Environmental Monitoring Report

Project Number: 45224-003
July 2017

Period: October 2016 – March 2017

IND: Rajasthan Renewable Energy Transmission Investment Program - Tranche 1

Subprojects: 400 kV Pooling Substation Bhadla & augmentation works at Bikaner GSS (ICB-2)

Submitted by

Rajasthan Rajya Vidyut Prasaran Nigam Limited, Jaipur

Asian Development Bank

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for logging PS

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Date: 20/07/2017 05:03 PM
Subject: Environmental monitoring report for ICB2

KFA

Regards,

J.P.Ramawat
TA to CE (Contracts),
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ICB-2

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Date: 07/27/2017 03:38 PM
Subject: Revised EMP

KFA the EMP for ICB 2.

Regards,

J.P.Ramawat
TA to CE (Contracts),
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Mobile : +91-9413345569

ICB-2 second Envionment

Monitoring Report-Bhadla GSS Oct-16-April 2017.docx

Environmental Safeguards Document

2nd
Environment Monitoring Report
For ICB 2: 400 kV Pooling Substation Bhadla& augmentation works at Bikaner GSS

Document Stage: Final Document
Project Number: 45224 (IND)
Period – Oct'2016–March 2017
Reporting – July'17

India: Rajasthan Renewable Energy Transmission Investment Program

Prepared for Asian Development Bank byRajasthan Rajya Vidyut Prasaran Nigam Limited (RRVPNL), Government of Rajasthan.

Environment Monitoring Report

Compliance Status & Monitoring Report of Environment Safeguards

Period: March Oct'2016–April 2017

Submitted by: Rajasthan Rajya Vidyut Prasaran Nigam Limited, Rajasthan

Table of Contents

Abbreviations

AP's	Affected Persons
C/o	Construction of
Deptt.	Department
Distt.	District
FCA	Forest Conservation Act
GIS	Gas Insulated Switchgear
GoI	Govt of India
GRC	Grievance Redressal Committee
Ha.	Hectare (10,000 sq. m. land)
IE Rule	Indian Electricity Rule
MOEFCC	Ministry of Forest, Environment and Climate Change
MPAF	Main Project Affected Family

Project Information

A.1. General

I	Name of Project	**Rajasthan Renewable Energy Transmission Investment Program**
II	Loan Number	Loan 3052-IND: Rajasthan Renewable Energy Transmission Investment Program - Tranche 1
II	Name of Monitoring/Reporting Agency and address	RRVPNL/Vidut Bhawan, Janpath, Jyoti Nagar Jaipur – 302005 Alstom T&D India Ltd. 910, OK Plus Tower, Govt. Hostel Circle, Near Vishal Mega Mart, Ajmer Road, Jaipur
III	Monitoring Period (Season/month)	Oct'2016–April 2017
IV	Report No.	2
V	Report for the period	Oct'2016–April 2017
VI	Date of reporting	July'17

A.2. Subproject details

	List of sub-projects	**Name of the Project site**
I	ICB 2: 400 kV Pooling Substation Bhadla & augmentation works at Bikaner	ICB 2: 400 kV Pooling Substation Bhadla & augmentation works at Bikaner under specification No. RRVPN / ADB / Tranche 1/ICB-2 (Supply & Service contract) to M/s. Alstom
II		Contract Agreement signed 18.03.2015
III		
IV		
V		
VI		

A.3. Overall Project Progress, Agreed Milestones and Implementation Schedules

S No	Stage of sub-project	Progress as on date of Report	Implementation Schedule
1	Design / Engineering	100%	18.03.15 to continue (Document detail Enclosed)
2	Civil work	100%	01.07.15 to Continue (Document detail Enclosed)
3	Supply order	100%	01.10.15 to Continue (Document detail Enclosed)
4	Erection	100%	13.03.16 to Continue(Document detail Enclosed)
5	Testing Commissioning	98%	Testing of reactors and 2 Nos. 500MVA Trafo's(Free issued item by RRVPNL)

B.1: Compliance Status with National/State/Local Statutory Environmental Requirements and international standards

S No	Legal Requirements/Acts/Rules/Guidelines	Applicable Attributes	RRVPNL's Compliance Status
1	The Water (Prevention and Control of Pollution) Act, 1974 as amended;	Water Pollution	Preventive measures are being adopted to avoid such pollution. .
2	The Air (Prevention and Control of Pollution) Act, 1981	Air Pollution	Preventive measures are being adopted to avoid such pollution.
3	The Environment (Protection) Act, 1986	Construction Practices	
4	The Environment Impact Assessment Notification, 1994 as amended	EMP monitoring	
5	The Hazardous Wastes (Management and Handling) Rules, 1989 as amended	Transformer Oil	Preventive measures are being adopted
6	The Ozone Depleting Substances (Regulation and Control) Rules, 2000	Cleaning of electrical contacts using HFCs etc.	Preventive measures are being adopted
7	The Batteries (Management and Handling) Rules, 2001 as amended	Batteries	Preventive measures are being adopted
8	The Indian Forest Act, 1927 as amended	Reserve Forest areas, Right of way	Forest Land is not involved in the substation.
9	The Wild Life (Protection) Act, 1972 as amended	Critical habitats	No Wild life is involved in Project.
10	The Biological Diversity Act, 2002	Wetland	No Wetland is involved.
11	The Forest (Conservation) Act, 1980 as amended	Construction work in forest areas	Forest Land is not involved.
12	The National Environmental Policy, 2006 of GoI	Construction Practices	GOI norms for environmental management followed for all construction work
13	Other State Level Acts	Compensation	Compensation as per RRVPNL and state Revenue department.
14	Other International levels conventions and treaties	Biodiversity, GHG emissions	Not being affected.

B.2: General Implementation Status

B.2.1. Forest Clearance.

SNo.	Measures/ stipulation	Compliance Status
I	**Sub-Project #**	
1	Right of Way/ land required	Government Land
2	Clearance from trees	No trees on the site
3	Forest area and Nos. of trees.	No Forest land is being involved.
4	Damage to forest	No forest in the vicinity.
5	Wild life sanctuaries	No Wild life is involved in Project.

B.2.2. Fulfillment of commitments made during Public Hearing/Consultation

S.No.	Query/Apprehension	Commitment	Compliance Statement
I	**Sub-project #**		
1	Compensation for crop	As per EPC contractor bid	None
2	Compensation for land damages	As per EPC contractor bid	No land is damaged during the construction of boundary wall.Terminal gantry located inside boundary wall.
3	Compensation for pathways, channels for waterway.	Restoration after erection by EPC contractor	Till date no pathways, channels for waterways have been

			affected during the work. If affected, they shall be restored properly.
4	Nuisance due to dust, noise, vibrations, labor during construction	As per EMP implemented by EPC contractor	Preventive actions are being adopted to avoid such nuisance. Measures to reduce dust, noise, vibrations and labor problems currently.

B.2.3. ADB Stipulations/ safeguarding measures on Environment.

SNo.	Product Activity/Stage	Parameter to be monitored	Compliance Status
I	**Sub-Project #**		
	Construction		
1	Archeological site/ monument safety	Chance find	Not involved
2	Public places, schools, ponds, airport, railway etc.	Distance 500 m away	No school, ponds in the area.
3	Safeguard against critically endangered Flora and fauna.	Avoid	No Flora Fauna involved in project
4	Rain and Flood prone area.	Avoid	Not a flood prone area
5	Environmental parameters for air, noise, land and water during project construction	Environmental Monitoring Plan	

B.2.4 Record of complaints (regarding environment safeguard measures) and their resolution

Sr.No	Complainant Name and address	Date of receipt	Subject/Issue	Date of resolution	Remarks
I	**Sub-Project #**				
	As on date no complaint has been received				

B.2.5. Staffing, Institutional Arrangements and Grievance Redress

S.No.	Parameters	Commitment	Compliance Statement
1	Numbers of Staff deputed/employed for environment safeguards	One at -site	One Safety Officer
2	PIU established as per proposed institutional mechanism	Date	01-July-2015
3	GRC formation	Proper record	Project Engineer, Safety Head, and RVPNL JEN
4	Grievance Redress Mechanism followed	Proper record	Currently no environment related grievance received.

B.2.6. Other measures:

I	Sub-Project #
1	Safety Motivation Program for month of Nov. 2016 & Jan'17 (RRVPNL Bhadla)
2	Risk Management for High-Risk Activities – 20-April-2017
3	Scaffolding Safety Training at Bhadla site -20-April-2017
4	Machine Safety Training – 20-April-2017
5	Banksman Training – NA
6	Incident communication & Vehicle movement awareness safety training – – 20-April-2017

B2.8 Annexures

I	Sub-Project #
1	Photographs of the following – Main Control room building,Kiosk ,Erected major equipment,Road

	workshop, training material for HSE etc.
2.	Baseline Report of Environmental Parameters (Pre-construction)
3.	Progress Status

B.3: Status of Implementation of Environment Management Plan (EMP) and Environment Monitoring Plan (EMoP)

B3.1. Environment Management Plan and Status on Implementation

Project Activity	Potential Environmental Impact	Mitigation Action	Standards	Actions during reporting period (incl. corrective)	Cumulative Progress to date	Corrective Actions Required	Further Follow-up required	Institutional Responsibility
Pre-construction								
Temporary use of land	Impact to the existing environment	Selection of lands adhering to local laws and regulations Construction facilities should be placed at least 500 m away from water bodies, natural flow paths, important ecological habitats and residential areas	water and air quality	Village areas are very far away	NA			RRVPNL
Substation location and design	Noise generation Exposure to noise, Nuisance to neighbouring properties	Substation designed to ensure noise will not be a nuisance.	Expected noise emissions based on substation design, noise levels	Village areas are very far away	Digging of foundations mostly in soil and no rock is there	NIL		RRVPNL
	Disturbance to the adjacent lands and the people due to cut and fill operations	Maintained adequate clearance, construction of retaining structures, minimise cut and fill operations adjoining to the dwellings	Setbacks to houses and other structures					
Location of transmission towers and transmission line alignment and design	Exposure to safety related risks	Setback of dwellings to overhead line route designed in accordance with permitted level of power frequency and the regulation of supervision at sites.	Tower location and line alignment selection with respect to nearest dwellings	House/dwelling area very far away	NA	NA	NA	RRVPNL
	Impact on water bodies / land/ residences	Consideration of site location to avoid water bodies or agricultural land as much as possible. Careful site selection to avoid existing settlements	Site location, line alignment selection (distance to dwelling, water and/or agricultural land)	All the water bodies/dwellings are more than 500 mtrs away from the substation land	NA	-	-	RRVPNL
Equipment specifications and design parameters	Release of chemicals and harmful gases in receptors (air,	PCBs free substation transformers or other project facilities or equipment.	Transformers and specifications and compliance with setback distances	Equipment Design for substation submitted to RRVPNL for review	Design approved			RRVPNL

Project Activity	Potential Environmental Impact	Mitigation Action	Standards	Actions during reporting period (incl. corrective)	Cumulative Progress to date	Corrective Actions Required	Further Follow-up required	Institutional Responsibility
	water, land)		(“as-built” diagrams)					
Encroachment into precious ecological areas	Loss of precious ecological values/ damage to precious species	Avoid encroachment by careful site and alignment selection and reconnaissance before final siting of activities. Minimise the RoW wherever possible	Floral and faunal habitats loss	No ecological areas are involved in substation.		-	-	RRVPNL
Involuntary resettlement or land acquisition	Loss of lands and structures	Compensation paid for temporary/ permanent loss of productive land	Public complaints		NA	NA	-	RRVPNL
Encroachment into farmland	Loss of agricultural productivity	Use existing tower footings/towers wherever possible Avoid siting new towers on farmland wherever possible Farmers compensated for any permanent loss of productive land and trees that need to be trimmed or removed along RoW.	Tower location and line alignment selection Design of Implementation of crop and tree compensation (based on affected area) Statutory approvals for tree trimming /removal		NA	NA	NA	RRVPNL
Interference with drainage patterns/Irrigation channels	Temporary flooding hazards/loss of agricultural production	Appropriate sighting of towers to avoid channel interference Appropriate provision or excess soil dug up from the foundations/trenches	Site location and line alignment selection	Substation foundations are spotted beyond the boundaries of water channel.		278	-	RRVPNL
Explosions/Fire	Hazards to life	Design of substations to include modern fire control systems/firewalls. Provision of firefighting equipment to be located close to transformers,	Substation design compliance with fire prevention and control codes	Design of substation equipment approved by RRVPNL	Design approved			RRVPNL

Project Activity	Potential Environmental Impact	Mitigation Action	Standards	Actions during reporting period (incl. corrective)	Cumulative Progress to date	Corrective Actions Required	Further Follow-up required	Institutional Responsibility
		power generation equipment.						
Construction								
Removal or disturbance to other public utilities	Public inconvenience	Advance notice to the public about the time and the duration of the utility disruption Use of well trained and experienced machinery operators to reduce accidental damage to the public utilities Restore the utilities immediately to overcome public inconvenience	Disruption to other commercial and public activities / Public complaints	Advance notice will be published into the local newspaper for electric utility shutdown.	As construction area is quite isolated from community, there is certainly not Availability of public utilities nearby. A separate road has been already constructed by RRVPNL for local public Conveyance.		-	RRVPNL
Acquisition of cultivable lands	Loss of agricultural productivity	Avoid farming season wherever possible for the project activities. Ensure existing irrigation facilities are maintained in working condition Protect /preserve topsoil and reinstate after construction completed Repair /reinstate damaged bunds etc. after construction completed Compensation for temporary loss in agricultural production.	Land area of agriculture loss Usage of existing utilities Status of facilities (earthwork in m^3) Implementation of crop compensation (amount paid, dates, etc.)	No work locations in any farming area Top soil will be restored during the back filling work.		-	-	RRVPNL
Temporary outage of the electricity	Loss of power supply to the local community when distribution lines crossing the new transmission	Advance notice to the public about the time and the duration of the utility disruption Restore the utilities	Power disruption to houses and commercial premises of power disruption	Advance notice will be published into the local newspaper for electric utility shutdown.			-	RRVPNL

Project Activity	Potential Environmental Impact	Mitigation Action	Standards	Actions during reporting period (incl. corrective)	Cumulative Progress to date	Corrective Actions Required	Further Follow-up required	Institutional Responsibility
	line are switched off	immediately to overcome public inconvenience						
Equipment layout and installation	Noise and vibrations	Selection of construction techniques and machinery to minimise ground disturbance.	Construction techniques and machinery	Construction activity carried out during in day.	Using the DG set with acoustic enclosure. Other machinery with less noise.		-	RRVPNL
	SF6 leakage during storage and erection of Switchgear	Record of all substation switchgear, storage cylinders located within secure casings	Switchgear casings and substation bounding	No equipment supplied currently	NA since All Breakers erected and tested			RRVPNL/Alstom
Substation construction	Loss of soil	Fill for the substation foundations obtained by creating or improving local drain system.	Borrow area sighting (area of site in m^2 and estimated volume in m^3)	Top soil retained inside substation	Excess soil shall be used in road construction at site only			
	Interference in drainage of rain and waste water at site	Removal of silt and trash choking the drainage of the substation land	Drains choked with rain/water due to silt and trash	None	Overall drainage system work in progress.			
	Water pollution	Construction activities involving significant ground disturbance (i.e. substation land forming) not undertaken during the monsoon season.	Water Quality (pH, BOD/COD, Suspended solids, other) during major earthworks	Testing to be done as per EMP requirement in March 2016	No ground water disturbance.			
Construction schedules	Noise nuisance to neighbouring properties	Minimize construction activities undertaken during the night and local communities informed of the construction schedule.	Timing of construction (noise emissions, [dB(a)])	Villages located very far away	No noisy activities carried out in Night.	-	-	RRVPNL/Alstom
Provision of facilities for construction workers	Nuisance to wildlife if the line construction crosses their migratory path	Restrict construction work during the known period of migration by any wildlife in the area	Timing of Construction	No wild life area involved	-	-	-	RRVPNL/Alstom
	Contamination of receptors (land, water, air)	Construction workforce facilities to include proper sanitation, water supply and waste disposal facilities.	Amenities for Workforce facilities	Covered and fence wall around the worker living area. Worker have sufficient waste water collection system and septic camp.	Arrangement made at site	-	-	RRVPNL/Alstom

Project Activity	Potential Environmental Impact	Mitigation Action	Standards	Actions during reporting period (incl. corrective)	Cumulative Progress to date	Corrective Actions Required	Further Follow-up required	Institutional Responsibility
Surplus earthwork/soil	Runoff to cause water pollution, solid waste disposal	Excess fill from tower foundation excavation to be reused on site or disposed of next to roads or around houses, in agreement with the local community or landowners.	Location and amount (m^3) of fill disposal Soil disposal locations and volume (m^3)	Excess soil is dumped inside the substation and then used for fill inside.	Excess soil used for Road work inside substation	-	-	RRVPNL/Alstom
Air Pollution	Loose dust might blow in the area causing dusty conditions	Damping of dust by sprinkling of water within the work area and stack the loose soil and contain it with covers if required.	Soil stacking locations, access roads, tower locations, substation site	Lack of water leading to no spraying of water to minimize dust releasing in case of windy and dry weather.	Water spraying done at site.	-	-	RRVPNL/Alstom
Wood/ vegetation harvesting, cut and fill operations	Loss of vegetation and deforestation	Construction workers prohibited from harvesting wood in the project area during their employment.	Illegal wood /vegetation harvesting (area in m^2, number of incidents reported)	Firewood used, however LPG cylinder will be provided to Labor.	Now LPG cylinders are being used at site.	-	-	RRVPNL/Alstom
	Effect on fauna	Prevent work force from disturbing the flora, fauna including hunting of animal and fishing in water bodies. Proper awareness programme regarding conservation of flora, fauna including ground vegetation to all drivers, operators and other workers.	Habitat loss	Training program to be conducted to create awareness among the workers and staff to conserve the flora and funa.	Worker awareness program done to conserve the flora and funa.	-	-	RRVPNL/Alstom
Site clearance	Vegetation	Marking of vegetation to be removed prior to clearance, and strict control on clearing activities to ensure minimal clearance.	Vegetation marking and clearance control (area in m^2)	Vegetation land not involved at the substation line		-	-	RRVPNL/Alstom
	Soil erosion and surface runoff	Construction near seasonal rivers, erosion and flood-prone areas (if any) should be restricted to the dry season. Provision and	Soil erosion	No soil erosion involveduring the construction activity of substation.	No soil erosion involved at site.	-	-	RRVPNL/Alstom

Project Activity	Potential Environmental Impact	Mitigation Action	Standards	Actions during reporting period (incl. corrective)	Cumulative Progress to date	Corrective Actions Required	Further Follow-up required	Institutional Responsibility
		maintenance of drains and retention ponds. Treat clearing and filling areas against flow acceleration and construction work should be carefully designed to minimise obstruction or destruction to natural drainage.						
Mechanised construction	Noise, vibration and operator safety, efficient operation Noise, vibration, equipment wear and tear	Construction equipment to be well maintained. Proper maintenance and turning off plant not in use.	Construction equipment - estimated noise emissions and operating schedules	Construction equipment is regularly maintained. Pollution under control certificate to be made available	Equipment fitness checked on regular basis.	-	-	RRVPNL/Alstom
Construction of roads for accessibility	Increase in airborne dust particles Increased land requirement for temporary accessibility	Existing roads and tracks used for construction and maintenance access to the site wherever possible. New access ways restricted to a single carriageway width within the Row.	Access roads, routes (length and width of access roads)	Existing road/path only used for the construction activity. Any new access path used is only one carriageway width for tractor, JCB machine and other machines.	Road constructed in inside substation.	-	-	RRVPNL/Alstom
Transportation and storage of materials	Nuisance to the general public	Transport loading and unloading of construction materials should not cause nuisance to the people by way of noise, vibration and dust Avoid storage of construction materials beside the road, around water bodies, residential or public sensitive locations Construction materials should be stored in	Water and Air Quality	Dropping material in the road collected. Construction material stored at high level ground level at construction site. Construction material – sand will be covered at top to avoid air pollution and stacked top soil to be also covered at top to avoid blowing during windy	NA.	-	-	RRVPNL/Alstom

Project Activity	Potential Environmental Impact	Mitigation Action	Standards	Actions during reporting period (incl. corrective)	Cumulative Progress to date	Corrective Actions Required	Further Follow-up required	Institutional Responsibility
		covered areas to ensure protection from dust, emissions and such materials should be bundled in environment friendly and nuisance free manner		conditions				
Trimming/cutting of trees within RoW	Fire hazards Loss of vegetation and deforestation	Trees allowed growing up to a height within the RoW by maintaining adequate clearance between the top of tree and the conductor as per the regulations. Trees that can survive trimming to comply with statutory distance should be lopped and not felled Felled trees and other cleared or pruned vegetation to be disposed of as authorised by the statutory bodies.	Species-specific tree retention as approved by statutory authorities (average and maximum tree height at maturity, in metres) Disposal of cleared vegetation as approved by the statutory authorities (area cleared in m^2)	NA	NA	-	-	
Health and safety ADD PPE	Injury and sickness of workers and members of the public	Contract provisions specifying minimum requirements for construction camps from water bodies, reserved areas etc. Contractor to prepare and implement a health and safety plan and provide workers with required personal protective equipment (PPE) at site. Contractor to arrange for health and safety awareness programmes	Contract clauses (number of incidents and total lost-work days caused by injuries and sickness)	Conducting training courses and meeting for the workers on safety and environmental hygienic Providing personal safety devices for workers safety boots, helmet, gloves, mask and protective cloths	Training conducted at site. All Personal protective equipment provide to workers.	-	-	RRVPNL/Alstom
Nuisance to nearby properties	Losses to neighbouring land uses/ values	Contract clauses specifying careful construction practices.	Contract clauses Design basis and layout	Excavated material will be used for filling ground itself.	Excess soil used road construction	-	-	RRVPNL/Alstom

Project Activity	Potential Environmental Impact	Mitigation Action	Standards	Actions during reporting period (incl. corrective)	Cumulative Progress to date	Corrective Actions Required	Further Follow-up required	Institutional Responsibility
					work inside substation.			
		As much as possible existing access ways will be used. Productive land will be reinstated following completion of construction Compensation will be paid for loss of production, if any.	Reinstatement of land status (area affected, m^2) Implementation of Tree/Crop compensation (amount paid)					
Operation and Maintenance Phase								
Electric shock	Death or injury to the workers and public	Security fences around substation Establishment of warning signs Careful design using appropriate Alstomlogies to minimise hazards	Proper maintenance of fences and sign boards Usage of appropriate Alstom logies (lost work days due to illness and injuries)				NA at this stage of Project	
Noise generation	Nuisance to the community around the site	Provision of noise barriers near substation sites	Noise level				NA at this stage of Project	
Soil Erosion	Removal of top soil	Planting of buffer zone species suitable for arid climate.	Turbidity of water (Visual Inspection)				NA at this stage of Project	
Maintenance of Transmission line	Exposure to electromagnetic interference	Transmission line design to comply with the limits of electromagnetic interference from overhead power lines	Required ground clearance (metres)				NA at this stage of Project	
Substation maintenance	Exposure to electromagnetic interference	Substation design to comply with the limits of electromagnetic interference within floor area	Required vibrations level, instrumentation					
Oil spillage	Contamination of land/nearby water bodies	Substation transformers located within secure and impervious bundled areas with a storage	Substation bounding (“as-built” diagrams)				NA at this stage of Project	

Project Activity	Potential Environmental Impact	Mitigation Action	Standards	Actions during reporting period (incl. corrective)	Cumulative Progress to date	Corrective Actions Required	Further Follow-up required	Institutional Responsibility
		capacity of at least 110% of the capacity of oil in transformers and associated reserve tanks.						
Operation of Switchgear	Leakage of SF6 gas	Record of all substation switchgear located within secure casings	Switchgear casings and Substation bounding			NA at this stage of Project		

B.3.2 Environment Monitoring Plan and Status on Implementation

Environmental component	Project stage	Parameters to be monitored	Sampling Location	Monitoring Frequency	Regulatory Standards for parameter	Agency responsible for implementation	Agency responsible for supervision	Test Results	Observations/Comments	Actions for Compliance	Further follow-up required
1.Air Quality	A. Pre construction stage (Baseline development)	PM_{10}, $PM_{2.5}$, SO_2, NOx, SPM, CO (Visible dust)	Boundary of substation	One time	Spot check using field portable instruments National Air quality standards of CPCB [PM10 or PM2.5]	RVPNL		Complied			
	B. Construction Stage	PM_{10}, $PM_{2.5}$, SO_2, NOx, SPM, CO (Visible dust)	Boundary of substation	Every one month of construction period	Spot check using field portable instruments National Air quality standards of CPCB [PM10 or PM2.5	Alstom		NA at this stage of Project			
	C. Operation Stage (Testing and Commissioning)	PM_{10}, $PM_{2.5}$, SO_2, NOx, SPM, CO (Visible dust)	Boundary of substation	One time during commissioning	Spot check using field portable instruments National Air quality standards of CPCB [PM10 or PM2.5						
2.Water Quality	A. Pre construction stage (Baseline development)	EC, TSS, DO, BOD, P^H Oil and grease, Pb,	Nearest well near substations	One time	National water quality standards of CPCB	RVPNL					
	B. Construction Stage	EC, TSS, DO, BOD, P^H Oil and grease, Pb,	Nearest well near substations	One time during cable laying	National water quality standards of CPCB	Alstom		NA at this stage of Project			
	C. Operation	EC, TSS,	Nearest	One time	National water						

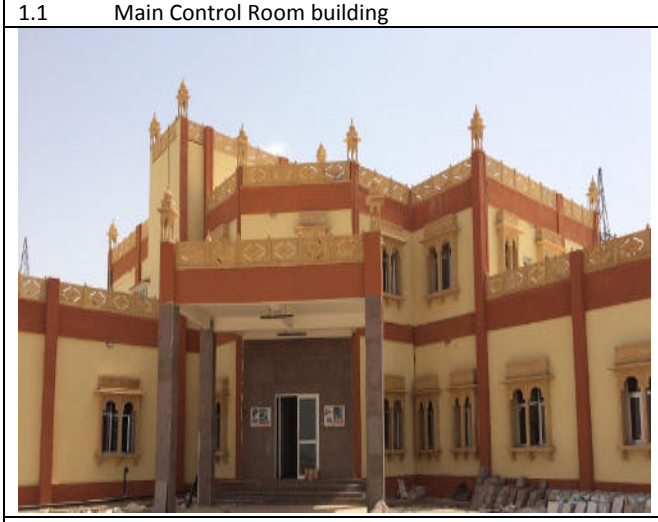
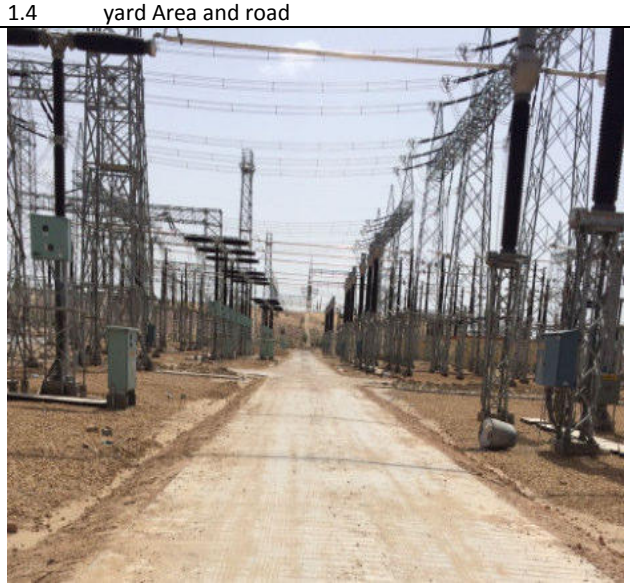
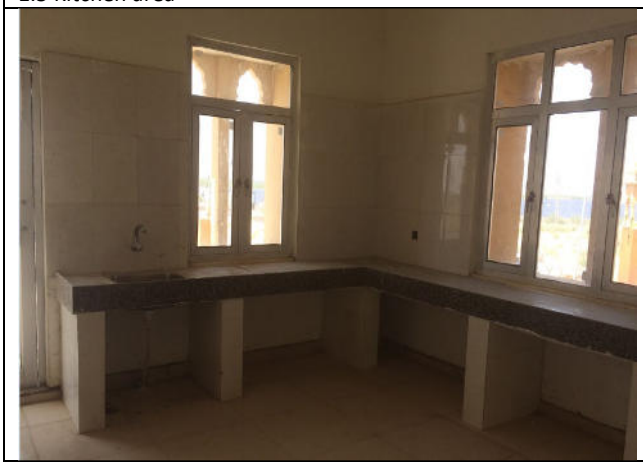
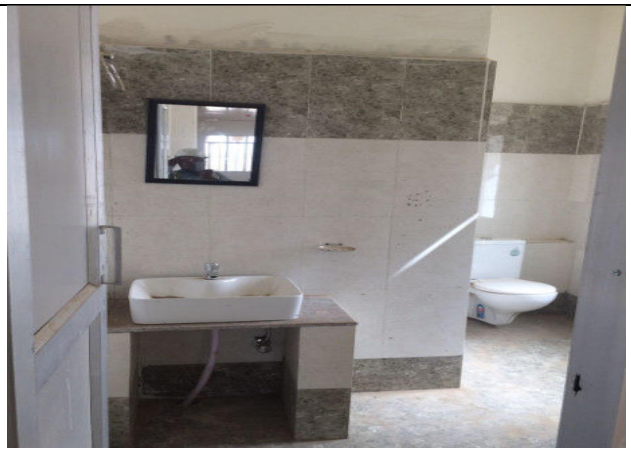
Environmental component	Project stage	Parameters to be monitored	Sampling Location	Monitoring Frequency	Regulatory Standards for parameter	Agency responsible for implementation	Agency responsible for supervision	Test Results	Observations/Comments	Actions for Compliance	Further follow-up required
	Stage	DO, BOD, P^H Oil and grease, Pb,	well near substations	during commissioning	quality standards of CPCB						
3.Noise/ Vibration	A. Pre construction stage (Baseline development)	Noise level [dB(A)]	Boundary of substation	One time	CPCB standards for Noise and vibrations	RVPNL					
	B. Construction Stage	Noise level [dB(A)]	Boundary of substation	Every one month of construction period	CPCB standards for Noise and vibrations	Alstom		NA at this stage of Project			
	C. Operation Stage	Noise level [dB(A)]	Boundary of substation	One time during commissioning	CPCB standards for Noise and vibrations						
4. Soil	A. Pre construction stage (Baseline development)	Visible spills and/or soil staining, Oil & grease	1 location inside substation	One time	Hazardous Waste Management rules	RVPNL					
	B. Construction Stage	Visible spills and/or soil staining, Oil & grease	1 location inside substation	One time	Hazardous Waste Management rules	Alstom		NA at this stage of Project			
	C. Operation Stage	Visible spills and/or soil staining, Oil & grease	1 location inside substation	One time during commissioning	Hazardous Waste Management rules						
SF6	Operation Stage	Volumetric loss from GIS equipment	Substation equipment, circuit breakers	Online monitoring by data loggers	As per Approved Specifications of Equipment	Alstom		NA since all breakers erected and tested			

Abbreviations:

SO_2- -Sulphur Dioxide; NO_2- - Nitrogen Dioxide; CO- Carbon Monoxide; EC – Electric Conductivity;

Pb – Lead; $PM_{2.5}$ - Particulate Matter <2.5;PM_{10} - Particulate Matter <10; TSPM- Total suspended Particulate Matter;
EC - Electrical Conductivity; DO - Dissolved Oxygen; TSS - Total Suspended Solids;
SF_6 – Sulphur Hexafluoride gas
BOD - Biological Oxygen Demand; ORP – Oxidation Reduction Potential
NAAQS - National Ambient Air Quality Standards specified by CPCB, GoI;
NWQS - National Water Quality Standards specified by CPCB, GoI.

Annexure 1:Site Pics

1.1 Main Control Room building	1.2 Transformer
	
1.3 AC Kiosk	1.4 yard Area and road
	
1.5 Kitchen area	1.6 Toilet
	

Annexure -2
Baseline Test Reports (Tests done during IEE assessment in 2011-2012)

Location of Sampling Inside the Bhadla Solar Park (November 2011)

S. No	Component	No. of Sample	Report Reference No.	Sampling Location
1 and 2	Air Monitoring and Noise Monitoring	6 6	AN - 1	Near Munna Ram's tube well
			AN – 2	Near Sarpanch (Mathar Khan's House) Churon Ki Basti
			AN - 3	GSS Bhadla Substation land
			AN - 4	Near ArniyokiNadi
			AN - 5	Near PannukiNadi
			AN -6	Near Mile stone of 0 km Bhadla Fanta on Nachna – Bhikampur road
3	**Water Analysis**	3	WS - 1	Munna Ram's tube well
			WS – 2	Govt. tube well Churon Ki Basti
			WS - 3	Water tank at Kamrudeen House in GamnokiBasti
4	**Soil Analysis**	3	SS - 1	GSS Bhadla Substation land
			SS – 2	Near ArniyokiNadi
			SS - 3	Near PannukiNadi

Location of Sampling along the associated Grid Substations (November 2011)

S. No	Component	No. of Sample	Report Reference No.	Sampling Location
1 and 2	for Air and Noise Monitoring	4 each	SS-1	GSS Sub Station Land, Khasara No. 8, Village: Bhadla, Post: Nuro Ki Burj, Tehsil: Phalodi, District Jodhpur
3	**Water Analysis**	4	SS-1	Water sample collected from Bore well of Munna Ram Ji, Village: Bhadla (Khasra No.9), Post: Nuro Ki Burj, Tehsil: Phalodi, District Jodhpur
4	**Soil Analysis**	4	SS-1	Soil sample collected from the land of proposed GSS Sub Station, Khasara No. 8, Village: Bhadla, Post: Nuro Ki Burj, Tehsil: Phalodi, District Jodhpur

A. AMBIENT AIR QUALITY MONITORING REPORT

i.Ambient Air Quality Monitoring Report for Solar Park at Bhadla (November 2011)

S. No	Site	Particulate Matter (PM 2.5)	Particulate Matter (PM 10)	Sulphur Dioxide (SO2)	Oxide Of Nitrogen (NOX)	Carbon Monoxide as (CO)
AN -1	Near House of Munna Ram Ji	26.5 μg / m3	53.1 μg / m3	6.2 μg / m3	9.3 μg / m3	573 μg / m3
AN –2	Near House of Mathar Khan (Sarpanch), Chudon Ki Basti	31.4 μg / m3	58.6 μg / m3	6.3 μg / m3	9.1 μg / m3	458 μg / m3
AN -3	GSS Sub Station Land	24.1 μg / m3	47.5 μg / m3	6.0 μg / m3	9.0 μg / m3	373 μg / m3
AN -4	Arniya Ki Nadi	29.4 μg / m3	56.8 μg / m3	6.3 μg / m3	9.2 μg / m3	458 μg / m3
AN -5	Panna Ki Nadi	25.3 μg / m3	50.8 μg / m3	6.0 μg / m3	9.0 μg / m3	458 μg / m3
AN -6	0 km Mile stone of Bhadla at Badhla Fanta	21.4 μg / m3	43.6 μg / m3	6.0 μg / m3	9.0 μg / m3	373 μg / m3
	Standard Value	60 μg / m3	100 μg / m3	80 μg / m3	80 μg / m3	2000 μg / m3
	Methods of Measurement	Gravimetric Method	Gravimetric Method	Improved West and Gaeke Method	Modified Jacob and Hochheiser Method	IS: 5182 – 1975 Part X

ii.Ambient Air Quality Monitoring Report for Grid Substations (November 2011)

Sample No	Site	Particulate Matter (PM 2.5)	Particulate Matter (PM 10)	Sulphur Dioxide (SO2)	Oxide of Nitrogen (NOX)	Carbon Monoxide as (CO)
SS - 1	GSS Sub Station Land, Khasara No. 8, Village: Bhadla, Post: Nuro Ki Burj, Tehsil: Phalodi, District Jodhpur	24.1 μg / m3	47.5 μg / m3	6.0 μg / m3	9.0 μg / m3	373 μg / m3
SS - 2	400 KVA GSS Site, Village: Meyon Ki Dhani, Post: Ramgarh, Jaisalmer	27.3 μg / m3	57.7 μg / m3	6.5 μg / m3	9.3 μg / m3	573 μg / m3
SS - 3	Near SE office 400 KVA (RRVPNL), Village: Akal, Post: Jodha, Jaisalmer	32.6 μg / m3	65.8 μg / m3	6.3 μg / m3	9.7 μg / m3	687 μg / m3
SS - 4	GSS 400 kVA Site, Village:	20.5 μg / m3	44.6 μg / m3	6.0 μg / m3	9.0 μg / m3	458 μg / m3

Sample No	Site	Particulate Matter (PM 2.5)	Particulate Matter (PM 10)	Sulphur Dioxide (SO2)	Oxide of Nitrogen (NOX)	Carbon Monoxide as (CO)
	Kakani, Post and Tehsil: Luni, Jodhpur					
	Standard Value	60 μg / m3	100 μg / m3	80 μg / m3	80 μg / m3	2000 μg / m3
	Methods of Measurement	Gravimetric Method	Gravimetric Method	Improved West and Gaeke Method	Modified Jacob and Hochheiser Method	IS: 5182 – 1975 Part X

B. AMBIENT NOISE MONITORING REPORT

i.Ambient Noise Monitoring Report for Solar Park (November 2011)

S. No	Site	Ld (Day Equivalent)	Ln (Night Equivalent)	Ldn (Day-Night Equivalent)
AN -1	Near House of Munna Ram	47.15	41.57	49.16
AN –2	Near House of Mathar Khan (Sarpanch), Chudon Ki Basti	47.35	41.87	49.42
AN -3	GSS Sub Station Land	45.45	41.00	48.15
AN -4	Arniya Ki Nadi	47.53	41.71	49.40
AN -5	Panna Ki Nadi	47.47	40.77	48.87
AN -6	0 km Mile stone of Bhadla at Badhla Fanta	44.20	40.31	47.27

ii.Ambient Noise Monitoring Report for Grid Substations (November 2011)

Sample No	Site	Ld (Day Equivalent)	Ln (Night Equivalent)	Ldn (Day-Night Equivalent)
SS - 1	GSS Sub Station Land, Khasara No. 8, Village: Bhadla, Post: Nuro Ki Burj, Tehsil: Phalodi, District Jodhpur	45.45	41.00	48.15
SS - 2	400 KVA GSS Site, Village: Meyon Ki Dhani, Post: Ramgarh, Jaisalmer	48.58	41.94	50.01
SS - 3	Near SE office 400 KVA (RRVPNL), Village: Akal, Post: Jodha, Jaisalmer	52.31	42.31	52.31
SS - 4	GSS 400 kVA Site, Village: Kakani, Post and Tehsil: Luni, Jodhpur	53.17	41.75	52.74

All results are in Decibel (dB) Unit

Ambient Air Quality Standards in respect of Noise

Area Code	Category of Area/Zone	Limits in dB(A) Leq *	
		Day Time	Night Time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone	50	40

Note

1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
3. Silence zone is defined as an area comprising not less than 100 metres around hospitals, educational institutions and courts. The silence zones are zones which are declared as such by the competent authority.
4. Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.

*dB(A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.
A "decibel" is a unit in which noise is measured.
"A", in dB(A) Leq, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.
Leq : It is an energy mean of the noise level, over a specified period.

Source: Ministry of Environment and Forests Notification, New Delhi, the 14 February, 2000 S.O. 123(E)

C. ANALYSIS REPORT OF SOIL

i.Analysis Report of Soil for Solar Park (November 2011)

Parameters (Unit)	Unit	SS -1: GSS Sub Station	SS -2 Near Arniya Ki Nadi	SS – 3: Near Pannu Ki Nadi
Color	Visual Comparison	Light Brown	Light Brown	Light Brown

pH (1:5)	-	7.87	7.86	7.56
Conductivity(1:5)	(μS/cm)	141	132	291
Moisture	(%)	6.1	4.8	5.3
Chlorides as Cl	(%)	0.004	0.002	0.004
Sulphate as SO4	(%)	0.005	0.001	0.005
Total Carbonates	(%)	0.05	0.04	0.05
Total Soluble Solids	(%)	0.064	0.036	0.136
Total Organic Matter	(%)	0.13	0.04	0.11
Nitrogen as N	(%)	0.07	0.03	0.09
Phosphorus as P	(%)	< 0.0005	< 0.0005	< 0.0005
Potassium as K	(%)	0.012	0.013	0.025
Zinc	Mg / 100 Gm	BDL	BDL	BDL
Copper	Mg / 100 Gm	BDL	BDL	BDL
Chromium	Mg / 100 Gm	BDL	BDL	BDL
Cadmium	Mg / 100 Gm	BDL	BDL	BDL
Nickel	Mg / 100 Gm	BDL	BDL	BDL
Lead	Mg / 100 Gm	BDL	BDL	BDL

BDL* - Below Detectable Limit

ii.Analysis Report of Soil for Grid Substations (November 2011)

Parameters (Unit)	**Unit**	**SS -1 Bhadla GSS**
Color	Visual Comparison	Light Brown
pH (1:5)	-	7.87
Conductivity(1:5)	(μS/cm)	141
Moisture	(%)	6.1
Chlorides as Cl	(%)	0.004
Sulphate as SO4	(%)	0.005
Total Carbonates	(%)	0.05
Total Soluble Solids	(%)	0.064
Total Organic Matter	(%)	0.13
Nitrogen as N	(%)	0.07
Phosphorus as P	(%)	< 0.0005
Potassium as K	(%)	0.012
Zinc	Mg / 100 Gm	BDL
Copper	Mg / 100 Gm	BDL
Chromium	Mg / 100 Gm	BDL
Cadmium	Mg / 100 Gm	BDL
Nickel	Mg / 100 Gm	BDL
Lead	Mg / 100 Gm	BDL

BDL* - Below Detectable Limit
All results are on dry basis.

D. ANALYSIS Of WATER QUALITY

i.Analysis of Water Quality Within Solar Park (November 2011)

Water sample collected from Govt. Bore well, ChuronkiBasti

Parameter	**Concentration**	**Standard Drinking water Specification as per IS –10500:1991 as amendment up to 3 July 2010**		**Protocol (Test Method)**
		Desirable Limit	**Permissible Limit in absence of alternate source**	
Essential Characteristics-Physical Parameter				
Color, Hazen Units	< 1	5	25	IS: 3025 Part 4 - 1983
Odour	Unobjectionable	Unobjectionable	-	IS: 3025 Part 5 - 1983
Taste	Agreeable	Agreeable	-	IS: 3025 Part 7,8 -1984
Turbidity, NTU	< 1	5	10	IS: 3025 Part 10 - 1984
pH	7.97	6.5 – 8.5	-	IS: 3025 Part 11 - 1984
Essential Characteristics-Chemical Parameters				
Total Hardness as CaCO3	588.00 Mg / L	300 Mg / L	600 Mg / L	IS: 3025 Part 21 - 1983
Iron as Fe	0.06 Mg / L	0.3 Mg / L	1.0 Mg / L	IS: 3025 Part 53 - 2003
Chloride as Cl	443.86 Mg / L	250 Mg / L	1000 Mg / L	IS: 3025 Part 32 - 1988
Residual Free Chlorine	< 0.1 Mg / L	0.2 Mg / L	-	IS: 3025 Part 26 - 1986
Desirable Characteristics-Chemical Parameters				
Dissolved Solids	2,674.00 Mg / L	500 Mg / L	2000 Mg / L	IS: 3025 Part 16 - 1984

Calcium as Ca	136.00 Mg / L	75 Mg / L	200 Mg / L	IS: 3025 Part 40 - 1991
Magnesium as Mg	60.76 Mg / L	30 Mg / L	100 Mg / L	IS: 3025 Part 46 - 1994
Copper as Cu	< 0.02 Mg / L	0.05 Mg / L	1.5 Mg / L	IS: 3025 Part 42 - 1992
Manganese as Mn	< 0.01 Mg / L	0.1 Mg / L	0.3 Mg / L	IS: 3025 Part 59 - 2006
Sulphate as SO4	137.03 Mg / L	200 Mg / L	400 Mg / L	IS: 3025 Part 24 - 1986
Nitrate as NO3	8.54 Mg / L	45 Mg / L	No relaxation	IS: 3025 Part 34 - 1988
Fluoride as F	1.31 Mg / L	1.0 Mg / L	1.5 Mg / L	IS: 3025 Part 60 - 2008
Phenolic Compounds as C6H5OH	< 0.001 Mg / L	0.001 Mg / L	0.002 Mg / L	IS: 3025 Part 43 - 1991
Mercury as Hg	< 0.2 µg / L	0.001 Mg / L	No relaxation	IS: 3025 Part 48 - 1994
Cadmium as Cd	< 0.005 Mg / L	0.01 Mg / L	No relaxation	IS: 3025 Part 41 - 1992
Selenium as Se	< 0.005 Mg / L	0.01 Mg / L	No relaxation	IS: 3025 Part 56 - 2003
Arsenic as As	< 0.005 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 37 - 1998
Cyanide as CN	< 0.02 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 27 - 1986
Lead as Pb	< 0.01 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 47 - 1994
Zinc as Zn	< 0.02 Mg / L	5 Mg / L	15 Mg / L	IS: 3025 Part 49 - 1994
Anionic Detergents as MBAS	< 0.1 Mg / L	0.2 Mg / L	1.0 Mg / L	APHA 5540 C
Chromium as Cr+6	< 0.02 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 52 - 2003
Mineral Oil	< 0.01 Mg / L	0.01 Mg / L	0.03 Mg / L	IS: 3025 Part 39 - 1991
Alkalinity	372.00 Mg / L	200 Mg / L	600 Mg / L	IS: 3025 Part 23 - 1986
Aluminum as Al	< 0.005 Mg / L	0.03 Mg / L	0.2 Mg / L	IS: 3025 Part 55 - 2003
Boron as B	< 0.02 Mg / L	1 Mg / L	5 Mg / L	IS: 3025 Part 57 - 2005
Bacteriological Characteristics				
Coliform Organisms	19 CFU	10 CFU	10 CFU	IS: 1622 - 1981
E. Coli	Absent	Absent	Absent	IS: 1622 - 1981

Water sample collected from Cement Tank (Kharuddin S/o Shri Kalu Khan, GamnokiBasti

Parameter	**Concentration**	**Standard Drinking water Specification as per IS –10500:1991 as amendment up to 3 July 2010**		**Protocol (Test Method)**
		Desirable Limit	**Permissible Limit in absence of alternate source**	
Essential Characteristics-Physical Parameter				
Color, Hazen Units	< 1	5	25	IS: 3025 Part 4 - 1983
Odour	Unobjectionable	Unobjectionable	-	IS: 3025 Part 5 - 1983
Taste	Agreeable	Agreeable	-	IS: 3025 Part 7,8 -1984
Turbidity, NTU	< 1	5	10	IS: 3025 Part 10 - 1984
pH	7.81	6.5 – 8.5	-	IS: 3025 Part 11 - 1984
Essential Characteristics-Chemical Parameters				
Total Hardness as CaCO3	552.00 Mg / L	300 Mg / L	600 Mg / L	IS: 3025 Part 21 - 1983
Iron as Fe	0.08 Mg / L	0.3 Mg / L	1.0 Mg / L	IS: 3025 Part 53 - 2003
Chloride as Cl	851.74 Mg / L	250 Mg / L	1000 Mg / L	IS: 3025 Part 32 - 1988
Residual Free Chlorine	< 0.1 Mg / L	0.2 Mg / L	-	IS: 3025 Part 26 - 1986
Desirable Characteristics-Chemical Parameters				
Dissolved Solids	2,652.00 Mg / L	500 Mg / L	2000 Mg / L	IS: 3025 Part 16 - 1984
Calcium as Ca	118.40 Mg / L	75 Mg / L	200 Mg / L	IS: 3025 Part 40 - 1991
Magnesium as Mg	62.72 Mg / L	30 Mg / L	100 Mg / L	IS: 3025 Part 46 - 1994
Copper as Cu	< 0.02 Mg / L	0.05 Mg / L	1.5 Mg / L	IS: 3025 Part 42 - 1992
Manganese as Mn	< 0.01 Mg / L	0.1 Mg / L	0.3 Mg / L	IS: 3025 Part 59 - 2006
Sulphate as SO4	147.94 Mg / L	200 Mg / L	400 Mg / L	IS: 3025 Part 24 - 1986
Nitrate as NO3	8.94 Mg / L	45 Mg / L	No relaxation	IS: 3025 Part 34 - 1988
Fluoride as F	1.21 Mg / L	1.0 Mg / L	1.5 Mg / L	IS: 3025 Part 60 - 2008
Phenolic Compounds as C6H5OH	< 0.001 Mg / L	0.001 Mg / L	0.002 Mg / L	IS: 3025 Part 43 - 1991
Mercury as Hg	< 0.2 µg / L	0.001 Mg / L	No relaxation	IS: 3025 Part 48 - 1994
Cadmium as Cd	< 0.005 Mg / L	0.01 Mg / L	No relaxation	IS: 3025 Part 41 - 1992
Selenium as Se	< 0.005 Mg / L	0.01 Mg / L	No relaxation	IS: 3025 Part 56 - 2003
Arsenic as As	< 0.005 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 37 - 1998
Cyanide as CN	< 0.02 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 27 - 1986
Lead as Pb	< 0.01 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 47 - 1994
Zinc as Zn	< 0.02 Mg / L	5 Mg / L	15 Mg / L	IS: 3025 Part 49 - 1994
Anionic Detergents as MBAS	< 0.1 Mg / L	0.2 Mg / L	1.0 Mg / L	APHA 5540 C
Chromium as Cr+6	< 0.02 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 52 - 2003
Mineral Oil	< 0.01 Mg / L	0.01 Mg / L	0.03 Mg / L	IS: 3025 Part 39 - 1991
Alkalinity	292.00 Mg / L	200 Mg / L	600 Mg / L	IS: 3025 Part 23 - 1986

Aluminum as Al	< 0.005 Mg / L	0.03 Mg / L	0.2 Mg / L	IS: 3025 Part 55 - 2003
Boron as B	< 0.02 Mg / L	1 Mg / L	5 Mg / L	IS: 3025 Part 57 - 2005
Bacteriological Characteristics				
Coliform Organisms	12 CFU	10 CFU	10 CFU	IS: 1622 - 1981
E. Coli	Absent	Absent	Absent	IS: 1622 - 1981

ii.Analysis of Water Quality Along the Grid Substation Sites (November 2011)

Sample No : SS-1: Water sample collected from Bore well of Munna Ram Ji, Village: Bhadla (Khasra No.9), Post: Nuro Ki Burj, Tehsil: Phalodi, District Jodhpur (for GSS Bhadla)

Parameter	**Concentration**	**Standard Drinking water Specification as per IS –10500:1991 as amendment up to 3 July 2010**		**Protocol (Test Method)**
		Desirable Limit	**Permissible Limit in absence of alternate source**	
1.1.1.1.1 Essential Characteristics-Physical Parameter				
Color, Hazen Units	< 1	5	25	IS: 3025 Part 4 - 1983
Odour	Unobjectionable	Unobjectionable	-	IS: 3025 Part 5 - 1983
Taste	Agreeable	Agreeable	-	IS: 3025 Part 7,8 -1984
Turbidity, NTU	< 1	5	10	IS: 3025 Part 10 - 1984
pH	7.40	6.5 – 8.5	-	IS: 3025 Part 11 - 1984
Essential Characteristics-Chemical Parameters				
Total Hardness as CaCO3	548.00 Mg / L	300 Mg / L	600 Mg / L	IS: 3025 Part 21 - 1983
Iron as Fe	0.10 Mg / L	0.3 Mg / L	1.0 Mg / L	IS: 3025 Part 53 - 2003
Chloride as Cl	775.76 Mg / L	250 Mg / L	1000 Mg / L	IS: 3025 Part 32 - 1988
Residual Free Chlorine	< 0.1 Mg / L	0.2 Mg / L	-	IS: 3025 Part 26 - 1986
Desirable Characteristics-Chemical Parameters				
Dissolved Solids	2,532.00 Mg / L	500 Mg / L	2000 Mg / L	IS: 3025 Part 16 - 1984
Calcium as Ca	110.40 Mg / L	75 Mg / L	200 Mg / L	IS: 3025 Part 40 - 1991
Magnesium as Mg	66.64 Mg / L	30 Mg / L	100 Mg / L	IS: 3025 Part 46 - 1994
Copper as Cu	< 0.02 Mg / L	0.05 Mg / L	1.5 Mg / L	IS: 3025 Part 42 - 1992
Manganese as Mn	< 0.01 Mg / L	0.1 Mg / L	0.3 Mg / L	IS: 3025 Part 59 - 2006
Sulphate as SO4	166.34 Mg / L	200 Mg / L	400 Mg / L	IS: 3025 Part 24 - 1986
Nitrate as NO3	7.56 Mg / L	45 Mg / L	No relaxation	IS: 3025 Part 34 - 1988
Fluoride as F	1.33 Mg / L	1.0 Mg / L	1.5 Mg / L	IS: 3025 Part 60 - 2008
Phenolic Compounds as C6H5OH	< 0.001 Mg / L	0.001 Mg / L	0.002 Mg / L	IS: 3025 Part 43 - 1991
Mercury as Hg	< 0.2 µg / L	0.001 Mg / L	No relaxation	IS: 3025 Part 48 - 1994
Cadmium as Cd	< 0.005 Mg / L	0.01 Mg / L	No relaxation	IS: 3025 Part 41 - 1992
Selenium as Se	< 0.005 Mg / L	0.01 Mg / L	No relaxation	IS: 3025 Part 56 - 2003
Arsenic as As	< 0.005 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 37 - 1998
Cyanide as CN	< 0.02 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 27 - 1986
Lead as Pb	< 0.01 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 47 - 1994
Zinc as Zn	< 0.02 Mg / L	5 Mg / L	15 Mg / L	IS: 3025 Part 49 - 1994
Anionic Detergents as MBAS	< 0.1 Mg / L	0.2 Mg / L	1.0 Mg / L	APHA 5540 C
Chromium as Cr+6	< 0.02 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 52 - 2003
Mineral Oil	< 0.01 Mg / L	0.01 Mg / L	0.03 Mg / L	IS: 3025 Part 39 - 1991
Alkalinity	404.00 Mg / L	200 Mg / L	600 Mg / L	IS: 3025 Part 23 - 1986
Aluminum as Al	< 0.005 Mg / L	0.03 Mg / L	0.2 Mg / L	IS: 3025 Part 55 - 2003
Boron as B	< 0.02 Mg / L	1 Mg / L	5 Mg / L	IS: 3025 Part 57 - 2005
Bacteriological Characteristics				
Coliform Organisms	6 CFU	10 CFU	10 CFU	IS: 1622 - 1981
E. Coli	Absent	Absent	Absent	IS: 1622 - 1981

Sample No. SS – 2: Water sample collected from Govt. Bore well (Nearest Bore well GSS Ramgarh), Village and Post: Sonu, Tehsil: Ramgarh, District Jaisalmer

Parameter	**Concentration**	**Standard Drinking water Specification as per IS –10500:1991 as amendment up to 3 July 2010**		**Protocol (Test Method)**
		Desirable Limit	**Permissible Limit in absence of alternate source**	
1.1.1.1.2 Essential Characteristics-Physical Parameter				
Color, Hazen Units	< 1	5	25	IS: 3025 Part 4 - 1983
Odour	Unobjectionable	Unobjectionable	-	IS: 3025 Part 5 - 1983
Taste	Agreeable	Agreeable	-	IS: 3025 Part 7,8 -1984
Turbidity, NTU	< 1	5	10	IS: 3025 Part 10 - 1984
pH	8.05	6.5 – 8.5	-	IS: 3025 Part 11 - 1984
Essential Characteristics-Chemical Parameters				
Total Hardness as CaCO3	276.00 Mg / L	300 Mg / L	600 Mg / L	IS: 3025 Part 21 - 1983
Iron as Fe	0.05 Mg / L	0.3 Mg / L	1.0 Mg / L	IS: 3025 Part 53 - 2003
Chloride as Cl	495.85 Mg / L	250 Mg / L	1000 Mg / L	IS: 3025 Part 32 - 1988
Residual Free Chlorine	< 0.1 Mg / L	0.2 Mg / L	-	IS: 3025 Part 26 - 1986
Desirable Characteristics-Chemical Parameters				
Dissolved Solids	1,785.00 Mg / L	500 Mg / L	2000 Mg / L	IS: 3025 Part 16 - 1984
Calcium as Ca	70.40 Mg / L	75 Mg / L	200 Mg / L	IS: 3025 Part 40 - 1991
Magnesium as Mg	24.50 Mg / L	30 Mg / L	100 Mg / L	IS: 3025 Part 46 - 1994
Copper as Cu	< 0.02 Mg / L	0.05 Mg / L	1.5 Mg / L	IS: 3025 Part 42 - 1992
Manganese as Mn	< 0.01 Mg / L	0.1 Mg / L	0.3 Mg / L	IS: 3025 Part 59 - 2006
Sulphate as SO4	113.49 Mg / L	200 Mg / L	400 Mg / L	IS: 3025 Part 24 - 1986
Nitrate as NO3	12.93 Mg / L	45 Mg / L	No relaxation	IS: 3025 Part 34 - 1988
Fluoride as F	1.47 Mg / L	1.0 Mg / L	1.5 Mg / L	IS: 3025 Part 60 - 2008
Phenolic Compounds as C6H5OH	< 0.001 Mg / L	0.001 Mg / L	0.002 Mg / L	IS: 3025 Part 43 - 1991
Mercury as Hg	< 0.2 µg / L	0.001 Mg / L	No relaxation	IS: 3025 Part 48 - 1994
Cadmium as Cd	< 0.005 Mg / L	0.01 Mg / L	No relaxation	IS: 3025 Part 41 - 1992
Selenium as Se	< 0.005 Mg / L	0.01 Mg / L	No relaxation	IS: 3025 Part 56 - 2003
Arsenic as As	< 0.005 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 37 - 1998
Cyanide as CN	< 0.02 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 27 - 1986
Lead as Pb	< 0.01 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 47 - 1994
Zinc as Zn	< 0.02 Mg / L	5 Mg / L	15 Mg / L	IS: 3025 Part 49 - 1994
Anionic Detergents as MBAS	< 0.1 Mg / L	0.2 Mg / L	1.0 Mg / L	APHA 5540 C
Chromium as Cr+6	< 0.02 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 52 - 2003
Mineral Oil	< 0.01 Mg / L	0.01 Mg / L	0.03 Mg / L	IS: 3025 Part 39 - 1991
Alkalinity	268.00 Mg / L	200 Mg / L	600 Mg / L	IS: 3025 Part 23 - 1986
Aluminum as Al	< 0.005 Mg / L	0.03 Mg / L	0.2 Mg / L	IS: 3025 Part 55 - 2003
Boron as B	< 0.02 Mg / L	1 Mg / L	5 Mg / L	IS: 3025 Part 57 - 2005
Bacteriological Characteristics				
Coliform Organisms	7 CFU	10 CFU	10 CFU	IS: 1622 - 1981
E. Coli	Absent	Absent	Absent	IS: 1622 - 1981

Sample No. SS – 3: Water sample collected from Govt. Bore well inside 400 KVA GSS (RRVPNL), Village: Akal, Post: Jodha, District Jaisalmer

Parameter	**Concentration**	**Standard Drinking water Specification as per IS –10500:1991 as amendment up to 3 July 2010**		**Protocol (Test Method)**
		Desirable Limit	**Permissible Limit in absence of alternate source**	
1.1.1.1.3 Essential Characteristics-Physical Parameter				
Color, Hazen Units	< 1	5	25	IS: 3025 Part 4 - 1983
Odour	Unobjectionable	Unobjectionable	-	IS: 3025 Part 5 - 1983
Taste	Agreeable	Agreeable	-	IS: 3025 Part 7,8 -1984
Turbidity, NTU	< 1	5	10	IS: 3025 Part 10 - 1984
pH	8.36	6.5 – 8.5	-	IS: 3025 Part 11 - 1984
Essential Characteristics-Chemical Parameters				
Total Hardness as CaCO3	120.00 Mg / L	300 Mg / L	600 Mg / L	IS: 3025 Part 21 - 1983
Iron as Fe	0.03 Mg / L	0.3 Mg / L	1.0 Mg / L	IS: 3025 Part 53 - 2003
Chloride as Cl	61.98 Mg / L	250 Mg / L	1000 Mg / L	IS: 3025 Part 32 - 1988
Residual Free Chlorine	< 0.1 Mg / L	0.2 Mg / L	-	IS: 3025 Part 26 - 1986
Desirable Characteristics-Chemical Parameters				
Dissolved Solids	977.00 Mg / L	500 Mg / L	2000 Mg / L	IS: 3025 Part 16 - 1984
Calcium as Ca	27.20 Mg / L	75 Mg / L	200 Mg / L	IS: 3025 Part 40 - 1991
Magnesium as Mg	12.74 Mg / L	30 Mg / L	100 Mg / L	IS: 3025 Part 46 - 1994
Copper as Cu	< 0.02 Mg / L	0.05 Mg / L	1.5 Mg / L	IS: 3025 Part 42 - 1992
Manganese as Mn	< 0.01 Mg / L	0.1 Mg / L	0.3 Mg / L	IS: 3025 Part 59 - 2006
Sulphate as SO4	131.75 Mg / L	200 Mg / L	400 Mg / L	IS: 3025 Part 24 - 1986
Nitrate as NO3	2.25 Mg / L	45 Mg / L	No relaxation	IS: 3025 Part 34 - 1988
Fluoride as F	0.83 Mg / L	1.0 Mg / L	1.5 Mg / L	IS: 3025 Part 60 - 2008
Phenolic Compounds as C6H5OH	< 0.001 Mg / L	0.001 Mg / L	0.002 Mg / L	IS: 3025 Part 43 - 1991
Mercury as Hg	0.2 Mg / L	0.001 Mg / L	No relaxation	IS: 3025 Part 48 - 1994
Cadmium as Cd	0.005 Mg / L	0.01 Mg / L	No relaxation	IS: 3025 Part 41 - 1992
Selenium as Se	0.005 Mg / L	0.01 Mg / L	No relaxation	IS: 3025 Part 56 - 2003
Arsenic as As	0.005 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 37 - 1998
Cyanide as CN	0.02 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 27 - 1986
Lead as Pb	0.01 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 47 - 1994
Zinc as Zn	0.02 Mg / L	5 Mg / L	15 Mg / L	IS: 3025 Part 49 - 1994
Anionic Detergents as MBAS	0.1 Mg / L	0.2 Mg / L	1.0 Mg / L	APHA 5540 C
Chromium as Cr+6	0.02 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 52 - 2003
Mineral Oil	0.01 Mg / L	0.01 Mg / L	0.03 Mg / L	IS: 3025 Part 39 - 1991
Alkalinity	204.00 Mg / L	200 Mg / L	600 Mg / L	IS: 3025 Part 23 - 1986
Aluminum as Al	0.005 Mg / L	0.03 Mg / L	0.2 Mg / L	IS: 3025 Part 55 - 2003
Boron as B	0.02 Mg / L	1 Mg / L	5 Mg / L	IS: 3025 Part 57 - 2005
Bacteriological Characteristics				
Coliform Organisms	6 CFU	10 CFU	10 CFU	IS: 1622 - 1981
E. Coli	Absent	Absent	Absent	IS: 1622 - 1981

Sample No. SS – 4: Water sample collected from Open Well of Babu Singh Champavat Village: Kakani, Post and Tehsil: Luni,

Parameter	**Concentration**	**Standard Drinking water Specification as per IS –10500:1991 as amendment up to 3 July 2010**		**Protocol (Test Method)**
		Desirable Limit	**Permissible Limit in absence of alternate source**	
1.1.1.1.4 Essential Characteristics-Physical Parameter				
Color, Hazen Units	< 1	5	25	IS: 3025 Part 4 - 1983
Odour	Unobjectionable	Unobjectionable	-	IS: 3025 Part 5 - 1983
Taste	Agreeable	Agreeable	-	IS: 3025 Part 7,8 - 1984
Turbidity, NTU	< 1	5	10	IS: 3025 Part 10 - 1984
pH	8.30	6.5 – 8.5	-	IS: 3025 Part 11 - 1984
Essential Characteristics-Chemical Parameters				
Total Hardness as CaCO3	108.00 Mg / L	300 Mg / L	600 Mg / L	IS: 3025 Part 21 - 1983
Iron as Fe	0.02 Mg / L	0.3 Mg / L	1.0 Mg / L	IS: 3025 Part 53 - 2003
Chloride as Cl	7.99 Mg / L	250 Mg / L	1000 Mg / L	IS: 3025 Part 32 - 1988
Residual Free Chlorine	< 0.1 Mg / L	0.2 Mg / L	-	IS: 3025 Part 26 - 1986
Desirable Characteristics-Chemical Parameters				
Dissolved Solids	181.00 Mg / L	500 Mg / L	2000 Mg / L	IS: 3025 Part 16 - 1984
Calcium as Ca	33.60 Mg / L	75 Mg / L	200 Mg / L	IS: 3025 Part 40 - 1991
Magnesium as Mg	5.88 Mg / L	30 Mg / L	100 Mg / L	IS: 3025 Part 46 - 1994
Copper as Cu	< 0.02 Mg / L	0.05 Mg / L	1.5 Mg / L	IS: 3025 Part 42 - 1992
Manganese as Mn	< 0.01 Mg / L	0.1 Mg / L	0.3 Mg / L	IS: 3025 Part 59 - 2006
Sulphate as SO4	27.22 Mg / L	200 Mg / L	400 Mg / L	IS: 3025 Part 24 - 1986
Nitrate as NO3	2.79 Mg / L	45 Mg / L	No relaxation	IS: 3025 Part 34 - 1988
Fluoride as F	0.18 Mg / L	1.0 Mg / L	1.5 Mg / L	IS: 3025 Part 60 - 2008
Phenolic Compounds as C6H5OH	< 0.001 Mg / L	0.001 Mg / L	0.002 Mg / L	IS: 3025 Part 43 - 1991
Mercury as Hg	< 0.2 µg / L	0.001 Mg / L	No relaxation	IS: 3025 Part 48 - 1994
Cadmium as Cd	< 0.005 Mg / L	0.01 Mg / L	No relaxation	IS: 3025 Part 41 - 1992
Selenium as Se	< 0.005 Mg / L	0.01 Mg / L	No relaxation	IS: 3025 Part 56 - 2003
Arsenic as As	< 0.005 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 37 - 1998
Cyanide as CN	< 0.02 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 27 - 1986
Lead as Pb	< 0.01 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 47 - 1994
Zinc as Zn	< 0.02 Mg / L	5 Mg / L	15 Mg / L	IS: 3025 Part 49 - 1994
Anionic Detergents as MBAS	< 0.1 Mg / L	0.2 Mg / L	1.0 Mg / L	APHA 5540 C
Chromium as Cr+6	< 0.02 Mg / L	0.05 Mg / L	No relaxation	IS: 3025 Part 52 - 2003
Mineral Oil	< 0.01 Mg / L	0.01 Mg / L	0.03 Mg / L	IS: 3025 Part 39 - 1991
Alkalinity	124.00 Mg / L	200 Mg / L	600 Mg / L	IS: 3025 Part 23 - 1986
Aluminum as Al	< 0.005 Mg / L	0.03 Mg / L	0.2 Mg / L	IS: 3025 Part 55 - 2003

Boron as B	< 0.02 Mg / L	1 Mg / L	5 Mg / L	IS: 3025 Part 57 - 2005
Bacteriological Characteristics				
Coliform Organisms	3 CFU	10 CFU	10 CFU	IS: 1622 - 1981
E. Coli	Absent	Absent	Absent	IS: 1622 - 1981

PROGRESS STATUS – ANNEXURE-03

Activity ID	Physical % Complete
400/220 KV 3 X 500 MVA POOLING SUBSTATION AT BHADLA	
INPUTS FROM CUSTOMER	
400/220kV switchyard plot plan CAD copy with coordinates : For BHADLA	100%
GA & Schematic drawings of Power Transformer & Bus reactor, NGR supplied by RRVPNL : For BHADLA	100%
Existing / RRVPNL scope 220/132/33KV end CRP &Busbar protection drawing : For BHADLA	100%
Existing Control Room Panel arrangement & ACK Layout : For BHADLA	100%
Remote end PLCC Make & drawing for the LILO line : For BHADLA	100%
All Transformer & Reactor Foundation Layout & Loading details Supplied by RRVPNL : BHADLA	100%
Line parameters,frequency, EPAX Scheme & details for outdoor equipment of other site for PLCC	100%
Relay Setting Inputs : Bhadla	100%
ENGINEERING	
ELECTRICAL	
ARRANGEMEN T LAYOUTS, OUTDOOR TYPE	100%
BUILDINGS, SWITCHGEARS INDOOR TYPE LAYOUTS	100%
ENGINEERING CALCULATIONS, PRIMARY ENGINEERING	100%
CABLING LAYOUTS	100%
EARTHING NETWORK DRAWINGS	100%
INSTALLATION DRAWINGS	100%
SINGLE LINE DIAGRAMS	100%
AC, DC AUX SERVICES SLD	100%
SCHEDULE (POWER)	100%
ENGINEERING CALCULATIONS, SECONDARY ENGG	100%
CIVIL	
PRELIMINARY	100%
LAYOUTS	100%
ARCHITECTURAL DRAWINGS - Control Room Building, Bay level Kiosk Biilding, Fire fighting Pump House	100%
DESIGN CALCULATIONS - 400 KV STRUCTURE	100%
DESIGN CALCULATIONS - 220 KV AND OTHER STRUCTURE	100%
FOUNDATION ENGINEERING - 400 KV STRUCTURES	100%
FOUNDATION ENGINEERING - 220 KV AND OTHER STRUCTURES	100%
OTHER MISC. DESIGNS	100%
CONTROL ROOM BUILDING	100%
BAY LEVEL KIOSK BUILDING	100%
FIRE FIGHTING PUMP HOUSE BUILDING	100%

STEEL STRUCTURAL - 400 KV FABRICATION DRAWINGS	100%
STEEL STRUCTURAL - 220 KV FABRICATION DRAWINGS	100%
FOUNDATION DRAWINGS FOR YARD - 400 KV	100%
FOUNDATION DRAWINGS FOR YARD - 220 KV	100%
OTHER MISCELLANEOUS DRAWINGS	100%
SUPPLY	
33/.433 kV, 800 kVA, 250 kV BIL LT THREE PHASE TRANSFORMER	100%
33/.433 kV, 630 kVA, 170 kV BIL LT THREE PHASE TRANSFORMER	100%
420 KV CIRCUIT BREAKER	100%
245 KV CIRCUIT BREAKER	100%
420 KV CT	100%
245 KV CT	100%
420 KV CVT	100%
245 KV CVT	100%
36 KV, 52 KV EMVT	100%
420 KV ISOLATOR	100%
245 KV ISOLATOR	100%
72.5 KV ISOLATOR	100%
390 KV LA	100%
198 KV LA	100%
120 KV LA FOR REACTOR	100%
42 KV LA	100%
400 KV WAVE TRAP	100%
220 KV WAVE TRAP	100%
400 KV CONTROL, RELAY & PROTECTION PANEL	100%
220 KV CONTROL, RELAY & PROTECTION PANEL	100%
SUBSTATION AUTOMATION SYSTEM	100%
PLCC	80%
BATTERY	100%
BATTERY CHARGER	100%
400 KV BPI	100%
220 KV BPI	100%
LT SWITCHGEAR	50%
400 KV HRDWARE	100%
220 KV HRDWARE	100%
DISC INSULATORS / LONG ROD	100%
40 MM DIA MS ROD	100%
ALUMINIUM TUBE	100%
400 KV CLAMPS & CONNECTORS	100%
220 KV CLAMPS & CONNECTORS	100%
LUGS & GLANDS	100%
POWER CABLE	100%
CONTROL CABLE	100%
ACSR MOOSE CONDUCTOR	100%

ACSR TARANTULLA CONDUCTOR	100%
EARTHING MATERIALS / ELECTRODES ETC.	100%
ILLUMINATION MATERIALS	100%
FIRE FIGHTING SYSTEM	100%
AIR-CONDITIONING AND VENTILATION SYSTEM	100%
400 KV LATTICE STRUCTURE	100%
220 KV LATTICE STRUCTURE	100%
400 KV PIPE STRUCTURES	100%
220 KV PIPE STRUCTURES	100%
FOUNDATION BOLTS	100%
TOOLS & TACKLES	100%
OIL FILTER MACHINE	100%
MOBILE CRANE	50%
TESTING & MEASURING KIT	100%
FURNITURE FOR CONTROL ROOM	100%
CONSTRUCTION	
BADHALA	
CIVIL WORKS	
Site Preparation	100%
Temporary Site Office for Owner	100%
TOWER FOUNDATIONS	100%
EQUIPMENTS FOUNDATIONS	100%
TRANSFORMER FOUNDATIONS	100%
CONTROL ROOM BUILDING	100%
BAY LEVEL KIOSK BUILDING	100%
FIRE FIGHTING PUMP HOUSE BUILDING	100%
CABLE TRENCH	100%
OTHER CIVIL WORKS (Road, Drain, Yard PCC etc)	100%
ERECTION / INSTALLATION	
400 KV TOWER ERECTION & STRINGING WORKS	100%
220 KV TOWER ERECTION & STRINGING WORKS	100%
ERECTION OF 400 KV EQUIPMENT SUPPORT STRUCTURE & EQUIPMENTS	100%
ERECTION OF 220 KV EQUIPMENT SUPPORT STRUCTURE & EQUIPMENTS	100%
ERECTION OF CONTROL ROOM EQUIPMENTS	100%
ERECTION OF PANELS IN BAY KIOSK ROOM	100%
ERECTION IN FIRE FIGHTING BUILDING	100%
ERECTION OF OTHER EQUIPMENTS	100%
ERECTION OF TRANSFORMERS & REACTORS	100%
CABLING WORKS	100%
EARTHING WORKS	100%
TESTING & COMMISSIONING	98%

REPORT ON SOIL INVESTIGATION
FOR 400/220KV GSS SUB-STATION
AT
RAMGARH
IN RAJASTHAN

SUBMITTED TO

M/s RVPNL

PREPARED BY

M/S TECHNO ELECTRIC & ENGG. CO. LTD.

KOLKATA

PREPARED BY

SANGUINE GEOTECH PVT. LTD.
RZ-456/13, TUGLAKABAD EXTN.
NEW DELHI – 110 019
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LIST OF CONTENTS

1.0 INTRODUCTION

M/s RVPNL is planning to construct the 400/220 KV GSS Sub-Substation at Ramgarh in Rajasthan. The work of sub-soil investigation has been carried out under supervision of M/s RVPNL & M/s Techno Electic & Engg. Ltd. The work of sub-soil investigation has been awarded to M/s Sanguine Geotech Pvt. Ltd.by M/s Techno Electric & Engg. Ltd.

The proposed structures are the 400/220 KV GSS sub-station at Ramgarh in Rajasthan. The different functional units to be installed for this sub-station may be power transformers, current transformers, voltage transformers, dis-connectors, surge arresters, circuit breakers, earthing transformers etc.

2.0 SCOPE OF WORK

In order to establish the sub-soil characteristics at the area marked for construction of the 400/220 KV GSS sub-station, the entire investigation program had been divided into field and laboratory tests leading to preparation of comprehensive report on the recommendations for foundation types and the corresponding design bearing capacity values for the foundations of the different functional units to be installed at the site.

As mentioned within the framework of this job contract, the field investigations comprised of the following :-

i) Drilling of forty five (45) no. of bore holes of 150mm dia, upto 6.0m depth below ground level or up to refusal, whichever occurs earlier. In case of Rock, 3.0m drilling is required in rock.

ii) Collection of representative disturbed and undisturbed soil samples, 75/100mm in diameter, from the exploratory bore holes for detailed laboratory analysis.

iii) Carrying out standard penetration tests as per IS:2131 – 1981 in each bore hole and subsequently preparation of penetration charts depth-wise for each bore hole.

iv) Excavating nine (09) no. of trial pits, 2.0m x 2.0 m size, upto 3.0 m depth below ground level or unto the excavable depth or as per site instruction.

v) Conducting twelve (12) no. of electrical resistivity tests.

vi) Conducting five (5) no. of D.C.P.T. on the location marked in drawing.

The laboratory tests part of this job contract comprised of the following:-

i) Grain size analysis
   a) Sieve analysis
   b) Hydrometer analysis
ii) Liquid limit, plastic limit
iii) Specific gravity
iv) Natural moisture content
v) Bulk density and dry density
vi) Unconfined compression tests on undisturbed cohesive soil samples
vii) Unconsolidated undrained triaxial shear tests
viii) Direct shear tests on granular soil samples

On Rock Samples

a) Bulk density
b) Specific Gravity
c) Porosity
d) Crushing strength
e) Point load strength index
f) Rock quality designation

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3.0 FIELD INVESTIGATION METHODOLOGY

3.1 DRILLING OF BOREHOLE

Boreholes of 150mm diameter were drilled by using auger method up to the depth of refusal as per IS:1892 at proposed site location. After refusal, drilling by rotary drilling method of Nx size are performed up to 3.0m depth or as per client requirements. The location plan of borehole is shown and details of the soil type, type of sample collected and SPT 'N'-value are shown in Table-1 to Table-45 in their respective laboratory test results.

3.2 COLLECTION OF UNDISTURBED SOIL SAMPLES

Undisturbed soil samples have been collected from boreholes wherever possible due to bouldery & rocky area in thin wall sampling tubes of 45cm long with area ratio less than of 10%. All undisturbed soil samples were collected by open drive tube sampler as per IS:2132 and the tube so recovered with samples, after removal of loose disturbed soil, were sealed by wax from both end to protect against the loss of moisture. After sealing, the sampling tubes were marked for testing of sample for various parameters.

3.3 STANDARD PENETRATION TEST

Standard Penetration tests have been conducted as per IS:2131 in each borehole at suitable interval or at the change of strata, whichever encountered earlier. The penetration resistance (SPT) is expressed as number of blows required for 30 cm on a rigid steel head and standard "A" rod attachment. The bottom of borehole have been cleaned before commencement of test. Also seating number of blows of 150mm were recorded before recording actual SPT 'N' for 30 cm penetration. On removal of sampler, the soil entrapped in the sampler is taken out and the representative disturbed soil sample is preserved in polythene bags to avoid any loss of fines and marked for identification.

3.4 TRIAL PITS

Trial pits have been carried at specified location as directed by the Employer. The trial pits was 2mx2m in size extending to 3m depths or rock level or as specified by the Employer. Disturbed samples have been collecteddue to rocky/bouldarystrata from the trial pits.

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4.0 LABORATORY TESTING

1. The laboratory test was carried out progressively during the field work after sufficient number of samples have reached the laboratory in order that the test results of the initial bore holes can be made use of in planning the later stages of the field investigation and quantum of laboratory test.

2. All samples brought from field, whether disturbed or undisturbed was extracted/prepared and examined by competent technical personnel, and the test was carried out as per the procedures laid out in the latest edition of the relevant I.S. Codes.

The following laboratory tests have been carried out

On soil samples

i)		Grain size analysis
	a)	Sieve analysis
	b)	Hydrometer analysis
i)		Liquid limit, plastic limit, Shrimkage limit
ii)		Specific gravity
iii)		Natural moisture content
iv)		Bulk density and dry density
v)		Drained direct shear tests
vi)		Unconsolidated undrained trial sheat test
vii)		Free swell Index & Swelling pressure

On Rock Samples

i)	Bulk density
ii)	Specific Gravity
iii)	Porosity
iv)	Crushing strength
v)	Point load strength index

All the above tests were conducted as per the provisions laid down in the relevant IS Code of practice. The test results for all the samples tested have been tabulated in proper format; please refer Table No.01 to Table No.55.

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5.0 LITHOLOGY

Forty five boreholes and Nine trial pits conducted at site reveals that the entire stratum consists of three Lithounits (layers), namely Lithounit-X, Lithounit-Y and Lithounit-Z.

LITHOUNIT-X

Lithounit-X is yellowish silty sand with gravels and pebbles encountered from GL to different depth for different boreholes. Refer Table-01 to Table-54. It is classified as SM showing non-plastic in nature. Standard penetration test conducted in the boreholes indicate that the strata are dense in nature. The Specific gravity is found from 2.61 to 2.63.

LITHOUNIT-Y

Lithounit-Y is yellowish clayey silt mixed with bentonite/sandy silt with gravels starting from different depth in different Boreholes in few Borekoles. Refer Table-01 to Table-54. It is classified as MI/CL showing medium to low plastic in nature. Standard penetration test conducted in the boreholes indicate that the strata are very stiff in nature. The Specific gravity is found from 2.66 to 2.68.

LITHOUNIT-Z

Lithounit-Z is highly weathered and fractured rock encountered from different depth in different boreholes. Refer Table-01 to Table-54. Standard penetration test conducted in the boreholes indicate that the strata are hard in nature.

6.0 ANALYSIS AND DISCUSSIONS OF TEST RESULTS

Forty five boreholes and nine trial pits drilled down to a depth of refusal and further 3.0m/6.0m in rock and disturbed/ undisturbed soil samples have been collected for laboratory testing. Standard Penetration Test has been carried out as per I.S. standard. On the field investigation data, it is found that strata is higly weathered and fractured rock in nature as indicated by core recovery & RQD observed.

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6.1 GENERAL

A suitable foundation for any structure should satisfy two basic criteria. Firstly, the soils should have adequate shear strength to support the superimposed loads so that there is an adequate safety factors against the bearing capacity. Secondly, the settlement of the soils including immediate elastic settlement and long terms consolidations settlement should be within the tolerable limits for the structure. The net allowable bearing pressure on the foundations should be taken as the lower of the two values obtained from these two criteria.

6.2 FOUNDATIONS TYPE

In general, light to medium loaded structure may bear on open shallow footings. Heavily loaded structure may bear on raft foundation.

6.3 ALTERNATIVE FOUNDATION SCHEMES.

Considering the above nature of soils & load coming through the structure, we recommend the isolated footing or raft foundation of different sizes at depth given below as per the suitability of designer.

Detailed recommendation of this scheme is given in the following sections. The designer may select the appropriate foundation scheme based on the loading condition, economic consideration & ease of construction.

6.4 OPEN FOUNDATION

Open foundation are feasible foundation schemes. Bearing capacity analysis for the shallow square footings is in accordance with IS 6403-1981. Bearing capacity may be taken as given below:

$$qu = CNc^1 Scd_c i_c + q (Nq^1 - 1) Sq dq iq + 0.5 Br Nr^1 Sr dr ir W^1$$

$$C = 0.0T/M^2, \phi = 33^\circ, Nq^1 = 27.34, Nr^1 = 37.78, r = 1.70 T/M3$$

<u>At 1.00 Depth (Considering Silty sand strata)</u>

$$qu = 1.70x1x26.34x1.2+0.5x1.70xBx37.78x0.8x1$$
$$= 53.73 + 25.69 B.$$

qa (for 1mx1m) = 31.77 T/M^2
qa (for 6mx6m) = 42.04 T/M^2

At 1.00 Depth (Considering sandy/clayey silt strata)

$C = 6.0T/M^2$, $\phi = 7^o$, $Nc^1 = 7.23$, $Nq^1 = 1.93$, $Nr^1 = 0.76$,

r = 1.70 T/M3, Sc=1.3, Sq=1.2, Sr=0.8 , FOS = 2.5.

Qu = 6.0x7.23x1.3 + 1.70x1x0.93x1.2 +0.5Bx1.70x0.76x0.8x1

= 58.29 + 0.52 B

qa (for 1mx1m) = 23.52 T/M^2
qa (for 6mx6m) = 24.56 T/M^2

At 1.50 Depth (Considering sandy/clayey silt strata)

$C = 6.0T/M^2$, $\phi = 7^o$, $Nc^1 = 7.23$, $Nq^1 = 1.93$, $Nr^1 = 0.76$,

r = 1.70 T/M3, Sc=1.3, Sq=1.2, Sr=0.8 , FOS = 2.5.

Qu = 6.0x7.23x1.3 + 1.70x1.5x0.93x1.2 +0.5Bx1.70x0.76x0.8x1

= 59.24 + 0.52 B

qa (for 1mx1m) = 23.90 T/M^2
qa (for 6mx6m) = 24.94 T/M^2

Since refusal is observed at shallow depth, so taking corrected N= 32, SBC=500/8= 62.5 T/M^2.

6.5 Soil strata varies location to location from GL to 1.50m depth. Weathered rock/fractured rock is encountered after soil layer/gravelly layer. In most of the boreholes, rock is encountered after 0.50m/1.50m depth. Rock cores were collected from boreholes showing recovery in order of about 0 % to 28 %. RQD were also observed in boreholes on which crushing tests were performed

6.6 The crushing strength of core samples have been used as a guiding factor to recommend allowable bearing pressures. As per core strength method, the net allowable bearing pressure may be estimated from the following expression

$q_a = K_{sp}\, q_{u\text{-}core}$

Where $q_{u\ core}$ = average unconfined compressive strength of rock cores.

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K_{sp} = empirical coefficient depending on joint spacing and including a factor of safety of 3
= 0.4 (joint spacing>3m), 0.25 (joint spacing 1- 3m), 0.1 (joint spacing 0.3-1m)

Taking lowest value into consideration,

$q_a = 0.1 \times 131 = 13.1$ kg/cm^2 (131 T/M^2)

6.7 DEPTH OF FOUNDATIONS

The minimum depth of foundation is governed by the following factors:

a) Foundation should be below the top weak zone
b) Depth of top weak zone.
c) Securing of adequate bearing capacity.
d) Requirement of structure.
e) Swelling properties of soil and
f) Depth of refusal strata.

6.8 As refusal strata in the form of highly weathered and fractured rock is available at shallow depths, foundations can be placed at minimum of 1.0m depth from EGL.

6.9 As the overburden varies in depth at site, the depth of placing foundation should be worked out carefully with reference to Table-01 to Table-54.

7.0 During the process of boring, no water pressure i.e, artesian condition has been observed.

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7.0 CONCLUSIONS AND RECOMMENDATIONS

Based on field and laboratory investigations, following recommendations can be made :

1. The strata is dense to very stiff to hard in nature. For detail, please refer Table-01 to Table-54.

2. The stratum consists of three lithounits. The detailed lithology is explained in article 5.0.

3. It is suggested that the net safe bearing capacity for isolated footings may be taken as the table given below:

NET SAFE BEARING CAPACITY IN T/M^2

Depth (m) From EGL	1mx1m	2mx2m	3mx3m	4mx4m	5mx5m
1.00	15.0	15.0	15.0	15.0	15.0
1.50	20.0	20.0	20.0	20.0	20.0
2.00	25.0	25.0	25.0	25.0	25.0
3.00	40.0	40.0	40.0	40.0	40.0

4. The net safe bearing capacity of combined or raft foundation may be taken as given below:

NET SAFE BEARING CAPACITY IN T/M^2

Depth(m) from EGL	5mx5m	6mx6m
1.00	20.0	20.0
2.00	30.0	30.0
3.00	40.0	40.0

4. The bulk density and dry density should be taken as 1.70 T/M^3 and 1.61 T/M^3 respectively.

5. Angle of repose may be taken as 20 degree for all the design purposes.

6. Water table was not encountered during the boring.

7. For soil resistivity data, please refer Table-56 to 67.

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TABLE NO-55

PHYSICAL PROPERTIES OF ROCK

BH.No	Depth (m)	Specific Gravity	Density (gm/cc)	Moisture Content (%)	Water Absorption (%)	Void Ratio	Porosity	Point Load Strength Index (kg/sq.cm)	Crushing Strength (kg/sq.cm)
1	2.50	2.70	2.51	1.12	0.65	0.075	0.070	7.1	-----
2	0.50	2.72	2.54	0.16	0.79	0.070	0.065	10.7	-----
2	2.0	2.73	2.55	0.22	0.85	0.070	0.065	---	131.0
3	2.4	2.71	2.48	0.18	0.91	0.093	0.085	17.8	-----
4	2.50	2.74	2.51	0.10	0.79	0.092	0.084	16.0	-----
5	2.50	2.76	2.52	0.15	0.82	0.095	0.086	21.2	-----
6	2.0	2.74	2.53	0.19	0.94	0.083	0.076	10.7	-----
6	3.0	2.71	2.51	0.22	0.78	0.080	0.074	21.4	-----
7	2.50	2.73	2.47	0.27	0.82	0.105	0.095	10.7	-----
8	1.60	2.71	2.50	0.29	0.98	0.084	0.077	7.1	-----
8	2.60	2.73	2.53	0.18	0.92	0.079	0.073	14.2	-----
13	2.50	2.72	2.51	0.16	0.98	0.084	0.077	12.5	-----
14	2.50	2.74	2.56	0.14	0.92	0.070	0.065	16.0	-----
15	2.50	2.72	2.53	0.12	0.88	0.075	0.070	19.6	-----
16	3.0	2.71	2.51	0.22	0.82	0.080	0.074	10.7	-----
17	2.50	2.72	2.48	0.25	0.96	0.097	0.088	7.1	-----
39	0.50	2.73	2.54	0.18	0.69	0.075	0.070	------	312.4
41	1.50	2.72	2.51	0.27	0.95	0.084	0.077	7.1	-----
42	2.50	2.74	2.55	0.22	0.85	0.074	0.069	17.8	-----
44	2.20	2.72	2.52	0.15	0.90	0.079	0.073	10.7	-----
44	5.20	2.75	2.56	0.23	0.86	0.074	0.069	19.6	-----
45	1.50	2.73	2.53	0.12	0.94	0.079	0.073	10.7	----
45	2.50	2.76	2.55	0.18	0.78	0.082	0.076	-----	235.4

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SWELLING & CHEMICAL PROPERTIES OF SOIL

B.H. No.	DEPTH (M)	DFS (%)	SHRINKAGE LIMIT (%)	S.P. (kg/cm2)	SULPHATE	CHLORIDE	pH VALUE
1	0.00	-----	-----	-----	0.123	0.03	8.2
6	0.50	-----	-----	-----	0.112	0.05	8.4
9	0.00	-----	-----	-----	0.134	0.08	8.6
12	0.50	-----	-----	-----	0.123	0.04	8.5
14	0.00	12.5	22.6	0.00	0.112	0.04	8.3
15	0.50	15.6	23.3	0.00	0.134	0.07	8.5
18	1.00	-----	-----	-----	0.144	0.09	8.7
21	1.00	-----	-----	-----	0.123	0.05	8.4
24	1.00	-----	-----	-----	0.134	0.07	8.5
27	1.00	-----	-----	-----	0.123	0.04	8.3
32	1.00	18.5	22.2	0.30	0.134	0.06	8.5
37	0.00	-----	-----	-----	0.144	0.08	8.6
44	0.50	-----	19.4	0.50	0.123	0.04	8.3
TP-1	1.00	-----	-----	-----	0.134	0.05	8.4
TP-4	2.00	-----	-----	-----	0.123	0.03	8.2
TP-7	1.00	-----	-----	-----	0.144	0.06	8.6

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