Royal Norwegian Council for Scientific and Industrial Research

SYSTEM OPERATIONS REPORT

1 January - 30 June 1973

Prepared by

P. Tveitane

NORWEGIAN SEISMIC ARRAY

NORSAR

P. O. Box 51. 2007 Kjeller – Norway

NTNF/NORSAR
Post Box 51
N-2007 Kjeller
NORWAY

NCRSAR Report No. 62

SYSTEM OPERATIONS REPORT

1 January - 30 June 1973

Prepared by

P. Tveitane

24 August 1973

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, through Contract F19628-70-C-0283 with the Royal Norwegian Council for Scientific and Industrial Research.

This report has been reviewed and accepted by the European Office of Aerospace Research and Development, London, England.

ARPA Order No. 800		Program Code No. IF10
Name of Contractor	:	Royal Norwegian Council for Scientific and Industrial Research
Date of Contract	:	15 May 1970
Amount of Contract	:	$2,051,886
Contract No.	:	F19628-70-C-0283
Contract Termination Date	:	30 June 1973
Project Supervisor	:	Robert Major, NTNF
Project Manager	:	Nils Marås
Title of Contract	:	Norwegian Seismic Array (NORSAR)

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

AM	-	Array Monitoring
ARPA	-	Advanced Research Projects Agency
CCB	-	Change Control Board
CTV	-	Central Terminal Vault
DP	-	Detection Processor
EP	-	Event Processor
ESD	-	Electronic Systems Division (USAF)
IBM	-	International Business Machines
LP	-	Long Period (Seismometer)
MTBF	-	Mean Time Between Failures
NDPC	-	NORSAR Data Processing Center
NMC	-	NORSAR Maintenance Center
NOAA	-	National Oceanographic and Atmospheric Administration
NORSAR	-	Norwegian Seismic Array
NTA	-	Norwegian Telegraph Administration
NTNF	-	Norges Teknisk-Naturvitenskapelige Forskningsråd (Royal Norwegian Council for Scientific and Industrial Reasearch)
SA	-	Subarray
SDAC	-	Seismic Data Analysis Center
SP	-	Short Period (Seismometer)
SPS	-	Special Processing System
TAL	-	Trans-Atlantic Line
TIP	-	Terminal Interface Processor

SUMMARY

This report covers the operation of the NORSAR system in the period 1 Jan - 30 Jun 1973. Array monitoring and control and associated field maintenance activities are, according to contract, covered in a special report (NORSAR Report No. 60).

No unusual or major problems were encountered in the period. Computer and other equipment still shows reasonably good stability. A somewhat high communications line outage was experienced, causing degraded performance or data loss for shorter periods.

1. INTRODUCTION

The Norwegian Seismic Array - NORSAR - was built in 1968-70, following an agreement between the Governments of the United States of America and Norway. The array is located in south-eastern Norway, with center approximately 100 km north of Oslo (Fig. 1.1). The array, consisting of 22 subarrays, is approximately 110 km in diameter. The subarrays (SA) are organized in an outer (14 SA) ring, an inner ring (7 SA) and one center SA. Each SA with diameter approximately 10 km consists of 5 short period seismometers in boreholes varying in depth from 2 to 15 meters, a long period vault housing 3 long period seismometers (E-W, N-S, Vertical) and one short period seismometer, and a central terminal vault housing the main SA electronic equipment. Buried cables interconnect the various parts of an SA (Fig. 1.2). Each SA is connected to the data center at Kjeller near Oslo via a dedicated telephone circuit, which is rented from the Norwegian Telegraph Administration (NTA).

Figure 1.1 Southern Norway

Figure 1.2 Typical Subarray

△ Central Area (LP and CTV Site) ——— Cable trench

□ Shallow (blasted) SP hole · · · o Power line

○ Deep (drilled) SP hole ·· – o Telephone/ data line

The construction of the array was administered by the Norwegian Defence Research Establishment under contract with the United States Air Force, whereas the operation of the system, from 1 July 1970, is the responsibility of the Royal Norwegian Council for Scientific and Industrial Research, also under contract with USAF.

2. STATUS OF SYSTEM

2.1 Facilities

The Data Processing Center at Kjeller consists of a rented permanent building containing computer room, adjacent rooms for air conditioning, card punching, line termination, storage and six offices, and a semipermanent prefabricated office building with 17 offices and auxiliary rooms, part of which is U.S. Government property, part of it rented.

The Maintenance Center (NMC) is located in the array area, near the city of Hamar. The NMC also includes main stores for field equipment, previously located in a rented warehouse near the data center at Kjeller. A small storeroom for cables, also in the array area, will be kept as before.

2.2 Personnel

Few personnel changes took place in the period. The Chief Programmer left 1 April, for temporary work at SDAC, Alexandria, initially for a one-year period. Two computer operators left, and two new were hired. The Librarian had a three-month leave of absence.

After a trial period of several months, the new operator duty schedule, initiated in September 1972, was reviewed. This schedule, based on seven operators, was found to be impractical and unduly strenuous on operators. It left no "spare" manpower in cases of illness and vacations, and resulted in excessive overtime, thus eliminating the anticipated savings. A decision was taken to return to the original schedule based on 10 operators. Vacancies are expected to be filled in the summer.

One secretary left at the end of the reporting period.

Major R.A. Jedlicka, ESD Technical Project Officer, left the project to return to the U.S.A. at the end of June.

2.3 Equipment, Maintenance

2.3.1 NDPC Equipment

The computer hall layout and functional diagram of the computer system are shown in Figs. 2.1 and 2.2.

The substantial changes in the period were

- Installation of a "second channel adapter" for the second plotter, acquired in the previous period. This allowed simultaneous operation of the two plotters, one from each processing unit (Detection Processor and Event Processor).

- Purchase of 3000 magnetic tapes, to allow the retention period for data tapes to be kept at nine months.

- Installation (June) of an ARPANET TIP with associated equipment (See para. 2.3.3).

Maintenance for IBM-delivered equipment, contracted with IBM Norway, continued on "minimum service" basis, i.e., nine hours per day, Monday through Friday, for standard equipment, plus "time and material" for non-standard equipment. Table 3.1.1 Computer Usage also gives an indication of maintenance and outage in the period.

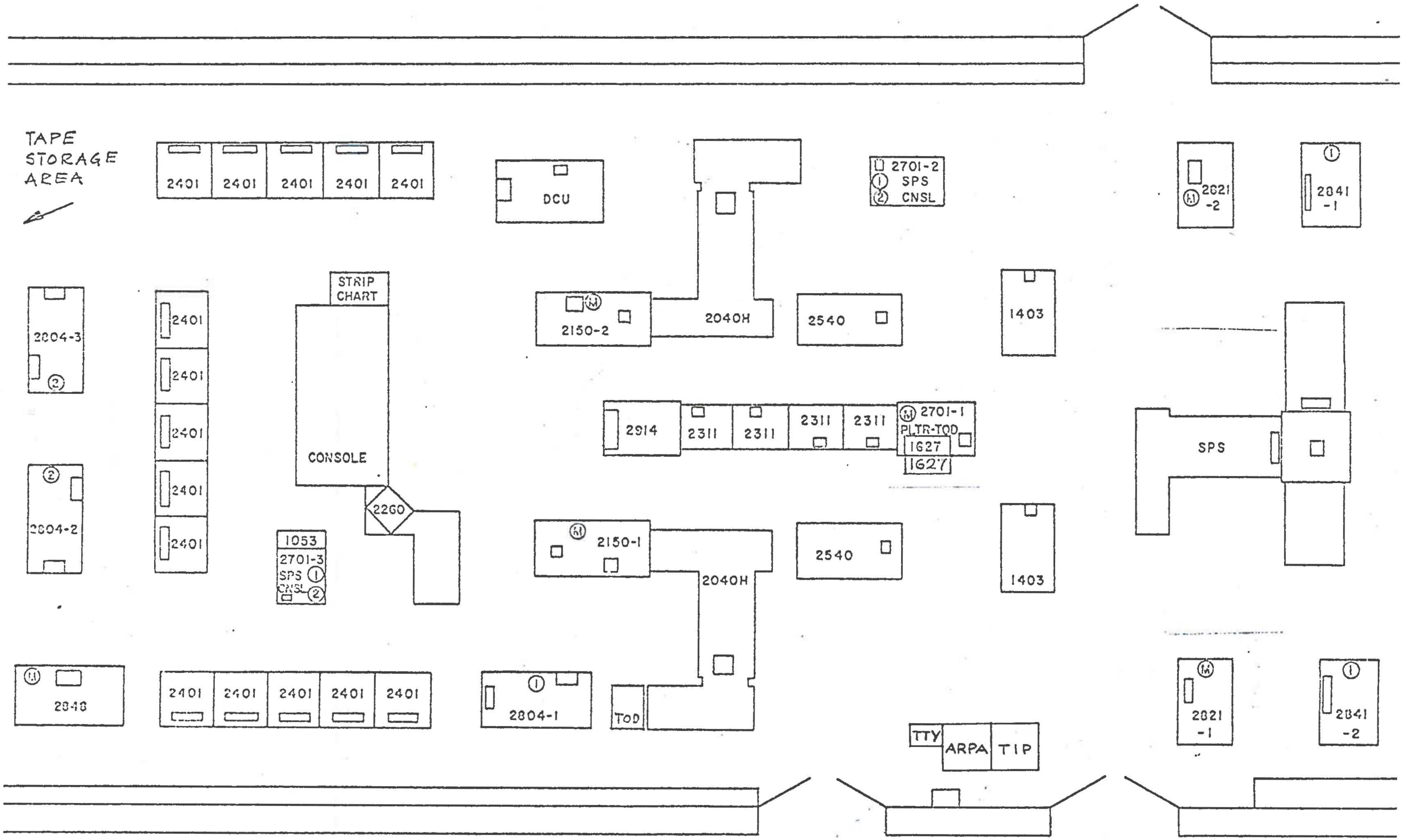

Figure 2.1 NDPC Computer Hall

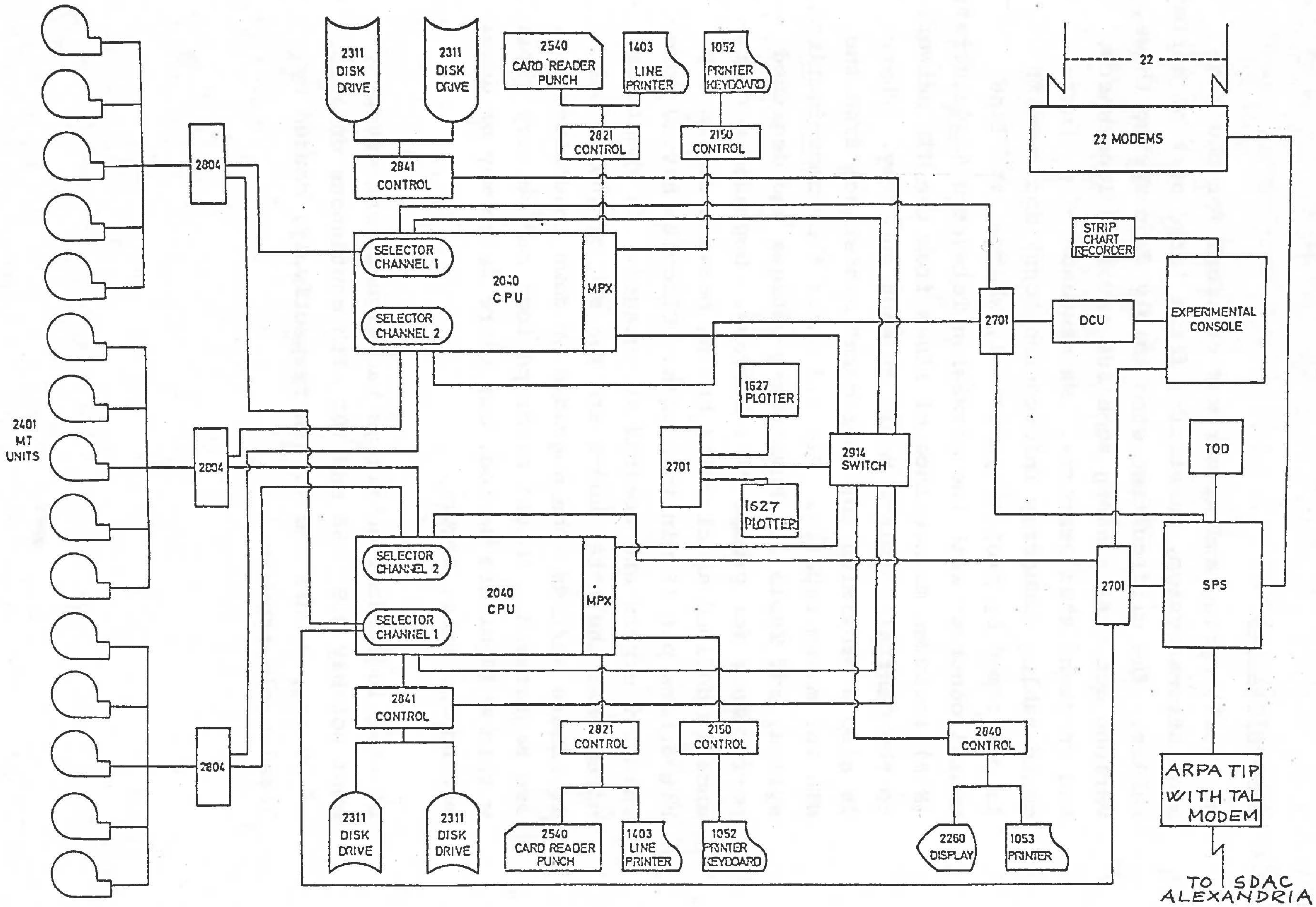

Figure 2.2 Functional Diagram of the Computer System

2.3.2 Communications

As usual, spring and summer was critical for the communications system, consisting for a large part of buried cables. The difficulties stem mainly from spring thaws, various activities among some 600 involved landowners, and frequent thunderstorms. Maintenance of project-owned cables (subarray interconnections) and modems is performed by project personnel, whereas the line rental contract with the Norwegian Telegraph Administration (NTA) includes maintenance of lines from the NTA network to the Central Terminal Vault of each subarray. There is also a provision for "per case" assistance from the NTA for modem repairs. Fig 2.3 shows the communications system, and Table 2.1 summarizes outages and degraded performance for groups of subarrays. Degraded performance is defined as circuits having between 20 and 200 bit errors per 16 min intervals. Circuits having more than 200 errors are treated as outages. It should be noted that the total hours are the sum of individual 16-minute periods when degraded or down conditions are registered. Actual error periods may be very short within a 16-minute period, but there is no way of determining the exact figure.

Several individual subarrays had significant outages, most notably 03B, 05B and 10C with continuous outages of 39 hrs, 39 hrs and 71 hrs respectively, caused by local cable trouble.

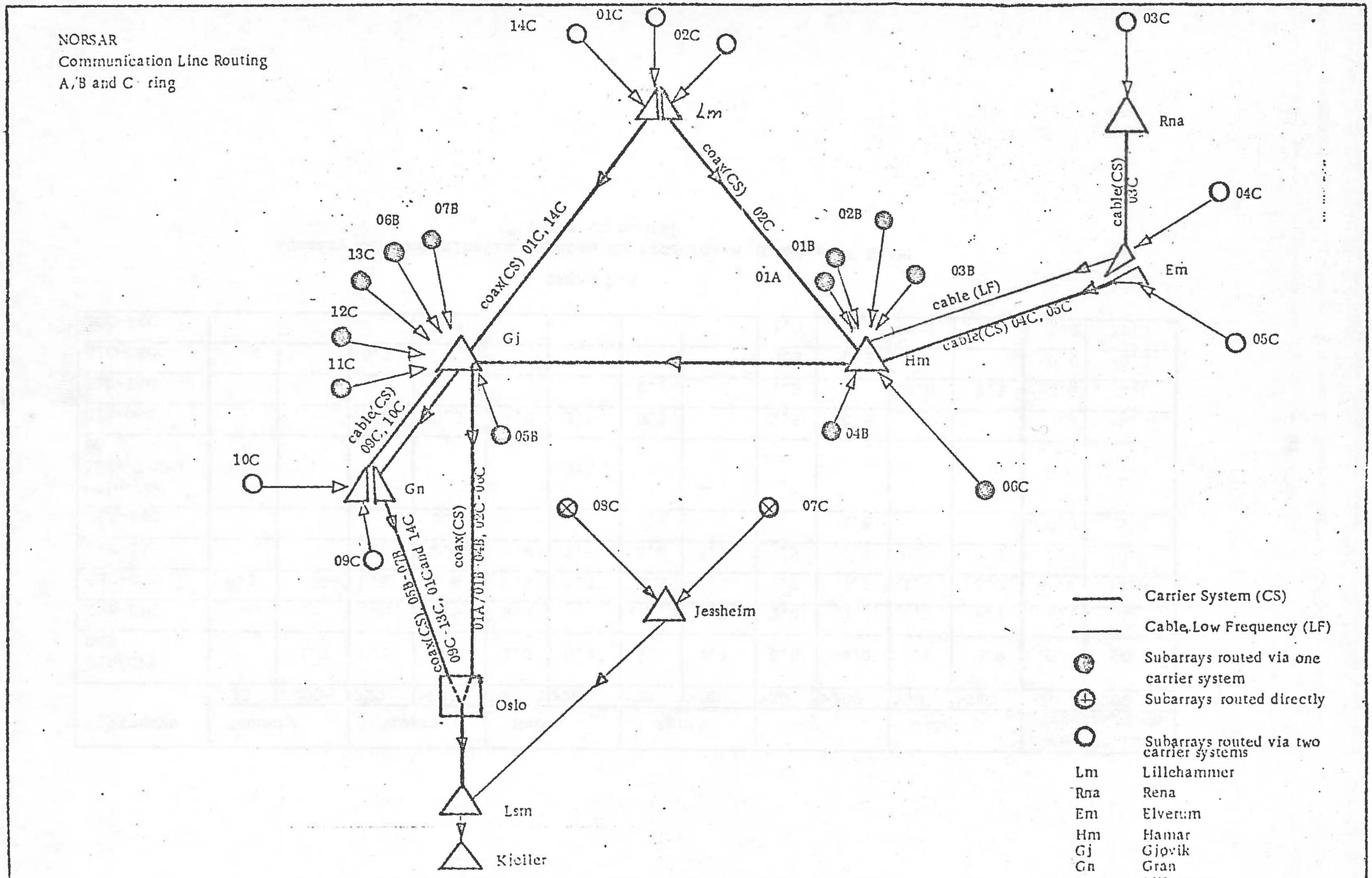

Figure 2.3 NORSAR Communications System

Subarrays	January		February		March		April		May		June		Total Hours Degraded/down	
	>20	>200	>20	>200	>20	>200	>20	>200	>20	>200	>20	>200	>20	>200
01A/01B-04B		2.0	0.8	0.3	1.0	0.3	5.0	4.3	6.8	4.0	1.8	3.8	15.4	14.7
05B-01C			0.5	0.5	0.5			3.5	2.8	0.3	0.3	2.1	4.1	6.4
02C-06C	0.3	1.8	0.5	1.8	1.5	0.3	4.5	3.0	8.7	3.8	1.1	3.3	16.6	14.0
09C-14C			0.8	2.6	1.8	2.5	0.5	3.5	4.5	0.8	0.3	0.8	7.9	10.2
01A-14C				1.3			0.8			2.3			0.8	3.6
01A-14C less 7 and 8C						7.1							0.0	7.1
01A-06C			0.8	3.3	1.0	2.5	0.3		1.5	0.5			3.6	6.3
11C-14C							0.3		1.5		0.8	2.1	2.6	2.1
01C-06C			0.5						0.3	0.3			0.8	0.3
10C-14C				0.3					1.0		0.3	21.0	1.3	21.3

TABLE 2.1

Summary of communication system degraded/down (Groups of SA's)
(Figures in hours)

2.3.3 ARPANET

Following negotiations initiated by ARPA in the fall of 1972 on the connection of NORSAR to the ARPANET, a Terminal Interface Processor (TIP) was installed at the NDPC in mid-June. After temporary permission from the NTA, pending final agreement between all involved parties on formal questions, testing of the system started with SDAC (network entry point) and Bolt Beranek & Newman, Inc. (Network Control Center). Initial testing was somewhat problematic partly due to equipment hardware/software problems, successively solved, mainly due to the trans-Atlantic line apparently not being able to handle the higher speed (9.6 Kb) traffic. Neither formal nor technical problems were solved by the end of June. The seismic data exchange between NORSAR and SDAC is integrated in the new system. Simultaneously, efforts were made for hooking the London University TIP to ARPANET via NORSAR. That connection is expected to be established later in the summer.

2.3.4 Field Equipment and Maintenance

Field equipment performance and maintenance is covered in NORSAR Report No. 60.

3. NDPC ACTIVITY

3.1 Detection Processor Operation

3.1.1 General Considerations

During this reporting period, the mode of operation of the Detection Processor (DP) remained essentially unchanged, i.e., a close to continuous data recording with emphasis on minimizing system down time.

Average daily recording time for DP was according to Table 3.1.2 98.8%, as compared to 99.1% for the previous reporting period.

No significant change has been made to the DP software in this reporting period.

3.1.2 Data Recording and DP Down Time

Fig. 3.1.1 shows the DP down time on a day-to-day basis for Jan-Jun 73. The total monthly recording time is given in Tables 3.1.1 and 3.1.2 together with statistics covering general computer usage.

It is seen from Fig. 3.1.1 that the down times are caused primarily by a few long breaks. The longest interval of down time occurred on 18-19 April, when a power break caused DP to be down 13 hours. Work on the telephone lines by NTA on 4-5 June and 13 June caused DP to be down 18 hours total. All other down times are of the order of 30 minutes except a few that were about 1-2 hours.

The 39 DP error stops in the reporting period were related to the following causes:

Tape drive problems	13
Power breaks and related stops	6
SPS problems	1
Other hardware problems	17
Software errors	1
Operator errors	1

The average mean time between failure in the reporting period was 4.6 days.

3.1.3 DP Operational Problems

There have been no major DP operational problems in this reporting period apart from the error stops explained in Chapter 3.1.2.

3.1.4 DP Algorithms and Parameters

No major changes were introduced to the DP algorithms.

The parameter changes relevant to the on-line DP during the reporting period were as follows:

2 January 0811 GMT

Selective Surveillance A-filter was changed from 1.4-3.4 Hz to 1.3-3.2 Hz. This is the same filter as was used up to 23 November 1972, and the coefficients and scaling parameters for this filter are given in Systems Operations Report 1 Jan - 30 Jun 72.

6 February 0814 GMT

New beam deployments for both partitions were implemented, as listed in Tables 3.1.3 and 3.1.4. All beams now have a phase associated to it, and since this beam set is based on better location corrections, all beams are located where the seismicity is both in slowness space and geographic space. This has given more reliable detections, which is one of the reasons why the DP bulletin reported on in Chapter 3.2.1 has been so successful. Modifications to the present beam set are likely only if changes in nuclear testing programs should make it necessary, or if a new region should become seismically active.

The number of Selected Surveillance (grouped) detections on a day-to-day basis is shown in Fig. 3.1.3. Since no system or parameter change was made in this period which should significantly affect the detection rate, the variation in the number of detections first of all reflects the variation in the power and structure of the background noise.

3.1.5 Detection Processor Performance

Statistics showing the number of on-line Selected Surveillance detections (i.e., coherent beamforming) as a function of signal-to-noise ratio (SNR) are presented in Fig. 3.1.2.

It is seen that the 'break point' on the cumulative curve, which is where noise detections or false alarms start to dominate the picture, occurs at about 12 dB SNR and corresponds to approximately 20 detections per day. This is about the same as was reported for the previous half year period, and corresponds also to the statistics on number of reported events given in Table 3.2.2.

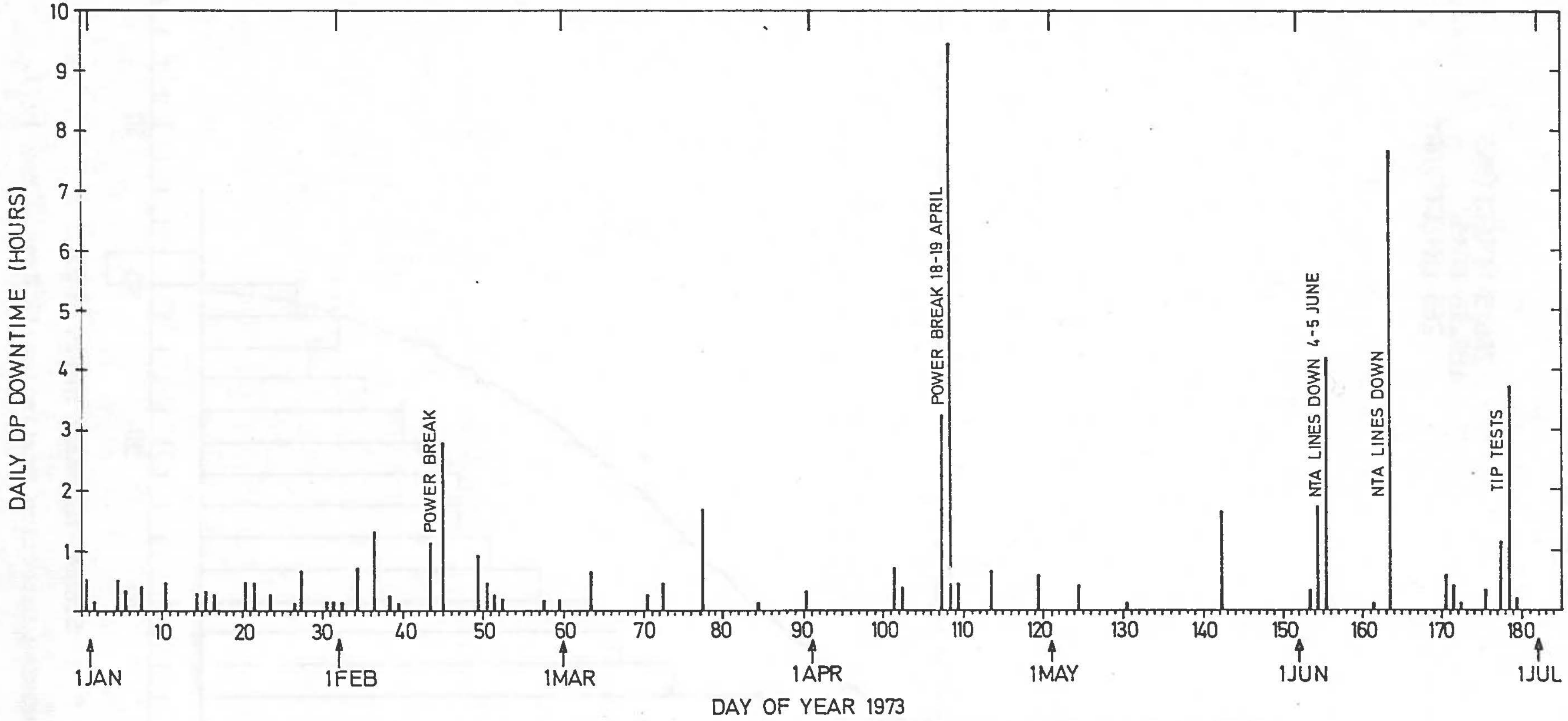

Fig. 3.1.1 Daily Detection Processor Down Time Jan-Jun 1973.

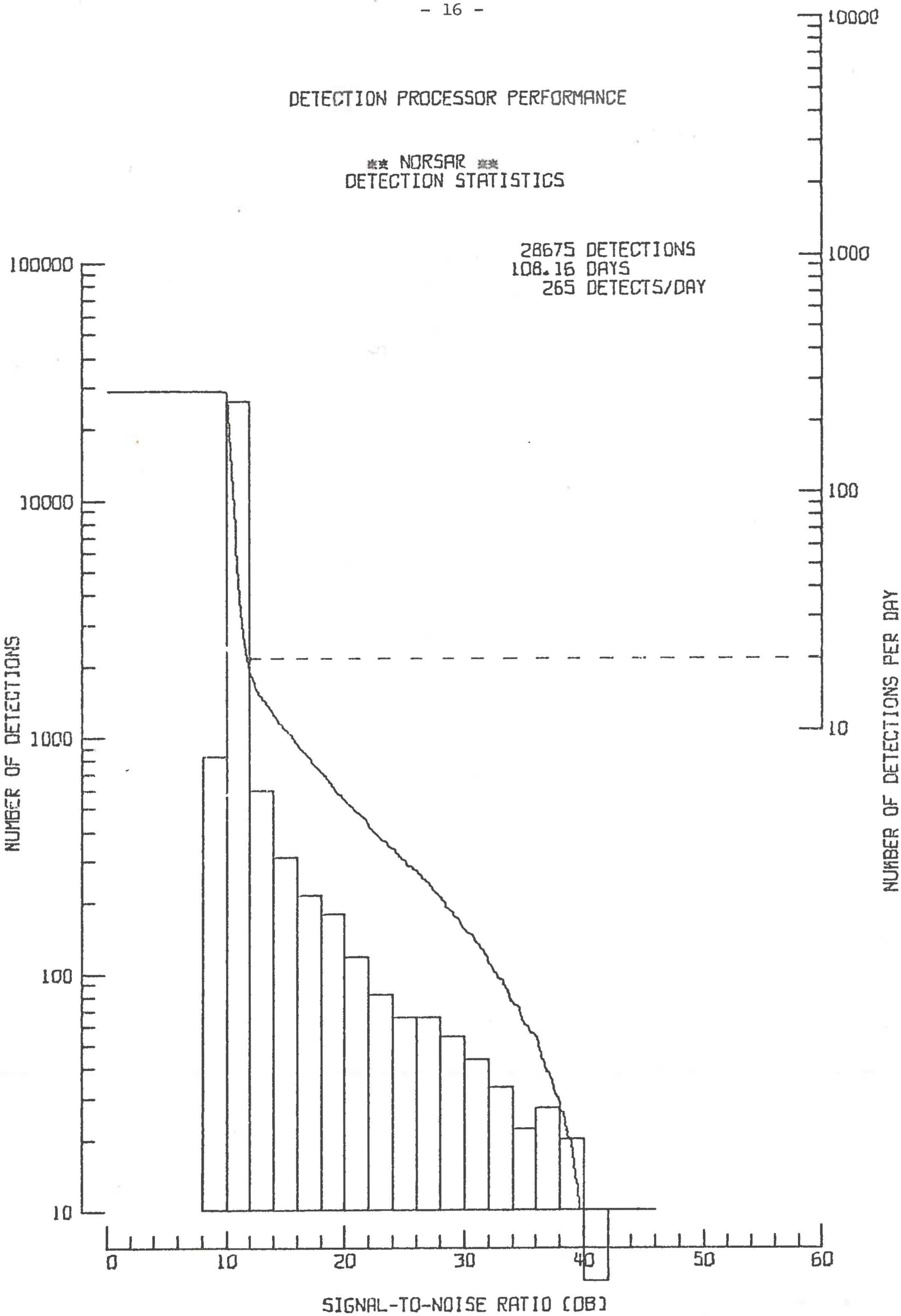

Fig. 3.1.2 NORSAR Detection Statistics 15 Jan-30 May 1973.

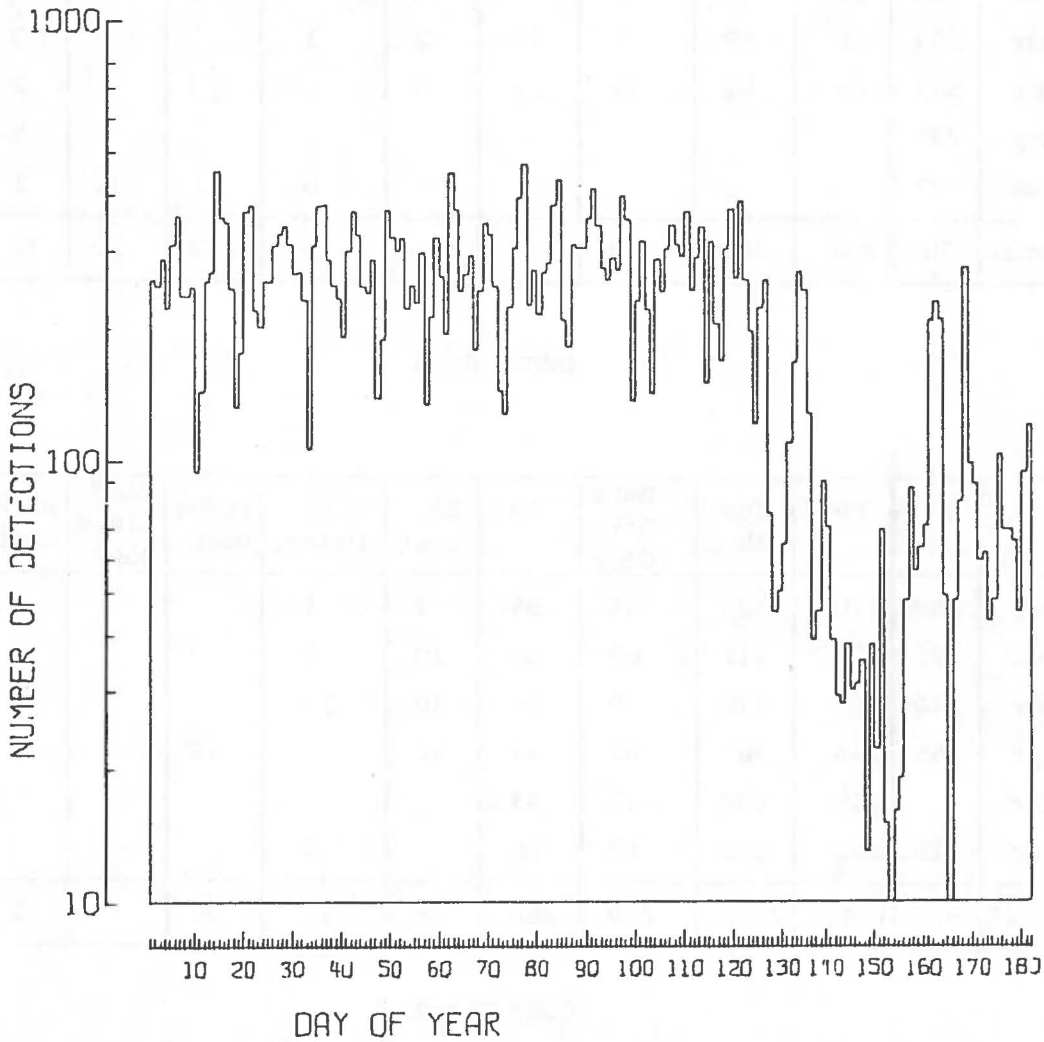

Fig. 3.1.3 Daily Number of DP Detections Jan-Jun 1973.

	DP	EP	Job Shop	Data Ret Copy	AM	DP Test	C.E. Maint.	Power Down	Data Lines Down	Mach Error	No. of Jobs
Jan	570	58	90	26	28	5				6	156
Feb	635	11	24		2			3		6	66
Mar	569	66	89	2	20	2	1			7	290
Apr	549	69	82	31	14	4		13		2	122
May	735									9	
Jun	699						6	1	13	1	
Total	3757	204	285	59	64	11	7	17	13	31	634

COMPUTER A

	DP	EP	Job Shop	Data Ret Copy	AM	DP Test	C.E. Maint.	Power Down	Data Lines Down	Mach Error	No. of Jobs
Jan	168	270	328	54	35	7	5			2	828
Feb	28	273	412	63	36	10	2	3			940
Mar	170	256	376	59	36	10	3				860
Apr	155	235	309	52	55	12		13			690
May		219	460	11	63						853
Jun	15	292	622	60	58		2				878
Total	536	1545	2507	299	283	39	12	16		2	5049

COMPUTER B

DP up time: $\frac{(3757+536)\cdot 100}{4344}\ \% = 98.83\%$

EP up time: $\frac{(204+1545)\cdot 100}{4344}\ \% = 40.26\%$

TABLE 3.1.1

Computer Usage 1 Jan-30 Jun 1973

	DP Uptime (hours)	DP UP (%)	EP Uptime (hours)	EP UP (%)	No. of DP Error Stops	DP MTBF (days)
Jan	738	99.3	328	44.1	12	2.5
Feb	663	98.7	284	42.3	9	3.1
Mar	739	99.3	322	43.3	4	7.8
Apr	704	97.8	304	42.2	7	4.5
May	735	98.8	219	29.4	2	15.5
Jun	714	99.2	292	40.6	5	6.0
Total	4293	98.8	1749	40.3	39	4.6

TABLE 3.1.2

DP and EP Computer Usage 1 Jan-30 Jun 1973

Beam Set 411 (02/06/73) Part I

BEAM NO	UX (S/KM)	UY (S/KM)	PHASE	LAT	LON	REGION	NUMBER AND NAME
1	0.0089900	-0.0913900	P	83N	7W	641	NORTH OF SVALBARD
2	-0.0638100	-0.0873700	P	73N	55E	648	NOVAYA ZEMLYA
3	0.0443600	-0.0689300	P	72N	74W	682	BAFFIN ISLAND REGION
4	0.0172400	-0.0659800	P	67N	137W	677	N. YUKON TERR.,CANADA
5	0.0117313	-0.0660309	P	65N	147W	676	ALASKA
6	0.0097600	-0.0650000	P	63N	151W	1	CENTRAL ALASKA
7	0.0072200	-0.0668100	P	66N	155W	676	ALASKA
8	0.0117700	-0.0638100	P	61N	148W	2	SOUTHERN ALASKA
9	0.0094000	-0.0634400	P	61N	152W	2	SOUTHERN ALASKA
10	0.0005800	-0.0645199	P	65N	165W	676	ALASKA
11	0.0184800	-0.0599800	P	59N	137W	19	SOUTHEASTERN ALASKA
12	0.0133000	-0.0617500	P	60N	146W	2	SOUTHERN ALASKA
13	0.0155900	-0.0610500	P	60N	141W	19	SOUTHEASTERN ALASKA
14	0.0113200	-0.0618500	P	59N	149W	14	KENAI PENINSULA, ALASKA
15	0.0075400	-0.0618300	P	58N	155W	12	ALASKA PENINSULA
16	0.0054900	-0.0602300	P	57N	158W	12	ALASKA PENINSULA
17	0.0093000	-0.0596800	P	57N	152W	13	KODIAK ISLAND REGION
18	0.0067900	-0.0591600	P	55N	156W	17	SOUTH OF ALASKA
19	0.0044000	-0.0584119	P	55N	160W	12	ALASKA PENINSULA
20	0.0019500	-0.0575700	P	54N	163W	10	UNIMAK ISLAND REGION
21	-0.0014651	-0.0584119	P	55N	168W	9	FOX ISLANDS, ALEUTIANS
22	-0.0317300	-0.0581200	P	62N	143E	671	EASTERN SIBERIA
23	-0.0009600	-0.0571200	P	53N	167W	9	FOX ISLANDS, ALEUTIANS
24	-0.0038300	-0.0565900	P	52N	171W	9	FOX ISLANDS, ALEUTIANS
25	-0.0058600	-0.0562600	P	52N	174W	7	ANDREANOF IS., ALEUTIANS
26	-0.0084800	-0.0557100	P	52N	178W	7	ANDREANOF IS., ALEUTIANS
27	-0.0118300	-0.0549600	P	52N	177E	6	RAT ISLANDS, ALEUTIANS
28	-0.0184400	-0.0554300	P	55N	166E	4	KOMANDORSKY ISLANDS REG.
29	-0.0205266	-0.0558723	P	56N	162E	218	NEAR EAST COAST KAMCHATKA
30	0.0247000	-0.0545300	P	50N	130W	25	VANCOUVER ISLAND REGION
31	-0.0076500	-0.0538300	P	50N	178W	7	ANDREANOF IS., ALEUTIANS
32	-0.0109500	-0.0539600	P	50N	179E	6	RAT ISLANDS, ALEUTIANS
33	-0.0136700	-0.0539700	P	51N	175E	6	RAT ISLANDS, ALEUTIANS
34	-0.0168600	-0.0545200	P	53N	169E	4	KOMANDORSKY ISLANDS REG.
35	-0.0151900	-0.0542300	P	52N	172E	5	NEAR ISLANDS, ALEUTIANS
36	-0.0219929	-0.0533326	P	52N	160E	219	OFF EAST COAST KAMCHATKA
37	-0.0207300	-0.0544200	P	54N	162E	218	NEAR EAST COAST KAMCHATKA
38	0.0382800	-0.0501600	P	45N	111W	456	MONTANA
39	0.0351916	-0.0507930	P	44N	116W	33	WESTERN IDAHO
40	0.0254800	-0.0511500	P	44N	129W	30	OFF COAST OF OREGON
41	0.0272200	-0.0503400	P	43N	126W	30	OFF COAST OF OREGON
42	-0.0241100	-0.0517800	P	50N	158E	222	KURILE ISLANDS REGION
43	-0.0263916	-0.0507930	P	50N	155E	221	KURILE ISLANDS
44	-0.0283900	-0.0519600	P	52N	152E	220	NORTHWEST OF KURILE IS.
45	-0.0699700	-0.0509800	P	67N	67E	335	URAL MOUNTAINS REGION
46	0.0372900	-0.0486100	P	42N	112W	457	EASTERN IDAHO
47	0.0308100	-0.0483500	P	40N	121W	36	NORTHERN CALIFORNIA
48	0.0278602	-0.0482533	P	41N	125W	34	OFF COAST OF NORTH CALIF.
49	0.0260400	-0.0483500	P	40N	128W	34	OFF COAST OF NORTH CALIF.
50	-0.0282200	-0.0488500	P	47N	154E	221	KURILE ISLANDS
51	-0.0312900	-0.0490500	P	49N	150E	220	NORTHWEST OF KURILE IS.
52	-0.0310900	-0.0473500	P	45N	152E	222	KURILE ISLANDS REGION
53	-0.0337200	-0.0474000	P	46N	148E	220	NORTHWEST OF KURILE IS.
54	0.0374000	-0.0462600	P	39N	112W	478	UTAH
55	0.0342800	-0.0461600	P	37N	116W	41	SOUTHERN NEVADA
56	0.0321200	-0.0468700	P	38N	119W	40	CALIFORNIA-NEVADA BORDER
57	0.0296800	-0.0454700	P	37N	122W	39	CENTRAL CALIFORNIA
58	-0.0322567	-0.0457137	P	44N	150E	222	KURILE ISLANDS REGION
59	-0.0366000	-0.0460200	P	46N	144E	663	SEA OF OKHOTSK
60	0.0423000	-0.0440100	P	40N	105W	479	COLORADO
61	0.0331700	-0.0437700	P	34N	117W	43	SOUTHERN CALIFORNIA
62	0.0307928	-0.0431740	P	34N	120W	43	SOUTHERN CALIFORNIA
63	-0.0343000	-0.0440100	P	43N	147E	221	KURILE ISLANDS
64	-0.0366555	-0.0431740	P	43N	144E	224	HOKKAIDO, JAPAN, REGION
65	-0.0395880	-0.0431740	P	44N	140E	223	EASTERN SEA OF JAPAN
66	-0.0567600	-0.0429400	P	56N	111E	327	LAKE BAIKAL REGION
67	-0.0891300	-0.0432500	P	64N	55E	335	URAL MOUNTAINS REGION
68	0.0347900	-0.0412400	P	31N	114W	49	GULF OF CALIFORNIA
69	0.0322590	-0.0406344	P	32N	117W	45	CALIFORNIA-MEXICO BORDER
70	-0.0362700	-0.0402000	P	39N	144E	229	OFF E COAST HONSHU,JAPAN
71	-0.0381218	-0.0406344	P	41N	142E	224	HOKKAIDO, JAPAN, REGION
72	-0.0410543	-0.0406344	P	42N	138E	223	EASTERN SEA OF JAPAN
73	0.0357200	-0.0378100	P	28N	112W	49	GULF OF CALIFORNIA
74	0.0337253	-0.0380947	P	29N	114W	48	BAJA CALIFORNIA
75	-0.0395880	-0.0380947	P	39N	140E	227	HONSHU, JAPAN
76	-0.0383200	-0.0377600	P	37N	142E	229	OFF E COAST HONSHU,JAPAN
77	-0.0446810	-0.0378100	P	41N	133E	663	SEA OF JAPAN
78	-0.0381219	-0.0355551	P	34N	142E	229	OFF E COAST HONSHU,JAPAN
79	-0.0410543	-0.0355551	P	36N	138E	227	HONSHU, JAPAN
80	-0.0430300	-0.0352000	P	34N	139E	230	NEAR S.COAST HONSHU,JAPAN

TABLE 3.1.3

Coherent Array Beam Deployment (Set 411). Valid from 16 Feb 1973.

(Sheet 1 of 4)

BEAM NO	UX (S/KM)	UY (S/KM)	PHASE	LAT	LON	REGION NUMBER AND NAME	
81	-0.0428700	-0.0352100	P	37N	135E	660	SEA OF JAPAN
82	0.0523500	-0.0326000	P	37N	90W	485	EASTERN MISSOURI
83	0.0360600	-0.0341800	P	25N	110W	49	GULF OF CALIFORNIA
84	-0.0379400	-0.0338000	P	31N	142E	211	SOUTH OF HONSHU, JAPAN
85	-0.0377700	-0.0324700	P	29N	142E	211	SOUTH OF HONSHU, JAPAN
86	-0.0406400	-0.0334000	P	32N	138E	211	SOUTH OF HONSHU, JAPAN
87	-0.0425206	-0.0330154	P	34N	135E	233	NEAR S COAST OF S. HONSHU
88	0.0351900	-0.0305800	P	22N	109W	47	OFF W.COAST OF BAJA CALIF.
89	-0.0339000	-0.0294900	P	18N	146E	216	MARIANA ISLANDS
90	-0.0355800	-0.0297600	P	23N	143E	213	VOLCANO ISLANDS REGION
91	-0.0394700	-0.0315200	P	29N	139E	211	SOUTH OF HONSHU, JAPAN
92	-0.0381218	-0.0304758	P	27N	140E	212	BONIN ISLANDS REGION
93	-0.0439500	-0.0309300	P	32N	132E	236	SHIKOKU, JAPAN
94	-0.0623600	-0.0313000	P	51N	101E	333	USSR-MONGOLIA BORDER REG.
95	0.0343600	-0.0283100	P	19N	109W	53	REVILLA GIGEDO ISLANDS
96	-0.0344800	-0.0278300	P	13N	145E	216	MARIANA ISLANDS
97	-0.0456800	-0.0269000	P	27N	129E	238	RYUKYU ISLANDS
98	-0.0449700	-0.0285400	P	29N	130E	238	RYUKYU ISLANDS
99	-0.0547600	-0.0272300	P	37N	115E	658	NORTHEASTERN CHINA
100	-0.0895300	-0.0272300	P	61N	56E	335	URAL MOUNTAINS REGION
101	0.0381241	-0.0253965	P	19N	102W	57	MICHOACAN, MEXICO
102	0.0357900	-0.0266500	P	19N	106W	54	OFF COAST OF JALISCO, MEX
103	-0.0470900	-0.0254200	P	26N	126E	238	RYUKYU ISLANDS
104	0.0429200	-0.0219900	P	17N	96W	60	OAXACA, MEXICO
105	0.0396600	-0.0231500	P	17N	98W	59	GUERRERO, MEXICO
106	-0.0493600	-0.0217700	P	23N	121E	244	TAIWAN
107	-0.0486600	-0.0234100	P	24N	123E	246	SOUTHWESTERN RYUKYU IS.
108	-0.0729899	-0.0238100	P	54N	81E	326	CENTRAL RUSSIA
109	0.0915100	-0.0193800	P	58N	33W	402	NORTH ATLANTIC OCEAN
110	0.0442600	-0.0201100	P	16N	93W	61	CHIAPAS, MEXICO
111	0.0354900	-0.0207200	P	9N	103W	63	OFF COAST OF MEXICO
112	-0.0486000	-0.0203000	P	20N	121E	248	PHILIPPINE ISLANDS REGION
113	0.0425229	-0.0177776	P	14N	92W	69	NEAR COAST OF CHIAPAS, MEX
114	0.0353200	-0.0168300	P	3N	102W	693	E. CENTRAL PACIFIC OCEAN
115	-0.0450100	-0.0184400	P	11N	125E	251	SAMAR, PHILIPPINE ISLANDS
116	-0.0472800	-0.0183900	P	16N	121E	249	LUZON, PHILIPPINE ISLANDS
117	-0.0710800	-0.0166000	P	50N	79E	329	EASTERN KAZAKH SSR
118	0.0477700	-0.0162600	P	17N	87W	94	CARIBBEAN SEA
119	0.0440200	-0.0160700	P	13N	90W	71	NEAR COAST OF GUATEMALA
120	-0.0442800	-0.0163500	P	5N	126E	259	MINDANAO, PHILIPPINE IS.
121	-0.0462000	-0.0156000	P	13N	121E	250	MINDORO, PHILIPPINE IS.
122	-0.0586495	-0.0152379	P	27N	105E	664	EASTERN CHINA
123	-0.0615821	-0.0152379	P	33N	99E	325	TSINGHAI PROVINCE, CHINA
124	-0.0636700	-0.0155100	P	37N	96E	325	TSINGHAI PROVINCE, CHINA
125	-0.0674471	-0.0152379	P	43N	89E	332	NORTHERN SINKIANG PROV.
126	-0.0700800	-0.0150600	P	47N	82E	331	KAZAKH-SINKIANG BORDER
127	0.0452500	-0.0135000	P	12N	87W	74	NEAR COAST OF NICARAGUA
128	-0.0601158	-0.0126983	P	28N	100E	307	SZECHWAN PROVINCE, CHINA
129	-0.0630484	-0.0126983	P	33N	96E	325	TSINGHAI PROVINCE, CHINA
130	-0.0659809	-0.0126983	P	38N	91E	325	TSINGHAI PROVINCE, CHINA
131	-0.0689133	-0.0126983	P	42N	86E	332	NORTHERN SINKIANG PROV.
132	0.0453600	-0.0106700	P	10N	84W	78	COSTA RICA
133	0.0373800	-0.0098600	P	0N	91W	697	GALAPAGOS ISLANDS
134	-0.0453500	-0.0108600	P	0N	121E	265	NORTHERN CELEBES
135	-0.0586495	-0.0101586	P	23N	101E	318	YUNAN PROVINCE, CHINA
136	-0.0615821	-0.0101586	P	28N	96E	313	INDIA-CHINA BORDER REGION
137	-0.0645146	-0.0101586	P	33N	92E	325	TSINGHAI PROVINCE, CHINA
138	-0.0674471	-0.0101586	P	38N	87E	321	SOUTHERN SINKIANG PROV.
139	-0.0703797	-0.0101586	P	42N	83E	332	NORTHERN SINKIANG PROV.
140	0.0836599	-0.0080900	P	54N	36W	402	NORTH ATLANTIC OCEAN
141	0.0443300	-0.0077000	P	8N	82W	80	PANAMA-COSTA RICA BORDER
142	0.0396500	-0.0067200	P	3N	84W	76	OFF COAST OF CENT.AMERICA
143	-0.0601158	-0.0076190	P	23N	98E	297	BURMA-CHINA BORDER REGION
144	-0.0630484	-0.0076190	P	28N	93E	313	INDIA-CHINA BORDER REGION
145	-0.0659809	-0.0076190	P	33N	89E	306	TIBET
146	0.0566300	-0.0043200	P	20N	71W	88	DOMINICAN REPUBLIC REGION
147	0.0458900	-0.0043500	P	8N	78W	81	PANAMA
148	-0.0615821	-0.0050793	P	23N	94E	294	BURMA-INDIA BORDER REGION
149	-0.0645146	-0.0050793	P	28N	90E	306	TIBET
150	-0.0714999	-0.0063000	P	41N	79E	320	KIRGIZ-SINKIANG BORDER
151	0.0429500	-0.0030000	P	5N	78W	83	SOUTH OF PANAMA
152	0.0406900	-0.0026300	P	2N	79W	83	SOUTH OF PANAMA
153	0.0389900	-0.0031600	P	0N	81W	104	OFF COAST OF ECUADOR
154	0.0379200	-0.0016400	P	4S	81W	109	NEAR COAST OF N. PERU
155	-0.0601158	-0.0025397	P	17N	94E	296	BURMA
156	-0.0631900	-0.0032200	P	24N	91E	315	INDIA-BANGLADESH BORDER
157	-0.0662100	-0.0033300	P	30N	87E	306	TIBET
158	-0.0689133	-0.0025397	P	34N	83E	306	TIBET
159	-0.0718459	-0.0025397	P	39N	78E	321	SOUTHERN SINKIANG PROV.
160	0.0574100	-0.0011700	P	19N	68W	402	NORTH ATLANTIC OCEAN

TABLE 3.1.3 (Cont.)

Coherent Array Beam Deployment (Set 411). Valid from 16 Feb 1973. (Sheet 2 of 4)

BEAM NO	UX (S/KM)	UY (S/KM)	PHASE	LAT	LON	REGION NUMBER AND NAME	
161	0.0435700	-0.0011600	P	5N	76W	103	COLOMBIA
162	0.0423400	0.0012700	P	3N	75W	103	COLOMBIA
163	0.0370100	0.0004700	P	7S	80W	108	OFF COAST OF N. PERU
164	0.0386000	-0.0002300	P	2S	78W	107	ECUADOR
165	-0.0481100	-0.0006000	P	6S	105E	276	SUNDA STRAIT
166	-0.0512500	0.0005400	P	2N	98E	706	NORTHERN SUMATRA
167	-0.0494300	0.0003400	P	2S	101E	274	SOUTHERN SUMATRA
168	-0.0543500	0.0007600	P	6N	96E	704	NICOBAR ISLANDS REGION
169	-0.0566000	0.0007900	P	9N	94E	704	NICOBAR ISLANDS REGION
170	-0.0586495	0.0	P	12N	93E	703	ANDAMAN ISLANDS REGION
171	-0.0666000	-0.0003000	P	28N	85E	310	NEPAL
172	-0.0735300	-0.0006100	P	40N	75E	320	KIRGIZ-SINKIANG BORDER
173	0.0578500	0.0020200	P	19N	65W	90	PUERTO RICO REGION
174	0.0496400	0.0020000	P	10N	71W	100	LAKE MARACAIBO
175	0.0467800	0.0017900	P	7N	73W	99	NORTHERN COLOMBIA
176	-0.0700300	0.0027200	P	32N	79E	304	KASHMIR-TIBET BORDER REG.
177	-0.0685900	0.0024400	P	29N	81E	310	NEPAL
178	-0.0718459	0.0025396	P	35N	77E	302	EASTERN KASHMIR
179	-0.0747785	0.0025396	P	41N	72E	716	KIRGIZ SSR
180	-0.0839100	0.0024000	P	52N	55E	335	URAL MOUNTAINS REGION
181	0.0578800	0.0052500	P	18N	63W	92	LEEWARD ISLANDS
182	0.0377900	0.0051300	P	7S	76W	111	NORTHERN PERU
183	-0.0733122	0.0050793	P	36N	74E	720	NORTHWESTERN KASHMIR
184	-0.0762448	0.0050793	P	41N	69E	716	KIRGIZ SSR
185	0.0655800	0.0076700	P	51N	30W	403	NORTH ATLANTIC RIDGE
186	0.0572300	0.0080400	P	16N	61W	92	LEEWARD ISLANDS
187	-0.0718459	0.0076189	P	32N	74E	711	SOUTHWESTERN KASHMIR
188	-0.0747785	0.0076189	P	37N	71E	717	AFGHANISTAN-USSR BORDER
189	0.0560800	0.0096800	P	13N	61W	95	WINDWARD ISLANDS
190	0.0533800	0.0090000	P	11N	62W	95	WINDWARD ISLANDS
191	0.0365400	0.0106300	P	10S	71W	112	PERU-BRAZIL BORDER REGION
192	-0.0743959	0.0099000	P	35N	70E	718	HINDU KUSH REGION
193	0.0352000	0.0132000	P	14S	69W	118	PERU-BOLIVIA BORDER REG.
194	-0.0760000	0.0127000	P	36N	67E	718	HINDU KUSH REGION
195	-0.0739000	0.0125000	P	33N	69E	709	AFGHANISTAN
196	-0.0654200	0.0157700	P	17N	74E	314	INDIA
197	-0.0725600	0.0149800	P	30N	69E	710	PAKISTAN
198	0.0333500	0.0175700	P	18S	64W	120	BOLIVIA
199	-0.0821500	0.0178700	P	44N	55E	336	WESTERN KAZAKH SSR
200	0.0674494	0.0203172	P	28N	45W	403	NORTH ATLANTIC RIDGE
201	0.0643100	0.0207600	P	25N	46W	403	NORTH ATLANTIC RIDGE
202	-0.0718300	0.0193300	P	27N	67E	710	PAKISTAN
203	-0.0863900	0.0210700	P	48N	48E	336	WESTERN KAZAKH SSR
204	0.0796000	0.0227600	P	46N	28W	403	NORTH ATLANTIC RIDGE
205	0.0700499	0.0229100	P	31N	41W	403	NORTH ATLANTIC RIDGE
206	0.0601181	0.0228568	P	21N	46W	403	NORTH ATLANTIC RIDGE
207	0.0574800	0.0232100	P	18N	47W	403	NORTH ATLANTIC RIDGE
208	-0.0772099	0.0232200	P	35N	59E	348	IRAN
209	0.0733145	0.0253965	P	36N	36W	403	NORTH ATLANTIC RIDGE
210	0.0536900	0.0264100	P	15N	46W	403	NORTH ATLANTIC RIDGE
211	-0.0402100	0.0263400	P	24S	70E	429	MID-INDIAN RISE
212	-0.0500800	0.0265900	P	5S	68E	426	CHAGOS ARCHIPELAGO REGION
213	-0.0703797	0.0253965	P	25N	63E	354	WESTERN PAKISTAN
214	0.0761000	0.0282800	P	41N	30W	404	AZORES ISLANDS REGION
215	0.0508500	0.0288400	P	12N	45W	403	NORTH ATLANTIC RIDGE
216	-0.0408900	0.0274600	P	20S	67E	429	MID-INDIAN RISE
217	-0.0434500	0.0274300	P	14S	66E	429	MID-INDIAN RISE
218	-0.0472900	0.0271500	P	9S	67E	429	MID-INDIAN RISE
219	-0.0546200	0.0273900	P	1N	66E	421	CARLSBERG RIDGE
220	-0.0724300	0.0270400	P	27N	60E	353	SOUTHERN IRAN
221	-0.0785900	0.0268100	P	36N	55E	348	IRAN
222	-0.0573700	0.0317300	P	6N	61E	421	CARLSBERG RIDGE
223	-0.0725000	0.0302000	P	27N	57E	353	SOUTHERN IRAN
224	-0.0755900	0.0312200	P	32N	54E	348	IRAN
225	0.0483880	0.0330154	P	10N	42W	403	NORTH ATLANTIC RIDGE
226	-0.0725000	0.0324000	P	28N	55E	353	SOUTHERN IRAN
227	-0.0773000	0.0335000	P	36N	50E	348	IRAN
228	-0.0807800	0.0329800	P	43N	45E	337	EASTERN CAUCASUS
229	-0.0589800	0.0350300	P	10N	57E	421	CARLSBERG RIDGE
230	-0.0622200	0.0349200	P	15N	56E	417	ARABIAN SEA
231	-0.0732000	0.0364000	P	31N	50E	348	IRAN
232	-0.0721100	0.0346400	P	28N	53E	353	SOUTHERN IRAN
233	-0.0609100	0.0386200	P	15N	53E	417	ARABIAN SEA
234	-0.0760900	0.0392000	P	38N	45E	344	N.W. IRAN-USSR BORDER REG
235	0.0448700	0.0397200	P	8N	37W	406	C. MID-ATLANTIC RIDGE
236	-0.0732000	0.0406000	P	34N	46E	347	WESTERN IRAN
237	0.0659500	0.0419900	P	37N	25W	405	AZORES ISLANDS
238	0.0414900	0.0439400	P	4N	33W	406	C. MID-ATLANTIC RIDGE
239	-0.0577300	0.0428700	P	13N	49E	415	EASTERN GULF OF ADEN
240	-0.0736000	0.0429700	P	39N	41E	366	TURKEY

TABLE 3.1.3 (Cont.)

Coherent Array Beam Deployment (Set 411). Valid from 16 Feb 1973.
(Sheet 3 of 4)

BEAM NO	UX (S/KM)	UY (S/KM)	PHASE	LAT	LON	REGION NUMBER AND NAME	
241	0.0361200	0.0459100	P	1N	30W	406	C. MID-ATLANTIC RIDGE
242	0.0110600	0.0455900	P	23S	13W	410	SOUTH ATLANTIC RIDGE
243	-0.0188100	0.0454100	P	26S	28E	584	REPUBLIC OF SOUTH AFRICA
244	0.0325800	0.0493900	P	1N	26W	406	C. MID-ATLANTIC RIDGE
245	0.0132100	0.0485400	P	18S	13W	410	SOUTH ATLANTIC RIDGE
246	0.0293265	0.0507930	P	1S	24W	406	C. MID-ATLANTIC RIDGE
247	0.0162300	0.0510100	P	13S	14W	410	SOUTH ATLANTIC RIDGE
248	-0.0222700	0.0506600	P	17S	29E	580	RHODESIA
249	-0.0293800	0.0508200	P	11S	34E	577	MALAWI
250	-0.0516000	0.0501200	P	12N	43E	555	WESTERN ARABIAN PENINSULA
251	-0.0330300	0.0537200	P	4S	35E	573	TANZANIA
252	-0.0459100	0.0538200	P	10N	39E	558	ETHIOPIA
253	-0.0655100	0.0539800	P	37N	36E	366	TURKEY
254	0.0258300	0.0550400	P	0N	18W	406	C. MID-ATLANTIC RIDGE
255	0.0185000	0.0547000	P	7S	13W	408	ASCENSION ISLAND REGION
256	-0.0270400	0.0562700	P	7S	30E	572	LAKE TANGANYIKA REGION
257	-0.0528700	0.0555800	P	20N	39E	555	WESTERN ARABIAN PENINSULA
258	0.0211600	0.0573100	P	2S	13W	407	NORTH OF ASCENSION ISLAND
259	-0.0298600	0.0596300	P	1N	30E	568	UGANDA
260	-0.0687600	0.0590700	P	41N	33E	366	TURKEY
261	-0.0811900	0.0575800	P	45N	34E	361	CRIMEA REGION
262	-0.0581000	0.0616500	P	35N	33E	372	CYPRUS
263	-0.0512400	0.0632100	P	28N	33E	553	UNITED ARAB REPUBLIC
264	0.0441000	0.0659200	P	36N	11W	402	NORTH ATLANTIC OCEAN
265	-0.0513182	0.0685706	P	37N	29E	366	TURKEY
266	-0.0452900	0.0716799	P	35N	27E	369	DODECANESE ISLANDS
267	-0.0561400	0.0702200	P	39N	28E	366	TURKEY
268	0.0306400	0.0755900	P	36N	4W	385	STRAITS OF GIBRALTER
269	-0.0381218	0.0761895	P	35N	24E	370	CRETE
270	0.0110300	0.0846300	P	36N	5E	396	ALGERIA
271	-0.0082600	0.1054600	P	44N	12E	545	NORTHERN ITALY
272	-0.0166900	0.0918900	P	39N	15E	390	SOUTHERN ITALY
273	-0.0295100	0.1043299	P	43N	17E	383	YUGOSLAVIA
274	-0.0337230	0.0787292	P	36N	22E	368	SOUTHERN GREECE
275	-0.0336800	0.0836400	P	38N	21E	364	GREECE
276	-0.0373900	0.0926400	P	41N	20E	391	ALBANIA
277	-0.0440400	0.0806600	P	39N	24E	365	AEGEAN SEA
278	-0.0731699	0.0846900	P	46N	27E	358	RUMANIA
279	-0.0540100	-0.0474300	PP	14N	145E	216	MARIANA ISLANDS
280	-0.0433800	-0.0457300	PP	9S	159E	193	SOLOMON ISLANDS
281	-0.0493300	-0.0420300	PP	5S	152E	192	NEW BRITAIN REGION
282	-0.0677900	-0.0285600	PP	20N	121E	248	PHILIPPINE ISLANDS REGION
283	-0.0615821	-0.0253965	PP	2S	132E	196	WEST NEW GUINEA REGION
284	-0.0653400	-0.0242600	PP	5N	126E	259	MINDANAO, PHILIPPINE IS.
285	-0.0684900	-0.0244300	PP	13N	121E	250	MINDORO, PHILIPPINE IS.
286	-0.0101900	-0.0285900	PKP	24S	176W	171	SOUTH OF FIJI ISLANDS
287	-0.0136800	-0.0286900	PKP	25S	180W	171	SOUTH OF FIJI ISLANDS
288	-0.0118800	-0.0250200	PKP	28S	177W	177	KERMADEC ISLANDS REGION
289	-0.0135100	-0.0225700	PKP	32S	179W	179	SOUTH OF KERMADEC ISLANDS
290	-0.0170200	-0.0165400	PKP	14S	167E	186	NEW HEBRIDES ISLANDS
291	-0.0081300	-0.0153900	PKP	16S	174W	173	TONGA ISLANDS
292	-0.0104500	-0.0154600	PKP	19S	179W	181	FIJI ISLANDS REGION
293	-0.0153400	-0.0160500	PKP	23S	172E	189	LOYALTY ISLANDS REGION
294	-0.0189700	-0.0139700	PKP	8S	158E	193	SOLOMON ISLANDS
295	-0.0201300	-0.0122100	PKP	5S	152E	192	NEW BRITAIN REGION
296	-0.0241300	-0.0064500	PKP	9S	130E	290	TIMOR SEA
297	0.0112900	-0.0030500	PKP	23S	113W	685	EASTER ISLAND REGION
298	0.0116700	0.0025300	PKP	36S	103W	692	SOUTHERN PACIFIC OCEAN
299	0.0108500	0.0074100	PKP	42S	90W	692	SOUTHERN PACIFIC OCEAN
300	0.0105400	0.0095400	PKP	30S	71W	135	NEAR COAST OF C. CHILE
301	0.0199200	0.0104600	PKP	37S	72W	136	CENTRAL CHILE
302	0.0193200	0.0114700	PKP	46S	75W	144	NEAR COAST OF S. CHILE
303	-0.0013500	0.0230600	PKP	59S	26W	153	SOUTH SANDWICH IS. REGION
304	-0.0001200	0.0196000	PKP	56S	30W	153	SOUTH SANDWICH IS. REGION
305	-0.0052000	0.0209000	PKP	55S	2W	410	SOUTH ATLANTIC RIDGE
306	-0.0106000	0.0205700	PKP	54S	27E	430	SOUTH OF AFRICA
307	-0.0330600	-0.0060300	PKKP	16S	73W	115	NEAR COAST OF PERU
308	0.0216200	0.0132000	PKKP	6S	131E	281	TANIMBAR ISLANDS REGION
309	0.0180800	0.0116800	PKKP	11N	121E	254	PANAY, PHILIPPINE ISLANDS
310	0.0183900	0.0196500	PKKP	4S	142E	202	NEW GUINEA
311	0.0187900	0.0238300	PKKP	7S	148E	207	EAST NEW GUINEA REGION
312	0.0159600	0.0278000	PKKP	7S	154E	193	SOLOMON ISLANDS
313	-0.0097400	-0.0391300	SKP	19S	175W	173	TONGA ISLANDS
314	-0.0134400	-0.0381900	SKP	19S	179W	181	FIJI ISLANDS REGION
315	-0.0258400	-0.0332200	SKP	18S	168E	186	NEW HEBRIDES ISLANDS
316	-0.0198000	-0.0234800	SKP	22S	170E	189	LOYALTY ISLANDS REGION
317	-0.0157900	-0.0359900	PCP	52N	174W	7	ANDREANOF IS., ALEUTIANS
318	-0.0192600	-0.0339000	PCP	51N	158E	218	NEAR EAST COAST KAMCHATKA

TABLE 3.1.3 (Cont.)

Coherent Array Beam Deployment (Set 411). Valid from 16 Feb 1973.
(Sheet 4 of 4).

Beam Set 411 (02/06/73) Part II

BEAM NO	UX (S/KM)	UY (S/KM)	PHASE	LAT.	LON	REGION NUMBER AND NAME	
1	0.0[illegible]85900	-0.0913900	P	83N	7W	641	NORTH OF SVALBARD
2	-0.0638100	-0.0873700	P	73N	55E	648	NOVAYA ZEMLYA
3	0.0[illegible]94000	-0.0634400	P	61N	152W	2	SOUTHERN ALASKA
4	0.0[illegible]19500	-0.0575700	P	54N	163W	10	UNIMAK ISLAND REGION
5	-0.0[illegible]84800	-0.0557100	P	52N	178W	7	ANDREANOF IS., ALEUTIANS
6	-0.0205266	-0.0558723	P	56N	162E	218	NEAR EAST COAST KAMCHATKA
7	0.0247000	-0.0545300	P	50N	130W	25	VANCOUVER ISLAND REGION
8	-0.0151900	-0.0542303	P	52N	172E	5	NEAR ISLANDS, ALEUTIANS
9	0.0382900	-0.0498000	P	44N	111W	458	HEBGEN LAKE REGION
10	-0.0699700	-0.0509800	P	67N	67E	335	URAL MOUNTAINS REGION
11	-0.0282200	-0.0488500	P	47N	154E	221	KURILE ISLANDS
12	-0.0366555	-0.0431740	P	43N	144E	224	HOKKAIDO, JAPAN, REGION
13	-0.0567600	-0.0429400	P	56N	111E	327	LAKE BAIKAL REGION
14	0.0347900	-0.0412400	P	31N	114W	49	GULF OF CALIFORNIA
15	-0.0379400	-0.0338000	P	31N	142E	211	SOUTH OF HONSHU, JAPAN
16	-0.0339000	-0.0294900	P	18N	146E	216	MARIANA ISLANDS
17	0.0343600	-0.0283100	P	19N	109W	53	REVILLA GIGEDO ISLANDS
18	-0.0456800	-0.0269000	P	27N	129E	238	RYUKYU ISLANDS
19	-0.0547600	-0.0272300	P	37N	115E	658	NORTHEASTERN CHINA
20	-0.0895300	-0.0272300	P	61N	56E	335	URAL MOUNTAINS REGION
21	-0.0493600	-0.0217700	P	23N	121E	244	TAIWAN
22	-0.0729899	-0.0238100	P	54N	81E	326	CENTRAL RUSSIA
23	0.0915100	-0.0193800	P	58N	33W	402	NORTH ATLANTIC OCEAN
24	0.0425229	-0.0177776	P	14N	92W	69	NEAR COAST OF CHIAPAS,MEX
25	-0.0442800	-0.0163500	P	5N	126E	259	MINDANAO, PHILIPPINE IS.
26	-0.0836700	-0.0155100	P	37N	96E	325	TSINGHAI PROVINCE, CHINA
27	-0.0689133	-0.0126983	P	42N	86E	332	NORTHERN SINKIANG PROV.
28	-0.1[illegible]05400	-0.0126800	P	58N	50E	724	WESTERN RUSSIA
29	-0.0615821	-0.0050793	P	23N	94E	294	BURMA-INDIA BORDER REGION
30	-0.0718459	-0.0025397	P	39N	78E	321	SOUTHERN SINKIANG PROV.
31	-0.0478000	0.0	P	8S	105E	282	SOUTH OF JAVA
32	-0.0566000	0.0007900	P	9N	94E	704	NICOBAR ISLANDS REGION
33	0.0578500	0.0020200	P	19N	65W	90	PUERTO RICO REGION
34	-0.0685900	0.0024400	P	29N	81E	310	NEPAL
35	-0.0747785	0.0025396	P	41N	72E	716	KIRGIZ SSR
36	-0.0839100	0.0024000	P	52N	55E	335	URAL MOUNTAINS REGION
37	-0.1[illegible]55559	0.0061700	P	55N	45E	724	WESTERN RUSSIA
38	-0.0747785	0.0076189	P	37N	71E	717	AFGHANISTAN-USSR BORDER
39	-0.0725600	0.0149800	P	30N	69E	710	PAKISTAN
40	-0.1[illegible]31500	0.0158000	P	53N	44E	724	WESTERN RUSSIA
41	-0.0863900	0.0210700	P	48N	48E	336	WESTERN KAZAKH SSR
42	0.0796000	0.0227600	P	46N	28W	403	NORTH ATLANTIC RIDGE
43	-0.0772099	0.0232200	P	35N	59E	348	IRAN
44	0.0733145	0.0253965	P	36N	36W	403	NORTH ATLANTIC RIDGE
45	-0.0500800	0.0265900	P	5S	68E	426	CHAGOS ARCHIPELAGO REGION
46	0.0483880	0.0330154	P	10N	42W	403	NORTH ATLANTIC RIDGE
47	-0.0725000	0.0324000	P	28N	55E	353	SOUTHERN IRAN
48	-0.0807800	0.0329800	P	43N	45E	337	EASTERN CAUCASUS
49	-0.0622200	0.0349200	P	15N	56E	417	ARABIAN SEA
50	-0.0732000	0.0436000	P	34N	46E	347	WESTERN IRAN
51	0.0132100	0.0485400	P	18S	13W	410	SOUTH ATLANTIC RIDGE
52	-0.0516000	0.0501200	P	12N	43E	555	WESTERN ARABIAN PENINSULA
53	0.0258300	0.0550400	P	0N	18W	406	C. MID-ATLANTIC RIDGE
54	-0.0270400	0.0562700	P	7S	30E	572	LAKE TANGANYIKA REGION
55	-0.0511900	0.0575800	P	45N	34E	361	CRIMEA REGION
56	0.0441000	0.0659200	P	36N	11W	402	NORTH ATLANTIC OCEAN
57	-0.0452900	0.0716799	P	35N	27E	369	DODECANESE ISLANDS
58	-0.0561400	0.0702200	P	39N	28E	366	TURKEY
59	-0.0336800	0.0836400	P	38N	21E	364	GREECE
60	-0.0135100	-0.0225700	PKP	32S	179W	179	SOUTH OF KERMADEC ISLANDS
61	-0.0170200	-0.0165400	PKP	14S	167E	186	NEW HEBRIDES ISLANDS
62	-0.0[illegible]84000	-0.0148100	PKP	20S	175W	173	TONGA ISLANDS
63	-0.0201300	-0.0122100	PKP	5S	152E	192	NEW BRITAIN REGION
64	-0.0[illegible]13500	0.0220600	PKP	59S	26W	153	SOUTH SANDWICH IS. REGION

TABLE 3.1.4

Incoherent Array Beam Deployment (Set 411). Valid from 6 Feb 1973.

3.2 Event Processor Operation

3.2.1 General Considerations

The EP operation in this reporting period was characterized by continuity and stability, and the analysts have further improved their skills. Still, a number of important changes have been implemented of which the more important are

- The filter setting has been regionalized and made a function of beam number.
- The processing method, beampacking or beamforming, has also been regionalized. Correlation is now dropped completely in on-line operation.
- The EP plotted and printed output has been streamlined, thereby reducing the paper output to 1/3 of the previous amount.

Details of these and other changes are given below.

Table 3.2.1 shows the number of detections processed by EP and what were the decisions of the analysts.

Analyst Classification	Number of Processings	Percentage
Accepted as events	3899	50.0
Rejected as being		
- Noise detections	1743	22.3
- Local events	1110	14.2
- Double processings	601	7.7
- Communication errors	449	5.8
Sum processed	7802	100.0

TABLE 3.2.1

Analyst decisions for detections processed by EP during the time period 1 Jan - 30 Jun 1973.

The numbers are fairly similar to those for the previous reporting period, although the number of accepted events has increased slightly and the number of noise detections is somewhat reduced. Around 200 (or 3%) fewer detections have been processed by EP, reflecting that the EP processing thresholds have been kept around the same values, 3.6 for Partition I (coherent) and 1.6 for Partition II (incoherent).

The automatic DP bulletin mentioned in the previous Operations Report has from 18 May 1973 been distributed by Telex to seismological institutions in Scandinavia. The bulletin, which is entirely based on DP data, is sent out every workday morning covering the previous day. In this way the receiving institutions have a reliable list of epicenters already when they start reading their own seismograms. The response indicates that the bulletin is greatly appreciated. Fig. 3.2.1 shows a sample copy of the DP bulletin, which on an average reports 20% less events than the final weekly bulletin, and contains around 10% false alarms. Being 100% automated, this is considered fairly satisfactory.

3.2.2 Computer Utilization

During this reporting period EP was up 40.3% of the time, according to Table 3.1.2. This is 5.5% less than for the previous period, while the number of processed detections has decreased by around 3%. This reflects that the computer usage from EP now is stabilized, and at a level where a sufficient amount of computer time also is allocated to other purposes. The problems with the plotter capacity which has been reported on previously has now been eliminated, and for two reasons: (1) a second plotter has been installed, (2) the EP plots have been reduced to 1/3 in size.

46 920+
853 +? 121199+
11.22
121199 seism sf
18147 kcin n
start norsar seismic bulletin

arr.time	beam	part	snr	vel	azi	phase	lat	lon	mb
21 jun 1973									
0.14.35.4	63	1	12.8	17.9	37.9	p	43n	147e	4.0
0.35.20.4	78	1	4.9	19.2	47.0	p	34n	142e	3.7
1. 3.11.4	107	1	5.7	18.5	64.3	p	24n	123e	3.9
1.55.14.9	227	1	15.4	11.9	113.4	p	36n	50e	4.1
2.34.45.9	64	1	4.3	17.7	40.3	p	43n	144e	3.8
2.37.50.9	175	1	5.4	21.4	267.8	p	7n	73w	3.8
3.22.49.4	192	1	4.2	13.3	97.6	p	35n	70e	3.5
5.12. 1.9	70	1	4.5	18.5	42.1	p	39n	144e	3.7
5.32.32.9	63	1	36.1	17.9	37.9	p	43n	147e	4.7
5.51. 5.4	63	1	4.4	17.9	37.9	p	43n	147e	3.7
6. 9.43.9	64	1	10.5	17.7	40.3	p	43n	144e	4.0
8.17. 8.4	63	1	11.2	17.9	37.9	p	43n	147e	4.1
9.12.59.4	197	1	9.9	13.5	101.7	p	30n	69e	3.9
9.15.23.9	98	1	9.9	18.3	57.6	p	29n	130e	4.1
10.33.25.4	64	1	5.6	17.7	40.3	p	43n	144e	3.9
11.28.24.9	80	1	4.2	18.8	48.7	p	34n	139e	3.8
12.35.56.5	28	2	3.4	9.9	82.8	p	58n	50e	3.3
18. 8.11.4	64	1	4.4	17.7	40.3	p	43n	144e	3.8
18.31.14.9	188	1	4.8	13.3	95.8	p	37n	71e	3.7
18.39.27.4	123	1	28.3	15.8	76.1	p	33n	99e	4.4
19.17.45.9	23	1	8.0	17.5	1.0	p	53n	167w	3.9
20.48.53.4	58	1	4.9	17.9	35.2	p	44n	150e	3.7
22. 3.53.9	289	1	13.0	38.0	30.9	pkp	32s	179w	3.9
22.27.42.4	63	1	7.0	17.9	37.9	p	43n	147e	4.0
22 jun 1973									
0. 1.11.4	20	1	7.1	17.4	359.1	p	54n	163w	3.8
0. 7.57.9	288	1	7.5	36.1	25.4	pkp	28s	177w	3.7
0.28.50.9	36	1	5.3	17.3	22.4	p	52n	160e	3.7
1. 8.28.9	289	1	20.0	38.0	30.9	pkp	32s	179w	4.0
1.20.52.9	36	1	9.2	17.3	22.4	p	52n	160e	4.0

end norsar seismic bulletin
18147 kcin n
121199 seism sf
35 955+

Fig. 3.2.1 Sample copy of the Telex-distributed NORSAR DP bulletin.

3.2.3 EP Operational Problems

Twice during this period, writing of EP-data to the TAL file on disk stopped completely. Both times the reason for this was that the Event Processor went down while writing to the TAL file, but before it was able to reset the status of the TAL file records from "being filled" to "data to be transmitted". The records were both times reset by an off-line program.

The designed accumulation of EP output on the Event Tape, together with the simultaneous use of this tape for editing, leads sometimes to loss of data and extra work for the analysts, when a bad tape drive or other hardware problems make the tape unreadable when it is nearly full. To avoid this problem, backups of the current Event Tape are taken at regular intervals.

3.2.4 EP Parameters and Algorithms

The following chronological list shows the major changes made in the EP software in this period:

6-8 February
The logic of using filters was changed. The filter base was reordered to include, besides an all-pass filter, a comb of filters with center frequencies from 1.8 Hz to 3.4 Hz all with bandwidth 2 Hz. The EP-controller reads a filter indicator from the Beam Location Table entry (byte 17) corresponding to the detection, and places this indicator in the Short Period Variable file record 1. It is subsequently read by the packages using the STFILT filter base, using the indicator as input to STFILT, to retrieve the desired filter. In this way the choice of filter

in EP is made dependent on the detection location. The Rerun Package was changed to incorporate an option for choosing a processing filter.

8 March
The lower threshold in SNR for events that should use the correlation refinement procedure was raised to 1000 in absolute value, thereby effectively preventing any event from using this procedure. Instead, all the events will use beampacking. However, the correlation refinement procedure still is available as an option for Reruns.

19 March
A table was inserted in the Event Processor Controller, giving upper and lower beam numbers for specific regions in both partitions, and the corresponding U-method code that should be used for the corresponding region. In this way, events from specific regions may be processed all in the same way. The table was initially only used for the Mediterranean area, with the U-method code equal to zero (use detected location, no refinement). This is done because any refinement procedure on events from this area usually gives a poorer solution than the original detected location. The EPX number of the event was added to the lines in the bulletin printed during a 'publish' mode of Job Step 3.

10 May
The default of U-method code for Reruns was changed to 2 (Beampacking). Various changes in the Job Step 3 packages, to 'streamline' the output:

- The high rate tape number appears on the DB File report for each event processed.
- The Parameter Report is not printed when Job Step 3 is in a 'publish' mode.

- The Plot Package was modified to give as output a plot with all the traces in one panel. The text is turned 90 degrees and put in front of the traces.
- The Summary Report Package was modified to give out a shortened Summary Report for all on-line events not using the correlation refinement technique (all events). Reruns will still have the full Summary Report printed out.

3.2.5 EP Performance Statistics

Table 3.2.2 shows the number of events reported by NORSAR on a monthly basis, together with a comparison with NOAA. The same is shown on a daily basis in Fig. 3.2.2. The large number of events in June is due to earthquake swarms from Kamchatka and Japan. The daily average for this half year period is 19.9 events.

Table 3.2.2 also shows the location differences between NORSAR and NOAA, and starts at Oct 1972 since the previous Operations Report gave the results up to Sep 1972. The results are not much different from those reported previously, although it is possible that a slight improvement can have been introduced by the new location corrections implemented in the beginning of December 1972. However, the final conclusion here cannot be made before more data is available from NOAA.

Month	NORSAR Number of Events		NORSAR/NOAA Comparison $0^{o}<\Delta<180^{o}$			NORSAR/NOAA Location Difference (km) $30^{o}<\Delta<90^{o}$		
	$0^{o}<\Delta<180^{o}$	$30^{o}<\Delta<90^{o}$	NORSAR only	NOAA only	NORSAR & NOAA	Events	50%	90%
Oct 72	496	399	324	142	170	93	140	380
Nov 72	427	349	245	165	179	97	160	640
Dec 72	708	625	322	267	381	198	120	300
Jan 73	487	401	271	174	211	126	140	440
Feb 73	502	412						
Mar 73	581	489						
Apr 73	579	478						
May 73	479	389						
Jun 73	978	884						

TABLE 3.2.2

Number of events reported by NORSAR Oct 72-Jun 73 and comparison with NOAA.

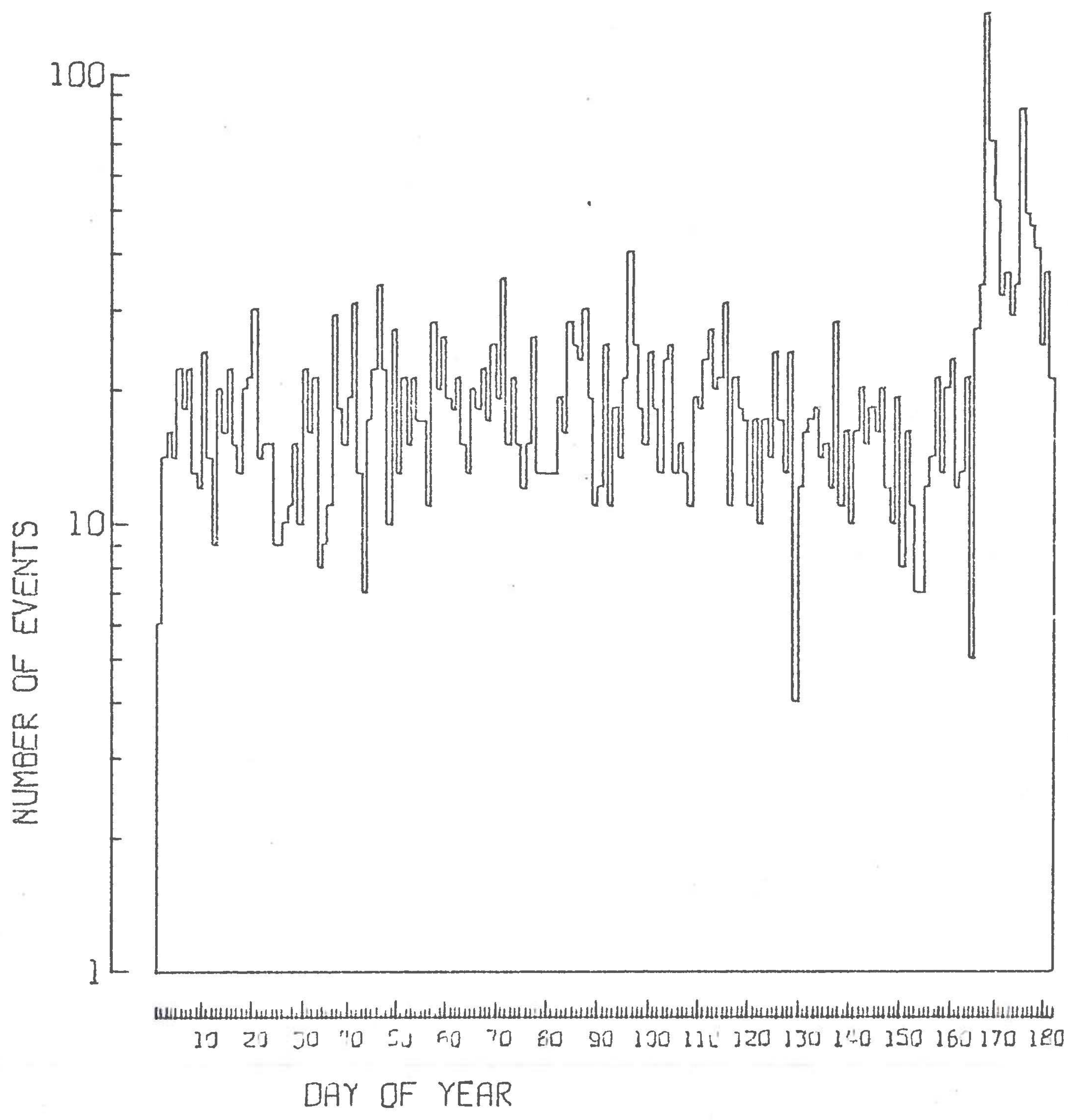

Fig. 3.2.2 Daily number of reported events vs. day of year for the time period 1 Jan - 30 Jun 1973.

3.3 Change Control Board (CCB)

The CCB makes decisions on Change Requests and initiates investigations of reported discrepancies. Board members are Operations Manager, Chief Programmer, and Chief Data and Systems Analysis, with other personnel attending as required. CCB meetings are held whenever there is a reasonable number of changes/discrepancies to review, or if an immediate meeting is required based on the judgment of one of the permanent members. Change Requests and Discrepancy Reports are filed by the board's secretary. An updated printout of status is presented at each meeting. Table 3.3.1 shows the activity of the CCB in the period.

NUMBER OF REQUESTS FOR EACH STATUS CODE		
	Status pr 31 Dec 72	Status pr 30 Jun 73
A	219	231
B	0	0
C	23	23
D	3	3
E	46	49
I	19	23
L	3	3
R	2	2
U	1	1
W	1	1

Code:
- A - Has been accomplished
- B - Is being implemented
- C - Has been cancelled
- D - Has been deferred, but will be reconsidered
- E - Has been adequately explained or answered
- I - Is being investigated
- L - Low priority
- R - Has been rejected
- U - Is presently unresolved
- W - Is waiting for implementation

TABLE 3.3.1

Change Control
(Reports closed before 31 Dec 72 not included)

Month	NORSAR Number of Events		NORSAR/NOAA Comparison $0^\circ<\Delta<180^\circ$			NORSAR/NOAA Location Difference $30^\circ<\Delta<90^\circ$		
	$0^\circ<\Delta<180^\circ$	$30^\circ<\Delta<90^\circ$	NORSAR only	NOAA only	NORSAR & NOAA	Events	50%	90%

3.4 Seismic Data Exchange

Distribution of the weekly seismic bulletin continued as before to about 50 institutions in 17 countries. Bulletins are received regularly from 9 institutions.

NORSAR data tapes were distributed to the following in the period:

E. Rygg, Seismological Obs. University of Bergen	4
E. Hjortenberg, University of Copenhagen	2
SDAC	179

3.5 Visitors

Nordic meeting on detection seismology, 30-31 January. Eight visitors from Denmark, Finland and Sweden.

Col. Wallace (AFOSR), Lt. Col. Stevens (EOARD), Capt. Rourke (AFOSR), Col. Heath (ESD) - 7-9 February.

A. Christoffersson, Univ. of Uppsala, Uppsala, Sweden, 12-23 February, 13 June - 7 July.

I. Noponen, Seismological Institute, Helsinki, Finland, 16-25 February, 10-20 June.

E. Hjortenberg, University of Copenhagen, 21 February-14 March.

W. Best, AFOSR, and Capt. Wilke, AFOSR, 10-14 April.

J. Capon, MIT Lincoln Lab, 16 May-4 June.

D. Doornbos, Vening Meinz Lab, Utrecht University, Utrecht, the Netherlands, 12 June-27 August.

J.M Vermeuleen, Utrecht University, Utrecht, the Netherlands, 18 June-to date.

N.M. Desourdy, Bolt Beranek and Newman, Inc., 11 June-2 July.

P. Kirstein, University of London, and L.G. Roberts, ARPA, 26-27 June.

Col. Kuehn, ESD, 27 June.

4. REFERENCES

The following NORSAR reports were issued in the period:

No. 53	Husebye, E.S., Progress Report 4th Quarter 1972.
No. 54	System Operations Report, 1 Jan - 30 Jun 1972.
No. 55	Hokland, B., Operating Instructions for EP/Job Step 4 Editing.
No. 56	System Operations Report, 1 Jul - 31 Dec 1972.
No. 57	Doornbos, D., and J. Vlaar, Regions of seismic wave scattering in the earth's mantle and precursors to PKP.
No. 58	Falch, K., Technical Description & operation instruction Ithaco Amplifier & Test Panel.
No. 59	Husebye, E.S., Progress Report 1st Quarter 1973.