Annexure - 1

NUCLEAR POWER CORPORATION OF INDIA LIMITED

(A Government of India Enterprise)

Mahi Banswara Rajasthan Atomic Power Project
District: Banswara, Rajasthan

एनपीसीआईएल
NPCIL

PROJECT REPORT

Nabhikiya Urja Bhavan,
Anushakti Nagar, Mumbai – 400094

1.0 GENERAL

Government of India had accorded “in-principle” approval to establish nuclear power plant of installed capacity 4 x 700 MWe PHWR (Indigenous Pressurized Heavy Water Reactors) at Mahi-Banswara, Rajasthan.

The 4x700 MWe Mahi-Banswara Rajasthan Atomic Power Project (MBRAPP) sites is an Inland site and situated on the right bank of Mahi River at the upstream of Mahi-Bajajsagar reservoir. The geographical co-ordinates of the centre of the proposed site is as follows:

Latitude : 23º 31’ 46” N

Longitude : 74º 35’ 26” E

It is proposed to acquire land about 553 Ha (approx.) for Project and 70 Ha (approx.) for Township including civic amenities, services & Environmental Survey Laboratory (ESL) and CISF colony.

The project area does not contain any important feature such as sanctuary, notified archeological site.

The total Forest land falls in the proposed project area is 107.57 Ha (73.38 Ha Forest Land and 34.19 Ha Forest land as per revenue records). The detail of forest land and forest land as per revenue records along with Khasara nos. are furnished below in Table no.-1&2.

Table No-1: Details of Forest Land

VILLAGE NAME	KHASRA NO.	AREA	ACTUAL AREA TO BE AQUIRD. IN BIGHA	REMARKS
ADIBHEET	384/183	12.02	12.02	100%
	315/194	21.04	21.04	100%
		33.06	**33.06**	
BARI	117	4.17	2.09	50%
	118	1.18	0.19	50%
	127	115.01	103.11	90%
	643	2.01	2.01	100%
	646	0.19	0.19	100%
	647	4.07	4.07	100%
	648	1.1	1.1	100%
	652	2.15	2.15	100%
	655	9.02	9.02	100%
	811	3.04	3.04	100%
	918	11.17	11.17	100%
		157.11	**142.14**	
REL	63	12.1	12.1	100%
	64	18	18	100%
	65	6	6	100%
		36.1	**36.1**	
SAJWANIA	808	34.1	34.1	100%
	880	62.17	9.09	15%
	881	0.15	0.01	6%
	889	22.13	22.13	100%
	914	15.12	15.12	100%
	915	0.05	0.05	100%
	917	0.19	0.19	100%
	919	0.1	0.1	100%
	956	27.17	27.17	100%
	957	0.1	0.1	100%
	984	3.19	3.19	100%
	985	0.05	0.05	100%
	992	7.15	7.15	100%
	995	2.15	2.15	100%
	999	47.06	47.06	100%
		228.08	**174.06**	
KUTUMBI	246/2	3.09	3.09	100%
	253/2	78.13	62.18	80%
	1683/253/1	0.05	0.05	100%
	254/2	0.06	0.06	100%
		82.13	**66.18**	
			453.14	73.38 Ha.

Table No-2: Details of Forest Land as per Revenue Records

VILLAGE NAME	KHASRA NO.	AREA	ACTUAL AREA TO BE ACQUIRED In Bigha-Biswa	REMARKS
ADIBHEET	19	22.05	22.05	100%
	32	6.16	6.16	100%
	100	1.05	1.05	100%
	103	7.07	7.07	100%
	109	4.1	4.1	100%
	111	6.01	6.01	100%
			48.04	
BARI	119	2.10	1.05	50%
	114	3.04	3.04	100%
	115	1.11	1.11	100%
	121	1.01	1.01	100%
	124	7.02	7.02	100%
	126	3.02	3.02	100%
	139	2.04	2.04	100%
	475	0.12	0.12	100%
	478	17.07	17.07	100%
	481	4.05	4.05	100%
	639	0.14	0.14	100%
	642	1.07	1.07	100%
	717	2.05	2.05	100%
	766	12.08	12.08	100%
	806	10.11	10.11	100%
	810	4.12	4.12	100%
	813	1.14	1.14	100%
	825	1.10	1.10	100%
	903	11.12	11.12	100%
	909	6.18	6.18	100%
	919	17.00	17.00	100%
	924	1.07	1.07	100%
	927	21.17	21.17	100%
	934	10.17	10.17	100%
	945	0.05	0.05	100%
	946	0.08	0.08	100%
	947	0.07	0.07	100%
	958	0.07	0.07	100%
	991	9.14	9.14	100%
	999	1.02	1.02	100%
	483	5.05	5.00	95%
		164.18	**163.08**	
REL, SAJWANIA & KUTUMBI	0	0	0	0%
			211.12	34.19 Ha.

The 70 Ha of land selected for township, does not have any habitation. It is non grazing grass land.

The Proposed MBRAPP site is at a distance of 520 km by road to the state capital, Jaipur. The nearest Rail head to the site is Ratlam Railway station on Kota-Ratlam section of Western Railway at a distance of about 60 km from the site. The nearest Airports to the site are Udaipur and Indore at road distances of about 180 km and 210 km, respectively from the project site. The nearest coal field is Pench-Kanhan, Tawa Valley, MP, which is aerially about 350km east of the project site.

2.0 CHARACTERISTICS OF SITE

Banswara district falls under "**Humid southern plains of Rajasthan**" The area has humid climate with an average Rainfall of more than 70cm per year .The temperature regimes do not fluctuate much in Summer and Winter so the area has mild winters and mild Summers. The humidity is always high and all these factors combine together, promote a profuse growth of natural vegetation.

The district is characterized by undulating topography. The eastern part is the extension of Malwa plateau & is comprising of high hills with intervening long and narrow valleys. In central part of the district undulating to rolling topography prevails. While in western part plain and rolling topography prevails. The drainage system of the area is influenced by Mahi River and its tributaries like, Pundiya, Chanp, Erau, Hiran and Kagdi Rivers and Avani Nadi & Bunand Nadi. The general slope of the area is from east to west. As per Rajasthan State Space Application Centre there are no drainage channels passing through project and township areas. At project area the general slope is towards Mahi-Bajajsagar Reservoir.

The annual average rainfall is about 919.2mm in Banswara district. The annual average evaporation rate is estimated to be about 7.4 mm/day.

Population (Year 2013) in the project area is about 2307 (approx.) with around 307 houses only.

3.0 FACILITIES AND THEIR ARRANGEMENT WITHIN THE SITE BOUNDARY

In the plant layout, each unit of 700 MWe reactors has one Nuclear Building (NB) which houses various systems and components pertaining to Reactor Building (RB), Reactor Auxiliary Building (RAB), Spent Fuel Building (SFB) and various other services required for reactor operation. The portion of the nuclear building inside and including the Secondary Containment (SC) structure is called RB. The portion of Nuclear Building (NB) housing the Spent Fuel Storage Bay (SFSB) including the tray-loading bay is termed as Spent Fuel Building (SFB). The portion of NB housing the Reactor Auxiliary Systems, PHT and Moderator Purification systems, D2O vapour recovery system and the various services related structures such as maintenance shops, etc is called the Reactor Auxiliary Building (RAB). The main plant buildings also include the Control Building (CB), Station Auxiliary Buildings (SABs) and the Turbine Building (TB).

Double containment as used now in all Indian PHWRs has been provided. The primary Containment is lined with Carbon Steel liner to reduce the leak rate.

4.0 MAIN PLANT BUILDINGS

<u>BUILDINGS AND STRUCTURES</u>:

The main features of structural layout are:

Specific features:

a) A single Nuclear Building (NB) consisting of Reactor Building (RB) at centre encompassed by Reactor Auxiliary Building (RAB).

b) Reactor auxiliary systems are located very near to the Reactor Building to avoid long piping lengths.

c) Spent Fuel Storage Bay is located adjacent to outer containment wall, thus deleting the Spent Fuel Transfer Ducts.

d) A separate Control Building has been provided as a common facility. The control room and control equipment rooms of both units are located in the same floor, which also cater for unitized operation.

e) A separate backup control room has been provided for each unit, in the Nuclear Building diametrically opposite to the main control room.

f) Emergency power supply systems such as Diesel Generators, UPS systems and Batteries are separately housed in safety related Station Auxiliary Buildings for each unit. These buildings have been named as Station Auxiliary Buildings A and B.

General features

All safety related systems and components are grouped appropriately and placed in separate buildings/structures of appropriate design satisfying the functional requirement, to take care of common mode failures.

a) The buildings have been grouped according to their seismic classification in consonance with the classification of the system/ equipment contained.

b) Requirements arising out of industrial and nuclear safety are satisfied.

c) Structural connection between different safety class structures and seismic category are generally avoided.

d) Care is taken to keep the structural system simple, symmetrical and regular as far as possible, fulfilling the functional requirement.

e) Efforts have been made to locate the equipment with heavy mass at lower elevations to keep the centre of gravity of the structure as low as possible and to minimize the distance between centre of mass & centre of rigidity at each floor level, as far as possible.

f) Uniform grade of concrete will be used for primary structural elements of the same structure, as far as practicable.

g) Direct and easy emergency escape routes are provided with reliable lighting.

h) Different radiation zones are clearly demarcated and adequate facilities are provided for personnel decontamination, to prevent spread of contamination.

i) Care is taken to ensure that the separation of containment environment from the outside environment is achieved at all times during personnel and equipment access to the Reactor Building through airlocks.

j) Adequate fire protection measures are provided.

k) Layout is prepared with appropriate access and hatch requirements and handling arrangements of adequate capacity, for easy maintenance and surveillance of equipment.

l) Overlapping of foundations of different buildings is avoided.

m) The foundations of all safety related buildings are resting on competent substrata, to reduce differential settlement between adjacent buildings as far as practicable.

n) Safety related buildings are founded on raft foundation instead of isolated/combined footings.

o) Concrete surfaces in areas likely to be contaminated during operation and decommissioning stages will be protected with suitable paints (epoxy) or steel liners to avoid contaminant penetration and easy decontamination.

p) Floors are given proper slope and proper draining facilities are planned to facilitate collection of possible fluid leakage and floor washings. Provisions in the form of floor curbs will be made in detailing stage. Two Reactor Buildings (RB) at the centre of respective Nuclear Buildings, are located at 108m centre to centre distance. The Reactor Auxiliary Building (RAB) completely surrounds the Reactor Building to avoid long piping lengths. The Control Building (CB) is located centrally with respect to Nuclear Buildings. The Station Auxiliary Buildings (SABs), two for each unit, are located on two sides of Nuclear Building and Control Building so as to provide physical separation between the two SABs of a Unit. D2O upgrading plant, Ventilation Stack, F/M mechanical workshop and waste management plant are located on one side of the Nuclear Building. The two Turbine Buildings are located next to Control Building.

4.1 NUCLEAR BUILDING

Nuclear buildings consisting of RB and RAB house main reactor and associated process systems. RB is provided with primary and secondary containments. Primary containment is made of pre-stressed concrete and secondary containment is reinforced concrete. RAB is a framed RCC structure. NB is seismic category-1 structure.

4.2 CONTROL BUILDING (CB)

A separate control building, common for both units, has been provided next to the Nuclear Buildings to house Main Control Rooms (MCR) & Control Equipment Rooms (CER), main steam lines, emergency feed water tanks and auxiliary boiler feed pumps for both units. In addition, the Control Building acts as a main entrance to the station complex and is located appropriately. This is a safety related structure and has been classified as Category-1 (SSE) structure from seismic considerations.

4.3 STATION AUXILIARY BUILDING (SAB)

Separate buildings called station auxiliary buildings are provided to house emergency power systems. Each unit has two station auxiliary buildings. Station Auxiliary Building 1A and 2A are located on either side of control building, while 1B and 2B are located abutting the nuclear buildings-1&2 respectively.

These are safety related structures and are classified as Category-1 (SSE) structures from seismic considerations. The buildings are three storied structure. Two D.G. sets are located in each SAB, making the number of DG sets available for each unit four. The internal layout of all the four buildings is identical except for some minor variations.

The day oil tanks with proper fencing are located outside the SABs in a fenced area. CO_2 fire fighting cylinder room is located in between the two day oil tanks.

4.4 VENTILATION STACK WITH MONITORING ROOM

The ventilation stack is common for both the units. It is located next to Waste management plant building. The Stack is 100.0 m high above ground level and has an internal diameter of 3.0 m at the top. The ventilation stack is of RCC construction. The structure will be suitably founded and is unlined.

External outside diameter at top is 3.440 m, with a shell thickness of 220 mm. The outside diameter of concrete shell increases uniformly from 3.440 m at top to 9.00 m at top of foundation level (shell thickness 500mm).

4.5 D2O UPGRADING PLANT BUILDING:

The building accommodates various equipment required for purifying the downgraded Heavy Water collected from various sources during the operation of power stations. The building is located to the west of Nuclear Building-4 abutting the covered passage. The upgrading plant may be generally divided into four major areas – D_2O distillation towers, D2O upgrading plant, D_2O clean-up and evaporation area and downgraded D_2O storage area.

4.6 WASTE MANAGEMENT FACILITY AND EXHAUST VENTILATION BUILDING

This building is a two storied RCC framed structure with a basement and is designed as seismic category – 1. The building is located to the west of nuclear buildings abutting the covered passage.

Proper passages are provided within the building, wherever zone change occurs. LESS facility is located at the basement of the building and the decontamination facility is provided just above LESS at EL 100000, for ease of drainage. The decontamination and resin fixation areas, being in zone-3, are provided with shielding walls of sufficient thickness. The concept of evaporator system is introduced for the disposal of Tritiated waste through air route, instead of liquid route. The ventilation discharge from plant buildings is routed to the exhaust ventilation system, at first floor of the building. The final gaseous exhaust is then taken through the ventilation duct and led to stack.

4.7 INDUCED DRAUGHT COOLING TOWERS

Two Induced Draught Cooling Towers (IDCT) per unit are provided. The main function of IDCT is to remove heat from the active process water system. Active process water is cooled in plate type heat exchanger. The cooling of hot water (from out-let of plate type heat exchangers) is achieved by mechanical induced draught created by fans mounted on top of the Towers. This structure is classified as safety class 3 & seismic category –1.

4.8 SAFETY RELATED PUMP HOUSE (SRPH)

The Safety Related Pump House (SRPH) is a R.C. framed building catering for both units of plant. The Building is designed for seismic category -1.

4.9 FIRE WATER PUMP HOUSE

Firewater pump house is a RCC framed structures for pumps for firewater. FWPH is located close to SRPH.The building is designed for seismic category 1.

4.10 UNDERGROUND TUNNELS AND TRENCHES

There are many reinforced concrete tunnels and trenches carrying a number of safety related service pipelines and cables. The seismic category is 1 and safety class is 3.The tunnels are buried under soil, with overburden, while the trenches have no earth cover on top. The main safety related tunnel in the plant area, is the tunnel carrying APW and NAPW lines from reactor auxiliary system to safety related pump house and IDCTs. Local tunnels are also provided, wherever the trenches or sleepers are crossing the roa

4.11 DIESEL OIL STORAGE AREA (DOSA)

Two Diesel Oil Storage areas, one per unit are provided for storing high-speed diesel oil for diesel engines, in underground tanks (4nos.). Additional tanks are provided which caters to fire water pump house (FWPH) where diesel operated pumps are located. Since, DG operation is safety related, more importance is given to system reliability and supporting arrangement. The tanks rest on steel saddle, which itself will be supported on concrete pedestal.

4.12 EMERGENCY MAKEUP WATER POND:

IDCT basins are designed to meet the emergency water make up requirement for a period of 7 days, over and above the minimum basin level to be maintained for operational requirement.

4.13 COVERED PASSAGE

A covered passage is provided between nuclear buildings and WMP / workshop buildings, for equipment and personnel movement between the buildings. Grade slab is provided at EL 100000. The roof slab is supported on brackets from the columns of nuclear building and WMP building.

4.14 DIESEL OIL STORAGE AREA (DOSA)

Two Diesel Oil Storage areas, one per unit are provided for storing high-speed diesel oil for diesel engines, in underground tanks (4 nos.). One additional tank is provided to cater for fire water pump house (FWPH) where diesel operated pumps are located.

4.15 TURBINE BUILDING (TB)

The Turbine building is a reinforced concrete framed structure with steel roof trusses. The building is 35 m x 100 m in plan and has a total height of 44 m above grade level. A portion below condenser is lowered by 4.7 M to provide for cooling water inlet and outlet pipes.

The turbine building has floors and mezzanine floors at various elevations, housing the turbo generator and other equipment like HP Turbine, LP Turbine, Generator, Moisture Separator & Reheater, Deaerator, HP and LP feed water heaters, Condensate Extraction Pumps, Boiler Feed Pumps, regenerative feed heaters, Deaerator & Storage tanks, Vacuum pumps, Generator Circuit Breaker, BUS Ducts etc.

The turbine generator is supported on a separate pedestal and Reinforcing Concrete foundation raft. This foundation is isolated from the main turbine building so as to avoid transmission of vibrations.

4.16 ELECTRICAL BAY

The class IV 6.6 kV / 415 V equipment like switch gear, auxiliary transformer, protection panel for SUT, UT and GT, SCADA panel etc are housed in this building. The GT, UT and SUTs are located outside the electrical bay in the transformer yard.

4.17 SWITCHYARD

The 400 kV switchyard has been provided for power evacuation from the station through 400 kV transmission lines. SUTs are connected to the existing 220 kV switchyard. The control panel, protection panel,SCADA panel, billing metering panel, Disturbance Recorder (DR) panel, etc are housed in the switchyard control room near the 400 kV switchyard.

5.0 GENERATION OPERATIONS

Natural uranium oxide is used as fuel and heavy water is used as coolant and moderator for the reactor. Refueling of the reactor is carried out "on-power".

Steam generators supply nearly dry saturated steam to the turbine. Turbine is a tandem compound machine directly coupled to an electrical generator, which produces electricity. Generator voltage is stepped up by the generator transformer, which in turn is connected, to a switchyard. Generated power is transmitted to the grid from the nuclear power station at 400 kV.

The concept of defense-in-depth is adopted in design of safety systems. Provision of multiple barriers, double containment structures with steel liner on inner containment wall of Reactor Building, containment spray cooling system, emergency core cooling system, reactor shut down systems etc. as engineered safety systems ensure safe operation of reactor.

Reactor protection system ensures shutdown requirements through two independent fast acting shut down systems. Reactor regulating system enables automatic control of reactor power and maintains neutron flux profile.

A closed loop cooling system has been provided by use of natural draft cooling towers that shall draw makeup water from Bargi Reservoir.

Safety of the plant will be as per the latest state of art, meeting the statuary requirement of AERB and various National & International codes.

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