

NARMADA VALLEY DEVELOPMENT AUTHORITY
INDIRA SAGAR PROJECT

A REPORT ON SEISMIC MONITORING OF N.S.P. COMPLEX (M.P.)

1.1 General :-

Narmada Sagar Project complex comprises of 3-major Projects on River Narmada i.e. Indira Sagar, Omkareshwar and Maheshwar Projects. Out of these projects Indira Sagar Dam is under advance state of construction. The construction of Maheshwar Project is also started, However the plan for construction of Omkareshwar Dam is yet to be considered.

On completion of these dams huge reservoir shall be formed. The Narmada Sagar reservoir will be one of the largest man made reservoir in the country with 12.220 Million Cubic Metre storage at FRL (EL 262.13m).

On the recommendations of Dam Review Panel Central Water Commission New Delhi, CWPRS Pune and India Meteorological Dept., New Delhi, NVDA has decided to establish 10-stations Seismological observatory Network around the periphery of the reservoir of NSP Complex. On the recommendations for suitability observatory site at all the 10-locations the NVDA had also constructed 9-observatory buildings out of 10 Nos., except Omkareshwar, where the agency has been fixed after finalization of alternative site near Kothi Village about 3-Kms. from Omkareshwar Dam site. The Index Map showing the location of 10-Seismic stations is enclosed vide Annexure - I. The 10-Seismic observatory stations in the NSP complex are as under:-

- | | |
|------------------------------------|------------------------|
| 1. Narmada Nagar (Central station) | 2. Omkareshwar (Kothi) |
| 3. Maheshwar | 4. Indore |
| 5. Khandwa | 6. Barwani |
| 7. Hirasapur (Harda) | 8. Kannod |
| 9. Bagli (Chapra) | 10. Channera. |

On the recommendations of the expert organisation the pre-impounding Seismicity studies were started in the year 1987; The NVDA had ordered to carry out preimpounding Seismicity studies to CWPRS Pune around the periphery of reservoirs of NSP Complex until such time when NVDA had procured and install Seismic instruments. The action taken time to time for monitoring seismicity studies and procurement and installation of Seismic instruments with chronological developments are enumerated below :-

2.0 Seismicity studies of Indira Sagar, Omkareshwar and Maheshwar Projects by CWPRS Pune :-

In order to collect pre-impounding Seismic data and carry out seismicity studies. The NVDA had requested CWPRS Pune. Accordingly seismic observatories at 3-locations i.e. Narmada Nagar, Omkareshwar and Maheshwar were commenced in year 1987 at Narmadanagar at Omkareshwar and Jan.91 at Maheshwar and CWPRS installed their instruments at above locations. The details collected from above locations were periodically sent to Pune for analysis etc. The details of analysed events for most of the period has been sent by CWPRS except for a small period However the report on seismicity studies is still awaited.

3.0 Procurement of Micro Earthquake Recording system for monitoring pre-impounding Seismicity by NVDA :

On the recommendations of IMD New Delhi NVDA had procured 11 Nos. of Micro Earthquake recorders (1 spare unit) for installation at the 10-Seismic observatory stations. Immediately after their procurement, one unit each was installed at Narmada Nagar, Omkareshwar and Maheshwar. Recently one unit is commissioned at Khandwa and other two units at Channera and Barwani will be commissioned during this financial year itself, or earlier as soon as the electrical connections at these Observatories are necessary efforts are being made to get electrical connections from M. P. Electricity Board.

Regular data being collected at Narmadanagar except for some time when MEQ could not be started due to repair or other reasons. The regular analysis of data at Narmadanagar since May-97 is also done by incharge of the observatory and significant earthquake recorded are reported. The locations of installations of Seismic instruments for NSP Complex as per the IMD letter dated July 7 1995 of recommendation of IMD. is enclosed as annexure - II-A and B.

3. Procurement of Wood Anderson Seismograph from IMD New Delhi :

IMD had recommended to install 6 Wood Anderson Seismograph accordingly, NVDA had ordered to procure the same from IMD . At present 4 sets of Wood Anderson Seismographs have been arrived at Narmadanagar, Out of 6-sets due to non supply of control units by IMD and procurement of Precision clocks for Wood Anderson Seismograph the units could not be installed, IMD had agreed on request by project authorities for commissioning of these units at the earliest possible date.

4. Procurement of advanced computerise data acquisition and analysis system and seismic instruments and spares for NSP Complex M.P.

The NVDA had already ordered to procure seismic instruments with spares etc. for 10-stations observatory network of NSP complex M.P. on the recommendations and in consultations with IMD New Delhi. The basic instruments consists of Long period and Short period Seismometers. Digital events recorder s which are to be installed in the observatories alongwith the strong motion accelerograph which are intended to be installed at Dams and Power house and 3-sets one unit at 3-project observatories; (i.e. Narmadanagar, Omkareshwar and Maheshwar). The data shall be collected on both digital and analog form and shall be analysed at the central station at Narmadanagar

where as advanced computerised data analysis system shall be installed. *The order for purchase of seismic instrument of M/s. Sprengnether Instruments Inc. USA and accordingly the order was placed to M/s Sprengnether Instruments Inc. USA. The list of the instruments for which the order was placed is enclosed Annexure - III.*
The first consignment of Lot-1 of Seismic instruments and essential spares has already been arrived at Narmadanagar.

The list of consignment of lot-1, arrived at Narmada nagar is enclosed vide annexure - IV.

- 4.0 Creation of infra structural facilities for monitoring seismicity in the NSP Complex (M.P.)
- 4.1 The construction of Seismological observatory buildings at 9-locations alongwith residential quarters for staff has already been either completed or at advance stage of construction. At Omkareshwar (Kothi) also the agency has been fixed. It is expected that this will also be completed within this financial year.
- 4.2 The electrification of the seismic observatory at Narmada Nagar and Khandwa observatory has been completed and Micro Earthquake recorders are operational, similarly Channera Mandleshwar and Barwani are in the process of getting electric connections from MPEB; Other will follow soon as internal electrical connections in the observatories are completed.
- 4.3 For installation of advanced computerised & data analysis system the necessary steps have been taken for establishing an A.C. EDP centre in the office of the Superintending Engineer Q/C Circle, in the office complex at Narmadanagar.

4.4 For creation of infra structural facilities for monitoring seismicity in the NSP Complex. An Agenda Note has been prepared and submitted for consideration which includes the basic requirement of officers/Scientific staff etc. Provision of touring vehicles, communication facilities and all such necessary items required for effectively running of the seismological observatory Network has been considered; On the same line as it has been adopted in the Sardar Sarovar Project (Gujrat).

4.5 Adequate attention is also being paid to train the concerned officers & staff who are basically Civil Engineers and some are graduate in Science/Arts subject, who has to cultivate an aptitude and knowledge in the field of Engineering Seismology. The provision has been made in the contract for supply of Seismic instruments to train the Project personnel at the factory of the seller as well as on field, for day to day operations, maintenance data acquisition and analysis by using advanced computerised analysis system.

Apart from the above every opportunity for training of above officers and personnels is availed to allow them to attend such training programmes being conducted by premier organisation, in India.

4.6 Upon receipt of the full consignment of Seismic instruments and after installation of these instruments, it will be possible to effectively monitor the seismicity of the Narmada Valley Project areas. The data collected over the past years will also be utilised to effectively monitor the pre and post impounding seismicity.

वी० पी० काम्बले
अपर-महानिदेशक
V. P. KAMBLE
Addl. Director General of Meteorology
(Instruments)



D. O. No : ADGM(I)-1
भारत मौसम विज्ञान विभाग
लोदी रोड, नई दिल्ली-110003
INDIA METEOROLOGICAL DEPARTMENT
Lodi Road, New Delhi-110003

July 7, 1995

Dear Shri Tinguria,

Kindly recall your discussions on 6.7.1995 regarding installation of Analogue and Digital Systems in Indira Sagar Project area.

The Strong Motion Accelerographs have to be installed in the body of the dam as per ICOLD specifications i.e. one at the foundation, one at the mid-section and 3rd at the top of the dam. As the structural response of the Power House will be different from the dam body, one accelerograph should be installed in each Power House. In addition, it will be necessary to estimate the free field acceleration (Pure Acceleration on Rock) for comparison of the attenuation factor of the dam body and appurtnent structures. As such, one accelerograph need be installed on the rock outcrop, preferably, in the dam site observatory.

The distribution of various instruments to be installed in the project area is given in the enclosed sheet.

With kind regards,

Yours sincerely,


(V.P. KAMBLE)

Shri G.P. Tinguria
Superintending Engineer
Quality Control Circle
Narmada Nagar,
Distt. Khandwa (M.P)

DETAILS OF INSTALLATION OF SEISMIC INSTRUMENTS FOR N.S.P. COMPLEX (M.P)
AS PER RECOMMENDATIONS OF IMD, NEW DELHI TO BE PROCURED

S.No.	Name of Station	Name of instruments and their placement position												
		Short period Seismometer		Long period Seismometer		Strong motion seismograph		Processing seismic data & analysis system	Micro-earth quake seismic station	Wood Anderson seismo-graph				
		Seismic station	Other Location	Seismic station	Dam body	Power house	Seis- mic station				Dam body	Power House		
1	2	3	4	5	6	7	8	9	10	11	12	13		
1.	Narmadanagar	1 No.	3-Components at dam site	1 No. + 1 No. (spare)	-	-	1 No. 1 found	1 Middle	1 Top of Dam.	1 No.	1 No.	1 No.	1 No.	
2.	Omkareshwar	1 No.	-do-	1 No.	-	-	1 No.	-do-	-do-	-	-	1 No.	1 No.	
3.	Maheshwar	1 No.	-do-	1 No.	-	-	1 No.	-do-	-do-	-	-	1 No.	1 No.	
4.	Khandwa	1 No.	-	-	-	-	-	-	-	-	-	1 No.	1 No.	
5.	Barwani	1 No.	-	-	-	-	-	-	-	-	-	1 No.	1 No.	
6.	Indore	1 No.	-	-	-	-	-	-	-	-	-	1 No.	1 No.	
7.	Harda	1 No.	-	-	-	-	-	-	-	-	-	1 No.	1 No.	
8.	Kannod	1 No.	-	-	-	-	-	-	-	-	-	1 No.	-	
9.	Bagli(Chapra)	1 No.	-	-	-	-	-	-	-	-	-	1 No.	-	
10.	Chhanera	1 No.	-	-	-	-	-	-	-	-	-	1 No.	-	
Total		10 Nos.	9 Nos.	4 Nos.	-	-	3 Nos.	9 Nos.	3 Nos.	1 No.	10 Nos.	6 Nos.		
Total qty.		(19 Nos)											(15 Nos)	

CATEGORY A - LIST OF SEISMIC INSTRUMENTS / SPARES FOR THE PROPOSED 10 - SEISMIC STATIONS FOR I.S.P. COMPLEX NET WORK (M.P.) COVERED UNDER SSP AGREEMENT.

Item No.	Description of item as per recommendations of I.M.D	Quantity Nos.
1.	2	3.

CATEGORY - A SEISMIC INST.

- | | | |
|----|---|----|
| 1. | SHORT PERIOD SEISMOMETER
moving Coil (velocity type) 1HZ
vertical or horizontal operation.
built in electromagnetic calibrator,
Single and three channel with recording unit drum drive type with seismic amplifier power supply etc. | 19 |
| 2. | LONG PERIOD SEISMOMETER
vertical type, electromechanical transducer that converts long period vertical motion into electrical output having thermally stable case with all accessories such as recorders, amplifier power supply etc. | 4 |
| 3. | SEISMIC DATA PROCESSING AND ANALYSIS SYSTEM
suitable for microearthquake studies and strong motion data analysis, advanced computer based system including CPU, memory, analog to digital converter, playback unit graphic display, printer plotter etc. with necessary software modules. | |

1.	2.	3.
4.(a)	STRONG MOTION ACCELEROGRAPH WITH RAM Microprocessor based recorder, triaxially mounted force balanced accelerometer with pre-event stored in a solid state memory, automatic Sine Wave Calibration and precision timing system.	15
(b)	CONNECTING CABLE for common triggering facilities for digital accelerographs in the body of Dam.	600m
5.	PLAYBACK SYSTEM Computerised Portable, microprocessor based low powered data retrieval system.	5 sets each for SMA & Digital Seis monograph i.e. total 10 Nos.
6.	DIGITAL TIME MARKING SYSTEM Crystal controlled, temperature compensated low powered timing system, having short period and long period time mark programme outputs and contain precision frequency regulated power output module operated on both. 230 V and 12 V or 24V DC source including WWV comparator, time code gene rator, power Amplifier DC power module and HF timing receiver.	15
7.	DIGITAL EVENT RECORDER Low powered CMOS microprocessor based with RAM digital recording system capable of recording microearth quake & strong motion earthquake data on four channels. Large recording capabi- lity and high dynamic range with ultra low noise (For Item No.1 short period seismometer and item No.2 long period seismometer. schedule of quantities.)	12
8.	PULSE CALIBRATOR Capable of generating current pulses to a seismometer calibration coil having crystal controlled oscillator (For Item No.1. Short period seismometer and item No.2. long period seismometer, schedule of quantities)	16

1.	2.	3.
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|--|--------|
| 9. DIGITIZER
Capable of digitizing the analog data received by visual recorders into magnetic tapes for analysis by Data processing and Analysis System. Low power high accuracy and resolution. | 2 |
| 10. DRUM RECORDER SPARES
(For Item No.1 short period seismometer. schedule of quantities) | 6 sets |
| 11. TIME MARK PROGRAMME
(For Item No.6. Digital Time Marking System, Schedule of quantities.) | 2 |
| 12. COAXIAL CABLE
30 m LONG (For Item No.1, Short period seismometer and Item No.2 Long period seismometer schedule of Quantities.) | Nil |
| 13. CPU MODULE
(For Item No.4, Strong motion accelerograph Schedule of Quantities.) | 1 |
| 14. ANALOG MODULE
(For Item No. 4, Strong motion accelerograph Schedule of Quantities.) | 1 |
| 15. POWER INTERFACE
(For Item No.4, Strong motion accelerograph, Schedule of Quantities.) | Nil |
| 16. POWER I/O MODULE
(For item No.4 strong motion accelerograph, Schedule of Quantities.) | 1 |

1.	2.	3.
17. MEMORY MODULE (For Item No.4, Strong motion accelerometer, Schedule of Quantities.)		1
18. FORCE BALANCE ACCELEROMETER (For Item No.4, Strong motion accelerometer, Schedule of Quantities.)		7
19. RECHARGEABLE BATTERY (For Item No.4, Strong motion accelerometer, Schedule of Quantities.)		15
20. FUSE 2A,250 V BOX OF 5 EACH (For Item No.4, Strong motion accelerometer, Schedule of Quantities.)		3 sets
21. INTERNAL BATTERY CHARGER (For Item No.4, Strong motion accelerometer, Schedule of Quantities.)		16
22. LED INDICATOR (For Item No.4, Strong motion accelerometer, Schedule of Quantities.)		1
23. CONNECTING SET (For Item No.4, Strong motion accelerometer, Schedule of Quantities.)		1
24. MAGNETIC TAPE CASSETTE (For Item No.4, Strong motion accelerometer, and Digital event recorder Schedule of Quantities.)		Nil
25. KEY BOARD (For Item No.4, Strong motion accelerometer, Schedule of Quantities.)		2

1.	2.	3.
26.	CASSETTE TAPE DRIVE (For Item No.4, Strong motion accelerometer. Schedule of Quantities.)	Nil
27.	SYSTEM INTERFACE BOARD (For Item No.4, Strong motion accelerometer, Schedule of Quantities.)	1
28.	LCD DISPLAY BOARD (For Item No.4, Strong motion accelerometer, Schedule of Quantities.)	Nil
29.	OSCILLOSCOPE Suitable for testing Seismological instruments having high sensitivity large display, highlight output and automatic TV Triggering.	Nil
30.	PORTABLE FREQUENCY GENERATOR	2

1.	2.	3.
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CATEGORY A:- INSTALLATION COMMISSIONING & TRAINING

1	Installation, Commissioning of seismic instruments including data processing and analysis system and training the Buyer's technical personnel	10 visits each visit of 10 days
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CATEGORY : A :- ESSENTIAL SPARES

1	Signal coil for short period seismometer.	4
2.	Pen Motors for Drum Recorder.	10
3.	Rotation Motors for drum Recorder.	10
4.	Digital Recorder extender board.	6
5.	Drive Board for drum Recorder.	6
6.	Internal battery for timing system.	30
7.	Translation Motors for Drum Recorders.	10

CATEGORY - A SOFTWARE MAINTENANCE AGREEMENT

1.	Software Maintenance Agreement	5years
	(For five years beyond warranty period)	

**CATEGORY B- LIST OF SEISMIC INSTRUMENTS/SPARES FOR PROPOSED 10 - SEISMIC STATIONS
FOR I.S.P. COMPLEX NETWORK (M.P.) NOT COVERED UNDER SSP AGREEMENT**

Item No.	Description of item as per recommendations of I.M.D.	Quantity Nos
1.	2.	3.

CATEGORY - B : ESSENTIAL SPARES

1.	Coaxial cable with 30 m long with connections.	23
2.	Fuses (sets of all types)	6
3.	Board level spares for digital recorders and Strong Motion Accelerograph complete set. (13 Boards in each set)	6
4.	Heated Stylus	20
5.	Heat Board Assembly	15

(Total)

CATEGORY B :- SERVICE CONTRACT

1.	Hardware service contract (for 5 years beyond warrantee period)	5 years
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(Total)

LIST - AList of items supplied in lot-1

Item No. as per Agmt.	S.No.	Description	Qty. supplied.	Remarks.
1	2	3	4	5
		<u>CATEGORY-A</u>		
3	1	Seismic data processing and analysis system		
	1(a)(i)	P.C. Computer (IBM Activa disk Top Computer)with	1 No.	With hard disc 1.6 Gb & 22 Mb.
	(b)	software loaded in hard disc Key board.	1 No.	RAM 17" SVGA colour Terminal.
	(c)	Mouse (without pad)	1 No.	
	(d)	speakers	2 Nos.	
	(e)	Backup Cd's	13Nos.	Soft.wares were not checked neither print out was taken.
	(f)	Ditto Tools 2 floppies + 1 CD	2 + 1 (F + CD)	
	(g)	Power cable	1 No.	
	(h)	Ditto cartridge type	1 No.	
	(i) (ii)	Line voltage regulator (1) with cable (1)	1 No. (set)	
	(j)	Cartridge IBM # 07 H 0970	1 No.	Extra Item
	(k)	Adaptor	1 No.	
	(l)	Cable for computer & Lasor printer	1 + 1	
	M (iii)	Lasor printer 1 Mb with floppy (B/W)	1 No.	Specification requi- rement 1.2 Mb.
	N(iv)	Plotter (Pen) 350G Model (11" x 17")	1 No.	Communication cable not supplied hence not tested
	(O)	Operation manual for PC	1 set.	

Note :- Item 3 system not tested.

4(a)	1	Strong motion Accelerograph Model DR-3016 (portable)	15 Nos.	Master/Slave units are provided.	
	2	Sensor model FB x with cable	15 Nos.		
	3	Battery with box with cable	15 Nos.		
	4	Manuals -- DR-3016	15 Nos.		
	5	Manual FBX	15 Nos.		
	6	Master slave connector	18 Nos.		
4(b)	1	Connecting cable	600 m	supplied but not tested.	
5	1	<u>Play back system</u>	5 sets (10 Nos.)	16 Mb RAM, Hard disc 1.34 Gb memory loaded with Com-3000 software and other software.	
	2	Communication cable RS 232	10 Nos.		
	3	Spare battery	10 Nos.		
	4	CD ROM	9 Nos.		
	5	Backup CD-3 Nos. (Set)	10 sets.		
	6	Manuals	10 Nos.		
Note :-		Spare floppy for booting	1 No.	supplied extra.	
7	1	Digital Event Recorders Model DR-3016 (Portable) with pulse calibrator	12 Nos.	3-channel portable recorder supplied.	
	2	Clips for external Battery	12 Nos.		Only Clips for external battery supplied.
	3	Manual	12 Nos.		

1	2	3	4	5
13	1	CPU - Module # 120606	1 No.	This item No. is named as a processor board.
14	1	Analog Module # 120603	1 No.	This item No. is named as a ADC/DSP module.
16	1	I/O Module # 120601	1 No.	-
17	1	MEMORY Module # 103723	1 No.	O.K.
18	1	FORCE BALANCE ACCELEROMETER	7 Nos.	# 1-003-0 vertical 3 Nos. & # 1-004 - 0 Horizontal 4 Nos.
19	1	Rechargeable Battery # 06-007-0	15 Nos.	O.K. Tested.
20	1	Fuse set # 37-004-1	3 sets	O.K.
21	1	Battery charger # 120302	16 Nos.	O.K.
22	1	LED INDICATOR	1 No.	O.K.
23		Connector set	1 set	O.K.
25	1	Key Board	2 Nos.	This item is supplied for Item No.3, The specification requirement for Item No.4.
27	1	System inter face board # 120602	1 No.	This item is supplied named as multipurpose board for SMA.
30	1	FREQUENCY GENERATOR	2 Nos.	

1	2	3	4	5
<u>CATEGORY - A (c) Essential Spares</u>				
4	1	Digital recorder Extender board.	6 Nos.	
<u>CATEGORY - B Essential spares</u>				
3	Board level spare for D R and SMA complete set. consist of		6 sets	The specification is for 13 boards in each set,
1	2 Mb Memory Board		6 Nos.	whereas the firm has supplied as indicated in col.3 of this item.
2	DR - 3016 Power board		6 Nos.	
3	Strong motion Alarm board		3 Nos.	
4	DR - 3016 Signal conditioning Bd		6 Nos.	
5	DR - 3016 Multipurpose board		6 Nos.	
6	DR - 3016 DSP Board		6 Nos.	
7	DR - 3016 Processor Bd w/LCD		3 Nos.	
8	DR - 3016 Processor board		Nil	Not supplied

12/12/97

12/12/97

15.12.97
Camp Delhi

Executive Engineer
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