

7 November 1977
76C073

QUARTERLY REPORT
ON THE
SEISMIC MONITORING NETWORK
IN THE VICINITY OF
INDIAN POINT, NEW YORK
CONSOLIDATED EDISON PROJECT
WCC/3

June 1977 through August 1977

INTRODUCTION

During this quarter a relatively low degree of natural seismicity occurred in the lower Hudson region. Two small events with magnitudes around 1.0 occurred near High Bridge and Hampton, New Jersey, approximately 65 miles southwest of Indian Point. Shortly after the end of the quarter on 2 September 1977, a small natural seismic event, accompanied by several aftershocks occurred near Peekskill, New York within the network. Only preliminary results of data analysis for the main event are presented here. A more comprehensive study of the sequence will be presented in the next quarterly report.

During this quarter the recording facility was relocated within the Woodward-Clyde Consultants Clifton office. This additional move was made to take advantage of the better air-conditioning facilities in the laboratory portion of the office.



PURPOSE

The objective of the seismic monitoring network is to provide identification and documentation of any microearthquakes or Naturally Occurring Seismic Events (NOSE) in the vicinity of the Indian Point Nuclear Power Station, and along adjacent portions of the Ramapo fault system. The primary task in achieving this objective is to separate the microearthquakes (NOSE) from the many seismic signals generated by quarrying and construction in the area.

DATA ANALYSIS

Routine Analysis

No basic changes were made in the analysis procedures during this quarter. The two small natural events in New Jersey were not detected during routine analysis but traces of these events were found on one or two of the more sensitive stations of our network after checking Lamont-Doherty data. The Indonesian earthquake of 19 August 1977 was used to check station polarities in addition to the periodic checks based on quarry blasts. Most of the teleseisms listed in Table 1 following 19 August are probably aftershocks of the Indonesian event.

Annsville Earthquake - 02 September 1977, Preliminary Results

At 01:53 am EDT a small earthquake occurred about 1 km NE of Annsville, New York. The magnitude is estimated to be about 2.5. The Peekskill police department reported calls from several people in the north part of the town who were awakened by the event. An initial hypocenter determination based on 21 phase readings from IPSMN and other stations in New York, New Jersey, and Connecticut follows:

Origin	05 hr 53 min 56.51 sec C.U.T.
N Latitude	41°N 18.80'
W Longitude	73°W 55.24'
Depth	1.87 km

Preliminary analysis of first motions at 18 stations yields a fault plane solution indicating thrust faulting on northwesterly trending faults. Nodal planes are:

Plane 1	Plane 2	
Strike Dip	Strike	Dip
N34°W 26°NE	N57-1/2°W+ 11-1/2°	66°+ 2°SW

STATUS OF THE NETWORK

The telemetry equipment was modified in order to reduce the number of necessary telephone lines between Indian Point and Clifton from four to two. Originally data was transmitted from the field stations over three different carriers, 1020Hz, 1700Hz, and 2380Hz; 1360Hz was used for the additional station at Indian Point. Data was multiplexed into four groups and recorded on four channels of the tape recorders. By modifying half of the telemetry equipment to use 680Hz, 1360Hz, and 2040Hz, with one station using 2720Hz, two of the telephone lines were eliminated. Since all the data are now recorded on two channels of the tape recorders, several components have been freed to act as spares in case of breakdowns.

Although a request had been made to the telephone company to reconfigure the existing thirteen point-to-point lines into two multipoint lines in May, this change had not been completed by the end of the quarter. When this change is complete the multiplexing bridges at Indian Point will be removed.

RESULTS

Of the 723 seismic events listed in Table I through Table IV nearly half, or 314 events are too small to determine phases. This number probably reflects summer construction activity. Forty teleseisms were noted during the first ten weeks of the quarter while thirty-nine teleseisms were noted following the Indonesian earthquake, thus almost half of the reported

teleseisms are probably Indonesian aftershocks. Only two small natural events occurred in the region during this quarter. These events occurred well beyond the limits of the network (approximately 65 mi southwest of Indian Point) and were barely detectable by the seismic monitoring network.

TABLE I

NATURALLY OCCURRING SEISMIC EVENTS

Within the Network

None

Regional Events

<u>Date</u>	<u>Time (cut)</u>	<u>Location</u>	<u>Magnitude</u>
01 June 1977	12:48	Near High Bridge, NJ	1.1
02 July 1977	11:13	Near Hampton, NJ	< 1

Teleseisms

<u>Date</u>	<u>Time (cut)</u>	<u>Date</u>	<u>Time (cut)</u>
06 June 1977	06:43	04 Aug 1977	13:27
06 June 1977	06:47	04 Aug 1977	18:52
08 June 1977	21:36	04 Aug 1977	20:52
08 June 1977	22:17	07 Aug 1977	07:14
12 June 1977	19:37	07 Aug 1977	07:17
14 June 1977	21:51	08 Aug 1977	02:02
19 June 1977	11:59	08 Aug 1977	07:06
21 June 1977	18:51	10 Aug 1977	07:27
22 June 1977	12:23	12 Aug 1977	00:26
(Tonga Island)		14 Aug 1977	04:29
27 June 1977	21:31	14 Aug 1977	21:58
28 June 1977	19:24	15 Aug 1977	20:31
29 June 1977	07:43	17 Aug 1977	16:59
		18 Aug 1977	22:43
13 July 1977	07:40	19 Aug 1977	05:28 (foreshock)
(Earthquake in Quebec)		19 Aug 1977	06:28
16 July 1977	18:11	(Earthquake in Indonesia)	
19 July 1977	19:34	19 Aug 1977	07:03
21 July 1977	02:29	19 Aug 1977	07:24
21 July 1977	12:12	19 Aug 1977	07:30
21 July 1977	14:04	19 Aug 1977	07:34
21 July 1977	22:00	19 Aug 1977	07:57
22 July 1977	17:35	19 Aug 1977	11:53
28 July 1977	01:58	19 Aug 1977	13:43
28 July 1977	15:29	19 Aug 1977	19:58
28 July 1977	18:05	19 Aug 1977	20:40
29 July 1977	11:34	19 Aug 1977	21:54
(Earthquake in Phillipines)		20 Aug 1977	02:51

Teleseisms

<u>Date</u>	<u>Time (cut)</u>	<u>Date</u>	<u>Time (cut)</u>
20 Aug 1977	03:57	26 Aug 1977	08:46
20 Aug 1977	04:18	26 Aug 1977	20:08
20 Aug 1977	04:40	27 Aug 1977	07:31
20 Aug 1977	09:41	28 Aug 1977	04:17
20 Aug 1977	19:36	28 Aug 1977	09:55
21 Aug 1977	02:32	29 Aug 1977	10:12
21 Aug 1977	02:41	29 Aug 1977	14:42
21 Aug 1977	07:10	29 Aug 1977	19:20
21 Aug 1977	10:59	29 Aug 1977	21:10
21 Aug 1977	15:56	30 Aug 1977	13:18
21 Aug 1977	20:49	30 Aug 1977	15:23
21 Aug 1977	20:57	30 Aug 1977	21:30
25 Aug 1977	18:24	31 Aug 1977	00:48
(Possibly Indonesia)			
25 Aug 1977	18:28		
25 Aug 1977	23:31		

TABLE II

PROBABLE NATURALLY OCCURRING SEISMIC EVENTS

None

TABLE III A

CLINTON POINT QUARRY BLASTS
 N41°37.5' W73°57.0

<u>Date</u>	<u>Time (cut)</u>
02 June 1977	16:07
03 June 1977	16:15
09 June 1977	16:02

No blasts from June 10 through July 31 because of a strike

02 Aug 1977	18:59
05 Aug 1977	16:59
12 Aug 1977	19:14
15 Aug 1977	17:04
17 Aug 1977	17:01
18 Aug 1977	17:17
22 Aug 1977	18:44
23 Aug 1977	17:39
25 Aug 1977	17:51
26 Aug 1977	18:57
29 Aug 1977	14:54
29 Aug 1977	17:07
31 Aug 1977	16:02

TABLE III B

HAYERSTRAW QUARRY BLASTS
 N41°10.6' W73°57.2'

<u>Date</u>	<u>Time (cut)</u>
02 June 1977	16:10
07 June 1977	16:10
08 June 1977	16:11
10 June 1977	16:10
14 June 1977	16:11
16 June 1977	16:09

No blasts in July

05 Aug 1977	16:12
10 Aug 1977	16:11
12 Aug 1977	16:00
16 Aug 1977	16:12
18 Aug 1977	16:10
23 Aug 1977	16:09
25 Aug 1977	16:29
29 Aug 1977	16:07
30 Aug 1977	16:09

TABLE III C

PLAZA MATERIALS QUARRY BLASTS
 N41°07.0' W74°08.8'

Date	Time (cut)
02 June 1977	13:09
15 June 1977	13:15
28 June 1977	15:57
01 July 1977	18:29
13 July 1977	13:00
14 July 1977	13:26
14 July 1977	15:42
26 July 1977	13:22
04 Aug 1977	13:00
26 Aug 1977	19:27

TABLE III D

WEST NYACK QUARRY BLASTS
N41°06.3' W73°57.5

<u>Date</u>	<u>Time</u>
01 June 1977	17:26

TABLE III G
ATLANTIC CEMENT QUARRY BLASTS

<u>Date</u>	<u>Time (cut)</u>
14 June 1977	17:48
24 June 1977	17:23
27 June 1977	18:43
14 July 1977	18:50
15 July 1977	17:08
20 July 1977	16:52
12 Aug 1977	19:00
16 Aug 1977	17:17
18 Aug 1977	17:17
25 Aug 1977	17:30

TABLE III F

Mt. Hope Quarry Blasts
40°N56.3 74°W32.3'

<u>Date</u>	<u>Time (cut)</u>
9 June 1977	16:38
27 June 1977	19:45
28 June 1977	17:12
6 July 1977	16:09
18 July 1977	16:20
25 July 1977	14:19
2 Aug 1977	19:31
18 Aug 1977	17:31

TABLE IV A

PROBABLE QUARRY OR OTHER MAN-MADE BLASTS
WITH DISTINCT PHASES

Date	Time (cut)	S-P (seconds) at		Nearest Station	Remarks
02 June 1977	18:52	14.0	STL		Possible Riverdale
04 June 1977	19:03	12.0	STL		
06 June 1977	17:28	4.0	STL		From South
06 June 1977	18.46	31.0	STL		
06 June 1977	19:15	4.0	OSB		Unconfirmed as Clinton Point
08 June 1977	18:30	38.0	STL		
08 June 1977	21:53	4.0	STL		From South
09 June 1977	17:06	5.0	STL		
13 June 1977	18:15	20.0	OSB		
14 June 1977	16:15	17.0	OSB		
15 June 1977	14:28	7.0	SNP		Possible quarry blast from Secaucus
15 June 1977	14:45	12.0	OSB		
15 June 1977	16:01	21.0	OSB		
15 June 1977	16:47	25.0	SNP		
15 June 1977	19:30	22.0	SNP		
16 June 1977	14:34	15.0	OSB		
16 June 1977	19:46	6.0	SNP		
17 June 1977	15:19	21.0	OSB		
17 June 1977	18:27	10.0	OSB		
20 June 1977	14:45	23.0	SNP		
20 June 1977	15:46	13.5	OSB		
20 June 1977	16:01	11.0	SNP		From South
20 June 1977	18:02	15.0	SNP		From South
20 June 1977	18:14	26.5	SNP		
21 June 1977	15:15	22.0	OSB		
21 June 1977	16:00	27.0	SNP		
21 June 1977	17:37	11.0	OSB		
21 June 1977	18:26		OSB		S-P not readable
22 June 1977	15:14	22.0	SNP		
22 June 1977	15:58	5.0	SNP		
22 June 1977	16:02	5.0	OSB		
22 June 1977	18:40	19.0	SNP		
22 June 1977	19:59	22.0	OSB		
23 June 1977	13:29	15.5	SNP		
23 June 1977	15:13	19.0	SNP		
23 June 1977	19:26	26.0	SNP		
24 June 1977	14:42	23.0	SNP		
24 June 1977	14:59	18.0	SNP		
24 June 1977	15:16	10.5	OSB		
24 June 1977	15:21	33.0	OSB		
24 June 1977	15:44	11.0	OSB		
24 June 1977	15:51	24.5	SNP		

TABLE IV A

PROBABLE QUARRY OR OTHER MAN-MADE BLASTS
WITH DISTINCT PHASES
(continued)

<u>Date</u>	<u>Time (cut)</u>	<u>S-P (seconds) at Nearest Station</u>	<u>Remarks</u>
25 June 1977	16:20	25.0 STL	
26 June 1977	13:54	24.0 STL	
27 June 1977	18:17	38.9 WGL	
27 June 1977	19:13	10.0 WGL	
28 June 1977	13:29	23.0 STL	
28 June 1977	14:13	6.0 STL	
28 June 1977	15:49	6.0 WGL	
28 June 1977	15:55	11.0 WGL	
28 June 1977	17:54	19.0 STL	
28 June 1977	18:30	35.0 DBM	
28 June 1977	19:18	45.0 STL	
29 June 1977	13:54	19.0 WGL	
29 June 1977	14:01	6.0 DBM	
29 June 1977	14:35	13.0 WGL	
29 June 1977	15:03	20.0 WGL	
29 June 1977	16:11	26.0 DBM	
30 June 1977	14:47	7.0 DBM	
30 June 1977	16:07	12.0 WGL	
30 June 1977	16:13	5.0 DBM	
30 June 1977	16:26	19.0 WGL	
30 June 1977	16:30	17.0 WGL	
01 July 1977	15:47	6.5 WGL	Possible quarry blast from Secaucus
01 July 1977	19:09	39.0 WGL	
02 July 1977	16:00	17.0 STL	
02 July 1977	17:18	39.0 WGL	
06 July 1977	16:07	5.0 WGL	
06 July 1977	18:29	2.0 CHR	
06 July 1977	19:45	16.0 WGL	
06 July 1977	20:28	12.0 WGL	
07 July 1977	17:35	17.0 CHR	
07 July 1977	18:25	12.0 CHR	
07 July 1977	19:15	4.0 WGL	
07 July 1977	20:34	4.0 WGL	
08 July 1977	15:44	3.0 SNP	
08 July 1977	17:19	12.0 CHR	
08 July 1977	21:17	40.0 CHR	
11 July 1977	12:46	16.0 WGL	
11 July 1977	13:18	9.0 CHR	
11 July 1977	13:56	13.0 CHR	
11 July 1977	14:06	13.0 WGL	
11 July 1977	14:47	12.0 WGL	
11 July 1977	15:10	7.0 WGL	

TABLE IV A

PROBABLE QUARRY OR OTHER MAN-MADE BLASTS
WITH DISTINCT PHASES
(continued)

<u>Date</u>	<u>Time (cut)</u>	<u>S-P (seconds) at Nearest Station</u>	<u>Remarks</u>
11 July 1977	16:56	9.0 WGL	
11 July 1977	18:31	15.0 CHR	
12 July 1977	16:13	18.0 CHR	
12 July 1977	16:23	11.0 CHR	
12 July 1977	19:23	11.0 CHR	
13 July 1977	14:12	24.0 CHR	
13 July 1977	15:20	5.0 WGL	
13 July 1977	16:15	19.0 WGL	
14 July 1977	14:14	4.0 CHR	
14 July 1977	18:38	37.0 OSB	
14 July 1977	19:55	20.0 OSB	
15 July 1977	15:30	11.0 OSB	
15 July 1977	18:47	12.0 CHR	
15 July 1977	19:04	22.0 OSB	
15 July 1977	20:17	13.0 OSB	
16 July 1977	19:06	19.0 CHR	
18 July 1977	17:23	21.0 OSB	
18 July 1977	18:21	18.0 CHR	
18 July 1977	18:30	23.0 CHR	
19 July 1977	15:08	20.0 OSB	
19 July 1977	15:46	10.0 CHR	
19 July 1977	17:00	6.0 OSB	
19 July 1977	17:06	10.0 CHR	Possible Riverdale quarry blast
19 July 1977	18:14	13.0 CHR	
19 July 1977	19:36	28.0 OSB	
20 July 1977	16:21	18.0 OSB	
20 July 1977	16:31	17.0 CHR	
21 July 1977	16:01	6.0 OSB	
21 July 1977	18:21	18.0 CHR	
22 July 1977	15:00	5.0 CHR	
22 July 1977	16:01	17.0 CHR	
22 July 1977	14:49	29.0 CHR	
25 July 1977	17:56	26.0 CHR	
25 July 1977	16:04	21.0 CHR	
26 July 1977	17:19	12.0 CHR	
26 July 1977	18:00	26.0 OSB	
27 July 1977	14:00	2.0 CHR	Possible Plaza Materials quarry blasts
27 July 1977	20:04	33.0 CHR	
27 July 1977	20:31	18.0 OSB	
27 July 1977	22:35	31.0 OSB	
28 July 1977	12:59	33.0 CHR	
28 July 1977	14:30	15.0 WGL	
28 July 1977	14:54	13.0 CHR	
28 July 1977	16:14	2.0 CHR	Possible Plaza Materials quarry blasts
28 July 1977	17:14	15.0 CHR	
28 July 1977	20:53	31.0 CHR	

TABLE IV A

PROBABLE QUARRY OR OTHER MAN-MADE BLASTS
WITH DISTINCT PHASES
(continued)

<u>Date</u>	<u>Time (cut)</u>	<u>S-P (seconds) at Nearest Station</u>	<u>Remarks</u>
29 July 1977	13:42	24.0 WGL	
29 July 1977	15:12	25.0 WGL	
29 July 1977	15:58	30.0 CHR	
29 July 1977	16:18	17.0 CHR	
29 July 1977	16:58	2.0 CHR	Possible Plaza Materials quarry blasts
29 July 1977	17:27	12.0 CHR	
29 July 1977	17:31	24.0 WGL	
29 July 1977	18:15	42.0 CHR	
29 July 1977	18:29	40.0 WGL	
29 July 1977	18:42	24.0 CHR	
29 July 1977	18:52	21.0 CHR	
29 July 1977	19:28	22.0 CHR	
30 July 1977	17:24	29.0 WGL	
01 Aug 1977	14:57	38.5 WGL	
01 Aug 1977	15:00	11.0 WGL	
01 Aug 1977	15:03	11.0 WGL	
01 Aug 1977	15:41	13.0 WGL	
01 Aug 1977	17:29	15.0 CHR	
01 Aug 1977	18:22	21.0 WGL	
01 Aug 1977	19:00	39.0 CHR	
01 Aug 1977	19:02	12.0 CHR	
01 Aug 1977	20:34	41.0 WGL	
02 Aug 1977	16:01	5.0 WGL	
02 Aug 1977	16:25	12.0 WGL	
02 Aug 1977	20:23	24.0 WGL	
03 Aug 1977	14:28	6.0 CHR	
04 Aug 1977	14:07	16.0 CHR	
04 Aug 1977	14:16	25.0 CHR	
04 Aug 1977	14:45	30.0 CHR	
04 Aug 1977	16:04	50.0 CHR	
04 Aug 1977	16:30	2.0 CHR	Possible Plaza Materials quarry blasts
08 Aug 1977	15:59	13.0 OSB	
08 Aug 1977	16:03	50.0 STL	
08 Aug 1977	18:13	10.0 OSB	
09 Aug 1977	13:43	20.0 OSB	
09 Aug 1977	18:18	STL	
11 Aug 1977	14:51	12.0 OSB	
11 Aug 1977	15:01	21.0 STL	
11 Aug 1977	16:21	23.5 STL	
12 Aug 1977	15:56	20.0 OSB	
15 Aug 1977	14:28	23.0 GSC	
15 Aug 1977	15:35	18.0 GSC	
15 Aug 1977	16:04	6.0 GSC	Possible quarry blasts from Secaucus

TABLE IV A

PROBABLE QUARRY OR OTHER MAN-MADE BLASTS
WITH DISTINCT PHASES
(continued)

<u>Date</u>	<u>Time (cut)</u>	<u>S-P (seconds) at Nearest Station</u>	<u>Remarks</u>
15 Aug 1977	16:30	11.0 GSC	
15 Aug 1977	19:24	27.0 GSC	
16 Aug 1977	18:09	25.0 GSC	
17 Aug 1977	13:44	15.0 GSC	
17 Aug 1977	15:55	8.5 OSB	
17 Aug 1977	17:34	16.0 GSC	
17 Aug 1977	17:54	20.0 STL	
18 Aug 1977	14:15	18.0 SRM	
18 Aug 1977	15:17	19.0 SRM	
18 Aug 1977	15:58	5.0 OSB	
18 Aug 1977	17:04	12.0 OSB	
18 Aug 1977	19:33	14.0 OSB	
18 Aug 1977	21:08	16.0 OSB	
19 Aug 1977	15:55	12.5 OSB	
19 Aug 1977	16:13	4.0 OSB	
19 Aug 1977	18:53	12.0 SRM	
19 Aug 1977	22:46	17.5 OSB	
22 Aug 1977	14:23	10.0 DBM	
22 Aug 1977	14:35	4.0 SRM	
22 Aug 1977	18:44	4.0 SRM	
23 Aug 1977	13:57	20.0 OSB	
23 Aug 1977	14:19	7.5 SRM	
23 Aug 1977	19:52	25.0 SRM	
23 Aug 1977	21:22	32.0 OSB	
23 Aug 1977	21:58	17.0 OSB	
24 Aug 1977	14:25	11.0 OSB	
24 Aug 1977	16:03	22.0 SRM	
24 Aug 1977	16:15	22.0 SRM	
24 Aug 1977	16:42	2.0 SRM	Possible Plaza Materials quarry blast
24 Aug 1977	21:17	30.0 SRM	
25 Aug 1977	18:19	26.0 SRM	
25 Aug 1977	18:22	20.0 OSB	
25 Aug 1977	21:16	16.5 SRM	
26 Aug 1977	14:32	18.0 SRM	
26 Aug 1977	14:59	15.0 SRM	
26 Aug 1977	17:30	12.0 SRM	
26 Aug 1977	18:18	12.0 CHR	
26 Aug 1977	19:32	45.0 CHR	
26 Aug 1977	23:50	26.0 CHR	From South
27 Aug 1977	13:46	27.0 CHR	
27 Aug 1977	17:13	39.0 CHR	
27 Aug 1977	18:25	19.0 OSB	
29 Aug 1977	15:00	5.0 SRM	
29 Aug 1977	16:20	3.0 SRM	Possible Plaza Materials quarry blast
29 Aug 1977	17:10	21.0 CHR	

TABLE IV A

PROBABLE QUARRY OR OTHER MAN-MADE BLASTS
WITH DISTINCT PHASES
(continued)

<u>Date</u>	<u>Time (cut)</u>	<u>S-P (seconds) at Nearest Station</u>	<u>Remarks</u>
29 Aug 1977	18:13	26.0 CHR	
29 Aug 1977	19:12	20.0 OSB	
30 Aug 1977	11:58	26.0 SRM	
30 Aug 1977	14:07	22.0 OSB	
30 Aug 1977	15:59	26.0 CHR	
30 Aug 1977	16:03	22.0 SRM	
30 Aug 1977	16:22	6.0 SRM	Possible blast from Secaucus
30 Aug 1977	18:59	12.0 SRM	
30 Aug 1977	19:00	13.5 CHR	
30 Aug 1977	21:23	16.0 OSB	
31 Aug 1977	14:43	35.0 CHR	
31 Aug 1977	15:12	22.0 OSB	
31 Aug 1977	16:11	2.0 CHR	Possible Plaza Materials quarry blasts
31 Aug 1977	18:42	12.0 CHR	
31 Aug 1977	19:01	18.0 OSB	
31 Aug 1977	19:41	17.5 OSB	

TABLE IV B

PROBABLE QUARRY OR OTHER MAN-MADE BLASTS
WITH INDISTINCT PHASES

<u>Date</u>	<u>Time (cut)</u>	<u>Date</u>	<u>Time (cut)</u>	<u>Date</u>	<u>Time (cut)</u>
01 June 1977	18:21	09 June 1977	13:26	17 June 1977	10:34
02 June 1977	13:59	09 June 1977	13:43	17 June 1977	12:45
02 June 1977	15:47	09 June 1977	14:59	17 June 1977	14:30
02 June 1977	19:04	09 June 1977	17:32	17 June 1977	15:21
03 June 1977	14:30	09 June 1977	17:53	17 June 1977	18:58
03 June 1977	14:36	09 June 1977	19:29	17 June 1977	19:13
03 June 1977	14:39	10 June 1977	12:23	17 June 1977	19:37
03 June 1977	15:32	10 June 1977	19:44	18 June 1977	18:34
03 June 1977	15:46	10 June 1977	20:35	18 June 1977	19:35
03 June 1977	15:48	10 June 1977	20:46	20 June 1977	15:28
03 June 1977	16:00	11 June 1977	10:31	20 June 1977	19:35
03 June 1977	17:55	11 June 1977	15:03	20 June 1977	19:51
03 June 1977	19:33	11 June 1977	16:09	20 June 1977	23:31
04 June 1977	18:02	11 June 1977	18:50	20 June 1977	23:59
06 June 1977	13:51	13 June 1977	13:03	21 June 1977	13:44
06 June 1977	14:18	13 June 1977	14:24	21 June 1977	15:17
06 June 1977	14:42	13 June 1977	16:17	21 June 1977	16:16
06 June 1977	15:00	13 June 1977	16:35	21 June 1977	19:06
06 June 1977	16:01	13 June 1977	18:00	22 June 1977	15:05
06 June 1977	16:55	13 June 1977	19:44	22 June 1977	16:06
06 June 1977	17:51	13 June 1977	20:24	22 June 1977	16:16
06 June 1977	20:14	14 June 1977	13:04	22 June 1977	17:17
07 June 1977	16:14	14 June 1977	14:00	22 June 1977	18:50
07 June 1977	16:44	14 June 1977	14:32	22 June 1977	21:50
07 June 1977	17:27	14 June 1977	16:45	23 June 1977	14:27
07 June 1977	17:29	14 June 1977	17:03	23 June 1977	15:26
07 June 1977	18:18	14 June 1977	19:23	23 June 1977	15:46
07 June 1977	19:01	15 June 1977	15:04	23 June 1977	20:36
07 June 1977	19:07	15 June 1977	15:23	23 June 1977	20:45
07 June 1977	21:11	15 June 1977	16:14	24 June 1977	16:13
07 June 1977	21:35	15 June 1977	16:51	24 June 1977	16:48
08 June 1977	14:24	15 June 1977	16:57	27 June 1977	15:59
08 June 1977	14:30	15 June 1977	18:59	27 June 1977	16:15
08 June 1977	14:33	15 June 1977	19:03	27 June 1977	23:26
08 June 1977	15:59	15 June 1977	19:09	28 June 1977	14:15
08 June 1977	16:09	15 June 1977	19:44	28 June 1977	17:26
08 June 1977	18:01	16 June 1977	13:30	28 June 1977	17:31
08 June 1977	18:45	16 June 1977	13:41	28 June 1977	20:13
08 June 1977	19:00	16 June 1977	15:27	29 June 1977	13:33
08 June 1977	20:01	16 June 1977	15:44	29 June 1977	15:17

TABLE IV B

PROBABLE QUARRY OR OTHER MAN-MADE BLASTS
WITH INDISTINCT PHASES
(continued)

<u>Date</u>	<u>Time (cut)</u>	<u>Date</u>	<u>Time (cut)</u>	<u>Date</u>	<u>Time (cut)</u>
29 June 1977	15:56	18 July 1977	15:00	28 July 1977	20:53
30 June 1977	14:00	18 July 1977	18:27	29 July 1977	15:00
30 June 1977	14:04	18 July 1977	19:00	29 July 1977	15:49
30 June 1977	14:07	18 July 1977	19:45	29 July 1977	16:10
30 June 1977	18:48	18 July 1977	20:32		
		19 July 1977	15:14	01 Aug 1977	14:00
01 July 1977	15:55	19 July 1977	18:28	01 Aug 1977	14:15
02 July 1977	17:14	19 July 1977	18:58	01 Aug 1977	15:12
05 July 1977	14:30	19 July 1977	19:13	01 Aug 1977	15:46
05 July 1977	16:30	19 July 1977	20:35	01 Aug 1977	16:03
05 July 1977	18:43	20 July 1977	15:55	01 Aug 1977	18:18
06 July 1977	14:10	20 July 1977	19:30	01 Aug 1977	18:26
06 July 1977	22:04	21 July 1977	13:44	02 Aug 1977	13:41
07 July 1977	18:00	21 July 1977	14:00	02 Aug 1977	14:20
07 July 1977	18:16	21 July 1977	14:42	02 Aug 1977	14:52
08 July 1977	20:31	21 July 1977	14:59	02 Aug 1977	16:14
08 July 1977	21:56	21 July 1977	15:15	02 Aug 1977	21:00
09 July 1977	17:01	21 July 1977	15:22	02 Aug 1977	21:08
09 July 1977	17:30	22 July 1977	16:42	03 Aug 1977	00:45
09 July 1977	18:29	22 July 1977	17:00	03 Aug 1977	15:30
10 July 1977	21:45	22 July 1977	18:25	03 Aug 1977	15:41
11 July 1977	16:15	23 July 1977	01:15	03 Aug 1977	16:17
11 July 1977	17:11	23 July 1977	15:33	03 Aug 1977	18:00
11 July 1977	19:11	23 July 1977	18:59	03 Aug 1977	19:00
11 July 1977	20:42	23 July 1977	22:15	03 Aug 1977	19:27
12 July 1977	15:30	25 July 1977	13:12	03 Aug 1977	20:13
12 July 1977	16:15	26 July 1977	14:00	04 Aug 1977	15:48
13 July 1977	13:50	26 July 1977	15:39	04 Aug 1977	16:14
13 July 1977	13:53	26 July 1977	20:57	04 Aug 1977	19:15
13 July 1977	14:09	26 July 1977	21:29	04 Aug 1977	20:42
13 July 1977	15:46	27 July 1977	16:29	04 Aug 1977	21:38
14 July 1977	15:28	27 July 1977	19:30	05 Aug 1977	13:29
14 July 1977	16:01	27 July 1977	19:54	05 Aug 1977	14:03
14 July 1977	16:14	27 July 1977	19:59	05 Aug 1977	15:45
14 July 1977	17:15	27 July 1977	20:50	05 Aug 1977	22:01
14 July 1977	18:18	28 July 1977	15:01	06 Aug 1977	16:15
14 July 1977	18:19	28 July 1977	15:16	06 Aug 1977	18:14
16 July 1977	15:21	28 July 1977	16:10	08 Aug 1977	13:48
18 July 1977	13:11	28 July 1977	17:16	08 Aug 1977	16:09
18 July 1977	14:00	28 July 1977	17:58	08 Aug 1977	21:16

TABLE IV B

PROBABLE QUARRY OR OTHER MAN-MADE BLASTS
WITH INDISTINCT PHASES
(continued)

<u>Date</u>	<u>Time (cut)</u>	<u>Date</u>	<u>Time (cut)</u>	<u>Date</u>	<u>Time (cut)</u>
09 Aug 1977	16:12	22 Aug 1977	18:41	29 Aug 1977	16:42
09 Aug 1977	16:16	22 Aug 1977	18:53	29 Aug 1977	19:00
09 Aug 1977	16:42	23 Aug 1977	13:33	30 Aug 1977	14:00
10 Aug 1977	14:30	23 Aug 1977	13:40	30 Aug 1977	14:10
10 Aug 1977	15:21	23 Aug 1977	13:59	30 Aug 1977	14:30
11 Aug 1977	15:57	23 Aug 1977	15:02	30 Aug 1977	16:14
12 Aug 1977	16:27	23 Aug 1977	15:31	30 Aug 1977	19:44
15 Aug 1977	14:14	23 Aug 1977	16:10	31 Aug 1977	15:30
15 Aug 1977	15:13	23 Aug 1977	16:20	31 Aug 1977	16:17
15 Aug 1977	15:45	23 Aug 1977	16:59	31 Aug 1977	17:28
15 Aug 1977	17:02	23 Aug 1977	19:47		
16 Aug 1977	18:53	24 Aug 1977	16:04		
16 Aug 1977	20:54	24 Aug 1977	16:48		
17 Aug 1977	15:11	24 Aug 1977	17:09		
17 Aug 1977	15:16	24 Aug 1977	17:31		
17 Aug 1977	18:11	24 Aug 1977	17:32		
18 Aug 1977	13:57	24 Aug 1977	18:41		
18 Aug 1977	14:29	25 Aug 1977	15:55		
18 Aug 1977	15:14	25 Aug 1977	16:15		
18 Aug 1977	15:48	25 Aug 1977	17:03		
18 Aug 1977	16:06	25 Aug 1977	19:21		
18 Aug 1977	16:15	26 Aug 1977	14:47		
18 Aug 1977	19:27	26 Aug 1977	18:23		
19 Aug 1977	13:45	26 Aug 1977	21:01		
19 Aug 1977	16:16	27 Aug 1977	21:56		
19 Aug 1977	19:57	28 Aug 1977	13:56		
19 Aug 1977	20:14	28 Aug 1977	20:29		
20 Aug 1977	13:13	29 Aug 1977	11:59		
20 Aug 1977	18:00	29 Aug 1977	13:01		
22 Aug 1977	14:15	29 Aug 1977	14:18		
22 Aug 1977	14:41	29 Aug 1977	15:03		
22 Aug 1977	15:06	29 Aug 1977	15:11		
22 Aug 1977	15:24	29 Aug 1977	16:14		