



BAGHJAN – MADHUBAN PIPELINE PROJECT (ASSAM)

**BID DOCUMENT FOR PROCUREMENT
OF**

PERMANENT CATHODIC PROTECTION (PCP) SYSTEM

**UNDER OPEN DOMESTIC
COMPETITIVE BIDDING**

TENDER No.: CPI2134P20

VOLUME – II OF II

PREPARED AND ISSUED BY



MECON LIMITED

(A Govt. of India Undertaking)

Delhi, India

Aug' 2019

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	TABLE OF CONTENT	DOCUMENT NO.	Page 1 of 3
			REVISION 0

TABLE OF CONTENT

Sl No.	Description	Document No./ Drawing No.	Rev. No.	Pages
MATERIAL REQUISITION, DESIGN BASIS, SCOPE OF WORK				
1	Design Basis for PCP system	MEC/23U1/05/E9/E/001	Rev. 0	9
2	Scope of Work	MEC/23U1/05/E9/E/002	Rev. 0	32
STANDARD SPECIFICATIONS				
3	Corrosion Survey	MEC/S/05/21/016C	Rev. 2	4
4	Permanent Cathodic Protection System	MEC/TS/05/E9/016B	Rev. 2	29
5	Cathodic protection Transformer rectifier (TR) unit	MEC/TS/05/E9/082A	Rev. 2	9
6	Cathodic protection Power supply module (CPPSM)	MEC/TS/05/E9/082	Rev. 2	9
STANDARD DATA SHEETS & QAP (Quality Assurance planning)				
7	Cathodic protection Transformer rectifier (TR) unit	MEC/DS/05/E9/082A	Rev. 0	5
8	Cathodic protection Power supply module (CPPSM)	MEC/DS/05/E9/082	Rev. 0	5
9	Quality Assurance Plan	MEC/05/E9/QAP/23U1/PCP/001	Rev. 0	2
STANDARD DRAWINGS				
10	Prepacked Zinc Anode	MEC/SD/05/E9/E/CP/1601	Rev. 1	
11	Prepacked Mg Anode	MEC/SD/05/E9/E/CP/1602	Rev. 1	
12	Details of Test Station for TCP	MEC/SD/05/E9/E/CP/1604	Rev. 1	
13	Test Station Connection Schemes	MEC/SD/05/E9/E/CP/1605	Rev. 1	
14	Galvanic Anode Installation	MEC/SD/05/E9/E/CP/1606	Rev. 1	

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project		 MECON LTD, DELHI
TITLE	TABLE OF CONTENT	DOCUMENT NO.	Page 2 of 3	
			REVISION 0	
15	Zinc Ribbon Anode for Cased Crossings with Coated Casings	MEC/SD/05/E9/E/CP/1607	Rev. 1	
16	Pipeline Grounding Through Polarisation Cell and Galvanic Anodes	MEC/SD/05/E9/E/CP/1608	Rev. 1	
17	Details of Zinc Grounding Cell	MEC/SD/05/E9/E/CP/1609	Rev. 1	
18	Permanent Copper – Copper Sulphate Reference Cell & Installation Details	MEC/SD/05/E9/E/CP/1610	Rev. 1	
19	Shallow Anode Ground Bed (PCP)	MEC/SD/05/E9/E/CP/1611	Rev. 1	
20	Anode Lead Junction Box	MEC/SD/05/E9/E/CP/1612	Rev. 1	
21	Casing Pipe Detail	MEC/SD/05/E9/E/CP/1613	Rev. 1	
22	Test station for polarization cell	MEC/SD/05/E9/E/CP/1614	Rev. 1	
23	Deep well anode bed	MEC/SD/05/E9/E/CP/1615	Rev. 1	
24	Connection scheme for hooking through CJB/TLP	MEC/SD/05/E9/E/CP/1616	Rev. 1	
25	Details of thermit weld for cable to pipe joint	MEC/SD/05/E9/E/CP/1618	Rev. 1	
26	Earth Electrode in Test Pit	MEC/SD/05/E9/02/1601	Rev. 1	
LIST OF ATTACHMENTS (For Tender Purpose)				
27	P&ID's			
28	Schematic route diagram			

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)		OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project		 मेकन ISO 9001:2000 Company MECON LTD, DELHI
TITLE		TABLE OF CONTENT	DOCUMENT NO.		Page 3 of 3
			REVISION 0		
29	Plot Plan				
30	Alignment & Crossing Sheets				
31	Soil resistivity report				
32	Soil stratification report				

DESIGN BASIS FOR PERMANENT CATHODIC PROTECTION WORK



Baghjan to CGGS Madhuban Pipeline Project

DOCUMENT NO. - MEC/23U1/05/E9/E/001, R-0



**(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092**

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	DESIGN BASIS FOR PCP SYSTEM	DOCUMENT NO. MEC/23U1/05/E9/E/001	Page 1 of 9 REVISION 0

CONTENTS

Sl. No.	Description
1.	INTRODUCTION
2.	SCOPE
3.	CODES & STANDARDS
4.	SITE CONDITIONS
5.	AREA CLASSIFICATIONS
6.	POWER SUPPLY DETAILS
7.	MONITORING AND CONTROL SIGNAL FOR SCADA
8.	CABLES
9.	CATHODIC PROTECTION SYSTEM
10.	STATUTORY APPROVAL
11.	DRWINGS AND DESIGN DOCUMENTS

PREPARED BY:	CHECKED BY:	APPROVED BY:	ISSUE DATE :
(Aashish Moyal)	(M.K.Jaiswara)	(DG Majumder)	ISSUE DATE: July 2019, R-0

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	DESIGN BASIS FOR PCP SYSTEM	DOCUMENT NO. MEC/23U1/05/E9/E/001	Page 2 of 9 REVISION 0

1.0 INTRODUCTION-

M/s OIL, a public sector under Petroleum ministry, intends to is proposing to lay a 40 kms (approx.) long Natural Gas pipeline starting from Baghjan to Madhuban, Duliajan. The proposed Baghjan to Duliajan gas Pipeline is in addition to the existing 400 mm NB (16"NB) gas pipeline.

M/s MECON Ltd has been engaged by M/s OIL to carry out design, engineering, procurement, inspection & Project Management Consultancy Services required for 30" NB x 40 Kms. (approx.) pipeline from Baghjan to Madhuban, Duliajan.

This document presents design criteria for PCP system for 3LPE Coated, 40 km (approx.) long gas pipeline against corrosion for a service life of 35 years. It indicates minimum requirements for detailed design of CP system and equipments.

In case of any conflict between the codes and standards listed, the same shall be brought to the notice of Owner/Consultant for final decision, which shall be binding.

2.0 SCOPE-

Survey, Design, Detailed Engineering, Manufacturing, Inspection/FAT (Factory acceptance test), Supply, packing, transportation to site, installation, testing and commissioning of the permanent cathodic protection system by impressed current method using MMO coated Titanium anodes to protect the external surface of 30" NB x 40 Km. (Approx) 3LPE Coated pipeline against corrosion for a service life of 35 years, as per Standard Specification No. MEC/TS/05/21/016B for Permanent Cathodic Protection system & Scope of Work, Data Sheets & Other relevant standards.

3.0 CODES & STANDARDS-

The system design, performance and materials to be supplied shall, unless otherwise specified, conform to the requirements of the following latest relevant applicable specifications:

i)	NACE Standard SP-0169	:	Standard Practice Control of External Corrosion on Underground or Submerged Metallic Piping Systems
ii)	NACE Publication 10A190	:	Measurement technique related to criteria for CP of Underground or Submerged Steel Piping System (as defined in NACE Standard RPO169-83)
ii)	NACE Standard SP-0177	:	Standard Practice Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control System.
iv)	NACE Standard SP-0286	:	Standard Practice the electrical isolation of Cathodically Protected Pipelines
v)	NACE Publication No. 54276	:	Cathodic Protection Monitoring for Buried Pipelines
vi)	NACE Standard SP-0572	:	Standard Practice for Design, Installation & Operation of Impressed Current Deep Ground beds
vii)	NACE Standard SP-200	:	Standard Practise for Steel Cased Pipeline Crossings
viii)	NACE Standard SP-0104	:	The Use of Coupons for Cathodic

 ऑयल इंडिया लिमिटेड (भारत सरकार का उपक्रम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	DESIGN BASIS FOR PCP SYSTEM	DOCUMENT NO. MEC/23U1/05/E9/E/001	Page 3 of 9 REVISION 0

vii)	IS 8062	:	Protection Monitoring Applications
viii)	BS 7361 Part I	:	Recommended Practice ICCP for Underground Piping
ix)	VDE 0150	:	Code of Practice for Cathodic Protection for land and marine application.
x)	IS: 7098 Part I	:	Protection against Corrosion due to Stray Current from DC Installations
xi)	IS: 1554 Part I	:	XLPE Insulated Cables.
		:	PVC Insulated (heavy duty) cables.

3.2 In case of imported equipments standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.

3.3 The equipment shall also confirm to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.

3.4 In case of any contradiction between various referred standards/ specifications/ data sheet and statutory regulations the following order of priority shall govern.

- Statutory regulations.
- Data sheets.
- Scope of Work/ Job specification.
- Design Basis.
- Standard Specification.
- Codes and standards.

4.0 SITE CONDITIONS-

The equipment offered and the installation shall be suitable for continuous operation under the following site conditions:

Ambient temperature	:	50°C/ 2°C (max.)
Max relative humidity	:	95%
Altitude	:	less than 1000 m
Atmosphere	:	To withstand site condition (Humid & Heavy Rainfall during Monsoon)
Hazardous area Classification	:	Zone-1, Gas group IIA & IIB, Temp. Class T3

5.0 ARES CLASSIFICATION-

Classification of hazardous area will be in accordance with BIS and IS: 5572.

Following selection will be considered for proper selection of electrical equipment for use in hazardous area:

a) Area Classification	:	Zone-1
b) Gas Group	:	IIA and IIB
c) Temperature Classification:		T3

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	DESIGN BASIS FOR PCP SYSTEM	DOCUMENT NO. MEC/23U1/05/E9/E/001	Page 4 of 9 REVISION 0

All electrical equipment installed in hazardous area will be selected as per IS: 5571.

- 5.1 All the electrical equipment for hazardous areas shall be of Ex-d type suitable for temp classification T3.

6.0 POWER SUPPLY DETAILS-

For Receiving/Dispatch Terminals power supply to CP system (CPPSM/TR unit) shall be through UPS (Grid power is available at these locations).

Power Supply detail- 230V AC +/- 15%, 50Hz +/- 5% Single Phase UPS Power supply from Existing UPS system.

7.0 MONITORING AND CONTROL SIGNAL FOR SCADA-

Digital and analogue monitoring signals as required for CP system shall be provided in various electrical equipment for connection to SCADA system.

CPPSM/TR unit shall be properly interfaced with RTU with Hardwired link for various analogue and digital signals, CONTRACTOR shall provide dedicated RS485 serial link for SCADA. The protocol will be ModBus. Supply, installation, testing of armoured RS-485 serial communication cable signal cable in the scope of CP contractor.

Details of SCADA monitoring signals are given below-

SI No.	DESCRIPTION	MONITERING/ CONTROL	ANALOUGE /DIGITAL	
1	CP TR/CPPSM OUT PUT VOLTAGE	M	AI	
2	CP TR/CPPSM OUT PUT CURRENT	M	AI	
3	PIPELINE OVER PROTECTED	M	DI	
4	PIPELINE UNDER PROTECTED	M	DI	
5	PIPE TO SOIL POTENTIAL	M	AI	
6	ALL REFERENCE CELLS FAILED	M	DI	
7	UNIT WORKING IN AUTO REF MODE	M	DI	
8	UNIT WORKING IN	M	DI	

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	DESIGN BASIS FOR PCP SYSTEM	DOCUMENT NO. MEC/23U1/05/E9/E/001	Page 5 of 9 REVISION 0

	MANUAL MODE			
9	AC INPUT FAIL	M	DI	
10	Battery Low	M	DI	For CPPSM Only
11	CURRENT INTERRUPTER START	C	DO	
12	CURRENT INTERRUPTER STOP	C	DO	
13	CURRENT INTERRUPTER RESET	C	DO	

- 1 AI: Analogue monitoring signal from Equipment to PLC/Telemetry interface cabinet (TIC)
- 2 DI: Digital Monitoring signal from Equipment to PLC/(TIC)
- 3 M-Monitoring signal
- 4 C-Control signal

Control signal shall be provided only for remote operation of the current interrupter.

8.0 CABLES-

PCP Cables-

- i) Anode & Cathode Header Cable- (Size 1Cx35 Sqmm)-

Anode & Cathode Header Cable shall be 1Cx35 Sqmm size, annealed high conductivity tinned stranded copper conductor, XLPE insulated, PVC sheathed, FRLS, 1.1kV Grade armoured cable as per IS: 7098.

- ii) Measurement cable & Permanent Reference cell tail cable- (Size 1Cx6 Sqmm/Multi-core, FRLS, 1.5 Sqmm, 8/12 pair, twisted pair, armoured, signal cables as per IS/BS)-

- a) **Measurement cable & Permanent Ref cell tail cable from Pipe/Tank/Bullet/Vessel to Cjb** shall be 1Cx6 Sqmm size, annealed high conductivity tinned stranded copper conductor, XLPE insulated, PVC sheathed, FRLS, 1.1kV Grade armoured, screened cable as per IS: 7098 and from **CJB to TR/CPPSM unit** shall be Multi-core, FRLS, 1.5 Sqmm, 8/12 pair, twisted pair, armoured, signal cables as per IS/BS.

- iii) The colour of outer sheath of the cables shall be as per the PJS/Scope of work/Design Basis and outer sheath should have marking of **"CP system Cable"** in each one meter interval by black colour for identification purpose.

- iv) Colour coding of CP cables shall be provided during detail engineering for various different type of CP cables.

b. CABLING SYSTEM

Cable laying philosophy

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	DESIGN BASIS FOR PCP SYSTEM	DOCUMENT NO. MEC/23U1/05/E9/E/001	Page 6 of 9 REVISION 0

- A. Paved area: Cable tray/RCC trench
B. Unpaved area: Directly buried
C. Type of cable trays: Galvanized prefabricated

9.0 CATHODIC PROTECTION SYSTEM-

PCP system- (Permanent Cathodic Protection System)

A. Type	Impressed current type
B. Design life of protection	35 Years
C. Pipeline coating	Three Layer Polyethylene
D. Design protection current density	As per specification
E. Hook-Up/Bonding of PCP system & Pipeline (Parallel Pipelines)	Shall be carried out
F. Type of Anodes for anode ground bed	Tubular mixed metal oxide titanium or as per specification.
G. Polarisation cell	Solid state type (shall be provided as per specification/scope of work)
H. Permanent Ref Cell	Permanent Ref cell for PCP system shall be Cu/Zn type. Cu-Cuso4 shall be as per tender drawing.
I. Computerized test stations (GSM based)	As per scope of work (Location of computerized test station shall be decided in detail engineering)
a) No. of computerised test station readers / portable data collection & storage instruments.	As per scope of work
b) Interval for data acquisition/ storing	Once every day (Refer Note1 below)
J. Acquisition of land or Lease (for 99 years) for Anode bed, Anode junction boxes and anode ground bed ROW (RIGHT OF WAY) for cable laying.	By contractor
K. Chain link fencing around the ground Bed	Shall be provided
L. Close interval potential logging survey	Shall be carried out

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	DESIGN BASIS FOR PCP SYSTEM	DOCUMENT NO.	Page 7 of 9
		MEC/23U1/05/E9/E/001	REVISION 0

M.	CAT Survey (Full Length of pipeline)	Shall be carried out
N.	Additional tests to be conducted for identifying pipe coating defects/ holidays	DCVG and CAT with frame 'A' survey
O.	Current drainage & Coating conductance survey	Shall be carried out
P.	AC Corrosion coupons (1Cm2) for AC corrosion densities measurement	Shall be provided at HT line crossings and AC interference prone area
Q.	AC/DC Interference Detection & Its Mitigation	Shall be carried out with help of software simulation & modelling and grounding shall be proposed accordingly for mitigation and control of AC induced voltages & AC corrosion density.
R.	Proposed location of CP stations/Anode	To be decided by CP contractor. (However tentative location of CP station are mentioned in the Scope of Work, Exact location shall be decided in detail engineering & approval of design document in consultation with OIL/MECON)

O. CP stations/ anode ground bed for Impressed current system:-

- a) Tentative locations of CP stations are mentioned in Scope of Work, actual numbers of CP stations shall be finalized during the approval of design documents submitted by the Contractor, Any other proposed location shall be included during detailed engineering, if required without any cost implication. However PCP system shall be designed in such a manner that CP stations & anode bed shall be located coinciding with D/T/R/T/SV / IP stations, as far as possible.

b) CATHODIC PROTECTION DESIGN CRITERIA FOR Zn TYPE PERMANENT REF CELL

Cathodic protection system shall be designed to meet the following criteria w.r.t. Zn type permanent ref cell (Electrode):

- i) The pipe to soil potential measurements shall be between (+) 0.2 V (Off) & (-) 0.08 V (Off) with respect to a Zn/ Zn sulphate reference electrode.
- ii) In rare circumstances, a minimum polarisation shift of 100 millivolts may be accepted as an adequate level of cathodic protection for the pipeline with the written approval of owner.
- iii) Discretion to use any of the criteria listed above shall solely rest with the owner/ owner's representative.
- iv) A positive potential swing of 50 to 100 mill volts shall be considered as sufficient to indicate the presence of an interaction situation (i.e. Interference on the pipeline) requiring investigation and incorporation of mitigation measures by the CONTRACTOR.

Note 1: - For computerized test station: Interval of data acquisition/storing may be kept for once in every hour. This feature will be helpful for detecting/trouble shooting in case

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	DESIGN BASIS FOR PCP SYSTEM	DOCUMENT NO.	Page 8 of 9
		MEC/23U1/05/E9/E/001	REVISION 0

of encountering any interference. However in normal case, one reading per day is enough.

Note 2: - Zn reference electrode shall be of reputed make and manufactured from High purity Zn (Hi-Pure Zinc 99.99% ASTM B418-73 Type II).

10.0 STATUTORY APPROVAL-

The submission of application on behalf of the Owner to Govt. Authority/ Central Electricity Authority, if required along with copies of required certificates complete in all respects, shall be done by the contractor well ahead of time so that the actual commissioning of are not delayed for want of approval from authority. The actual inspection of work by the Govt. inspector shall be arranged by the Contractor and necessary coordination and liaison work in this respect shall be the responsibility of the contractor. However any fee paid to the Govt. Authority in this regard shall be reimbursed by the Owner on submission of bills with documentary evidence.

The Inspection and acceptance of the work as above shall not absolve the Contractor from any of responsibilities under this contract.

11.0 DRWINGS AND DESIGN DOCUMENTS-

11.1 The following documents shall be submitted along with the offer:

- Filled up data sheet/Checklist.
- HSE Policy
- Bar Charts & Project completion schedule
- List of two years operation and maintenance spare.
- Approx. dimensions of the system
- Catalogues for CP units, MMO & Sacrificial Anodes, polarization cells, spark gap arrestors, ER Probe, reference cells etc.

11.2 The following drawings (in three sets) & documents shall be submitted for approval within 3 weeks of award of contract.

1.1.1 The following drawings (in three sets) & documents shall be submitted for approval within 3 weeks of award of contract.

- Various Procedures of CP system Installation Like- Soil survey (PCP), Thermit weld, Pin Brazing, Sacrificial anode (Zn/Mg/Ribbon) installations, Test stations & Junction Boxes installation, Cable laying, AGB installation, CP unit installation, Installation of polarization cell, CTSU, Earthing of above ground pipeline etc.
- PCP commissioning procedures along with formats for individual items (CP unit, AGB etc) and commissioning of whole pipeline.
- Basis of system design and design calculations, equipment selection criteria and sizing calculations, formulae used
- Detailed design calculations of PCP system (Complete Design Package).
- Equipment layout, Cable layout & schedule.
- Construction drawing for fencing of anode bed & AJB.
- Colour code identification for the various CP System cables used in the system
- Procedures for Various Post commissioning surveys (CPL, CAT, CAT Frame 'A'

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	DESIGN BASIS FOR PCP SYSTEM	DOCUMENT NO.	Page 9 of 9
		MEC/23U1/05/E9/E/001	REVISION 0

- DCVG & coating conductance etc).
- Procedure for AC & DC interference detection & mitigation.
 - Procedure for field testing, pre-commissioning & commissioning of PCP.
 - Procedure for Monitoring & maintenance of CP system.
 - Detailed design of Anode ground bed, typical lay out drawings for Anode bed connection & installation for CP system.
 - TLP's & junction boxes installation & erection details drawings.
 - Incorporation of Anode bed, Polarisation cell, surge arrester, TLP, Junction boxes & other relevant feature in CP system design in Alignment sheet, pipeline route diagram & Plot plan.
 - G.A. of TR/CPPSM unit.
 - Schematic
 - Tentative Bill of Material

11.3 After the job completion, contractor shall prepare AS-BUILT drawings/data sheets and documents, submit catalogues/manuals (O&M) of major brought out items. Final certified as built drawings, documents and manuals etc shall be submitted by the contractor to owner in bound volume with one set in soft copy (CD) plus five sets of prints to owner & one set to MECON..

Other drawings and documents shall be submitted by contractor along with AS-BUILT Drawings/Datasheets-

- Original deed OR Lease agreement for acquired/leased land (In favour of M/s OIL) for Anode Bed, ROW (RIGHT OF WAY) for cable laying etc shall be handed over to M/s OIL.
- Test documents & drawings for bought out items.
- Detailed commissioning report of pipeline CP system (PCP).

-X-X-X-

SCOPE OF WORKS FOR PERMANENT CATHODIC PROTECTION WORK



ऑयल इंडिया लिमिटेड
(भारत सरकार का उद्यम)
Oil India Limited
(A Government of India Enterprise)

Baghjan to CGGS Madhuban Pipeline Project

DOCUMENT NO. - MEC/23U1/05/E9/E/002, R-0



**(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092**

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 1 of 32 REVISION 0

CONTENTS

SL.NO.	DESCRIPTION
1.	General
2.	Project Description
3.	Standards
4.	Guarantee
5.	Site Conditions
6.	Power Supply Parameters
7.	Abbreviations
8.	Eligibility criteria for CP contractor and co-ordination with other contractors
9.	Scope of Work (PCP)
10.	Statutory Approval of Works
11.	Quality Assurance, Inspection & Testing
12.	Testing & commissioning
13.	Drawings, Standard Specification And Installation Standards
14.	Resources/ Facilities
15.	Project Scheduling & Monitoring
16.	Construction
17.	Documentation
18.	Make of Material/ Bought Out Items
19.	Inspection of Supply Items
20.	Escalation
21.	Documents to be submitted/ produced along with R.A. Bills

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 2 of 32 REVISION 0

- Appendix-I (List of Vendors for Bought out items)
Appendix-II (2 Years Operational & Maintenance Spares for Permanent Cathodic protection system)
Annexure-A (Format for Daily Progress Report for PCP system)
Annexure-B (Format for PCP system commissioning & Monthly Monitoring of PCP system)
Annexure-C Organogram for the CP work
- Annexure-AA Compliance to the Technical Bid (CP Work).

PREPARED BY:	CHECKED BY:	APPROVED BY:	ISSUE DATE :
(Aashish Moyal)	(M.K.Jaiswara)	(DG Majumder)	ISSUE DATE: July 2019 R-0

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 3 of 32 REVISION 0

1.0 GENERAL

1.1 Introduction

Special Condition of Contract shall be read in Conjunction with the General Conditions of Contract, specification of work, Drawing and any other documents forming part of this contract wherever the context so requires.

Notwithstanding the sub-division of the documents into these separate sections and volumes every part of each shall be deemed to be supplementary to and complementary of every other part and shall be read with and into the contract so far as it may be practicable to do so.

Where any portion of the General Condition of Contract is repugnant, to or at variance with any provisions of the Special Conditions of Contract, unless a different intention appears, the provisions of the Special Conditions of Contract shall be deemed to over-ride the provisions of the General Condition of Contract and shall to the extent of such repugnancy, or variations, prevail.

The materials, design and workmanship shall satisfy the relevant INDIAN STANDARDS, the TECHNICAL SPECIFICATIONS contained herein and CODES referred to. Where the technical specification stipulate requirements in addition to those contained in the standard codes and specifications, these additional requirements shall also be satisfied.

Wherever it is mentioned in the specifications that the CONTRACTOR shall perform certain work or provide certain facilities, it is understood that the CONTRACTOR shall do so at his cost and the VALUE OF CONTRACT shall be deemed to have included cost of such performance and provisions, so mentioned.

It will be Contractor's responsibility to bring to the notice of Engineer-in-charge any irreconcilable conflict in the contract documents before starting the work(s) or making the supply with reference which the conflict exists.

In the absence of any specifications covering any material, design of work(s) the same shall be performed/ supplied/ executed in accordance with Standard Engineering Practice as per the instructions/ directions of the Engineer-in-charge, which will be binding on the Contractor.

2.0 PROJECT DESCRIPTION

M/s OIL, a public sector under Petroleum ministry, intends to is proposing to lay a 40 kms (approx.) long Natural Gas pipeline starting from Baghjan to Madhuban, Duliajan. The proposed Baghjan to Duliajan gas Pipeline is in addition to the existing 400 mm NB (16"NB) gas pipeline.

M/s MECON Ltd has been engaged by M/s OIL to carry out design, engineering, procurement, inspection & Project Management Consultancy Services required for 30" NB x 40 Kms. (approx.) pipeline from Baghjan to Madhuban, Duliajan.

2.1 PROJECT DETAIL

The work being tendered is covered as indicated below:

Details of Proposed Pipeline

— Material of Construction : Carbon Steel

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 4 of 32 REVISION 0

–	Line Size	: 30" NB
–	Length, in km	: $\approx$ As mentioned above
–	Pipe Specification	: As per P&ID
–	Thickness	: As per P&ID
–	Design pressure	: As per P&ID
–	Corrosion Allowance	: As per Pipeline data
–	External Coating	: 3-LPE
–	Internal Coating	: Liquid epoxy
–	Design Code	: ANSI/ ASME B31.8 (Latest Edition)
–	Major Water Crossings	: As per Alignment Sheet
–	Major Road Crossings	: As per Alignment Sheet
–	Rail Crossings	: As per Alignment Sheet
–	HT line crossing	: As per Alignment Sheet

3.0 STANDARDS

- 3.1 The work shall be performed in conformity with this specification, standard specifications and installation standards enclosed elsewhere in this tender and code of practices of the Bureau of Indian Standards. In case of any conflict, the stipulations under this specification shall govern.

In addition, the work shall also conform to the requirements of the following:

- 3.2 The Indian Electricity Act, and the rules framed there under.
The regulations laid down by the Chief Electrical Inspector of the state government/ Central Electricity Authority (CEA).
The regulations laid down by the Factory Inspector.

The regulations laid down by the Chief Controller of Explosives.
Any other regulations laid down by the Central, State or Local Authorities from time to time during the execution of this contract.
OISD Standards
OIL's Safety Standard

- 3.3 The design, selection and installation of equipment and materials shall also conform to the requirements of the relevant latest standards of:
BS Specification and codes of practice
OISD Standard 138
IS: 8437 (Part-II)/ 8062 (Part-I)
NACE Standards
DNV Publications
IEEE Publications

4.0 GUARANTEE

- 4.1 The contractor shall guarantee the installation against any defects of workmanship and materials (supplied by the contractor) for a period 12 months after successful commissioning at site. Any damage or defects connected with the erection of materials, equipments of fittings supplied by the contractor that may be undiscovered at the time of issue of the completion certificate, or may arise or come to light thereafter, shall be rectified or replaced by the contractor at his own expense as deemed necessary and as per the instruction of the Engineer-in-charge within the time limit specified by Engineer-in-charge.

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 5 of 32 REVISION 0

4.2 The above guarantee shall be applicable for the quality of work executed as well as for the equipment/ cable/ fittings/ other materials etc supplied by the contractor.

Equipments installed or commissioned by others within the battery limit. This is for the purpose of obtaining a comprehensive approval from competent authority.

5.0 SITE CONDITIONS

The equipment offered and the installation shall be suitable for continuous operation under the following site conditions:

Ambient temperature	:	50°C/ 2°C (max.)
Max relative humidity	:	95%
Altitude	:	less than 1000 m
Atmosphere	:	To withstand site condition (Dry during summer, Humid & Heavy rainfall during monsoon & low temp during winter)
Hazardous area Classification	:	Zone-II, Gas group IIA & IIB, Temp. Class T3

6.0 Power Supply Parameters

230V +/- 15%, 50Hz +/- 5% AC Voltage supply for CP unit input.

7.0 Abbreviations

3LPE	-	Three layer Poly Ethylene
AJB	-	Anode Junction Box
CJB	-	Cathode Junction Box
CPPSM	-	Cathodic protection power supply module
CTSU	-	Computerised Test Station Unit
CAT	-	Current Attenuation Test
DCVG	-	Direct Current Voltage Gradient
D/T	-	Despatch Terminal
ER Probe	-	Electrical Resistance Probe
ICCP	-	Impressed Current Cathodic Protection
IP	-	Intermediate Pigging
PCP	-	Permanent Cathodic Protection
PSP	-	Pipe to Soil Potential
R/T	-	Receiving Terminal
SV	-	Sectionalizing Valve
TCP	-	Temporary Cathodic Protection
TR Unit	-	Transformer Rectifier Unit
TLP	-	Test Location Point (Test Station)
QA/QC	-	Quality Assurance & Quality Control
XLPE	-	Cross Link Poly-Ethylene

8.0 ELIGIBILITY CRITERIA FOR CP CONTRACTOR AND CO-ORDINATION WITH OTHER CONTRACTORS

8.1 ELIGIBILITY CRITERIA-Refer BEC in Vol-I.

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 6 of 32 REVISION 0

- 8.2 CP contractor shall be entirely responsible for Co-ordination with other contractors & it should be ensured that the CP work should be executed simultaneously with laying of pipeline. Contractor shall mobilize necessary teams in each respective section as per the site organisation chart (Annexure-C) enclosed with this tender with the key responsibility, education qualification, designation, experience as defined and shall be responsible for the timely execution of CP work.

If the contractor fails to timely execution of the CP work, mobilization of teams as defined in tender and it founds delay in the pipeline laying due to of CP work & poor co-ordination with laying contractor necessary penalty clause shall be applied as per the direction of the Engineer-in-Charge.

9.0 SCOPE OF WORK (SUPPLY, INSTALLATION, TESTING & COMMISSIONING)

General

Contractor shall execute PCP work simultaneously in coordination with other contractor when Lowering, Electrical & Civil of the -pipeline is going on. Activities like- Cable to pipe connection, installation of ER probe, Polarisation cell, Polarisation coupon etc shall be coordinated with other contractors.

9.1 Permanent Cathodic Protection System

Survey, Design, Detailed Engineering, Manufacturing, Inspection/FAT (Factory acceptance test), Supply, packing, transportation to site, installation, testing and commissioning of the permanent cathodic protection system by impressed current method using MMO coated Titanium anodes to protect the external surface of 3LPE Coated pipeline against corrosion for a service life of 35 years, as per Standard Specification No. MEC/TS/05/21/016B for Permanent Cathodic Protection system. The detailed length of pipeline is as under-

Sl. No.	Section	Location Description	Pipeline Dia.	Length (KM) (Approx.)
1	N/A	Baghjan to Madhuban, Duliajan	30"	40

The scope shall include complete Permanent Cathodic Protection system, including carrying out the soil resistivity measurement for anode ground beds, design of anode ground beds considering size / rating of anode bed not less than the minimum requirements of the anode ground bed specified, AC/DC Interference detection and mitigation, AC/DC interference on pipeline and CP System due to proximity of foreign AC/DC source, detection and mitigation of high induced voltage at pipeline due to proximity of HT lines, substations etc, close interval potential logging survey for entire length of 30" dia pipelines and additional surveys i.e. CAT survey (Full length), CAT with frame 'A' /DCVG etc at selected locations which shall be decided from the abnormal areas of close interval potential logging survey results & CAT survey result to identify coating defects/holiday, conducting pipeline line current & coating resistance test at selected locations where current measurement test stations installed, preparation of commissioning report and as built drawings etc. All work shall be carried out conforming to the Scope of work, Design Basis, Data Sheets, standard specifications enclosed with this tender & other standards as applicable.

Scope shall also include disconnection of TCP system which does not form part of PCP system. Equipments coming under TCP system if useful & required in PCP system shall be used

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO.	Page 7 of 32
		MEC/23U1/05/E9/E/002	REVISION 0

effectively in designing of PCP system. If any inadequacy present in these equipments at the time of commissioning of PCP, in such case all work associated with supply, installation, testing and commissioning shall be in scope of CP contractor with no extra cost.

The Scope shall also include but not limited to the following for completion of jobs:-

- a) Selection of plot for shallow type anode groundbed/ Deepwell anode groundbed at CP station at following proposed locations of CP stations given below (Min. three plots nearby each location shall be selected for the survey out of which the most favorable plot shall be considered for installation of anode ground bed).

CP Stations Location:

- i- D/T at Bhghjan (Ch 00.00 km)-**CP#01**
ii- R/T at CGGS Madhuban (Ch 37.766 km)-**CP#02**

The above selected plot for the anode ground bed will be truly remote with respect to the proposed pipeline's & other nearby foreign structure/pipeline. For calculating the remoteness of the groundbed from cathodically protected pipeline and nearby foreign structure/pipeline location (NACE latest recommendation shall be utilized & remoteness from both cathodically protected pipeline & nearby foreign structure/pipeline shall be calculated). However the distance of anode bed from cathodically protected pipeline and other nearby foreign structure/pipeline shall not be less than 100 mtr.

- b) Carrying out the soil resistivity survey for design of anode ground bed at the selected CP station locations. (Min. at three locations shall be selected for the soil resistivity survey & necessary data shall be collected to determine the most suitable anodebed location).
- c) Preparation & submission of design document as per the results of surveys, specification & data sheet for procurement of CP System equipment/materials, drawing/document to the Engineer-in-charge for review & approval, preparation of site engineering & installation drawings for installation work wherever applicable or required by the Engineer-in-charge, and submit the same for approval and comments. All documents of PCP system including survey, Design, review of collected survey data, installation procedures, post commissioning surveys and complete PCP system of pipeline shall be designed & signed by NACE certified CP specialist having valid CP specialist certificate.
- d) Development of topo sheets which should be suitable for use in land acquisition for anode ground bed, Anode Junction box, ROW (RIGHT OF WAY) for laying at CP stations.
- e) Acquisition of land/ ROW (RIGHT OF WAY) of Land OR Lease (for 99 years or as per statutory regulation) for anode ground bed (Min 46mx3m for shallow and Min. 3mx3m, for deepwell type), Anode Junction box, ROW (RIGHT OF WAY) for laying of cables. Transferring the title of the acquired land OR Lease in favour of OIL at selected CP station locations.
- f) Design of shallow/deep-well anode beds for construction at selected locations as per national/ international standard & specification. The type of the anode bed i.e. shallow type or deep well type will depend upon the soil resistivity of the anode bed plot location. CP contractor will submit necessary data for the type of anode bed considered & shall be decided during detail engineering. Bidder shall take specific approval for Installation of Deep-Well anode groundbed from OIL/MECON.

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO.	Page 8 of 32
		MEC/23U1/05/E9/E/002	REVISION 0

- g) Design, Supply, installation, testing & commissioning of anode ground bed (Shallow bed size Min. 46x3 mtr or size may increase as per the design calculation), consisting of minimum ten (10) numbers Mixed Metal Oxide Coated Titanium Hollow Tubular Anodes of 25mm dia. / 1000mm long size and **8A Rating** along with tail cable of 1C x 10mm² Annealed Stranded Copper conductor, PVDF insulated, HMWPE sheathed/Jacket (Kynar Cable) shall be terminated at AJB at the CP station locations, with anode canister in normal resistivity area (0-100 Ohm-m). Actual numbers of anodes shall be finalized during the approval of design calculation submitted by the Contractor.

In high resistivity area (where resistivity ≥ 100) anodes shall be installed without canister & anode bed trench of cross-section 300mmx300mm for horizontal type of anode bed shall be backfill by Coke breeze (In slurry form) for its full length.

Anode Ground Bed resistance should be maintained less than 1 Ohms (Max.).

MMO anodes shall be as per ASTM B861 GR-I.

- h) Incase of deep-well anode bed, supply, installation, testing & commissioning of individual anodes in vertical installation, consisting of minimum ten (10) numbers of Mixed Metal Oxide Coated Titanium

Tubular Anodes of 25mm dia./ 1000mm long size and **8A Rating** with tail cable of 1C x 10mm² Annealed Stranded Copper conductor, PVDF insulated, HMWPE sheathed/Jacket (Kynar Cable) shall be terminated at AJB. Actual numbers of anodes shall be finalized during the approval of design calculation submitted by the Contractor. Design of deep anode-bed shall be as per NACE:0572:2007 requirements.

Anode Ground Bed resistance should be maintained less than 1 Ohms.

Minimum depth of anode bed shall be 48m (As per drawing) & it may increase as per the survey data. The bore hole shall be filled by coke breeze in slurry form.

- i) Anode bed backfill material bulk density and other requirements shall be as per NACE: 0572:2007.
- j) Disconnection of temporary cathodic protection system which does not form part of permanent cathodic protection system, prices for disconnection of temporary cathodic protection system is integral part of bid & deemed to be inclusive in prices quoted by the Bidder.
- k) Supply & Installation of Chainlink Fencing for Anodebed & AJB as per instruction of Engineer-In-Charge & approved drawings.
- l) Supply, laying, termination, glanding and ferruling of all the cables of CP system, including all incoming power cable and outgoing CP cables of CPTR/ CPPSM units.
- m) Minimum nos. of CP stations considered are mentioned in cl no. a), however actual numbers of CP stations shall be finalized during the approval of design documents submitted by the Contractor, but it won't less than the minimum mentioned. The nos. of CP stations may increase during the detailed engineering, Bidder shall supply, Install & commission the increased CP stations without any extra cost implication to protect the pipeline. PCP system shall be designed in such a manner that TR/CPPSM units comes at Intermediate SV/IP station locations. The proposed locations of CP stations may also change during the detail engineering.
- n) Supply, installation & commissioning of Min 3 Nos. permanent references cell (Cu-CuSo₄/Zn type) each at the proposed locations for CP stations locations. (Design criteria for Zn type ref electrode is

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK		Page 9 of 32 REVISION 0

given in design basis) The installation locations of reference cell shall be decided during detail engineering. Cu-CuSo₄ type ref cell shall be as per the tender drawing.

Bidder to note that at D/T, R/T, TOP/TOT, IP stations min 02 additional ref cells shall be installed at each pipeline terminating/originating from the stations & all measurement /Ref cable shall be terminated to the CP stations. CP unit shall have selector switches for required no. of inputs of ref available as per the nos. of ref cells of pipeline terminating/originating at station and provision to select the ref PSP of any of pipeline in CP unit. Separate local monitoring meter shall also be provided in CP units. Multi-core signal cable of suitable pair shall be considered for the measurement cable & reference cell cable. (For this bidder may consider 8/12 pair, Multi-core, FRLS, 1.5 Sqmm, 8/12 pair, twisted pair, armoured, signal cables as per IS/BS).

- o) Separate drainage connections are to be made with separate junction box (having provision to control the current) to each pipeline at IP station location feeding from the common CPPSM/CPTR unit.
- p) Supply including design, manufacturing, shop testing, inspection, packing, forwarding, delivery erection/ installation, civil/ structural support, earthing, testing & commissioning of Min. 48V/25A output rating AC operated automatic CP transformer rectifier unit at Dispatch terminal & Receipt Terminal confirming to standard specification No. MEC/TS/05/E9/082A, data sheet & drawing. The TR Units at dispatch/receiving terminal end shall be installed inside the control room. All the TR units shall have SCADA monitoring facility, current interruption facility with timer (GPS Synchronized) etc as per specification including commissioning spares as required.
- q) Supply including design, manufacturing, shop testing, inspection, packing, forwarding, delivery erection/ installation, civil/ structural support, earthing, testing & commissioning of Min. 48V/ 25A output rating DC operated (42-55V) automatic CPPSM unit each at intermediate locations as per design & detail engineering confirming to standard specification No. MEC/05/S/26/082, data sheet & Drawing. The CPPSM units shall be installed inside the control room. All the CPPSM units shall have SCADA monitoring facility, current interruption facility with timer (GPS Synchronized) etc as per specification including commissioning spares as required.
- r) Supply, installation, testing & commissioning of Computerized Test Stations (CTSU) @ 4 Nos. & portable data readers 1 no. along with permanent reference cell (Zn/Cu ref cell) and central Monitoring server with PC (Intel 2nd Generation Processor and 19" LED Monitor) at one maintenance base for automatically monitoring and recording the pipe to soil potential, pipe current etc of the pipeline. Locations of CTSU shall be decided during detailed engineering. Central monitoring server shall have facility to interface the CP unit signals available in SCADA system and the work related to interfacing the signals is in the scope of the bidder, including supply & installation of all items.

Note-All hardware & software required for the central Monitoring of the system shall be supplied.

- s) Bonding in between pipelines running parallel or crossing as required including taking of permission from the owner of the foreign pipeline wherever required for effective PCP protection and to reduce the anodic interference among them. Bonding with existing/new CP system of parallel pipelines hook-up methodology shall be designed by the NACE CP specialist after conducting all required field surveys including details study of existing PCP system & past PCP system problems of existing pipeline in common ROW (RIGHT OF WAY) and its mitigations.
- t) Carrying out Close interval potential logging (CPL) survey for the entire length of all the pipelines as

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO.	Page 10 of 32
		MEC/23U1/05/E9/E/002	REVISION 0

per the applicable NACE standard and approved procedures.

- u) In case, anode groundbed of foreign pipeline existing within the ROW of proposed pipeline & is source of interference to the proposed pipeline, the contractor shall relocate the anode ground bed in consultation with Owner of foreign pipeline without any extra cost.
- v) The contractor shall carry out interference detection and mitigation measures for all the pipelines including detection of AC and DC interference on pipeline's and its mitigation due to proximity of foreign AC and DC source i.e. HT line (Parallel, Crossing), Underground HT Cables in proximity, substation, railway traction, welding yard, existing pipeline running parallel or crosses & other foreign pipeline/structure/utilities. For the interference detection & mitigations (AC & DC interference study & mitigation) the contractor shall include the services of specialist agencies having proven track records & experience on software modelling & recommendation for its mitigation.

Pipeline AC Interference studies & Mitigations measures including measurement of AC pick-up due to long term (Induced, conducting due to transformer neutral, fault) & short term interference (Ground Fault, Lightning, conducting etc) as per field data collected, AC corrosion study, Effect of HT line/ Cables running parallel/crossing the pipeline and discharge of current from nearest HT tower/Substations due to fault or lightning etc. Implementations of interference mitigative measures on pipeline's bring down these voltages (touch & step potentials) to safe limits as per the National/International standards & other mitigation measures to reduce the AC corrosion densities. Mitigation measures suggested by the bidder shall be submitted for review and approval to Engineer-In-Charge.

As a part of AC interference detection, the following AC modelling shall be done by the contractor through an expert agency/contractor itself as approved by MECON/OIL:

- The software suggested for AC modelling shall be of SES's Right-of-Way Pro software or equivalent approved which can models complex arrangements of buried and aboveground conductors and computes currents and voltages resulting on every utility modelled, including conductors associated with the power line, for normal (load) and fault conditions.
- Software package for the analysis of electromagnetic interference between electric power lines and adjacent installations such as pipelines, communication lines and railways and able to model a large network including multiple power lines and pipelines in one model and have Large Conductor database to choose from including most transmission line conductors and mitigation devices like Zinc ribbon, Diodes, SSPC and copper wire Mitigator, etc. Copper wire Mitigator shall have Outer wrapping (Sealed, porous, non-degrading acid reducing fabric) and braiding with carbon backfill with copper corrosion inhibitors for long life. Dia and installation length of the mitigator shall be as derived by the software modelling.
- Software package have ability to model transformers, transmission system (AC/DC), sub stations, Faults Modelling etc.
- Provide results on Touch and coating stress output, GPR, CSV (Coating stress voltage) & AC corrosion output (AC corrosion densities) on whole modelled pipeline.
- Have Multi-layer Soil Resistivity Model.

The software shall be capable to:

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 11 of 32 REVISION 0

- Analyses electromagnetic interference effects, currents and voltages in every span of a multi-conductor, multi-phase power network and in any neighbouring victim circuits sharing the same corridor with pipeline.
- Capable of modelling a total interference scenario consisting of inductive, conductive and capacitive interference and generating outputs based on different current loading conditions in different seasons.
- Capable to calculate mitigating measures with sizing the SSD's (Solid State Decoupler devices), earthing devices & earthing system to reduce the AC interference.
- Able to generate outputs for true Touch Potential, and 1 cm² coating holiday current density output in amperes per square meter to analyse the effects of AC Corrosion on a pipeline.
- All required data of pipeline, soil resistivity; HT lines, sub-station and other interfering sources as suggested by interference specialist shall be collected CP contractor/Expert agency and reviewed by the NACE CP specialist.
- Mitigations of Interference as per the results of software modelling are in the scope of the Bidder.
- The agency proposed by CP contractor shall be subject to acceptance as per sole discretion of MECON / OIL.

Pipeline DC Interference studies & Mitigations measures shall also be carried out due to proximity of DC interference source. GPS coordinates of all HT tower locations, distribution transformers, Foreign Pipeline crossings & other interfering source shall be taken during field data collection.

For the interference detection & mitigations (AC & DC Interference study & Mitigation) the contractor shall include the services of specialist agency or will carry out the same on their own as per the BEC requirement as mentioned in the BEC clause of Vol-1.

The contractor shall handover interference free CP system to M/s OIL. If OIL/MECON desires, contractor have to take opinion from specialist other than the hired agency for the Detection/ Mitigation of interference, recommendations, if any is in the scope of the contractor.

- w) The contractor shall carry out post commissioning surveys including close interval potential logging survey for entire length of 30" pipeline & CAT survey (entire length of 30" pipeline), coating resistance/conductance test at current measurement test location, current drainage test at bonding locations, CAT with frame 'A' and DCVG survey (Both) at selected locations which shall be decided from the abnormal areas of CPL survey and CAT survey results to identify coating defects/holiday and implement mitigation measures for the same.
- x) The TR/CPPSM units shall be provided with facilities for sending and receiving digital and analogue input/output signals for remote SCADA monitoring.
- y) Supply and installation of the power supply cable from switch fuse unit/ MCC /PDB of OWNER'S Electrical substation to CPPSM/CPTR Units shall be CP Contractor's scope of work.
- z) Supply of Two Years O&M Spares as described in Appendix-II for one maintenance base.
- aa) Monitoring & maintenance (as a whole) of PCP System of entire length of 30" 3LPE Coated

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO.	Page 12 of 32
		MEC/23U1/05/E9/E/002	REVISION 0

pipelines for 3 months (Monthly Basis) including collection of data from data loggers after completion of all PCP works, post commissioning activities and Interference study & Mitigation.

- bb) Supply, Installation, Testing & commissioning of AC corrosion coupons (exposed area 1cm²) for monitoring of AC corrosion densities at HT line crossings and AC interference prone area along with high accuracy AC shunt (Additional 10% quantity of coupons shall be also be considered).
- cc) All civil/ structural & other miscellaneous works related to PCP system including supply of bricks, cement & steel etc. required for completion of the system.
- dd) Site Works – Bidder's scope also includes maintaining the store at site (for supplied material) during the extended period as required (payable if site is not ready even after 6 months of Contractual completion date of Supply, Installation, Testing & commissioning as per terms & condition of contract and as defined in the tender scope of work). The Contractual completion period of Supply, Installation, Testing & commissioning of PCP works shall be as per BEC.
- ee) Operation philosophy for combined CP System of existing pipeline in common ROW (RIGHT OF WAY) and 30", 16" (Gas Pipeline_02 nos.), 8" pipelines in common ROW (RIGHT OF WAY):

There are 16" (Gas pipeline), 8"(Crude oil pipeline) pipelines from Baghjan to Madhuban and 16" (Gas pipeline) pipeline from Loc. HNE, Makum to Madhuban in common ROW.

Common CP unit shall be considered for CP System of both the existing pipelines and new pipelines. New anode ground beds shall be installed at for protection of both existing & new pipelines.

CP Stations shall be operating with new ground beds & CP units and shall protect new & existing pipelines both. Positive header cable from the AJB of anode ground bed shall be terminated to the Positive terminal of common CPPSM/CPTR.

Similarly, Negative header cable from the CJB of the existing pipelines & new pipelines shall be connected to the common Negative terminal of CPPSM/CPTR at all the CP Stations, so that separate drainage connections are made to each pipeline from the common CPPSM/CPTR at each CP Station. A new junction box shall be installed at all locations for current drainage at existing & new CP station locations and have provision to control the CP current of both pipelines.

In addition to the separate drainage connections at each CP Station stated above, direct/resistance/diode bonding connections shall also be made between the two pipelines at the test stations along the pipeline route at an average interval 5Km and at additional locations where ever required to minimise interference between the two lines. (All required material for the bonding at every 5 KM shall be in the scope of the Bidder)

Out of the three permanent reference cell connections at CPPSM/CPTR from the new pipeline at each CP Station, one permanent reference cell connection shall be to the each existing pipeline, so that each common CPPSM/CPTR at each CP Station can get feedback from both the existing & new pipeline for control of CP System current. Operating current of each CP Stations shall be shared by anode ground beds according to their resistances and each pipeline according to their coating conductance. Due to such current sharing the PSP level of any one of the pipelines may become higher than the other. To minimize this PSP level difference between old pipelines, the max current limit settings and the target PSP settings at each CPPSM/CPTR

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO.	Page 13 of 32
		MEC/23U1/05/E9/E/002	REVISION 0

at each CP Station need to be adjusted in such a manner so that entire length of both the pipeline is adequately protected without overprotecting any one of the pipelines.

Note-

Note-1:-The distance between the anode bed & Pipeline shall be as per the remoteness calculation between pipeline & anodebed, successful CP contractor will submit the remoteness calculation of the anodebed based on actual site data collected.

Note-2:- It may be noted that the size of plot/land for anode-bed mentioned above may increased from the minimum specified (As per the design) Accordingly, the suitable size land for anodebed shall be acquired.

Note-3:- At saline soil Ag/Agcl Permanent Reference electrode shall be used.

Note-4:- Vendor list of Make of CP Materials is enclosed with the tender as appendix-I all CP material shall be as per the make mentioned in the vendor list.

Note-5:- The CP contractor/s shall handover interference free CP protected pipeline to the owner.

Note-6:- TR/CPPSM unit shall be designed and manufactured as per the design criteria mentioned for the Zn type permanent ref cell.

Note-7:- For chainages refer Pipeline Schematic Route Diagram

Note-8:- Permanent reference (Cu-CuSo₄) shall be as per the tender drawings attached.

Note-9 Current & Voltage rating of the CP unit may increase from the specified O/P rating as specified above as per the requirement of the parallel pipelines.

9.2 Tentative Bill of Material

Tentative bill of material of PCP system shall be prepared separately by the successful contractor for each section/part as per the approved design and the same shall be submitted with the detail engineering package for review.

9.3 Other Miscellaneous Works

- The job includes all civil works including supply of bricks, cements steel etc. connected with grouting of equipment to be installed. The job includes repairing of all civil works damaged during installation of electrical and other facilities.
- Preparation of buried cable trenches including excavation, back filling, compacting, providing of brick protection by second-class bricks, spreading of fine river sand, including all supplies.
- CP contractor shall provide Colour code identification for the various CP System cables used in the system with design document for approval.
- The job includes the engagement of the service of a specialist agency for doing interference survey & implementing mitigation measures against interference for CP System, if bidder doesn't possess experience for the same (Refer BEC clause mentioned in Vol-I).

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK		DOCUMENT NO. MEC/23U1/05/E9/E/002
			Page 14 of 32 REVISION 0

- v) The scope of work under this contract shall be inclusive of breaking of walls and floors, and chipping of concrete foundations necessary for the installation of equipment, materials, and making good of the same. Minor modifications wherever required to be done in the owner free supplied equipments or devices to enable cable entry, termination, etc.
- vi) Checking of all connections, i.e. power, control, earthing and testing and commissioning of all equipment erected and/or connected under this contract as per testing procedures and instructions of Engineer-in-Charge.
- vii) All electrical equipments are to be doubly earthed by connecting two earth wires from the frame of the equipment to be earth grid. The cable armours will be earthed thro' cable glands.

The following shall be earthed:

- All non-current carrying metallic parts of electrical equipments such as lighting and power panels, push button stations, cable trays etc.
- viii) Supply and installation of all other accessories not specifically mentioned herein but nevertheless necessary for completion of job.
- ix) Engineering and preparation of specifications, data sheets, procedures and drawings etc required for procurement & installation of CP System wherever applicable/required by Owner/ MECON and submit to Owner/ MECON for approval/comments.
- x) Correction and submission of all owners' drawings for as-built status.
- xi) Test certificates, catalogues, vendor drawings, installation, operation and maintenance manuals for all equipment/materials in contractor's scope of supply.
- xii) All civil work related to the CP work is in scope of the CP contractor.
- xiii) Co-ordination with other Contractors/Pipeline contractor.
- xiv) All works included in the scope of CP work will be done simultaneously with main pipeline construction by main pipeline Contractor. Bidder will supply all the materials required for completing the system and organize manpower & equipments accordingly to meet the requirement of Cathodic Protection work in time as per completion schedule specified elsewhere.

9.4 WORK CONTRACT

The entire work as per Scope of Work covered under this contract shall be treated as "Works Contract".

All works included in the scope of CP work will be done simultaneously with main pipeline construction by main pipeline Contractor. Bidder will supply all the materials required for completing the system and organise manpower & equipments accordingly to meet the requirement of Cathodic Protection work in time as per completion schedule given in Volume I of II.

9.5 SCOPE OF SUPPLY

9.5.1 Owner's Supply – NIL

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 15 of 32 REVISION 0

Supply, testing, Packing, Forwarding, Delivery, Installation and commissioning of all the equipment covered in this package are included in the scope of the contractor. No equipment will be free issued by the owner to the contractor.

9.5.2 Contractor's scope of supply shall be as mentioned in Cl. No. 9.1 & 9.3.

9.5.3 Bidder shall submit list of two year operational & maintenance spares along with offer.

O&M CP Spares/ Tool / Tackles for CP system like Multimeter, Clamp meter, Portable reference cell, UT meter, Tool box Complete for each maintenance base (5 nos.) etc.

List of O&M spares/tools & tackles is enclosed with Appendix-II.

All commissioning & start up spares are in bidder's scope (Included in this package). Any commissioning & start-up spare consumed during the start up & commissioning is included in the supply of this package, for which no extra payment is made.

1. Contractor to note that the exact cable routing shall be decided at site based on actual site conditions. Exact cable quantities/sizes shall be based on actual measured route lengths at site by Contractor in coordination with Engineer-in-Charge/Client. Contractor shall ensure that there is no surplus or shortage of cables at site and procure cables accordingly.

2. Contractor to note that all cabling (including supply & laying) & other electrics for the CP System shall be supplied along with the package and no separate payment shall be admissible for the same. Owner shall provide only single point power supply for the same.

3. Job is lump-sum basis, However the work to be carried out & material to be supplied for the project which is not covered under this contract the payment shall be done as per unit price.

10.0 STATUTORY APPROVAL OF WORKS

The submission of application on behalf of the Owner to Govt. Authority/ Central Electricity Authority/State authority/Private bodies, if required along with copies of required certificates complete in all respects, shall be done by the contractor well ahead of time so that the actual commissioning is not delayed for want of approval from respective authority. The actual inspection of work by the above mentioned authority inspector shall be arranged by the Contractor and necessary coordination and liaison work in this respect shall be the responsibility of the contractor. However any fee paid to these Authorities in this regard shall be reimbursed by the Owner on submission of bills with documentary evidence.

The Inspection and acceptance of the work as above shall not absolve the Contractor from any of responsibilities under this contract.

The necessary permissions required for the bonding etc for the interference mitigation (From SEB's, Water works Departments/ Boards, Railways & Other pipeline owners) shall be obtain before taking mitigation measures in the scope of contractor & the same will be hand over to OIL after commissioning of CP system. All such correspondence shall be submitted to M/s OIL.

11.0 QUALITY ASSURANCE, INSPECTION AND TESTING

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 16 of 32 REVISION 0

All the equipment supplied by the contractor shall be inspected by the Owner/MECON and/or their approved inspection agency (TPI) at the manufacturer's works prior to despatch. The equipment will be inspected as per the tests pre-identified in the approved QAP to ensure conformity of the same with relevant approved drawings, data sheets, specifications, National/International standards. The TPI shall be arranged by the CP contractor for the testing of the material/equipments at the vendor works.

- 11.1 Performance tests of any equipments which cannot be conducted/demonstrated either partially or wholly at the manufacturer's work, shall be conducted after erection at site in the presence of Owner & their inspection agency. In all the cases, prior approval of the inspection shall be obtained.
- 11.2 In case of waiver category of items, the same shall be pre identified. For such items, the contractor shall furnish necessary certificates, test reports etc for Review/Approval to Owner/Inspection agency. The issue of Inspection Certificate/Waiver Certificate for any equipment or component there of does absolve the contractor from his contractual obligations towards subsequent satisfactory performance of the equipment at site. Should any equipment be found defective, In whole or part thereof after receipt at site or during erection/commissioning and testing shall be Rectified/Changed by contractor free of cost.
- 11.3 Contractor shall submit test plan for the equipments with four week advance notice.
- 11.4 The following equipment/items shall be tested and inspected by MECON/ owner at manufacturer's works before dispatch. Test certificates duly signed by MECON/ Owner shall be issued by the contractor as part of the final document.
- CP TR/ CPPSM units
 - MMO anodes

12.0 TESTING & COMMISSIONING

- 12.1 The successful bidder shall submit detailed installation, site testing & commission procedure with time schedules for Review/Approval to Owner/MECON.
- 12.2 The successful tenderer shall provide adequate supervisory/ skilled personnel and all tools and tackles, testing equipment and instruments required for complete checking of installations and testing and commissioning of all equipment and accessories.
- 12.3 All the tests shall be conducted in the presence of Owner/ MECON/Engineer-in-charge or his authorized representative unless he waives this requirement in writing.
- 12.4 The testing and commissioning of all equipment under the scope of the bidder & shall be carried out in accordance with the latest edition of relevant Indian Standards, International Standard NACE standards and IE Rules.
- 12.5 Test reports shall be submitted in required number of copies duly signed by the **Bidder** to **MECON** and **OWNER**.
- 12.6 On successful completion of erection of each item /equipment, a final inspection will be carried out at site by **Owner / MECON**, for correctness and completeness of erection.

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 17 of 32 REVISION 0

12.7 After the completion of all tests and rectification of all defects pointed out during final inspection, start-up trials would be commenced. During the start-up trials contractor shall provide skilled / unskilled personnel and supervision round the clock at his cost. The number and category of workmen and duration up to which required, will be decided by the Engineer-in-charge. Any defects noticed during the start-up trial relating to the equipment supplied and work carried out by the Contractor, will be rectified by the contractor at his own cost.

12.8 Any work not conforming to the execution drawings, specifications or codes shall be rejected forthwith and the contractor shall carry out the rectification at his own cost.

12.9 After the operating conditions are fully achieved for CP system and the other requirements as stated in the General Conditions of Contract are fulfilled, the contractor would be eligible for applying for a completion certificate.

13.0 DRAWINGS, STANDARD SPECIFICATION AND INSTALLATION STANDARDS

13.1 The drawings accompanying the tender document are indicative of the nature of work and issued for tendering purposes only. Construction shall be as per drawings/specifications issued/ approved by the Owner/ MECON during the course of execution of work.

After the job completion, contractor shall prepare 'AS-BUILT' drawings, final certified as built drawings vendor drawings for bought out equipments shall be submitted by the contractor to owner in bound volume with one set of reproducible original sepia plus five sets of prints & one set to MECON.

The equipments/ materials to be supplied by the contractor shall conform to the requirements of the applicable standard specifications. Also the installation of various material/ equipment shall also conform to the standard specification.

The purpose of the pipeline alignment drawings, P&IDs & Plot Plan drawings enclosed with the tender is to enable the tenderer to make an offer in line with the requirements of the Owner. These are indicative of the nature of work and issued for tendering purposes only. The bidders, however, shall visit the site before bidding for proper information of site conditions. Construction shall be as per drawings/ specifications issued/ approved by the Owner/ Consultant during the course of execution of work.

A) SPECIFICATION

1. Specification for PCP system	MEC/TS/05/E9/016B
2. Specification for Corrosion Survey	MEC/TS/05/21/016C
3. Specification for Cathodic Protection TR Units	MEC/TS/05/E9/082A
4. Specification for Cathodic Protection CPPSM Units	MEC/TS/05/E9/082

B) DATA SHEETS & QAP

1. Data- sheet for Cathodic Protection TR Units	MEC/DS/05/E9/082A
2. Data- sheet for Cathodic Protection CPPSM Units	MEC/DS/05/E9/082
3. Quality Assurance Plan	MEC/05/E9/23U2/QAP/082

C) STANDARD DRAWINGS

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 18 of 32 REVISION 0

1.0	Prepacked Zinc Anode	MEC/SD/05/E9/E/CP/1601
2.0	Prepacked Mg Anode	MEC/SD/05/E9/E/CP/1602
3.0	Mg Ribbon anode for Grounding	MEC/SD/05/E9/E/CP/1603
4.0	Details of Test Station	MEC/SD/05/E9/E/CP/1604
5.0	Test Station Connection Schemes	MEC/SD/05/E9/E/CP/1605
6.0	Galvanic Anode Installation	MEC/SD/05/E9/E/CP/1606
7.0	Zinc Ribbon Anode for Cased Crossings with Coated Casings	MEC/SD/05/E9/E/CP/1607
8.0	Pipeline Grounding Through Polarisation Cell and Galvanic Anodes	MEC/SD/05/E9/E/CP/1608
9.0	Details of Zinc Grounding Cell	MEC/SD/05/E9/E/CP/1609
10.0	Permanent Copper – Copper Sulphate Reference Cell & Installation Details	MEC/SD/05/E9/E/CP/1610
11.0	Shallow Anode Ground Bed (PCP)	MEC/SD/05/E9/E/CP/1611
12.0	Anode Lead Junction Box	MEC/SD/05/E9/E/CP/1612
13.0	Casing Pipe Detail	MEC/SD/05/E9/E/CP/1613
14.0	Test station for polarization cell	MEC/SD/05/E9/E/CP/1614
15.0	Deep well anode bed	MEC/SD/05/E9/E/CP/1615
16.0	Connection scheme for hooking through CJB/TLP	MEC/SD/05/E9/E/CP/1616
17.0	Details of thermit weld for cable to pipe joint	MEC/SD/05/E9/E/CP/1618
18.0	Electrode for Earthing System	MEC/SD/05/26/23/01
19.0	Earth Electrode in Test Pit	MEC/SD/05/26/23/02

13.2 Drawings for Tender purpose enclosed with construction tender

Schematic Route Diagram
P&ID
Plot Plan

13.3 Survey Drawings/ Details

a) Overall Schematic Route Diagram

14.0 RESOURCES FACILITIES

14.1 Recruitment of Personnel by Contractor

The Contractor shall not recruit personnel of any category from among those who are already employed by the other agencies working at the sites but shall make maximum use of local

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK		Page 19 of 32 REVISION 0

labour available.

14.2 Construction Water and Power Supply

No water and power will be provided by the owner. It should be the responsibilities of the contractor to arrange water and power at his own cost.

14.3 Land for Residential Accommodation

Owner shall not provide any land for residential accommodation of contractor's staff and labour.

15.0 PROJECT SCHEDULING & MONITORING

The following schedules/documents/reports shall be prepared and submitted by the Bidder/Contractor for review/approval at various stages of the contract.

15.1 Along with Bid

a) Time Schedule

The Completion Time Schedule for the work (including mobilization period) as given in VOL-I of in all respect, from the date of issue of letter/Fax of Intent.

The Bidder is required to submit a Project Time Schedule in Bar Chart Form, along with the Bid. The Schedule shall cover all aspects like sub-ordering, manufacturing and delivery, indicated in the Bid Document. The Owner interface activities shall be clearly identified with their latest required dates. Owner reserves the right to disqualify the Bidder if the above Schedule submitted by the Bidder is not in line with the over all Project requirement.

b) Scheduling & Monitoring System

The Bidders should describe their system of Project Scheduling and monitoring, the extent of computerization, level of detailing, tracing methodology etc as required from Engineer-In charge.

15.2 After the Award of Contract

a) Overall Project Schedule

The Contractor shall submit within 2 week of Fax of Intent, a sufficiently detailed over all Project Schedule in the activity network form, clearly indicating the major milestones, interrelationship/ interdependence between various activities together with analysis of critical path and floats.

The network will be reviewed and approved by Engineer- in-Charge and the comments if any shall be incorporated in the network before issuing the same for implementation. The network thus finalised shall form part of the contract document and the same shall not be revised without the prior permission from Engineer-in- Charge during the entire period of contract.

b) Progress Measurement Methodology

The contractor is required to submit within 2 week of award of WORK, the methodology of progress measurement of sub-ordering, manufacturing/ delivery, sub- contracting construction and commissioning works and the basis of computation of overall services/physical progress informed.

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO.	Page 20 of 32
		MEC/23U1/05/E9/E/002	REVISION 0

Owner reserves the right to modify the methodology in part or in full.

c) Functional Schedules

The contractor should prepare detailed functional schedules in line with network for functional monitoring and control and submit scheduled progress covers for each function viz. ordering, delivery and construction.

15.3 **Project Review Meetings**

The Contractor shall present the programme and status at various review meetings as required.

Weekly Review Meeting

Level of Participation	:	Contractor's/Consultant's RCM/ Site Incharge & Job Engineers.
Agenda	:	a) Weekly programme v/s actual achieved in the past week & programme for next week. b) Remedial Actions and hold up analysis. c) Client query/ approval.
Venue	:	Site Office

Monthly Review Meeting

Level of	:	Senior Officers of OIL/MECON and Participating Contractors.
Agenda	:	a) Progress Status/ Statistics b) Completion Outlook c) Major hold ups/slippages d) Assistance required e) Critical issues f) Client query/ approval
Venue	:	OIL/MECON Office/ Site Office

15.4 **Progress Reporting Proforma**

A) Monthly Progress Report

This report shall be submitted on a monthly basis within 10 (ten) calendar days from cut-off date, as agreed upon covering overall scenarios of the work. The report shall include, but not limited to the following:

- Brief Introduction of the work.
- Activities executed/ achievements during the month.
- Schedule versus actual percentage progress and progress curves for Detail Engg. Sub-ordering, Manufacturing/ Delivery, Sub-contracting, Construction, Commissioning and Overall and quantum wise status & purchase orders against schedule.

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO.	Page 21 of 32
		MEC/23U1/05/E9/E/002	REVISION 0

- Area of concern/ problem/ hold-ups, impacts and action plans.
- Resources deployment status.
- Annexures giving status summary for drawings, MRs, deliveries, sub-contracting and construction.
- Procurement status for items to be supplied by Contractor.

B) Weekly Reports

The report will be prepared and submitted by the Contractor on weekly basis and will cover following items :

- Activities programmed and completed during the week.
- Resource deployed men and machines.
- Quantities achieved against target in construction
- Record of Mandays lost.
- Construction percentage progress schedule and actual.

C) Daily Repots

- Activity programme for the day
- Progress of the previous day and commutative progress.
- Manpower & machinery deployed.

Successful bidder shall submit DPR (Daily progress report) & Monthly Monitoring Report to the owner/MECON as per the format in Annexure-A & B.

15.5 Progress Reports

15.5.1 CONTRACTOR shall make every effort to keep the OWNER adequately informed as to the progress of the WORK throughout the CONTRACT period.

CONTRACTOR shall keep the OWNER informed well in advance of the construction schedule so as to permit the OWNER to arrange for requisite inspection to be carried out in such a manner as to minimize interference with progress of WORK. It is imperative that close coordination be maintained with the OWNER during all phases of WORK.

15.5.2 By the 10th (tenth) of each month, CONTRACTOR shall furnish the OWNER a detailed report covering the progress as of the last day of the previous month. These reports will indicate actual and scheduled percentage of completion of construction as well as general comments of interest or the progress of various phases of the WORK. The frequency of progress reporting by the CONTRACTOR shall be weekly.

15.5.3 Once a week, CONTRACTOR shall submit a summary of the WORK accomplished during the preceding week in form of percentage completion of the various phases of the WORK, to the OWNER.

15.5.4 Progress reports shall be supplied by CONTRACTOR with documents such as chart, networks, photographs, test certificate etc. Such progress reports shall be in the form and size as may be required by the OWNER and shall be submitted in at least 3 (three) copies.

15.5.5 Contractor shall prepare daily progress report (DPR) in the desired format and submit it to Engineer-in-charge alongwith schedule of next day to Engineer-in-charge.

ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	मेकन (ISO 9001 Company) MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO.	Page 22 of 32
		MEC/23U1/05/E9/E/002	REVISION 0

16.0 CONSTRUCTION

OWNER reserves the right to inspect all phases of CONTRACTOR's operations to ensure conformity to the SPECIFICATIONS. Owner will have Engineers, Inspectors or other duly authorised representatives, made known to the CONTRACTOR present during progress of the WORK and such representatives shall have free access to the WORK at all times. The presence or absence of a OWNER's representative does not relieve the CONTRACTOR of the responsibility for quality control in all phases of the WORK. In the event that any of the WORK being done by the CONTRACTOR or any SUB-CONTRACTOR is found by OWNER's representatives to be unsatisfactory or not in accordance with the DRAWINGS, procedures and SPECIFICATIONS, the CONTRACTOR shall, upon verbal notice of such, revise the work in a manner to conform to the relevant DRAWINGS, procedures and SPECIFICATIONS.

16.1 Rules & Regulations

CONTRACTOR shall observe in addition to Codes specified in respective specification, all National and Local Laws, Ordinances, Rules and Regulations and requirements pertaining to the WORK and shall be responsible for extra costs arising from violations of the same.

16.2 Procedures

Various procedures and method statements to be adopted by CONTRACTOR during the construction as required in the respective specifications shall be submitted to OWNER in due time for APPROVAL. No such construction activity shall commence unless approved by OWNER in writing.

16.3 Field Inspection

CONTRACTOR shall have at all times during the performance of the WORK, a Competent Superintendent on the premises. Any instruction given to such superintendent shall be construed as having been given to the CONTRACTOR.

16.4 Erection and Installation

The CONTRACTOR shall carry out required supervision and inspection as per quality Assurance plan and furnish all assistance required by the OWNER in carrying out inspection work during this phase. The OWNER will have engineers, inspectors or other authorised representatives present who are to have free access to the WORK at all times. If an Owner's representative notifies the Contractor's authorised representative not lower than a Foreman of any deficiency, or recommends action regarding compliance with the SPECIFICATIONS, the CONTRACTOR shall make every effort to carry out such instructions to complete the WORK conforming to the SPECIFICATIONS and approved DRAWINGS in the fullest degree consistent with best industry practice.

16.5 Construction Aids, Equipment, Tools & Tackles

CONTRACTOR shall be solely responsible for making available for executing the work, all requisite Construction Equipments, Special Aids, Cranes, Tools, Tackles and testing equipments and appliances. Such construction equipments etc. shall be subject to examination by owner and approval for the same being in first class operating condition. Any discrepancies pointed out by OWNER shall be immediately got rectified, repaired or the equipment replaced altogether, by

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO.	Page 23 of 32
		MEC/23U1/05/E9/E/002	REVISION 0

CONTRACTOR. OWNER shall not in any way be responsible for providing any such equipment, machinery, tools and tackles.

The OWNER reserves the right to rearrange such deployment depending upon the progress and priority of work in various sections.

Tie-end between main line and starting point of terminal is included in the scope of contract, as and when main line section is available for Tie-ins.

16.6 ORDER OF WORKS/PERMISSIONS/RIGHT OF ENTRY/CARE OF EXISTING SERVICES

The order in which the WORK shall be carried out shall be subject to the approval of the Engineer-in-charge and shall be so as to suit the detailed method of construction adopted by the CONTRACTOR, as well as the agreed joint programme. The WORK shall be carried out in a manner so as to enable the other contractors, if any, to work concurrently.

OWNER reserves right to fix up priorities which will be conveyed by Engineer-in-Charge and the CONTRACTOR shall plan and execute work accordingly.

Existing Service

Drains, pipes, cables, overhead wires and similar services encountered in course of the works shall be guarded from injury by the CONTRACTOR at his own cost, so that they may continue in full and uninterrupted use to the satisfaction of the Owners thereof, or otherwise occupy any part of the SITE in a manner likely to hinder the operation of such services.

Should any damage be done by the CONTRACTOR to any mains, pipes, cables or lines (whether above or below ground etc.), whether or not shown on the drawings the CONTRACTOR must make good or bear the cost of making good the same without delay to the satisfaction of the Engineer-in-Charge.

17.0 DOCUMENTATION

17.1 Drawings and design documents

17.1.1 The following documents shall be submitted along with the offer:

- Filled up data sheets & Check lists
- HSE Policy
- QAP
- Bar Charts & Project completion schedule
- Bidder's Compliance Report (Annexure-AA)
- Un-priced List of two years operation and maintenance spare

17.1.2 The following drawings (in three sets) & documents shall be submitted for approval within 3 weeks of award of contract.

- Various Procedures of CP system Installation Like- Soil survey (PCP), Thermit weld, Pin Brazing, Sacrificial anode (Zn/Mg/Ribbon) installations, Test stations & Junction Boxes installation, Cable laying, AGB installation, CP unit installation, Installation of polarization cell, CTSU, Earthing of above ground pipeline etc.
- PCP commissioning procedures along with formats for individual items (CP unit,

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 24 of 32 REVISION 0

- AGB etc) and commissioning of whole pipeline.
- c) Basis of system design and design calculations, equipment selection criteria and sizing calculations, formulae used
 - d) Detailed design calculations of PCP system (Complete Design Package).
 - e) Equipment layout, Cable layout & schedule.
 - f) Construction drawing for fencing of anode bed & AJB.
 - g) Colour code identification for the various CP System cables used in the system
 - h) Procedures for Various Post commissioning surveys (CPL, CAT, CAT Frame 'A' DCVG & coating conductance etc).
 - i) Procedure for AC & DC interference detection & mitigation.
 - j) Procedure for field testing, pre-commissioning & commissioning of PCP.
 - k) Procedure for Monitoring & maintenance of CP system.
 - l) Detailed design of Anode ground bed, typical lay out drawings for Anode bed connection & installation for CP system.
 - m) TLP's & junction boxes installation & erection details drawings.
 - n) Incorporation of Anode bed, Polarisation cell, surge arrester, TLP, Junction boxes & other relevant feature in CP system design in Alignment sheet, pipeline route diagram & Plot plan.
 - o) G.A. of TR/CPSPM unit.
 - p) Schematic
 - q) Tentative Bill of Material

17.1.3 After the job completion, contractor shall prepare AS-BUILT drawings/data sheets and documents, submit catalogues/manuals (O&M) of major brought out items. Final certified as built drawings, documents and manuals etc shall be submitted by the contractor to owner in bound volume with one set in soft copy (CD) plus five sets of prints to owner & one set to MECON..

Other drawings and documents shall be submitted by contractor along with AS-BUILT Drawings/Datasheets-

- a) Warranty certificates as per DLP (defect liability period).
- b) Original deed OR Lease agreement for acquired/leased land (In favour of M/s OIL) for Anode Bed, ROW (RIGHT OF WAY) for cable laying etc shall be handed over to M/s OIL.
- c) Test documents & drawings for bought out items.
- d) Detailed commissioning report of pipeline CP system (PCP).

18.0 MAKE OF MATERIAL/BOUGHT OUT ITEMS

An Appendix-I of approved vendors for various major items is enclosed with this tender specification. The bidder shall consider such names only as indicated in the aforesaid list and clearly indicate in the bid the name(s) as selected against these items. For any other item not covered in the list enclosed with this tender document, prior approval shall be obtained by the contractor for its make/ supplier's name.

19.0 INSPECTION OF SUPPLY ITEMS

All inspections and tests shall be made as required by the specifications forming part of this contract. Contractor shall advise Owner/ Consultant in writing at least 10 days in advance of the date of final inspection/tests. Manufactures inspection or testing certificates for equipment and materials supplied, may be considered for acceptance at the discretion of Owner/ Consultant. All

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 25 of 32 REVISION 0

costs towards testing etc. shall be borne by the contractor within their quoted rates. All inspection of various items shall be carried out based on Quality Assurance Plan, which will be submitted by the Contractor and duly approved by Owner/ Consultant.

20.0 ESCALATION

The Rates quoted shall be kept firm till completion of work and no price Escalation shall be paid.

21.0 DOCUMENTS TO BE SUBMITTED/ PRODUCED ALONGWITH R.A. BILLS

- Computerized R.A. Bill/ Manual Bill, with IT No./ ST No./ Labour License No. printed thereon.
- ESI/ EPF clearance certificates for the last month alongwith R.A. Bills.
- Insurance Policy as per relevant clauses of Contract Agreement.
- Attendance Register and Salary Records.
- Photocopy of the measurement book to be attached with R.A. Bills.
- Any other document required for the purpose of processing the bills.
- Registration Certificate with Sales tax authorities of state concerned.

-X-X-X-

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 26 of 32 REVISION 0

APPENDIX-I
Sheet 1 of 2

1.0 APPENDIX-I (LIST OF SUPPLIER/S OF MAJOR BOUGHT OUT ITEMS)

1) CABLES

- i) Brooks Cables
- ii) Nicco Corporation Ltd
- iii) CMI Ltd
- iv) Delton Cables Ltd
- v) KEI Industries
- vi) Torrent Cables
- vii) Universal cables
- viii) Victor Cables
- ix) Associated Flexible & Wires Pvt Ltd
- x) Asain Cables (RPG Cables)
- xi) Fort Gloster (Gloster Cables Ltd)
- xii) Finolex Cable
- xiii) Rediant Cables
- xiv) NETCO Cables Pvt Ltd
- xv) GemsCab
- xvi) Icon cables (For signal cable only)
- xvii) Suyog

2) JUNCTION BOX (FLP Type)

- i) Exprotecta, Beroda
- ii) Baliga
- iii) Flexpro
- iv) FFLP Control Gears
- v) Sterling
- vi) Sudhir

3) SACRIFICIAL ANODES

- i) M/s Scientific Metals Engineers Pvt. Ltd., Karaikudi
- ii) M/s Shakti Metal, Ahmedabad
- iii) M/s PSL Holding Pvt. Ltd., Mumbai
- iv) M/s BHEL, Bhopal
- v) M/s Nippon Corrosion, Japan
- vi) M/s AFIC, KSA
- vii) M/s Platt Bros. and Company, USA
- viii) M/s YUXI, CHINA
- ix) M/s Wilson Walton International
- x) M/s XIAN METAL, CHINA
- xi) M/s SHUNRUI, CHINA
- xii) M/s Impalloy International
- xiii) M/s Corrpro International
- xiv) M/s HOCKWAY, UK
- xv) M/s NAKABOHTEC, Japan

4) Portable Reference Cell : M/s MC Miller (USA) or Equivalent

5) Permanent Reference Cell : M/s Borin Manufacturer USA, M/s MC Miller USA, M/s Corrttech

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 27 of 32 REVISION 0

APPENDIX-I

Sheet 2 of 2

6)	AC operated Automatic Transformer Rectifier Unit/DC operated Automatic CPPSM Unit	:	M/s Canara Electric (M/s Raychem RPG Ltd), M/s Kriston systems
7)	Thermit Weld Pin Brazing	: :	M/s Erico, USA, M/s Cad Weld M/s Safe Track, M/s BAC UK
8)	Surge diverter(Ex-d)	:	M/s Dhen, M/s OBO, M/s Sohne, M/s Corrpro systems, USA
9)	Digital Multimeter	:	MOTWANE, Rishabh, Fluke or Equivalent
10)	CTSU	:	M/s Kriston systems or equivalent
11)	Solid state polarisation cell	:	M/s Dairyland, M/s Corrpro systems, USA
12)	Anode (MMO Type)	:	1) Titanor Component Ltd., Goa, India 2) Denora Permelic S.P.A (Italy) Oronzio De Nora S.A. Ingano, Switzerland 3) CER Anode Technologies International USA 4) ACTEL, UK 5) ELTECH System Corporation, Texas 6) MAGNETO-CHEMIE, Netherlands 7) M/S MATCOR (USA)
13)	Backup Agency for doing CIPL / interference survey	:	As per BEC.
14)	Anode Backfill Material	:	1) M/S Goa Carbon (Goa) 2) M/S India Carbon (Calcutta), 3) M/S Petrocarbon & Chemical Company (Haldia)
15)	Heat Shrink Cap For Anode To Cable Joint	:	M/s RAYCHEM, M/s MATCOR (USA)
16)	MCCB/MCB for Power Distribution Board	:	Siemens, Indo Asian, L&T, Hager, Merlin Gerin Schneider Electric, AEG, HAVELL'S, ABB, MDS
17)	ER- PROBE (External Corrosion Monitoring)	:	M/s Rose Corrosion Services UK, M/s Metal Samples, USA M/s Roharbak Cosasco, USA M/s Caproco, UK
18)	ER- PROBE & Corrosion Coupon Assembly	:	M/s Rose Corrosion Services UK, M/s Metal Samples, USA M/s Roharbak Cosasco, USA, M/s Caproco, UK

Note-For any other brought out item(s) for which the vendor list is not provided in the tender , bidders can supply those item(s) from vendors/ suppliers who have earlier supplied similar item(s) for the intended services in earlier Oil and Gas projects and the item(s) offered is in their regular manufacturing/ supply range.

- 1) The vendor / supplier should not be in the Holiday list of OIL/ MECON / other PSU
- 2) The bidder is not required to enclose documentary evidences (PO copies, Inspection Certificate etc.) along with their offer, however in case of successful bidder, these documents shall required to be submitted by them within 30 days from date of Placement of Order for approval to OIL/ MECON.

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 28 of 32 REVISION 0

Appendix-II
Sheet 1 of 1

2 Years Operational & Maintenance Spares for Permanent Cathodic protection system-(Lot)

Sl. No.	Description	Unit	Total Qty.
1	Multimeter- Fluke 87V Digital Multimeter	Nos.	1
2	Clamp Meter (AC&DC)-Fluke	Nos.	1
3	Portable Cu/CuSO4 Reference Cell –Mc-Miller/Tinkar Razor	Nos.	1
4	UT (Ultrasonic Thickness Tester) Meter –Olympus model 27MG or equivalent	Nos.	1
5	Tool Box-Taparia Make (Consisting of Screw Driver Set, Electrical screw driver set, Adjustable Spanner 12", Flat File 12", Round File 12", Plyer, Chiesel, Hexa Frame, Hexa Blade, Hammer, Nose Plyer, DE Spanner set 6-32, Ring spanner set 6-32", Allen key set etc.)	Set	1
6	02 Year O&M CP Spares for TR / CPPSM units		
6.1	TR/CPPSM Unit Spares		
a	Set of control Card Consisting of 1 No. each Type	Set	1
b	Set of meters consisting of 1 No. of each Type	Set	1
c	Set of fuse link consisting 1 No. of each Type	Set	1
d	Set of Indicator lamps consisting of one no. of each type	Set	1
e	Diode Module	Set	1
f	SCR Module	Set	1
g	Lighting Arrestor	Set	1
h	Set of Surge Suppressor consisting of one each type	Set	1
i	Filter Capacitor	Set	1
j	Set of Rotary Switches consisting of one no. of switch of each type	Set	1
k	Set of SCADA Modules consisting of one no. Module each type	Set	1

Note- Bidder shall note that above lot of spare shall be provided for one maintenance base.

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 29 of 32 REVISION 0

Annexure-A

Format for Daily Progress report

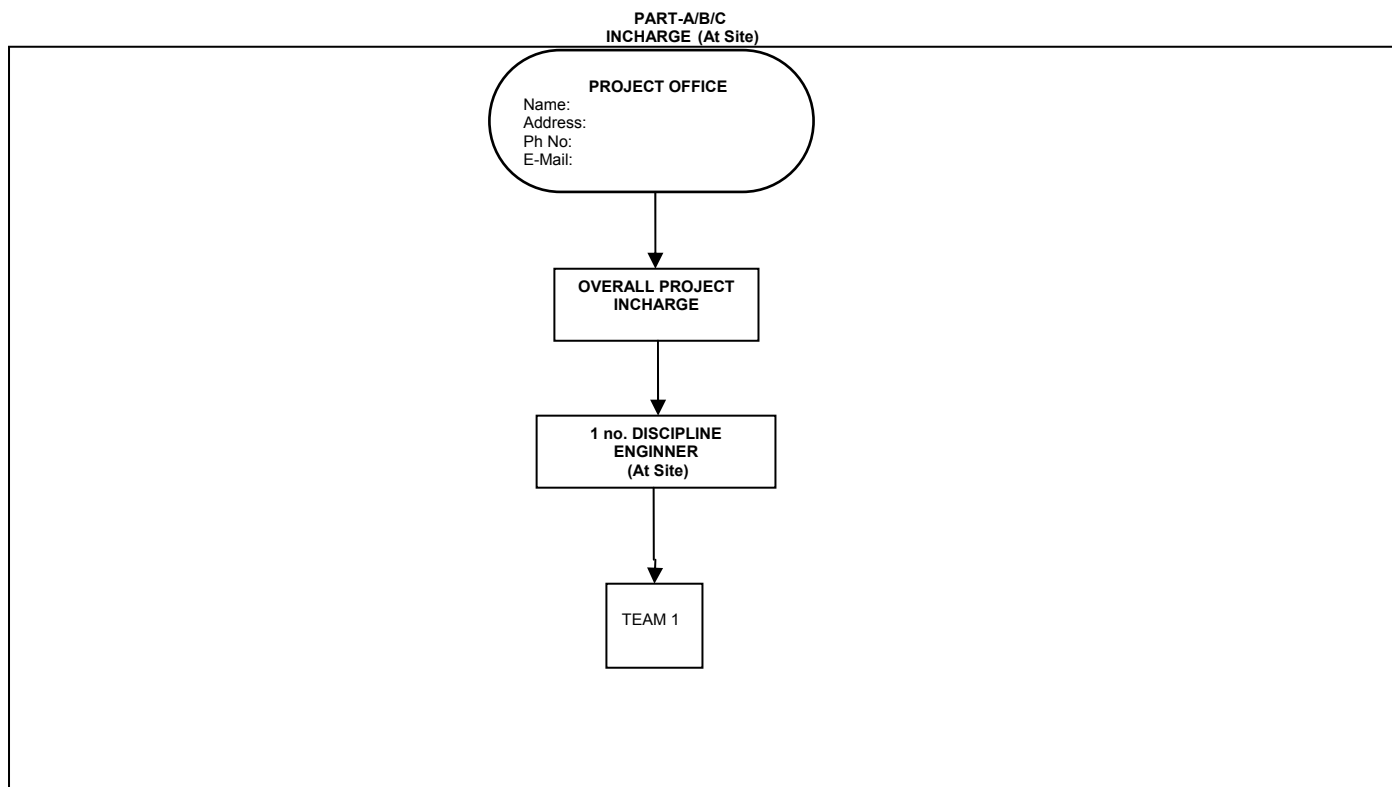
DAILY PROGRESS REPORT – PCP SYSTEM (Material Installation)							
CLIENT:				DPR NO.			
CONSULTANT:		MECON Limited		PROGRESS DATE:			
CONTRACTOR:				REPORT DATE:			
PROJECT:				PLACE:			
S.No.	ACTIVITY	UOM	SCOPE	PROGRESS (Spreads I, II.....)			Remarks
				PREVIOUS	TODAY	CUMULATIVE	
1	Soil Resistivity of Anodebed & Chemical Analysis	Nos.					
2	PCP Design Document	Nos.					
3	Registration of Land of Anodebed	Nos.					
4	Installation of TR Unit	Nos.					
5	Installation of CPPSM Unit	Nos.					
6	Installation of Shallow Anode bed	Nos.					
7	Installation of Deepwell Anode bed	Nos.					
8	Installation of Anode Junction Box	Nos.					
9	Installation of Cathode Junction Box	Nos.					
10	Installation of Permanent Ref cell for CJB	Nos.					
11	Installation of Permanent Ref cell for CTSU	Nos.					
12	Installation of Zinc Grounding anode	Nos.					
13	Installation of Polarization cell	Nos.					
14	Installation of CTSU Unit	Nos.					
15	Cable Laying - 1Cx06 Sq mm	Mtr					
16	Cable Laying - 1Cx25 Sq mm	Mtr					
17	Cable Laying -	Mtr					

[illegible]

 ऑयल इंडिया लिमिटेड (भारत सरकार का उपक्रम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 31 of 32 REVISION 0

Annexure-C

Organogram for the PCP work



Note-

1. Overall Project In charge should have B.E. in (Electrical, Chemical or Metallurgical Engineering) & at least 10 year Experience in the Cathodic Protection and shall be NACE certified level-II/III personnel & shall be available for entire time schedule of the project.
2. Spread Incharge should have B.E. or Diploma in (Electrical, Chemical or Metallurgical Engineering) & at least 5 year Experience in the Cathodic protection and shall be available for entire time schedule of the project.
3. CVs including Experience & Qualification shall be submitted by successful bidder.

 ऑयल इंडिया लिमिटेड (भारत सरकार का उद्यम) Oil India Limited (A Government of India Enterprise)	OIL & GAS SBU	Baghjan to CGGS Madhuban Pipeline Project	 MECON LTD, DELHI
TITLE	PERMANENT CATHODIC PROTECTION WORK	DOCUMENT NO. MEC/23U1/05/E9/E/002	Page 32 of 32 REVISION 0

Annexure-AA

Compliance to Technical Bid (CP System)

SI No.	Tender Clause No.	Description	Documents Required for Qualification (Technical Part of Bid)/ Bidder's Compliance/Bidder's Confirmation	Submitted in E-Bid (Bidder to Indicate Yes/No)	Reference In E-Bid Document (Bidder to indicate Place, Page No. /Vol No. In the Bid)
1	-	Technical Compliance to the complete scope of work	Bidder shall furnish "No Deviation Certificate". Deviation if any, due to change/amendment/revision in design code (vendor specific) shall not be considered at this stage and subjected to review/approval of Client/MECON. (For the acceptance of the deviation in the design code suitable justification is required during detail engineering).		
2	-	Confirm No Deviation in Technical Bid.	Confirm (Offer may be rejected if there is any deviation).		
3	Annexure	Confirm No Deviation.	Confirm (Offer may be rejected if there is any deviation).		
4	Installation, Commissioning & Start-Up spares	All the spares required for Installation, Commissioning & Start-Up of the CP system shall be included in the scope of the bidder, any spares required permanently for the Installation, Commissioning & Start-Up of the CP system the same shall be supplied free of cost.	Confirm.		
5	17.1.1	All the required documents are enclosed with the bid document as per the clause.	Confirm.		
6	Tentative BOQ/BOM	Tentative BOQ/BOM shall be prepared by bidder and shall be reviewed & approved by MECON during the detail engineering stage. As this is a Lump-Sump contract for any change in quantity mentioned in the scope of work the bidder's compensation for these changed quantities shall remain unchanged.	Confirm.		
7	Confirmation on Interference Detection (AC & DC) and Mitigation & cl no. 9.1 (c) (s) (v)	The qualification of the surveyor for these works should be Min NACE Level IV (CP Specialist).	Confirmation, submission of valid certificate & association/employment proof with the Bidder along with consent letter along with Bid.		
8	Interference Modelling Software licence	Bidder/Back up agency shall have valid license/key for Operating Interference Modelling Software.	Submission of relevant document along with Bid.		
9	CV & Qualification documents as per Organogram	Submission of relevant Documents along with Bid.	Submission of CV & relevant qualification document.		

-X-X-X-

Rev. : 2

Edition : 1

SPECIFICATION FOR CORROSION SURVEY

SPECIFICATION NO.: MEC/S/05/21/016C



**(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092**

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	CORROSION SURVEY	DOCUMENT NO. MEC/S/05/21/016C	Page 1 of 1
			REVISION : 2
			EDITION : 1

C O N T E N T S

SL. NO.	DESCRIPTION
1.0	SCOPE
2.0	CODES AND STANDARDS
3.0	GENERAL
4.0	SOIL RESISTIVITY SURVEY
5.0	TESTS ON SOIL SAMPLES
6.0	ADDITIONAL DATA COLLECTION
7.0	REPORT
8.0	INFORMATION REQUIRED WITH BID

PREPARED BY:	CHECKED BY:	APPROVED BY:	ISSUE DATE :
(Aashish Moyal/Saurabh Singh)	(Quasim Ahmad)	(DG Majuder)	ISSUE DATE : Nov. 2010
(Amit Lavania)	(Sunil Kumar)	(A.K. Johri)	ISSUE DATE : Feb. 2009

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	CORROSION SURVEY	DOCUMENT NO. MEC/S/05/21/016C	Page 1 of 4
			REVISION : 2
			EDITION : 1

1.0 **SCOPE**

The specification covers the corrosion survey including measurement of soil resistivity, chemical analysis of soil/ water and other cathodic protection related data collection along right of way of the pipelines.

2.0 **CODES AND STANDARDS**

Equipment and measurement techniques shall unless otherwise specified, conform to the requirement of following latest applicable standards:-

BIS Specifications

BS Specifications and Codes of Practice

NACE TM0106:2006 [Detection, Testing, and Evaluation of Microbiologically Influenced Corrosion (MIC) on External Surfaces of Buried Pipelines]

NACE standards

Pbody book on control of pipeline corrosion

3.0 **GENERAL**

This specification defines the basic guidelines for carrying out the corrosion survey. Contractor shall be responsible for providing necessary data interpretation based on corrosion survey measurement which is intended to form a basis for design of cathodic protection system for the pipeline to be buried along ROW.

4.0 **SOIL RESISTIVITY SURVEY**

- 4.1 Unless otherwise specified the soil resistivity measurements shall be carried out at intervals of approximately 500 mtr. along the ROW. Where soil resistivity is less than 100 ohm mtr and two successive readings differ by more than 2:1 then additional soil resistivity readings in between the two locations shall be taken.
- 4.2 To carryout the soil resistivity measurement Wenner's 4 pin method or approved equal shall be used. The depth of resistivity measurement shall be around the burial depth of the pipeline or 1.5 mtr & additional depth of 2.5 mtr (approx.) & 3.5 mtr (approx.) or more shall be taken for Temprrory CP design & shallow bed design for Permanent CP design. In general the resistivity of soil which shall be surrounding the pipe shall be measured. Hence the depth of measurement/ electrode spacings may vary depending on totography and strata at the area.
- 4.3 At locations where multi layer soil with large variation in resistivity/ corrosiveness is expected and/ or locations specifically advised by Owner or his representative resistivity measurements at additional depth

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	CORROSION SURVEY	DOCUMENT NO. MEC/S/05/21/016C	Page 2 of 4
			REVISION : 2
			EDITION : 1

- 4.4 For design of Permanent CP deep well anode ground beds two or more ground bed plots may be required to be selected for soil resistivity survey at proposed anode bed location. Depth of soil resistivity shall be as per type of anode ground bed.

For shallow type-1.5, 2.5 & 3.5 meter depth

For Deepwell anode bed-1, 3, 5, 7, 10, 15, 20, 25, 30, 35, 40, 45, 50...Meter as per depth of anode ground bed

- 4.5 Soil layer resistivity shall be calculated from soil survey results to enable to know the layer resistivity and to compensate the averaging effect of wenner's four pin method.
- 4.6 At places where Right-of-way has not yet been cleared, measurement shall be made right over the centre line of pipeline route surveyed accounting for the cuttings/ fillings also.
- 4.7 Observations shall be made enclosing the soils adjoining the trench wherever pipeline trenching has already been done.
- 4.8 The observations shall be made enclosing the soil immediately surrounding the pipeline route where right of way has been cleared but trenching has not been done.
- 4.9 All measurement shall be taken at right angles to the right of way unless otherwise asked by Owner or his representative at site.
- 4.10 At places in right of way where other pipelines are already existing care shall be taken to precisely locate such pipes line and take such precautions that observations are not adversely affected by presence of such pipelines.
- 4.11 Care shall also be taken that the observations are not influenced by presence of other earth currents in the area especially in the vicinity of HT lines and plants using earth return in their source of power etc.
- 4.12 Wherever possible/ advised by Owner or his representative depth of water table shall be determined by resistivity observations.
- 4.13 All measurements shall be made and recorded in metric units. While recording the data reference to the nearest point shall be made. To provide visual representation of variations in the resistivities along right of way, values shall be plotted on semilog graph sheets. The resistivity graph shall also indicate the resistivities at additional depths measured at various locations and depth of water table.

5.0 TESTS ON SOIL SAMPLES

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	CORROSION SURVEY	DOCUMENT NO. MEC/S/05/21/016C	Page 3 of 4
			REVISION : 2
			EDITION : 1

Soil/ water samples shall be collected along the right of way for analysis. Samples shall be collected on an average at one location per every 5 km along right of way with minimum at two locations. Exact locations shall be decided at site depending on the type of soil, soil resistivity and in consultation with Owner or his representative. The soil samples shall be collected at 1 mtr & 2 mtr depth at each location for Temporary CP system & for shallow type anodebed location for Permanent CP system.

The collected soil/ water samples shall be analysed to determine presence and percentage of corrosive compounds i.e. chloride, sulphate, including moisture content, oxygen activity, MIC, presence of bacteria and pH value at NABL accredited laboratories as per NACE TM 106:2006.

6.0 ADDITIONAL DATA COLLECTION

The following data shall be collected with a view to generate design data of evaluation of cathodic protection interaction possibilities due to presence of other services in right of way and its vicinity.

- 6.1 Route and types of foreign service/ pipelines in and around, running parallel or crossing the right of way.
- 6.2 Diameter, wall thickness, pressure, soil cover etc. of the foreign pipeline.
- 6.3 Foreign pipeline coating details.
- 6.4 Details of existing cathodic protection systems protecting the services including rating and location of grounds bed, test station locations and connections schemes etc. Where pipeline is likely to pass close to any existing ground bed, necessary anode-bed potential gradient survey shall be carried out.
- 6.5 Interference remedial measures existing on foreign pipelines/ services/ shall be collected from the owner of the foreign pipeline/ services.
- 6.6 Graphical representation of existing structure/ pipe to soil potential records, Transformer Rectifier Unit/ CP Power source voltage/ current readings.
- 6.7 Possibilities of integration / isolation of the proposed pipeline CP System with foreign pipeline / structure CP System, which may involve negotiation with Owner's of foreign services.
- 6.8 Crossings or parallel running of any H.T. AC/ DC overhead line with in approximately 25 mtr from ROW along with details of voltage rating, fault level etc.
- 6.9 Voltage rating, phases and sheathing details of parallel running or crossing of under ground cables with ROW.

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	CORROSION SURVEY	DOCUMENT NO.	Page 4 of 4
		MEC/S/05/21/016C	REVISION : 2
			EDITION : 1

- 6.10 Crossing and parallel running of electrified and non-electrified railway tracks along with details of operating voltage and type (AC/ DC) as well as abandoned tracks near ROW having electrical continuity with track in use.
- 6.11 Information on existing and proposed DC / AC power sources and system such as electric substations / earthing stations, fabrication yards with electric welding in the vicinity of the entire right of way.
- 6.12 Major river / canal crossings.
- 6.13 Major cased crossings.
- 6.14 Any other relevant information that may be needed in designing and implementing of proper cathodic protection scheme for the proposed pipeline.

7.0 REPORT

On completion of all the field and laboratory work, an interim report incorporating results generated from surveys, additional data collected, results of test carried out, etc. shall be submitted for comments/ approval. The final report incorporating comments/ missing data shall be furnished for records. The report alongwith various drawings, graphs etc. prepared in connection with the work shall be submitted alongwith six prints by the contractor.

8.0 INFORMATION REQUIRED AFTER AWARD OF CONTRACT

- 8.1 Instruments that will be used for carrying out soil resistivity survey.
- 8.2 Measures that will be taken to avoid foreign pipelines/ HT lines etc. affecting the soil resistivity observations.
- 8.3 Measurement location identification procedure.
- 8.4 Procedure for collection of soil samples.
- 8.5 Description of soil test procedure.
- 8.6 Specification of soil testing instruments.
- 8.7 Formats for presentation of results.

-X-X-X-

Rev. : 2

Edition : 1

SPECIFICATION FOR PERMANENT CATHODIC PROTECTION SYSTEM

SPECIFICATION NO.: MEC/TS/05/E9/016B



**(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092**

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 1 of 1
			REVISION : 2
			EDITION : 1

CONTENTS

<u>Sl. No.</u>	<u>Description</u>
1.0	SCOPE
2.0	CODES AND STANDARDS
3.0	SYSTEM IMPLEMENTATION
4.0	CORROSION SURVEY
5.0	CATHODIC PROTECTION DESIGN PARAMETERS
6.0	CATHODIC PROTECTION DESIGN CRITERIA
7.0	SYSTEM DETAILS
8.0	INSTALLATION
9.0	SHOP INSPECTION AND TESTING
10.0	PACKING AND TRANSPORT
11.0	FIELD TESTING AND COMMISSIONING
12.0	INTERFERENCE MITIGATION
13.0	CLOSE INTERVAL POTENTIAL SURVEY
14.0	DRAWINGS AND DOCUMENTS
15.0	INSTRUMENTS, TOOLS AND SPARES
16.0	INFORMATION REQUIRED WITH BID

PREPARED BY: (Aashish Moyal)	CHECKED BY: (Saurabh Singh)	APPROVED BY: (D.K. Pandey)	ISSUE DATE : March, 2009

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 1 of 1
			REVISION : 1
			EDITION : 1

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)
1	Revised & re-issued as standard specification	-	1	Mar-2009	AM	DKP
2	Cathodic Protection Design Parameters CI No.-6.1 (ii)	-	1	June-11	AM	SS
3	CI No. 6.15	-	1	June-11	AM	SS
4	6.7 & 8.3 (ii) (Anode Tail Cable)	-	-	Sept-12	AM	DGM
5	8.12 (CP Cables)	-	-	Sept-12	AM	DGM
6	Revised & Issued as Standard Specification	-	2	Oct-15	AM	MKJ

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 1 of 29
			REVISION : 2
			EDITION : 1

1.0 **SCOPE**

- 1.1 This specification defines the requirements of survey, design, engineering, supply of equipment/ materials, Quality assurance & Quality control (QA & QC), inspection at manufacturer works, installation, testing and commissioning of a permanent impressed current Cathodic Protection System for protection of external surface of underground cross-country pipelines for 35 year design life including supplementing of corrosion survey, close interval potential logging survey, investigations for interaction / interference problems (AC & DC) and mitigation of the same.

This specification provides the basic parameters to develop a suitable permanent impressed current cathodic protection (ICCP) system for the pipeline/ structures requiring protection. All data required in this context shall be taken into consideration to develop an acceptable design and for proper engineering of the system.

Compliance with these specifications and/or approval of any documents submitted by contractor shall in no case relieve the contractor of his contractual obligations of providing interference free PCP system for the pipeline for 35 year of design life or as mentioned in PJS.

- 1.2 Unless otherwise specified in job specifications for contracts involving survey, complete system design, supply of material / equipment, system installation and commissioning, integration of the permanent impressed current CP system with the temporary CP system (whether provided by a different contractor or included along with permanent CP system) shall be the responsibility of the permanent CP contractor whose scope shall include disconnection of sacrificial anodes wherever required.

This specification includes certain activities which are common with the temporary cathodic protection facilities. In cases where temporary and permanent cathodic protection works are being executed by the same agency, the common activities would be completed as part of temporary cathodic protection system. In cases where temporary and permanent cathodic protection works are being executed by different agencies, the contractual scope of work/ Particular Job specification shall be referred for further details.

2.0 **CODES AND STANDARDS**

- 2.1 The system design, performance and materials to be supplied shall, unless otherwise specified, conform to the requirements of the following latest relevant applicable specifications:

i)	NACE Standard SP-0169	:	Standard Recommended Practice Control of External Corrosion on Underground or Submerged Metallic Piping Systems.
ii)	NACE Publication 10A190	:	Measurement technique related to criteria for CP of Underground or Submerged Steel Piping System (as defined in NACE Standard RPO169-83).
ii)	NACE Standard SP-0177	:	Standard Recommended Practice Mitigation of

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 2 of 29
			REVISION : 2
			EDITION : 1

- Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control System.
- iv) NACE Standard SP-0286 : Standard Recommended Practice the electrical isolation of Cathodically Protected Pipelines.
 - v) NACE Publication No. 54276 : Cathodic Protection Monitoring for Buried Pipelines.
 - vi) NACE Standard SP-0572 : Standard Recommended Practice Design, Installation & Operation of Impressed Current Deep Ground beds.
 - vii) IS: 8062 : Recommended Practice ICCP for Underground Piping.
 - viii) BS 7361 Part I : Code of Practice for Cathodic Protection for land and marine application.
 - ix) VDE 0150 : Protection against Corrosion due to Stray Current from DC Installations.
 - x) IEEE Standards : Institute for Electrical and Electronic Engineers
 - xi) OISD Standards : Oil Industry Safety Directorate
 - xii) IEC Standards : International electro technical commission
 - xiii) PNGRB Guidelines : Petroleum & Natural Gas Regulatory Board
 - xiv) ASTM Standards : American Society for Testing and Materials
 - xv) PESO Norms : Petroleum and Explosive Safety Organisation
 - xvi) API Safety Norms : American Petroleum Institute
 - xvii) IS: 7098 Part I : XLPE Insulated Cables.
 - xi) IS: 1554 Part I : PVC Insulated (heavy duty) cables.
- 2.2 In case of imported equipments standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.
- 2.3 The equipment shall also confirm to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.
- 2.4 In case of any contradiction between various referred standards/ specifications/ data sheet and statutory regulations the following order of priority shall govern.
- Statutory regulations.
 - Data sheets.
 - Scope of Work/ Job specification.
 - Design Basis.
 - This specification.

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 3 of 29
			REVISION : 2
			EDITION : 1

- Codes and standards.

3.0 **ABBREVIATIONS**

TCP	-	Temporary Cathodic Protection
PCP	-	Permanent Cathodic Protection
PSP	-	Pipe to Soil Potential
ICCP	-	Impressed Current Cathodic Protection
CPPSM	-	Cathodic protection power supply module
TR Unit	-	Transformer Rectifier Unit
CTSU	-	Computerised Test Station Unit
TLP	-	Test Location Point (Test Station)
GTP	-	Guaranteed Technical Particulars
QA/QC	-	Quality Assurance & Quality Control

4.0 **SYSTEM IMPLIMENTATION**

All work to be performed and supplies to be effected as a part of contract shall require specific approval of owner or his authorised representative. Major activities requiring approval as per design basis but not limited to the following:

- a) Various installation procedures & Erection Methodology.
- b) Corrosion survey data interpretation report, formats and plot plans for land acquisition.
- c) Conceptual system design.
- d) Basic engineering package.
- e) Purchase requisition for major equipment, and vendor approval, if any.
- f) Specification/catalogue/data sheet of bought out items.
- g) Detailed engineering package.
- h) Detailed design of Anode ground bed, typical lay out drawings for Anode bed connection & installation.
- i) QA/QC Plan.
- j) Procedure for field testing, pre-commissioning & commissioning.
- k) Procedure for AC & DC interference detection & mitigation.
- l) Procedure for post commissioning surveys.
- m) Monitoring formats for PCP.
- n) CPL survey procedure.
- o) O&M Manuals.
- p) As built documentation.

5.0 **CORROSION SURVEY**

5.1 **General**

- 5.1.1 The details of corrosion survey including soil resistivity, collection of additional data along the right of way and other data required for CP design, if available with owner, shall be included as part of project specification. However, verification of its veracity and adequacy shall be the entire responsibility of the contractor. In addition contractor shall have to

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 4 of 29
			REVISION : 2
			EDITION : 1

generate / collect additional data as specified elsewhere required for completeness of the job.

- 5.1.2 Soil resistivity measurement shall be carried out by CP contractor at anode ground bed locations using Wenner's 4-pin method by calibrated instruments. Survey instruments shall have maximum AC and DC ground current rejection feature.

Care shall be taken to ensure that the resistivity observations are not influenced by the presence of foreign pipelines/ structures, and earth currents in the vicinity of EHV/HV lines and installations using earth return in their power system etc.

5.2 Soil resistivity survey at impressed current anode ground bed plot

- 5.2.1 Each selected anode bed plot shall be sub-divided into sub-plots. Sizes of sub-plots shall depend upon the expected depth for soil resistivity investigations. Each of these sub-plots shall be investigated for resistivity data individually. Sufficient observations shall be taken at each of these sub-plots as required and desired by Owner/ Owner's representative to obtain sufficient information about sub- soil stratification and, wherever possible, to establish the depth of water table/ basement. The number of subplots at each ground bed plot may vary from six to ten. The exact number of sub-plots etc shall be decided at site in consultation with OWNER/ OWNER's representative.

- 5.2.2 Number, location, demarcation and size of sub-plots and number of sets of resistivity observations required for each sub-plot shall be individually decided for each ground bed plot location.

- 5.2.3 Two or more ground bed plots may be required to be selected for soil resistivity survey at proposed anodebed location.

Depth of soil resistivity shall be as per type of anode ground bed.

For shallow type-1.5, 2.5 & 3.5 meter depth

For Deepwell anode bed-10, 15, 20, 25, 30, 35, 40, 45, 50...Meter as per depth of anode ground bed.

5.3 Topographic Surveys

Cathodic protection stations consisting of anode ground bed, CP power supply equipment etc. alongwith all associated cabling upto pipeline and any other related equipment and accessories for CP stations shall be demarcated on the ground. Ground plots so demarcated shall be surveyed for all other topographical and cadastral features and topo-sheets shall be developed by the CONTRACTOR which should be suitable for use in land acquisition etc.

5.4 Additional data to be collected

The following data shall be collected to generate design data for evaluation of interaction /

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 5 of 29
			REVISION : 2
			EDITION : 1

interference possibilities due to presence of other services in ROW/ vicinity. Client shall provide assistance for liaison work to the extent possible.

- i) Route and types of foreign services / pipeline in and around or crossing the right of way (including those existing and those which are likely to come up during contract execution).
- ii) Diameter, wall thickness, pressure, soil cover, and coating scheme used in case of pipelines.
- iii) Details of the existing cathodic protection system protecting the services i.e. location, type of protection, anode beds, test station locations and their connection scheme. Present output of current and voltage readings of CP power supply units.
- iv) Remedial measures existing on foreign pipeline/ services to prevent interaction.
- v) Graphical representation of existing structure/ pipe-to-soil potential records, T/R unit current / voltage readings.
- vi) Possibility of integration / isolation of CP systems which may involve negotiations with owners of other services.
- vii) Information on existing and proposed DC/AC power sources and system using earth return path in the vicinity of the entire pipeline route such as HVDC/ earthing stations/ substations, fabrication yards with electric welding etc.
- viii) Crossing and parallel running of electrified and non-electrified traction (alongwith information regarding operating voltage, AC/DC type etc.) as well as abandoned tracks near ROW having electrical continuity with the tracks in use and the track to soil potential measurement using Cu to CuSo₄ half cell after tracks in use.
- ix) Crossing or parallel running of any existing or proposed HT AC/DC overhead power lines along with details of voltage, AC/DC type etc.
- x) Voltage rating, phases, sheathing details of underground power cables along ROW or in its vicinity.
- xi) Any other relevant information that may be needed in designing and implementation proper protection scheme for the proposed pipeline.

Unless otherwise mentioned, contractor shall conduct necessary potential gradient surveys for any existing anode ground beds that may interfere with the CP system of the pipelines covered under this project.

5.5 Report

After completion of all field work, a report incorporating all the results generated from site surveys and details of additional data collected shall be furnished to the MECON/CLIENT for necessary approval. The report shall also contain detailed interpretation of survey results and resistivity data, probable interference prone areas etc to form a design basis for the PCP system. This report shall also include various drawings prepared in connection with the above work. The soil resistivity values shall be plotted on semi log graph sheets.

6.0 CATHODIC PROTECTION DESIGN PARAMETERS

6.1 Protection current density range :

- i) Pipeline with FBE Coating

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 6 of 29
			REVISION : 2
			EDITION : 1

Pipeline surrounding Resistivity	Minimum Protection current density* @30 deg C
	Temporary CP ($\mu\text{A}/\text{m}^2$)
Normal Soil (10-100 Ohm-Mtr)	150
Marshy Area/ HDD (<10 Ohm-Mtr)	250
High Resistivity Area (more than 100 ohm-mtr. Resistivity)	100

ii) Pipeline with Polyethylene Coating

Pipeline surrounding Resistivity	Minimum Protection current density* @30 deg C
	Temporary CP ($\mu\text{A}/\text{m}^2$)
Normal Soil (10-100 Ohm-Mtr)	25
Marshy Area/ HDD (<10 Ohm-Mtr)	50
High Resistivity Area (more than 100 ohm-mtr. Resistivity)	15

The pipe to soil "ON" potential must not exceed a value more negative than (-) 1.5V.

The pipe to soil "OFF" potential must not exceed a value more negative than (-) 1.2V.

(*) Actual current density to be adopted shall be decided based upon soil and other environmental conditions, proximity of foreign pipelines and structures affecting interference. Where considered necessary for satisfactory protection of pipeline the current density shall be suitably increased by contractor. Where operating temperatures of U/G pipeline is above 30 deg. C, such as CP Stations located near Compressor stations, protection Current Density shall be increased in minimum by 25% for every 10 °C rise in temperature over 30 °C up to a temperature of 60 deg.C.

In case of HDD crossing the protection current density shall be same as applicable for Marshy area.

6.2	Safety Factor	(S_F)	:	1.3
6.3	Protection Current Density to be considered for Pipeline without Coating in Soil	(I_2)	:	10 mA/m ²
6.4	Service Life	(S_L)	:	35 years

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 7 of 29
			REVISION : 2
			EDITION : 1

6.5	Type of Anode	:	MMO Coated Titanium Anode/ HiSiCr Fe Anode
6.6	Anode Consumption Rate		0.2 kg/Amp (Max) Year for HiSiCrFe anode 1.0 mg/ Amp (Max) Year for MMO Titanium anode
6.7	Type of Tail Cable	:	PVDF Insulated/ HMWPE Sheathed (Kynar)
6.8	Size of Tail Cable	:	10mm ²
6.9	Type of Anode bed	:	Shallow- Horizontal / Vertical or Deepwell
6.10	Shape of Anode for Shallow Bed System	:	Sheet Steel Canistered Anode pre-packaged with petroleum coke breeze
6.11	Shape of Anode for deep well anode bed	:	String Anode or Individual anode as per Scope of work/PJS
6.12	Current Density for Anode		10 Amp/m ² for HiSiCrFe Anode 100 Amp/m ² for MMO Titanium anode
6.13	Anode Utilisation Factor	(U _F)	: 0.8 for centrally connected HiSiCrFe anode / MMO Titanium Anode 0.6 for end connected HiSiCrFe anode 0.5 for ribbon anode
6.14	Total Circuit Resistance (Anode to ground resistance, anode & cathode cable resistance for CP System)	(R _C)	: 0.5 - 1.0 ohm (Max.)
6.15	Coating Resistance		: 15,000 ohm/m ² for normal soil 7,500 ohm/m ² for marshy area 20,000 ohm/m ² for high resistivity area
6.16	Steel resistivity		: 2.2 x 10 ⁻⁷ ohm-m
6.17	Cathode Polarisation at Drainage Point (Off Potential)		: (-) 1.20 V (max.)
6.18	Cathode Polarisation at farthest Point (Off Potential)		: (-) 0.95V (min)

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 8 of 29
			REVISION : 2
			EDITION : 1

6.19 Pipeline Natural Potential : (-) 0.45 V

7.0 **CATHODIC PROTECTION DESIGN CRITERIA**

Cathodic protection system shall be designed to meet the following criteria:

- a) The pipe to soil potential measurements shall be between (-) 850 mV (Off) & (-) 1180 mV (Off) polarized potentials with respect to a copper/ copper sulphate reference electrode.
- a) In rare circumstances a minimum polarisation shift of (-) 100 millivolts of cathodic polarization between the structure surface & a stable reference electrode shall indicate adequate levels of cathodic protection for the pipeline. The formation or decay of this polarisation can be measured to satisfy this criterion.

Discretion to use any of the criteria listed above shall solely rest with the owner/ owner's representative.

- b) A positive potential swing of 50 to 100 mill volts shall be considered as sufficient to indicate the presence of an interaction situation (i.e. Interference on the pipeline) requiring investigation and incorporation of mitigation measures by the CONTRACTOR.

8.0 **SYSTEM DETAILS**

The system shall include the following major equipment / sub-system unless otherwise specified in project specifications:

- CP stations
- TR units/ cathodic protection power supply modules (CPPSM).
- Anode ground beds and anodes.
- Anode lead junction box.
- Test stations.
- Permanent reference cells.
- Electrical resistance probes.
- Solid state polarisation cell/ surge diverter/ grounding cell.
- CP system at cased crossing.
- Polarisation coupons for external corrosion monitoring.
- Bonding Stations.
- CTSU (Computerised Test Station Unit)
- Cables & Cable markers.
- Cathode Junction Box.

The detailed specification of each system and equipment shall be furnished by the CONTRACTOR. However, certain minimum requirements for the major equipment are highlighted in this document.

All equipment shall be new and procured from approved reputed manufacturers. Equipment offered shall be field proven. Equipment requiring specialised maintenance or operation shall

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 9 of 29
			REVISION : 2
			EDITION : 1

be avoided as far as possible. Prototype equipment shall not be accepted. Make and construction of all materials shall be subject to owner's approval.

As far as possible, equipment including test stations, anode lead junction boxes etc. shall be located in safe non-hazardous areas. However, equipments to be installed in hazardous areas shall be of flameproof type confirming to IS:2148, IS:5572, IEC:79 & API 500C and suitable for gas groups IIA & IIB and temperature class – T3 (200°C).

All flame proof equipments/materials manufactured in India should be certified by CMRI or any other recognised testing body & BIS marked.

All imported equipments/materials for hazardous area shall be tested and certified by an independent agency of country of equipment/material origin and shall be approved by the concerned statutory authority in India.

8.1 Cathodic Protection Stations

The number and exact locations of CP stations shall be worked out based on the corrosion survey data collected. In addition, the following guidelines shall be followed for selecting the locations.

- Number of CP stations and their selected location shall ensure that these remain valid and are adequate for the full design life of the system after considering all foreseeable factors.
- As far as possible, the availability of near by low resistivity areas for location of associated ground beds must be ensured while selecting the locations of CP stations.
- As far as possible, locations of intermediate CP stations shall coincide with the locations of SV stations.

The proposed locations of CP stations are detailed in project specifications (PJS). The same shall be verified for adequacy by the contractor and any additional requirements shall be clearly brought out at the bidding stage itself.

8.2 Transformer Rectifier Unit/ CPPSM

- Cathodic protection transformer rectifier unit (T/R Unit) working on controlled rectification principle shall supply power for cathodic protection system. The T/R unit shall be provided at CP stations where reliable AC power supply is available and specified in project Specification.

The T/R unit shall be field proven. The design, internal component quality, ratings and layout of components shall ensure high MTBF and low MTTR.

The T/R unit shall conform to MECON's specification no MEC/TS/05/E9/082A and T/R unit data sheet.

- Cathodic Protection Power supply Module (CPPSM) for supply of power to Cathodic

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 10 of 29
			REVISION : 2
			EDITION : 1

Protection System shall work on DC input power supply & control the output DC supply using power switch mode principle. The CPPSM unit shall be provided at CP stations where reliable DC power supply is available and specified in project Specification.

The CPPSM shall be field proven. The design, internal components, quality, rating & layout of components shall ensure high MTBF & low MTTR.

The CPPSM shall conform to MECON Standard Specification No. MEC/TS/05/E9/082 and CPPSM Data Sheet.

8.3 Anode Ground Beds and Anodes

- i) Each CP station shall have an independent anode ground bed which may be of shallow or deep well construction depending upon the corrosion data collected by the contractor. Deep well ground beds may also be used in the congested locations where availability of suitable land for spread out ground beds is restricted.
- ii) Ground bed shall be located electrically remote from the pipeline. Nearest part of the anode bed shall at least be 100 metres away from the pipeline and foreign pipelines/ structures. The anodes installed in the ground shall be located in perennially moist strata, wherever possible. Horizontal ground beds shall be at right angles to the pipeline, as far as possible.

The location of ground bed shall be checked and ensured for remoteness from the pipeline and other buried foreign pipelines/ structures, building foundations, switchyards, electrical earthing systems etc.

All MMO Anodes to be placed in Petroleum cock breeze in Shallow-Horizontal/Vertical or Deepwell configuration as per design for 35 year of protective life.

- iii) Anodes shall be of MMO coated titanium anode or HiSiCrFe anode alongwith tail cable (Factory jointed) of sufficient length for termination upto the junction box without any joint.
MMO coated titanium anodes

MMO coated titanium anodes shall conform to ASTM A518M-86, Gr-III & composition shall be as below:-

MMO coated titanium anodes shall be of pure Ti substrate. The MMO anodes shall be centre connected sealed tubular type & dimensionally stable.

MMO Anode Dimension	-	As per manufacturer's detailed drawings
Weight of Anode	-	Recommended by manufacturer w.r.t. dimension
Max. Recommended Current density	-	100 A/m ²
Service Life	-	35 years

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 11 of 29
			REVISION : 2
			EDITION : 1

Anode Cable	-	Single MMO Anode–PVDF Insulated/ HMWPE Sheathed (Kynar Cable) String MMO Anode – EPR/CSPE
Cable Length	-	As required
Utilisation Factor	-	0.8 for centre connected 0.9 for end connected

The GTP (Guaranteed Technical Particulars) of MMO anodes i.e. Current density, consumption rate (max. specified), rated current output, shape, dimension, physical & mechanical property, thickness of coating of noble meta shall be as per manufacturer's specification/data sheet & CONTRACTOR shall submit routine & type test report for the anodes.

High Silicon Chromium Cast Iron Anode

Anode shall conform to ASTM A518M-86, Gr-III & composition shall be as below:-

Silicon	:	14.2 – 14.75%
Manganese	:	1.5% max.
Carbon	:	0.7 – 1.1%
Chromium	:	3.25 – 5.0%
Copper	:	0.5% max.
Molybdenum	:	0.2% max.
Iron	:	Reminder
Utilisation Factor	-	0.8 for centre connected 0.6 for end connected

- iv) The anode shall be hollow type centrally connected or solid type end connected, cable to anode joint shall be reliable and adequate for design life of anode.
- v) Sheet steel anode canisters of adequate size shall be provided for each anode of shallow bed type. Anode canisters shall be filled with petroleum coke breeze with a chemical composition as given below:-
 - Fixed carbon content by mass : 99% min.
 - Ash by mass : 0.5% max.
 - Moisture by mass : 0.1% max.
 - Volatile matters by mass : 0.5% max.
- vi) String anode/ Individual anode shall be used for deepwell ground bed. In case of deep well ground beds calcined fluid petroleum coke breeze with chemical composition as given below shall be provided in the well surrounding the anodes.
 - Fixed carbon content by mass : 99% min.
 - Ash by mass : 0.5% max.

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 12 of 29
			REVISION : 2
			EDITION : 1

- Moisture by mass : 0.1% max.
- Volatile matters by mass : 0.5% max.

- vii) Each shallow anode bed shall contain anodes with canisters positioned horizontal or vertical in the soil with suitable backfill at minimum depth of 2 meter with respect to horizontal or vertical configuration.
- viii) Layout of anode installation in anode bed shall be detailed out in drawings showing anode installation details, anode grouping, anode wiring, anode cable routing etc.
- ix) The deepwell anode ground bed details shall include the details of anodes, deepwell casing, anode positioning, anode cable supporting, deepwell gas venting, active, passive portions of ground bed etc.
- x) Anodes shall be supplied complete with tail cables which shall be long enough for termination on their associated junction boxes without intermediate joints. Exact lengths and termination details shall be indicated in construction drawings by Contractor.
- xi) Anode bed separation from pipeline shall be tested for interference.
- xii) Potential gradient around the anode bed shall be within safety requirements and its effective boundary shall be defined and secured.
- xiii) In case two parallel pipelines running in the same ROW. The anode ground beds of respective pipelines shall be located on the respective sides of the pipelines.
- xiv) The depth of deepwell anode ground bed shall be sufficient enough to reduce anode influence on incidental structures within proposed location.

8.4 Anode Junction Box

- i) Depending on the size and configuration of anode ground beds, one or more anode junction boxes shall be provided at each ground bed.
All cable tails from individual anodes shall be terminated to these anode junction boxes which shall be further connected to anode cable coming from CP station power source.
- ii) Junction boxes shall have sheet steel enclosure of minimum 3 mm thickness and hinged lockable shutters. They shall be weatherproof with degree of protection IP-55. Junction boxes shall have Tinned plated Cu anode bus and terminal plate with adequate number of anti-loosening type of identified terminals. Provision shall be made for measurement and control of individual anode current by providing suitable shunt and resistors. Anode disconnecting link shall be provided for each anode circuit. 30% spare terminals shall be provided in each junction box. Anode junction boxes shall be epoxy coated (Both inside & outside surface).
Anodised Al name plate shall be provided inside the AJB with black background with white letters with following information-

- a) AJB number & location

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 13 of 29
			REVISION : 2
			EDITION : 1

- b) Current rating of ground bed
- c) Ground-bed resistance during commissioning
- d) Ground-bed resistance___ Ω with Date_____ (Editable)
- e) Connection scheme
- f) Distance from pipeline
- g) Distance from CP station

- iii) In case of sectionalized ground beds, an additional common anode disconnecting link for each section of ground bed shall be provided for disconnection of any section of ground bed.

8.5 Cathode Junction Box

One cathode junction box shall be provided at each CP Station for Permanent Pipe to soil potential measurement circuit & cathode connection. Junction boxes shall have sheet steel enclosure of minimum 3 mm thickness and hinged lockable shutters & Allen key locks. They shall be weatherproof with degree of protection IP-55. Junction boxes shall have cathode bus and terminal plate with adequate number of anti-loosening type of identified terminals. Cathode junction boxes shall be epoxy coated (Both inside & outside surface).

The negative of the CP power supply source shall be connected to the incoming circuit of the cathode junction box. The junction box shall have separate out going circuit one for each pipeline to collect the negative drainage currents from each of the parallel pipelines.

The incoming circuit shall have a current measurement facility. Each out going circuits shall have provision for measurement and control of current.

Anodised Al name plate shall be provided inside the CJB with black background with white letters with information same as test station (TLP) CI. No. 7.6.(vi) except test station no.

AJB & CJB shall be full welded, joint welded AJB & CJB shall not be acceptable.

8.6 Test Stations

Test stations shall be provided along the pipeline ROW for monitoring the performance of the cathodic protection system at intervals not exceeding 1000 meters. The type of test stations (A,B,C,D,E,F,H or combination of any) shall be as per site requirement/terrain. In addition to above, test stations shall also be provided at the following locations:-

- a) At both sides of metallised road crossings.
- b) At all insulating joints.
- c) At vulnerable locations with drastic changes in soil resistivity.
- d) At locations of grounding cells, surge diverters and polarisation cells.
- e) At EHT/HT AC/DC overhead line crossings selected locations where EHT/HT overhead is in the vicinity of the pipeline.
- f) At both sides of railway line crossings and running parallel to the pipeline.
- g) At both sides of major river crossings.
- h) At high voltage cable crossing or along routes where HV cables are running in parallel.

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 14 of 29
			REVISION : 2
			EDITION : 1

- i) In the vicinity of DC network or grounding systems where interference problems are suspected.
 - j) At crossings of other pipelines/ structures.
 - k) At the locations of reference cell, Polarisation coupons Installation and ER probe installation.
 - l) At both sides of cased crossings.
 - m) Locations where interference is expected.
 - n) At location of CTSU.
 - o) At location of sectionalizing valve (SV) & Intermediate Pigging (IP) stations.
 - p) At any other locations considered necessary by OWNER/ OWNER'S representative.
- i) Installation of TCP system may be in the scope of pipeline laying contractor (not in the scope of PCP contractor), TLP installed during TCP shall be utilized if there is no inadequacy. New TLP is required to be install during PCP, if TLP installed during TCP damaged or inadequate or existing TLP is not located at the designed location during PCP.
- ii) All test stations shall be provided with shunt & resistors.
- iii) Bond stations shall be provided at required locations with shunt and resistor as a means to monitor and control current flow between the pipeline and foreign pipelines / structures / electrified railway tracks etc that crosses and runs parallel to the pipeline in common ROW or within 25 metre from the pipeline.
- iv) Test stations with current measuring facility shall be provided at interval not exceeding 10.00 KM, at each intermediate CP station drainage point (to measure pipeline current on any one side of pipeline from drainage point), at interference prone areas, on both sides of major river crossings, marshy areas and at least at two additional locations along the pipeline ROW between two CP stations.
- v) All test stations shall have weatherproof enclosure, with hinged lockable shutter with two Allen key locks and degree of protection IP-55 with epoxy coating (Inside & out side surface). Enclosure shall be made of sheet steel of atleast 3 mm thickness and shall be suitable for MS post mounting. The test station shall be suitable for design life of CP system.
- vi) Test station shall be installed with the face of the test station facing the pipeline. The nameplate of test stations shall carry the following minimum information:
- Test station number
 - Chainage in Km.
 - Test station connection scheme
 - Distance from pipeline in mtrs.
 - Direction of product flow.
- vii) Number of terminals and different schemes of wiring shall be as per the test station connection scheme sketch. Minimum twenty percent (20%) spare terminals shall be provided in each test station.
- viii) Test station for EHT/HT line crossing shall be installed approx. 100-500 m away from the

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 15 of 29
			REVISION : 2
			EDITION : 1

EHT/HT line.

- ix) The location of all the test station shall be marked with their connection scheme and other relevant information on alignment sheets. A detailed test- station schedules shall be prepared.

8.7 Permanent Reference Cells

- i) High purity copper / copper sulphate reference cells with proven high reliability shall be provided for stable pipe to soil potential measurement reference at CP stations and at computerized test station locations along ROW.
- ii) Three numbers reference electrodes shall be installed at each cathodic protection station location.
- iii) The reference cell for high resistivity areas shall be suitable for the prevailing dry soil conditions to give maximum service life.
- iv) Permanent reference cells shall be installed with backfill material.
- v) Silver/ Silver Chloride reference cells in place of copper / copper sulphate cells shall be provided at marshy area locations where water table is high and sub-soil water or soil shows chlorine concentration more than 300 PPM.
- vi) The cable from reference cells shall be provided upto CP power source at CP stations. The cable shall be routed through cathode junction box near pipeline.
- vii) The life of reference cell shall be minimum 10 years under installed condition.

8.8 Electrical Resistance Probe/Coupons

ER Probes-

Where specified in project specifications (PJS)/Data sheet, electrical resistance probes utilising the electrical resistance technique shall be provided along the pipeline at marshy areas and at vulnerable locations to monitor the external corrosion activity on the pipeline. The lead wires of the probe shall be connected to pipeline and terminated inside test station enabling periodic resistance measurement with the probe using a portable measuring instrument.

The material of the E/R probe element shall be of the same alloy as of the pipeline material.

The E/R probes shall be provided preferably at the bottom portion of pipeline. The locations of E/R probes shall be got approved.

Portable E/R probe reading instrument shall be supplied by contractor.

For Internal corrosion monitoring ER probes & Coupons shall be provided if specified in

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 16 of 29
			REVISION : 2
			EDITION : 1

PJS/Data sheet as per specification of CMS (Corrosion monitoring system).

Polarisation Coupons-

Where specified in project specifications (PJS)/ Datasheet polarisation coupons of pipeline material shall be provided along the pipeline to monitor the CP system performance. Coupons shall be installed at CP station, at marshy areas, at vulnerable locations, at foreign pipeline crossings, Interference prone areas & location deemed necessary by Owner/Owner's representative.

The location & the number of coupons to be provided along the pipeline get approved from owner.

Coupons shall be installed at the bottom of the pipeline. The coupons shall be same as the pipeline material & having 100mmx100mm uncoated exposed area to the soil. Two cables one connection for pipeline & other for potential measurement shall be provided with each coupon. Reed-Switch shall be connected to the protection cable to measure the coupon "OFF" potential.

A permanent reference shall be provided at the location of Coupon to enable the measurement of PSP.

8.9 Polarisation Cell and Surge Diverter / Grounding Cell

- ii) Where high voltage/ Extra High Voltage (66 KV and above) transmission line runs in parallel or crosses the pipeline, the pipeline shall be grounded through polarisation cells & zinc anodes of minimum 20 kg net each. Alternatively, grounding could be done directly with zinc galvanic anodes of minimum 20 kg net each at the discretion of owner. Grounding shall be done at regular intervals of maximum 1.0 km where EHV/HV transmission lines run parallel within 25 meter of the pipeline to ground any surges on the pipeline that would appear in case of transmission line faults. Type of polarisation cell (Electrolyte/Solid state) shall be as per job specification/Data sheet/Scope of work.
- iii) In case of continuous induction of voltage on the pipeline beyond safe limits is expected or observed during commissioning due to HV Line of any rating/Underground Cables or others equipment, the pipeline shall be grounded to the earth system of nearest HV transmission tower of the transmission line causing the voltage induction through polarisation cell or the pipeline shall be grounded to a separate earthing system of zinc galvanic anodes through polarisation cell. Alternatively, the pipeline shall be directly grounded with zinc galvanic anodes/Grounding cells of minimum 20 kg net each at the discretion of the owner. The polarisation cell shall be installed in test station.
- iv) Spark gap arrestor shall be connected across each insulating joint to protect it from high voltage surges at the location of terminals/end of the pipeline etc.

Alternatively, zinc grounding cell may be provided across insulating joints along ROW where the pipeline on both the sides of the insulating joint are cathodically protected and difference of protection voltage is not more than 0.4 volts.

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 17 of 29
			REVISION : 2
			EDITION : 1

- v) The total system including cables, cable termination, anodes/ surge divertors shall be suitable for the anticipated fault current at the location of installation.
- vi) Unless otherwise specified on data sheet, the minimum rating of grounding cells, polarisation cells and surge diverters shall be as below:
- a) Grounding Cell
- Type : Zinc, 2 or 4 plate type.
 - Current rating : Suitable to pass more than 10KA surge
- b) Polarisation cell
- Type : 5 kA Solid state/ 5kA Electrolyte type (As specified in Job specification/ Data sheet/Scope of work)
- c) Spark Gap Arrester
- Type : Spark gap.
 - Current, 8/20 & 10/350 : 100 Kilo Amp.
micro second wave
 - Spark- over, AC Voltage
 - 50 Hz : 1 KV
 - Impulse (1.2/50 : 2.2 KV
micro sec)
- vii) The grounding cell, spark gap arrester and polarisation cell system shall be adequately sized and suitable for the design life of permanent CP system. The directly buried zinc or magnesium anodes shall also be adequately sized for the life of the permanent CP system, taking into consideration discharge from the anodes. The grounding system shall have minimum resistance to earth to restrict the pipeline voltage as per NACE Criteria but shall not exceed 5 ohms.
- viii) The anodes shall be pre packed with special backfill adequately so that the performance of the anode is not affected by the carbonates, bicarbonates, nitrates, etc. present in the soil. In any case, the thickness of back fill shall not be less than 50mm on all the sides of the anode.
- ix) Motor operated valves where located on the cathodically protected portion of the pipeline shall be grounded by a zinc anode of 20 kg net. Magnesium anodes grounding, if any, provided during temporary CP system shall be disconnected. The MOV power supply cable armour shall be insulated (by cutting and taping with insulation tape) at MOV end to avoid armour carrying CP current.
- x) The above ground cathodically unprotected pipeline at terminals, intermediate SV stations, pigging station, etc. shall be earthed with GI earth electrodes. The resistance to earth of grounding shall be limited to 5 ohms max.

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 18 of 29
			REVISION : 2
			EDITION : 1

- xi) HT transmission overhead lines of voltage below 66KV shall also require mitigation measures in case of continuous voltage induction of 15.0 V AC due to presence of transmission line in close proximity.

8.10 Computerized Test Stations

Where specified in the project specification/ data sheet computerized test station shall be provided along the ROW of the pipeline for automatically monitoring and recording the pipe to soil potential, pipe current, etc of the pipeline, casing pipeline and foreign pipelines, etc, as required. The computer with in the test station shall measure and record these parameters regularly at programmed intervals. The computers shall have required number of input ports for measurement of potentials and current as applicable at the location of its installation. Computers shall have real time clock and record the time of data measurement. Each computer shall have an identification number incorporated in its software, which shall be clearly indicated along with the data display/ print out.

The computers shall be programmed to collect and store all the field parameters at intervals as specified in the project specification/ data sheet.

Data-retrieval computer of portable type suitable for use in field shall be provided as specified in the project specification/ data sheet for programming the field computers and retrieving the data stored by the field computers.

CONTRACTOR shall submit datasheet/specification of CTSU for prior approval.

8.11 Painting

The sheet steel used for fabrication shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The under surface shall be free from all imperfections before undertaking the finishing coat.

After preparation of the under surface, spray painting with two coats of final paint shall be done. The finished panels shall be dried in ovens in dust free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint etc. Bidder shall furnish detailed painting procedure alongwith bids.

All unpainted steel parts shall be cadmium plated to prevent rust formation.

8.12 Cables

- i) MMO Anode tail/lead cable (Size 1Cx10 Sqmm)-

Anode tail/lead cable shall be 1Cx10 Sqmm size, annealed high conductivity tinned stranded copper conductor (7 Strands), PVDF insulated (Thickness 0.040 Inch), HMWPE sheathed/Jacket (Thickness 0.065 Inch), un-armoured.

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 19 of 29
			REVISION : 2
			EDITION : 1

ii) Anode & Cathode Header Cable- (Size 1Cx35 Sqmm)-

Anode & Cathode Header Cable shall be 1Cx35 Sqmm size, annealed high conductivity tinned stranded copper conductor, XLPE insulated, PVC sheathed, FRLS, 1.1kV Grade armoured cable as per IS: 7098.

iii) TR/CPPSM Input Power Supply Cable - (Size 3Cx10 Sqmm)-

TR/CPPSM Input Power Supply Cable shall be 3Cx10 Sqmm size, annealed high conductivity tinned stranded copper conductor, XLPE insulated, PVC sheathed, FRLS, 1.1kV Grade armoured cable as per IS: 7098 for Single Phase TR Units and 4 core type for 3 phase TR units.

iv) Measurement cable & Permanent Reference cell tail cable- (Size 1Cx6 Sqmm)-

a) **Measurement cable & Permanent Ref cell tail cable from Pipe/Tank/Buller/Vessel to CJB & CJB to TR/CPPSM Unit** shall be 1Cx6 Sqmm size, annealed high conductivity tinned stranded copper conductor, XLPE insulated, PVC sheathed, FRLS, 1.1kV Grade armoured, screened cable as per IS: 7098.

v) The colour of outer sheath of the cables shall be as per the PJS/Scope of work/Design Basis and outer sheath should have marking of **"CP system Cable"** in each one meter interval by black colour for identification purpose.

vi) The cables for connecting various transducers from TR unit/ CPPSM to telemetry interface junction box shall be twisted pair with individual pair shielded and overall shielded with aluminium backed by mylar/polyster tape, PVC sheathed, armoured, PVC over all sheathed type.

8.13 Panel Cabling and cable glands

Adequate space shall be provided inside the panel for termination of cables. Termination shall be performed using crimped lugs. Tags with cable numbers engraved on it shall be attached to each cable at both ends. Cable glands shall be double compression type of Nickel/ Chromium plated brass. The lugs shall be of tinned copper. Phases of AC power cables shall be identified with red, yellow, blue PVC adhesive material.

The armour of the cables from pipeline to CP station (potential measurement, reference cell & drainage cables etc.), CP station to ground bed (anode cable) and test station to pipeline shall be earthed only at one end of the cable to avoid armour carrying CP current.

9.0 INSTALLATION

9.1 Cable Laying

i) Cables shall be laid in accordance with approved layout drawings to be prepared by the contractor. No straight through joint shall be permitted in a single run of cable. Cable route shall be carefully measured and cables cut to required length. Enough slackness in cable

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 20 of 29
			REVISION : 2
			EDITION : 1

shall be provided near anodes, AJB, test stations, pipelines etc to account for any settling.

- ii) All cables inside station/plant area shall be laid at a depth of 0.75 M. Cables outside station/plant area shall be laid at a depth of 1.5m. Cables shall be laid in sand under brick cover and back filled with normal soil. Outside station/plant area, the routes shall be marked with polyethylene cable warning mats placed at a depth of 0.9 mtr. from the finished grade.
- iii) In case of above ground cable installations, all un-armoured CP cables shall be laid in GI conduits of sufficiently large size.
- iv) All underground unarmoured cables shall run through PE sleeves. Distant measurement cables and permanent reference cell cables routed along the pipeline shall be carried at the top of the carrier pipe by securely strapping it with adhesive tape or equivalent as required.
- v) RCC or GI pipes of proper size shall be provided for all underground cables for road crossings.
- vi) Cables shall be neatly arranged in trenches in such a manner that criss-crossing is avoided and final take-off to equipment is facilitated.
- vii) Cable marker & tags (at both end) shall be provided to mark the cable route.
- viii) Cable crossing with Underground pipeline, All cables shall be placed above underground pipeline (Below underground pipeline is not permitted).

9.2 Cable to pipe connections

All cable connections to the pipeline including charged foreign pipelines shall be made by an approved (by owner) exothermic process. A suitable water proof sealing system of the cable connections shall be made which will be compatible with parent coating system of the pipeline after exothermic process. The resistance of cable to pipe at pin brazing/ thermit weld connection point shall not exceed 0.1 ohm.

For charged pipeline, pin-brazing shall be used. Eutectic solder shall not be accepted for charged or non-charged pipeline. Pipe coating shall be repaired after connection of cable to pipeline. The coating repair material shall be compatible with original coating and shall prevent ingress of water along cable surface and at the interface of coating repair with original pipe coating.

9.3 Ground bed fencing

Chain link fencing shall be provided around each ground bed & AJB location as per job requirements/PJS.

9.4 Civil Works

All civil works as per enclosed specifications associated with the complete cathodic protection system are included in scope of contractor. This shall include providing cable

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 21 of 29
			REVISION : 2
			EDITION : 1

trenches and foundations for all equipment, outdoor T/R units, anode lead junction boxes, all test stations, polarisation cells, etc.

10.0 **SHOP INSPECTION AND TESTING**

- i) Owner/ Owner's representative shall visit the works during manufacture of various equipment to assess the progress of work as well as to ascertain that only quality raw materials & fabrication technology are used. All necessary assistance shall be provided by contractor and vendors during such inspections.
- ii) The minimum testing, inspection requirements for all components/equipment shall conform to requirement as defined in the relevant codes and standards. Detailed inspection and testing procedures alongwith the acceptance criteria shall be prepared by contractor for Owner's approval.
- iii) Test certificates including test records, performance curves etc. shall be furnished with sufficient information to identify the equipment to which the certificate refers and must carry project title, owner's name and purchase order details etc.
- iv) Owner reserves the right to ask for inspection of all or any item under the contract and witness all tests and carryout inspection or authorise his representative to witness tests and carryout inspection. Contractor shall notify the Owner/ Owner's representative atleast 20 days in advance giving exact details of tests, dates and addresses of locations where the tests would be carried out.

11.0 **PACKING AND TRANSPORT**

All equipment/material shall be protected for inland/marine, transport, carriage at site and outdoor storage during transit and at site. All packages shall be clearly, legibly and durably marked with uniform block letters giving the relevant equipment / material details. Each package shall contain a packing list in a water proof envelope. Copies of the packing list, in triplicate, shall be forwarded to owner prior to despatch. All items of material shall be clearly marked for easy identification against the packing list.

12.0 **FIELD TESTING AND COMMISSIONING**

12.1 **System Testing at Site**

The contractor shall furnish the detailed field testing and commissioning procedures for approval. Field tests as per these approved procedures shall be carried out on the equipment/systems before these are put into service. Acceptance of the complete installation shall be contingent upon inspection and test results. Field testing shall include but not be limited to the following.

- i) Contractor shall carryout pre-commissioning operation after completion of installation of the system including all pre-commissioning checks, setting of all equipment, control and protective devices. All site tests, reliability and performances tests shall be carried out by contractor in direction of equipment supplier.

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 22 of 29
			REVISION : 2
			EDITION : 1

- ii) Before the electrical & CP facilities are put into operation, necessary tests shall be carried out to establish that all equipment, devices, wiring and connection have been correctly installed, connected and are in good working condition as required for the intended operation.
- iii) Owner/ Owner's representative may witness all tests. At least one week's notice shall be given before commencing the tests.
- iv) All tools, equipment and instruments required for testing shall be provided by contractor.
- v) Generally, the following minimum tests must be carried out and recorded in proformas given in subsequent clauses :

Checking : Visual inspection, comparison with drawings and specifications

Inspection : Detailed physical inspection, if necessary, by taking apart the component parts

Testing : Simulation tests of equipment to determine its operational fitness

a) Cables

- Cable no.
- Voltage grade.
- Conductor cross section
- Continuity check
- Voltage test
- Insulation resistance values between each core & earth, between cores.
- All cables shall be tested by 500V megger.

b) E/R Probe

- Location / Identification number
- Checking of wiring as per schematics
- Resistance reading of probe
- Location of installed probe

c) Polarisation coupons

- Location
- Exposed area/size of coupon
- Coupon to soil "ON" & "OFF" potential
- Type of reference cell
- Magnetic reed switch rating & its operation with magnet

d) Reference Cell

- Location
- Potential reading

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 23 of 29
			REVISION : 2
			EDITION : 1

- Type of cell
- Installed Location

e) Insulating Joint

- Insulation resistance across the joint shall be checked before and after charging the pipeline by means of insulating joint tester. Pipe to soil potential of both protected and non-protected sides of the insulating joint shall be checked before and after energisation of CP system.

f) Surge Diverter

- Location / identification number
- Rating
- Check for healthiness

g) Polarisation Cell

- Location / Identification number
- Rating
- Check for electrolyte
- Check for wiring
- Check standby current drain after CP system energisation. (Current drain with respect to voltage across the cell shall be recorded).
- Details of grounding provided for the polarisation cell.

h) Anode Ground Bed

- Location / Station
- Check for actual layout and compliance with drawings
- Resistance of each individual anode
- Current dissipation by each individual anode with respect to anode voltage
- Total resistance of complete anode bed
- Mutual interference
-

i) Grounding Cell

- Location
- Type / no. of anodes
- Ratings

j) CTSU (Computerised test station unit)

- Location / Identification number
- Check for wiring
- Checking programmed interval for collection of the field data by the computer
- Type of reference cell

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 24 of 29
			REVISION : 2
			EDITION : 1

12.2 CP Commissioning Procedure

A model commissioning procedure for a 2 station CP system of a pipeline is given below for general guidance. Contractor shall develop detailed commissioning procedure as per this guideline and get it approved before commencing CP system commissioning activities.

- i) On completion of installation of anode beds and other systems as envisaged in this specification, they shall be individually checked, tested and compared against the agreed specifications and procedure.
- ii) The CP commissioning shall be carried out with current interrupter provided in the output of the TR/ CPPSM Unit to measure CP "ON" & "OFF" potentials.
- iii) Current dissipated by each anode shall be corrected through anode lead junction box.
- iv) Electrical continuity of the entire pipeline shall be verified in conformity with design.
- v) Input resistance of the pipeline at all the drainage points shall be checked and recorded.
- vi) All current measuring test stations shall be calibrated and recorded using portable battery, variable resistance, voltmeters, ammeters, etc. as required.
- vii) Temporary protection facilities provided (if any) which do not form part of permanent CP shall be disconnected from the system & removed unless agreed otherwise.
- viii) Anodes provided for grounding at the MOVs on cathodically protected portion of the pipeline shall be disconnected. Sacrificial anode where provided for the protection of the casing pipe at cased crossing shall be disconnected.
- ix) The pipeline shall be allowed to depolarize for atleast 72 hours after switching 'off' the protection (if any) of all other pipelines in the common ROW.
- x) Before the pipeline are put on charge by switching 'ON' any of the CP stations, natural structure-to-electrolyte potential (PSP), Casing pipe to soil & coupon to soil values at all the test stations of the system shall be measured with respect to Copper/ Copper Sulphate half cell.
- xi) CP station no. 1 shall be energised so as to achieve a maximum pipe soil potential (PSP) as specified at the test station nearest to the drainage point, and observations on either spread of protected portion of pipeline under this CP station and coupons shall be taken for PSP values (Both "ON" & "OFF" values) at each installed test station. Pipeline current values across the cross section of the pipeline shall also be determined at all the intended test stations influenced by this station.
- xii) CP station no. 1 shall now be switched "OFF" and CP station no. 2 shall be switched "ON" and measurement procedure as adopted in above step (at cl. xi) shall be repeated.
- xiii) All the CP stations of the system shall be switched "OFF" and the pipelines shall be allowed to depolarize. All the two CP stations in the system shall then be simultaneously switched "ON" and PSP values at the drainage points of pipeline shall be brought to a value of maximum PSP as specified, and a complete set of PSP observations shall be taken.

Another complete set of PSP observations shall be taken after lines have stayed on charge for 24/ 48 hours. If there are appreciable differences in these observations as compared to those of earlier set, a third set of observations shall be taken after 72 hrs. Maximum drainage point protective potentials shall not be allowed to go beyond the maximum PSP values as specified, in any case.

The output of all CP stations shall then be so adjusted that the sites of occurrence of least negative protective potentials are not less negative than (-) 0.95V "OFF" or not more

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 25 of 29
			REVISION : 2
			EDITION : 1

- negative than (-) 1.20V "OFF". A full set of observations shall again be taken 72 hrs after the adjustment of potentials and the protection system shall be left in this state of operation.
- xiv) Care shall be exercised to ensure that power supply remains uninterrupted during the period of commissioning. In case of an interruption, the test in progress shall be repeated after allowing time for polarization. More sets of observations may be advised to be taken by the Owner/ Owner's representative in any of the above-mentioned steps.
 - xv) PSP values at each of the test stations of the existing pipelines shall be measured and plotted where existing pipelines run in parallel to the new pipeline and mutual interference situations between the pipelines shall be identified and necessary mitigation shall be carried out. Interference situations shall also be identified and mitigated by comparing different sets of readings taken at same test stations at different intervals of time under identical conditions where positive potential swing exceed 50 mV.
 - xvi) The zinc anodes for grounding of MOVs at the locations of MOVs on cathodically protected portion of the pipeline shall be reconnected to the MOVs.
 - xvii) At cased crossings where casing is protected, sacrificial anodes provided for the casing shall be connected to the casing pipe. The casing to soil potential and anode out put current shall be measured and recorded. Where casing pipe protection is inadequate or the out put current of the anode is more than the designed current, then additional anodes shall be provided as required.
 - xviii) Current readings at all the current measuring test stations shall be measured and recorded.
 - xix) Where computerized test stations are provided the computer shall be initialized/ started to collect and store the field data of potentials, current readings, etc as programmed.
 - xx) After one month of starting the computer to collect the field data, the data stored by the computers at all the computerized test stations shall be retrieved/ down loaded using the field data-retrieving computer. The data shall be analysed with the help of a station main computer.
 - xxi) At the locations of the Electrical resistance probe installations the resistance readings of the probes shall be measured using probe reader.
 - xxii) Final records of testing and commissioning including graphical representation of final structure to electrolyte potential readings shall be compiled with interpretation in consultation with owner/ owner's representative and submitted.
 - xxiii) As a result of these tests, if any deficiencies are found in the system, the same shall be rectified by the contractor at no extra cost or time effect, to the complete satisfaction of Owner/ Owner's representative. Such deficiencies shall include mitigation of interference problems that may be found existing in the course of testing and commissioning. A set of PSP observations shall also be taken during the peak of the first dry season after commissioning the system into regular operation. Any deficiency found in the protection of the pipeline shall have to be rectified by the contractor at his own cost.
 - xxiv) If it is found during commissioning that the sites of occurrence of least negative protective potentials are less negative than (-) 0.95 V off & more negative than (-) 1.20 V off even after 72 hrs of operation, then the drainage point potentials shall be adjusted depending upon anode ground bed currents in consultation with Owner/ Owner's representative. In any case, the drainage point protective 'ON' & 'OFF' potential shall not exceed the PSP values specified in Cl.No. 6.0 & 7.0 of this document, at any location of pipeline.
 - xxv) The reference cell shall be calibrated minimum once in 24 hours during the commissioning.
 - xxvi) The current dissipated by individual anodes shall be measured from the anode lead junction box and corrected for equal dissipation to the extent possible keeping the total ground bed current same.

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 26 of 29
			REVISION : 2
			EDITION : 1

xxvii) After connecting all anode groundbeds to pipeline PSP shall be taken at each test station locations to ensure the protection criteria.

13.0 **INTERFERENCE MITIGATION**

- i) Investigation shall be made for stray current electrolysis of the pipeline, mutual interference between the pipeline and foreign pipelines / structures, interference on foreign pipelines / structures due to the CP of the pipeline and ground bed, interference on metallic structures which lie in between pipeline and ground bed or near to ground bed, AC induction on pipeline due to overhead EHV/HV power lines, interference due to high voltage DC lines, electric traction, HV earthing system/Substation earthing system etc.
- ii) Measurements including pipe to soil potentials and pipe currents etc. on the pipeline / structure being CP protected and on foreign pipelines / structures, and ground potential gradient etc. shall be made to investigate the current discharge and pickup locations. In case of fluctuating stray currents, investigations shall be made continuously over a period of time and if required simultaneously at different locations to find out the stray current source (s). Recorders shall be preferably be used for long time measurements.
- iii) Where foreign pipelines (Cathodically protected or unprotected) by an independent CP system run in parallel to the protected pipeline, either in the same trench or very near to the protected pipeline and are not bonded to it, investigations shall be performed for current discharge points on both the pipelines.
- iv) Mitigative measures shall be provided depending upon the type of interference. These shall include installation of bond with variable resistor and diodes, installation of galvanic anodes for auxiliary drainage of current, adjustment/ relocation (if possible) of offending interference source, provision of electrical shield etc. depending on the type of interference.
- v) Bonding with foreign pipelines / structures as a mitigation measure shall be provided where the owners of the foreign pipelines / structures have no objection. Otherwise alternative mitigation measures shall be provided. Wherever bonding is provided for mitigation, the bonding resistor shall be adjusted for optimum value for minimum / no interference. Galvanic anodes installed as a mitigation measure shall be adequately sized for the design life specified for permanent CP system.
- vi) Where high voltage (66 KV and above) transmission lines run in parallel or cross the pipeline, the pipeline shall be grounded through polarisation cells at regular intervals to ground any surge on the pipeline that would appear in case of transmission line faults. Alternatively, grounding could also be done with galvanic anodes (Magnesium or Zinc depending on pipeline voltage) at the discretion of the owner. These grounding installation shall be provided wherever transmission lines run within 25 mtr. of the pipeline.

A.C. voltage measurements shall also be made on the pipeline to find out continuous induction of voltage beyond safe limits. In such a case, the pipeline shall be grounded to the earth of nearest transmission tower causing voltage induction through polarization cell or to a separate earthing system of zinc anodes through polarization cell.

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 27 of 29
			REVISION : 2
			EDITION : 1

14.0 **CLOSE INTERVAL POTENTIAL SURVEY**

Where specified, contractor shall carry out a close internal potential survey over the entire length of pipeline by computerised potential logging method and identify suspected holiday spots on the pipeline coating, under protected/overprotected areas after the back filling has been consolidated sufficiently and CP system has stabilized. Contractor shall identify the necessary pipe coating required to be repaired. Detailed procedures for running this survey shall be submitted for approval. During survey the reference cell shall be calibrated minimum once in 24 hours.

The close interval potential logging survey shall be carried out at approx. 0.75m intervals & both "ON & "OFF" potentials shall be measured by operating the current interrupters of TR/ CPPSM unit during survey.

15.0 **DRAWINGS AND DOCUMENTS**

15.1 **General**

- i) Within three weeks from the date of issue of Purchase Order, Contractor shall submit four copies of the list of all drawings / data/ manuals / procedures for approval, identifying each document by a number and descriptive title and schedule date. This list shall be revised and extended, as necessary, during the progress of work.
- ii) All drawings and documents shall be in English and shall follow metric system. Number of copies for each submission shall be as follows unless specified otherwise :

Submission	No. of copies
a) For Review/ Approval	5 copies
b) Drawings issued for Execution / construction	5 copies+2 soft copy
c) Final / As-built drgs.	5 copies+2 soft copy
d) Operation / Maintenance Manual, Vendor data	5 copies+2 soft copy

15.2 **Contract Drawings and Documents**

As a part of the contract, drawings and documents to be furnished by the contractor shall include but are not limited to the following :

- i) Report on corrosion survey.
- ii) Basis of system design and design calculations, equipment selection criteria and sizing calculations.

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 28 of 29
			REVISION : 2
			EDITION : 1

- iii) Bills of material, material requisitions and Purchase requisitions.
- iv) QA/QC Procedures/Formats
- v) Detailed construction drawings (including as-built status).
 - a) Separate layout drawings for each CP station showing anode- ground bed location, anode-ground bed installation details, CP station location, cable laying, ROW location. Drainage connection location, permanent reference cell locations and topographic details of the entire area.
 - b) Equipment layout, cable layout and schedules.
 - c) GTP of MMO or Hi-Cr cast iron anodes.
 - d) Marker drawings for cable route, anode-ground bed, drainage connection point, permanent reference cell, E/R probe, polarisation cell, pipeline grounding anodes, grounding cells, etc.
 - e) Fabrication details of High Silicon Cast Iron/MMO canistered anode with tail cable.
 - f) Fabrication, connection and installation drawing for anode-junction box.
 - g) Anode- ground bed construction and installation details for horizontal anode-ground bed and deep well ground bed.
 - h) Fabrication, installation and connection scheme drawing for different types of test-stations.
 - i) Fabrication and installation details of Copper/ Copper Sulphate type, Silver/ Silver Chloride type and Zinc type permanent reference cells, E/R probes, grounding cells, surge divertor, etc.
 - j) Fabrication and installation details of polarisation cell and its enclosure/ housing.
 - k) Cable to pipe joint details for charged and non-charged pipelines.
 - l) Incorporation of corrosion survey data, CP stations, test stations, anode beds, polarisation cells, grounding cells, grounding anodes, surge diverters etc. and other relevant features of CP system in pipeline alignment sheets and other related drawings.
 - m) Identification of sections of pipeline affected by interference, sources of interference, details of interference mitigation arrangements provided. Various measurement data at all relevant test stations with and without mitigation measures provided.
 - n) Detailed commissioning report including various measurement data at all test stations.
 - o) Vendor drawings and catalogues, test certificates.
 - p) Operation and maintenance manual.
 - q) Miscellaneous
 - Equipment inspection and testing procedures.
 - Construction, installation procedures.
 - Field testing and commissioning procedures.
 - Procedures and report on close interval potential survey.
 - Procedure for monitoring of cathodic protection after commissioning.
 - Quality control procedure.

16.0 INSTRUMENTS, TOOLS AND SPARES

- i) Contractor shall provide a list of all instruments, tools and tackles necessary for proper operation and maintenance of complete cathodic protection system and associated equipment alongwith prices.
- ii) Contractor shall provide a list of spares and consumables required alongwith prices for

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	OIL & GAS SBU, DELHI		
TITLE	PERMANENT CATHODIC PROTECTION SYSTEM	DOCUMENT NO. MEC/TS/05/E9/016B	Page 29 of 29
			REVISION : 2
			EDITION : 1

proper operation and maintenance of complete cathodic protection system and associated equipment for two years' operation of the system.

- iii) All commissioning & start-up equipment/spares shall be part of contract.

17.0 **INFORMATION REQUIRED WITH THE BID**

Bidders are advised in their own interest to provide the following information alongwith the bid offer without which the bids are liable for summary rejection:

- a) Basis and calculations for preliminary system design of permanent cathodic protection system.
- b) List of formula to be used for detailed system design calculations, with brief explanations.
- c) Basis of system design, design calculations, equipment selection criteria, sizing calculations alongwith characteristic curves for various equipments.
- d) Preliminary bill of material for major equipment.
- e) Details of the equipment/ material offered along with technical leaflets / related literature / catalogues, make, rating, type test certificates etc.
- f) Dimensions, weight and general arrangement drawings for each offered equipment.
- g) List of instruments, tools, tackles offered for maintenance and operation.
- h) List of recommended maintenance / operation spares.
- i) Clause wise deviations, if any, to the specifications alongwith justifications.
- j) Project schedule & manpower chart to be deployed at site.

-X-X-X-

**SPECIFICATION
FOR
CATHODIC PROTECTION
TRANSFORMER RECTIFIER (TR) UNIT**

SPECIFICATION NO.:- MEC/TS/05/E9/082A



**(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092**

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION TRANSFORMER RECTIFIER (CPTR) UNIT	DOCUMENT NO. MEC/TS/05/E9/082A	Page 1 of 1
			REVISION : 2
			EDITION : 1

CONTENTS

<u>Sl. No.</u>	<u>Description</u>
1.0	SCOPE
2.0	STANDARDS
3.0	SERVICE CONDITIONS
4.0	GENERAL REQUIREMENTS
5.0	PERFORMANCE REQUIREMENTS
6.0	CONTROLS, INDICATIONS & METERING
7.0	PAINTING
8.0	SPARES
9.0	DRAWINGS & DOCUMENTS
10.0	INSPECTION AND TESTING

ANNEXURE-I PURCHASER'S DATA FOR CPTR UNIT
 ANNEXURE-IA GUARANTEED TECHNICAL PARTICULARS
 ANNEXURE-II ACCEPTABLE MAKES FOR COMPONENTS

PREPARED BY:	CHECKED BY:	APPROVED BY:	ISSUE DATE :
(A.Moyal)	(M.K.Jaiswara)	(D.G.Majumder)	ISSUE DATE : Feb. 2016
(Aashish Moyal/Saurabh Singh)	(Quasim Ahmad)	(DG Majumder)	ISSUE DATE : Nov. 2010
(Saurabh Singh)	(Quasim Ahmad)	(D. K. Pande)	ISSUE DATE :Jan. 2009

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION TRANSFORMER RECTIFIER (CPTR) UNIT	DOCUMENT NO. MEC/TS/05/E9/082A	Page 1 of 9
			REVISION : 2
			EDITION : 1

1.0 **SCOPE**

Cathodic Protection Transformer Rectifier Unit (T/R) working on controlled Rectification principle is intended to supply power to cathodic protection system for under ground pipelines. This specification covers the requirements for the design, manufacture, testing, delivery to site and commissioning of the T/R Unit (as specified in data sheet).

2.0 **CODES AND STANDARDS**

2.1 In general the equipment covered by this specification shall, unless otherwise specified, be in line with the requirements of any of the latest applicable standards of:

- IS:13947 : Specification for low voltage switchgear & control gear
- IS:12021 : Control transformer for switchgear & control gear
- IS:5469 : Code of practice for use of semiconductor junction devices
- IS:3700 : Essential rating & characteristics of semiconductor devices
- IS:1248 : Analogue electrical measuring instruments
- IEC: 60947 : Low-voltage switchgear and controlgear

- a) International Electromechanical Commission (IEC)
- b) American Standards Institution (ANSI)

2.2 Wherever the requirements in this specification are in conflict with any of the above standards, the requirements under this specification shall be binding.

2.3 In case of imported equipments standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.

2.4 The equipment shall also confirm to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.

2.5 In case of any contradiction between various referred standards/ specifications/ data sheet and statutory regulations the following order of priority shall govern.

- Statutory regulations.
- Data sheets.
- Scope of Work/ Job specification.
- Specification for PCP system.
- Codes and standards

3.0 **SERVICE CONDITIONS**

The T/R unit shall be suitable for installation in non air-conditioned restricted ventilated room in locations having generally warm and dusty atmosphere. Service condition shall be as specified in the data sheet/design basis/PJS (Particular Job Specification). If not specifically mentioned

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION TRANSFORMER RECTIFIER (CPTR) UNIT	DOCUMENT NO. MEC/TS/05/E9/082A	Page 2 of 9
			REVISION : 2
			EDITION : 1

therein, a design ambient temperature of 40° C and an altitude not exceeding 1000 M above mean sea level shall be considered.

4.0 **GENERAL REQUIREMENTS**

CPTR unit shall be capable of continuous trouble free operation at full load rating specified. The design & manufacturing of unit shall have highest grade workmanship. Interchangeability must be guaranteed for the similar type equipments/Parts & material.

4.1 **Constructional Features**

- a) Sheet steel clad, floor mounted, freestanding design.
- b) Minimum sheet steel thickness shall be 2mm (3mm for out door application).
- c) Hinged lock shall be provided at front & back
- d) IP-55 for Outdoor type (dust & weather proof) and IP 42 for Indoor type as specified in data sheet.
- e) Assembled on base channel of minimum height 50mm and 2.5mm thickness.
- f) Zinc bi-chromated and passivated hardware.
- g) Suitable lifting arrangement shall be provided.
- h) Cable entry from bottom, 2mm thick removable gland plates. CPTR unit shall be supplied with cable lugs for termination, Cable glands (Brass, Ni Plated single compression type for indoor application & Double compression type for outdoor application)
- i) Hinged doors shall be provided at front & back side.
- j) Panel designation with screwed nameplate shall have letter not less than 2.5mm high.
- k) Device identification on front door and inside the panel shall be of non-rusting metal.
- l) All metal parts of the panel to under go surface treatment that includes cleaning, chemical degreasing, pickling in acid, cold rinsing, phosphating and passivating followed by spraying with two coats of epoxy based primer and two coats of epoxy based paint/powder coating of approved colour (By owner/MECON) & shade.
- m) Natural Air (AN) cooled type (Louvered openings for natural ventilation may be provided with wire mesh).
- n) All wiring shall be ferruled at both ends for identification of connection.
- o) Input power factor of unit shall be better than 0.8 (lag) @ rated load.
- p) CPTR unit shall have high MBTF & low MTTR.
- q) Space heaters shall be provided inside the unit to prevent the moisture condensation.
- r) Maximum & Minimum height of installation of control equipments (i.e. switches, push buttons etc) shall be 1800mm & 300mm from ground level.
- s) Earth busbar of minimum 25x3 mm shall be provided throughout the length of unit & all non-current carrying metallic parts & installed equipments shall be earthed by this busbar.
- t) CPTR unit shall be doubly earthed, and all doors & movable parts shall be earthed by means flexible cu wire connected to earth bus bar.
- u) Suitable nameplate of Anodised AL shall be provided for all panel mounted equipments, lamps, indications, switches, meters etc.
- v) All live parts shall be shrouded for safety purpose.
- w) 20% extra spare terminal shall be provided.

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION TRANSFORMER RECTIFIER (CPTR) UNIT	DOCUMENT NO. MEC/TS/05/E9/082A	Page 3 of 9
			REVISION : 2
			EDITION : 1

4.2 Equipment Description

The TR unit shall be complete with following main section:

- Transformer and Input Controls.
- Rectifier and Filter.
- Out put Protection.
- System Controls.
- Current interpreter
- Controls, Indication and Metering.

4.3 Transformer and Input Controls

The transformer shall be natural cooled, class-F insulation, and dry type with separate primary and secondary windings. An intermediate earth screen shall be provided between primary and secondary windings. Transformer shall be vacuum impregnated with epoxy varnish and backed.

Unless otherwise specified transformer shall have primary with tappings for $\pm 5\%$

- 4.3.1 MCCB/MCB with thermal over load and Magnetic short circuit release shall be provided at the input of the T/R unit and shall also serve as power ON/ OFF switch. A lightning arrestor rated for 5.0 KA impulse current discharge capacity and rated voltage, maximum spark over voltage rating suitable to protect the TR unit against lightning surges.

4.4 Rectifier and Filters

- 4.4.1 The rectifier shall be made of thyristors and diodes as basic components. The rectifier shall be full wave and fully controlled type. CPTR unit shall be single phase type (suitable for 230V 1-Ph AC supply). The current rating of thyristors and diodes shall be at least three times the nominal load current and voltage rating shall be sufficient to coordinate protection with lightning arrestor provided at the output. Shunt Zeners/ MOVs shall be provided across the rectifier elements for protection.

The rectifier elements shall have humidity/ moisture resistant finish and mounted in sufficiently sized heat sink. The rectifier elements shall have protection against high dv/ dt and di/ dt.

- 4.4.2 Ripple content in the DC output of the rectifier should be less than 5% RMS at rated output for which adequate filtering shall be provided on the to limit the ripple content.
- 4.4.3 For T/R units with multiple output circuits, each output circuit shall have independent rectifier and filter fed from separate secondary windings of the transformer.

4.5 Output Protection

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION TRANSFORMER RECTIFIER (CPTR) UNIT	DOCUMENT NO. MEC/TS/05/E9/082A	Page 4 of 9
			REVISION : 2
			EDITION : 1

MCCB/MCB (2-Pole) having thermal over load & Magnetic Short Ckt Protection shall be provided on both the terminals of the output mainly for output isolation purpose. A lightning arrestor rated for 5.0 KA impulse current discharge capacities and rated voltage, maximum spark over voltage rating suitable to protect the TR unit against lightning surges. For TR units with multiple output circuits each output circuit shall have independent protections.

5.0 PERFORMANCE REQUIREMENTS

5.1 The T/R unit shall be a D. C. Voltage / Current controller operating on controlled Rectification principle. Input power supply as mentioned in data sheet shall be converted into a continuously variable / adjustable output voltage/current by the control of duty cycle of conduction of the power semiconductor device. The T/R shall have two distinct modes of operation as below:

a) **Manual Mode**

In manual mode the output voltage of T/R unit shall be continuously adjustable over the entire rated output voltage range. The set output voltage (V_{os}) shall remain constant irrespective of output current. Current limit feature shall be provided in this mode of operation. The current limit (I_{ps}) shall be continuously adjustable from zero to rated output current.

Constant Voltage Mode- In this operation the output current limit set to the maximum value. The output voltage shall be varied irrespective to the output current demand. The set value of output voltage shall be maintained constant till maximum output current limit is reached by controller, after that output voltage shall decrease to maintain the current constant.

Constant Current Mode- In this operation the output voltage limit set to the maximum value. The output current shall be varied irrespective to the output voltage. The set value of output current shall be maintained constant till maximum output voltage limit is reached by controller, after that output current shall decrease to maintain the voltage constant.

b) **Auto Mode**

In this mode of operation the output of the T/R unit shall operate in an external closed loop with pipe-to-soil potential (PSP) in feed back loop. The T/R unit shall adjust the output voltage so that the PSP as measured by reference cell always remain equal to the set potential. The set potential (V_{ps}) shall be continuously adjustable over the specified range.

T/R unit shall be designed to operate with three number of reference cells (Provided by Main CP/Pipeline contractor) as specified in data sheet. T/R unit shall automatically select the reference cell having less negative potential than the others and use the same for auto PSP control (e.g. (-) 0.7 V is less negative than (-) 0.8 V).

In case of open circuit or short circuit or potential being less negative than a minimum set potential (V_{rs}) for the controlling reference cell, the T/R shall sense these conditions as reference cell failure and shall automatically switch over to the other healthy reference cell for control. If fault occur in all the reference cells (All reference cell fail), the output voltage of the T/R unit shall adjust automatically to a preset value (V_{os}) which shall be adjustable.

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION TRANSFORMER RECTIFIER (CPTR) UNIT	DOCUMENT NO. MEC/TS/05/E9/082A	Page 5 of 9
			REVISION : 2
			EDITION : 1

In no case shall the maximum PSP be allowed to exceed the specified maximum potential in any combination of circumstances. (The maximum potential is the maximum PSP measured by any of all the connected non faulty ref. Cell).

Fast acting electronic over current limit protection shall be provided, The protection shall be fast enough & operate before tripping of MCCB/MCB or blowing of fuse.

- 5.2 T/R unity shall continuously monitor the PSP and necessary annunciation shall be provided in case of PSP either exceeding the specified maximum limit (Vpm) or remaining lower than the specified minimum limit (Vpn).
- 5.3 **Instruments used for measuring pipe to soil potentials with Permanent reference cell shall have high input impedance in range of 10^6 Ohm or higher, so that very least current flow from Permanent ref cell. High input impedance Op-Amp/COMS chips shall be used for each feed-back circuit from each permanent reference cell with CP unit to enhance the life of permanent reference cell.**
- 5.4 T/R unit shall operate on controlled Rectification Principle. The overall efficiency shall preferably be above 80 %. The output of T/R unit shall be filtered / smoothened to provide DC output with less than 5 % RMS ripple. Output regulation for no load to full load and with input voltage variation shall be better than $\pm 0.25V$ of the output setting throughout the range of output voltage and over the specified ambient temperature variation. T/R unit shall allow grounding of positive terminal of its output.
- 5.5 T/R unit shall be of natural Air Cooled (AN) type.
- 5.6 T/R unit shall have input filters to minimize the RFI feedback to the AC power supply. Radio interference noise emitted by T/R unit shall be minimized to allow proper operation of telecom and SCADA systems in the vicinity. T/R output shall be protected against lightning surges and high voltage surges due to possible faults in high voltage transmission lines along the pipelines.
- 5.7 T/R unit shall be field proven and shall be suitable for unattended operation at remote locations. T/R unit design, internal component layout and component rating shall ensure high MTBF and low MTTR. Design life of T/R unit shall not be less than fifteen years. Prototype equipment shall not be acceptable.

Note- Various Settings of CP unit for Zn ref electrode will be differ from conventional Cu-Cuso4 ref electrode, Bidder shall submit the data sheet of the CP unit for approval before manufacturing of CP unit considering the Constant conversion factor of -1.1v to CuSO4.

6.0 CONTROLS, INDICATIONS AND METERING

- 6.1 Following controls shall be provided on T/R unit front door :
 - a) ON/OFF switch for DC output (MCCB/MCB 2-Pole)
 - b) ON/OFF control for input thru MCCB/MCB
 - c) Auto/Manual mode selector switch

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION TRANSFORMER RECTIFIER (CPTR) UNIT	DOCUMENT NO. MEC/TS/05/E9/082A	Page 6 of 9
			REVISION : 2
			EDITION : 1

d) Potentiometers for Vos, Vps and Ips settings.

6.2 Following controls shall be provided inside the module :

- a) Potentiometer for Vrs, Vpm and Vpn Settings.
- b) Controls for current interrupter (As per Manufacturer standard).

6.3 T/R unit shall have following indicating lamps:

- a) T/R UNIT ON/OFF (AC Supply ON) – Visible.
- b) Reference 1 lowest – Visual
Reference 2 lowest – Visual
Reference 3 lowest – Visual
- c) Reference 1 Fail – Visual
Reference 2 Fail – Visual
Reference 3 Fail – Visual
- d) Pipeline over protected – Visual & Remote
- e) Pipeline under protected – Visual & Remote
- f) Unit in Auto – Visual & Remote
Unit in Manual – Visual & Remote
- g) All Reference Fail – Visual & Remote
- h) Current Interrupter
Power ON, ON time & OFF time

6.4 Following metering shall be provided on the T/R unit (Accuracy CI 1.5) :

- a) Output Voltage (Preferably Digital)
- b) Output Current (Preferably Digital)
- c) Digital voltmeter to measure PSP (Set and actual through a selector switch for all the reference cells) (Alternatively analog voltmeter with 0.5 accuracy class may be accepted).
- d) Digital meters for measuring Vrs, Vpm, Vpn.
- e) Input AC Voltage and AC Current.

6.5 T/R unit shall incorporate provision for remote monitoring of T/R unit through SCADA system as per enclosed datasheet.

6.6 MONITORING AND CONTROL SIGNAL FOR SCADA

Digital and analogue monitoring signals as required for CP system shall be provided in CP unit for connection to SCADA system through Ethernet port to monitor the signals along with hardwire signals.

Details of SCADA monitoring & control signals are given below-

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION TRANSFORMER RECTIFIER (CPTR) UNIT	DOCUMENT NO. MEC/TS/05/E9/082A	Page 7 of 9
			REVISION : 2
			EDITION : 1

SI No.	DESCRIPTION	MONITERING/ CONTROL	ANALOUGE /DIGITAL	
1	CP TR OUT PUT VOLTAGE	M	AI and On Ethernet port	
2	CP TR OUT PUT CURRENT	M	AI and On Ethernet port	
3	PIPELINE OVER PROTECTED	M	DI and On Ethernet	
4	PIPELINE UNDER PROTECTED	M	DI and On Ethernet port	
5	PIPE TO SOIL POTENTIAL	M	AI and On Ethernet port	
6	ALL REFERENCE CELLS FAILED	M	DI and On Ethernet port	
7	UNIT WORKING IN AUTO REF MODE	M	DI and On Ethernet port	
8	UNIT WORKING IN MANUAL MODE	M	DI and On Ethernet port	
9	AC INPUT FAIL	M	DI and On Ethernet port	

- 1 AI: Analogue monitoring signal from Equipment to Telemetry interface cabinet (TIC)
- 2 DI: Digital Monitoring signal from Equipment to TIC
- 3 M-Monitoring signal
- 4 C-Control signal

6.7 Current Interruption :

A built-in Current Interrupter will be provided in the CP T/R unit, if specified in the Data Sheet. The Timer of the current Interrupter will be programmable/synchronisable type with keypad facility for setting the ON/OFF time from 1 sec to 999 sec. The Timer will have facility for synchronization to timers in other CP units. The timer will also have GPS synchronization feature.

7.0 PAINTING

The sheet steel used for fabrication shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surfaces shall be prepared by applying a coat of phosphate and a coat of zinc oxide / phosphate primer. The under surface shall be free from all imperfections before undertaking the finishing coat. It shall then be spray painted with two coats of epoxy paint/powder

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION TRANSFORMER RECTIFIER (CPTR) UNIT	DOCUMENT NO. MEC/TS/05/E9/082A	Page 8 of 9
			REVISION : 2
			EDITION : 1

coating. Colour of final paint shall be vendor standard unless otherwise specified in data sheet. The finished panel shall be dried in stoving ovens in dust free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels etc. All unpainted steel parts shall be cadmium plated or suitably treated to prevent corrosion.

8.0 **SPARES**

The vendor shall indicate item wise unit prices and recommended quantity of spares for two years normal operation. However, spares for start up and commissioning as required shall be included in T/R unit supply.

9.0 **DRAWINGS AND DOCUMENTS**

9.1 Vendor shall furnish all data/drawings/documents specified in the vendor data requirement.

9.2 Approval of the drawing shall not relieve the manufacturer of his responsibility to equipment conforming to the relevant specification and standards or for any mistakes, errors or omissions in the drawing.

9.3 Following minimum information shall be furnished with bed :

- a) Clause wise deviations, if any, to the specifications.

9.4 The following drawings (in three sets) & documents shall be submitted for approval within 3 weeks of award of contract.

- a) Power and control circuit diagrams.
- b) General arrangement drawing along with dimension.
- c) Technical detail along with block diagram.
- d) Guaranteed technical particulars as per data sheet.
- e) Recommended list of spares for 2 years operation and maintenance.
- f) Installation Procedure for CPTR unit
- g) Schematic diagram & wiring diagram.
- h) Bill of material.
- i) Ratings of major components and actual design parameters considered.
- j) Terminal diagram and connection details.
- k) Field testing and commissioning procedures.
- l) Maintenance and operation manual, Installation instructions with dispatch.

Final drawings, operation & maintenance manual and erection instructions shall be submitted along with despatch of equipments in three sets in hard copy & two sets in soft copy (CD).

10.0 **INSPECTION AND TESTING**

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION TRANSFORMER RECTIFIER (CPTR) UNIT	DOCUMENT NO. MEC/TS/05/E9/082A	Page 9 of 9
			REVISION : 2
			EDITION : 1

- 10.1 The owner or his authorized representatives may visit the works during manufacture of equipment to assess the progress of work as well as to ascertain that only quality raw materials are used for the same. He shall be given all assistance to carry out the inspection.
- 10.2 The contractor shall submit Quality Assurance Plan (QAP) for respective equipments within three weeks of award of contract. Owner's representative shall be given minimum two weeks advance notice for witnessing the final testing.
- 10.3 Inspection and testing of equipment shall be carried out by the owner/ consultant at the works of the contractor on final product to ensure conformity of the same with the acceptable criteria of technical specification, approved drawings and reference national/ international standards.
- 10.4 QAP shall be prepared and furnished by the contractor in MECON Form No. 11.20(4.4) F-10. Test certificates including test records and performance data etc shall be furnished by the vendor.
- 10.5 **'Type test' including 8 hr. heat run test shall be conducted on one system of similar type rating and 'Acceptance test' on the remaining. Final acceptance testing shall be done at site. Site acceptance test procedure shall be submitted by the Contractor along with QAP.**
- 10.6 Final acceptance testing shall be done at site. Site acceptance test procedure shall be submitted by the Contractor along with QAP.

-X-X-X-

**SPECIFICATION
FOR
CATHODIC PROTECTION
POWER SUPPLY MODULE (CPPSM)**

SPECIFICATION NO.: MEC/TS/05/E9/082



**(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092**

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION POWER SUPPLY MODULE (CPPSM) DC-DC	DOCUMENT NO. MEC/TS/05/E9/082	Page 1 of 1
			REVISION : 2
			EDITION : 1

CONTENTS

<u>Sl. No.</u>	<u>Description</u>
1.0	SCOPE
2.0	STANDARDS
3.0	SERVICE CONDITIONS
4.0	GENERAL REQUIREMENTS
5.0	PERFORMANCE REQUIREMENTS
6.0	CONTROLS, INDICATIONS & METERING
7.0	PAINTING
8.0	SPARES
9.0	INSPECTION AND TESTING
10.0	DRAWINGS

ANNEXURE-I PURCHASER'S DATA FOR CPTR UNIT
ANNEXURE-IA GUARANTEED TECHNICAL PARTICULARS
ANNEXURE-II ACCEPTABLE MAKES FOR COMPONENTS

PREPARED BY:	CHECKED BY:	APPROVED BY:	ISSUE DATE :
(A.Moyal)	(M.K.Jaiswara)	(D.G.Majumder)	ISSUE DATE : Feb. 2016
(Aashish Moyal / Saurabh Singh)	(Quasim Ahmad)	(DG Majumder)	ISSUE DATE : Nov. 2010
(Saurabh Singh)	(Quasim Ahmad)	(D. K. Pande)	ISSUE DATE : Jan. 2009

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION POWER SUPPLY MODULE (CPPSM) DC-DC	DOCUMENT NO. MEC/TS/05/E9/082	Page 1 of 8
			REVISION : 2
			EDITION : 1

1.0 **SCOPE**

Cathodic Protection Power Supply Module (CPPSM) working on switch – mode principle is intended to supply power to cathodic protection system for under ground pipelines. This specification covers the requirements for the design, manufacture, testing, delivery to site and commissioning of the CPPSM.

2.0 **CODES AND STANDARDS**

2.1 In general the equipment covered by this specification shall, unless otherwise specified, be in line with the requirements of any of the latest applicable standards of:

IS:13947 : Specification for low voltage switchgear & control gear

IS:12021 : Control transformer for switchgear & control gear

IS:5469 : Code of practice for use of semiconductor junction devices

IS:3700 : Essential rating & characteristics of semiconductor devices

IS:1248 : Analogue electrical measuring instruments

IEC: 60947 : Low-voltage switchgear and controlgear

- a) International Electromechanical Commission (IEC)
- b) American Standards Institution (ANSI)

2.2 Wherever the requirements in this specification are in conflict with any of the above standards, the requirements under this specification shall be binding.

2.3 In case of imported equipments standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.

2.4 The equipment shall also conform to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.

2.5 In case of any contradiction between various referred standards/ specifications/ data sheet and statutory regulations the following order of priority shall govern.

- Statutory regulations.
- Data sheets.
- Scope of Work/ Job specification.
- Specification for PCP system.
- Codes and standards

3.0 **SERVICE CONDITIONS**

The CPPSM shall be suitable for installation in non air-conditioned restricted ventilated room in locations having generally warm and dusty atmosphere. Service condition shall be as specified in

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION POWER SUPPLY MODULE (CPPSM) DC-DC	DOCUMENT NO. MEC/TS/05/E9/082	Page 2 of 8
			REVISION : 2
			EDITION : 1

the data sheet. If not specifically mentioned therein, a design ambient temperature of 40° C and an altitude not exceeding 1000 M above mean sea level shall be considered.

4.0 **GENERAL REQUIREMENTS**

CPPSM unit shall be capable of continuous trouble free operation at full load rating specified. The design & manufacturing of unit shall have highest grade workmanship. Interchangeability must be guaranteed for the similar type equipments/Parts & material.

4.1 **Constructional Features**

- a) Sheet steel clad, floor mounted, freestanding design.
- b) Minimum sheet steel thickness shall be 2mm (3mm for out door application).
- c) Hinged door shall be provided at front & back.
- d) IP-55 for Outdoor type (dust & weather proof) and IP 42 for Indoor type as specified in data sheet.
- e) Suitable louvers shall be fitted for ventilation.
- f) Assembled on base channel of minimum height 50mm and 2.5mm thickness.
- g) Zinc bi-chromated and passivated hardware.
- h) Suitable lifting arrangement shall be provided.
- i) Cable entry from bottom, 2mm thick removable gland plates. CPPSM unit shall be supplied with cable lugs for termination, Cable glands (Brass, Ni Plated single compression type for indoor application & Double compression type for outdoor application)
- j) Panel designation with screwed nameplate shall have letter not less than 2.5mm high.
- k) Device identification on front door and inside the panel shall be of non-rusting metal.
- l) Galvanic isolation between input & output shall be provided.
- m) All metal parts of the panel to under go surface treatment that includes cleaning, chemical degreasing, pickling in acid, cold rinsing, phosphating and passivating followed by spraying with two coats of epoxy based primer and two coats of epoxy based paint/powder coating of approved colour (By owner/MECON) & shade.
- n) All instruments shall be switchboard type and back – connected. 660V PVC insulated wires with stranded copper conductor of size 2.5 mm² shall be used for control wiring. All fuses shall be provided inside the panel and shall be link type.
- o) Natural Air (AN) cooled type (Louvered openings for natural ventilation may be provided).
- p) All wiring shall be ferruled at both ends for identification of connection.
- q) CPPSM unit shall have high MBTF & low MTTR.
- r) Space heaters shall be provided inside the unit to prevent the moisture condensation.
- s) Maximum & Minimum height of installation of control equipments (i.e. switches, push buttons etc) shall be 1800mm & 300mm from ground level.
- t) Earth busbar of minimum 25x3 mm shall be provided throughout the length of unit & all non-current carrying metallic parts & installed equipments shall be earthed by this busbar.
- u) CPPSM unit shall be doubly earthed, and all doors & movable parts shall be earthed by means flexible cu wire connected to earth bus bar.
- v) Suitable nameplate of Anodised AL shall be provided for all panel mounted equipments, lamps, indications, switches, meters etc.
- w) All live parts shall be shrouded for safety purpose.
- x) 20% extra spare terminal shall be provided.

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION POWER SUPPLY MODULE (CPPSM) DC-DC	DOCUMENT NO. MEC/TS/05/E9/082	Page 3 of 8
			REVISION : 2
			EDITION : 1

4.2 Equipment Description

The CPPSM shall be complete with following main section:

- Input Controls.
- Converters and Filters.
- Out put Protection.
- System Controls.
- Current interpreter
- Controls, Indication and Metering.

5.0 PERFORMANCE REQUIREMENTS

5.1 The CPPSM unit shall be a D. C. Voltage / Current controller operating on switching mode principle. Input power supply as mentioned in data sheet shall be converted into a continuously variable / adjustable output voltage/current by the control of duty cycle of conduction of the power semiconductor device. The CPPSM shall have two distinct modes of operation as below:

a) Manual Mode

In manual mode the output voltage of CPPSM shall be continuously adjustable over the entire rated output voltage range. The set output voltage (V_{os}) shall remain constant irrespective of output current. Current limit feature shall be provided in this mode of operation. The current limit (I_{ps}) shall be continuously adjustable from zero to rated output current.

Constant Voltage Mode- In this operation the output current limit set to the maximum value. The output voltage shall be varied irrespective to the output current demand. The set value of output voltage shall be maintained constant till maximum output current limit is reached by controller, after that output voltage shall decrease to maintain the current constant.

Constant Current Mode-In this operation the output voltage limit set to the maximum value. The output current shall be varied irrespective to the output voltage. The set value of output current shall be maintained constant till maximum output voltage limit is reached by controller, after that output current shall decrease to maintain the voltage constant.

b) Auto Mode

In this mode of operation the output of the CPPSM shall operate in an external closed loop with pipe-to-soil potential (PSP) in feed back loop. The CPPSM shall adjust the output voltage so that the PSP as measured by reference cell always remain equal to the set potential. The set potential (V_{ps}) shall be continuously adjustable over the specified range.

CPPSM shall be designed to operate with three number of reference cells (Provided by Main CP/Pipeline contractor) as specified in data sheet. CPPSM shall automatically select the reference cell having less negative potential than the others and use the same for CPPSM auto control (e.g. (-) 0.7 V is less negative than (-) 0.8 V).

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION POWER SUPPLY MODULE (CPPSM) DC-DC	DOCUMENT NO. MEC/TS/05/E9/082	Page 4 of 8
			REVISION : 2
			EDITION : 1

In case of open circuit or short circuit or potential being less negative than a minimum set potential (Vrs) for the controlling reference cell, the CPPSM shall sense these conditions as reference cell failure and shall automatically switch over to the other healthy reference cell for control. Should a fault occur in all the reference cells, the output voltage of the CPPSM shall adjust automatically to a preset value (Vos) which shall be adjustable.

In no case shall the maximum PSP be allowed to exceed the specified maximum potential in any combination of circumstances. (The maximum potential is the maximum PSP measured by any of all the connected non faulty ref. Cell).

Fast acting electronic over current limit protection shall be provided, The protection shall be fast enough & operate before tripping of MCCB/MCB or blowing of fuse.

5.2 CPPSM shall continuously monitor the PSP and necessary annunciation shall be provided in case of PSP either exceeding the specified maximum limit (Vpm) or remaining lower than the specified minimum limit (Vpn).

5.2 Instruments used for measuring pipe to soil potentials with Permanent reference cell shall have high input impedance in range of 10^6 Ohm or higher, so that very least current flow from Permanent ref cell. High input impedance Op-Amp/COMS chips shall be used for each feed-back circuit from each permanent reference cell with CP unit to enhance the life of permanent reference cell.

5.3 CPPSM will consist of a DC-DC converter operating on high frequency PWM principle. The overall efficiency shall preferably be above 80 %. The output of CPPSM shall be filtered / smoothened to provide DC output with less than 5 % RMS ripple. Output regulation for no load to full load and with input voltage variation shall be better than $\pm 0.25V$ of the output setting throughout the range of output voltage and over the specified ambient temperature variation. CPPSM shall be suitable for ungrounded input supply system and shall allow grounding of positive terminal of its output.

5.4 CPPSM shall be of natural Air cooled (AN) type.

5.5 CPPSM shall have input filters to minimise the A. C. feedback to the power supply. Radio interference noise emitted by CPPSM shall be minimized to allow proper operation of telecom and SCADA systems in the vicinity. CPPSM output shall be protected against lightning surges and high voltage surges due to possible faults in high voltage transmission lines along the pipelines.

5.6 CPPSM shall be field proven and shall be suitable for unattended operation at remote locations. CPPSM design, internal component layout and component rating shall ensure high MTBF and low MTTR. Design life of CPPSM shall not be less than fifteen years. Prototype equipment shall not be acceptable.

5.7 Where specified in Data sheet, the converter shall electrically isolate the input power to CPPSM from its output so that the grounding of the (+) ve output of the CPPSM though anode ground bed shall not affect the grounding system of the input power supply. Alternatively, a separate DC-DC converter having electrical isolation between input & output power supply shall be provided at the input of CPPSM.

6.0 CONTROLS, INDICATIONS AND METERING

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION POWER SUPPLY MODULE (CPPSM) DC-DC	DOCUMENT NO. MEC/TS/05/E9/082	Page 5 of 8
			REVISION : 2
			EDITION : 1

6.1 Following controls shall be provided on CPPSM front door:

- a) ON/OFF switch for CPPSM output (MCCB/MCB 2-Pole).
- b) ON/OFF control for input thru MCCB/MCB.
- c) Auto/Manual mode selector switch.
- d) Potentiometers for Vos, Vps and Ips settings.

6.2 Following controls shall be provided inside the module :

- a) Potentiometer for Vrs, Vpm and Vpn Settings.
- b) Controls for current interrupter (As per Manufacturer standard).

6.3 CPPSM shall have following indicating lights:

- a) CPPSM ON/OFF (DC Supply ON) – Visible.
- b) Reference 1 lowest – Visual
Reference 2 lowest – Visual
Reference 3 lowest – Visual
- c) Reference 1 Fail – Visual
Reference 2 Fail – Visual
Reference 3 Fail – Visual
- d) Pipeline over protected – Visual & Remote
- e) Pipeline under protected – Visual & Remote
- f) Unit in Auto – Visual & Remote
Unit in Manual – Visual & Remote
- g) All Reference Fail – Visual & Remote
- h) Current Interrupter
Power ON, ON time & OFF time

6.4 Following metering shall be provided on the CPPSM unit (Accuracy CI 1.5) :

- a) Output DC Voltage (Preferably Digital)
- b) Output DC Current (Preferably Digital)
- c) Digital voltmeter to measure PSP (Set and actual through a selector switch for all the reference cells) (Alternatively analog voltmeter with 0.5 accuracy class may be accepted).
- d) Digital meters for measuring Vrs, Vpm, Vpn.
- e) Input DC Voltage and DC Current.

6.5 CPPSM unit shall incorporate provision for remote monitoring of signals through SCADA system as per enclosed datasheet.

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION POWER SUPPLY MODULE (CPPSM) DC-DC	DOCUMENT NO. MEC/TS/05/E9/082	Page 6 of 8
			REVISION : 2
			EDITION : 1

6.6 MONITORING AND CONTROL SIGNAL FOR SCADA

Digital and analogue monitoring signals as required for CP system shall be provided in CP unit for connection to SCADA system through Ethernet port to monitor the signals along with hardwire signals.

Details of SCADA monitoring & control signals are given below-

SI No.	DESCRIPTION	MONITERING/ CONTROL	ANALOUGE /DIGITAL	
1	CPPSM OUT PUT VOLTAGE	M	AI and On Ethernet port	
2	CPPSM OUT PUT CURRENT	M	AI and On Ethernet port	
3	PIPELINE OVER PROTECTED	M	DI and On Ethernet	
4	PIPELINE UNDER PROTECTED	M	DI and On Ethernet port	
5	PIPE TO SOIL POTENTIAL	M	AI and On Ethernet port	
6	ALL REFERENCE CELLS FAILED	M	DI and On Ethernet port	
7	Unit Working in AUTO REF Mode	M	DI and On Ethernet port	
8	Unit Working in Manual mode	M	DI and On Ethernet port	
9	DC (solar)/ AC input fail.	M	DI and On Ethernet port	
10	Battery Low	M	AI and On Ethernet port	

- 1 AI: Analogue monitoring signal from Equipment to PLC/Telemetry interface cabinet (TIC)
- 2 DI: Digital Monitoring signal from Equipment to PLC/(TIC)
- 3 M-Monitoring signal
- 4 C-Control signal

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION POWER SUPPLY MODULE (CPPSM) DC-DC	DOCUMENT NO. MEC/TS/05/E9/082	Page 7 of 8
			REVISION : 2
			EDITION : 1

6.7 **Current Interruption:**

A built-in Current Interrupter will be provided in the CPPSM unit, if specified in the Data Sheet. The Timer of the current Interrupter will be programmable/synchronisable type with keypad facility for setting the ON/OFF time from 1 sec to 999 sec. The Timer will have facility for synchronisation to timers in other CP units. The Timer will have facility for remote START, STOP & RESET through SCADA by means of potential free contacts. The timer will also have GPS synchronization feature.

7.0 **PAINTING**

The sheet steel used for fabrication shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surfaces shall be prepared by applying a coat of phosphate and a coat of zinc oxide / phosphate primer. The under surface shall be free from all imperfections before undertaking the finishing coat. It shall then be spray painted /powder coated with two coats of epoxy paint. Colour of final paint shall be vendor standard unless otherwise specified in data sheet. The finished panel shall be dried in stoving ovens in dust free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels etc. All unpainted steel parts shall be cadmium plated or suitably treated to prevent corrosion.

8.0 **SPARES**

The vendor shall indicate item wise unit prices and recommended quantity of spares for two years normal operation. However, spares for start up and commissioning as required shall be included in CPPSM supply.

9.0 **DRAWINGS AND DOCUMENTS**

- 9.1 Vendor shall furnish all data/drawings/documents specified in the vendor data requirement.
- 9.2 Approval of the drawing shall not relieve the manufacturer of his responsibility to equipment conforming to the relevant specification and standards or for any mistakes, errors or omissions in the drawing.
- 9.3 Following minimum information shall be furnished with bid :
 - a) Clause wise deviations, if any, to the specifications.
- 9.4 The following drawings (in three sets) & documents shall be submitted for approval within 3 weeks of award of contract.
 - a) Power and control circuit diagrams.
 - b) General arrangement drawing along with dimension.
 - c) Technical detail along with block diagram.
 - d) Guaranteed technical particulars as per data sheet.
 - e) Recommended list of spares for 2 years operation and maintenance.
 - f) Installation Procedure for CPTR unit
 - g) Schematic diagram & wiring diagram.

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION POWER SUPPLY MODULE (CPPSM) DC-DC	DOCUMENT NO. MEC/TS/05/E9/082	Page 8 of 8
			REVISION : 2
			EDITION : 1

- h) Bill of material.
- i) Ratings of major components and actual design parameters considered.
- j) Terminal diagram and connection details.
- k) Field testing and commissioning procedures.
- l) Maintenance and operation manual, Installation instructions with dispatch.

Final drawings, operation & maintenance manual and erection instructions shall be submitted along with despatch of equipments in three sets in hard copy & two sets in soft copy (CD).

10.0 **INSPECTION AND TESTING**

Inspection and testing of equipment shall be carried out by the owner/ consultant at the works of the contractor on final product to ensure conformity of the same with the acceptable criteria of technical specification, approval drgs. and reference national/ international standards.

- 10.1 The owner or his authorized representatives may visit the works during manufacture of equipment to assess the progress of work as well as to ascertain that only quality raw materials are used for the same. He shall be given all assistance to carry out the inspection.
- 10.2 The contractor shall submit Quality Assurance Plan (QAP) for respective equipments within three weeks of award of contract. Owner's representative shall be given minimum two weeks advance notice for witnessing the final testing.
- 10.3 Inspection and testing of equipment shall be carried out by the owner/ consultant at the works of the contractor on final product to ensure conformity of the same with the acceptable criteria of technical specification, approved drawings and reference national/ international standards.
- 10.4 QAP shall be prepared and furnished by the contractor in MECON Form No. 11.20(4.4) F-10. Test certificates including test records and performance data etc shall be furnished by the vendor.
- 10.5 **'Type test' including 8 hr. heat run test shall be conducted on one system of similar type rating and 'Acceptance test' on the remaining. Final acceptance testing shall be done at site. Site acceptance test procedure shall be submitted by the Contractor along with QAP.**
- 10.6 Final acceptance testing shall be done at site. Site acceptance test procedure shall be submitted by the Contractor along with QAP.

REV. : 0
Edition : 1

**DATA SHEET
FOR
CATHODIC PROTECTION
TRANSFORMER RECTIFIER (TR) UNIT**

SPECIFICATION NO.- MEC/DS/05/E9/082A



**(OIL & GAS SBU)
MECON LIMITED**

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD DATA SHEET		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION TRANSFORMER RECTIFIER UNIT	DOCUMENT NO. MEC/DS/05/E9/082A	Page 1 of 5
			REVISION : 0
			EDITION : 1

<u>PURCHASER'S DATA FOR CPTR UNIT</u>			<u>ANNEXURE - I</u>
1	Type	Floor mounted , Indoor – IP 42 AC Operated Transformer Rectifier Unit for Impressed Current CP System	
2	Cooling	Natural Air cooling (AN)	
3	Quantity	As per Scope of work	
4	Input Power Supply	As per Scope of work	
5	Input Fault Level	10 KA (for 1 Second)	
6	Number of output circuits	One/Two As required	
7	Modes of Operation	(a) Auto Ref (b) Manual mode	
8	Rated output Voltage (+ve earthed)	As per Scope of work	
9	DC Voltage Regulation	±0.25 V	
10	Rated Output Current	As per Scope of work	
11	DC Current Regulation	±0.5 Amp	
12	PSP Voltage Regulation	Better than ±15 mV	
13	Pipe to Soil Potential Setting range (Vps)	(-)0.700mV to (-) 2500 mV – (For Cu/CuSO4 Electrode)	
14	Minimum set potential range (Vrs)	(-)0.4 V to (-)1 V	
15	Maximum pipeline potential range (Vpm)	(-)1.2 V to (-)2.5 V	
16	Minimum pipeline potential range (Vpn)	(-)0.7 V to (-)1.0 V	
17	Number of reference cells for control	Required (3 Nos.)	
18	SCADA Interface and Current Interruption facility	Required	
19	Inbuilt Current Interruption Facility	Required	

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD DATA SHEET		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION TRANSFORMER RECTIFIER UNIT	DOCUMENT NO. MEC/DS/05/E9/082A	Page 2 of 5
			REVISION : 0
			EDITION : 1

20	Site conditions: (i) Ambient Temperature (ii) Relative Humidity (iii) Altitude above mean sea level. (iv) Specific Environment	0°-50°C (max.) 94% (max.) Less than 1000m above MSL To withstand site condition (Dry & Dust Storms during summer & low temp during winter)
21	Shade for final paint	RAL 7032
22	Commissioning at site	By Vendor
23	Meters	1) Digital Meters (Three & Half Digits) for a) AC Input Voltage b) AC Input Current c) DC output voltage d) DC output current e) Reference voltage (P.S.P.)
24	Alarm & Indication (Indication Lamp shall be Cluster LED type)	a) T/R UNIT ON/OFF (AC Supply ON) – Visible. b) Reference 1 lowest – Visual Reference 2 lowest – Visual Reference 3 lowest – Visual c) Reference 1 Fail – Visual Reference 2 Fail – Visual Reference 3 Fail – Visual d) Pipeline over protected – Visual & Remote e) Pipeline under protected – Visual & Remote f) Unit in Auto – Visual & Remote Unit in Manual – Visual & Remote g) DC output over current (Visual) h) All Reference Fail – Visual & Remote i) Current Interrupter Power ON, ON time & OFF time
25	SCADA Monitoring Facility	Signals / Contacts shall be provided for remote monitoring & control as per cl. No. 6.6 of specification MEC/TS/05/E9/082A.
26	Current interruption Facility	Current interruption facility will be provided by means of a built-in Electronic Interrupter logic &

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD DATA SHEET		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION TRANSFORMER RECTIFIER UNIT	DOCUMENT NO. MEC/DS/05/E9/082A	Page 3 of 5
			REVISION : 0
			EDITION : 1

		microprocessor based digital timer with real time clock & ON/OFF time display. The timer will have facility for adjusting the ON time & OFF time from 0 to 999 Sec. by means of digital setting facility. The timer will also have Start/stop facility thru a single external potential free contact. The Timer will have GPS Synchronisation facility.
27	Protection	a) Lightning Arrestor on AC & DC Sides b) HRC fuses in input AC supply lines and in each DC leads c) Surge suppressors on input, output and across each diode and SCR (Power Transistors). d) Adjustable current limit, overcurrent and short-circuit protection. e) HRC fuses outgoing DC +ve lead and the DC – ve lead. f) MCB/MCCB in AC I/P (2-Pole). g) MCB/MCCM in DC O/P (2-Pole). h) Fast acting electronic over current limit circuit. i) Glass cartridge fuses in live line of all lamps, auxiliary power line to control circuit. Note-Electronic earthing for PLC/Modules shall be provided separately (Other then equipment earthing)

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD DATA SHEET		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION TRANSFORMER RECTIFIER UNIT	DOCUMENT NO. MEC/DS/05/E9/082A	Page 4 of 5
			REVISION : 0
			EDITION : 1

ANNEXURE – I A

1	Guaranteed Technical Particulars	
1.1	Efficiency:	
	At 10% Load	
	At 25% Load	
	At 50% Load	
	At 75% Load	
	At 100% Load	
1.2	Voltage regulation (from zero to 100% load variation and throughout the output voltage range) Better than $\pm 0.25V$	
	Manual mode	
	Auto mode	
1.3	Output ripple at full load current (less than 5% RMS)	
	At 10% output voltage	
	At 100% output voltage	
2	Inspection	8 hour heat run test & routine test shall be witnessed by purchase at manufacturers work. Final integrated field testing shall be done at site.
3	Combined	Combined load test at site.

Note- Various Settings of CP unit for Zn ref electrode will be differ from conventional Cu-Cuso4 ref electrode, Bidder shall submit the data sheet of the CP unit for approval before manufacturing of CP unit considering the Constant conversion factor of -1.1v to CuSO4.

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD DATA SHEET		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION TRANSFORMER RECTIFIER UNIT	DOCUMENT NO. MEC/DS/05/E9/082A	Page 5 of 5
			REVISION : 0
			EDITION : 1

ACCEPTABLE MAKES FOR COMPONENTS			<u>ANNEXURE-II</u>
S.No.	Material	Make	
1	Contactors	Siemens/ L&T/ BCH/ Telemechnique	
2	Moulded Case Circuit Breaker	GE/ Crompton/ L&T / Hager	
3	Miniature circuit breaker	MDS/ Indoasian/ Havell / Hager	
4	Transformer	Indcoil/ Kappa Electrical/ AE	
5	Switches, Fuses, Fuse base	Siemens/ L&T/ GE / Kaycee/Salzer	
6	PB Elements/ Indication Lamps	Siemens / L&T / Teknic / Concord/ BCH	
7	Selector Switch	EE/ Siemens/ Kaycee/ L&T	
8	Terminals	Elmex/ Connect Well/ Phoenix	
9	Meters	AEP/ Simco/ IMP/ GEC/ Rishab/Meco	
10	Cable Glands	Commet/ Baliga / Flexpro/ Sudhir	

(List of suppliers for solid-state devices shall be furnished by the vendor for Owner's approval).

(1)	HRC Fuses	(13)	Lightning Arrestor
(2)	Auxiliary Fuses	(14)	Blade Resistance
(3)	Interrupter Contractor	(15)	Potential Meter
(4)	DC – DC Converter Power Transistors	(16)	LED's
(5)	Volt Meter (Digital) 3 1/2	(17)	Convertors (4 to 20 ma)
(6)	Ammeter (Digital) 3 1/2	(18)	Timer (Interrupter)
(7)	Shunt	(19)	All electronic (AC DC)
(8)	Filter Choke in DC Output	(20)	Display Board
(9)	Filter Capacitor bank in DC Output	(21)	Filters
(10)	Power Diode	(22)	Links
(11)	Diode		
(12)	Search Suppressor Network		

-X-X-X-

REV. : 0
Edition : 1

**DATA SHEET
FOR
CATHODIC PROTECTION
POWER SUPPLY MODULE (CPPSM)**

SPECIFICATION NO. - MEC/DS/05/E9/082



**(OIL & GAS SBU)
MECON LIMITED**

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION POWER SUPPLY MODULE (CPPSM) DC-DC	DOCUMENT NO. MEC/DS/05/E9/082	Page 1 of 5
			REVISION : 0
			EDITION : 1

ANNEXURE - I

PURCHASER'S DATA FOR CPPSM UNIT

1	Type	Floor mounted , Indoor – IP 42 DC-DC Operated power supply module with Galvanic Isolation unit for Impressed Current CP System
2	Cooling	Natural Air cooling (AN)
3	Quantity	As per Scope of work.
4	Input Power Supply	From standalone 800W, 48V DC solar system /OR As per Scope of work.
5	Input Fault Level	-----
6	Number of output circuits	One/Two As required
7	Modes of Operation	(a) Auto Ref (b) Manual mode
8	Rated output Voltage (+ve earthed)	As per Scope of work.
9	DC Voltage Regulation	±0.25 V
10	Rated Output Current	As per Scope of work.
11	DC Current Regulation	±0.5 Amp
12	PSP Voltage Regulation	Better than ±15 mV
13	Pipe to Soil Potensial Setting range (Vps)	(-)0.700mV to (-) 2500 mV – (For Cu/CuSO4 Electrode)
14	Minimum set potential range (Vrs)	(-) 0.4 V to (-) 1 V
15	Maximum pipeline potential range (Vpm)	(-) 1.2 V to (-) 2.5 V
16	Minimum pipeline potential range (Vpn)	(-) 0.7 V to (-)1.0 V
17	Number of reference cells for control	Required (3 Nos.)
18	Scada Interface and Current Interruption facility	Required
19	Inbuilt Current Interruption Facility	Required

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION POWER SUPPLY MODULE (CPPSM) DC-DC	DOCUMENT NO. MEC/DS/05/E9/082	Page 2 of 5
			REVISION : 0
			EDITION : 1

20	Site conditions: (i) Ambient Temperature (ii) Relative Humidity (iii) Altitude above mean sea level. (iv) Specific Environment	0°-50°C (max.) 94% (max.) Less than 1000m above MSL To withstand site condition (Dry & Dust Storms during summer & low temp during winter)
21	Shade for final paint	RAL 7032
22	Commissioning at site	By Vendor
23	Meters	1) Digital Meters (Three & Half Digits) for a) AC Input Voltage b) AC Input Current c) DC output voltage d) DC output current e) Reference voltage (P.S.P.)
24	Alarm & Indication (Indication Lamp shall be Cluster LED type)	a) CPPSM ON/OFF (DC Supply ON) – Visible. b) Reference 1 lowest – Visual Reference 2 lowest – Visual Reference 3 lowest – Visual c) Reference 1 Fail – Visual Reference 2 Fail – Visual Reference 3 Fail – Visual d) Pipeline over protected – Visual & Remote e) Pipeline under protected – Visual & Remote f) Unit in Auto – Visual & Remote Unit in Manual – Visual & Remote g) DC output over current (Visual) h) All Reference Fail – Visual & Remote i) Current Interrupter Power ON, ON time & OFF time
25	SCADA Monitoring Facility	Signals / Contacts shall be provided for remote monitoring & control as per cl. No. 6.6 of specification.
26	Current interruption Facility	Current interruption facility will be provided by means of a built-in Electronic Interrupter logic & microprocessor based digital timer with real time clock & ON/OFF time display. The timer will have facility for adjusting the ON time & OFF time from 0 to 999 Sec. by means of digital

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION POWER SUPPLY MODULE (CPPSM) DC-DC	DOCUMENT NO. MEC/DS/05/E9/082	Page 3 of 5
			REVISION : 0
			EDITION : 1

		setting facility. The timer will also have Start/stop facility thru a single external potential free contact. The Timer will have GPS Synchronisation facility.
27	Protection	a) Lightning Arrestor on DC Input & DC Output Sides. b) HRC fuses in input DC supply lines and in each DC leads c) Surge suppressors on input, output and across each diode and SCR (Power Transistors). d) Battery deep discharge Protection. e) Adjustable current limit, overcurrent and short-circuit protection. f) HRC fuses outgoing DC +ve lead and the DC –ve lead. g) MCCB/MCB in DC I/P. h) MCCBMCB in DC O/P. i) Fast acting electronic over current limit circuit. j) Glass cartridge fuses in live line of all lamps, auxiliary power line to control circuit. Note-Electronic earthing for PLC/Modules shall be provided separately (Other then equipment earthing)

Note- Various Settings of CP unit for Zn ref electrode will be differ from conventional Cu-Cuso4 ref electrode, Bidder shall submit the data sheet of the CP unit for approval before manufacturing of CP unit considering the Constant conversion factor of -1.1v to CuSO4.

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION POWER SUPPLY MODULE (CPPSM) DC-DC	DOCUMENT NO. MEC/DS/05/E9/082	Page 4 of 5
			REVISION : 0
			EDITION : 1

ANNEXURE – I A

28	Guaranteed Technical Particulars	
28.1	Efficiency:	
	At 10% Load	
	At 25% Load	
	At 50% Load	
	At 75% Load	
	At 100% Load	
28.2	Voltage regulation (from zero to 100% load variation and throughout the output voltage range) Better than $\pm 0.25V$	
	Manual mode	
	Auto mode	
28.3	Output ripple at full load current (less than 5% RMS)	
	At 10% output voltage	
	At 100% output voltage	
29	Inspection	8 hour heat run test & routine test shall be witnessed by purchase at manufacturers work. Final integrated field testing shall be done at site.
30	Combined	Combined load test at site.

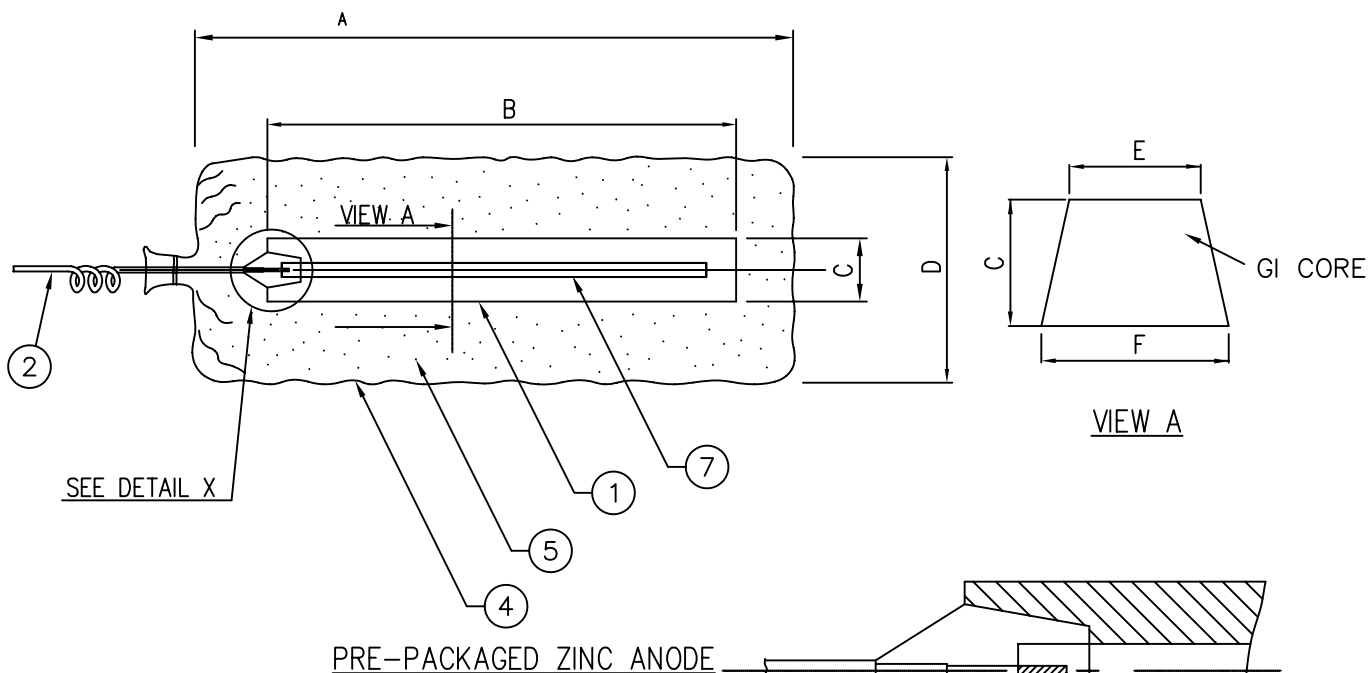
MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION		
	ELECTRICAL SECTION, DELHI		
TITLE	CATHODIC PROTECTION POWER SUPPLY MODULE (CPPSM) DC-DC	DOCUMENT NO. MEC/DS/05/E9/082	Page 5 of 5
			REVISION : 0
			EDITION : 1

ACCEPTABLE MAKES FOR COMPONENTS			<u>ANNEXURE-II</u>
S.No.	Material	Make	
1	Contactors	Siemens/ L&T/ BCH/ Telemechnique	
2	Moulded Case Circuit Breaker	GE/ Crompton/ L&T / Hager	
3	Miniature circuit breaker	MDS/ Indoasian/ Havell / Hager	
4	Transformer	Indcoil/ Kappa Electrical/ AE	
5	Switches, Fuses, Fuse base	Siemens/ L&T/ GE / Kaycee/Salzer	
6	PB Elements/ Indication Lamps	Siemens / L&T / Teknic / Concord/ BCH	
7	Selector Switch	EE/ Siemens/ Kaycee/ L&T	
8	Terminals	Elmex/ Connect Well/ Phoenix	
9	Meters	AEP/ Simco/ IMP/ GEC/ Rishab/Meco	
10	Cable Glands	Commet/ Baliga / Flexpro/ Sudhir	

(List of suppliers for solid-state devices shall be furnished by the vendor for Owner's approval).

(1)	HRC Fuses	(13)	Lightning Arrestor
(2)	Auxiliary Fuses	(14)	Blade Resistance
(3)	Interrupter Contractor	(15)	Potential Meter
(4)	DC – DC Converter Power Transistors	(16)	LED's
(5)	Volt Meter (Digital) 3 1/2	(17)	Convertors (4 to 20 ma)
(6)	Ammeter (Digital) 3 1/2	(18)	Timer (Interrupter)
(7)	Shunt	(19)	All electronic (AC DC)
(8)	Filter Choke in DC Output	(20)	Display Board
(9)	Filter Capacitor bank in DC Output	(21)	Filters
(10)	Power Diode	(22)	Links
(11)	Diode		
(12)	Search Suppressor Network		

-X-X-X-



CHEMICAL COMPOSITION OF ANODE (% WEIGHT)

ELEMENT	TYPE-I	TYPE-II
Al	: 0.1% - 0.5 %	0.005 %MAX
Cd	: 0.025% - 0.07%	0.003%MAX
Cu	: 0.005% MAX	0.002% MAX
Fe	: 0.005% MAX	0.0014% MAX
Pb	: 0.006% MAX	0.003% MAX
OTHERS	: 0.1%MAX	-
Zn	: REMAINDER	REMAINDER

NOTES: -

1. ANODE COMPOSITION, NET WEIGHT, GROSS WEIGHT DIMENSIONS SHALL BE FURNISHED BY CONTRACTOR.
2. ANODE TAIL CABLE SHALL BE HIGH CONDUCTIVITY, STRANDED, COPPER CONDUCTOR, 600/1100 V GRADE, XLPE INSULATED, PVC SHEATHED & UNARMoured.
3. THICKNESS OF BACKFILL SHALL BE ADEQUATE TO SAFEGUARD THE ANODES AGAINST THE EFFECT OF CARBONATES, BICARBONATES, NITRATES, etc. IN SOIL ANODES SHALL BE PROVIDED WITH MIN. 50MM THICK BACKFILL ON ALL SIDES OF ANODE OR MIN. 20 KG NET WHICHEVER IS HIGHER. TYPE-I & TYPE-II ANODE SHALL BE USED AS PER THEIR APPLICATION DESCRIBED IN ASTM B418-09.

Anode Open Circuit Potential : (-) 1.1 Volts (min.) w.r.t CSE

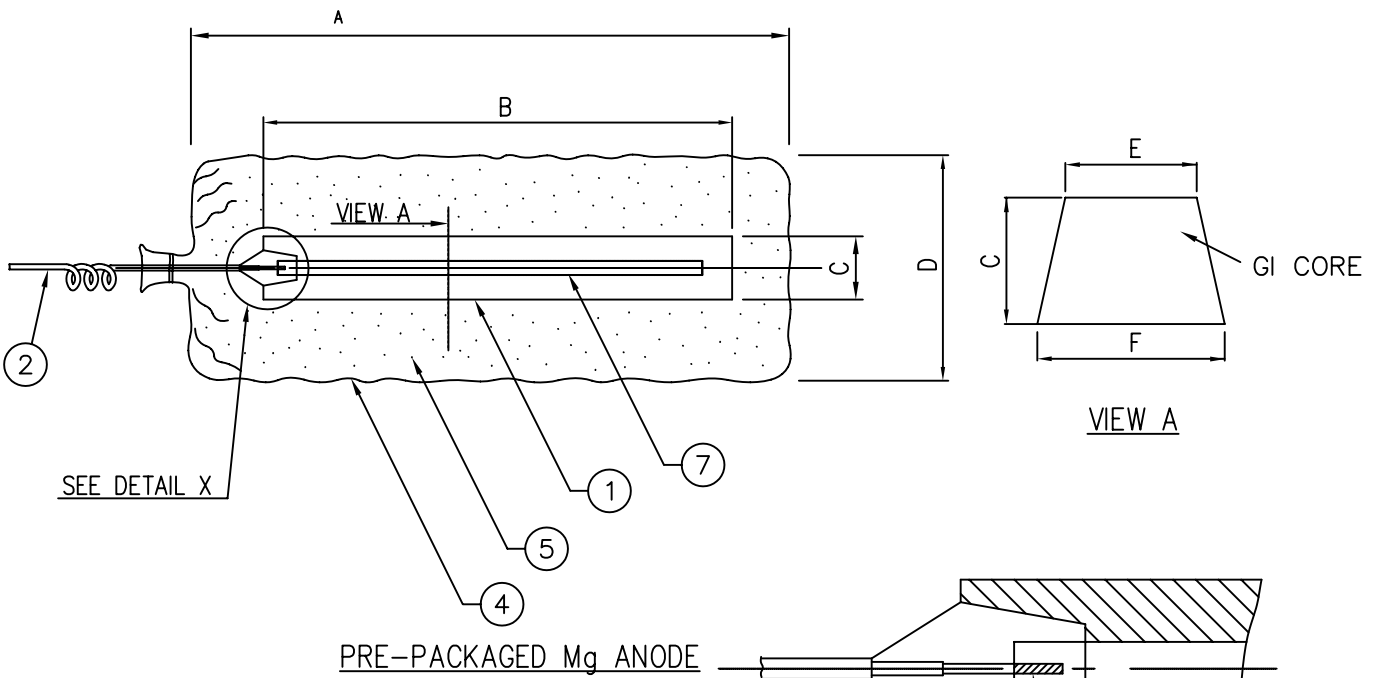
Anode Consumption Rate : 11.2 kg/ (A year) Max.

BACKFILL COMPOSITION

Gypsum : 75%
Bentonite : 20%
Sodium sulphate : 5%

7	2.5 THICK x 15 WIDE GI CORE STRIP (PART OF ZINC ANODE)	1
6	SILVER SOLDER	AS REQD.
5	BACKFILL MATERIAL	AS REQD.
4	COTTON BAG	1
3	M-SEAL COMPOUND	AS REQD.
2	ANODE TAIL CABLE, PE INSULATED, PVC SHEATHED, UNARMoured, SINGLE CORE COPPER, 600/1100 V.	AS REQD.
1	ZINC ANODE	1
ITEM	DESCRIPTION	QTY.
BILL OF MATERIALS		

01	07.09	05/E9	REVISED & ISSUED	AM	DG			
REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD			
REVISIONS				REFERENCES		DRG. NO.		
SECTION: ELECTRICAL				PREPACKAGED ZINC ANODE		 मेकॉन लिमिटेड MECON LIMITED		
NAME	DATE	CHKD	DATE					
DSGN	AM	02.09	SS					05.09
DRWN	SJ	02.09						
APPROVED				SCALE : N.T.S.		REV 1		
				DRG.NO: -MEC/SD/05/E9/E/CP/1601				



CHEMICAL COMPOSITION OF ANODE

ELEMENT	High Potential Type	ELEMENT	Low Potential Type
Al	: 0.010% MAX	Al	: 5.3-6.7% MAX
Mn	: 0.50-1.3% MAX	Mn	: 0.15-0.7% MAX
Cu	: 0.02% MAX	Cu	: 0.02% MAX
Fe	: 0.03% MAX	Fe	: 0.003% MAX
Ni	: 0.001% MAX	Ni	: 0.002% MAX
Zn	: -	Zn	: 2.5-3.5% MAX
Si	: 0.05% MAX	Si	: 0.1% MAX
OTHERS	: 0.3% MAX	OTHERS	: 0.3% MAX
Mg	: REMAINDER	Mg	: REMAINDER

NOTES: -

1. ANODE COMPOSITION, NET WEIGHT, GROSS WEIGHT DIMENSIONS SHALL BE FURNISHED BY CONTRACTOR.
2. ANODE TAIL CABLE SHALL BE HIGH CONDUCTIVITY, STRANDED, COPPER CONDUCTOR, 650V GRADE, PVC INSULATED, PVC SHEATHED & ARMURED. TYPE-I & TYPE-II ANODE SHALL BE USED AS PER THEIR APPLICATION DESCRIBED IN ASTM B843-07.

Anode Open Circuit Potential : (-) 1.5 Volts (min.)
w.r.t CSE

Anode Consumption Rate : 7.9 kg/ (A year) Max.

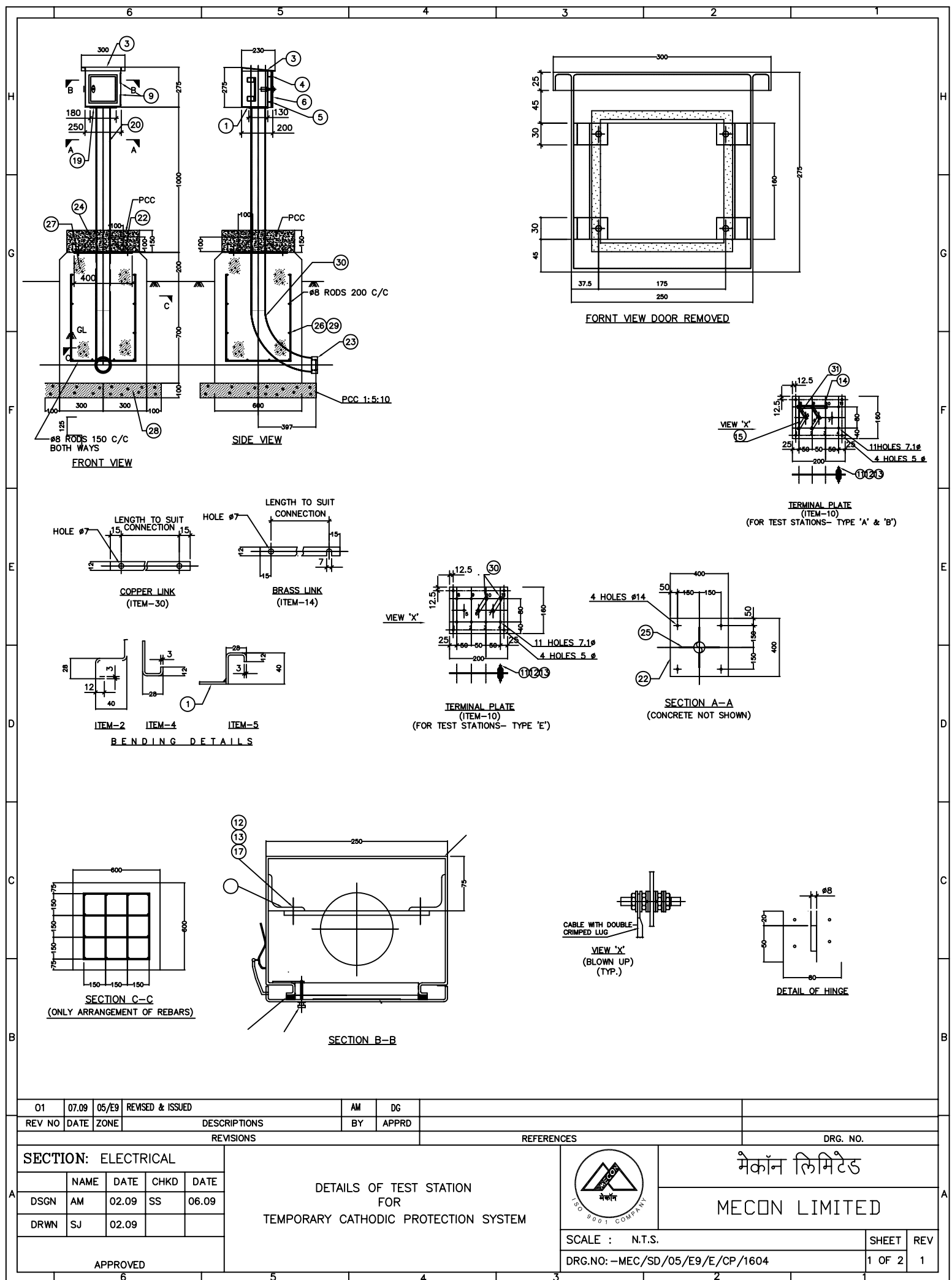
BACKFILL COMPOSITION

Gypsum : 75%
Bentonite : 20%
Sodium sulphate : 5%

ASTM B418-09

7	2.5 THICK x 15 WIDE GI CORE STRIP (PART OF MAGNESIUM ANODE)	1
6	SILVER SOLDER	AS REQD.
5	BACKFILL MATERIAL	AS REQD.
4	COTTON BAG	1
3	M-SEAL COMPOUND	AS REQD.
2	ANODE TAIL CABLE, PE INSULATED, PVC SHEATHED, ARMURED, SINGLE CORE COPPER, 600/1100 V.	AS REQD.
1	MAGNESIUM ANODE	1
ITEM	DESCRIPTION	QTY.
BILL OF MATERIALS		

01	07.09	05/E9	REVISED & ISSUED	AM	DG			
REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD			
REVISIONS				REFERENCES		DRG. NO.		
SECTION: ELECTRICAL				PREPACKAGED MAGNESIUM ANODE		 मेकॉन लिमिटेड MECON LIMITED		
NAME	DATE	CHKD	DATE					
DSGN	AM	02.09	SS					05.09
DRWN	SJ	03.09						
APPROVED				SCALE : N.T.S.		REV 1		
				DRG.NO:-MEC/SD/05/E9/E/CP/1602				



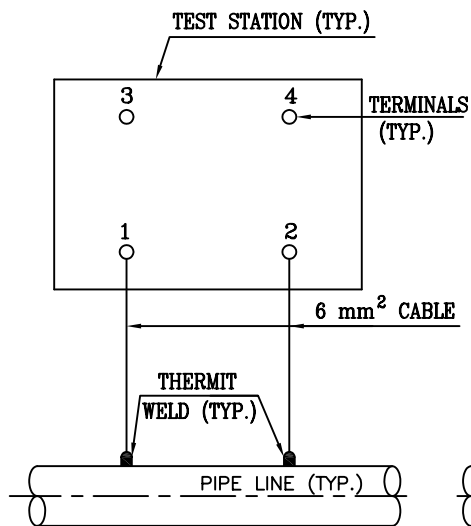
01	07.09	05/E9	REVISED & ISSUED		AM	DG							
REV NO	DATE	ZONE	DESCRIPTIONS		BY	APPRD							
REVISIONS						REFERENCES		DRG. NO.					
SECTION: ELECTRICAL			DETAILS OF TEST STATION FOR TEMPORARY CATHODIC PROTECTION SYSTEM					मेकॉन लिमिटेड					
								MECON LIMITED					
DSGN	AM	02.09					SS	06.09	SCALE : N.T.S.			SHEET	REV
DRWN	SJ	02.09							DRG.NO: -MEC/SD/05/E9/E/CP/1604			1 OF 2	1
APPROVED													

NOTES:-

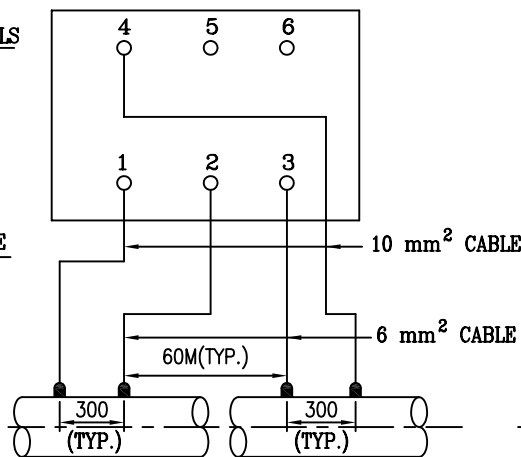
- TEST STATION SHALL HAVE WEATHERPROOF ENCLOSURE HAVING DEGREE OF PROTECTION IP-55, AS DEFINED IN IEC-529(1989)/ IS:2147 (1962) THE SHUTTER SHALL BE HINGED TYPE WITH CONCEALED LOCK AND SHALL HAVE DOOR GASKET.
- THE HINGES SHALL BE WELDED TO THE SHUTTER AND THE BOX SUITABLY.
- THE MS ANGLES SHALL BE WELDED TO THE SIDES. THE ANGLES SHALL HAVE TAPPED HOLES FOR FIXING TERMINAL PLATE.
- THE INNER SURFACE OF THE TEST STATION SHALL BE PAINTED WITH LEAD OXIDE PRIMER GRADE.
- THE OUTSIDE OF THE TEST STATION SHALL BE PAINTED WITH TWO COATS OF ZINC RED EPOXY PRIMER AND THREE COATS OF GREY COLOURED EPOXY PAINT COMPLETE WITH CABLE PIPE & FDN. PLATE.
- THE NAME PLATE SHALL BE OF ANODISED ALUMINIUM WITH BLACK BACKGROUND AND WHITE LETTERS (SIZE 3mm). THE NAME PLATE SHALL BE FIXED TO INNER SIDE OF SHUTTER BY ARALDITE OR EQUIVALENT.
- THE NAME PLATE OF EACH TEST STATION SHALL CARRY THE FOLLOWING INFORMATION.
 - TEST STATION CONNECTION SCHEME TYPE
 - RELEVANT TEST STATION CONNECTION SCHEME DIAGRAM
 - TEST STATION NO.
 - CHAINAGE IN KM
 - DISTANCE FROM PIPE IN m
 - DIRECTION OF GAS FLOW
- WHEN ERECTED, THE TEST STATION SHALL BE IN UPRIGHT POSITION.
- TEST STATION SHALL BE SO ERECTED AS TO SERVE ALSO AS PIPELINE MARKER. AND ANODE GROUND BED MARKER. THEIR SHUTTERS SHALL BE PARALLEL TO THE LINE OF AXIS OF PIPELINE AND FACING IT.
- THE NUMBER OF ALL TEST STATIONS SHALL BE WRITTEN WITH BLACK PAINT USING 40 mm STENCIL BLOCK ON THE OUTER SIDE OF THE SHUTTER IN A UNIFORM MANNER. AN ARROW SHOWING DIRECTION OF FLOW OF GAS SHALL BE MARKED TO UNDERLINE THE TEST STATION NUMBER ON SHUTTER.
- HEIGHT OF THE TEST STATION ABOVE GROUND LEVEL SHOWN IN THE DRAWING IS TYPICAL.
- ALL CABLES COMING TO TEST STATION SHALL BE LABELLED ON BOTH ENDS WITH IDENTIFICATION NUMBERS
- TOTAL NUMBER OF TEST STATIONS AND THEIR TYPES ARE MENTIONED IN CONSOLIDATED B.O.M.
- TEST BETWEEN BRASS TERMINALS AND BODY AT 2kv FOR ONE MINUTE.
- ALL DIMENSIONS ARE APPROXIMATE AND CAN VARY SLIGHTLY.
- ALL DIMENSIONS ARE IN mm.

31	VARIABLE RESISTANCE 0-0.1 Ohm.	01
30	100 MM Ø M.S. SCH.40 90° ELBOW, R=5D	01
29	BINDING WIRE, MS	AS REQD.
28	PCC MIX, 1:5:10	0.064 m ³
27	RCC MIX, M20	0.324 m ³
26	ROD, 8Ø MS	28 m
25	STIFFENER PLATE, 8THK.	04
24	FOUNDATION BOLT M12	04
23	RUBBER BUSH MATCHING WITH PIPE	01
22	FOUNDATION PLATE, 6THKx400x400 MS PLATE	02
21	NEOPRENE RUBBER GASKET, 6THK.	01 SET
20	MS PIPE, 100 Ø, IS: 1239 PT.1(1990)-HEAVY GRADE	01
19	COUPLING PLATE, 5THK.x180x130 MS PLATE, 100Ø HOLE AT CENTRE	01
18	LATCH FOR SHUTTER	01
17	BRASS SCREW, M6x16	04
16	ANGLE, 5THK. x 50 x 50 x 30	04
15	SHUNT, 0.1 OHM, 0.5 A, 50 mV	01
14	COPPER LINK, 2.5 THK.x 12 x LENGTH AS REQD.	01
13	BRASS WASHER 8 mm dia (M8) Cd Coated	AS REQD.
12	BRASS NUT, M6 Brass Nut Bolt washer	AS REQD.
11	BRASS STUD, M6 x 50	AS REQD.
10	TERMINAL PLATE, 6THK.x160 x 200 PHENOLIC LAM. SHT	01
9	HINGE FOR SHUTTER	02
8	CASTLE LOCK WITH ONE KEY PER TEST STATION	01
7	NAME PLATE, 0.9THK.x120x160 ANODISED ALUMINIUM	01
6	SHUTTER, 3 THK.x250x296 MS SHT	01
5	FRONT BOTTOM, 3 THK.x170x74 MS SHT	01
4	FRONT TOP, 3 THK.x170x79 MS SHT	01
3	TOP, 3 THK.x232x300/344 MS SHT	01
2	REAR & SIDES, 3 THK.x275/250x718 MS SHT	01
1	BOTTOM PLATE, 5 THK.x160x244 MS PLATE, 100Ø HOLE AT CENTRE	01
ITEM	DESCRIPTION	QTY.
BILL OF MATERIALS		

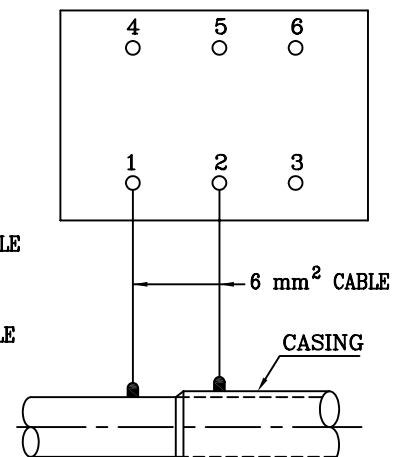
01	07.09	05/E9	REVISED & ISSUED	AM	DG			
REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD			
REVISIONS				REFERENCES		DRG. NO.		
SECTION: ELECTRICAL				DETAILS OF TEST STATION FOR CATHODIC PROTECTION SYSTEM		 मेकॉन लिमिटेड MECON LIMITED		
NAME	DATE	CHKD	DATE					
DSGN	AM	02.09	SS					05.09
DRWN	SJ	02.09						
APPROVED				SCALE : N.T.S.		SHEET	REV	
				DRG.NO:-MEC/SD/05/E9/E/CP/1604		2 OF 2	1	



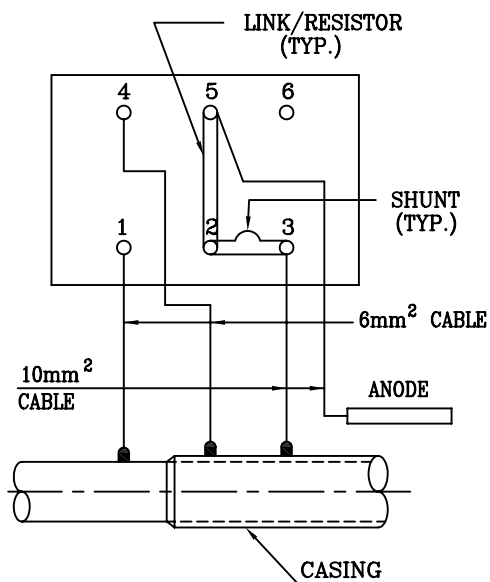
POTENTIAL MEASUREMENT
(CONNECTION SCHEME-A)



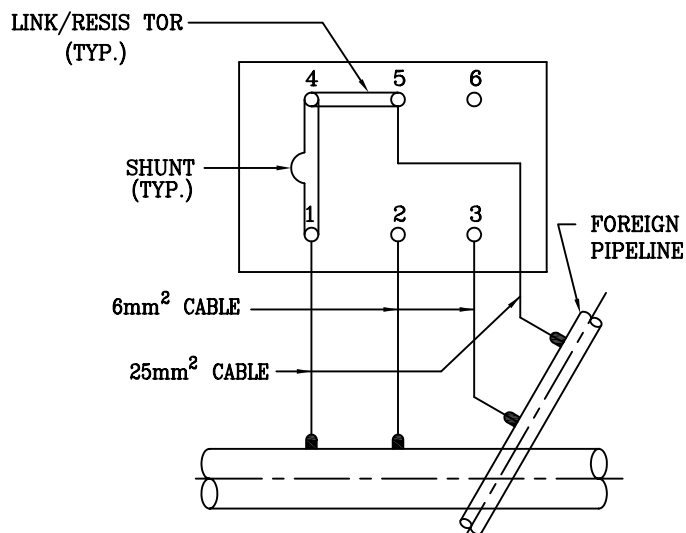
CURRENT MEASUREMENT
(CONNECTION SCHEME-B)



CASED CROSSING WITH
UNCOATED CASING
(CONNECTION SCHEME-C)

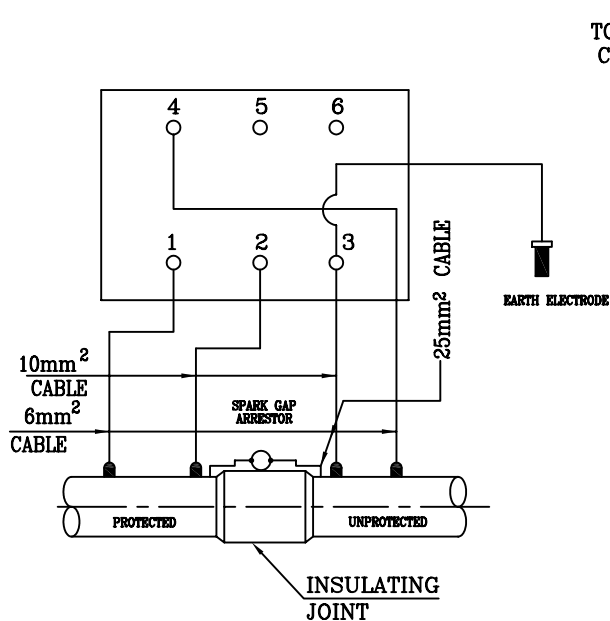


CASED CROSSING WITH
COATED CASING
(CONNECTION SCHEME-D)

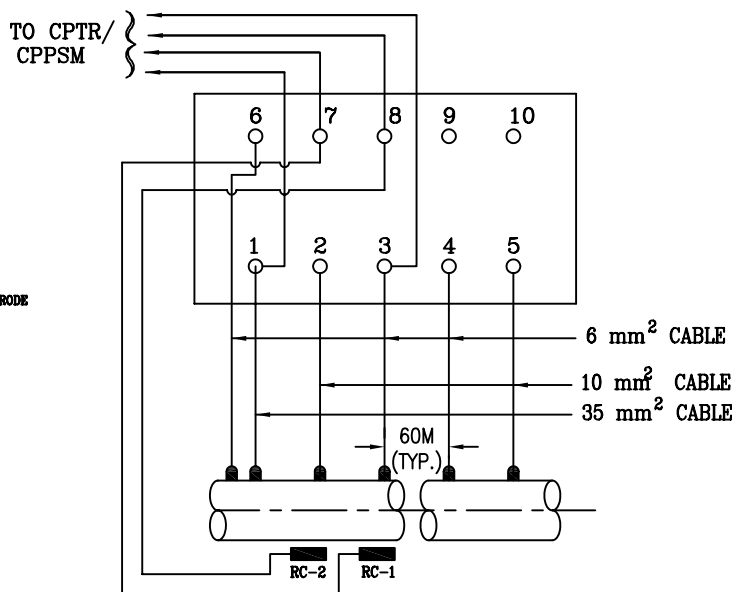


FOREIGN PIPELINE CROSSING
(CONNECTION SCHEME-E)

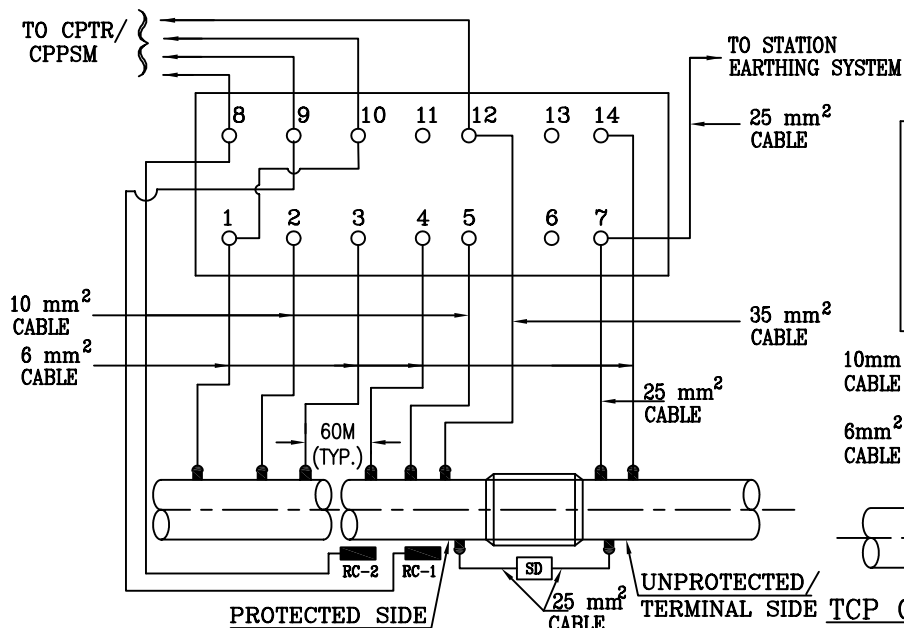
01	07.09	05/E9	REVISED & ISSUED		AM	DG				
REV NO	DATE	ZONE	DESCRIPTIONS		BY	APPRD				
REVISIONS							REFERENCES		DRG. NO.	
SECTION: ELECTRICAL					TEST STATION CONNECTION SCHEME				 मेकॉन लिमिटेड MECON LIMITED	
	NAME	DATE	CHKD	DATE						
DSGN	AM	01.09	SS	05.09						
DRWN	SJ	01.09								
APPROVED									SCALE : N.T.S.	
					DRG.NO: –MEC/SD/05/E9/E/CP/1605				1 OF 4	1



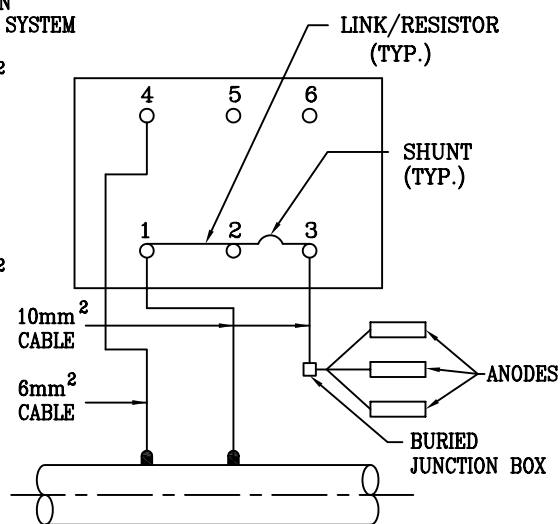
**INSULATING JOINT
(CONNECTION SCHEME-F)**



**INTERMEDIATE STATION
IMPRESSED CURRENT DRAINAGE POINT
(CONNECTION SCHEME-G)**



**TERMINAL STATION
CURRENT DRAINAGE POINT FOR PCP
(CONNECTION SCHEME-H)**



**TCP GALVANIC ANODE INSTALLATION
(CONNECTION SCHEME-I)**

01	07.09	05/E9	REVISED & ISSUED		AM	DG				
REV NO	DATE	ZONE	DESCRIPTIONS		BY	APPRD				
REVISIONS							REFERENCES		DRG. NO.	
SECTION: ELECTRICAL					TEST STATION CONNECTION SCHEMES				मेकॉन लिमिटेड	
	NAME	DATE	CHKD	DATE					MECON LIMITED	
DSGN	AM	05.09	SS	07.09						
DRWN	SJ	02.09								
APPROVED									SCALE : N.T.S.	
					DRG.NO: -MEC/SD/05/E9/E/CP/1605		2 OF 4	1		

TEST STATION CONNECTION SCHEMES



मेकॉन लिमिटेड

MECON LIMITED

SCALE : N.T.S.

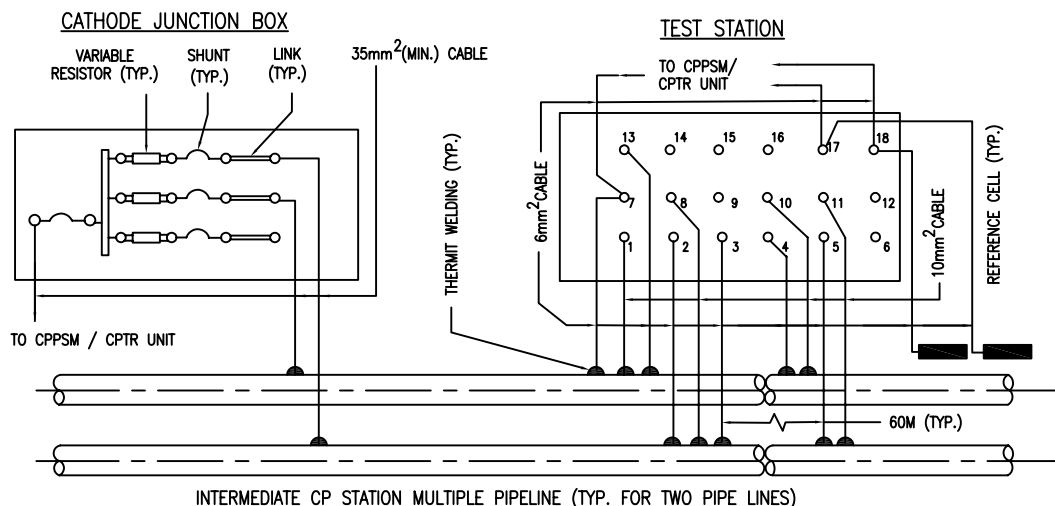
DRG.NO:-MEC/SD/05/E9/E/CP/1605

SHEET

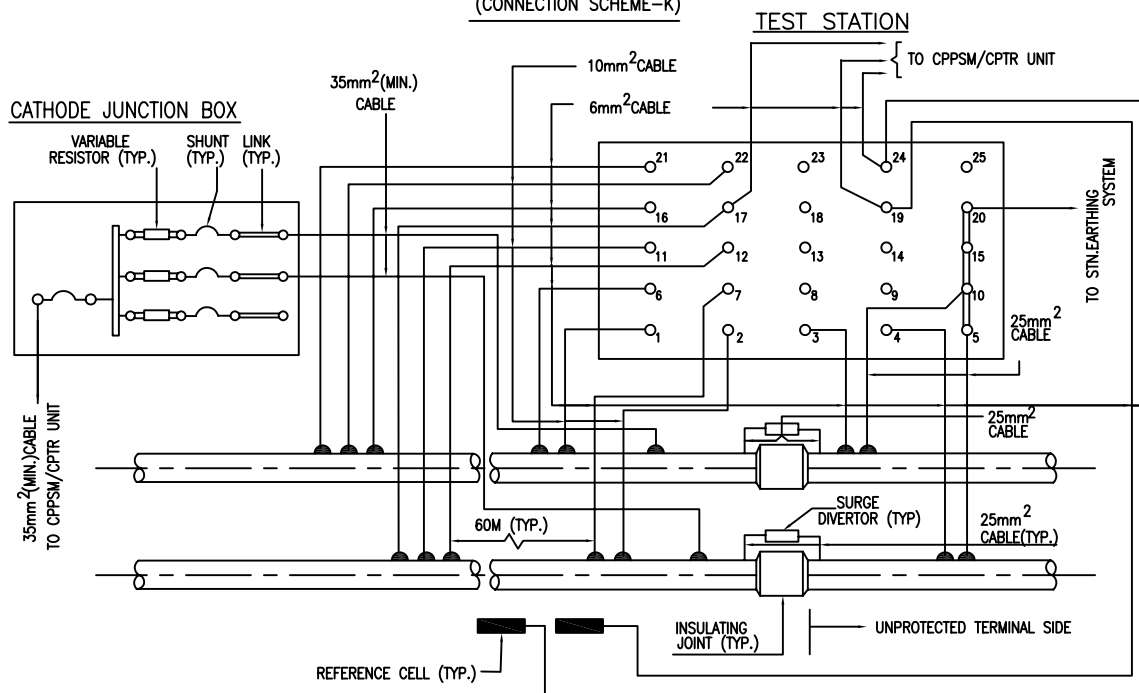
REV

2 OF 4

1



IMPRESSED CURRENT DRAINAGE POINT(WITHOUT IJs ON LINE PIPS AT THE STATION)
(CONNECTION SCHEME-K)



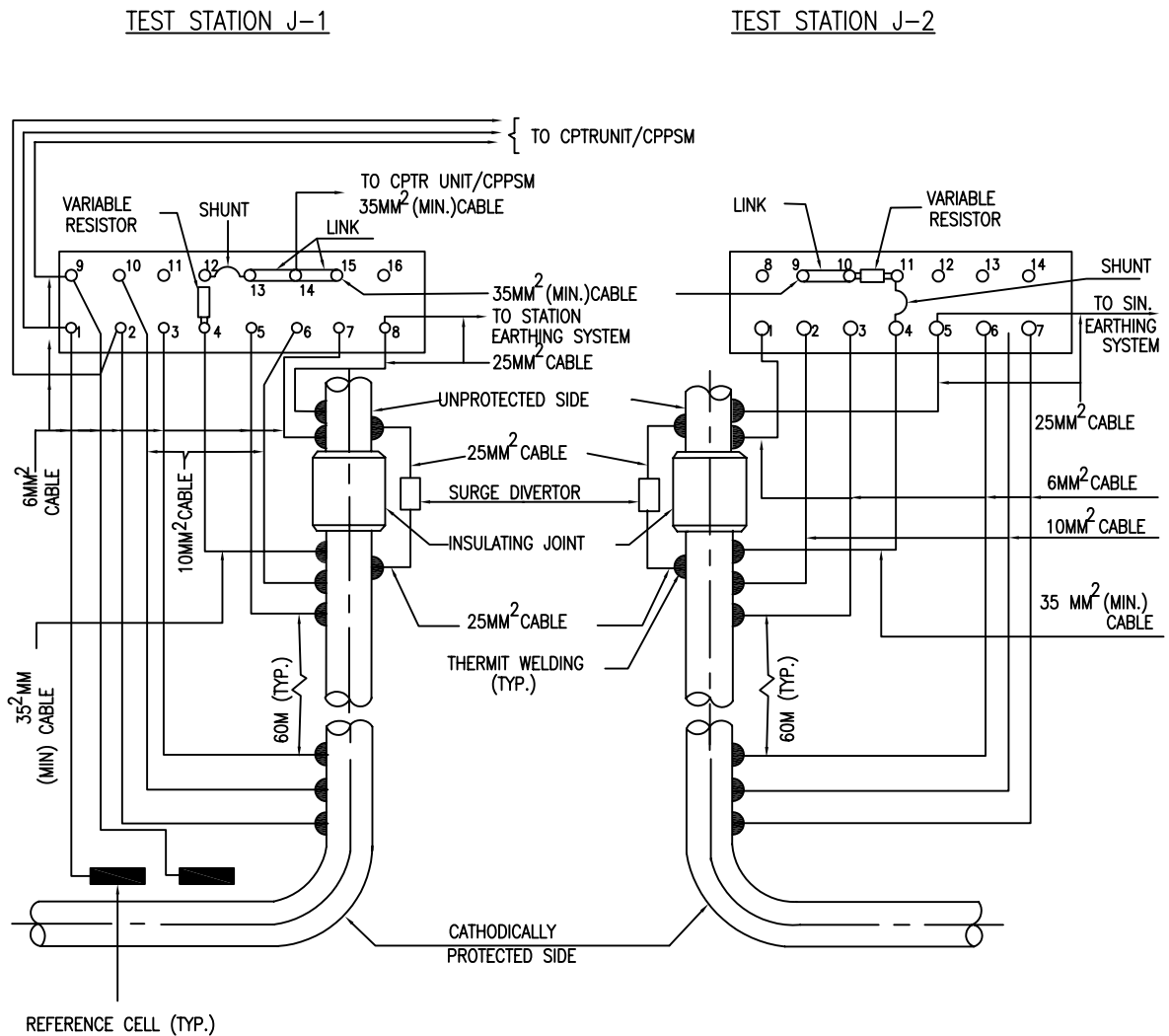
IMPRESSED CURRENT DRAINAGE POINT.(CONNECTION SCHEME-L)

NOTES:-

1. NUMBER OF TERMINALS FOR TEST STATION OF DIFFERENT CONNECTION SCHEME SHALL BE AS SHOWN ON THE RESPECTIVE SCHEME DRAWING. TEST STATION FOR ANY OTHER SCHEME SHALL PREFERABLY BE SIMILAR TO ANY OF THE ABOVE TYPE.
2. ELECTRICAL CONNECTIONS SHALL BE CLEAN TO BRIGHT SURFACE & TIGHTEND WITH NONOXIDE GREASE APPLIED ON MECHANICALLY MATED SURFACE.
3. FOR SACRIFICIAL ANODE GROUND BED WHICH IS INTENDED FOR PERMANENT CP SYSTEM AND/OR TO BE INTEGRATED WITH PERMANENT CP SYSTEM, THE LEADS OF ALL ANODES SHALL BE BROUGHT UP TO THE TEST STATION AND SHALL BE TERMINATED INDIVIDUALLY. ACCORDINGLY, THE NUMBER OF TERMINALS FOR TEST STATION SHALL BE DECIDED BASED ON NO OF ANODES.
4. WHWRE INSULATING JOINT (IJ) ON THE PIPELINE IS BURIED, THE SURGE DIVERTOR MOUNTED ACCROSS THE IJ SHALL BE HOUSED SUITABLY SO THAT OPERATION OF THE SAME IS NOT AFFECTED.
5. THE DISTANCE BETWEEN TWO SUCCESSIVE THERMIT WELDING POINTS SHALL BE MIN. 300 mm.

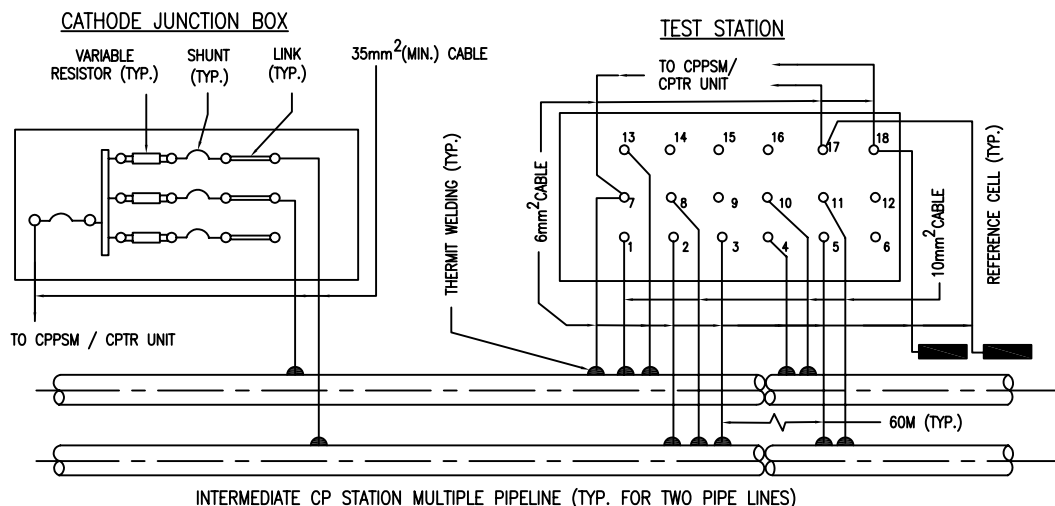
01	07.09	05/E9	REVISED & ISSUED		AM	DG				
REV NO	DATE	ZONE	DESCRIPTIONS		BY	APPRD				
REVISIONS						REFERENCES		DRG. NO.		
SECTION: ELECTRICAL				TEST STATION CONNECTION SCHEMES				मेकॉन लिमिटेड		
	NAME	DATE	CHKD					DATE	MECON LIMITED	
DSGN	AM	03.09	SS				06.09	SCALE : N.T.S.		
DRWN	SJ	03.09								
APPROVED							SHEET			REV
				4 OF 4			1			

TEST STATION CONNECTION SCHEMES

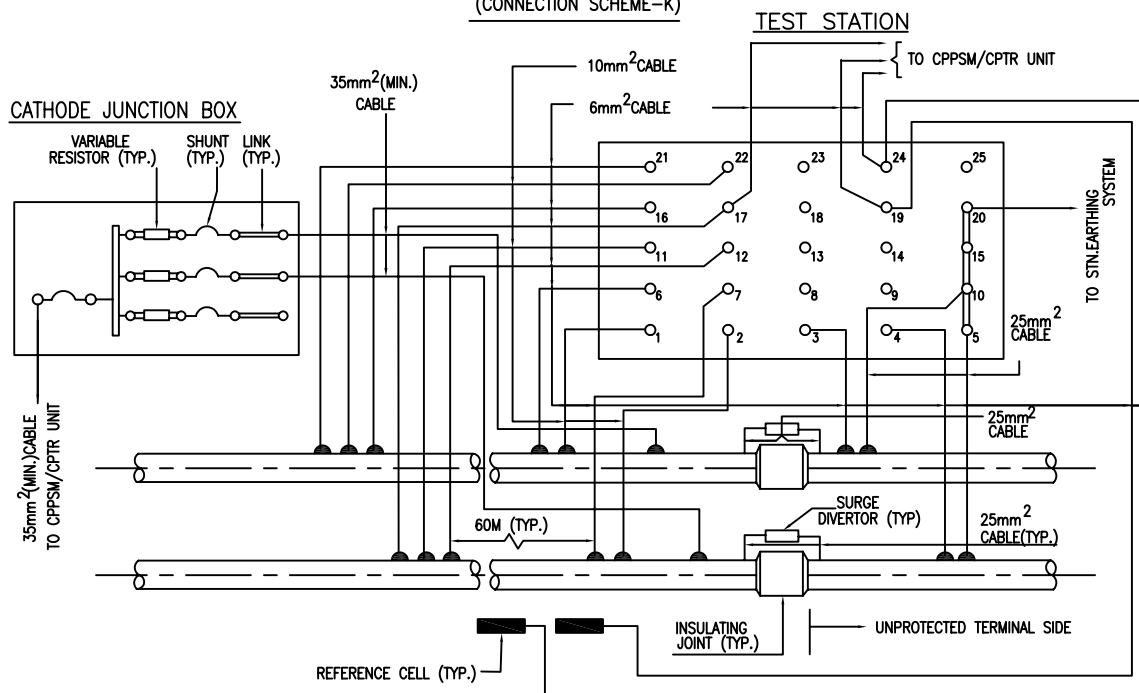


INTERMEDIATE PIGGING STATION IMPRESSED CURRENT DRAINAGE POINT
CONNECTION SCHEME-J

01	07.09	05/E9	REVISED & ISSUED			AM	DG				
REV NO	DATE	ZONE	DESCRIPTIONS			BY	APPRD				
REVISIONS							REFERENCES			DRG. NO.	
SECTION: ELECTRICAL					 मेकॉन लिमिटेड MECON LIMITED						
	NAME	DATE	CHKD	DATE							
DSGN	AM	02.09	SS	05.09							
DRWN	SJ	02.09									
APPROVED					SCALE : N.T.S.					SHEET	REV
					DRG.NO: -MEC/SD/05/E9/E/CP/1605					3 OF 4	1



IMPRESSED CURRENT DRAINAGE POINT(WITHOUT IJs ON LINE PIPS AT THE STATION)
(CONNECTION SCHEME-K)



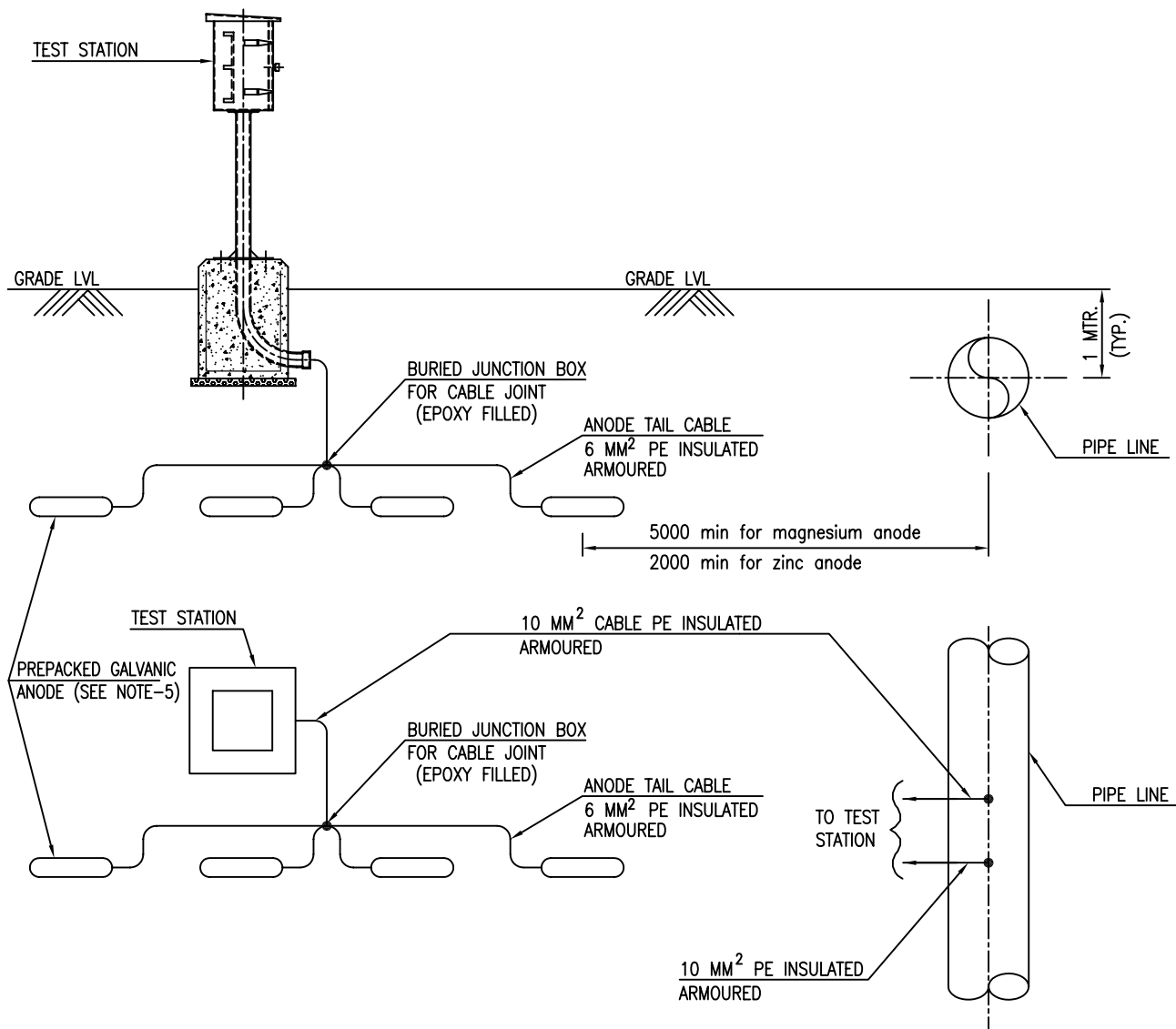
IMPRESSED CURRENT DRAINAGE POINT.(CONNECTION SCHEME-L)

NOTES:-

1. NUMBER OF TERMINALS FOR TEST STATION OF DIFFERENT CONNECTION SCHEME SHALL BE AS SHOWN ON THE RESPECTIVE SCHEME DRAWING. TEST STATION FOR ANY OTHER SCHEME SHALL PREFERABLY BE SIMILAR TO ANY OF THE ABOVE TYPE.
2. ELECTRICAL CONNECTIONS SHALL BE CLEAN TO BRIGHT SURFACE & TIGHTEND WITH NONOXIDE GREASE APPLIED ON MECHANICALLY MATED SURFACE.
3. FOR SACRIFICIAL ANODE GROUND BED WHICH IS INTENDED FOR PERMANENT CP SYSTEM AND/OR TO BE INTEGRATED WITH PERMANENT CP SYSTEM, THE LEADS OF ALL ANODES SHALL BE BROUGHT UP TO THE TEST STATION AND SHALL BE TERMINATED INDIVIDUALLY. ACCORDINGLY, THE NUMBER OF TERMINALS FOR TEST STATION SHALL BE DECIDED BASED ON NO OF ANODES.
4. WHWRE INSULATING JOINT (IJ) ON THE PIPELINE IS BURIED, THE SURGE DIVERTOR MOUNTED ACCROSS THE IJ SHALL BE HOUSED SUITABLY SO THAT OPERATION OF THE SAME IS NOT AFFECTED.
5. THE DISTANCE BETWEEN TWO SUCCESSIVE THERMIT WELDING POINTS SHALL BE MIN. 300 mm.

01	07.09	05/E9	REVISED & ISSUED	AM	DG		
REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD		
REVISIONS				REFERENCES		DRG. NO.	
SECTION: ELECTRICAL						मेकॉन लिमिटेड	
NAME	DATE	CHKD	DATE			MECON LIMITED	
DSGN	AM	03.09	SS				
DRWN	SJ	03.09					
APPROVED				SCALE : N.T.S.		SHEET	REV
				DRG.NO:-MEC/SD/05/E9/E/CP/1605		4 OF 4	1

TEST STATION CONNECTION SCHEMES



NOTES:—

1. THE PREPACKED GALVANIC ANODE SHALL BE INSTALLED AT MINIMUM DEPTH, EQUAL TO BOTTOM LEVEL OF THE PIPELINE.
2. ALL NATIVE BACKFILL SHALL BE FREE OF ROCKS, GARBAGE, PAPERS, ETC.
3. CABLE SHALL BE LAID WITH ENOUGH SLACKNESS TO AVOID DAMAGE TO CABLES DURING BACKFILLING ECT.
4. THE GALVANIC ANODES FOR PERMANENT CATHODIC PROTECTION SYSTEM SHALL BE INSTALLED IN A SIMILAR MANNER AS SHOWN. BUT ANODE TAIL CABLES OF EACH ANODE SHALL BE BROUGHT UPTO TEST STATION AND TERMINATED. NO BURIED JUNCTION BOX SHALL BE USED.
5. THE ANODES ARE SHOWN HORIZONTALLY LAID. ALTERNATIVELY THE ANODES MAY BE LAID VERTICALLY.
6. ANODE TAIL CABLE & CABLE FROM BURIED JUNCTION BOX TO TEST STATION OR TEMPERATURE C.P. ANODE MAY BE PVC INSULATED TYPE.

01	07.09	05/E9	REVISED & ISSUED				AM	DG											
REV NO	DATE	ZONE	DESCRIPTIONS				BY	APPRD											
REVISIONS									REFERENCES					DRG. NO.					
SECTION: ELECTRICAL					GALVANIC ANODE INSTALLATION											मेकॉन लिमिटेड			
	NAME	DATE	CHKD	DATE												MECON LIMITED			
DSGN	AM	01.09	SS	05.09															
DRWN	SJ	01.09																	
APPROVED																			
													DRG.NO: –MEC/SD/05/E9/E/CP/1606				1		

GALVANIC ANODE INSTALLATION

6						5						4						3						2						1					

CHEMICAL COMPOSITION OF ANODE :-

TYPE-I		TYPE-II	
Al	: 0.1-0.5%	Al	: 0.005%
Cd	: 0.025-0.07%	Cd	: 0.003%
Cu	: 0.005% MAX.	Cu	: 0.002% MAX.
Fe	: 0.005% MAX.	Fe	: 0.0014% MAX.
Pb	: 0.006% MAX.	Pb	: 0.003% MAX.
Others:	0.1% MAX.	Others	: -
Zn	: Remainder	Zn	: Remainder

NOTE :-

- STEEL CORE TO BE THERMIT WELD DIRECTLY TO CARRIER PIPE WITHIN CASING AT 4 & 8 'O' CLOCK POSITION. FOR CARRIER PIPE OF LESS THAN 4 INCH DIA., ANODES MAY BE PROVIDED ALONG THE CARRIER PIPE LENGTH AT BOTTOM
- SIZE OF ANODE & SPACING BETWEEN ANODE SHALL BE DECIDED BASED ON DESIGN CRITERIA.
- PIPE SPACER / CENTRALISERS NOT SHOWN.
- DIMENSION & WEIGHT OF THE ANODE PER UNIT LENGTH SHALL BE FURNISHED BY THE CONTRACTOR.
- CASING PIPE SHALL BE PROTECTED BY GALVANIC ANODES INSTALLED AT BOTH THE ENDS IF THE CASING PIPE IS COATED AGAINST CORROSION OF EXTERNAL SURFACE.

01	07.09	05/E9	REVISED & ISSUED	AM	DG		
REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD		
REFERENCES						DRG. NO.	

SECTION: ELECTRICAL

	NAME	DATE	CHKD	DATE
DSGN	AM	03.09	SS	04.09
DRWN	SJ	03.09		

APPROVED

ZINC RIBBON ANODE FOR CASED CROSSING WITH COATED CASING

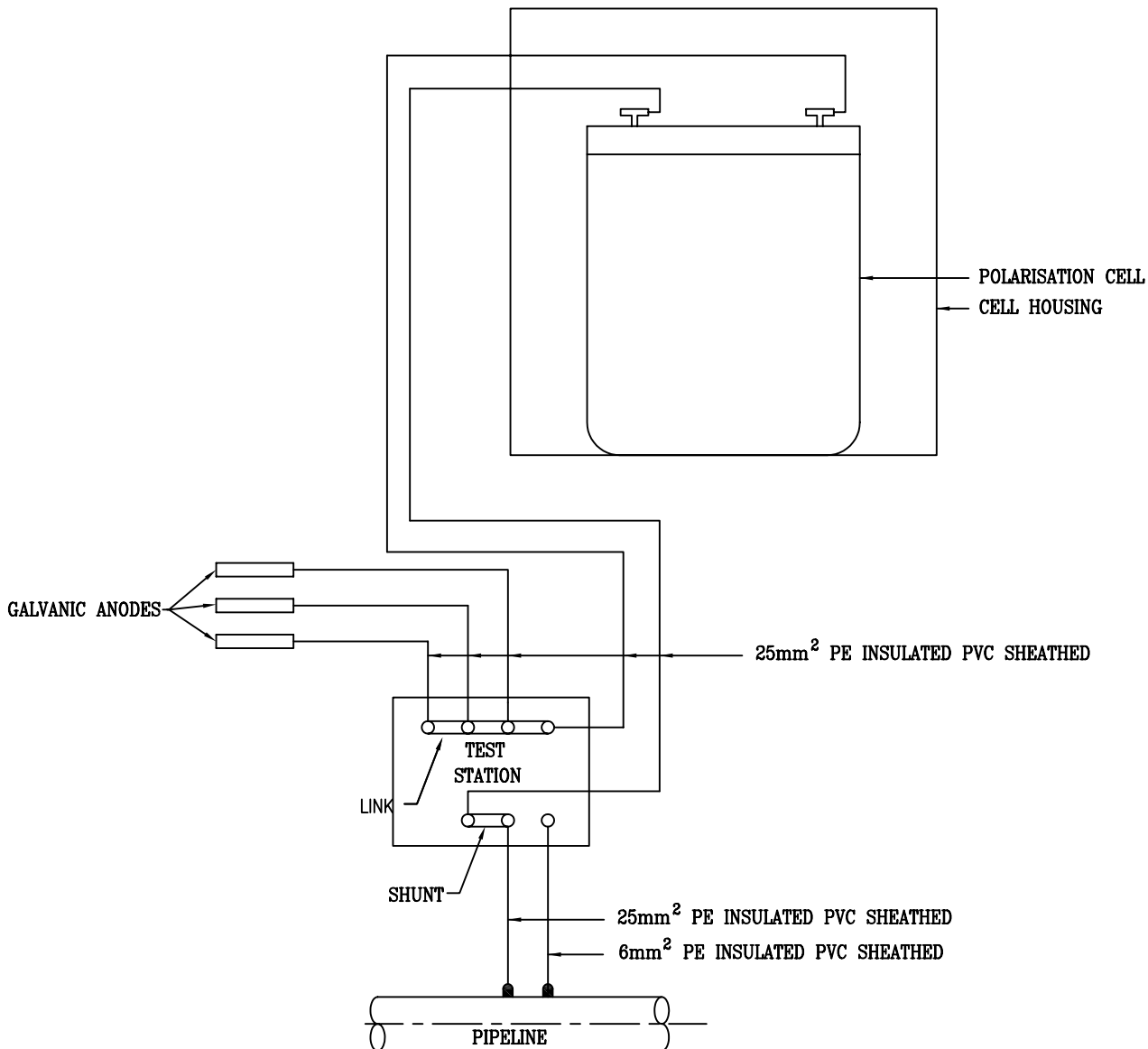
MECON LIMITED

SCALE : N.T.S.

DRG.NO:-MEC/SD/05/E9/E/CP/1607

REV 1

6						5						4						3						2						1					



(CONNECTION SCHEME-H)

NOTES:-

1. THE POLARISATION CELL, ANODES, CABLE, CABLE JOINT ETC. SHALL MINIMUM BE RATED FOR THE EXPECTED FAULT CURRENT AT THE LOCATION OF THE INSTALLATION & SIZED FOR PERMANENT C.P. LIFE.
2. THE POLARISATION CELL SHALL BE HOUSED IN A VANDALLISM PROOF HOUSING.
3. CELL SHALL HAVE GOOD VENTILATION TO ATMOSPHERE & SHALL BE PROTECTED AGAINST DIRECT SUN LIGHT & RAIN/ WATER.
4. ANODE TAIL CABLES OF EACH ANODE SHALL BE TERMINATED INDIVIDUALLY IN TEST STATION.
5. CONTRACTOR SHALL FURNISHED DRAWING WITH ACTUAL DIMENSIONS & RATING.
6. EASY ACCESS TO CELL SHALL BE PROVIDED FOR PERIODIC INSPECTION.
4. 20% EXTRA TERMINALS SHALL BE PROVIDED.

01	07.09	05/E9	REVISED & ISSUED		AM	DG				
REV NO	DATE	ZONE	DESCRIPTIONS		BY	APPRD				
REVISIONS						REFERENCES		DRG. NO.		
SECTION: ELECTRICAL			PIPELINE GROUNDING THROUGH POLARISATION CELL & GALVANIC ANODE					मेकॉन लिमिटेड		
	NAME	DATE						CHKD	DATE	MECON LIMITED
DSGN	AM	02.09					SS	05.09		
DRWN	SJ	02.09								
APPROVED							SCALE : N.T.S.		SHEET	REV
							DRG.NO: –MEC/SD/05/E9/E/CP/1608		1 OF 2	1

PIPELINE GROUNDING THROUGH
POLARISATION CELL & GALVANIC ANODE



मेकॉन लिमिटेड

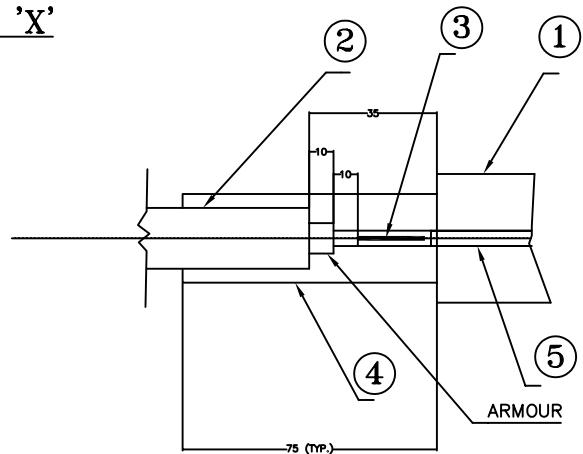
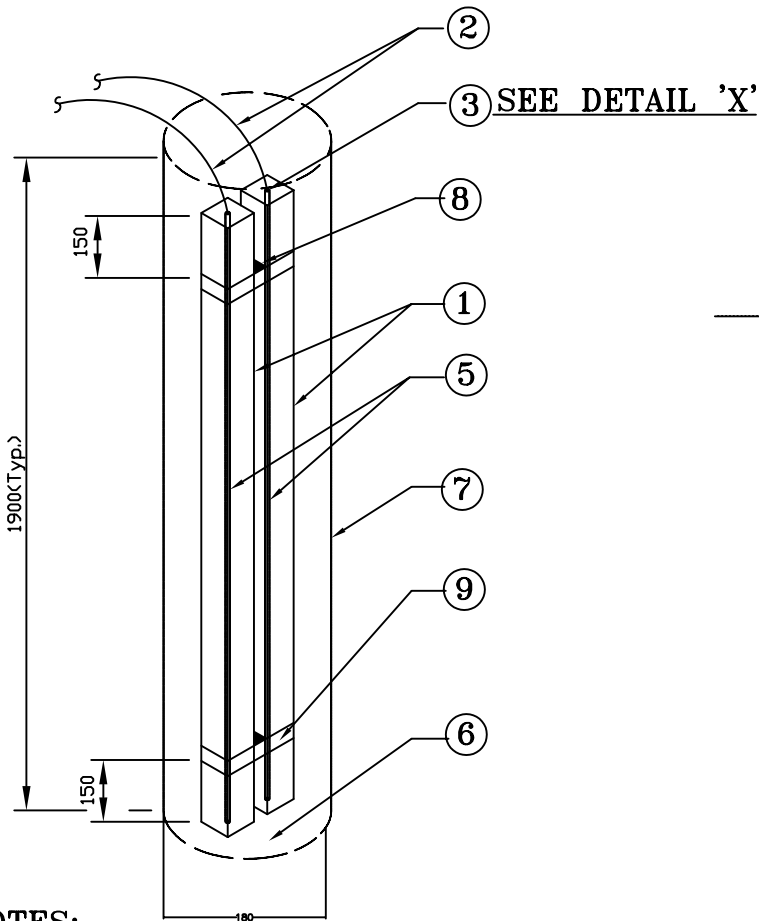
MECON LIMITED

SCALE : N.T.S.

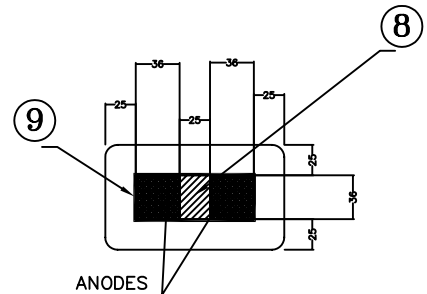
DRG.NO:-MEC/SD/05/E9/E/CP/1608

SHEET REV

1 OF 2 1



DETAIL 'X'



NOTES:-

1. ALL DIMENSIONS ARE TYPICAL IN mm.
2. ZINC GROUNDING CELLS SHALL BE INSTALLED VERTICALLY SUCH THAT THE TOP OF THE CELL IS APPROX. AT THE SAME ELEV. AS PIPE BOTTOM.
3. ALL CABLE LEADS FOR ZINC GROUNDING CELL SHALL BE KEPT AS SHORT AND DIRECT AS POSSIBLE.
4. GROUNDING CELL CABLE ARMOUR SHALL NOT HAVE ELECT. CONNECTION TO ANODE.

ZINC ANODE COMPOSITION (%WEIGHT)

ELEMENT	TYPE-I	TYPE-II
Al	0.1-0.5 %MAX	0.005 %MAX
Cd	0.025-0.07%MAX	0.003 %MAX
Cu	0.005% MAX	0.002 %MAX
Fe	0.005% MAX	0.0014%MAX
Pb	0.006% MAX	0.003 %MAX
OTHERS	0.1% MAX	-
Zn	REMAINDER	REMAINDER

ZINC ALLOY CONFORMING TO ASTM-B-418-67

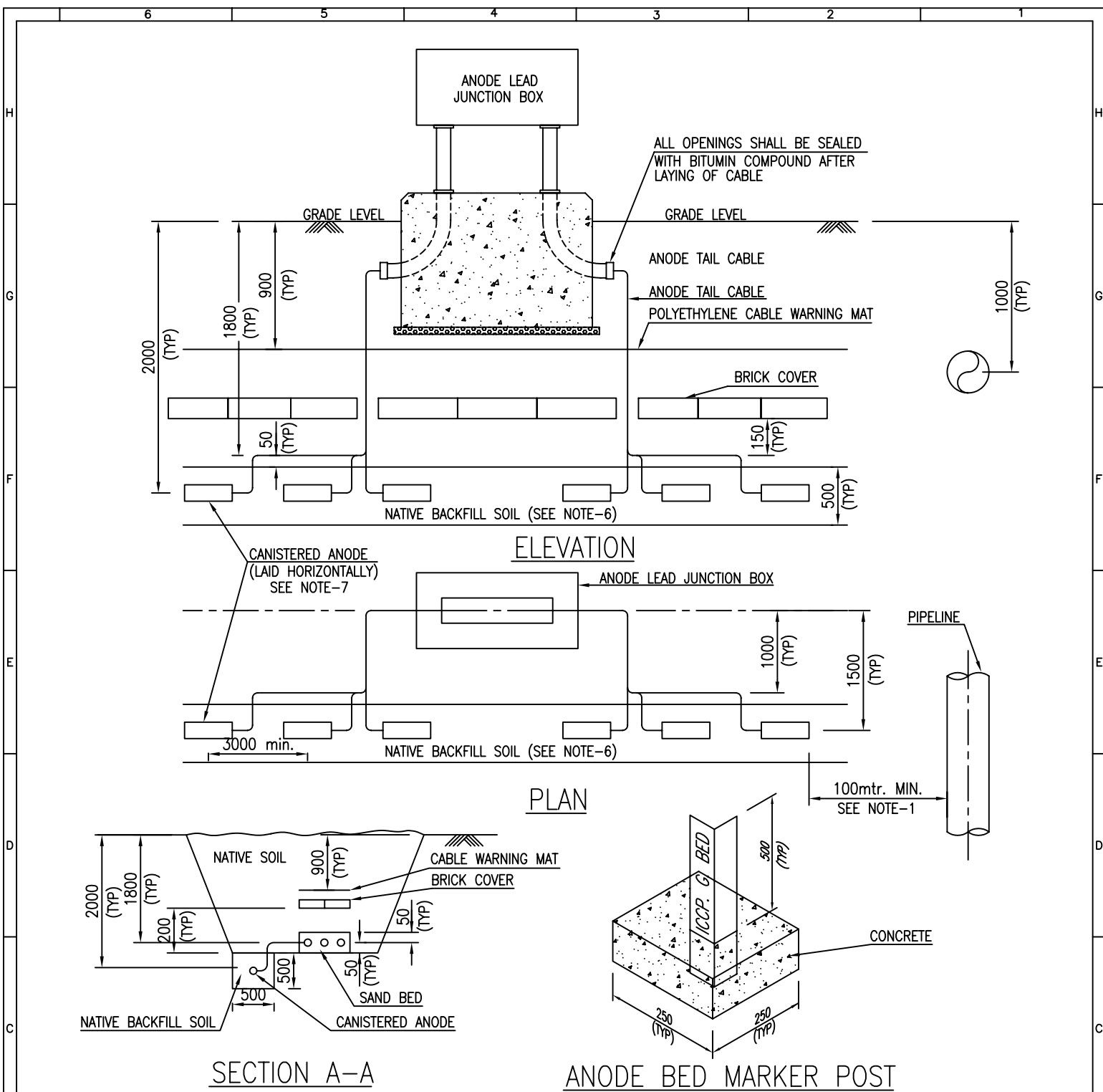
BACKFILL COMPOSITION

GYPSUM	75%
BENTONITE	20%
SODIUM SULPHATE	5%

9	TAPE STRAP	AS REQD.
8	BAKELITE INSULATING SPACER 25X36X50	2 NOS.
7	COTTON BAG 180Ø.	1 NO.
6	BACK FILL MAT.	AS REQD.
5	6mmØ GALVANISED STEEL CORE	AS REQD.
4	HEAT SHRINK SLEEVE.	2 NOS.
3	SILVER BRAZED CONNECTION	2 NOS.
2	ANODE TAIL CABLE 25mm Sq. 1C Cu XLPE/ PVC SHEATHED ARMoured 600/1000V.	30 mt.
1	ZINC ANODE	2 NOS.
ITEM NO.	DESCRIPTION	QTY.
BILL OF MATERIALS		

01	07.09	05/E9	REVISED & ISSUED	AM	DG			
REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD			
REVISIONS				REFERENCES		DRG. NO.		
SECTION: ELECTRICAL				 मेकॉन लिमिटेड MECON LIMITED		SCALE : N.T.S.		
DSGN	AM	03.09	SS			05.09	REV	
DRWN	SJ	03.09					1	
APPROVED						DRG.NO:-MEC/SD/05/E9/E/CP/1609		

**DETAILS OF
ZINC GROUNDING CELL**



NOTES:-

1. THE ANODE GROUND BED SHALL BE LOCATED ELECTRICALLY REMOTE FROM THE PIPELINE WITH MIN. 100 MTR. AWAY FROM THE NEAREST POINT ON THE PIPELINE.
2. NO SPLICING SHALL BE ALLOWED FOR THE CABLES.
3. CONTRACTOR SHALL FURNISH THE DIMENSIONS DRAWING SHOWING ACTUAL QUANTITY OF ANODES FOR EACH GROUND BED.
4. ALL UNARMoured CABLES SHALL BE RUN THROUGH PE SLEEVES.
5. ANODE BED MARKER SHALL BE FIXED ON BOTH SIDES OF GROUND BEDS.
6. NATIVE BACKFILL SOIL SHALL BE FREE OF ROCKS, GARBAGE, PAPER, PLASTICS ETC.
7. ANODES MAY BE LAID VERTICALLY IN CASE VERTICAL SHALLOW ANODE GROUND BED DESIGN.
8. ALL THE DIMENSIONS ARE IN MM.

REV NO	DATE	ZONE	DESCRIPTIONS	AM	DG	REFERENCES	DRG. NO.
01	07.09	05/E9	REVISED & ISSUED	AM	DG		
02	07.09	05/E9	REVISED & ISSUED	AM	DG		
03	07.09	05/E9	REVISED & ISSUED	AM	DG		
04	07.09	05/E9	REVISED & ISSUED	AM	DG		
05	07.09	05/E9	REVISED & ISSUED	AM	DG		
06	07.09	05/E9	REVISED & ISSUED	AM	DG		
07	07.09	05/E9	REVISED & ISSUED	AM	DG		
08	07.09	05/E9	REVISED & ISSUED	AM	DG		
09	07.09	05/E9	REVISED & ISSUED	AM	DG		
10	07.09	05/E9	REVISED & ISSUED	AM	DG		
11	07.09	05/E9	REVISED & ISSUED	AM	DG		
12	07.09	05/E9	REVISED & ISSUED	AM	DG		
13	07.09	05/E9	REVISED & ISSUED	AM	DG		
14	07.09	05/E9	REVISED & ISSUED	AM	DG		
15	07.09	05/E9	REVISED & ISSUED	AM	DG		
16	07.09	05/E9	REVISED & ISSUED	AM	DG		
17	07.09	05/E9	REVISED & ISSUED	AM	DG		
18	07.09	05/E9	REVISED & ISSUED	AM	DG		
19	07.09	05/E9	REVISED & ISSUED	AM	DG		
20	07.09	05/E9	REVISED & ISSUED	AM	DG		
21	07.09	05/E9	REVISED & ISSUED	AM	DG		
22	07.09	05/E9	REVISED & ISSUED	AM	DG		
23	07.09	05/E9	REVISED & ISSUED	AM	DG		
24	07.09	05/E9	REVISED & ISSUED	AM	DG		
25	07.09	05/E9	REVISED & ISSUED	AM	DG		
26	07.09	05/E9	REVISED & ISSUED	AM	DG		
27	07.09	05/E9	REVISED & ISSUED	AM	DG		
28	07.09	05/E9	REVISED & ISSUED	AM	DG		
29	07.09	05/E9	REVISED & ISSUED	AM	DG		
30	07.09	05/E9	REVISED & ISSUED	AM	DG		
31	07.09	05/E9	REVISED & ISSUED	AM	DG		
32	07.09	05/E9	REVISED & ISSUED	AM	DG		
33	07.09	05/E9	REVISED & ISSUED	AM	DG		
34	07.09	05/E9	REVISED & ISSUED	AM	DG		
35	07.09	05/E9	REVISED & ISSUED	AM	DG		
36	07.09	05/E9	REVISED & ISSUED	AM	DG		
37	07.09	05/E9	REVISED & ISSUED	AM	DG		
38	07.09	05/E9	REVISED & ISSUED	AM	DG		
39	07.09	05/E9	REVISED & ISSUED	AM	DG		
40	07.09	05/E9	REVISED & ISSUED	AM	DG		
41	07.09	05/E9	REVISED & ISSUED	AM	DG		
42	07.09	05/E9	REVISED & ISSUED	AM	DG		
43	07.09	05/E9	REVISED & ISSUED	AM	DG		
44	07.09	05/E9	REVISED & ISSUED	AM	DG		
45	07.09	05/E9	REVISED & ISSUED	AM	DG		
46	07.09	05/E9	REVISED & ISSUED	AM	DG		
47	07.09	05/E9	REVISED & ISSUED	AM	DG		
48	07.09	05/E9	REVISED & ISSUED	AM	DG		
49	07.09	05/E9	REVISED & ISSUED	AM	DG		
50	07.09	05/E9	REVISED & ISSUED	AM	DG		
51	07.09	05/E9	REVISED & ISSUED	AM	DG		
52	07.09	05/E9	REVISED & ISSUED	AM	DG		
53	07.09	05/E9	REVISED & ISSUED	AM	DG		
54	07.09	05/E9	REVISED & ISSUED	AM	DG		
55	07.09	05/E9	REVISED & ISSUED	AM	DG		
56	07.09	05/E9	REVISED & ISSUED	AM	DG		
57	07.09	05/E9	REVISED & ISSUED	AM	DG		
58	07.09	05/E9	REVISED & ISSUED	AM	DG		
59	07.09	05/E9	REVISED & ISSUED	AM	DG		
60	07.09	05/E9	REVISED & ISSUED	AM	DG		
61	07.09	05/E9	REVISED & ISSUED	AM	DG		
62	07.09	05/E9	REVISED & ISSUED	AM	DG		
63	07.09	05/E9	REVISED & ISSUED	AM	DG		
64	07.09	05/E9	REVISED & ISSUED	AM	DG		
65	07.09	05/E9	REVISED & ISSUED	AM	DG		
66	07.09	05/E9	REVISED & ISSUED	AM	DG		
67	07.09	05/E9	REVISED & ISSUED	AM	DG		
68	07.09	05/E9	REVISED & ISSUED	AM	DG		
69	07.09	05/E9	REVISED & ISSUED	AM	DG		
70	07.09	05/E9	REVISED & ISSUED	AM	DG		
71	07.09	05/E9	REVISED & ISSUED	AM	DG		
72	07.09	05/E9	REVISED & ISSUED	AM	DG		
73	07.09	05/E9	REVISED & ISSUED	AM	DG		
74	07.09	05/E9	REVISED & ISSUED	AM	DG		
75	07.09	05/E9	REVISED & ISSUED	AM	DG		
76	07.09	05/E9	REVISED & ISSUED	AM	DG		
77	07.09	05/E9	REVISED & ISSUED	AM	DG		
78	07.09	05/E9	REVISED & ISSUED	AM	DG		
79	07.09	05/E9	REVISED & ISSUED	AM	DG		
80	07.09	05/E9	REVISED & ISSUED	AM	DG		
81	07.09	05/E9	REVISED & ISSUED	AM	DG		
82	07.09	05/E9	REVISED & ISSUED	AM	DG		
83	07.09	05/E9	REVISED & ISSUED	AM	DG		
84	07.09	05/E9	REVISED & ISSUED	AM	DG		
85	07.09	05/E9	REVISED & ISSUED	AM	DG		
86	07.09	05/E9	REVISED & ISSUED	AM	DG		
87	07.09	05/E9	REVISED & ISSUED	AM	DG		
88	07.09	05/E9	REVISED & ISSUED	AM	DG		
89	07.09	05/E9	REVISED & ISSUED	AM	DG		
90	07.09	05/E9	REVISED & ISSUED	AM	DG		
91	07.09	05/E9	REVISED & ISSUED	AM	DG		
92	07.09	05/E9	REVISED & ISSUED	AM	DG		
93	07.09	05/E9	REVISED & ISSUED	AM	DG		
94	07.09	05/E9	REVISED & ISSUED	AM	DG		
95	07.09	05/E9	REVISED & ISSUED	AM	DG		
96	07.09	05/E9	REVISED & ISSUED	AM	DG		
97	07.09	05/E9	REVISED & ISSUED	AM	DG		
98	07.09	05/E9	REVISED & ISSUED	AM	DG		
99	07.09	05/E9	REVISED & ISSUED	AM	DG		
100	07.09	05/E9	REVISED & ISSUED	AM	DG		

NAME	DATE	CHKD	DATE
DSGN	AM	02.09	SS
DRWN	SJ	02.09	
APPROVED			

SHALLOW ANODE GROUND BED (PCP) WITH CANISTERED ANODE



मेकॉन लिमिटेड

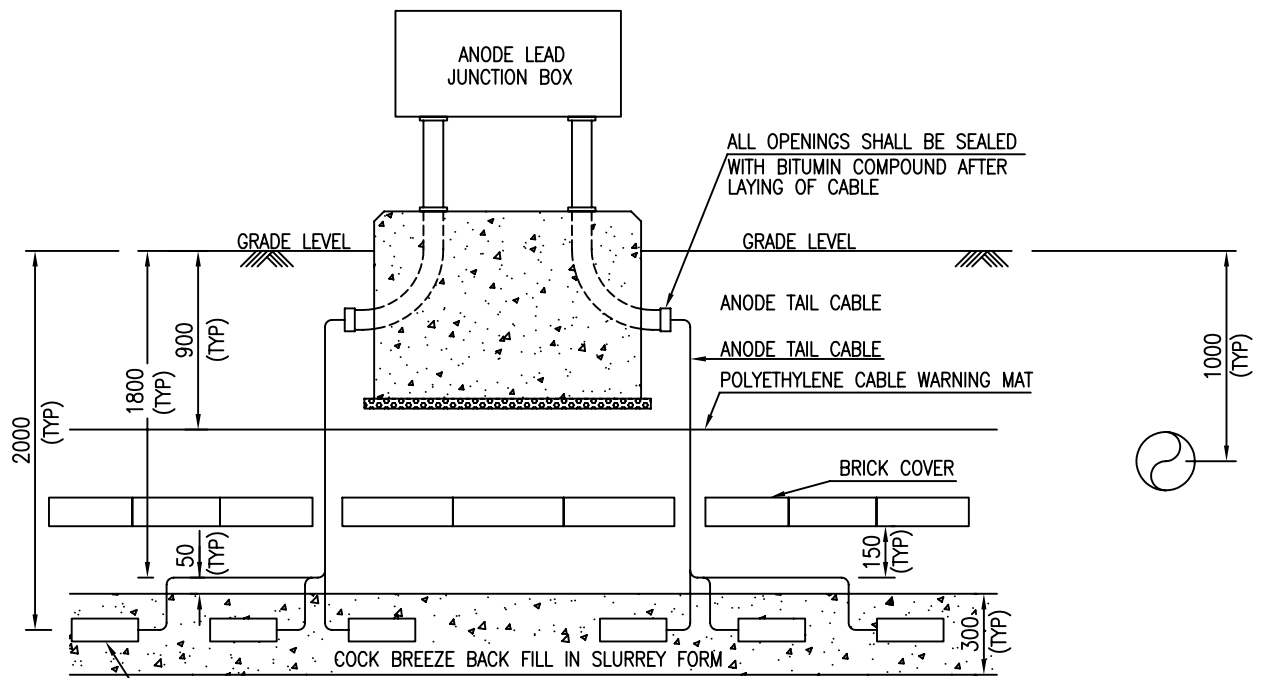
MECON LIMITED

SCALE : N.T.S.

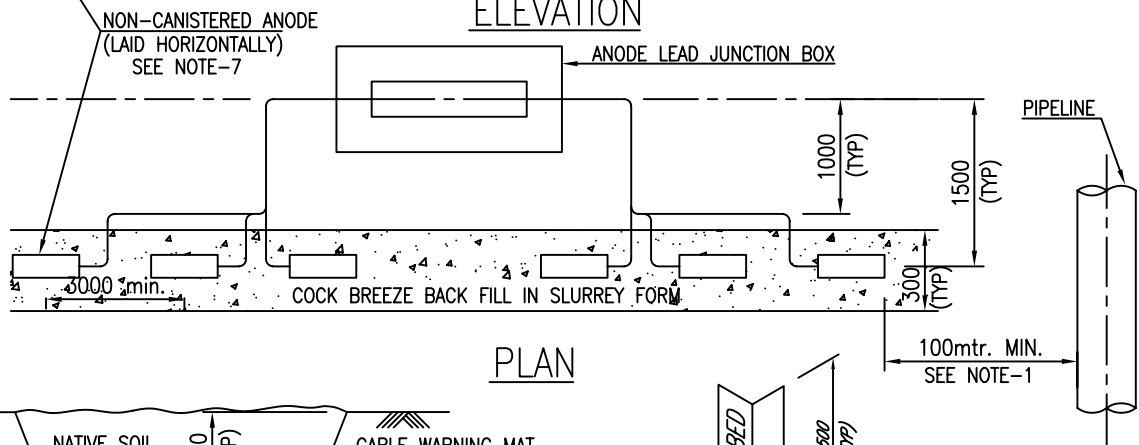
DRG.NO: -MEC/SD/05/E9/E/CP/1611

SHEET REV

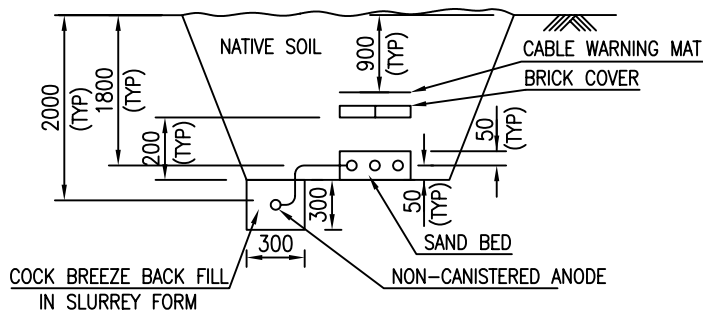
1 OF 3 1



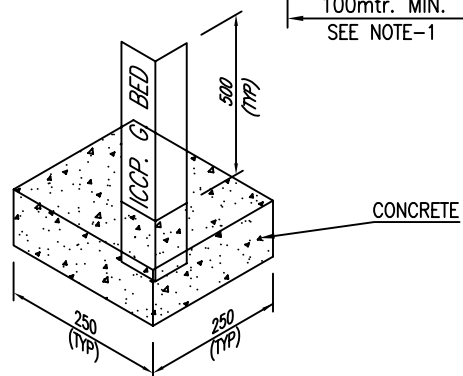
ELEVATION



PLAN



SECTION A-A

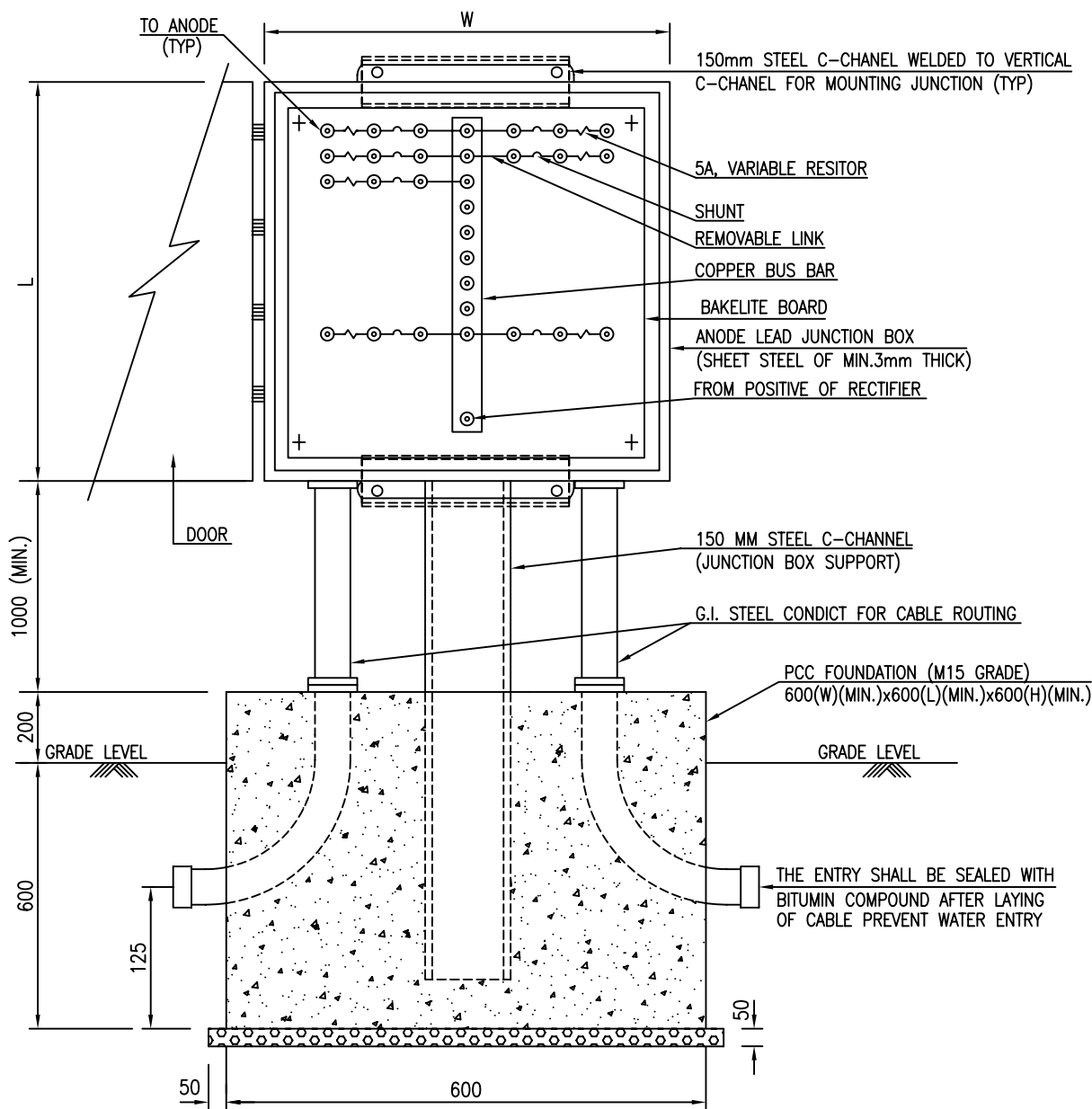


ANODE BED MARKER POST

NOTES:-

1. THE ANODE GROUND BED SHALL BE LOCATED ELECTRICALLY REMOTE FROM THE PIPELINE WITH MIN. 100 MTR. AWAY FROM THE NEAREST POINT ON THE PIPELINE.
2. NO SPLICING SHALL BE ALLOWED FOR THE CABLES.
3. CONTRACTOR SHALL FURNISH THE DIMENSIONS DRAWING SHOWING ACTUAL QUANTITY OF ANODES FOR EACH GROUND BED.
4. ALL UNARMoured CABLES SHALL BE RUN THROUGH PE SLEEVES.
5. ANODE BED MARKER SHALL BE FIXED ON BOTH SIDES OF GROUND BEDS.
6. ANODES MAY BE LAID VERTICALLY IN CASE VERTICAL SHALLOW ANODE GROUND BED DESIGN.
7. ALL THE DIMENSIONS ARE IN MM.

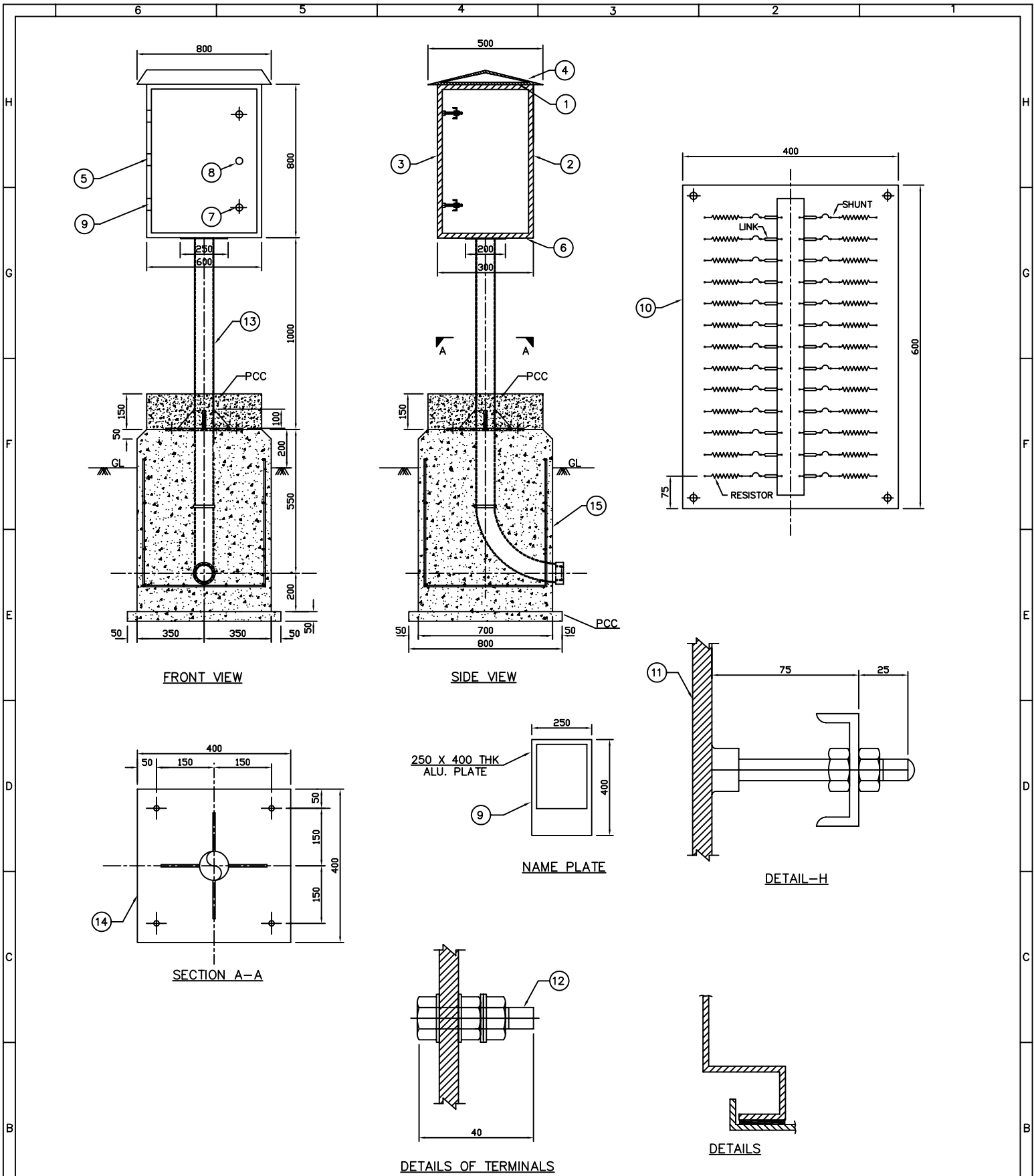
01	07.09	05/E9	REVISED & ISSUED	AM	DG		
REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD		
REVISIONS				REFERENCES		DRG. NO.	
SECTION: ELECTRICAL				MECON LIMITED		MECON LIMITED	
NAME	DATE	CHKD	DATE	SCALE : N.T.S.		SHEET	REV
DSGN	AM	02.09	SS	05.09		2 OF 3	1
DRWN	SJ	02.09					
APPROVED				DRG.NO:-MEC/SD/05/E9/E/CP/1611			



NOTES:-

1. SHUTTER SHALL BE HINGED TYPE WITH CONCEALED LOCK THE DOOR SHALL BE PROVIDED WITH GASKET TO MAKE THE BOX WEATHER PROOF (IP:55).
2. INSIDE & OUTSIDE OF THE BOX SHALL BE EPOXY PAINTED.
3. THE HEIGHT OF THE JUNCTION BOX ABOVE GROUND LEVEL, INDICATED IN THIS STANDARD IS MINIMUM. THE ACTUAL HEIGHT SHALL BE DECIDED BASED ON LOCAL FLOOD LEVELS.
4. NUMBER OF ANODE CIRCUITS SHOWN IN THIS STANDARD ARE INDICATE ONLY. CONTRACTOR DRAWING WITH ACTUAL DIMENSIONS & NUMBER OF ANODE CIRCUITS. SHALL FURNISH
5. THE SIZE OF THE CONCRETE FOOTING SHOWN IS MINIMUM ONLY, CONTRACTOR SHALL PROVIDE ADEQUATELY SIZED FOUNDATION BASED ON SOIL CONDITION AND DIMENSIONS OF ANODE LEAD JUNCTION BOX.
6. ALL THE DIMENSIONS ARE IN MM.

01	07.09	05/E9	REVISED & ISSUED		AM	DG					
REV NO	DATE	ZONE	DESCRIPTIONS		BY	APPRD					
REVISIONS						REFERENCES		DRG. NO.			
SECTION: ELECTRICAL			SHALLOW ANODE GROUND BED (PCP)					मेकॉन लिमिटेड			
	NAME	DATE						CHKD	DATE	MECON LIMITED	
DSGN	AM	03.09					SS	06.09	SCALE : N.T.S.	SHEET	REV
DRWN	SJ	03.09									
APPROVED							DRG.NO: -MEC/SD/05/E9/E/CP/1611	3 OF 3			



01	07.09	05/E9	REVISED & ISSUED				AM	DG															
REV NO	DATE	ZONE	DESCRIPTIONS				BY	APPRD															
REVISIONS								REFERENCES				DRG. NO.											
SECTION: ELECTRICAL					ANODE LEAD JUNCTION BOX						मेकॉन लिमिटेड												
	NAME	DATE	CHKD	DATE																			
DSGN	AM	03.09	SS	04.09																			
DRWN	SJ	03.09																					
APPROVED															SCALE : N.T.S.		SHEET	REV					
										DRG.NO: -MEC/SD/05/E9/E/CP/1612					1 OF 2	1							
		6				5				4				3				2				1	

NOTES:-

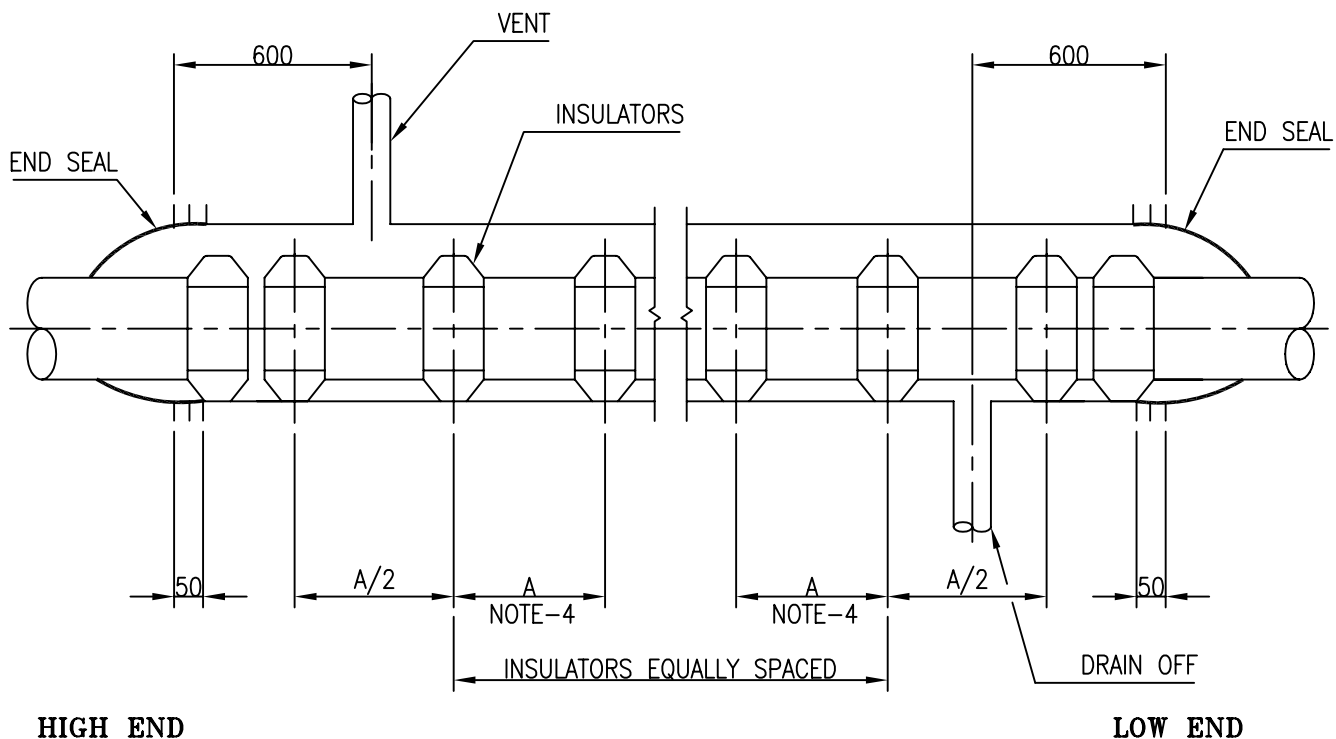
1. ANODE LEAD JUNCTION BOX SHALL HAVE WEATHERPROOF ENCLOSURE HAVING DEGREE OF PROTECTION IP-55, AS DEFINED IN IEC-529 (1989)/IS:2147 (1962)THE SHUTTER SHALL BE HINGED TYPE WITH CONCEALED LOCK AND SHALL HAVE DOOR GASKET.
2. THE HINGES SHALL BE WELDED TO THE SHUTTER AND THE BOX SUITABLY.
3. THE MS ANGLES SHALL BE WELDED TO THE SIDES. THE ANGLES SHALL HAVE TAPPED HOLES FOR FIXING TERMINAL PLATE.
4. THE INNER SURFACE OF THE AJB SHALL BE PAINTED WITH LEAD OXIDE PRIMER GRADE.
5. THE OUTSIDE OF THE AJB SHALL BE PAINTED WITH TWO COATS OF ZINC RED EPOXY PRIMER AND THREE COATS OF GREY COLOURED EPOXY PAINT COMPLETE WITH CABLE PIPE & FDN. PLATE.
6. THE NAME PLATE SHALL BE OF ANODISED ALUMINIUM WITH BLACK BACKGROUND AND WHITE LETTERS (SIZE 3mm). THE NAME PLATE SHALL BE FIXED TO INNER SIDE OF SHUTTER BY ARALDITE OR EQUIVALENT.
7. WHEN ERECTED,THE AJB SHALL BE IN UPRIGHT POSITION.
8. HEIGHT OF THE AJB ABOVE GROUND LEVEL SHOWN IN THE DRAWING IS TYPICAL.
9. ALL CABLES COMING TO AJB SHALL BE LABELLED ON BOTH ENDS WITH IDENTIFICATION NUMBERS
10. TEST BETWEEN BRASS TERMINALS AND BODY AT 2kv FOR ONE MINUTE.
11. ALL DIMENSIONS ARE APPROXIMATE AND CAN VARY SLIGHTLY.
12. ALL DIMENSIONS ARE IN mm.
13. PIPE ENTRY SHALL BE SEALED WITH BITUMEN COMPOUND AFTER LAYING OF CABLE TO PREVENT WATER ENTRY.

16	NEOPRENE RUBBER GASKET FOR SHUTTER	AS REQD.
15	CONCRETE FOUNDATION (PCC 1:5:10, RCC M20)	01
14	BASE PLATE (400 X 400 X5 THICK)	2
13	4' DIA MS PIPE(4MM WALL THICK) ALONG WITH BEND)	1 SET
12	BRASS TERMINAL M5 DIA 60MM LONG FOR ONE TERM.	01
11	NUT BOLT FOR FIXING TERMINAL PLATE	04
10	BACKELITE TERMINAL PLATE,350 X600 X 6 MM THICK MS	01
9	HINGE FOR SHUTTER	03
8	CASTLE LOCK WITH ONE KEY PER TEST STATION	01
7	NORMAL PANEL LOCK WITH MASTER KEY	02
6	BOTTOM PLATE 225 X 500 X 3 MM THICK MS	01
5	SIDE PLATE 225 X800 X 3 MM THICK MS	01
4	CANOPY (TRIANGLE AS PER DRG.) 3 MM THK MS	01
3	SIDE PLATE 225 X800 X 3 MM THICK MS	01
2	REAR PLATE 500 X 800 X 3 MM THICK MS	01
1	TOP PLATE, 550 X 275 X 3 MM THICK M.S.	01
ITEM	DESCRIPTION	QTY.
BILL OF MATERIALS		

8 mm dia (M8) Cd Coated
Brass Nut Bolt

01	07.09	05/E9	REVISED & ISSUED	AM	DG			
REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD			
REVISIONS				REFERENCES		DRG. NO.		
SECTION: ELECTRICAL				 मेकॉन लिमिटेड MECON LIMITED		SCALE : N.T.S.		
NAME	DATE	CHKD	DATE			SHEET		
DSGN	AM	03.09	SS			04.09	REV	
DRWN	SJ	03.09					1	
APPROVED				DRG.NO:-MEC/SD/05/E9/E/CP/1612		2 OF 2		

DETAILS OF ANODE LEAD JUNCTION BOX

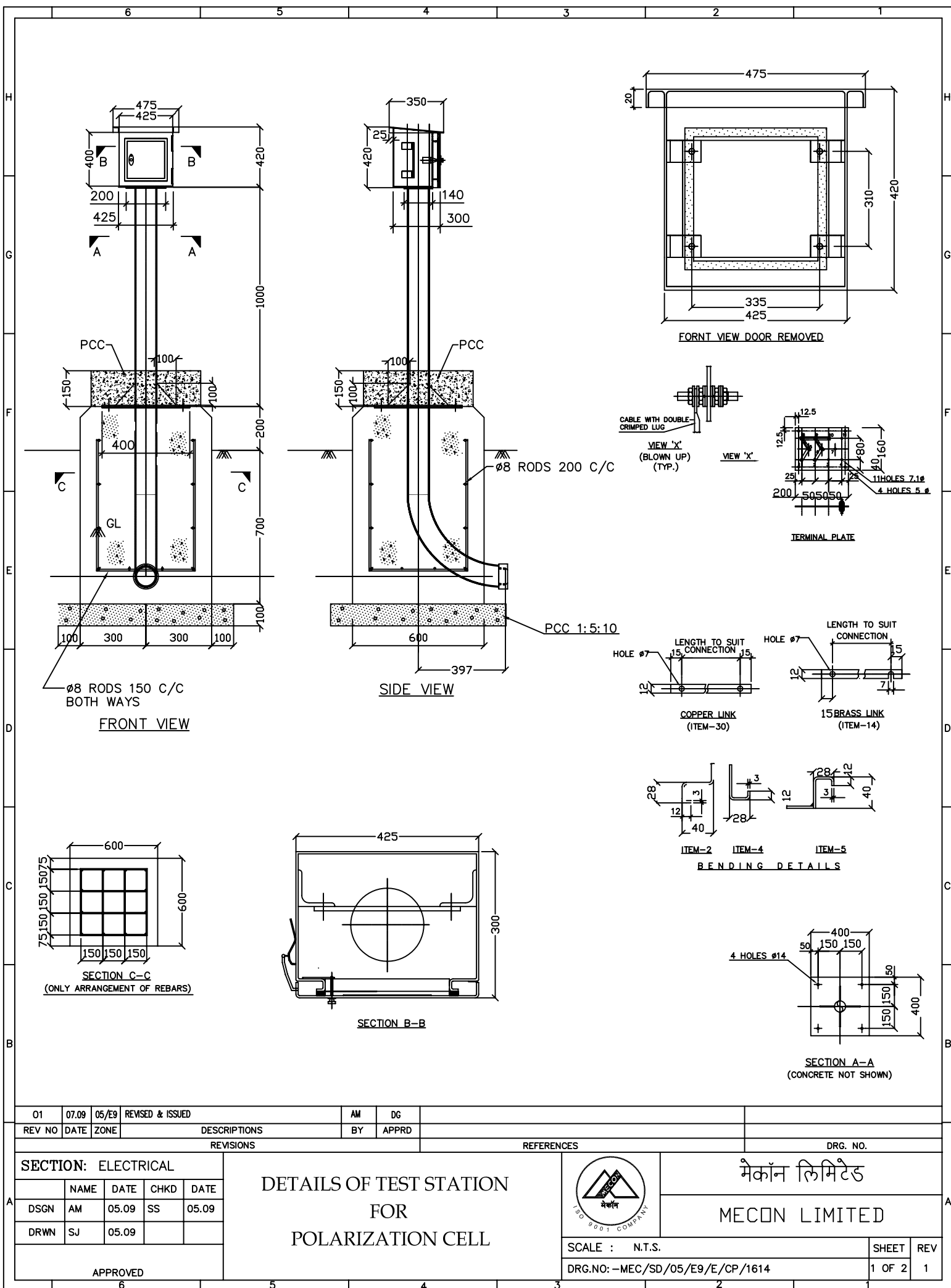


NOTES:-

1. THE CASING PIPE SHALL BE DESIGNED IN ACCORDANCE WITH API RP 1102.
2. CASING PIPE IS NOT BE COATED NORMALLY BUT IN HIGHLY CORROSIVE AREAS THE CASING SHALL BE COATED, WRAPPED AND CATHODIC PROTECTION PROVIDED WITH SACRIFICIAL ANODES.
3. AT BOTH ENDS OF CASING PIPE A DOUBLE SET OF INSULATORS SHALL BE INSTALLED.
4. THE MAXIMUM SPACING OF THE INSULATORS SHALL BE AS PER MANUFACTURERS RECOMMENDATIONS BUT IN NO CASE MORE THAN 2500 MM.
5. ELECTRICAL INSULATION BETWEEN THE CASING AND CARRIER PIPE SHALL BE CHECKED WITH A SUITABLE MEGGER.
6. CASING INSULATORS AND END SEALS SHALL AS PER THE SPECIFICATION ISSUED FOR THE SAME.
7. END SEALS SHOWN HERE ARE ONLY INDICATIVE, POSSIBILITY OF PROVIDING OTHER TYPES OF FLEXIBLE END SEALS MAY BE CONSIDERED.
8. IN CASE OF BORED/JACKED CROSSING IN ORDER TO PREVENT DAMAGE TO COATING AND WRAPPING. (IF APPROX.) A PROTECTIVE COATING OF CONCRETE OR SUITABLE MATERIAL SHALL BE PROVIDED ON CASING PIPE.

01	07.09	05/E9	REVISED & ISSUED	AM	DG		
REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD		
REVISIONS				REFERENCES		DRG. NO.	
SECTION: ELECTRICAL				मेकॉन लिमिटेड MECON LIMITED		SCALE : N.T.S. DRG.NO:-MEC/SD/05/E9/E/CP/1613	
	NAME	DATE	CHKD				DATE
DSGN	AM	05.09	SS				07.09
DRWN	SJ	05.09					
APPROVED				1			

CASING PIPE DETAILS



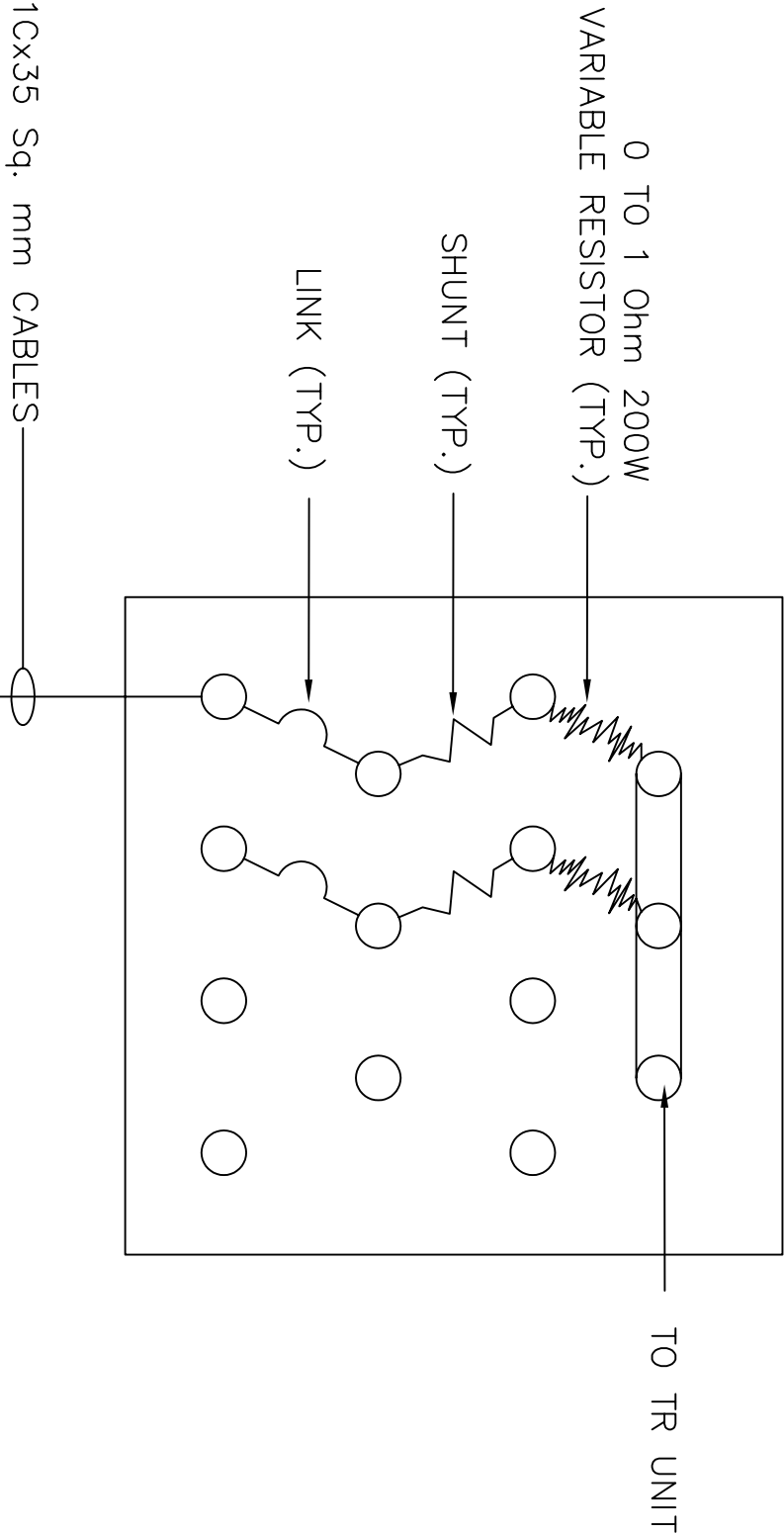
NOTES:-

- TEST STATION SHALL HAVE WEATHERPROOF ENCLOSURE HAVING DEGREE OF PROTECTION IP-55, AS DEFINED IN IEC-529(1989)/ IS:2147 (1962) THE SHUTTER SHALL BE HINGED TYPE WITH CONCEALED LOCK AND SHALL HAVE DOOR GASKET.
- THE HINGES SHALL BE WELDED TO THE SHUTTER AND THE BOX SUITABLY.
- THE MS ANGLES SHALL BE WELDED TO THE SIDES. THE ANGLES SHALL HAVE TAPPED HOLES FOR FIXING TERMINAL PLATE.
- THE INNER SURFACE OF THE TEST STATION SHALL BE PAINTED WITH LEAD OXIDE PRIMER GRADE.
- THE OUTSIDE OF THE TEST STATION SHALL BE PAINTED WITH TWO COATS OF ZINC RED EPOXY PRIMER AND THREE COATS OF GREY COLOURED EPOXY PAINT COMPLETE WITH CABLE PIPE & FDN. PLATE.
- THE NAME PLATE SHALL BE OF ANODISED ALUMINIUM WITH BLACK BACKGROUND AND WHITE LETTERS (SIZE 3mm). THE NAME PLATE SHALL BE FIXED TO INNER SIDE OF SHUTTER BY ARLDITE OR EQUIVALENT.
- THE NAME PLATE OF EACH TEST STATION SHALL CARRY THE FOLLOWING INFORMATION.
 - TEST STATION CONNECTION SCHEME TYPE
 - RELEVANT TEST STATION CONNECTION SCHEME DIAGRAM
 - TEST STATION NO.
 - CHAINAGE IN KM
 - DISTANCE FROM PIPE IN m
 - DIRECTION OF GAS FLOW
- WHEN ERECTED, THE TEST STATION SHALL BE IN UPRIGHT POSITION.
- TEST STATION SHALL BE SO ERECTED AS TO SERVE ALSO AS PIPELINE MARKER. AND ANODE GROUNDBED MARKER. THEIR SHUTTERS SHALL BE PARALLEL TO THE LINE OF AXIS OF PIPELINE AND FACING IT.
- THE NUMBER OF ALL TEST STATIONS SHALL BE WRITTEN WITH BLACK PAINT USING 40 mm STENCIL BLOCK ON THE OUTER SIDE OF THE SHUTTER IN A UNIFORM MANNER. AN ARROW SHOWING DIRECTION OF FLOW OF GAS SHALL BE MARKED TO UNDERLINE THE TEST STATION NUMBER ON SHUTTER.
- HEIGHT OF THE TEST STATION ABOVE GROUND LEVEL SHOWN IN THE DRAWING IS TYPICAL.
- ALL CABLES COMING TO TEST STATION SHALL BE LABELLED ON BOTH ENDS WITH IDENTIFICATION NUMBERS
- TOTAL NUMBER OF TEST STATIONS AND THEIR TYPES ARE MENTIONED IN CONSOLIDATED B.O.M.
- TEST BETWEEN BRASS TERMINALS AND BODY AT 2kV FOR ONE MINUTE.
- ALL DIMENSIONS ARE APPROXIMATE AND CAN VARY SLIGHTLY.
- ALL DIMENSIONS ARE IN mm.
- THE ENTRY SHALL BE SEALED WITH BITUMEN COMPOUND AFTER CABLE LAYING TO PREVENT WATER ENTRY.

30	VARIABLE RESISTANCE 0-0.1 Ohm.	01
29	100 MM ϕ M.S. SCH.40 90° ELBOW, R=5D	01
28	BINDING WIRE, MS	AS REQD.
27	PCC MIX, 1:5:10	0.064 m ³
26	RCC MIX, M20	0.324 m ³
25	ROD, 8 ϕ MS	28 m
24	STIFFENER PLATE, 8THK.	04
23	FOUNDATION BOLT M12	04
22	RUBBER BUSH MATCHING WITH PIPE	01
21	FOUNDATION PLATE, 6THK x 400 x 400 MS PLATE	02
20	NEOPRENE RUBBER GASKET, 6THK.	01 SET
19	MS PIPE, 100 ϕ , IS: 1239 P.T.1(1990)-HEAVY GRADE	01
18	COUPLING PLATE, 5THK x 180 x 130 MS PLATE, 100 ϕ HOLE AT CENTRE	01
17	LATCH FOR SHUTTER	01
16	BRASS SCREW, M6 x 16	04
15	ANGLE, 5THK. x 50 x 50 x 30	04
14	SHUNT, 0.1 OHM, 0.5 A, 50 mV	01
13	COPPER LINK, 2.5 THK. x 12 x LENGTH AS REQD.	01
12	BRASS WASHER 8 mm dia (M8) Cd Coated	AS REQD.
11	BRASS NUT, M6 Brass Nut Bolt washer	AS REQD.
10	BRASS STUD, M6 x 50	AS REQD.
9	TERMINAL PLATE, 6THK x 160 x 200 PHENOLIC LAM. SHT	01
8	HINGE FOR SHUTTER	02
7	CASTLE LOCK WITH ONE KEY PER TEST STATION	01
6	NAME PLATE, 0.9THK x 120 x 160 ANODISED ALUMINIUM	01
5	SHUTTER, 3mm THK MS SHT	01
4	TOP, 475 x 350 x 3mm THK. MS SHT	01
3	SIDE PLATE 300 x 420 x 300 x 400 x 3mm THK MS SHT	01
2	REAR PLATE 425 x 420 x 3mm THK. MS SHT	01
1	BOTTOM PLATE, 250 x 175 x 3mm THK MS PLATE, 100 ϕ HOLE AT CENTRE	01
ITEM	DESCRIPTION	QTY.
BILL OF MATERIALS		

01	07.09	05/E9	REVISED & ISSUED	AM	DG		
REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.
SECTION: ELECTRICAL				DETAILS OF TEST STATION FOR POLARISATION CELL		 मेकॉन लिमिटेड MECON LIMITED	
NAME	DATE	CHKD	DATE	SCALE : N.T.S.			
DSGN	AM	05.09	SS	DRG. NO: -MEC/SD/05/E9/E/CP/1614			
DRWN	SJ	05.09		SHEET 2 OF 2			
APPROVED				REV 1			

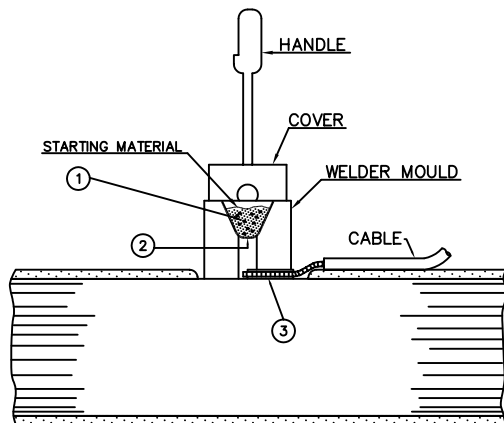
CATHODE JUNCTION BOX



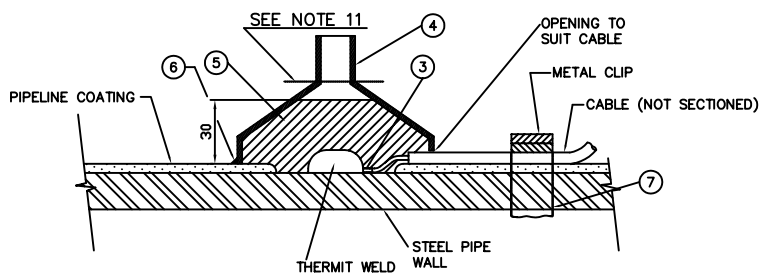
PROTECTED PIPELINE

FOR TENDER PURPOSE	
SIGNATURE :	DATE :
	
मेकॉन लिमिटेड	
MECON LIMITED	

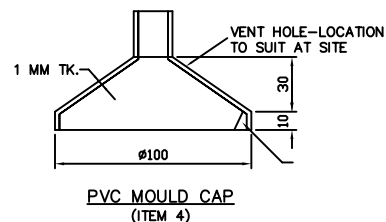
CONNECTION SCHEME FOR HOOKING THROUGH C/JB/TEST STATION										REV
SCALE :- 1:10										REV
DWG. NO. MEC/SD/05/E/CP/16/16										REV
DATE										REV
APPROVED										REV
S.S										REV
VERIFIED										REV
CHECKED										REV
DWG. NO.										REV
REFERENCES										REV
© Copyright MECOCON - All right reserved.										REV
THIS DRAWING IS THE PROPERTY OF MECOCON AND ISSUED FOR THE PROJECT ONLY. IT IS NOT TO BE COPIED OR USED FOR OTHER PROJECTS UNLESS EXPRESSLY PERMITTED BY MECOCON.										REV
BY										REV
VERIFIED										REV
DESCRIPTION										REV
REVISION										REV
ZONE										REV
DATE										REV
REV/NO										REV
SECTION										REV
CIVIL										REV
LOCATION										REV
DELHI										REV
DESIGNED										REV
AASHISH MOYAL										REV
DRAWN										REV
SUNNY										REV
NOTES:-										REV
CONCURRED BY										REV
12										REV
11										REV
10										REV
9										REV
8										REV
7										REV
6										REV
5										REV
4										REV
3										REV
2										REV
1										REV



DETAIL - 1
WELDER-CABLE ASSEMBLY



DETAIL - 2
CROSS-SECTION OF FINISHED THERMIT WELD



7	PLASTIC STRAPPING BAND, 12 WIDE WITH METALLIC CLIP	AS REQD.
6	12 WIDE PROTECTIVE ADHESIVE TAPE OR M-SEAL COMPOUND	AS REQD.
5	EPOXY COATING COMPOUND WITH HARDENER	AS REQD.
4	PVC MOULD CAP	1
3	COPPER SLEEVE, ID 5 x OD 6	1
2	METAL DISC	1
1	THERMIT WELD CHARGE	1
ITEM NO.	DESCRIPTION	QTY.
BILL OF MATERIALS		

NOTES:-

1. REMOVE PIPELINE COATING 45mm X 65mm OR ANY SUITABLE SIZE AS REQUIRED WITH A CUTTING TOOL HAVING CUTTING SURFACE CONTOUR MATCHING THAT OF THE PIPE. EXPOSED AREA OF PIPELINE SHALL BE CLEANED WITH FILE TO BRIGHT STEEL, FREE OF RUST, PAINT, DIRT, GREASE AND MOISTURE.
2. REMOVE APPROXIMATELY 40mm OF INSULATION FROM END OF CABLE. INSTALL COPPER SLEEVE TO SUIT THE CABLE.
3. HOLD MOULD IN A VERTICAL POSITION AND INSERT METAL DISC IN THE BOTTOM OF THE MOULD CAVITY.
4. DUMP THERMIT WELD CHARGE WEIGHING 15g MAX. OR AS SPECIFIED BY MANUFACTURER INTO MOULD, BEING CAREFUL NOT TO UPSET THE METAL DISC. TAP THE MOULD TO LOOSEN STARTING MATERIAL.
5. POSITION WELDER OVER EXPOSED AREA OF PIPELINE AND INSERT CABLE UNDER MOULD. PACK CABLE AND MOULD WITH PACKING MATERIAL, IF NECESSARY.
6. PLACE IGNITOR AT OPENING OF MOULD AND APPLY SPARK WHICH WILL IGNITE WELD CHARGE. WITHDRAW IGNITOR QUICKLY TO PREVENT FOULING.
7. AFTER WELDER HAS BEEN IGNITED, HOLD WELDER IN PLACE FOR 15 SECONDS. THEN REMOVE WELDER.
8. LIGHTLY TAP THERMIT WELD WITH HAMMER TO REMOVE SLAG AND TEST WELD FOR GOOD BOND. CLEAN THE WELD.
9. REMAKE THE THERMIT WELD, IF FOUND DEFECTIVE.
10. PLACE PVC MOULD CAP OVER THE THERMIT WELD. SEAL CAP WITH ADHESIVE TAPE AROUND PVC MOULD. FILL THE MOULD WITH EPOXY COATING COMPOUND.
11. CUT OFF THE STEM OF PVC MOULD CAP.
12. ANY OTHER SUITABLE COATING MATERIAL TO COVER THERMIT WELD AND ALL EXPOSED COPPER WITHOUT ANY VOID MAY BE USED IN PLACE OF ITEMS 4, 5 & 6 OF BILL OF MATERIALS. THE COATING PATCH MUST OVERLAP EXISTING PIPELINE COATING AND INSULATION ON WIRE.
13. ALL DIMENSIONS ARE APPROXIMATE AND CAN VARY SLIGHTLY.
14. ALL DIMENSIONS ARE IN mm.

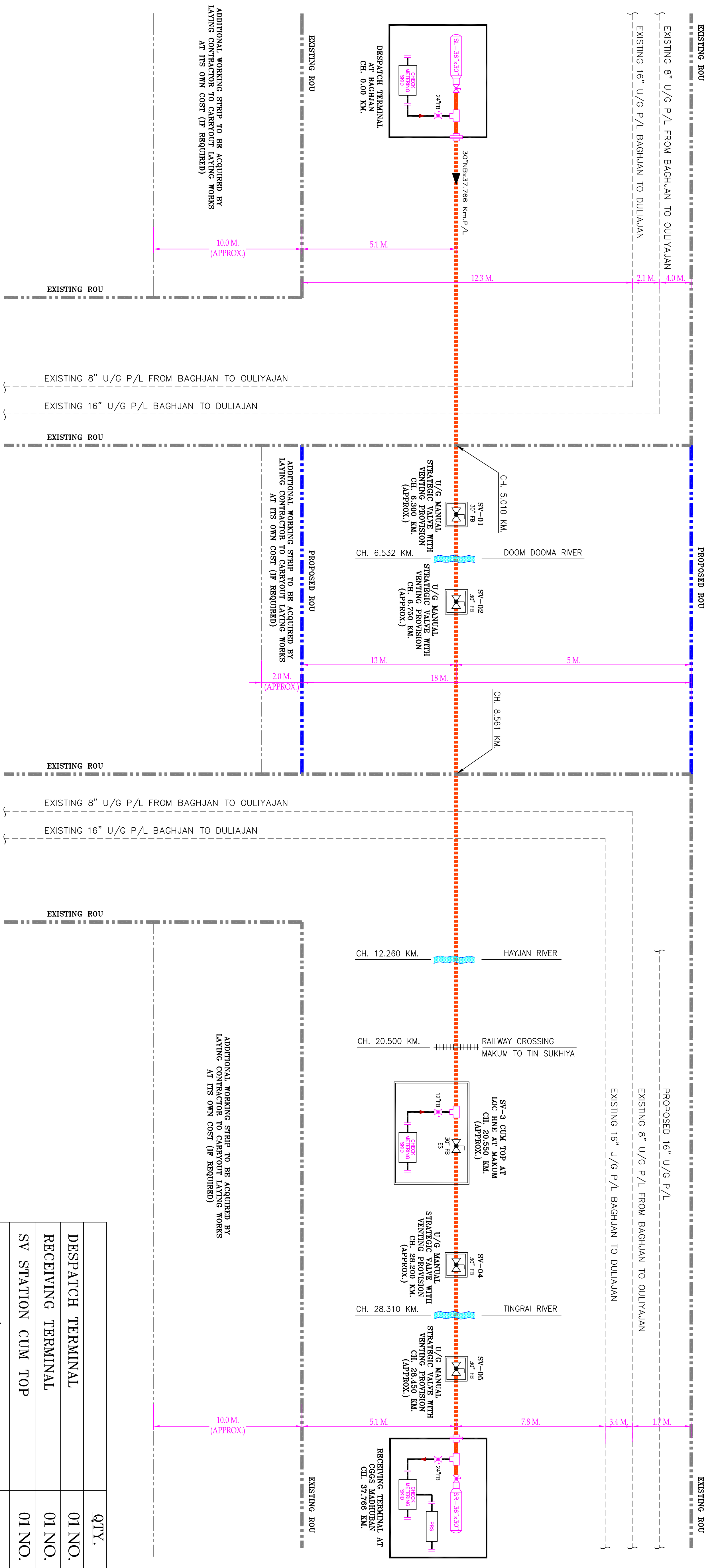
01	07.09	05/E9	REVISED & ISSUED	AM	DG		
REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD		
REVISIONS				REFERENCES		DRG. NO.	
SECTION: ELECTRICAL							
NAME	DATE	CHKD	DATE				
DSGN	AM	05.09	SS	06.09			
DRWN	SJ	05.09					
APPROVED							
DETAILS OF THERMIT WELD FOR CABLE TO PIPE JOINT							
				SCALE : N.T.S.		REV	
				DRG.NO:-MEC/SD/05/E9/E/CP/1618		1	



मेकॉन लिमिटेड

MECON LIMITED

SCHEMATIC ROUTE DIAGRAM FOR GAS PIPELINE FROM BACHJAN TO CGGS MADHUBAN, ASSAM
30"Ø x 37.766 Km. (APPROX.)

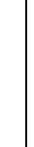
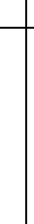
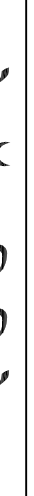


	QTY.
DESPATCH TERMINAL	01 NO.
RECEIVING TERMINAL	01 NO.
SV STATION CUM TOP	01 NO.
SV WITH U/G MANUAL STRATEGIC VALVE WITH VENTING PROVISION	04 NOS.

LEGEND

LEGEND			
	30"Ø PROPOSED U/G PIPELINE	RT :	RECEIVING TERMINAL
	30"Ø PROPOSED A/G PIPELINE	DT :	DESPATCH TERMINAL
	EXISTING ROU	SV:	SECTIONALISING VALVE STATION
	PROPOSED ROU	NB:	NOMINAL BORE
	EXISTING PIPELINES	FB:	FULL BORE
		BS	EXTENDED STEM
		P/L	PIPELINE

DETAIL OF CROSSINGS			
S.No.	SYMBOL OF X-ING	TYPE OF X-ING	
1.		RIVER	03 Nos.
2.	+++++	RAILWAY CROSSING	01 No.
3.		ROADS	32 Nos.
4.		DRAIN/NALA	23 Nos.
5.		PIPELINE	28 Nos.
6.		CANAL/DISTRIBUTORY/CHANNEL	01 No.

NOTES:—

1. THIS DRAWING HAS BEEN PREPARED ON THE BASIS OF DETAILED SURVEY REPORT No. DPC/MECON/01L/BMP/LDSR_0A.
2. CHAINAGES OF STATIONS ARE TENTATIVE. MAY CHANGE DURING EXECUTION.

[illegible]



Oil India Limited

(A Govt. of India Enterprises)
Duliajan, Assam

PROJECT

Gas Pipeline from Baghjan to CGGS Madhuban



VOLUME-I

Section-I : Detailed Survey Report
Section-II : Soil Resistivity Survey Report
Section-III : Soil Stratification Report

SEPTEMBER - 2018



Consultant

MECON LIMITED

15th Floor, Scope Minar, North Tower, Laxmi Nagar, District Centre, Delhi – 110 092



Surveyor

DESHPANDE-PATIL CONSULTANTS

(..... Since 1988 - Survey of pipelines ... Nations lifelines)

(LAND / TOPOGRAPHIC SURVEYS, PIPE LINE SURVEY, GPR SURVEY, SOIL INVESTIGATION, ROU & STATUTORY CLEARANCES)
CORPORATE OFFICE : 36, "Sheshachal", Ajanta Nagar, BHARUCH - 392001 (Guj.)

B : 26, Guru Dakshina, Mahavir Nagar, Nr. Sai Ganesh Temple, Bharuch-392001, Gujarat

Phone No. : (02642) 250052, Fax No. (02642) 250052 E-mail : dpcsurvey@yahoo.com, dpcsurvey36@gmail.com



ISO 9001:2015
75786/A/0001/UK/En



CONTENTS

Sr. No.	Description	Page No.
	<u>VOLUME - I</u>	
	<u>Section - I - Detailed Survey Report</u>	
1	Introduction	1 - 2
2	Basis of Pipeline Route Study	2
3	Scope Of Work For Detailed Survey Work	2 - 3
4	Selection Criteria For Cross-Country Pipeline Route	4
5	Survey Mothodology	5 - 7
6	Maps	7
7	RoU Detailes	8
8	Executive Summary	8 - 11
9	Crossings	11
10	Profile	11
11	Locating Of Exiting Pipelines Within Rou	11
12	River Crossings	11 - 13
13	Wild Life Sanctuaries/Crz/Critical Areas	13
14	Determination of Broad Population Density Index & Class Location	13 - 15
15	Seismic Hazard	15 - 16
16	Recommendations	16
17	<u>ANNEXURES</u>	
	Salient Features Annex. - I	17 - 18
	Total Length Statement Annex. - II	19
	List of Stretches Along Proposed Route of Pipeline Annex. - III	20 - 21
	Turning Points, Distances & Deflection Angles Annex. - IV(A)	22 - 33
	List Of DGPS Co-Ordinate of Oil India Ltd. Annex. - IV(B)	34 - 35
	List Of Village Falling En-route Annex. - V	36
	List Of All Crossings Falling En-route Annex. - VI(A)	37 - 44
	List Of Major Crossings(Type Wise) Falling En-Route (Railway Crossings) Annex. - VI(B)	45
	List of Major Crossings(Type Wise) Falling En-Route (Asphalt Road/Metal Road/Other Road Crossings) Annex. - VI(C)	46 - 47

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

- 2 -

Sr. No.	Description	Page No.
	List of Major Crossings(Type Wise) Falling En-Route (River Crossings) Annex. - VI(D)	48
	List of Major Crossings(Type Wise) Falling En-Route (Nala/Drain/Creek Crossings) Annex. - VI(E)	49 - 50
	List of Major Crossings(Type Wise) Falling En-Route (Pipeline Crossings) Annex. - VI(F)	51 - 53
	Population Density Index At A Glance Annex. - VII(A)	54
	Broad Population Density Index Annex. - VII(B)	55 - 56
	Terrian Details Annex. - VIII	57
	Details Of Existing Underground Utilities Along RoU Annex. - IX	58 - 86
	<u>Section - II - Soil Resistivity Survey Report</u>	
1	Introduction	87 - 88
2	Scope	88 - 89
3	Measuring Principle	89 - 91
4	Procedure For Taking An Aqua li Plus Reading	91 - 92
5	General Instructions	92 - 93
6	Test Results	93
7	Conclusions & Recommendations	94
8	<u>ANNEXURES</u>	
	Soil Resistivity Test Results Annex. - I(A)	95-102
	Soil Resistivity Test Results At a Glance Annex. - I(B)	103-105
	Aggressiveness Of Soil Annex. - II	106
	Histogram Annex. - III	107
	Calibration Certificate	108
	Soil Resistivity Curves	3 Nos.

- 3 -

Sr. No.	Description	Page No.
	<u>Section - III - Soil Stratification Report</u>	
1	Introduction	109-110
2	Scope of the work	110
3	Boring	110-111
4	Ground Water Table	111
5	Rocky Stretch	111
6	Chemical Analysis of soil	111
7	Detailed Procedure of Chemical Analysis	112-154
8	Method for Determination of Soil Corrosivity	154-157
9	Test Results	157-158
10	Conclusions & Recommendations	158
11	<u>ANNEXURES</u>	
	List Of Bore Hole Locations And Soil Analysis Annex. - I	159-177
	Bore Logs	178-214
	Chemical Analysis Report for Soil Sampes Annex. - II	215
	Chemical Analysis Report Of Soil Samples Annex. - III	216
	Rating Of Soil Samples Annex. - IV	217
	Degree Of Corrosivity As Per Chemical Analysis Annex. - V	218
	Soil Profile Drawing	3 Nos.

Section – I

DETAILED SURVEY REPORT



MECON LIMITED

15th Floor, Scope Minar, North Tower,
Laxmi Nagar, District Centre,
Delhi – 110 092

Oil India Limited

Duliajan, Assam

Gas Pipeline from Baghjan to CGGS Madhuban

SECTION – I : DETAILED SURVEY REPORT

1. INTRODUCTION:

Oil India Limited (OIL) traces and symbolises the development and growth of the Indian petroleum industry. From the discovery of crude oil in the far East of India at Digboi, Assam in 1889 to its present status as a fully integrated upstream petroleum company, OIL has come far, crossing many milestones.

On February 18, 1959, Oil India Private Limited was incorporated to expand and develop the newly discovered oil fields of Naharkatiya and Moran in the Indian North East. In 1961, it became a joint venture company between the Indian Government and Burmah Oil Company Limited, UK.

In 1981, OIL became a wholly-owned Government of India enterprise. Today, OIL is a premier Indian National Oil Company engaged in the business of exploration, development and production of crude oil and natural gas, transportation of crude oil and production of LPG. OIL also provides various E&P related services and holds 26% equity in Numaligarh Refinery Limited.

M/s Oil India Limited, Duliajan, Assam intends to lay 762mm/400mm Ø Natural Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban, Duliajan. The Proposed route is planned within RoU of Ex. 400mm Ø Gas Pipeline and 200mmØ COD Pipeline from Baghjan to Duliajan.

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Accordingly, M/s Oil India Limited appointed M/s MECON Limited as a Consultant and M/s MECON Limited has entrusted M/s Deshpande-Patil Consultants (DPC), Bharuch for carrying out the Reconnaissance Survey, Detailed Survey, Cadastral Survey, Soil Investigation, Corrosion Survey and Bench Mark installation for Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban & 16"Ø Gas Pipeline from O.I.L. Makum OCS to CGGS Madhuban in Assam State as per **LAC Dtd. 5th July, 2018.**

This report covers the Detailed Engineering Survey for Proposed 30" Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban admeasuring length 37.766 km and proposed 16" Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban and its entire length 17.206 km.

2. BASIS OF PIPELINE ROUTE STUDY:

BAGHJAN EPS/ GGS

The Start Point of Proposed 30"Ø Gas Pipeline is located in Village-Baghjan in Revenue Circle of Doom Dooma in District-Tinsukia of State-Assam (Co-ordinates : Latitude-27°36'14.39"(N), Longitude-95°24'21.5"(E)).

CGGS MADHUBAN

The End Point of Proposed 30"Ø & 16"Ø Gas Pipeline is located in Village-Duliajan in Revenue Circle of Tengakhat in District-Dibrugarh of State-Assam at South-East of BPCL GDU Plant. (Co-ordinates:Latitude- 27°22'46.12"(N), Longitude-95°20'3.08" (E)).

O.I.L MAKUM OCS

The Start Point of Proposed 16"Ø Gas Pipeline is located in Village-Makum in Revenue Circle of Margherita in District-Tinsukia of State-Assam at South of Asphalt Road (Makum – Tinsukia) (Co-ordinates: Latitude- 27°29'8.43" (N), Longitude-95°25'22.81" (E)).

3. SCOPE OF WORK FOR DETAILED SURVEY WORK:

The Detailed Engineering survey shall be carried, for the pipeline route finalized after Reconnaissance survey with a view to obtaining data those are necessary for final system design of the proposed Gas Pipelines from Baghjan EPS/GGS to CGGS Madhuban for 37.766 Km. length and the proposed Gas Pipelines from O.I.L. Makum OCS to CGGS Madhuban for 17.206 Km. length as per following details with submission of:

Detail Route survey work along the entire route of the proposed/ existing pipeline/pipelines and other proposed installations shall be in accordance with technical specification.

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Carrying out soil investigation along the proposed pipeline route in accordance with enclosed technical specifications.

Pipeline alignment shall be surveyed and marked taking into account all existing and planned/proposed future development along the proposed/existing route.

Locating all buried/ above ground pipelines, cables and other utilites within a distance of 15 metres on either side of the centre line of ROW with the help of cable locators or other suitable instruments.[In case of the city portions and other restrictive locations this may be limited to the extent feasible and approved by Engineer-in-charge on the merit of each case.] All detailed interference survey work to be carried out as per technical specification.

Carrying out population density survey along the pipeline route as per enclosed technical specification.

To liasion with NHAI and/or other concerned authorities and to procure maps indicating the extent of their ROW's in the various regions.

Carrying out corrosion survey including measurement of soil resistivity, chemical analysis of soil/water and collection of Cathodic Protection related data including identifying & marking powerlines along ROW of the proposed/existing pipeline and of data as per Standard Specification of Corrosion Survey.

Carrying out cadastral survey covering areas 30 metres on either side of centerline of the proposed corridor for the entire pipeline routes. All revenues and other related records/maps as well as forms required for carrying out this survey shall be arranged by the Contractor at his own cost and responsibility. The contractor shall digitise all such maps and data/records and mark the pipeline route on maps with the following details.

Land schedules giving the survey numbers, area and details of owners as per the latest official revenue records.

Major features/land marks including:

- All built-up areas such as-
- Religious place, school, hospital etc.
- District/village and panchayat roads.
- Water bodies
- Forest land
- Overhead and underground utility crossings
- Marshy land/ waste land

4. SELECTION CRITERIA FOR CROSS-COUNTRY PIPELINE ROUTE:

- 4.1 Route selected should be the shortest possible one.
- 4.2 Avoid environmentally sensitive areas such as Reserved Forests, Protected Forests, Wildlife areas, Marine parks, Bird sanctuaries, etc. to the maximum possible extent.
- 4.3 For all the cities / Major towns along the pipeline route the Contractor shall procure the Maps of all notified development Plans (City, Industrial, Capital, etc) from the respective authorities and superimpose them on SOI Maps prior to selection of the pipeline route. The pipeline route shall be selected by avoiding such proposed development areas. If it is unavoidable then it must confirm to the norms laid down by the concerned level of development authority.
- 4.4 Should be accessible from Road during construction and the subsequent operation / maintenance stages.
- 4.5 Should make minimum number of crossings with Railways, Roads, Rivers, and Canals etc. Following points should be considered while making these crossings.
- 4.6 Rivers & Canals
 - 4.6.1 Length between bank to bank should be shortest and cross at right angles.
 - 4.6.2 Bed and bank conditions should be stable and not subject to scouring.
 - 4.6.3 Identify rivers / crossings coming under CRZ.
- 4.7 All National highways & Rail crossings should be at right angles and away from existing structures and other utilities.
- 4.8 Avoid mining / quarrying areas, built-up areas, planed development areas, Villages, Towns, Cities, industrial areas, settlements, places of worship / burial etc.
- 4.9 As far as possible, avoid parallel alignment of the pipeline with overhead power lines and railway lines. Minimize interference with other pipelines cables etc.
- 4.10 Number of Turning Points (TPs) should be minimum number and avoid acute angles at Turning Points.
- 4.11 Select easy and favorable terrain conditions – avoiding water logged and swampy areas, ravines, meandering rivers, low lying marshy areas, unstable ground, depressions, hard rock, boulders, rock outcrops areas etc. to the maximum possible extent.

5. SURVEY METHODOLOGY:

DGPS Survey:

When the Route survey of pipelines stretches upto few hundreds of kilometers, it demands horizontal control.

Horizontal control point has to attain accuracies in millimeters. To achieve such degree of accuracy, DGPS surveying has been adopted in this age of advanced surveying techniques.

GPS surveying has an efficiency of attaining 5mm±2ppm accuracy.

Methodology:

GPS Data Collection:

GPS control point for horizontal control are fixed along the entire route of pipeline at an interval of 3 to 5 Km. Each control point is connected in the GPS network by setting one GPS receiver at say point 01 & an another GPS receiver at point 2 both points being 3 - 5 Km. away from each other. Common observation of about 30 minutes was recorded thus measuring the distance between two control points.

Subsequently, the GPS receiver at point 01 was shifted to point 03, Again 30 min. common observation was recorded thereby measuring the length between point 02 & point 03. The receiver at point 02 was then shifted to point 04 for measuring distance between point 03 & point 04. This kind of GPS observations are carried for rest of the points & similar method is employed for the entire stretch of pipeline. The observations are recorded in "static mode" thereby achieving greater accuracies for each point.

After completion of site data collection major part of DGPS surveying i.e. "Post-processing of raw GPS data" was carried out through "SKI-Pro-V-2.5", software manufactured by Lieca.

*** Software Approach:**

Raw GPS data is downloaded from the PCMCIA card connected to sensor. The raw data is then imported into a particular project for processing each point is recorded in WGS 1984 co-ordinate system, every point is designated with a point class such as Navigated, control or estimated with further sub-classification as measured, reference or SPP (Single Point Processed) Point. The highest point class attributed to a point from raw data is "Navigated". Any of the point, which was data, recorded for a long time is single point processed. (Say point 1 has collected a data for 1 hour then point 01 is single point processed.

Thereby we fix the co-ordinate of point 01 globally. Now, this point 01 is taken as a reference for calculating base line point-01 to point-02. After measuring the base line & calculating the co-ordinate for point-02 we measure base line point 02 – point 03 by assigning reference point to point-02 & rover point to point-03. Hence, point-03 co-ordinates are calculated. In this manner rest of the co-ordinates are calculated.

*** Co-ordinate Projection:**

Now that all the co-ordinates are calculated in WGS-84 system the points need to be projected in a local grid say Universal Transverse Mercator (UTM) or transverse Mercator (TM). The projection is required since total station traverse & detail demand for planner co-ordinate system i.e. (Northing, easting, elevation / Cartesian co-ordinates) & not in Geoid (i.e. lat, long, ellipsoidal height). For the proposed Pipeline all the co-ordinates are projected in UTM 46 zone. The co-ordinates for all points in an individual line are now established. The co-ordinates of each DGPS points are provided to total station traversing & detailed route survey.

Results:

The total station traversing encountered an error at some DGPS points (error not exceeding 1M in either Northing or Easting). This error is further distributed between all the intermediate points for precise details surveying.

Equipment Details: -

Hardware:

1. Two Nos. of Lieca SR510 GPS receivers
2. Two Nos. of Lieca AT501 GPS Antenna
3. Two Nos. of Lieca 16MB PCMCIA and
4. Two Nos. of Lieca Terminals for controlling sensor
5. One No. of Tripod (Stub, optical planet etc.)
6. One No. of Tripod Antenna pole.

Software:

SKI-pro V.2.5 Lieca post processing software & hardware lock.

After compilation of DGPS survey, Alignment survey is carried out along with detailed engineering survey to establish final route with Turning Points (TP) and Intermediate Points (IP).

Alignment Survey using Total Station:

After approval from EIC the alignment survey along with detailed engineering survey for the pipeline route is carried out to stake the pipeline alignment on the ground.

The alignment is carried out by ranging on ground with the help of total station.

Methodology for alignment survey:

The alignment survey is done along the proposed pipeline route approved by the EIC. Any major shift from the approved route due to any obstruction will be carried out in consultation with the EIC stationed at site.

The Turning Points (TP) and Intermediate Points (IP) shall be located by the surveyor and care will be taken to provide minimum TPs as possible.

Care is taken to cross major crossings with right angle and also for crossings which require HDD care is taken that preceding and subsequent TPs are placed at minimum distance equal to the width of the crossing from edge of the row of crossing.

Special care is taken to avoid grave yards, wells and other such structures along the pipeline route.

Also care is taken to avoid water logged areas, marshy areas, ponds, site prone to flooding etc.

In case of pipeline route in CRZ area care will be taken to have minimum route length in CRZ area.

The detailed route survey covers picking up of field bund, trees and all relevant site data 50 m on both side of the center line of the proposed pipeline route.

The elevation along the pipeline route is taken at every 50 m Interval.

6. MAPS:

The following Survey of India (SOI) topographic maps were referred during the study.

Scale – 1:50000 83-M-6, 83-M-7

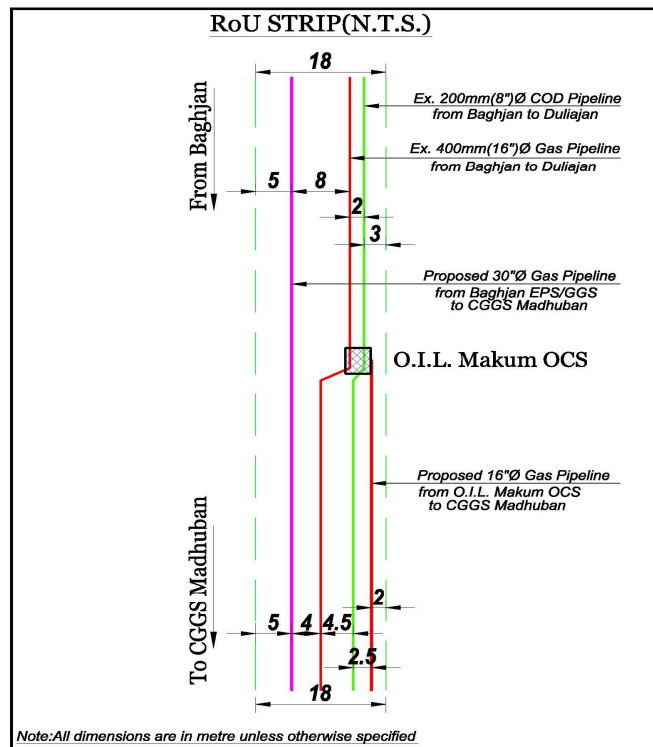
Scale – 1:250000 83-M

The lists of other maps which have been considered for selecting the route are given below:

District & Revenue Circle Maps, Wild Life Sanctuary Map, Forest Map, Rock Type Map, Soil Type Map, Google Imagery, Geological Map and Land use maps.

7. RoU DETAILS:

The route of Proposed Pipeline passes along 18m wide existing RoU of 400mm Ø Gas Pipeline and 200mm Ø COD Pipeline from Baghjan to Duliajan except some re-route portion where 15m wide RoU is proposed. The details of RoU is as mentioned in fig.7.1:



[fig:7.1]

8. EXECUTIVE SUMMARY:

- 1) Proposed 30" Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban**
The total length of the Proposed Gas Pipeline is = 37.766km.

Route & Corridor Description:

The proposed route of the pipeline takes off from **Baghjan EPS/GGS** in Village-Baghjan in Revenue Circle of Doom Dooma in District-Tinsukia of State-Assam.

The Pipeline passes within premises of Baghjan EPS/GGS for its initial length of 76.09 m, then it passes within RoU of Ex. 400mm Ø Gas Pipeline and 200mm Ø COD Pipeline from Baghjan to Duliajan for total 33.324 km length, it passes within premises of O.I.L Makum OCS for length of 150 m and then it passes within premises of STF Plant for 246.68 m length.

The Pipeline passes through cross-country land for total 3.552 km length by acquiring RoU of 15m width & it terminates at CGGS Madhuban in Duliajan Village of Revenue Circle-Tengakhat in District-Dibrugarh **(Refer Annexure – III)**.

The pipeline route commences from **Baghjan EPS/GGS** & it passes in the South-East direction from ch:0.0 km to ch:13.3 km & the Pipeline follows in South-West direction from Ch:13.3km to Ch:37.766 km to terminate at **CGGS Madhuban**.

The proposed pipeline crosses 1-Raiway, 32-Asphalt Roads/Metal Roads/Other Roads, 39-Cart tracks, 3-Rivers, 23-Nalas/Drains/Creeks, 28-Pipelines(Hydrocarbon/Water Supply/Effluent), 8-Cables/OFC Cables and 90-Power Lines/H.T Lines **(Refer Annexures – VI(A))**.

Population Density Index

The Proposed pipeline passes through Class-I for 6.4 Km length, Class-II for 12.166 km length & Class-III for 9.2 km length. **(Refer Annexures – VII(A&B))**.

Forest Involvement:

The route of Proposed Pipeline does not pass through any Forest/Reserved Forest/Open Mixed Jungle land.

Terrain:

The terrain along the proposed route of the pipeline is flat for 36.948 Km length and slightly undulating for 0.818 km. length. **(Refer Annexures – VIII)**

General Land Use Pattern, Soil Type, Crop Type:

State	District	Crop	Soil Type	Land Use
Assam	Tinsukia	Paddy & Tea Garden	Clay and silty Soil	Agriculture
	Dibrugarh			

Rocky Stretch:

The proposed pipeline route does not pass through any rock strata along the observed pipeline route.

While aligning the pipeline alignment care is taken to keep the pipeline kept away from historical places. Similarly the pipeline route is kept clearly off wild life sanctuary.

2) Proposed 16"Ø Gas Pipeline from O.I.D Makum OCS to CGGS Madhuban

The total length of the Proposed Gas Pipeline is = 17.206 km.

Route & Corridor Description:

The proposed route of the pipeline takes off from **OIL Makum OCS** in Village-Makum in Revenue Circle of Margherita in District-Tinsukia of State-Assam.

The Pipeline passes within premises of O.I.L Makum OCS for its initial length of 95.15 m, then it passes within RoU of Ex. 400mm Ø Gas Pipeline and 200mmØ COD Pipeline from Baghjan to Duliajan for total 16.465km length, its passes within premises of STF Plant for 231.07 m length and it terminates at CGGS Madhuban in Duliajan Village of Revenue Circle-Tengakhat in District-Dibrugarh **(Refer Annexure – III)**.

The pipeline route commences from **Makum OCS** & it passes in the South-South-West direction from Ch: 0km to Ch:17.206 km to terminate at **CGGS Madhuban**.

The proposed pipeline crosses 13-Asphalt Roads/Metal Roads/Other Roads, 14-Cart tracks, 1-River, 7-Nalas/Drains/Creeks, 29-Pipelines (Hydrocarbon/ Water Supply/Effluent), 4-Cables/OFC Cables and 59-Power Lines/H.T Lines **(Refer Annexures – VI(A))**.

Population Density Index

The Proposed pipeline passes through Class-II for 6.006 km length & Class-III for 11.2 km length. **(Refer Annexures – VII(A&B))**

Forest Involvement:

The route of Proposed Pipeline does not pass through any Forest/Reserved Forest/Open Mixed Jungle land.

Terrain:

The terrain along the proposed route of the pipeline is flat for its entire length. **(Refer Annexures – VIII)**

General Land Use Pattern, Soil Type, Crop Type:

State	District	Crop	Soil Type	Land Use
Assam	Tinsukia	Paddy & Tea Garden	Clay and silty Soil	Agriculture
	Dibrugarh			

Rocky Stretch:

The proposed pipeline route does not passing through any rock strata along the observed pipeline route.

While aligning the pipeline alignment care is taken to keep the pipeline away from historical places. Similarly the pipeline route is kept clearly off wild life sanctuary.

9. CROSSINGS:

The lists of all crossings & major crossings are given along with this report as **(Annexures-VI(A-F))** Attempts have been made to cross all major crossings at right angle where ever possible and feasible as per requirements of statutory authorities. The approx. width of crossing is also indicated. The Digital Photographs of all important crossings are also enclosed along with separate section wise reports in different volumes.

10. PROFILE:

The elevations are taken at approximately every 50 m interval all along the centerline of the proposed pipeline and the profile is generated to a scale of 1:250 Vertical and 1:2500 Horizontal and Alignment sheets are prepared. (Refer Volume No.II-Alignment sheets: OIL – ASSAM – P85 – 001 TO 022).

11. CADASTRAL SURVEY:

The entire route of the pipeline is plotted on Taluka wise Village Maps as made available in Govt. of India (GOI) Census Book and after merging all these Talukas/Tahsils and Districts, a list of Revenue Villages is prepared for various Alternates of pipeline.

The list of Villages, Tahsils and District falling on the proposed pipeline route is presented as **Annexures-V**.

12. LOCATING OF EXISTING PIPELINES WITHIN ROU:

The route of existing pipeline within pipeline corridor have been detected with the help of VIVEX line locator of approved make at regular interval and depth of pipeline encountered at various locations is mentioned (**refer Annexure-IX**)

13. RIVER CROSSINGS:

Brahmaputra River Basin:

The route of proposed Gas Pipeline mainly passes through the Brahmaputra River Basin in the state of Assam.

The Brahmaputra Valley has an average width of about 80 Km. The main river of the valley, Brahmaputra is one of the largest rivers in the world and rank fifth with

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

respect to its average discharge. The river originates from the Kailash ranges of Himalayas at an elevation of 5300 M. After flowing through Tibet it enters India through Arunachal Pradesh and flows through Assam and Bangladesh before it joins Bay of Bengal.

The catchments area of Brahmaputra in Tibet is 2,93,000 Sq. Km; in India and Bhutan is 2,40,000 Sq. Km and in Bangladesh is 47,000 Sq. Km. The Brahmaputra basin extends over an area of 5,80,000 Sq. Km up to its confluence within Bangladesh.

The average width of Brahmaputra is 5.46 Km. The maximum discharge of Brahmaputra at Pandu near Guwahati was recorded as 72,779 cumec on 23.08.62 and minimum discharge was recorded as 1757 cumec on 22.02.63. The average annual discharge is about 20,000 cumec and average dry season discharge is 4,420 cumec.

The river slope is very steep till it enters India. A drop of about 4800 M is achieved in a length at about 1700 Km in China (Tibet). This average slope of about 2.82 m/Km gets reduced to about 0.1m/Km in Assam valley. Due to this sudden flattening of river slope, the river becomes braided in nature in the Assam valley. During its course in Assam valley from Kobo to Dhubri the river is joined by about 20 (twenty) important tributaries on its North bank and 13 (thirteen) on its South bank. Joining of these tributaries bringing high sediment load activates braiding.

Brahmaputra sub-basin extends over an area of 580,000 sq.km lying in Tibet (China), Bhutan, India and Bangladesh. The drainage area lying in India is 194413 sq.km which is nearly 5.9% of the total geographical area of the country. It is bounded on the north by the Himalayas, on the east by the Patkari range of hills running along the Assam-Burma border, on the south by the Assam range of hills and on the west by the Himalayas and the ridge separating it from Ganga sub-basin. The sub-basin lies in the States of Arunachal Pradesh, Assam,

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban:

Sr. No.	Name of River	Bank Width (m)	Bed Width (m)	Perennial /Non Perennial	Bank Soil Type	Bed Soil Type
1	Doom Dooma River	54.32	27.10	Non Perennial	Black Silty Clay	Black Clay & Sandy soil
2	Hayjan River	20.58	10.29	Non Perennial	Black Silty Clay	Black Clay & Sandy soil
3	Tingrai River	20.16	10.16	Non Perennial	Black Silty Clay	Black Clay & Sandy soil

2) Proposed 16"Ø Gas Pipeline from O.I.D Makum OCS to CGGS Madhuban:

Sr. No.	Name of River	Bank Width (m)	Bed Width (m)	Perennial /Non Perennial	Bank Soil Type	Bed Soil Type
1	Tingrai River	20.16	10.16	Non Perennial	Black Silty Clay	Black Clay & Sandy soil

14. WILD LIFE SANCTUARIES/CRZ/CRITICAL AREAS:

Dibru-Saikhowa National Park:

Dibru-Saikhowa ational Park is a national park in Assam, India. It is located in Dibrugarh and Tinsukia districts and was designated a Biosphere Reserve in July 1997 with an area of 765 km² (295 sq mi), including a core area of 340 km² (130 sq mi) and a buffer zone of 425 km² (164 sq mi).

It is located at about 12 km (7.5 mi) north of Tinsukia town at between 27°30' N to 27°45' N latitude and 95°10' E to 95°45'E longitude at an average elevation of 118 m (387 ft), ranging from 110 to 126 m (361 to 413 ft). The park is bounded by the Brahmaputra and Lohit rivers in the north and Dibru river in the south. It mainly consists of moist mixed semi-evergreen forests, moist mixed deciduous forests, canebrakes and grasslands. It is the largest salix swamp forest in north-eastern India, with a tropical monsoon climate with a hot and wet summer and cool and usually dry winter. Annual rainfall ranges from 2300 mm to 3800 mm. It is a haven for many endangered species and rich in fish diversity.

Distances of National Park from proposed Gas P/L Route

Sr. No.	Particular	Pipeline	Chainage (km)	Approx. Distance of the section of Pipeline in 'Km'
1	Dibru-Saikhowa National Park	1	0	8.0
		2	0	21.0

15. DETERMINATION OF BROAD POPULATION DENSITY INDEX & CLASS LOCATION:

14.0.0 SCOPE

14.1.0 When survey for gas pipeline is performed, the Location Class based on Population Density Index as per ANSI B31.8 "Gas transmission and Distribution piping System" and OISD Standard 141 (Design and Construction Requirements for cross country hydrocarbon pipelines) shall

be recorded along with Chainages at Change points of each location. The methodology of the survey shall be as per the above referred Standards.

14.2.0 Population Density Index

14.2.1 A zone of approx. 400 M (one quarter mile) wide along the route of the pipeline with pipeline on the centre-line of this zone. The entire route of the pipeline shall be divided into lengths of approx. 1600 M (one mile) on the "sliding mile" method such that the individual lengths will include the maximum number of dwelling which is intended for human occupancy. Within each 1600 M zone, such dwellings shall be counted and reported along with other survey data. For this purpose, each separate dwelling unit in a multiple dwelling unit building is to be counted as a separate building intended for human occupancy.

14.2.2 The services associated with human dwellings such as water, gas and electrical supply, sewage systems, drainage lines and ditches, buried power and communication cables, streets and roads, etc shall be recorded in the report.

14.3.0 CLASS LOCATION: The areas shall be classified based on guidelines as given below:

14.3.1 Location Class – 1: A Location Class –1 is any 1600 M (one mile) section that has 10 or fewer dwellings intended for human occupancy.

14.3.2 Location Class – 2: A Location Class –2 is any 1600 M (one mile) section that has more than 10 but less than 46 dwellings intended for human occupancy.

14.3.3 Location Class – 3: A Location Class –3 is any 1600 M (one mile) section that has 46 or more dwellings intended for human occupancy, except when a location class 4 prevails.

14.3.4 Location Class – 4: A Location Class – 4 includes areas where multistory buildings are located intended for human occupancy. This class includes the areas where traffic is heavy or dense and where there may be numerous other utilities underground. Multistory means 4 or more floors above ground including the first or ground floor. The depth of basements or number of basement floors is immaterial. A class - 4 locations ends 220 meters from the nearest building with 4 or more stories above ground.

14.3.5 In addition to the criteria contained in aforesaid clauses, while classifying areas, additional consideration must be given to the areas where a concentration of people is likely, such as, temple, church, school, multiple dwelling unit, hospital, recreational areas of an organized character, places of assembly, places of worship, etc in Location Class 1 or 2. If one or more of these facilities are present in Location Class 1 or 2, the area shall be classified as Location Class – 3. Concentrations of people referred

herewith, are not intended to include groups of fewer than 20 people per instance or location but are intended to cover people in an outside area as well as in a building.

- 14.3.6 Notwithstanding the provisions of clause 14.1.0 to 14.3.5 above, while determining Location Class of an area due consideration shall be given to the possibility of future development of the area during the design life of the pipeline. If it appears likely that future development may cause a change in the location class; this shall be taken into consideration while determining its Location Class.

The various class locations observed in various sections are represented in the form of **Annexures- VII (A) & (B).**

16. SEISMIC HAZARD:

Bureau of Indian Standards, based on the past seismic history, grouped the country into four seismic zones, viz. Zone-II, -III, -IV and -V. Of these, Zone V is the most seismically active region, while zone II is the least. The Modified Mercalli (MM) intensity, which measures the impact of the earthquakes on the surface of the earth, broadly associated with various zones, is as follows:

Seismic Zone Intensity on MM scale

II (Low intensity zone)	VI (or less)
III (Moderate intensity zone)	VII
IV (Severe intensity zone)	VIII
V (Very severe intensity zone)	IX (and above)

Broadly, **Zone-V** comprises of entire northeastern India, parts of Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Rann of Kutch in Gujarat, parts of North Bihar and Andaman & Nicobar Islands.

Zone-IV covers remaining parts of Jammu & Kashmir and Himachal Pradesh, Union Territory of Delhi, Sikkim, northern parts of Uttar Pradesh, Bihar and West Bengal, parts of Gujarat and small portions of Maharashtra near the west coast and Rajasthan.

Zone-III comprises of Kerala, Goa, Lakshadweep islands, and remaining parts of Uttar Pradesh, Gujarat and West Bengal, parts of Punjab, Rajasthan, Madhya Pradesh, Bihar, Jharkhand, Chhattisgarh, Maharashtra, Orissa, Andhra Pradesh, Tamilnadu and Karnataka. **Zone-II** covers remaining parts of the country.

Further, as part of pre-disaster preparedness measure, Government of India has also completed seismic microzonation studies of some of the major cities in the country such as, Jabalpur, Guwahati, Bangalore, greater Bharuch in Gujarat, Jammu in J & K, Shillong in Meghalaya, Chennai in Tamilnadu and sikkim state.

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

These studies involving preparation of geological, geomorphological and land use maps followed by drilling, geological logging, standard penetration test and geophysical studies to demarcate the zones of least to most damage prone areas within the urban areas helps the respective town and country planning agencies to formulate perspective planning within the overall earthquake impact minimization efforts.

17. RECOMMENDATIONS:

Based on the various considerations, observations and ground realities ascertained during physical validation, the best approved route has been carried out as per directives of the client for Pipeline sections from Baghjan EPS/GGS to CGGS Madhuban & O.I.L Makum OCS to CGGS Madhuban Gas Pipelines due to optimum length, availability of existing RoU, less hindrance in construction, less utility crossings & easy accessibility for getting Government Clearances, and least disturbance while laying the pipeline along the route. In view of this Mecon Limited is suggested to take up the further studies along with simultaneous clearances from the concerned authorities so as to enable pipeline project.

For DESHPANDE-PATIL CONSULTANTS

Report Prepared by

Panchal H.B.

(Himanshu Panchal)
.....Engineer



Report Reviewed By

Virendra Bhatt

(Virendra Bhatt)
.....Engineer

Date : 07-09-2018

ANNEXURES

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

SALIENT FEATURES

	Salient Features	1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban (Along Existing & Proposed RoU)	2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)
(A)	Length (km)	37.766	17.206
(B)	Terrain (km)		
	(a) Flat	36.948	17.206
	(b) Slightly undulating	0.818	-
(C)	Soil Encountered (km)		
	(a) Clay and silty Soil	37.766	17.206
(D)	Surface Features (km)		
	(a) Within Premises of Baghjan EPS/GGS	0.076	-
	(b) Cross-Country	3.552	-
	(c) Within RoU of Existing Pipeline	33.324	16.466
	(d) Within Premises of O.I.L Makum OCS	0.150	0.095
	(e) Within Premises of STF Plant	0.247	0.231
	(d) Within Premises of CGGS Madhuban	0.418	0.414
(E)	Road Crossing (Nos.)		
	(a) National Highway	-	-
	(b) State Highway	-	-
	(c) Asphalt Road/Metal Road/Other Road	32	13
	(d) Cart Track	39	14
(F)	Water Bodies (Nos.)		
	(a) River	3	1
	(b) Canal/Distributory/Minor/Channel	1	-
	(c) Nala/Drain/Creek	23	7
(G)	Railway Crossing (Nos.)	1	-
(H)	Utility Crossing (Nos.)		
	(a) Power Line/H.T Line	90	59
	(b) Pipeline(Hydrocarbon/Water Supply/Effluent)	28	29
	(c) Cable	8	4

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

	Salient Features	Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban (Along Existing & Proposed RoU)	Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)
(I)	Co-ordinates		
	(a) Value of co-ordinates at		
	(i) Start Point	N:27°36'14.39" E:95°24'21.5"	N:27°29'8.43" E:95°25'22.81"
	(ii) End Point and	N:27°22'46.12"	N:27°22'46.19"
		E:95°20'3.08"	E:95°20'3.09"
(J)	Population Density (km)		
	(a) Class-I	6.400	-
	(b) Class-II	12.166	6.006
	(c) Class-III	19.200	11.200
	(d) Class-IV	-	-

ANNEXURE-II

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

TOTAL LENGTH STATEMENT

SR. NO.	DESCRIPTION	LENGTH (km)
1	Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban (Along Existing & Proposed RoU)	37.766
2	Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)	17.206
	Total Length (km)	54.972

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

LIST OF STRETCHES ALONG PROPOSED ROUTE OF PIPELINE

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban
(Along Existing & Proposed RoU)

Sr. No.	Description	Chainage (m)		Length (m)	RoU Width(m)	
		From	To		Existing	Proposed
1	Within Premises of Baghjan EPS/GGS	0.00	76.09	76.09	-	-
2	Within RoU of Ex. 400mm Ø Gas Pipeline and 200mmØ COD Pipeline from Baghjan to Duliajan	76.09	5010.08	4933.99	18	
3	Cross-country land	5010.08	8561.84	3551.76	-	15
4	Within RoU of Ex. 400mm Ø Gas Pipeline and 200mmØ COD Pipeline from Baghjan to Duliajan	8561.84	20507.16	11945.32	18	-
5	Within Premises of Makum HNE	20507.16	20657.17	150.01	-	-
6	Within RoU of Ex. 400mm Ø Gas Pipeline and 200mmØ COD Pipeline from Baghjan to Duliajan	20657.17	37101.47	16444.30	18	-
7	Within Premises of STF PLANT	37101.47	37348.15	246.68		
8	Within Premises of CGGS Madhuban	37348.15	37766.57	418.42	-	-
	Total Length (m)			37766.57		

2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)

Sr. No.	Description	Chainage (m)		Length (m)	RoU Width(m)	
		From	To		Existing	Proposed
1	Within Premises of Makum HNE	0.00	95.15	95.15	-	-
2	Within RoU of Ex. 400mm Ø Gas Pipeline and 200mmØ COD Pipeline from Baghjan to Duliajan	95.15	16560.69	16465.54	18	-
3	Within Premises of STF Plant	16560.69	16791.76	231.07	-	-
4	Within Premises of CGGS Madhuban	16791.76	17206.24	414.48	-	-
	Total Length (m)			17206.24		

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

TURNING POINTS, DISTANCES & BEARING STATEMENT

**1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban
(Along Existing & Proposed RoU)**

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	RL (m)	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
					EASTING	NORTHING	LATITUDE	LONGITUDE
1	TP0	0	0 ° 0 ' 0 "	121.35	737460.4718	3055650.523	27°36'14.39"	95°24'21.5"
2	TP1	31.23	87 ° 28 ' 40 "R	121.38	737491.1716	3055656.247	27°36'14.56"	95°24'22.62"
3	TP2	51.61	28 ° 22 ' 27 "L	121.48	737495.7863	3055636.393	27°36'13.91"	95°24'22.78"
4	TP3	247.96	59 ° 37 ' 11 "R	121.81	737444.011	3055446.999	27°36'7.79"	95°24'20.76"
5	TP4	532.64	0 ° 17 ' 8 "L	122.15	737642.9417	3055243.36	27°36'1.05"	95°24'27.86"
6	TP5	698.81	3 ° 58 ' 16 "R	121.58	737759.6517	3055125.073	27°35'57.14"	95°24'32.03"
7	TP6	844.92	24 ° 6 ' 11 "R	121.9	737854.8232	3055014.209	27°35'53.48"	95°24'35.42"
8	TP7	1096.71	83 ° 59 ' 6 "L	122.96	737926.5113	3054772.836	27°35'45.59"	95°24'37.86"
9	TP8	1381.64	68 ° 45 ' 35 "R	121.29	738206.6461	3054824.89	27°35'47.11"	95°24'48.11"
10	IP8/1	1584.94	0 ° 0 ' 0 "R	120.47	738313.676	3054652.045	27°35'41.43"	95°24'51.89"
11	TP9	1785	3 ° 40 ' 33 "L	118.78	738419.0012	3054481.952	27°35'35.84"	95°24'55.61"
12	TP10	1943	1 ° 32 ' 26 "L	120.96	738510.622	3054353.232	27°35'31.6"	95°24'58.85"
13	TP11	2102.02	10 ° 29 ' 58 "L	121.68	738606.2839	3054226.206	27°35'27.41"	95°25'2.25"
14	IP11/1	2353.91	0 ° 0 ' 0 "	122.8	738791.9453	3054055.974	27°35'21.77"	95°25'8.89"
15	TP12	2602.33	2 ° 44 ' 37 "L	122.53	738975.0503	3053888.086	27°35'16.2"	95°25'15.45"
16	TP13	2685.9	6 ° 26 ' 57 "L	121.66	739039.2804	3053834.621	27°35'14.42"	95°25'17.75"
17	TP14	2847.14	29 ° 33 ' 24 "L	121.33	739174.0005	3053746.043	27°35'11.46"	95°25'22.6"
18	TP15	3169.54	35 ° 18 ' 14 "R	120.6	739495.71	3053724.855	27°35'10.57"	95°25'34.31"
19	TP16	3178.97	26 ° 49 ' 4 "R	120.75	739503.0297	3053718.912	27°35'10.37"	95°25'34.57"
20	TP17	3414.09	30 ° 53 ' 2 "L	121.33	739599.0751	3053504.303	27°35'3.34"	95°25'37.91"
21	IP17/1	3593.75	0 ° 0 ' 0 "R	121.74	739746.2353	3053401.238	27°34'59.9"	95°25'43.2"
22	TP18	3784.22	16 ° 50 ' 10 "L	121.66	739902.2415	3053291.977	27°34'56.25"	95°25'48.81"
23	TP19	3800.76	16 ° 1 ' 7 "R	121.68	739917.9638	3053286.817	27°34'56.07"	95°25'49.38"
24	IP19/1	4005.41	0 ° 0 ' 0 "	122.2	740087.2451	3053171.823	27°34'52.23"	95°25'55.47"
25	TP20	4212.04	54 ° 27 ' 16 "R	118.28	740258.1652	3053055.715	27°34'48.35"	95°26'1.61"
26	TP21	4340.43	5 ° 38 ' 11 "L	118.08	740261.2056	3052927.36	27°34'44.18"	95°26'1.63"
27	TP22	4411.84	9 ° 52 ' 17 "L	118.45	740269.9008	3052856.476	27°34'41.87"	95°26'1.9"
28	TP23	4448.13	5 ° 2 ' 37 "L	118.65	740280.4273	3052821.753	27°34'40.74"	95°26'2.26"
29	TP24	4536.65	7 ° 38 ' 16 "L	118.9	740313.4566	3052739.625	27°34'38.05"	95°26'3.4"
30	TP25	4598.39	3 ° 38 ' 25 "L	117.34	740343.9026	3052685.913	27°34'36.29"	95°26'4.47"
31	TP26	4675.71	3 ° 12 ' 47 "L	117.67	740386.2271	3052621.2	27°34'34.16"	95°26'5.97"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	RL (m)	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
					EASTING	NORTHING	LATITUDE	LONGITUDE
32	TP27	4752.35	14 ° 46 ' 56 "L	117.15	740431.7058	3052559.513	27°34'32.13"	95°26'7.58"
33	TP28	4871.74	70 ° 37 ' 11 "L	117.14	740524.7234	3052484.675	27°34'29.64"	95°26'10.92"
34	TP29	4907.21	27 ° 26 ' 32 "R	119.23	740536.529	3052518.128	27°34'30.72"	95°26'11.37"
35	TP30	4931.03	6 ° 31 ' 58 "L	121.24	740553.9117	3052534.405	27°34'31.23"	95°26'12.01"
36	TP31	4971.7	17 ° 35 ' 11 "R	121.34	740580.2453	3052565.404	27°34'32.22"	95°26'13"
37	TP32	5064.81	20 ° 40 ' 60 "R	120.03	740659.151	3052614.837	27°34'33.78"	95°26'15.91"
38	TP33	5178.02	9 ° 4 ' 36 "R	120.76	740770.1287	3052637.179	27°34'34.43"	95°26'19.97"
39	TP34	5268.39	1 ° 2 ' 36 "R	122.06	740860.4284	3052640.815	27°34'34.49"	95°26'23.26"
40	TP35	5388.38	9 ° 32 ' 55 "L	122.65	740980.3881	3052643.46	27°34'34.5"	95°26'27.63"
41	TP36	5399.12	8 ° 56 ' 13 "R	122.65	740990.9363	3052645.474	27°34'34.56"	95°26'28.02"
42	TP37	5689.69	44 ° 33 ' 20 "L	122.21	741281.3531	3052654.98	27°34'34.68"	95°26'38.61"
43	TP38	5839.14	30 ° 41 ' 32 "R	119.76	741384.3632	3052763.266	27°34'38.13"	95°26'42.44"
44	TP39	5933.47	66 ° 2 ' 11 "R	121.1	741475.152	3052788.85	27°34'38.9"	95°26'45.77"
45	IP39/1	6248.03	0 ° 0 ' 0 "	117.23	741676.0938	3052546.831	27°34'30.92"	95°26'52.91"
46	TP40	6562.72	0 ° 1 ' 57 "R	116.46	741877.1099	3052304.721	27°34'22.92"	95°27'0.06"
47	TP41	6831.54	32 ° 11 ' 23 "R	116.17	742048.7168	3052097.795	27°34'16.09"	95°27'6.17"
48	TP42	6963.32	10 ° 16 ' 45 "L	116.43	742065.8712	3051967.136	27°34'11.84"	95°27'6.7"
50	TP43	7122.07	66 ° 52 ' 30 "R	117.64	742058.1179	3051808.577	27°34'6.7"	95°27'6.3"
51	TP44	7295.57	18 ° 31 ' 28 "R	116.85	742214.1554	3051732.727	27°34'4.13"	95°27'11.93"
52	TP45	7351	21 ° 56 ' 32 "R	117.28	742253.7276	3051693.909	27°34'2.85"	95°27'13.35"
53	TP46	7448.35	19 ° 31 ' 30 "R	117.66	742292.7142	3051604.709	27°33'59.93"	95°27'14.7"
54	TP47	7623.97	32 ° 27 ' 6 "L	119.53	742305.2216	3051429.533	27°33'54.23"	95°27'15.03"
55	TP48	7687	28 ° 14 ' 15 "L	119.62	742275.272	3051374.068	27°33'52.45"	95°27'13.9"
56	TP49	7985.38	9 ° 15 ' 59 "R	119.54	742274.5945	3051075.688	27°33'42.76"	95°27'13.66"
57	TP50	8222.11	17 ° 22 ' 15 "L	120.03	742312.1816	3050841.969	27°33'35.15"	95°27'14.86"
58	TP51	8347.7	3 ° 33 ' 39 "R	120.24	742294.1926	3050717.668	27°33'31.12"	95°27'14.12"
59	TP52	8543.84	1 ° 50 ' 48 "L	121.86	742254.0977	3050525.67	27°33'24.91"	95°27'12.52"
60	TP53	8578.71	50 ° 31 ' 37 "R	122.93	742248.0731	3050491.324	27°33'23.8"	95°27'12.27"
61	TP54	8878.07	0 ° 11 ' 3 "L	125.33	742442.8006	3050263.955	27°33'16.29"	95°27'19.2"
62	TP55	9092.09	8 ° 24 ' 23 "L	125.55	742582.5374	3050101.853	27°33'10.94"	95°27'24.18"
63	TP56	9294.95	29 ° 14 ' 25 "L	125.04	742736.0276	3049969.217	27°33'6.54"	95°27'29.67"
64	TP57	9456.96	0 ° 17 ' 50 "R	125.12	742894.7405	3049936.664	27°33'5.38"	95°27'35.43"
65	TP58	9774.29	18 ° 12 ' 41 "R	125.79	743205.2569	3049871.294	27°33'3.05"	95°27'46.69"
66	TP59	9788.57	17 ° 28 ' 27 "R	125.8	743217.6175	3049864.129	27°33'2.81"	95°27'47.14"
67	TP60	9889.01	1 ° 12 ' 33 "L	125.99	743285.3755	3049789.992	27°33'0.36"	95°27'49.55"
68	IP60/1	10123.22	0 ° 0 ' 0 "	126.15	743446.9953	3049620.484	27°32'54.75"	95°27'55.32"
69	IP60/2	10347.35	0 ° 0 ' 0 "	125.5	743601.6617	3049458.268	27°32'49.38"	95°28'0.84"
70	TP61	10567.79	33 ° 14 ' 2 "R	125.19	743753.7784	3049298.727	27°32'44.1"	95°28'6.26"
71	TP62	10581.06	19 ° 50 ' 22 "L	125.32	743756.1737	3049285.677	27°32'43.68"	95°28'6.34"
72	TP63	10725.75	36 ° 41 ' 32 "R	124.37	743732.447	3049142.946	27°32'39.06"	95°28'5.37"
73	TP64	10828.3	17 ° 13 ' 17 "L	124.75	743658.5142	3049071.874	27°32'36.8"	95°28'2.63"
74	TP65	11050.89	11 ° 55 ' 23 "L	124.17	743550.9095	3048877.021	27°32'30.54"	95°27'58.57"
75	TP66	11070.39	25 ° 12 ' 21 "R	124.39	743545.2148	3048858.378	27°32'29.94"	95°27'58.34"
76	TP67	11122.2	20 ° 59 ' 52 "L	124.26	743552.6226	3048807.098	27°32'28.27"	95°27'58.58"
77	TP68	11265.49	14 ° 25 ' 45 "R	124.99	743520.9295	3048667.349	27°32'23.75"	95°27'57.32"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	RL (m)	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
					EASTING	NORTHING	LATITUDE	LONGITUDE
78	TP69	11535.16	1 ° 10 ' 40 "L	126.68	743528.7015	3048397.795	27°32'15"	95°27'57.41"
79	TP70	11840.42	0 ° 18 ' 49 "R	126.41	743543.7701	3048092.91	27°32'5.09"	95°27'57.74"
80	TP71	12092.36	28 ° 33 ' 46 "L	118.71	743554.83	3047841.212	27°31'56.91"	95°27'57.96"
81	TP72	12152.44	6 ° 2 ' 11 "R	118.88	743528.4499	3047787.237	27°31'55.17"	95°27'56.96"
82	TP73	12338.29	37 ° 54 ' 26 "R	122.57	743429.7361	3047629.77	27°31'50.12"	95°27'53.25"
83	TP74	12503.06	0 ° 31 ' 54 "L	126.24	743446.457	3047465.845	27°31'44.79"	95°27'53.74"
84	TP75	12652.1	6 ° 35 ' 37 "L	126.03	743462.9561	3047317.724	27°31'39.97"	95°27'54.23"
85	TP76	12869.67	0 ° 29 ' 58 "R	125.94	743511.7109	3047105.691	27°31'33.05"	95°27'55.85"
86	TP77	13155.05	0 ° 45 ' 46 "L	125.44	743573.2359	3046827.019	27°31'23.97"	95°27'57.89"
87	IP77/1	13381.98	0 ° 0 ' 0 "	125.38	743625.1058	3046606.091	27°31'16.76"	95°27'59.62"
88	TP78	13603.63	0 ° 27 ' 9 "L	125.83	743675.7665	3046390.313	27°31'9.72"	95°28'1.31"
89	TP79	13828.53	1 ° 36 ' 51 "R	125.75	743728.8982	3046171.779	27°31'2.59"	95°28'3.09"
90	TP80	13930.48	24 ° 28 ' 23 "L	125.58	743750.1845	3046072.07	27°30'59.34"	95°28'3.79"
91	TP81	13940.69	22 ° 58 ' 24 "R	125.44	743747.9886	3046062.101	27°30'59.01"	95°28'3.7"
92	TP82	13953.72	19 ° 11 ' 21 "R	125.22	743740.4455	3046051.485	27°30'58.67"	95°28'3.42"
93	TP83	14081.12	8 ° 2 ' 49 "L	126.05	743636.6102	3045977.652	27°30'56.34"	95°27'59.58"
94	TP84	14170.97	14 ° 11 ' 27 "R	125.99	743571.398	3045915.85	27°30'54.38"	95°27'57.16"
95	TP85	14251.01	1 ° 43 ' 8 "R	125.92	743501.5791	3045876.715	27°30'53.15"	95°27'54.59"
96	TP86	14315.98	17 ° 38 ' 50 "L	125.74	743443.9771	3045846.663	27°30'52.22"	95°27'52.47"
97	TP87	14342.52	14 ° 10 ' 60 "L	125.69	743425.2757	3045827.831	27°30'51.62"	95°27'51.78"
98	IP87/1	14484.4	0 ° 0 ' 0 "	120.56	743353.0174	3045705.732	27°30'47.7"	95°27'49.06"
99	TP88	14718.88	1 ° 3 ' 32 "R	125.21	743233.5965	3045503.94	27°30'41.22"	95°27'44.56"
100	TP89	14844.35	20 ° 53 ' 28 "R	125.7	743167.7105	3045397.163	27°30'37.8"	95°27'42.09"
101	TP90	14902.56	3 ° 6 ' 59 "R	124.85	743121.4831	3045361.777	27°30'36.68"	95°27'40.38"
102	TP91	15099.66	1 ° 12 ' 15 "L	126.55	742958.693	3045250.661	27°30'33.18"	95°27'34.37"
103	IP91/1	15290.49	0 ° 0 ' 0 "	126.11	742803.3789	3045139.793	27°30'29.68"	95°27'28.63"
104	TP92	15481.53	0 ° 43 ' 20 "L	125.25	742647.8869	3045028.798	27°30'26.17"	95°27'22.89"
105	TP93	15541.58	20 ° 28 ' 47 "L	124.99	742599.4536	3044993.295	27°30'25.05"	95°27'21.1"
106	TP94	15558.18	10 ° 29 ' 37 "L	124.35	742590.3444	3044979.416	27°30'24.61"	95°27'20.76"
107	TP95	15727.28	22 ° 28 ' 5 "R	126.02	742524.8609	3044823.514	27°30'19.59"	95°27'18.26"
108	TP96	15937.9	1 ° 2 ' 40 "R	125.35	742375.2727	3044675.236	27°30'14.87"	95°27'12.71"
109	TP97	16164.9	8 ° 48 ' 39 "R	126.79	742211.1682	3044518.396	27°30'9.88"	95°27'6.62"
110	TP98	16280.98	0 ° 8 ' 54 "R	126.85	742115.9597	3044451.996	27°30'7.79"	95°27'3.11"
111	TP99	16533.53	0 ° 13 ' 26 "R	126.67	741908.4393	3044308.064	27°30'3.25"	95°26'55.45"
112	TP100	16796.38	0 ° 32 ' 42 "R	125.12	741691.8686	3044159.106	27°29'58.55"	95°26'47.45"
113	TP101	16931.6	28 ° 13 ' 57 "R	125.87	741579.731	3044083.539	27°29'56.17"	95°26'43.31"
114	TP102	17084.67	4 ° 45 ' 57 "L	125.19	741427.4295	3044068.221	27°29'55.77"	95°26'37.76"
115	TP103	17331.98	0 ° 54 ' 13 "L	125.16	741184.2697	3044023.116	27°29'54.46"	95°26'28.87"
116	TP104	17451.88	2 ° 43 ' 23 "L	125.48	741066.7455	3043999.393	27°29'53.77"	95°26'24.57"
117	TP105	17770.62	1 ° 33 ' 57 "R	124.62	740757.6498	3043921.55	27°29'51.44"	95°26'13.26"
118	IP105/1	17948	0 ° 0 ' 0 "	124.14	740584.5281	3043882.949	27°29'50.29"	95°26'6.93"
119	TP106	18120.12	0 ° 26 ' 4 "L	124.17	740416.5291	3043845.491	27°29'49.18"	95°26'0.79"
120	TP107	18310.09	8 ° 1 ' 4 "R	124.25	740231.4274	3043802.743	27°29'47.91"	95°25'54.02"
121	TP108	18393.17	20 ° 22 ' 40 "R	125.28	740148.6617	3043795.522	27°29'47.73"	95°25'51"
122	TP109	18661.94	19 ° 6 ' 40 "L	124.61	739889.5327	3043866.856	27°29'50.21"	95°25'41.61"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	RL (m)	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
					EASTING	NORTHING	LATITUDE	LONGITUDE
123	TP110	18683.11	11 ° 29 ' 47 "L	124.37	739868.4062	3043865.483	27°29'50.18"	95°25'40.84"
124	TP111	18740.85	6 ° 1 ' 12 "R	124.26	739812.6962	3043850.33	27°29'49.73"	95°25'38.8"
125	TP112	18856.04	13 ° 40 ' 24 "L	123.36	739698.9897	3043831.921	27°29'49.2"	95°25'34.65"
126	TP113	18956.88	6 ° 11 ' 7 "L	123.64	739606.0703	3043792.729	27°29'47.99"	95°25'31.24"
127	TP114	19093.76	1 ° 43 ' 15 "R	123.94	739486.4179	3043726.255	27°29'45.91"	95°25'26.83"
128	TP115	19199.11	7 ° 16 ' 54 "R	124.37	739392.8336	3043677.883	27°29'44.39"	95°25'23.39"
129	TP116	19348.85	15 ° 4 ' 2 "L	124.23	739252.1627	3043626.537	27°29'42.82"	95°25'18.23"
130	TP117	19379.2	18 ° 57 ' 19 "L	124.22	739227.3455	3043609.083	27°29'42.27"	95°25'17.32"
131	TP118	19507.37	5 ° 36 ' 44 "L	124.69	739152.1392	3043505.286	27°29'38.94"	95°25'14.5"
132	TP119	19600.83	33 ° 14 ' 41 "R	123.46	739104.9697	3043424.607	27°29'36.35"	95°25'12.73"
133	TP120	19624.14	30 ° 18 ' 29 "L	123.45	739106.162	3043401.325	27°29'35.6"	95°25'12.76"
134	TP121	19707.3	4 ° 21 ' 20 "L	123.72	739151.7471	3043331.77	27°29'33.31"	95°25'14.37"
135	IP121/1	19913.2	0 ° 0 ' 0 "	124.19	739277.3622	3043168.627	27°29'27.93"	95°25'18.83"
136	TP122	20115.12	21 ° 54 ' 5 "R	124.96	739400.5466	3043008.641	27°29'22.66"	95°25'23.2"
137	TP123	20176.64	17 ° 7 ' 44 "L	124.73	739417.1866	3042949.418	27°29'20.72"	95°25'23.76"
138	TP124	20435.89	19 ° 30 ' 10 "R	125.37	739410.6943	3042690.241	27°29'12.31"	95°25'23.34"
139	TP125	20509.77	25 ° 37 ' 29 "R	124.43	739384.2947	3042621.245	27°29'10.09"	95°25'22.33"
140	TP126	20635.96	7 ° 24 ' 51 "L	123.79	739394.6052	3042495.478	27°29'6"	95°25'22.62"
141	TP127	20693.57	30 ° 24 ' 40 "R	123.64	739391.8636	3042437.931	27°29'4.13"	95°25'22.47"
142	TP128	20771.19	1 ° 53 ' 15 "R	123.51	739349.4317	3042372.936	27°29'2.05"	95°25'20.88"
143	IP128/1	20962.38	0 ° 0 ' 0 "	123.09	739239.699	3042216.373	27°28'57.03"	95°25'16.78"
144	TP129	21152.72	30 ° 50 ' 11 "R	123.54	739130.4525	3042060.504	27°28'52.04"	95°25'12.69"
145	TP130	21183.69	4 ° 20 ' 46 "R	123.62	739102.189	3042047.839	27°28'51.65"	95°25'11.65"
146	TP131	21290.12	13 ° 23 ' 27 "R	122.74	739002.0444	3042011.802	27°28'50.54"	95°25'7.98"
147	TP132	21424.88	33 ° 6 ' 39 "R	124.05	738868.1313	3041996.78	27°28'50.14"	95°25'3.09"
148	TP133	21519.74	0 ° 32 ' 15 "R	122.61	738783.394	3042039.417	27°28'51.58"	95°25'0.04"
149	TP134	21615.5	36 ° 6 ' 17 "L	122.95	738698.2532	3042083.264	27°28'53.06"	95°24'56.97"
150	TP135	21715.39	10 ° 46 ' 5 "R	124.12	738599.5547	3042067.884	27°28'52.62"	95°24'53.37"
151	TP136	21763.33	15 ° 58 ' 4 "L	124.24	738551.6425	3042069.483	27°28'52.7"	95°24'51.62"
152	TP137	22048.13	9 ° 37 ' 29 "R	123.68	738275.3745	3042000.311	27°28'50.63"	95°24'41.51"
153	TP138	22193.34	6 ° 25 ' 41 "L	123.72	738130.597	3041989.09	27°28'50.36"	95°24'36.24"
154	TP139	22298.43	6 ° 17 ' 20 "R	123.45	738027.3865	3041969.289	27°28'49.78"	95°24'32.46"
155	TP140	22379.83	12 ° 21 ' 37 "L	123.46	737946.2482	3041962.802	27°28'49.62"	95°24'29.5"
156	TP141	22564.49	7 ° 52 ' 33 "L	122.84	737769.5901	3041909.024	27°28'47.99"	95°24'23.03"
157	TP142	22622.97	0 ° 46 ' 49 "L	122.85	737716.5072	3041884.488	27°28'47.22"	95°24'21.08"
158	IP142/1	22844.38	0 ° 0 ' 0 "	122.41	737516.8155	3041788.865	27°28'44.24"	95°24'13.75"
159	TP143	23065.09	2 ° 0 ' 4 "L	122.14	737317.7441	3041693.539	27°28'41.27"	95°24'6.43"
160	TP144	23222.18	5 ° 26 ' 42 "L	122.74	737178.5222	3041620.791	27°28'39"	95°24'1.31"
161	IP144/1	23464.09	0 ° 0 ' 0 "	121.7	736975.719	3041488.919	27°28'34.84"	95°23'53.84"
162	TP145	23703.98	0 ° 16 ' 49 "L	121.69	736774.6058	3041358.146	27°28'30.72"	95°23'46.42"
163	IP145/1	23893.61	0 ° 0 ' 0 "R	121.34	736616.1327	3041253.994	27°28'27.44"	95°23'40.58"
164	TP146	24064.5	7 ° 38 ' 44 "R	121.51	736473.3262	3041160.138	27°28'24.48"	95°23'35.31"
165	TP147	24223.03	0 ° 1 ' 48 "L	121.21	736330.4418	3041091.47	27°28'22.34"	95°23'30.06"
166	IP147/1	24390.33	0 ° 0 ' 0 "	120.87	736179.6875	3041018.922	27°28'20.08"	95°23'24.52"
167	TP148	24559.38	2 ° 18 ' 26 "R	121.57	736027.3579	3040945.616	27°28'17.8"	95°23'18.93"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	RL (m)	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
					EASTING	NORTHING	LATITUDE	LONGITUDE
168	IP148/1	24731.14	0 ° 0 ' 0 "	120.7	735869.7162	3040877.427	27°28'15.68"	95°23'13.14"
169	TP149	24905.19	0 ° 32 ' 47 "L	120.6	735709.972	3040808.328	27°28'13.54"	95°23'7.28"
170	TP150	25112.82	38 ° 17 ' 3 "L	120.65	735520.1974	3040724.082	27°28'10.92"	95°23'0.31"
171	TP151	25277.23	3 ° 39 ' 50 "L	120.71	735443.5746	3040578.621	27°28'6.25"	95°22'57.42"
172	TP152	25465.34	6 ° 14 ' 41 "R	120.55	735366.7186	3040406.923	27°28'0.72"	95°22'54.5"
173	TP153	25721.03	12 ° 21 ' 58 "L	121.72	735237.4922	3040186.302	27°27'53.63"	95°22'49.64"
174	TP154	25804.43	6 ° 43 ' 48 "R	120.9	735211.7292	3040106.978	27°27'51.07"	95°22'48.65"
175	TP155	25894.57	11 ° 7 ' 51 "L	120.06	735174.0275	3040025.095	27°27'48.44"	95°22'47.22"
176	TP156	25964.06	2 ° 3 ' 54 "L	120.43	735157.6967	3039957.551	27°27'46.26"	95°22'46.58"
177	TP157	26020.57	9 ° 50 ' 22 "R	120.23	735146.4047	3039902.183	27°27'44.47"	95°22'46.13"
178	TP158	26029.16	25 ° 10 ' 30 "R	120.23	735143.2749	3039894.183	27°27'44.21"	95°22'46.01"
179	TP159	26043.96	14 ° 27 ' 44 "R	120.14	735132.536	3039884.007	27°27'43.88"	95°22'45.61"
180	TP160	26230.42	19 ° 19 ' 55 "R	119.6	734969.4472	3039793.62	27°27'41.05"	95°22'39.61"
181	TP161	26381.68	10 ° 1 ' 51 "L	119.91	734820.3341	3039768.228	27°27'40.32"	95°22'34.16"
182	TP162	26418.35	3 ° 1 ' 11 "L	120.73	734785.8017	3039755.868	27°27'39.94"	95°22'32.9"
183	TP163	26461.56	9 ° 6 ' 53 "L	120.37	734745.9434	3039739.183	27°27'39.42"	95°22'31.44"
184	TP164	26557.18	6 ° 8 ' 28 "R	120.19	734664.7027	3039688.755	27°27'37.83"	95°22'28.44"
185	TP165	26775.56	33 ° 54 ' 32 "R	119.37	734467.9092	3039594.096	27°27'34.88"	95°22'21.21"
186	TP166	26825.53	4 ° 35 ' 15 "R	119.32	734418.4471	3039601.242	27°27'35.15"	95°22'19.42"
187	TP167	26994.87	5 ° 59 ' 47 "R	119.24	734253.324	3039638.784	27°27'36.47"	95°22'13.43"
188	TP168	27100.68	1 ° 27 ' 41 "R	119.53	734153.1668	3039672.891	27°27'37.64"	95°22'9.81"
189	TP169	27205.54	50 ° 8 ' 17 "L	119.57	734054.7968	3039709.214	27°27'38.88"	95°22'6.25"
190	TP170	27303.31	2 ° 39 ' 51 "R	119.92	733970.011	3039660.517	27°27'37.35"	95°22'3.13"
191	TP171	27384.27	12 ° 55 ' 56 ""Ø	120.73	733898.0165	3039623.505	27°27'36.19"	95°22'0.49"
192	TP172	27445.48	4 ° 28 ' 29 ""Ø	121.6	733838.6953	3039608.412	27°27'35.74"	95°21'58.32"
193	TP173	27583.1	18 ° 17 ' 60 "R	121.02	733703.0834	3039584.988	27°27'35.06"	95°21'53.36"
194	TP174	27683.7	48 ° 19 ' 27 "L	120.78	733603.5814	3039599.858	27°27'35.61"	95°21'49.75"
195	TP175	27766.27	11 ° 33 ' 12 "L	120.3	733540.1698	3039546.979	27°27'33.93"	95°21'47.41"
196	TP176	27881.13	15 ° 3 ' 21 "L	118.85	733468.4779	3039457.243	27°27'31.06"	95°21'44.74"
197	TP177	27950.58	4 ° 23 ' 28 "L	118.3	733440.7103	3039393.584	27°27'29.01"	95°21'43.68"
198	TP178	28054.45	2 ° 51 ' 18 "L	118.71	733406.5918	3039295.473	27°27'25.84"	95°21'42.37"
199	TP179	28113.94	2 ° 52 ' 36 "L	119.18	733389.8745	3039238.379	27°27'24"	95°21'41.72"
200	TP180	28190.19	12 ° 45 ' 28 "L	117.88	733372.1491	3039164.227	27°27'21.6"	95°21'41.03"
201	TP181	28334.46	0 ° 4 ' 50 "R	117.13	733370.4221	3039019.96	27°27'16.92"	95°21'40.86"
202	IP181/1	28515.26	0 ° 0 ' 0 "	120.3	733368.0037	3038839.178	27°27'11.05"	95°21'40.65"
203	TP182	28696.41	0 ° 9 ' 20 "L	120.56	733365.5807	3038658.046	27°27'5.17"	95°21'40.44"
204	IP182/1	28865.22	0 ° 0 ' 0 "L	121.25	733363.781	3038489.244	27°26'59.69"	95°21'40.25"
205	TP183	29035.07	18 ° 56 ' 17 "R	120.88	733361.9702	3038319.4	27°26'54.18"	95°21'40.07"
206	TP184	29124.51	5 ° 31 ' 29 "L	120.58	733332.0444	3038235.121	27°26'51.46"	95°21'38.92"
207	TP185	29296.92	1 ° 17 ' 1 "L	120.69	733290.2629	3038067.846	27°26'46.05"	95°21'37.29"
208	TP186	29454.42	0 ° 4 ' 45 "L	120.62	733255.5288	3037914.226	27°26'41.08"	95°21'35.92"
209	TP187	29527.77	3 ° 38 ' 41 "R	121.2	733239.451	3037842.658	27°26'38.77"	95°21'35.28"
210	TP188	29555.63	9 ° 54 ' 42 "R	121.46	733231.6287	3037815.918	27°26'37.91"	95°21'34.98"
211	IP188/1	29734.88	0 ° 0 ' 0 "L	121.21	733152.4402	3037655.11	27°26'32.73"	95°21'31.99"
212	TP189	29911.66	0 ° 12 ' 53 "R	121.3	733074.3441	3037496.521	27°26'27.63"	95°21'29.03"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	RL (m)	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
					EASTING	NORTHING	LATITUDE	LONGITUDE
213	TP190	30046.85	53 ° 26 ' 39 "R	122.17	733014.1628	3037375.457	27°26'23.74"	95°21'26.76"
214	TP191	30218.23	7 ° 39 ' 20 "R	121.5	733092.0001	3037222.773	27°26'18.73"	95°21'29.49"
215	TP192	30239.99	32 ° 30 ' 43 "L	121.05	733099.2116	3037202.245	27°26'18.06"	95°21'29.74"
216	TP193	30464.58	6 ° 36 ' 27 "L	121.02	733048.0979	3036983.554	27°26'10.99"	95°21'27.72"
217	TP194	30550.15	15 ° 41 ' 55 "R	120.88	733038.3397	3036898.541	27°26'8.24"	95°21'27.31"
218	TP195	30739.56	6 ° 25 ' 33 "L	121.04	732966.6316	3036723.232	27°26'2.59"	95°21'24.58"
219	TP196	30902.76	0 ° 32 ' 50 "L	120.82	732922.1384	3036566.213	27°25'57.52"	95°21'22.85"
220	TP197	31080.82	7 ° 6 ' 28 "L	120.96	732875.2318	3036394.44	27°25'51.97"	95°21'21.03"
221	TP198	31167.78	1 ° 24 ' 44 "R	120.7	732862.88	3036308.36	27°25'49.18"	95°21'20.52"
222	TP199	31377.28	14 ° 44 ' 2 "R	121.27	732828.0217	3036101.784	27°25'42.49"	95°21'19.11"
223	IP199/1	31573.81	0 ° 0 ' 0 "R	121.37	732747.109	3035922.681	27°25'36.73"	95°21'16.04"
224	TP200	31768.14	2 ° 2 ' 45 "L	122.41	732667.1026	3035745.584	27°25'31.03"	95°21'13"
225	TP201	31888.97	19 ° 0 ' 38 "R	122.26	732621.3171	3035633.759	27°25'27.42"	95°21'11.26"
226	TP202	32043.61	17 ° 3 ' 33 "L	121.99	732519.3021	3035517.543	27°25'23.71"	95°21'7.47"
227	TP203	32103.47	0 ° 52 ' 21 "L	122.43	732494.7501	3035462.957	27°25'21.95"	95°21'6.54"
228	TP204	32159.71	6 ° 28 ' 20 "L	121.54	732472.4619	3035411.316	27°25'20.29"	95°21'5.69"
229	TP205	32324.63	1 ° 51 ' 53 "R	120.89	732424.5951	3035253.498	27°25'15.19"	95°21'3.84"
230	TP206	32653.4	29 ° 33 ' 18 "R	120.91	732318.9833	3034942.15	27°25'5.15"	95°20'59.78"
231	TP207	32665.16	7 ° 38 ' 19 "R	120.93	732310.2018	3034934.324	27°25'4.9"	95°20'59.46"
232	TP208	32711.37	4 ° 25 ' 19 "R	120.95	732271.9281	3034908.441	27°25'4.08"	95°20'58.05"
233	TP209	32755.53	17 ° 6 ' 27 "L	120.81	732233.5489	3034886.597	27°25'3.4"	95°20'56.64"
234	TP210	32885.35	18 ° 28 ' 29 "L	120.8	732144.6075	3034792.036	27°25'0.38"	95°20'53.33"
235	TP211	32935.04	3 ° 16 ' 26 "L	121.54	732123.7872	3034746.917	27°24'58.93"	95°20'52.55"
236	TP212	32950.6	17 ° 33 ' 17 "R	121.13	732118.0833	3034732.435	27°24'58.46"	95°20'52.33"
237	TP213	32960.54	27 ° 55 ' 29 "R	120.75	732111.819	3034724.713	27°24'58.22"	95°20'52.09"
238	TP214	33023.72	23 ° 1 ' 34 "L	120.53	732053.6788	3034700.007	27°24'57.45"	95°20'49.96"
239	IP214/1	33201.61	0 ° 0 ' 0 "	120.07	731930.2154	3034571.936	27°24'53.37"	95°20'45.38"
240	TP215	33381.72	15 ° 10 ' 5 "L	119.91	731805.2103	3034442.266	27°24'49.23"	95°20'40.74"
241	TP216	33408.72	46 ° 8 ' 35 "R	119.63	731792.2109	3034418.603	27°24'48.47"	95°20'40.25"
242	TP217	33494.02	2 ° 43 ' 13 "R	120.67	731817.664	3034337.186	27°24'45.81"	95°20'41.12"
243	TP218	33608.32	4 ° 26 ' 50 "R	121.54	731846.5528	3034226.597	27°24'42.2"	95°20'42.1"
244	TP219	33726.79	0 ° 6 ' 35 "L	120.67	731867.5177	3034109.998	27°24'38.4"	95°20'42.78"
245	TP220	33881.85	1 ° 0 ' 34 "L	119.69	731895.2512	3033957.434	27°24'33.43"	95°20'43.69"
246	TP221	33967.06	1 ° 20 ' 15 "R	119.91	731911.9653	3033873.882	27°24'30.71"	95°20'44.24"
247	TP222	34122.71	17 ° 52 ' 6 "L	120.59	731938.9263	3033720.586	27°24'25.71"	95°20'45.11"
248	TP223	34144.83	23 ° 18 ' 24 "L	120.71	731949.2554	3033701.031	27°24'25.07"	95°20'45.48"
249	TP224	34329.11	42 ° 8 ' 3 "R	119.85	732092.7759	3033585.431	27°24'21.23"	95°20'50.62"
250	TP225	34394.05	20 ° 13 ' 45 "L	120.29	732102.9524	3033521.292	27°24'19.14"	95°20'50.95"
251	TP226	34505.43	20 ° 45 ' 55 "R	120.02	732081.2937	3033412.044	27°24'15.61"	95°20'50.08"
252	TP227	34769.46	19 ° 28 ' 26 "L	120.18	732125.1052	3033151.678	27°24'7.13"	95°20'51.5"
253	TP228	34911.62	6 ° 1 ' 16 "L	119.79	732100.6089	3033011.641	27°24'2.59"	95°20'50.51"
254	TP229	34976.53	18 ° 34 ' 39 "R	119.54	732096.1928	3032946.879	27°24'0.49"	95°20'50.31"
255	TP230	35118.5	37 ° 29 ' 40 "L	119.8	732132.1613	3032809.546	27°23'56.01"	95°20'51.52"
256	TP231	35295.18	12 ° 36 ' 2 "R	119.52	732063.6433	3032646.691	27°23'50.76"	95°20'48.92"
257	TP232	35466.05	3 ° 11 ' 39 "L	119.69	731964.6134	3032507.438	27°23'46.3"	95°20'45.22"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	RL (m)	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
					EASTING	NORTHING	LATITUDE	LONGITUDE
258	TP233	35680.38	1 ° 59 ' 54 "L	119.22	731850.3286	3032326.128	27°23'40.49"	95°20'40.93"
259	TP234	35827.3	8 ° 47 ' 30 "R	118.67	731776.3648	3032199.178	27°23'36.41"	95°20'38.16"
260	IP234/1	35933.29	0 ° 0 ' 0 "	118.36	731709.6383	3032116.83	27°23'33.78"	95°20'35.67"
261	TP235	36160.23	2 ° 42 ' 1 "L	118.73	731566.7633	3031940.506	27°23'28.14"	95°20'30.35"
262	TP236	36444.8	11 ° 4 ' 19 "R	119.13	731398.2248	3031711.216	27°23'20.79"	95°20'24.07"
263	TP237	36671.31	1 ° 13 ' 32 "L	118.54	731231.5188	3031557.866	27°23'15.92"	95°20'17.9"
264	TP238	36810.46	0 ° 17 ' 21 "L	118.93	731131.145	3031461.489	27°23'12.85"	95°20'14.18"
265	TP239	36967.3	9 ° 27 ' 21 "L	118.86	731018.565	3031352.296	27°23'9.37"	95°20'10.01"
266	TP240	37044.64	26 ° 11 ' 26 "R	119.73	730972.6498	3031290.061	27°23'7.38"	95°20'8.3"
267	TP241	37079.45	2 ° 33 ' 28 "R	119.71	730941.746	3031274.048	27°23'6.88"	95°20'7.16"
268	TP242	37111.59	47 ° 36 ' 32 "L	119.5	730912.5771	3031260.55	27°23'6.46"	95°20'6.09"
269	TP243	37135.74	7 ° 49 ' 17 "L	119.44	730905.2914	3031237.524	27°23'5.71"	95°20'5.81"
270	TP244	37363.21	1 ° 25 ' 9 "L	119.95	730866.8213	3031013.333	27°22'58.46"	95°20'4.26"
271	TP245	37435.02	1 ° 23 ' 12 "R	120.09	730856.4324	3030942.273	27°22'56.15"	95°20'3.83"
272	TP246	37653.7	11 ° 15 ' 31 "R	119.55	730819.5715	3030726.725	27°22'49.18"	95°20'2.34"
273	TP247	37746.98	87 ° 4 ' 24 "L	119.3	730822.1018	3030633.476	27°22'46.15"	95°20'2.37"
274	TP248	37766.57	77 ° 48 ' 51 "L	119.42	730841.6837	3030633.007	27°22'46.12"	95°20'3.08"

2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
				EASTING	NORTHING	LATITUDE	LONGITUDE
1	TP0	0	0 ° 0 ' 0 "	739398.5499	3042570.312	27°29'8.43"	95°25'22.81"
2	TP1	95.15	6 ° 24 ' 31 "L	739404.659	3042475.355	27°29'5.34"	95°25'22.97"
3	TP2	136.13	30 ° 24 ' 39 "R	739402.7088	3042434.421	27°29'4.01"	95°25'22.87"
4	TP3	216.92	1 ° 53 ' 15 "R	739358.5435	3042366.771	27°29'1.84"	95°25'21.21"
5	TP4	601.67	30 ° 50 ' 11 "R	739137.7191	3042051.706	27°28'51.75"	95°25'12.95"
6	TP5	636.09	4 ° 20 ' 46 "R	739106.3063	3042037.63	27°28'51.31"	95°25'11.79"
7	TP6	744.23	13 ° 23 ' 27 "R	739004.5539	3042001.014	27°28'50.19"	95°25'8.06"
8	TP7	883.55	33 ° 6 ' 39 "R	738866.1081	3041985.484	27°28'49.77"	95°25'3.01"
9	TP8	1024.71	0 ° 58 ' 27 "R	738740.0113	3042048.932	27°28'51.91"	95°24'58.47"
10	TP9	1074	36 ° 32 ' 29 "L	738696.3585	3042071.836	27°28'52.69"	95°24'56.89"
11	TP10	1171.3	10 ° 46 ' 5 "R	738600.224	3042056.855	27°28'52.26"	95°24'53.38"
12	TP11	1218.73	15 ° 58 ' 4 "L	738552.8176	3042058.437	27°28'52.34"	95°24'51.66"
13	TP12	1502.91	9 ° 37 ' 29 "R	738277.1478	3041989.415	27°28'50.27"	95°24'41.57"
14	TP13	1648.43	6 ° 25 ' 40 "L	738132.0629	3041978.17	27°28'50"	95°24'36.28"
15	TP14	1753.53	6 ° 27 ' 59 "R	738028.8487	3041958.369	27°28'49.42"	95°24'32.51"
16	TP15	1833.2	12 ° 43 ' 40 "L	737949.4072	3041952.265	27°28'49.28"	95°24'29.61"
17	TP16	2016.97	7 ° 4 ' 24 "L	737773.7856	3041898.166	27°28'47.63"	95°24'23.18"
18	TP17	2074.65	1 ° 18 ' 46 "L	737721.1735	3041874.527	27°28'46.9"	95°24'21.25"
19	TP18	2476.52	1 ° 24 ' 10 "L	737358.4733	3041701.471	27°28'41.5"	95°24'7.92"
20	TP19	2681.45	7 ° 5 ' 48 "L	737175.728	3041608.718	27°28'38.61"	95°24'1.2"
21	TP20	2774.27	0 ° 43 ' 11 "R	737098.781	3041556.803	27°28'36.97"	95°23'58.36"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
				EASTING	NORTHING	LATITUDE	LONGITUDE
22	TP21	2816.91	0 ° 21 ' 55 "R	737063.142	3041533.404	27°28'36.23"	95°23'57.05"
23	TP22	2927.39	0 ° 52 ' 23 "L	736970.401	3041473.357	27°28'34.34"	95°23'53.63"
24	TP23	2969.06	0 ° 16 ' 59 "L	736935.776	3041450.182	27°28'33.61"	95°23'52.35"
25	TP24	3051.37	1 ° 50 ' 18 "R	736867.595	3041404.058	27°28'32.16"	95°23'49.84"
26	TP25	3157.32	1 ° 47 ' 52 "L	736777.981	3041347.538	27°28'30.38"	95°23'46.54"
27	TP26	3254.72	0 ° 10 ' 45 "L	736697.272	3041293.022	27°28'28.66"	95°23'43.56"
28	TP27	3350.34	0 ° 32 ' 33 "R	736618.202	3041239.252	27°28'26.96"	95°23'40.64"
29	TP28	3452.27	3 ° 24 ' 26 "R	736533.376	3041182.735	27°28'25.18"	95°23'37.52"
30	TP29	3501.76	2 ° 12 ' 20 "R	736490.63	3041157.789	27°28'24.4"	95°23'35.94"
31	TP30	3547.49	2 ° 2 ' 24 "R	736450.275	3041136.276	27°28'23.72"	95°23'34.46"
32	TP31	3626.71	0 ° 23 ' 52 "R	736379.09	3041101.523	27°28'22.64"	95°23'31.84"
33	TP32	3678.27	2 ° 49 ' 13 "L	736332.603	3041079.226	27°28'21.94"	95°23'30.13"
34	TP33	3724.86	2 ° 0 ' 26 "R	736291.636	3041057.034	27°28'21.25"	95°23'28.63"
35	TP34	3817.93	0 ° 24 ' 2 "R	736208.292	3041015.594	27°28'19.96"	95°23'25.56"
36	TP35	3890.85	0 ° 21 ' 29 "L	736142.781	3040983.59	27°28'18.96"	95°23'23.16"
37	TP36	3944.46	3 ° 6 ' 40 "R	736094.759	3040959.757	27°28'18.21"	95°23'21.39"
38	TP37	4020.57	0 ° 56 ' 50 "R	736024.846	3040929.671	27°28'17.28"	95°23'18.82"
39	TP38	4147.46	0 ° 52 ' 2 "L	735907.475	3040881.446	27°28'15.79"	95°23'14.52"
40	TP39	4325.84	2 ° 8 ' 31 "R	735743.52	3040811.162	27°28'13.61"	95°23'8.5"
41	TP40	4355.13	1 ° 55 ' 11 "L	735716.187	3040800.636	27°28'13.28"	95°23'7.5"
42	TP41	4375.7	2 ° 43 ' 47 "L	735697.255	3040792.607	27°28'13.04"	95°23'6.8"
43	TP42	4436.53	1 ° 44 ' 60 "R	735642.446	3040766.216	27°28'12.21"	95°23'4.79"
44	TP43	4559.35	36 ° 55 ' 11 "L	735530.2071	3040716.335	27°28'10.66"	95°23'0.67"
45	TP44	4596.28	0 ° 0 ' 26 "L	735512.237	3040684.074	27°28'9.63"	95°22'59.99"
46	TP45	4638.26	0 ° 29 ' 50 "L	735491.814	3040647.399	27°28'8.45"	95°22'59.22"
47	TP46	4690.86	0 ° 4 ' 41 "L	735466.621	3040601.22	27°28'6.96"	95°22'58.27"
48	TP47	4718.72	3 ° 1 ' 33 "L	735453.314	3040576.749	27°28'6.18"	95°22'57.77"
50	TP48	4777.79	1 ° 39 ' 8 "L	735427.874	3040523.439	27°28'4.46"	95°22'56.81"
51	TP49	4833.27	0 ° 14 ' 13 "R	735405.433	3040472.699	27°28'2.83"	95°22'55.95"
52	TP50	4909.4	5 ° 7 ' 35 "R	735374.3532	3040403.205	27°28'0.59"	95°22'54.77"
53	TP51	5051.03	3 ° 23 ' 10 "R	735305.207	3040279.594	27°27'56.62"	95°22'52.17"
54	TP52	5115.75	7 ° 56 ' 33 "L	735270.3342	3040225.082	27°27'54.87"	95°22'50.86"
55	TP53	5172.29	6 ° 7 ' 50 "L	735246.7377	3040173.699	27°27'53.22"	95°22'49.97"
56	TP54	5244.88	19 ° 49 ' 0 "R	735223.661	3040104.871	27°27'51"	95°22'49.08"
57	TP55	5265.84	16 ° 49 ' 27 "L	735210.654	3040088.432	27°27'50.47"	95°22'48.6"
58	TP56	5337.37	7 ° 12 ' 44 "L	735184.4081	3040021.898	27°27'48.33"	95°22'47.59"
59	TP57	5396.23	5 ° 31 ' 50 "L	735169.8524	3039964.859	27°27'46.49"	95°22'47.02"
60	TP58	5459.98	0 ° 40 ' 38 "R	735160.117	3039901.864	27°27'44.45"	95°22'46.63"
61	TP59	5474.71	52 ° 52 ' 33 "R	735157.695	3039887.332	27°27'43.98"	95°22'46.53"
62	TP60	5486.95	2 ° 35 ' 49 "L	735146.851	3039881.648	27°27'43.8"	95°22'46.13"
63	TP61	5657.27	2 ° 50 ' 27 "R	734999.735	3039795.823	27°27'41.1"	95°22'40.71"
64	TP62	5686.18	16 ° 37 ' 58 "R	734974.0749	3039782.512	27°27'40.69"	95°22'39.77"
65	TP63	5718.39	1 ° 40 ' 28 "R	734942.4306	3039776.484	27°27'40.51"	95°22'38.61"
66	TP64	5832.59	9 ° 27 ' 8 "L	734829.6711	3039758.401	27°27'39.99"	95°22'34.5"
67	TP65	5875.26	4 ° 3 ' 44 "L	734789.226	3039744.819	27°27'39.58"	95°22'33.01"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
				EASTING	NORTHING	LATITUDE	LONGITUDE
68	TP66	5916.8	10 ° 0 ' 27 "L	734750.8834	3039728.839	27°27'39.08"	95°22'31.61"
69	TP67	5966.98	3 ° 47 ' 20 "R	734708.6215	3039701.778	27°27'38.23"	95°22'30.05"
70	TP68	6029.39	4 ° 11 ' 43 "R	734653.9579	3039671.672	27°27'37.29"	95°22'28.04"
71	TP69	6103.62	1 ° 9 ' 25 "L	734586.486	3039640.712	27°27'36.32"	95°22'25.56"
72	TP70	6236.03	31 ° 23 ' 36 "R	734467.281	3039583.073	27°27'34.53"	95°22'21.18"
73	TP71	6255.78	4 ° 16 ' 32 "R	734447.626	3039584.996	27°27'34.6"	95°22'20.47"
74	TP72	6287.44	2 ° 35 ' 1 "R	734416.438	3039590.419	27°27'34.8"	95°22'19.34"
75	TP73	6457.74	7 ° 7 ' 4 "R	734250.1393	3039627.126	27°27'36.09"	95°22'13.31"
76	TP74	6562.37	0 ° 2 ' 59 "L	734151.55	3039662.164	27°27'37.29"	95°22'9.74"
77	TP75	6664.39	47 ° 7 ' 46 "L	734055.3932	3039696.244	27°27'38.46"	95°22'6.27"
78	TP76	6757.81	0 ° 41 ' 47 "R	733972.611	3039652.941	27°27'37.1"	95°22'3.22"
79	TP77	6851.95	14 ° 19 ' 13 "R	733888.6708	3039610.324	27°27'35.77"	95°22'0.14"
80	TP78	6897.22	2 ° 17 ' 27 "R	733844.488	3039600.45	27°27'35.48"	95°21'58.52"
81	TP79	7030.68	16 ° 8 ' 3 "R	733713.1794	3039576.572	27°27'34.78"	95°21'53.73"
82	TP80	7080.86	1 ° 32 ' 25 "R	733663.263	3039581.667	27°27'34.98"	95°21'51.91"
83	TP81	7138.5	48 ° 42 ' 56 "L	733606.0972	3039589.059	27°27'35.25"	95°21'49.84"
84	TP82	7152.29	2 ° 8 ' 15 "R	733595.749	3039579.953	27°27'34.97"	95°21'49.45"
85	TP83	7211.52	11 ° 52 ' 30 "L	733549.853	3039542.508	27°27'33.78"	95°21'47.76"
86	TP84	7329.31	13 ° 58 ' 34 "L	733475.86	3039450.857	27°27'30.85"	95°21'45"
87	TP85	7374.16	6 ° 8 ' 2 "L	733456.9493	3039410.19	27°27'29.54"	95°21'44.28"
88	TP86	7499.14	3 ° 2 ' 34 "L	733416.662	3039291.881	27°27'25.72"	95°21'42.74"
89	TP87	7576.08	2 ° 19 ' 38 "L	733395.761	3039217.832	27°27'23.33"	95°21'41.92"
90	TP88	7633.33	12 ° 47 ' 11 "L	733382.4594	3039162.148	27°27'21.53"	95°21'41.4"
91	TP89	7824.23	0 ° 10 ' 47 "R	733380.299	3038971.263	27°27'15.33"	95°21'41.19"
92	TP90	7957.85	0 ° 21 ' 5 "L	733378.368	3038837.661	27°27'11"	95°21'41.03"
93	TP91	8091.72	0 ° 47 ' 30 "R	733377.254	3038703.792	27°27'6.65"	95°21'40.89"
94	TP92	8152.66	1 ° 13 ' 8 "L	733375.905	3038642.87	27°27'4.67"	95°21'40.8"
95	TP93	8229.87	1 ° 4 ' 12 "R	733375.838	3038565.658	27°27'2.16"	95°21'40.75"
96	TP94	8330.03	0 ° 47 ' 11 "L	733373.881	3038465.518	27°26'58.91"	95°21'40.61"
97	TP95	8423.26	0 ° 16 ' 3 "L	733373.339	3038372.287	27°26'55.89"	95°21'40.52"
98	TP96	8466.46	17 ° 14 ' 34 "R	733373.2896	3038329.085	27°26'54.48"	95°21'40.49"
99	TP97	8564.6	3 ° 41 ' 31 "L	733344.093	3038235.394	27°26'51.46"	95°21'39.36"
100	TP98	8606.23	1 ° 2 ' 51 "R	733334.291	3038194.928	27°26'50.15"	95°21'38.98"
101	TP99	8672.62	0 ° 14 ' 23 "L	733317.485	3038130.702	27°26'48.08"	95°21'38.32"
102	TP100	8739.08	1 ° 51 ' 6 "L	733300.93	3038066.337	27°26'46"	95°21'37.67"
103	TP101	8900.94	1 ° 0 ' 48 "L	733265.699	3037908.364	27°26'40.89"	95°21'36.28"
104	TP102	8916.5	0 ° 2 ' 43 "R	733262.58	3037893.114	27°26'40.4"	95°21'36.16"
105	TP103	8970.54	7 ° 22 ' 27 "R	733251.71	3037840.179	27°26'38.68"	95°21'35.73"
106	TP104	9005.39	7 ° 25 ' 38 "R	733240.376	3037807.222	27°26'37.62"	95°21'35.29"
107	TP105	9235.09	0 ° 24 ' 40 "L	733138.224	3037601.486	27°26'31"	95°21'31.43"
108	TP106	9358.76	1 ° 27 ' 39 "R	733084.024	3037490.331	27°26'27.43"	95°21'29.38"
109	TP107	9371.51	0 ° 26 ' 33 "L	733078.143	3037479.012	27°26'27.06"	95°21'29.16"
110	TP108	9415.89	0 ° 4 ' 55 "L	733057.99	3037439.481	27°26'25.79"	95°21'28.4"
111	TP109	9477.51	5 ° 2 ' 12 "L	733030.0806	3037384.541	27°26'24.02"	95°21'27.35"
112	TP110	9486.17	34 ° 48 ' 28 "R	733026.849	3037376.5	27°26'23.76"	95°21'27.22"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
				EASTING	NORTHING	LATITUDE	LONGITUDE
113	TP111	9491.32	13 ° 37 ' 49 "L	733028	3037371.48	27°26'23.6"	95°21'27.26"
114	TP112	9656.91	5 ° 30 ' 10 "R	733101.999	3037223.346	27°26'18.74"	95°21'29.85"
115	TP113	9672.98	3 ° 31 ' 29 "L	733107.769	3037208.347	27°26'18.25"	95°21'30.05"
116	TP114	9680.24	34 ° 9 ' 36 "L	733110.786	3037201.747	27°26'18.04"	95°21'30.16"
117	TP115	9695.34	2 ° 32 ' 2 "R	733108.27	3037186.862	27°26'17.56"	95°21'30.05"
118	TP116	9769.46	2 ° 15 ' 48 "R	733092.698	3037114.398	27°26'15.21"	95°21'29.44"
119	TP117	9908	7 ° 43 ' 53 "L	733058.264	3036980.203	27°26'10.88"	95°21'28.09"
120	TP118	9998.3	16 ° 19 ' 1 "R	733047.791	3036890.51	27°26'7.97"	95°21'27.65"
121	TP119	10168.07	5 ° 18 ' 4 "L	732981.5204	3036734.211	27°26'2.94"	95°21'25.13"
122	TP120	10192.79	1 ° 21 ' 51 "L	732974.013	3036710.653	27°26'2.18"	95°21'24.84"
123	TP121	10280.12	0 ° 1 ' 6 "L	732949.485	3036626.838	27°25'59.47"	95°21'23.89"
124	TP122	10343.27	0 ° 34 ' 48 "L	732931.769	3036566.229	27°25'57.51"	95°21'23.2"
125	TP123	10512.3	7 ° 28 ' 3 "L	732885.991	3036403.519	27°25'52.26"	95°21'21.42"
126	TP124	10607.7	0 ° 25 ' 53 "R	732872.308	3036309.106	27°25'49.2"	95°21'20.86"
127	TP125	10685.99	0 ° 35 ' 36 "R	732860.495	3036231.705	27°25'46.69"	95°21'20.38"
128	TP126	10824.33	15 ° 13 ' 51 "R	732838.209	3036095.175	27°25'42.27"	95°21'19.47"
129	TP127	10860.76	0 ° 22 ' 25 "R	732823.099	3036062.022	27°25'41.2"	95°21'18.9"
130	TP128	10957.45	0 ° 56 ' 34 "L	732782.427	3035974.302	27°25'38.38"	95°21'17.36"
131	TP129	11128.75	0 ° 55 ' 37 "R	732712.939	3035817.733	27°25'33.34"	95°21'14.72"
132	TP130	11213.21	2 ° 15 ' 54 "L	732677.4329	3035741.1	27°25'30.87"	95°21'13.38"
133	TP131	11338.32	19 ° 7 ' 21 "R	732629.3634	3035625.589	27°25'27.15"	95°21'11.55"
134	TP132	11452.84	3 ° 4 ' 6 "L	732553.158	3035540.109	27°25'24.42"	95°21'8.72"
135	TP133	11493.5	12 ° 42 ' 32 "L	732527.7617	3035508.351	27°25'23.41"	95°21'7.77"
136	TP134	11548.34	2 ° 14 ' 34 "L	732503.7762	3035459.042	27°25'21.82"	95°21'6.86"
137	TP135	11576.82	3 ° 17 ' 54 "L	732492.3272	3035432.956	27°25'20.98"	95°21'6.43"
138	TP136	11607.59	3 ° 41 ' 34 "L	732481.602	3035404.115	27°25'20.05"	95°21'6.02"
139	TP137	11654.66	0 ° 32 ' 10 "R	732468.073	3035359.037	27°25'18.6"	95°21'5.5"
140	TP138	11768.78	1 ° 19 ' 40 "R	732434.248	3035250.049	27°25'15.08"	95°21'4.19"
141	TP139	11889.66	0 ° 20 ' 10 "L	732395.75	3035135.454	27°25'11.38"	95°21'2.71"
142	TP140	11983.35	0 ° 24 ' 51 "R	732366.435	3035046.468	27°25'8.51"	95°21'1.58"
143	TP141	12099.34	37 ° 15 ' 18 "R	732329.3488	3034936.572	27°25'4.96"	95°21'0.16"
144	TP142	12161.15	2 ° 18 ' 22 "R	732278.165	3034901.922	27°25'3.87"	95°20'58.27"
145	TP143	12205.99	10 ° 22 ' 9 "L	732240.047	3034878.296	27°25'3.12"	95°20'56.87"
146	TP144	12221.65	5 ° 27 ' 18 "L	732228.441	3034867.787	27°25'2.79"	95°20'56.44"
147	TP145	12332.5	18 ° 28 ' 31 "L	732153.7193	3034785.913	27°25'0.18"	95°20'53.66"
148	TP146	12396.86	9 ° 54 ' 44 "R	732127.6343	3034727.075	27°24'58.28"	95°20'52.67"
149	TP147	12407.28	18 ° 28 ' 2 "R	732121.8355	3034718.42	27°24'58.01"	95°20'52.46"
150	TP148	12413.59	15 ° 7 ' 37 "R	732116.8387	3034714.557	27°24'57.88"	95°20'52.27"
151	TP149	12473.46	22 ° 45 ' 41 "L	732061.564	3034691.566	27°24'57.17"	95°20'50.24"
152	TP150	12535.86	0 ° 4 ' 46 "R	732017.709	3034647.179	27°24'55.76"	95°20'48.62"
153	TP151	12624.05	0 ° 6 ' 13 "R	731955.635	3034584.526	27°24'53.76"	95°20'46.32"
154	TP152	12656.72	3 ° 7 ' 8 "L	731932.599	3034561.359	27°24'53.02"	95°20'45.46"
155	TP153	12699.54	2 ° 19 ' 57 "R	731904.105	3034529.399	27°24'52"	95°20'44.4"
156	TP154	12737.24	0 ° 31 ' 9 "L	731877.893	3034502.304	27°24'51.14"	95°20'43.43"
157	TP155	12781.75	0 ° 39 ' 24 "R	731847.236	3034470.034	27°24'50.11"	95°20'42.29"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
				EASTING	NORTHING	LATITUDE	LONGITUDE
158	TP156	12830.46	15 ° 44 ' 54 "L	731813.283	3034435.105	27°24'48.99"	95°20'41.03"
159	TP157	12851.85	45 ° 21 ' 0 "R	731803.0978	3034416.299	27°24'48.39"	95°20'40.65"
160	TP158	12933.92	1 ° 37 ' 14 "R	731826.971	3034337.773	27°24'45.83"	95°20'41.46"
161	TP159	13053.1	5 ° 17 ' 42 "R	731858.397	3034222.817	27°24'42.07"	95°20'42.53"
162	TP160	13166.63	0 ° 57 ' 1 "L	731878.101	3034111.01	27°24'38.43"	95°20'43.17"
163	TP161	13321.94	0 ° 26 ' 12 "L	731907.59	3033958.522	27°24'33.46"	95°20'44.14"
164	TP162	13404.19	2 ° 50 ' 50 "R	731923.822	3033877.888	27°24'30.83"	95°20'44.67"
165	TP163	13500.66	2 ° 3 ' 30 "L	731938.138	3033782.49	27°24'27.73"	95°20'45.13"
166	TP164	13561.57	18 ° 5 ' 30 "L	731949.3353	3033722.616	27°24'25.77"	95°20'45.49"
167	TP165	13580.45	23 ° 56 ' 38 "L	731958.3967	3033706.054	27°24'25.23"	95°20'45.81"
168	TP166	13596.55	1 ° 38 ' 27 "R	731971.195	3033696.279	27°24'24.91"	95°20'46.27"
169	TP167	13765.77	42 ° 4 ' 7 "R	732102.6753	3033589.761	27°24'21.37"	95°20'50.98"
170	TP168	13833.6	20 ° 29 ' 41 "L	732113.1919	3033522.746	27°24'19.18"	95°20'51.32"
171	TP169	13915.8	3 ° 45 ' 45 "L	732096.697	3033442.217	27°24'16.58"	95°20'50.66"
172	TP170	13946.3	18 ° 7 ' 49 "R	732092.5511	3033412.004	27°24'15.6"	95°20'50.49"
173	TP171	14045.88	1 ° 6 ' 56 "R	732110.385	3033314.034	27°24'12.41"	95°20'51.07"
174	TP172	14158.72	0 ° 3 ' 17 "L	732128.429	3033202.643	27°24'8.78"	95°20'51.65"
175	TP173	14210.16	18 ° 15 ' 42 "L	732136.702	3033151.878	27°24'7.12"	95°20'51.92"
176	TP174	14317.58	1 ° 1 ' 59 "R	732119.887	3033045.782	27°24'3.69"	95°20'51.24"
177	TP175	14353.65	4 ° 3 ' 41 "L	732113.598	3033010.256	27°24'2.54"	95°20'50.98"
178	TP176	14371.05	1 ° 21 ' 48 "L	732111.787	3032992.96	27°24'1.98"	95°20'50.9"
179	TP177	14417.99	19 ° 24 ' 0 "R	732108.0107	3032946.17	27°24'0.46"	95°20'50.74"
180	TP178	14559.99	39 ° 5 ' 27 "L	732144.2515	3032808.867	27°23'55.98"	95°20'51.96"
181	TP179	14585.75	1 ° 0 ' 32 "L	732133.652	3032785.397	27°23'55.23"	95°20'51.56"
182	TP180	14599.98	0 ° 43 ' 41 "R	732128.023	3032772.324	27°23'54.8"	95°20'51.34"
183	TP181	14741.18	10 ° 36 ' 26 "R	732070.5392	3032643.359	27°23'50.65"	95°20'49.16"
184	TP182	14786.86	2 ° 38 ' 55 "R	732044.579	3032605.771	27°23'49.45"	95°20'48.19"
185	TP183	14812.45	1 ° 45 ' 31 "L	732029.074	3032585.403	27°23'48.8"	95°20'47.62"
186	TP184	14867.17	0 ° 7 ' 12 "R	731997.286	3032540.873	27°23'47.37"	95°20'46.43"
187	TP185	14887.83	12 ° 19 ' 23 "L	731985.245	3032524.08	27°23'46.83"	95°20'45.98"
188	TP186	14907.43	10 ° 40 ' 56 "R	731977.487	3032506.082	27°23'46.25"	95°20'45.68"
189	TP187	15005.79	1 ° 29 ' 15 "L	731922.482	3032424.535	27°23'43.64"	95°20'43.63"
190	TP188	15099.44	3 ° 12 ' 22 "L	731872.147	3032345.564	27°23'41.1"	95°20'41.74"
191	TP189	15170.15	0 ° 10 ' 30 "L	731837.536	3032283.905	27°23'39.12"	95°20'40.44"
192	TP190	15223.24	0 ° 50 ' 18 "R	731811.691	3032237.531	27°23'37.63"	95°20'39.47"
193	TP191	15275.2	8 ° 54 ' 20 "R	731785.7338	3032192.517	27°23'36.19"	95°20'38.49"
194	TP192	15470.83	0 ° 21 ' 26 "R	731662.951	3032040.218	27°23'31.32"	95°20'33.92"
195	TP193	15603.04	2 ° 18 ' 4 "L	731579.332	3031937.81	27°23'28.04"	95°20'30.81"
196	TP194	15818.77	0 ° 9 ' 35 "R	731449.712	3031765.369	27°23'22.52"	95°20'25.98"
197	TP195	15862.87	0 ° 10 ' 3 "R	731423.112	3031730.186	27°23'21.39"	95°20'24.98"
198	TP196	15899.48	11 ° 5 ' 48 "R	731400.952	3031701.053	27°23'20.46"	95°20'24.16"
199	TP197	15928.69	0 ° 48 ' 50 "L	731379.121	3031681.64	27°23'19.85"	95°20'23.35"
200	TP198	16017.03	1 ° 15 ' 21 "L	731313.943	3031622.002	27°23'17.95"	95°20'20.94"
201	TP199	16125.74	0 ° 9 ' 20 "L	731235.371	3031546.879	27°23'15.56"	95°20'18.03"
202	TP200	16171.71	0 ° 26 ' 8 "R	731202.231	3031515.021	27°23'14.54"	95°20'16.8"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
				EASTING	NORTHING	LATITUDE	LONGITUDE
203	TP201	16249.03	1 ° 25 ' 44 "L	731146.087	3031461.864	27°23'12.85"	95°20'14.72"
204	TP202	16291.14	1 ° 16 ' 16 "R	731116.236	3031432.155	27°23'11.9"	95°20'13.62"
205	TP203	16339.21	1 ° 20 ' 7 "L	731081.422	3031399.011	27°23'10.85"	95°20'12.33"
206	TP204	16363.25	1 ° 59 ' 46 "R	731064.404	3031382.036	27°23'10.31"	95°20'11.7"
207	TP205	16408.29	5 ° 34 ' 54 "L	731031.427	3031351.358	27°23'9.33"	95°20'10.48"
208	TP206	16437.92	3 ° 57 ' 22 "L	731011.797	3031329.16	27°23'8.62"	95°20'9.75"
209	TP207	16448.08	2 ° 33 ' 32 "L	731005.607	3031321.102	27°23'8.37"	95°20'9.52"
210	TP208	16491.28	26 ° 56 ' 28 "R	730980.8485	3031285.706	27°23'7.23"	95°20'8.59"
211	TP209	16526.55	2 ° 25 ' 1 "R	730949.732	3031269.101	27°23'6.71"	95°20'7.45"
212	TP210	16545.18	2 ° 28 ' 12 "L	730932.9338	3031261.027	27°23'6.46"	95°20'6.83"
213	TP211	16563.66	49 ° 8 ' 55 "L	730916.6459	3031252.315	27°23'6.19"	95°20'6.23"
214	TP212	16623.26	7 ° 58 ' 7 "L	730903.5306	3031194.172	27°23'4.31"	95°20'5.72"
215	TP213	16673.25	4 ° 40 ' 1 "R	730899.3972	3031144.35	27°23'2.69"	95°20'5.53"
216	TP214	16786.78	0 ° 42 ' 16 "L	730880.8359	3031032.348	27°22'59.06"	95°20'4.78"
217	TP215	16789.75	1 ° 27 ' 42 "L	730880.3862	3031029.411	27°22'58.97"	95°20'4.76"
218	TP216	16807.83	1 ° 21 ' 43 "R	730878.1069	3031011.478	27°22'58.39"	95°20'4.67"
219	TP217	16884.56	0 ° 27 ' 44 "R	730866.6261	3030935.614	27°22'55.93"	95°20'4.2"
220	TP218	17157.74	9 ° 11 ' 23 "R	730823.5714	3030665.846	27°22'47.2"	95°20'2.45"
221	TP219	17188.15	88 ° 30 ' 22 "L	730823.636	3030635.44	27°22'46.21"	95°20'2.43"
222	TP220	17206.25	77 ° 48 ' 51 "L	730841.7316	3030635.007	27°22'46.19"	95°20'3.09"

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

LIST OF DGPS CO-ORDINATE

SR NO	POINT ID	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)		R.L ON BM (m)
		NORTHING	EASTING	LATITUDE	LONGITUDE	
1	B_DGPS-1.(BM-1)	3027919.534	729870.874	27°21'18.59"	95°19'25.93"	132.927
2	SAT-103 BM	3028545.43	730306.419	27°21'38.65"	95°19'42.19"	120.227
3	DGPS-1 OF SAT-103	3027920.3	729870.317	27°21'18.62"	95°19'25.91"	120.713
4	BM-2	3046714.286	744854.279	27°31'19.47"	95°28'44.47"	127.123
5	BM-3	3038536.529	732664.381	27°27'1.66"	95°21'14.83"	122.151
6	RLY BM	3043827.044	742709.786	27°29'47.11"	95°27'24.28"	127.163
7	TBM-0	3049047.42	743660.147	27°32'36.01"	95°28'2.67"	123.786
8	TBM-1	3044540.573	742231.767	27°30'10.59"	95°27'7.39"	127.18
9	TBM-2	3048093.516	743556.7561	27°32'5.1"	95°27'58.21"	127.1334
10	TBM-3	3047305.263	743468.4617	27°31'39.56"	95°27'54.42"	126.103
11	TBM-4	3044101.068	741643.562	27°29'56.7"	95°26'45.65"	126.426
12	TBM-5	3042473.764	739500.495	27°29'5.23"	95°25'26.46"	124.769
13	GPS-1	3055649.515	737228.801	27°36'14.5"	95°24'13.06"	122.403
14	GPS-1 RF1	3055577.731	737307.469	27°36'12.12"	95°24'15.87"	122.114
15	GPS-1 RF2	3055534.461	737226.373	27°36'10.77"	95°24'12.89"	123.059
16	GPS-2	3053864.166	739024.254	27°35'15.39"	95°25'17.22"	122.827
17	GPS-2 RF	3053878.45	739058.843	27°35'15.83"	95°25'18.49"	122.752
18	GPS-3	3053064.689	740239.682	27°34'48.65"	95°26'0.94"	123.146
19	GPS-3RF	3053060.032	740273.313	27°34'48.48"	95°26'2.17"	119.551
20	GPS-4	3050583.418	741970.686	27°33'26.97"	95°27'2.23"	121.584
21	GPS-4 RF	3050543.868	742175.661	27°33'25.56"	95°27'9.67"	123.708
22	GPS-5	3048417.691	743525.513	27°32'15.65"	95°27'57.31"	126.618
23	GPS-5 RF	3048530.945	743513.29	27°32'19.33"	95°27'56.94"	124.549
24	GPS-6	3047925.29	743549.836	27°31'59.64"	95°27'57.84"	122.472
25	GPS-6 RF1	3047811.981	743538.689	27°31'55.97"	95°27'57.35"	119.849
26	GPS-6 RF2	3047698.06	743533.207	27°31'52.27"	95°27'57.07"	120.336
27	GPS-6A	3046067.848	743762.719	27°30'59.19"	95°28'4.24"	126.276
28	GPS-6A RF	3046402.685	743684.767	27°31'10.11"	95°28'1.65"	126.2
29	GPS-7	3044540.573	742231.781	27°30'10.59"	95°27'7.39"	127.189
30	GPS-7 RF	3044510.365	742231.318	27°30'9.61"	95°27'7.35"	127.024
31	GPS-8	3043876.83	740107.202	27°29'50.4"	95°25'49.55"	126.067
32	GPS-8 RF1	3043765.19	740167.687	27°29'46.74"	95°25'51.67"	125.337
33	GPS-8 RF2	3043767.352	740172.283	27°29'46.8"	95°25'51.84"	125.535
34	GPS-9	3042648.676	739415.826	27°29'10.96"	95°25'23.5"	126.558
35	GPS-9 RF	3042684.866	739629.081	27°29'12"	95°25'31.29"	125.898
36	GPS-10	3041598.972	737140.479	27°28'38.31"	95°23'59.91"	122.14
37	GPS-10 RF	3041614.515	737189.689	27°28'38.79"	95°24'1.71"	122.498
38	GPS-11	3041098.956	736493.736	27°28'22.48"	95°23'36.01"	122.462

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR NO	POINT ID	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)		R.L ON BM (m)
		NORTHING	EASTING	LATITUDE	LONGITUDE	
39	GPS-11 RF	3041217.575	736481.275	27°28'26.34"	95°23'35.64"	122.005
40	GPS-12	3040214.337	735231.47	27°27'54.55"	95°22'49.44"	122.092
41	GPS-12 RF1	3040175.596	735242.489	27°27'53.28"	95°22'49.82"	121.92
42	GPS-12 RF2	3040120.945	735400.164	27°27'51.41"	95°22'55.52"	121.853
43	GPS-13	3039624.577	733900.65	27°27'36.23"	95°22'0.58"	121.458
44	GPS-13 RF	3039664.917	733967.606	27°27'37.49"	95°22'3.05"	120.5
45	GPS-14	3038705.568	733369.783	27°27'6.71"	95°21'40.62"	123.031
46	GPS-14 RF1	3038631.154	733375.738	27°27'4.29"	95°21'40.79"	121.037
47	GPS-14 RF2	3038641.908	733369.212	27°27'4.64"	95°21'40.56"	120.957
48	GPS-15	3036724.075	732961.675	27°26'2.62"	95°21'24.4"	121.938
49	GPS-15 RF	3036761.641	732856.499	27°26'3.9"	95°21'20.6"	122.055
50	STN-15A	3034935.101	732320.822	27°25'4.92"	95°20'59.84"	121.095
51	STN-15B	3034983.398	732300.526	27°25'6.5"	95°20'59.14"	121.613
52	GPS-16	3034418.454	731778.832	27°24'48.48"	95°20'39.77"	120.593
53	GPS-16 RF	3034484.039	731761.932	27°24'50.62"	95°20'39.2"	121.427
54	GPS-17	3032763.14	732134.669	27°23'54.5"	95°20'51.58"	120.395
55	GPS-17 RF	3032849.892	732095.334	27°23'57.34"	95°20'50.21"	120.235
56	GPS-18	3031264.144	730978.135	27°23'6.53"	95°20'8.48"	120.532
57	GPS-18 RF	3031311.127	730894.148	27°23'8.11"	95°20'5.45"	120.424
58	B_es	3027918.452	729872.342	27°21'18.56"	95°19'25.98"	123.217

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

LIST OF VILLAGES FALLING EN-ROUTE

**1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban
(Along Existing & Proposed RoU)**

Sr. No.	Location Code as per Census 2011	Village	Revenue Circle	District	State
1	227	Rupai T.E.232/230 Nir	DOOM DOOMA REVENUE CIRCLE	TINSUKIA	ASSAM
2	212	Daisa T.E. 13/9(A)			
3	273	Diamuli Gaon No.-2			
4	269	Diamuli T.E.181 WI.			
5	307	Longsowal T.E. 109/112			

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

LIST OF ALL CROSSINGS FALLING EN-ROUTE

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban (Along Existing & Proposed RoU)

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
1	CART TRACK	CART TRACK	1225.34	1228.89	3.55
2	CART TRACK	CART TRACK	1384.15	1387.05	2.9
3	DRAIN	DRAIN	1769.66	1777.12	7.46
4	CART TRACK	CART TRACK	1797.45	1800.76	3.31
5	CART TRACK	CART TRACK	1921.42	1924.41	2.99
6	CART TRACK	CART TRACK	2017.8	2022.78	4.98
7	DRAIN	DRAIN	2122.34	2127.95	5.61
8	ROAD	ASPHALT ROAD (TO Baghjan-TO Tea Manufacturing Plant)	2649.13	2676.25	27.12
9	CART TRACK	CART TRACK	2740.76	2745.39	4.63
10	CART TRACK	CART TRACK	2940.77	2946.55	5.78
11	ROAD	WBM ROAD (TO Baghjan-TO Tea Manufacturing Plant)	3168.61	3181.55	12.94
12	CART TRACK	CART TRACK	3397.53	3403.14	5.61
13	CART TRACK	CART TRACK	3595.33	3597.89	2.56
14	CART TRACK	CART TRACK	3785.12	3790.89	5.77
15	CART TRACK	CART TRACK	3982.82	3986.93	4.11
16	ROAD	WBM ROAD (TO Baghjan-TO Tea Manufacturing Plant)	4197.26	4205	7.74
17	CART TRACK	CART TRACK	4205	4208.15	3.15
18	POWER LINE	440V Power Line	4224.84	--	--
19	PIPELINE	EX. 400 MM NATURAL GAS PL FROM BAGJAN EPS TO MADHUBAN CGGS	4993.37	--	--
20	PIPELINE	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	4997.62	--	--
21	DRAIN	DRAIN	5152.72	5155.82	3.1
22	CART TRACK	CART TRACK	5389.91	5395.78	5.87
23	CART TRACK	CART TRACK	5685.69	5688.4	2.71
24	DRAIN	DRAIN	5883.58	5885.71	2.13
25	NALA	NALA	6304.07	6376.84	72.77
26	RIVER	DOOM DOOMA RIVER	6504.83	6559.16	54.33
27	DRAIN	DRAIN	6588.47	6595.82	7.35
28	DRAIN	DRAIN	6823.58	6829.95	6.37
29	DRAIN	DRAIN	7393.3	7399.69	6.39
30	ROAD	WBM ROAD (TO HILIKHA VILLAGE)	7506.07	7514.84	8.77
31	POWER LINE	11 KV POWER LINE	7519.38	--	--
32	DRAIN	DRAIN	7543.96	7557.17	13.21
33	DRAIN	DRAIN	7906.45	7908.48	2.03
34	POWER LINE	440V Powerline	7978.07	--	--
35	CART TRACK	CART TRACK	7980.28	7984.42	4.14
36	POWER LINE	200V Powerline	8198.28	--	--

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
37	CART TRACK	CART TRACK	8219.66	8221.37	1.71
38	DRAIN	DRAIN	8299.23	8301.28	2.05
39	DRAIN	DRAIN	8515.05	8518.15	3.1
40	ROAD	ASPHALTROAD(To Gutuyu-To Charemiri))	8536.74	8544.18	7.44
41	PIPELINE	EX. 4"Ø OIL INDIA PL	8559.91	--	--
42	PIPELINE	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	8563.66	--	--
43	PIPELINE	EX. 400 MM NATURAL GAS PL FROM BAGJAN EPS TO MADHUBAN CGGS	8567.96	--	--
44	CART TRACK	CART TRACK	9153.79	9158.15	4.36
45	ROAD	ASPHALTROAD(To 15 Line -To WM Road)	9282.28	9290.53	8.25
46	CART TRACK	CART TRACK	9881.27	9884.21	2.94
47	POWER LINE	POWER LINE	9885.81	--	--
48	POWER LINE	High Tension Power Lines	10105.01	--	--
49	ROAD	ASPHALTROAD(To Tea Garden)	10705.4	10725.75	20.35
50	NALA	NALA	10935.72	10947.97	12.25
51	ROAD	ASPHALTROAD(To Long Sowal- To Papujan)	12124.3	12145.56	21.26
52	RIVER	Hayjan River	12250.13	12270.71	20.58
53	POWER LINE	POWER LINE	12461.8	--	--
54	POWER LINE	POWER LINE	12613.6	--	--
55	ROAD	ASPHALTROAD(To Longswal)	12637.65	12650.25	12.6
56	ROAD	ASPHALTROAD(To Tea Garden)	13137.01	13144.51	7.5
57	POWER LINE	POWER LINE	13143.92	--	--
58	CHANNEL	FIELD CHANNEL	13581.7	13583.54	1.84
59	CART TRACK	CART TRACK	13594.22	13597.37	3.15
60	ROAD	ASPHALTROAD(To Medical Line)	14350.7	14354.47	3.77
61	NALA	NALA	14461.3	14476.50	15.2
62	ROAD	ASPHALTROAD(To Longsawl-To 17 NO.Line)	15112.51	15119.78	7.27
63	NALA	NALA	15833.58	15841	7.42
64	CART TRACK	CART TRACK	16139.14	16143.79	4.65
65	POWER LINE	High Tension Power Line	16621.49	--	--
66	ROAD	ROAD(To R.I.G H2)	16735.87	16748.44	12.57
67	NALA	NALA	16800.82	16803.85	3.03
68	POWER LINE	POWER LINE	16810.86	--	--
69	POWER LINE	POWER LINE	16902.68	0.00	-16902.7
70	CART TRACK	CART TRACK	16904.47	16907.96	3.49
71	POWER LINE	POWER LINE	16911.81	--	--
72	POWER LINE	POWER LINE	17444.48	--	--
73	ROAD	ASPHALTROAD(To Makum Thanar-To Barakari)	17444.88	17450.34	5.46
74	POWER LINE	POWER LINE	17453.38	--	--
75	ROAD	ASPHALTROAD(To By Pass Road-To Bejan)	18384.48	18394.25	9.77
76	CABLE	NFS OFC CABLE	18385.99	--	--
77	POWER LINE	POWER LINE	18397.66	--	--
78	POWER LINE	POWER LINE	18443.95	--	--
79	CART TRACK	CART TRACK	18661.99	18664.72	2.73
80	POWER LINE	POWER LINE	18838.8	--	--
81	POWER LINE	POWER LINE	18911.69	--	--
82	POWER LINE	POWER LINE	19204.94	--	--
83	CART TRACK	CART TRACK	19205.71	19208.04	2.33
84	POWER LINE	POWER LINE	19235.47	--	--
85	ROAD	ASPHALTROAD(To Makum Thanar-To Barakari)	19493.5	19503.22	9.72
86	POWER LINE	POWER LINE	19498.42	--	--
87	POWER LINE	POWER LINE	19505.8	--	--

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
88	POWER LINE	220kv High Tension Power Line(To Kolavadi)	19531.38	--	--
89	ROAD	ASPHALTROAD(To Makum-To Badgudi)	19629.18	19675.47	46.29
90	POWER LINE	POWER LINE	20079.35	--	--
91	CART TRACK	CART TRACK	20084.4	20088.22	3.82
92	POWER LINE	POWER LINE	20112.76	--	--
93	POWER LINE	POWER LINE	20117.84	--	--
94	DRAIN	DRAIN	20275.65	20277.31	1.66
95	ROAD	ASPHALTROAD(To Makum-To Tin Sukhiya)	20465.13	20482.88	17.75
96	POWER LINE	POWER LINE	20467.18	--	--
97	PIPELINE	12"Ø WSPL	20467.9	--	--
98	PIPELINE	RJIL OFC CABLE	20469.74	--	--
99	CABLE	NFS OFC CABLE	20471.52	--	--
100	RAILWAY	RAILWAY(To Makum-To Tin Sukhiya)	20482.88	20507.16	24.28
101	CABLE	NFS OFC CABLE	20491.4	--	--
102	PIPELINE	EX.8 INCH GAS LINE	20511.35	--	--
103	PIPELINE	EX.10 INCH PL	20512.6	--	--
104	PIPELINE	EX. 4"Ø OIL INDIA PL	20533.01	--	--
105	PIPELINE	EX. 4"Ø OIL INDIA PL	20533.2	--	--
106	PIPELINE	EX. 4"Ø OIL INDIA PL	20533.46	--	--
107	PIPELINE	EX. 4"Ø OIL INDIA PL	20533.78	--	--
108	PIPELINE	EX. 4"Ø OIL INDIA PL	20534.19	--	--
109	PIPELINE	EX. 4"Ø OIL INDIA PL	20606.06	--	--
110	PIPELINE	EX. 4"Ø OIL INDIA PL	20606.35	--	--
111	PIPELINE	EX. 4"Ø OIL INDIA PL	20606.51	--	--
112	PIPELINE	EX. 4"Ø OIL INDIA PL	20606.66	--	--
113	PIPELINE	EX. 4"Ø OIL INDIA PL	20607.03	--	--
114	POWER LINE	POWER LINE	20667.03	--	--
115	ROAD	ASPHALTROAD(To Collage Road-To Sukhapokri)	20668.24	20670.45	2.21
116	POWER LINE	POWER LINE	20868.29	--	--
117	POWER LINE	POWER LINE	20934.29	--	--
118	POWER LINE	POWER LINE	20956.76	--	--
119	POWER LINE	POWER LINE	20973.6	--	--
120	POWER LINE	POWER LINE	20982.39	--	--
121	CART TRACK	CART TRACK	21114.65	21119	4.35
122	POWER LINE	POWER LINE	21450	--	--
123	POWER LINE	POWER LINE	21454.78	--	--
124	POWER LINE	POWER LINE	21463.13	--	--
125	POWER LINE	POWER LINE	21470.39	--	--
126	POWER LINE	POWER LINE	21482.98	--	--
127	NALA	NALA	21524.72	21532.21	7.49
128	POWER LINE	POWER LINE	21621.45	--	--
129	NALA	NALA	22151.64	22156.12	4.48
130	POWER LINE	POWER LINE	22373.35	--	--
131	CART TRACK	CART TRACK	22375.96	22378.74	2.78
132	POWER LINE	POWER LINE	22428.79	--	--
133	POWER LINE	POWER LINE	22640.32	--	--
134	POWER LINE	POWER LINE	22653.48	--	--
135	POWER LINE	POWER LINE	22669.11	--	--
136	POWER LINE	POWER LINE	22682.96	--	--
137	POWER LINE	POWER LINE	22712.28	--	--
138	NALA	NALA	23069.9	23073.46	3.56
139	POWER LINE	POWER LINE	23186.86	--	--
140	POWER LINE	POWER LINE	23212.91	--	--

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
141	CART TRACK	CART TRACK	23216.91	23221.44	4.53
142	POWER LINE	POWER LINE	23259.88	--	--
143	POWER LINE	High Tension Power Line	23629.01	--	--
144	ROAD	Asphalt Road(To Sidhama)	24039.08	24056.07	16.99
145	POWER LINE	POWER LINE	24184.31	--	--
146	ROAD	Asphalt Road	24550.16	24558.52	8.36
147	CART TRACK	CART TRACK	24557.09	24560.64	3.55
148	POWER LINE	POWER LINE	24559.38	--	--
149	POWER LINE	High Tension Power Lines	25046.96	--	--
150	POWER LINE	High Tension Power Lines	25345.55	--	--
151	ROAD	Asphalt Road(To Makum-To Teli Vasti)	25722.21	25727.2	4.99
152	POWER LINE	POWER LINE	25724.38	--	--
153	POWER LINE	POWER LINE	26386.3	--	--
154	POWER LINE	POWER LINE	26416.51	--	--
155	CART TRACK	CART TRACK	27003.72	27007.28	3.56
156	NALA	NALA	27200.31	27204.7	4.39
157	POWER LINE	POWER LINE	27309.84	--	--
158	ROAD	Asphalt Road(To Shelember Vasti-To Main Road)	27696.73	27708.06	11.33
159	POWER LINE	POWER LINE	27701.57	--	--
160	POWER LINE	POWER LINE	27797.88	--	--
161	POWER LINE	POWER LINE	28088.41	--	--
162	RIVER	Tingrai River	28294.29	28314.45	20.16
163	POWER LINE	POWER LINE	28693.32	--	--
164	ROAD	Asphalt Road(To ChotuTindal)	28699.88	28711.52	11.64
165	CART TRACK	CART TRACK	29113.59	29116.7	3.11
166	POWER LINE	POWER LINE	29557.07	--	--
167	ROAD	Asphalt Road(To ChotuTindal -To Tin Sukhiya)	29555.63	29563.35	7.72
168	CABLE	BBNL OFC CABLE	29562.5	--	--
169	POWER LINE	POWER LINE	29564.05	--	--
170	POWER LINE	POWER LINE	29566.8	--	--
171	POWER LINE	POWER LINE	29682.64	--	--
172	CABLE	BBNL OFC CABLE	30739.95	--	--
173	ROAD	Asphalt Road	30740.07	30747.33	7.26
174	CART TRACK	CART TRACK	31090.57	31094.18	3.61
175	POWER LINE	POWER LINE	31386.12	--	--
176	CART TRACK	CART TRACK	31387.81	31390.94	3.13
177	CART TRACK	CART TRACK	31874.12	31877.19	3.07
178	POWER LINE	11Kv Power Line	31880.81	--	--
179	CART TRACK	CART TRACK	32040.12	32042.82	2.7
180	POWER LINE	POWER LINE	32650.69	--	--
181	POWER LINE	11Kv Power Line	32654.81	--	--
182	ROAD	Asphalt Road	32656.25	32663.40	7.15
183	POWER LINE	POWER LINE	32663.86	--	--
184	POWER LINE	POWER LINE	32716.38	--	--
185	CART TRACK	CART TRACK	32716.46	32720.47	4.01
186	ROAD	Asphalt Road	33605.62	33617.59	11.97
187	POWER LINE	POWER LINE	33615.21	--	--
188	POWER LINE	11kv Power Line	33802.2	--	--
189	NALA	NALA	33881.71	33890.9	9.19
190	ROAD	Asphalt Road	34148.68	34157.85	9.17
191	POWER LINE	POWER LINE	34160.97	--	--
192	POWER LINE	POWER LINE	34169.59	--	--
193	CART TRACK	CART TRACK	34559.61	34564.6	4.99

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
194	POWER LINE	High Tension Power Line	35001.88	--	--
195	POWER LINE	11Kv Power Line	35082.68	--	--
196	ROAD	Asphalt Road	35122.09	35138.14	16.05
197	PIPELINE	EX. 4"Ø OIL INDIA PL	35128.29	--	--
198	PIPELINE	EX. 4"Ø OIL INDIA PL	35128.78	--	--
199	PIPELINE	EX. 4"Ø OIL INDIA PL	35136.54	--	--
200	PIPELINE	EX. 4"Ø OIL INDIA PL	35137.03	--	--
201	POWER LINE	11Kv Power Line	35137.2	--	--
202	PIPELINE	EX. 4"Ø OIL INDIA PL	35137.53	--	--
203	PIPELINE	EX. 4"Ø OIL INDIA PL	35138.03	--	--
204	PIPELINE	EX. 4"Ø OIL INDIA PL	35138.52	--	--
205	POWER LINE	11Kv Power Line	35182.18	--	--
206	POWER LINE	11Kv Power Line	35234.87	--	--
207	POWER LINE	11Kv Power Line	35468.83	--	--
208	CART TRACK	CART TRACK	35471.64	35474.38	2.74
209	CART TRACK	CART TRACK	35724.37	35726.57	2.2
210	POWER LINE	High Tension Power Lines	35842	--	--
211	NALA	NALA	35921.06	35930.31	9.25
212	POWER LINE	11Kv Power Line	36308.66	--	--
213	POWER LINE	High Tension Power Lines	36435.39	--	--
214	CART TRACK	CART TRACK	36436.86	36441.01	4.15
215	POWER LINE	11Kv Power Line	36919.27	--	--
216	POWER LINE	11Kv Power Line	37045.45	--	--
217	ROAD	Asphalt Road	37044.64	37057.49	12.85
218	ROAD	Asphalt Road	37057.49	37073.79	16.3
219	CABLE LINE	U.G ELECTRIC CABLE	37060.55	--	--
220	CABLE LINE	BSNL OFC CABLE	37061.62	--	--
221	CABLE LINE	RJIL OFC CABLE	37071.09	--	--
222	POWER LINE	11Kv Power Line	37073.62	--	--
223	POWER LINE	11Kv Power Line	37080.41	--	--
224	PIPELINE	EX. 400 MM NATURAL GAS PL FROM BAGJAN EPS TO MADHUBAN CGGS	37118.5	--	--
225	PIPELINE	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	37344.44	--	--

2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
1	PIPELINE	EX. 4"Ø OIL INDIA PL	44.14	--	--
2	PIPELINE	EX. 4"Ø OIL INDIA PL	44.37	--	--
3	PIPELINE	EX. 4"Ø OIL INDIA PL	44.64	--	--
4	PIPELINE	EX. 4"Ø OIL INDIA PL	44.77	--	--
5	PIPELINE	EX. 4"Ø OIL INDIA PL	44.90	--	--
6	PIPELINE	EX. 4"Ø OIL INDIA PL	45.08	--	--
7	PIPELINE	EX. 4"Ø OIL INDIA PL	45.28	--	--
8	PIPELINE	EX. 4"Ø OIL INDIA PL	45.46	--	--
9	PIPELINE	EX. 4"Ø OIL INDIA PL	45.61	--	--
10	PIPELINE	EX. 4"Ø OIL INDIA PL	45.83	--	--
11	PIPELINE	EX. 4"Ø OIL INDIA PL	97.68	--	--
12	PIPELINE	EX. 4"Ø OIL INDIA PL	97.85	--	--

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
13	PIPELINE	EX. 4"Ø OIL INDIA PL	98.17	--	--
14	PIPELINE	EX. 4"Ø OIL INDIA PL	98.43	--	--
15	PIPELINE	EX. 4"Ø OIL INDIA PL	98.88	--	--
16	POWER LINE	POWER LINE	102.72	--	--
17	ROAD	ASPHALTROAD(To Collage Road-To Sukhapokri)	107.01	109.25	2.24
18	PIPELINE	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	132.24	--	--
19	POWER LINE	POWER LINE	358.46	--	--
20	POWER LINE	POWER LINE	382.19	--	--
21	POWER LINE	POWER LINE	398.86	--	--
22	POWER LINE	POWER LINE	408.19	--	--
23	POWER LINE	POWER LINE	420.97	--	--
24	CART TRACK	CART TRACK	557.45	561.80	4.35
25	POWER LINE	POWER LINE	920.19	--	--
26	POWER LINE	POWER LINE	924.84	--	--
27	POWER LINE	POWER LINE	933.18	--	--
28	POWER LINE	POWER LINE	940.39	--	--
29	POWER LINE	POWER LINE	953.19	--	--
30	NALA	NALA	987.41	994.19	6.78
31	POWER LINE	POWER LINE	1118.04	--	--
32	NALA	NALA	1603.99	1608.39	4.40
33	POWER LINE	POWER LINE	1826.14	--	--
34	CART TRACK	CART TRACK	1829.04	1831.62	2.58
35	POWER LINE	POWER LINE	1882.45	--	--
36	POWER LINE	POWER LINE	2059.17	--	--
37	POWER LINE	POWER LINE	2083.49	--	--
38	POWER LINE	POWER LINE	2109.25	--	--
39	POWER LINE	POWER LINE	2111.60	--	--
40	POWER LINE	POWER LINE	2139.99	--	--
41	NALA	NALA	2526.55	2530.45	3.90
42	POWER LINE	POWER LINE	2666.76	--	--
43	CART TRACK	CART TRACK	2671.00	2675.51	4.51
44	POWER LINE	POWER LINE	2698.65	--	--
45	POWER LINE	High Tension Power Line	3067.46	--	--
46	ROAD	Asphalt Road(To Sidhama)	3496.57	3512.46	15.89
47	POWER LINE	POWER LINE	3644.24	--	--
48	ROAD	Asphalt Road	4012.40	4020.46	8.06
49	POWER LINE	POWER LINE	4023.18	--	--
50	POWER LINE	High Tension Power Lines	4494.92	--	--
51	POWER LINE	High Tension Power Lines	4790.23	--	--
52	ROAD	Asphalt Road(To Makum-To Teli Vasti)	5165.87	5171.04	5.17
53	POWER LINE	POWER LINE	5172.14	--	--
54	CART TRACK	CART TRACK	6467.39	6470.92	3.53
55	NALA	NALA	6665.41	6674.59	9.18
56	POWER LINE	POWER LINE	6774.36	--	--
57	ROAD	Asphalt Road(To Shelember Vasti-To Main Road)	7136.91	7149.29	12.38
58	POWER LINE	POWER LINE	7171.54	--	--
59	POWER LINE	POWER LINE	7218.30	--	--
60	POWER LINE	POWER LINE	7513.23	--	--
61	RIVER	Tingrai River	7726.04	7750.41	24.37
62	POWER LINE	POWER LINE	8134.58	--	--
63	ROAD	Asphalt Road(To ChotuTindal)	8141.17	8152.96	11.79
64	CART TRACK	CART TRACK	8554.05	8557.28	3.23

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
65	POWER LINE	POWER LINE	9003.65	--	--
66	ROAD	Asphalt Road(To ChotuTindal -To Tin Sukhiya)	9004.75	9009.28	4.53
67	POWER LINE	POWER LINE	9010.68	--	--
68	POWER LINE	POWER LINE	9013.30	--	--
69	PIPELINE	EX. 4"Ø OIL INDIA PL	9018.45	--	--
70	POWER LINE	POWER LINE	9128.06	--	--
71	CABLE	BBNL OFC CABLE	10184.39	--	--
72	ROAD	Asphalt Road	10184.87	10191.15	6.28
73	CART TRACK	CART TRACK	10530.60	10533.83	3.23
74	POWER LINE	POWER LINE	10827.99	--	--
75	CART TRACK	CART TRACK	10829.73	10832.36	2.63
76	CART TRACK	CART TRACK	11331.79	11335.39	3.60
77	POWER LINE	11Kv Power Line	11338.69	--	--
78	CART TRACK	CART TRACK	11483.72	11486.38	2.66
79	POWER LINE	POWER LINE	12089.27	--	--
80	POWER LINE	11Kv Power Line	12106.99	--	--
81	ROAD	Asphalt Road	12109.69	12116.70	7.01
82	POWER LINE	POWER LINE	12117.00	--	--
83	CART TRACK	CART TRACK	12157.78	12161.46	3.68
84	POWER LINE	POWER LINE	12160.68	--	--
85	PIPELINE	EX. 4"Ø OIL INDIA PL	12233.66	--	--
86	ROAD	Asphalt Road	13052.50	13062.70	10.20
87	POWER LINE	POWER LINE	13060.20	--	--
88	POWER LINE	POWER LINE	13228.42	--	--
89	POWER LINE	11kv Power Line	13251.04	--	--
90	NALA	NALA	13322.96	13331.79	8.83
91	ROAD	Asphalt Road	13586.28	13595.25	8.97
92	POWER LINE	POWER LINE	13596.63	--	--
93	POWER LINE	POWER LINE	13599.46	--	--
94	CART TRACK	CART TRACK	13981.65	13986.65	5.00
95	POWER LINE	High Tension Power Line	14435.19	--	--
96	POWER LINE	11Kv Power Line	14506.06	--	--
97	ROAD	Asphalt Road	14581.03	14600.17	19.14
98	PIPELINE	EX. 4"Ø OIL INDIA PL	14587.10	--	--
99	PIPELINE	EX. 4"Ø OIL INDIA PL	14587.58	--	--
100	PIPELINE	EX. 4"Ø OIL INDIA PL	14588.06	--	--
101	PIPELINE	EX. 4"Ø OIL INDIA PL	14596.16	--	--
102	PIPELINE	EX. 4"Ø OIL INDIA PL	14596.65	--	--
103	POWER LINE	11Kv Power Line	14596.82	--	--
104	PIPELINE	EX. 4"Ø OIL INDIA PL	14597.14	--	--
105	PIPELINE	EX. 4"Ø OIL INDIA PL	14597.63	--	--
106	PIPELINE	EX. 4"Ø OIL INDIA PL	14598.13	--	--
107	POWER LINE	11Kv Power Line	14613.64	--	--
108	POWER LINE	11Kv Power Line	14694.88	--	--
109	POWER LINE	11Kv Power Line	14907.01	--	--
110	CART TRACK	CART TRACK	14909.39	14912.19	2.80
111	CART TRACK	CART TRACK	15168.72	15170.91	2.19
112	POWER LINE	High Tension Power Lines	15308.91	--	--
113	NALA	NALA	15319.40	15339.80	20.40
114	NALA	NALA	15373.92	15382.24	8.32
115	POWER LINE	11Kv Power Line	15730.64	--	--
116	CART TRACK	CART TRACK	15868.70	15875.59	6.89
117	POWER LINE	High Tension Power Lines	15918.13	--	--

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
118	POWER LINE	11Kv Power Line	16365.63	--	--
119	ROAD	Asphalt Road	16503.58	16520.13	16.55
120	CABLE LINE	U.G ELECTRIC CABLE	16506.50	--	--
121	CABLE LINE	BSNL OFC CABLE	16507.55	--	--
122	CABLE LINE	RJIL OFC CABLE	16516.91	--	--
123	POWER LINE	11Kv Power Line	16519.02	--	--
124	POWER LINE	11Kv Power Line	16526.45	--	--
125	PIPELINE	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	16554.86	--	--
126	PIPELINE	EX. 400 MM NATURAL GAS PL FROM BAGJAN EPS TO MADHUBAN CGGS	16557.08	--	--
127	PIPELINE	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	16781.20	--	--

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

LIST OF MAJOR CROSSINGS(TYPE WISE) FALLING EN-ROUTE
(Railway Crossings)

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS
Madhuban (Along Existing & Proposed RoU)

SR. NO.	MC. NO.	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
1	38	RAILWAY(To Makum-To Tin Sukhiya)	20482.88	20507.16	24.28

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

LIST OF MAJOR CROSSINGS(TYPE WISE) FALLING EN-ROUTE
(Asphalt Road/Metal Road/Other Road Crossings)

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban
(Along Existing & Proposed RoU)

SR. NO.	MC. NO.	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
1	3	ASPHALTROAD(TO Baghjan-TO Tea Manufacturing Plant)	2649.13	2676.25	27.12
2	4	WBM ROAD(TO Baghjan-TO Tea Manufacturing Plant)	3168.61	3181.55	12.94
3	5	WBM ROAD(TO Baghjan-TO Tea Manufacturing Plant)	4197.26	4205	7.74
4	13	WBM ROAD(TO HILIKHA VILLAGE)	7506.07	7514.84	8.77
5	18	ASPHALTROAD(TO Gutuyu-To Charemiri))	8536.74	8544.18	7.44
6	19	ASPHALTROAD(TO 15 Line -To WM Road)	9282.28	9290.53	8.25
7	20	ASPHALTROAD(TO Tea Garden)	10705.4	10725.75	20.35
8	22	ASPHALTROAD(TO Long Sowel- To Papujan)	12124.3	12145.56	21.26
9	24	ASPHALTROAD(To Longswal)	12637.65	12650.25	12.6
10	25	ASPHALTROAD(To Tea Garden)	13137.01	13144.51	7.5
11	26	ASPHALTROAD(To Medical Line)	14350.7	14354.47	3.77
12	28	ASPHALTROAD(To Longsawl-To 17 NO.Line)	15112.51	15119.78	7.27
13	30	ROAD(TO R.I.G H2)	16735.87	16748.44	12.57
14	32	ASPHALTROAD(To Makum Thanar-To Barakari)	17444.88	17450.34	5.46
15	33	ASPHALTROAD(To By Pass Road-To Bejan)	18384.48	18394.25	9.77
16	34	ASPHALTROAD(To Makum Thanar-To Barakari)	19493.5	19503.22	9.72
17	35	ASPHALTROAD(To Makum-To Badgudi)	19629.18	19675.47	46.29
18	37	ASPHALTROAD(To Makum-To Tin Sukhiya)	20465.13	20482.88	17.75
19	39	ASPHALTROAD(To Collage Road-To Sukhapokri)	20668.24	20670.45	2.21
20	43	Asphalt Road(To Sidhama)	24039.08	24056.07	16.99
21	44	Asphalt Road	24550.16	24558.52	8.36

SR. NO.	MC. NO.	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
22	45	Asphalt Road(To Makum-To Teli Vasti)	25722.21	25727.2	4.99
23	47	Asphalt Road(To Shelember Vasti-To Main Road)	27696.73	27708.06	11.33
24	49	Asphalt Road(To ChotuTindal)	28699.88	28711.52	11.64
25	50	Asphalt Road(To ChotuTindal -To Tin Sukhiya)	29555.63	29563.35	7.72
26	51	Asphalt Road	30740.07	30747.33	7.26
27	52	Asphalt Road	32656.25	32663.40	7.15
28	53	Asphalt Road	33605.62	33617.59	11.97
29	55	Asphalt Road	34148.68	34157.85	9.17
30	56	Asphalt Road	35122.09	35138.14	16.05
31	58	Asphalt Road	37044.64	37057.49	12.85
32	59	Asphalt Road	37057.49	37073.79	16.3

**2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban
(Along Existing RoU)**

SR. NO.	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
		FROM	TO	
1	ASPHALTROAD(To Collage Road-To Sukhapokri)	107.01	109.25	2.24
2	Asphalt Road(To Sidhama)	3496.57	3512.46	15.89
3	Asphalt Road	4012.40	4020.46	8.06
4	Asphalt Road(To Makum-To Teli Vasti)	5165.87	5171.04	5.17
5	Asphalt Road(To Shelember Vasti-To Main Road)	7136.91	7149.29	12.38
6	Asphalt Road(To ChotuTindal)	8141.17	8152.96	11.79
7	Asphalt Road(To ChotuTindal -To Tin Sukhiya)	9004.75	9009.28	4.53
8	Asphalt Road	10184.87	10191.15	6.28
9	Asphalt Road	12109.69	12116.70	7.01
10	Asphalt Road	13052.50	13062.70	10.20
11	Asphalt Road	13586.28	13595.25	8.97
12	Asphalt Road	14581.03	14600.17	19.14
13	Asphalt Road	16503.58	16520.13	16.55

ANNEXURE –VI(D)

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

LIST OF MAJOR CROSSINGS(TYPE WISE) FALLING EN-ROUTE
(River Crossings)

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS
Madhuban (Along Existing & Proposed RoU)

SR. NO.	MC. NO.	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
1	9	DOOM DOOMA RIVER	6504.83	6559.16	54.33
2	23	Hayjan River	12250.13	12270.71	20.58
3	48	Tingrai River	28294.29	28314.45	20.16

2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS
Madhuban (Along Existing RoU)

SR. NO.	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
		FROM	TO	
1	Tingrai River	7726.04	7750.41	24.37

ANNEXURE –VI(E)

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

LIST OF MAJOR CROSSINGS(TYPE WISE) FALLING EN-ROUTE
(Nala/Drain/Creek Crossings)

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS
Madhuban (Along Existing & Proposed RoU)

SR. NO.	MC. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
				FROM	TO	
1	1	DRAIN	DRAIN	1769.66	1777.12	7.46
2	2	DRAIN	DRAIN	2122.34	2127.95	5.61
3	6	DRAIN	DRAIN	5152.72	5155.82	3.1
4	7	DRAIN	DRAIN	5883.58	5885.71	2.13
5	8	NALA	NALA	6304.07	6376.84	72.77
6	10	DRAIN	DRAIN	6588.47	6595.82	7.35
7	11	DRAIN	DRAIN	6823.58	6829.95	6.37
8	12	DRAIN	DRAIN	7393.30	7399.69	6.39
9	14	DRAIN	DRAIN	7543.96	7557.17	13.21
10	15	DRAIN	DRAIN	7906.45	7908.48	2.03
11	16	DRAIN	DRAIN	8299.23	8301.28	2.05
12	17	DRAIN	DRAIN	8515.05	8518.15	3.1
13	21	NALA	NALA	10935.72	10947.97	12.25
14	27	NALA	NALA	14461.30	14476.50	15.2
15	29	NALA	NALA	15833.58	15841.00	7.42
16	31	NALA	NALA	16800.82	16803.85	3.03
17	36	DRAIN	DRAIN	20275.65	20277.31	1.66
18	40	NALA	NALA	21524.72	21532.21	7.49
19	41	NALA	NALA	22151.64	22156.12	4.48
20	42	NALA	NALA	23069.90	23073.46	3.56
21	46	NALA	NALA	27200.31	27204.70	4.39
22	54	NALA	NALA	33881.71	33890.90	9.19
23	57	NALA	NALA	35921.06	35930.31	9.25

**2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS
Madhuban (Along Existing RoU)**

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
1	NALA	NALA	987.41	994.19	6.78
2	NALA	NALA	1603.99	1608.39	4.40
3	NALA	NALA	2526.55	2530.45	3.90
4	NALA	NALA	6665.41	6674.59	9.18
5	NALA	NALA	13322.96	13331.79	8.83
6	NALA	NALA	15319.40	15339.80	20.40
7	NALA	NALA	15373.92	15382.24	8.32

ANNEXURE –VI(F)

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

LIST OF MAJOR CROSSINGS(TYPE WISE) FALLING EN-ROUTE
(Pipeline Crossings)

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS
Madhuban (Along Existing & Proposed RoU)

SR. NO.	DESCRIPTION	CHAINAGE (m)
1	EX. 400 MM NATURAL GAS PL FROM BAGJAN EPS TO MADHUBAN CGGS	4993.37
2	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	4997.62
3	EX. 4"Ø OIL INDIA PL	8559.91
4	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	8563.66
5	EX. 400 MM NATURAL GAS PL FROM BAGJAN EPS TO MADHUBAN CGGS	8567.96
6	12"Ø WSPL	20467.9
7	RJIL OFC CABLE	20469.74
8	EX.8 INCH GAS LINE	20511.35
9	EX.10 INCH PL	20512.6
10	EX. 4"Ø OIL INDIA PL	20533.01
11	EX. 4"Ø OIL INDIA PL	20533.2
12	EX. 4"Ø OIL INDIA PL	20533.46
13	EX. 4"Ø OIL INDIA PL	20533.78
14	EX. 4"Ø OIL INDIA PL	20534.19
15	EX. 4"Ø OIL INDIA PL	20606.06
16	EX. 4"Ø OIL INDIA PL	20606.35
17	EX. 4"Ø OIL INDIA PL	20606.51
18	EX. 4"Ø OIL INDIA PL	20606.66

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR. NO.	DESCRIPTION	CHAINAGE (m)
19	EX. 4"Ø OIL INDIA PL	20607.03
20	EX. 4"Ø OIL INDIA PL	35128.29
21	EX. 4"Ø OIL INDIA PL	35128.78
22	EX. 4"Ø OIL INDIA PL	35136.54
23	EX. 4"Ø OIL INDIA PL	35137.03
24	EX. 4"Ø OIL INDIA PL	35137.53
25	EX. 4"Ø OIL INDIA PL	35138.03
26	EX. 4"Ø OIL INDIA PL	35138.52
27	EX. 400 MM NATURAL GAS PL FROM BAGJAN EPS TO MADHUBAN CGGS	37118.5
28	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	37344.44

2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)

SR. NO.	DESCRIPTION	CHAINAGE (m)
1	EX. 4"Ø OIL INDIA PL	44.14
2	EX. 4"Ø OIL INDIA PL	44.37
3	EX. 4"Ø OIL INDIA PL	44.64
4	EX. 4"Ø OIL INDIA PL	44.77
5	EX. 4"Ø OIL INDIA PL	44.90
6	EX. 4"Ø OIL INDIA PL	45.08
7	EX. 4"Ø OIL INDIA PL	45.28
8	EX. 4"Ø OIL INDIA PL	45.46
9	EX. 4"Ø OIL INDIA PL	45.61
10	EX. 4"Ø OIL INDIA PL	45.83
11	EX. 4"Ø OIL INDIA PL	97.68
12	EX. 4"Ø OIL INDIA PL	97.85
13	EX. 4"Ø OIL INDIA PL	98.17

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR. NO.	DESCRIPTION	CHAINAGE (m)
14	EX. 4"Ø OIL INDIA PL	98.43
15	EX. 4"Ø OIL INDIA PL	98.88
16	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	132.24
17	EX. 4"Ø OIL INDIA PL	9018.45
18	EX. 4"Ø OIL INDIA PL	12233.66
19	EX. 4"Ø OIL INDIA PL	14587.10
20	EX. 4"Ø OIL INDIA PL	14587.58
21	EX. 4"Ø OIL INDIA PL	14588.06
22	EX. 4"Ø OIL INDIA PL	14596.16
23	EX. 4"Ø OIL INDIA PL	14596.65
24	EX. 4"Ø OIL INDIA PL	14597.14
25	EX. 4"Ø OIL INDIA PL	14597.63
26	EX. 4"Ø OIL INDIA PL	14598.13
27	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	16554.86
28	EX. 400 MM NATURAL GAS PL FROM BAGJAN EPS TO MADHUBAN CGGS	16557.08
29	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	16781.20

ANNEXURE –VII(A)

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

POPULATION DENSITY INDEX-AT A GLANCE

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban (Along Existing & Proposed RoU)

Location Class	LENGTH (km)
I	6.400
II	12.166
III	19.200
IV	-
TOTAL LENGTH (km)	37.766

2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)

Location Class	LENGTH (km)
I	-
II	6.006
III	11.200
IV	-
TOTAL LENGTH (km)	17.206

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

BROAD POPULATION DENSITY INDEX

**1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban
(Along Existing & Proposed RoU)**

Sr. No.	Chainage (km)		Stretch (km)	Location Class	Total No. of Dwellings	Remarks
	From	To				
1	0.000	1.600	1.600	III	60	HOUSES
2	1.600	3.200	1.600	II	40	HOUSES
3	3.200	4.800	1.600	III	85	VILLAGE SITE BAGHJAN
4	4.800	6.400	1.600	I	4	HOUSES
5	6.400	8.000	1.600	I	10	HOUSES
6	8.000	9.600	1.600	I	1	HOUSE
7	9.600	11.200	1.600	II	12	HOUSES
8	11.200	12.800	1.600	II	45	VILLAGE SITE LONGSOWAL T.E. 254 Nir
9	12.800	14.400	1.600	II	17	HOUSES
10	14.400	16.000	1.600	I	1	HOUSE
11	16.000	17.600	1.600	III	95	VILLAGE SITE (BETJAN GAON & MAKUM JUNCTION GAON)
12	17.600	19.200	1.600	III	90	VILLAGE SITE MAKUM JUNCTION GAON
13	19.200	20.800	1.600	III	72	VILLAGE SITE MAKUM
14	20.800	22.400	1.600	III	49	HOUSES
15	22.400	24.000	1.600	III	47	HOUSES
16	24.000	25.600	1.600	II	18	HOUSES

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Chainage (km)		Stretch (km)	Location Class	Total No. of Dwellings	Remarks
	From	To				
17	25.600	27.200	1.600	III	65	VILLAGE SITE CHARALI
18	27.200	28.800	1.600	II	44	VILLAGE SITE CHARALI
19	28.800	30.400	1.600	III	60	VILLAGE SITE BORBHETA BONGALI GAON
20	30.400	32.000	1.600	II	38	VILLAGE SITE BORJAN GAON
21	32.000	33.600	1.600	III	75	VILLAGE SITE KONWARI PATHAR GAON
22	33.600	35.200	1.600	III	77	VILLAGE SITE KONWARI PATHAR BLOCK 2
23	35.200	36.800	1.600	III	93	VILLAGE SITE MOHKHULI GAON
24	36.800	37.766	0.966	II	45	VILLAGE SITE MOHKHULI GAON & CGGS MADHUBAN
Total Length (km)			37.766			

2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)

Sr. No.	Chainage (km)		Stretch (km)	Location Class	Total No. of Dwellings	Remarks
	From	To				
1	0.000	1.600	1.600	III	49	HOUSES
2	1.600	3.200	1.600	III	47	HOUSES
3	3.200	4.800	1.600	II	18	HOUSES
4	4.800	6.400	1.600	III	65	VILLAGE SITE CHARALI
5	6.400	8.000	1.600	II	44	VILLAGE SITE CHARALI
6	8.000	9.600	1.600	III	60	VILLAGE SITE BORBHETA BONGALI GAON
7	9.600	11.200	1.600	II	38	VILLAGE SITE BORJAN GAON
8	11.200	12.800	1.600	III	75	VILLAGE SITE KONWARI PATHAR GAON
9	12.800	14.400	1.600	III	77	VILLAGE SITE KONWARI PATHAR BLOCK 2
10	14.400	16.000	1.600	III	93	VILLAGE SITE MOHKHULI GAON
11	16.000	17.206	1.206	II	45	VILLAGE SITE MOHKHULI GAON & CGGS MADHUBAN
Total Length (km)			17.206			

ANNEXURE –VIII

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

TERRAIN DETAILS

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban (Along Existing & Proposed RoU)

Sr. No.	Chainage (km)		Length (km)	Terrain
	Start	End		
1	0.00	4.18	4.18	Flat
2	4.18	5.00	0.82	Slightly undulating
3	5.00	37.77	32.77	Flat
	Total		37.77	

2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)

Sr. No.	Chainage (km)		Length (km)	Terrain
	Start	End		
1	0	17.206	17.206	Flat
	Total		17.206	

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

DETAILS OF EXISTING UNDERGROUND UTILITIES ALONG RoU

**1) EX. 400 mm ø NATURAL GAS PIPELINE FROM BAGHJAN
EPS/GGS TO CGGS MADHUBAN**

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
1	1.21	3050552.5760	742086.4850
2	1.25	3050544.4760	742125.9730
3	1.17	3050538.4570	742155.8330
4	1.17	3050538.4090	742156.0380
5	1.32	3050526.7800	742211.8690
6	1.13	3050522.9190	742224.8060
7	1.07	3050510.4750	742242.9450
8	1.37	3050500.7210	742250.9010
9	1.22	3050491.4560	742258.9120
10	1.45	3050470.5320	742276.1660
11	1.23	3050451.8840	742292.2990
12	1.20	3050409.6690	742327.9240
13	1.28	3050367.1860	742363.9120
14	1.17	3050329.2120	742396.6930
15	1.78	3050277.2290	742440.8380
16	1.45	3050228.4220	742481.3600
17	1.67	3050202.2830	742503.1210
18	1.50	3050162.9940	742536.5980
19	0.90	3050142.4290	742554.1520
20	35.00	3050122.2340	742571.1770
21	1.36	3050118.4550	742573.9380
22	1.36	3050081.2440	742614.4000
23	1.41	3050080.9030	742614.2040
24	1.02	3050028.4850	742675.6280
25	1.03	3049980.9480	742730.0640
26	1.03	3049966.4070	742769.4640
27	1.08	3049958.1700	742812.0000
28	1.00	3049941.1930	742895.6760
29	1.05	3049930.9690	742943.4160

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
30	1.21	3049908.9660	743054.3430
31	1.36	3049877.3910	743204.2940
32	1.36	3049873.2820	743214.0160
33	1.07	3049869.0910	743220.6100
34	1.17	3049860.4750	743230.3030
35	1.57	3049798.4350	743283.7740
36	1.17	3049671.6030	743405.1830
37	1.27	3049575.8970	743494.5160
38	1.27	3049546.4840	743522.2970
39	1.15	3049516.6910	743551.2610
40	1.15	3049514.7450	743552.9310
41	1.13	3049401.7540	743662.5490
42	1.53	3049329.6050	743731.8180
43	1.53	3049329.5810	743731.8040
44	1.63	3049301.2070	743756.2740
45	1.63	3049299.5360	743757.7430
46	1.63	3049296.4670	743758.7530
47	1.63	3049292.1900	743759.8370
48	1.63	3049286.9890	743760.4540
49	1.44	3049281.4760	743760.9830
50	1.52	3049272.8760	743759.9740
51	1.44	3049212.1300	743750.3150
52	1.49	3049169.8430	743743.6330
53	1.39	3049154.6780	743740.7480
54	1.39	3049151.2730	743739.3950
55	1.39	3049145.4960	743736.9840
56	1.39	3049140.6770	743734.0350
57	1.39	3049137.0860	743731.4430
58	1.21	3049131.3010	743726.6780
59	1.21	3049071.3330	743666.8580
60	1.21	3049067.1470	743663.5340
61	0.86	3049006.8170	743627.8640
62	1.43	3048909.9870	743574.4340
63	2.15	3048875.3330	743555.2600
64	1.90	3048859.2440	743551.1350
65	1.90	3048852.4890	743550.5850
66	1.70	3048832.6580	743553.6800
67	1.70	3048811.4330	743557.2640
68	1.70	3048803.6070	743557.2800
69	1.72	3048782.8530	743552.4390
70	1.74	3048740.2320	743542.7150

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
71	1.74	3048712.6800	743536.2760
72	1.74	3048670.9170	743526.5030
73	1.74	3048641.3610	743526.0090
74	1.64	3048570.4180	743527.2500
75	1.55	3048528.5890	743528.2330
76	1.48	3048452.1020	743531.5670
77	1.89	3048398.0450	743533.6410
78	1.58	3048281.6780	743539.0080
79	1.31	3048136.6880	743545.9050
80	1.62	3048091.7680	743547.3540
81	1.41	3048022.4730	743550.6410
82	1.77	3047923.9560	743555.6260
83	1.31	3047865.3730	743558.5540
84	1.68	3047797.9170	743538.0520
85	2.08	3047785.3120	743531.5710
86	1.67	3047590.2480	743437.2590
87	1.83	3047466.3220	743451.3800
88	1.38	3047217.8790	743490.5000
89	1.33	3047107.0330	743515.4470
90	1.20	3046930.1880	743557.3600
91	1.07	3046844.5360	743577.1560
92	1.50	3046710.6530	743607.5240
93	1.49	3046562.0270	743642.2240
94	2.26	3046409.7600	743676.6840
95	1.48	3046274.4260	743709.8800
96	1.27	3046172.6450	743733.8960
97	1.12	3046091.1910	743752.7220
98	2.24	3046079.8600	743754.6220
99	2.24	3046073.5340	743754.4950
100	2.24	3046069.3990	743753.5700
101	2.24	3046064.9030	743751.9290
102	2.36	3046056.8420	743747.9970
103	2.36	3046050.7430	743743.5890
104	1.24	3046037.9190	743726.9190
105	1.29	3045992.0370	743663.2820
106	2.36	3045982.7580	743648.5910
107	1.03	3045968.0740	743630.2510
108	2.36	3045928.6210	743588.0600
109	1.72	3045916.8330	743576.7740
110	1.90	3045905.6400	743562.9710
111	1.50	3045893.0020	743537.3550

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
112	1.50	3045843.1590	743446.7440
113	1.61	3045835.9190	743437.5820
114	2.36	3045827.7010	743427.9320
115	1.48	3045814.6660	743420.5110
116	2.06	3045789.5340	743405.5140
117	0.85	3045602.1370	743294.6100
118	1.15	3045574.5960	743278.0770
119	1.66	3045554.7910	743266.3030
120	1.31	3045502.7370	743235.6610
121	1.85	3045458.0790	743208.4550
122	1.54	3045407.7840	743177.1350
123	1.35	3045395.1920	743169.0670
124	0.89	3045359.8690	743122.9210
125	1.36	3045326.8950	743075.9030
126	0.86	3045289.1780	743022.8630
127	2.34	3045245.4740	742960.5340
128	1.20	3045202.1860	742900.1870
129	0.75	3045170.3030	742854.1070
130	1.00	3045120.6890	742781.5530
131	1.00	3045064.7330	742703.1750
132	0.88	3045026.8790	742649.3110
133	1.63	3044999.8040	742611.7250
134	1.59	3044990.7500	742601.9220
135	1.73	3044983.4050	742596.4440
136	1.23	3044978.3180	742592.4910
137	1.58	3044910.2470	742563.0500
138	1.35	3044877.5730	742549.6280
139	0.91	3044818.1320	742522.8250
140	1.32	3044673.5090	742376.9240
141	1.32	3044628.8750	742330.6790
142	0.77	3044578.0180	742281.3760
143	1.25	3044534.5250	742236.6330
144	1.67	3044515.1260	742217.3020
145	1.53	3044481.3920	742167.4030
146	1.27	3044370.5930	742009.1510
147	1.48	3044303.5390	741911.4510
148	1.63	3044241.3900	741818.9090
149	1.44	3044220.7650	741788.1960
150	1.46	3044183.0250	741732.7850
151	1.14	3044156.2680	741692.4320
152	1.36	3044117.9530	741634.6200

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
153	1.47	3044093.0470	741598.8930
154	1.20	3044085.0790	741586.8280
155	1.63	3044080.5260	741572.4430
156	1.10	3044063.1810	741446.9160
157	1.39	3044040.1370	741293.5520
158	0.39	3044052.2870	741364.5170
159	1.45	3044020.5540	741184.9430
160	1.11	3043981.8470	741011.0180
161	1.86	3043940.4480	740848.2390
162	1.71	3043878.8840	740588.6530
163	1.39	3043842.3730	740417.0390
164	2.65	3043791.1020	740151.1760
165	2.44	3043863.2750	739890.6750
166	2.16	3043863.7010	739885.1680
167	2.50	3043855.8610	739849.0600
168	2.18	3043847.3740	739814.7220
169	2.21	3043838.8930	739761.0380
170	2.21	3043834.4640	739732.4320
171	2.47	3043830.0780	739713.4480
172	2.48	3043681.1610	739406.5230
173	1.98	3043671.2200	739384.5480
174	1.36	3043636.9710	739300.1060
175	1.29	3043623.4180	739259.6490
176	1.13	3043605.3550	739230.4170
177	1.10	3043542.6020	739183.4390
178	2.58	3043510.9200	739158.4760
179	1.00	3043479.3980	739140.9710
180	1.31	3043460.2060	739130.4650
181	1.26	3043433.8780	739114.2290
182	0.69	3043423.0790	739109.1460
183	1.15	3043403.3340	739111.5950
184	2.05	3043384.5180	739123.9460
185	1.12	3043364.9970	739136.3100
186	2.53	3043354.0050	739143.4330
187	1.23	3043334.4850	739157.2490
188	1.23	3043301.3240	739183.4780
189	1.34	3043236.5990	739233.9660
190	1.27	3043154.4130	739295.2670
191	1.14	3043078.7850	739353.3240
192	0.98	3043034.7390	739389.3100
193	1.21	3042970.7800	739416.5970

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
194	1.35	3042852.0410	739418.0920
195	1.37	3042765.8080	739416.5620
196	3.98	3042662.2300	739405.2260
197	1.60	3042661.3260	739404.2960
198	3.53	3042655.5120	739403.3570
199	2.81	3042647.6400	739399.2710
200	3.86	3042640.9500	739397.8860
201	3.53	3042634.0530	739395.4410
202	2.63	3042623.4580	739390.1000
203	2.22	3042617.3330	739387.7500
204	2.22	3042615.9700	739387.2430
205	1.32	3042610.0010	739386.0980
206	0.00	3042603.9060	739386.1340
207	1.35	3042599.4920	739386.5800
208	1.41	3042593.5770	739388.0630
209	1.22	3042582.2550	739391.5600
210	1.25	3042576.3280	739393.4080
211	1.48	3042557.7640	739396.5520
212	1.15	3042537.3720	739397.5040
213	1.06	3042526.5300	739397.7100
214	0.93	3042506.6920	739397.4660
215	1.14	3042491.2800	739397.6030
216	1.07	3042480.7680	739397.5450
217	1.51	3042473.9230	739397.5640
218	1.67	3042466.2500	739397.5280
219	0.98	3042457.3850	739397.5320
220	1.41	3042437.0840	739395.7420
221	1.59	3042416.7160	739384.2670
222	1.55	3042374.6730	739355.8280
223	1.88	3042341.0530	739332.4060
224	1.79	3042312.5040	739311.4970
225	1.85	3042264.6000	739277.6660
226	1.83	3042179.0360	739216.9210
227	1.78	3042158.2440	739202.9610
228	1.95	3042110.9510	739171.0110
229	2.43	3042088.3000	739154.7520
230	1.72	3042061.5840	739136.1750
231	1.72	3042059.3870	739133.5620
232	1.72	3042057.9390	739132.0120
233	1.72	3042056.0480	739129.4010
234	1.82	3042044.1750	739103.8030

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
235	2.23	3042032.8000	739073.6270
236	1.44	3042014.9700	739023.0510
237	1.42	3042004.5930	738973.6640
238	1.23	3041993.5180	738874.9360
239	1.15	3041995.0500	738862.6720
240	1.37	3042005.7980	738841.3310
241	1.23	3042036.8300	738780.2030
242	1.23	3042040.5770	738773.1450
243	1.42	3042055.1020	738743.3230
244	0.93	3042067.5530	738718.7030
245	1.67	3042075.8670	738703.4240
246	1.46	3042078.7170	738691.6860
247	1.63	3042073.9590	738660.9940
248	1.21	3042067.7460	738623.9150
249	1.20	3042063.8740	738599.8150
250	1.55	3042064.3450	738585.6670
251	1.25	3042065.4440	738552.7300
252	1.25	3042054.1720	738506.9540
253	1.56	3042046.3300	738475.6280
254	1.23	3042023.8030	738389.9370
255	1.27	3042011.4760	738342.2300
256	1.41	3041999.1740	738288.3340
257	1.20	3041994.6970	738253.0850
258	1.32	3041991.6300	738210.3890
259	0.70	3041988.1400	738169.0160
260	0.92	3041987.3670	738154.5950
261	1.42	3041982.0190	738109.9640
262	1.70	3041970.4290	738050.5550
263	1.50	3041963.5160	737989.1450
264	1.58	3041961.0560	737950.7090
265	1.35	3041926.0090	737836.7440
266	1.13	3041910.3750	737787.1840
267	1.11	3041903.9320	737769.6920
268	1.67	3041844.8550	737646.6640
269	1.75	3041807.0940	737563.7450
270	1.37	3041780.7380	737507.2580
271	1.52	3041720.0360	737379.3910
272	1.34	3041687.4010	737314.6430
273	1.37	3041664.5460	737270.8330
274	1.41	3041632.8880	737208.6410
275	1.93	3041619.2680	737179.8410

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
276	0.71	3041566.0680	737098.4650
277	0.73	3041542.4770	737062.6700
278	1.31	3041476.3880	736962.3540
279	1.43	3041406.7400	736855.2360
280	1.44	3041355.2090	736776.5250
281	1.39	3041252.6700	736620.0530
282	1.14	3041146.3580	736451.7270
283	1.53	3041088.7490	736331.7250
284	1.89	3041068.7050	736289.4730
285	1.01	3041027.9480	736206.6070
286	1.04	3040995.0870	736139.4310
287	1.46	3040972.2110	736091.5810
288	1.83	3040946.2770	736032.8620
289	1.52	3040915.4890	735963.9670
290	1.48	3040892.2760	735909.6530
291	1.19	3040820.3990	735744.1650
292	1.55	3040808.2210	735717.0540
293	1.28	3040759.1990	735606.9780
294	1.96	3040744.8080	735573.9700
295	1.38	3040729.5120	735540.5160
296	1.24	3040693.0230	735509.4740
297	1.28	3040658.9340	735490.2200
298	1.45	3040606.7300	735461.3060
299	1.25	3040577.3220	735446.2870
300	1.21	3040529.4220	735424.3890
301	1.98	3040478.0550	735401.4100
302	1.17	3040405.5730	735369.4120
303	2.06	3040284.2560	735298.9640
304	1.11	3040230.7450	735266.6870
305	1.36	3040176.4000	735242.0300
306	3.00	3040167.7830	735240.0420
307	1.66	3040104.2340	735213.1320
308	1.58	3040103.6980	735213.0500
309	1.25	3040023.9370	735177.8629
310	2.64	3039905.7870	735151.2220
311	1.83	3039905.8140	735151.8160
312	1.94	3039897.0920	735149.3240
313	1.23	3039894.1460	735147.9490
314	1.23	3039891.9520	735146.5520
315	1.25	3039891.7270	735146.6092
316	1.25	3039879.8700	735135.0153

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
317	1.37	3039878.3220	735130.7450
318	1.25	3039792.3580	734975.6435
319	1.25	3039764.3610	734821.3981
320	1.27	3039752.1370	734787.2490
321	0.90	3039735.6270	734747.8071
322	1.46	3039706.7970	734701.3540
323	1.32	3039678.6360	734652.7710
324	1.99	3039647.2150	734586.8800
325	1.32	3039634.5760	734559.9910
326	0.82	3039610.1110	734509.3680
327	0.82	3039592.0470	734454.1840
328	1.74	3039629.6120	734282.1710
329	2.95	3039634.0700	734261.7011
330	1.62	3039641.9400	734236.8820
331	0.79	3039669.1340	734151.7750
332	2.95	3039700.9220	734073.3200
333	2.95	3039704.9410	734063.3999
334	2.31	3039673.1110	734002.5190
335	2.83	3039668.7750	733992.7020
336	1.10	3039657.9570	733971.5550
337	0.68	3039620.6880	733899.0840
338	1.59	3039615.5900	733876.4840
339	1.09	3039605.4620	733839.2400
340	1.25	3039598.3100	733801.5520
341	1.36	3039586.9560	733739.6840
342	2.33	3039583.8950	733717.5180
343	1.56	3039583.5700	733689.3660
344	1.40	3039586.6540	733663.7630
345	1.57	3039593.6150	733614.8930
346	1.57	3039593.4150	733599.3950
347	1.64	3039579.9930	733585.3980
348	1.36	3039455.7970	733471.1130
349	1.49	3039416.5390	733453.9890
350	2.00	3039375.1310	733437.6490
351	1.73	3039295.2960	733410.7640
352	1.91	3039267.2150	733402.1260
353	1.59	3039221.7040	733389.0370
354	1.60	3039166.5540	733375.2790
355	2.53	3038998.5370	733373.4300
356	2.35	3038966.4350	733372.8600
357	1.54	3038837.3210	733371.7610

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
358	1.49	3038708.3790	733370.1440
359	1.62	3038684.7620	733369.7870
360	1.54	3038566.4570	733368.8030
361	1.52	3038462.1030	733367.4720
362	1.52	3038374.1340	733366.4430
363	1.49	3038330.6130	733363.4390
364	1.64	3038234.5030	733335.1580
365	1.10	3038196.9480	733325.8840
366	1.19	3038130.4650	733310.3870
367	1.12	3038066.8710	733294.4190
368	0.03	3037909.4870	733258.5240
369	1.45	3037841.5890	733241.2430
370	1.42	3037602.3640	733130.7810
371	1.41	3037494.6280	733078.1700
372	1.23	3037442.6570	733052.7440
373	1.76	3037386.4300	733023.7880
374	1.68	3037380.7520	733021.1150
375	1.63	3037370.6290	733019.7370
376	0.94	3037224.5150	733095.9090
377	0.94	3037185.8210	733101.6140
378	1.00	3037115.3770	733084.5670
379	0.98	3036982.7420	733052.2930
380	2.24	3036899.5450	733041.5410
381	2.17	3036885.3470	733036.1070
382	1.40	3036787.9160	732996.6900
383	1.34	3036629.9860	732944.7310
384	1.46	3036565.0590	732926.2480
385	1.57	3036534.5340	732918.0270
386	1.54	3036460.6920	732897.3600
387	1.42	3036382.6940	732876.8020
388	1.77	3036308.0110	732864.8410
389	3.17	3036091.2950	732827.5770
390	1.69	3036061.2080	732815.6830
391	1.67	3035971.6730	732775.1400
392	1.47	3035819.1370	732705.8580
393	1.32	3035743.8950	732671.0230
394	1.53	3035635.8250	732627.1520
395	1.42	3035542.2090	732546.4250
396	1.49	3035516.2330	732525.2040
397	1.22	3035408.1150	732477.0520
398	1.41	3035362.6570	732462.4170

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
399	1.47	3035252.1730	732428.6540
400	1.37	3035139.6000	732391.3180
401	1.47	3035048.9180	732361.3790
402	1.78	3034949.8310	732326.2800
403	1.61	3034902.2030	732272.4500
404	1.28	3034882.9650	732239.9239
405	1.61	3034874.1320	732229.8080
406	0.78	3034694.9960	732056.7590
407	1.67	3034650.2580	732011.8030
408	1.65	3034586.6200	731949.9750
409	1.65	3034534.2470	731899.5410
410	1.65	3034507.2400	731873.4460
411	1.38	3034469.2960	731837.5930
412	1.19	3034439.7400	731808.6930
413	1.56	3034419.3750	731797.5053
414	2.65	3034373.3540	731810.4558
415	1.17	3034338.3370	731821.7740
416	1.67	3034224.1520	731851.1550
417	1.85	3034110.6870	731871.7310
418	1.55	3033958.3120	731897.5800
419	1.18	3033874.1030	731912.7500
420	1.72	3033785.4520	731929.4330
421	1.35	3033699.9870	731953.3230
422	1.35	3033686.9410	731969.6220
423	1.19	3033600.7930	732077.1430
424	1.42	3033522.1700	732105.6840
425	1.04	3033442.6380	732091.3400
426	2.00	3033373.8090	732091.3950
427	1.20	3033322.5110	732100.5410
428	1.79	3033201.3860	732120.2410
429	1.02	3033150.6450	732128.0140
430	8.66	3032956.3420	732100.7374
431	2.38	3032900.4700	732110.4831
432	1.28	3032809.7010	732134.3550
433	1.55	3032693.2910	732086.9350
434	1.73	3032642.8920	732064.1670
435	1.59	3032588.5480	732026.6480
436	2.01	3032546.5950	731997.1600
437	2.10	3032529.4760	731985.0863
438	2.15	3032425.5360	731916.4557
439	1.71	3032346.1770	731865.5670

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
440	1.64	3032286.9080	731830.4470
441	1.29	3032193.3020	731776.2720
442	1.89	3032126.9280	731722.0520
443	1.59	3032045.1660	731655.7400
444	1.90	3031938.6040	731569.2230
445	1.89	3031770.8000	731445.8750
446	1.97	3031738.5520	731422.2710
447	1.38	3031707.1410	731398.2040
448	1.57	3031623.7830	731308.4850
449	2.15	3031554.7170	731234.4020
450	1.31	3031518.7440	731197.1480
451	1.59	3031467.2300	731142.8970
452	2.01	3031386.3400	731057.3600
453	1.30	3031362.8200	731032.8550
454	1.29	3031350.1320	731020.7720
455	1.29	3031289.7930	730974.2081
456	1.93	3031267.0310	730929.8870
457	3.38	3031262.0340	730921.2524
458	2.09	3031250.7060	730906.4429
459	2.00	3031249.9390	730905.4460
460	2.00	3031248.9840	730904.7070
461	2.09	3031247.6690	730903.9940
462	2.02	3031242.3980	730901.5900
463	2.23	3031227.8420	730899.0367
464	3.67	3031170.6620	730889.0070
465	2.10	3031153.4410	730885.8230
466	1.84	3031135.2530	730882.6010
467	2.16	3031106.6000	730878.2360
468	1.87	3031074.5400	730872.5930
469	1.60	3031045.7310	730867.5560
470	1.98	3031028.0040	730865.5910
471	2.19	3031014.0560	730864.0470
472	2.19	3030971.9380	730858.5510
473	2.40	3030946.5290	730854.8200
474	2.16	3030928.1370	730851.6158
475	2.35	3030892.5030	730845.4078
476	2.54	3030815.6680	730832.0217
477	2.24	3030772.0920	730824.4300
478	1.86	3030718.3080	730816.8042
479	1.94	3030664.5830	730818.2988
480	1.77	3030588.1700	730820.4250
481	1.42	3030542.0190	730807.5689
482	1.01	3030539.5290	730785.4014

**2) EX. 200 mm ø ND CRUDE OIL PL FROM BAGHJAN
EPS/GGS TO CGGS MADHUBAN**

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
1	1.00	3050473.5280	742278.0420
2	1.08	3050454.2900	742294.7460
3	1.02	3050411.9890	742330.4396
4	1.00	3050370.0600	742365.8200
5	1.00	3050331.4110	742399.5090
6	1.20	3050281.6080	742442.7800
7	1.07	3050230.6570	742485.5153
8	1.00	3050206.5800	742505.7100
9	1.00	3050165.9620	742539.6475
10	1.00	3050142.2500	742559.4600
11	0.89	3050126.1820	742573.1988
12	0.89	3050122.4730	742576.3695
13	0.89	3050119.6670	742578.7688
14	0.91	3050083.8800	742617.0564
15	0.80	3050030.9840	742677.2950
16	0.85	3049985.6150	742730.3960
17	1.02	3049968.8270	742772.1940
18	0.85	3049961.4610	742811.3060
19	0.77	3049944.7360	742895.5720
20	0.78	3049934.5550	742943.6710
21	0.73	3049911.8250	743055.0940
22	0.81	3049879.9420	743204.0740
23	0.95	3049872.1660	743222.9450
24	0.95	3049864.4440	743231.1380
25	1.23	3049800.4070	743287.7410
26	0.92	3049675.3970	743406.1260
27	0.92	3049579.9290	743495.7940
28	0.00	3049517.2150	743556.3760
29	0.89	3049404.6540	743664.6780
30	0.20	3049332.6800	743734.2270
31	1.44	3049303.3510	743758.9850
32	0.91	3049270.5710	743764.0730
33	1.04	3049211.4310	743754.0040
34	1.04	3049173.3340	743747.7650
35	0.85	3049163.0920	743746.0269

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
36	0.99	3049152.6480	743744.2542
37	0.99	3049144.4800	743742.1060
38	0.99	3049139.4710	743739.4690
39	0.99	3049134.3870	743735.2640
40	0.99	3049127.9770	743728.6430
41	0.79	3049069.1110	743669.4538
42	0.53	3049005.2670	743631.0490
43	2.13	3048909.8410	743578.2170
44	1.00	3048872.9280	743558.5650
45	1.00	3048859.1880	743553.4520
46	1.00	3048833.1100	743557.6230
47	0.05	3048637.9120	743530.2030
48	1.03	3048136.3010	743550.4660
49	1.30	3048092.3380	743552.9650
50	0.86	3047918.5660	743560.6840
51	1.23	3047864.3830	743561.4220
52	1.76	3047680.1400	743470.7190
53	1.78	3047622.3150	743438.8394
54	1.08	3047589.9170	743442.2920
55	1.20	3047466.9350	743455.3980
56	1.34	3047346.5260	743468.7160
57	1.95	3047104.3460	743521.5460
58	1.19	3046933.6740	743561.0950
59	1.00	3046845.4770	743580.5760
60	1.00	3046711.6870	743611.5380
61	1.08	3046564.3890	743646.1050
62	1.52	3046406.6180	743682.1840
63	1.69	3046384.9640	743687.3140
64	1.39	3046276.1560	743714.1510
65	1.89	3046173.4590	743738.2070
66	1.03	3046091.7260	743757.0660
67	1.03	3046081.5020	743759.5950
68	1.03	3046075.8030	743760.0420
69	1.03	3046070.7250	743758.9190
70	0.64	3046066.7710	743757.5630
71	1.18	3046046.6560	743745.3460
72	1.31	3046035.1880	743729.2180
73	1.03	3045978.1250	743651.1279
74	1.97	3045964.3280	743632.2470
75	1.16	3045923.7050	743589.2440

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
76	1.00	3045913.8330	743578.1890
77	1.89	3045902.9050	743563.1230
78	1.05	3045888.8050	743537.2930
79	1.07	3045840.9420	743449.0100
80	1.25	3045834.3020	743438.9250
81	1.03	3045824.6120	743430.9010
82	1.03	3045815.3210	743425.4750
83	2.05	3045787.8290	743409.8800
84	1.18	3045599.6260	743297.9860
85	1.46	3045552.2850	743270.0570
86	1.52	3045501.1880	743240.0500
87	1.22	3045458.3080	743213.0180
88	1.14	3045403.7390	743181.0155
89	1.69	3045391.9880	743172.5060
90	1.33	3045356.0530	743123.9990
91	1.74	3045323.4630	743078.8150
92	1.44	3045288.0550	743028.1660
93	1.20	3045242.4620	742963.3620
94	0.82	3045199.2530	742901.8900
95	1.32	3045167.1340	742856.2460
96	1.10	3045117.9820	742785.5260
97	1.15	3045061.3190	742705.3440
98	1.23	3045023.8420	742651.5710
99	1.11	3044994.6620	742611.8690
100	1.22	3044987.8210	742603.6450
101	0.89	3044977.3270	742595.9130
102	1.71	3044907.7440	742566.8010
103	1.03	3044875.4650	742553.0000
104	0.81	3044815.3090	742525.3950
105	0.86	3044671.6960	742379.2920
106	0.67	3044627.2350	742334.3960
107	1.08	3044575.1340	742282.9210
108	1.08	3044532.1490	742239.9680
109	1.34	3044516.7160	742224.5190
110	1.10	3044368.0700	742010.2810
111	1.01	3044301.1470	741912.9320
112	1.21	3044217.6160	741789.3643
113	1.01	3044153.9190	741694.4180
114	1.38	3044115.1990	741638.3170
115	1.32	3044090.1280	741601.2710
116	1.28	3044081.1150	741587.9528

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
117	1.39	3044077.4390	741573.5408
118	1.20	3044059.9260	741446.6600
119	0.49	3044050.2870	741363.9260
120	1.59	3044036.7030	741294.5710
121	1.75	3043789.7660	740157.8470
122	2.44	3043854.2480	739849.3700
123	1.11	3043602.4220	739234.3110
124	1.75	3043537.8280	739186.4450
125	1.75	3043506.6850	739164.0220
126	1.07	3043475.8350	739145.1480
127	1.98	3043459.0430	739136.1940
128	1.83	3043435.6640	739122.6520
129	1.55	3043404.5530	739115.5750
130	1.02	3043356.5550	739148.3722
131	0.77	3043350.5960	739151.8515
132	0.89	3043337.0450	739159.7630
133	0.86	3043228.4570	739244.1100
134	1.44	3042970.9540	739421.1330
135	1.44	3042850.7980	739422.5530
136	1.00	3042767.1160	739420.1913
137	1.02	3042679.4420	739424.4648
138	1.47	3042431.3290	739398.6516
139	1.55	3042414.7370	739388.6380
140	1.47	3042371.6740	739359.3371
141	1.17	3042222.1280	739252.8420
142	0.59	3042172.5640	739218.1970
143	0.68	3042153.8080	739205.1930
144	0.97	3042109.9810	739175.3450
145	1.26	3042086.7180	739160.1100
146	1.14	3042062.1520	739142.3900
147	1.27	3042050.9540	739129.5860
148	1.27	3042040.9970	739106.5780
149	1.73	3042027.5950	739075.2360
150	1.55	3042010.4820	739023.9510
151	1.13	3041999.3540	738973.0465
152	1.68	3041989.1370	738874.6374
153	1.20	3041988.9180	738861.5493
154	1.65	3042001.3830	738837.7040
155	1.37	3042032.3130	738777.9570
156	1.37	3042049.9000	738742.4340
157	1.79	3042061.7010	738719.2830

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
158	88.00	3042071.4790	738701.6720
159	1.21	3042074.4620	738692.5830
160	0.85	3042069.9250	738660.4730
161	1.53	3042063.4300	738623.8790
162	1.00	3042059.9240	738600.4400
163	1.53	3042060.9550	738583.6270
164	1.53	3042061.0020	738555.9763
165	0.76	3042049.5540	738507.9350
166	1.62	3042041.7960	738479.5250
167	1.72	3042019.0450	738389.4760
168	1.57	3042006.6750	738342.2810
169	1.43	3041994.1500	738289.0110
170	1.77	3041989.0540	738254.5560
171	1.72	3041986.4840	738210.0830
172	1.44	3041984.0060	738170.2660
173	1.39	3041983.4990	738155.2180
174	1.39	3041977.0680	738111.1040
175	1.39	3041965.6370	738051.1210
176	1.47	3041958.3410	737988.5470
177	1.22	3041955.7010	737951.6360
178	1.56	3041921.0490	737838.3394
179	1.42	3041905.8940	737793.6310
180	1.52	3041897.7320	737770.8840
181	1.65	3041886.0440	737742.1890
182	1.25	3041840.1260	737648.6630
183	1.35	3041801.1770	737564.6130
184	1.60	3041775.6330	737509.6920
185	1.65	3041713.8180	737380.6740
186	1.84	3041680.5490	737315.1040
187	1.84	3041660.9320	737276.5770
188	1.49	3041627.2930	737209.2770
189	1.55	3041562.2740	737099.2830
190	1.52	3041477.0690	736971.4760
191	1.34	3041296.3190	736697.3750
192	1.15	3041139.6220	736450.0560
193	1.15	3041104.7120	736378.3655
194	1.74	3041082.2860	736332.3110
195	1.15	3041061.5800	736290.5840
196	1.16	3041021.3450	736207.4810
197	1.91	3040989.0340	736141.4370
198	1.45	3040964.8210	736090.6560

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
199	2.53	3040936.2180	736030.5270
200	2.02	3040909.1790	735966.3090
201	1.34	3040884.4620	735907.4220
202	1.44	3040813.8380	735743.1770
203	1.68	3040756.5330	735613.6850
204	1.34	3040685.3740	735511.0460
205	1.64	3040230.3620	735271.1040
206	2.18	3040181.6450	735248.5200
207	1.59	3040137.0630	735228.6590
208	1.37	3040120.2220	735221.7769
209	1.11	3040103.5950	735214.9820
210	1.25	3040022.2020	735180.5200
211	1.30	3039901.5820	735158.1470
212	1.30	3039894.0270	735156.6110
213	1.30	3039891.7770	735155.7080
214	1.30	3039889.6990	735154.6210
215	1.25	3039885.4290	735149.0531
216	1.25	3039785.3280	734973.0634
217	1.25	3039762.7480	734827.5911
218	1.25	3039759.4410	734819.7210
219	0.90	3039746.0470	734787.7240
220	0.90	3039730.4540	734750.4736
221	1.62	3039703.9660	734705.1117
222	1.32	3039674.6540	734654.9230
223	1.18	3039605.9650	734511.4310
224	1.42	3039588.5240	734452.6444
225	1.39	3039625.3330	734279.7014
226	2.95	3039631.3920	734252.0169
227	1.83	3039636.9140	734235.6910
228	1.23	3039665.4180	734151.4220
229	3.20	3039697.6600	734065.5610
230	2.95	3039699.8930	734059.6145
231	0.86	3039655.0190	733972.6128
232	0.86	3039611.6230	733876.0850
233	1.18	3039601.8790	733842.8463
234	0.82	3039583.6340	733740.2150
235	0.67	3039584.0220	733663.3820
236	0.89	3039590.0820	733612.1190
237	0.93	3039590.0010	733603.1130
238	1.08	3039582.2420	733594.5340
239	1.09	3039543.5730	733548.6980

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
240	2.17	3039452.7190	733473.1040
241	1.62	3039221.1130	733392.1710
242	5.23	3038998.6780	733376.4130
243	2.26	3038706.3530	733375.1160
244	2.03	3038687.0640	733374.5130
245	1.91	3038566.2490	733373.2900
246	1.67	3038465.1330	733372.5300
247	1.93	3038333.6660	733370.0940
248	1.99	3037908.6990	733263.1990
249	1.63	3037840.7790	733245.9036
250	2.61	3037600.9860	733135.6760
251	2.55	3037440.7140	733055.9860
252	1.14	3037115.4490	733088.8470
253	1.69	3036309.0850	732869.4100
254	1.25	3036231.9760	732858.6590
255	3.33	3036090.1460	732832.1037
256	1.55	3036062.5180	732821.7730
257	1.44	3035973.3240	732780.3770
258	1.85	3035818.1470	732711.3570
259	1.14	3035633.3900	732630.2120
260	1.11	3035360.9410	732464.7470
261	1.11	3035136.9390	732393.6610
262	0.83	3035047.7050	732364.2760
263	1.98	3034947.8140	732330.8200
264	1.74	3034902.4700	732275.0530
265	2.00	3034880.0740	732237.7170
266	0.15	3034692.9970	732058.8510
267	1.36	3034584.9640	731953.6490
268	0.53	3034222.6860	731855.7010
269	1.77	3033957.9360	731904.8040
270	2.07	3033878.1140	731918.9170
271	2.06	3033787.6890	731935.2851
272	1.42	3033704.7430	731955.0970
273	0.92	3033690.4410	731971.6530
274	0.45	3033598.2920	732082.1160
275	0.46	3033521.4140	732108.7510
276	0.48	3033442.6880	732092.6880
277	1.26	3033423.0390	732088.2730
278	0.69	3033376.8430	732093.6830
279	1.30	3033323.1740	732103.4930
280	1.52	3033202.2100	732124.3170

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
281	0.75	3033151.4580	732132.0810
282	1.42	3033011.0650	732107.8210
283	0.89	3032956.1230	732104.5660
284	0.59	3032900.8110	732115.3160
285	1.28	3032809.0720	732139.3350
286	3.60	3032779.9160	732129.1670
287	2.44	3032740.6520	732113.1470
288	2.88	3032681.0480	732089.1910
289	2.36	3032633.3390	732066.3920
290	1.90	3032604.3100	732045.7080
291	1.52	3032532.6730	731992.2190
292	1.22	3032122.2640	731724.3790
293	1.38	3032017.6720	731638.7110
294	1.71	3031766.5270	731448.8140
295	1.97	3031730.7220	731421.7920
296	2.05	3031702.7280	731400.4850
297	0.91	3031622.4910	731312.5860
298	0.89	3031549.3150	731234.7330
299	0.81	3031516.8100	731200.2560
300	0.87	3031464.9260	731145.4550
301	1.18	3031383.8260	731060.3530
302	1.62	3031359.0570	731034.7818
303	1.91	3031287.1820	730977.6480
304	3.12	3031282.0050	730967.2230
305	2.40	3031264.5150	730929.4830
306	1.92	3031257.9530	730924.7410
307	1.79	3031196.1460	730910.8083
308	1.69	3031185.0370	730908.8487
309	1.82	3031151.7840	730904.9620
310	2.04	3031143.2600	730903.5150
311	2.49	3031110.6750	730898.4970
312	1.20	3031054.4580	730888.5760
313	0.98	3031047.6910	730886.8950
314	1.50	3031044.0740	730885.3360

**3) 400 mm ø NATURAL GAS PL FROM O.I.L. MAKUM OCS TO CGGS
MADHUBAN (UNDER CONTRACTION)**

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
1	1.55	3041608.7180	737175.7280
2	1.55	3041556.8030	737098.7810
3	1.63	3041533.4040	737063.1420
4	1.94	3041473.3570	736970.4010
5	2.53	3041450.1820	736935.7760
6	2.00	3041404.0580	736867.5950
7	1.72	3041347.5380	736777.9810
8	1.76	3041293.0220	736697.2720
9	1.70	3041239.2520	736618.2020
10	1.68	3041182.7350	736533.3760
11	1.64	3041136.2760	736450.2750
12	1.74	3041101.5230	736379.0900
13	1.63	3041079.2260	736332.6030
14	1.46	3041057.0340	736291.6360
15	1.39	3041015.5940	736208.2920
16	1.84	3040983.5900	736142.7810
17	1.61	3040959.7570	736094.7590
18	1.61	3040881.4460	735907.4750
19	1.65	3040811.1620	735743.5200
20	1.65	3040800.6360	735716.1870
21	1.65	3040792.6070	735697.2550
22	1.65	3040766.2160	735642.4460
23	1.54	3040714.6810	735529.2860
24	1.75	3040684.0740	735512.2370
25	1.75	3040647.3990	735491.8140
26	1.75	3040601.2200	735466.6210
27	1.75	3040576.7490	735453.3140
28	1.75	3040523.4390	735427.8740
29	1.75	3040472.6990	735405.4330
30	1.47	3040400.1190	735372.2330
31	2.32	3040279.5940	735305.2070
32	2.40	3040174.2840	735247.1460
33	1.13	3040104.8710	735223.6610
34	1.17	3040088.4320	735210.6540
35	1.69	3039901.7190	735160.3090
36	1.25	3039782.5115	734974.0749
37	1.10	3039757.5980	734827.2800

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
38	1.00	3039744.8190	734789.2260
39	0.90	3039728.8494	734750.9083
40	1.20	3039702.0850	734708.7520
41	1.25	3039669.4470	734649.1090
42	1.60	3039640.7120	734586.4860
43	1.74	3039628.1930	734559.3770
44	1.40	3039662.1640	734151.5500
45	1.10	3039696.0880	734055.8340
46	0.99	3039664.3890	733994.4960
47	0.86	3039616.0400	733899.9300
48	0.86	3039600.4500	733844.4880
49	0.86	3039581.5900	733740.7730
50	1.12	3039578.8260	733691.0980
51	1.12	3039581.6670	733663.2630
52	0.48	3039542.5080	733549.8530
53	1.38	3039450.8570	733475.8600
54	1.70	3039414.3160	733458.8680
55	1.69	3039369.9190	733443.2360
56	1.70	3039291.8810	733416.6620
57	1.46	3039263.8010	733408.2680
58	1.71	3039217.8320	733395.7610
59	1.86	3039162.5440	733382.5540
60	2.00	3038971.2630	733380.2990
61	2.10	3038837.6610	733378.3680
62	2.50	3038703.7920	733377.2540
63	2.30	3038565.6580	733375.8380
64	2.40	3038465.5180	733373.8810
65	2.60	3038372.2870	733373.3390
66	2.80	3038333.8350	733373.2950
67	2.96	3038299.2880	733364.0040
68	2.80	3038235.3940	733344.0930
69	2.65	3038194.9280	733334.2910
70	2.43	3038130.7020	733317.4850
71	1.80	3038066.3370	733300.9300
72	1.45	3037908.3640	733265.6990
73	1.20	3037893.1140	733262.5800
74	1.45	3037840.1790	733251.7100
75	2.03	3037601.4860	733138.2240
76	1.85	3037479.0120	733078.1430
77	1.68	3037439.4810	733057.9900
78	1.40	3037376.5000	733026.8490

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
79	1.23	3037223.3460	733101.9990
80	1.41	3037186.8620	733108.2700
81	1.40	3036885.1280	733045.5090
82	1.25	3036785.4130	733003.2300
83	1.38	3036626.8380	732949.4850
84	1.20	3036566.2290	732931.7690
85	1.30	3036457.8610	732901.2800
86	1.20	3036383.3570	732883.0690
87	1.22	3036309.1060	732872.3080
88	1.15	3036231.7050	732860.4950
89	1.12	3035974.3020	732782.4270
90	1.18	3035817.7330	732712.9390
91	1.30	3035540.1090	732553.1580
92	1.20	3035513.8710	732532.1760
93	1.00	3035404.1150	732481.6020
94	0.97	3035359.0370	732468.0730
95	1.19	3035250.0490	732434.2480
96	1.40	3035135.4540	732395.7500
97	1.65	3035046.4680	732366.4350
98	1.73	3034901.9220	732278.1650
99	1.68	3034878.2960	732240.0470
100	1.48	3034867.7870	732228.4410
101	1.04	3034691.5660	732061.5640
102	1.48	3034647.1790	732017.7090
103	1.22	3034584.5260	731955.6350
104	1.22	3034561.3800	731932.6110
105	1.00	3034549.0860	731920.9190
106	1.48	3034530.9450	731903.8500
107	1.55	3034502.7560	731876.7200
108	1.64	3034502.3040	731877.8930
109	1.43	3034470.0340	731847.2360
110	1.50	3034435.1050	731813.2830
111	1.80	3034373.4060	731816.1380
112	1.65	3034337.7730	731826.9710
113	1.43	3034222.8170	731858.3970
114	1.25	3034111.0100	731878.1010
115	1.48	3033958.5220	731907.5900
116	1.24	3033914.3730	731917.4600
117	1.33	3033877.8880	731923.8220
118	1.20	3033782.4900	731938.1380
119	1.40	3033708.2010	731957.2220

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
120	1.42	3033600.3800	732089.4640
121	1.23	3033520.7980	732112.7910
122	1.32	3033442.2170	732096.6970
123	1.36	3033423.6190	732094.1450
124	1.45	3033381.4720	732099.4120
125	1.49	3033314.0340	732110.3850
126	1.57	3033202.6430	732128.4290
127	1.04	3033151.8780	732136.7020
128	1.25	3033045.7820	732119.8870
129	1.25	3033010.2560	732113.5980
130	1.60	3032992.9600	732111.7870
131	0.82	3032954.4010	732108.6750
132	1.40	3032900.8880	732120.0410
133	2.44	3032740.6520	732113.1470
134	2.10	3032684.1160	732088.7060
135	2.10	3032635.3790	732065.0280
136	2.10	3032585.4030	732029.0740
137	1.20	3032506.0820	731977.4870
138	1.09	3032424.5350	731922.4820
139	1.95	3032369.6320	731887.4800
140	2.31	3032345.5640	731872.1470
141	1.91	3032283.9050	731837.5360
142	1.91	3032237.5310	731811.6910
143	1.75	3032198.4590	731789.1600
144	1.03	3032120.6280	731727.7770
145	1.56	3032040.2180	731662.9510
146	1.54	3031937.8100	731579.3320
147	1.60	3031765.3690	731449.7120
148	1.65	3031730.1860	731423.1120
149	1.62	3031701.0530	731400.9520
150	1.58	3031681.6400	731379.1210
151	1.48	3031622.0020	731313.9430
152	1.32	3031546.8790	731235.3710
153	1.42	3031515.0210	731202.2310
154	1.52	3031461.8640	731146.0870
155	1.55	3031432.1550	731116.2360
156	1.59	3031399.0110	731081.4220
157	1.57	3031382.0360	731064.4040
158	1.54	3031351.3580	731031.4270

**4) EX. 4"Ø OIL PIPELINE FROM BAGHJAN EPS/GGS
TO CGGS MADHUBAN**

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
1	0.79	3050544.8210	742157.2250
2	0.68	3050533.9715	742209.1149
3	0.75	3050285.3680	742443.9820
4	1.02	3050032.8150	742678.8970
5	1.02	3049988.2510	742730.6410
6	0.47	3049913.9870	743055.8820
7	0.59	3049883.5660	743203.7700
8	0.64	3049867.2150	743234.6390
9	0.48	3049801.6210	743291.1000
10	0.64	3049678.0430	743408.1210
11	0.58	3049584.3760	743497.0870
12	0.98	3049328.6680	743741.9770
13	0.98	3049306.1440	743763.9160
14	0.99	3049269.2600	743765.7680
15	0.99	3049210.1940	743756.6500
16	0.84	3049176.8450	743751.3860
17	0.65	3049140.4290	743746.0450
18	0.46	3049124.7060	743730.6740
19	0.85	3049068.0620	743672.1010
20	1.23	3049048.2520	743659.2040
21	0.75	3049003.8040	743634.6890
22	0.82	3048528.6740	743535.6490
23	1.10	3048451.5760	743538.5580
24	0.70	3048279.6790	743546.6740
25	0.83	3048136.8600	743553.2000
26	0.74	3048092.6570	743555.6520
27	0.17	3047864.0100	743564.7560
28	1.23	3047768.9910	743530.4990
29	1.40	3047618.8170	743443.0460
30	0.54	3047467.5980	743458.3840
31	0.55	3047350.1130	743471.8300
32	0.53	3047224.1130	743497.7080
33	0.61	3047104.2890	743525.8440
34	0.51	3046936.1190	743565.4090
35	0.45	3046845.8710	743586.3800
36	1.35	3046714.7250	743617.1280

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
37	0.68	3046567.9000	743651.4870
38	0.43	3046411.9200	743688.2950
39	0.69	3046273.1940	743719.3820
40	0.83	3046175.2480	743742.8090
41	0.64	3046090.1770	743762.1700
42	0.64	3046079.4020	743764.1550
43	0.64	3046076.5990	743762.9980
44	0.64	3046049.7510	743752.2950
45	0.64	3046044.0880	743750.3100
46	0.64	3046041.6070	743747.7170
47	0.41	3046030.5040	743731.9270
48	0.54	3046012.1820	743706.3810
49	0.54	3045997.1870	743684.0080
50	0.54	3045949.5860	743624.5670
51	0.54	3045922.0860	743595.9610
52	0.64	3045911.7450	743585.6460
53	0.77	3045897.2990	743563.6970
54	0.68	3045913.5440	743587.5550
55	0.51	3045865.5650	743507.6040
56	0.51	3045844.7280	743467.2580
57	0.73	3045837.6370	743453.8350
58	0.46	3045353.0940	743125.3650
59	0.38	3045321.0390	743080.0920
60	1.23	3045286.0060	743030.9940
61	1.97	3045240.6630	742966.0010
62	1.46	3045163.8120	742857.7530
63	1.32	3045115.1630	742788.4320
64	1.12	3045041.4970	742684.0170
65	0.92	3045020.4590	742653.0940
66	0.90	3044986.0390	742606.4570
67	0.92	3044976.5590	742597.4610
68	0.95	3044910.9390	742574.9000
69	0.98	3044851.4460	742546.2920
70	1.07	3044811.5490	742531.1880
71	1.89	3044667.0300	742378.6340
72	1.23	3044624.9520	742337.1550
73	1.23	3044560.8840	742275.5660
74	1.23	3044532.3280	742245.7100
75	0.79	3043849.1930	739850.0050
76	0.85	3043839.6070	739803.2530
77	0.67	3043830.1030	739757.7330

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
78	1.32	3043821.7010	739715.1050
79	1.52	3043679.5220	739414.5730
80	1.53	3043664.5740	739383.9460
81	1.45	3043626.8910	739284.5190
82	1.23	3043617.9860	739264.8210
83	1.33	3043611.6110	739254.4720
84	1.46	3043609.7430	739251.1080
85	1.12	3043600.4060	739237.0870
86	1.18	3043553.5120	739206.3250
87	1.08	3043580.5720	739223.8250
88	1.05	3043533.2740	739189.2510
89	0.97	3043496.7400	739165.8090
90	0.93	3043426.5780	739141.0840
91	1.14	3043406.5550	739135.0250
92	1.43	3043360.5170	739153.9310
93	1.41	3043339.2050	739162.0080
94	1.28	3043342.3920	739167.4960
95	1.11	3043337.7160	739160.2130
96	0.86	3043307.3610	739186.0120
97	0.82	3043232.3570	739244.7230
98	0.78	3043142.5510	739312.6610
99	0.70	3043035.3060	739396.7450
100	0.56	3042971.0080	739423.8130
101	0.48	3042850.7480	739426.5750
102	0.82	3042768.2330	739425.1670
103	2.05	3042658.7260	739425.8740
104	0.30	3037599.2730	733142.3210
105	0.37	3037480.1590	733080.0640
106	0.40	3037489.1260	733084.6670
107	0.24	3037438.9510	733059.4860
108	0.22	3037384.0660	733031.1340
109	0.28	3037369.7950	733030.1610
110	0.32	3037331.1420	733049.6060
111	0.38	3037309.7590	733060.5740
112	0.42	3037282.1160	733074.6130
113	0.56	3037231.6230	733099.2330
114	0.62	3037214.2180	733106.9110
115	0.78	3037205.9140	733110.7600
116	0.46	3037202.2170	733112.7250
117	0.58	3037186.3460	733109.3400
118	0.52	3037157.8550	733103.0220

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
119	0.48	3037114.8180	733093.9180
120	0.38	3036980.0300	733059.5310
121	0.41	3036897.6620	733049.8660
122	0.44	3036884.9660	733046.2460
123	0.44	3036785.0750	733004.4670
124	0.68	3036718.0180	732977.6240
125	0.72	3036671.8510	732964.0170
126	0.86	3036626.6970	732950.7750
127	1.21	3036566.2370	732932.8010
128	1.25	3036533.5750	732923.8580
129	1.86	3036382.4850	732885.9250
130	1.77	3036309.2340	732874.5070
131	1.73	3036231.3220	732862.1690
132	2.86	3036089.3990	732838.1640
133	0.23	3036061.8530	732823.9180
134	0.25	3035974.3640	732783.3830
135	0.34	3035817.3810	732713.5780
136	1.68	3035539.6389	732553.7146
137	1.32	3035513.6180	732532.7680
138	1.09	3035401.6690	732482.6080
139	0.97	3035358.5690	732468.4650
140	0.24	3035248.6860	732434.7730
141	0.24	3035135.2140	732396.4640
142	0.28	3035046.0880	732367.0400
143	0.35	3034946.0120	732333.7270
144	0.78	3034927.9760	732322.3390
145	1.10	3034922.5310	732311.9510
146	1.73	3034901.9220	732278.1650
147	1.56	3034878.2960	732240.0470
148	1.58	3034867.7870	732228.4410
149	1.48	3034691.4240	732061.8260
150	1.42	3034646.8200	732018.1440
151	1.23	3034584.1830	731956.0810
152	1.10	3034560.8760	731933.0670
153	0.98	3034549.0860	731920.9190
154	0.97	3034530.9450	731903.8500
155	0.82	3034502.7560	731876.7200
156	0.86	3034469.4600	731839.9700
157	0.72	3034435.6450	731809.4730
158	0.58	3034419.2920	731800.1090
159	0.46	3034373.4860	731814.2440

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

SALIENT FEATURES

	Salient Features	1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban (Along Existing & Proposed RoU)	2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)
(A)	Length (km)	37.766	17.206
(B)	Terrain (km)		
	(a) Flat	36.948	17.206
	(b) Slightly undulating	0.818	-
(C)	Soil Encountered (km)		
	(a) Clay and silty Soil	37.766	17.206
(D)	Surface Features (km)		
	(a) Within Premises of Baghjan EPS/GGS	0.076	-
	(b) Cross-Country	3.552	-
	(c) Within RoU of Existing Pipeline	33.324	16.466
	(d) Within Premises of O.I.L Makum OCS	0.150	0.095
	(e) Within Premises of STF Plant	0.247	0.231
	(d) Within Premises of CGGS Madhuban	0.418	0.414
(E)	Road Crossing (Nos.)		
	(a) National Highway	-	-
	(b) State Highway	-	-
	(c) Asphalt Road/Metal Road/Other Road	32	13
	(d) Cart Track	39	14
(F)	Water Bodies (Nos.)		
	(a) River	3	1
	(b) Canal/Distributory/Minor/Channel	1	-
	(c) Nala/Drain/Creek	23	7
(G)	Railway Crossing (Nos.)	1	-
(H)	Utility Crossing (Nos.)		
	(a) Power Line/H.T Line	90	59
	(b) Pipeline(Hydrocarbon/Water Supply/Effluent)	28	29
	(c) Cable	8	4

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

	Salient Features	Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban (Along Existing & Proposed RoU)	Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)
(I)	Co-ordinates		
	(a) Value of co-ordinates at		
	(i) Start Point	N:27°36'14.39"	N:27°29'8.43"
		E:95°24'21.5"	E:95°25'22.81"
	(ii) End Point and	N:27°22'46.12"	N:27°22'46.19"
		E:95°20'3.08"	E:95°20'3.09"
(J)	Population Density (km)		
	(a) Class-I	6.400	-
	(b) Class-II	12.166	6.006
	(c) Class-III	19.200	11.200
	(d) Class-IV	-	-

ANNEXURE-II

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

TOTAL LENGTH STATEMENT

SR. NO.	DESCRIPTION	LENGTH (km)
1	Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban (Along Existing & Proposed RoU)	37.766
2	Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)	17.206
	Total Length (km)	54.972

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

LIST OF STRETCHES ALONG PROPOSED ROUTE OF PIPELINE

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban
(Along Existing & Proposed RoU)

Sr. No.	Description	Chainage (m)		Length (m)	RoU Width(m)	
		From	To		Existing	Proposed
1	Within Premises of Baghjan EPS/GGS	0.00	76.09	76.09	-	-
2	Within RoU of Ex. 400mm Ø Gas Pipeline and 200mmØ COD Pipeline from Baghjan to Duliajan	76.09	5010.08	4933.99	18	
3	Cross-country land	5010.08	8561.84	3551.76	-	15
4	Within RoU of Ex. 400mm Ø Gas Pipeline and 200mmØ COD Pipeline from Baghjan to Duliajan	8561.84	20507.16	11945.32	18	-
5	Within Premises of Makum HNE	20507.16	20657.17	150.01	-	-
6	Within RoU of Ex. 400mm Ø Gas Pipeline and 200mmØ COD Pipeline from Baghjan to Duliajan	20657.17	37101.47	16444.30	18	-
7	Within Premises of STF PLANT	37101.47	37348.15	246.68		
8	Within Premises of CGGS Madhuban	37348.15	37766.57	418.42	-	-
	Total Length (m)			37766.57		

2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)

Sr. No.	Description	Chainage (m)		Length (m)	RoU Width(m)	
		From	To		Existing	Proposed
1	Within Premises of Makum HNE	0.00	95.15	95.15	-	-
2	Within RoU of Ex. 400mm Ø Gas Pipeline and 200mmØ COD Pipeline from Baghjan to Duliajan	95.15	16560.69	16465.54	18	-
3	Within Premises of STF Plant	16560.69	16791.76	231.07	-	-
4	Within Premises of CGGS Madhuban	16791.76	17206.24	414.48	-	-
	Total Length (m)			17206.24		

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

TURNING POINTS, DISTANCES & BEARING STATEMENT

**1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban
(Along Existing & Proposed RoU)**

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	RL (m)	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
					EASTING	NORTHING	LATITUDE	LONGITUDE
1	TP0	0	0 ° 0 ' 0 "	121.35	737460.4718	3055650.523	27°36'14.39"	95°24'21.5"
2	TP1	31.23	87 ° 28 ' 40 "R	121.38	737491.1716	3055656.247	27°36'14.56"	95°24'22.62"
3	TP2	51.61	28 ° 22 ' 27 "L	121.48	737495.7863	3055636.393	27°36'13.91"	95°24'22.78"
4	TP3	247.96	59 ° 37 ' 11 "R	121.81	737444.011	3055446.999	27°36'7.79"	95°24'20.76"
5	TP4	532.64	0 ° 17 ' 8 "L	122.15	737642.9417	3055243.36	27°36'1.05"	95°24'27.86"
6	TP5	698.81	3 ° 58 ' 16 "R	121.58	737759.6517	3055125.073	27°35'57.14"	95°24'32.03"
7	TP6	844.92	24 ° 6 ' 11 "R	121.9	737854.8232	3055014.209	27°35'53.48"	95°24'35.42"
8	TP7	1096.71	83 ° 59 ' 6 "L	122.96	737926.5113	3054772.836	27°35'45.59"	95°24'37.86"
9	TP8	1381.64	68 ° 45 ' 35 "R	121.29	738206.6461	3054824.89	27°35'47.11"	95°24'48.11"
10	IP8/1	1584.94	0 ° 0 ' 0 "R	120.47	738313.676	3054652.045	27°35'41.43"	95°24'51.89"
11	TP9	1785	3 ° 40 ' 33 "L	118.78	738419.0012	3054481.952	27°35'35.84"	95°24'55.61"
12	TP10	1943	1 ° 32 ' 26 "L	120.96	738510.622	3054353.232	27°35'31.6"	95°24'58.85"
13	TP11	2102.02	10 ° 29 ' 58 "L	121.68	738606.2839	3054226.206	27°35'27.41"	95°25'2.25"
14	IP11/1	2353.91	0 ° 0 ' 0 "	122.8	738791.9453	3054055.974	27°35'21.77"	95°25'8.89"
15	TP12	2602.33	2 ° 44 ' 37 "L	122.53	738975.0503	3053888.086	27°35'16.2"	95°25'15.45"
16	TP13	2685.9	6 ° 26 ' 57 "L	121.66	739039.2804	3053834.621	27°35'14.42"	95°25'17.75"
17	TP14	2847.14	29 ° 33 ' 24 "L	121.33	739174.0005	3053746.043	27°35'11.46"	95°25'22.6"
18	TP15	3169.54	35 ° 18 ' 14 "R	120.6	739495.71	3053724.855	27°35'10.57"	95°25'34.31"
19	TP16	3178.97	26 ° 49 ' 4 "R	120.75	739503.0297	3053718.912	27°35'10.37"	95°25'34.57"
20	TP17	3414.09	30 ° 53 ' 2 "L	121.33	739599.0751	3053504.303	27°35'3.34"	95°25'37.91"
21	IP17/1	3593.75	0 ° 0 ' 0 "R	121.74	739746.2353	3053401.238	27°34'59.9"	95°25'43.2"
22	TP18	3784.22	16 ° 50 ' 10 "L	121.66	739902.2415	3053291.977	27°34'56.25"	95°25'48.81"
23	TP19	3800.76	16 ° 1 ' 7 "R	121.68	739917.9638	3053286.817	27°34'56.07"	95°25'49.38"
24	IP19/1	4005.41	0 ° 0 ' 0 "	122.2	740087.2451	3053171.823	27°34'52.23"	95°25'55.47"
25	TP20	4212.04	54 ° 27 ' 16 "R	118.28	740258.1652	3053055.715	27°34'48.35"	95°26'1.61"
26	TP21	4340.43	5 ° 38 ' 11 "L	118.08	740261.2056	3052927.36	27°34'44.18"	95°26'1.63"
27	TP22	4411.84	9 ° 52 ' 17 "L	118.45	740269.9008	3052856.476	27°34'41.87"	95°26'1.9"
28	TP23	4448.13	5 ° 2 ' 37 "L	118.65	740280.4273	3052821.753	27°34'40.74"	95°26'2.26"
29	TP24	4536.65	7 ° 38 ' 16 "L	118.9	740313.4566	3052739.625	27°34'38.05"	95°26'3.4"
30	TP25	4598.39	3 ° 38 ' 25 "L	117.34	740343.9026	3052685.913	27°34'36.29"	95°26'4.47"
31	TP26	4675.71	3 ° 12 ' 47 "L	117.67	740386.2271	3052621.2	27°34'34.16"	95°26'5.97"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	RL (m)	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
					EASTING	NORTHING	LATITUDE	LONGITUDE
32	TP27	4752.35	14 ° 46 ' 56 "L	117.15	740431.7058	3052559.513	27°34'32.13"	95°26'7.58"
33	TP28	4871.74	70 ° 37 ' 11 "L	117.14	740524.7234	3052484.675	27°34'29.64"	95°26'10.92"
34	TP29	4907.21	27 ° 26 ' 32 "R	119.23	740536.529	3052518.128	27°34'30.72"	95°26'11.37"
35	TP30	4931.03	6 ° 31 ' 58 "L	121.24	740553.9117	3052534.405	27°34'31.23"	95°26'12.01"
36	TP31	4971.7	17 ° 35 ' 11 "R	121.34	740580.2453	3052565.404	27°34'32.22"	95°26'13"
37	TP32	5064.81	20 ° 40 ' 60 "R	120.03	740659.151	3052614.837	27°34'33.78"	95°26'15.91"
38	TP33	5178.02	9 ° 4 ' 36 "R	120.76	740770.1287	3052637.179	27°34'34.43"	95°26'19.97"
39	TP34	5268.39	1 ° 2 ' 36 "R	122.06	740860.4284	3052640.815	27°34'34.49"	95°26'23.26"
40	TP35	5388.38	9 ° 32 ' 55 "L	122.65	740980.3881	3052643.46	27°34'34.5"	95°26'27.63"
41	TP36	5399.12	8 ° 56 ' 13 "R	122.65	740990.9363	3052645.474	27°34'34.56"	95°26'28.02"
42	TP37	5689.69	44 ° 33 ' 20 "L	122.21	741281.3531	3052654.98	27°34'34.68"	95°26'38.61"
43	TP38	5839.14	30 ° 41 ' 32 "R	119.76	741384.3632	3052763.266	27°34'38.13"	95°26'42.44"
44	TP39	5933.47	66 ° 2 ' 11 "R	121.1	741475.152	3052788.85	27°34'38.9"	95°26'45.77"
45	IP39/1	6248.03	0 ° 0 ' 0 "	117.23	741676.0938	3052546.831	27°34'30.92"	95°26'52.91"
46	TP40	6562.72	0 ° 1 ' 57 "R	116.46	741877.1099	3052304.721	27°34'22.92"	95°27'0.06"
47	TP41	6831.54	32 ° 11 ' 23 "R	116.17	742048.7168	3052097.795	27°34'16.09"	95°27'6.17"
48	TP42	6963.32	10 ° 16 ' 45 "L	116.43	742065.8712	3051967.136	27°34'11.84"	95°27'6.7"
50	TP43	7122.07	66 ° 52 ' 30 "R	117.64	742058.1179	3051808.577	27°34'6.7"	95°27'6.3"
51	TP44	7295.57	18 ° 31 ' 28 "R	116.85	742214.1554	3051732.727	27°34'4.13"	95°27'11.93"
52	TP45	7351	21 ° 56 ' 32 "R	117.28	742253.7276	3051693.909	27°34'2.85"	95°27'13.35"
53	TP46	7448.35	19 ° 31 ' 30 "R	117.66	742292.7142	3051604.709	27°33'59.93"	95°27'14.7"
54	TP47	7623.97	32 ° 27 ' 6 "L	119.53	742305.2216	3051429.533	27°33'54.23"	95°27'15.03"
55	TP48	7687	28 ° 14 ' 15 "L	119.62	742275.272	3051374.068	27°33'52.45"	95°27'13.9"
56	TP49	7985.38	9 ° 15 ' 59 "R	119.54	742274.5945	3051075.688	27°33'42.76"	95°27'13.66"
57	TP50	8222.11	17 ° 22 ' 15 "L	120.03	742312.1816	3050841.969	27°33'35.15"	95°27'14.86"
58	TP51	8347.7	3 ° 33 ' 39 "R	120.24	742294.1926	3050717.668	27°33'31.12"	95°27'14.12"
59	TP52	8543.84	1 ° 50 ' 48 "L	121.86	742254.0977	3050525.67	27°33'24.91"	95°27'12.52"
60	TP53	8578.71	50 ° 31 ' 37 "R	122.93	742248.0731	3050491.324	27°33'23.8"	95°27'12.27"
61	TP54	8878.07	0 ° 11 ' 3 "L	125.33	742442.8006	3050263.955	27°33'16.29"	95°27'19.2"
62	TP55	9092.09	8 ° 24 ' 23 "L	125.55	742582.5374	3050101.853	27°33'10.94"	95°27'24.18"
63	TP56	9294.95	29 ° 14 ' 25 "L	125.04	742736.0276	3049969.217	27°33'6.54"	95°27'29.67"
64	TP57	9456.96	0 ° 17 ' 50 "R	125.12	742894.7405	3049936.664	27°33'5.38"	95°27'35.43"
65	TP58	9774.29	18 ° 12 ' 41 "R	125.79	743205.2569	3049871.294	27°33'3.05"	95°27'46.69"
66	TP59	9788.57	17 ° 28 ' 27 "R	125.8	743217.6175	3049864.129	27°33'2.81"	95°27'47.14"
67	TP60	9889.01	1 ° 12 ' 33 "L	125.99	743285.3755	3049789.992	27°33'0.36"	95°27'49.55"
68	IP60/1	10123.22	0 ° 0 ' 0 "	126.15	743446.9953	3049620.484	27°32'54.75"	95°27'55.32"
69	IP60/2	10347.35	0 ° 0 ' 0 "	125.5	743601.6617	3049458.268	27°32'49.38"	95°28'0.84"
70	TP61	10567.79	33 ° 14 ' 2 "R	125.19	743753.7784	3049298.727	27°32'44.1"	95°28'6.26"
71	TP62	10581.06	19 ° 50 ' 22 "L	125.32	743756.1737	3049285.677	27°32'43.68"	95°28'6.34"
72	TP63	10725.75	36 ° 41 ' 32 "R	124.37	743732.447	3049142.946	27°32'39.06"	95°28'5.37"
73	TP64	10828.3	17 ° 13 ' 17 "L	124.75	743658.5142	3049071.874	27°32'36.8"	95°28'2.63"
74	TP65	11050.89	11 ° 55 ' 23 "L	124.17	743550.9095	3048877.021	27°32'30.54"	95°27'58.57"
75	TP66	11070.39	25 ° 12 ' 21 "R	124.39	743545.2148	3048858.378	27°32'29.94"	95°27'58.34"
76	TP67	11122.2	20 ° 59 ' 52 "L	124.26	743552.6226	3048807.098	27°32'28.27"	95°27'58.58"
77	TP68	11265.49	14 ° 25 ' 45 "R	124.99	743520.9295	3048667.349	27°32'23.75"	95°27'57.32"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	RL (m)	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
					EASTING	NORTHING	LATITUDE	LONGITUDE
78	TP69	11535.16	1 ° 10 ' 40 "L	126.68	743528.7015	3048397.795	27°32'15"	95°27'57.41"
79	TP70	11840.42	0 ° 18 ' 49 "R	126.41	743543.7701	3048092.91	27°32'5.09"	95°27'57.74"
80	TP71	12092.36	28 ° 33 ' 46 "L	118.71	743554.83	3047841.212	27°31'56.91"	95°27'57.96"
81	TP72	12152.44	6 ° 2 ' 11 "R	118.88	743528.4499	3047787.237	27°31'55.17"	95°27'56.96"
82	TP73	12338.29	37 ° 54 ' 26 "R	122.57	743429.7361	3047629.77	27°31'50.12"	95°27'53.25"
83	TP74	12503.06	0 ° 31 ' 54 "L	126.24	743446.457	3047465.845	27°31'44.79"	95°27'53.74"
84	TP75	12652.1	6 ° 35 ' 37 "L	126.03	743462.9561	3047317.724	27°31'39.97"	95°27'54.23"
85	TP76	12869.67	0 ° 29 ' 58 "R	125.94	743511.7109	3047105.691	27°31'33.05"	95°27'55.85"
86	TP77	13155.05	0 ° 45 ' 46 "L	125.44	743573.2359	3046827.019	27°31'23.97"	95°27'57.89"
87	IP77/1	13381.98	0 ° 0 ' 0 "	125.38	743625.1058	3046606.091	27°31'16.76"	95°27'59.62"
88	TP78	13603.63	0 ° 27 ' 9 "L	125.83	743675.7665	3046390.313	27°31'9.72"	95°28'1.31"
89	TP79	13828.53	1 ° 36 ' 51 "R	125.75	743728.8982	3046171.779	27°31'2.59"	95°28'3.09"
90	TP80	13930.48	24 ° 28 ' 23 "L	125.58	743750.1845	3046072.07	27°30'59.34"	95°28'3.79"
91	TP81	13940.69	22 ° 58 ' 24 "R	125.44	743747.9886	3046062.101	27°30'59.01"	95°28'3.7"
92	TP82	13953.72	19 ° 11 ' 21 "R	125.22	743740.4455	3046051.485	27°30'58.67"	95°28'3.42"
93	TP83	14081.12	8 ° 2 ' 49 "L	126.05	743636.6102	3045977.652	27°30'56.34"	95°27'59.58"
94	TP84	14170.97	14 ° 11 ' 27 "R	125.99	743571.398	3045915.85	27°30'54.38"	95°27'57.16"
95	TP85	14251.01	1 ° 43 ' 8 "R	125.92	743501.5791	3045876.715	27°30'53.15"	95°27'54.59"
96	TP86	14315.98	17 ° 38 ' 50 "L	125.74	743443.9771	3045846.663	27°30'52.22"	95°27'52.47"
97	TP87	14342.52	14 ° 10 ' 60 "L	125.69	743425.2757	3045827.831	27°30'51.62"	95°27'51.78"
98	IP87/1	14484.4	0 ° 0 ' 0 "	120.56	743353.0174	3045705.732	27°30'47.7"	95°27'49.06"
99	TP88	14718.88	1 ° 3 ' 32 "R	125.21	743233.5965	3045503.94	27°30'41.22"	95°27'44.56"
100	TP89	14844.35	20 ° 53 ' 28 "R	125.7	743167.7105	3045397.163	27°30'37.8"	95°27'42.09"
101	TP90	14902.56	3 ° 6 ' 59 "R	124.85	743121.4831	3045361.777	27°30'36.68"	95°27'40.38"
102	TP91	15099.66	1 ° 12 ' 15 "L	126.55	742958.693	3045250.661	27°30'33.18"	95°27'34.37"
103	IP91/1	15290.49	0 ° 0 ' 0 "	126.11	742803.3789	3045139.793	27°30'29.68"	95°27'28.63"
104	TP92	15481.53	0 ° 43 ' 20 "L	125.25	742647.8869	3045028.798	27°30'26.17"	95°27'22.89"
105	TP93	15541.58	20 ° 28 ' 47 "L	124.99	742599.4536	3044993.295	27°30'25.05"	95°27'21.1"
106	TP94	15558.18	10 ° 29 ' 37 "L	124.35	742590.3444	3044979.416	27°30'24.61"	95°27'20.76"
107	TP95	15727.28	22 ° 28 ' 5 "R	126.02	742524.8609	3044823.514	27°30'19.59"	95°27'18.26"
108	TP96	15937.9	1 ° 2 ' 40 "R	125.35	742375.2727	3044675.236	27°30'14.87"	95°27'12.71"
109	TP97	16164.9	8 ° 48 ' 39 "R	126.79	742211.1682	3044518.396	27°30'9.88"	95°27'6.62"
110	TP98	16280.98	0 ° 8 ' 54 "R	126.85	742115.9597	3044451.996	27°30'7.79"	95°27'3.11"
111	TP99	16533.53	0 ° 13 ' 26 "R	126.67	741908.4393	3044308.064	27°30'3.25"	95°26'55.45"
112	TP100	16796.38	0 ° 32 ' 42 "R	125.12	741691.8686	3044159.106	27°29'58.55"	95°26'47.45"
113	TP101	16931.6	28 ° 13 ' 57 "R	125.87	741579.731	3044083.539	27°29'56.17"	95°26'43.31"
114	TP102	17084.67	4 ° 45 ' 57 "L	125.19	741427.4295	3044068.221	27°29'55.77"	95°26'37.76"
115	TP103	17331.98	0 ° 54 ' 13 "L	125.16	741184.2697	3044023.116	27°29'54.46"	95°26'28.87"
116	TP104	17451.88	2 ° 43 ' 23 "L	125.48	741066.7455	3043999.393	27°29'53.77"	95°26'24.57"
117	TP105	17770.62	1 ° 33 ' 57 "R	124.62	740757.6498	3043921.55	27°29'51.44"	95°26'13.26"
118	IP105/1	17948	0 ° 0 ' 0 "	124.14	740584.5281	3043882.949	27°29'50.29"	95°26'6.93"
119	TP106	18120.12	0 ° 26 ' 4 "L	124.17	740416.5291	3043845.491	27°29'49.18"	95°26'0.79"
120	TP107	18310.09	8 ° 1 ' 4 "R	124.25	740231.4274	3043802.743	27°29'47.91"	95°25'54.02"
121	TP108	18393.17	20 ° 22 ' 40 "R	125.28	740148.6617	3043795.522	27°29'47.73"	95°25'51"
122	TP109	18661.94	19 ° 6 ' 40 "L	124.61	739889.5327	3043866.856	27°29'50.21"	95°25'41.61"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	RL (m)	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
					EASTING	NORTHING	LATITUDE	LONGITUDE
123	TP110	18683.11	11 ° 29 ' 47 "L	124.37	739868.4062	3043865.483	27°29'50.18"	95°25'40.84"
124	TP111	18740.85	6 ° 1 ' 12 "R	124.26	739812.6962	3043850.33	27°29'49.73"	95°25'38.8"
125	TP112	18856.04	13 ° 40 ' 24 "L	123.36	739698.9897	3043831.921	27°29'49.2"	95°25'34.65"
126	TP113	18956.88	6 ° 11 ' 7 "L	123.64	739606.0703	3043792.729	27°29'47.99"	95°25'31.24"
127	TP114	19093.76	1 ° 43 ' 15 "R	123.94	739486.4179	3043726.255	27°29'45.91"	95°25'26.83"
128	TP115	19199.11	7 ° 16 ' 54 "R	124.37	739392.8336	3043677.883	27°29'44.39"	95°25'23.39"
129	TP116	19348.85	15 ° 4 ' 2 "L	124.23	739252.1627	3043626.537	27°29'42.82"	95°25'18.23"
130	TP117	19379.2	18 ° 57 ' 19 "L	124.22	739227.3455	3043609.083	27°29'42.27"	95°25'17.32"
131	TP118	19507.37	5 ° 36 ' 44 "L	124.69	739152.1392	3043505.286	27°29'38.94"	95°25'14.5"
132	TP119	19600.83	33 ° 14 ' 41 "R	123.46	739104.9697	3043424.607	27°29'36.35"	95°25'12.73"
133	TP120	19624.14	30 ° 18 ' 29 "L	123.45	739106.162	3043401.325	27°29'35.6"	95°25'12.76"
134	TP121	19707.3	4 ° 21 ' 20 "L	123.72	739151.7471	3043331.77	27°29'33.31"	95°25'14.37"
135	IP121/1	19913.2	0 ° 0 ' 0 "	124.19	739277.3622	3043168.627	27°29'27.93"	95°25'18.83"
136	TP122	20115.12	21 ° 54 ' 5 "R	124.96	739400.5466	3043008.641	27°29'22.66"	95°25'23.2"
137	TP123	20176.64	17 ° 7 ' 44 "L	124.73	739417.1866	3042949.418	27°29'20.72"	95°25'23.76"
138	TP124	20435.89	19 ° 30 ' 10 "R	125.37	739410.6943	3042690.241	27°29'12.31"	95°25'23.34"
139	TP125	20509.77	25 ° 37 ' 29 "R	124.43	739384.2947	3042621.245	27°29'10.09"	95°25'22.33"
140	TP126	20635.96	7 ° 24 ' 51 "L	123.79	739394.6052	3042495.478	27°29'6"	95°25'22.62"
141	TP127	20693.57	30 ° 24 ' 40 "R	123.64	739391.8636	3042437.931	27°29'4.13"	95°25'22.47"
142	TP128	20771.19	1 ° 53 ' 15 "R	123.51	739349.4317	3042372.936	27°29'2.05"	95°25'20.88"
143	IP128/1	20962.38	0 ° 0 ' 0 "	123.09	739239.699	3042216.373	27°28'57.03"	95°25'16.78"
144	TP129	21152.72	30 ° 50 ' 11 "R	123.54	739130.4525	3042060.504	27°28'52.04"	95°25'12.69"
145	TP130	21183.69	4 ° 20 ' 46 "R	123.62	739102.189	3042047.839	27°28'51.65"	95°25'11.65"
146	TP131	21290.12	13 ° 23 ' 27 "R	122.74	739002.0444	3042011.802	27°28'50.54"	95°25'7.98"
147	TP132	21424.88	33 ° 6 ' 39 "R	124.05	738868.1313	3041996.78	27°28'50.14"	95°25'3.09"
148	TP133	21519.74	0 ° 32 ' 15 "R	122.61	738783.394	3042039.417	27°28'51.58"	95°25'0.04"
149	TP134	21615.5	36 ° 6 ' 17 "L	122.95	738698.2532	3042083.264	27°28'53.06"	95°24'56.97"
150	TP135	21715.39	10 ° 46 ' 5 "R	124.12	738599.5547	3042067.884	27°28'52.62"	95°24'53.37"
151	TP136	21763.33	15 ° 58 ' 4 "L	124.24	738551.6425	3042069.483	27°28'52.7"	95°24'51.62"
152	TP137	22048.13	9 ° 37 ' 29 "R	123.68	738275.3745	3042000.311	27°28'50.63"	95°24'41.51"
153	TP138	22193.34	6 ° 25 ' 41 "L	123.72	738130.597	3041989.09	27°28'50.36"	95°24'36.24"
154	TP139	22298.43	6 ° 17 ' 20 "R	123.45	738027.3865	3041969.289	27°28'49.78"	95°24'32.46"
155	TP140	22379.83	12 ° 21 ' 37 "L	123.46	737946.2482	3041962.802	27°28'49.62"	95°24'29.5"
156	TP141	22564.49	7 ° 52 ' 33 "L	122.84	737769.5901	3041909.024	27°28'47.99"	95°24'23.03"
157	TP142	22622.97	0 ° 46 ' 49 "L	122.85	737716.5072	3041884.488	27°28'47.22"	95°24'21.08"
158	IP142/1	22844.38	0 ° 0 ' 0 "	122.41	737516.8155	3041788.865	27°28'44.24"	95°24'13.75"
159	TP143	23065.09	2 ° 0 ' 4 "L	122.14	737317.7441	3041693.539	27°28'41.27"	95°24'6.43"
160	TP144	23222.18	5 ° 26 ' 42 "L	122.74	737178.5222	3041620.791	27°28'39"	95°24'1.31"
161	IP144/1	23464.09	0 ° 0 ' 0 "	121.7	736975.719	3041488.919	27°28'34.84"	95°23'53.84"
162	TP145	23703.98	0 ° 16 ' 49 "L	121.69	736774.6058	3041358.146	27°28'30.72"	95°23'46.42"
163	IP145/1	23893.61	0 ° 0 ' 0 "R	121.34	736616.1327	3041253.994	27°28'27.44"	95°23'40.58"
164	TP146	24064.5	7 ° 38 ' 44 "R	121.51	736473.3262	3041160.138	27°28'24.48"	95°23'35.31"
165	TP147	24223.03	0 ° 1 ' 48 "L	121.21	736330.4418	3041091.47	27°28'22.34"	95°23'30.06"
166	IP147/1	24390.33	0 ° 0 ' 0 "	120.87	736179.6875	3041018.922	27°28'20.08"	95°23'24.52"
167	TP148	24559.38	2 ° 18 ' 26 "R	121.57	736027.3579	3040945.616	27°28'17.8"	95°23'18.93"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	RL (m)	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
					EASTING	NORTHING	LATITUDE	LONGITUDE
168	IP148/1	24731.14	0 ° 0 ' 0 "	120.7	735869.7162	3040877.427	27°28'15.68"	95°23'13.14"
169	TP149	24905.19	0 ° 32 ' 47 "L	120.6	735709.972	3040808.328	27°28'13.54"	95°23'7.28"
170	TP150	25112.82	38 ° 17 ' 3 "L	120.65	735520.1974	3040724.082	27°28'10.92"	95°23'0.31"
171	TP151	25277.23	3 ° 39 ' 50 "L	120.71	735443.5746	3040578.621	27°28'6.25"	95°22'57.42"
172	TP152	25465.34	6 ° 14 ' 41 "R	120.55	735366.7186	3040406.923	27°28'0.72"	95°22'54.5"
173	TP153	25721.03	12 ° 21 ' 58 "L	121.72	735237.4922	3040186.302	27°27'53.63"	95°22'49.64"
174	TP154	25804.43	6 ° 43 ' 48 "R	120.9	735211.7292	3040106.978	27°27'51.07"	95°22'48.65"
175	TP155	25894.57	11 ° 7 ' 51 "L	120.06	735174.0275	3040025.095	27°27'48.44"	95°22'47.22"
176	TP156	25964.06	2 ° 3 ' 54 "L	120.43	735157.6967	3039957.551	27°27'46.26"	95°22'46.58"
177	TP157	26020.57	9 ° 50 ' 22 "R	120.23	735146.4047	3039902.183	27°27'44.47"	95°22'46.13"
178	TP158	26029.16	25 ° 10 ' 30 "R	120.23	735143.2749	3039894.183	27°27'44.21"	95°22'46.01"
179	TP159	26043.96	14 ° 27 ' 44 "R	120.14	735132.536	3039884.007	27°27'43.88"	95°22'45.61"
180	TP160	26230.42	19 ° 19 ' 55 "R	119.6	734969.4472	3039793.62	27°27'41.05"	95°22'39.61"
181	TP161	26381.68	10 ° 1 ' 51 "L	119.91	734820.3341	3039768.228	27°27'40.32"	95°22'34.16"
182	TP162	26418.35	3 ° 1 ' 11 "L	120.73	734785.8017	3039755.868	27°27'39.94"	95°22'32.9"
183	TP163	26461.56	9 ° 6 ' 53 "L	120.37	734745.9434	3039739.183	27°27'39.42"	95°22'31.44"
184	TP164	26557.18	6 ° 8 ' 28 "R	120.19	734664.7027	3039688.755	27°27'37.83"	95°22'28.44"
185	TP165	26775.56	33 ° 54 ' 32 "R	119.37	734467.9092	3039594.096	27°27'34.88"	95°22'21.21"
186	TP166	26825.53	4 ° 35 ' 15 "R	119.32	734418.4471	3039601.242	27°27'35.15"	95°22'19.42"
187	TP167	26994.87	5 ° 59 ' 47 "R	119.24	734253.324	3039638.784	27°27'36.47"	95°22'13.43"
188	TP168	27100.68	1 ° 27 ' 41 "R	119.53	734153.1668	3039672.891	27°27'37.64"	95°22'9.81"
189	TP169	27205.54	50 ° 8 ' 17 "L	119.57	734054.7968	3039709.214	27°27'38.88"	95°22'6.25"
190	TP170	27303.31	2 ° 39 ' 51 "R	119.92	733970.011	3039660.517	27°27'37.35"	95°22'3.13"
191	TP171	27384.27	12 ° 55 ' 56 ""Ø	120.73	733898.0165	3039623.505	27°27'36.19"	95°22'0.49"
192	TP172	27445.48	4 ° 28 ' 29 ""Ø	121.6	733838.6953	3039608.412	27°27'35.74"	95°21'58.32"
193	TP173	27583.1	18 ° 17 ' 60 "R	121.02	733703.0834	3039584.988	27°27'35.06"	95°21'53.36"
194	TP174	27683.7	48 ° 19 ' 27 "L	120.78	733603.5814	3039599.858	27°27'35.61"	95°21'49.75"
195	TP175	27766.27	11 ° 33 ' 12 "L	120.3	733540.1698	3039546.979	27°27'33.93"	95°21'47.41"
196	TP176	27881.13	15 ° 3 ' 21 "L	118.85	733468.4779	3039457.243	27°27'31.06"	95°21'44.74"
197	TP177	27950.58	4 ° 23 ' 28 "L	118.3	733440.7103	3039393.584	27°27'29.01"	95°21'43.68"
198	TP178	28054.45	2 ° 51 ' 18 "L	118.71	733406.5918	3039295.473	27°27'25.84"	95°21'42.37"
199	TP179	28113.94	2 ° 52 ' 36 "L	119.18	733389.8745	3039238.379	27°27'24"	95°21'41.72"
200	TP180	28190.19	12 ° 45 ' 28 "L	117.88	733372.1491	3039164.227	27°27'21.6"	95°21'41.03"
201	TP181	28334.46	0 ° 4 ' 50 "R	117.13	733370.4221	3039019.96	27°27'16.92"	95°21'40.86"
202	IP181/1	28515.26	0 ° 0 ' 0 "	120.3	733368.0037	3038839.178	27°27'11.05"	95°21'40.65"
203	TP182	28696.41	0 ° 9 ' 20 "L	120.56	733365.5807	3038658.046	27°27'5.17"	95°21'40.44"
204	IP182/1	28865.22	0 ° 0 ' 0 "L	121.25	733363.781	3038489.244	27°26'59.69"	95°21'40.25"
205	TP183	29035.07	18 ° 56 ' 17 "R	120.88	733361.9702	3038319.4	27°26'54.18"	95°21'40.07"
206	TP184	29124.51	5 ° 31 ' 29 "L	120.58	733332.0444	3038235.121	27°26'51.46"	95°21'38.92"
207	TP185	29296.92	1 ° 17 ' 1 "L	120.69	733290.2629	3038067.846	27°26'46.05"	95°21'37.29"
208	TP186	29454.42	0 ° 4 ' 45 "L	120.62	733255.5288	3037914.226	27°26'41.08"	95°21'35.92"
209	TP187	29527.77	3 ° 38 ' 41 "R	121.2	733239.451	3037842.658	27°26'38.77"	95°21'35.28"
210	TP188	29555.63	9 ° 54 ' 42 "R	121.46	733231.6287	3037815.918	27°26'37.91"	95°21'34.98"
211	IP188/1	29734.88	0 ° 0 ' 0 "L	121.21	733152.4402	3037655.11	27°26'32.73"	95°21'31.99"
212	TP189	29911.66	0 ° 12 ' 53 "R	121.3	733074.3441	3037496.521	27°26'27.63"	95°21'29.03"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	RL (m)	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
					EASTING	NORTHING	LATITUDE	LONGITUDE
213	TP190	30046.85	53 ° 26 ' 39 "R	122.17	733014.1628	3037375.457	27°26'23.74"	95°21'26.76"
214	TP191	30218.23	7 ° 39 ' 20 "R	121.5	733092.0001	3037222.773	27°26'18.73"	95°21'29.49"
215	TP192	30239.99	32 ° 30 ' 43 "L	121.05	733099.2116	3037202.245	27°26'18.06"	95°21'29.74"
216	TP193	30464.58	6 ° 36 ' 27 "L	121.02	733048.0979	3036983.554	27°26'10.99"	95°21'27.72"
217	TP194	30550.15	15 ° 41 ' 55 "R	120.88	733038.3397	3036898.541	27°26'8.24"	95°21'27.31"
218	TP195	30739.56	6 ° 25 ' 33 "L	121.04	732966.6316	3036723.232	27°26'2.59"	95°21'24.58"
219	TP196	30902.76	0 ° 32 ' 50 "L	120.82	732922.1384	3036566.213	27°25'57.52"	95°21'22.85"
220	TP197	31080.82	7 ° 6 ' 28 "L	120.96	732875.2318	3036394.44	27°25'51.97"	95°21'21.03"
221	TP198	31167.78	1 ° 24 ' 44 "R	120.7	732862.88	3036308.36	27°25'49.18"	95°21'20.52"
222	TP199	31377.28	14 ° 44 ' 2 "R	121.27	732828.0217	3036101.784	27°25'42.49"	95°21'19.11"
223	IP199/1	31573.81	0 ° 0 ' 0 "R	121.37	732747.109	3035922.681	27°25'36.73"	95°21'16.04"
224	TP200	31768.14	2 ° 2 ' 45 "L	122.41	732667.1026	3035745.584	27°25'31.03"	95°21'13"
225	TP201	31888.97	19 ° 0 ' 38 "R	122.26	732621.3171	3035633.759	27°25'27.42"	95°21'11.26"
226	TP202	32043.61	17 ° 3 ' 33 "L	121.99	732519.3021	3035517.543	27°25'23.71"	95°21'7.47"
227	TP203	32103.47	0 ° 52 ' 21 "L	122.43	732494.7501	3035462.957	27°25'21.95"	95°21'6.54"
228	TP204	32159.71	6 ° 28 ' 20 "L	121.54	732472.4619	3035411.316	27°25'20.29"	95°21'5.69"
229	TP205	32324.63	1 ° 51 ' 53 "R	120.89	732424.5951	3035253.498	27°25'15.19"	95°21'3.84"
230	TP206	32653.4	29 ° 33 ' 18 "R	120.91	732318.9833	3034942.15	27°25'5.15"	95°20'59.78"
231	TP207	32665.16	7 ° 38 ' 19 "R	120.93	732310.2018	3034934.324	27°25'4.9"	95°20'59.46"
232	TP208	32711.37	4 ° 25 ' 19 "R	120.95	732271.9281	3034908.441	27°25'4.08"	95°20'58.05"
233	TP209	32755.53	17 ° 6 ' 27 "L	120.81	732233.5489	3034886.597	27°25'3.4"	95°20'56.64"
234	TP210	32885.35	18 ° 28 ' 29 "L	120.8	732144.6075	3034792.036	27°25'0.38"	95°20'53.33"
235	TP211	32935.04	3 ° 16 ' 26 "L	121.54	732123.7872	3034746.917	27°24'58.93"	95°20'52.55"
236	TP212	32950.6	17 ° 33 ' 17 "R	121.13	732118.0833	3034732.435	27°24'58.46"	95°20'52.33"
237	TP213	32960.54	27 ° 55 ' 29 "R	120.75	732111.819	3034724.713	27°24'58.22"	95°20'52.09"
238	TP214	33023.72	23 ° 1 ' 34 "L	120.53	732053.6788	3034700.007	27°24'57.45"	95°20'49.96"
239	IP214/1	33201.61	0 ° 0 ' 0 "	120.07	731930.2154	3034571.936	27°24'53.37"	95°20'45.38"
240	TP215	33381.72	15 ° 10 ' 5 "L	119.91	731805.2103	3034442.266	27°24'49.23"	95°20'40.74"
241	TP216	33408.72	46 ° 8 ' 35 "R	119.63	731792.2109	3034418.603	27°24'48.47"	95°20'40.25"
242	TP217	33494.02	2 ° 43 ' 13 "R	120.67	731817.664	3034337.186	27°24'45.81"	95°20'41.12"
243	TP218	33608.32	4 ° 26 ' 50 "R	121.54	731846.5528	3034226.597	27°24'42.2"	95°20'42.1"
244	TP219	33726.79	0 ° 6 ' 35 "L	120.67	731867.5177	3034109.998	27°24'38.4"	95°20'42.78"
245	TP220	33881.85	1 ° 0 ' 34 "L	119.69	731895.2512	3033957.434	27°24'33.43"	95°20'43.69"
246	TP221	33967.06	1 ° 20 ' 15 "R	119.91	731911.9653	3033873.882	27°24'30.71"	95°20'44.24"
247	TP222	34122.71	17 ° 52 ' 6 "L	120.59	731938.9263	3033720.586	27°24'25.71"	95°20'45.11"
248	TP223	34144.83	23 ° 18 ' 24 "L	120.71	731949.2554	3033701.031	27°24'25.07"	95°20'45.48"
249	TP224	34329.11	42 ° 8 ' 3 "R	119.85	732092.7759	3033585.431	27°24'21.23"	95°20'50.62"
250	TP225	34394.05	20 ° 13 ' 45 "L	120.29	732102.9524	3033521.292	27°24'19.14"	95°20'50.95"
251	TP226	34505.43	20 ° 45 ' 55 "R	120.02	732081.2937	3033412.044	27°24'15.61"	95°20'50.08"
252	TP227	34769.46	19 ° 28 ' 26 "L	120.18	732125.1052	3033151.678	27°24'7.13"	95°20'51.5"
253	TP228	34911.62	6 ° 1 ' 16 "L	119.79	732100.6089	3033011.641	27°24'2.59"	95°20'50.51"
254	TP229	34976.53	18 ° 34 ' 39 "R	119.54	732096.1928	3032946.879	27°24'0.49"	95°20'50.31"
255	TP230	35118.5	37 ° 29 ' 40 "L	119.8	732132.1613	3032809.546	27°23'56.01"	95°20'51.52"
256	TP231	35295.18	12 ° 36 ' 2 "R	119.52	732063.6433	3032646.691	27°23'50.76"	95°20'48.92"
257	TP232	35466.05	3 ° 11 ' 39 "L	119.69	731964.6134	3032507.438	27°23'46.3"	95°20'45.22"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	RL (m)	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
					EASTING	NORTHING	LATITUDE	LONGITUDE
258	TP233	35680.38	1 ° 59 ' 54 "L	119.22	731850.3286	3032326.128	27°23'40.49"	95°20'40.93"
259	TP234	35827.3	8 ° 47 ' 30 "R	118.67	731776.3648	3032199.178	27°23'36.41"	95°20'38.16"
260	IP234/1	35933.29	0 ° 0 ' 0 "	118.36	731709.6383	3032116.83	27°23'33.78"	95°20'35.67"
261	TP235	36160.23	2 ° 42 ' 1 "L	118.73	731566.7633	3031940.506	27°23'28.14"	95°20'30.35"
262	TP236	36444.8	11 ° 4 ' 19 "R	119.13	731398.2248	3031711.216	27°23'20.79"	95°20'24.07"
263	TP237	36671.31	1 ° 13 ' 32 "L	118.54	731231.5188	3031557.866	27°23'15.92"	95°20'17.9"
264	TP238	36810.46	0 ° 17 ' 21 "L	118.93	731131.145	3031461.489	27°23'12.85"	95°20'14.18"
265	TP239	36967.3	9 ° 27 ' 21 "L	118.86	731018.565	3031352.296	27°23'9.37"	95°20'10.01"
266	TP240	37044.64	26 ° 11 ' 26 "R	119.73	730972.6498	3031290.061	27°23'7.38"	95°20'8.3"
267	TP241	37079.45	2 ° 33 ' 28 "R	119.71	730941.746	3031274.048	27°23'6.88"	95°20'7.16"
268	TP242	37111.59	47 ° 36 ' 32 "L	119.5	730912.5771	3031260.55	27°23'6.46"	95°20'6.09"
269	TP243	37135.74	7 ° 49 ' 17 "L	119.44	730905.2914	3031237.524	27°23'5.71"	95°20'5.81"
270	TP244	37363.21	1 ° 25 ' 9 "L	119.95	730866.8213	3031013.333	27°22'58.46"	95°20'4.26"
271	TP245	37435.02	1 ° 23 ' 12 "R	120.09	730856.4324	3030942.273	27°22'56.15"	95°20'3.83"
272	TP246	37653.7	11 ° 15 ' 31 "R	119.55	730819.5715	3030726.725	27°22'49.18"	95°20'2.34"
273	TP247	37746.98	87 ° 4 ' 24 "L	119.3	730822.1018	3030633.476	27°22'46.15"	95°20'2.37"
274	TP248	37766.57	77 ° 48 ' 51 "L	119.42	730841.6837	3030633.007	27°22'46.12"	95°20'3.08"

2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
				EASTING	NORTHING	LATITUDE	LONGITUDE
1	TP0	0	0 ° 0 ' 0 "	739398.5499	3042570.312	27°29'8.43"	95°25'22.81"
2	TP1	95.15	6 ° 24 ' 31 "L	739404.659	3042475.355	27°29'5.34"	95°25'22.97"
3	TP2	136.13	30 ° 24 ' 39 "R	739402.7088	3042434.421	27°29'4.01"	95°25'22.87"
4	TP3	216.92	1 ° 53 ' 15 "R	739358.5435	3042366.771	27°29'1.84"	95°25'21.21"
5	TP4	601.67	30 ° 50 ' 11 "R	739137.7191	3042051.706	27°28'51.75"	95°25'12.95"
6	TP5	636.09	4 ° 20 ' 46 "R	739106.3063	3042037.63	27°28'51.31"	95°25'11.79"
7	TP6	744.23	13 ° 23 ' 27 "R	739004.5539	3042001.014	27°28'50.19"	95°25'8.06"
8	TP7	883.55	33 ° 6 ' 39 "R	738866.1081	3041985.484	27°28'49.77"	95°25'3.01"
9	TP8	1024.71	0 ° 58 ' 27 "R	738740.0113	3042048.932	27°28'51.91"	95°24'58.47"
10	TP9	1074	36 ° 32 ' 29 "L	738696.3585	3042071.836	27°28'52.69"	95°24'56.89"
11	TP10	1171.3	10 ° 46 ' 5 "R	738600.224	3042056.855	27°28'52.26"	95°24'53.38"
12	TP11	1218.73	15 ° 58 ' 4 "L	738552.8176	3042058.437	27°28'52.34"	95°24'51.66"
13	TP12	1502.91	9 ° 37 ' 29 "R	738277.1478	3041989.415	27°28'50.27"	95°24'41.57"
14	TP13	1648.43	6 ° 25 ' 40 "L	738132.0629	3041978.17	27°28'50"	95°24'36.28"
15	TP14	1753.53	6 ° 27 ' 59 "R	738028.8487	3041958.369	27°28'49.42"	95°24'32.51"
16	TP15	1833.2	12 ° 43 ' 40 "L	737949.4072	3041952.265	27°28'49.28"	95°24'29.61"
17	TP16	2016.97	7 ° 4 ' 24 "L	737773.7856	3041898.166	27°28'47.63"	95°24'23.18"
18	TP17	2074.65	1 ° 18 ' 46 "L	737721.1735	3041874.527	27°28'46.9"	95°24'21.25"
19	TP18	2476.52	1 ° 24 ' 10 "L	737358.4733	3041701.471	27°28'41.5"	95°24'7.92"
20	TP19	2681.45	7 ° 5 ' 48 "L	737175.728	3041608.718	27°28'38.61"	95°24'1.2"
21	TP20	2774.27	0 ° 43 ' 11 "R	737098.781	3041556.803	27°28'36.97"	95°23'58.36"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
				EASTING	NORTHING	LATITUDE	LONGITUDE
22	TP21	2816.91	0 ° 21 ' 55 "R	737063.142	3041533.404	27°28'36.23"	95°23'57.05"
23	TP22	2927.39	0 ° 52 ' 23 "L	736970.401	3041473.357	27°28'34.34"	95°23'53.63"
24	TP23	2969.06	0 ° 16 ' 59 "L	736935.776	3041450.182	27°28'33.61"	95°23'52.35"
25	TP24	3051.37	1 ° 50 ' 18 "R	736867.595	3041404.058	27°28'32.16"	95°23'49.84"
26	TP25	3157.32	1 ° 47 ' 52 "L	736777.981	3041347.538	27°28'30.38"	95°23'46.54"
27	TP26	3254.72	0 ° 10 ' 45 "L	736697.272	3041293.022	27°28'28.66"	95°23'43.56"
28	TP27	3350.34	0 ° 32 ' 33 "R	736618.202	3041239.252	27°28'26.96"	95°23'40.64"
29	TP28	3452.27	3 ° 24 ' 26 "R	736533.376	3041182.735	27°28'25.18"	95°23'37.52"
30	TP29	3501.76	2 ° 12 ' 20 "R	736490.63	3041157.789	27°28'24.4"	95°23'35.94"
31	TP30	3547.49	2 ° 2 ' 24 "R	736450.275	3041136.276	27°28'23.72"	95°23'34.46"
32	TP31	3626.71	0 ° 23 ' 52 "R	736379.09	3041101.523	27°28'22.64"	95°23'31.84"
33	TP32	3678.27	2 ° 49 ' 13 "L	736332.603	3041079.226	27°28'21.94"	95°23'30.13"
34	TP33	3724.86	2 ° 0 ' 26 "R	736291.636	3041057.034	27°28'21.25"	95°23'28.63"
35	TP34	3817.93	0 ° 24 ' 2 "R	736208.292	3041015.594	27°28'19.96"	95°23'25.56"
36	TP35	3890.85	0 ° 21 ' 29 "L	736142.781	3040983.59	27°28'18.96"	95°23'23.16"
37	TP36	3944.46	3 ° 6 ' 40 "R	736094.759	3040959.757	27°28'18.21"	95°23'21.39"
38	TP37	4020.57	0 ° 56 ' 50 "R	736024.846	3040929.671	27°28'17.28"	95°23'18.82"
39	TP38	4147.46	0 ° 52 ' 2 "L	735907.475	3040881.446	27°28'15.79"	95°23'14.52"
40	TP39	4325.84	2 ° 8 ' 31 "R	735743.52	3040811.162	27°28'13.61"	95°23'8.5"
41	TP40	4355.13	1 ° 55 ' 11 "L	735716.187	3040800.636	27°28'13.28"	95°23'7.5"
42	TP41	4375.7	2 ° 43 ' 47 "L	735697.255	3040792.607	27°28'13.04"	95°23'6.8"
43	TP42	4436.53	1 ° 44 ' 60 "R	735642.446	3040766.216	27°28'12.21"	95°23'4.79"
44	TP43	4559.35	36 ° 55 ' 11 "L	735530.2071	3040716.335	27°28'10.66"	95°23'0.67"
45	TP44	4596.28	0 ° 0 ' 26 "L	735512.237	3040684.074	27°28'9.63"	95°22'59.99"
46	TP45	4638.26	0 ° 29 ' 50 "L	735491.814	3040647.399	27°28'8.45"	95°22'59.22"
47	TP46	4690.86	0 ° 4 ' 41 "L	735466.621	3040601.22	27°28'6.96"	95°22'58.27"
48	TP47	4718.72	3 ° 1 ' 33 "L	735453.314	3040576.749	27°28'6.18"	95°22'57.77"
50	TP48	4777.79	1 ° 39 ' 8 "L	735427.874	3040523.439	27°28'4.46"	95°22'56.81"
51	TP49	4833.27	0 ° 14 ' 13 "R	735405.433	3040472.699	27°28'2.83"	95°22'55.95"
52	TP50	4909.4	5 ° 7 ' 35 "R	735374.3532	3040403.205	27°28'0.59"	95°22'54.77"
53	TP51	5051.03	3 ° 23 ' 10 "R	735305.207	3040279.594	27°27'56.62"	95°22'52.17"
54	TP52	5115.75	7 ° 56 ' 33 "L	735270.3342	3040225.082	27°27'54.87"	95°22'50.86"
55	TP53	5172.29	6 ° 7 ' 50 "L	735246.7377	3040173.699	27°27'53.22"	95°22'49.97"
56	TP54	5244.88	19 ° 49 ' 0 "R	735223.661	3040104.871	27°27'51"	95°22'49.08"
57	TP55	5265.84	16 ° 49 ' 27 "L	735210.654	3040088.432	27°27'50.47"	95°22'48.6"
58	TP56	5337.37	7 ° 12 ' 44 "L	735184.4081	3040021.898	27°27'48.33"	95°22'47.59"
59	TP57	5396.23	5 ° 31 ' 50 "L	735169.8524	3039964.859	27°27'46.49"	95°22'47.02"
60	TP58	5459.98	0 ° 40 ' 38 "R	735160.117	3039901.864	27°27'44.45"	95°22'46.63"
61	TP59	5474.71	52 ° 52 ' 33 "R	735157.695	3039887.332	27°27'43.98"	95°22'46.53"
62	TP60	5486.95	2 ° 35 ' 49 "L	735146.851	3039881.648	27°27'43.8"	95°22'46.13"
63	TP61	5657.27	2 ° 50 ' 27 "R	734999.735	3039795.823	27°27'41.1"	95°22'40.71"
64	TP62	5686.18	16 ° 37 ' 58 "R	734974.0749	3039782.512	27°27'40.69"	95°22'39.77"
65	TP63	5718.39	1 ° 40 ' 28 "R	734942.4306	3039776.484	27°27'40.51"	95°22'38.61"
66	TP64	5832.59	9 ° 27 ' 8 "L	734829.6711	3039758.401	27°27'39.99"	95°22'34.5"
67	TP65	5875.26	4 ° 3 ' 44 "L	734789.226	3039744.819	27°27'39.58"	95°22'33.01"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
				EASTING	NORTHING	LATITUDE	LONGITUDE
68	TP66	5916.8	10 ° 0 ' 27 "L	734750.8834	3039728.839	27°27'39.08"	95°22'31.61"
69	TP67	5966.98	3 ° 47 ' 20 "R	734708.6215	3039701.778	27°27'38.23"	95°22'30.05"
70	TP68	6029.39	4 ° 11 ' 43 "R	734653.9579	3039671.672	27°27'37.29"	95°22'28.04"
71	TP69	6103.62	1 ° 9 ' 25 "L	734586.486	3039640.712	27°27'36.32"	95°22'25.56"
72	TP70	6236.03	31 ° 23 ' 36 "R	734467.281	3039583.073	27°27'34.53"	95°22'21.18"
73	TP71	6255.78	4 ° 16 ' 32 "R	734447.626	3039584.996	27°27'34.6"	95°22'20.47"
74	TP72	6287.44	2 ° 35 ' 1 "R	734416.438	3039590.419	27°27'34.8"	95°22'19.34"
75	TP73	6457.74	7 ° 7 ' 4 "R	734250.1393	3039627.126	27°27'36.09"	95°22'13.31"
76	TP74	6562.37	0 ° 2 ' 59 "L	734151.55	3039662.164	27°27'37.29"	95°22'9.74"
77	TP75	6664.39	47 ° 7 ' 46 "L	734055.3932	3039696.244	27°27'38.46"	95°22'6.27"
78	TP76	6757.81	0 ° 41 ' 47 "R	733972.611	3039652.941	27°27'37.1"	95°22'3.22"
79	TP77	6851.95	14 ° 19 ' 13 "R	733888.6708	3039610.324	27°27'35.77"	95°22'0.14"
80	TP78	6897.22	2 ° 17 ' 27 "R	733844.488	3039600.45	27°27'35.48"	95°21'58.52"
81	TP79	7030.68	16 ° 8 ' 3 "R	733713.1794	3039576.572	27°27'34.78"	95°21'53.73"
82	TP80	7080.86	1 ° 32 ' 25 "R	733663.263	3039581.667	27°27'34.98"	95°21'51.91"
83	TP81	7138.5	48 ° 42 ' 56 "L	733606.0972	3039589.059	27°27'35.25"	95°21'49.84"
84	TP82	7152.29	2 ° 8 ' 15 "R	733595.749	3039579.953	27°27'34.97"	95°21'49.45"
85	TP83	7211.52	11 ° 52 ' 30 "L	733549.853	3039542.508	27°27'33.78"	95°21'47.76"
86	TP84	7329.31	13 ° 58 ' 34 "L	733475.86	3039450.857	27°27'30.85"	95°21'45"
87	TP85	7374.16	6 ° 8 ' 2 "L	733456.9493	3039410.19	27°27'29.54"	95°21'44.28"
88	TP86	7499.14	3 ° 2 ' 34 "L	733416.662	3039291.881	27°27'25.72"	95°21'42.74"
89	TP87	7576.08	2 ° 19 ' 38 "L	733395.761	3039217.832	27°27'23.33"	95°21'41.92"
90	TP88	7633.33	12 ° 47 ' 11 "L	733382.4594	3039162.148	27°27'21.53"	95°21'41.4"
91	TP89	7824.23	0 ° 10 ' 47 "R	733380.299	3038971.263	27°27'15.33"	95°21'41.19"
92	TP90	7957.85	0 ° 21 ' 5 "L	733378.368	3038837.661	27°27'11"	95°21'41.03"
93	TP91	8091.72	0 ° 47 ' 30 "R	733377.254	3038703.792	27°27'6.65"	95°21'40.89"
94	TP92	8152.66	1 ° 13 ' 8 "L	733375.905	3038642.87	27°27'4.67"	95°21'40.8"
95	TP93	8229.87	1 ° 4 ' 12 "R	733375.838	3038565.658	27°27'2.16"	95°21'40.75"
96	TP94	8330.03	0 ° 47 ' 11 "L	733373.881	3038465.518	27°26'58.91"	95°21'40.61"
97	TP95	8423.26	0 ° 16 ' 3 "L	733373.339	3038372.287	27°26'55.89"	95°21'40.52"
98	TP96	8466.46	17 ° 14 ' 34 "R	733373.2896	3038329.085	27°26'54.48"	95°21'40.49"
99	TP97	8564.6	3 ° 41 ' 31 "L	733344.093	3038235.394	27°26'51.46"	95°21'39.36"
100	TP98	8606.23	1 ° 2 ' 51 "R	733334.291	3038194.928	27°26'50.15"	95°21'38.98"
101	TP99	8672.62	0 ° 14 ' 23 "L	733317.485	3038130.702	27°26'48.08"	95°21'38.32"
102	TP100	8739.08	1 ° 51 ' 6 "L	733300.93	3038066.337	27°26'46"	95°21'37.67"
103	TP101	8900.94	1 ° 0 ' 48 "L	733265.699	3037908.364	27°26'40.89"	95°21'36.28"
104	TP102	8916.5	0 ° 2 ' 43 "R	733262.58	3037893.114	27°26'40.4"	95°21'36.16"
105	TP103	8970.54	7 ° 22 ' 27 "R	733251.71	3037840.179	27°26'38.68"	95°21'35.73"
106	TP104	9005.39	7 ° 25 ' 38 "R	733240.376	3037807.222	27°26'37.62"	95°21'35.29"
107	TP105	9235.09	0 ° 24 ' 40 "L	733138.224	3037601.486	27°26'31"	95°21'31.43"
108	TP106	9358.76	1 ° 27 ' 39 "R	733084.024	3037490.331	27°26'27.43"	95°21'29.38"
109	TP107	9371.51	0 ° 26 ' 33 "L	733078.143	3037479.012	27°26'27.06"	95°21'29.16"
110	TP108	9415.89	0 ° 4 ' 55 "L	733057.99	3037439.481	27°26'25.79"	95°21'28.4"
111	TP109	9477.51	5 ° 2 ' 12 "L	733030.0806	3037384.541	27°26'24.02"	95°21'27.35"
112	TP110	9486.17	34 ° 48 ' 28 "R	733026.849	3037376.5	27°26'23.76"	95°21'27.22"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
				EASTING	NORTHING	LATITUDE	LONGITUDE
113	TP111	9491.32	13 ° 37 ' 49 "L	733028	3037371.48	27°26'23.6"	95°21'27.26"
114	TP112	9656.91	5 ° 30 ' 10 "R	733101.999	3037223.346	27°26'18.74"	95°21'29.85"
115	TP113	9672.98	3 ° 31 ' 29 "L	733107.769	3037208.347	27°26'18.25"	95°21'30.05"
116	TP114	9680.24	34 ° 9 ' 36 "L	733110.786	3037201.747	27°26'18.04"	95°21'30.16"
117	TP115	9695.34	2 ° 32 ' 2 "R	733108.27	3037186.862	27°26'17.56"	95°21'30.05"
118	TP116	9769.46	2 ° 15 ' 48 "R	733092.698	3037114.398	27°26'15.21"	95°21'29.44"
119	TP117	9908	7 ° 43 ' 53 "L	733058.264	3036980.203	27°26'10.88"	95°21'28.09"
120	TP118	9998.3	16 ° 19 ' 1 "R	733047.791	3036890.51	27°26'7.97"	95°21'27.65"
121	TP119	10168.07	5 ° 18 ' 4 "L	732981.5204	3036734.211	27°26'2.94"	95°21'25.13"
122	TP120	10192.79	1 ° 21 ' 51 "L	732974.013	3036710.653	27°26'2.18"	95°21'24.84"
123	TP121	10280.12	0 ° 1 ' 6 "L	732949.485	3036626.838	27°25'59.47"	95°21'23.89"
124	TP122	10343.27	0 ° 34 ' 48 "L	732931.769	3036566.229	27°25'57.51"	95°21'23.2"
125	TP123	10512.3	7 ° 28 ' 3 "L	732885.991	3036403.519	27°25'52.26"	95°21'21.42"
126	TP124	10607.7	0 ° 25 ' 53 "R	732872.308	3036309.106	27°25'49.2"	95°21'20.86"
127	TP125	10685.99	0 ° 35 ' 36 "R	732860.495	3036231.705	27°25'46.69"	95°21'20.38"
128	TP126	10824.33	15 ° 13 ' 51 "R	732838.209	3036095.175	27°25'42.27"	95°21'19.47"
129	TP127	10860.76	0 ° 22 ' 25 "R	732823.099	3036062.022	27°25'41.2"	95°21'18.9"
130	TP128	10957.45	0 ° 56 ' 34 "L	732782.427	3035974.302	27°25'38.38"	95°21'17.36"
131	TP129	11128.75	0 ° 55 ' 37 "R	732712.939	3035817.733	27°25'33.34"	95°21'14.72"
132	TP130	11213.21	2 ° 15 ' 54 "L	732677.4329	3035741.1	27°25'30.87"	95°21'13.38"
133	TP131	11338.32	19 ° 7 ' 21 "R	732629.3634	3035625.589	27°25'27.15"	95°21'11.55"
134	TP132	11452.84	3 ° 4 ' 6 "L	732553.158	3035540.109	27°25'24.42"	95°21'8.72"
135	TP133	11493.5	12 ° 42 ' 32 "L	732527.7617	3035508.351	27°25'23.41"	95°21'7.77"
136	TP134	11548.34	2 ° 14 ' 34 "L	732503.7762	3035459.042	27°25'21.82"	95°21'6.86"
137	TP135	11576.82	3 ° 17 ' 54 "L	732492.3272	3035432.956	27°25'20.98"	95°21'6.43"
138	TP136	11607.59	3 ° 41 ' 34 "L	732481.602	3035404.115	27°25'20.05"	95°21'6.02"
139	TP137	11654.66	0 ° 32 ' 10 "R	732468.073	3035359.037	27°25'18.6"	95°21'5.5"
140	TP138	11768.78	1 ° 19 ' 40 "R	732434.248	3035250.049	27°25'15.08"	95°21'4.19"
141	TP139	11889.66	0 ° 20 ' 10 "L	732395.75	3035135.454	27°25'11.38"	95°21'2.71"
142	TP140	11983.35	0 ° 24 ' 51 "R	732366.435	3035046.468	27°25'8.51"	95°21'1.58"
143	TP141	12099.34	37 ° 15 ' 18 "R	732329.3488	3034936.572	27°25'4.96"	95°21'0.16"
144	TP142	12161.15	2 ° 18 ' 22 "R	732278.165	3034901.922	27°25'3.87"	95°20'58.27"
145	TP143	12205.99	10 ° 22 ' 9 "L	732240.047	3034878.296	27°25'3.12"	95°20'56.87"
146	TP144	12221.65	5 ° 27 ' 18 "L	732228.441	3034867.787	27°25'2.79"	95°20'56.44"
147	TP145	12332.5	18 ° 28 ' 31 "L	732153.7193	3034785.913	27°25'0.18"	95°20'53.66"
148	TP146	12396.86	9 ° 54 ' 44 "R	732127.6343	3034727.075	27°24'58.28"	95°20'52.67"
149	TP147	12407.28	18 ° 28 ' 2 "R	732121.8355	3034718.42	27°24'58.01"	95°20'52.46"
150	TP148	12413.59	15 ° 7 ' 37 "R	732116.8387	3034714.557	27°24'57.88"	95°20'52.27"
151	TP149	12473.46	22 ° 45 ' 41 "L	732061.564	3034691.566	27°24'57.17"	95°20'50.24"
152	TP150	12535.86	0 ° 4 ' 46 "R	732017.709	3034647.179	27°24'55.76"	95°20'48.62"
153	TP151	12624.05	0 ° 6 ' 13 "R	731955.635	3034584.526	27°24'53.76"	95°20'46.32"
154	TP152	12656.72	3 ° 7 ' 8 "L	731932.599	3034561.359	27°24'53.02"	95°20'45.46"
155	TP153	12699.54	2 ° 19 ' 57 "R	731904.105	3034529.399	27°24'52"	95°20'44.4"
156	TP154	12737.24	0 ° 31 ' 9 "L	731877.893	3034502.304	27°24'51.14"	95°20'43.43"
157	TP155	12781.75	0 ° 39 ' 24 "R	731847.236	3034470.034	27°24'50.11"	95°20'42.29"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
				EASTING	NORTHING	LATITUDE	LONGITUDE
158	TP156	12830.46	15 ° 44 ' 54 "L	731813.283	3034435.105	27°24'48.99"	95°20'41.03"
159	TP157	12851.85	45 ° 21 ' 0 "R	731803.0978	3034416.299	27°24'48.39"	95°20'40.65"
160	TP158	12933.92	1 ° 37 ' 14 "R	731826.971	3034337.773	27°24'45.83"	95°20'41.46"
161	TP159	13053.1	5 ° 17 ' 42 "R	731858.397	3034222.817	27°24'42.07"	95°20'42.53"
162	TP160	13166.63	0 ° 57 ' 1 "L	731878.101	3034111.01	27°24'38.43"	95°20'43.17"
163	TP161	13321.94	0 ° 26 ' 12 "L	731907.59	3033958.522	27°24'33.46"	95°20'44.14"
164	TP162	13404.19	2 ° 50 ' 50 "R	731923.822	3033877.888	27°24'30.83"	95°20'44.67"
165	TP163	13500.66	2 ° 3 ' 30 "L	731938.138	3033782.49	27°24'27.73"	95°20'45.13"
166	TP164	13561.57	18 ° 5 ' 30 "L	731949.3353	3033722.616	27°24'25.77"	95°20'45.49"
167	TP165	13580.45	23 ° 56 ' 38 "L	731958.3967	3033706.054	27°24'25.23"	95°20'45.81"
168	TP166	13596.55	1 ° 38 ' 27 "R	731971.195	3033696.279	27°24'24.91"	95°20'46.27"
169	TP167	13765.77	42 ° 4 ' 7 "R	732102.6753	3033589.761	27°24'21.37"	95°20'50.98"
170	TP168	13833.6	20 ° 29 ' 41 "L	732113.1919	3033522.746	27°24'19.18"	95°20'51.32"
171	TP169	13915.8	3 ° 45 ' 45 "L	732096.697	3033442.217	27°24'16.58"	95°20'50.66"
172	TP170	13946.3	18 ° 7 ' 49 "R	732092.5511	3033412.004	27°24'15.6"	95°20'50.49"
173	TP171	14045.88	1 ° 6 ' 56 "R	732110.385	3033314.034	27°24'12.41"	95°20'51.07"
174	TP172	14158.72	0 ° 3 ' 17 "L	732128.429	3033202.643	27°24'8.78"	95°20'51.65"
175	TP173	14210.16	18 ° 15 ' 42 "L	732136.702	3033151.878	27°24'7.12"	95°20'51.92"
176	TP174	14317.58	1 ° 1 ' 59 "R	732119.887	3033045.782	27°24'3.69"	95°20'51.24"
177	TP175	14353.65	4 ° 3 ' 41 "L	732113.598	3033010.256	27°24'2.54"	95°20'50.98"
178	TP176	14371.05	1 ° 21 ' 48 "L	732111.787	3032992.96	27°24'1.98"	95°20'50.9"
179	TP177	14417.99	19 ° 24 ' 0 "R	732108.0107	3032946.17	27°24'0.46"	95°20'50.74"
180	TP178	14559.99	39 ° 5 ' 27 "L	732144.2515	3032808.867	27°23'55.98"	95°20'51.96"
181	TP179	14585.75	1 ° 0 ' 32 "L	732133.652	3032785.397	27°23'55.23"	95°20'51.56"
182	TP180	14599.98	0 ° 43 ' 41 "R	732128.023	3032772.324	27°23'54.8"	95°20'51.34"
183	TP181	14741.18	10 ° 36 ' 26 "R	732070.5392	3032643.359	27°23'50.65"	95°20'49.16"
184	TP182	14786.86	2 ° 38 ' 55 "R	732044.579	3032605.771	27°23'49.45"	95°20'48.19"
185	TP183	14812.45	1 ° 45 ' 31 "L	732029.074	3032585.403	27°23'48.8"	95°20'47.62"
186	TP184	14867.17	0 ° 7 ' 12 "R	731997.286	3032540.873	27°23'47.37"	95°20'46.43"
187	TP185	14887.83	12 ° 19 ' 23 "L	731985.245	3032524.08	27°23'46.83"	95°20'45.98"
188	TP186	14907.43	10 ° 40 ' 56 "R	731977.487	3032506.082	27°23'46.25"	95°20'45.68"
189	TP187	15005.79	1 ° 29 ' 15 "L	731922.482	3032424.535	27°23'43.64"	95°20'43.63"
190	TP188	15099.44	3 ° 12 ' 22 "L	731872.147	3032345.564	27°23'41.1"	95°20'41.74"
191	TP189	15170.15	0 ° 10 ' 30 "L	731837.536	3032283.905	27°23'39.12"	95°20'40.44"
192	TP190	15223.24	0 ° 50 ' 18 "R	731811.691	3032237.531	27°23'37.63"	95°20'39.47"
193	TP191	15275.2	8 ° 54 ' 20 "R	731785.7338	3032192.517	27°23'36.19"	95°20'38.49"
194	TP192	15470.83	0 ° 21 ' 26 "R	731662.951	3032040.218	27°23'31.32"	95°20'33.92"
195	TP193	15603.04	2 ° 18 ' 4 "L	731579.332	3031937.81	27°23'28.04"	95°20'30.81"
196	TP194	15818.77	0 ° 9 ' 35 "R	731449.712	3031765.369	27°23'22.52"	95°20'25.98"
197	TP195	15862.87	0 ° 10 ' 3 "R	731423.112	3031730.186	27°23'21.39"	95°20'24.98"
198	TP196	15899.48	11 ° 5 ' 48 "R	731400.952	3031701.053	27°23'20.46"	95°20'24.16"
199	TP197	15928.69	0 ° 48 ' 50 "L	731379.121	3031681.64	27°23'19.85"	95°20'23.35"
200	TP198	16017.03	1 ° 15 ' 21 "L	731313.943	3031622.002	27°23'17.95"	95°20'20.94"
201	TP199	16125.74	0 ° 9 ' 20 "L	731235.371	3031546.879	27°23'15.56"	95°20'18.03"
202	TP200	16171.71	0 ° 26 ' 8 "R	731202.231	3031515.021	27°23'14.54"	95°20'16.8"

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	TP - IP PILLAR NO.	CHAINAGE (m)	DEFLECTION ANGLE DEG MIN SEC	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)	
				EASTING	NORTHING	LATITUDE	LONGITUDE
203	TP201	16249.03	1 ° 25 ' 44 "L	731146.087	3031461.864	27°23'12.85"	95°20'14.72"
204	TP202	16291.14	1 ° 16 ' 16 "R	731116.236	3031432.155	27°23'11.9"	95°20'13.62"
205	TP203	16339.21	1 ° 20 ' 7 "L	731081.422	3031399.011	27°23'10.85"	95°20'12.33"
206	TP204	16363.25	1 ° 59 ' 46 "R	731064.404	3031382.036	27°23'10.31"	95°20'11.7"
207	TP205	16408.29	5 ° 34 ' 54 "L	731031.427	3031351.358	27°23'9.33"	95°20'10.48"
208	TP206	16437.92	3 ° 57 ' 22 "L	731011.797	3031329.16	27°23'8.62"	95°20'9.75"
209	TP207	16448.08	2 ° 33 ' 32 "L	731005.607	3031321.102	27°23'8.37"	95°20'9.52"
210	TP208	16491.28	26 ° 56 ' 28 "R	730980.8485	3031285.706	27°23'7.23"	95°20'8.59"
211	TP209	16526.55	2 ° 25 ' 1 "R	730949.732	3031269.101	27°23'6.71"	95°20'7.45"
212	TP210	16545.18	2 ° 28 ' 12 "L	730932.9338	3031261.027	27°23'6.46"	95°20'6.83"
213	TP211	16563.66	49 ° 8 ' 55 "L	730916.6459	3031252.315	27°23'6.19"	95°20'6.23"
214	TP212	16623.26	7 ° 58 ' 7 "L	730903.5306	3031194.172	27°23'4.31"	95°20'5.72"
215	TP213	16673.25	4 ° 40 ' 1 "R	730899.3972	3031144.35	27°23'2.69"	95°20'5.53"
216	TP214	16786.78	0 ° 42 ' 16 "L	730880.8359	3031032.348	27°22'59.06"	95°20'4.78"
217	TP215	16789.75	1 ° 27 ' 42 "L	730880.3862	3031029.411	27°22'58.97"	95°20'4.76"
218	TP216	16807.83	1 ° 21 ' 43 "R	730878.1069	3031011.478	27°22'58.39"	95°20'4.67"
219	TP217	16884.56	0 ° 27 ' 44 "R	730866.6261	3030935.614	27°22'55.93"	95°20'4.2"
220	TP218	17157.74	9 ° 11 ' 23 "R	730823.5714	3030665.846	27°22'47.2"	95°20'2.45"
221	TP219	17188.15	88 ° 30 ' 22 "L	730823.636	3030635.44	27°22'46.21"	95°20'2.43"
222	TP220	17206.25	77 ° 48 ' 51 "L	730841.7316	3030635.007	27°22'46.19"	95°20'3.09"

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

LIST OF DGPS CO-ORDINATE

SR NO	POINT ID	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)		R.L ON BM (m)
		NORTHING	EASTING	LATITUDE	LONGITUDE	
1	B_DGPS-1.(BM-1)	3027919.534	729870.874	27°21'18.59"	95°19'25.93"	132.927
2	SAT-103 BM	3028545.43	730306.419	27°21'38.65"	95°19'42.19"	120.227
3	DGPS-1 OF SAT-103	3027920.3	729870.317	27°21'18.62"	95°19'25.91"	120.713
4	BM-2	3046714.286	744854.279	27°31'19.47"	95°28'44.47"	127.123
5	BM-3	3038536.529	732664.381	27°27'1.66"	95°21'14.83"	122.151
6	RLY BM	3043827.044	742709.786	27°29'47.11"	95°27'24.28"	127.163
7	TBM-0	3049047.42	743660.147	27°32'36.01"	95°28'2.67"	123.786
8	TBM-1	3044540.573	742231.767	27°30'10.59"	95°27'7.39"	127.18
9	TBM-2	3048093.516	743556.7561	27°32'5.1"	95°27'58.21"	127.1334
10	TBM-3	3047305.263	743468.4617	27°31'39.56"	95°27'54.42"	126.103
11	TBM-4	3044101.068	741643.562	27°29'56.7"	95°26'45.65"	126.426
12	TBM-5	3042473.764	739500.495	27°29'5.23"	95°25'26.46"	124.769
13	GPS-1	3055649.515	737228.801	27°36'14.5"	95°24'13.06"	122.403
14	GPS-1 RF1	3055577.731	737307.469	27°36'12.12"	95°24'15.87"	122.114
15	GPS-1 RF2	3055534.461	737226.373	27°36'10.77"	95°24'12.89"	123.059
16	GPS-2	3053864.166	739024.254	27°35'15.39"	95°25'17.22"	122.827
17	GPS-2 RF	3053878.45	739058.843	27°35'15.83"	95°25'18.49"	122.752
18	GPS-3	3053064.689	740239.682	27°34'48.65"	95°26'0.94"	123.146
19	GPS-3RF	3053060.032	740273.313	27°34'48.48"	95°26'2.17"	119.551
20	GPS-4	3050583.418	741970.686	27°33'26.97"	95°27'2.23"	121.584
21	GPS-4 RF	3050543.868	742175.661	27°33'25.56"	95°27'9.67"	123.708
22	GPS-5	3048417.691	743525.513	27°32'15.65"	95°27'57.31"	126.618
23	GPS-5 RF	3048530.945	743513.29	27°32'19.33"	95°27'56.94"	124.549
24	GPS-6	3047925.29	743549.836	27°31'59.64"	95°27'57.84"	122.472
25	GPS-6 RF1	3047811.981	743538.689	27°31'55.97"	95°27'57.35"	119.849
26	GPS-6 RF2	3047698.06	743533.207	27°31'52.27"	95°27'57.07"	120.336
27	GPS-6A	3046067.848	743762.719	27°30'59.19"	95°28'4.24"	126.276
28	GPS-6A RF	3046402.685	743684.767	27°31'10.11"	95°28'1.65"	126.2
29	GPS-7	3044540.573	742231.781	27°30'10.59"	95°27'7.39"	127.189
30	GPS-7 RF	3044510.365	742231.318	27°30'9.61"	95°27'7.35"	127.024
31	GPS-8	3043876.83	740107.202	27°29'50.4"	95°25'49.55"	126.067
32	GPS-8 RF1	3043765.19	740167.687	27°29'46.74"	95°25'51.67"	125.337
33	GPS-8 RF2	3043767.352	740172.283	27°29'46.8"	95°25'51.84"	125.535
34	GPS-9	3042648.676	739415.826	27°29'10.96"	95°25'23.5"	126.558
35	GPS-9 RF	3042684.866	739629.081	27°29'12"	95°25'31.29"	125.898
36	GPS-10	3041598.972	737140.479	27°28'38.31"	95°23'59.91"	122.14
37	GPS-10 RF	3041614.515	737189.689	27°28'38.79"	95°24'1.71"	122.498
38	GPS-11	3041098.956	736493.736	27°28'22.48"	95°23'36.01"	122.462

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR NO	POINT ID	UTM-46 CO-ORDINATES (m)		WGS-84 CO-ORDINATES (deg-min-sec)		R.L ON BM (m)
		NORTHING	EASTING	LATITUDE	LONGITUDE	
39	GPS-11 RF	3041217.575	736481.275	27°28'26.34"	95°23'35.64"	122.005
40	GPS-12	3040214.337	735231.47	27°27'54.55"	95°22'49.44"	122.092
41	GPS-12 RF1	3040175.596	735242.489	27°27'53.28"	95°22'49.82"	121.92
42	GPS-12 RF2	3040120.945	735400.164	27°27'51.41"	95°22'55.52"	121.853
43	GPS-13	3039624.577	733900.65	27°27'36.23"	95°22'0.58"	121.458
44	GPS-13 RF	3039664.917	733967.606	27°27'37.49"	95°22'3.05"	120.5
45	GPS-14	3038705.568	733369.783	27°27'6.71"	95°21'40.62"	123.031
46	GPS-14 RF1	3038631.154	733375.738	27°27'4.29"	95°21'40.79"	121.037
47	GPS-14 RF2	3038641.908	733369.212	27°27'4.64"	95°21'40.56"	120.957
48	GPS-15	3036724.075	732961.675	27°26'2.62"	95°21'24.4"	121.938
49	GPS-15 RF	3036761.641	732856.499	27°26'3.9"	95°21'20.6"	122.055
50	STN-15A	3034935.101	732320.822	27°25'4.92"	95°20'59.84"	121.095
51	STN-15B	3034983.398	732300.526	27°25'6.5"	95°20'59.14"	121.613
52	GPS-16	3034418.454	731778.832	27°24'48.48"	95°20'39.77"	120.593
53	GPS-16 RF	3034484.039	731761.932	27°24'50.62"	95°20'39.2"	121.427
54	GPS-17	3032763.14	732134.669	27°23'54.5"	95°20'51.58"	120.395
55	GPS-17 RF	3032849.892	732095.334	27°23'57.34"	95°20'50.21"	120.235
56	GPS-18	3031264.144	730978.135	27°23'6.53"	95°20'8.48"	120.532
57	GPS-18 RF	3031311.127	730894.148	27°23'8.11"	95°20'5.45"	120.424
58	B_es	3027918.452	729872.342	27°21'18.56"	95°19'25.98"	123.217

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

LIST OF VILLAGES FALLING EN-ROUTE

**1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban
(Along Existing & Proposed RoU)**

Sr. No.	Location Code as per Census 2011	Village	Revenue Circle	District	State
1	227	Rupai T.E.232/230 Nir	DOOM DOOMA REVENUE CIRCLE	TINSUKIA	ASSAM
2	212	Daisa T.E. 13/9(A)			
3	273	Diamuli Gaon No.-2			
4	269	Diamuli T.E.181 WI.			
5	307	Longsowal T.E. 109/112			

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

LIST OF ALL CROSSINGS FALLING EN-ROUTE

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban (Along Existing & Proposed RoU)

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
1	CART TRACK	CART TRACK	1225.34	1228.89	3.55
2	CART TRACK	CART TRACK	1384.15	1387.05	2.9
3	DRAIN	DRAIN	1769.66	1777.12	7.46
4	CART TRACK	CART TRACK	1797.45	1800.76	3.31
5	CART TRACK	CART TRACK	1921.42	1924.41	2.99
6	CART TRACK	CART TRACK	2017.8	2022.78	4.98
7	DRAIN	DRAIN	2122.34	2127.95	5.61
8	ROAD	ASPHALT ROAD (TO Baghjan-TO Tea Manufacturing Plant)	2649.13	2676.25	27.12
9	CART TRACK	CART TRACK	2740.76	2745.39	4.63
10	CART TRACK	CART TRACK	2940.77	2946.55	5.78
11	ROAD	WBM ROAD (TO Baghjan-TO Tea Manufacturing Plant)	3168.61	3181.55	12.94
12	CART TRACK	CART TRACK	3397.53	3403.14	5.61
13	CART TRACK	CART TRACK	3595.33	3597.89	2.56
14	CART TRACK	CART TRACK	3785.12	3790.89	5.77
15	CART TRACK	CART TRACK	3982.82	3986.93	4.11
16	ROAD	WBM ROAD (TO Baghjan-TO Tea Manufacturing Plant)	4197.26	4205	7.74
17	CART TRACK	CART TRACK	4205	4208.15	3.15
18	POWER LINE	440V Power Line	4224.84	--	--
19	PIPELINE	EX. 400 MM NATURAL GAS PL FROM BAGJAN EPS TO MADHUBAN CGGS	4993.37	--	--
20	PIPELINE	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	4997.62	--	--
21	DRAIN	DRAIN	5152.72	5155.82	3.1
22	CART TRACK	CART TRACK	5389.91	5395.78	5.87
23	CART TRACK	CART TRACK	5685.69	5688.4	2.71
24	DRAIN	DRAIN	5883.58	5885.71	2.13
25	NALA	NALA	6304.07	6376.84	72.77
26	RIVER	DOOM DOOMA RIVER	6504.83	6559.16	54.33
27	DRAIN	DRAIN	6588.47	6595.82	7.35
28	DRAIN	DRAIN	6823.58	6829.95	6.37
29	DRAIN	DRAIN	7393.3	7399.69	6.39
30	ROAD	WBM ROAD (TO HILIKHA VILLAGE)	7506.07	7514.84	8.77
31	POWER LINE	11 KV POWER LINE	7519.38	--	--
32	DRAIN	DRAIN	7543.96	7557.17	13.21
33	DRAIN	DRAIN	7906.45	7908.48	2.03
34	POWER LINE	440V Powerline	7978.07	--	--
35	CART TRACK	CART TRACK	7980.28	7984.42	4.14
36	POWER LINE	200V Powerline	8198.28	--	--

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
37	CART TRACK	CART TRACK	8219.66	8221.37	1.71
38	DRAIN	DRAIN	8299.23	8301.28	2.05
39	DRAIN	DRAIN	8515.05	8518.15	3.1
40	ROAD	ASPHALTROAD(To Gutuyu-To Charemiri))	8536.74	8544.18	7.44
41	PIPELINE	EX. 4"Ø OIL INDIA PL	8559.91	--	--
42	PIPELINE	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	8563.66	--	--
43	PIPELINE	EX. 400 MM NATURAL GAS PL FROM BAGJAN EPS TO MADHUBAN CGGS	8567.96	--	--
44	CART TRACK	CART TRACK	9153.79	9158.15	4.36
45	ROAD	ASPHALTROAD(To 15 Line -To WM Road)	9282.28	9290.53	8.25
46	CART TRACK	CART TRACK	9881.27	9884.21	2.94
47	POWER LINE	POWER LINE	9885.81	--	--
48	POWER LINE	High Tension Power Lines	10105.01	--	--
49	ROAD	ASPHALTROAD(To Tea Garden)	10705.4	10725.75	20.35
50	NALA	NALA	10935.72	10947.97	12.25
51	ROAD	ASPHALTROAD(To Long Sowal- To Papujan)	12124.3	12145.56	21.26
52	RIVER	Hayjan River	12250.13	12270.71	20.58
53	POWER LINE	POWER LINE	12461.8	--	--
54	POWER LINE	POWER LINE	12613.6	--	--
55	ROAD	ASPHALTROAD(To Longswal)	12637.65	12650.25	12.6
56	ROAD	ASPHALTROAD(To Tea Garden)	13137.01	13144.51	7.5
57	POWER LINE	POWER LINE	13143.92	--	--
58	CHANNEL	FIELD CHANNEL	13581.7	13583.54	1.84
59	CART TRACK	CART TRACK	13594.22	13597.37	3.15
60	ROAD	ASPHALTROAD(To Medical Line)	14350.7	14354.47	3.77
61	NALA	NALA	14461.3	14476.50	15.2
62	ROAD	ASPHALTROAD(To Longsawl-To 17 NO.Line)	15112.51	15119.78	7.27
63	NALA	NALA	15833.58	15841	7.42
64	CART TRACK	CART TRACK	16139.14	16143.79	4.65
65	POWER LINE	High Tension Power Line	16621.49	--	--
66	ROAD	ROAD(To R.I.G H2)	16735.87	16748.44	12.57
67	NALA	NALA	16800.82	16803.85	3.03
68	POWER LINE	POWER LINE	16810.86	--	--
69	POWER LINE	POWER LINE	16902.68	0.00	-16902.7
70	CART TRACK	CART TRACK	16904.47	16907.96	3.49
71	POWER LINE	POWER LINE	16911.81	--	--
72	POWER LINE	POWER LINE	17444.48	--	--
73	ROAD	ASPHALTROAD(To Makum Thanar-To Barakari)	17444.88	17450.34	5.46
74	POWER LINE	POWER LINE	17453.38	--	--
75	ROAD	ASPHALTROAD(To By Pass Road-To Bejan)	18384.48	18394.25	9.77
76	CABLE	NFS OFC CABLE	18385.99	--	--
77	POWER LINE	POWER LINE	18397.66	--	--
78	POWER LINE	POWER LINE	18443.95	--	--
79	CART TRACK	CART TRACK	18661.99	18664.72	2.73
80	POWER LINE	POWER LINE	18838.8	--	--
81	POWER LINE	POWER LINE	18911.69	--	--
82	POWER LINE	POWER LINE	19204.94	--	--
83	CART TRACK	CART TRACK	19205.71	19208.04	2.33
84	POWER LINE	POWER LINE	19235.47	--	--
85	ROAD	ASPHALTROAD(To Makum Thanar-To Barakari)	19493.5	19503.22	9.72
86	POWER LINE	POWER LINE	19498.42	--	--
87	POWER LINE	POWER LINE	19505.8	--	--

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
88	POWER LINE	220kv High Tension Power Line(To Kolavadi)	19531.38	--	--
89	ROAD	ASPHALTROAD(To Makum-To Badgudi)	19629.18	19675.47	46.29
90	POWER LINE	POWER LINE	20079.35	--	--
91	CART TRACK	CART TRACK	20084.4	20088.22	3.82
92	POWER LINE	POWER LINE	20112.76	--	--
93	POWER LINE	POWER LINE	20117.84	--	--
94	DRAIN	DRAIN	20275.65	20277.31	1.66
95	ROAD	ASPHALTROAD(To Makum-To Tin Sukhiya)	20465.13	20482.88	17.75
96	POWER LINE	POWER LINE	20467.18	--	--
97	PIPELINE	12"Ø WSPL	20467.9	--	--
98	PIPELINE	RJIL OFC CABLE	20469.74	--	--
99	CABLE	NFS OFC CABLE	20471.52	--	--
100	RAILWAY	RAILWAY(To Makum-To Tin Sukhiya)	20482.88	20507.16	24.28
101	CABLE	NFS OFC CABLE	20491.4	--	--
102	PIPELINE	EX.8 INCH GAS LINE	20511.35	--	--
103	PIPELINE	EX.10 INCH PL	20512.6	--	--
104	PIPELINE	EX. 4"Ø OIL INDIA PL	20533.01	--	--
105	PIPELINE	EX. 4"Ø OIL INDIA PL	20533.2	--	--
106	PIPELINE	EX. 4"Ø OIL INDIA PL	20533.46	--	--
107	PIPELINE	EX. 4"Ø OIL INDIA PL	20533.78	--	--
108	PIPELINE	EX. 4"Ø OIL INDIA PL	20534.19	--	--
109	PIPELINE	EX. 4"Ø OIL INDIA PL	20606.06	--	--
110	PIPELINE	EX. 4"Ø OIL INDIA PL	20606.35	--	--
111	PIPELINE	EX. 4"Ø OIL INDIA PL	20606.51	--	--
112	PIPELINE	EX. 4"Ø OIL INDIA PL	20606.66	--	--
113	PIPELINE	EX. 4"Ø OIL INDIA PL	20607.03	--	--
114	POWER LINE	POWER LINE	20667.03	--	--
115	ROAD	ASPHALTROAD(To Collage Road-To Sukhapokri)	20668.24	20670.45	2.21
116	POWER LINE	POWER LINE	20868.29	--	--
117	POWER LINE	POWER LINE	20934.29	--	--
118	POWER LINE	POWER LINE	20956.76	--	--
119	POWER LINE	POWER LINE	20973.6	--	--
120	POWER LINE	POWER LINE	20982.39	--	--
121	CART TRACK	CART TRACK	21114.65	21119	4.35
122	POWER LINE	POWER LINE	21450	--	--
123	POWER LINE	POWER LINE	21454.78	--	--
124	POWER LINE	POWER LINE	21463.13	--	--
125	POWER LINE	POWER LINE	21470.39	--	--
126	POWER LINE	POWER LINE	21482.98	--	--
127	NALA	NALA	21524.72	21532.21	7.49
128	POWER LINE	POWER LINE	21621.45	--	--
129	NALA	NALA	22151.64	22156.12	4.48
130	POWER LINE	POWER LINE	22373.35	--	--
131	CART TRACK	CART TRACK	22375.96	22378.74	2.78
132	POWER LINE	POWER LINE	22428.79	--	--
133	POWER LINE	POWER LINE	22640.32	--	--
134	POWER LINE	POWER LINE	22653.48	--	--
135	POWER LINE	POWER LINE	22669.11	--	--
136	POWER LINE	POWER LINE	22682.96	--	--
137	POWER LINE	POWER LINE	22712.28	--	--
138	NALA	NALA	23069.9	23073.46	3.56
139	POWER LINE	POWER LINE	23186.86	--	--
140	POWER LINE	POWER LINE	23212.91	--	--

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
141	CART TRACK	CART TRACK	23216.91	23221.44	4.53
142	POWER LINE	POWER LINE	23259.88	--	--
143	POWER LINE	High Tension Power Line	23629.01	--	--
144	ROAD	Asphalt Road(To Sidhama)	24039.08	24056.07	16.99
145	POWER LINE	POWER LINE	24184.31	--	--
146	ROAD	Asphalt Road	24550.16	24558.52	8.36
147	CART TRACK	CART TRACK	24557.09	24560.64	3.55
148	POWER LINE	POWER LINE	24559.38	--	--
149	POWER LINE	High Tension Power Lines	25046.96	--	--
150	POWER LINE	High Tension Power Lines	25345.55	--	--
151	ROAD	Asphalt Road(To Makum-To Teli Vasti)	25722.21	25727.2	4.99
152	POWER LINE	POWER LINE	25724.38	--	--
153	POWER LINE	POWER LINE	26386.3	--	--
154	POWER LINE	POWER LINE	26416.51	--	--
155	CART TRACK	CART TRACK	27003.72	27007.28	3.56
156	NALA	NALA	27200.31	27204.7	4.39
157	POWER LINE	POWER LINE	27309.84	--	--
158	ROAD	Asphalt Road(To Shelember Vasti-To Main Road)	27696.73	27708.06	11.33
159	POWER LINE	POWER LINE	27701.57	--	--
160	POWER LINE	POWER LINE	27797.88	--	--
161	POWER LINE	POWER LINE	28088.41	--	--
162	RIVER	Tingrai River	28294.29	28314.45	20.16
163	POWER LINE	POWER LINE	28693.32	--	--
164	ROAD	Asphalt Road(To ChotuTindal)	28699.88	28711.52	11.64
165	CART TRACK	CART TRACK	29113.59	29116.7	3.11
166	POWER LINE	POWER LINE	29557.07	--	--
167	ROAD	Asphalt Road(To ChotuTindal -To Tin Sukhiya)	29555.63	29563.35	7.72
168	CABLE	BBNL OFC CABLE	29562.5	--	--
169	POWER LINE	POWER LINE	29564.05	--	--
170	POWER LINE	POWER LINE	29566.8	--	--
171	POWER LINE	POWER LINE	29682.64	--	--
172	CABLE	BBNL OFC CABLE	30739.95	--	--
173	ROAD	Asphalt Road	30740.07	30747.33	7.26
174	CART TRACK	CART TRACK	31090.57	31094.18	3.61
175	POWER LINE	POWER LINE	31386.12	--	--
176	CART TRACK	CART TRACK	31387.81	31390.94	3.13
177	CART TRACK	CART TRACK	31874.12	31877.19	3.07
178	POWER LINE	11Kv Power Line	31880.81	--	--
179	CART TRACK	CART TRACK	32040.12	32042.82	2.7
180	POWER LINE	POWER LINE	32650.69	--	--
181	POWER LINE	11Kv Power Line	32654.81	--	--
182	ROAD	Asphalt Road	32656.25	32663.40	7.15
183	POWER LINE	POWER LINE	32663.86	--	--
184	POWER LINE	POWER LINE	32716.38	--	--
185	CART TRACK	CART TRACK	32716.46	32720.47	4.01
186	ROAD	Asphalt Road	33605.62	33617.59	11.97
187	POWER LINE	POWER LINE	33615.21	--	--
188	POWER LINE	11kv Power Line	33802.2	--	--
189	NALA	NALA	33881.71	33890.9	9.19
190	ROAD	Asphalt Road	34148.68	34157.85	9.17
191	POWER LINE	POWER LINE	34160.97	--	--
192	POWER LINE	POWER LINE	34169.59	--	--
193	CART TRACK	CART TRACK	34559.61	34564.6	4.99

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
194	POWER LINE	High Tension Power Line	35001.88	--	--
195	POWER LINE	11Kv Power Line	35082.68	--	--
196	ROAD	Asphalt Road	35122.09	35138.14	16.05
197	PIPELINE	EX. 4"Ø OIL INDIA PL	35128.29	--	--
198	PIPELINE	EX. 4"Ø OIL INDIA PL	35128.78	--	--
199	PIPELINE	EX. 4"Ø OIL INDIA PL	35136.54	--	--
200	PIPELINE	EX. 4"Ø OIL INDIA PL	35137.03	--	--
201	POWER LINE	11Kv Power Line	35137.2	--	--
202	PIPELINE	EX. 4"Ø OIL INDIA PL	35137.53	--	--
203	PIPELINE	EX. 4"Ø OIL INDIA PL	35138.03	--	--
204	PIPELINE	EX. 4"Ø OIL INDIA PL	35138.52	--	--
205	POWER LINE	11Kv Power Line	35182.18	--	--
206	POWER LINE	11Kv Power Line	35234.87	--	--
207	POWER LINE	11Kv Power Line	35468.83	--	--
208	CART TRACK	CART TRACK	35471.64	35474.38	2.74
209	CART TRACK	CART TRACK	35724.37	35726.57	2.2
210	POWER LINE	High Tension Power Lines	35842	--	--
211	NALA	NALA	35921.06	35930.31	9.25
212	POWER LINE	11Kv Power Line	36308.66	--	--
213	POWER LINE	High Tension Power Lines	36435.39	--	--
214	CART TRACK	CART TRACK	36436.86	36441.01	4.15
215	POWER LINE	11Kv Power Line	36919.27	--	--
216	POWER LINE	11Kv Power Line	37045.45	--	--
217	ROAD	Asphalt Road	37044.64	37057.49	12.85
218	ROAD	Asphalt Road	37057.49	37073.79	16.3
219	CABLE LINE	U.G ELECTRIC CABLE	37060.55	--	--
220	CABLE LINE	BSNL OFC CABLE	37061.62	--	--
221	CABLE LINE	RJIL OFC CABLE	37071.09	--	--
222	POWER LINE	11Kv Power Line	37073.62	--	--
223	POWER LINE	11Kv Power Line	37080.41	--	--
224	PIPELINE	EX. 400 MM NATURAL GAS PL FROM BAGJAN EPS TO MADHUBAN CGGS	37118.5	--	--
225	PIPELINE	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	37344.44	--	--

2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
1	PIPELINE	EX. 4"Ø OIL INDIA PL	44.14	--	--
2	PIPELINE	EX. 4"Ø OIL INDIA PL	44.37	--	--
3	PIPELINE	EX. 4"Ø OIL INDIA PL	44.64	--	--
4	PIPELINE	EX. 4"Ø OIL INDIA PL	44.77	--	--
5	PIPELINE	EX. 4"Ø OIL INDIA PL	44.90	--	--
6	PIPELINE	EX. 4"Ø OIL INDIA PL	45.08	--	--
7	PIPELINE	EX. 4"Ø OIL INDIA PL	45.28	--	--
8	PIPELINE	EX. 4"Ø OIL INDIA PL	45.46	--	--
9	PIPELINE	EX. 4"Ø OIL INDIA PL	45.61	--	--
10	PIPELINE	EX. 4"Ø OIL INDIA PL	45.83	--	--
11	PIPELINE	EX. 4"Ø OIL INDIA PL	97.68	--	--
12	PIPELINE	EX. 4"Ø OIL INDIA PL	97.85	--	--

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
13	PIPELINE	EX. 4"Ø OIL INDIA PL	98.17	--	--
14	PIPELINE	EX. 4"Ø OIL INDIA PL	98.43	--	--
15	PIPELINE	EX. 4"Ø OIL INDIA PL	98.88	--	--
16	POWER LINE	POWER LINE	102.72	--	--
17	ROAD	ASPHALTROAD(To Collage Road-To Sukhapokri)	107.01	109.25	2.24
18	PIPELINE	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	132.24	--	--
19	POWER LINE	POWER LINE	358.46	--	--
20	POWER LINE	POWER LINE	382.19	--	--
21	POWER LINE	POWER LINE	398.86	--	--
22	POWER LINE	POWER LINE	408.19	--	--
23	POWER LINE	POWER LINE	420.97	--	--
24	CART TRACK	CART TRACK	557.45	561.80	4.35
25	POWER LINE	POWER LINE	920.19	--	--
26	POWER LINE	POWER LINE	924.84	--	--
27	POWER LINE	POWER LINE	933.18	--	--
28	POWER LINE	POWER LINE	940.39	--	--
29	POWER LINE	POWER LINE	953.19	--	--
30	NALA	NALA	987.41	994.19	6.78
31	POWER LINE	POWER LINE	1118.04	--	--
32	NALA	NALA	1603.99	1608.39	4.40
33	POWER LINE	POWER LINE	1826.14	--	--
34	CART TRACK	CART TRACK	1829.04	1831.62	2.58
35	POWER LINE	POWER LINE	1882.45	--	--
36	POWER LINE	POWER LINE	2059.17	--	--
37	POWER LINE	POWER LINE	2083.49	--	--
38	POWER LINE	POWER LINE	2109.25	--	--
39	POWER LINE	POWER LINE	2111.60	--	--
40	POWER LINE	POWER LINE	2139.99	--	--
41	NALA	NALA	2526.55	2530.45	3.90
42	POWER LINE	POWER LINE	2666.76	--	--
43	CART TRACK	CART TRACK	2671.00	2675.51	4.51
44	POWER LINE	POWER LINE	2698.65	--	--
45	POWER LINE	High Tension Power Line	3067.46	--	--
46	ROAD	Asphalt Road(To Sidhama)	3496.57	3512.46	15.89
47	POWER LINE	POWER LINE	3644.24	--	--
48	ROAD	Asphalt Road	4012.40	4020.46	8.06
49	POWER LINE	POWER LINE	4023.18	--	--
50	POWER LINE	High Tension Power Lines	4494.92	--	--
51	POWER LINE	High Tension Power Lines	4790.23	--	--
52	ROAD	Asphalt Road(To Makum-To Teli Vasti)	5165.87	5171.04	5.17
53	POWER LINE	POWER LINE	5172.14	--	--
54	CART TRACK	CART TRACK	6467.39	6470.92	3.53
55	NALA	NALA	6665.41	6674.59	9.18
56	POWER LINE	POWER LINE	6774.36	--	--
57	ROAD	Asphalt Road(To Shelember Vasti-To Main Road)	7136.91	7149.29	12.38
58	POWER LINE	POWER LINE	7171.54	--	--
59	POWER LINE	POWER LINE	7218.30	--	--
60	POWER LINE	POWER LINE	7513.23	--	--
61	RIVER	Tingrai River	7726.04	7750.41	24.37
62	POWER LINE	POWER LINE	8134.58	--	--
63	ROAD	Asphalt Road(To ChotuTindal)	8141.17	8152.96	11.79
64	CART TRACK	CART TRACK	8554.05	8557.28	3.23

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
65	POWER LINE	POWER LINE	9003.65	--	--
66	ROAD	Asphalt Road(To ChotuTindal -To Tin Sukhiya)	9004.75	9009.28	4.53
67	POWER LINE	POWER LINE	9010.68	--	--
68	POWER LINE	POWER LINE	9013.30	--	--
69	PIPELINE	EX. 4"Ø OIL INDIA PL	9018.45	--	--
70	POWER LINE	POWER LINE	9128.06	--	--
71	CABLE	BBNL OFC CABLE	10184.39	--	--
72	ROAD	Asphalt Road	10184.87	10191.15	6.28
73	CART TRACK	CART TRACK	10530.60	10533.83	3.23
74	POWER LINE	POWER LINE	10827.99	--	--
75	CART TRACK	CART TRACK	10829.73	10832.36	2.63
76	CART TRACK	CART TRACK	11331.79	11335.39	3.60
77	POWER LINE	11Kv Power Line	11338.69	--	--
78	CART TRACK	CART TRACK	11483.72	11486.38	2.66
79	POWER LINE	POWER LINE	12089.27	--	--
80	POWER LINE	11Kv Power Line	12106.99	--	--
81	ROAD	Asphalt Road	12109.69	12116.70	7.01
82	POWER LINE	POWER LINE	12117.00	--	--
83	CART TRACK	CART TRACK	12157.78	12161.46	3.68
84	POWER LINE	POWER LINE	12160.68	--	--
85	PIPELINE	EX. 4"Ø OIL INDIA PL	12233.66	--	--
86	ROAD	Asphalt Road	13052.50	13062.70	10.20
87	POWER LINE	POWER LINE	13060.20	--	--
88	POWER LINE	POWER LINE	13228.42	--	--
89	POWER LINE	11kv Power Line	13251.04	--	--
90	NALA	NALA	13322.96	13331.79	8.83
91	ROAD	Asphalt Road	13586.28	13595.25	8.97
92	POWER LINE	POWER LINE	13596.63	--	--
93	POWER LINE	POWER LINE	13599.46	--	--
94	CART TRACK	CART TRACK	13981.65	13986.65	5.00
95	POWER LINE	High Tension Power Line	14435.19	--	--
96	POWER LINE	11Kv Power Line	14506.06	--	--
97	ROAD	Asphalt Road	14581.03	14600.17	19.14
98	PIPELINE	EX. 4"Ø OIL INDIA PL	14587.10	--	--
99	PIPELINE	EX. 4"Ø OIL INDIA PL	14587.58	--	--
100	PIPELINE	EX. 4"Ø OIL INDIA PL	14588.06	--	--
101	PIPELINE	EX. 4"Ø OIL INDIA PL	14596.16	--	--
102	PIPELINE	EX. 4"Ø OIL INDIA PL	14596.65	--	--
103	POWER LINE	11Kv Power Line	14596.82	--	--
104	PIPELINE	EX. 4"Ø OIL INDIA PL	14597.14	--	--
105	PIPELINE	EX. 4"Ø OIL INDIA PL	14597.63	--	--
106	PIPELINE	EX. 4"Ø OIL INDIA PL	14598.13	--	--
107	POWER LINE	11Kv Power Line	14613.64	--	--
108	POWER LINE	11Kv Power Line	14694.88	--	--
109	POWER LINE	11Kv Power Line	14907.01	--	--
110	CART TRACK	CART TRACK	14909.39	14912.19	2.80
111	CART TRACK	CART TRACK	15168.72	15170.91	2.19
112	POWER LINE	High Tension Power Lines	15308.91	--	--
113	NALA	NALA	15319.40	15339.80	20.40
114	NALA	NALA	15373.92	15382.24	8.32
115	POWER LINE	11Kv Power Line	15730.64	--	--
116	CART TRACK	CART TRACK	15868.70	15875.59	6.89
117	POWER LINE	High Tension Power Lines	15918.13	--	--

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
118	POWER LINE	11Kv Power Line	16365.63	--	--
119	ROAD	Asphalt Road	16503.58	16520.13	16.55
120	CABLE LINE	U.G ELECTRIC CABLE	16506.50	--	--
121	CABLE LINE	BSNL OFC CABLE	16507.55	--	--
122	CABLE LINE	RJIL OFC CABLE	16516.91	--	--
123	POWER LINE	11Kv Power Line	16519.02	--	--
124	POWER LINE	11Kv Power Line	16526.45	--	--
125	PIPELINE	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	16554.86	--	--
126	PIPELINE	EX. 400 MM NATURAL GAS PL FROM BAGJAN EPS TO MADHUBAN CGGS	16557.08	--	--
127	PIPELINE	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	16781.20	--	--

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

LIST OF MAJOR CROSSINGS(TYPE WISE) FALLING EN-ROUTE
(Railway Crossings)

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS
Madhuban (Along Existing & Proposed RoU)

SR. NO.	MC. NO.	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
1	38	RAILWAY(To Makum-To Tin Sukhiya)	20482.88	20507.16	24.28

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

LIST OF MAJOR CROSSINGS(TYPE WISE) FALLING EN-ROUTE
(Asphalt Road/Metal Road/Other Road Crossings)

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban
(Along Existing & Proposed RoU)

SR. NO.	MC. NO.	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
1	3	ASPHALTROAD(TO Baghjan-TO Tea Manufacturing Plant)	2649.13	2676.25	27.12
2	4	WBM ROAD(TO Baghjan-TO Tea Manufacturing Plant)	3168.61	3181.55	12.94
3	5	WBM ROAD(TO Baghjan-TO Tea Manufacturing Plant)	4197.26	4205	7.74
4	13	WBM ROAD(TO HILIKHA VILLAGE)	7506.07	7514.84	8.77
5	18	ASPHALTROAD(TO Gutuyu-To Charemiri))	8536.74	8544.18	7.44
6	19	ASPHALTROAD(TO 15 Line -To WM Road)	9282.28	9290.53	8.25
7	20	ASPHALTROAD(TO Tea Garden)	10705.4	10725.75	20.35
8	22	ASPHALTROAD(TO Long Sowel- To Papujan)	12124.3	12145.56	21.26
9	24	ASPHALTROAD(To Longswal)	12637.65	12650.25	12.6
10	25	ASPHALTROAD(To Tea Garden)	13137.01	13144.51	7.5
11	26	ASPHALTROAD(To Medical Line)	14350.7	14354.47	3.77
12	28	ASPHALTROAD(To Longsawl-To 17 NO.Line)	15112.51	15119.78	7.27
13	30	ROAD(TO R.I.G H2)	16735.87	16748.44	12.57
14	32	ASPHALTROAD(To Makum Thanar-To Barakari)	17444.88	17450.34	5.46
15	33	ASPHALTROAD(To By Pass Road-To Bejan)	18384.48	18394.25	9.77
16	34	ASPHALTROAD(To Makum Thanar-To Barakari)	19493.5	19503.22	9.72
17	35	ASPHALTROAD(To Makum-To Badgudi)	19629.18	19675.47	46.29
18	37	ASPHALTROAD(To Makum-To Tin Sukhiya)	20465.13	20482.88	17.75
19	39	ASPHALTROAD(To Collage Road-To Sukhapokri)	20668.24	20670.45	2.21
20	43	Asphalt Road(To Sidhama)	24039.08	24056.07	16.99
21	44	Asphalt Road	24550.16	24558.52	8.36

SR. NO.	MC. NO.	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
22	45	Asphalt Road(To Makum-To Teli Vasti)	25722.21	25727.2	4.99
23	47	Asphalt Road(To Shelember Vasti-To Main Road)	27696.73	27708.06	11.33
24	49	Asphalt Road(To ChotuTindal)	28699.88	28711.52	11.64
25	50	Asphalt Road(To ChotuTindal -To Tin Sukhiya)	29555.63	29563.35	7.72
26	51	Asphalt Road	30740.07	30747.33	7.26
27	52	Asphalt Road	32656.25	32663.40	7.15
28	53	Asphalt Road	33605.62	33617.59	11.97
29	55	Asphalt Road	34148.68	34157.85	9.17
30	56	Asphalt Road	35122.09	35138.14	16.05
31	58	Asphalt Road	37044.64	37057.49	12.85
32	59	Asphalt Road	37057.49	37073.79	16.3

**2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban
(Along Existing RoU)**

SR. NO.	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
		FROM	TO	
1	ASPHALTROAD(To Collage Road-To Sukhapokri)	107.01	109.25	2.24
2	Asphalt Road(To Sidhama)	3496.57	3512.46	15.89
3	Asphalt Road	4012.40	4020.46	8.06
4	Asphalt Road(To Makum-To Teli Vasti)	5165.87	5171.04	5.17
5	Asphalt Road(To Shelember Vasti-To Main Road)	7136.91	7149.29	12.38
6	Asphalt Road(To ChotuTindal)	8141.17	8152.96	11.79
7	Asphalt Road(To ChotuTindal -To Tin Sukhiya)	9004.75	9009.28	4.53
8	Asphalt Road	10184.87	10191.15	6.28
9	Asphalt Road	12109.69	12116.70	7.01
10	Asphalt Road	13052.50	13062.70	10.20
11	Asphalt Road	13586.28	13595.25	8.97
12	Asphalt Road	14581.03	14600.17	19.14
13	Asphalt Road	16503.58	16520.13	16.55

ANNEXURE –VI(D)

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

LIST OF MAJOR CROSSINGS(TYPE WISE) FALLING EN-ROUTE
(River Crossings)

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban (Along Existing & Proposed RoU)

SR. NO.	MC. NO.	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
1	9	DOOM DOOMA RIVER	6504.83	6559.16	54.33
2	23	Hayjan River	12250.13	12270.71	20.58
3	48	Tingrai River	28294.29	28314.45	20.16

2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)

SR. NO.	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
		FROM	TO	
1	Tingrai River	7726.04	7750.41	24.37

ANNEXURE –VI(E)

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

LIST OF MAJOR CROSSINGS(TYPE WISE) FALLING EN-ROUTE
(Nala/Drain/Creek Crossings)

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS
Madhuban (Along Existing & Proposed RoU)

SR. NO.	MC. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
				FROM	TO	
1	1	DRAIN	DRAIN	1769.66	1777.12	7.46
2	2	DRAIN	DRAIN	2122.34	2127.95	5.61
3	6	DRAIN	DRAIN	5152.72	5155.82	3.1
4	7	DRAIN	DRAIN	5883.58	5885.71	2.13
5	8	NALA	NALA	6304.07	6376.84	72.77
6	10	DRAIN	DRAIN	6588.47	6595.82	7.35
7	11	DRAIN	DRAIN	6823.58	6829.95	6.37
8	12	DRAIN	DRAIN	7393.30	7399.69	6.39
9	14	DRAIN	DRAIN	7543.96	7557.17	13.21
10	15	DRAIN	DRAIN	7906.45	7908.48	2.03
11	16	DRAIN	DRAIN	8299.23	8301.28	2.05
12	17	DRAIN	DRAIN	8515.05	8518.15	3.1
13	21	NALA	NALA	10935.72	10947.97	12.25
14	27	NALA	NALA	14461.30	14476.50	15.2
15	29	NALA	NALA	15833.58	15841.00	7.42
16	31	NALA	NALA	16800.82	16803.85	3.03
17	36	DRAIN	DRAIN	20275.65	20277.31	1.66
18	40	NALA	NALA	21524.72	21532.21	7.49
19	41	NALA	NALA	22151.64	22156.12	4.48
20	42	NALA	NALA	23069.90	23073.46	3.56
21	46	NALA	NALA	27200.31	27204.70	4.39
22	54	NALA	NALA	33881.71	33890.90	9.19
23	57	NALA	NALA	35921.06	35930.31	9.25

**2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS
Madhuban (Along Existing RoU)**

SR. NO.	TYPE OF CROSSING	DESCRIPTION	CHAINAGE (m)		WIDTH (m)
			FROM	TO	
1	NALA	NALA	987.41	994.19	6.78
2	NALA	NALA	1603.99	1608.39	4.40
3	NALA	NALA	2526.55	2530.45	3.90
4	NALA	NALA	6665.41	6674.59	9.18
5	NALA	NALA	13322.96	13331.79	8.83
6	NALA	NALA	15319.40	15339.80	20.40
7	NALA	NALA	15373.92	15382.24	8.32

ANNEXURE –VI(F)

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

LIST OF MAJOR CROSSINGS(TYPE WISE) FALLING EN-ROUTE
(Pipeline Crossings)

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS
Madhuban (Along Existing & Proposed RoU)

SR. NO.	DESCRIPTION	CHAINAGE (m)
1	EX. 400 MM NATURAL GAS PL FROM BAGJAN EPS TO MADHUBAN CGGS	4993.37
2	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	4997.62
3	EX. 4"Ø OIL INDIA PL	8559.91
4	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	8563.66
5	EX. 400 MM NATURAL GAS PL FROM BAGJAN EPS TO MADHUBAN CGGS	8567.96
6	12"Ø WSPL	20467.9
7	RJIL OFC CABLE	20469.74
8	EX.8 INCH GAS LINE	20511.35
9	EX.10 INCH PL	20512.6
10	EX. 4"Ø OIL INDIA PL	20533.01
11	EX. 4"Ø OIL INDIA PL	20533.2
12	EX. 4"Ø OIL INDIA PL	20533.46
13	EX. 4"Ø OIL INDIA PL	20533.78
14	EX. 4"Ø OIL INDIA PL	20534.19
15	EX. 4"Ø OIL INDIA PL	20606.06
16	EX. 4"Ø OIL INDIA PL	20606.35
17	EX. 4"Ø OIL INDIA PL	20606.51
18	EX. 4"Ø OIL INDIA PL	20606.66

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR. NO.	DESCRIPTION	CHAINAGE (m)
19	EX. 4"Ø OIL INDIA PL	20607.03
20	EX. 4"Ø OIL INDIA PL	35128.29
21	EX. 4"Ø OIL INDIA PL	35128.78
22	EX. 4"Ø OIL INDIA PL	35136.54
23	EX. 4"Ø OIL INDIA PL	35137.03
24	EX. 4"Ø OIL INDIA PL	35137.53
25	EX. 4"Ø OIL INDIA PL	35138.03
26	EX. 4"Ø OIL INDIA PL	35138.52
27	EX. 400 MM NATURAL GAS PL FROM BAGJAN EPS TO MADHUBAN CGGS	37118.5
28	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	37344.44

2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)

SR. NO.	DESCRIPTION	CHAINAGE (m)
1	EX. 4"Ø OIL INDIA PL	44.14
2	EX. 4"Ø OIL INDIA PL	44.37
3	EX. 4"Ø OIL INDIA PL	44.64
4	EX. 4"Ø OIL INDIA PL	44.77
5	EX. 4"Ø OIL INDIA PL	44.90
6	EX. 4"Ø OIL INDIA PL	45.08
7	EX. 4"Ø OIL INDIA PL	45.28
8	EX. 4"Ø OIL INDIA PL	45.46
9	EX. 4"Ø OIL INDIA PL	45.61
10	EX. 4"Ø OIL INDIA PL	45.83
11	EX. 4"Ø OIL INDIA PL	97.68
12	EX. 4"Ø OIL INDIA PL	97.85
13	EX. 4"Ø OIL INDIA PL	98.17

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

SR. NO.	DESCRIPTION	CHAINAGE (m)
14	EX. 4"Ø OIL INDIA PL	98.43
15	EX. 4"Ø OIL INDIA PL	98.88
16	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	132.24
17	EX. 4"Ø OIL INDIA PL	9018.45
18	EX. 4"Ø OIL INDIA PL	12233.66
19	EX. 4"Ø OIL INDIA PL	14587.10
20	EX. 4"Ø OIL INDIA PL	14587.58
21	EX. 4"Ø OIL INDIA PL	14588.06
22	EX. 4"Ø OIL INDIA PL	14596.16
23	EX. 4"Ø OIL INDIA PL	14596.65
24	EX. 4"Ø OIL INDIA PL	14597.14
25	EX. 4"Ø OIL INDIA PL	14597.63
26	EX. 4"Ø OIL INDIA PL	14598.13
27	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	16554.86
28	EX. 400 MM NATURAL GAS PL FROM BAGJAN EPS TO MADHUBAN CGGS	16557.08
29	EX. 200 MM ND CRUDE OIL PL FROM BAGJAN EPS TO MADHUBAN CGGS	16781.20

ANNEXURE –VII(A)

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

POPULATION DENSITY INDEX-AT A GLANCE

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban (Along Existing & Proposed RoU)

Location Class	LENGTH (km)
I	6.400
II	12.166
III	19.200
IV	-
TOTAL LENGTH (km)	37.766

2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)

Location Class	LENGTH (km)
I	-
II	6.006
III	11.200
IV	-
TOTAL LENGTH (km)	17.206

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

BROAD POPULATION DENSITY INDEX

**1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban
(Along Existing & Proposed RoU)**

Sr. No.	Chainage (km)		Stretch (km)	Location Class	Total No. of Dwellings	Remarks
	From	To				
1	0.000	1.600	1.600	III	60	HOUSES
2	1.600	3.200	1.600	II	40	HOUSES
3	3.200	4.800	1.600	III	85	VILLAGE SITE BAGHJAN
4	4.800	6.400	1.600	I	4	HOUSES
5	6.400	8.000	1.600	I	10	HOUSES
6	8.000	9.600	1.600	I	1	HOUSE
7	9.600	11.200	1.600	II	12	HOUSES
8	11.200	12.800	1.600	II	45	VILLAGE SITE LONGSOWAL T.E. 254 Nir
9	12.800	14.400	1.600	II	17	HOUSES
10	14.400	16.000	1.600	I	1	HOUSE
11	16.000	17.600	1.600	III	95	VILLAGE SITE (BETJAN GAON & MAKUM JUNCTION GAON)
12	17.600	19.200	1.600	III	90	VILLAGE SITE MAKUM JUNCTION GAON
13	19.200	20.800	1.600	III	72	VILLAGE SITE MAKUM
14	20.800	22.400	1.600	III	49	HOUSES
15	22.400	24.000	1.600	III	47	HOUSES
16	24.000	25.600	1.600	II	18	HOUSES

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Chainage (km)		Stretch (km)	Location Class	Total No. of Dwellings	Remarks
	From	To				
17	25.600	27.200	1.600	III	65	VILLAGE SITE CHARALI
18	27.200	28.800	1.600	II	44	VILLAGE SITE CHARALI
19	28.800	30.400	1.600	III	60	VILLAGE SITE BORBHETA BONGALI GAON
20	30.400	32.000	1.600	II	38	VILLAGE SITE BORJAN GAON
21	32.000	33.600	1.600	III	75	VILLAGE SITE KONWARI PATHAR GAON
22	33.600	35.200	1.600	III	77	VILLAGE SITE KONWARI PATHAR BLOCK 2
23	35.200	36.800	1.600	III	93	VILLAGE SITE MOHKHULI GAON
24	36.800	37.766	0.966	II	45	VILLAGE SITE MOHKHULI GAON & CGGS MADHUBAN
Total Length (km)			37.766			

2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)

Sr. No.	Chainage (km)		Stretch (km)	Location Class	Total No. of Dwellings	Remarks
	From	To				
1	0.000	1.600	1.600	III	49	HOUSES
2	1.600	3.200	1.600	III	47	HOUSES
3	3.200	4.800	1.600	II	18	HOUSES
4	4.800	6.400	1.600	III	65	VILLAGE SITE CHARALI
5	6.400	8.000	1.600	II	44	VILLAGE SITE CHARALI
6	8.000	9.600	1.600	III	60	VILLAGE SITE BORBHETA BONGALI GAON
7	9.600	11.200	1.600	II	38	VILLAGE SITE BORJAN GAON
8	11.200	12.800	1.600	III	75	VILLAGE SITE KONWARI PATHAR GAON
9	12.800	14.400	1.600	III	77	VILLAGE SITE KONWARI PATHAR BLOCK 2
10	14.400	16.000	1.600	III	93	VILLAGE SITE MOHKHULI GAON
11	16.000	17.206	1.206	II	45	VILLAGE SITE MOHKHULI GAON & CGGS MADHUBAN
Total Length (km)			17.206			

ANNEXURE –VIII

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

TERRAIN DETAILS

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban (Along Existing & Proposed RoU)

Sr. No.	Chainage (km)		Length (km)	Terrain
	Start	End		
1	0.00	4.18	4.18	Flat
2	4.18	5.00	0.82	Slightly undulating
3	5.00	37.77	32.77	Flat
	Total		37.77	

2) Proposed 16"Ø Gas Pipeline from O.I.L Makum OCS to CGGS Madhuban (Along Existing RoU)

Sr. No.	Chainage (km)		Length (km)	Terrain
	Start	End		
1	0	17.206	17.206	Flat
	Total		17.206	

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

DETAILS OF EXISTING UNDERGROUND UTILITIES ALONG RoU

**1) EX. 400 mm ø NATURAL GAS PIPELINE FROM BAGHJAN
EPS/GGS TO CGGS MADHUBAN**

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
1	1.21	3050552.5760	742086.4850
2	1.25	3050544.4760	742125.9730
3	1.17	3050538.4570	742155.8330
4	1.17	3050538.4090	742156.0380
5	1.32	3050526.7800	742211.8690
6	1.13	3050522.9190	742224.8060
7	1.07	3050510.4750	742242.9450
8	1.37	3050500.7210	742250.9010
9	1.22	3050491.4560	742258.9120
10	1.45	3050470.5320	742276.1660
11	1.23	3050451.8840	742292.2990
12	1.20	3050409.6690	742327.9240
13	1.28	3050367.1860	742363.9120
14	1.17	3050329.2120	742396.6930
15	1.78	3050277.2290	742440.8380
16	1.45	3050228.4220	742481.3600
17	1.67	3050202.2830	742503.1210
18	1.50	3050162.9940	742536.5980
19	0.90	3050142.4290	742554.1520
20	35.00	3050122.2340	742571.1770
21	1.36	3050118.4550	742573.9380
22	1.36	3050081.2440	742614.4000
23	1.41	3050080.9030	742614.2040
24	1.02	3050028.4850	742675.6280
25	1.03	3049980.9480	742730.0640
26	1.03	3049966.4070	742769.4640
27	1.08	3049958.1700	742812.0000
28	1.00	3049941.1930	742895.6760
29	1.05	3049930.9690	742943.4160

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
30	1.21	3049908.9660	743054.3430
31	1.36	3049877.3910	743204.2940
32	1.36	3049873.2820	743214.0160
33	1.07	3049869.0910	743220.6100
34	1.17	3049860.4750	743230.3030
35	1.57	3049798.4350	743283.7740
36	1.17	3049671.6030	743405.1830
37	1.27	3049575.8970	743494.5160
38	1.27	3049546.4840	743522.2970
39	1.15	3049516.6910	743551.2610
40	1.15	3049514.7450	743552.9310
41	1.13	3049401.7540	743662.5490
42	1.53	3049329.6050	743731.8180
43	1.53	3049329.5810	743731.8040
44	1.63	3049301.2070	743756.2740
45	1.63	3049299.5360	743757.7430
46	1.63	3049296.4670	743758.7530
47	1.63	3049292.1900	743759.8370
48	1.63	3049286.9890	743760.4540
49	1.44	3049281.4760	743760.9830
50	1.52	3049272.8760	743759.9740
51	1.44	3049212.1300	743750.3150
52	1.49	3049169.8430	743743.6330
53	1.39	3049154.6780	743740.7480
54	1.39	3049151.2730	743739.3950
55	1.39	3049145.4960	743736.9840
56	1.39	3049140.6770	743734.0350
57	1.39	3049137.0860	743731.4430
58	1.21	3049131.3010	743726.6780
59	1.21	3049071.3330	743666.8580
60	1.21	3049067.1470	743663.5340
61	0.86	3049006.8170	743627.8640
62	1.43	3048909.9870	743574.4340
63	2.15	3048875.3330	743555.2600
64	1.90	3048859.2440	743551.1350
65	1.90	3048852.4890	743550.5850
66	1.70	3048832.6580	743553.6800
67	1.70	3048811.4330	743557.2640
68	1.70	3048803.6070	743557.2800
69	1.72	3048782.8530	743552.4390
70	1.74	3048740.2320	743542.7150

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
71	1.74	3048712.6800	743536.2760
72	1.74	3048670.9170	743526.5030
73	1.74	3048641.3610	743526.0090
74	1.64	3048570.4180	743527.2500
75	1.55	3048528.5890	743528.2330
76	1.48	3048452.1020	743531.5670
77	1.89	3048398.0450	743533.6410
78	1.58	3048281.6780	743539.0080
79	1.31	3048136.6880	743545.9050
80	1.62	3048091.7680	743547.3540
81	1.41	3048022.4730	743550.6410
82	1.77	3047923.9560	743555.6260
83	1.31	3047865.3730	743558.5540
84	1.68	3047797.9170	743538.0520
85	2.08	3047785.3120	743531.5710
86	1.67	3047590.2480	743437.2590
87	1.83	3047466.3220	743451.3800
88	1.38	3047217.8790	743490.5000
89	1.33	3047107.0330	743515.4470
90	1.20	3046930.1880	743557.3600
91	1.07	3046844.5360	743577.1560
92	1.50	3046710.6530	743607.5240
93	1.49	3046562.0270	743642.2240
94	2.26	3046409.7600	743676.6840
95	1.48	3046274.4260	743709.8800
96	1.27	3046172.6450	743733.8960
97	1.12	3046091.1910	743752.7220
98	2.24	3046079.8600	743754.6220
99	2.24	3046073.5340	743754.4950
100	2.24	3046069.3990	743753.5700
101	2.24	3046064.9030	743751.9290
102	2.36	3046056.8420	743747.9970
103	2.36	3046050.7430	743743.5890
104	1.24	3046037.9190	743726.9190
105	1.29	3045992.0370	743663.2820
106	2.36	3045982.7580	743648.5910
107	1.03	3045968.0740	743630.2510
108	2.36	3045928.6210	743588.0600
109	1.72	3045916.8330	743576.7740
110	1.90	3045905.6400	743562.9710
111	1.50	3045893.0020	743537.3550

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
112	1.50	3045843.1590	743446.7440
113	1.61	3045835.9190	743437.5820
114	2.36	3045827.7010	743427.9320
115	1.48	3045814.6660	743420.5110
116	2.06	3045789.5340	743405.5140
117	0.85	3045602.1370	743294.6100
118	1.15	3045574.5960	743278.0770
119	1.66	3045554.7910	743266.3030
120	1.31	3045502.7370	743235.6610
121	1.85	3045458.0790	743208.4550
122	1.54	3045407.7840	743177.1350
123	1.35	3045395.1920	743169.0670
124	0.89	3045359.8690	743122.9210
125	1.36	3045326.8950	743075.9030
126	0.86	3045289.1780	743022.8630
127	2.34	3045245.4740	742960.5340
128	1.20	3045202.1860	742900.1870
129	0.75	3045170.3030	742854.1070
130	1.00	3045120.6890	742781.5530
131	1.00	3045064.7330	742703.1750
132	0.88	3045026.8790	742649.3110
133	1.63	3044999.8040	742611.7250
134	1.59	3044990.7500	742601.9220
135	1.73	3044983.4050	742596.4440
136	1.23	3044978.3180	742592.4910
137	1.58	3044910.2470	742563.0500
138	1.35	3044877.5730	742549.6280
139	0.91	3044818.1320	742522.8250
140	1.32	3044673.5090	742376.9240
141	1.32	3044628.8750	742330.6790
142	0.77	3044578.0180	742281.3760
143	1.25	3044534.5250	742236.6330
144	1.67	3044515.1260	742217.3020
145	1.53	3044481.3920	742167.4030
146	1.27	3044370.5930	742009.1510
147	1.48	3044303.5390	741911.4510
148	1.63	3044241.3900	741818.9090
149	1.44	3044220.7650	741788.1960
150	1.46	3044183.0250	741732.7850
151	1.14	3044156.2680	741692.4320
152	1.36	3044117.9530	741634.6200

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
153	1.47	3044093.0470	741598.8930
154	1.20	3044085.0790	741586.8280
155	1.63	3044080.5260	741572.4430
156	1.10	3044063.1810	741446.9160
157	1.39	3044040.1370	741293.5520
158	0.39	3044052.2870	741364.5170
159	1.45	3044020.5540	741184.9430
160	1.11	3043981.8470	741011.0180
161	1.86	3043940.4480	740848.2390
162	1.71	3043878.8840	740588.6530
163	1.39	3043842.3730	740417.0390
164	2.65	3043791.1020	740151.1760
165	2.44	3043863.2750	739890.6750
166	2.16	3043863.7010	739885.1680
167	2.50	3043855.8610	739849.0600
168	2.18	3043847.3740	739814.7220
169	2.21	3043838.8930	739761.0380
170	2.21	3043834.4640	739732.4320
171	2.47	3043830.0780	739713.4480
172	2.48	3043681.1610	739406.5230
173	1.98	3043671.2200	739384.5480
174	1.36	3043636.9710	739300.1060
175	1.29	3043623.4180	739259.6490
176	1.13	3043605.3550	739230.4170
177	1.10	3043542.6020	739183.4390
178	2.58	3043510.9200	739158.4760
179	1.00	3043479.3980	739140.9710
180	1.31	3043460.2060	739130.4650
181	1.26	3043433.8780	739114.2290
182	0.69	3043423.0790	739109.1460
183	1.15	3043403.3340	739111.5950
184	2.05	3043384.5180	739123.9460
185	1.12	3043364.9970	739136.3100
186	2.53	3043354.0050	739143.4330
187	1.23	3043334.4850	739157.2490
188	1.23	3043301.3240	739183.4780
189	1.34	3043236.5990	739233.9660
190	1.27	3043154.4130	739295.2670
191	1.14	3043078.7850	739353.3240
192	0.98	3043034.7390	739389.3100
193	1.21	3042970.7800	739416.5970

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
194	1.35	3042852.0410	739418.0920
195	1.37	3042765.8080	739416.5620
196	3.98	3042662.2300	739405.2260
197	1.60	3042661.3260	739404.2960
198	3.53	3042655.5120	739403.3570
199	2.81	3042647.6400	739399.2710
200	3.86	3042640.9500	739397.8860
201	3.53	3042634.0530	739395.4410
202	2.63	3042623.4580	739390.1000
203	2.22	3042617.3330	739387.7500
204	2.22	3042615.9700	739387.2430
205	1.32	3042610.0010	739386.0980
206	0.00	3042603.9060	739386.1340
207	1.35	3042599.4920	739386.5800
208	1.41	3042593.5770	739388.0630
209	1.22	3042582.2550	739391.5600
210	1.25	3042576.3280	739393.4080
211	1.48	3042557.7640	739396.5520
212	1.15	3042537.3720	739397.5040
213	1.06	3042526.5300	739397.7100
214	0.93	3042506.6920	739397.4660
215	1.14	3042491.2800	739397.6030
216	1.07	3042480.7680	739397.5450
217	1.51	3042473.9230	739397.5640
218	1.67	3042466.2500	739397.5280
219	0.98	3042457.3850	739397.5320
220	1.41	3042437.0840	739395.7420
221	1.59	3042416.7160	739384.2670
222	1.55	3042374.6730	739355.8280
223	1.88	3042341.0530	739332.4060
224	1.79	3042312.5040	739311.4970
225	1.85	3042264.6000	739277.6660
226	1.83	3042179.0360	739216.9210
227	1.78	3042158.2440	739202.9610
228	1.95	3042110.9510	739171.0110
229	2.43	3042088.3000	739154.7520
230	1.72	3042061.5840	739136.1750
231	1.72	3042059.3870	739133.5620
232	1.72	3042057.9390	739132.0120
233	1.72	3042056.0480	739129.4010
234	1.82	3042044.1750	739103.8030

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
235	2.23	3042032.8000	739073.6270
236	1.44	3042014.9700	739023.0510
237	1.42	3042004.5930	738973.6640
238	1.23	3041993.5180	738874.9360
239	1.15	3041995.0500	738862.6720
240	1.37	3042005.7980	738841.3310
241	1.23	3042036.8300	738780.2030
242	1.23	3042040.5770	738773.1450
243	1.42	3042055.1020	738743.3230
244	0.93	3042067.5530	738718.7030
245	1.67	3042075.8670	738703.4240
246	1.46	3042078.7170	738691.6860
247	1.63	3042073.9590	738660.9940
248	1.21	3042067.7460	738623.9150
249	1.20	3042063.8740	738599.8150
250	1.55	3042064.3450	738585.6670
251	1.25	3042065.4440	738552.7300
252	1.25	3042054.1720	738506.9540
253	1.56	3042046.3300	738475.6280
254	1.23	3042023.8030	738389.9370
255	1.27	3042011.4760	738342.2300
256	1.41	3041999.1740	738288.3340
257	1.20	3041994.6970	738253.0850
258	1.32	3041991.6300	738210.3890
259	0.70	3041988.1400	738169.0160
260	0.92	3041987.3670	738154.5950
261	1.42	3041982.0190	738109.9640
262	1.70	3041970.4290	738050.5550
263	1.50	3041963.5160	737989.1450
264	1.58	3041961.0560	737950.7090
265	1.35	3041926.0090	737836.7440
266	1.13	3041910.3750	737787.1840
267	1.11	3041903.9320	737769.6920
268	1.67	3041844.8550	737646.6640
269	1.75	3041807.0940	737563.7450
270	1.37	3041780.7380	737507.2580
271	1.52	3041720.0360	737379.3910
272	1.34	3041687.4010	737314.6430
273	1.37	3041664.5460	737270.8330
274	1.41	3041632.8880	737208.6410
275	1.93	3041619.2680	737179.8410

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
276	0.71	3041566.0680	737098.4650
277	0.73	3041542.4770	737062.6700
278	1.31	3041476.3880	736962.3540
279	1.43	3041406.7400	736855.2360
280	1.44	3041355.2090	736776.5250
281	1.39	3041252.6700	736620.0530
282	1.14	3041146.3580	736451.7270
283	1.53	3041088.7490	736331.7250
284	1.89	3041068.7050	736289.4730
285	1.01	3041027.9480	736206.6070
286	1.04	3040995.0870	736139.4310
287	1.46	3040972.2110	736091.5810
288	1.83	3040946.2770	736032.8620
289	1.52	3040915.4890	735963.9670
290	1.48	3040892.2760	735909.6530
291	1.19	3040820.3990	735744.1650
292	1.55	3040808.2210	735717.0540
293	1.28	3040759.1990	735606.9780
294	1.96	3040744.8080	735573.9700
295	1.38	3040729.5120	735540.5160
296	1.24	3040693.0230	735509.4740
297	1.28	3040658.9340	735490.2200
298	1.45	3040606.7300	735461.3060
299	1.25	3040577.3220	735446.2870
300	1.21	3040529.4220	735424.3890
301	1.98	3040478.0550	735401.4100
302	1.17	3040405.5730	735369.4120
303	2.06	3040284.2560	735298.9640
304	1.11	3040230.7450	735266.6870
305	1.36	3040176.4000	735242.0300
306	3.00	3040167.7830	735240.0420
307	1.66	3040104.2340	735213.1320
308	1.58	3040103.6980	735213.0500
309	1.25	3040023.9370	735177.8629
310	2.64	3039905.7870	735151.2220
311	1.83	3039905.8140	735151.8160
312	1.94	3039897.0920	735149.3240
313	1.23	3039894.1460	735147.9490
314	1.23	3039891.9520	735146.5520
315	1.25	3039891.7270	735146.6092
316	1.25	3039879.8700	735135.0153

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
317	1.37	3039878.3220	735130.7450
318	1.25	3039792.3580	734975.6435
319	1.25	3039764.3610	734821.3981
320	1.27	3039752.1370	734787.2490
321	0.90	3039735.6270	734747.8071
322	1.46	3039706.7970	734701.3540
323	1.32	3039678.6360	734652.7710
324	1.99	3039647.2150	734586.8800
325	1.32	3039634.5760	734559.9910
326	0.82	3039610.1110	734509.3680
327	0.82	3039592.0470	734454.1840
328	1.74	3039629.6120	734282.1710
329	2.95	3039634.0700	734261.7011
330	1.62	3039641.9400	734236.8820
331	0.79	3039669.1340	734151.7750
332	2.95	3039700.9220	734073.3200
333	2.95	3039704.9410	734063.3999
334	2.31	3039673.1110	734002.5190
335	2.83	3039668.7750	733992.7020
336	1.10	3039657.9570	733971.5550
337	0.68	3039620.6880	733899.0840
338	1.59	3039615.5900	733876.4840
339	1.09	3039605.4620	733839.2400
340	1.25	3039598.3100	733801.5520
341	1.36	3039586.9560	733739.6840
342	2.33	3039583.8950	733717.5180
343	1.56	3039583.5700	733689.3660
344	1.40	3039586.6540	733663.7630
345	1.57	3039593.6150	733614.8930
346	1.57	3039593.4150	733599.3950
347	1.64	3039579.9930	733585.3980
348	1.36	3039455.7970	733471.1130
349	1.49	3039416.5390	733453.9890
350	2.00	3039375.1310	733437.6490
351	1.73	3039295.2960	733410.7640
352	1.91	3039267.2150	733402.1260
353	1.59	3039221.7040	733389.0370
354	1.60	3039166.5540	733375.2790
355	2.53	3038998.5370	733373.4300
356	2.35	3038966.4350	733372.8600
357	1.54	3038837.3210	733371.7610

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
358	1.49	3038708.3790	733370.1440
359	1.62	3038684.7620	733369.7870
360	1.54	3038566.4570	733368.8030
361	1.52	3038462.1030	733367.4720
362	1.52	3038374.1340	733366.4430
363	1.49	3038330.6130	733363.4390
364	1.64	3038234.5030	733335.1580
365	1.10	3038196.9480	733325.8840
366	1.19	3038130.4650	733310.3870
367	1.12	3038066.8710	733294.4190
368	0.03	3037909.4870	733258.5240
369	1.45	3037841.5890	733241.2430
370	1.42	3037602.3640	733130.7810
371	1.41	3037494.6280	733078.1700
372	1.23	3037442.6570	733052.7440
373	1.76	3037386.4300	733023.7880
374	1.68	3037380.7520	733021.1150
375	1.63	3037370.6290	733019.7370
376	0.94	3037224.5150	733095.9090
377	0.94	3037185.8210	733101.6140
378	1.00	3037115.3770	733084.5670
379	0.98	3036982.7420	733052.2930
380	2.24	3036899.5450	733041.5410
381	2.17	3036885.3470	733036.1070
382	1.40	3036787.9160	732996.6900
383	1.34	3036629.9860	732944.7310
384	1.46	3036565.0590	732926.2480
385	1.57	3036534.5340	732918.0270
386	1.54	3036460.6920	732897.3600
387	1.42	3036382.6940	732876.8020
388	1.77	3036308.0110	732864.8410
389	3.17	3036091.2950	732827.5770
390	1.69	3036061.2080	732815.6830
391	1.67	3035971.6730	732775.1400
392	1.47	3035819.1370	732705.8580
393	1.32	3035743.8950	732671.0230
394	1.53	3035635.8250	732627.1520
395	1.42	3035542.2090	732546.4250
396	1.49	3035516.2330	732525.2040
397	1.22	3035408.1150	732477.0520
398	1.41	3035362.6570	732462.4170

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
399	1.47	3035252.1730	732428.6540
400	1.37	3035139.6000	732391.3180
401	1.47	3035048.9180	732361.3790
402	1.78	3034949.8310	732326.2800
403	1.61	3034902.2030	732272.4500
404	1.28	3034882.9650	732239.9239
405	1.61	3034874.1320	732229.8080
406	0.78	3034694.9960	732056.7590
407	1.67	3034650.2580	732011.8030
408	1.65	3034586.6200	731949.9750
409	1.65	3034534.2470	731899.5410
410	1.65	3034507.2400	731873.4460
411	1.38	3034469.2960	731837.5930
412	1.19	3034439.7400	731808.6930
413	1.56	3034419.3750	731797.5053
414	2.65	3034373.3540	731810.4558
415	1.17	3034338.3370	731821.7740
416	1.67	3034224.1520	731851.1550
417	1.85	3034110.6870	731871.7310
418	1.55	3033958.3120	731897.5800
419	1.18	3033874.1030	731912.7500
420	1.72	3033785.4520	731929.4330
421	1.35	3033699.9870	731953.3230
422	1.35	3033686.9410	731969.6220
423	1.19	3033600.7930	732077.1430
424	1.42	3033522.1700	732105.6840
425	1.04	3033442.6380	732091.3400
426	2.00	3033373.8090	732091.3950
427	1.20	3033322.5110	732100.5410
428	1.79	3033201.3860	732120.2410
429	1.02	3033150.6450	732128.0140
430	8.66	3032956.3420	732100.7374
431	2.38	3032900.4700	732110.4831
432	1.28	3032809.7010	732134.3550
433	1.55	3032693.2910	732086.9350
434	1.73	3032642.8920	732064.1670
435	1.59	3032588.5480	732026.6480
436	2.01	3032546.5950	731997.1600
437	2.10	3032529.4760	731985.0863
438	2.15	3032425.5360	731916.4557
439	1.71	3032346.1770	731865.5670

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
440	1.64	3032286.9080	731830.4470
441	1.29	3032193.3020	731776.2720
442	1.89	3032126.9280	731722.0520
443	1.59	3032045.1660	731655.7400
444	1.90	3031938.6040	731569.2230
445	1.89	3031770.8000	731445.8750
446	1.97	3031738.5520	731422.2710
447	1.38	3031707.1410	731398.2040
448	1.57	3031623.7830	731308.4850
449	2.15	3031554.7170	731234.4020
450	1.31	3031518.7440	731197.1480
451	1.59	3031467.2300	731142.8970
452	2.01	3031386.3400	731057.3600
453	1.30	3031362.8200	731032.8550
454	1.29	3031350.1320	731020.7720
455	1.29	3031289.7930	730974.2081
456	1.93	3031267.0310	730929.8870
457	3.38	3031262.0340	730921.2524
458	2.09	3031250.7060	730906.4429
459	2.00	3031249.9390	730905.4460
460	2.00	3031248.9840	730904.7070
461	2.09	3031247.6690	730903.9940
462	2.02	3031242.3980	730901.5900
463	2.23	3031227.8420	730899.0367
464	3.67	3031170.6620	730889.0070
465	2.10	3031153.4410	730885.8230
466	1.84	3031135.2530	730882.6010
467	2.16	3031106.6000	730878.2360
468	1.87	3031074.5400	730872.5930
469	1.60	3031045.7310	730867.5560
470	1.98	3031028.0040	730865.5910
471	2.19	3031014.0560	730864.0470
472	2.19	3030971.9380	730858.5510
473	2.40	3030946.5290	730854.8200
474	2.16	3030928.1370	730851.6158
475	2.35	3030892.5030	730845.4078
476	2.54	3030815.6680	730832.0217
477	2.24	3030772.0920	730824.4300
478	1.86	3030718.3080	730816.8042
479	1.94	3030664.5830	730818.2988
480	1.77	3030588.1700	730820.4250
481	1.42	3030542.0190	730807.5689
482	1.01	3030539.5290	730785.4014

**2) EX. 200 mm ø ND CRUDE OIL PL FROM BAGHJAN
EPS/GGS TO CGGS MADHUBAN**

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
1	1.00	3050473.5280	742278.0420
2	1.08	3050454.2900	742294.7460
3	1.02	3050411.9890	742330.4396
4	1.00	3050370.0600	742365.8200
5	1.00	3050331.4110	742399.5090
6	1.20	3050281.6080	742442.7800
7	1.07	3050230.6570	742485.5153
8	1.00	3050206.5800	742505.7100
9	1.00	3050165.9620	742539.6475
10	1.00	3050142.2500	742559.4600
11	0.89	3050126.1820	742573.1988
12	0.89	3050122.4730	742576.3695
13	0.89	3050119.6670	742578.7688
14	0.91	3050083.8800	742617.0564
15	0.80	3050030.9840	742677.2950
16	0.85	3049985.6150	742730.3960
17	1.02	3049968.8270	742772.1940
18	0.85	3049961.4610	742811.3060
19	0.77	3049944.7360	742895.5720
20	0.78	3049934.5550	742943.6710
21	0.73	3049911.8250	743055.0940
22	0.81	3049879.9420	743204.0740
23	0.95	3049872.1660	743222.9450
24	0.95	3049864.4440	743231.1380
25	1.23	3049800.4070	743287.7410
26	0.92	3049675.3970	743406.1260
27	0.92	3049579.9290	743495.7940
28	0.00	3049517.2150	743556.3760
29	0.89	3049404.6540	743664.6780
30	0.20	3049332.6800	743734.2270
31	1.44	3049303.3510	743758.9850
32	0.91	3049270.5710	743764.0730
33	1.04	3049211.4310	743754.0040
34	1.04	3049173.3340	743747.7650
35	0.85	3049163.0920	743746.0269

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
36	0.99	3049152.6480	743744.2542
37	0.99	3049144.4800	743742.1060
38	0.99	3049139.4710	743739.4690
39	0.99	3049134.3870	743735.2640
40	0.99	3049127.9770	743728.6430
41	0.79	3049069.1110	743669.4538
42	0.53	3049005.2670	743631.0490
43	2.13	3048909.8410	743578.2170
44	1.00	3048872.9280	743558.5650
45	1.00	3048859.1880	743553.4520
46	1.00	3048833.1100	743557.6230
47	0.05	3048637.9120	743530.2030
48	1.03	3048136.3010	743550.4660
49	1.30	3048092.3380	743552.9650
50	0.86	3047918.5660	743560.6840
51	1.23	3047864.3830	743561.4220
52	1.76	3047680.1400	743470.7190
53	1.78	3047622.3150	743438.8394
54	1.08	3047589.9170	743442.2920
55	1.20	3047466.9350	743455.3980
56	1.34	3047346.5260	743468.7160
57	1.95	3047104.3460	743521.5460
58	1.19	3046933.6740	743561.0950
59	1.00	3046845.4770	743580.5760
60	1.00	3046711.6870	743611.5380
61	1.08	3046564.3890	743646.1050
62	1.52	3046406.6180	743682.1840
63	1.69	3046384.9640	743687.3140
64	1.39	3046276.1560	743714.1510
65	1.89	3046173.4590	743738.2070
66	1.03	3046091.7260	743757.0660
67	1.03	3046081.5020	743759.5950
68	1.03	3046075.8030	743760.0420
69	1.03	3046070.7250	743758.9190
70	0.64	3046066.7710	743757.5630
71	1.18	3046046.6560	743745.3460
72	1.31	3046035.1880	743729.2180
73	1.03	3045978.1250	743651.1279
74	1.97	3045964.3280	743632.2470
75	1.16	3045923.7050	743589.2440

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
76	1.00	3045913.8330	743578.1890
77	1.89	3045902.9050	743563.1230
78	1.05	3045888.8050	743537.2930
79	1.07	3045840.9420	743449.0100
80	1.25	3045834.3020	743438.9250
81	1.03	3045824.6120	743430.9010
82	1.03	3045815.3210	743425.4750
83	2.05	3045787.8290	743409.8800
84	1.18	3045599.6260	743297.9860
85	1.46	3045552.2850	743270.0570
86	1.52	3045501.1880	743240.0500
87	1.22	3045458.3080	743213.0180
88	1.14	3045403.7390	743181.0155
89	1.69	3045391.9880	743172.5060
90	1.33	3045356.0530	743123.9990
91	1.74	3045323.4630	743078.8150
92	1.44	3045288.0550	743028.1660
93	1.20	3045242.4620	742963.3620
94	0.82	3045199.2530	742901.8900
95	1.32	3045167.1340	742856.2460
96	1.10	3045117.9820	742785.5260
97	1.15	3045061.3190	742705.3440
98	1.23	3045023.8420	742651.5710
99	1.11	3044994.6620	742611.8690
100	1.22	3044987.8210	742603.6450
101	0.89	3044977.3270	742595.9130
102	1.71	3044907.7440	742566.8010
103	1.03	3044875.4650	742553.0000
104	0.81	3044815.3090	742525.3950
105	0.86	3044671.6960	742379.2920
106	0.67	3044627.2350	742334.3960
107	1.08	3044575.1340	742282.9210
108	1.08	3044532.1490	742239.9680
109	1.34	3044516.7160	742224.5190
110	1.10	3044368.0700	742010.2810
111	1.01	3044301.1470	741912.9320
112	1.21	3044217.6160	741789.3643
113	1.01	3044153.9190	741694.4180
114	1.38	3044115.1990	741638.3170
115	1.32	3044090.1280	741601.2710
116	1.28	3044081.1150	741587.9528

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
117	1.39	3044077.4390	741573.5408
118	1.20	3044059.9260	741446.6600
119	0.49	3044050.2870	741363.9260
120	1.59	3044036.7030	741294.5710
121	1.75	3043789.7660	740157.8470
122	2.44	3043854.2480	739849.3700
123	1.11	3043602.4220	739234.3110
124	1.75	3043537.8280	739186.4450
125	1.75	3043506.6850	739164.0220
126	1.07	3043475.8350	739145.1480
127	1.98	3043459.0430	739136.1940
128	1.83	3043435.6640	739122.6520
129	1.55	3043404.5530	739115.5750
130	1.02	3043356.5550	739148.3722
131	0.77	3043350.5960	739151.8515
132	0.89	3043337.0450	739159.7630
133	0.86	3043228.4570	739244.1100
134	1.44	3042970.9540	739421.1330
135	1.44	3042850.7980	739422.5530
136	1.00	3042767.1160	739420.1913
137	1.02	3042679.4420	739424.4648
138	1.47	3042431.3290	739398.6516
139	1.55	3042414.7370	739388.6380
140	1.47	3042371.6740	739359.3371
141	1.17	3042222.1280	739252.8420
142	0.59	3042172.5640	739218.1970
143	0.68	3042153.8080	739205.1930
144	0.97	3042109.9810	739175.3450
145	1.26	3042086.7180	739160.1100
146	1.14	3042062.1520	739142.3900
147	1.27	3042050.9540	739129.5860
148	1.27	3042040.9970	739106.5780
149	1.73	3042027.5950	739075.2360
150	1.55	3042010.4820	739023.9510
151	1.13	3041999.3540	738973.0465
152	1.68	3041989.1370	738874.6374
153	1.20	3041988.9180	738861.5493
154	1.65	3042001.3830	738837.7040
155	1.37	3042032.3130	738777.9570
156	1.37	3042049.9000	738742.4340
157	1.79	3042061.7010	738719.2830

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
158	88.00	3042071.4790	738701.6720
159	1.21	3042074.4620	738692.5830
160	0.85	3042069.9250	738660.4730
161	1.53	3042063.4300	738623.8790
162	1.00	3042059.9240	738600.4400
163	1.53	3042060.9550	738583.6270
164	1.53	3042061.0020	738555.9763
165	0.76	3042049.5540	738507.9350
166	1.62	3042041.7960	738479.5250
167	1.72	3042019.0450	738389.4760
168	1.57	3042006.6750	738342.2810
169	1.43	3041994.1500	738289.0110
170	1.77	3041989.0540	738254.5560
171	1.72	3041986.4840	738210.0830
172	1.44	3041984.0060	738170.2660
173	1.39	3041983.4990	738155.2180
174	1.39	3041977.0680	738111.1040
175	1.39	3041965.6370	738051.1210
176	1.47	3041958.3410	737988.5470
177	1.22	3041955.7010	737951.6360
178	1.56	3041921.0490	737838.3394
179	1.42	3041905.8940	737793.6310
180	1.52	3041897.7320	737770.8840
181	1.65	3041886.0440	737742.1890
182	1.25	3041840.1260	737648.6630
183	1.35	3041801.1770	737564.6130
184	1.60	3041775.6330	737509.6920
185	1.65	3041713.8180	737380.6740
186	1.84	3041680.5490	737315.1040
187	1.84	3041660.9320	737276.5770
188	1.49	3041627.2930	737209.2770
189	1.55	3041562.2740	737099.2830
190	1.52	3041477.0690	736971.4760
191	1.34	3041296.3190	736697.3750
192	1.15	3041139.6220	736450.0560
193	1.15	3041104.7120	736378.3655
194	1.74	3041082.2860	736332.3110
195	1.15	3041061.5800	736290.5840
196	1.16	3041021.3450	736207.4810
197	1.91	3040989.0340	736141.4370
198	1.45	3040964.8210	736090.6560

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
199	2.53	3040936.2180	736030.5270
200	2.02	3040909.1790	735966.3090
201	1.34	3040884.4620	735907.4220
202	1.44	3040813.8380	735743.1770
203	1.68	3040756.5330	735613.6850
204	1.34	3040685.3740	735511.0460
205	1.64	3040230.3620	735271.1040
206	2.18	3040181.6450	735248.5200
207	1.59	3040137.0630	735228.6590
208	1.37	3040120.2220	735221.7769
209	1.11	3040103.5950	735214.9820
210	1.25	3040022.2020	735180.5200
211	1.30	3039901.5820	735158.1470
212	1.30	3039894.0270	735156.6110
213	1.30	3039891.7770	735155.7080
214	1.30	3039889.6990	735154.6210
215	1.25	3039885.4290	735149.0531
216	1.25	3039785.3280	734973.0634
217	1.25	3039762.7480	734827.5911
218	1.25	3039759.4410	734819.7210
219	0.90	3039746.0470	734787.7240
220	0.90	3039730.4540	734750.4736
221	1.62	3039703.9660	734705.1117
222	1.32	3039674.6540	734654.9230
223	1.18	3039605.9650	734511.4310
224	1.42	3039588.5240	734452.6444
225	1.39	3039625.3330	734279.7014
226	2.95	3039631.3920	734252.0169
227	1.83	3039636.9140	734235.6910
228	1.23	3039665.4180	734151.4220
229	3.20	3039697.6600	734065.5610
230	2.95	3039699.8930	734059.6145
231	0.86	3039655.0190	733972.6128
232	0.86	3039611.6230	733876.0850
233	1.18	3039601.8790	733842.8463
234	0.82	3039583.6340	733740.2150
235	0.67	3039584.0220	733663.3820
236	0.89	3039590.0820	733612.1190
237	0.93	3039590.0010	733603.1130
238	1.08	3039582.2420	733594.5340
239	1.09	3039543.5730	733548.6980

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
240	2.17	3039452.7190	733473.1040
241	1.62	3039221.1130	733392.1710
242	5.23	3038998.6780	733376.4130
243	2.26	3038706.3530	733375.1160
244	2.03	3038687.0640	733374.5130
245	1.91	3038566.2490	733373.2900
246	1.67	3038465.1330	733372.5300
247	1.93	3038333.6660	733370.0940
248	1.99	3037908.6990	733263.1990
249	1.63	3037840.7790	733245.9036
250	2.61	3037600.9860	733135.6760
251	2.55	3037440.7140	733055.9860
252	1.14	3037115.4490	733088.8470
253	1.69	3036309.0850	732869.4100
254	1.25	3036231.9760	732858.6590
255	3.33	3036090.1460	732832.1037
256	1.55	3036062.5180	732821.7730
257	1.44	3035973.3240	732780.3770
258	1.85	3035818.1470	732711.3570
259	1.14	3035633.3900	732630.2120
260	1.11	3035360.9410	732464.7470
261	1.11	3035136.9390	732393.6610
262	0.83	3035047.7050	732364.2760
263	1.98	3034947.8140	732330.8200
264	1.74	3034902.4700	732275.0530
265	2.00	3034880.0740	732237.7170
266	0.15	3034692.9970	732058.8510
267	1.36	3034584.9640	731953.6490
268	0.53	3034222.6860	731855.7010
269	1.77	3033957.9360	731904.8040
270	2.07	3033878.1140	731918.9170
271	2.06	3033787.6890	731935.2851
272	1.42	3033704.7430	731955.0970
273	0.92	3033690.4410	731971.6530
274	0.45	3033598.2920	732082.1160
275	0.46	3033521.4140	732108.7510
276	0.48	3033442.6880	732092.6880
277	1.26	3033423.0390	732088.2730
278	0.69	3033376.8430	732093.6830
279	1.30	3033323.1740	732103.4930
280	1.52	3033202.2100	732124.3170

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
281	0.75	3033151.4580	732132.0810
282	1.42	3033011.0650	732107.8210
283	0.89	3032956.1230	732104.5660
284	0.59	3032900.8110	732115.3160
285	1.28	3032809.0720	732139.3350
286	3.60	3032779.9160	732129.1670
287	2.44	3032740.6520	732113.1470
288	2.88	3032681.0480	732089.1910
289	2.36	3032633.3390	732066.3920
290	1.90	3032604.3100	732045.7080
291	1.52	3032532.6730	731992.2190
292	1.22	3032122.2640	731724.3790
293	1.38	3032017.6720	731638.7110
294	1.71	3031766.5270	731448.8140
295	1.97	3031730.7220	731421.7920
296	2.05	3031702.7280	731400.4850
297	0.91	3031622.4910	731312.5860
298	0.89	3031549.3150	731234.7330
299	0.81	3031516.8100	731200.2560
300	0.87	3031464.9260	731145.4550
301	1.18	3031383.8260	731060.3530
302	1.62	3031359.0570	731034.7818
303	1.91	3031287.1820	730977.6480
304	3.12	3031282.0050	730967.2230
305	2.40	3031264.5150	730929.4830
306	1.92	3031257.9530	730924.7410
307	1.79	3031196.1460	730910.8083
308	1.69	3031185.0370	730908.8487
309	1.82	3031151.7840	730904.9620
310	2.04	3031143.2600	730903.5150
311	2.49	3031110.6750	730898.4970
312	1.20	3031054.4580	730888.5760
313	0.98	3031047.6910	730886.8950
314	1.50	3031044.0740	730885.3360

**3) 400 mm ø NATURAL GAS PL FROM O.I.L. MAKUM OCS TO CGGS
MADHUBAN (UNDER CONTRACTION)**

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
1	1.55	3041608.7180	737175.7280
2	1.55	3041556.8030	737098.7810
3	1.63	3041533.4040	737063.1420
4	1.94	3041473.3570	736970.4010
5	2.53	3041450.1820	736935.7760
6	2.00	3041404.0580	736867.5950
7	1.72	3041347.5380	736777.9810
8	1.76	3041293.0220	736697.2720
9	1.70	3041239.2520	736618.2020
10	1.68	3041182.7350	736533.3760
11	1.64	3041136.2760	736450.2750
12	1.74	3041101.5230	736379.0900
13	1.63	3041079.2260	736332.6030
14	1.46	3041057.0340	736291.6360
15	1.39	3041015.5940	736208.2920
16	1.84	3040983.5900	736142.7810
17	1.61	3040959.7570	736094.7590
18	1.61	3040881.4460	735907.4750
19	1.65	3040811.1620	735743.5200
20	1.65	3040800.6360	735716.1870
21	1.65	3040792.6070	735697.2550
22	1.65	3040766.2160	735642.4460
23	1.54	3040714.6810	735529.2860
24	1.75	3040684.0740	735512.2370
25	1.75	3040647.3990	735491.8140
26	1.75	3040601.2200	735466.6210
27	1.75	3040576.7490	735453.3140
28	1.75	3040523.4390	735427.8740
29	1.75	3040472.6990	735405.4330
30	1.47	3040400.1190	735372.2330
31	2.32	3040279.5940	735305.2070
32	2.40	3040174.2840	735247.1460
33	1.13	3040104.8710	735223.6610
34	1.17	3040088.4320	735210.6540
35	1.69	3039901.7190	735160.3090
36	1.25	3039782.5115	734974.0749
37	1.10	3039757.5980	734827.2800

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
38	1.00	3039744.8190	734789.2260
39	0.90	3039728.8494	734750.9083
40	1.20	3039702.0850	734708.7520
41	1.25	3039669.4470	734649.1090
42	1.60	3039640.7120	734586.4860
43	1.74	3039628.1930	734559.3770
44	1.40	3039662.1640	734151.5500
45	1.10	3039696.0880	734055.8340
46	0.99	3039664.3890	733994.4960
47	0.86	3039616.0400	733899.9300
48	0.86	3039600.4500	733844.4880
49	0.86	3039581.5900	733740.7730
50	1.12	3039578.8260	733691.0980
51	1.12	3039581.6670	733663.2630
52	0.48	3039542.5080	733549.8530
53	1.38	3039450.8570	733475.8600
54	1.70	3039414.3160	733458.8680
55	1.69	3039369.9190	733443.2360
56	1.70	3039291.8810	733416.6620
57	1.46	3039263.8010	733408.2680
58	1.71	3039217.8320	733395.7610
59	1.86	3039162.5440	733382.5540
60	2.00	3038971.2630	733380.2990
61	2.10	3038837.6610	733378.3680
62	2.50	3038703.7920	733377.2540
63	2.30	3038565.6580	733375.8380
64	2.40	3038465.5180	733373.8810
65	2.60	3038372.2870	733373.3390
66	2.80	3038333.8350	733373.2950
67	2.96	3038299.2880	733364.0040
68	2.80	3038235.3940	733344.0930
69	2.65	3038194.9280	733334.2910
70	2.43	3038130.7020	733317.4850
71	1.80	3038066.3370	733300.9300
72	1.45	3037908.3640	733265.6990
73	1.20	3037893.1140	733262.5800
74	1.45	3037840.1790	733251.7100
75	2.03	3037601.4860	733138.2240
76	1.85	3037479.0120	733078.1430
77	1.68	3037439.4810	733057.9900
78	1.40	3037376.5000	733026.8490

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
79	1.23	3037223.3460	733101.9990
80	1.41	3037186.8620	733108.2700
81	1.40	3036885.1280	733045.5090
82	1.25	3036785.4130	733003.2300
83	1.38	3036626.8380	732949.4850
84	1.20	3036566.2290	732931.7690
85	1.30	3036457.8610	732901.2800
86	1.20	3036383.3570	732883.0690
87	1.22	3036309.1060	732872.3080
88	1.15	3036231.7050	732860.4950
89	1.12	3035974.3020	732782.4270
90	1.18	3035817.7330	732712.9390
91	1.30	3035540.1090	732553.1580
92	1.20	3035513.8710	732532.1760
93	1.00	3035404.1150	732481.6020
94	0.97	3035359.0370	732468.0730
95	1.19	3035250.0490	732434.2480
96	1.40	3035135.4540	732395.7500
97	1.65	3035046.4680	732366.4350
98	1.73	3034901.9220	732278.1650
99	1.68	3034878.2960	732240.0470
100	1.48	3034867.7870	732228.4410
101	1.04	3034691.5660	732061.5640
102	1.48	3034647.1790	732017.7090
103	1.22	3034584.5260	731955.6350
104	1.22	3034561.3800	731932.6110
105	1.00	3034549.0860	731920.9190
106	1.48	3034530.9450	731903.8500
107	1.55	3034502.7560	731876.7200
108	1.64	3034502.3040	731877.8930
109	1.43	3034470.0340	731847.2360
110	1.50	3034435.1050	731813.2830
111	1.80	3034373.4060	731816.1380
112	1.65	3034337.7730	731826.9710
113	1.43	3034222.8170	731858.3970
114	1.25	3034111.0100	731878.1010
115	1.48	3033958.5220	731907.5900
116	1.24	3033914.3730	731917.4600
117	1.33	3033877.8880	731923.8220
118	1.20	3033782.4900	731938.1380
119	1.40	3033708.2010	731957.2220

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
120	1.42	3033600.3800	732089.4640
121	1.23	3033520.7980	732112.7910
122	1.32	3033442.2170	732096.6970
123	1.36	3033423.6190	732094.1450
124	1.45	3033381.4720	732099.4120
125	1.49	3033314.0340	732110.3850
126	1.57	3033202.6430	732128.4290
127	1.04	3033151.8780	732136.7020
128	1.25	3033045.7820	732119.8870
129	1.25	3033010.2560	732113.5980
130	1.60	3032992.9600	732111.7870
131	0.82	3032954.4010	732108.6750
132	1.40	3032900.8880	732120.0410
133	2.44	3032740.6520	732113.1470
134	2.10	3032684.1160	732088.7060
135	2.10	3032635.3790	732065.0280
136	2.10	3032585.4030	732029.0740
137	1.20	3032506.0820	731977.4870
138	1.09	3032424.5350	731922.4820
139	1.95	3032369.6320	731887.4800
140	2.31	3032345.5640	731872.1470
141	1.91	3032283.9050	731837.5360
142	1.91	3032237.5310	731811.6910
143	1.75	3032198.4590	731789.1600
144	1.03	3032120.6280	731727.7770
145	1.56	3032040.2180	731662.9510
146	1.54	3031937.8100	731579.3320
147	1.60	3031765.3690	731449.7120
148	1.65	3031730.1860	731423.1120
149	1.62	3031701.0530	731400.9520
150	1.58	3031681.6400	731379.1210
151	1.48	3031622.0020	731313.9430
152	1.32	3031546.8790	731235.3710
153	1.42	3031515.0210	731202.2310
154	1.52	3031461.8640	731146.0870
155	1.55	3031432.1550	731116.2360
156	1.59	3031399.0110	731081.4220
157	1.57	3031382.0360	731064.4040
158	1.54	3031351.3580	731031.4270

**4) EX. 4"Ø OIL PIPELINE FROM BAGHJAN EPS/GGS
TO CGGS MADHUBAN**

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
1	0.79	3050544.8210	742157.2250
2	0.68	3050533.9715	742209.1149
3	0.75	3050285.3680	742443.9820
4	1.02	3050032.8150	742678.8970
5	1.02	3049988.2510	742730.6410
6	0.47	3049913.9870	743055.8820
7	0.59	3049883.5660	743203.7700
8	0.64	3049867.2150	743234.6390
9	0.48	3049801.6210	743291.1000
10	0.64	3049678.0430	743408.1210
11	0.58	3049584.3760	743497.0870
12	0.98	3049328.6680	743741.9770
13	0.98	3049306.1440	743763.9160
14	0.99	3049269.2600	743765.7680
15	0.99	3049210.1940	743756.6500
16	0.84	3049176.8450	743751.3860
17	0.65	3049140.4290	743746.0450
18	0.46	3049124.7060	743730.6740
19	0.85	3049068.0620	743672.1010
20	1.23	3049048.2520	743659.2040
21	0.75	3049003.8040	743634.6890
22	0.82	3048528.6740	743535.6490
23	1.10	3048451.5760	743538.5580
24	0.70	3048279.6790	743546.6740
25	0.83	3048136.8600	743553.2000
26	0.74	3048092.6570	743555.6520
27	0.17	3047864.0100	743564.7560
28	1.23	3047768.9910	743530.4990
29	1.40	3047618.8170	743443.0460
30	0.54	3047467.5980	743458.3840
31	0.55	3047350.1130	743471.8300
32	0.53	3047224.1130	743497.7080
33	0.61	3047104.2890	743525.8440
34	0.51	3046936.1190	743565.4090
35	0.45	3046845.8710	743586.3800
36	1.35	3046714.7250	743617.1280

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
37	0.68	3046567.9000	743651.4870
38	0.43	3046411.9200	743688.2950
39	0.69	3046273.1940	743719.3820
40	0.83	3046175.2480	743742.8090
41	0.64	3046090.1770	743762.1700
42	0.64	3046079.4020	743764.1550
43	0.64	3046076.5990	743762.9980
44	0.64	3046049.7510	743752.2950
45	0.64	3046044.0880	743750.3100
46	0.64	3046041.6070	743747.7170
47	0.41	3046030.5040	743731.9270
48	0.54	3046012.1820	743706.3810
49	0.54	3045997.1870	743684.0080
50	0.54	3045949.5860	743624.5670
51	0.54	3045922.0860	743595.9610
52	0.64	3045911.7450	743585.6460
53	0.77	3045897.2990	743563.6970
54	0.68	3045913.5440	743587.5550
55	0.51	3045865.5650	743507.6040
56	0.51	3045844.7280	743467.2580
57	0.73	3045837.6370	743453.8350
58	0.46	3045353.0940	743125.3650
59	0.38	3045321.0390	743080.0920
60	1.23	3045286.0060	743030.9940
61	1.97	3045240.6630	742966.0010
62	1.46	3045163.8120	742857.7530
63	1.32	3045115.1630	742788.4320
64	1.12	3045041.4970	742684.0170
65	0.92	3045020.4590	742653.0940
66	0.90	3044986.0390	742606.4570
67	0.92	3044976.5590	742597.4610
68	0.95	3044910.9390	742574.9000
69	0.98	3044851.4460	742546.2920
70	1.07	3044811.5490	742531.1880
71	1.89	3044667.0300	742378.6340
72	1.23	3044624.9520	742337.1550
73	1.23	3044560.8840	742275.5660
74	1.23	3044532.3280	742245.7100
75	0.79	3043849.1930	739850.0050
76	0.85	3043839.6070	739803.2530
77	0.67	3043830.1030	739757.7330

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
78	1.32	3043821.7010	739715.1050
79	1.52	3043679.5220	739414.5730
80	1.53	3043664.5740	739383.9460
81	1.45	3043626.8910	739284.5190
82	1.23	3043617.9860	739264.8210
83	1.33	3043611.6110	739254.4720
84	1.46	3043609.7430	739251.1080
85	1.12	3043600.4060	739237.0870
86	1.18	3043553.5120	739206.3250
87	1.08	3043580.5720	739223.8250
88	1.05	3043533.2740	739189.2510
89	0.97	3043496.7400	739165.8090
90	0.93	3043426.5780	739141.0840
91	1.14	3043406.5550	739135.0250
92	1.43	3043360.5170	739153.9310
93	1.41	3043339.2050	739162.0080
94	1.28	3043342.3920	739167.4960
95	1.11	3043337.7160	739160.2130
96	0.86	3043307.3610	739186.0120
97	0.82	3043232.3570	739244.7230
98	0.78	3043142.5510	739312.6610
99	0.70	3043035.3060	739396.7450
100	0.56	3042971.0080	739423.8130
101	0.48	3042850.7480	739426.5750
102	0.82	3042768.2330	739425.1670
103	2.05	3042658.7260	739425.8740
104	0.30	3037599.2730	733142.3210
105	0.37	3037480.1590	733080.0640
106	0.40	3037489.1260	733084.6670
107	0.24	3037438.9510	733059.4860
108	0.22	3037384.0660	733031.1340
109	0.28	3037369.7950	733030.1610
110	0.32	3037331.1420	733049.6060
111	0.38	3037309.7590	733060.5740
112	0.42	3037282.1160	733074.6130
113	0.56	3037231.6230	733099.2330
114	0.62	3037214.2180	733106.9110
115	0.78	3037205.9140	733110.7600
116	0.46	3037202.2170	733112.7250
117	0.58	3037186.3460	733109.3400
118	0.52	3037157.8550	733103.0220

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
119	0.48	3037114.8180	733093.9180
120	0.38	3036980.0300	733059.5310
121	0.41	3036897.6620	733049.8660
122	0.44	3036884.9660	733046.2460
123	0.44	3036785.0750	733004.4670
124	0.68	3036718.0180	732977.6240
125	0.72	3036671.8510	732964.0170
126	0.86	3036626.6970	732950.7750
127	1.21	3036566.2370	732932.8010
128	1.25	3036533.5750	732923.8580
129	1.86	3036382.4850	732885.9250
130	1.77	3036309.2340	732874.5070
131	1.73	3036231.3220	732862.1690
132	2.86	3036089.3990	732838.1640
133	0.23	3036061.8530	732823.9180
134	0.25	3035974.3640	732783.3830
135	0.34	3035817.3810	732713.5780
136	1.68	3035539.6389	732553.7146
137	1.32	3035513.6180	732532.7680
138	1.09	3035401.6690	732482.6080
139	0.97	3035358.5690	732468.4650
140	0.24	3035248.6860	732434.7730
141	0.24	3035135.2140	732396.4640
142	0.28	3035046.0880	732367.0400
143	0.35	3034946.0120	732333.7270
144	0.78	3034927.9760	732322.3390
145	1.10	3034922.5310	732311.9510
146	1.73	3034901.9220	732278.1650
147	1.56	3034878.2960	732240.0470
148	1.58	3034867.7870	732228.4410
149	1.48	3034691.4240	732061.8260
150	1.42	3034646.8200	732018.1440
151	1.23	3034584.1830	731956.0810
152	1.10	3034560.8760	731933.0670
153	0.98	3034549.0860	731920.9190
154	0.97	3034530.9450	731903.8500
155	0.82	3034502.7560	731876.7200
156	0.86	3034469.4600	731839.9700
157	0.72	3034435.6450	731809.4730
158	0.58	3034419.2920	731800.1090
159	0.46	3034373.4860	731814.2440

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
160	0.19	3034338.2470	731825.2730
161	1.61	3034222.2300	731857.1510
162	0.33	3034110.8210	731875.5550
163	0.30	3033956.3650	731900.0480
164	0.26	3033875.2560	731914.0010
165	0.24	3033785.8430	731930.9280
166	0.46	3033707.1750	731956.1610
167	0.64	3033691.8310	731972.4890
168	1.62	3033601.7280	732085.7170
169	1.53	3033520.8930	732111.1860
170	1.83	3033422.9630	732091.1090
171	1.20	3033377.9390	732095.2280
172	0.83	3033323.5190	732105.6840
173	0.57	3033202.1750	732126.8660
174	0.22	3032956.0610	732106.4510
175	0.32	3032900.8870	732117.9040
176	0.50	3032811.5210	732141.9200

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Detailed Survey Report

Sr. No.	Pipeline Depth (m)	UTM-46 CO-ORDINATES (m)	
		Northing	Easting
160	0.19	3034338.2470	731825.2730
161	1.61	3034222.2300	731857.1510
162	0.33	3034110.8210	731875.5550
163	0.30	3033956.3650	731900.0480
164	0.26	3033875.2560	731914.0010
165	0.24	3033785.8430	731930.9280
166	0.46	3033707.1750	731956.1610
167	0.64	3033691.8310	731972.4890
168	1.62	3033601.7280	732085.7170
169	1.53	3033520.8930	732111.1860
170	1.83	3033422.9630	732091.1090
171	1.20	3033377.9390	732095.2280
172	0.83	3033323.5190	732105.6840
173	0.57	3033202.1750	732126.8660
174	0.22	3032956.0610	732106.4510
175	0.32	3032900.8870	732117.9040
176	0.50	3032811.5210	732141.9200

Section – II
SOIL RESISTIVITY SURVEY REPORT

Accordingly, M/s Oil India Limited appointed M/s MECON Limited as a Consultant and M/s MECON Limited has entrusted M/s Deshpande-Patil Consultants (DPC), Bharuch for carrying out the Reconnaissance Survey, Detailed Survey, Cadastral Survey, Soil Investigation, Corrosion Survey and Bench Mark installation for Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to Central Gas Gathering Station Madhuban & 16"Ø Gas Pipeline from O.I.L. Makum Oil Change Service to Central Gas Gathering Station Madhuban in Assam State as per **LAC Dtd. 5th July, 2018.**

This report covers the Soil Resistivity Survey of the same.

2. SCOPE:

2.1.0 SOIL RESISTIVITY SURVEY:

2.1.1 The soil resistivity method which involves driving 4 steel pins into earth in a straight line equally spaced with pin spacing equal to depth to which knowledge of average soil resistivity is required. The average soil resistivity, being the function of voltage drops between two outer pins, first the resistance in ohm between centre pair of pins is determined. This measured value of resistance is multiplied by a factor $2\pi l/a$ to obtain average soil resistivity, where 'a' is the pin spacing in feet.

2.1.2 As general guidelines, all soils below 1000 ohm-cm resistivity shall be classified as very highly corrosive and soils between 1000-2500 ohm-cm as highly corrosive, between 2500-5000 ohm-cm the soil would be termed as medium corrosive and between 5000-10000, it is low corrosive. If the soil resistivity is more than 10000 ohm-cm then soil will be very low corrosive. These tabulated readings shall be jointly signed by Contractor's and owner's engineers after completion of each day of survey.

2.2.0 ROW SURVEY:

2.2.1 Soil resistivity all along the route shall be measured at 500 mtrs. interval by using standard 4 pin Wenner method. The soil resistivity data shall be recorded in the presence of Owner's representative in a tabular form as per format enclosed as Annexure-I. The following pin spacing shall be used.

- a) 150 cm
- b) 300 cm

2.2.2 The soil resistivity readings shall normally be taken at an interval of 500 mtrs. at a depth of 150 cm and 300 cm. The readings at successive interval should not differ by a ratio greater than 2:1, otherwise the readings shall be taken at intermediate points to meet this condition of 2:1 ratio.

2.2.3 Soil resistivity shall also be measured at locations of all crossings such as road, rail, water crossing etc. and wherever there is a visible change in soil characteristics.

2.2.4 As an exception to para 2.2.2, the condition regarding 2:1 ratio shall not apply when the lower of the two readings is greater than 20000 ohm-cm.

2.2.5 Soil resistivity at locations other than the regular interval as noted in para 2.2.2 shall be paid on prorata basis.

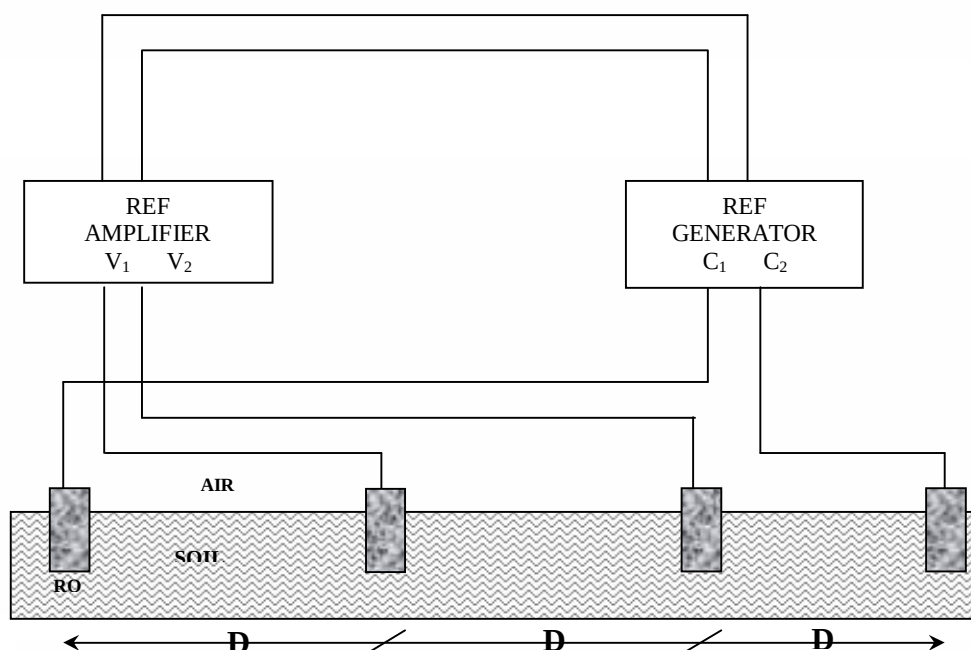
3. MEASURING PRINCIPLE:

The Soil Resistivity at approx. 500 m distance at various depths viz. 1.5m and 3m was measured. The method for measuring Soil resistivity adopted by us is 4 Terminal Method popularly known as Wenner Method. The calibration certificates for the instruments are attached with this report.

In the Wenner arrangement for measurement of resistivity, the four electrodes are driven into ground at equal distance (D) when a small current is passed through outer electrodes, a potential difference is set up between the inner pair, and this potential is measured on the meter. Then it is compared with the potential drop across a known resistance. The value of the resistance (R) giving the same potential drop is the apparent resistance between the inner electrodes. The Soil Resistivity (ρ) as per Wenner's principle is:

$$\rho = 2\pi DR \text{ ohm - cm.}$$

Where D = Spacing between the electrodes in 'cm' &
R = Resistance of the soil at a depth of 'D' meter in Ohm.



EQUIPMENTS USED

- (i) Aqua II Plus A.C. Resistivity Meter consists of two units - Generator & Amplifier - 1 Set
- (ii) Current / Potential Electrodes 19 mm dia and 500mm long M.S. Rods - 4 Nos.
- (iii) Interconnecting Cable between meters and current and potential electrodes.

Aqua II Plus is a compact, self contained instrument based on the principal of electrical resistivity. It consists of two units housed in a metal case. One unit - The Generator, generates the necessary low frequency square wave current. The Second unit - The Amplifier contains the necessary circuits to measure the resistivity of the ground.

GENERATOR

The Generator generates low frequency about 4 Hz. square wave of electric pulse by using Relay as commutator. Different voltage ranges of 100 V, 200 V are generated using 9 Volts dry cells or 12 Volts rechargeable batteries.

The high frequency oscillator and a specially designed transformer step-up Voltages from Small battery voltages. Voltage Selector switch is used to obtain the desired voltage. The ammeter connected in series with output voltage indicates drain current.

The battery indicator is provided to assess the battery condition at any time.

Specifications

(i) Power Supply	12 cells of 1.5 Volts type Eveready 1055 or equivalent.
(ii) Power output	4 Watts max.
(iii) Voltage output (Peak to Peak)	Two Ranges i) 100 volts ii) 200 volts @ 4 Hz. approx.
(iv) Current output (Peak to Peak)	80 mA max.
(v) Weight	4.75 Kg.
(vi) Dimensions	370 mm x 140 mm x 120 mm

AMPLIFIER

This unit consists of a filter and an amplifier. The filter is used to filter out unwanted signals and allow only the signals generated by the generator to pass through. Thus the effect of D.C. ground currents and 50 Hz power lines is filtered and selected signal is passed on to the amplifier. The amplifier like the generator has its built-in power source i.e. 2 x 9 Volts dry cells or 12 x 1.5 Volts dry cells. Integrated circuitry is used for high stability.

The amplifier is provided with minimum controls, which enable getting quick readings. The external, internal switch is used to record the voltage developed between the points V1 and V2 and to compare it by using the ten turn helical potentiometer. Depending upon the position of the range selector, the reading of the potentiometer is recorded by using appropriate multiplying factor. Coarse gain control and fine gain control used to get a reading of 30 to 509 microamperes on the micro-ammeter on external seating. A battery indicator is provided to assess the battery condition at any time.

Specifications

(i) Power Supply	12 cells of 1.5 Volt type Everyday 1055 or its equivalent.
(ii) Resistance Ranges	i) 0 - 1 ohm ii) 0 - 10 ohm iii) 0 - 100 ohm iv) 0 - 1000 ohm v) 0 - 10000 ohm.
(iii) Least count	0.001 Ohm
(iv) Weight	4.5 kg.
(v) Depth of Penetration	600 meters for 0 = 50 Ohm meter
(vi) Accuracy	+ 2% up to 0.1 Ohm, + 8% upto 0.003 Ohm.

4. PROCEDURE FOR TAKING AN AQUA II PLUS READING :

1. Coarse gain was set on position '1' and fine gain was rotated completely anti clock-wise. Then the amplifier was switched on. A momentary deflection was observed on the meter.
2. Voltage Selector Switch was set at 100 V and generator was switched on.
3. Internal / External switch was set on position external. Amplifier was connected to Voltage electrodes and meter showed relative value of Voltage at EXT.
4. Fine and coarse gain control was adjusted in such a way that deflection of approx. three quarters on ammeter is obtained.

5. Internal / External switch was then positioned on internal. Amplifier was connected to reference Voltage potentiometer measuring relative value of voltage.
6. Reference potentiometer and potentiometer range control was adjusted so that the same meter deflection was achieved in the position internal and external
7. The necessary checks were carried out by switching from internal to external and multi turn Potentiometer was adjusted so as to give same reading, which was obtained for internal and external.
8. Generator was switched off.
9. Potentiometer scale reading was noted along with range setting. It was multiplied with necessary range factor.
10. Amplifier was switched off.

The resistivity was measured at every 500 meter distance. The above measurements were repeated for electrode spacing of 1.5m and 3m at every location. The readings obtained from the meter were used in calculation for soil resistivity as described in methodology.

TEST RESULTS

The test results are tabulated and enclosed in Annexure. The summary is also tabulated and represented. The above test results are also represented in a graphical form (Soil Resistivity Curves) with distance and locations indicated on X - axis and soil resistivity indicated on Y - axis. Soil Resistivity at various depths indicated by means of various soil resistivity curves.

5. GENERAL INSTRUCTIONS

1. The drawings show the soil resistivity at various locations marked at L1, L2.
2. 'X' axis represents chainage of various locations along the route.
3. 'Y' axis represents resistivity in ohm-cm.
4. The curves show joined resistivity values at various depths and they do not represent intermediate values in between the locations marked.
5. The method of horizontal profiling is used to determine the variations in the apparent resistivity in a horizontal direction within a pre-selected depth range.

INSTRUMENT DETAILS

Sr. No.	Instrument Type	Instrument Sr. No.	Make	Date of Calibration
1.	AQUA II Plus Compact AC Earth Resistivity meter	20171002	Minitronix	13.10.2017

CORROSIVITY OF SOIL

Before any system of cathodic protection can be designed, a few data are necessary. These data pertain to the conditions existing on each location.

Soil can hold different moisture and thereby different dissolved salts. Increased dissolved salts increase the conductivity of the soil, increased conductivity means larger current for given potential difference, and therefore larger corrosion rate. Specific conductivity is reciprocal of specific resistivity. Therefore soil resistivity gives a fair measure of the corrosiveness in the manner indicated below:

Degree of Corrosivity of Soil					
	Very Low	Low	Medium	High	Very High
Soil Resistivity In Ohm-cm.	10,000 and above	5000 to 10000	2500 to 5000	1000 to 2500	Less than 1000

If any pipeline is yet at a design stage, this survey helps in determining the specifications of the coating material. If the soil is of high resistivity, an average coating can be specified and in more corrosive soil, coating with very rigid specification and of higher standards of workmanship is essential. Also the presence of different chemicals present in the soil affects the degree of corrosivity of the soil. The importance of the chemicals present in the soil along with the resistivity values is taken into account.

6. TEST RESULTS :

Degree of Corrosivity As Per Resistivity Data.

The field tests indicate the corrosivity of the soil along the pipeline is tabulated in **Annexure-III**.

Soil along the route of Proposed pipeline is Very low corrosive for 24.5km length, low corrosive for 12.16km length & medium corrosive for 1km length.

7. CONCLUSIONS & RECOMMENDATIONS:

Based on aggressiveness of the soil it is recommended to design a good cathodic protection system like ICCP to protect the pipeline from corrosion. It should be noted that the method used for calculation is empirical and further analysis has to be performed before designing the protection system. If the pipe line is to be cathodically protected impressed current cathodic protection must serve the purpose.

For Deshpande-Patil Consultant

Report Prepared by

Panchal H.B

(Himanshu Panchal)
.....Engineer



Report Reviewed By

Virendra Bhatt

(Virendra Bhatt)
.....Engineer

Date : 07-09-2018

ANNEXURES

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

SOIL RESISTIVITY TEST RESULTS

**1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban
(Along Existing & Proposed RoU)**

**WENNER ELECTRICAL SOUNDING DATA-FIELD RESISTIVITY TEST RESULTS
INSTRUMENT TYPE - AQUA II A.C. RESISTIVITY METRE**

Location No. 1		Chainage(m)- 500		wet		
DEPTH OF PENETRATION D in cm	POTENTIAL ELECTRODES P1P2/2 = D/2	CURRENT ELECTRODES C1C2/2 = 3D/2	CONSTANT K = $2\pi\rho L/D$	DIAL READING	RESISTANCE MEASURED R OHM	RESISTIVITY = KR OHM-CM
150	75	225	942.477796	100 x 116	11.600	10933
300	150	450	1884.95559	10 x 823	8.230	15513

Location No. 2		Chainage(m)- 1000		wet		
150	75	225	942.477796	100 x 390	39.000	36757
300	150	450	1884.95559	100 x 176	17.600	33175

Location No. 3		Chainage(m)- 1500		wet		
150	75	225	942.477796	100 x 245	24.500	23091
300	150	450	1884.95559	100 x 129	12.900	24316

Location No. 4		Chainage(m)- 2000		wet		
150	75	225	942.477796	10 x 953	9.530	8982
300	150	450	1884.95559	10 x 677	6.770	12761

Location No. 5		Chainage(m)- 2500		wet		
150	75	225	942.477796	100 x 273	27.300	25730
300	150	450	1884.95559	100 x 118	11.800	22242

Location No. 6		Chainage(m)- 3000		wet		
150	75	225	942.477796	100 x 451	45.100	42506
300	150	450	1884.95559	100 x 246	24.600	46370

Location No. 7		Chainage(m)- 3500		wet		
150	75	225	942.477796	100 x 277	27.700	26107
300	150	450	1884.95559	100 x 106	10.600	19981

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Resistivity Survey Report

Location No. 8		Chainage(m)- 4000		wet		
DEPTH OF PENETRATION D in cm	POTENTIAL ELECTRODES P1P2/2 = D/2	CURRENT ELECTRODES C1C2/2 = 3D/2	CONSTANT K = 2xPIxD	DIAL READING	RESISTANCE MEASURED R OHM	RESISTIVITY = KR OHM-CM
150	75	225	942.477796	100 x 392	39.200	36945
300	150	450	1884.95559	100 x 268	26.800	50517

Location No. 9		Chainage(m)- 4500		wet		
150	75	225	942.477796	100 x 298	29.800	28086
300	150	450	1884.95559	100 x 117	11.700	22054

Location No. 10		Chainage(m)- 5000		wet		
150	75	225	942.477796	100 x 402	40.200	37888
300	150	450	1884.95559	100 x 266	26.600	50140

Location No. 11		Chainage(m)- 5500		wet		
150	75	225	942.477796	100 x 772	77.200	72759
300	150	450	1884.95559	100 x 537	53.700	101222

Location No. 12		Chainage(m)- 6000		wet		
150	75	225	942.477796	100 x 621	62.100	58528
300	150	450	1884.95559	100 x 332	33.200	62581

Location No. 13		Chainage(m)- 6500		wet		
150	75	225	942.477796	100 x 207	20.700	19509
300	150	450	1884.95559	10 x 936	9.360	17643

Location No. 14		Chainage(m)- 7000		wet		
150	75	225	942.477796	10 x 942	9.420	8878
300	150	450	1884.95559	10 x 592	5.920	11159

Location No. 15		Chainage(m)- 7500		wet		
150	75	225	942.477796	10 x 402	4.020	3789
300	150	450	1884.95559	10 x 305	3.050	5749

Location No. 16		Chainage(m)- 8000		wet		
150	75	225	942.477796	10 x 882	8.820	8313
300	150	450	1884.95559	10 x 472	4.720	8897

Location No. 17		Chainage(m)- 8500		wet		
150	75	225	942.477796	100 x 320	32.000	30159
300	150	450	1884.95559	10 x 998	9.980	18812

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Resistivity Survey Report

Location No. 18		Chainage(m)- 9000		wet		
DEPTH OF PENETRATION D in cm	POTENTIAL ELECTRODES P1P2/2 = D/2	CURRENT ELECTRODES C1C2/2 = 3D/2	CONSTANT K = 2xPIxD	DIAL READING	RESISTANCE MEASURED R OHM	RESISTIVITY = KR OHM-CM
150	75	225	942.477796	100 x 471	47.100	44391
300	150	450	1884.95559	100 x 228	22.800	42977

Location No. 19		Chainage(m)- 9500		wet		
150	75	225	942.477796	100 x 732	73.200	68989
300	150	450	1884.95559	100 x 481	48.100	90666

Location No. 20		Chainage(m)- 10000		wet		
150	75	225	942.477796	100 x 619	61.900	58339
300	150	450	1884.95559	100 x 390	39.000	73513

Location No. 21		Chainage(m)- 10500		wet		
150	75	225	942.477796	100 x 435	43.500	40998
300	150	450	1884.95559	100 x 287	28.700	54098

Location No. 22		Chainage(m)- 11000		wet		
150	75	225	942.477796	100 x 522	52.200	49197
300	150	450	1884.95559	100 x 241	24.100	45427

Location No. 23		Chainage(m)- 11500		wet		
150	75	225	942.477796	100 x 691	69.100	65125
300	150	450	1884.95559	100 x 324	32.400	61073

Location No. 24		Chainage(m)- 12000		wet		
150	75	225	942.477796	100 x 539	53.900	50800
300	150	450	1884.95559	100 x 317	31.700	59753

Location No. 25		Chainage(m)- 12500		wet		
150	75	225	942.477796	100 x 388	38.800	36568
300	150	450	1884.95559	100 x 261	26.100	49197

Location No. 26		Chainage(m)- 13000		wet		
150	75	225	942.477796	100 x 207	20.700	19509
300	150	450	1884.95559	100 x 191	19.100	36003

Location No. 27		Chainage(m)- 13500		wet		
150	75	225	942.477796	100 x 225	22.500	21206
300	150	450	1884.95559	100 x 155	15.500	29217

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Resistivity Survey Report

Location No. 28		Chainage(m)- 14000		wet		
DEPTH OF PENETRATION D in cm	POTENTIAL ELECTRODES P1P2/2 = D/2	CURRENT ELECTRODES C1C2/2 = 3D/2	CONSTANT K = 2xPIxD	DIAL READING	RESISTANCE MEASURED R OHM	RESISTIVITY = KR OHM-CM
150	75	225	942.477796	100 x 370	37.000	34872
300	150	450	1884.95559	100 x 189	18.900	35626

Location No. 29		Chainage(m)- 14500		wet		
150	75	225	942.477796	100 x 399	39.900	37605
300	150	450	1884.95559	100 x 106	10.600	19981

Location No. 30		Chainage(m)- 15000		wet		
150	75	225	942.477796	100 x 495	49.500	46653
300	150	450	1884.95559	100 x 201	20.100	37888

Location No. 31		Chainage(m)- 15500		wet		
150	75	225	942.477796	100 x 412	41.200	38830
300	150	450	1884.95559	100 x 301	30.100	56737

Location No. 32		Chainage(m)- 16000		wet		
150	75	225	942.477796	100 x 535	53.500	50423
300	150	450	1884.95559	100 x 247	24.700	46558

Location No. 33		Chainage(m)- 16500		wet		
150	75	225	942.477796	100 x 218	21.800	20546
300	150	450	1884.95559	10 x 906	9.060	17078

Location No. 34		Chainage(m)- 17000		wet		
150	75	225	942.477796	10 x 902	9.020	8501
300	150	450	1884.95559	10 x 392	3.920	7389

Location No. 35		Chainage(m)- 17500		wet		
150	75	225	942.477796	10 x 425	4.250	4006
300	150	450	1884.95559	10 x 101	1.010	1904

Location No. 36		Chainage(m)- 18000		wet		
150	75	225	942.477796	10 x 715	7.150	6739
300	150	450	1884.95559	10 x 401	4.010	7559

Location No. 37		Chainage(m)- 18500		wet		
150	75	225	942.477796	10 x 942	9.420	8878
300	150	450	1884.95559	10 x 314	3.140	5919

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Resistivity Survey Report

Location No. 38		Chainage(m)- 19000		wet		
DEPTH OF PENETRATION D in cm	POTENTIAL ELECTRODES P1P2/2 = D/2	CURRENT ELECTRODES C1C2/2 = 3D/2	CONSTANT K = 2xPIxD	DIAL READING	RESISTANCE MEASURED R OHM	RESISTIVITY = KR OHM-CM
150	75	225	942.477796	100 x 274	27.400	25824
300	150	450	1884.95559	100 x 106	10.600	19981

Location No. 39		Chainage(m)- 19510		wet		
150	75	225	942.477796	100 x 187	18.700	17624
300	150	450	1884.95559	10 x 972	9.720	18322

Location No. 40		Chainage(m)- 20000		wet		
150	75	225	942.477796	100 x 187	18.700	17624
300	150	450	1884.95559	10 x 972	9.720	18322

Location No. 41		Chainage(m)- 20500		wet		
150	75	225	942.477796	100 x 232	23.200	21865
300	150	450	1884.95559	100 x 107	10.700	20169

Location No. 42		Chainage(m)- 21000		wet		
150	75	225	942.477796	100 x 340	34.000	32044
300	150	450	1884.95559	100 x 113	11.300	21300

Location No. 43		Chainage(m)- 21500		wet		
150	75	225	942.477796	100 x 475	47.500	44768
300	150	450	1884.95559	10 x 720	7.200	13572

Location No. 44		Chainage(m)- 22000		wet		
150	75	225	942.477796	100 x 157	15.700	14797
300	150	450	1884.95559	10 x 778	7.780	14665

Location No. 45		Chainage(m)- 22500		wet		
150	75	225	942.477796	10 x 938	9.380	8840
300	150	450	1884.95559	10 x 681	6.810	12837

Location No. 46		Chainage(m)- 23000		wet		
150	75	225	942.477796	10 x 653	6.530	6154
300	150	450	1884.95559	10 x 377	3.770	7106

Location No. 47		Chainage(m)- 23500		wet		
150	75	225	942.477796	10 x 794	7.940	7483
300	150	450	1884.95559	10 x 434	4.340	8181

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Resistivity Survey Report

Location No. 48		Chainage(m)- 24000		wet		
DEPTH OF PENETRATION D in cm	POTENTIAL ELECTRODES P1P2/2 = D/2	CURRENT ELECTRODES C1C2/2 = 3D/2	CONSTANT K = 2xPIxD	DIAL READING	RESISTANCE MEASURED R OHM	RESISTIVITY = KR OHM-CM
150	75	225	942.477796	10 x 934	9.340	8803
300	150	450	1884.95559	10 x 487	4.870	9180

Location No. 49		Chainage(m)- 24500		wet		
150	75	225	942.477796	10 x 884	8.840	8332
300	150	450	1884.95559	10 x 336	3.360	6333

Location No. 50		Chainage(m)- 25000		wet		
150	75	225	942.477796	10 x 630	6.300	5938
300	150	450	1884.95559	10 x 387	3.870	7295

Location No. 51		Chainage(m)- 25500		wet		
150	75	225	942.477796	100 x 111	11.100	10462
300	150	450	1884.95559	10 x 408	4.080	7691

Location No. 52		Chainage(m)- 26000		wet		
150	75	225	942.477796	100 x 213	21.300	20075
300	150	450	1884.95559	10 x 581	5.810	10952

Location No. 53		Chainage(m)- 26500		wet		
150	75	225	942.477796	10 x 972	9.720	9161
300	150	450	1884.95559	10 x 423	4.230	7973

Location No. 54		Chainage(m)- 27000		wet		
150	75	225	942.477796	100 x 137	13.700	12912
300	150	450	1884.95559	10 x 854	8.540	16098

Location No. 55		Chainage(m)- 27500		wet		
150	75	225	942.477796	100 x 203	20.300	19132
300	150	450	1884.95559	100 x 140	14.000	26389

Location No. 56		Chainage(m)- 28000		wet		
150	75	225	942.477796	100 x 224	22.400	21112
300	150	450	1884.95559	10 x 967	9.670	18228

Location No. 57		Chainage(m)- 28500		wet		
150	75	225	942.477796	100 x 144	14.400	13572
300	150	450	1884.95559	10 x 632	6.320	11913

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Resistivity Survey Report

Location No. 58		Chainage(m)- 29000		wet		
DEPTH OF PENETRATION D in cm	POTENTIAL ELECTRODES P1P2/2 = D/2	CURRENT ELECTRODES C1C2/2 = 3D/2	CONSTANT K = 2xPIxD	DIAL READING	RESISTANCE MEASURED R OHM	RESISTIVITY = KR OHM-CM
150	75	225	942.477796	10 x 911	9.110	8586
300	150	450	1884.95559	10 x 229	2.290	4317

Location No. 59		Chainage(m)- 29500		wet		
150	75	225	942.477796	10 x 584	5.840	5504
300	150	450	1884.95559	10 x 338	3.380	6371

Location No. 60		Chainage(m)- 30000		wet		
150	75	225	942.477796	10 x 880	8.800	8294
300	150	450	1884.95559	10 x 572	5.720	10782

Location No. 61		Chainage(m)- 30500		wet		
150	75	225	942.477796	100 x 266	26.600	25070
300	150	450	1884.95559	100 x 104	10.400	19604

Location No. 62		Chainage(m)- 31000		wet		
150	75	225	942.477796	100 x 253	25.300	23845
300	150	450	1884.95559	10 x 987	9.870	18605

Location No. 63		Chainage(m)- 31500		wet		
150	75	225	942.477796	100 x 291	29.100	27426
300	150	450	1884.95559	100 x 132	13.200	24881

Location No. 64		Chainage(m)- 32000		wet		
150	75	225	942.477796	100 x 192	19.200	18096
300	150	450	1884.95559	10 x 981	9.810	18491

Location No. 65		Chainage(m)- 32500		wet		
150	75	225	942.477796	100 x 132	13.200	12441
300	150	450	1884.95559	10 x 360	3.600	6786

Location No. 66		Chainage(m)- 33000		wet		
150	75	225	942.477796	100 x 113	11.300	10650
300	150	450	1884.95559	10 x 734	7.340	13836

Location No. 67		Chainage(m)- 33500		wet		
150	75	225	942.477796	100 x 229	22.900	21583
300	150	450	1884.95559	10 x 800	8.000	15080

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Resistivity Survey Report

Location No. 68		Chainage(m)- 34000		wet		
DEPTH OF PENETRATION D in cm	POTENTIAL ELECTRODES P1P2/2 = D/2	CURRENT ELECTRODES C1C2/2 = 3D/2	CONSTANT K = 2xPIxD	DIAL READING	RESISTANCE MEASURED R OHM	RESISTIVITY = KR OHM-CM
150	75	225	942.477796	10 x 837	8.370	7889
300	150	450	1884.95559	10 x 232	2.320	4373

Location No. 69		Chainage(m)- 34500		wet		
150	75	225	942.477796	10 x 962	9.620	9067
300	150	450	1884.95559	10 x 430	4.300	8105

Location No. 70		Chainage(m)- 35000		wet		
150	75	225	942.477796	10 x 893	8.930	8416
300	150	450	1884.95559	10 x 412	4.120	7766

Location No. 71		Chainage(m)- 35500		wet		
150	75	225	942.477796	10 x 799	7.990	7530
300	150	450	1884.95559	10 x 393	3.930	7408

Location No. 72		Chainage(m)- 36000		wet		
150	75	225	942.477796	10 x 843	8.430	7945
300	150	450	1884.95559	10 x 357	3.570	6729

Location No. 73		Chainage(m)- 36500		wet		
150	75	225	942.477796	10 x 957	9.570	9020
300	150	450	1884.95559	10 x 311	3.110	5862

Location No. 74		Chainage(m)- 37000		wet		
150	75	225	942.477796	10 x 897	8.970	8454
300	150	450	1884.95559	10 x 413	4.130	7785

Location No. 75		Chainage(m)- 37500		wet		
150	75	225	942.477796	10 x 932	9.320	8784
300	150	450	1884.95559	10 x 547	5.470	10311

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

Soil Resistivity Test Results At a Glance

**1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban
(Along Existing & Proposed RoU)**

Location No.	Chainage (m)	Resistivity (OHM-CM)	
		150	300
1	500	10933	15513
2	1000	36757	33175
3	1500	23091	24316
4	2000	8982	12761
5	2500	25730	22242
6	3000	42506	46370
7	3500	26107	19981
8	4000	36945	50517
9	4500	28086	22054
10	5000	37888	50140
11	5500	72759	101222
12	6000	58528	62581
13	6500	19509	17643
14	7000	8878	11159
15	7500	3789	5749
16	8000	8313	8897
17	8500	30159	18812
18	9000	44391	42977
19	9500	68989	90666
20	10000	58339	73513
21	10500	40998	54098
22	11000	49197	45427
23	11500	65125	61073
24	12000	50800	59753

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Resistivity Survey Report

Location No.	Chainage (m)	Resistivity (OHM-CM)	
		150	300
25	12500	36568	49197
26	13000	19509	36003
27	13500	21206	29217
28	14000	34872	35626
29	14500	37605	19981
30	15000	46653	37888
31	15500	38830	56737
32	16000	50423	46558
33	16500	20546	17078
34	17000	8501	7389
35	17500	4006	1904
36	18000	6739	7559
37	18500	8878	5919
38	19000	25824	19981
39	19510	17624	18322
40	20000	17624	18322
41	20500	21865	20169
42	21000	32044	21300
43	21500	44768	13572
44	22000	14797	14665
45	22500	8840	12837
46	23000	6154	7106
47	23500	7483	8181
48	24000	8803	9180
49	24500	8332	6333
50	25000	5938	7295
51	25500	10462	7691
52	26000	20075	10952
53	26500	9161	7973
54	27000	12912	16098
55	27500	19132	26389
56	28000	21112	18228
57	28500	13572	11913
58	29000	8586	4317

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Resistivity Survey Report

Location No.	Chainage (m)	Resistivity (OHM-CM)	
		150	300
59	29500	5504	6371
60	30000	8294	10782
61	30500	25070	19604
62	31000	23845	18605
63	31500	27426	24881
64	32000	18096	18491
65	32500	12441	6786
66	33000	10650	13836
67	33500	21583	15080
68	34000	7889	4373
69	34500	9067	8105
70	35000	8416	7766
71	35500	7530	7408
72	36000	7945	6729
73	36500	9020	5862
74	37000	8454	7785
75	37500	8784	10311

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

AGGRESSIVENESS OF SOIL

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban **(Along Existing & Proposed RoU)**

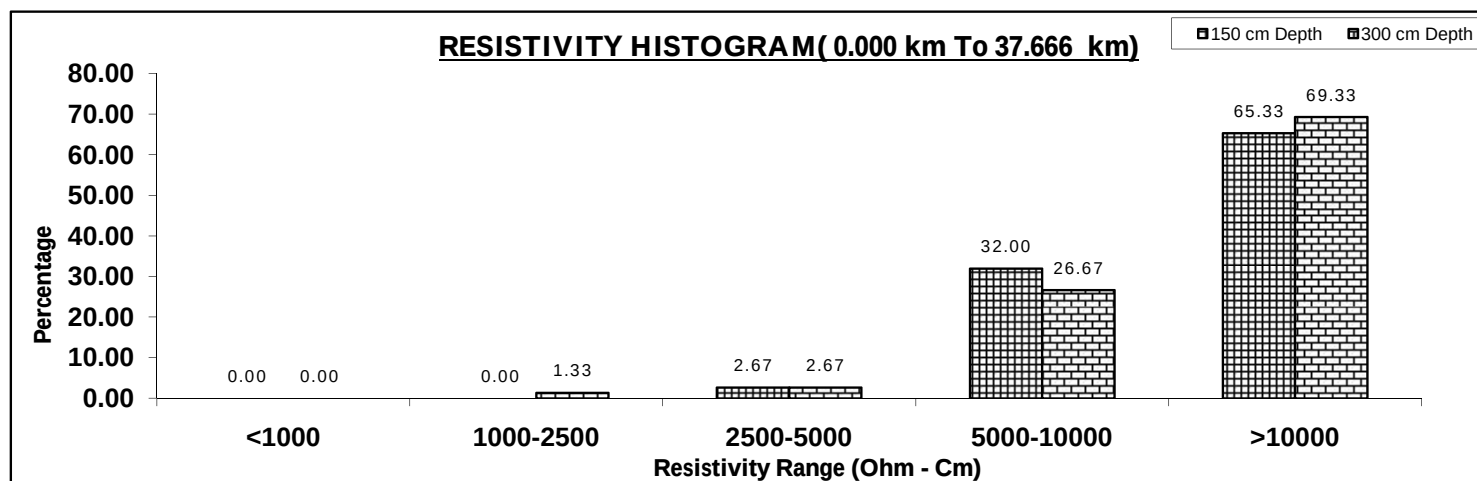
Sr. No.	Chainage (km)			Length(km)	Aggresiveness
	From		To		
1	0.00	-	1.50	1.50	VERY LOW CORROSIVE
2	1.50	-	2.00	0.50	LOW CORROSIVE
3	2.00	-	6.50	4.50	VERY LOW CORROSIVE
4	6.50	-	7.00	0.50	LOW CORROSIVE
5	7.00	-	7.50	0.50	MEDIUM CORROSIVE
6	7.50	-	8.00	0.50	LOW CORROSIVE
7	8.00	-	16.50	8.50	VERY LOW CORROSIVE
8	16.50	-	17.00	0.50	LOW CORROSIVE
9	17.00	-	17.50	0.50	MEDIUM CORROSIVE
10	17.50	-	18.50	1.00	LOW CORROSIVE
11	18.50	-	22.00	3.50	VERY LOW CORROSIVE
12	22.00	-	25.00	3.00	LOW CORROSIVE
13	25.00	-	26.00	1.00	VERY LOW CORROSIVE
14	26.00	-	26.50	0.50	LOW CORROSIVE
15	26.50	-	28.50	2.00	VERY LOW CORROSIVE
16	28.50	-	30.00	1.50	LOW CORROSIVE
17	30.00	-	33.50	3.50	VERY LOW CORROSIVE
18	33.50	-	37.66	4.16	LOW CORROSIVE
	Total Length(km)			37.66	

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

HISTOGRAM

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban (Along Existing & Proposed RoU)

	<1000	1000-2500	2500-5000	5000-10000	>10000
150 cm Depth	0.00	0.00	2.67	32.00	65.33
300 cm Depth	0.00	1.33	2.67	26.67	69.33



SOIL RESISITIVITY CURVES

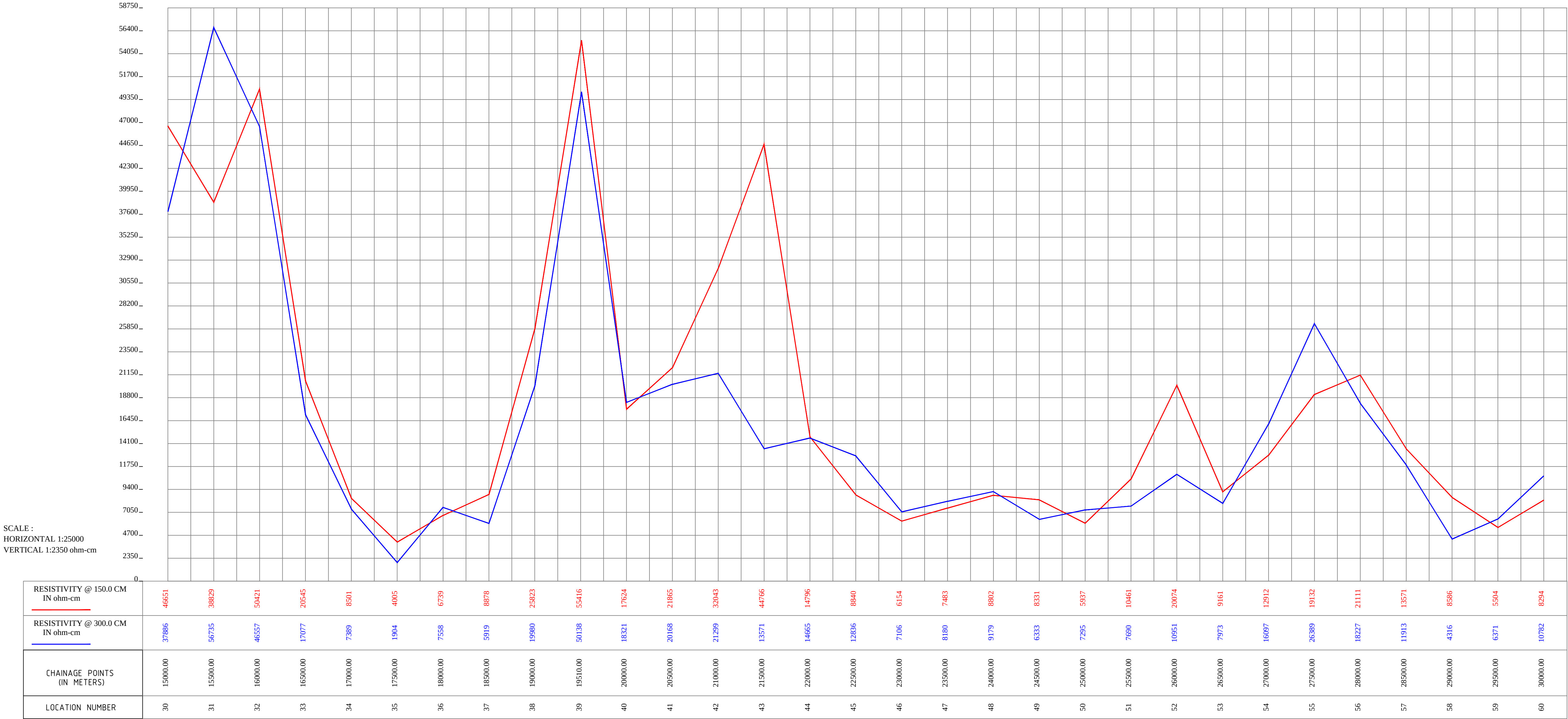
SOIL RESISTIVITY CURVES

SCALE :
HORIZONTAL 1:25000
VERTICAL 1:4150 ohm-cm

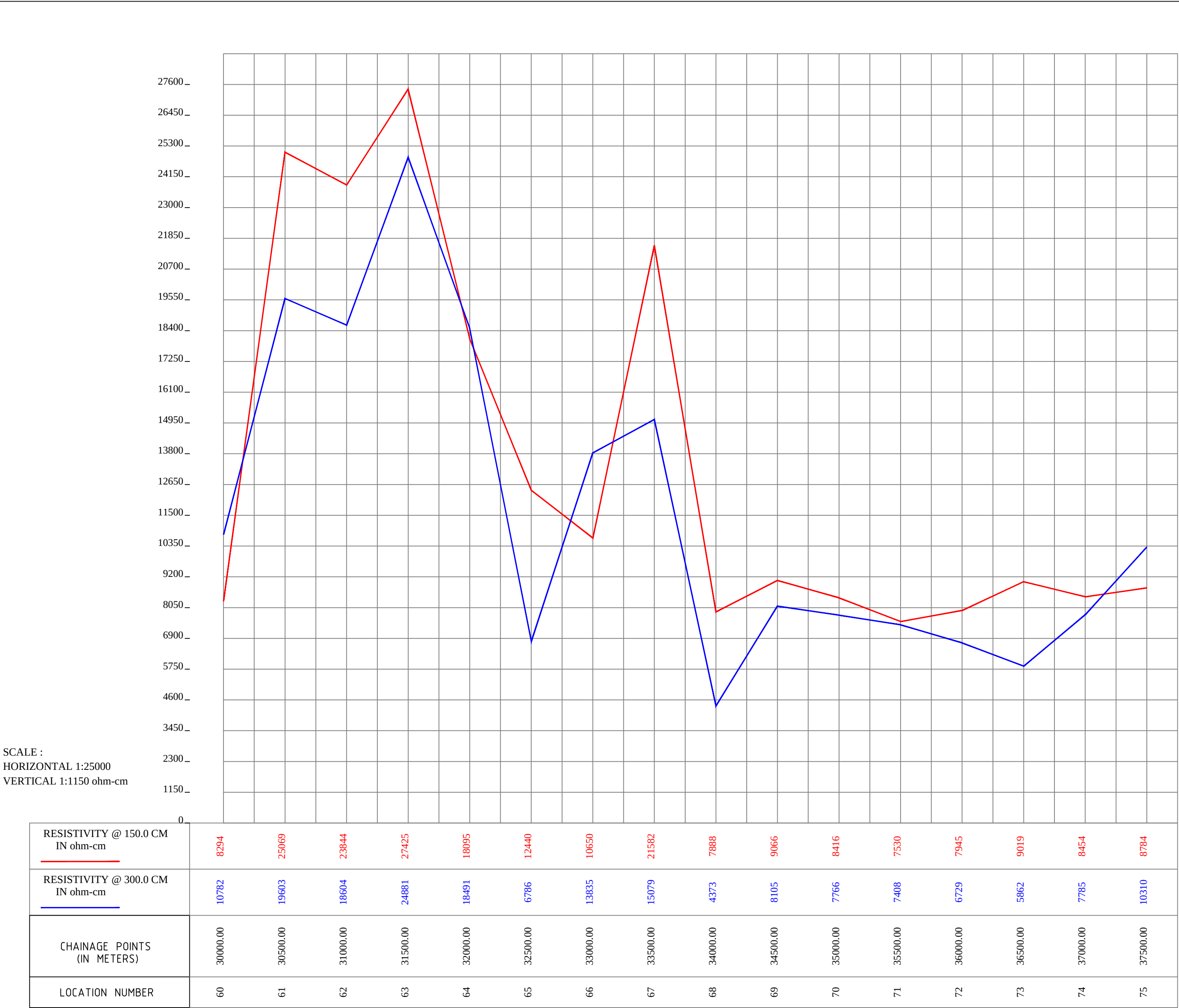
RESISTIVITY @ 150.0 CM IN ohm-cm	10932	36756	23090	8982	25729	42505	26106	36944	28085	37886	72757	58526	19509	8878	3789	8312	30158	44389	68987	58338	40997	49196	65123	50798	36567	19509	21205	34871	37604	46651
RESISTIVITY @ 300.0 CM IN ohm-cm	15513	33174	24315	12761	22242	46369	19980	50515	22053	50138	101219	62579	17643	11159	5749	8887	18811	42976	90664	73511	54097	45426	61071	59751	49196	36002	29216	35625	19980	37886
CHAINAGE POINTS (IN METERS)	500.00	1000.00	1500.00	2000.00	2500.00	3000.00	3500.00	4000.00	4500.00	5000.00	5500.00	6000.00	6500.00	7000.00	7500.00	8000.00	8500.00	9000.00	9500.00	10000.00	10500.00	11000.00	11500.00	12000.00	12500.00	13000.00	13500.00	14000.00	14500.00	15000.00
LOCATION NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30



REFERENCE DRAWINGS						
DRAWING TITLE				DRAWING NO		
PIPELINE ROUTE MAP (1:50,000)				OIL-ASSAM-EP&D-RM-01_R0		
SOIL RESISTIVITY REPORT				DPC-OIL-ASSAM-DSR_R0		
R0	05.09.18	ISSUED FOR CLIENT'S APPROVAL		PURVI	PRS	MND
NO.	DATE	REVISIONS		BY	CHKD	APPD
						PROJ ENGR
CLIENT:-						
Oil India Limited (A Government Of India Enterprise) Dulaijan, Assam, India						
CONSULTANT:						
MECON LIMITED 15th Floor, Scope Minar, North Tower Laxmi Nagar, District Centre, Delhi - 110092						
DESHPANDE - PATIL CONSULTANTS						
DESHPANDE - PATIL CONSULTANTS (Surveyed & Prepared by :- <i>Patil Group of Engineers</i>) (LAND / TOPOGRAPHIC SURVEYS, PIPE LINE SURVEY, SOIL INVESTIGATION, ROU & STATUTORY CLEARANCES) CORPORATE OFFICE: 36, "SHESHACHAL", AJANTA NAGAR, BHARUCH - 392 001,(GUJ). BASE CAMP : 26, GURU DAKSHINA, MAHAVIR NAGAR, NR. SAI GANESH TEMPLE, BHARUCH - 392 001, GUJARAT Phone: (02642) 250052, 654859, Fax No.: (02642) 250052, E-mail : dpsurvey@yahoo.com, dpsurvey36@gmail.com						
PROJECT : Detail Route Survey for underground pipeline From Baghjan EPS/GGS To Madhuban Oil Central Gas Gathering station						
				SHEET : 001 of 003		
DWG. TITLE : SOIL RESISTIVITY CURVES						
SECTION : FROM BAGHJAN EPS/GGS TO MADHUBAN OIL CENTRAL GAS GATHERING STATION						
FROM 0.50 km TO 15.00 km						
SCALE		DRAWING NO.				REV.
AS SHOWN		OIL-ASSAM-S17-001				R0



REFERENCE DRAWINGS									
DRAWING TITLE					DRAWING NO				
PIPELINE ROUTE MAP (1:50,000)					OIL-ASSAM-EP&D-RM-01_R0				
SOIL RESISTIVITY REPORT					DPC-OIL-ASSAM-DSR_R0				
R0	05.09.18	ISSUED FOR CLIENT'S APPROVAL			PURVI	PRS	MND		
NO.	DATE	REVISIONS			BY	CHKD	APPD	PROJ	ENGR
CLIENT-									
 Oil India Limited (A Government Of India Enterprise) Duliajan, Assam, India									
CONSULTANT-									
 MECON LIMITED 15th Floor, Scope Minar, North Tower Laxmi Nagar, District Centre, Delhi - 110092									
 DESHPANDE - PATIL CONSULTANTS <i>(Civil, Survey, Road - Survey of pipeline, - Retainer Offices)</i> (LAND / TOPOGRAPHIC SURVEYS, PIPE LINE SURVEY, SOIL INVESTIGATION, ROU & STATUTORY CLEARANCES) CORPORATE OFFICE: 36, "SHESHACHAL", AJANTA NAGAR, BHARUCH - 392 001,(GUJ). BASE CAMP : 26, GURU DAKSHINA, MAHAVIR NAGAR, NR. SAI GANESH TEMPLE, BHARUCH - 392 001, GUJARAT Phone: (02642) 250052, 654859, Fax No.: (02642) 250052, E-mail : dpsurvey@yahoo.com, dpsurvey36@gmail.com									
PROJECT : Detail Route Survey for underground pipeline From Baghjan EPS/GGS To Madhuban Oil Central Gas Gathering station									
					SHEET : 001 of 003				
DWG. TITLE : SOIL RESISTIVITY CURVES									
SECTION : FROM BAGHJAN EPS/GGS TO MADHUBAN OIL CENTRAL GAS GATHERING STATION									
FROM 15.00 km TO 30.00 km									
SCALE		DRAWING NO.						REV.	
AS SHOWN		OIL-ASSAM-S17-002						R0	



SOIL RESISTIVITY CURVES

	SOIL RESISTIVITY @ 150.00 CM DEPTH FROM G.L.
	SOIL RESISTIVITY @ 300.00 CM DEPTH FROM G.L.

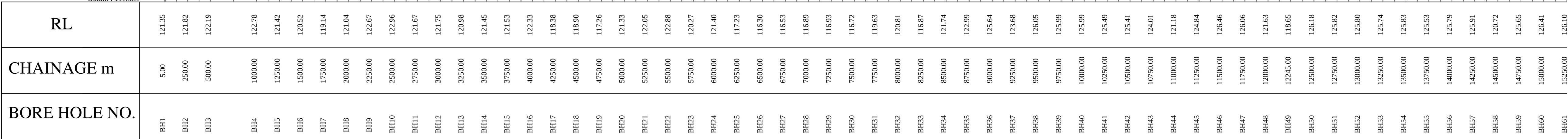
REFERENCE DRAWINGS						
DRAWING TITLE				DRAWING NO		
PIPELINE ROUTE MAP (1:50,000)				OIL-ASSAM-EP&D-RM-01_R0		
SOIL RESISTIVITY REPORT				DPC-OIL-ASSAM-DSR_R0		
R0	05.09.18	ISSUED FOR CLIENT'S APPROVAL		PURVI	PRS	MND
NO.	DATE	REVISIONS		BY	CHKD	APPD
						PROJ ENGR
CLIENT:  Oil India Limited (A Government Of India Enterprise) Duliajan, Assam, India						
CONSULTANT:  MECON LIMITED 15th Floor, Scope Minar, North Tower Laxmi Nagar, District Centre, Delhi - 110092						
Surveyed & Prepared by:-  DESHPANDE - PATIL CONSULTANTS (Land / Topographic Surveys, Pipe Line Survey, Soil Investigation, ROU & Statutory Clearances) CORPORATE OFFICE: 36, "SHESHACHAL", AJANTA NAGAR, BHARUCH - 392 001, GUJARAT. BASE CAMP - 26, GURU DAKSHINA, MAHA VIR NAGAR, NR. SAI GANESH TEMPLE, BHARUCH - 392 001, GUJARAT. Phone: (02642) 250052, 654959, Fax No.: (02642) 250052, E-mail : dpcsurvey@yahoo.com , dpcsurvey36@gmail.com						
PROJECT : Detail Route Survey for underground pipeline From Baghjan EPS/GGS To Madhuban Oil Central Gas Gathering station						
				SHEET : 001 of 003		
DWG. TITLE :				SOIL RESISTIVITY CURVES		
SECTION :				FROM BAGHJAN EPS/GGS TO MADHUBAN OIL CENTRAL GAS GATHERING STATION		
FROM		30.00 km		TO		37.50 km
SCALE		DRAWING NO.			REV.	
AS SHOWN		OIL-ASSAM-S17-001			R0	

S

SOIL PROFILE DRAWING

HORIZONTAL 1:25000
VERTICAL 1:1

Datum : 111.303



LEGEND :-

SOIL PROFILE DRAWING

CODE	HATCH	DESCRIPTION
CI		SILTY CLAY
GM		GRAVEL-SAND-SILT MIX
MI		CLAYEY SILT
SC		SAND-CLAY MIX
SP		SAND
MH		SILT

REFERENCE DRAWINGS

DRAWING TITLE		DRAWING NO			
PIPELINE ROUTE MAP (1:50,000)		OIL-ASSAM-EP&D-RM-01_R0			
SOIL STRATIFICATION REPORT		DPC-OIL-ASSAM-DSR_R0			
R0	05.09.18	ISSUED FOR CLIENT'S APPROVAL	PURVI	PRS	MND
NO.	DATE	REVISIONS	BY	CHKD	APPD
					PROJ ENGR

Oil India Limited
(A Government Of India Enterprise)
Duliajan, Assam, India

MECON LIMITED
15th Floor, Scope Minar, North Tower
Laxmi Nagar, District Centre,
Delhi - 110092

DESHPANDE - PATIL CONSULTANTS
(Civil, Survey, Soil & Foundation Engineering)
(LAND / TOPOGRAPHIC SURVEYS, PIPE LINE SURVEY, SOIL INVESTIGATION, ROU & STATUTORY CLEARANCES)
CORPORATE OFFICE: 36, "SHESHACHAL", AJANTA NAGAR, BHARUCH - 392 001, (GUJ).
BASE CAMP: 26, GURU DAKSHINA, MAHAVIR NAGAR, NR. SAI GANESH TEMPLE, BHARUCH - 392 001, GUJARAT
Phone: (02642) 250052, 654959, Fax No.: (02642) 250052, E-mail : dpsurvey@yahoo.com, dpsurvey36@gmail.com

PROJECT : Detail Route Survey for underground pipeline From Baghjan
EPS/GGS To Madhuban Oil Central Gas Gathering station

SHEET :		001 of 003

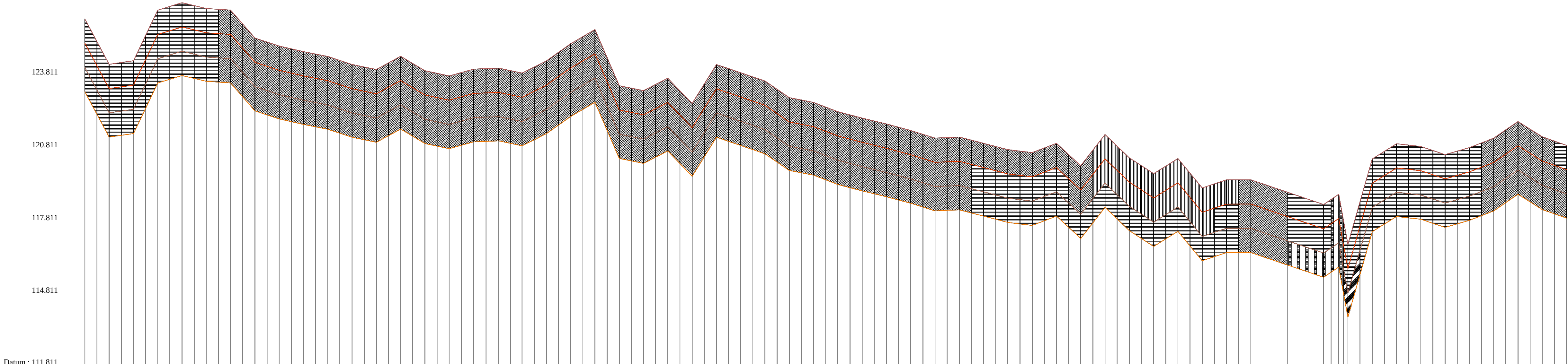
DWG. TITLE :

SECTION :

FROM 0.00 km TO 15.25 km

SCALE	DRAWING NO.	REV.
AS SHOWN	OIL-ASSAM-S18-001	R0

HORIZONTAL 1:25000
VERTICAL 1:1



RL	126.10	124.23	124.38	126.46	126.77	126.53	126.46	125.32	124.98	124.75	124.56	124.23	124.02	124.56	123.97	123.75	124.03	124.08	123.87	124.37	125.08	125.67	123.35	123.15	123.66	122.62	124.22	123.89	123.54	122.86	122.66	122.28	122.02	121.77	121.51	121.19	121.23	120.98	120.72	120.59	120.98	120.05	121.34	120.38	119.73	120.35	119.14	119.47	119.47		118.45	118.88	116.81	120.33	120.96	120.85	120.51	120.80	121.19	121.87	121.25	120.89
CHAINAGE m	15250.00	15500.00	15750.00	16000.00	16250.00	16500.00	16750.00	17000.00	17250.00	17500.00	17750.00	18000.00	18250.00	18500.00	18750.00	19000.00	19250.00	19510.00	19750.00	20000.00	20250.00	20500.00	20750.00	21000.00	21250.00	21500.00	21750.00	22000.00	22250.00	22500.00	22750.00	23000.00	23250.00	23500.00	23750.00	24000.00	24250.00	24500.00	24750.00	25000.00	25250.00	25500.00	25750.00	26000.00	26250.00	26500.00	26750.00	27000.00	27250.00		28000.00	28155.00	28250.00	28500.00	28750.00	29000.00	29250.00	29500.00	29750.00	30000.00	30250.00	30500.00
BORE HOLE NO.	BH61	BH62	BH63	BH64	BH65	BH66	BH67	BH68	BH69	BH70	BH71	BH72	BH73	BH74	BH75	BH76	BH77	BH78	BH79	BH80	BH81	BH82	BH83	BH84	BH85	BH86	BH87	BH88	BH89	BH90	BH91	BH92	BH93	BH94	BH95	BH96	BH97	BH98	BH99	BH100	BH101	BH102	BH103	BH104	BH105	BH106	BH107	BH108	BH109		BH110	BH111	BH112	BH113	BH114	BH115	BH116	BH117	BH118	BH119	BH120	BH121

LEGEND :-

SOIL PROFILE DRAWING

CODE	HATCH	DESCRIPTION
CI		SILTY CLAY
GM		GRAVEL-SAND-SILT MIX
MI		CLAYEY SILT
SC		SAND-CLAY MIX
SP		SAND
MH		SILT

2/3

REFERENCE DRAWINGS

DRAWING TITLE		DRAWING NO			
PIPELINE ROUTE MAP (1:50,000)		OIL-ASSAM-EP&D-RM-01_R0			
SOIL STRATIFICATION REPORT		DPC-OIL-ASSAM-DSR_R0			
R0	05.09.18	ISSUED FOR CLIENT'S APPROVAL	PURVI	PRS	MND
NO.	DATE	REVISIONS	BY	CHKD	APPD
					PROJ ENGR

CLIENT:-



Oil India Limited
(A Government Of India Enterprise)

Duliajan, Assam, India

CONSULTANT:



MECON LIMITED

15th Floor, Scope Minar, North Tower
Laxmi Nagar, District Centre,
Delhi - 110092



Surveyed & Prepared by :-

DESHPANDE - PATIL CONSULTANTS

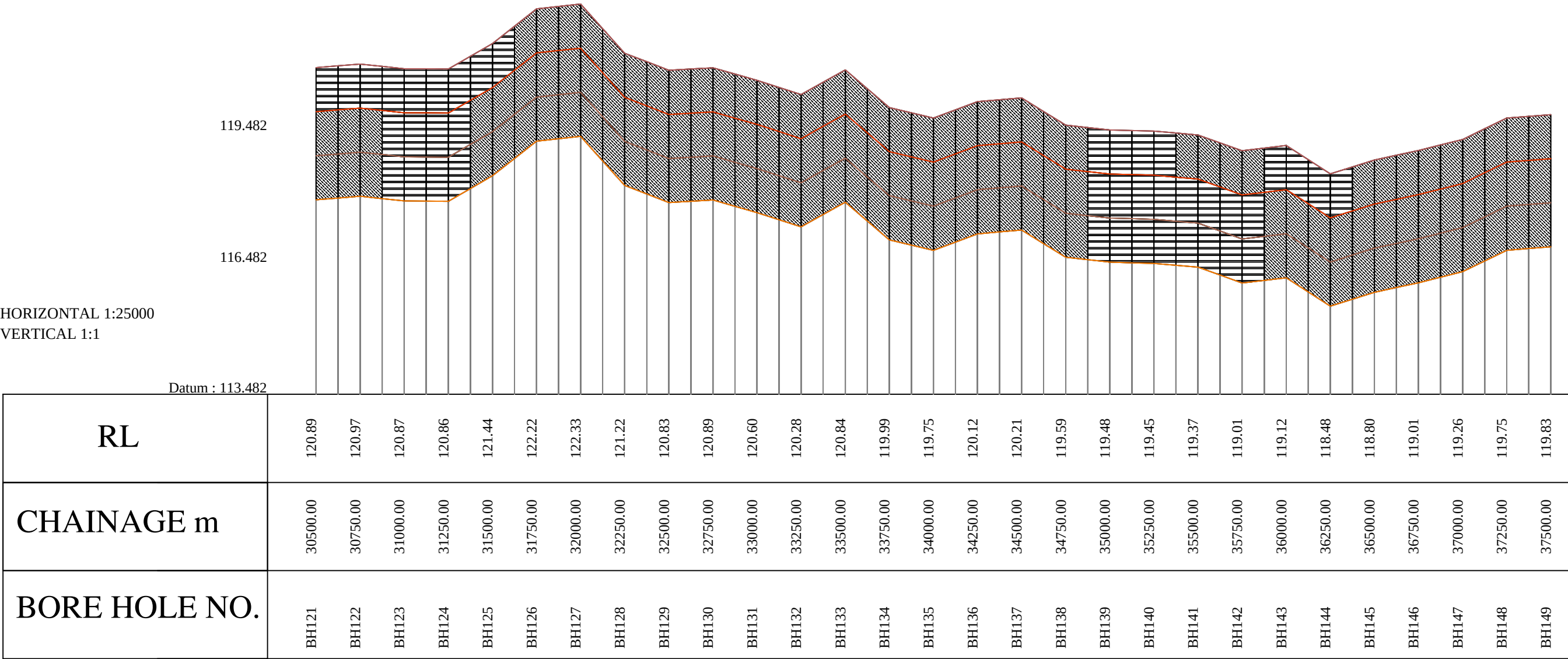
(LAND / TOPOGRAPHIC SURVEYS, PIPE LINE SURVEY, SOIL INVESTIGATION, ROU & STATUTORY CLEARANCES)

CORPORATE OFFICE: 36, "SHESHACHAL", AJANTA NAGAR, BHARUCH - 392 001,(GUJ).
BASE CAMP : 26, GURU DAKSHINA, MAHAVIR NAGAR, NR. SAI GANESH TEMPLE, BHARUCH - 392 001, GUJARAT
Phone: (02642) 250052, 654859, Fax No.: (02642) 250052, E-mail : dpsurvey@yahoo.com, dpsurvey36@gmail.com

PROJECT : Detail Route Survey for underground pipeline From Baghjan
EPS/GGS To Madhuban Oil Central Gas Gathering station

DWG. TITLE		SOIL PROFILE DRAWING	
SECTION		FROM BAGHJAN EPS/GGS TO MADHUBAN OIL CENTRAL GAS GATHERING STATION	
FROM		15.25 km	TO 30.50 km
SCALE	DRAWING NO.		REV.
AS SHOWN	OIL-ASSAM-S18-002		R0

HORIZONTAL 1:25000
VERTICAL 1:1



LEGEND :-			SOIL PROFILE DRAWING
CODE	HATCH	DESCRIPTION	3/3
CI		SILTY CLAY	
GM		GRAVEL-SAND-SILT MIX	
MI		CLAYEY SILT	
SC		SAND-CLAY MIX	
SP		SAND	
MH		SILT	

REFERENCE DRAWINGS						
DRAWING TITLE			DRAWING NO			
PIPELINE ROUTE MAP (1: 50,000)			OIL-ASSAM-EP&D-RM-01_R0			
SOIL STRATIFICATION REPORT			DPC-OIL-ASSAM-DSR_R0			
R0	05.09.18	ISSUED FOR CLIENT'S APPROVAL	PURVI	PRS	MND	
NO.	DATE	REVISIONS	BY	CHKD	APPD	PROJ ENGR
CLIENT:- Oil India Limited (A Government Of India Enterprise) Dulajjan, Assam, India						
CONSULTANT MECON LIMITED 15th Floor, Scope Minar, North Tower Laxmi Nagar, District Centre, Delhi - 110092						
Surveyed & Prepared by:- DESHPANDE - PATIL CONSULTANTS (Land / Topographic Surveys, Pipe Line Survey, Soil Investigation, ROU & Statutory Clearances) CORPORATE OFFICE: 36, "SHESHACHAL", AJANTA NAGAR, BHARUCH - 392 001, GUJARAT BASE CAMP : 26, GURU DAKSHINA, MAHAVIR NAGAR, NR. SAI GANESH TEMPLE, BHARUCH - 392 001, GUJARAT Phone: (02642) 250052, 654959, Fax No.: (02642) 250052, E-mail : dpcsurvey@yahoo.com , dpcsurvey36@gmail.com						
PROJECT : Detail Route Survey for underground pipeline From Baghjan EPS/GGS To Madhuban Oil Central Gas Gathering station						
			SHEET : 001 of 003			
DWG. TITLE :			SOIL PROFILE DRAWING			
SECTION :			FROM BAGHJAN EPS/GGS TO MADHUBAN OIL CENTRAL GAS GATHERING STATION			
FROM			30.50 km	TO		37.50 km
SCALE		DRAWING NO.			REV.	
AS SHOWN		OIL-ASSAM-S18-003			R0	



MECON LIMITED

15th Floor, Scope Minar, North Tower,
Laxmi Nagar, District Centre,
Delhi – 110 092

Oil India Limited

Duliajan, Assam

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

SECTION-III : SOIL STRATIFICATION & CHEMICAL ANALYSIS REPORT

1. INTRODUCTION:

Oil India Limited (OIL) traces and symbolizes the development and growth of the Indian petroleum industry. From the discovery of crude oil in the far East of India at Digboi, Assam in 1889 to its present status as a fully integrated upstream petroleum company, OIL has come far, crossing many milestones.

On February 18, 1959, Oil India Private Limited was incorporated to expand and develop the newly discovered oil fields of Naharkatiya and Moran in the Indian North East. In 1961, it became a joint venture company between the Indian Government and Burmah Oil Company Limited, UK.

In 1981, OIL became a wholly-owned Government of India enterprise. Today, OIL is a premier Indian National Oil Company engaged in the business of exploration, development and production of crude oil and natural gas, transportation of crude oil and production of LPG. OIL also provides various E&P related services and holds 26% equity in Numaligarh Refinery Limited.

M/s Oil India Limited, Duliajan, Assam intends to lay 762mm/400mm Ø Natural Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban, Duliajan. The Proposed route is planned within its Ex. 400mm Ø Gas Pipeline and 200mmØ COD Pipeline from Baghjan to Duliajan.

Accordingly, M/s Oil India Limited appointed M/s MECON Limited as a Consultant and M/s MECON Limited has entrusted M/s Deshpande-Patil Consultants (DPC), Bharuch for carrying out the Reconnaissance Survey, Detailed Survey, Cadastral Survey, Soil Investigation, Corrosion Survey and Bench Mark installation for Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban & 16"Ø Gas Pipeline from O.I.L. Makum Oil Change Service to Central Gas Gathering Station Madhuban in Assam State as per **LAC Dtd. 5th July, 2018**.

This report covers the Soil Investigation & Corrosion Survey for Existing ROW for entire **38.000 km** length.

The Investigation has been carried out approximately at every 250 meters upto 3.0 meters depth. While Corrosion Survey has been carried out approximately at every 10 km & at River crossings up to 3.0 meters depth.

2. SCOPE OF THE WORK:

2.1 SOIL INVESTIGATION ALONG PIPELINE ROUTE:

The scope of soil investigation includes boring, collection of disturbed samples from boreholes and visual engineering classification of soil along the pipeline route, and submission of detailed report to OIL/MECON. Visual classification of soil shall be in accordance with IS-1498, "IS Classification and Identification of Soils for General Engineering Purposes."

2.2 CORROSION SURVEY:

The specification covers the corrosion survey including measurement of soil resistivity chemical analysis of soil/ water and other cathodic protection related data collection along right of way of the pipelines.

Soil/ water samples shall be collected along the Right of way for analysis. Samples shall be collected on an average at one location per every 10 KM along Right of way with minimum at two locations. Exact locations shall be decided at site depending on the type of soil, soil resistivity and in consultation with OIL/MECON. The soil samples shall be collected at 1 mtr and 2 mtr depth at each location.

The collected soil/ water samples shall be analyzed to determine presence and percentage of corrosive compounds including moisture content, oxygen activity and pH value.

3. BORING

Soil samples at various depths up to a maximum 3.0 meter below normal ground level (NGL) were taken by boring 150 mm diameter by Auger at approximately

250 meter intervals along the route of the pipeline up to a depth of 3.0 m or till the rock is encountered.

Disturbed samples were collected at every change of strata after inspection and visual classifications were sealed in a polythene bag and sent to our Vadodara laboratory for further engineering classification as per IS standards.

The bore log form after getting the results from the laboratory was plotted and presented in the form of booklet showing bore log details taken at various chainages of the pipeline.

The locations of soil samples taken through boreholes are marked as BH1, BH2 ...in soil profile drawing along with its chainages of respective section. In all 148 nos of boreholes have been taken along the route.

4. GROUND WATER TABLE

The ground water table was not encountered along entire route during the sub soil exploration work.

5. ROCKY STRETCH:

The rocky stretch was not encountered along entire route during the sub soil exploration work.

6. CHEMICALS ANALYSIS OF SOIL :

Soil samples at every 10 km along the route of proposed pipeline as suggested by OIL INDIA LTD. at various locations were tested for Chemical Analysis as desired by Client. The soil samples were collected at different depths as per change of strata at 1.0 m, 2.0 m and 3.0 m. The samples were collected in plastic bags and were sent for chemical analysis in Government approved laboratory.

The chemical analysis includes:

- a) Cations: Ca, Mg, Na, K.
- b) Anions: Chlorides, Sulphates, Sulphides, Carbonate, Bicarbonate, Nitrite, Nitrate,
- c) General: Oxygen Activity, moisture Content, pH value.

In the chemical analysis, 150 g sample was dissolved in 500 ml. water and the various tests were performed as per standard method on this prepared leachate of soil sample.

Moisture content was performed directly on the soil sample and not on the prepared leachate.

All the parameters are in mmol/kg except indicated.

7. **DETAILED PROCEDURE OF CHEMICAL ANALYSIS:**

The detailed method of analysis for determination of above mentioned parameters is described below:

(a) **3500-Ca B. EDTA Titrimetric Method (Calcium)**

General Discussion

a. **Principle :**

When EDTA (ethylenediaminetetraacetic acid or its salts) is added to water containing both calcium can be determined directly, with EDTA, when the pH is made sufficiently high that the magnesium is largely precipitated as the hydroxide and an indicator is used that combines with calcium only. Several indicators give a color change when all of the calcium has been complexed by the EDTA at a pH of 12 to 13.

b. **Interference:**

Under conditions of this test, the following concentrations of ions cause no interference with the calcium hardness determination: Cu^{2+} , 2 mg/L; Fe^{2+} , 20 mg/L; Fe^{3+} , 20 mg/L; Mn^{2+} , 10 mg/L; Zn^{2+} , 5 mg/L; Pb^{2+} , 5mg/L ; Al^{3+} , 5 mg/L; and Sn^{4+} , 5 mg/L. Orthophosphate precipitates calcium at the pH of the test. Strontium and barium give a positive interference and alkalinity in excess of 300 mg/L may cause an indistinct end point in hard waters.

Reagents

a. **Sodium hydroxide, NaOH, 1N**

b. **Indicators:**

Many indicators are available for the calcium titration. Murexide (ammonium Purpurate) was the first indicator available for detecting the calcium and point; directions for its use are presented in this procedure. Individuals who have difficulty recognizing the murexide end point may find the indicator Eriochrome Blue Black R (color index number 202) or Solochrome Dark Blue an improvement because of the color change from red to pure blue. Eriochrome Blue Black R is sodium-1-(2-hydroxy-1-naph-thylazo)-2-naphthol-4sulfonic acid. Other indicators specifically designed for use as end-point detectors in EDTA titration of calcium may be used.

(1) Murexide (ammonium Purpurate) indicator :

This indicator changes from pink to purple at the end point. Prepare by dissolving 150 mg dye in 100 g absolute ethylene glycol. Water solutions of the dye are not stable for longer than 1 d. A ground mixture of dye powder and sodium chloride (NaCl) provides a stable form of the indicator. Prepare by Mixing 200 mg murexide with 100 g solid NaCl and grinding the mixture to 40 to 50 mesh. Titrate immediately after adding indicator because it is unstable under alkaline conditions. Facilitate end-point recognition by preparing a color comparison blank containing 2.0 mL NaOH solution, 0.2 g solid indicator mixture (or 1 to 2 drops if a solution is used), and sufficient standard EDTA titrant (0.05 to 0.10 mL) to produce an unchanging color.

(2) Eriochrome Blue Black R indicator :

Prepare a stable form of the indicator by grinding together in a mortar 200 mg powdered dye and 100g solid NaCl to 40 to 50 mesh. Store in a stoppered bottle. Use 0.2 g of ground mixture for the titration in the same manner as murexide indicator. During titration the color changes from red through purple to bluish purple to a pure blue with no trace of reddish or purple tint. The pH of some (not all) waters must be raised to 14 (rather than 12 to 13) by the use of 8N NaOH to get a good color change.

c. **Standard EDTA titrant, 0.01M:**

Prepare standard EDTA titrant and standardize against standard calcium solution as described in Section 2340C to obtain EDTA/CaCO₃ equivalent to 1000 mg CaCO₃/1.00 mL; use titrated equivalent for B in the calculations in 4.

Procedure

a. Pretreatment of water and wastewater samples :

Follow the procedure described in Section 3030E or I if samples require preliminary digestion.

b. Sample preparation:

Because of the high pH used in this procedure, titrate immediately after adding alkali and indicator. Use 50.0 mL sample, or a smaller portion diluted to 50 mL so that the calcium content is about 5 to 10 mg. Analyze hard waters with alkalinity higher than 300 mg CaCO₃/L by taking a smaller portion and

diluting to 50 mL. Alternatively, adjust sample pH into the acid range (pH <6), boil for 1 min to dispel CO₂ and cool before beginning titration.

c. Titration:

Add 2.0 mL NaOH solution or a volume sufficient to produce a pH of 12 to 13 Stir. Add 0.1 to 0.2 g indicator mixture selected (or 1 to 2 drops if a solution is used). Add EDTA titrant slowly, with continuous stirring to the proper end point. When using murexide, check end point by adding 1 to 2 drops of titrant in excess to make certain that no further color change occurs.

Calculation

$$\text{Mg Ca/L} = \frac{A \times B \times 400.8}{\text{mL sample}}$$

$$\text{Calcium hardness as mg CaCO}_3 \text{ /L} = \frac{A \times B \times 1000}{\text{mL sample}}$$

where:

A = mL titrant for sample and

B = mg CaCO₃ equivalent to 1.00 mL EDTA titrant at the calcium indicator end point.

Precision and Bias

A synthetic sample containing 108mg Ca/L, 82 mg Mg/L, 3.1 mg K/L, 19.9 mg Na/L, 241 mg Cl-/L, 1.1 mg NO₃- /L, 0.25 mg NO₂- /L, 259 mg SO₄2-/L, and 42.5 mg total alkalinity/L (contributed by NaHCO₃) in distilled water was analyzed in 44 laboratories by the EDTA titrimetric method, with a relative standard deviation of 9.2% and a relative error of 1.9%.

Bibliography

DIEHL, H. & J.L. ELLINGBOE. 1956. Indicator for titration of calcium in the presence of magnesium using disodium dihydrogen ethylenediamine tetraacetate. Anal. Chem. 28:882. HILDEBRAND, G.P. & C.N. REILLEY. 1957. New indicator for complexometric titration of calcium in the presence of magnesium. Anal. Chem. 29:258. PATTON, J. & W. REEDER. 1956. New indicator for titration of calcium with (ethylenedinitrilo) tetraacetate. Anal. Chem. 28:1026. SCHWARZENBACH, G. 1957. Complexometric Titrations. Interscience Publishers. New York, N.Y. FURMAN, N.H. 1962, Standard Methods of Chemical Analysis, 6th ed. D. Van Nostrand Co., Inc., Princeton, N.J. KATZ, H. & R. NAVONE 1964. Method for simultaneous determination of calcium and magnesium. J. Amer. Water Works Assoc. 56:121.

(b) Determination of (3500-Mg B. Calculation Method (Magnesium))

Magnesium may be estimated as the difference between hardness and calcium as CaCO₃ if interfering metals are present in non interfering concentrations in the calcium titration (Section 3500-Ca.B) and suitable inhibitors are used in the hardness titration (Section 2340C).

Mg Mg/L = [total hardness (as Mg CaCO₃/L)

Calcium hardness (as mg CaCO₃/L] x 0.243

(c) 3500-Na B. Flame Emission Photometric Method (Sodium)

Reference:

Standard method for examination of water & waste water method No. 3500 – NaB

General Discussion

a. Principle:

Trace amounts of sodium can be determined by flame emission photometry at 589 nm. Sample is nebulized into a gas flame under carefully controlled, reproducible excitation conditions. The sodium resonant spectral line at 589 nm is isolated by interference filters or by light-dispersing devices such as prisms or gratings. Emission light intensity is measured by a phototube, photomultiplier, or photodiode. The light intensity at 589 nm is approximately proportional to the sodium concentration. Alignment of the wavelength-dispersing device and wavelength readout may not be precise. The appropriate wavelength setting, which may be slightly more or less than 589 nm, can be determined from the maximum emission intensity when aspirating a sodium standard solution, and then used for emission measurements. The calibration curve may be linear but has a tendency to level off or even reverse at higher concentration. Work in the linear to near-linear range.

b. Minimize interference by incorporation of one or more of the following:

1. Operate at the lowest practical concentration range.
2. Add releasing agents, such as strontium or lanthanum at 1000mg/L, to suppress ionization and anion interference. Among common anions capable of causing interference are Cl⁻, SO₄²⁻ and HCO₃⁻ in relatively large amounts.

3. Matrix-match standard and samples by adding identical amounts of interfering substances present in the sample to calibration standards.
 4. Apply an experimentally determined correction in those instances where the sample contains a single important interference.
 5. Remove interfering ions.
 6. Remove burner-clogging particulate matter from the sample by filtration through a filter paper of medium retentiveness.
 7. Use the standard addition technique as described in the flame photometric method for strontium (3500-Sr.B). The method involves preparing a calibration curve using the sample matrix as a diluent, and determining the sample concentration either mathematically or graphically.
 8. Use the internal standard technique. Potassium and calcium interfere with sodium determination by the internal-standard method if the potassium-to-sodium ratio is $\geq 5:1$ and the calcium-to-sodium ratio is $\geq 10:1$. When these ratios are exceeded, determine calcium and potassium concentrations and matrix-match sodium calibration standards by addition of approximately equivalent concentrations of interfering ions. Interference from magnesium is not significant until the magnesium-to-sodium ratio exceeds 100, a rare occurrence.
- c. Minimum detectable concentration:
- Better flame photometers or atomic absorption spectrometers operating in the emission mode can be used to determine sodium levels approximating $5\mu\text{g/L}$.

Apparatus

- a. Flame photometer (either direct-reading or internal-standard type) or atomic absorption spectrometer operating in the flame emission mode.
- b. Glassware: Rinse all glassware with 1 + 15 HNO₃ followed by several portions of reagent water (¶ 3a).

Reagents

To minimize sodium contamination, store all solutions in plastic bottles. Use small containers to reduce the amount of dry element that may be picked up from the bottle walls when the solution is poured. Shake each container vigorously to wash accumulated salts from walls before pouring solution.

- a. Reagent water: Use reagent water to prepare all reagents and calibration standards, and as dilution water.
- b. Stock sodium solution : Dissolve 2.542 g NaCl dried at 140°C to constant weight and dilute to 1000 mL with water; 1.00 mL = 1.00 mg Na, Intermediate sodium solution:

Dilute 10.00 mL stock sodium solution with water to 100.0 mL: 1.00 mL = 0.10 mg Na (1.00 mL = 100 µg Na). Use this intermediate solution to prepare calibration curve in sodium range of 1 to 10 mg/L.

- a. Standard sodium solution:

Dilute 10.00mL intermediate sodium solution with water to 100 mL: 1.00 mL = 10.0 µg Na. Use this solution to prepare calibration curve in sodium range of 0.1 to 1.0 mg/L.

Procedure:

- a. Pretreatment of polluted water and wastewater samples:
- b. Instrument operation: Because of differences between makes and models of instruments, it is impossible to formulate detailed operating instructions. Manufacturers' recommendation for selecting proper photocell and wavelength, adjusting slit width and sensitivity, appropriate fuel and oxidant gas pressures, and the steps for warm-up, correcting for interferences and flame background, rinsing of burner, igniting flame and measuring emission intensity should be followed.
- c. Direct-intensity measurement: Prepare a black and sodium calibration standards in stepped amounts in any of the following applicable ranges: 0 to 1.0, 0 to 10, or 0 to 100 mg/L. Determine emission intensity at 589nm. Aspirate calibration standards and samples enough times to secure a reliable average reading for each. Construct a calibration curve from the sodium standards. Determine sodium concentration of sample from the calibration curve. Where a large number of samples must be run routinely, the calibration curve provides sufficient accuracy.
- d. Bracketing approach: From the calibration curve, select and prepare sodium standards that immediately bracket the emission intensity of the sample. Determine emission intensities of the bracketing standards (one sodium standard slightly less and the other slightly greater than the sample) and the nearly simultaneously as possible. Repeat the determination on bracketing standards and sample. Calculate the sodium concentration by the equation in ¶ 5b and average the findings.

Calculation

a. For direct reference to the calibration curve:
 $\text{mg Na/L} = (\text{mg Na/L in portion}) \times D$

b. For the bracketing approach:

$$\text{Mg} \left[\text{Na/L} = \frac{(B - A)(s - a) + A}{(b - a)} \right] \times D$$

Where:

B = mg Na/L in upper bracketing standard,

A = mg Na/L in lower bracketing standard,

b = emission intensity of upper bracketing standard,

a = emission intensity of lower bracketing standard,

s = emission intensity of sample, and

D = dilution ratio.

$$= \frac{\text{mL sample} + \text{mL water}}{\text{mL sample}}$$

Precision and Bias

A synthetic sample containing 19.9 mg Na⁺/L, 108 mg Ca²⁺ + L, 82 mg Mg²⁺/L, 3.1 mg K⁺/L, 241 mg Cl⁻/L, 0.25mg NO₂ N/L, 1.1 mg NO₃⁻ -N/L, 259 mg SO₄²⁻/L, and 42.5 mg total alkalinity/L (as CaCO₃) was analyzed in 35 laboratories by the flame photometric method, with a relative standard deviation 17.3 % and a relative error of 4.0 %.

Some important references to the above method

WEST, P.W., P. FOLSE & D. MONTGOMERY. 1950. Application of flame Spectrophotometry to water analysis Anal. Chem.22:667.

COLLINS, C.G. & H.POLKINHORNE. 1952. An investigation of anionic interference in the determination of small quantities of potassium and sodium with a new flame photometer. Analyst 77:430.

MELOCHE, V.W. 1956. Flame photometry, Anal. Chem. 28:1844.

BURRIEL-MARTI , F.& J. RAMIREZ-MUNOZ 1957. Flame Photometry Manual of Methods and Applications. D. Van Nostrand Co., Princeton, N.J.

DEAN, J.A. 1960. Flame Photometry. McGraw-Hill Publishing Co., New York, N.Y.

URE, A.M. & R.L. MRRCHELL. 1975. Lithium, Sodium, potassium, rubidium, and cesium. In J.A. Dean & T.C. Rains, eds. Flame Emission and Atomic Absorption Spectrometry. Dekker, New York, N.Y.

THOMPSON, K.C. & REYNOLDS, R.J. 1978. Atomic Absorption, Fluorescence, and Flame Spectroscopy – A Practical Approach, 2nd John Wiley & Sons, New York, N.Y.

WILLARD, H.H., L.L. MERRIT, JR., J.A. DEAN & F.A. SETTLE, JR. 198

Instrumental Methods of Analysis, 6th ed. Wadsworth Publishing Co., Belmont, Calif.

AMERICAN SOCIETY FOR TESTING AND MATERIALS. 1988. Method D 142 82 : Standard test methods for sodium and potassium in water a water – formed deposits by flame photometry. Annual Book of ASD Standards, Vol. 11.01. American Soc. Testing & Materials, Philadelphia, Pa.

(d) Determination of (3500-K B. Flame Photometric Method (Potassium)):

General Discussion

a. Principle:

Trace amounts of potassium can be determined in either a direct-reading or internal – standard type of flame photometer at a wavelength of 766.5nm. Because much of the information pertaining to sodium applies equally to the potassium determination, the entire discussion dealing with the flame photometric determination of sodium (Section 3500 – Na B) should be dealt before making a potassium determination.

b. Interference:

Interference in the internal-standard method may occur at sodium-to-potassium ratios of 1:1 or greater. Calcium may interfere if the calcium-to-potassium ratio is 10:1 or more. Magnesium begins to interfere when the magnesium-to-potassium ratio exceeds 100:1.

Minimum detectable concentration :

Potassium levels of approximately 0.1 mg/L can be determined.

Apparatus

Refer 3500-Na.B.2.

Reagents

To minimize potassium pickup, store all solutions in plastic bottles. Shake each container thoroughly to dissolve accumulated salts from walls before pouring.

Reagent water:

See Section 1080. Use this water for preparing all reagents and calibration standards, and as dilution water.

Stock potassium solution:

Dissolve 1.907 g KCl dried at 140°C and dilute to 1000 mL with water; 1 mL = 1.00 mg K.

Intermediate potassium solution:

Dilute 10.0 mL stock potassium solution with water to 100 mL; 1.00 mL = 0.100 mg K. Use this solution to prepare calibration curve in potassium range of 1 to 10 mg/L.

Standard potassium solution:

Dilute 10.0 mL intermediate potassium solution with water to 100 mL; 1.00 mL = 0.010 mg Use this solution to prepare calibration curve in potassium range of 0.1 to 1.0 mg/L.

Procedure

Make determination as described in Section 3500-Na.B.4, but measure emission intensity at 766.5 nm.

Calculation

See Section 3500-Na. B.5.

Precision and Bias

A synthetic sample containing 3.1 mg K⁺/L, 108 mg Ca²⁺/L, 82 mg Mg²⁺/L, 19.9 mg Na⁺/L, 241 mg Cl⁻/L, 0.25 mg NO₂⁻ - N/L, 1.1 mg NO₃⁻ - N/L, 259 mg SO₄²⁻/L, and 42.5 mg total alkalinity/L (contributed by NaHCO₃) was analyzed in 33 laboratories by the flame photometric method, with a relative standard deviation of 15.5 % and a relative error of 2.3 %.

Some important references for the above method

MEHLICH, A. & R.J. MONROE. 1952. report on potassium analyses by means of flame photometer methods. J. Assoc. Offic. Agr. Chem. 35:588. Also see 3500-Na.B.7.

(e) 4500-Cl- B. Argentometric Method (Chloride)

General Discussion

a. Principle:

In a neutral or slightly alkaline solution, potassium chromate can indicate the end point of the silver nitrate titration of chloride. Silver chloride is precipitated quantitatively before red silver chromate is formed.

b. Interference:

Substances in amounts normally found in potable waters will not interfere. Bromide, iodide, and cyanide register as equivalent chloride concentrations. Sulfide, thiosulfate, and sulfite ions interfere but can be removed by treatment with hydrogen peroxide. Orthophosphate in excess of 25 mg/L interferes by precipitating as silver phosphate. Iron in excess of 10 mg/L interferes by masking the end point.

Apparatus

- a. Erlenmeyer flask, 250-mL.
- b. Burette, 50-mL.

Reagents

- a. Potassium chromate indicator solution: Dissolve 50 g K_2CrO_4 in a little distilled water. Add $AgNO_3$ solution until a definite red precipitate is formed. Let stand 12 h, filter, and dilute to 1 L with distilled water.
- b. Standard silver nitrate titrant, 0.0141M (0.0141N): Dissolve 2.395 g $AgNO_3$ in distilled water and dilute to 1000 mL. Standardize against NaCl by the procedure described in ¶ 4b below; 1.00 mL = 500 μg Cl^- , store in a brown bottle.
- c. Standard sodium chloride, 0.0141M (0.0141N): Dissolve 824.0 mg NaCl (dried at 140°C) in distilled water and dilute to 1000 mL; 1.00 mL = 500 μg Cl.
- d. Special reagents for removal of interference:
 - 1. Aluminum hydroxide suspension: Dissolve 125 g aluminum potassium sulfate or aluminum ammonium sulfate, $AlK(SO_4)_2 \cdot 12H_2O$ or $AlNH_4(SO_4)_2 \cdot 12H_2O$, in 1 L distilled water. Warm to 60°C and add 55 mL conc. ammonium hydroxide (NH_4OH) slowly with stirring. Let stand about 1h, transfer to large bottle, and wash by successive additions, with thorough mixing and decanting with distilled water, until formation from chloride. When freshly prepared, the suspension occupies volume of approximately 1 L.
 - 2. Phenolphthalein indicator solution.
 - 3. Sodium hydroxide NaOH, 1N.

4. Sulphuric acid, H₂SO₄, 1N.
5. Hydrogen peroxide, H₂O₂, 30%.

Procedure

a. **Sample preparation:**

Use a 100-mL sample or a suitable portion diluted to 100 mL. If the sample is highly colored, add mL Al(OH)₃ suspension, mix, let settle, and filter.

If sulphite, or thiosulphate is present, add 1 mL H₂O₂ and stir for 1 min.

b. **Titration:**

Directly titrate samples in the pH range 7 to 10. Adjust sample pH to 7 to 10 with H₂SO₄ or NaOH if it is not in this range. For adjustment, preferably use a pH meter with a non-chloride-type reference electrode. (If only a chloride-type electrode is available, determine amount of acid or alkali needed for adjustment and discard this sample portion. Treat a separate portion with required acid or alkali and continue analysis.) Add 1 mL K₂CrO₄ indicator solution. Titrate with standard AgNO₃ titrant to a pinkish yellow end point. Be consistent in end-point recognition.

Standardize AgNO₃ titrant and establish reagent blank value the titration method outlined above. A blank of 0.2 to 0.3 mL usual.

Calculation

$$\text{Mg Cl}^-/\text{L} = \frac{(A - B) \times N \times 35450}{\text{mL sample}}$$

A = mL titration for sample,

B = mL titration for blank, and

N = normality of AgNO₃.

$$\text{Mg NaCl/L} = (\text{mg Cl}^-/\text{L}) \times 1.65$$

Precision and Bias

A synthetic sample containing 241 mg Cl⁻/L, 108 mg Ca/L, mg Mg/L; 3.1 mg K/L, 19.9 mg Na/L, 1.1 mg NO₃⁻ - N/L, 25 mg NO₂⁻ - N/L, 259 mg SO₄²⁻/L, and 42.5 mg total alkalinity/L (contributed by NaHCO₃) in distilled water was analyzed in 41 laboratories by the argentometric method, with a relative standard deviation of 4.2 % and a relative error of 1.7 %.

Some important references for the above method

HAZEN, A. 1889. On the determination of chlorine in water. Amer. Chem. J. 11:409

KOLTHOFF, I.M. & V.A. STANGER. 1947. Volumetric Analysis, 2nd ed. Vol.

2. Interscience Publishers, New York, N.Y. pp. 242-245, 256-258.

PAUSTIAN, P. 1987. A novel method to calculate the Mohr chloride titration. In Advances in Water Analysis and Treatment, Proc. 14th Annu. AWWA Water Quality Technology Conf., November 16-20, 1986, Portland, Ore., p. 673. American Water Works Assoc., Denver, Colo.

(f) **Determination of $4500\text{-SO}_4^{2-}\text{C}$ Gravimetric Method with Ignition of Residue (Sulfate)**

Reference:

Standard method for examination of water & waste water Method No. $4500\text{-SO}_4^{2-}\text{C}$

General Discussion:

Principle:

Sulphate is precipitated in a hydrochloric acid (HCl) solution as barium sulphate (BaSO_4) by the addition of barium chloride (BaCl_2).

The precipitation is carried out near the boiling temperature and after a period of digestion the precipitate is filtered, washed with water until free Cl^- , ignited or dried, and weighed as BaSO_4 .

Interference:

The gravimetric determination of SO_4^{2-} is subject to many errors, both positive and negative. In potable water where the mineral concentration is low, these may be of minor importance.

1) **Interferences leading to high results:**

Suspended matter, silica BaCl_2 precipitant, NO_3^- , SO_3^{2-} and occluded mother liquor in the precipitate are the principal factors in positive errors. Suspended matter may be present in both the sample and the precipitating solution; soluble silicate may be rendered insoluble and SO_3^{2-} may be oxidized to SO_4^{2-} during analysis. Barium nitrate [$\text{Ba}(\text{NO}_3)_2$], BaCl_2 , and water are occluded to some extent with the BaSO_4 although water is driven off if the temperature of ignition is sufficiently high.

2) Interferences leading to low results:

Alkali metal sulfates frequently yield low results. This is true especially of alkali hydrogen sulfates. Occlusion of alkali Sulfate with BaSO₄ causes substitution of an element of lower atomic weight than barium in the precipitate. Hydrogen sulfates of alkali metals act similarly and, in addition, decompose on being heated. Heavy metals, such as chromium and iron, cause low results by interfering with the complete precipitation of SO₄²⁻ and by formation of heavy metal sulfates. BaSO₄ has small but significant solubility, which increases in the presence of acid. Although an acid medium is necessary to prevent precipitation of barium carbonate and phosphate, it is important to limit its concentration to minimize the solution effect.

Apparatus:

- a. Steam bath.
- b. Drying oven, equipped with thermostatic control.
- c. Muffle furnace, with temperature indicator.
- d. Desiccator.
- e. Analytical balance, capable of weighing to 0.1 mg.
- f. Filter: Use one of the following.
 - 1) Filter paper, acid – washed, ashless hard – finish, sufficiently retentive for fine precipitates.
 - 2) Membrane filter, with a pore size of about 0.45 µm.
 - 3). Filtering apparatus, appropriate to the type of filter selected (Coat membrane filter holder with silicone fluid to prevent precipitate from adhering.)

Reagents:

- a. Methyl red indica: Dissolve 100 mg methyl red sodium salt in distilled water and dilute to 100 mL
- b. Hydrochloric acid HC 1 + 1.
- c. Barium chloride so Dissolve 100g BaCl₂·2H₂O in 1 L distilled water. Filter a membrane filter or hard – finish filter paper before user 1 mL is capable of precipitating approximately 40 mg SO₄²⁻
- d. Silver nitrate-nitric acid reagent: Dissolve 8.5 g AgNO₃ and 0.5 mL conc HNO₃ in 500 mL distilled water.
- e. Silicone fluid. *

Procedure:

- a. Removal of silica: If the silica concentration exceeds 25 mg/ L. evaporate sample nearly to dryness in a platinum dish on a steam bath. Add 1 mL HCL tilt, and rotate dish until the acid comes in complete contact with the residue. Continue evaporation to dryness. Complete drying in an oven at 180oC and if organic matter is present. Char over flame of a burner. Moisten residue with 2 mL distilled water and 1 mL HCl. Take up soluble residue in hot water. And filter. Wash insoluble silica with several small portions of hot distilled water. Combine filtrate and washings. Discard residue.
- b. Precipitation of barium sulphate: Adjust volume of clarified sample to contain approximately 50 mg SO₄²⁻ in a 250-mL volume. Lower concentrations of SO₄²⁻ may be tolerated if it is impracticable to concentrate sample to the optimum level, but in such cases limit total volume to 150mL. Adjust pH with HCl to pH 4.5 to 5.0 using a pH meter or the orange color of methyl red indicator. Add 1 to 2 mL HCl. Heat to boiling and, while stirring gently. Slowly add warm BaCl₂ solution until precipitation appears to be complete: then add about 2 mL in excess. If amount of precipitate is small, add a total of 5 mL BaCl₂ solution. Digest precipitate at 80 to 90oC. Preferably overnight but for not less than 2 h.
- c. Filtration and weighing: Mix a small amount of ashless filter paper pulp with the BaSO₄. Quantitatively transfer to a filter, are filter at room temperature. The pulp aids filtration and reduced the tendency of the precipitate to creep. Wash precipitate with small portions of warm distilled water until washings are free Cl⁻ as indicated by testing with AgNO₃-HNO₃ reagent. Pla filter and precipitate in a weighted platinum crucible and ignite 800oC for 1 h. Do not let filter paper flame. Cool in desiccator and weigh.

Calculation:

$$\text{Mg SO}_4^{2-}/\text{L} = \frac{\text{Mg BaSO}_4 \times 411.6}{\text{mL sample}}$$

Precision and Bias:

A synthetic sample containing 259 mg SO₄²⁻/L, 108 mg Ca²⁺/L. 82 mg Mg²⁺/L, 3.1 mg K⁺/L, 19.9 mg Na⁺/L, 241 mg Cl⁻/L, 0.250 mg NO₂⁻ -N/L, 1.1 mg NO₃⁻ -N/L, and 42.5 mg total alkalinity/L (contributed by NaHCO₃) was analyzed in 3 laboratories by the gravimetric method, with a relative standard deviation of 4.7 % and a relative error of 1.9%.

Some important references for the method:

HILLABRAND. W.F. et al. 1953. Applied Inorganic Analysis. 2nd ed. John Wiley Sons. New York, N.Y.

KOLTHOFF. I.M., E.J. MEEHAN.E.B. SANDELL & S. BRUCKENSTEIN. 1960 Quantitative Chemical Analysis. 4th ed. Macmillan Co., New York N.Y.

(g) 4500-S²⁻ F. Iodometric Method (Sulfide)

Reference

Standard method for examination of water & waste water Method No. 4500 – S2-B

Reagents

- a. Hydrochloric acid, HCl, 6N.
- b. Standard iodine solution, 0.050N: Dissolve 20 to 25 g KI in a little water and add 3.2 g iodine. After iodine has dissolved, dilute to 1000 mL and standardize against 0.0250N Na₂S₂O₃, using starch solution as indicator.
- c. Standard sodium thiosulfate solution, 0.0250N.
- d. Starch solution.

Procedure

- a. Measure from a burette into a 500-mL flask an amount of iodine solution estimated to be an excess over the amount of sulfide present. Add distilled water, if necessary, to bring volume to about 20 mL. Add 2 mL 6N HCl. Pipette 200 mL sample into flask, discharging sample under solution surface. If iodine color disappears, add more iodine until color remains. Back-titrate with Na₂S₂O₃ solution, adding a few drops of starch solution as end point is approached and continuing until blue color disappears.
- b. If sulfide was precipitated with zinc and ZnS filtered return filter with precipitate to original bottle and add about mL water. Add iodine solution and HCl and titrate as in above.

Calculation:

One milliliter 0.0250N iodine solution reacts with 0.4 mg:

$$\text{Mg S}^{2-}/\text{L} = \frac{[(A \times B) - (C \times D)] \times 16000}{\text{mL sample}}$$

Where:

A = mL iodine solution,
B = normality of iodine solution,
C = mL $\text{Na}_2\text{S}_2\text{O}_3$ solution, and
D = normality of $\text{Na}_2\text{S}_2\text{O}_3$ solution.

Precision:

The precision of the end point varies with the sample. In c waters it should be determinable within 1 drop, which is equivalent to 0.1 mg/L in a 200-mL sample.

(h) 2320 B. Titration Method (Carbonate (CO_3)):

General Discussion:

- (a) Principle: Hydroxyl ions present in a sample as a result of dissociate or hydrolysis of solutes reacts with additions of standard acid Alkalinity thus depends on the end point pH used.

For samples of low alkalinity (less than 20 mg CaCO_3/L) use an extrapolations technique based on the near proportionality of concentration of hydrogen ions to excess of titrant beyond the equivalence point. The amount of standard acid required to reduce pH exactly 0.30-pH unit is measured carefully. Because this change in pH corresponds to an exact doubling of the hydrogen ion concentration a simple extrapolation can be made to the equivalence point.

End points : When alkalinity is due entirely to carbonate or bicarbonate content the pH at the equivalence point of the titration is determined by the concentration of carbon dioxide (CO_2) at the stage CO_2 concentration depends, in turn, on the total carbonate species originally present and any losses that may have occurred curing titration. The pH values in Table 2320:I are suggested as the equivalence points for the corresponding alkalinity concentrations as milligrams Ca CO_3 per liter. 'Phenolphthalein alkalinity' is the term traditionally used for the quantity measured by titration to pH 8.3 irrespective of the colored indicator, if any, used in the determination. Phenolphthalein or metacresol purple may be used for alkalinity titration to pH 8.3. Bromcresol green or a mixed bromcresol green-methyl red indicator may be used for pH 4.5.

TABLE 2320: I END-POINT pH values

Test Condition	End Point pH	
	Total Alkalinity	Phenolphthalein Alkalinity
Alkalinity		
mg CaCO ₃ /L		
30	4.9	8.3
150	4.6	8.3
500	4.3	8.3
Silicates phosphates known or suspected	4.5	8.3
Routine or automated analyses	4.5	8.3
Industrial waste or complex system	4.5	8.3

Interferences:

Soaps, oily matter, suspended solids, or precipitates may coat the glass electrode and cause a sluggish response. Allow additional time between titrant additions to let electrode come to equilibrium or clean the electrodes occasionally. Do not filter, dilute, concentrate, or alter sample.

Selection of procedure:

Determine sample alkalinity from volume of standard acid required to titrate a portion to a designated pH taken from ¶ 1b. Titrate at room temperature with a properly calibrated pH meter or electrically operated titrator, or use color indicators. If using color indicators, prepare and titrate an indicator blank.

Report alkalinity less than 20 mg CaCO₃/L only if it has been determined by the low-alkalinity method of ¶ 4d.

Construct a titration curve for standardization of reagents. Color indicators may be used for routine and control titrations in the absence of interfering color and turbidity and for preliminary titrations to select sample size and strength of titrant (see below).

Sample size:

See Section 2310B. 1e for selection of size sample to be titrated and normality of titrant, substituting 0.02N or 0.1N sulfuric (H₂SO₄) or hydrochloric (HCl) acid for the standard alkali of that method. For the low-

alkalinity method, titrate a 200-mL sample with 0.02N H₂SO₄ from a 10-mL buret.

Sampling and storage: See Section 2310B.1f.

Reagents:

- a. Sodium carbonate solution, approximately 0.05N: Dry 3 to 5 g primary standard Na₂CO₃ at 250°C for 4 h and cool in a desiccator. Weigh 2.5 ± 0.2 g (to the nearest mg), transfer to a 1-L volumetric flask, fill flask to the mark with distilled water, and dissolve and mix reagent. Do not keep longer than 1 week.
- b. Standard sulfuric acid or hydrochloric acid, 0.1N: Prepare acid solution of approximate normality as indicated under Preparation of Desk Reagents (see inside front cover). Standardize against 40.00 mL 0.05N Na₂CO₃ solution, with about 60 mL water, in a beaker by titrating potentiometrically to pH of about 5. Lift out electrodes, rinse into the same beaker, and boil gently for 3 to 5 min under a watch glass cover. Cool to room temperature, rinse cover glass into beaker, and finish titrating to the pH inflection point. Calculate normality:

$$\text{Normality, N} = \frac{A \times B}{53.00 \times C}$$

A = g Na₂CO₃ weighed into 1-L flask,

B = mL Na₂CO₃ solution taken for titration, and

C = mL acid used.

Use measured normality in calculations or adjust to 0.1000N: 1 mL 0.1000N solution = 5.00 mg CaCO₃.

- c. Standard sulfuric acid or hydrochloric acid, 0.02N: Dilute 200.00 mL 0.1000N standard acid to 1000 mL with distilled or deionized water. Standardize by potentiometric titration of 15.00 mL 0.05N Na₂CO₃ according to the procedure of ¶ 3b; 1 mL = 1.00 mg CaCO₃.
- d. Bromcresol green indicator solution, pH 4.5 indicator: Dissolve 100 mg bromcresol green, sodium salt, in 100 mL distilled water.
- e. Mixed bromcresol green-methyl red indicator solution: Use either the aqueous or the alcoholic solution:
 - 1) Dissolve 100 mg bromcresol green sodium salt and 20 mg methyl red sodium salt in 100 mL distilled water.
 - 2) Dissolve 100 mg bromcresol green and 20 mg methyl red in 100 mL 95% ethyl alcohol or isopropyl alcohol.

- f. Metacresol purple indicator solution, pH 8.3 indicator: Dissolve 100 mg metacresol purple in 100 mL water.
- g. Phenolphthalein solution, alcoholic, pH 8.3 indicator.
- h. Sodium thiosulfate, 0.1N: See Section 2310B.3i.

Procedure:

- a. Color change: See Section 2310B. 4b.
- b. Potentiometric titration curve: Follow the procedure for determining acidity (Section 2310B.4c), substituting the appropriate normality of standard acid solution for standard NaOH, and continue titration to pH 4.5 or lower. Do not filter, dilute, concentrate, or alter the sample.
- c. Potentiometric titration to preselected pH: Determine the appropriate end-point pH according to ¶ 1b. Prepare sample and titration assembly (Section 2310B.4c). Titrate to the end-point pH without recording intermediate pH values and without undue delay. As the end point is approached make smaller additions of acid and be sure that pH equilibrium is reached before adding more titrant.
- d. Potentiometric titration of low alkalinity: For alkalinities less than 20 mg/L titrate 100 to 200 mL according to the procedure of ¶ 4c, above, using a 10-mL microburet and 0.02N standard acid solution. Stop the titration at a pH in the range 4.3 to 4.7 and record volume and exact pH. Carefully add additional titrant to reduce the pH exactly 0.30 pH unit and again record volume.

Calculations:

- a. Potentiometric titration to end-point pH:

$$\text{Alkalinity, mg CaCO}_3/\text{L} = \frac{A \times N \times 50\,000}{\text{mL sample}}$$

where:

A = mL standard acid used and

B = normality of standard acid

Or

$$\text{Alkalinity, mg CaCO}_3/\text{L} = \frac{A \times t \times 1000}{\text{mL sample}}$$

where:

t = titer or standard acid, mg CaCO₃/mL.

Report pH of end point used as follows: 'The alkalinity to pH _____ = _____ mg CaCO₃/L' and indicate clearly if this pH corresponds to an inflection point of the titration curve.

b. Potentiometric titration of low alkalinity:

Total alkalinity, mg CaCO₃/L

$$= \frac{(2B - C) \times N \times 50,000}{\text{mL sample}}$$

where :

B = mL titrant to first recorded pH,

C = total mL titrant to reach pH 0.3 unit lower, and

N = normality of acid.

c. Calculation of alkalinity relationships:

The results obtained from the phenolphthalein and total alkalinity determinations offer a means for stoichiometric classification of the three principal forms of alkalinity present in many waters. The classification ascribes the entire alkalinity to bicarbonate, carbonate, and hydroxide, and assumes the absence of other (weak) inorganic or organic acids, such as silicic, phosphoric, and boric acids. It further presupposes the incompatibility of hydroxide and bicarbonate alkalities. Because the calculations are made on a stoichiometric basis, ion concentration in the strictest sense are not represented in the results, which may differ significantly from actual concentrations especially at pH>10.

According to this scheme:

- 1) Carbonate (CO₃²⁻) alkalinity is present when phenolphthalein alkalinity is not zero but is less than total alkalinity.
- 2) Hydroxide (OH⁻) alkalinity is present if phenolphthalein alkalinity is more than half the total alkalinity.
- 3) Bicarbonate (HCO₃⁻) alkalinity is present if phenolphthalein alkalinity is less than half total alkalinity. These relationships may be calculated by the following scheme, where P is phenolphthalein alkalinity and T is total alkalinity (¶1b):

Select the smaller value of P or (T – P). Then, carbonate alkalinity equals twice the smaller value. When the smaller value is P, the balance (T – 2P) is bicarbonate. When the smaller value is (T – P), the balance (2P – T) is hydroxide. All results are expressed as CaCO₃. The mathematical conversion of the results is shown in Table 2320:II. (A modification of Table 2320:II that is more accurate when P = ½ T has been proposed.⁴)

Alkalinity relationships also may be computed nomographically (see Carbon Dioxide, Section 4500-CO₂). Accurately measure pH, calculate OH⁻ concentration as milligrams CaCO₃ per liter, and calculate concentrations of CO₃²⁻ and HCO₃⁻ as milligrams CaCO₃ per liter from the OH⁻ concentration, and the phenolphthalein and total alkalinities by the following equations:

$$\begin{aligned}\text{CO}_3^{2-} &= 2P - 2[\text{OH}^-] \\ \text{HCO}_3^- &= T - 2P + [\text{OH}^-]\end{aligned}$$

CALCIUM CARBONATE SATURATION (2330)/Introduction

TABLE 2320:II ALKALINITY RELATINSHIP*

Result of Titration	Hydroxide Alkalinity As CaCO ₃	Carbonate Alkalinity As CaCO ₃	Bicarbonate Concentration as CaCO ₃
P = 0	0	0	T
P < ½ T	0	2P	T - 2P
P = ½ T	0	2P	0
P > ½ T	2P - T	2(T - P)	0
P = T	T	0	0

* Key P – phenolphthalein alkalinity; T – total alkalinity.

Similarly, if difficulty is experienced with the phenolphthalein end point or if a check on the phenolphthalein titration is desired, calculate phenolphthalein alkalinity as CaCO₃ from the results of the nomographic determinations of carbonate and hydroxide ion concentrations:

$$P = 1/2 [\text{CO}_3^{2-}] + [\text{OH}^-]$$

Precision and Bias:

No general statement can be made about precision because of the great variation in sample characteristics. The precision of the titration is likely to be much greater than the uncertainties involved in sampling and sample handling before the analysis.

In the range of 10 to 500 mg/L. when the alkalinity is due entirely to carbonates or bicarbonates, a standard deviation of 1 mg CaCO₃/L can be achieved. Forty analysis in 17 laboratories analyzed synthetic samples containing increments of bicarbonate equivalent to 120 mg CaCO₃/L. The titration procedure of ¶ 4b was used, with an end point pH of 4.5. The

standard deviation was 5 mg/L and the average bias (lower than the true value) was 9 mg/L⁵.

Sodium carbonate solutions equivalent to 80 and 65 mg CaCO₃/L were analyzed by 12 laboratories according to the procedure of ¶ 4c6. The standard deviations were 8 and 5 mg/L respectively, with negligible bias.⁶ Four laboratories analyzed is samples having total alkalinities of about 1000 mg CaCO₃/L and containing various ratios of carbonate/bicarbonate by the procedures of both ¶ 4a and ¶ 4c. The pooled standard deviation was 40 mg/L, with negligible difference between the procedures.

References

1. LARSON T.E. & L.M. HENLEY. 1955. Determination of low alkalinit or acidit in water. Anal. Chem, 27:851.
2. THOMAS, J.F.J. & J.J.LYNCH. 1960. Determination of carbonate alkalinity in natural waters J. Amer. Water Works Assoc. 52:259.
2. COOPER, S.S. 1941. The mixed indicator bromocresol green-methyl red for carbonates in water. Ind. Eng. Chem., Anal. Ed. 13:466.
3. JENKNS, S.R. & R.C. MOORE. 1977. A proposed modification to the classical method of calculating alkalinity in natural waters. J. Amer Water Works Assoc. 69:56.
4. Winter, J.A. & M.R. MIDGETT. 1969. FWPCA Method Study 1. Mineral and Physical Analyses. Federal Water Pollution Control Admin. Washington, D.C.
5. smith, r. 1980. Research Rep. No. 379, Council for Scientific and Industrial Ressearch, South Africa.

Bibliograph:

AMERICAN SOCIETY FOR TESTING AND MATERIALS. 1982. Standard Method for Acidity or Alkalinity of Water. Publ. D1067-70 (reapproved 1977), American Soc. Testing & Materials, Philadelphia, Pa.

SKOOGSTAD M.W., M.J. FISHMAN, L.C. FRIEDMAN, D.E.ERDMAN, & S.S. DUNCAN. 1979. Methods for determination of inorganic substance in water and fluvial sediments. In Techniques of Water-Resource Investigation of the United States Geological Survey. U.S.Geological Survey, Book 5, Chapter A1, Washington, D.C.

(i) Determination of (2320 B. Titration Method (Bicarbonate (HCO₃))

General Discussion

- a. Principle Hydroxyl ions present in a sample as a result of dissociates or hydrolysis of solutes react with additions of standard acid Alkalinity thus depends on the end point pH used. For methods of determining inflection points from titration curves and the rellionale for titrating to fixed pH end points, see Section 2310B. 1a

For samples of low alkalinity (less than 20 mg CaCO₃/L) use an extrapolations technique based on the near proportionality of concentration of hydrogen ions to excess of titrant beyond the equivalence point. The amount of standard acid required to reduce pH exactly 0.30 pH unit is measured carefully. Because this change in pH corresponds to an exact doubling of the hydrogen ion concentration a simple extrapolation can be made to the equivalence point.

- b. End points:

When alkalinity is due entirely to carbonate or bicarbonate content the pH at the equivalence point of the titration is determined by the concentration of carbon dioxide (CO₂) at the stage CO₂ concentration depends, in turn, on the total carbonate species originally present and any losses that may have occurred curing titration. The pH values in Table 2320:I are suggested as the equivalence points for the corresponding alkalinity concnertrations as milligrams Ca CO₃ per liter. 'Phenolphthalein alkalinity' is the term traditionally used for the quantity measured by titration to pH 8.3 irrespective of the colored indicator, if any, used in the determination. Phenolphthalein or metacresol purple may be used for alkalinity titration to pH 8.3. Bromcresol green or a mixed bromcresol green-methyl red indicator may be used for pH 4.5.

TABLE 2320:I END-POINT pH values

Test Condition	End Point pH	
	Total Alkalinity	Phenolphthalein Alkalinity
Alkalinity		
<u>Interferences:</u>		
mg CaCO ₃ /L		
30	4.9	8.3
150	4.6	8.3
500	4.3	8.3
Silicates phosphares known or suspected	4.5	8.3
Routine or amomated analyses	4.5	8.3
Industrial waste or complex system	4.5	8.3
ily matter, suspended solids, or precipitates may coat the glass electrode		

and cause a sluggish response. Allow additional time between titrant additions to let electrode come to equilibrium or clean the electrodes occasionally. Do not filter, dilute, concentrate, or alter sample.

Selection of procedure:

Determine sample alkalinity from volume of standard acid required to titrate a portion to a designated pH taken from ¶ 1b. Titrate at room temperature with a properly calibrated pH meter or electrically operated titrator. or use color indicators. If using color indicators, prepare and titrate an indicator blank.

Report alkalinity less than 20 mg CaCO₃/L only if it has been determined by the low-alkalinity method of ¶ 4d.

Construct a titration curve for standardization of reagents. Color indicators may be used for routine and control titrations in the absence of interfering color and turbidity and for preliminary titrations to select sample size and strength of titrant (see below).

Sample size:

See Section 2310B. 1e for selection of size sample to be titrated and normality of titrant, substituting 0.02N or 0.1N sulfuric (H₂SO₄) or hydrochloric (HCl) acid for the standard alkali of that method. For the low-alkalinity method, titrate a 200-mL sample with 0.02N H₂SO₄ from a 10-mL buret.

f. Sampling and storage: See Section 2310B.1f.

Apparatus

See Section 2310B 2.

Reagents

- a. Sodium carbonate solution, approximately 0.05N: Dry 3 to 5 g primary standard Na₂CO₃ at 250°C for 4 h and cool in a desiccator. Weigh 2.5 ± 0.2 g (to the nearest mg), transfer to a 1-L volumetric flask, fill flask to the mark with distilled water, and dissolve and mix reagent. Do not keep longer than 1 week.
- b. Standard sulfuric acid or hydrochloric acid, 0.1N: Prepare acid solution of approximate normality as indicated under Preparation of Desk Reagents (see inside front cover). Standardize against 40.00 mL 0.05N Na₂CO₃ solution, with about 60 mL water, in a beaker by titrating potentiometrically to pH of about 5. Lift out electrodes, rinse into the same beaker, and boil gently for 3 to 5 min under a watch

glass cover. Cool to room temperature, rinse cover glass into beaker, and finish titrating to the pH inflection point. Calculate normality:

$$\text{Normality, } N = \frac{A \times B}{53.00 \times C}$$

A = g Na₂CO₃ weighed into 1-L flask,
B = mL Na₂CO₃ solution taken for titration, and
C = mL acid used.

Use measured normality in calculations or adjust to 0.1000N: 1 mL 0.1000N solution = 5.00 mg CaCO₃.

- c. Standard sulfuric acid or hydrochloric acid, 0.02N: Dilute 200.00 mL 0.1000N standard acid to 1000 mL with distilled or deionized water. Standardize by potentiometric titration of 15.00 mL 0.05N Na₂CO₃ according to the procedure of ¶ 3b; 1 mL = 1.00 mg CaCO₃.
- d. Bromcresol green indicator solution, pH 4.5 indicator: Dissolve 100 mg bromcresol green, sodium salt, in 100 mL distilled water.
- e. Mixed bromcresol green-methyl red indicator solution:³ Use either the aqueous or the alcoholic solution:
 - 1) Dissolve 100 mg bromcresol green sodium salt and 20 mg methyl red sodium salt in 100 mL distilled water.
 - 2) Dissolve 100 mg bromcresol green and 20 mg methyl red in 100 mL 95% ethyl alcohol or isopropyl alcohol.
- f. Metacresol purple indicator solution, pH 8.3 indicator: Dissolve 100 mg metacresol purple in 100 mL water.
- g. Phenolphthalein solution, alcoholic, pH 8.3 indicator.
- h. Sodium thiosulfate, 0.1N: See Section 2310B.3i.

Procedure

- a. Color change: See Section 2310B. 4b.
- b. Potentiometric titration curve: Follow the procedure for determining acidity (Section 2310B.4c), substituting the appropriate normality of standard acid solution for standard NaOH, and continue titration to pH 4.5 or lower. Do not filter, dilute, concentrate, or alter the sample.
- c. Potentiometric titration to preselected pH :

Determine the appropriate end-point pH according to ¶ 1b. Prepare sample and titration assembly (Section 2310B.4c). Titrate to the end-point pH without recording intermediate pH values and without undue delay. As the end point is approached make smaller additions of acid and be sure that pH equilibrium is reached before adding more titrant.

- d. Potentiometric titration of low alkalinity: For alkalinities less than 20 mg/L titrate 100 to 200 mL according to the procedure of ¶ 4c, above, using a 10-mL microburet and 0.02N standard acid solution. Stop the titration at a pH in the range 4.3 to 4.7 and record volume and exact pH. Carefully add additional titrant to reduce the pH exactly 0.30 pH unit and again record volume.

Calculations

- a. Potentiometric titration to end-point pH :

$$\text{Alkalinity, mg CaCO}_3/\text{L} = \frac{A \times N \times 50\,000}{\text{mL sample}}$$

where:

A = mL standard acid used and

B = normality of standard acid

Or

$$\text{Alkalinity, mg CaCO}_3/\text{L} = \frac{A \times t \times 1000}{\text{mL sample}}$$

where :

t = titer or standard acid, mg CaCO₃/mL.

Report pH of end point used as follows: 'The alkalinity to pH _____ = _____ mg CaCO₃/L" and indicate clearly if this pH corresponds to an inflection point of the titration curve.

- b. Potentiometric titration of low alkalinity:

Total alkalinity, mg CaCO₃/L

$$= \frac{(2 B - C) \times N \times 50\,000}{\text{mL sample}}$$

where:

B = mL titrant to first recorded pH,

C = total mL titrant to reach pH 0.3 unit lower, and

N = normality of acid.

c. Calculation of alkalinity relationships:

The results obtained from the phenolphthalein and total alkalinity determinations offer a means for stoichiometric classification of the three principal forms of alkalinity present in many waters. The classification ascribes the entire alkalinity to bicarbonate, carbonate, and hydroxide, and assumes the absence of other (weak) inorganic or organic acids, such as silicic, phosphoric, and boric acids. It further presupposes the incompatibility of hydroxide and bicarbonate alkalities. Because the calculations are made on a stoichiometric basis, ion concentration in the strictest sense are not represented in the results, which may differ significantly from actual concentrations especially at pH>10. According to this scheme:

- 1) Carbonate (CO_3^{2-}) alkalinity is present when phenolphthalein alkalinity is not zero but is less than total alkalinity.
- 2) Hydroxide (OH^-) alkalinity is present if phenolphthalein alkalinity is more than half the total alkalinity.
- 3) Bicarbonate (HCO_3^-) alkalinity is present if phenolphthalein alkalinity is less than half total alkalinity. These relationships may be calculated by the following scheme, where P is phenolphthalein alkalinity and T is total alkalinity (¶1b):

Select the smaller value of P or (T – P). Then, carbonate alkalinity equals twice the smaller value. When the smaller value is P, the balance (T – 2P) is bicarbonate. When the smaller value is (T – P), the balance (2P – T) is hydroxide. All results are expressed as CaCO_3 . The mathematical conversion of the results is shown in Table 2320:II. (A modification of Table 2320:II that is more accurate when $P = \frac{1}{2} T$ has been proposed.4)

Alkalinity relationships also may be computed nomographically (see Carbon Dioxide, Section 4500- CO_2). Accurately measure pH, calculate OH^- concentration as milligrams CaCO_3 per liter, and calculate concentrations of CO_3^{2-} and HCO_3^- as milligrams CaCO_3 per liter from the OH^- concentration, and the phenolphthalein and total alkalinities by the following equations :

$$\begin{aligned}\text{CO}_3^{2-} &= 2P - 2[\text{OH}^-] \\ \text{HCO}_3^- &= T - 2P + [\text{OH}^-]\end{aligned}$$

CALCIUM CARBONATE SATURATION (2330)/Introduction

TABLE 2320:II ALKALINITY RELATINSHIP*

Result of Titration	Hydroxide Alkalinity As CaCO ₃	Carbonate Alkalinity As CaCO ₃	Bicarbonate Concentration as CaCO ₃
P = 0	0	0	T
P < ½ T	0	2P	T – 2P
P = ½ T	0	2P	0
P > ½ T	2P – T	2(T – P)	0
P = T	T	0	0

* Key P – phenolphthalein alkalinity : T – total alkalinity.

Similarly, if difficulty is experienced with the phenolphthalein end point or if a check on the phenolphthalein titration is desired, calculate phenolphthalein alkalinity as CaCO₃ from the results of the nomographic determinations of carbonate and hydroxide ion concentrations:

$$P = 1/2 [CO_3^{2-}] + [OH^-]$$

Precision and Bias

No general statement can be made about precision because of the great variation in sample characteristics. The precision of the titration is likely to be much greater than the uncertainties involved in sampling and sample handling before the analysis.

In the range of 10 to 500 mg/L. when the alkalinity is due entirely to carbonates or bicarbonates, a standard deviation of 1 mg CaCO₃/L can be achieved. Forty analysis in 17 laboratories analyzed synthetic samples containing increments of bicarbonate equivalent to 120 mg CaCO₃/L. The titration procedure of ¶ 4b was used, with an end point pH of 4.5. The standard deviation was 5 mg/L and the average bias (lower than the true value) was 9 mg/L⁵.

Sodium carbonate solutions equivalent to 80 and 65 m CaCO₃/L were analyzed by 12 laboratories according to the procedure of ¶ 4c⁶. The standard deviations were 8 and 5 mg/L respectively, with negligible bias. Four laboratories analyzed si samples having total alkalinities of about 1000 mg CaCO₃/L and containing various ratios of carbonate/bicarbonate by the procedures of both ¶ 4a and ¶ 4c. The pooled standard deviation was 40 mg/L, with negligible difference between the procedures.

References

1. LARSON T.E. & L.M. HENLEY. 1955. Determination of low alkalinit or acidity in water. Anal. Chem, 27:851.

2. THOMAS, J.F.J. & J.J.LYNCH. 1960. Determination of carbonate alkalinity in natural waters J. Amer. Water Works Assoc. 52:259.
3. COOPER, S.S. 1941. The mixed indicator bromocresol green-methyl red for carbonates in water. Ind. Eng. Chem., Anal. Ed. 13:466.
4. JENKNS, S.R. & R.C. MOORE. 1977. A proposed modification to the classical method of calculating alkalinity in natural waters. J. Amer Water Works Assoc. 69:56.
5. Winter, J.A. & M.R. MIDGETT. 1969. FWPCA Method Study 1. Mineral and Physical Analyses. Federal Water Pollution Control Admin. Washington, D.C.
6. smith, r. 1980. Research Rep. No. 379, Council for Scientific and Industrial Research, South Africa.

Bibliograph

AMERICAN SOCIETY FOR TESTING AND MATERIALS. 1982. Standard Method for Acidity or Alkalinity of Water. Publ. D1067-70 (reapproved 1977), American Soc. Testing & Materials, Philadelphia, Pa.

SKOOGSTAD M.W., M.J. FISHMAN, L.C. FRIEDMAN, D.E.ERDMAN, & S.S. DUNCAN. 1979. Methods for determination of inorganic substance in water and fluvial sediments. In Techniques of Water-Resource Investigation of the United States Geological Survey. U.S.Geological Survey, Book 5, Chapter A1, Washington, D.C.

(j) Determination of Nitrite

Reference

Standard method for examination of water & waste water Method No. 4500-NO2-B

General Discussion

Principle:

Nitrite (NO₂⁻) is determined through formation of a reddish purple azo dye produced at pH 2.0 to 2.5 by coupling diazotized sulfanilamide with N-(1-naphthyl)-ethylenediamine dihydrochloride (NED dihydrochloride). The applicable range of the method for spectrophotometric measurement is 10 to 1000 µg NO₂-N/L. Photometric measurements can be made in the range 5 to 50 µg N/L if a 5-cm light path and a green color filter are used. The color system obeys Beer's law up to 180 µg N/L with a 1-cm light path at 543 nm. Higher NO₂—concentrations can be determined by diluting a sample.

Interferences:

Chemicals incompatibility makes it unlikely that NO_2^- , free chloride and nitrogen trichloride (NCl_3) will co-exist. NCl_3 imparts a false red colour when colour reagent is added. The following ions interfere because of precipitation under test conditions and should be absent Sb^{3+} , Au^{3+} , Bi^{3+} , Fe^{3+} , Pb^{3+} , Hg^{3+} , Ag^{3+} , Chloroplatinate (PtCl_2^+ and metavanadate (VO_3^{2-}). Cupric ion may cause low results by catalyzing decomposition of the diazonium salt. Colored ions than alter the colour system also should be absent. Remove suspended solids by filtration.

Storage of sample:

Never use acid preservation for samples to be analyzed for NO_2^- . Make the determination promptly on fresh samples to prevent bacteria conversion of NO_2^- to NO_3^- or NH_3 . For short-term preservation for 1 to 2 d, freeze at -20°C or store at 4°C .

Apparatus

Colorimetric equipment: One of the following is required:

- a. Spectrophotometer, for use at 543 nm, providing a light path of 1cm or longer.
- b. Filter photometer, providing a light path of 1 cm or longer and equipped with a green filter having maximum transmittance near 540 nm.

Reagents

- a. Nitrate-free water: If it is not known that the distilled or demineralized water is free from NO_2^- use either of the following procedures to prepare nitrite-free water.
 - 1) Add to 1 L distilled water one small crystal each of KMnO_4 and either $\text{Ba}(\text{OH})_2$ or $\text{Ca}(\text{OH})_2$. Redistill in an all-borosilicate-glass apparatus and discard the initial 50 mL of distillate. Collect the distillate fraction that is free of permanganate; a red color with DPD reagent (Section 4500-CLF.2B) indicates the presence of permanganate.
 - 2) Add 1 mL conc H_2SO_4 and 0.2 mL MnSO_4 solution (36.4 g $\text{MnSO}_4 \cdot \text{H}_2\text{O}$ /100 mL distilled water to each 1 L distilled water, and make pink with 1 to 3 mL KMnO_4 solution (400 mg KMnO_4 /L distilled water). Redistill as described in the preceding paragraph.

Use nitrite-free water in making all reagents and dilutions.

b. Color reagent:

To 800 mL water and 100 mL 85% phosphoric acid and 10 g sulfanilamide. After dissolving sulfanilamide completely, add 1 g N-(1-naphthyl)-ethylenediamine dihydrochloride. Mix to dissolve, then dilute to 1 L with water. Solution is stable for about a month when stored in a dark bottle in refrigerator.

c. Sodium oxalate, 0.025M (0.05N):

Dissolve 3.350 g $\text{Na}_2\text{C}_2\text{O}_4$, primary standard grade in water and dilute to 1000 mL.

d. Ferrous ammonium sulfate, 0.05M (0.05N):

Dissolve 19.607 g $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ plus 20 mL conc H_2SO_4 in water and dilute to 1000 mL. Standardize as in Section 5220B.3d.

e. Stock nitrite solution:

Commercial reagent-grade NaNO_2 assays at less than 99%. Because NO_2^- is oxidized readily in the presence of moisture, use a fresh bottle of reagent for preparing the stock solution and keep bottles tightly stoppered against free access of air when not in use. To determine NaNO_2 content, add a known excess of standard 0.01M (0.05N) KMnO_4 solution discharge permanganate color with a known quantity of standard reductant such as 0.025M $\text{Na}_2\text{C}_2\text{O}_4$ or 0.05M $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2$, and back-titrate with standard permanganate solution.

- 1) Preparation of stock solution – Dissolve 1.232 g NaNO_2 in water and dilute to 1000 mL; 1.00 mL = 250 μg N. Preserve with 1 mL CHCl_3 .
- 2) Standardization of stock nitrite solution – Pipet, in order, 50.00 mL standard 0.01 M (0.05N) KMnO_4 , 5 mL conc H_2SO_4 , and 50.00 mL stock NO_2^- solution into a glass-stoppered flask or bottle. Submerge pipet tip well below surface of permanganate acid solution while adding stock NO_2^- solution. Shake gently and warm to 70 to 80°C on a hot plate. Discharge permanganate color by adding sufficient 10-mL portions of standard 0.025 M $\text{Na}_2\text{C}_2\text{O}_4$. Titrate excess $\text{Na}_2\text{C}_2\text{O}_4$ with 0.01M (0.05N) KMnO_4 to the faint pink end point. Carry a water blank through the entire procedure and make the necessary corrections in the final calculation as shown in the equation below.

If standard 0.05M ferrous ammonium sulfate solution is substituted for $\text{Na}_2\text{C}_2\text{O}_4$, omit heating and extend reaction period between KMnO_4 and Fe^{2+} to 5 min before making final KMnO_4 titration.

Calculate N NO₂[—] -N content of stock solution by the following equation :

$$A = \frac{[(B \times C (D \times E)] \times 7}{F}$$

Where:

A = mg NO₂[—] -N/mL in stock NaNO₂ solution.

B = total mL standard KMnO₄ used.

C = normality of standard KMnO₄.

D = total mL standard reductant added.

E = normality of standard reductant, and

F = mL stock NaNO₂ solution taken for titration.

Each 1.00 mL 1.01M (0.05N) KMnO₄ consumed by the NaNO₂ solution corresponds to 1750 µg NO₂[—] -N.

f. Intermediate nitrite solution:

Calculate the volume, G, of stock NO₂[—] solution required for the intermediate NO₂[—] solution from G = 12.5/A. (approximately 50 mL) to 250 mL with water; 1.00 mL = 50.0 µg N. Prepare daily.

g. Standard nitrite solution:

Dilute 10.00 mL intermediate NO₂[—] solution to 1000 mL with water; 1.00 mL = 0.500 µg N. Prepare daily.

h. Standard potassium permanganate titrant, 0.01M (0.05N) :

Dissolve 1.6 g KMnO₄ in 1 L distilled water. Keep in a brown glass-stoppered bottle and age for at least 1 week. Carefully decant or pipet supernate without stirring up any sediment. Standardize this solution frequently by the following procedure :

Weigh to the nearest 0.1 mg several 100- to 200- mg samples of anhydrous Na₂C₂O₄ into 400- mL beakers. To each beaker, in turn, add 100 mL distilled water and stir to dissolve. Add 10 mL 1 + 1 H₂SO₄ and heat rapidly to 90 to 95°C. Titrate rapidly with permanganate solution to be standardized, while stirring to a slight pink end-point color that persists for at least 1 min. Do not let temperature fall below 85°. If necessary, warm beaker con-

Where:

[H⁺] = activity of hydrogen ions. Moles/L,

[OH⁻] = activity of hydroxyl ions. Moles/L, and

K_w = ion product of water.

Because of ionic interactions in all but very dilute solutions, it is necessary to use the "activity" of an ion and not its molar concentration. Use of the term pH assumes that the activity of the hydrogen ion, aH⁺, is being considered. The approximate equivalence to molarity, [H⁺] can be presumed only in very dilute solutions (ionic strength <0.1).

A logarithmic scale is convenient for expressing a wide range of ionic activities. Equation 1 in logarithmic form and corrected to reflect activity is:

$$(-\log_{10} aH^+) + (-\log_{10} aOH^-) = 14$$

or

$$pH + pOH = pK_w$$

Where:

$$pH^+ = \log_{10} aH^+ \text{ and}$$

$$pOH = \log_{10} aOH^-$$

+p designates $-\log_{10}$ of a number

Equation 2 states that as pH increases pOH decreases correspondingly and vice versa because pK_w is constant for a given temperature. At 25°C, pH 7.0 is neutral, the activities of the hydrogen and hydroxyl ions are equal, and each corresponds to an approximate activity of 10^{-7} moles/L. The neutral point is temperature dependent and is pH 7.5 at 0°C and pH 6.5 at 60°C.

The pH value of a highly dilute solution is approximately the same as the negative common logarithm of the hydrogen ion concentration. Natural waters usually have pH values in the range of 4 to 9 and most are slightly basic because of the presence of bicarbonates and carbonates of the alkali and alkaline earth metals.

Reference

1. SORENSON, S. 1909. Über die Messung und die Bedeutung der Wassertoff ionen Konzentration bei Enzymatischen Prozessen. Biochem. Z. 21:131.

(k) Determination of Nitrate

1. Apparatus :

- a) Reduction column: Columns can be constructed by modification of 100 ml volumetric pipette. Metering valve is recommended to control flow rate.
- b) Spectrophotometer for use at 543nm filter photometer with green filter, maximum transmittance near 540nm, providing 1 cm light path or longer.

2. Reagents :

- a) Nitrate free water: Use as reagent blank. The NO_3-N concentration should not exceed 0.01 mg/ l. Use nitrate free water for all solutions and dilutions.

- b) Copper-cadmium granules: Wash 25g 20- to 100- mesh Cd granules with water.
Swir granules with 100 ml 2% CuSO₄ till blue colour partially fades. Decant repeat with Fresh Cu solution until brown colloidal precipitate is seen. Rinse with nitrate free water to remove colloidal Cu precipitate.
- c) Ammonium chloride-EDTA solution: Dissolve 13g NH₄CL and 1.7 gm. disodium ethylenediamine tetraacetate in 900 ml water. Adjust pH to 8.5 with conc. NH₄OH and . dilute to 1 L.
- d) Dilute ammonium chloride- EDTA solution: Dilute 300 ml ammonium chloride-EDTA solution to 500 ml with water.
- e) Hydrochloric acid, HCL, 6N.
- f) Copper sulphate solution 2% : Dissolve 20 gm CuSO₄.5H₂O in 500 ml water and dilute to 1L.
- g) Color reagent: To 800ml water add 100ml 85% phosphoric acid and 10g sulphanilamide. After dissolving add 1g N-(1-naphtyl)-ethylenediamine dihydrochloride. Mix to dissolve, then dilute to 1L with. Solution is stable for one month when stored in dark bottle in refrigerator.
- h) Stock nitrite : Dissolve 1.232g NaNO₂ in water and dilute to 1000 ml; 1.00 ml = 250ugN. Preserve with 1 ml CHCl₃. Standardize by pipeting, in order, 50 ml 0.01M KMnO₄, 5 ml conc. H₂SO₄ and 50 ml stock NO₂⁻ solution in to a glass stoppered flask. Shake gently and warm to 70-80°C. Discharge permanganate color by adding 10 ml Portions of point. Calculate nitrite content of stock solution:
- $$A = \{[(B \times C) - (D \times E)] \times 7\} / F$$
- Where:
- A = mg NO₂⁻ - N/ ml in stock solution
B = ml total KMnO₄ used
C = normality of KMnO₄
D = total ml oxalate added
E = normality of oxalate
F = ml stock nitrite taken for titration
- i) Intermediate nitrite solution: calculate the volume, G, of stock nitrite solution required for the intermediate nitrite solution from $G = 12.5/A$. Dilute the volume G to 250 ml with water; 1 ml = 50.0 ug NO₂⁻ -N, prepare daily.
- j) Stock nitrate solution: Dissolve 0.7218g KNO₃, earlier dried in hot air oven at 105° C overnight and cooled in desiccator, in distilled water and dilute to 1 L. Preserve with 2ml of CHCl₃/ L ; 1 ml = 100 ug NO₃⁻ -N, stable for 6 months.

- k) Standard nitrite solution : Dilute 100 ml of stock solution to 1000 ml with water, preserve with 2 ml CHCl_3 / L = 10 $\mu\text{g NO}_3^- - \text{N}$, stable for 6 months.
- l) Working Nitrite Solution: Dilute 50.0 ml intermediate nitrite solution to 500 ml with nitrite free water; 1 ml = 5 $\mu\text{g NO}_2^- - \text{N}$.

3. Procedure:

- a) Prepare reduction columns: insert glass wool plug into bottom of column and fill with water. Add sufficient Cd granules to obtain a length of 18.5 cm. prevent air entrapment by keeping water level above granules. Wash the column with 200 ml $\text{NH}_4\text{CL-EDTA}$ solution. Activate the column by flushing at least 100 ml of a mixture of 25% 1.0 mg $\text{NO}_3^- - \text{N}$ standard and 75% $\text{NH}_4\text{CL-EDTA}$ solution. Flush-rate should be between 7 and 10 ml/min.
- b) Pre-treatment of the sample: Remove turbidity, if any, by filtering through 0.45 μm membrane filter. Adjust pH between 7 and 9 if needed. Use pH-meter, dilute HCL and NaOH.
- c) Sample reduction: Obtain a 25 ml sample or portion diluted up to less than 4 mg/L $\text{NO}_3^- - \text{N}$ and mix with 75 ml $\text{NH}_4\text{CL-EDTA}$ solution. Flush mixture over the column at a rate of 7 to 10 ml/min discard first 25 ml and collect rest in original sample flask. Analyse within 15 minutes. Washing column in between different samples is not needed if columns are not used for more several hours flush with 50 ml $\text{NH}_4\text{CL-EDTA}$ solution. Never let column dry, granules should be immersed.
- d) Color development: As soon as possible but at least within 15 minutes after reduction add 2 ml color reagent to 50 ml sample and mix.
- e) Measurement of absorbance at 543nm. Wait between 10 min to 2h after addition of color reagent before measurement. Measure against a distilled nitrite free water reagent blank. If NO_3^- concentration exceeds highest standard (1mg/L) use remaining portion of reduced sample to make approximate dilution and develop color again.
- f) Standards: Use the intermediate $\text{NO}_3^- - \text{N}$ solution to prepare standards in the range of 0.05 to 1.0 mg $\text{NO}_3^- - \text{N}$ /L by diluting the following volumes to 100 ml in volumetric flask: 0.5, 1.0, 2.0, 5.0 and 10.0 ml. carry out reduction of standards exactly as for samples.
- g) Column efficiency check: Using an appropriate dilution of the working nitrite (NO_2^-) solution, compare to a reduced nitrate (NO_3^-) standard at the same Concentration to verify reduction column efficiency. Reactivate Cu-Cd granules as Described above when reduction efficiency falls below 75%.

4. Calculation:

Obtain a standard curve by plotting the absorbance at least 5 standards against their NO_3^- -N concentration. Read sample concentration directly from standard curve. Account for dilutions if any and report as milligrams oxidized N per litre (TON or NO_3^- -N plus NO_2^- -N).

(I) Moisture percentage: Standard method (drying at 105° C at constant weight)

1. APPARATUS

- 1.1 Container - Any suitable non-corrodible air-tight container.
- 1.2 Balance - of sufficient sensitivity to weigh the soil samples to an accuracy of 0.04 percent of the weight of the soil taken for the test (566 4.1).
- 1.3 Oven - thermostatically controlled, with interior of non-corroding material to maintain the temperature at $110 \pm 5^\circ\text{C}$.
- 1.4 Desiccator - A desiccator with any suitable desiccating agent.

2. SOIL SPECIMEN

- 2.1 The soil specimen taken shall be representative of the soil mass. The size of the specimen selected depends on the quantity required for good representation, which is influenced by the gradation and the maximum size of particles, and on the accuracy of weighing. The following quantities are recommended for general laboratory use:

Size of particles	Minimum Quantity of Soil Specimen to be Taken for Test
	Mass in g
425-micron IS Sieve	25
2-mm IS Sieve	50
4.75-mm IS Sieve	200
10-mm IS Sieve	300
20-mm IS Sieve	500
40-mm IS Sieve	1000

Note 1 - For sizes of sieves, see IS: 460-1962t.

Note 2 - Drier the soil, the greater shall be the quantity of the soil taken.

Note 3 - Water content specimen should be discarded and should not be used in any other tests.

3. PROCEDURE

- 3.1 Clean the container with lid, dry and weigh W_1 . Take the required quantity of the soil specimen in the container crumbled and placed loosely, and weigh with lid (W_2). Then keep in an oven with the lid removed, and maintain the temperature of the oven at $110 \pm 5^\circ\text{C}$

(□□□ Note). Dry the specimen in the oven for 24 h. Every time the container is taken out for weighing. Replace the lid on the container and cool the container in a desiccator. Record the final mass (W_3) of the container with lid with dried soil sample.

Note - Oven-drying at $110 \pm 5^\circ\text{C}$ does not result in reliable water content values for soil containing, gypsum or other minerals having loosely bound water of hydration or for soil containing significant amounts of organic material. Reliable water content values for these soils can be obtained by drying in an oven at approximately 60 to 80°C .

4. CALCULATION

4.1 The percent of water content shall be calculated as follows:

$$W = \frac{W_2 - W_3}{W_3 - W_1} \times 100$$

Where

□ = water content percent,

W_2 = mass of container with lid with wet soil in g,

W_3 = mass of container with lid with dry soil in g, and

W_1 = mass of container with lid in g.

5. REPORT

5.1 The water content (w) of the soil shall be reported to two significant figures.

5.2 The results of the test shall be suitably recorded. A recommended proforma for this record is given in Annexure-III.

(m) Determination of [4500-H⁺B. Electrometric Method (pH)]

Reference

Standard method for examination of water & waste water Method No. 4500 – H+B

a. Principle

The basic principle of electrometric pH measurement is determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode. The hydrogen electrode consists of a platinum electrode across which hydrogen gas is bubbled at a pressure of 84 kPa. Because of difficulty in its use and the potential for poisoning the hydrogen electrode, the glass electrode commonly is used. The electromotive force (emf) produced in the glass electrode system varies linearly with pH. This linear relationship is described by plotting the measured emf against the pH of different buffers. Sample pH is determined by extrapolation.

Because single ion activities such as a_{H^+} cannot be measured, pH is defined operationally in a potentiometric scale. The pH measuring instrument is calibrated potentiometrically with an indicating (glass) electrode and a reference electrode using National Institute of Standards and Technology (NIST) buffers having assigned values so that :

$$pH_B = 0 \log_{10} a_{H^+}$$

Where:

pH_B = assigned pH of NIST buffer.

The operational pH scale is used to measure sample pH and is defined as:

$$pH_x = pH_b \pm \frac{F(E_x - E_s)}{2.303 RT}$$

Where:

pH_x = potentiometrically measured sample pH,

F = Faraday : 9.649×10^4 coulomb/mole,

E_x = sample emf, V,

E_s = buffer emf, V,

R = gas constant; 8.314 joule/(mole °K), and

T = absolute temperature, °K

Note:

Although the equation for pH_x appears in the literature with a plus sign, the sign of emf readings in millivolts for most pH meters manufactured in the U.S. is negative. The choice of negative sign is consistent with the IUPAC Stockholm convention concerning the sign of electrode potential.

The activity scale gives values that are higher than those on Sorenson's scale by 0.04 units:

$$pH(\text{activity}) = pH(\text{Sorenson}) + 0.04$$

The equation for pH_x assumes that the emf of the cells containing the sample and buffer is due solely to hydrogen ion activity unaffected by sample composition. In practice, samples will have varying ionic species and ionic strengths, both affecting H^+ activity. This imposes an experimental limitation on pH measurement; thus, to obtain meaningful results, the differences between E_x and E_s should be minimal. Samples must be dilute aqueous solutions of simple solutes (<0.2M). (Choose buffers to bracket the sample.) Determination of pH cannot be made accurately in non-aqueous media, suspensions, colloids, or high-ionic-strength solutions.

b. Interferences:

The glass electrode is relatively free from interference from color, turbidity, colloidal matter, oxidants, reductants, or high salinity, except for a sodium error at $\text{pH} > 10$. Reduce this error by using special "low sodium error" electrodes. pH measurements are affected by temperature in two ways : mechanical effects that are caused by changes in the properties of the electrodes and chemical effects caused by equilibrium changes. In the first instance, the Nernstian slope increases with increasing temperature and electrodes take time to achieve thermal equilibrium. This can cause long-term drift in pH. Because chemical equilibrium affects pH, standard pH buffers have a specified pH at indicated temperatures. Always report temperature at which pH is measured.

Apparatus

- a. pH meter consisting of potentiometer, a glass electrode, a reference electrode, and a temperature compensating device. A circuit is completed through the potentiometer when the electrodes are immersed in the test solution. Many pH meters are capable of reading pH or millivolts and some have scale expansion that permits reading to 0.001 pH unit, but most instruments are not that precise.

For routine work use a pH meter accurate and reproducible to 0.1 pH unit with a range of 0 to 14 and equipped with a temperature compensation adjustment.

Although manufacturers provide operating instruction, the use of different descriptive terms may be confusing. For most instruments, there are two controls: intercept (set buffer, asymmetry, standardize) and slope (temperature, offset); their functions are shown diagrammatically in figures 4500-H+:1 and 2. The intercept control shifts the response curve laterally to pass through the isopotential point with no change in slope. This permits bringing the instrument on scale (0 mV) with a pH 7 buffer that has not change in potential with temperature.

The slope control rotates the emf/pH slope about the isopotential point (0 mV/pH 7). To adjust slope for temperature without disturbing the intercept, select a buffer that brackets the sample with pH 7 buffer and adjust slope control to pH of this buffer. The instrument will indicate correct mill volt change per unit pH at the test temperature.

- b. Reference electrode consisting of a half-cell that provides a constant electrode potential. Commonly used are calomel and silver: silver-chloride electrodes. Either is available with several types of liquid junctions.

The liquid junction of the reference electrode is critical because at this point the electrode forms a salt bridge with the sample of buffer and a liquid junction potential is generated that in turn affects the potential produced by the reference electrode. Reference electrode junctions may be annular

ceramic, quartz, or asbestos fiber, or the sleeve type. The quartz type is most widely used. The asbestos fiber type is not recommended for strongly use and care of the reference electrode.

Refill non-sealed electrodes with the correct electrolyte to proper level and make sure junction of properly wetted.

- c. Glass electrode: The sensor electrode is a bulb of special glass containing a fixed concentration of HCl or a buffered chloride solution in contact with an internal reference electrode. Upon immersion of a new electrode in a solution the outer bulb surface becomes hydrated and exchanges sodium ions for hydrogen ions to build up a surface layer of hydrogen ions. This, together with the repulsion of anions by fixed, negatively charged silicate sites, produces at the glass-solution interface a potential that is a function of hydrogen ion activity in solution.

Several types of glass electrodes are available. Combination electrodes incorporate the glass and reference electrodes into a single probe. Use a "low sodium error" electrode that can operate at high temperatures for measuring pH over 10 because standard glass electrodes yield erroneously low values. For measuring pH below 1 standard glass electrodes yield erroneously high values; use liquid membrane electrodes instead.

- d. Beakers: Preferably use polyethylene or TFE(Teflon or equivalent) beakers.
- e. Stirrer: Use either a magnetic, TFE-coated stirring bar or a mechanical stirrer with inert plastic-coated impeller.
- f. Flow chamber: Use for continuous flow measurements or for poorly buffered solutions.

Reagents

- a. General preparation: Calibrate the electrode system against standard buffer solutions of known pH. Because buffer solutions may deteriorate as a result of mold growth or contamination, prepare fresh as needed for accurate work by weighing the amounts of chemicals specified in Table 4500-H+:I, dissolving in distilled water at 25°C, and diluting to 1000 mL. This is particularly important for borate and carbonate buffers.

Boil and cool distilled water having a conductivity of less than 2 $\mu\text{mho/cm}$ to 50 mL add 1 drop of saturated KCl solution suitable for reference electrode use. If the pH of this test solution is between 6.0 and 7.0, use it to prepare all standard solutions.

Dry KH_2PO_4 at 110 to 130°C for 2 h before weighing but to not heat unstable hydrated potassium tetroxalate above 60°C nor dry the other specified buffer salts.

Although ACS-grade chemicals generally are satisfactory for preparing buffer solutions, use certified materials available from the National Institute of standards and Technology when the greatest accuracy is required. For routine analysis, use commercially available buffer tablets, powders or solution of tested quality. In preparing buffer solutions from solid salts, insure complete solution.

As a rule, select and prepare buffer solutions classed as primary standards in Table 4500-H+I: reserve secondary standards for extreme situations encountered in wastewater measurements. Consult Table 4500-H+II for accepted pH of standard buffer solutions at temperatures other than 25°C. In routine use, store buffer solutions and samples in polyethylene bottles. Replace buffer solutions every 4 weeks.

- b. Saturated potassium hydrogen tartrate solution: Shake vigorously an excess (5 to 10 g) of finely crystalline $\text{KHC}_4\text{H}_4\text{O}_6$ with 100 to 300 mL distilled water at 25°C in a glass-stoppered bottle. Separate clear solution from undissolved material by decantation or filtration. Preserve for 2 months or more by adding on thymol crystal (8 mm diam) per 200 mL solution.
- c. Saturated calcium hydroxide solution: Calcine a well-washed, low-alkali grade CaCO_3 in a platinum dish by igniting for 1 h at 1000°C. Cool, hydrate by slowly adding distilled water with stirring and heat to boiling. Cool, filter, and collected solid Ca(OH)_2 on a fritted glass filter of medium porosity. Dry at 110°C, cool, and pulverize to uniformly fine granules. Vigorously shake an excess of fine granules with distilled water in a stoppered polyethylene bottle. Let temperature come to 25°C after mixing. Filter supernatant under suction through a sintered glass filter of medium porosity and use filtrate as the buffer solution. Discard buffer solution when atmospheric CO_2 causes turbidity to appear.
- d. Auxiliary solutions: 0.1N NaOH, 0.1N HCl, 5N HCl (dilute five volumes 6N HCl with one volume distilled water), and acid potassium fluoride solution (dissolve 2 g KF in 2mL conc H_2SO_4 and dilute to 100 mL with distilled water).

TABLE 4500-H+I. PREPARATION OF pH STANDARD SOLUTIONS³

Standard Solution (molality)	pH 25°C	at Weight of Chemicals Needed/1000 mL Aqueous Solution at 25°C
Primary standards :		
Potassium hydrogen tartrate (saturated at 25°C)	3.557	> 7 g $\text{KHC}_4\text{H}_4\text{O}_6$ (Approximate solubility)
0.05 potassium dihydrogen citrate	3.776	11.41 g $\text{KH}_2\text{C}_6\text{H}_5\text{O}_7$
0.05 potassium hydrogen phthalate	4.004	10.12 g $\text{KHC}_8\text{H}_4\text{O}_4$
0.025 potassium dihydrogen phosphate +	6.863	3.387 g KH_2PO_4 + 3.533 g Na_2HPO_4

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification & Chemical Analysis Report

0.025 disodium hydrogen phosphate		[Prepare with freshly boiled and cooled distilled water (carbon-dioxide-free)].
0.008 695 potassium dihydrogen phosphate + 0.030 43 disodium hydrogen phosphate	7.415	1.179 g KH ₂ PO ₄ + 4.303 g Na ₂ HPO ₄ [Prepare with freshly boiled and cooled distilled water (carbon-dioxide-free)].
0.01 sodium borate decahydrate (borax)	9.183	3.80 g Na ₂ B ₄ O ₇ 10H ₂ O
0.025 sodium bicarbonate + 0.025 sodium carbonate	10.014	[Prepare with freshly boiled and cooled distilled water (carbon-dioxide-free)]. 2.092 g NaHCO ₃ + 2.640 g Na ₂ CO ₃
Secondary standards :		
0.05 potassium tetroxalate dehydrate	1.679	12.61 g KH ₃ C ₄ O ₈ 2H ₂ O
	12.454	> 2 g Ca(OH) ₂
Calcium hydroxide (saturated at 25°C)		(Approximate solubility)

Procedure

- a. Instrument calibration: In each case follow manufacturer's instructions for pH meter and for storage and preparation of electrodes for use. Recommended solutions for short-term storage of electrodes vary with type of electrode and manufacturer, but generally have a conductivity greater than 4000 µmhos/cm. Tap water is a better substitute than distilled water, but pH 4 buffer is best for the single glass electrode and saturated KCl is preferred for a calomel and Ag/AgCl reference electrode. Saturated KCl is the preferred solution for a combination electrode. Keep electrodes wet by returning them to storage solution whenever pH meter is not in use.

Before use, remove electrodes from storage solution, rinse, blot dry with a soft tissue, place in initial buffer solution, and set the isopotential point (¶ 2a above). Select a second buffer within 2 pH units of sample pH and bring sample and buffer to same temperature, which may be the room temperature, a fixed temperature such as 25°C, or the temperature of a fresh sample. Remove electrodes from first buffer, rinse thoroughly with distilled water, blot dry, and immerse in second buffer. Record temperature of measurement and adjust temperature dial on meter so that meter indicates pH value of buffer at test temperature (this is a slope adjustment).

Use the pH value listed in the tables for the buffer used at the test temperature. Remove electrodes from second buffer, rinse thoroughly with distilled water and dry electrodes as indicated above. Immerse in a third buffer below pH 10, approximately 3 pH units different from the second; the reading should be within 0.1 units for the pH of the third buffer. If the

meter response shows a difference greater than 0.1 pH unit from expected value, look for trouble with the electrodes or potentiometer (see 5a and b below).

The purpose of standardization is to adjust the response of the glass electrode to the instrument. When only occasional pH measurements are made standardize instrument before each measurement. When frequent measurements are made and the instrument is stable, standardize less frequently. If sample pH values vary widely, standardize for each sample with a buffer having a pH within 1 to 2 pH units of the sample.

- b. Sample analysis: Establish equilibrium between electrodes and sample by stirring sample to insure homogeneity; stir gently to minimize carbon dioxide entrainment. For buffered samples or those of high ionic strength, condition electrodes after cleaning by dipping them into sample for 1 min. Blot dry immerse in a fresh portion of the same sample, and read pH.

With dilute, poorly buffered solutions, equilibrate electrodes by immersing in three or four successive portions of sample. Take a fresh sample to measure pH.

Trouble Shooting

- a. Potentiometer: To locate trouble source disconnect electrodes and, using a short-circuit strap, connect reference electrode terminal to glass electrode terminal. Observe change in pH when instrument calibration knob is adjusted. If potentiometer is operating properly, it will respond rapidly and evenly to changes in calibration over a wide scale range. A faulty potentiometer will fail to respond, will react erratically, or will show a drift upon adjustment. Switch to the mill volt scale on which the meter should read zero. If inexperienced, do not attempt potentiometer repair other than maintenance as described in instrument manual.
- b. Electrodes: If potentiometer is functioning properly, look for the instrument fault in the electrode pair. Substitute one electrode at a time and crosscheck with two buffers that are about 4 pH units apart. A deviation greater than 0.1 pH unit indicates a faulty electrode. Glass electrodes fail because of scratches deterioration or accumulation of debris on the glass surface.

8. METHOD FOR DETERMINATION OF SOIL CORROSIVITY:

The Corrosivity of soil plays an important role in the design life of the pipeline. Hence determination of corrosivity is important. There are many parameters that affect the corrosivity of soil, the chemical parameters being one. The corrosiveness of soil can be tabulated with the help of different parameters viz. R1 to R11.

Sr. No.	Legend	Parameters
1.	R1	Soil Type
2.	R2	Resistivity
3.	R3	Water Content
4.	R4	pH
5.	R5	Buffer Capacity
6.	R6	Sulfides
7.	R7	Neutral Salts
8.	R8	Sulphates
9.	R9	Ground Water
10.	R10	Horizontal Homogeneity
11.	R11	Vertical Homogeneity

Different ratings are given for a particular soil for R1 to R11.

Depending upon the sum of R1 to R11 for a particular soil. Its corrosivity can be determined as shown in the table below:

Sr. No.	Sum R1...R11	Soil Corrosivity
1	≥ 0	Virtually Not Corrosive
2.	-1 to -4	Slightly Corrosive
3.	-5 to -10	Corrosive
4.	< -10	Highly Corrosive

1. **Rating 'R1': TYPE OF SOIL (Texture & Structure)**

	wt%	rating
a) coherency : elutriable fraction; (= mainly clay & silt matter)	$\leq 10\%$	+4
	>10 to 30%	+2
	>30 to 50%	0
	>50 to 80%	-2
	>80%	-4
b) soils containing organic carbon, e.g.muddy or swampy soils: peat,fen,mud,marsh,.. organic carbon	>5	-12
c) severely polluted soil: pollution by fuel ash,slag coal, coke, refuse, rubbish or waste water		-12

2. Rating 'R2': SOIL RESISTIVITY

Ohm.cm	rating
>50,000	+4
>20,000 to 50,000	+2
>5,000 to 20,000	0
>2,000 to 5,000	-2
1,000 to 2,000	-4
<1,000	-6

3. Rating 'R3': WATER CONTENT

wt%	rating
<= 20%	0
>20%	-1

4. Rating 'R4': pH

pH	rating
>9	+2
>5.5 to 9	0
4.0 to 5.5	-1
<4	-3

5. Rating 'R5': BUFFERING CAPACITY

	mmol/kg	rating
acid capacity to pH 4.3: (alkalinity Ka4.3)	>1,000	+3
	200 to 1000	+1
	<200	0
base capacity to pH 7 : (acidity Kb7.0)	<2.5	0
	2.5 to 5	-2
	>5.0 to 10	-4
	>10 to 20	-6
	>20 to 30	-8
	>30	-10

6. Rating 'R6': SULFIDE CONTENT

mg/kg	rating
<5 (i.e.none or traces)	0
5 to 10	-3
>10	-6

7. Rating 'R7': NEUTRAL SALTS – water extract conc (Cl-) + 2 conc (SO4=)

mmol/kg	Rating
<3	0
3 to 10	-1
>10 to 30	-2
>30 to 100	-3
>100	-4

8. Rating 'R8': SULFATES –hydrochloric acid extract (SO₄=)

(mmol/kg)	Rating
<2	0
2 to 5	-1
>5 to 10	-2
>10	-3

9. Rating 'R9': GROUNDWATER

	rating
No groundwater	0
Groundwater	-1
Groundwater at times	-2

10. Rating 'R10': HORIZONTAL SOIL HOMOGENEITY

Resistivity variation	rating
Determination of soil resistivity profiles, i.e. variations of R2 values between adjacent domains (to this end all positive R2 values are made=)	+1
R2 difference <2	0
R2 difference >=2 and <=3	-2
R2 difference >3	-4

11. Rating 'R11': VERTICAL SOIL HOMOGENEITY

		rating
a) adjacent soils with same resistivity:	- homogeneously embedded in soils with same structure (similar type) or in sand	0
	- inhomogeneously embedded in soils with different structure (& relatively corrosive soils), or containing foreign matter (e.g. roots, wood)	-6
b) adjacent soils with different resistivity: (different R2 values; determination of R2 according to Rating R2 above)	R2 difference >=2 and <=3	-1
	R2 difference >3	-6

9. **TEST RESULTS:**

A) Degree of Corrosivity as per Chemical Analysis:

As per the rating obtained from chemical analysis of Soil collected at every 10 km interval, the same is presented in a tabular form in **Annexure-III**.

The soil is Virtually Not Corrosive in 4.25 km length, Slightly Corrosive in 33.52 km length.

- B) The chemicals present in the soil affect the degree of corrosivity. Based on corrosivity of the soil it is recommended to design a good cathodic protection system like ICCP to protect the pipeline from corrosion. The ratings are calculated based on chemical values of the strata encountered and have been included in this report. It should be noted that the method used for calculation is empirical and further analysis has to be performed before designing the protection system. If the pipeline is to be cathodically protected impressed current cathodic protection must serve the purpose.

6. CONCLUSIONS & RECOMMENDATIONS

From the Geo-Technical Investigations, the following recommendations may be drawn:

1. Soil along entire route of Proposed pipeline is Brownish & Yellow Soil comprising clay & major portion of silt with high, medium & low plasticity.
2. The sub soil profiles of various sections along the pipeline are indicated by a graphical representation enclosed along with the report.
3. The Coding for various type of soil encountered used in the drawings are shown in the legend enclosed along with this report.

Report Prepared by

Panchal H.B.

(Himanshu Panchal)
.....Engineer

Date : 07-09-2018



Report Reviewed By

Virendra Bhatt

(Virendra Bhatt)
.....Engineer

The soil is Virtually Not Corrosive in 4.25 km length, Slightly Corrosive in 33.52 km length.

- B) The chemicals present in the soil affect the degree of corrosivity. Based on corrosivity of the soil it is recommended to design a good cathodic protection system like ICCP to protect the pipeline from corrosion. The ratings are calculated based on chemical values of the strata encountered and have been included in this report. It should be noted that the method used for calculation is empirical and further analysis has to be performed before designing the protection system. If the pipeline is to be cathodically protected impressed current cathodic protection must serve the purpose.

6. CONCLUSIONS & RECOMMENDATIONS

From the Geo-Technical Investigations, the following recommendations may be drawn:

1. Soil along entire route of Proposed pipeline is Brownish & Yellow Soil comprising clay & major portion of silt with high, medium & low plasticity.
2. The sub soil profiles of various sections along the pipeline are indicated by a graphical representation enclosed along with the report.
3. The Coding for various type of soil encountered used in the drawings are shown in the legend enclosed along with this report.

Report Prepared by

Panchal H.B.

(Himanshu Panchal)
.....Engineer

Date : 07-09-2018



Report Reviewed By

Virendra Bhatt

(Virendra Bhatt)
.....Engineer

ANNEXURES

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban (Along Existing & Proposed RoU)

LIST OF BORE HOLE LOCATIONS AND SOIL ANALYSIS

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
1	TP0	5	5	121.349	>3	1.00	BLACKISH CLAY	CI	17-08-18	
						2.00	BLACKISH CLAY	CI	17-08-18	
						3.00	BLACKISH CLAY	CI	17-08-18	
2	TP3	2	250	121.821	>3	1.00	BLACKISH CLAY	CI	17-08-18	
						2.00	BLACKISH CLAY	CI	17-08-18	
						3.00	BLACKISH CLAY	CI	17-08-18	
3	TP3	252	500	122.193	>3	1.00	BLACKISH CLAY	CI	17-08-18	
						2.00	BLACKISH CLAY	CI	17-08-18	
						3.00	BLACKISH CLAY	CI	17-08-18	
4	TP6	155	1,000	122.777	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	17-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	17-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	17-08-18	
5	TP7	153	1,250	121.422	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	17-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	17-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	17-08-18	

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification Chemical Analysis Report

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
6	TP8	118	1,500	120.522	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	17-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	17-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	17-08-18	
7	IP8/1	165	1,750	119.140	>3	1.00	YELLOWISH CLAY	CI	17-08-18	
						2.00	YELLOWISH CLAY	CI	17-08-18	
						3.00	YELLOWISH CLAY	CI	17-08-18	
8	TP10	57	2,000	121.036	>3	1.00	YELLOWISH CLAY	CI	17-08-18	
						2.00	YELLOWISH CLAY	CI	17-08-18	
						3.00	YELLOWISH CLAY	CI	17-08-18	
9	TP11	148	2,250	122.674	>3	1.00	YELLOWISH CLAY	CI	17-08-18	
						2.00	YELLOWISH CLAY	CI	17-08-18	
						3.00	YELLOWISH CLAY	CI	17-08-18	
10	IP11/1	146	2,500	122.963	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	17-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	17-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	17-08-18	
11	TP13	64	2,750	121.674	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	17-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	17-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	17-08-18	
12	TP14	153	3,000	121.745	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	17-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	17-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	17-08-18	
13	TP16	71	3,250	120.980	>3	1.00	YELLOWISH CLAY	CI	17-08-18	
						2.00	YELLOWISH CLAY	CI	17-08-18	
						3.00	BROWNIES CLAY	CI	17-08-18	

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification Chemical Analysis Report

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
14	TP17	86	3,500	121.453	>3	1.00	YELLOWISH CLAY	CI	17-08-18	
						2.00	YELLOWISH CLAY	CI	17-08-18	
						3.00	BROWNIES CLAY	CI	17-08-18	
15	IP17/1	156	3,750	121.534	>3	1.00	YELLOWISH CLAY	CI	17-08-18	
						2.00	YELLOWISH CLAY	CI	16-08-18	
						3.00	BROWNIES CLAY	CI	16-08-18	
16	TP19	199	4,000	122.326	>3	1.00	YELLOWISH CLAY	CI	16-08-18	
						2.00	YELLOWISH CLAY	CI	16-08-18	
						3.00	BROWNIES CLAY	CI	16-08-18	
17	TP20	38	4,250	118.378	>3	1.00	YELLOWISH CLAY	CI	16-08-18	
						2.00	YELLOWISH CLAY	CI	16-08-18	
						3.00	YELLOWISH CLAY	CI	16-08-18	
18	TP23	52	4,500	118.897	>3	1.00	YELLOWISH CLAY	CI	16-08-18	
						2.00	YELLOWISH CLAY	CI	16-08-18	
						3.00	YELLOWISH CLAY	CI	16-08-18	
19	TP26	74	4,750	117.264	>3	1.00	BLACKISH CLAY-SILT MIX	MI	16-08-18	
						2.00	BLACKISH CLAY-SILT MIX	MI	16-08-18	
						3.00	BLACKISH CLAY-SILT MIX	MI	16-08-18	
20	TP31	28	5,000	121.325	>3	1.00	BLACKISH CLAY-SILT MIX	MI	16-08-18	
						2.00	BLACKISH CLAY-SILT MIX	MI	16-08-18	
						3.00	BLACKISH CLAY-SILT MIX	MI	16-08-18	
21	TP33	72	5,250	122.053	>3	1.00	BLACKISH CLAY-SILT MIX	MI	16-08-18	
						2.00	BLACKISH CLAY-SILT MIX	MI	16-08-18	
						3.00	BLACKISH CLAY-SILT MIX	MI	16-08-18	

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification Chemical Analysis Report

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
22	TP36	101	5,500	122.881	>3	1.00	BLACKISH CLAY-SILT MIX	MI	16-08-18	
						2.00	BLACKISH CLAY-SILT MIX	MI	16-08-18	
						3.00	BLACKISH CLAY-SILT MIX	MI	16-08-18	
23	TP37	60	5,750	120.271	>3	1.00	BLACKISH CLAY-SILT MIX	MI	16-08-18	
						2.00	BLACKISH CLAY-SILT MIX	MI	16-08-18	
						3.00	BLACKISH CLAY-SILT MIX	MI	16-08-18	
24	TP39	67	6,000	121.403	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	16-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	16-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	16-08-18	
25	IP39/1	2	6,250	117.225	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	16-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	16-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	16-08-18	
26	IP39/1	252	6,500	116.303	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	16-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	16-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	16-08-18	
27	TP40	187	6,750	116.534	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	16-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	16-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	16-08-18	
28	TP42	37	7,000	116.890	>3	1.00	BLACKISH CLAY	CI	14-08-18	
						2.00	BLACKISH CLAY	CI	14-08-18	
						3.00	BLACKISH CLAY	CI	14-08-18	
29	TP43	128	7,250	116.925	>3	1.00	BLACKISH CLAY	CI	14-08-18	
						2.00	BLACKISH CLAY	CI	14-08-18	
						3.00	BLACKISH CLAY	CI	14-08-18	

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification Chemical Analysis Report

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
30	TP46	52	7,500	116.718	>3	1.00	BLACKISH CLAY	CI	14-08-18	
						2.00	BLACKISH CLAY	CI	14-08-18	
						3.00	BLACKISH CLAY	CI	14-08-18	
31	TP48	63	7,750	119.627	>3	1.00	BLACKISH CLAY	CI	14-08-18	
						2.00	BLACKISH CLAY	CI	14-08-18	
						3.00	BLACKISH CLAY	CI	14-08-18	
32	TP49	15	8,000	120.805	>3	1.00	BLACKISH CLAY	CI	14-08-18	
						2.00	BLACKISH CLAY	CI	14-08-18	
						3.00	BLACKISH CLAY	CI	14-08-18	
33	TP50	28	8,250	116.865	>3	1.00	BLACKISH CLAY	CI	14-08-18	
						2.00	BLACKISH CLAY	CI	14-08-18	
						3.00	BLACKISH CLAY	CI	14-08-18	
34	TP51	152	8,500	121.737	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	14-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	14-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	14-08-18	
35	TP53	171	8,750	122.985	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	14-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	14-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	14-08-18	
36	TP54	122	9,000	125.637	>3	1.00	YELLOWISH CLAY	CI	14-08-18	
						2.00	YELLOWISH CLAY	CI	14-08-18	
						3.00	YELLOWISH CLAY	CI	14-08-18	
37	TP55	158	9,250	123.676	>3	1.00	YELLOWISH CLAY	CI	14-08-18	
						2.00	YELLOWISH CLAY	CI	14-08-18	
						3.00	YELLOWISH CLAY	CI	14-08-18	

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification Chemical Analysis Report

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
38	TP57	43	9,500	126.047	>3	1.00	BROWNIES CLAY	CI	14-08-18	
						2.00	BROWNIES CLAY	CI	14-08-18	
						3.00	BROWNIES CLAY	CI	14-08-18	
39	TP57	293	9,750	125.990	>3	1.00	BROWNIES CLAY	CI	14-08-18	
						2.00	BROWNIES CLAY	CI	14-08-18	
						3.00	BROWNIES CLAY	CI	14-08-18	
40	TP60	111	10,000	125.993	>3	1.00	YELLOWISH CLAY	CI	14-08-18	
						2.00	YELLOWISH CLAY	CI	14-08-18	
						3.00	YELLOWISH CLAY	CI	14-08-18	
41	IP60/1	127	10,250	125.489	>3	1.00	YELLOWISH CLAY	CI	14-08-18	
						2.00	YELLOWISH CLAY	CI	14-08-18	
						3.00	YELLOWISH CLAY	CI	14-08-18	
42	IP60/2	153	10,500	125.413	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	14-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	14-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	14-08-18	
43	TP63	24	10,750	124.012	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
44	TP64	172	11,000	121.184	>3	1.00	YELLOWISH CLAY	CI	13-08-18	
						2.00	YELLOWISH CLAY	CI	13-08-18	
						3.00	YELLOWISH CLAY	CI	13-08-18	
45	TP67	128	11,250	124.840	>3	1.00	YELLOWISH CLAY	CI	13-08-18	
						2.00	YELLOWISH CLAY	CI	13-08-18	
						3.00	YELLOWISH CLAY	CI	13-08-18	

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification Chemical Analysis Report

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
46	TP68	235	11,500	126.461	>3	1.00	YELLOWISH CLAY	CI	13-08-18	
						2.00	YELLOWISH CLAY	CI	13-08-18	
						3.00	YELLOWISH CLAY	CI	13-08-18	
47	TP69	215	11,750	126.059	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
48	TP70	160	12,000	121.628	>3	1.00	YELLOWISH SAND	SP	13-08-18	HAPJAN RIVER
						2.00	YELLOWISH SAND	SP	13-08-18	
						3.00	YELLOWISH SAND	SP	13-08-18	
49	TP72	93	12,245	118.654	>3	1.00	YELLOWISH CLAY	CI	13-08-18	
						2.00	YELLOWISH CLAY	CI	13-08-18	
						3.00	YELLOWISH CLAY	CI	13-08-18	
50	TP73	162	12,500	126.177	>3	1.00	YELLOWISH CLAY	CI	13-08-18	
						2.00	YELLOWISH CLAY	CI	13-08-18	
						3.00	YELLOWISH CLAY	CI	13-08-18	
51	TP75	98	12,750	125.824	>3	1.00	YELLOWISH CLAY	CI	13-08-18	
						2.00	YELLOWISH CLAY	CI	13-08-18	
						3.00	YELLOWISH CLAY	CI	13-08-18	
52	TP76	130	13,000	125.802	>3	1.00	YELLOWISH CLAY	CI	13-08-18	
						2.00	YELLOWISH CLAY	CI	13-08-18	
						3.00	YELLOWISH CLAY	CI	13-08-18	
53	TP77	95	13,250	125.743	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification Chemical Analysis Report

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
54	IP77/1	118	13,500	125.825	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
55	TP78	146	13,750	125.525	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
56	TP82	46	14,000	125.789	>3	1.00	YELLOWISH CLAY	CI	13-08-18	
						2.00	YELLOWISH CLAY	CI	13-08-18	
						3.00	YELLOWISH CLAY	CI	13-08-18	
57	TP84	79	14,250	125.905	>3	1.00	YELLOWISH SAND	SP	13-08-18	HAPJAN RIVER
						2.00	YELLOWISH SAND	SP	13-08-18	
						3.00	YELLOWISH SAND	SP	13-08-18	
58	IP87/1	16	14,500	120.723	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
59	TP88	31	14,750	125.648	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	13-08-18	
60	TP90	97	15,000	126.408	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	12-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	12-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	12-08-18	
61	TP91	150	15,250	126.101	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	12-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	12-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	12-08-18	

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification Chemical Analysis Report

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
62	TP92	18	15,500	124.232	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	12-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	12-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	12-08-18	
63	TP95	23	15,750	124.377	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	12-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	12-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	12-08-18	
64	TP96	62	16,000	126.462	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	12-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	12-08-18	
						3.00	BROWNIES CLAY-SILT MIX	MI	12-08-18	
65	TP97	85	16,250	126.771	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	12-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	12-08-18	
						3.00	BROWNIES CLAY-SILT MIX	MI	12-08-18	
66	TP98	219	16,500	126.531	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	12-08-18	
						2.00	BROWNIES CLAY-SILT MIX	MI	12-08-18	
						3.00	BROWNIES CLAY-SILT MIX	MI	12-08-18	
67	TP99	216	16,750	126.464	>3	1.00	YELLOWISH CLAY	CI	12-08-18	
						2.00	YELLOWISH CLAY	CI	12-08-18	
						3.00	BLACKISH CLAY	CI	12-08-18	
68	TP101	68	17,000	125.315	>3	1.00	YELLOWISH CLAY	CI	12-08-18	
						2.00	BLACKISH CLAY	CI	12-08-18	
						3.00	BLACKISH CLAY	CI	12-08-18	
69	TP102	165	17,250	124.983	>3	1.00	YELLOWISH CLAY	CI	12-08-18	
						2.00	BLACKISH CLAY	CI	12-08-18	
						3.00	BLACKISH CLAY	CI	12-08-18	

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification Chemical Analysis Report

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
70	TP104	48	17,500	124.754	>3	1.00	BROWNIES CLAY	CI	12-08-18	
						2.00	BROWNIES CLAY	CI	12-08-18	
						3.00	BROWNIES CLAY	CI	12-08-18	
71	TP104	298	17,750	124.556	>3	1.00	BROWNIES CLAY	CI	12-08-18	
						2.00	BROWNIES CLAY	CI	12-08-18	
						3.00	BROWNIES CLAY	CI	12-08-18	
72	IP105/1	52	18,000	124.227	>3	1.00	BROWNIES CLAY	CI	12-08-18	
						2.00	BROWNIES CLAY	CI	12-08-18	
						3.00	YELLOWISH CLAY	CI	12-08-18	
73	TP106	130	18,250	124.017	>3	1.00	BROWNIES CLAY	CI	12-08-18	
						2.00	BROWNIES CLAY	CI	12-08-18	
						3.00	YELLOWISH CLAY	CI	12-08-18	
74	TP108	107	18,500	124.563	>3	1.00	BROWNIES CLAY	CI	12-08-18	
						2.00	YELLOWISH CLAY	CI	12-08-18	
						3.00	YELLOWISH CLAY	CI	12-08-18	
75	TP111	9	18,750	123.968	>3	1.00	YELLOWISH CLAY	CI	12-08-18	
						2.00	YELLOWISH CLAY	CI	12-08-18	
						3.00	YELLOWISH CLAY	CI	12-08-18	
76	TP113	43	19,000	123.754	>3	1.00	YELLOWISH CLAY	CI	12-08-18	
						2.00	YELLOWISH CLAY	CI	12-08-18	
						3.00	YELLOWISH CLAY	CI	12-08-18	
77	TP115	51	19,250	124.033	>3	1.00	YELLOWISH CLAY	CI	12-08-18	
						2.00	YELLOWISH CLAY	CI	12-08-18	
						3.00	YELLOWISH CLAY	CI	12-08-18	

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification Chemical Analysis Report

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
78	TP118	3	19,510	124.076	>3	1.00	YELLOWISH CLAY	CI	12-08-18	
						2.00	YELLOWISH CLAY	CI	12-08-18	
						3.00	YELLOWISH CLAY	CI	12-08-18	
79	TP121	43	19,750	123.872	>3	1.00	YELLOWISH CLAY	CI	11-08-18	
						2.00	YELLOWISH CLAY	CI	11-08-18	
						3.00	BROWNIES CLAY	CI	11-08-18	
80	IP121/1	87	20,000	124.372	>3	1.00	YELLOWISH CLAY	CI	11-08-18	
						2.00	YELLOWISH CLAY	CI	11-08-18	
						3.00	BROWNIES CLAY	CI	11-08-18	
81	TP123	73	20,250	125.079	>3	1.00	YELLOWISH CLAY	CI	11-08-18	
						2.00	YELLOWISH CLAY	CI	11-08-18	
						3.00	BROWNIES CLAY	CI	11-08-18	
82	TP124	64	20,500	125.667	>3	1.00	YELLOWISH CLAY	CI	11-08-18	
						2.00	YELLOWISH CLAY	CI	11-08-18	
						3.00	YELLOWISH CLAY	CI	11-08-18	
83	TP127	56	20,750	123.351	>3	1.00	YELLOWISH CLAY	CI	11-08-18	
						2.00	YELLOWISH CLAY	CI	11-08-18	
						3.00	YELLOWISH CLAY	CI	11-08-18	
84	IP128/1	38	21,000	123.148	>3	1.00	YELLOWISH CLAY	CI	11-08-18	
						2.00	YELLOWISH CLAY	CI	11-08-18	
						3.00	YELLOWISH CLAY	CI	11-08-18	
85	TP130	66	21,250	123.661	>3	1.00	YELLOWISH CLAY	CI	11-08-18	
						2.00	YELLOWISH CLAY	CI	11-08-18	
						3.00	YELLOWISH CLAY	CI	11-08-18	

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification Chemical Analysis Report

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
86	TP132	75	21,500	122.618	>3	1.00	YELLOWISH CLAY	CI	11-08-18	
						2.00	YELLOWISH CLAY	CI	11-08-18	
						3.00	YELLOWISH CLAY	CI	11-08-18	
87	TP135	35	21,750	124.224	>3	1.00	YELLOWISH CLAY	CI	11-08-18	
						2.00	YELLOWISH CLAY	CI	11-08-18	
						3.00	YELLOWISH CLAY	CI	11-08-18	
88	TP136	237	22,000	123.885	>3	1.00	YELLOWISH CLAY	CI	11-08-18	
						2.00	YELLOWISH CLAY	CI	11-08-18	
						3.00	YELLOWISH CLAY	CI	11-08-18	
89	TP138	57	22,250	123.544	>3	1.00	YELLOWISH CLAY	CI	11-08-18	
						2.00	YELLOWISH CLAY	CI	11-08-18	
						3.00	YELLOWISH CLAY	CI	11-08-18	
90	TP140	120	22,500	122.857	>3	1.00	YELLOWISH CLAY	CI	11-08-18	
						2.00	YELLOWISH CLAY	CI	11-08-18	
						3.00	YELLOWISH CLAY	CI	11-08-18	
91	TP142	127	22,750	122.662	>3	1.00	YELLOWISH CLAY	CI	11-08-18	
						2.00	YELLOWISH CLAY	CI	11-08-18	
						3.00	BROWNIES CLAY	CI	11-08-18	
92	IP142/1	156	23,000	122.279	>3	1.00	YELLOWISH CLAY	CI	10-08-18	
						2.00	YELLOWISH CLAY	CI	10-08-18	
						3.00	BROWNIES CLAY	CI	10-08-18	
93	TP144	28	23,250	122.016	>3	1.00	YELLOWISH CLAY	CI	10-08-18	
						2.00	YELLOWISH CLAY	CI	10-08-18	
						3.00	BROWNIES CLAY	CI	10-08-18	

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification Chemical Analysis Report

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
94	IP144/1	36	23,500	121.774	>3	1.00	YELLOWISH CLAY	CI	10-08-18	
						2.00	YELLOWISH CLAY	CI	10-08-18	
						3.00	BROWNIES CLAY	CI	10-08-18	
95	TP145	46	23,750	121.506	>3	1.00	YELLOWISH CLAY	CI	10-08-18	
						2.00	YELLOWISH CLAY	CI	10-08-18	
						3.00	YELLOWISH CLAY	CI	10-08-18	
96	IP145/1	106	24,000	121.191	>3	1.00	YELLOWISH CLAY	CI	10-08-18	
						2.00	YELLOWISH CLAY	CI	10-08-18	
						3.00	YELLOWISH CLAY	CI	10-08-18	
97	TP147	27	24,250	121.234	>3	1.00	YELLOWISH CLAY	CI	10-08-18	
						2.00	YELLOWISH CLAY	CI	10-08-18	
						3.00	YELLOWISH CLAY	CI	10-08-18	
98	IP147/1	110	24,500	120.977	>3	1.00	YELLOWISH CLAY	CI	10-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	10-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	10-08-18	
99	IP148/1	19	24,750	120.715	>3	1.00	YELLOWISH CLAY	CI	10-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	10-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	10-08-18	
100	TP149	95	25,000	120.593	>3	1.00	YELLOWISH CLAY	CI	10-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	10-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	10-08-18	
101	TP150	137	25,250	120.976	>3	1.00	YELLOWISH CLAY	CI	10-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	10-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	10-08-18	

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification Chemical Analysis Report

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
102	TP152	35	25,500	120.053	>3	1.00	YELLOWISH CLAY	CI	10-08-18	
						2.00	YELLOWISH CLAY	CI	10-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	10-08-18	
103	TP153	29	25,750	121.338	>3	1.00	YELLOWISH SILT	MH	10-08-18	
						2.00	YELLOWISH SILT	MH	10-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	10-08-18	
104	TP156	36	26,000	120.378	>3	1.00	YELLOWISH SILT	MH	10-08-18	
						2.00	YELLOWISH SILT	MH	10-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	10-08-18	
105	TP160	20	26,250	119.725	>3	1.00	YELLOWISH SILT	MH	10-08-18	
						2.00	YELLOWISH SILT	MH	10-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	10-08-18	
106	TP163	38	26,500	120.349	>3	1.00	YELLOWISH SILT	MH	10-08-18	
						2.00	YELLOWISH SILT	MH	10-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	10-08-18	
107	TP164	193	26,750	119.136	>3	1.00	YELLOWISH SILT	MH	10-08-18	
						2.00	YELLOWISH SILT	MH	10-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	10-08-18	
108	TP167	5	27,000	119.471	>3	1.00	YELLOWISH SILT	MH	09-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
109	TP169	44	27,250	119.472	>3	1.00	YELLOWISH CLAY	CI	09-08-18	
						2.00	YELLOWISH CLAY	CI	09-08-18	
						3.00	YELLOWISH CLAY	CI	09-08-18	

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification Chemical Analysis Report

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
110	TP177	49	28,000	118.454	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						3.00	YELLOWISH CLAY-SAND MIX	GM	09-08-18	
	TP179	41	28,155	118.876		1.00	BLACKISH SILT-SAND MIX	GM	09-08-18	TINGRAI RIVER
						2.00	BLACKISH SILT-SAND MIX	GM	09-08-18	
						3.00	BLACKISH SILT-SAND MIX	GM	09-08-18	
111	TP180	60	28,250	116.811	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						3.00	YELLOWISH CLAY-SAND MIX	SC	09-08-18	
112	TP181	166	28,500	120.333	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
113	TP182	54	28,750	120.959	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
114	IP182/1	135	29,000	120.846	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
115	TP184	125	29,250	120.511	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
116	TP186	46	29,500	120.799	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification Chemical Analysis Report

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
117	IP188/1	15	29,750	121.189	>3	1.00	BROWNIES CLAY	CI	09-08-18	
						2.00	YELLOWISH CLAY	CI	09-08-18	
						3.00	YELLOWISH CLAY	CI	09-08-18	
118	TP189	88	30,000	121.874	>3	1.00	BROWNIES CLAY	CI	09-08-18	
						2.00	YELLOWISH CLAY	CI	09-08-18	
						3.00	YELLOWISH CLAY	CI	09-08-18	
119	TP192	10	30,250	121.246	>3	1.00	BROWNIES CLAY	CI	09-08-18	
						2.00	YELLOWISH CLAY	CI	09-08-18	
						3.00	YELLOWISH CLAY	CI	09-08-18	
120	TP193	35	30,500	120.892	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						2.00	YELLOWISH CLAY	CI	09-08-18	
						3.00	YELLOWISH CLAY	CI	09-08-18	
121	TP195	10	30,750	120.973	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						2.00	YELLOWISH CLAY	CI	09-08-18	
						3.00	YELLOWISH CLAY	CI	09-08-18	
122	TP196	97	31,000	120.868	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						2.00	YELLOWISH CLAY-SILT-MURRAM MIX	MI	09-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
123	TP198	82	31,250	120.861	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
124	TP199	123	31,500	121.438	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	09-08-18	
						2.00	YELLOWISH CLAY	CI	09-08-18	
						3.00	YELLOWISH CLAY	CI	09-08-18	

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification Chemical Analysis Report

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
125	IP199/1	176	31,750	122.224	>3	1.00	YELLOWISH CLAY	CI	09-08-18	
						2.00	YELLOWISH CLAY	CI	09-08-18	
						3.00	YELLOWISH CLAY	CI	09-08-18	
126	TP201	111	32,000	122.333	>3	1.00	YELLOWISH CLAY	CI	09-08-18	
						2.00	YELLOWISH CLAY	CI	09-08-18	
						3.00	YELLOWISH CLAY	CI	09-08-18	
127	TP204	90	32,250	121.219	>3	1.00	YELLOWISH CLAY	CI	09-08-18	
						2.00	YELLOWISH CLAY	CI	09-08-18	
						3.00	YELLOWISH CLAY	CI	09-08-18	
128	TP205	175	32,500	120.830	>3	1.00	YELLOWISH CLAY	CI	09-08-18	
						2.00	YELLOWISH CLAY	CI	09-08-18	
						3.00	YELLOWISH CLAY	CI	09-08-18	
129	TP208	39	32,750	120.889	>3	1.00	YELLOWISH CLAY	CI	09-08-18	
						2.00	YELLOWISH CLAY	CI	09-08-18	
						3.00	YELLOWISH CLAY	CI	09-08-18	
130	TP213	39	33,000	120.603	>3	1.00	YELLOWISH CLAY	CI	09-08-18	
						2.00	YELLOWISH CLAY	CI	09-08-18	
						3.00	YELLOWISH CLAY	CI	09-08-18	
131	IP214/1	48	33,250	120.280	>3	1.00	YELLOWISH CLAY	CI	09-08-18	
						2.00	YELLOWISH CLAY	CI	09-08-18	
						3.00	YELLOWISH CLAY	CI	09-08-18	
132	TP217	6	33,500	120.839	>3	1.00	YELLOWISH CLAY	CI	08-08-18	
						2.00	YELLOWISH CLAY	CI	08-08-18	
						3.00	YELLOWISH CLAY	CI	08-08-18	

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification Chemical Analysis Report

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
133	TP219	23	33,750	119.985	>3	1.00	YELLOWISH CLAY	CI	08-08-18	
						2.00	YELLOWISH CLAY	CI	08-08-18	
						3.00	YELLOWISH CLAY	CI	08-08-18	
134	TP221	33	34,000	119.748	>3	1.00	YELLOWISH CLAY	CI	08-08-18	
						2.00	YELLOWISH CLAY	CI	08-08-18	
						3.00	YELLOWISH CLAY	CI	08-08-18	
135	TP223	105	34,250	120.121	>3	1.00	YELLOWISH CLAY	CI	08-08-18	
						2.00	YELLOWISH CLAY	CI	08-08-18	
						3.00	YELLOWISH CLAY	CI	08-08-18	
136	TP225	106	34,500	120.207	>3	1.00	YELLOWISH CLAY	CI	08-08-18	
						2.00	YELLOWISH CLAY	CI	08-08-18	
						3.00	YELLOWISH CLAY	CI	08-08-18	
137	TP226	245	34,750	119.588	>3	1.00	YELLOWISH CLAY	CI	08-08-18	
						2.00	YELLOWISH CLAY	CI	08-08-18	
						3.00	YELLOWISH CLAY	CI	08-08-18	
138	TP229	23	35,000	119.479	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	08-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	08-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	08-08-18	
139	TP230	131	35,250	119.451	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	08-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	08-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	08-08-18	
140	TP232	34	35,500	119.365	>3	1.00	YELLOWISH CLAY	CI	08-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	08-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	08-08-18	

Oil India Limited
Gas Pipeline from Baghjan to CGGS Madhuban
Soil Stratification Chemical Analysis Report

BORE NO.	TP/IP	LOCATION OFFSET (m)	CHAINAGE (m)	R.L (m)	GWT (m)	DEPTH (m)	VISUAL ENGINEERING CLASSIFICATIONS	SOIL TYPE	DATE OF EXTRACTION	REMARK
141	TP233	70	35,750	119.006	>3	1.00	YELLOWISH CLAY	CI	08-08-18	
						2.00	YELLOWISH CLAY-SILT MIX	MI	08-08-18	
						3.00	YELLOWISH CLAY-SILT MIX	MI	08-08-18	
142	IP234/1	67	36,000	119.124	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	08-08-18	
						2.00	YELLOWISH CLAY	CI	08-08-18	
						3.00	YELLOWISH CLAY	CI	08-08-18	
143	TP235	90	36,250	118.482	>3	1.00	YELLOWISH CLAY-SILT MIX	MI	08-08-18	
						2.00	YELLOWISH CLAY	CI	08-08-18	
						3.00	YELLOWISH CLAY	CI	08-08-18	
144	TP236	55	36,500	118.796	>3	1.00	YELLOWISH CLAY	CI	08-08-18	
						2.00	YELLOWISH CLAY	CI	08-08-18	
						3.00	YELLOWISH CLAY	CI	08-08-18	
145	TP237	79	36,750	119.011	>3	1.00	YELLOWISH CLAY	CI	08-08-18	
						2.00	YELLOWISH CLAY	CI	08-08-18	
						3.00	YELLOWISH CLAY	CI	08-08-18	
146	TP239	33	37,000	119.263	>3	1.00	YELLOWISH CLAY	CI	08-08-18	
						2.00	YELLOWISH CLAY	CI	08-08-18	
						3.00	YELLOWISH CLAY	CI	08-08-18	
147	TP243	114	37,250	119.748	>3	1.00	YELLOWISH CLAY	CI	08-08-18	
						2.00	YELLOWISH CLAY	CI	08-08-18	
						3.00	WHITISH YELLOW CLAY	CI	08-08-18	
148	TP245	65	37,500	119.825	>3	1.00	YELLOWISH CLAY	CI	08-08-18	
						2.00	WHITISH YELLOW CLAY	CI	08-08-18	
						3.00	WHITISH YELLOW CLAY	CI	08-08-18	

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

**1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban
(Along Existing & Proposed RoU)**

METHOD OF ANALYSIS

Following are the analysis method adopted for the sample testing

Sr. No.	Parameter	Reference of Method (From Standard Methods For Examination of Water & Waste Water, 20th Ed.)
1	Calcium (Ca ⁺⁺)	Standard method for examination of water & waste water Method No. 3500 - Ca B
2	Magnesium(Mg)	Standard method for examination of water & waste water Method No. 3500 - Mg B
3	Sodium (Na ⁺)	Standard method for examination of water & waste water Method No. 3500 - Na B
4	Potassium(K)	Standard method for examination of water & waste water Method No. 3500 - Na B
5	Chloride (Cl ⁻)	Standard method for examination of water & waste water Method No. 4500 - Cl ⁻ B
6	Sulphate SO ₄)	Standard method for examination of water & waste water Method No. 4500 - SO ₄ ²⁻ C
7	Sulphide (S)	Standard method for examination of water & waste water Method No. 4500 - S ²⁻ B
8	Carbonate	2320 B. Titration Method (Carbonate (CO ₃))
9	BiCarbonates	2320 B. Titration Method (Bicarbonate (HCO ₃))
10	Nitrite	Standard method for examination of water & waste water Method No. 4500-NO ₂ -B
11	Nitrate	Standard method for examination of water & waste water Method No. 4500-NO ₃ -B
13	Moisture Percentage	Standard method (drying at 105° C at constant weight)
14	Oxygen Activity	Standard method for examination of water & waste water Method No. 4500 - O
15	pH	Standard method for examination of water & waste water Method No. 4500 - H ⁺ B

Note :

- * In the chemical analysis, 150 g sample was dissolve in 500 ml. water and various tests were performed as per standard method (specified above) on this prepared leachate of soil sample.
- * ND indicates the parameter is not detected at the time of testing

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban (Along Existing & Proposed RoU)

CHEMICAL ANALYSIS REPORT OF SOIL SAMPLES

S. No	Description	BH-26			BH-40		BH-57			BH-80			BH-110			BH-118			BH-138		
1	Date of Extraction	16-08-18			14-08-18		13-08-18			11-08-18			09-08-18			09-08-18			08-08-18		
2	Chainage / Location (mtr.)	6500.00			10000.00		14250.00			20000.00			28000.00			30000.00			35000.00		
3	Depth in mtr.	1.0	2.0	3.0	1.0	1.5	1.0	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0
4	Classification	MI	MI	MI	CI	CI	SP	SP	SP	CI	CI	CI	MI	MI	GM	CI	CI	CI	MI	MI	MI
5	Cations																				
	(i) Calcium Hardness (mmol/kg)	0.777	0.980	0.656	0.846	0.879	0.803	0.765	0.836	0.802	0.832	0.841	0.685	0.752	0.714	0.860	0.855	0.870	0.826	0.866	0.798
	(ii) Magnesium Hardness (mmol/kg)	0.385	0.402	0.398	0.402	0.383	0.303	0.285	0.281	0.236	0.222	0.213	0.303	0.285	0.298	0.362	0.352	0.312	0.235	0.265	0.245
	(iii) Sodium (mmol/kg)	0.022	0.028	0.029	0.016	0.022	0.019	0.022	0.015	0.018	0.025	0.031	0.019	0.020	0.014	0.014	0.010	0.012	0.020	0.021	0.020
	(iv) Potassium (mmol/kg)	ND	ND		0.032	0.034	0.034	0.031	0.028	0.029	0.030	0.028	0.025	0.023	0.033	0.031	0.038	0.034	0.038	0.034	0.030
6	Anions																				
	(i) Chloride (mmol/kg)	212.8	200.0	198.2	283.5	313.5	235.1	312.5	311.4	198.7	214.5	226.0	303.0	316.5	342.5	222.5	219.5	362.5	198.5	122.0	134.5
	(ii) Sulphate (mmol/kg)	334.5	366.8	416.5	537.5	416.5	365.5	462.5	612.5	346.5	366.5	342.5	416.5	411.5	368.3	454.5	468.5	525.1	419.5	435.0	422.3
	(iii) Sulphide (mmol/kg)	198.5	202.5	221.5	248.4	303.8	234.5	365.2	416.5	214.5	238.4	198.5	284.5	213.4	212.3	216.8	213.2	320.0	168.5	202.1	213.7
	(iv) Carbonate (g/kg)	10.0	18.5	12.0	8.1	8.1	8.7	22.1	8.5	14.8	16.2	14.7	18.3	19.2	20.1	16.2	10.1	10.4	14.7	18.5	11.3
	(v) BICarbonates as CaCo3 (gm/kg)	7.8	12.3	16.2	6.7	5.8	13.2	18.4	7.2	13.7	14.8	12.9	14.8	16.4	18.2	14.2	8.9	7.8	12.6	13.6	11.2
	(vi) Nitrite (mmol/kg)	0.0	0.031	0.028	0.028	0.032	0.035	0.028	0.029	0.034	0.031	0.032	0.031	0.032	0.029	0.026	0.038	0.032	0.035	0.026	0.035
	(vii) Nitrate (mmol/kg)	0.0	0.020	0.018	0.030	0.029	0.320	0.019	0.021	0.022	0.025	0.021	0.021	0.040	0.031	0.030	0.031	0.024	0.034	0.031	0.032
7	General Test.																				
	(i) Moisture Content (%)	8.98	16.32	14.25	11.34	11.11	11.35	16.32	10.25	13.34	15.23	12.68	14.68	14.26	10.35	10.25	8.45	15.43	13.28	12.46	15.16
	(ii) Oxygen Activity (CFU/gm)	0.346	0.289	0.402	0.346	0.298	0.298	0.313	0.358	0.249	0.312	0.288	0.297	0.312	0.198	0.312	0.298	0.279	0.365	0.345	0.285
	(iii) PH	7.46	7.77	8.08	7.99	7.56	7.68	8.56	7.46	7.46	7.83	7.79	8.1	8.03	7.58	8.11	8.13	8.03	7.46	7.98	7.83
Rating		-3	-3	-3	-1	-1	5	5	5	-1	-1	-1	-3	-3	-1	-1	-1	-1	-3	-3	-3

GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban (Along Existing & Proposed RoU)

RATING OF SOIL SAMPLES

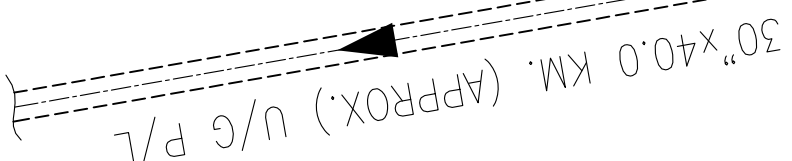
Sr. No.	Parameter	BH-26			BH-40		BH-57			BH-80			BH-110			BH-118			BH-138		
1	Date of Extraction	16-08-18			14-08-18		13-08-18			11-08-18			09-08-18			09-08-18			08-08-18		
2	Chainage / Location (mtr.)	6500.00			10000.00		14250.00			20000.00			28000.00			30000.00			35000.00		
3	Depth (m)	1.0	2.0	3.0	1.0	1.5	1.0	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0
4	Classification	MI	MI	MI	CI	CI	SP	SP	SP	CI	CI	CI	MI	MI	GM	CI	CI	CI	MI	MI	MI
5	R1	-4	-4	-4	-2	-2	4	4	4	-2	-2	-2	-4	-4	-2	-2	-2	-2	-4	-4	-4
6	R2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
7	R3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	R4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	R5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	R6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	R7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	R8	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3
12	R9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	R10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	R11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rating	-3	-3	-3	-1	-1	5	5	5	-1	-1	-1	-3	-3	-1	-1	-1	-1	-3	-3	-3

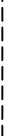
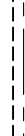
GAS PIPELINE FROM BAGHJAN TO CGGS MADHUBAN

**1) Proposed 30"Ø Gas Pipeline from Baghjan EPS/GGS to CGGS Madhuban
(Along Existing & Proposed RoU)**

DEGREE OF CORROSIVITY AS PER CHEMICAL ANALYSIS

Sr. No.	Chainage (km)		Length(km)	Rating	Corrosivity
	From	To			
1	0.000	6.500	6.500	-3.5	Slightly Corrosive
2	6.500	10.000	3.500	0.5	Virtually Not Corrosive
3	10.000	14.250	4.250	0.5	Virtually Not Corrosive
4	14.250	20.000	5.750	-3.2	Slightly Corrosive
5	20.000	28.000	8.000	-1.7	Slightly Corrosive
6	28.000	29.333	1.333	-1.0	Slightly Corrosive
7	29.333	35.000	5.667	-2.0	Slightly Corrosive
8	35.000	37.766	2.766	-3.0	Slightly Corrosive
	Total Length(km)		37.766		



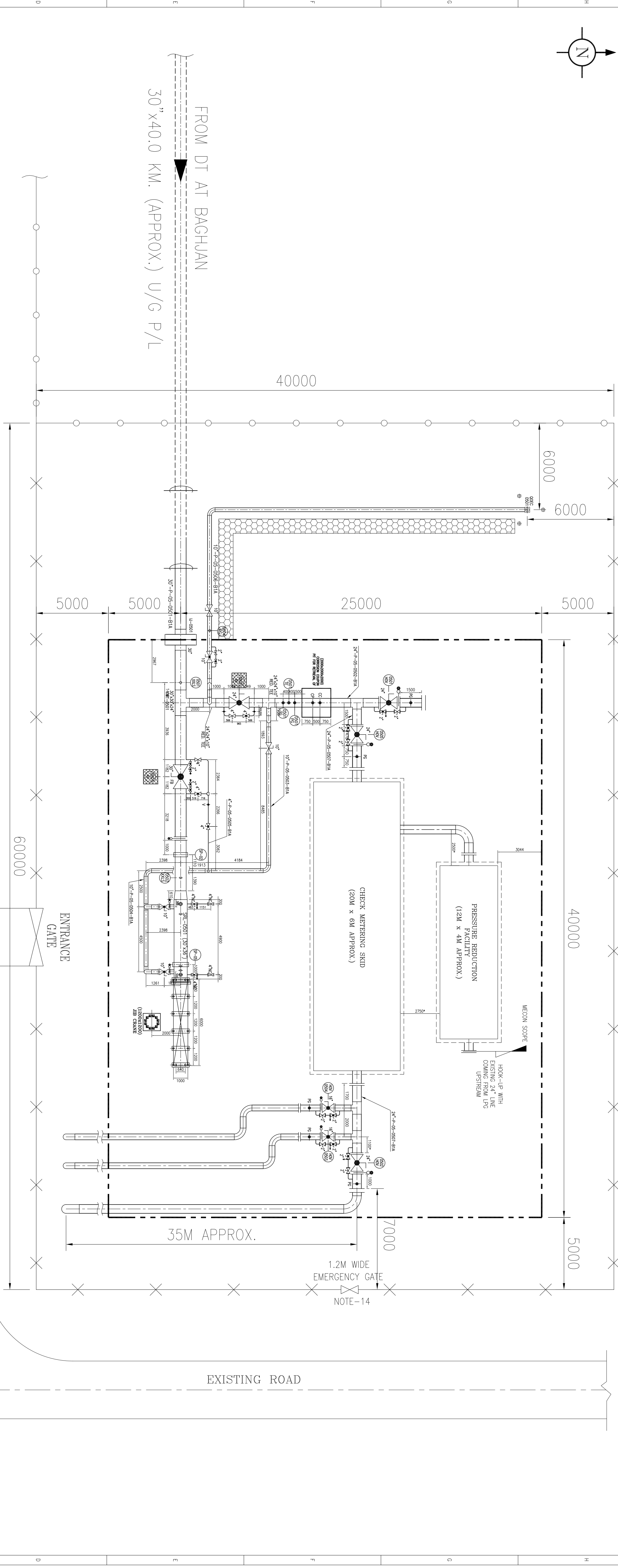
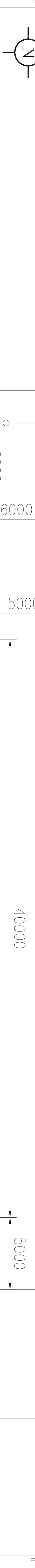
	PROPOSED A/G PIPELINE
	PROPOSED U/G PIPELINE
	EXISTING BOUNDARY WALL
	PROPOSED BOUNDARY WALL
	PROPOSED FENCING
	PAVED AREA
	PAVEMENT BLOCK

FOR TENDER PURPOSE ONLY

मेकान सिमिट

NATURAL GAS PIPELINE FROM BAGHJAN TO MADHUBAN, DALIYAJ

SECTION	OIL & GAS	NATURAL GAS PIPELINE FROM BAGHDAN TO MADHUBAN, DALIYAJAN	PLOT PLAN FOR DESPATCH TERMINAL AT BAGHDAN (CH. 0.00 KM)	SCALE : N.T.S.	DRC. NO. MEC/2301/05/28/N/000/1011	APPROVED
LOCATION	IRH					REV
DESIGNED	SABRIDDH					0
DRAWN	AMN					
CHECKED (AND VERIFIED)	ABHSRKH					
SG	(A.K.AH)					
DATE	20.11.2018					



NOTES

A	1. ALL DIMENSIONS ARE IN MM. EXCEPT CO-ORDINATES AND UNLESS MENTIONED OTHERWISE. 2. LEVEL 100.00 CORRESPONDS TO THE TOP OF NEAREST EXISTING ROAD/H/L IN METER. 3. PLOT SIZE DIMENSIONS MENTIONED AND DIRECTION & LOCATION OF LAYOUT ARE TENTATIVE. ACTUAL TO CONFORM AT THE AVAILABLE SITE. 4. MINIMUM 4.0 M. WIDE APPROACH ROAD SHALL BE PROVIDED UPTO THE GATE FROM THE NEAREST EXISTING ROAD. 5. STORM WATER DRAINAGE TO BE DISPOSED TO ADJACENT LOW LYING AREA AS PER SITE CONDITIONS TO AVOID WATER LOGGING. 6. SIZE, LOCATION, LENGTH, LEVELS FOR PIPE / BOX CULVERT SHALL SUIT TO SITE. 7. OUTER EDGE OF FOOTING OF COMPOUND WALL SHALL BE KEPT WITHIN THE ACQUIRED LAND LIMIT. 8. THE HEIGHT OF COMPOUND WALL SHALL BE MEASURED FROM ADJACENT FGL/MGL. WHICHEVER IS HIGHER. 9. DETAIL OF ELECTRICAL CABLE TRENCH AND ROAD CROSSING SHALL BE DEVELOPED BY CONTRACTOR AS PER ACTUAL REQUIREMENT. 10. ALL EXISTING UNDERGROUND UTILITIES SUCH AS PIPELINES, H/T CABLES ETC. SHALL BE IDENTIFIED & LOCATED BY THE CONTRACTOR BEFORE START OF ANY EXCAVATION AND TRENCHING WORK. CONTRACTOR SHALL INTIMATE THE CONCERNED AUTHORITY HAVING JURISDICTION AND SHALL CARRY OUT SUCH WORKS TAKING ADEQUATE PRECAUTIONS & SAFETY MEASURES TO PREVENT ANY DAMAGE TO UTILITIES. 11. SUFFICIENT CLEARANCE ALL AROUND THE EXISTING UNDERGROUND GAS PIPELINES & OTHER UTILITIES SHALL BE ENSURED BEFORE CONSTRUCTION OF PROPOSED FACILITIES. ALSO NECESSARY ENGAGEMENT FOR U/G FACILITIES SHALL BE PROVIDED IN CONSULTATION WITH MECON/CONCERNED AUTHORITY. 12. DISTANCE OF BUILDING FROM THE ROAD SHALL BE CHECKED PRIOR TO STARTING THE CONSTRUCTION OF THE BUILDING AS PER BUILDING BY-LAWS. 13. ELECTRIC LINE (IF ANY) TO BE DISMANTLED OR SHIFTED OUTSIDE THE PLOT PREMISES. 14. LOCATION OF EMERGENCY GATE IS TENTATIVE AND ACTUAL LOCATION TO BE FINALISED AT SITE.		
	LEGEND: PROPOSED A/G PIPELINE PROPOSED U/G PIPELINE PROPOSED FENCING EXISTING BOUNDARY WALL PAVED AREA PAVOR BLOCK		
EXISTING ROAD	
HOOK-UP WITH EXISTING FACILITY 150M APPROX. 15M APPROX.	
FOR TENDER PURPOSE ONLY	
मेकॉन लिमिटेड Oil India Limited MECON LIMITED मेकॉन लिमिटेड MECON LIMITED	

[illegible]

9. DETAIL OF ELECTRICAL CABLE TRENCH AND ROAD CROSSING SHALL BE DEVELOPED BY CONTRACTOR AS PER ACTUAL REQUIREMENT

PROPOSED A/C PIPELINE

HOOK-UP WITH

10. ALL EXISTING UNDERGROUND UTILITIES SUCH AS PIPELINES, H/T CABLES ETC. SHALL BE IDENTIFIED

=====

PROPOSED U/G PIPELINE

=====

EXISTING UTILITY

=====

FOR LENDER PURPOSE ONLY

CONTRACTOR SHALL INTIMATE THE CONCERNED AUTHORITY HAVING JURISDICTION AND SHALL CAREY OUT
 PROPOSED FENCING

50

EXISTING BOUNDARY WALL

UTILITIES.

3. SUFFICIENT CLEARANCE ALL AROUND THE EXISTING UNDERGROUND AND SURFACE & OTHER UTILITIES.

Oil India Limited

PAVED AREA

SHALL BE ENSURED BEFORE CONSTRUCTION OF PROPOSED FACILITIES. ALSO NECESSARY ENGAGEMENT FOR II /c/ ENLIGHTENED SHALL BE PROVIDED IN CONSULTATION WITH WFOON/PROPOSED AUTHORITY

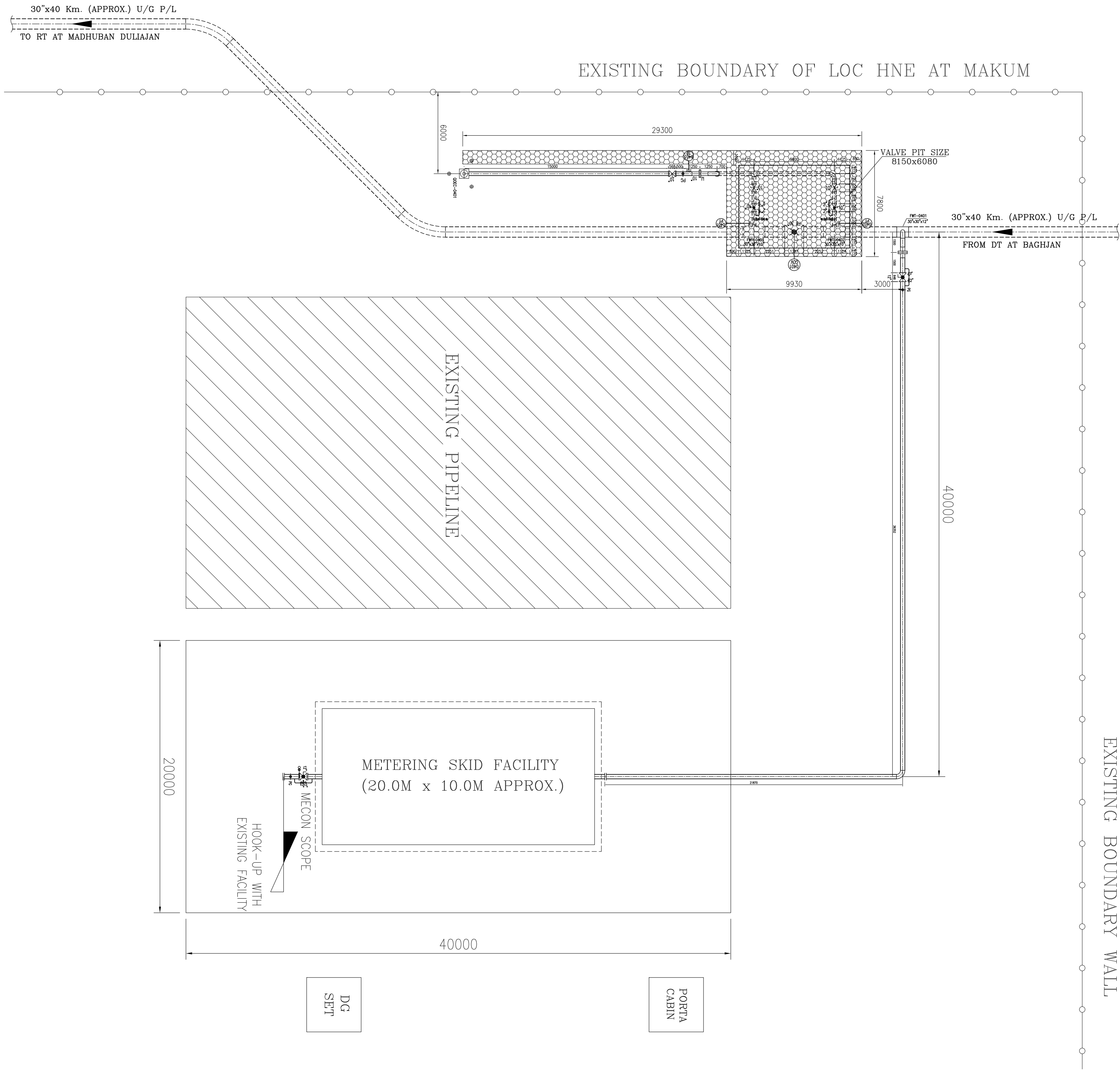
12. DISTANCE OF BUILDING FROM THE ROAD SHALL BE CHECKED PRIOR TO STARTING

PAVED PAVEMENT

4917 11/1/83

[illegible]

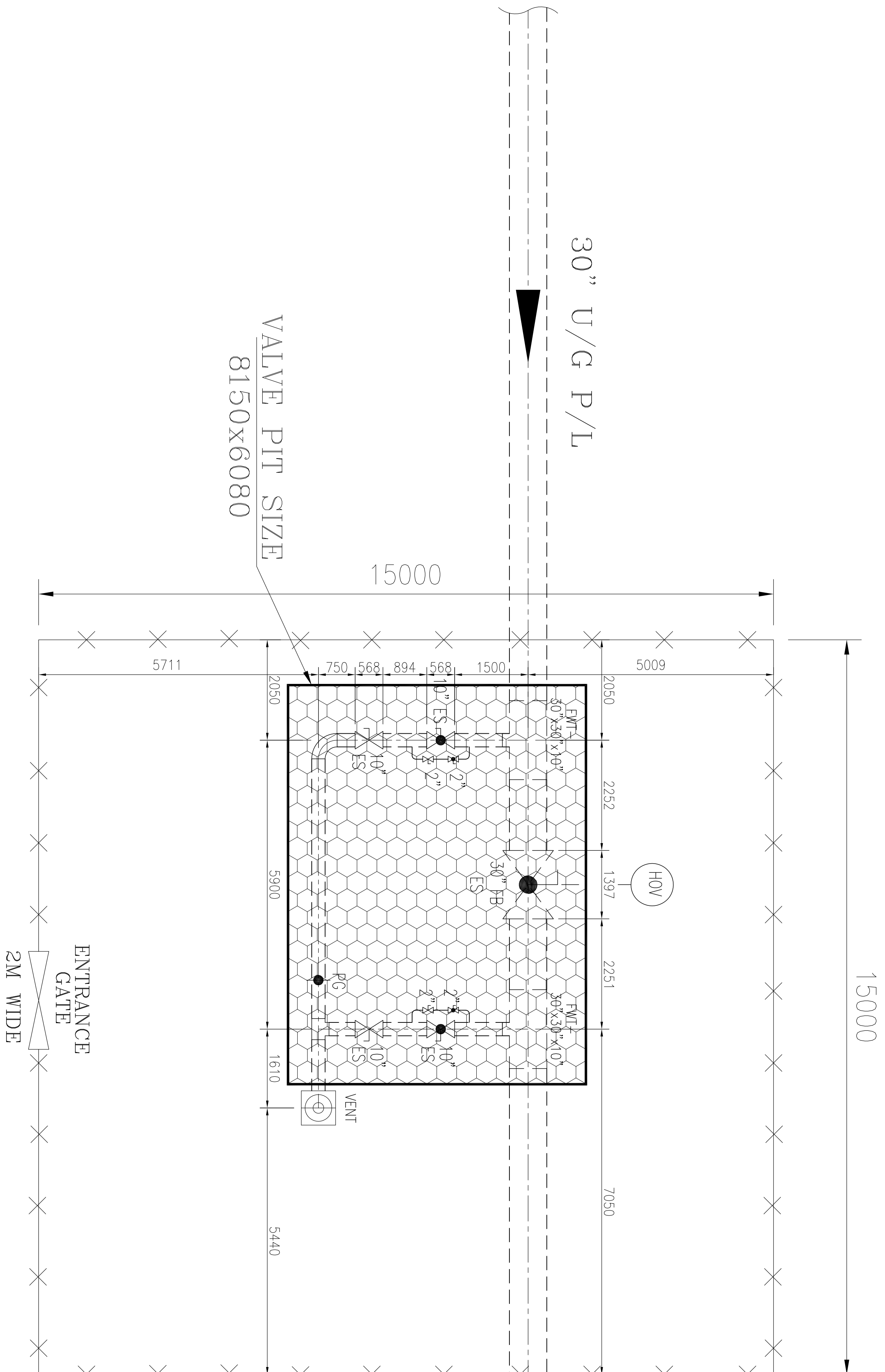
EXISTING BOUNDARY WALL



NOTES :-

1. ALL DIMENSIONS ARE IN MM. EXCEPT CO-ORDINATES AND UNLESS MENTIONED OTHERWISE.
2. LEVEL 100.00 CORRESPONDS TO THE TOP OF NEAREST EXISTING ROAD/HFL IN METER.
3. PLOT SIZE DIMENSIONS MENTIONED AND DIRECTION & LOCATION OF LAYOUT ARE TENTATIVE.
4. ACTUAL TO CONFORM AT THE AVAILABLE SITE.
5. 4.0 M. WIDE APPROACH ROAD SHALL BE PROVIDED UPTO THE GATE FROM THE NEAREST EXISTING ROAD.
6. STORM WATER DRAINAGE TO BE DISPOSED TO ADJACENT LOW LYING AREA AS PER SITE CONDITIONS TO AVOID WATER LOGGING.
7. SIZE, LOCATION, LENGTH, LEVELS FOR PIPE / BOX CULVERT SHALL SUIT TO SITE.
8. OUTER EDGE OF FOOTING OF COMPOUND WALL SHALL BE KEPT WITHIN THE ACQUIRED LAND LIMIT.
9. THE HEIGHT OF COMPOUND WALL SHALL BE MEASURED FROM ADJACENT FGL/NGL, WHICHEVER IS HIGHER.
10. ALL EXISTING UNDERGROUND UTILITIES SUCH AS PIPELINES, H/T CABLES ETC. SHALL BE IDENTIFIED & LOCATED BY THE CONTRACTOR BEFORE START OF ANY EXCAVATION AND TRENCHING WORK.
11. CONTRACTOR SHALL INTIMATE THE CONCERNED AUTHORITY HAVING JURISDICTION AND SHALL CARRY OUT SUCH WORKS TAKING ADEQUATE PRECAUTIONS & SAFETY MEASURES TO PREVENT ANY DAMAGE TO UTILITIES.
12. SUFFICIENT CLEARANCE ALL AROUND THE EXISTING UNDERGROUND GAS PIPELINES & OTHER UTILITIES SHALL BE ENSURED BEFORE CONSTRUCTION OF PROPOSED FACILITIES. ALSO NECESSARY ENCASEMENT FOR U/G FACILITIES SHALL BE PROVIDED IN CONSULTATION WITH MECON/CONCERNED AUTHORITY.
13. DISTANCE OF BUILDING FROM THE ROAD SHALL BE CHECKED PRIOR TO STARTING THE CONSTRUCTION OF THE BUILDING AS PER BUILDING BY-LAWS/LATEST CODE.
14. ELECTRIC LINE IF ANY TO BE DISMANTLED OR SHIFTED OUTSIDE THE PLOT PREMISES.
15. LOCATION OF EMERGENCY GATE IS TENTATIVE AND ACTUAL LOCATION TO BE FINALISED AT SITE.
16. INTER DISTANCE BETWEEN DT/RT/P & SVS SHALL BE AS PER CODE/PD DATA AND SAME SHALL BE VERIFIED AT SITE.
17. * MARKED DIMENSIONS SHALL SUIT TO ACTUAL SITE CONDITION.
18. FOR SEPTIC TANK, SOAK PIT & BOREWELL REFER PLOT DEVELOPMENT PLANT DRAWING.

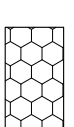
A	△																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													



LEGEND:

PROPOSED A/G PIPELINE

PROPOSED U/G PIPELINE



PAVOR BLOCK

FOR TENDER PURPOSE ONLY



भारत ईंधन निगम
Oil India Limited
INCORPORATED IN INDIA

OIL INDIA LIMITED

मेकॉन लिमिटेड

MECON LIMITED

[illegible]