LP systems at 04C and 11C, various repair work of previous installations, introduction of new site logs and continued temperature checks.
Figure 1.1 shows the geographical area of interest for this report.

2. SEISMIC SHORT & LONG PERIOD ELECTRONICS MODULES (SLEM) INTEGRATION INTO NORSAR

The introduction of the advanced electronics system SLEM was probably the most challenging part of the NORSAR so far from the FO&M point of view.
ESD Detachment 9, Oslo Field Office, submitted a well prepared plan for the SLEM integration, a task which involved the coordinated efforts of several American and Norwegian organizations (Revised issue dated 20 May 1970).
Various kinds of difficulties, mainly design problems within the SLEM, caused interruptions, however, and delayed the plan somewhat. The overall responsibility for the co-ordination of the plan lay with the NORSAR Operations Manager, and further details of the progress will be found in (3).
The Philco-Ford Corporation, Western Development Lab. (Philco) which manufactured the SLEM, carried the full responsibility for the handling and testing of the units, until they were installed in the field, tested out and accepted. They were also responsible for training of the NORATOM FO&M staff to such an extent that they would be able to take over responsibility of adjustment, testing and servicing of the SLEM

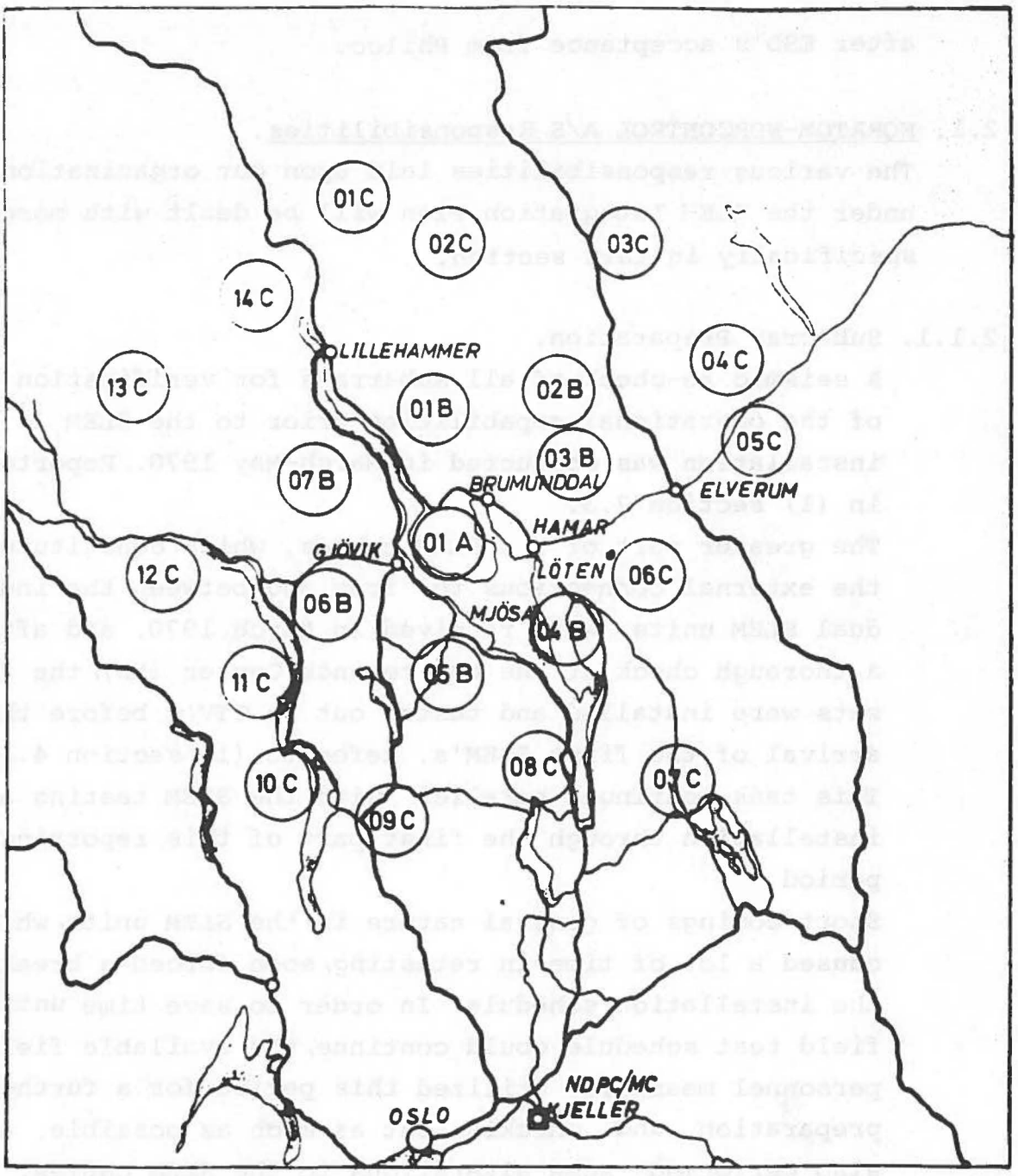

Figure 1.1 Geographical area of interest for the FO&M group

after ESD's acceptance from Philco.

2.1. NORATOM-NORCONTROL A/S Responsibilities.

The various responsibilities laid upon our organization under the SLEM Integration Plan will be dealt with more specifically in this section.

2.1.1. Subarray Preparation.

A seismic re-check of all subarrays for verification of the operational capabilities prior to the SLEM installation was conducted in March-May 1970. Reported in (1) section 2.3.

The greater part of the SLEM cables, which constitute all the external connections to, from and between the individual SLEM units, were received in March 1970, and after a thorough check at the Maintenance Center (MC), the first sets were installed and tested out in CTV's before the arrival of the first SLEM's. Refer to (1) section 4.3. This task continued parallel with the SLEM testing and installation through the first part of this reporting period.

Short-comings of general nature in the SLEM units, which caused a lot of time in retesting, soon forced a break in the installation schedule. In order to save time until the field test schedule could continue, the available field personnel meanwhile utilized this period for a further preparation and checking out as much as possible, and also performed some alterations to the SLEM cables. (Memo from Mr. Bostic, IBM, to the Operations Manager P. Tveitane, dated August 18, 1970). All of the CTV's were visited during the period 10 August to 24 September.

2.1.2. Instrumentation for Pre-field and Field Tests.

We already possessed most of the test instruments needed for the Pre-field as well as the Field test groups. The necessary equipment was checked and calibrated.

Two power supplies and a memory oscilloscope for use with the Test bed at NDPC were purchased (Later transferred to the MC), and in addition another memory oscilloscope for field use was rented.
As part of the Test bed installation at NDPC, Refer to (3), two special test panels, one for each test rack, were made after direction of IBM. The test panel is shown in fig. 2.1.

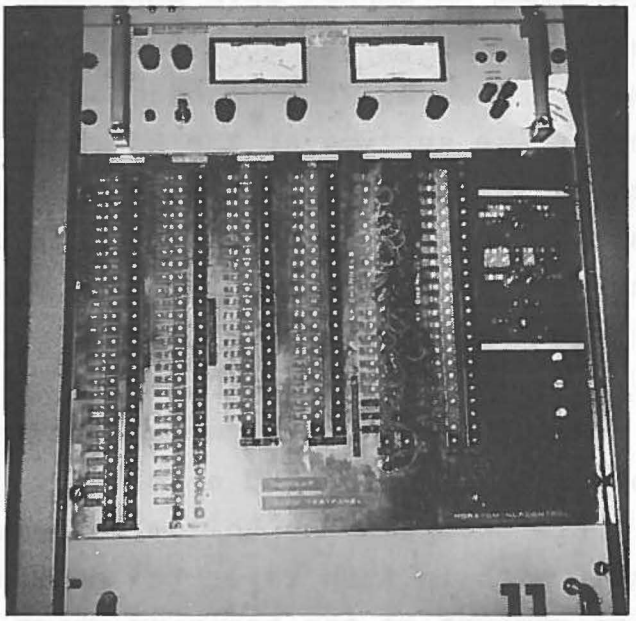

Figure 2.1 SLEM Test panel for test bed use.

2.1.3. Unpacking and Inspection of the SLEM's.
The first 4 SLEM's arrived Kjeller 9 June. 2 of them were unpacked, visually inspected and installed at the NDPC Test bed the same day. No damage was detected. 4 more were received in June, and the rest of them in shipments of 4 during July, August and September. The visual inspections showed no serious damage to any of the units.

2.1.4. Pre-field Test at NDPC.

To further assure that no SLEM was damaged in transit, to establish a level of confidence in performance and to make initial adjustments, each SLEM was tested and adjusted at the NDPC before it was transported into field and installed at a subarray.

Our participation in this part of the SLEM Integration program was to assist Philco in setup and testing of the SLEM, and thereby receive necessary training to be able to carry out the testing and service ourselves later on. The FO&M personnel were work scheduled on a turnus basis, so as to get some training for all of them. However, the technicians later to be responsible for the service at the MC were given more training here than the others, who in turn received further training during the Field tests. Two to three of our technicians participated in these Pre-field Tests at a time.

As already mentioned the SLEM's were infested with some design faults which caused a lot of retesting and delays. This occupied the Philco representatives a great deal, which in turn reflected on the training. Further, with regards to the training which was an important part of this phase of the SLEM Integration, it should be noticed that the working conditions for training were rather difficult. The heavy space requirement at NDPC at the time necessitated that the SLEM Test bed had to share a small room with other equipment like the Data Modems, the Plan D Data Collection and not least the Trans-Atlantic Link (TAL) terminal with its telephone unit, and on top of this the traffic to and from the computer room passed mostly through this same room. With several people working and communicating on different subjects around each other on such a small space, one can imagine that it would be difficult to concentrate on the training.

The Philco representatives though, should be acknowledged for the training they were able to conduct in spite of the difficult situation.
For details about the testing procedures and the progress of the Pre-field testing, refer to (3).

2.1.5. Transport of SLEM's from NDPC and Installation in CTV's.
As the SLEM's were accepted through the Pre-field Test they were transported into field and installed in the various CTV's.

Each SLEM consists of 3 units, one "Analog Unit" and one "Digital Unit", each 19"x21"x21", and one "Power Unit" 19"x10½"x14½". Although rather large in volume the units are not heavier than they can be handled by one man if necessary, and they were mostly transported in private cars by the FO&M or by the Philco personnel.

Two sets of transport boxes were made for protection and for the convenience of carrying the units. They were made of aluminum with inner lining of felt and were equipped with carrying handles.

The transportation of the SLEM's and the installations in the CTV's went on without any noticeable problems.

2.1.6. Field Test.
After installation in the CTV the SLEM was first tested locally by means of a test set before it was connected to any of the external circuitry other than the power. This was done to confirm that the units were fully intact after the transit to the CTV.

Later on all the external connections were hooked up, and the fully integrated SLEM was than tested from the NDPC.

To the FO&M personnel the most important part of the field test was to acquire the necessary skill and knowledge to be able to accomplish SLEM installations, adjustments and testing on their own without guidance. Philco who were responsible for the training here as at the NDPC conducted this to our full satisfaction.

The SLEM's were Philco's property, and they had the full responsibility of all handling and testing of the SLEM's up to Final Acceptance after complete and successful Field Test. IBM was the coordinator of all SLEM testing.

For details about the testing procedures and the progress of the Field testing refer to (3).

2.1.7. Modifications and Retesting.

As already mentioned the testing soon revealed certain design problems with the SLEM's that caused delay in the scheduled installation program. Lack of spare parts added to this delay.

After the problems had been solved , 9 SLEM's, which had previously been installed in field, were modified, retested and Finally Accepted by 23 October when the Philco personnel left. Meanwhile the remaining 15 SLEM's were modified, tested and Finally Accepted at the NDPC test bed.

In an attempt to complete the installation before the snow would cause any difficulties, 13 more SLEM's were transported into field and installed within the next few days. The very last transportation, to the site 08C 2 November, was hampered somewhat by the snow; otherwise there were no problems with the transports.

Later on the field crews went back for further testing of these SLEM's, and most of them were Finally Accepted during November. 4 SLEM's however, were lacking A/D converters and could not be finally tested until the converters arrived at the end of January 1971.

The two spare SLEM's together with the SLEM test beds were moved to the MC.

More specific details of the SLEM problems as well as complete lists of all the installation - testing - and acceptance dates are reported in (3).

2.2. SLEM Status Meetings.

The first draft of the SLEM Integration Plan was dated 12 January 1970, and in the course of the following months several meetings were held to coordinate the planning of the various tasks involved.

From the middle of May more regular meetings were held between the organizations involved to follow up the SLEM Integration, and from the time the SLEM testing started in June the meetings usually took place on monday mornings at the NDPC to coordinate the plans for the coming week. The last meeting of this kind was held 9 November 1970.

2.3. Data Circuit between NDPC and MC.

The need for a data circuit between the NDPC and the MC mainly for the purpose of SLEM testing had been foreseen at an early stage, but during the hectic SLEM Integration period nothing had been done about it. As the SLEM Integration was nearing its completion, the matter was raised again, and with the recent SLEM problems in mind the need for the circuit was now even more obvious.

Televerket (The Telegraph Administration) was not able to supply such a circuit at the time, so it would have to be a task for the NORSAR project itself.

With the short distance between the NDPC and the MC the ideal solution would be to use a ground cable which would have to pass through the areas of The Institute for Atomic Energy (IFA) and The Norwegian Defence Research Establishment (NDRE). The necessary cable was available at NORSAR's storage at Løten.

At the SLEM meeting 22 November it was decided to go ahead with this plan providing the agreement from IFA and NDRE. The two institutions gave their consent, and a cable was put in between the MC in "Villa Sole" at IFA's ground and an existing cable terminal in a building on NDRE's ground from which existing circuits were available to NDPC. The circuits were finally hooked up at the end of December.

3. LONG PERIOD (LP) INSTALLATIONS AT 04C and 11C.

The installations in the Long Period Vaults (LPV) at the sites 04C and 11C were not carried out during the original installation period in phase II, because of a proposed special experiment, and the LPV's were not available for installation until May 1970. (Refer to "Final Technical Report NORSAR Phase II" chapter 10.2).

The installations and check-out were now performed by the FO&M personnel as the sites were prepared for the SLEM Integration. The installation started at 04C 17 August and at 11C 27 August. Some problems were experienced with the seismometers as well as with the CTV wiring, but nothing serious, and both sites were completed by 18 September.

4. CLEANUP AND REPAIR OF C-RING SUBARRAYS

In the Fall of 1970 the task was laid upon us to clean up and repair various defects after the construction works of the C-ring. Most of these discrepancies were of such nature that they could be handled by the FO&M group with the use of hand tools. There were a great deal of cable remnants and other rubbish left at various places, there were washouts of cable ditches, various carpenter work to be done, treaded parts of the CTV ventilation pipes or LPV manhole covers had to be greased, a score of vault markers were missing, and at some Well Head Vaults (WHV) the tightning ring for the rubber lid or the insulation pad underneath the rubber lid were missing.
All major points of this task were dealt with within the end of the year.

5. TEMPERATURE INVESTIGATIONS

5.1. Minimum - Maximum Temperature Registrations.

A test performed with a number of SP Seismometers at the MC in December 1969 clearly indicated that the Natural Frequency of the seismometers was greatly influenced by variations in the environmental temperature. (For further details of this test refer to (1) chapter 6). This discovery led in turn to the decision to investigate the temperature variations at various SP points in the field (Project meeting 10 December 1969).

To get a reliable picture of the temperature variations within the array it would be necessary to register the lowest and highest temperatures through the year at a number of places with representative geographical locations. The solution to this was the use of minimum - maximum thermometers, and in January 1970 such thermometers were placed at a number of SP points with one thermometer down in the borehole and one in the Amplifier Box in the WHV. Thermometers were also placed in a few LPV s and in one CTV.

The thermometers were checked in June for reading of the minimum temperatures through the winter, and again in September to read the maximum temperatures reached through the summer. The readings are listed in table 5.1, and the graph in figure 5.1 shows the temperature readings in relation to the altitude at the various locations.

5.2. Continuous Temperature Registration at 06B - 02

In addition to the minimum - maximum temperature registrations, ESD proposed in February that continuous registrations should be carried out for one SP point. After some investigation it was finally decided to start such registration at the SP point -02 at 06B. The temperature would be recorded on a Chart recorder in the CTV at 06B as well as being transmitted to NDPC over available Plan D equipment, where it would be read directly off a Digital Voltmeter.

The recording started in March, continued for the rest of the year and was terminated in June 1971. The results for the complete recording period will be submitted in the FO&M report succeeding this one.

6. OTHER TASKS

Apart from the matters already discussed we have also dealt with a number of other, less significant tasks. The major items of these will be commented on briefly in the following.

6.1. New Station Log.

A more appropriate "Station Log" was created in cooperation with the Operations Manager.
These new logs were placed out at the various CTV's in connection with other duties during the period 5 October - 2 November. Notes from the previous "Visitors' Logs" were transferred into the new logs. A page from one of the logs is shown in figure 6.1.

N O R S A R - MINIMUM / MAXIMUM TEMPERATURES 1970

Min.temp. January - June Max.temp. June - September

Temperatures in degrees C.

Site	WHV(Ja-box)		Shallow hole		Deep hole		LPV/CTV	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
01A CTV							4,1	17,8
01A LPV							1,0	10,0
01A 03	- 1,2	16,5			4,0	13,0		
01A 04	- 0,5	17,0	2,0	Note 1				
01A 05	- 1,5	19,0	1,0	10,0				
04B LPV							0,0	10,0
04B 02 Note 3	- 2,5	19,5	1,5	10,8				
04B 03								
04B 05	- 1,0	16,2			4,0	5,3		
03C 01	- 3,2	15,4			4,1	6,2		
03C 05	- 1,5	15,4			2,0	7,5		
03C 02	- 2,0	17,4	1,2	12,4				
05C 02	- 1,0	18,5	1,5	11,0				
05C 04	- 2,8	18,8	1,7	11,0				
05C 05	- 0,3	16,5			4,0	5,0		
09C 04	- 1,5	17,5	1,5	11,0				
09C 00	- 1,8	19,0	2,1	11,0				
09C 01	- 2,0	18,0	1,3	8,0				
13C 04	- 0,8	19,0	1,0	14,8				
13C 05	- 2,0	15,7	1,8	8,0				
01C LPV							1,2	15,0
01C 04(F1)	- 5,0	13,9			1,8	5,4		
01C 00(OY)	- 4,8	11,9			2,0	Note 2		
01C 05(A1)	- 3,5	12,9			2,5	3,5		
02C 05 Note 3								
02C 01								
02C 02								

Notes:

1) Thermometer previously removed by mistake.

2) Thermometer accidently broken during maintenance work.

3) Thermometers moved from 04B to 02C September 1970.

Table 5.1 NORSAR minimum/maximum temperature readings 1970.

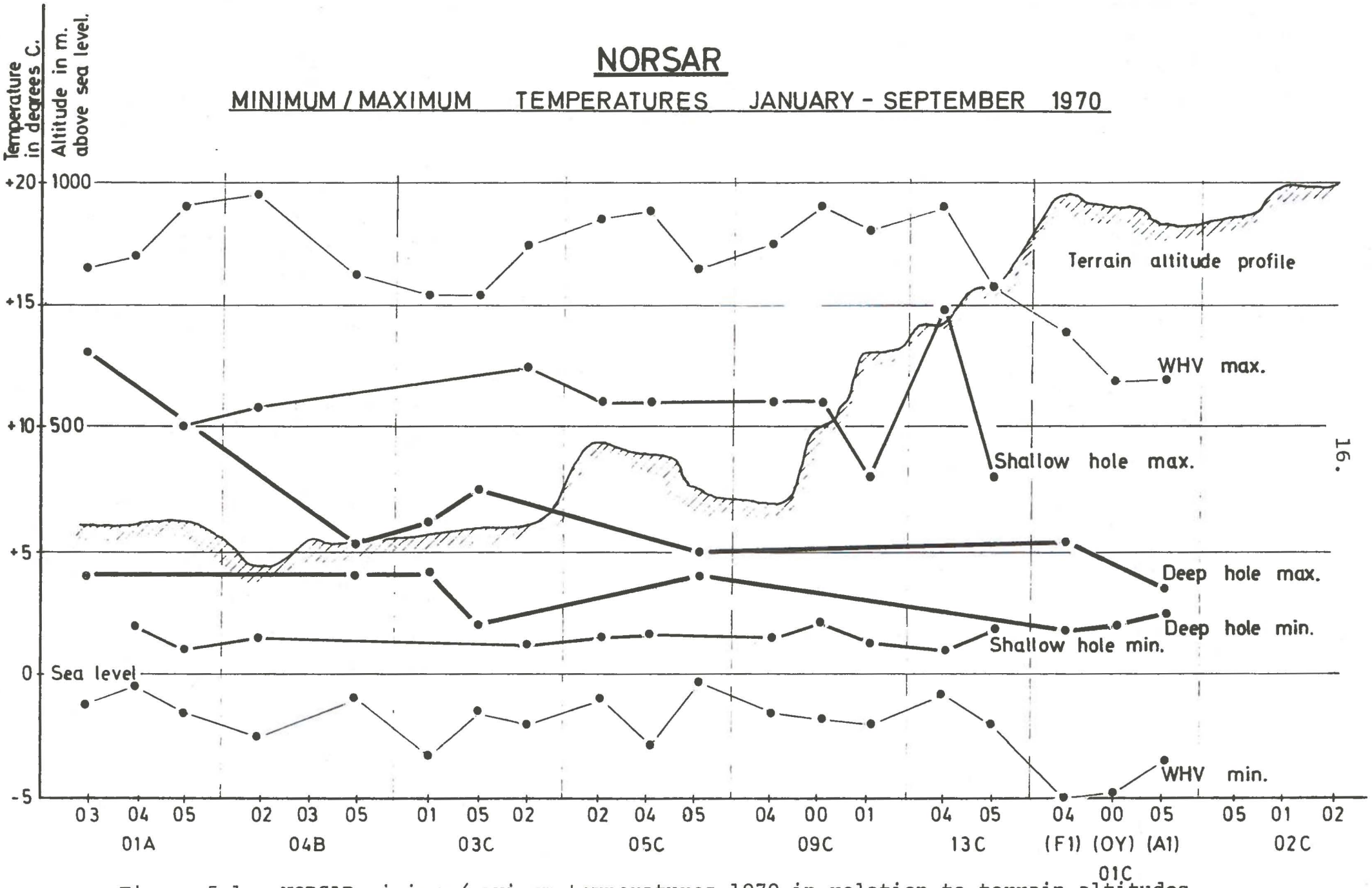

Figure 5.1 NORSAR minimum/maximum temperatures 1970 in relation to terrain altitudes.

Dato Date 1970	Besøkendes navn Visitors name	Grunn for besøk / Arbeide utført Reason for visit / Work performed	Merknader Remarks	DPC kontaktet DPC called Ank. kl. Arr. time	 Avr. kl. Dep. time
21.4	RP/KH	Seismic reflection out started		0915	1530
22.4	-"-	" " continued		0930	1445
23.4	-"-	" " completed		0920	1215
26.4	EJ, Tele-plan	MODEM installed		1000	1100
15.5	LJD, -"-	line test	(Communication - NTA)	0830	1400
26.5	EJ/RP	SLEM cables installed		1000	1200
18.6	J. Hansen	Constr. work inspected	(NORCONSULT)	1115	1140
22.6	EJ.	Noise study		1100	1315
29.6	RAJ/USAF	SLEM #004 installation	NORATOM, PHILCO, TELEPLAN, IBM	1330	1700
30.6	-" -	Cont. SLEM installation & check		0900	1700

Figure 6.1 Side from Station Log at 06C.

6.2. Site Inventory (CTV/LPV).

FO&M personnel assisted the NORSAR Administration and Support Office with an inventory of all the CTV/LPV equipment. It was conducted in the beginning of October.

6.3. Water Leakage in CTVs at 10C and 11C.

6.3.1. 10C CTV.

When the site was inspected on 7 July there was 2 cm of water standing on the floor in the CTV. The water seemed to have leaked in through a cable entrance. The ground outside was soaked with water after a heavy rainfall. A couple of months earlier, during the snow-melting season, there were about 15 cm of water in the vault. At that time it was believed to have been caused by the overflow of a creek nearby forcing its way into the vault.

The vault was now, 8 July, inspected by NDRE's project leader accompanied by the building contractor responsible for the site, and actions for improvement of the drainage were decided upon.

At an inspection 29 July there were again puddles of water on the floor, and the drainage above the vault was further improved.

The site had not yet been in operation, and due to all the dampness, fungus had started growing on the equip-ment. It was therefore necessary to clean the whole installation thoroughly.

The LPV manhole lid was at the same time equipped with a new gasket as the original one did not give the neces-sary air seal any more.

6.3.2. 11C CTV.

There were puddles of water on the floor of the CTV when the site was inspected 7 July. This CTV also had water leak into it last spring, when the snow was melting, but in this case it was not due to incomplete drainage. The water had come in through an open ditch outside a still open cableduct, which in turn aparantly was open due to incomplete installation work, because of long-lasting powerbreak last winter. The site had not yet been in operation.

The installation was completed shortly after this, and all the equipment was then thoroughly cleaned.

6.4. Cable Faults.

At the end of August a 6-pair data cable crossing a shooting range at the subarray 03B was cut during some construction work, and at the same time three cables, one 12-pair and two 6-pair, at the Subarray 05B was cut by a farmer digging in his field.
As in the past, the cables were spliced by Stange Elektriske A/S.

In November a break came up in the Cal.Amp. pair of the SP 04 cable at the subarray 04B. There was no report of outside destruction to the cable, so it was measured, and the fault was localized. An inspection to the area, which was in farm land, did not reveal any sign of work that might have caused any damage to the cable. The cable had previously been spliced twice in this same area, however, and it was decided to use one of the power pairs for Cal.Amp. for the time being rather than to dig up the cable for further fault localization and repair.

6.5. Moving of previous Data hut at 04C.

The data hut previously used at the Trysil site during phase I and later at the site 07B during the local recording period of phase II was later placed at the site 04C to be used in connection with the proposed special Long Period experiment. There was no longer any use for it in the field, and it was therefore moved to Løten 11 November to be stored outside NORSAR's storage there.

7. STAFF AND ORGANIZATION.

7.1. Staff.

The maintenance philosophy of the FO&M, upon which the contract was based, made it necessary to increase the previous staff with one technician for the field group. The staff was complete from the beginning of the period and counted now 10 members as follows:

1 project leader
1 project leader assistant
2 technicians assigned to the MC
6 technicians assigned to the field group.

Most of the technicians in the field group lived in the Hamar region and operated in general from the field base at Brumunddal. During the SLEM Integration period though, they worked occasionally at the NDPC as previously mentioned.

7.2. Working Schedule.

As most of the activities during this period were concentrated around the SLEM Integration, it was very difficult to keep any regular working schedule. Our dispositions had to be adjusted to fit in with the various other organizations involved, and at the same time the training program necessitated a certain rotation of the whole staff.

At the end of the period though, when the SLEM activities were slowing down, we initiated a rotating working schedule for the field group based upon the philosophy of having two separate groups of two technicians in the field simultaneously, both groups fully equipped with instruments for the various tasks, while a third group would be standby for other assignments.

7.3. Transportation.

Transportation has, as in the past, mostly been accomplished by use of the personnel's private cars. A total of 110.500 km were driven by the FO&M staff during the period.

As the winter started at the end of the period, the snow scooters were taken into use on some of the forest roads.

We also had at our disposal a Land Rover 109 for special purposes.

7.4. Communications.

In the past the use of radio telephones in the cars had proved to be very useful. Additional ones were therefore provided to equip all the staff members with such telephones in their cars.

During this period with extensive travelling in connection with the SLEM Integration and other, related tasks, this communication link proved to be a valuable tool.

All the telephones are PYE Westminster type 10/W15FMD/V.

8. CONCLUDING REMARKS

As the report clearly reflects the SLEM Integration into the NORSAR system occupied most all of the FO&M staff's capacity during the whole period.

The main goal for the FO&M staff during the SLEM Integration period was to acquire necessary skill and knowledge to be able to handle the maintenance of the SLEM s themselves later on. This we feel has been accomplished although the conditions with respect to training at the SLEM Testbed at NDPC were a bit difficult.

As the SLEM training occupied the MC technicians almost all the time, there has not been any particular activity at the MC during the period. Various test equipment started on in the previous period will be completed in the coming period, and also the SLEM Testbed with connection to the NDPC will have to be completed soon.

All in all it has been an interesting period.

ooOoo