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|  L&T, E&C DIVISION | Additional Gas Processing Facilities (Phase-IV) | Client:  ONGC OIL AND NATURAL GAS CORPORATION LIMITED | Sheet No.1050 |
| | | PMC:  ENGINEERS INDIA LIMITED <small>(भारत सरकार का उपक्रम) (A Govt. of India Undertaking)</small> | |
| Contractor : Larsen & Toubro Limited, E&C DIVISION, Mumbai | | Doc. No. : A067-LT-00-CV-04-RP-0004 Rev. : 01 | |
| TITLE : GEOTECHNICAL INVESTIGATION REPORT – INSIDE AREA | | | |


OWNER : OIL AND NATURAL GAS CORPORATION LIMITED,
HAZIRA, GUJARAT

PMC : Engineers India Limited (EIL)


UNIT : Additional Gas Processing Facilities (Phase-IV)


EIL JOB NO : A067

L&T JOB NO : 5014

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| PROJECT : Additional Gas : Processing Facilities (Phase-IV) | | REVISION : 01 |
| CUSTOMER : ONGC,HAZIRA | | PAGE : 2 OF 3 |
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| PROJECT : Additional Gas : Processing Facilities (Phase-IV) | | REVISION : 01 |
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1.0 PURPOSE

ONGC has decided to extend their existing plant (Phase IV) under Additional Gas Processing Facilities Project at ONGC-Hazira.

The scope covers the work required for Geotechnical Investigation: field investigations and tests, laboratory tests and analysis and interpretation of data and results and preparation of a detailed geotechnical report including recommendations.

2.0 SCOPE

This report covers the area inside the existing plant boundary wall and includes the following units:

- A. Dew Point Depression Unit
- B. Caustic Wash Unit
- C. Off-Site Piperacks

The geotechnical investigation has been performed as per the provisions of:

1. Document No. 6962-00-50-48-SOW-01, Geotechnical Input for Additional Gas Processing Facilities Project at ONGCL Hazira (Ph IV), and
2. Additional points agreed upon at the Engineering Kick-off Meeting at EIL ROV. MoM of the same is attached in Annexure II

3.0 INVESTIGATION REPORT

The geotechnical investigation was performed by KCT Consultancy Services of Ahmedabad. The report is attached in Annexure I.

The main recommendations are provided in Section 7.0 of the report.

Calculations and detailed test results are provided in Appendices 1 and 2 of the report.

Compressor foundation shall be designed using the soil parameters obtained from Borehole 5 and the Block Vibration Test performed close to it.

LARSEN & TOUBRO LIMITED

TECHNICAL REPORT

OF

GEOTECHNICAL INVESTIGATION

FOR

**PROPOSED STRUCTURES INSIDE PLANT AREA UNDER PROJECT
OF ADDITIONAL GAS PROCESSING FACILITIES (PHASE 4) FOR
ONGC AT HAZIRA, SURAT (INSIDE PLANT AREA)**

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August - 2010

GEOTECHNICAL INVESTIGATION REPORT FOR PROPOSED STRUCTURES OF ADDITIONAL GAS PROCESSING FACILITIES PROJECT (PHASE 4 – INSIDE OF PLANT) OF ONGC AT HAJIRA, SURAT

1.0 Introduction

For foundation analysis of the structures of Additional Gas Processing Facilities Project (Phase 4) of ONGC at Hajira, Surat, It is necessary,

1. To determine the subsoil profile of the site and to know physical properties and strength characteristics of soil at various depths.
2. To suggest suitable foundation and to know the safe bearing pressure and probable settlement of foundation.
3. To know any adverse soil conditions to the foundation structures and to take precautionary measures.

For this purpose, the geotechnical investigation was entrusted to us by Larsen and Toubro Limited. Following points were decided,

1. No. Bore holes – 4 nos. in side plant boundary
2. Standard penetration tests are conducted at regular interval.
3. Collection of Undisturbed soil samples at regular interval.
4. Collection of disturbed samples during drilling and from SPT.
5. To find physical properties and strength characteristics of samples as per the testing schedules.
6. To locate ground water table, if any.
7. To conduct block vibration test.
8. To conduct electrical resistivity test.
9. Interpretation of results, Analysis and Recommendations.

Based on the above points the detailed Geotechnical Investigation Program included the following:

(A) Field Investigation

1. Drilling of bore hole.
2. Collection of soil samples (Disturbed and Undisturbed)
3. Conducting Standard Penetration Test.
4. Conducting Block Vibration Test.
5. Conducting Electrical Resistivity Test

(B) Laboratory Investigation

1. Bulk Density and moisture content
2. Grain size analysis
3. Consistency limits
4. Shear tests
5. Consolidation tests
6. Chemical analysis of soil and water

(C) Recommendations

Based on above investigations, the results are to be obtained. The findings would be based on interpretation of results, analysis and computations as per relevant Indian standards.

2.0 Field Investigation

2.1 Boring

The exploratory boreholes of 150mm diameter were drilled by rotary drilling method. The depth of the test bore at the proposed location is as under:

| Bore Hole No. | Co-Ordinates | | Reduced Level (m) | Depth Investigated (m) |
|---------------|--------------|------|-------------------|------------------------|
| | N | E | | |
| BH – 4 | 365 | 1025 | 98.466 | 20 |
| BH – 5 | 780 | 1100 | 99.423 | 25 |
| BH – 6 | 799 | 1170 | 99.620 | 20 |
| BH – 9 | 1065 | 1750 | 99.232 | 20 |

2.2 Sampling

2.2.1 Disturbed samples

Disturbed samples were collected during boring and from the split spoon sampler. The samples recovered were logged, labeled and placed in polyethylene bags and sent to laboratory for testing.

2.2.2 Undisturbed samples

Undisturbed soil samples were collected in thin walled Shelby tubes as per IS 2132 at regular intervals. The samples collected were sealed properly using wax, labeled and transported to the laboratory.

2.2.3 Standard penetration test

The standard penetration tests were conducted in accordance with IS:2131-1981 in test bore at regular intervals. The test gives N – Value, the blow counts of last 30 cm penetration of split spoon sampler with 63.5 kg hammer falling from 76 cm height.

2.2.4 Block Vibration Test

For determining various parameters influencing the design of machine foundation like physical properties of elastic base of the foundation, block vibration test was conducted. For this purpose Oscillator was fixed on the PCC block cast of size 1.00 x 0.75 x 0.75 m at Co ordinates N 789 and E 1087, and vibration was induced. The vibration peak ups were attached, on this block to measure the frequency and amplitude. The test was conducted as per the provisions of IS 5249 – 1969. Various dynamic properties as listed below were calculated for 10sq.mt area.

C_u - Coefficient of elastic uniform compression (kg / cu.cm)

C_τ - Coefficient of elastic uniform shear (Kg / cu.cm)

C_ϕ - Coefficient of elastic non – uniform compression (Kg / cu.cm)

C_ψ – Coefficient of elastic non – uniform shear (Kg / cu.cm)

The above coefficients are reported for foundation contact area, A of 10.0 sq. m

2.2.5 Electrical Resistivity Test

Geophysical Survey In all geophysical surveys, Electrical Resistivity method is best and reliable to know geological formation of the the area. All geological formations possess properties called electrical resistivity when the current flows through them. Resistivity thus

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is defined as the resistance offered by a unit cube of material to direct current flowing through it in a direction perpendicular to two of its opposite faces. The numerical value of the resistivity is expressed in ohm. m in general. Thus the electrical resistivity is principally based on the study of resistance offered by the sub-surface formation to the flow of current. The study in turns helps in evaluation of the characteristic of the sub surface layers in terms of electrical resistivity. Vertical electrical soundings (VES) have been conducted by using resistivity meter of I G I S make direct current in deployed during survey as per IS : 3043. Two metal stakes called current electrodes into the sub surface transmit the current and the potential response is observed by means two copper electrodes called potential electrodes. Apparent resistivity is calculated from the equation:-

$$\rho = 2\pi SR$$

$K = 2\pi S$ = Geometric factor for electrode spacing (Wenner's configuration)

R = Resistance in Ohms

S = Spacing between adjacent electrodes in (m)

ρ = Resistivity in ohm.m.

Test was conducted at Co ordinates: N 762 E 1087

3.0 Laboratory investigation

The laboratory tests were conducted on the samples collected. The following laboratory tests were conducted on undisturbed and disturbed soil samples collected from various depths to find physical properties and strength characteristics.

| Tests | Recom nd procedure | Type Samples |
|-----------------------------|-------------------------------|--------------|
| 1. Sample Preparation | IS 2720 Pt I | DS / UDS |
| 2. Moisture Content | IS 2720 Pt II | DS / UDS |
| 3. Dry Unit Weight | LAMBE | UDS |
| 4. Specific Gravity | IS 2720 Pt III | DS |
| 5. Liquid Limit | IS 2720 | DS |
| 6. Plastic Limit | IS 2720 Pt V | DS |
| 7. Grain Size Analysis | IS 2720 Pt IV | DS |
| 8. Soil Classification | IS 1498 | DS / UDS |
| 9. Consolidation | IS 2720 Pt XV | UDS |
| 10. Triaxial Comp. Test | IS 2720 Pt X | UDS |
| 11. Laboratory permeability | IS 2720 Part XVII | UDS |

4.0 Results

1. The location plan of Bore hole is shown in fig no.1
2. The bore log details of Bore hole are shown in fig nos. 2 to 5
3. Results of permeability of Bore hole are given in table no 1
4. The Chemical analysis of soil and water is given in table nos.2 & 3
5. Laboratory test results of Bore hole are appended in table nos. 4 to 7
6. Results of BVT are shown in fig nos. 6 & 7
7. Results of ERT are given in fig no. 8

5.0 General stratification

The soil deposits at Hajira are alluvial in nature formed by River Tapti and its interaction with the sea over the geological history. The layers consist of plastic clays from stiff to very stiff consistency at top. The subsequent layer consists of plastic clays and silts from very
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soft to stiff consistency, followed by silty sands with density varying from loose to dense and very dense.

6.0 Discussion

Two foundation options are suggested:

1. Pile Foundations :

For heavy equipment and major structures, pile foundations are recommended. Due to proximity to process areas driven piles are not permitted and bored cast-in-situ piles are recommended. Piles of 500 mm diameter with depth of embedment of 16 m are suitable. Pile calculations are given in Appendix – 1. The lateral capacities are 4.5 t for a fixed headed pile and 2.0 t for a free headed pile. The lateral capacity is also to be confirmed by means of a lateral load test on a test pile. The tests have to be carried out as per IS 2911 / Part 4 – 1985.

2. Open foundations for lightly loaded structures and equipment :

The possibility of placing the light to intermediate loaded structures and equipment foundations, open shallow foundations can be explored. The minimum depth of foundation recommended is 2 m from FGL. The permissible settlement is 25mm. The recommended bearing capacity values borehole wise for permissible settlements for 25mm are as given in Section 7 (Conclusion) below and the calculations are appended in Appendix 2.

7.0 Conclusions

1) Two foundation options are recommended.

Option 1 : For process equipments and heavily loaded structures, Bored cast –in- situ piles, 500 mm diameter, length of embedment of 16 and cutoff level approximately at 2.50 m from NGL having capacities given below may be provided,

| | |
|----------------------|-------|
| Axial Compression | 65 T |
| Lateral – Fixed Head | 4.5 T |
| Lateral – Free Head | 2.0 T |
| Uplift | 24 T |

Option 2: For light to moderately loaded structures and equipment foundations, open foundations with minimum depth of 2m below FGL is recommended. A 30 cm thick, well compacted coarse sand layer below the bottom of foundation is recommended.

The net safe bearing pressures as tabulated below are recommended.

| Size of Foundation | | Recommended net Safe Bearing Pressure (T/m ²) |
|--------------------|-----------|--|
| Depth (m) | Width (m) | |
| 2.0 | 1.0 | 14 |
| 2.0 | 2.0 | 8 |

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| | | |
|-----|-------|----|
| 2.0 | 3.0 | 6 |
| 2.0 | Strip | 5 |
| 2.5 | 1.0 | 15 |
| 2.5 | 2.0 | 10 |
| 2.5 | 3.0 | 7 |
| 2.5 | Strip | 6 |

2) Ground water table is encountered at around 3.50 m from EGL, during investigation, which is likely to rise up to two mt from ground level in monsoon. Design groundwater level shall be at EL 99.500 to account for rain and tidal effects.

3) From results of chemical soil as reported in table 2 & 3, the sub soil is classified in class 2 based on sulphite Content (SO_3), as per the table no. 4 under clauses 8.2.2.4 and 9.1.2 of IS: 456, 2000. PPC or PSC with minimum cement content of 330kg/m^3 and maximum face water-cement ratio of 0.5 can be used for all RCC in foundation structures. OPC may be used provided the C_3A content is within 5 to 8% as per IS 456, Table 4, Note 6. Alternatively, OPC mixed with fly ash as per the provisions of IS 456 and IS 3812 may be used with validation of concrete characteristics through testing. Minimum cement content in piles shall be 400kg/m^3 as per the requirements of IS 2911. As the chloride content is high, clear cover to the reinforcement in foundation systems shall at least be 65 mm.

4) Suitable side slope in excavation and any measures if required and so far as is reasonably practicable shall be provided to prevent dislodgement of earth or any other material forming the side of excavation.

5) Considering the swelling characteristic adequate measures shall be taken to mitigate adverse consequences of swelling and shrinking due to moisture movement. A layer of compacted coarse sand having 300 mm thickness shall be provided under the pile caps and aprons around the structures and in plinths under floor finishes.

7) The comments given in this report and the opinion expressed are based on the ground conditions encountered during site work and on the results of tests made in field and in the laboratory. There may however, special conditions prevailing at the site which have not been disclosed by the investigation and which have not been taken in to account in the report. Any variation in stratification in any of the foundation location shall be studied thoroughly before executing the foundation work

(K.K.Thaker)

(Dr. K.C.Thaker)

APPENDIX – I
Calculation of Safe Load on Bored Cast in Situ Pile
(As per IS: 2911 (Part I / Sec II))

1) Design Stipulations

Pile Diameter: 0.50m

Existing GWT level: 0.00m

Pile Cut-Off level: 2.50m from existing ground level.

Pile Termination level: 18.50m from E.G.L

For maximum overburden pressure at Pile tip 15 x diameter of pile length of pile has been taken

2) Soil Parameters Considered

| Layer Thickness m | Cohesion Kg / cm ² | Angle of Internal Friction | Field Density gm / cc | SPT N Value |
|----------------------|----------------------------------|-------------------------------|--------------------------|-------------|
| 5.10 | 0.39 | 9 | 1.76 | 8 |
| 7.50 | 0.00 | 25 | 1.70 | 10 |
| 12.4 | 0.00 | 34 | 1.90 | 19 |

3) Ultimate End Bearing Capacity

$$Q_{ue} = A_p (0.5 * D * \gamma * N_\gamma + P_d * N_q)$$

Where,

A_p = Cross sectional Area = 0.196 m²

D = Pile Stem Diameter = 0.50 m

 γ = Bulk Unit Weight of soil at Pile tip = 0.90 T/m³N _{γ} = Bearing Capacity factor = 41.06P_d = Effective overburden pressure at pile tip = 5.56 T/m²N_q = Bearing Capacity factor = 42.80

$$\text{Ultimate End Bearing Capacity } Q_{ue} = 0.196 * (0.5 * 0.50 * 0.90 * 41.06 + 5.56 * 42.8) = 48.48 \text{ T}$$

P_d Level for this pile = 7.50 mLayer No.1 Effective overburden pressure due to this layer = 0.00 x 1.76 + 5.10 x (1.76 - 1) = 3.88 T/m²Layer No.2 Effective overburden pressure due to this layer = 2.40 x (1.70 - 1) = 1.68 T/m²

Layer No.3 No contribution from this layer

Total effective overburden pressure up to 7.50m level from EGL= 5.56T/m².**4) Ultimate Skin Friction Capacity**

$$Q_{sg} = \sum [K * P_{di} * \tan(\delta) * A_{si}] \text{ for all layers}$$

Where,

K = Earth Pressure Coefficient

P_{di} = Effective Overburden pressure for ith layer δ = Angle of wall friction for ith layerA_{si} = Surface area of pile stem for ith layer

$$Q_{sc} = \sum [\alpha * C * a_s] \text{ for all layers}$$

Where, α = Reduction factor

C = Average Cohesion

A_{si} = Surface area of pile stem for ith layer**Layer no. 1:**K: 1.00 P_{d1} : 1.94 T/m² tan(δ): 0.16 A_{s1} : 4.08 m²

$$Q_{sg} = K * P_{d1} * \tan(\delta) * A_{s1} = 1.00 * 1.94 * 0.16 * 4.08 = 1.25 \text{ T}$$

Reduction factor (α): 0.40 Average Cohesion(C): 3.90 T/m².

$$Q_{sc} = \alpha * C * A_{s1} = 0.40 * 3.90 * 4.08 = 6.37 \text{ T}$$

$$\text{Total net skin friction of this layer} = 7.62 \text{ T/m}^2$$

Layer no. 2:

K: 1.50 Pd2: 4.72 T/m². tan (δ) : 0.47 As2 : 11.78 m².
 Qsg = K*Pd2*tan (δ)*As2 =1.50*4.72*0.47*11.78 = 38.82 T
 Reduction factor (α): 0.40 Average Cohesion(C): 0.00 T/m².
 Qsc = α*C*As2 =0.40*0.00*11.78 = 0.00 T
Total net skin friction of this layer = 38.82 T/m².

Layer no. 3:

K: 2.00 Pd3 : 5.56 T/m². tan (δ) : 0.67 As3 : 9.26 m².
 Qsg = K*Pd3*tan (δ)*As3 =2.00*5.56*0.67*9.26 = 69.38 T
 Reduction factor (α): 0.30 Average Cohesion(C): 0.00 T/m².
 Qsc = α*C*As3 =0.30*0.00*9.26 = 0.00 T
Total net skin friction of this layer = 69.38T/m².

Total Skin Friction Capacity Qus = Qsg + Qsc = 115.82 T
 Total Ultimate Pile Capacity Qu = Qus + Que = 164.30 T
Net Ultimate Pile Capacity Qu/FOS = 65.7 T

5) Safe Load in Compression in Ton

| Pile Diameter in m | Pile Length after cutoff in m | | |
|--------------------|-------------------------------|------|------|
| | 14.0 | 16.0 | 18.0 |
| 0.45 | 45.1 | 52.8 | 60.5 |
| 0.50 | 56.3 | 65.7 | 75.1 |

Calculating safe load on pile in uplift for various diameters,

6) Safe Load in Uplift in Ton

| Pile Diameter in m | Pile Length after cutoff in m | | |
|--------------------|-------------------------------|------|------|
| | 14.0 | 16.0 | 18.0 |
| 0.45 | 30.9 | 38.6 | 46.2 |
| 0.50 | 36.9 | 46.4 | 55.7 |

7) Computation of Lateral Capacity

Lateral capacity is computed based up on the allowable top deflection of 5.0mm. Free Length L1 is 0.00 m and overall nature of soil is clayey.

For a Fixed Head Pile of 500 mm diameter, soil constant K2= 48.8 Kg/cm³ (From IS Code), E = 273861.27 Kg/cm², I = 306640.63 cm⁴, R = 203.67, L1/R = 0.00. Depth of Fixity Lf = 443.99 cm = 4.4 m
 Total Ultimate Horizontal Load Capacity H [As per IS Code] =12EIY/(L1+Lf)³ = 5.76 T

Ultimate Horizontal Load Capacity is recommended as 4.50 T

Moment Reduction Factor m = 0.825(From IS Code)

Total Ultimate Moment Capacity M [As per IS Code] =mH (L1+Lf)/2 = 8.24 ~ 8.2 Tm

Recommended Lateral Capacities For Fixed Head Piles

| Pile Diameter in m | 0.45 | 0.50 |
|-------------------------------|------|------|
| Horizontal Load Capacity in T | 4.0 | 4.5 |

For a Free Head Pile of 500 mm diameter, soil constant K2= 48.8 Kg/cm³ (From IS Code), E = 273861.27 Kg/cm², I = 306640.63 cm⁴, R = 203.67, L1/R = 0.00. Depth of Fixity Lf = 391.05 cm = 3.9 m

Total Ultimate Horizontal Load Capacity H [As per IS Code] = $3EIY/(L1+Lf)^3 = 2.1 \text{ T}$

Ultimate Horizontal Load Capacity is recommended as 2.0 T

Moment Reduction Factor $m = 0.4$ (From IS Code)

Total Ultimate Moment Capacity M [As per IS Code] = $mH (L1+Lf) = 3.13 \sim 3.0 \text{ Tm}$

Recommended Lateral Capacities For Free Head Piles

| Pile Diameter in m | 0.45 | 0.50 |
|-------------------------------|------|------|
| Horizontal Load Capacity in T | 1.9 | 2.0 |

8) Notes:

1) Initial and routine pile load tests shall be carried out on the piles at site to confirm the capacity of pile worked out theoretically.

(K.K.Thaker)

KCT Consultancy Services, Ahmedabad**APPENDIX - 2 a (Borehole No. 4)****Calculation of net Safe Bearing Capacity Based on Shear Parameters C - ϕ**

$$q_u = 1 / FS [2 / 3 C N_c d_c S_c i_c + \gamma d (N_q - 1) S_q d_q i_q W_q + 0.5 \gamma B N_\gamma S_\gamma d_\gamma i_\gamma W_\gamma]$$

Project : Proposed structures of plant of Additional gas processing facilities project (Phase 4) of ONGC at Hazira, Surat, L & T Ltd

For Isolated Square Footing

| Sr. No. | Size of Foundation | | Depth of Foundation m | Shear Parameter | | Bearing Capacity Factors | | | Shape Factors | | | Depth Factors | | | Inclination Factors | | | Unit Weight | | Water Table Correction | | Safe Bearing Capacity t / m ² |
|------------|--------------------|-------|--------------------------|--------------------|--------|--------------------------|--------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------------|----------------|----------------|-------------|-------|------------------------|----------------|---|
| | Length | Width | | C | ϕ | N _c | N _q - 1 | N _γ | S _c | S _q | S _γ | d _c | d _q | d _γ | i _c | i _q | i _γ | γ | 0.5 γ | W _q | W _γ | |
| | m | m | | Kg/cm ² | degree | | | | | | | | | | | | | | gm/cc | | | |
| 1 | 1.00 | 1.00 | 2.00 | 0.39 | 9 | 6.82 | 0.72 | 0.57 | 1.30 | 1.20 | 0.80 | 1.44 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 1.00 | 15 |
| 2 | 2.00 | 2.00 | 2.00 | 0.39 | 9 | 6.82 | 0.72 | 0.57 | 1.30 | 1.20 | 0.80 | 1.22 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.75 | 13 |
| 3 | 3.00 | 3.00 | 2.00 | 0.39 | 9 | 6.82 | 0.72 | 0.57 | 1.30 | 1.20 | 0.80 | 1.15 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.67 | 12 |
| 4 | 4.00 | 4.00 | 2.00 | 0.39 | 9 | 6.82 | 0.72 | 0.57 | 1.30 | 1.20 | 0.80 | 1.11 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.63 | 12 |
| 5 | 1.00 | 1.00 | 2.50 | 0.39 | 9 | 6.82 | 0.72 | 0.57 | 1.30 | 1.20 | 0.80 | 1.56 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.75 | 16 |
| 6 | 2.00 | 2.00 | 2.50 | 0.39 | 9 | 6.82 | 0.72 | 0.57 | 1.30 | 1.20 | 0.80 | 1.28 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.63 | 14 |
| 7 | 3.00 | 3.00 | 2.50 | 0.39 | 9 | 6.82 | 0.72 | 0.57 | 1.30 | 1.20 | 0.80 | 1.19 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.58 | 13 |
| 8 | 4.00 | 4.00 | 2.50 | 0.39 | 9 | 6.82 | 0.72 | 0.57 | 1.30 | 1.20 | 0.80 | 1.14 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.56 | 12 |
| 9 | 1.00 | 1.00 | 3.00 | 0.39 | 9 | 6.82 | 0.72 | 0.57 | 1.30 | 1.20 | 0.80 | 1.67 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.50 | 17 |
| 10 | 2.00 | 2.00 | 3.00 | 0.39 | 9 | 6.82 | 0.72 | 0.57 | 1.30 | 1.20 | 0.80 | 1.33 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.50 | 14 |
| 11 | 3.00 | 3.00 | 3.00 | 0.39 | 9 | 6.82 | 0.72 | 0.57 | 1.30 | 1.20 | 0.80 | 1.22 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.50 | 13 |
| 12 | 4.00 | 4.00 | 3.00 | 0.39 | 9 | 6.82 | 0.72 | 0.57 | 1.30 | 1.20 | 0.80 | 1.17 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.50 | 13 |

Note :-

1) Factor of safety is 2.5

2) Depth of foundation shall be from E G L

KCT Consultancy Services, Ahmedabad**APPENDIX - 2 b (Borehole No. 5)****Calculation of net Safe Bearing Capacity Based on Shear Parameters C - ϕ**

$$q_u = 1 / FS [2 / 3 C N_c d_c S_c i_c + \gamma d (N_q - 1) S_q d_q i_q W_q + 0.5 \gamma B N_\gamma S_\gamma d_\gamma i_\gamma W_\gamma]$$

Project : Proposed structures of plant of Additional gas processing facilities project (Phase 4) of ONGC at Hazira, Surat, L & T Ltd

For Isolated Square Footing

| Sr. No. | Size of Foundation | | Depth of Foundation m | Shear Parameter | | Bearing Capacity Factors | | | Shape Factors | | | Depth Factors | | | Inclination Factors | | | Unit Weight | | Water Table Correction | | Safe Bearing Capacity t / m ² |
|------------|--------------------|-------|--------------------------|--------------------|--------|--------------------------|--------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------------|----------------|----------------|-------------|-------|------------------------|----------------|---|
| | Length | Width | | C | ϕ | N _c | N _q - 1 | N _γ | S _c | S _q | S _γ | d _c | d _q | d _γ | i _c | i _q | i _γ | γ | 0.5 γ | W _q | W _γ | |
| | m | m | | Kg/cm ² | degree | | | | | | | | | | | | | | gm/cc | | | |
| 1 | 1.00 | 1.00 | 2.00 | 0.46 | 12 | 7.55 | 1.07 | 0.87 | 1.30 | 1.20 | 0.80 | 1.46 | 1.23 | 1.23 | 1.00 | 1.00 | 1.00 | 1.71 | 0.86 | 1.00 | 1.00 | 20 |
| 2 | 2.00 | 2.00 | 2.00 | 0.46 | 12 | 7.55 | 1.07 | 0.87 | 1.30 | 1.20 | 0.80 | 1.23 | 1.12 | 1.12 | 1.00 | 1.00 | 1.00 | 1.71 | 0.86 | 1.00 | 0.75 | 17 |
| 3 | 3.00 | 3.00 | 2.00 | 0.46 | 12 | 7.55 | 1.07 | 0.87 | 1.30 | 1.20 | 0.80 | 1.15 | 1.08 | 1.08 | 1.00 | 1.00 | 1.00 | 1.71 | 0.86 | 1.00 | 0.67 | 16 |
| 4 | 4.00 | 4.00 | 2.00 | 0.46 | 12 | 7.55 | 1.07 | 0.87 | 1.30 | 1.20 | 0.80 | 1.12 | 1.06 | 1.06 | 1.00 | 1.00 | 1.00 | 1.71 | 0.86 | 1.00 | 0.63 | 16 |
| 5 | 1.00 | 1.00 | 2.50 | 0.46 | 12 | 7.55 | 1.07 | 0.87 | 1.30 | 1.20 | 0.80 | 1.58 | 1.29 | 1.29 | 1.00 | 1.00 | 1.00 | 1.71 | 0.86 | 1.00 | 0.75 | 22 |
| 6 | 2.00 | 2.00 | 2.50 | 0.46 | 12 | 7.55 | 1.07 | 0.87 | 1.30 | 1.20 | 0.80 | 1.29 | 1.14 | 1.14 | 1.00 | 1.00 | 1.00 | 1.71 | 0.86 | 1.00 | 0.63 | 18 |
| 7 | 3.00 | 3.00 | 2.50 | 0.46 | 12 | 7.55 | 1.07 | 0.87 | 1.30 | 1.20 | 0.80 | 1.19 | 1.10 | 1.10 | 1.00 | 1.00 | 1.00 | 1.71 | 0.86 | 1.00 | 0.58 | 17 |
| 8 | 4.00 | 4.00 | 2.50 | 0.46 | 12 | 7.55 | 1.07 | 0.87 | 1.30 | 1.20 | 0.80 | 1.14 | 1.07 | 1.07 | 1.00 | 1.00 | 1.00 | 1.71 | 0.86 | 1.00 | 0.56 | 17 |
| 9 | 1.00 | 1.00 | 3.00 | 0.46 | 12 | 7.55 | 1.07 | 0.87 | 1.30 | 1.20 | 0.80 | 1.69 | 1.35 | 1.35 | 1.00 | 1.00 | 1.00 | 1.71 | 0.86 | 1.00 | 0.50 | 24 |
| 10 | 2.00 | 2.00 | 3.00 | 0.46 | 12 | 7.55 | 1.07 | 0.87 | 1.30 | 1.20 | 0.80 | 1.35 | 1.17 | 1.17 | 1.00 | 1.00 | 1.00 | 1.71 | 0.86 | 1.00 | 0.50 | 20 |
| 11 | 3.00 | 3.00 | 3.00 | 0.46 | 12 | 7.55 | 1.07 | 0.87 | 1.30 | 1.20 | 0.80 | 1.23 | 1.12 | 1.12 | 1.00 | 1.00 | 1.00 | 1.71 | 0.86 | 1.00 | 0.50 | 18 |
| 12 | 4.00 | 4.00 | 3.00 | 0.46 | 12 | 7.55 | 1.07 | 0.87 | 1.30 | 1.20 | 0.80 | 1.17 | 1.09 | 1.09 | 1.00 | 1.00 | 1.00 | 1.71 | 0.86 | 1.00 | 0.50 | 18 |

Note :-

1) Factor of safety is 2.5

2) Depth of foundation shall be from E G L

KCT Consultancy Services, Ahmedabad**APPENDIX - 2 C (Borehole No. 6)****Calculation of net Safe Bearing Capacity Based on Shear Parameters C - ϕ**

$$q_u = 1 / FS [2 / 3 C N_c d_c S_c i_c + \gamma d (N_q - 1) S_q d_q i_q W_q + 0.5 \gamma B N_\gamma S_\gamma d_\gamma i_\gamma W_\gamma]$$

Project : Proposed structures of plant of Additional gas processing facilities project (Phase 4) of ONGC at Hazira, Surat, L & T Ltd

For Isolated Square Footing

| Sr. No. | Size of Foundation | | Depth of Foundation m | Shear Parameter | | Bearing Capacity Factors | | | Shape Factors | | | Depth Factors | | | Inclination Factors | | | Unit Weight | | Water Table Correction | | Safe Bearing Capacity t / m ² |
|------------|--------------------|-------|--------------------------|--------------------|--------|--------------------------|--------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------------|----------------|----------------|-------------|-------|------------------------|----------------|---|
| | Length | Width | | C | ϕ | N _c | N _q - 1 | N _γ | S _c | S _q | S _γ | d _c | d _q | d _γ | i _c | i _q | i _γ | γ | 0.5 γ | W _q | W _γ | |
| | m | m | | Kg/cm ² | degree | | | | | | | | | | | | | | gm/cc | | | |
| 1 | 1.00 | 1.00 | 2.00 | 0.24 | 2 | 5.46 | 0.13 | 0.10 | 1.30 | 1.20 | 0.80 | 1.41 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.70 | 0.85 | 1.00 | 1.00 | 7 |
| 2 | 2.00 | 2.00 | 2.00 | 0.24 | 2 | 5.46 | 0.13 | 0.10 | 1.30 | 1.20 | 0.80 | 1.20 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.70 | 0.85 | 1.00 | 0.75 | 6 |
| 3 | 3.00 | 3.00 | 2.00 | 0.24 | 2 | 5.46 | 0.13 | 0.10 | 1.30 | 1.20 | 0.80 | 1.14 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.70 | 0.85 | 1.00 | 0.67 | 5 |
| 4 | 4.00 | 4.00 | 2.00 | 0.24 | 2 | 5.46 | 0.13 | 0.10 | 1.30 | 1.20 | 0.80 | 1.10 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.70 | 0.85 | 1.00 | 0.63 | 5 |
| 5 | 1.00 | 1.00 | 2.50 | 0.24 | 2 | 5.46 | 0.13 | 0.10 | 1.30 | 1.20 | 0.80 | 1.51 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.70 | 0.85 | 1.00 | 0.75 | 7 |
| 6 | 2.00 | 2.00 | 2.50 | 0.24 | 2 | 5.46 | 0.13 | 0.10 | 1.30 | 1.20 | 0.80 | 1.26 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.70 | 0.85 | 1.00 | 0.63 | 6 |
| 7 | 3.00 | 3.00 | 2.50 | 0.24 | 2 | 5.46 | 0.13 | 0.10 | 1.30 | 1.20 | 0.80 | 1.17 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.70 | 0.85 | 1.00 | 0.58 | 6 |
| 8 | 4.00 | 4.00 | 2.50 | 0.24 | 2 | 5.46 | 0.13 | 0.10 | 1.30 | 1.20 | 0.80 | 1.13 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.70 | 0.85 | 1.00 | 0.56 | 5 |
| 9 | 1.00 | 1.00 | 3.00 | 0.24 | 2 | 5.46 | 0.13 | 0.10 | 1.30 | 1.20 | 0.80 | 1.61 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.70 | 0.85 | 1.00 | 0.50 | 8 |
| 10 | 2.00 | 2.00 | 3.00 | 0.24 | 2 | 5.46 | 0.13 | 0.10 | 1.30 | 1.20 | 0.80 | 1.31 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.70 | 0.85 | 1.00 | 0.50 | 6 |
| 11 | 3.00 | 3.00 | 3.00 | 0.24 | 2 | 5.46 | 0.13 | 0.10 | 1.30 | 1.20 | 0.80 | 1.20 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.70 | 0.85 | 1.00 | 0.50 | 6 |
| 12 | 4.00 | 4.00 | 3.00 | 0.24 | 2 | 5.46 | 0.13 | 0.10 | 1.30 | 1.20 | 0.80 | 1.15 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.70 | 0.85 | 1.00 | 0.50 | 6 |

Note :-

1) Factor of safety is 2.5

2) Depth of foundation shall be from E G L

KCT Consultancy Services, Ahmedabad**APPENDIX - 2 d (Borehole No. 9)****Calculation of net Safe Bearing Capacity Based on Shear Parameters C - ϕ**

$$q_u = 1 / FS [2 / 3 C N_c d_c S_c i_c + \gamma d (N_q - 1) S_q d_q i_q W_q + 0.5 \gamma B N_\gamma S_\gamma d_\gamma i_\gamma W_\gamma]$$

Project : Proposed structures of plant of Additional gas processing facilities project (Phase 4) of ONGC at Hazira, Surat, L & T Ltd

For Isolated Square Footing

| Sr. No. | Size of Foundation | | Depth of Foundation m | Shear Parameter | | Bearing Capacity Factors | | | Shape Factors | | | Depth Factors | | | Inclination Factors | | | Unit Weight | | Water Table Correction | | Safe Bearing Capacity t / m ² |
|------------|--------------------|-------|--------------------------|--------------------|--------|--------------------------|--------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------------|----------------|----------------|-------------|-------|------------------------|----------------|---|
| | Length | Width | | C | ϕ | N _c | N _q - 1 | N _γ | S _c | S _q | S _γ | d _c | d _q | d _γ | i _c | i _q | i _γ | γ | 0.5 γ | W _q | W _γ | |
| | m | m | | Kg/cm ² | degree | | | | | | | | | | | | | gm/cc | | | | |
| 1 | 1.00 | 1.00 | 2.00 | 0.38 | 13 | 7.82 | 1.20 | 0.99 | 1.30 | 1.20 | 0.80 | 1.47 | 1.23 | 1.23 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 1.00 | 18 |
| 2 | 2.00 | 2.00 | 2.00 | 0.38 | 13 | 7.82 | 1.20 | 0.99 | 1.30 | 1.20 | 0.80 | 1.23 | 1.12 | 1.12 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.75 | 15 |
| 3 | 3.00 | 3.00 | 2.00 | 0.38 | 13 | 7.82 | 1.20 | 0.99 | 1.30 | 1.20 | 0.80 | 1.16 | 1.08 | 1.08 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.67 | 15 |
| 4 | 4.00 | 4.00 | 2.00 | 0.38 | 13 | 7.82 | 1.20 | 0.99 | 1.30 | 1.20 | 0.80 | 1.12 | 1.06 | 1.06 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.63 | 14 |
| 5 | 1.00 | 1.00 | 2.50 | 0.38 | 13 | 7.82 | 1.20 | 0.99 | 1.30 | 1.20 | 0.80 | 1.58 | 1.29 | 1.29 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.75 | 20 |
| 6 | 2.00 | 2.00 | 2.50 | 0.38 | 13 | 7.82 | 1.20 | 0.99 | 1.30 | 1.20 | 0.80 | 1.29 | 1.15 | 1.15 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.63 | 17 |
| 7 | 3.00 | 3.00 | 2.50 | 0.38 | 13 | 7.82 | 1.20 | 0.99 | 1.30 | 1.20 | 0.80 | 1.19 | 1.10 | 1.10 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.58 | 16 |
| 8 | 4.00 | 4.00 | 2.50 | 0.38 | 13 | 7.82 | 1.20 | 0.99 | 1.30 | 1.20 | 0.80 | 1.15 | 1.07 | 1.07 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.56 | 15 |
| 9 | 1.00 | 1.00 | 3.00 | 0.38 | 13 | 7.82 | 1.20 | 0.99 | 1.30 | 1.20 | 0.80 | 1.70 | 1.35 | 1.35 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.50 | 22 |
| 10 | 2.00 | 2.00 | 3.00 | 0.38 | 13 | 7.82 | 1.20 | 0.99 | 1.30 | 1.20 | 0.80 | 1.35 | 1.17 | 1.17 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.50 | 18 |
| 11 | 3.00 | 3.00 | 3.00 | 0.38 | 13 | 7.82 | 1.20 | 0.99 | 1.30 | 1.20 | 0.80 | 1.23 | 1.12 | 1.12 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.50 | 17 |
| 12 | 4.00 | 4.00 | 3.00 | 0.38 | 13 | 7.82 | 1.20 | 0.99 | 1.30 | 1.20 | 0.80 | 1.17 | 1.09 | 1.09 | 1.00 | 1.00 | 1.00 | 1.76 | 0.88 | 1.00 | 0.50 | 16 |

Note :-

1) Factor of safety is 2.5

2) Depth of foundation shall be from E G L

KCT Consultancy Services, Ahmedabad

Calculation of Settlement (BH 4)

$$\text{Settlement } S_c = \left\{ \left(C_c H \right) / \left(1 + e_0 \right) \right\} \log_{10} \left\{ \left(P_0 + \Delta P \right) / P_0 \right\}$$

Project:- Proposed structures of plant of Additional gas processing facilities project (Phase 4) of ONGC at Hazira, Surat, L & T Ltd

| Sr. No. | Comp Index Cc | Depth of Footing D | Width of Footing B | H | Voids Ratio e ₀ | Field Density γ | d | p ₀ | SBC | Δp | (Δp+p ₀)/p ₀ | λ factor related to pore pressure parameter | Correction for depth | Consolidation Settlement S _c |
|---------|---------------|--------------------|--------------------|------|----------------------------|-----------------|------|--------------------|--------------------|--------------------|-------------------------------------|---|----------------------|---|
| | | m | m | m | | gm / cc | m | T / m ² | T / m ² | T / m ² | | | | mm |
| 1 | 0.15 | 2.00 | 1.00 | 2.00 | 0.82 | 1.76 | 3.00 | 5.28 | 15 | 3.68 | 1.70 | 0.7 | 0.66 | 17.5 |
| 2 | 0.15 | 2.00 | 2.00 | 3.15 | 0.82 | 1.76 | 3.58 | 6.29 | 13 | 3.98 | 1.63 | 0.7 | 0.73 | 28.2 |
| 3 | 0.15 | 2.00 | 3.00 | 3.15 | 0.82 | 1.76 | 3.58 | 6.29 | 12 | 5.22 | 1.83 | 0.7 | 0.80 | 38.0 |
| 4 | 0.15 | 2.00 | 4.00 | 3.15 | 0.82 | 1.76 | 3.58 | 6.29 | 12 | 6.11 | 1.97 | 0.7 | 0.85 | 45.5 |
| 5 | 0.15 | 2.50 | 1.00 | 2.00 | 0.82 | 1.76 | 3.50 | 6.16 | 16 | 4.00 | 1.65 | 0.7 | 0.65 | 16.2 |
| 6 | 0.15 | 2.50 | 2.00 | 2.65 | 0.82 | 1.76 | 3.83 | 6.73 | 14 | 4.89 | 1.73 | 0.7 | 0.73 | 26.4 |
| 7 | 0.15 | 2.50 | 3.00 | 2.65 | 0.82 | 1.76 | 3.83 | 6.73 | 13 | 6.13 | 1.91 | 0.7 | 0.75 | 32.4 |
| 8 | 0.15 | 2.50 | 4.00 | 2.15 | 0.82 | 1.76 | 3.58 | 6.29 | 12 | 7.70 | 2.22 | 0.7 | 0.81 | 34.8 |
| 9 | 0.15 | 3.00 | 1.00 | 2.00 | 0.82 | 1.76 | 4.00 | 7.04 | 17 | 4.32 | 1.61 | 0.7 | 0.63 | 15.2 |
| 10 | 0.15 | 3.00 | 2.00 | 2.15 | 0.82 | 1.76 | 4.08 | 7.17 | 14 | 6.04 | 1.84 | 0.7 | 0.73 | 24.0 |
| 11 | 0.15 | 3.00 | 3.00 | 2.15 | 0.82 | 1.76 | 4.08 | 7.17 | 13 | 7.23 | 2.01 | 0.7 | 0.73 | 27.4 |
| 12 | 0.15 | 3.00 | 4.00 | 2.15 | 0.82 | 1.76 | 4.08 | 7.17 | 13 | 8.02 | 2.12 | 0.7 | 0.77 | 31.3 |

KCT Consultancy Services, Ahmedabad

Calculation of Settlement (BH 5)

$$\text{Settlement } S_c = \left\{ \left(C_c H \right) / \left(1 + e_0 \right) \right\} \log_{10} \left\{ \left(P_0 + \Delta P \right) / P_0 \right\}$$

Project:- Proposed structures of plant of Additional gas processing facilities project (Phase 4) of ONGC at Hazira, Surat, L & T Ltd

| Sr. No. | Comp Index Cc | Depth of Footing D | Width of Footing B | H | Voids Ratio e ₀ | Field Density γ | d | p ₀ | SBC | Δp | (Δp+p ₀)/p ₀ | λ factor related to pore pressure parameter | Correction for depth | Consolidation Settlement S _c |
|---------|---------------|--------------------|--------------------|------|----------------------------|-----------------|------|--------------------|--------------------|--------------------|-------------------------------------|---|----------------------|---|
| | | m | m | m | | gm / cc | m | T / m ² | T / m ² | T / m ² | | | | mm |
| 1 | 0.18 | 2.00 | 1.00 | 2.00 | 0.91 | 1.71 | 3.00 | 5.13 | 20 | 5.01 | 1.98 | 0.7 | 0.66 | 25.8 |
| 2 | 0.18 | 2.00 | 2.00 | 3.15 | 0.91 | 1.71 | 3.58 | 6.11 | 17 | 5.38 | 1.88 | 0.7 | 0.73 | 41.5 |
| 3 | 0.18 | 2.00 | 3.00 | 3.15 | 0.91 | 1.71 | 3.58 | 6.11 | 16 | 7.01 | 2.15 | 0.7 | 0.80 | 54.9 |
| 4 | 0.18 | 2.00 | 4.00 | 3.15 | 0.91 | 1.71 | 3.58 | 6.11 | 16 | 8.19 | 2.34 | 0.7 | 0.85 | 65.2 |
| 5 | 0.18 | 2.50 | 1.00 | 2.00 | 0.91 | 1.71 | 3.50 | 5.99 | 22 | 5.51 | 1.92 | 0.7 | 0.65 | 24.2 |
| 6 | 0.18 | 2.50 | 2.00 | 2.65 | 0.91 | 1.71 | 3.83 | 6.54 | 18 | 6.64 | 2.02 | 0.7 | 0.73 | 38.8 |
| 7 | 0.18 | 2.50 | 3.00 | 2.65 | 0.91 | 1.71 | 3.83 | 6.54 | 17 | 8.28 | 2.27 | 0.7 | 0.75 | 46.9 |
| 8 | 0.18 | 2.50 | 4.00 | 2.15 | 0.91 | 1.71 | 3.58 | 6.11 | 17 | 10.38 | 2.70 | 0.7 | 0.81 | 49.5 |
| 9 | 0.18 | 3.00 | 1.00 | 2.00 | 0.91 | 1.71 | 4.00 | 6.84 | 24 | 6.02 | 1.88 | 0.7 | 0.63 | 23.0 |
| 10 | 0.18 | 3.00 | 2.00 | 2.15 | 0.91 | 1.71 | 4.08 | 6.97 | 20 | 8.28 | 2.19 | 0.7 | 0.73 | 35.2 |
| 11 | 0.18 | 3.00 | 3.00 | 2.15 | 0.91 | 1.71 | 4.08 | 6.97 | 18 | 9.84 | 2.41 | 0.7 | 0.73 | 39.6 |
| 12 | 0.18 | 3.00 | 4.00 | 2.15 | 0.91 | 1.71 | 4.08 | 6.97 | 18 | 10.87 | 2.56 | 0.7 | 0.77 | 44.8 |

KCT Consultancy Services, Ahmedabad

Calculation of Settlement (BH 6)

$$\text{Settlement } S_c = \left\{ \frac{C_c H}{1 + e_0} \right\} \log_{10} \left\{ \frac{P_0 + \Delta P}{P_0} \right\}$$

Project:- Proposed structures of plant of Additional gas processing facilities project (Phase 4) of ONGC at Hazira, Surat, L & T Ltd

| Sr. No. | Comp Index Cc | Depth of Footing D m | Width of Footing B m | H m | Voids Ratio e ₀ | Field Density γ gm / cc | d m | p ₀ T / m ² | SBC T / m ² | Δp T / m ² | (Δp+p ₀)/p ₀ | λ factor related to pore pressure parameter | Correction for depth | Consolidation Settlement S _c mm |
|---------|---------------|-------------------------|-------------------------|--------|----------------------------|----------------------------|--------|--------------------------------------|---------------------------|--------------------------|-------------------------------------|---|----------------------|---|
| 1 | 0.29 | 2.00 | 1.00 | 2.00 | 0.92 | 1.7 | 3.00 | 5.10 | 7 | 1.66 | 1.33 | 0.7 | 0.66 | 17.1 |
| 2 | 0.29 | 2.00 | 2.00 | 2.00 | 0.92 | 1.7 | 3.00 | 5.10 | 6 | 2.54 | 1.50 | 0.7 | 0.73 | 27.1 |
| 3 | 0.29 | 2.00 | 3.00 | 2.00 | 0.92 | 1.7 | 3.00 | 5.10 | 5 | 3.05 | 1.60 | 0.7 | 0.80 | 34.2 |
| 4 | 0.29 | 2.00 | 4.00 | 2.00 | 0.92 | 1.7 | 3.00 | 5.10 | 5 | 3.38 | 1.66 | 0.7 | 0.85 | 39.6 |
| 5 | 0.29 | 2.50 | 1.00 | 1.50 | 0.92 | 1.7 | 3.25 | 5.53 | 7 | 2.33 | 1.42 | 0.7 | 0.65 | 15.7 |
| 6 | 0.29 | 2.50 | 2.00 | 1.50 | 0.92 | 1.7 | 3.25 | 5.53 | 6 | 3.17 | 1.57 | 0.7 | 0.73 | 22.8 |
| 7 | 0.29 | 2.50 | 3.00 | 1.50 | 0.92 | 1.7 | 3.25 | 5.53 | 6 | 3.60 | 1.65 | 0.7 | 0.75 | 26.0 |
| 8 | 0.29 | 2.50 | 4.00 | 1.50 | 0.92 | 1.7 | 3.25 | 5.53 | 5 | 3.86 | 1.70 | 0.7 | 0.81 | 29.5 |
| 9 | 0.29 | 3.00 | 1.00 | 1.00 | 0.92 | 1.7 | 3.50 | 5.95 | 8 | 3.40 | 1.57 | 0.7 | 0.63 | 13.2 |
| 10 | 0.29 | 3.00 | 2.00 | 1.00 | 0.92 | 1.7 | 3.50 | 5.95 | 6 | 4.02 | 1.68 | 0.7 | 0.73 | 17.3 |
| 11 | 0.29 | 3.00 | 3.00 | 1.00 | 0.92 | 1.7 | 3.50 | 5.95 | 6 | 4.28 | 1.72 | 0.7 | 0.73 | 18.1 |
| 12 | 0.29 | 3.00 | 4.00 | 1.00 | 0.92 | 1.7 | 3.50 | 5.95 | 6 | 4.43 | 1.74 | 0.7 | 0.77 | 19.7 |

KCT Consultancy Services, Ahmedabad

Calculation of Settlement (BH 9)

$$\text{Settlement } S_C = mv H \Delta P$$

Project:- Proposed structures of plant of Additional gas processing facilities project (Phase 4) of ONGC at Hazira, Surat, L & T Ltd

| Sr. No. | Depth of Footing D | Width of Footing B | mv | H | Δp | SBC | λ factor related to pore pressure parameter | Correction for depth | Consolidation Settlement S_c |
|---------|--------------------|--------------------|------|------|--------------------|--------------------|---|----------------------|--------------------------------|
| | m | m | | m | T / m ² | T / m ² | | | mm |
| 1 | 2.00 | 1.00 | 0.12 | 1.50 | 5.88 | 18 | 0.3 | 0.73 | 23.2 |
| 2 | 2.00 | 2.00 | 0.12 | 1.50 | 7.93 | 15 | 0.3 | 0.76 | 32.6 |
| 3 | 2.00 | 3.00 | 0.12 | 1.50 | 9.60 | 15 | 0.3 | 0.80 | 41.3 |
| 4 | 2.00 | 4.00 | 0.12 | 1.50 | 9.93 | 14 | 0.3 | 0.83 | 44.3 |
| 5 | 2.50 | 1.00 | 0.12 | 1.00 | 8.89 | 20 | 0.3 | 0.73 | 23.3 |
| 6 | 2.50 | 2.00 | 0.12 | 1.00 | 10.88 | 17 | 0.3 | 0.73 | 28.6 |
| 7 | 2.50 | 3.00 | 0.12 | 1.00 | 11.76 | 16 | 0.3 | 0.75 | 31.9 |
| 8 | 2.50 | 4.00 | 0.12 | 1.00 | 11.85 | 15 | 0.3 | 0.78 | 33.4 |
| 9 | 3.00 | 1.00 | 0.12 | 0.50 | 14.08 | 22 | 0.3 | 0.73 | 18.5 |
| 10 | 3.00 | 2.00 | 0.12 | 0.50 | 14.22 | 18 | 0.3 | 0.73 | 18.7 |
| 11 | 3.00 | 3.00 | 0.12 | 0.50 | 14.49 | 17 | 0.3 | 0.73 | 19.0 |
| 12 | 3.00 | 4.00 | 0.12 | 0.50 | 14.17 | 16 | 0.3 | 0.75 | 19.1 |

KCT Consultancy Services, Ahmedabad

Allowable Bearing Pressure for 25 mm Settlement (BH 4)

$$\text{Settlement } S_c = \left\{ \left(C_c H \right) / \left(1 + e_0 \right) \right\} \log_{10} \left\{ \left(P_0 + \Delta P \right) / P_0 \right\}$$

Project:- Proposed structures of plant of Additional gas processing facilities project (Phase 4) of ONGC at Hazira, Surat, L & T Ltd

| Sr. No. | Comp Index Cc | Depth of Footing D m | Width of Footing B m | H m | Voids Ratio e ₀ | Field Density γ gm / cc | d m | p ₀ T / m ² | Δp T / m ² | (Δp+p ₀)/p ₀ | λ factor related to pore pressure parameter | Correction for depth | Consolidation Settlement S _c mm | Allowable Bearing Pressure T / m ² |
|---------|---------------|-------------------------|-------------------------|--------|----------------------------|----------------------------|--------|--------------------------------------|--------------------------|-------------------------------------|---|----------------------|---|--|
| 1 | 0.15 | 2.00 | 1.00 | 2.00 | 0.82 | 1.76 | 3.00 | 5.28 | 5.94 | 2.13 | 0.7 | 0.66 | 25 | 24 |
| 2 | 0.15 | 2.00 | 2.00 | 3.15 | 0.82 | 1.76 | 3.58 | 6.29 | 3.42 | 1.54 | 0.7 | 0.73 | 25 | 11 |
| 3 | 0.15 | 2.00 | 3.00 | 3.15 | 0.82 | 1.76 | 3.58 | 6.29 | 3.07 | 1.49 | 0.7 | 0.80 | 25 | 7 |
| 4 | 0.15 | 2.00 | 4.00 | 3.15 | 0.82 | 1.76 | 3.58 | 6.29 | 2.84 | 1.45 | 0.7 | 0.85 | 25 | 6 |
| 5 | 0.15 | 2.50 | 1.00 | 2.00 | 0.82 | 1.76 | 3.50 | 6.16 | 7.17 | 2.16 | 0.7 | 0.65 | 25 | 29 |
| 6 | 0.15 | 2.50 | 2.00 | 2.65 | 0.82 | 1.76 | 3.83 | 6.73 | 4.55 | 1.68 | 0.7 | 0.73 | 25 | 13 |
| 7 | 0.15 | 2.50 | 3.00 | 2.65 | 0.82 | 1.76 | 3.83 | 6.73 | 4.36 | 1.65 | 0.7 | 0.75 | 25 | 9 |
| 8 | 0.15 | 2.50 | 4.00 | 2.15 | 0.82 | 1.76 | 3.58 | 6.29 | 4.87 | 1.77 | 0.7 | 0.81 | 25 | 8 |
| 9 | 0.15 | 3.00 | 1.00 | 2.00 | 0.82 | 1.76 | 4.00 | 7.04 | 8.41 | 2.19 | 0.7 | 0.63 | 25 | 34 |
| 10 | 0.15 | 3.00 | 2.00 | 2.15 | 0.82 | 1.76 | 4.08 | 7.17 | 6.38 | 1.89 | 0.7 | 0.73 | 25 | 15 |
| 11 | 0.15 | 3.00 | 3.00 | 2.15 | 0.82 | 1.76 | 4.08 | 7.17 | 6.38 | 1.89 | 0.7 | 0.73 | 25 | 12 |
| 12 | 0.15 | 3.00 | 4.00 | 2.15 | 0.82 | 1.76 | 4.08 | 7.17 | 5.89 | 1.82 | 0.7 | 0.77 | 25 | 9 |

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Allowable Bearing Pressure for 25 mm Settlement (BH 5)

$$\text{Settlement } S_c = \left\{ \left(C_c H \right) / \left(1 + e_0 \right) \right\} \log_{10} \left\{ \left(P_0 + \Delta P \right) / P_0 \right\}$$

Project:- Proposed structures of plant of Additional gas processing facilities project (Phase 4) of ONGC at Hazira, Surat, L & T Ltd

| Sr. No. | Comp Index Cc | Depth of Footing D m | Width of Footing B m | H m | Voids Ratio e ₀ | Field Density γ gm / cc | d m | p ₀ T / m ² | Δp T / m ² | (Δp+p ₀)/p ₀ | λ factor related to pore pressure parameter | Correction for depth | Consolidation Settlement S _c mm | Allowable Bearing Pressure T / m ² |
|---------|---------------|-------------------------|-------------------------|--------|----------------------------|----------------------------|--------|--------------------------------------|--------------------------|-------------------------------------|---|----------------------|---|--|
| 1 | 0.18 | 2.00 | 1.00 | 2.00 | 0.91 | 1.71 | 3.00 | 5.13 | 4.79 | 1.93 | 0.7 | 0.66 | 25 | 19 |
| 2 | 0.18 | 2.00 | 2.00 | 3.15 | 0.91 | 1.71 | 3.58 | 6.11 | 2.82 | 1.46 | 0.7 | 0.73 | 25 | 9 |
| 3 | 0.18 | 2.00 | 3.00 | 3.15 | 0.91 | 1.71 | 3.58 | 6.11 | 2.54 | 1.42 | 0.7 | 0.80 | 25 | 6 |
| 4 | 0.18 | 2.00 | 4.00 | 3.15 | 0.91 | 1.71 | 3.58 | 6.11 | 2.36 | 1.39 | 0.7 | 0.85 | 25 | 5 |
| 5 | 0.18 | 2.50 | 1.00 | 2.00 | 0.91 | 1.71 | 3.50 | 5.99 | 5.78 | 1.96 | 0.7 | 0.65 | 25 | 23 |
| 6 | 0.18 | 2.50 | 2.00 | 2.65 | 0.91 | 1.71 | 3.83 | 6.54 | 3.73 | 1.57 | 0.7 | 0.73 | 25 | 10 |
| 7 | 0.18 | 2.50 | 3.00 | 2.65 | 0.91 | 1.71 | 3.83 | 6.54 | 3.58 | 1.55 | 0.7 | 0.75 | 25 | 7 |
| 8 | 0.18 | 2.50 | 4.00 | 2.15 | 0.91 | 1.71 | 3.58 | 6.11 | 3.98 | 1.65 | 0.7 | 0.81 | 25 | 6 |
| 9 | 0.18 | 3.00 | 1.00 | 2.00 | 0.91 | 1.71 | 4.00 | 6.84 | 6.76 | 1.99 | 0.7 | 0.63 | 25 | 27 |
| 10 | 0.18 | 3.00 | 2.00 | 2.15 | 0.91 | 1.71 | 4.08 | 6.97 | 5.19 | 1.74 | 0.7 | 0.73 | 25 | 12 |
| 11 | 0.18 | 3.00 | 3.00 | 2.15 | 0.91 | 1.71 | 4.08 | 6.97 | 5.19 | 1.74 | 0.7 | 0.73 | 25 | 10 |
| 12 | 0.18 | 3.00 | 4.00 | 2.15 | 0.91 | 1.71 | 4.08 | 6.97 | 4.81 | 1.69 | 0.7 | 0.77 | 25 | 8 |

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Allowable Bearing Pressure for 25 mm Settlement (BH 6)

$$\text{Settlement } S_c = \left\{ \left(C_c H \right) / \left(1 + e_0 \right) \right\} \log_{10} \left\{ \left(P_0 + \Delta P \right) / P_0 \right\}$$

Project:- Proposed structures of plant of Additional gas processing facilities project (Phase 4) of ONGC at Hazira, Surat, L & T Ltd

| Sr. No. | Comp Index Cc | Depth of Footing D m | Width of Footing B m | H m | Voids Ratio e ₀ | Field Density γ gm / cc | d m | p ₀ T / m ² | Δp T / m ² | (Δp+p ₀)/p ₀ | λ factor related to pore pressure parameter | Correction for depth | Consolidation Settlement S _c mm | Allowable Bearing Pressure T / m ² |
|---------|---------------|-------------------------|-------------------------|--------|----------------------------|----------------------------|--------|--------------------------------------|--------------------------|-------------------------------------|---|----------------------|---|--|
| 1 | 0.29 | 2.00 | 1.00 | 2.00 | 0.92 | 1.70 | 3.00 | 5.10 | 2.60 | 1.51 | 0.7 | 0.66 | 25.0 | 10.4 |
| 2 | 0.29 | 2.00 | 2.00 | 2.00 | 0.92 | 1.70 | 3.00 | 5.10 | 2.31 | 1.45 | 0.7 | 0.73 | 25.0 | 5.2 |
| 3 | 0.29 | 2.00 | 3.00 | 2.00 | 0.92 | 1.70 | 3.00 | 5.10 | 2.08 | 1.41 | 0.7 | 0.80 | 25.0 | 3.7 |
| 4 | 0.29 | 2.00 | 4.00 | 2.00 | 0.92 | 1.70 | 3.00 | 5.10 | 1.93 | 1.38 | 0.7 | 0.85 | 25.0 | 3.0 |
| 5 | 0.29 | 2.50 | 1.00 | 1.50 | 0.92 | 1.70 | 3.25 | 5.53 | 4.18 | 1.76 | 0.7 | 0.65 | 25.0 | 12.8 |
| 6 | 0.29 | 2.50 | 2.00 | 1.50 | 0.92 | 1.70 | 3.25 | 5.53 | 3.57 | 1.65 | 0.7 | 0.73 | 25.0 | 6.8 |
| 7 | 0.29 | 2.50 | 3.00 | 1.50 | 0.92 | 1.70 | 3.25 | 5.53 | 3.42 | 1.62 | 0.7 | 0.75 | 25.0 | 5.3 |
| 8 | 0.29 | 2.50 | 4.00 | 1.50 | 0.92 | 1.70 | 3.25 | 5.53 | 3.14 | 1.57 | 0.7 | 0.81 | 25.0 | 4.4 |
| 9 | 0.29 | 3.00 | 1.00 | 1.00 | 0.92 | 1.70 | 3.50 | 5.95 | 8.10 | 2.36 | 0.7 | 0.63 | 25.0 | 18.2 |
| 10 | 0.29 | 3.00 | 2.00 | 1.00 | 0.92 | 1.70 | 3.50 | 5.95 | 6.62 | 2.11 | 0.7 | 0.73 | 25.0 | 10.3 |
| 11 | 0.29 | 3.00 | 3.00 | 1.00 | 0.92 | 1.70 | 3.50 | 5.95 | 6.62 | 2.11 | 0.7 | 0.73 | 25.0 | 9.0 |
| 12 | 0.29 | 3.00 | 4.00 | 1.00 | 0.92 | 1.70 | 3.50 | 5.95 | 6.09 | 2.02 | 0.7 | 0.77 | 25.0 | 7.7 |

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Calculation of Settlement (BH 9)

$$\text{Settlement } S_C = mv H \Delta P$$

Project:- Proposed structures of plant of Additional gas processing facilities project (Phase 4) of ONGC at Hazira, Surat, L & T Ltd

| Sr. No. | Depth of Footing D | Width of Footing B | mv | H | Δp | λ factor related to pore pressure parameter | Correction for depth | Settlement Sc | Allowable Bearing Pressure |
|---------|--------------------|--------------------|------|------|--------------------|---|----------------------|---------------|----------------------------|
| | m | m | | m | T / m ² | | | mm | T / m ² |
| 1 | 2.00 | 1.00 | 0.12 | 1.50 | 6.35 | 0.3 | 0.73 | 25.0 | 19 |
| 2 | 2.00 | 2.00 | 0.12 | 1.50 | 6.08 | 0.3 | 0.76 | 25.0 | 11 |
| 3 | 2.00 | 3.00 | 0.12 | 1.50 | 5.81 | 0.3 | 0.80 | 25.0 | 9 |
| 4 | 2.00 | 4.00 | 0.12 | 1.50 | 5.61 | 0.3 | 0.83 | 25.0 | 8 |
| 5 | 2.50 | 1.00 | 0.12 | 1.00 | 9.52 | 0.3 | 0.73 | 25.0 | 21 |
| 6 | 2.50 | 2.00 | 0.12 | 1.00 | 9.52 | 0.3 | 0.73 | 25.0 | 15 |
| 7 | 2.50 | 3.00 | 0.12 | 1.00 | 9.21 | 0.3 | 0.75 | 25.0 | 13 |
| 8 | 2.50 | 4.00 | 0.12 | 1.00 | 8.87 | 0.3 | 0.78 | 25.0 | 11 |
| 9 | 3.00 | 1.00 | 0.12 | 0.50 | 19.04 | 0.3 | 0.73 | 25.0 | 30 |
| 10 | 3.00 | 2.00 | 0.12 | 0.50 | 19.04 | 0.3 | 0.73 | 25.0 | 24 |
| 11 | 3.00 | 3.00 | 0.12 | 0.50 | 19.04 | 0.3 | 0.73 | 25.0 | 22 |
| 12 | 3.00 | 4.00 | 0.12 | 0.50 | 18.53 | 0.3 | 0.75 | 25.0 | 21 |

NOTATIONS

| | |
|----------------------|--|
| C | Cohesion |
| ϕ | Angle of internal friction of soil |
| DS | Disturbed Sample |
| UDS | Undisturbed Sample |
| NMC | Natural Moisture Content |
| NP | Non Plastic Soils |
| G | Specific Gravity |
| G | Gravel Content |
| M | Silt Content |
| S | Sand Content |
| C | Clay Content |
| LL | Liquid Limit |
| PL | Plastic Limit |
| PI | Plasticity Index |
| Cc | Compression Index |
| K | Coefficient of Permeability |
| UCS | Unconfined Compression |
| N | SPT Value |
| BH | Bore Hole |
| Suffix | The Number of Bore Holes |
| N_c, N_q, N_γ | Bearing Capacity Factor |
| S_c, S_q, S_γ | Shape Factors |
| D | Depth of foundation |
| FS | Factor of Safety |
| Cv | Coefficient of consolidation |
| UU | Unconsolidated undrained triaxial test |
| CU | Consolidated undrained triaxial test |
| CD | Consolidated drained triaxial test |
| GC | Clayey Gravels |
| GP | Poorely Graded Gravels |
| GW | Well Graded Gravels |
| SC | Clayey Sand |
| SM | Silty Sand |
| SW | Wel Graded Sand |
| SP | Poorly Graded Sand |
| CH | Clays of High Plasticity |
| CI | Clays of Intermediate Plasticity |
| CL | Clays of Low Plasticity |
| MH | Silts of High Plasticity |
| MI | Silts of Intermediate Plasticity |
| ML | Silts of Low Plasticity |

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TABLE NO. – 1**RESULTS OF LABORATORY PERMEABILITY**

| Sr. No. | Bore Hole No. | Depth (m) | Permeability (mm/s) |
|----------------|----------------------|------------------|----------------------------|
| 1. | BH – 4 | 2.50 | 0.66×10^{-6} |
| 2. | BH – 5 | 2.50 | 0.68×10^{-6} |
| 3. | BH – 6 | 2.50 | 0.60×10^{-6} |
| 4. | BH – 9 | 5.50 | 0.58×10^{-6} |

(K K Thaker)

Table No. 2
Results of Chemical Analysis of Soil

| Sr. No. | BH No. | Depth (m) | pH | SO ₃ in 2:1 Water : Soil Extract (mg/l) | Chlorides |
|---------|--------|-----------|------|---|-----------|
| 1 | BH 4 | 2.50 | 7.45 | 886 | 2013 |
| 2 | BH 5 | 4.50 | 7.63 | 926 | 2003 |
| 3 | BH 6 | 2.50 | 7.72 | 947 | 2014 |
| 4 | BH 9 | 2.50 | 7.75 | 868 | 2045 |

Table No. 3
Results of Chemical Analysis of Ground Water

| Sr. No. | Location | pH | Total Dissolved Solids | | Sulphate (SO ₃) (mg/l) | Chloride (mg/l) |
|---------|----------|------|------------------------|-----------|---------------------------------------|--------------------|
| | | | Organic | Inorganic | | |
| 1 | BH 4 | 7.65 | Nil | 905 | 1081 | 1036 |
| 2 | BH 5 | 7.72 | Nil | 895 | 1015 | 1028 |
| 3 | BH 6 | 7.53 | Nil | 907 | 1059 | 1053 |
| 4 | BH 9 | 7.63 | Nil | 884 | 1083 | 1026 |

For KCT Consultancy Services

(K K Thaker)

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RESULTS OF LABORATORY TEST

Project :- Proposed structures of plant of Additional gas processing facilities project (Phase 4) of ONGC at Hazira, Surat, L & T Ltd
BH No. :- 4

| Sr No | Depth m | Type of Sample | Field Density gm / cc | Natural Moisture Content % | Specific Gravity | Grain Size Analysis | | | | Consistency limits | | | | Swelling Pressure Kg/cm ² | Free Swell Index % | Soil Classification | Shear Parameter | | Uncorrelated Compression Test Kg/cm ² | Compression Index C _c | SPT N Value | Rock Quality Designation % | Void Ratio | Porosity % |
|-------|------------|----------------|--------------------------|-------------------------------|------------------|---------------------|-----------|-----------|-----------|--------------------|--------------------|-----------------------|----------------------|---|-----------------------|---------------------|-------------------------|-------------|---|----------------------------------|-------------|-------------------------------|------------|---------------|
| | | | | | | Gravel % | Sand % | Silt % | Clay % | Liquid Limit % | Plastic Limit % | Plasticity Index % | Shrinkage Limit % | | | | C Kg/cm ² | φ Degree | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 0.00 | DS | - | 10.64 | - | 1 | 3 | 54 | 42 | 55 | 29 | 26 | - | - | CH | - | - | - | - | - | - | - | - | - |
| 2 | 0.50 | SPT | - | - | - | 1 | 10 | 47 | 42 | 54 | 28 | 26 | - | - | CH | - | - | - | - | 19 | - | - | - | - |
| 3 | 1.50 | SPT | - | - | - | 1 | 8 | 44 | 47 | 54 | 25 | 29 | - | - | CH | - | - | - | - | 16 | - | - | - | - |
| 4 | 2.50 | UDS | 1.76 | 21.34 | 2.64 | 2 | 6 | 46 | 46 | 55 | 26 | 29 | 8 | 0.26 | 54.3 | CH | 0.39 | 9 | - | 0.15 | - | - | 0.82 | 45.1 |
| 5 | 3.00 | SPT | - | - | - | 2 | 9 | 43 | 46 | 57 | 31 | 26 | - | - | CH | - | - | - | - | 8 | - | - | - | - |
| 6 | 4.50 | SPT | - | - | - | 2 | 10 | 71 | 17 | 51 | 36 | 15 | - | - | MH | - | - | - | - | 2 | - | - | - | - |
| 7 | 5.50 | UDS | 1.70 | 35.70 | 2.64 | 2 | 79 | 15 | 4 | NP | NP | NP | - | - | SM | - | 25 | - | - | - | - | 1.11 | 52.6 | |
| 8 | 6.00 | SPT | - | - | - | 1 | 8 | 76 | 15 | 50 | 39 | 11 | - | - | MH | - | - | - | - | 10 | - | - | - | - |
| 9 | 7.50 | SPT | - | - | - | 0 | 9 | 72 | 19 | 55 | 41 | 14 | - | - | MH | - | - | - | - | 8 | - | - | - | - |
| 10 | 8.50 | UDS | 1.76 | 22.06 | 2.66 | 0 | 16 | 79 | 5 | 50 | 42 | 8 | - | - | MH | - | 28 | - | - | - | - | 0.84 | 45.7 | |
| 11 | 9.00 | SPT | - | - | - | 1 | 83 | 13 | 3 | NP | NP | NP | - | - | SM | - | - | - | - | 15 | - | - | - | - |
| 12 | 10.50 | SPT | - | - | - | 0 | 82 | 14 | 4 | NP | NP | NP | - | - | SM | - | - | - | - | 19 | - | - | - | - |
| 13 | 11.50 | DS | - | - | - | 1 | 82 | 13 | 4 | NP | NP | NP | - | - | SM | - | - | - | - | - | - | - | - | - |
| 14 | 12.00 | SPT | - | - | - | 0 | 83 | 14 | 3 | NP | NP | NP | - | - | SM | - | - | - | - | 22 | - | - | - | - |
| 15 | 13.50 | SPT | - | - | - | 1 | 80 | 15 | 4 | NP | NP | NP | - | - | SM | - | - | - | - | 28 | - | - | - | - |
| 16 | 14.50 | DS | - | - | - | 2 | 79 | 15 | 4 | NP | NP | NP | - | - | SM | - | - | - | - | - | - | - | - | - |
| 17 | 15.00 | SPT | - | - | - | 0 | 82 | 15 | 3 | NP | NP | NP | - | - | SM | - | - | - | - | 41 | - | - | - | - |
| 18 | 16.50 | SPT | - | - | - | 4 | 82 | 12 | 2 | 21 | NP | NP | - | - | SM | - | - | - | - | 59 | - | - | - | - |
| 19 | 17.50 | DS | - | - | - | 4 | 82 | 12 | 2 | 20 | NP | NP | - | - | SM | - | - | - | - | - | - | - | - | - |
| 20 | 18.00 | SPT | - | - | - | 1 | 33 | 34 | 32 | 40 | 29 | 11 | - | - | CI | - | - | - | - | > 100 | - | - | - | - |
| 21 | 20.00 | SPT | - | - | - | 4 | 78 | 14 | 4 | 24 | NP | NP | - | - | SM | - | - | - | - | 94 | - | - | - | - |

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|---|------------|----------------|--------------------------|-------------------------------|------------------|---|-----------|-----------|-----------|--------------------|--------------------|-----------------------|----------------------|---|-----------------------|---------------------|-------------------------|-------------|---|----------------------------------|-------------|-------------------------------|------------|---------------|---|
| RESULTS OF LABORATORY TEST | | | | | | | | | | | | | | | | | | | | | | | | | |
| Project :- Proposed structures of plant of Additional gas processing facilities project (Phase 4) of ONGC at Hazira, Surat, L & T Ltd | | | | | | | | | | | | | | | | | | | | | | | | | |
| BH No. :- 5 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sr No | Depth m | Type of Sample | Field Density gm / cc | Natural Moisture Content % | Specific Gravity | Grain Size Analysis | | | | Consistency limits | | | | Swelling Pressure Kg/cm ² | Free Swell Index % | Soil Classification | Shear Parameter | | Unconfined Compression Test Kg/cm ² | Compression Index C _c | SPT N Value | Rock Quality Designation % | Void Ratio | Porosity % | |
| | | | | | | Gravel % | Sand % | Silt % | Clay % | Liquid Limit % | Plastic Limit % | Plasticity Index % | Shrinkage Limit % | | | | C Kg/cm ² | φ Degree | | | | | | | |
| 1 | 0.00 | DS | - | - | - | Filled up Clay of high plasticity with debris and gravels | | | | | | | | | | | | | | | | | | - | - |
| 2 | 1.50 | SPT | - | - | - | 1 | 13 | 42 | 44 | 59 | 30 | 29 | - | - | - | CH | - | - | - | - | 16 | - | - | - | |
| 3 | 2.50 | UDS | 1.71 | 23.24 | 2.65 | 0 | 10 | 44 | 46 | 58 | 29 | 29 | 7 | 0.22 | 46.3 | CH | 0.46 | 12 | - | 0.18 | - | - | 0.91 | 47.6 | |
| 4 | 3.00 | SPT | - | - | - | 1 | 13 | 43 | 43 | 55 | 26 | 29 | - | - | - | CH | - | - | - | - | 4 | - | - | - | |
| 5 | 4.50 | SPT | - | - | - | 0 | 86 | 12 | 2 | NP | NP | NP | - | - | - | SM | - | - | - | - | 6 | - | - | - | |
| 6 | 5.50 | UDS | 1.76 | 31.54 | 2.64 | 2 | 84 | 12 | 2 | NP | NP | NP | - | - | - | SM | - | 26 | - | - | - | - | 0.97 | 49.3 | |
| 7 | 6.00 | SPT | - | - | - | 0 | 14 | 50 | 36 | 53 | 40 | 13 | - | - | - | MH | - | - | - | - | 9 | - | - | - | |
| 8 | 7.50 | SPT | - | - | - | 6 | 79 | 12 | 3 | NP | NP | NP | - | - | - | SM | - | - | - | - | 27 | - | - | - | |
| 9 | 8.50 | UDS | 1.95 | 28.43 | 2.65 | 6 | 79 | 12 | 3 | NP | NP | NP | - | - | - | SM | - | 32 | - | - | - | - | 0.75 | 42.7 | |
| 10 | 9.00 | SPT | - | - | - | 6 | 77 | 15 | 2 | NP | NP | NP | - | - | - | SM | - | - | - | - | 30 | - | - | - | |
| 11 | 10.50 | SPT | - | - | - | 4 | 78 | 15 | 3 | NP | NP | NP | - | - | - | SM | - | - | - | - | 23 | - | - | - | |
| 12 | 11.50 | DS | - | - | - | 5 | 78 | 14 | 3 | NP | NP | NP | - | - | - | SM | - | - | - | - | - | - | - | - | |
| 13 | 12.00 | SPT | - | - | - | 3 | 81 | 13 | 3 | NP | NP | NP | - | - | - | SM | - | - | - | - | 45 | - | - | - | |
| 14 | 13.50 | SPT | - | - | - | 3 | 83 | 12 | 2 | NP | NP | NP | - | - | - | SM | - | - | - | - | 39 | - | - | - | |
| 15 | 14.50 | DS | - | - | - | 6 | 80 | 12 | 2 | NP | NP | NP | - | - | - | SM | - | - | - | - | - | - | - | - | |
| 16 | 15.00 | SPT | - | - | - | 0 | 56 | 24 | 20 | 24 | 15 | 9 | - | - | - | SC | - | - | - | - | 38 | - | - | - | |
| 17 | 16.50 | SPT | - | - | - | 2 | 83 | 12 | 3 | NP | NP | NP | - | - | - | SM | - | - | - | - | 80 | - | - | - | |
| 18 | 17.50 | DS | - | - | - | 0 | 85 | 12 | 3 | NP | NP | NP | - | - | - | SM | - | - | - | - | - | - | - | - | |
| 19 | 18.00 | SPT | - | - | - | 0 | 83 | 15 | 2 | NP | NP | NP | - | - | - | SM | - | - | - | - | 92 | - | - | - | |
| 20 | 19.50 | SPT | - | - | - | 0 | 30 | 38 | 32 | 35 | 30 | 5 | - | - | - | MI | - | - | - | - | 77 | - | - | - | |
| 21 | 20.50 | DS | - | - | - | 7 | 76 | 14 | 3 | NP | NP | NP | - | - | - | SM | - | - | - | - | - | - | - | - | |
| 22 | 21.00 | SPT | - | - | - | 3 | 28 | 37 | 32 | 36 | 30 | 6 | - | - | - | MI | - | - | - | - | 83 | - | - | - | |
| 23 | 22.50 | SPT | - | - | - | 16 | 19 | 32 | 33 | 38 | 32 | 6 | - | - | - | MI | - | - | - | - | 91 | - | - | - | |
| 24 | 23.50 | UDS | 2.26 | 23.51 | 2.65 | 12 | 25 | 30 | 33 | 36 | 29 | 7 | - | - | - | MI | 0.10 | 36 | - | - | - | - | 0.45 | 31.0 | |
| 25 | 25.00 | SPT | - | - | - | 15 | 25 | 30 | 30 | 36 | 31 | 5 | - | - | - | MI | - | - | - | - | > 100 | - | - | - | |

KCT Consultancy Services, Ahmedabad

RESULTS OF LABORATORY TEST

Project :- Proposed structures of plant of Additional gas processing facilities project (Phase 4) of ONGC at Hazira, Surat, L & T Ltd

BH No. :- 6

| Sr No | Depth m | Type of Sample | Field Density gm / cc | Natural Moisture Content % | Specific Gravity | Grain Size Analysis | | | | Consistency limits | | | | Swelling Pressure Kg/cm ² | Free Swell Index % | Soil Classification | Shear Parameter | | Unconfined Compression Test Kg/cm ² | Compression Index C _c | SPT N Value | Rock Quality Designation % | Void Ratio | Porosity % |
|-------|------------|----------------|--------------------------|-------------------------------|------------------|---|-----------|-----------|-----------|--------------------|--------------------|-----------------------|----------------------|---|-----------------------|---------------------|-------------------------|-------------|---|----------------------------------|-------------|-------------------------------|------------|---------------|
| | | | | | | Gravel % | Sand % | Silt % | Clay % | Liquid Limit % | Plastic Limit % | Plasticity Index % | Shrinkage Limit % | | | | C Kg/cm ² | φ Degree | | | | | | |
| 1 | 0.00 | DS | - | - | - | Filled up Clay of high plasticity with debris and gravels | | | | | | | | | | | | | | | | - | - | |
| 2 | 1.50 | SPT | - | - | - | 0 | 25 | 39 | 36 | 56 | 27 | 29 | 7 | - | 61.3 | CH | - | - | - | - | 18 | - | - | - |
| 3 | 2.50 | UDS | 1.70 | 23.40 | 2.65 | 0 | 24 | 37 | 39 | 54 | 26 | 28 | 8 | 0.21 | 52.4 | CH | 0.24 | 2 | - | 0.29 | - | - | 0.92 | 48.0 |
| 4 | 3.00 | SPT | - | - | - | 1 | 19 | 43 | 37 | 51 | 26 | 25 | - | - | - | CH | - | - | - | - | 4 | - | - | - |
| 5 | 4.50 | SPT | - | - | - | 1 | 86 | 10 | 3 | NP | NP | NP | - | - | - | SM | - | - | - | - | 6 | - | - | - |
| 6 | 5.50 | DS | - | - | - | 0 | 16 | 64 | 20 | 52 | 39 | 13 | - | - | - | MH | - | - | - | - | - | - | - | - |
| 7 | 6.00 | SPT | - | - | - | 1 | 18 | 67 | 14 | 54 | 40 | 14 | - | - | - | MH | - | - | - | - | 4 | - | - | - |
| 8 | 7.50 | SPT | - | - | - | 0 | 82 | 14 | 4 | NP | NP | NP | - | - | - | SM | - | - | - | - | 12 | - | - | - |
| 9 | 8.50 | UDS | 1.78 | 29.34 | 2.67 | 1 | 82 | 14 | 3 | NP | NP | NP | - | - | - | SM | - | 28 | - | - | - | - | 0.94 | 48.5 |
| 10 | 9.00 | SPT | - | - | - | 13 | 71 | 12 | 4 | NP | NP | NP | - | - | - | SM | - | - | - | - | 20 | - | - | - |
| 11 | 10.50 | SPT | - | - | - | 12 | 69 | 15 | 4 | NP | NP | NP | - | - | - | SM | - | - | - | - | 33 | - | - | - |
| 12 | 11.50 | DS | - | - | - | 1 | 87 | 10 | 2 | NP | NP | NP | - | - | - | SM | - | - | - | - | - | - | - | - |
| 13 | 12.00 | SPT | - | - | - | 1 | 83 | 13 | 3 | NP | NP | NP | - | - | - | SM | - | - | - | - | 42 | - | - | - |
| 14 | 13.50 | SPT | - | - | - | 2 | 85 | 10 | 3 | NP | NP | NP | - | - | - | SM | - | - | - | - | 44 | - | - | - |
| 15 | 14.50 | DS | - | - | - | 56 | 22 | 16 | 6 | NP | NP | NP | - | - | - | GM | - | - | - | - | - | - | - | - |
| 16 | 15.00 | SPT | - | - | - | 0 | 85 | 12 | 3 | NP | NP | NP | - | - | - | SM | - | - | - | - | 48 | - | - | - |
| 17 | 16.50 | SPT | - | - | - | 1 | 57 | 24 | 18 | 21 | 13 | 8 | - | - | - | SC | - | - | - | - | 52 | - | - | - |
| 18 | 17.50 | UDS | 1.99 | 21.34 | 2.66 | 2 | 21 | 38 | 39 | 55 | 27 | 28 | - | - | - | CH | 0.41 | 18 | - | 0.11 | - | - | 0.62 | 38.3 |
| 19 | 18.00 | SPT | - | - | - | 1 | 26 | 36 | 37 | 51 | 22 | 29 | - | - | - | CH | - | - | - | - | 51 | - | - | - |
| 20 | 20.00 | SPT | - | - | - | 0 | 25 | 39 | 36 | 56 | 28 | 28 | - | - | - | CH | - | - | - | - | 72 | - | - | - |

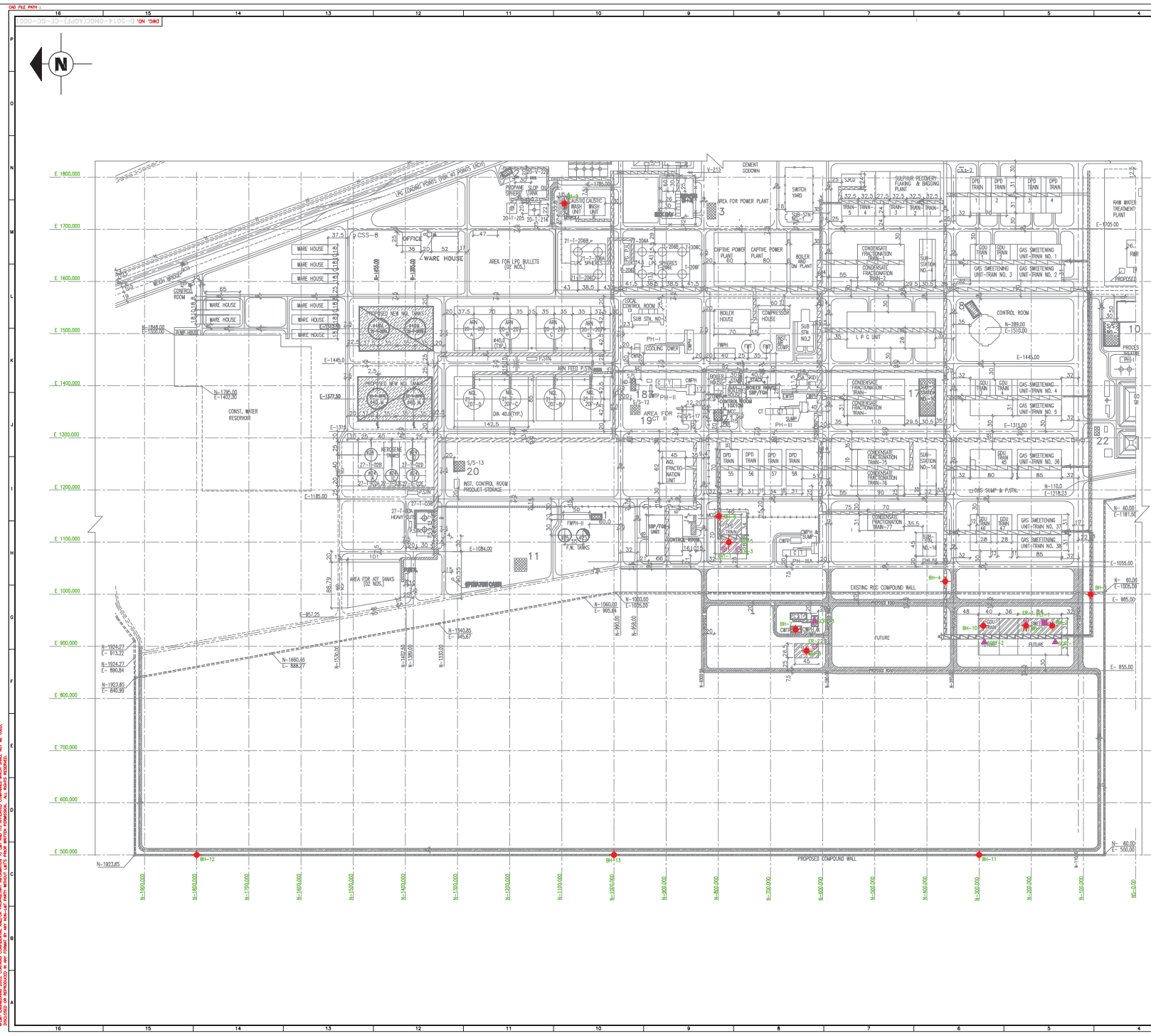
KCT Consultancy Services, Ahmedabad

RESULTS OF LABORATORY TEST

Project :- Proposed structures of plant of Additional gas processing facilities project (Phase 4) of ONGC at Hazira, Surat, L & T Ltd

BH No. :- 9

| Sr No | Depth m | Type of Sample | Field Density gm / cc | Natural Moisture Content % | Specific Gravity | Grain Size Analysis | | | | Consistency limits | | | | Swelling Pressure Kg/cm ² | Free Swell Index % | Soil Classification | Shear Parameter | | Unconfined Compression Test Kg/cm ² | Compression Index C _c | SPT N Value | Rock Quality Designation % | Void Ratio | Porosity % |
|-------|------------|----------------|--------------------------|-------------------------------|------------------|---|-----------|-----------|-----------|--------------------|--------------------|-----------------------|----------------------|---|-----------------------|---------------------|-------------------------|-------------|---|----------------------------------|-------------|-------------------------------|------------|---------------|
| | | | | | | Gravel % | Sand % | Silt % | Clay % | Liquid Limit % | Plastic Limit % | Plasticity Index % | Shrinkage Limit % | | | | C Kg/cm ² | φ Degree | | | | | | |
| 1 | 0.00 | DS | - | - | - | Filled up Clayey Sand with debris and gravels | | | | | | | | | | | | | | | | - | - | |
| 2 | 1.50 | SPT | - | - | - | 0 | 22 | 38 | 40 | 57 | 30 | 27 | - | - | - | CH | - | - | - | - | 15 | - | - | - |
| 3 | 2.50 | UDS | 1.76 | 26.57 | 2.64 | 0 | 12 | 48 | 40 | 54 | 27 | 27 | 7 | 0.28 | 53.1 | CH | 0.38 | 13 | - | 0.17 | - | - | 0.90 | 47.3 |
| 4 | 3.00 | SPT | - | - | - | 2 | 15 | 45 | 38 | 58 | 29 | 29 | - | - | - | CH | - | - | - | - | 8 | - | - | - |
| 5 | 4.50 | SPT | - | - | - | 0 | 82 | 15 | 3 | NP | NP | NP | - | - | - | SM | - | - | - | - | 13 | - | - | - |
| 6 | 5.50 | UDS | 1.86 | 31.05 | 2.63 | 2 | 81 | 13 | 4 | NP | NP | NP | - | - | - | SM | - | 29 | - | - | - | - | 0.85 | 46.0 |
| 7 | 6.00 | SPT | - | - | - | 2 | 86 | 10 | 2 | NP | NP | NP | - | - | - | SM | - | - | - | - | 21 | - | - | - |
| 8 | 7.50 | SPT | - | - | - | 2 | 79 | 15 | 4 | NP | NP | NP | - | - | - | SM | - | - | - | - | 24 | - | - | - |
| 9 | 8.50 | UDS | 1.95 | 24.61 | 2.64 | 2 | 82 | 12 | 4 | NP | NP | NP | - | - | - | SM | - | 33 | - | - | - | - | 0.69 | 40.7 |
| 10 | 9.00 | SPT | - | - | - | 2 | 80 | 14 | 4 | NP | NP | NP | - | - | - | SM | - | - | - | - | 28 | - | - | - |
| 11 | 10.50 | SPT | - | - | - | 16 | 67 | 13 | 4 | 21 | NP | NP | - | - | - | SM | - | - | - | - | 32 | - | - | - |
| 12 | 11.50 | DS | - | - | - | 5 | 77 | 14 | 4 | NP | NP | NP | - | - | - | SM | - | - | - | - | - | - | - | - |
| 13 | 12.00 | SPT | - | - | - | 3 | 84 | 10 | 3 | NP | NP | NP | - | - | - | SM | - | - | - | - | 44 | - | - | - |
| 14 | 13.50 | SPT | - | - | - | 5 | 77 | 15 | 3 | NP | NP | NP | - | - | - | SM | - | - | - | - | 43 | - | - | - |
| 15 | 14.50 | DS | - | - | - | 15 | 68 | 13 | 4 | NP | NP | NP | - | - | - | SM | - | - | - | - | - | - | - | - |
| 16 | 15.00 | SPT | - | - | - | 58 | 20 | 16 | 6 | NP | NP | NP | - | - | - | GM | - | - | - | - | 54 | - | - | - |
| 17 | 16.50 | SPT | - | - | - | 56 | 19 | 19 | 6 | NP | NP | NP | - | - | - | GM | - | - | - | - | 64 | - | - | - |
| 18 | 17.50 | DS | - | - | - | 16 | 42 | 22 | 20 | 29 | 20 | 9 | - | - | - | SC | - | - | - | - | - | - | - | - |
| 19 | 18.00 | SPT | - | - | - | 13 | 23 | 31 | 33 | 36 | 30 | 6 | - | - | - | MI | - | - | - | - | 59 | - | - | - |
| 20 | 20.00 | SPT | - | - | - | 2 | 25 | 40 | 33 | 38 | 32 | 6 | - | - | - | MI | - | - | - | - | 94 | - | - | - |



| DOCUMENT/DRAWING NO. | DOCUMENT/DRAWING TITLE |
|--------------------------------------|--|
| D-5014-ONGC(AGPF)-CE-MR-0001-REV. 00 | TECHNICAL SPECIFICATION FOR GEOTECHNICAL INVESTIGATION |

NOTES:
 1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS UNDO.

COORDINATES OF DIFFERENT TEST POINTS.

| S.NO. | TEST | COORDINATES | | DEPTH(m) | |
|-------|-----------|--------------|-------------|----------|-------|
| | | NORTHING (m) | EASTING (m) | | |
| 1 | BORE HOLE | BH-1 | 086.000 | 1000.000 | 20.00 |
| | | BH-2 | 160.000 | 940.000 | 25.00 |
| | | BH-3 | 210.000 | 940.000 | 20.00 |
| | | BH-4 | 365.000 | 1025.000 | 20.00 |
| | | BH-5 | 780.000 | 1100.000 | 25.00 |
| | | BH-6 | 799.000 | 1150.000 | 20.00 |
| | | BH-7 | 652.000 | 933.000 | 20.00 |
| | | BH-8 | 631.000 | 892.000 | 20.00 |
| | | BH-9 | 1095.000 | 1750.000 | 20.00 |
| | | BH-10 | 292.000 | 940.000 | 25.00 |
| | | BH-11 | 300.000 | 500.000 | 06.00 |
| | | BH-12 | 1800.000 | 500.000 | 06.00 |
| | | BH-13 | 1000.000 | 500.000 | 06.00 |

| S.NO. | TEST | COORDINATES | | DEPTH(m) | |
|-------|------------------------------|--------------|-------------|----------|--|
| | | NORTHING (m) | EASTING (m) | | |
| 2 | STATIC CONE PENETRATION TEST | SCPT-1 | 154.000 | 915.000 | |
| | | SCPT-2 | 290.000 | 915.000 | |
| | | SCPT-3 | 615.000 | 955.000 | |

| S.NO. | TEST | COORDINATES | | DEPTH(m) | |
|-------|------------------------|--------------|-------------|----------|--|
| | | NORTHING (m) | EASTING (m) | | |
| 3 | EARTH RESISTIVITY TEST | ER-1 | 210.000 | 950.000 | |
| | | ER-2 | 615.000 | 900.000 | |
| | | ER-3 | 762.000 | 1087.000 | |

| S.NO. | TEST | COORDINATES | | DEPTH(m) | |
|-------|-----------------|--------------|-------------|----------|--|
| | | NORTHING (m) | EASTING (m) | | |
| 4 | PLATE LOAD TEST | PLT-1 | 175.000 | 946.000 | |

| S.NO. | TEST | COORDINATES | | DEPTH(m) | |
|-------|----------------------|--------------|-------------|----------|--|
| | | NORTHING (m) | EASTING (m) | | |
| 5 | BLOCK VIBRATION TEST | BVT-1 | 789.000 | 1087.000 | |

LEGEND:

| SYMBOL | TYPE OF TEST |
|--------|-------------------------------------|
| ● | BORE HOLE (BH) |
| ▲ | STATIC CONE PENETRATION TEST (SCPT) |
| ⊗ | CALIFORNIA BEARING RATIO TEST (CBR) |
| ⊕ | EARTH RESISTIVITY TEST (ER) |
| ⊕ | BLOCK VIBRATION TEST (BVT) |
| ⊕ | PLATE LOAD TEST (PLT) |

| REV. | DATE | DESCRIPTION | BY | CHK. | APPD. |
|------|------------|-------------------|----|------|-------|
| 00 | 12/07/2010 | ISSUED FOR REVIEW | SU | SN | SB |

OWNER:
OIL & NATURAL GAS CORPORATION LIMITED

ENGINEERS INDIA LIMITED
 (A Govt. of India Undertaking)
 E.I. JOB NO. XXXX

CONTRACTOR:
LARSEN & TOUBRO LIMITED
 E & C DIVISION

PROJECT:
 ADDITIONAL GAS PROCESSING FACILITIES PROJECT
 PROJECT-HAZIRA (PHASE-IV)

TITLE :
 TEST LOCATIONS FOR SOIL INVESTIGATION

| SCALE: | DOCUMENT NUMBER | SHT. | REV. |
|--------|------------------------------|------|------|
| 1:3000 | D-5014-ONGC(AGPF)-CE-CC-0001 | 1 | 00 |

| PS | CS | MS | MR | EL | PD | CE | PE | REL Date | DTN | DTN Date |
|----|----|----|----|----|----|----|----|----------|-----|----------|
| | | | | | | | | | | |

KCT Consultancy Services, Ahmedabad
 Project : L & T , HAZIRA
 Bore Hole No. : 4
 Co-ordinates: N-365, E-1025
 Reduced Level: 98.466m
 Depth of Termination : 20.0 m
 Depth of Water Table : Encountered at m depth during investigation

Date of commencement: 07-02-10
 Date of Completion: 07-07-10
 Diameter of Bore : 150 mm

BORE LOG DATA SHEET

| Method of Boring | Depth m | Casing | Notation | Soil Description | Depth of Sample m | Drill Run | | Type of Sample | SPT N Value/Penetration of S.S.S | | | | Core Recovery (%) | RQD (%) | Remarks | | | | |
|------------------------------------|---------|----------|----------|--|-------------------|-----------|------|----------------|----------------------------------|----------------|----------------|---|-------------------|---------|---------|--|--|--|--|
| | | | | | | From m | To m | | N ₁ | N ₂ | N ₃ | N | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| Rotary Drilling by mud circulation | 0.00 | Not Used | | Dark brownish, fine to very fine grained, silty clays of high plasticity with occasional gravels (CH) water table encountered at m depth during investigation | 0.00 | 0.00 | 0.50 | DS | - | - | - | - | - | - | | | | | |
| | 0.50 | | | | 0.50 | 1.50 | SPT | 6 | 9 | 10 | 19 | - | - | | | | | | |
| | 1.00 | | | | | | | | | | | | | | | | | | |
| | 1.50 | | | | | | | | | | | | | | | | | | |
| | 2.00 | | | | | | | | | | | | | | | | | | |
| | 2.50 | | | | | | | | | | | | | | | | | | |
| | 3.00 | | | | | | | | | | | | | | | | | | |
| | 3.50 | | | | | | | | | | | | | | | | | | |
| | 4.00 | | | | | | | | | | | | | | | | | | |
| | 4.50 | | | | | | | | | | | | | | | | | | |
| | 5.00 | | | | | | | | | | | | | | | | | | |
| | 5.50 | | | | | | | | | | | | | | | | | | |
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| | 8.50 | | | | | | | | | | | | | | | | | | |
| | 9.00 | | | | | | | | | | | | | | | | | | |
| | 9.50 | | | | | | | | | | | | | | | | | | |
| 10.00 | | | | | | | | | | | | | | | | | | | |
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| 14.00 | | | | | | | | | | | | | | | | | | | |
| 14.50 | | | | | | | | | | | | | | | | | | | |
| 15.00 | | | | | | | | | | | | | | | | | | | |
| 15.50 | | | | | | | | | | | | | | | | | | | |
| 16.00 | | | | | | | | | | | | | | | | | | | |
| 16.50 | | | | | | | | | | | | | | | | | | | |
| 17.00 | | | | | | | | | | | | | | | | | | | |
| 17.50 | | | | | | | | | | | | | | | | | | | |
| 18.00 | | | | | | | | | | | | | | | | | | | |
| 18.50 | | | | | | | | | | | | | | | | | | | |
| 19.00 | | | | | | | | | | | | | | | | | | | |
| 19.50 | | | | | | | | | | | | | | | | | | | |
| 20.00 | | | | | | | | | | | | | | | | | | | |
| 19.60 to 20.00 m | | | | | | | | | | | | | | | | | | | |

KCT Consultancy Services, Ahmedabad
 Project : L & T , HAZIRA
 Bore Hole No. : 5
 Co-ordinates: N-780, E-1100
 Reduced Level: 99.423m
 Depth of Termination : 25.0 m
 Depth of Water Table : Encountered at 3.40m depth during investigation

Date of commencement: 15/7/2010
 Date of Completion: 19/7/2010
 Diameter of Bore : 150 mm

BORE LOG DATA SHEET

| Method of Boring | Depth m | Casing | Notation | Soil Description | Depth of Sample m | Drill Run | | Type of Sample | SPT N Value/Penetration of S.S.S | | | | Core Recovery (%) | RQD (%) | Remarks | |
|------------------------------------|---------|----------|--|--|--|-----------|-------|----------------|----------------------------------|----------------|----------------|----|-------------------|---------|---------|--|
| | | | | | | From m | To m | | N ₁ | N ₂ | N ₃ | N | | | | |
| | | | | | | | | | | | | | | | | |
| Rotary Drilling by mud circulation | 0.00 | Not Used | | Dark brownish, fine to medium grained, filled up clayey sand with debris 0.00 to 0.70 m | 0.00 | 0.00 | 1.50 | DS | - | - | - | - | - | - | | |
| | 0.50 | | | | | | | | | | | | | | | |
| | 1.00 | | | | | | | | | | | | | | | |
| | 1.50 | | | | Dark brownish, fine to very fine grained, silty clays of high plasticity with occasional gravels and occasional fine sand (CH) 0.70 to 2.20 m | 1.50 | 1.50 | 2.50 | SPT | 4 | 7 | 9 | 16 | - | - | |
| | 2.00 | | | | | | | | | | | | | | | |
| | 2.50 | | | | Dark brownish, fine to very fine grained, silty clays of high plasticity with occasional gravels (CH) 2.20 to 3.70 m | 2.50 | 2.50 | 3.00 | UDS | - | - | - | - | - | - | |
| | 3.00 | | | | | 3.00 | 3.00 | 4.50 | SPT | 1 | 2 | 2 | 4 | - | - | |
| | 3.50 | | | | water table encountered at 340m depth during | | | | | | | | | | | |
| | 4.00 | | | | Blackish brown, fine to very fine grained, silty sand with occasional gravels (SM) | 4.50 | 4.50 | 5.50 | SPT | 2 | 3 | 3 | 6 | - | - | |
| | 4.50 | | | | | | | | | | | | | | | |
| | 5.00 | | | | 3.70 to 6.00 m | 5.50 | 5.50 | 6.00 | UDS | - | - | - | - | - | - | |
| | 5.50 | | | | | | | | | | | | | | | |
| | 6.00 | | | | Blackish grey, fine to very fine grained, silt of high compressibility with occasional gravels (MH) 6.00 to 7.25 m | 6.00 | 6.00 | 7.50 | SPT | 4 | 4 | 5 | 9 | - | - | |
| | 6.50 | | | | | | | | | | | | | | | |
| | 7.00 | | | | | | | | | | | | | | | |
| | 7.50 | | | | | 7.50 | 7.50 | 8.50 | SPT | 7 | 12 | 15 | 27 | - | - | |
| | 8.00 | | | | | | | | | | | | | | | |
| | 8.50 | | | | | 8.50 | 8.50 | 9.00 | UDS | - | - | - | - | - | - | |
| | 9.00 | | | | | 9.00 | 9.00 | 10.50 | SPT | 10 | 14 | 16 | 30 | - | - | |
| | 9.50 | | | | | | | | | | | | | | | |
| | 10.00 | | | | | | | | | | | | | | | |
| | 10.50 | | | | Blackish grey, fine to medium grained, silty sand with little gravels (SM) | 10.50 | 10.50 | 11.50 | SPT | 9 | 11 | 12 | 23 | - | - | |
| | 11.00 | | | | | | | | | | | | | | | |
| | 11.50 | | | | | 11.50 | 11.50 | 12.00 | DS | - | - | - | - | - | - | |
| | 12.00 | | | | | 12.00 | 12.00 | 13.50 | SPT | 18 | 20 | 25 | 45 | - | - | |
| 12.50 | | | | | | | | | | | | | | | | |
| 13.00 | | | | | | | | | | | | | | | | |
| 13.50 | | | | 13.50 | 13.50 | 14.50 | SPT | 11 | 17 | 22 | 39 | - | - | | | |
| 14.00 | | | 7.25 to 14.95 m | | | | | | | | | | | | | |
| 14.50 | | | | 14.50 | 14.50 | 15.00 | DS | - | - | - | - | - | - | | | |
| 15.00 | | | Blackish grey, fine to coarse grained, clayey sand (SC) 14.95 to 15.30 m | 15.00 | 15.00 | 16.50 | SPT | 10 | 18 | 20 | 38 | - | - | | | |
| 15.50 | | | | | | | | | | | | | | | | |
| 16.00 | | | | | | | | | | | | | | | | |
| 16.50 | | | | 16.50 | 16.50 | 17.50 | SPT | 20 | 35 | 45 | 80 | - | - | | | |
| 17.00 | | | Blackish grey, fine to very fine grained, silty sand with occasional gravels (SM) | | | | | | | | | | | | | |
| 17.50 | | | | 17.50 | 17.50 | 18.00 | DS | - | - | - | - | - | - | | | |
| 18.00 | | | | 18.00 | 18.00 | 19.50 | SPT | 21 | 40 | 52 | 92 | - | - | | | |
| 18.50 | | | 15.30 to 19.20 m | | | | | | | | | | | | | |
| 19.00 | | | | | | | | | | | | | | | | |
| 19.50 | | | | 19.50 | 19.50 | 20.50 | SPT | 18 | 32 | 45 | 77 | - | - | | | |
| 20.00 | | | Dark brownish, fine to very fine grained, silt of intermediate compressibility with occasional gravels(MI) 19.20 to 20.50 m | | | | | | | | | | | | | |
| 20.50 | | | | | | | | | | | | | | | | |
| 21.00 | | | | 20.50 | 20.50 | 21.00 | DS | - | - | - | - | - | - | | | |
| 21.50 | | | | | | | | | | | | | | | | |
| 22.00 | | | | 21.00 | 21.00 | 22.50 | SPT | 20 | 35 | 48 | 83 | - | - | | | |
| 22.50 | | | Dark brownish, fine to medium grained, silt of intermediate compressibility with little gravels (MI) 21.00 to 22.10 m | | | | | | | | | | | | | |
| 23.00 | | | | | | | | | | | | | | | | |
| 23.50 | | | | 22.50 | 22.50 | 23.50 | SPT | 23 | 41 | 50 | 91 | - | - | | | |
| 24.00 | | | | | | | | | | | | | | | | |
| 24.50 | | | | 23.50 | 23.50 | 25.00 | UDS | - | - | - | - | - | - | | | |
| 25.00 | | | | | | | | | | | | | | | | |
| | | | | 25.00 | 25.00 | 25.50 | SPT | 20 | 65 | 40 | >100 | - | - | | | |
| | | | | 22.10 to 25.00 m | | | | 5cm | | | | | | | | |

| KCT Consultancy Services, Ahmedabad | | | | | | | | | | | | | | | | | |
|--|---------|----------|----------|--|-------------------|---|-------|----------------|----------------------------------|----------------|----------------|----|-------------------|---------|---------|---|--|
| Project : L & T , HAZIRA | | | | | | | | | | | | | | | | | |
| Bore Hole No. : 6 | | | | | | | | | | | | | | | | | |
| Co-ordinates: N-799, E-1170 | | | | | | | | | | | | | | | | | |
| Reduced Level: 99.620m | | | | | | | | | | | | | | | | | |
| Date of commencement: 19/7/2010 | | | | | | | | | | | | | | | | | |
| Date of Completion: 20/7/2010 | | | | | | | | | | | | | | | | | |
| Depth of Termination : 20.0 m | | | | | | | | | | | | | | | | | |
| Diameter of Bore : 150 mm | | | | | | | | | | | | | | | | | |
| Depth of Water Table : Encountered at 3.60m depth during investigation | | | | | | | | | | | | | | | | | |
| BORE LOG DATA SHEET | | | | | | | | | | | | | | | | | |
| Method of Boring | Depth m | Casing | Notation | Soil Description | Depth of Sample m | Drill Run | | Type of Sample | SPT N Value/Penetration of S.S.S | | | | Core Recovery (%) | RQD (%) | Remarks | | |
| | | | | | | From m | To m | | N ₁ | N ₂ | N ₃ | N | | | | | |
| Rotary Drilling by mud circulation | 0.00 | Not Used | | Blackish brown, fine to very fine grained, filled up silty clays of high plasticity with occasional gravels and some fine sand with debris 0.00 to 0.65 m | 0.00 | 0.00 | 1.50 | DS | - | - | - | - | - | - | | | |
| | 0.50 | | | | | | | | | | | | | | | | |
| | 1.00 | | | | | | | | | | | | | | | | |
| | 1.50 | | | | | Blackish brown, fine to very fine grained, silty clays of high plasticity with occasional gravels and some fine sand (CH) | 1.50 | 1.50 | 2.50 | SPT | 5 | 8 | 10 | 18 | - | - | |
| | 2.00 | | | | | | | | | | | | | | | | |
| | 2.50 | | | | | | | | | | | | | | | | |
| | 3.00 | | | | | water table encountered at 3.60m depth during 0.65 to 3.60 m | 2.50 | 2.50 | 3.00 | UDS | - | - | - | - | - | - | |
| | 3.50 | | | | | | 3.00 | 3.00 | 4.50 | SPT | 1 | 2 | 2 | 4 | - | - | |
| | 4.00 | | | | | Blackish brown, fine to very fine grained, silty sand with occasional gravels (SM) 3.60 to 5.20 m | 4.50 | 4.50 | 5.50 | SPT | 2 | 3 | 3 | 6 | - | - | |
| | 4.50 | | | | | | | | | | | | | | | | |
| | 5.00 | | | | | | | | | | | | | | | | |
| | 5.50 | | | | | Blackish, fine to very fine grained, silt of high compressibility with occasional gravels(MH) 5.20 to 6.60 m | 5.50 | 5.50 | 6.00 | DS | - | - | - | - | - | - | |
| | 6.00 | | | | | | 6.00 | 6.00 | 7.50 | SPT | 2 | 2 | 2 | 4 | - | - | |
| | 6.50 | | | | | | | | | | | | | | | | |
| | 7.00 | | | | | Blackish, fine to very fine grained, silty sand with occasional gravels(SM) 6.60 to 8.90 m | 7.50 | 7.50 | 8.50 | SPT | 4 | 5 | 7 | 12 | - | - | |
| | 7.50 | | | | | | | | | | | | | | | | |
| | 8.00 | | | | | | | | | | | | | | | | |
| | 8.50 | | | | | | | | | | | | | | | | |
| | 9.00 | | | | | Blackish, fine to very fine grained, silty sand with much gravels(SM) 8.90 to 10.70 m | 8.50 | 8.50 | 9.00 | UDS | - | - | - | - | - | - | |
| | 9.50 | | | | | | 9.00 | 9.00 | 10.50 | SPT | 7 | 9 | 11 | 20 | - | - | |
| 10.00 | | | | | | | | | | | | | | | | | |
| 10.50 | | | | | 10.50 | 10.50 | 11.50 | SPT | 10 | 15 | 18 | 33 | - | - | | | |
| 11.00 | | | | | | | | | | | | | | | | | |
| 11.50 | | | | Blackish, fine to very fine grained, silty sand with occasional gravels(SM) 10.70 to 12.60 m | 11.50 | 11.50 | 12.00 | DS | - | - | - | - | - | - | | | |
| 12.00 | | | | | 12.00 | 12.00 | 13.50 | SPT | 12 | 19 | 23 | 42 | - | - | | | |
| 12.50 | | | | | | | | | | | | | | | | | |
| 13.00 | | | | Dark brownish with whitish grey coarse sand, fine to coarse grained, silty sand with some gravels (SM) 12.60 to 14.00 m | 13.50 | 13.50 | 14.50 | SPT | 12 | 20 | 24 | 44 | - | - | | | |
| 13.50 | | | | | | | | | | | | | | | | | |
| 14.00 | | | | Brownish, coarse grained, silty gravels (GM) 14.00 to 14.80 m | 14.50 | 14.50 | 15.00 | DS | - | - | - | - | - | - | | | |
| 14.50 | | | | | | | | | | | | | | | | | |
| 15.00 | | | | Brownish grey, fine to very fine grained, silty sand with occasional gravels (SM) 14.80 to 15.50 m | 15.00 | 15.00 | 16.50 | SPT | 15 | 22 | 26 | 48 | - | - | | | |
| 15.50 | | | | | | | | | | | | | | | | | |
| 16.00 | | | | Brownish grey, fine to very fine grained, clayey sand with little plastic fines and occasional gravels (SC) 15.50 to 17.45 m | 16.50 | 16.50 | 17.50 | SPT | 17 | 24 | 28 | 52 | - | - | | | |
| 16.50 | | | | | | | | | | | | | | | | | |
| 17.00 | | | | | | | | | | | | | | | | | |
| 17.50 | | | | | 17.50 | 17.50 | 18.00 | UDS | - | - | - | - | - | - | | | |
| 18.00 | | | | | 18.00 | 18.00 | 20.00 | SPT | 15 | 21 | 30 | 51 | - | - | | | |
| 18.50 | | | | | | | | | | | | | | | | | |
| 19.00 | | | | Dark brownish, fine to very fine grained, silty clays of high plasticity with occasional gravels(CH) | | | | | | | | | | | | | |
| 19.50 | | | | | | | | | | | | | | | | | |
| 20.00 | | | | | 20.00 | 20.00 | 20.45 | SPT | 23 | 32 | 40 | 72 | - | - | | | |
| 17.45 to 20.00 m | | | | | | | | | | | | | | | | | |

| | |
|--|--------------------------------|
| KCT Consultancy Services, Ahmedabad | |
| Project : L & T , HAZIRA | Date of commencement: 07-12-10 |
| Bore Hole No. : 9 | Date of Completion: 13/7/2010 |
| Co-ordinates: N-1095, E-1750 | |
| Reduced Level: 99.232m | |
| Depth of Termination : 20.0 m | Diameter of Bore : 150 mm |
| Depth of Water Table : Encountered at 3.50m depth during investigation | |
| BORE LOG DATA SHEET | |

| Method of Boring | Depth m | Casing | Notation | Soil Description | Depth of Sample m | Drill Run | | Type of Sample | SPT N Value/Penetration of S.S.S | | | | Core Recovery (%) | RQD (%) | Remarks | | |
|------------------------------------|---------|----------|--|---|--|-----------|------|----------------|----------------------------------|----------------|----------------|----|-------------------|---------|---------|--|--|
| | | | | | | From m | To m | | N ₁ | N ₂ | N ₃ | N | | | | | |
| | | | | | | | | | | | | | | | | | |
| Rotary Drilling by mud circulation | 0.00 | Not Used | | Blackish, fine to very fine grained, filled up clayey sand with debries 0.00 to 0.70 m | 0.00 | 0.00 | 1.50 | DS | - | - | - | - | - | - | | | |
| | 0.50 | | | | | | | | | | | | | | | | |
| | 1.00 | | | | | | | | | | | | | | | | |
| | 1.50 | | | | Blackish, fine to very fine grained, silty clays of high plasticity with occasional gravels (CH) 0.70 to 3.45 m | 1.50 | 1.50 | 2.50 | SPT | 4 | 7 | 8 | 15 | - | - | | |
| | 2.00 | | | | | | | | | | | | | | | | |
| | 2.50 | | | | | | | | | | | | | | | | |
| | 3.00 | | | | water table encountered at 3.50m depth during | 2.50 | 2.50 | 3.00 | UDS | - | - | - | - | - | - | | |
| | 3.50 | | | | | 3.00 | 3.00 | 4.50 | SPT | 5 | 3 | 5 | 8 | - | - | | |
| | 4.00 | | | | | | | | | | | | | | | | |
| | 4.50 | | | | Blackish, fine to very fine grained, silty sand with occasional gravels (SM) 3.45 to 5.95 m | 4.50 | 4.50 | 5.50 | SPT | 4 | 6 | 7 | 13 | - | - | | |
| | 5.00 | | | | | | | | | | | | | | | | |
| | 5.50 | | | | | | | | | | | | | | | | |
| | 6.00 | | | | | | | | | | | | | | | | |
| | 6.50 | | | | | | | | | | | | | | | | |
| | 7.00 | | | | | | | | | | | | | | | | |
| | 7.50 | | | | Blackish brown, fine to very fine grained, silty sand with occasional gravels (SM) | 7.50 | 7.50 | 8.50 | SPT | 6 | 10 | 14 | 24 | - | - | | |
| | 8.00 | | | | | | | | | | | | | | | | |
| | 8.50 | | | | | | | | | | | | | | | | |
| | 9.00 | | | | | | | | | | | | | | | | |
| | 9.50 | | | | | | | | | | | | | | | | |
| 10.00 | | | 5.95 to 10.50 m | | | | | | | | | | | | | | |
| 10.50 | | | Blackish brown, fine to coarse grained, silty sand with little plastic fines and much gravels (SM) 10.50 to 11.35 m | 10.50 | 10.50 | 11.50 | SPT | 8 | 15 | 17 | 32 | - | - | | | | |
| 11.00 | | | | | | | | | | | | | | | | | |
| 11.50 | | | | | | | | | | | | | | | | | |
| 12.00 | | | Blackish brown, fine to medium grained, silty sand with little gravels (SM) | 11.50 | 11.50 | 12.00 | DS | - | - | - | - | - | - | | | | |
| 12.50 | | | | 12.00 | 12.00 | 13.50 | SPT | 10 | 18 | 22 | 44 | - | - | | | | |
| 13.00 | | | | | | | | | | | | | | | | | |
| 13.50 | | | 11.35 to 14.10 m | 13.50 | 13.50 | 14.50 | SPT | 11 | 18 | 25 | 43 | - | - | | | | |
| 14.00 | | | | | | | | | | | | | | | | | |
| 14.50 | | | Dark brownish and slightly blackish, fine to coarse grained, silty sand with much gravels (SM) 14.10 to 15.00 m | 14.50 | 14.50 | 15.00 | DS | - | - | - | - | - | - | | | | |
| 15.00 | | | | 15.00 | 15.00 | 16.50 | SPT | 15 | 24 | 30 | 54 | - | - | | | | |
| 15.50 | | | Blackish, coarse grained, silty gravels (GM) | | | | | | | | | | | | | | |
| 16.00 | | | | | | | | | | | | | | | | | |
| 16.50 | | | 15.00 to 17.05 m | 16.50 | 16.50 | 17.50 | SPT | 18 | 30 | 34 | 64 | - | - | | | | |
| 17.00 | | | | | | | | | | | | | | | | | |
| 17.50 | | | Brownish, fine to coarse grained, clayey sand with much gravels (SC) 17.05 to 18.00 m | 17.50 | 17.50 | 18.00 | DS | - | - | - | - | - | - | | | | |
| 18.00 | | | | 18.00 | 18.00 | 20.00 | SPT | 15 | 26 | 33 | 59 | - | - | | | | |
| 18.50 | | | | | | | | | | | | | | | | | |
| 19.00 | | | | | | | | | | | | | | | | | |
| 19.50 | | | Dark brownish, fine to medium grained, silt of intermediate compressibility with occasional gravels (MI) | | | | | | | | | | | | | | |
| 20.00 | | | | 20.00 | 20.00 | 20.45 | SPT | 16 | 46 | 48 | 94 | - | - | | | | |
| 18.00 to 20.00 m | | | | | | | | | | | | | | | | | |

Results of Block Vibration Test

(As per IS : 5249, 1992, reaffirmed 1995)

Project : Proposed structures of plant of Additional gas processing facilities project (Phase 4)
of ONGC at Hazira, Surat, L & T Ltd

| | |
|----------|--------------------|
| Test No. | 1 (N 789, E 1087) |
|----------|--------------------|

Data

| | |
|---------------------------------|---|
| Size of the block | = 0.75 m wide, 1.00 m long and 0.75 m deep |
| Depth of Conducting test | = 2.50 m from EGL |
| Base Area of the Block (A1) | = 0.75 sq. m |
| Mass of the block | = 1406.25 kg |
| Mass of the vibrator | = 37.0 kg |
| Total vibrating mass (M) | = Mass of block + mass of vibrator = 1443.25 kg |
| Acceleration due to gravity (g) | = 9.81 m/sec ² |

Terminology

| | | |
|------------|--|----------------|
| C_u - | Coefficient of elastic uniform compression in kg / cm ³ | |
| C_τ - | Coefficient of elastic uniform shear in kg / cm ³ | = 0.50 X C_u |
| C_ϕ - | Coefficient of elastic non uniform compression in kg / cm ³ | = 1.73 X C_u |
| C_ψ - | Coefficient of elastic non uniform shear in kg / cm ³ | = 0.75 X C_u |

The above coefficients are reported for foundation contact area, A of 10.0 m² (1,00,000 cm²) or more

| | |
|--------------|---|
| C_{u1} - | Coefficient of elastic uniform compression in kg / cm ³ for block of size 0.75m wide, 1.00m long and 0.75m deep = $C_u / \sqrt{A1 / A}$ = { $4 \times \pi^2 \times f_{nz}^2 \times M / (A1 \times g)$ } X 10 ⁻⁶ kg / cm ³ |
| G - | Modulus of rigidity of strata in Kg / cm ² , $G = C_u \times \sqrt{A} \times (1 - \mu) / 2.13$ |
| μ - | Poisson's ratio = 0.4 for this particular situation |
| E - | Modulus of elasticity of strata in kg / cm ² = $G \times 2 \times (1 + \mu)$ |
| f_{nz} - | Resonance frequency of foundation block – soil system in cycles / sec |
| ϵ - | Damping coefficient |

Calculations

From chart between amp v/s. freq f_{nz} = 21.6 cycles / sec and ϵ = 0.09

Coefficient of Elastic uniform compression

$$C_{u1} = \{4 * \pi^2 * 21.6^2 * 1443.25 / (0.75 * 9.81)\} * 10^{-6} = 3.61 \text{ kg/cu.cm}$$

$$C_u = 3.61 * \sqrt{0.75/10.0} = 0.99 \text{ kg/cu.cm}$$

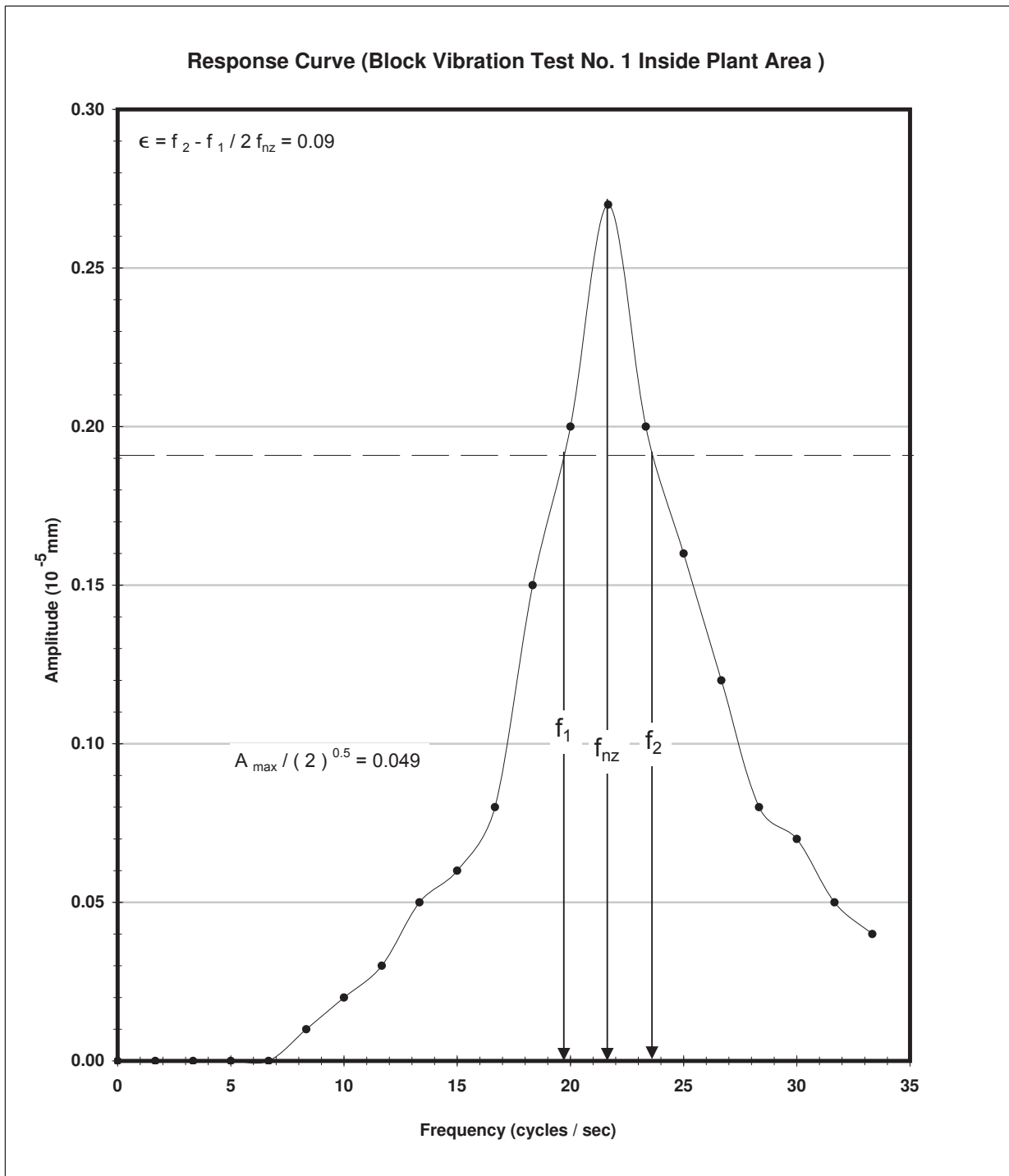
$$\text{Coefficient of elastic uniform shear } C_\tau = 0.5 * 0.99 = 0.49 \text{ kg/cu.cm}$$

$$\text{Coefficient of elastic non-uniform compression } C_\phi = 1.73 * 0.99 = 1.71 \text{ kg/cu.cm}$$

$$\text{Coefficient of elastic non - uniform shear } C_\psi = 0.75 * 0.99 = 0.74 \text{ kg/cu.cm}$$

$$\text{Modulus of rigidity of strata } G = 0.99 * \sqrt{100000} * (1.0 - 0.40) / 2.13 = 88.2 \text{ kg/sq.cm}$$

$$\text{Modulus of elasticity of strata } E = 88.2 * 2 * (1 + 0.40) = 246.9 \text{ kg/sq. cm}$$



| | | | |
|----------------------|-------|---------------------|------|
| Amax = | 0.270 | damping coefficient | 0.09 |
| A max / sqrt (2) = | 0.191 | | |
| f 1 = | 19.7 | | |
| f 2 = | 23.7 | | |
| f nz = | 21.6 | | |

KCT Consultancy Services

RESULTS OF ELECTRICAL RESISTIVITY

(IS : 3043, 1987)

ERT No. : 3

Name of Project : Proposed structures of plant of Additional gas processing facilities project (Phase4) of ONGC at Hazira, Surat, L&T Ltd (Inside Plant area)

Battery Condition : Good

Climatic Condition : Humid and moderately hot

Resistivity at given depth $\rho = 2 \pi S R$

Where

ρ = Resistivity in ohm - m (Ω m)

π = Value of pi - 22 / 7

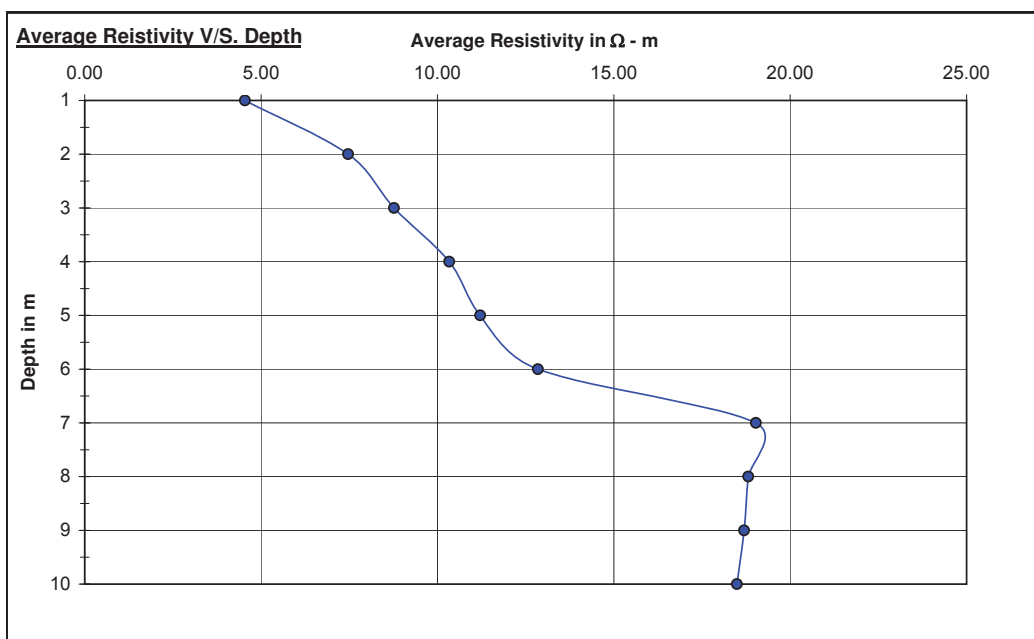
S = Electrode Spacing (equal to the depth at which resistivity is determined) in m


R = V / I in ohm (Ω)

V = Voltage Drop between inner electrodes in Volt

I = Current applied in outer electrodes in Amp.

| Spacing of Electrode in (m) | Direction | | | | Average Resistivity (Ω - m) |
|-------------------------------|---------------------------------|----------------------------------|---------------------------------|----------------------------------|--------------------------------------|
| | N - S | | E - W | | |
| | Resistance Observed in Ω | Resistivity ρ in Ω m | Resistance Observed in Ω | Resistivity ρ in Ω m | |
| 1 | 0.99 | 6.22 | 0.83 | 5.22 | 4.54 |
| 2 | 0.88 | 11.06 | 0.63 | 7.92 | 7.47 |
| 3 | 0.68 | 12.82 | 0.50 | 9.42 | 8.77 |
| 4 | 0.59 | 14.83 | 0.45 | 11.31 | 10.33 |
| 5 | 0.50 | 15.71 | 0.40 | 12.57 | 11.21 |
| 6 | 0.48 | 18.10 | 0.38 | 14.33 | 12.85 |
| 7 | 0.98 | 43.10 | 0.30 | 13.19 | 19.03 |
| 8 | 0.88 | 44.23 | 0.25 | 12.57 | 18.81 |
| 9 | 0.78 | 44.11 | 0.22 | 12.44 | 18.69 |
| 10 | 0.68 | 42.73 | 0.20 | 12.57 | 18.49 |



| | | | | |
|---|--|-------------------------------|-------------|--------------------|
|  | Subject | Doc. No. | Rev. | Vol. / Sec. |
| | BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT | 5111168-ME-SPC-100-001 | R1 | II / 1 |
| | | | | Sheet No. |
| | | | | 92 |

19.0.0 PROGRESS REPORTS

19.1.0 Reports during design and procurement

The Contractor will submit a progress report each month, within the first 7 days of each month, which indicates the following aspects as a minimum:

- Executive summary
- Work completed last month
- Status of design and its approval
- Status of procurement, manufacturing, works test, shippings
- Status of permission from authorities
- Time schedule, indicating progress achieved
- Preview, indicating major activities, design meetings.
- Areas of concern

19.2.0 Report during Site Erection, Start-up, Testing

The intervals for report submission shall be decided jointly between Owner/Owner's representative and Contractor in addition to the aspects mentioned above, the following information should be added:

- Site safety report
- Photos showing erection progress
- employed personnel / equipments / cranes
- Preview on tests to be performed, start-up requirements.

FORMT9-P REV-A (MUM)



ONGC HAZIRA
BHEL - HYDERABAD

Doc. No. : HY/PESD/ONGC/LS/001
Rev. No. : 00
Date :
Page No. : 1 OF 1

LEVEL SWITCH

Units : Flow =>Liquid- Gas- Steam- Pressure=> Temperature=>°C Level / Length=>

A. GENERAL

- 1. Type Micro
- 2. Contact rating 5A max,
- 3. Contact arrangement 2 SPDT
- 4. Differential 25± 5mm
- 5. Enclosure IP-65 (IS: 13947 Part-I)

B. MATERIALS

- 6. Enclosure Aluminium
- 7. Cable Gland 3/4" NPT(F) Double compression
Ni plated Brass
- 8. Cooling Fins Aluminium

| Tag No. | Service | Remarks |
|---------|---------|---------|
| | | |
| | | |
| | | |
| | | |
| | | |



ONGC HAZIRA
BHEL - HYDERABAD

Doc. No. : HY/PESD/ONGC/PG/001
Rev. No. : 00
Date :
Page No. : 1 OF 1

Pressure Gauge

Units : Flow =>Liquid- Gas- Steam- Pressure=> Temperature=>°C Level / Length=>

A. GENERAL

- | | | |
|-----|-----------------------|--------------------------|
| 1. | Pressure Element | Bourdon tube |
| 2. | Mounting | Panel(surface) mounted |
| 3. | Dial Size/scale | 150mm / linear in kg/cm2 |
| 4. | Dial Colors | Al. Painted white |
| 5. | Numerals | Black |
| 6. | Zero Adjustment | Micrometer pointer |
| 7. | Front ring/bezel | Screwed |
| 8. | Blow out disc | Neoprene |
| 9. | Accuracy | ±1% of FSD |
| 10. | Repeatability | ±1% of FSD |
| 11. | Hysteresis | ±2% of FSD |
| 12. | Over range protection | 130% of FSD |
| 13. | Enclosure | IP-65 (IS: 13947 Part-I) |

B. MATERIALS

- | | | |
|-----|---------------|---------------------------|
| 14. | Bourdon | SS316 |
| 15. | Movement | SS304 |
| 16. | Case | SS304 |
| 17. | Socket | AISI316 |
| 18. | Name plate | AISI304 |
| 19. | Process Conn. | 1/2" NPT(M)(Bottom entry) |

| Tag No. | Maximum process Pressure (kg/cm2 (g)) | Range (kg/cm2) | Service | Remarks |
|---------|---------------------------------------|----------------|---------|---------|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |



ONGC HAZIRA
 BHEL - HYDERABAD

Doc. No. : HY/PESD/ONGC/VS/001
 Rev. No. : 00
 Date :
 Page No. : 1 OF 1

VIBRATION SWITCH

Units : Flow =>Liquid- Gas- Steam- Pressure=> Temperature=>°C Level / Length=>

A. GENERAL

- | | | |
|----|---------------------|------------------------------|
| 1. | Type | Magnetic |
| 2. | Temp. limits | Max 200°F , Min -40°F |
| 3. | Contact rating | 5A max, 240V AC, 50/60 Hz |
| 4. | Contact arrangement | SPDT |
| 5. | Accuracy | ±5% of full range upto 300Hz |
| 6. | Location | Outdoor |
| 7. | Enclosure | IP-65 (IS: 13947 Part-I) |

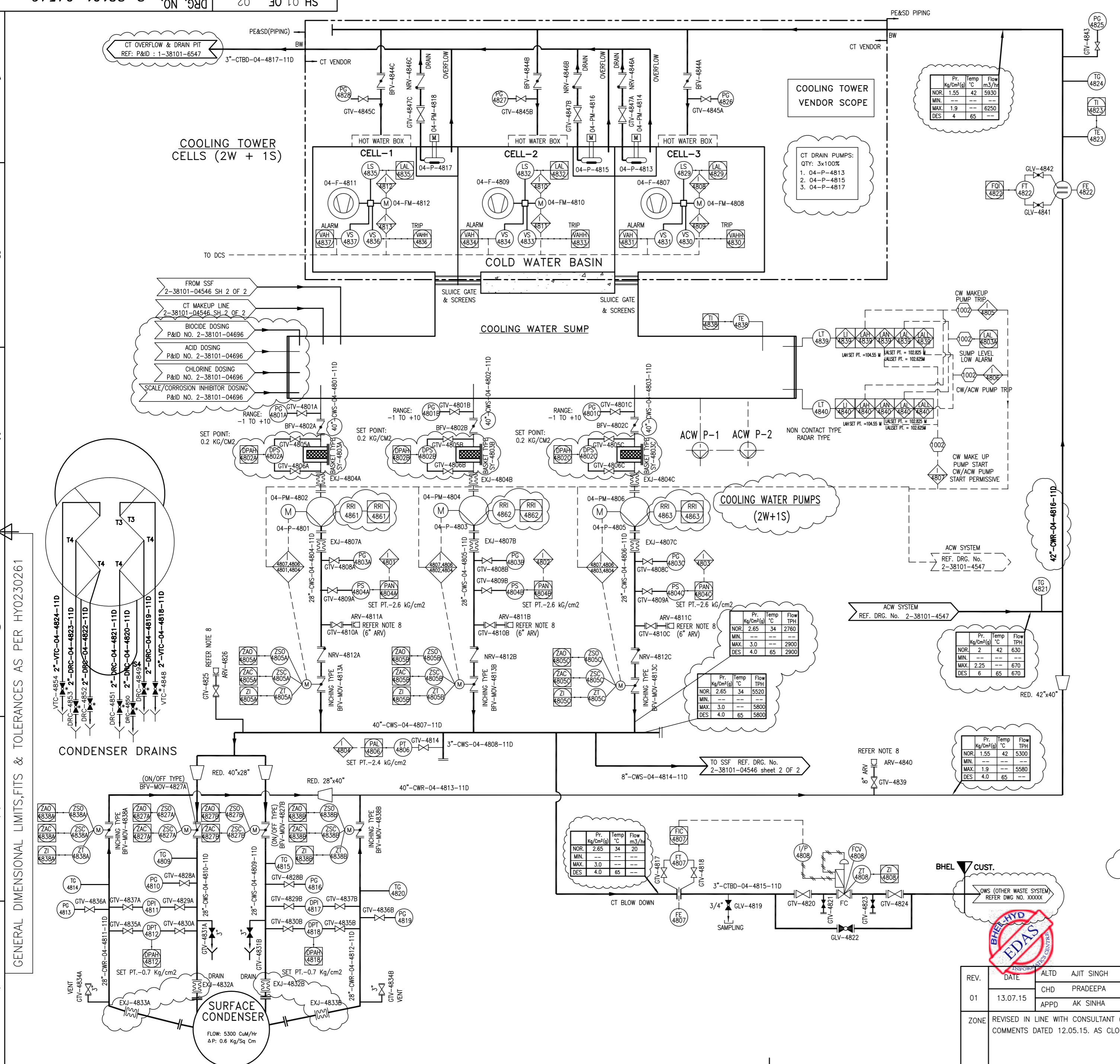
B. MATERIALS

- | | | |
|----|---------|-------------|
| 8. | Housing | LM-6 (Alum) |
|----|---------|-------------|

| Tag No. | Service | Remarks |
|---------|---------|---------|
| | | |
| | | |
| | | |
| | | |
| | | |

DRG. NO. 2-38101-04546 SH. 01 OF 02

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 COMPUTER FILE NAME: GENERAL DIMENSIONAL LIMITS, FITS & TOLERANCES AS PER HY0230261
 REF. DRG. NO. SIGN. AND DATE INVENTORY NO.



INTERLOCK SUMMARY:-

| TITLE OF LOGIC | LOGIC NO. | TAGS INVOLVED | CONDITIONS FOR LOGIC EXECUTION | REMARKS |
|---|------------------------|---------------------------------------|---|---|
| COOLING WATER PUMP START PERMISSIVE | 4807 | LAN - 4841, 4842 | CT SUMP LEVEL NORMAL | START PERMISSIVE FOR CW PUMPS |
| | | ZAC - 4804A, ZAC - 4804B, ZAC - 4804C | CW PUMP DISCH. BVF CLOSED | |
| | | ZAO - 4804A, ZAO - 4804B, ZAO - 4804C | ON CW PUMP START | |
| COOLING WATER PUMP DISCHARGE BUTTERFLY VALVES | 4801, 4802, 4803 | PAN - 4804A, PAN - 4804B, PAN - 4804C | COOLING WATER PUMP DISCHARGE PRESSURE NORMAL (AFTER PUMP START) | OPEN CW PUMP DISCHARGE VALVE FURTHER TO 90 deg i.e. FULL OPEN. |
| | | LAL - 4839, 4840 | CT SUMP LEVEL LOW LOW | TRIP CONDENSER COOLING WATER PUMPS AND CLOSE DISCHARGE VALVE ON PUMP TRIP. IN CASE BVF GETS STUCK BETWEEN 10deg to 90deg WITHIN A PREFIXED TIME AN ANNUNCIATION SHALL BE GIVEN IN DCS (FOR OPERATOR'S INTERVENTION FOR MANUAL OPENING.) |
| COOLING WATER PUMP TRIP | 4806 | LAL - 4839, 4840 | CT SUMP LEVEL LOW LOW | DISCHARGE VALVE BY 10 deg. |
| COOLING WATER STANDBY PUMP | 4804 | PAL - 4806 | | FAN VIBRATION HIGH ALARM. |
| CT FAN VIBRATION ALARM | 4804 | VAH - 4830, 4833, 4836 | FAN VIBRATION HIGH | FAN VIBRATION HIGH ALARM. |
| CT FAN TRIP | 4808, 4810, 4811, 4813 | LAL - 4829, 4832, 4835 | OIL LEVEL IN FAN GEARBOX LOW | TRIP THE RESPECTIVE COOLING TOWER FAN |
| | | VAHH - 4830, 4833, 4836 | FAN VIBRATION VERY HIGH | |
| COOLING TOWER SUMP MAKE -UP | 4807, 4805 | LAN - 4839, 4840 | CT SUMP LEVEL NORMAL | START THE CW MAKE UP PUMP |
| | | LAH - 4839, 4840 | CT SUMP LEVEL HIGH | |
| SERVICE WATER TANK | 4815, 4816 | LAL - 4859 | WATER LEVEL HIGH | CLOSE THE GTV-MOV-4861. |
| CW MAKE UP WATER STOR. TANK | 4814, 4817 | LAH - 4845 | WATER LEVEL HIGH | CLOSE THE CONTROL VALVE (UV 4841) |
| | | LAL - 4845 | WATER LEVEL LOW | |
| CW SUMP MAKE UP WATER PUMP | 4818 | PAL - 4843 | DISCHARGE HEADER PRESSURE LOW | START CT SUMP MAKE UP WATER STANDBY PUMP. |

TAG NOS. ALLOCATION SUMMARY

| | USED IN THIS DRG. NO. | RANGE | NOT USED |
|----------------------|-----------------------|-----------|------------|
| VALVE TAG. | 4801-4891 | 4801-4899 | 4815, 4816 |
| INTERLOCKS | 4801-4818 | 4801-4899 | - |
| INSTRUMENTATION TAG. | 4801-4863 | 4801-4899 | 4844 |
| LINE NUMBERS | 4801-4833 | 4801-4899 | - |
| EQUIPMENT TAG. | 4801-4834 | 4801-4899 | - |

- NOTES:-**
- LOW DRAIN POINTS AND HIGH VENT SHALL BE AS PER ISOMETRIC/PIPING LAYOUT.
 - ALL LEVEL INSTRUMENTS/TRANSMITTERS PROVIDED IN THE TANKS/PITS/CW SUMP SHALL BE TOP MOUNTED TYPE.
 - ALL PIPE LINE/TANK DRAINS & VENTS IN CW SYSTEM SHALL BE OF 80 NB AND 25 NB IN OTHER LINES UNLESS OTHERWISE SPECIFIED.
 - ALL INSTRUMENTS OF COOLING TOWER ARE IN CT VENDOR'S SCOPE.
 - ALL ABOVE GROUND DRAINS SHALL BE ROUTED TO THE NEAREST DRAIN.
 - BURIED PIPES WILL BE COAL TAR COATED AS PER ANMA C203-02. ALL BURIED PIPES SHALL BE DOUBLE COATED AND WRAPPED AS PER IS: 10221 / IS: 15337 -2003.
 - ALL INSTRUMENT TAG NOS SHALL BE PREFIXED WITH 04.
 - ALL ARV TO BE LOCATED AT HIGHEST POINT AS PER PIPING LAYOUT. ARV SHALL BE COMBINATION AIR RELEASE VALVE. ADDITIONAL AIR RELEASE VALVES SHALL BE PROVIDED, IF REQUIRED AS PER SURGE ANALYSIS.
 - MANHOLE SHALL BE PROVIDED AT BURIED PIPES IN SUPPLY AND RETURN HEADER.
 - VIBRATION LEVEL SWITCH WITH ALARM & TRIP PROVISION FOR FAN WITH ALL THE SWITCH CONTACTS WIRED TO A JUNCTION BOX LOCATED TO GROUND LEVEL.
 - ALL ON/OFF TYPE MOTORISED VALVES SHALL BE PROVIDED WITH OPEN & CLOSE LIMIT SWITCHES. ALL INCHING TYPE MOV SHALL BE PROVIDED WITH OPEN & CLOSE LIMIT SWITCHES AND ALSO THE POSITION TRANSMITTER.
 - ITEMS WILL BE SUPPLIED WITH THE RESPECTIVE EQUIPMENT. HOWEVER COUNTER FLANGES, GASKETS AND STUD NUTS SHALL BE IN PE&SD-PIPING SCOPE OF SUPPLY.

REFERENCE DRAWINGS

| DRAWING NO. | TITLE | REMARKS |
|----------------|--|---------|
| 2-38101-04696 | P&ID CW TREATMENT SYSTEM | |
| 2-38101-04547 | P&ID ACW SYSTEM | |
| 1-38101-06547 | P&ID EFFLUENT COLLECT. & DISPOSAL SYS. | |
| 1-38101-06495 | STANDARD LEGEND | |
| PEMC-05061-R01 | NUMBERING PHILOSOPHY | |

CUSTOMER:
OIL AND NATURAL GAS CORPORATION LIMITED

CONSULTANT:
FICHTNER CONSULTING ENGINEERS (INDIA) PVT. LTD.

PROJECT: 1x51MW COMBINED CYCLE CAPTIVE POWER PLANT, AT HAZIRA PLANT, GUJARAT.

| REV. | DATE | ALTD | AJIT SINGH | NAME | SIGN. | DATE | NO. OF VAR. |
|------|----------|------|------------|------|-------|----------|-------------|
| 01 | 13.07.15 | CHD | CHD | CHD | CHD | 16.06.15 | N.A. |
| | | APPD | APPD | APPD | APPD | 16.06.15 | N.A. |

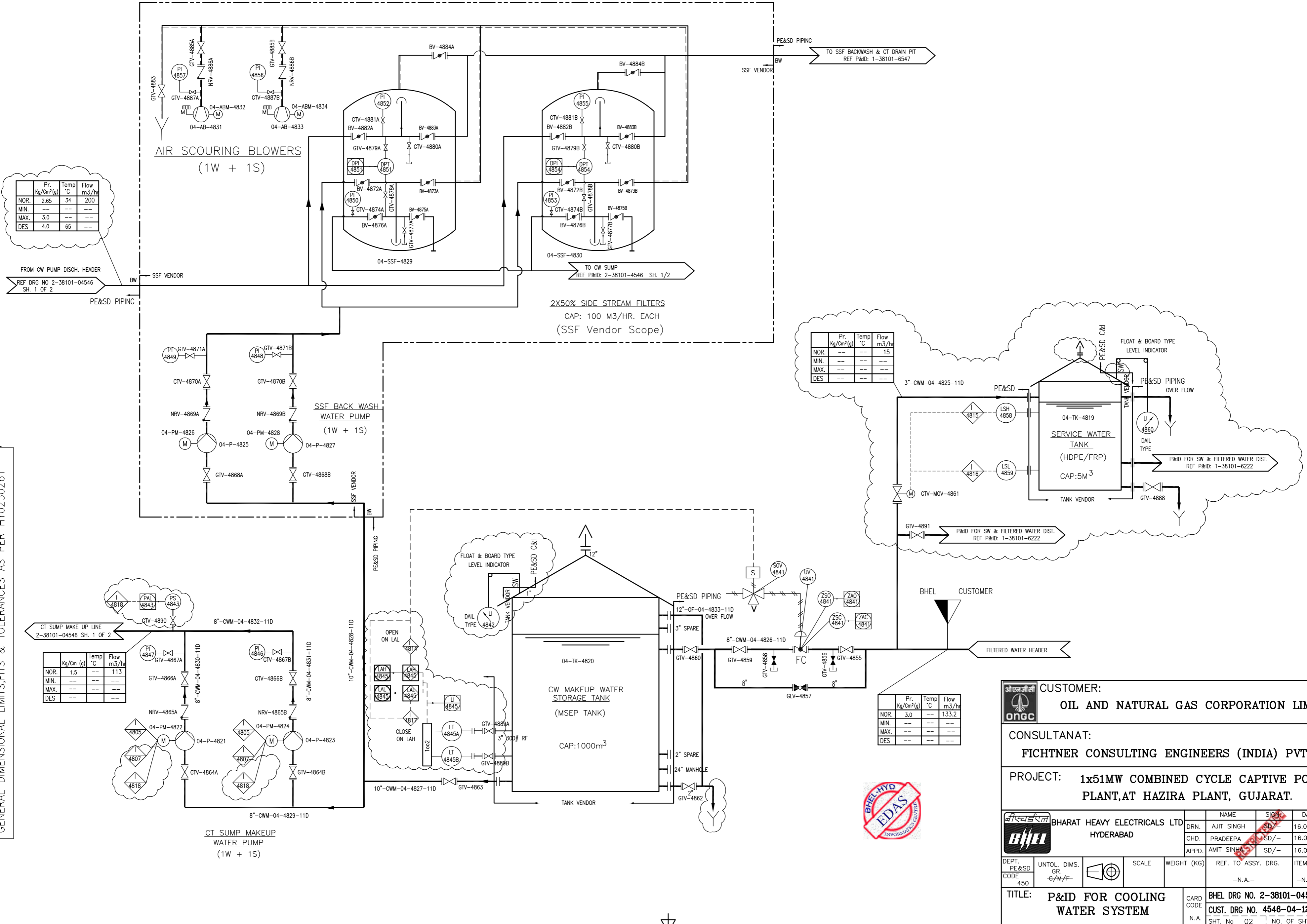
DEPT. PE&SD CODE 450 UNTO. DIMS. CR. G/M/F SCALE WEIGHT (KG) REF. TO ASSY. DRG. ITEM NO. NO. OF ITEMS

TITLE: P&ID FOR COOLING WATER SYSTEM

CARD CODE: BHEL DRG NO. 2-38101-04546 REV. 01
 CUST. DRG NO. 4546-04-1248 SHT. No. 01 NO. OF SHT. 02

DRG. NO. 2-38101-04546 SH. 02 OF 02

INVENTORY NO. SIGN. AND DATE. REF. DRG. NO. COMPUTER FILE NAME. GENERAL DIMENSIONAL LIMITS, FITS & TOLERANCES AS PER HY0230261



CUSTOMER:
ONGC OIL AND NATURAL GAS CORPORATION LIMITED

CONSULTANT:
FICHTNER CONSULTING ENGINEERS (INDIA) PVT. LTD.

PROJECT: 1x51MW COMBINED CYCLE CAPTIVE POWER PLANT, AT HAZIRA PLANT, GUJARAT.

| NAME | SIGN. | DATE | NO. OF VAR. |
|------------------|-------|----------|-------------|
| DRN. AJIT SINGH | SD | 16.06.15 | --- |
| CHD. PRADEEPA | SD/- | 16.06.15 | -N.A.- |
| APPD. AMIT SINHA | SD/- | 16.06.15 | --- |

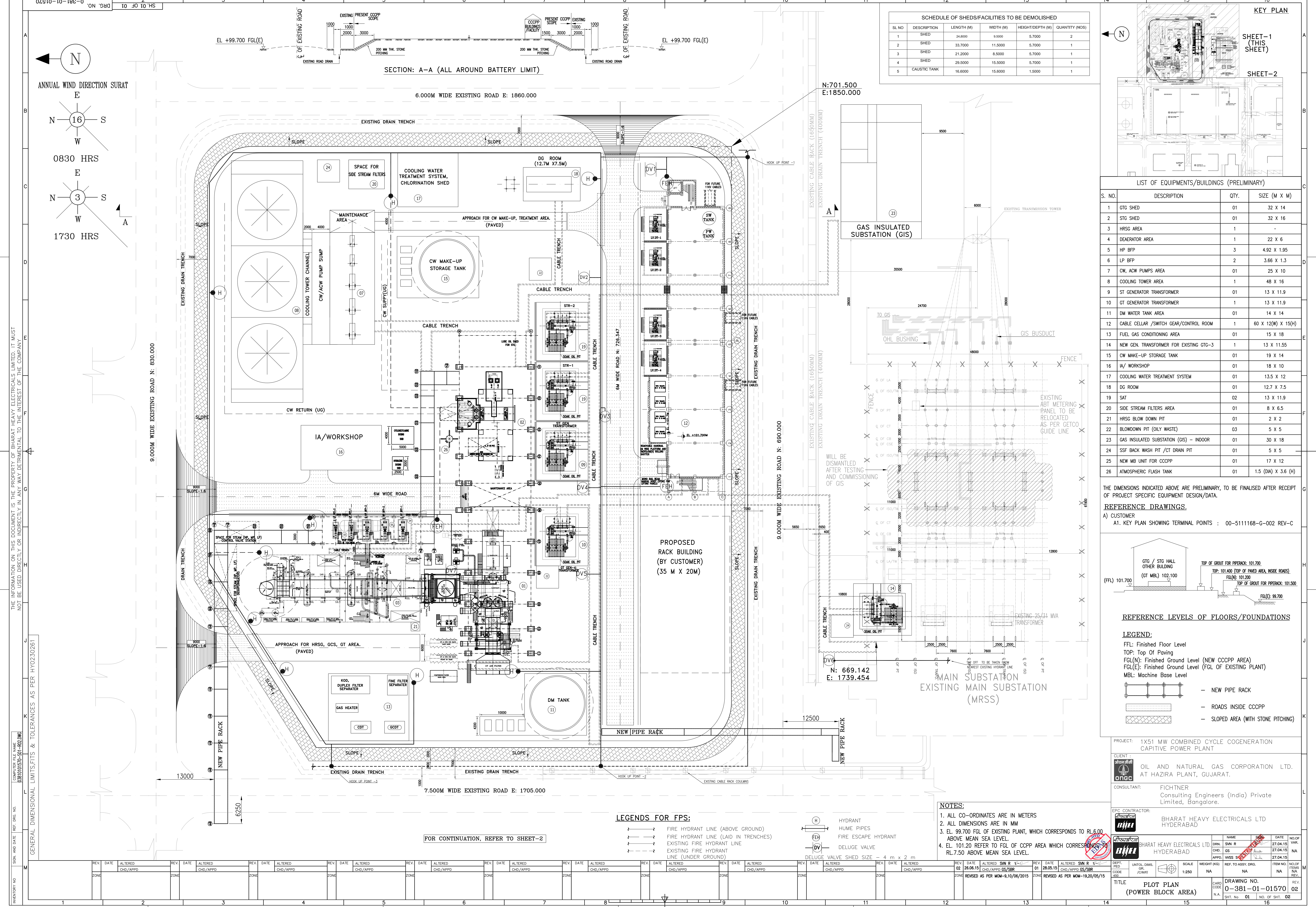
| DEPT. | UNTOL. DIMS. GR. | SCALE | WEIGHT (KG) | REF. TO ASSY. DRG. | ITEM NO. | NO. OF ITEMS |
|-------|------------------|-------|-------------|--------------------|----------|--------------|
| PE&SD | G/M/F | | | -N.A.- | -N.A.- | -N.A.- |

TITLE: P&ID FOR COOLING WATER SYSTEM

CARD CODE: BHEL DRG NO. 2-38101-04546
CUST. DRG NO. 4546-04-1248

REV. 01

SHT. No. 02 No. OF SHT. 02



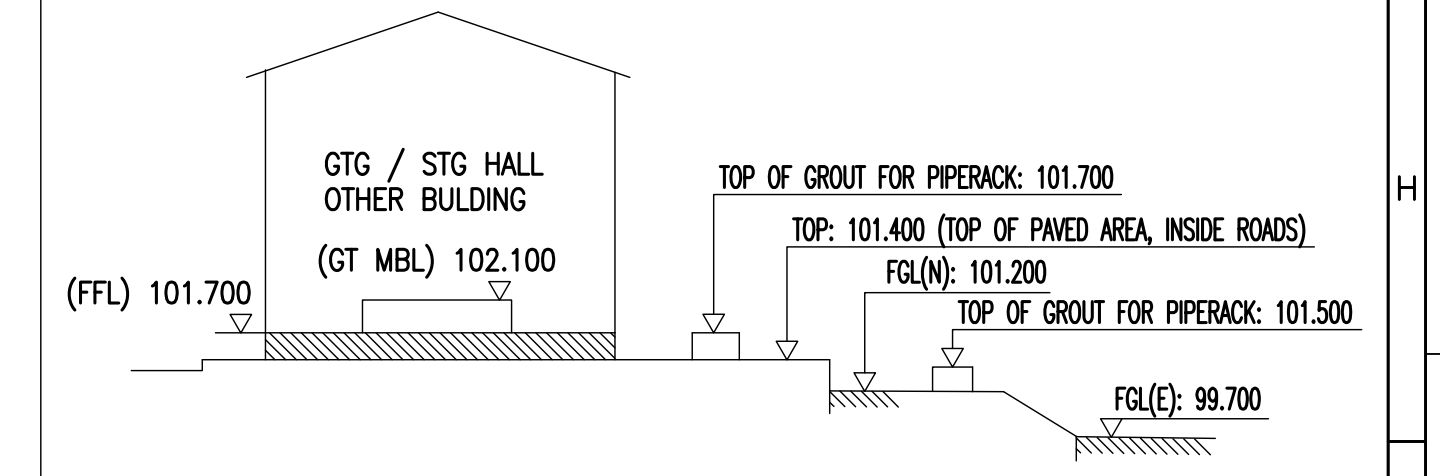
SCHEDULE OF SHEDS/FACILITIES TO BE DEMOLISHED

| SL NO | DESCRIPTION | LENGTH (M) | WIDTH (M) | HEIGHT/DEPTH (M) | QUANTITY (NO) |
|-------|--------------|------------|-----------|------------------|---------------|
| 1 | SHED | 24.0000 | 9.5000 | 5.7000 | 2 |
| 2 | SHED | 33.7000 | 11.5000 | 5.7000 | 1 |
| 3 | SHED | 21.2000 | 8.5000 | 5.7000 | 1 |
| 4 | SHED | 29.5000 | 15.5000 | 5.7000 | 1 |
| 5 | CAUSTIC TANK | 16.6000 | 15.6000 | 1.5000 | 1 |

LIST OF EQUIPMENTS/BUILDINGS (PRELIMINARY)

| S. NO. | DESCRIPTION | QTY. | SIZE (M X M) |
|--------|---|------|---------------------|
| 1 | GTG SHED | 01 | 32 X 14 |
| 2 | STG SHED | 01 | 32 X 16 |
| 3 | HRSG AREA | 1 | - |
| 4 | DEAERATOR AREA | 1 | 22 X 6 |
| 5 | HP BFP | 3 | 4.92 X 1.95 |
| 6 | LP BFP | 2 | 3.66 X 1.3 |
| 7 | CW, ACW PUMPS AREA | 01 | 25 X 10 |
| 8 | COOLING TOWER AREA | 1 | 48 X 16 |
| 9 | ST GENERATOR TRANSFORMER | 01 | 13 X 11.9 |
| 10 | GT GENERATOR TRANSFORMER | 1 | 13 X 11.9 |
| 11 | DM WATER TANK AREA | 01 | 14 X 14 |
| 12 | CABLE CELLAR / SWITCH GEAR/CONTROL ROOM | 1 | 60 X 12(W) X 15(H) |
| 13 | FUEL GAS CONDITIONING AREA | 01 | 15 X 18 |
| 14 | NEW GEN. TRANSFORMER FOR EXISTING GTG-3 | 1 | 13 X 11.55 |
| 15 | CW MAKE-UP STORAGE TANK | 01 | 19 X 14 |
| 16 | IA/ WORKSHOP | 01 | 18 X 10 |
| 17 | COOLING WATER TREATMENT SYSTEM | 01 | 13.5 X 12 |
| 18 | DG ROOM | 01 | 12.7 X 7.5 |
| 19 | SAT | 02 | 13 X 11.9 |
| 20 | SIDE STREAM FILTERS AREA | 01 | 8 X 6.5 |
| 21 | HRSG BLOW DOWN PIT | 01 | 2 X 2 |
| 22 | BLOWDOWN PIT (OLY WASTE) | 03 | 5 X 5 |
| 23 | GAS INSULATED SUBSTATION (GIS) - INDOOR | 01 | 30 X 18 |
| 24 | SSF BACK WASH PIT /CT DRAIN PIT | 01 | 5 X 5 |
| 25 | NEW MB UNIT FOR CCGPP | 01 | 17 X 12 |
| 26 | ATMOSPHERIC FLASH TANK | 01 | 1.5 (DIA) X 3.6 (H) |

THE DIMENSIONS INDICATED ABOVE ARE PRELIMINARY, TO BE FINALISED AFTER RECEIPT OF PROJECT SPECIFIC EQUIPMENT DESIGN/DATA.
REFERENCE DRAWINGS:
 A) CUSTOMER
 A1. KEY PLAN SHOWING TERMINAL POINTS : 00-511168-G-002 REV-C



LEGEND:
 FFL: Finished Floor Level
 TOP: Top Of Paving
 FGL(N): Finished Ground Level (NEW CCGPP AREA)
 FGL(E): Finished Ground Level (FGL OF EXISTING PLANT)
 MBL: Machine Base Level

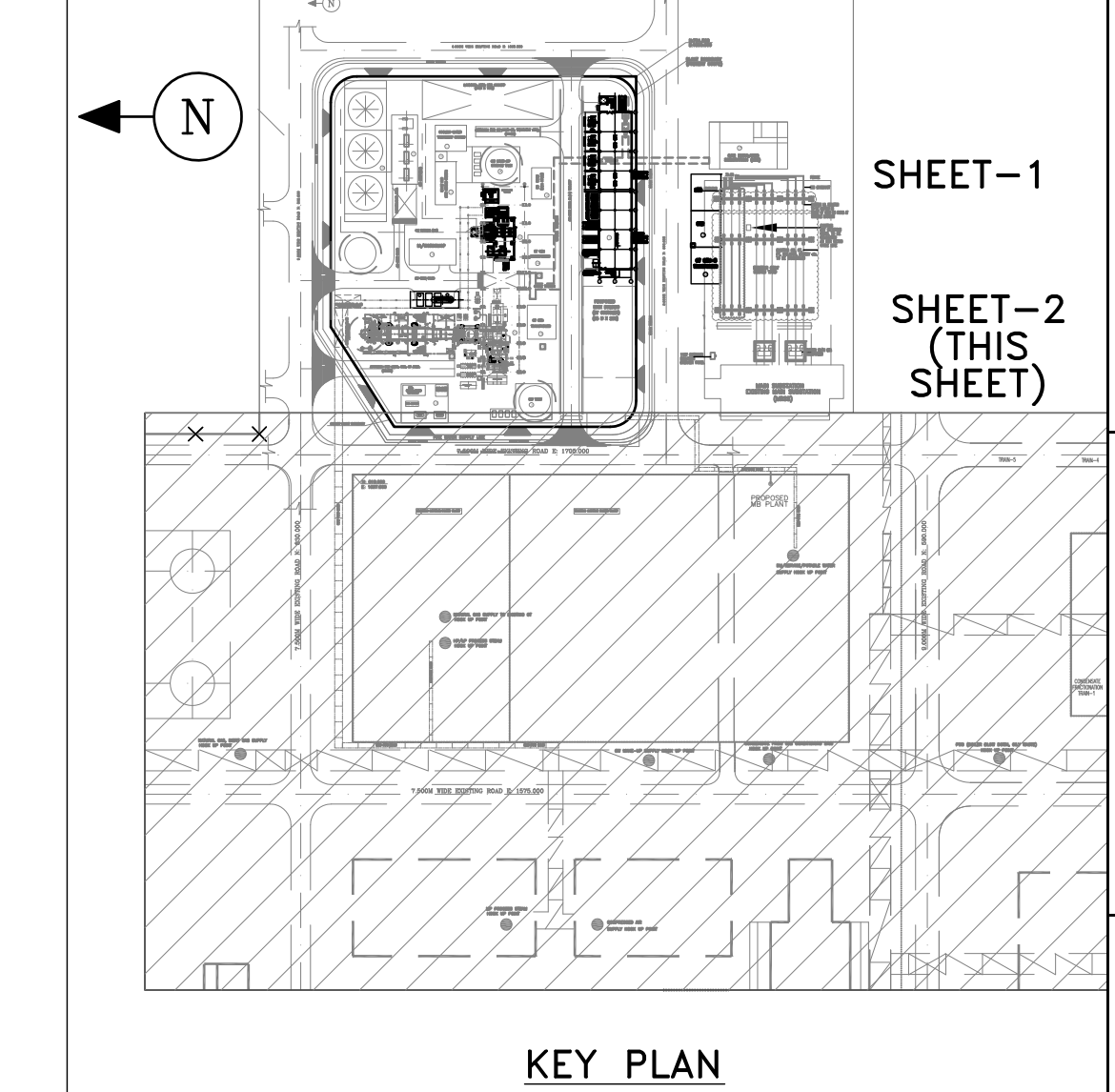
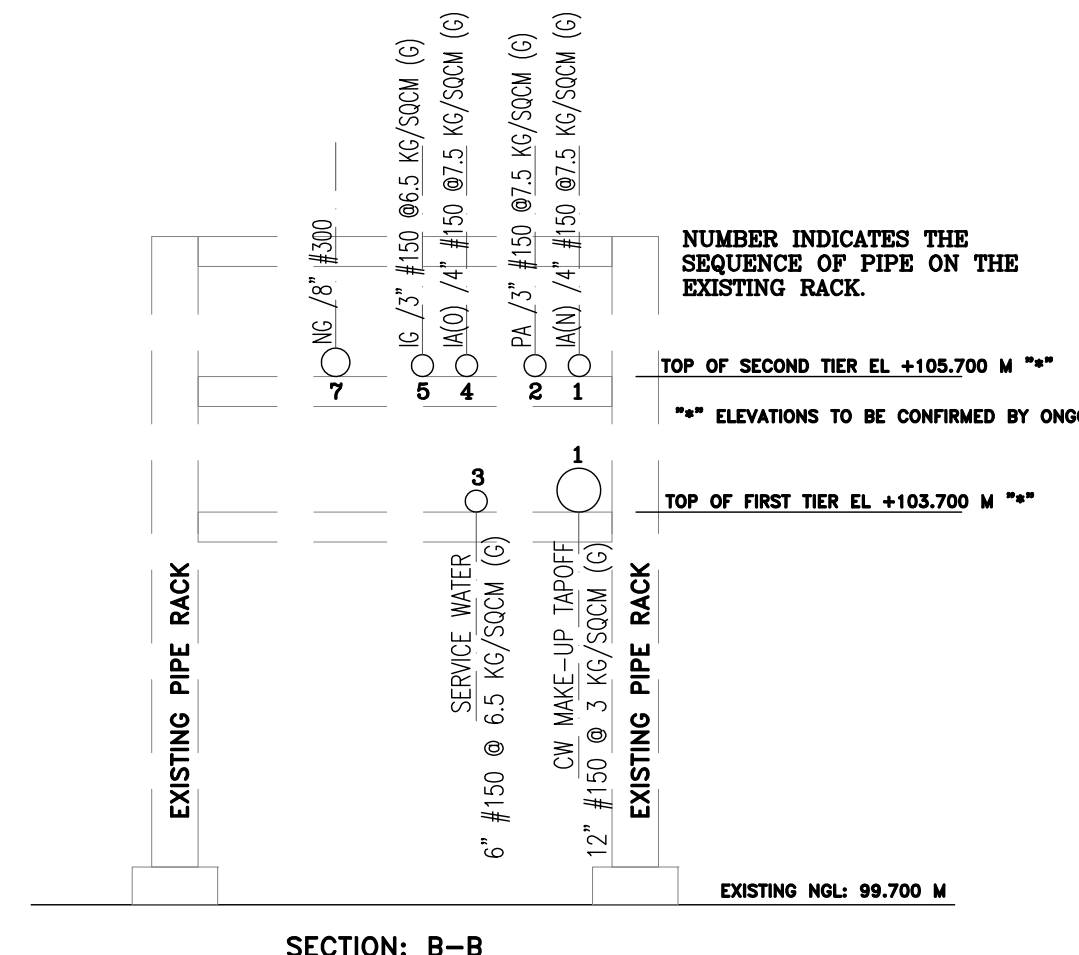
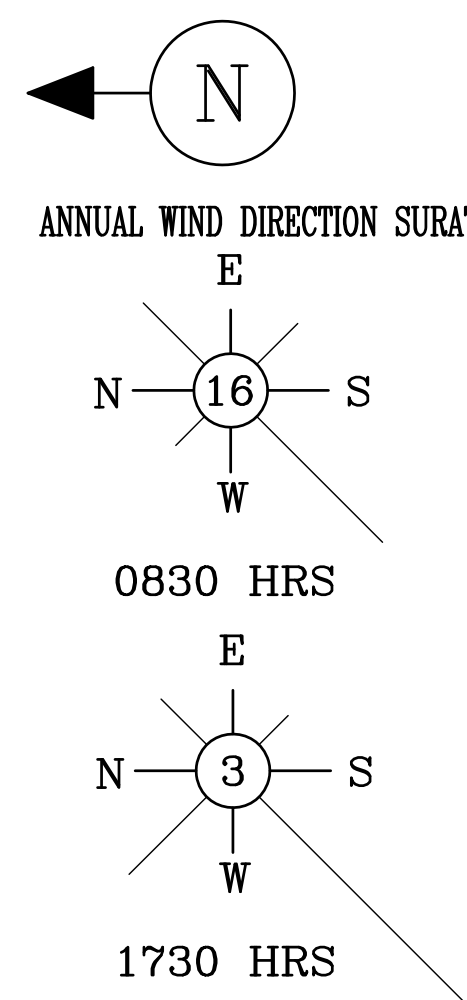
- NEW PIPE RACK
- ROADS INSIDE CCGPP
- SLOPED AREA (WITH STONE PITCHING)

PROJECT: 1X51 MW COMBINED CYCLE COGENERATION CAPTIVE POWER PLANT
 CLIENT: ONGC
 CONSULTANT: FICHTNER Consulting Engineers (India) Private Limited, Bangalore.
 EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LTD HYDERABAD

| REV. | DATE | ALTERED | CHD/APPD | ZONE | REV. | DATE | ALTERED | CHD/APPD | ZONE | REV. | DATE | ALTERED | CHD/APPD | ZONE | REV. | DATE | ALTERED | CHD/APPD | ZONE | REV. | DATE | ALTERED | CHD/APPD | ZONE | REV. | DATE | ALTERED | CHD/APPD | ZONE | REV. | DATE | ALTERED | CHD/APPD | ZONE | REV. | DATE | ALTERED | CHD/APPD | ZONE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|------|------|---------|----------|------|------|------|---------|----------|------|------|------|---------|----------|------|------|------|---------|----------|------|------|------|---------|----------|------|------|------|---------|----------|------|------|------|---------|----------|------|------|------|---------|----------|------|---|--|--|--|--|----|--|--|--|--|----|--|--|--|--|----|--|--|--|--|----|--|--|--|--|----|--|--|--|--|----|--|--|--|--|----|--|--|--|--|
| 1 | | | | | 2 | | | | | 3 | | | | | 4 | | | | | 5 | | | | | 6 | | | | | 7 | | | | | 8 | | | | | 9 | | | | | 10 | | | | | 11 | | | | | 12 | | | | | 13 | | | | | 14 | | | | | 15 | | | | | 16 | | | | |

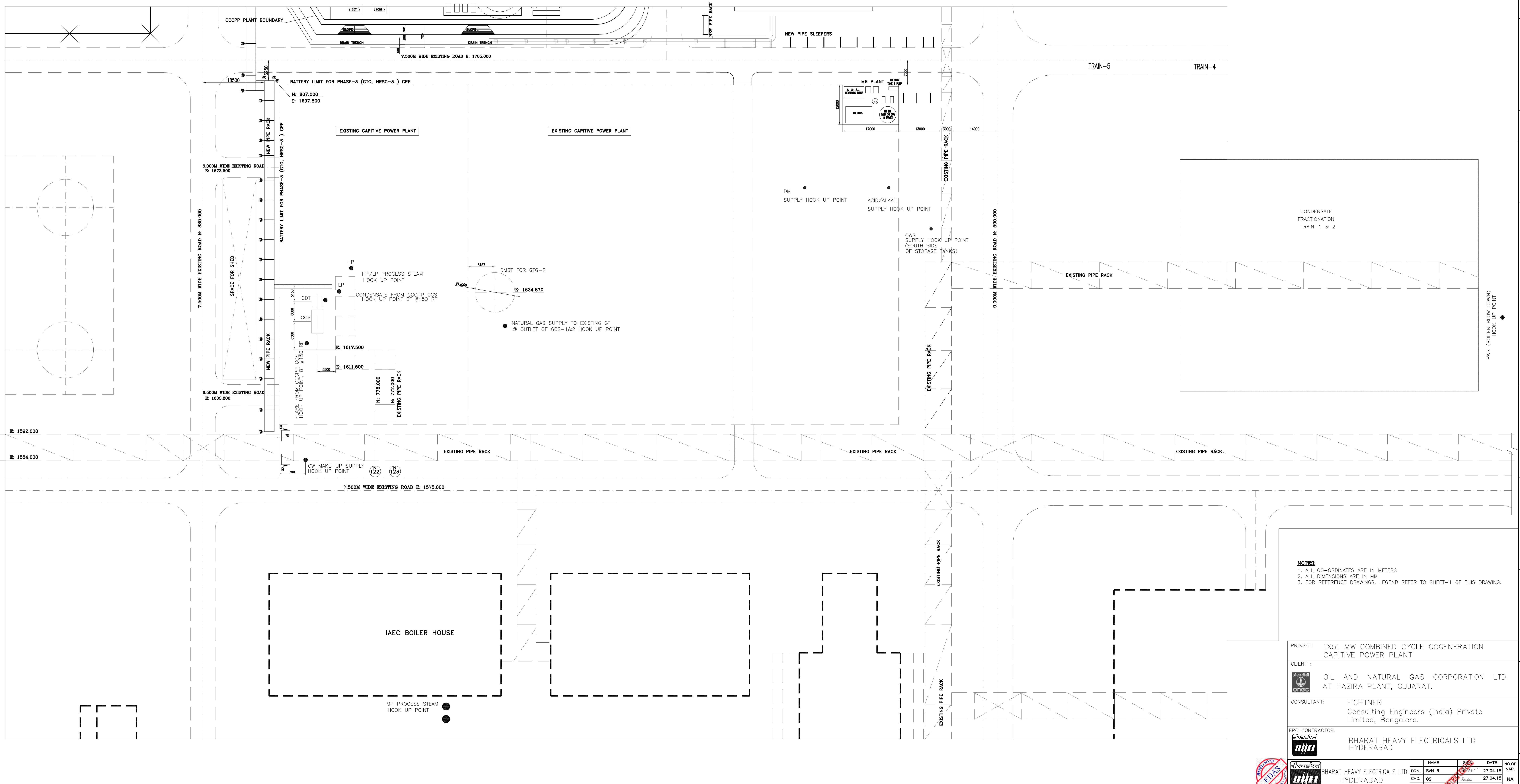
TITLE: PLOT PLAN (POWER BLOCK AREA)
 DRAWING NO. 0-381-01-01570
 SHEET NO. 01 OF 02

THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LIMITED. IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.
 GENERAL DIMENSIONAL LIMITS, FITS & TOLERANCES AS PER HY0230261
 SIGN. AND DATE: REV. DRG. NO. 03/01/15/10-501-102/002
 COMPUTER FILE NAME: 03/01/15/10-501-102/002



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GENERAL DIMENSIONAL LIMITS, FITS & TOLERANCES AS PER HY0230261



- NOTES:**
1. ALL CO-ORDINATES ARE IN METERS
 2. ALL DIMENSIONS ARE IN MM
 3. FOR REFERENCE DRAWINGS, LEGEND REFER TO SHEET-1 OF THIS DRAWING.

PROJECT: 1X51 MW COMBINED CYCLE COGENERATION CAPITIVE POWER PLANT

CLIENT: OIL AND NATURAL GAS CORPORATION LTD. AT HAZIRA PLANT, GUJARAT.

CONSULTANT: FICHTNER Consulting Engineers (India) Private Limited, Bangalore.

EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LTD HYDERABAD

| | | | | | | |
|------------|---|---------|-------------|--------------------|----------|--------------|
| DEPT. CODE | UNTO. DIMS. | SCALE | WEIGHT (KG) | REF. TO ASSY. DRG. | ITEM NO. | NO. OF ITEMS |
| 001 | 0/1 | 1:250 | NA | NA | NA | NA |
| TITLE | PLOT PLAN (DM PLANT AREA, PIPING HOOK-UP LOCATIONS) | | DRAWING NO. | 0-381-01-01570 02 | | |
| CARD CODE | N.A. | SHT. No | 02 | NO. OF SHT. | 02 | |

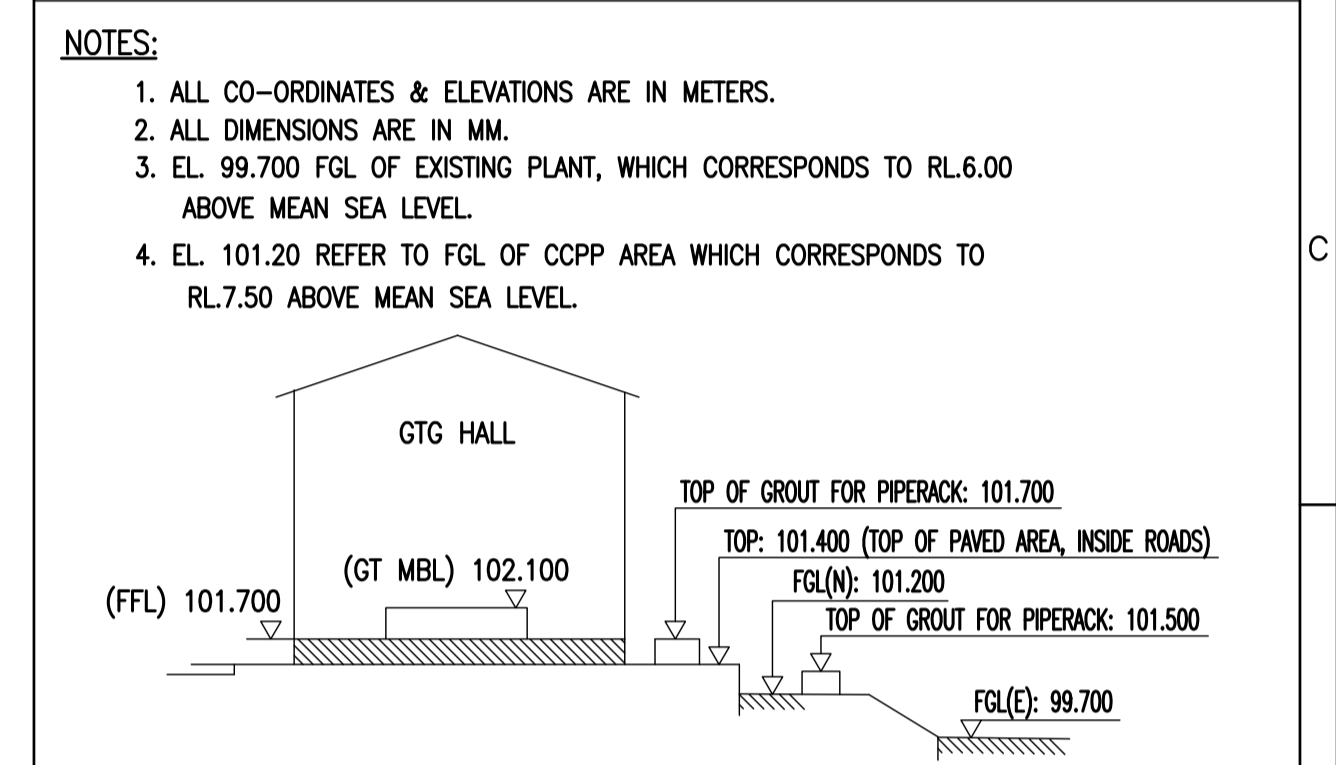
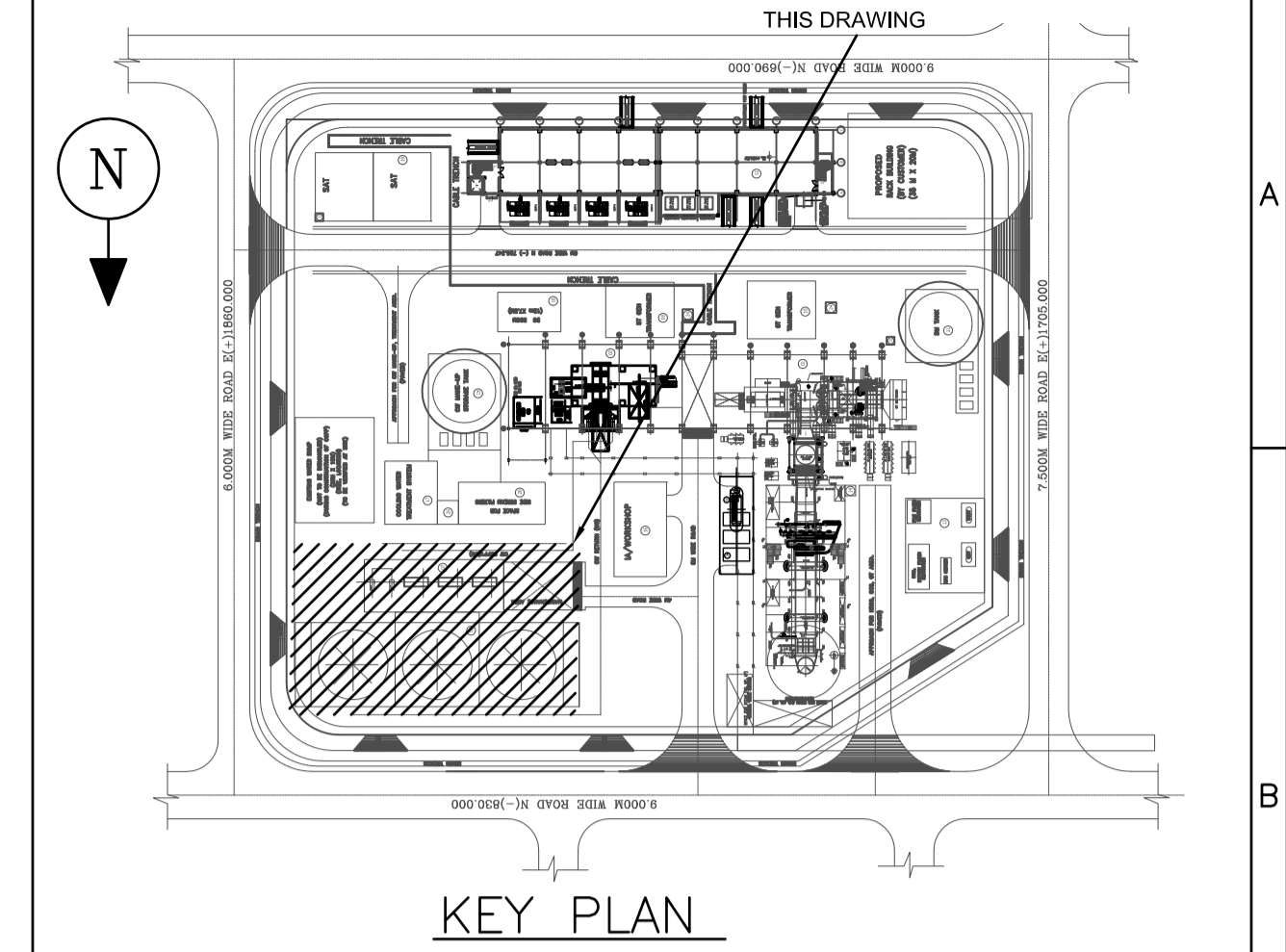
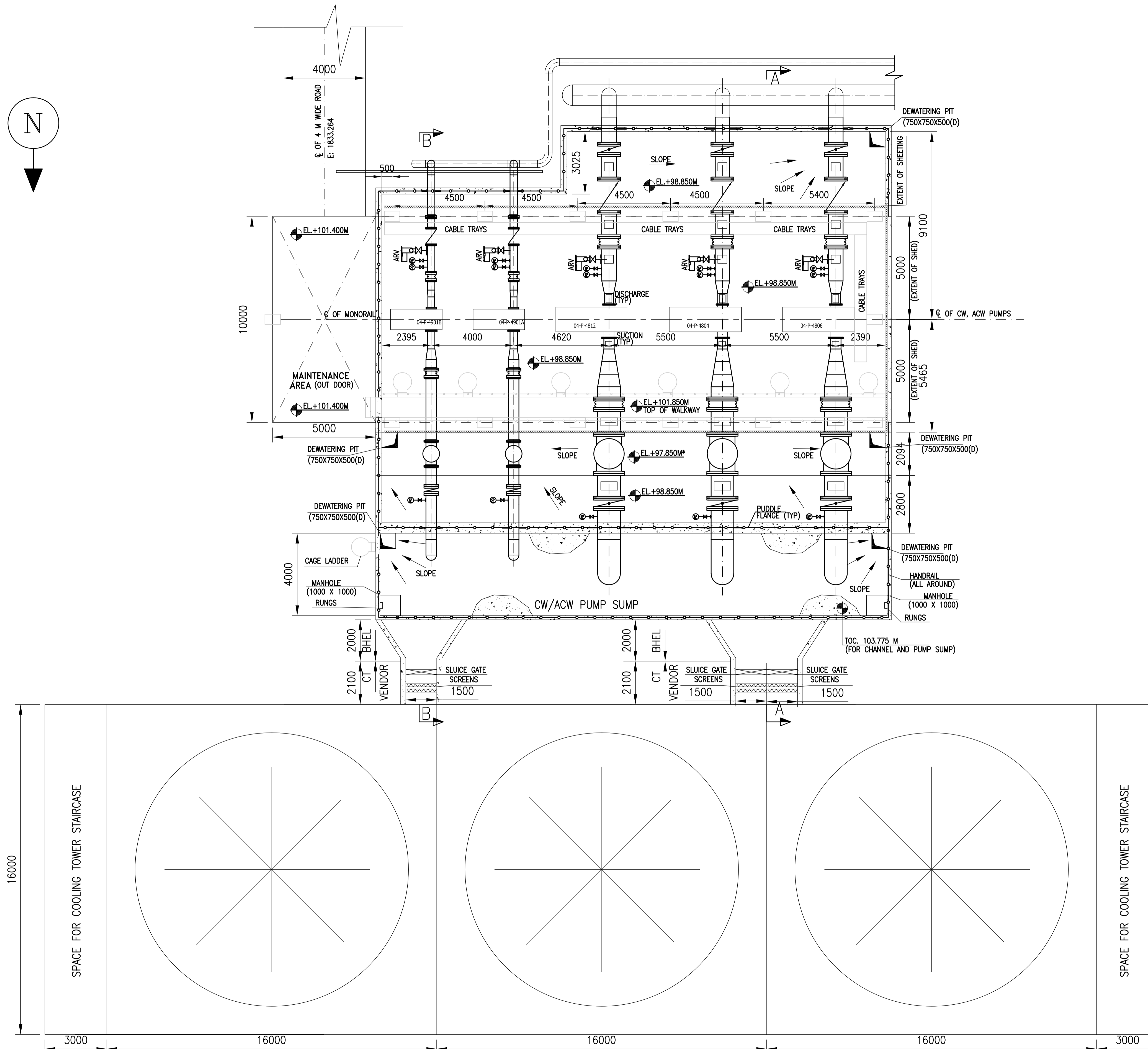
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GENERAL DIMENSIONAL LIMITS, FITS & TOLERANCES AS PER HY0230261

INVENTORY NO

SIGN. AND DATE REF. DRG. NO.

13810106543-501-R00



- NOTES:**
1. ALL CO-ORDINATES & ELEVATIONS ARE IN METERS.
 2. ALL DIMENSIONS ARE IN MM.
 3. EL. 99.700 FGL OF EXISTING PLANT, WHICH CORRESPONDS TO RL.6.00 ABOVE MEAN SEA LEVEL.
 4. EL. 101.20 REFER TO FGL OF CAPP AREA WHICH CORRESPONDS TO RL.7.50 ABOVE MEAN SEA LEVEL.

- REFERENCE LEVELS OF FLOORS/FOUNDATIONS**
- HOLD:**
1. VALVE, SUCTION STRAINER & EXPANSION JOINT DIMENSIONS.

EQUIPMENT LIST

| SL.No. | DESCRIPTION | SIZE (MM) | WEIGHT(KGS) | QTY |
|--------|------------------------------|---------------|-----------------|-----|
| 01 | COOLING WATER PUMP | 3500* X 1200* | 5000 (FLOODED)* | 03 |
| 02 | AUXILIARY COOLING WATER PUMP | 2500* X 1000* | 3000 (FLOODED)* | 02 |
| 03 | GA OF COOLING TOWER | 4800 X 16000 | -- | 01 |

DIMENSION INDICATED WITH "*" IS PRELIMINARY, SHALL BE FINALISED AFTER RECEIPT OF OF PROJECT SPECIFIC DATA.

REFERENCE DRAWINGS

| SL.No. | DESCRIPTION | DRAWING No. |
|--------|-------------|----------------|
| 01 | PLOT PLAN | 0-381-01-01570 |

PROJECT: 1X51 MW COMBINED CYCLE COGENERATION CAPTIVE POWER PLANT

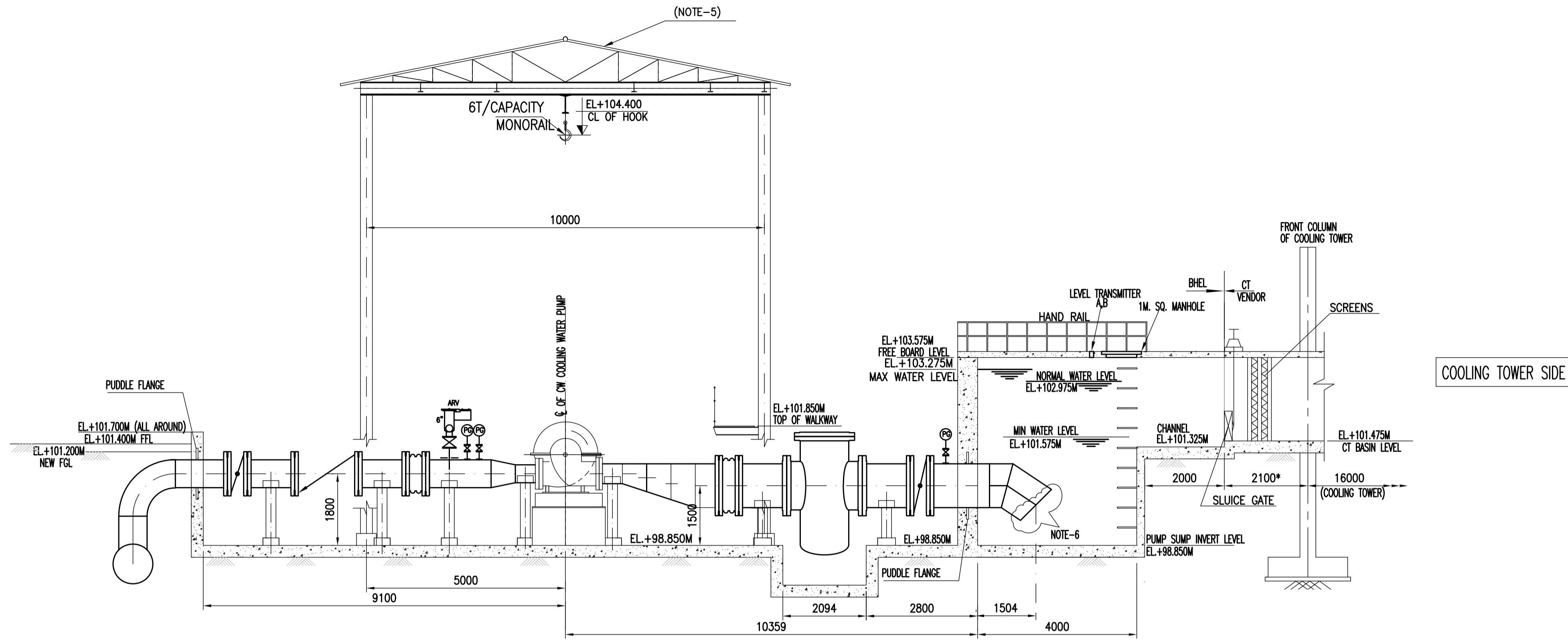
CLIENT: OIL AND NATURAL GAS CORPORATION LTD. AT HAZIRA PLANT, GUJARAT.

CONSULTANT: FICHTNER Consulting Engineers (India) Private Limited, Bangalore.

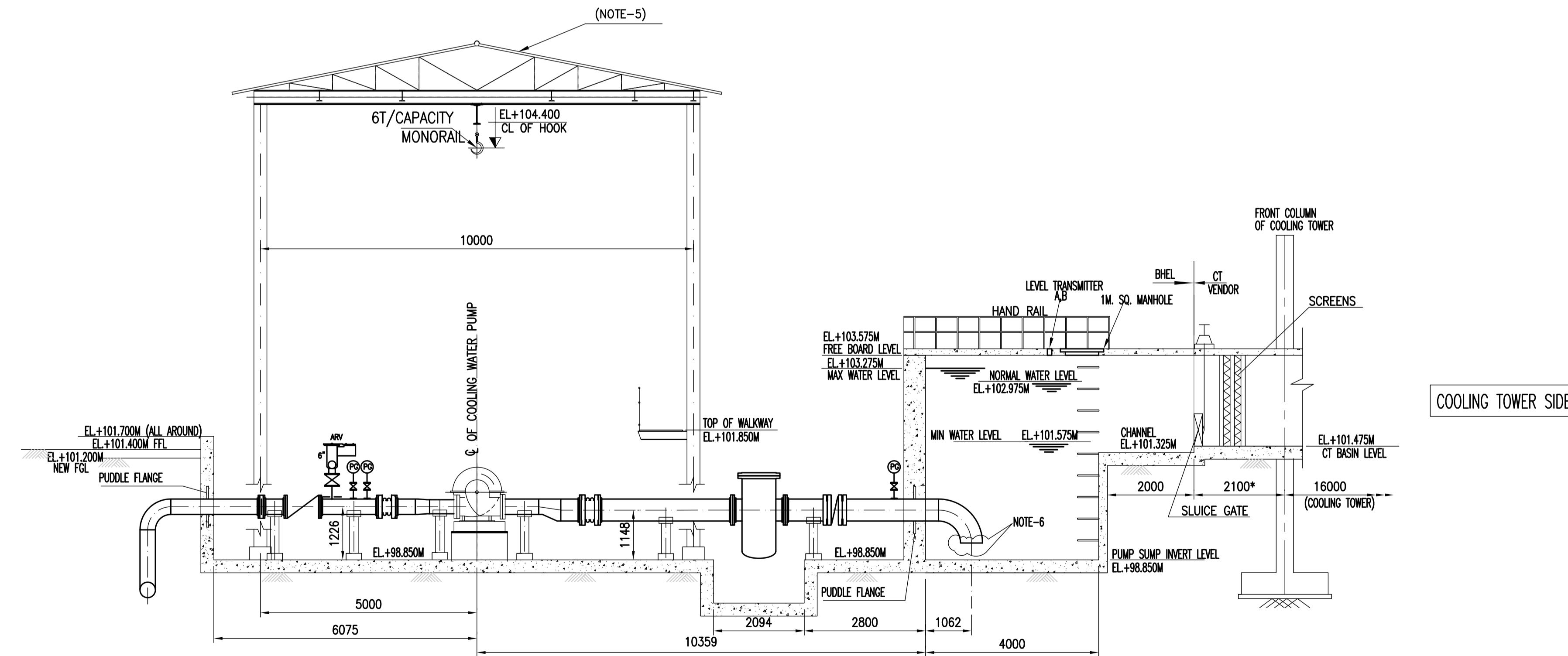
EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LTD HYDERABAD

| DRN. | NAME | SIGN. | DATE | NO.OF VAR. |
|------|------|-------|----------|------------|
| SVNR | | | 06.07.15 | 06.07.15 |
| GS | | | 06.7.15 | NA |
| SBR | | | 06.07.15 | 06.07.15 |

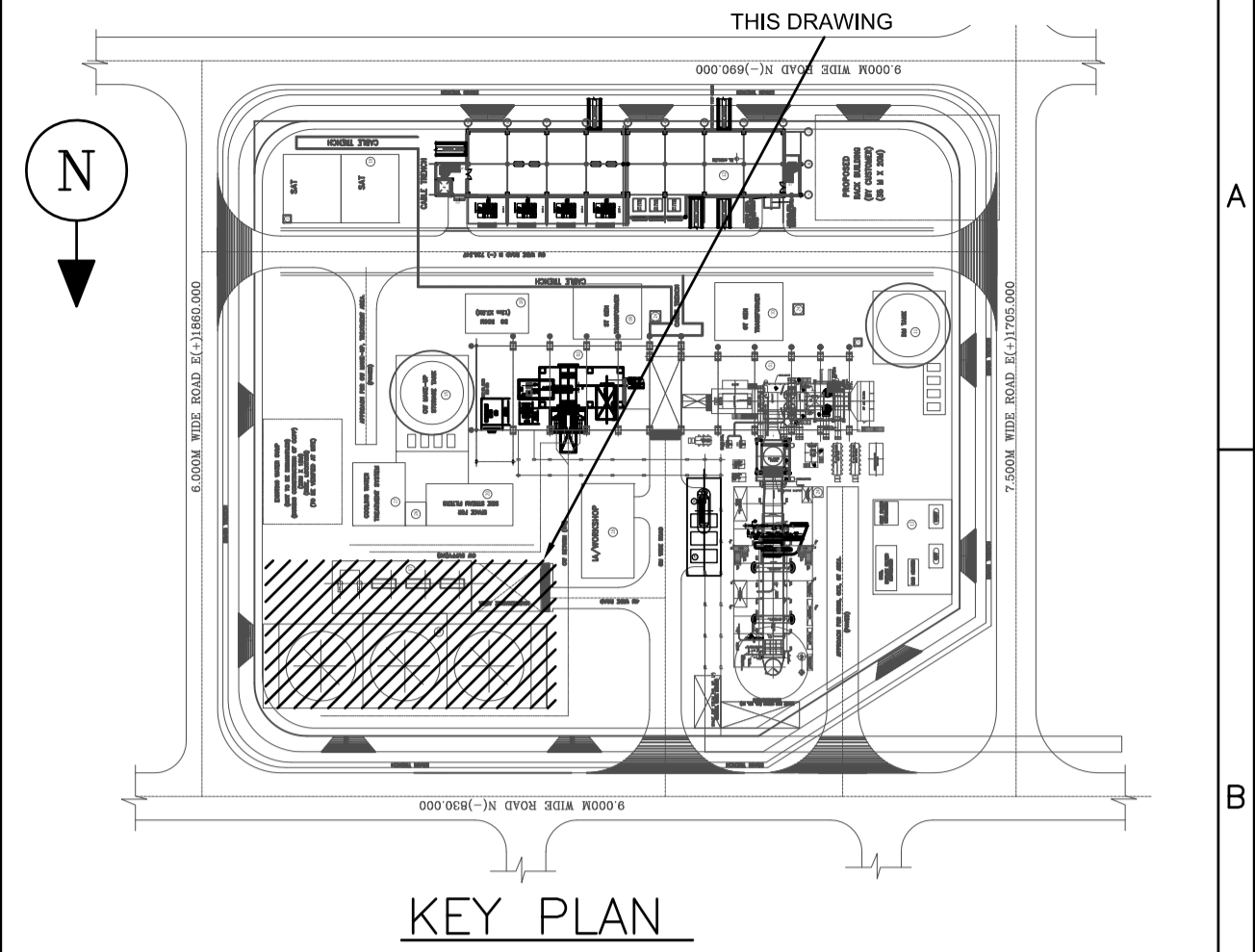
| | | | | | | |
|---------------------------------------|------------------------|------------------------|----------------|-----------------------|----------------|----------------|
| DEPT. CODE 450 | UNTOL. DIMS. GR. 9/M/F | SCALE 1:100 | WEIGHT (KG) NA | REF. TO ASSY. DRG. NA | ITEM NO. NA | NO.OF ITEMS NA |
| TITLE CW & ACW PUMP HOUSE AREA LAYOUT | CARD CODE N.A. | DWG NO: 1-381-01-06543 | REV. 00 | SHT. No 01 | NO. OF SHT. 02 | |



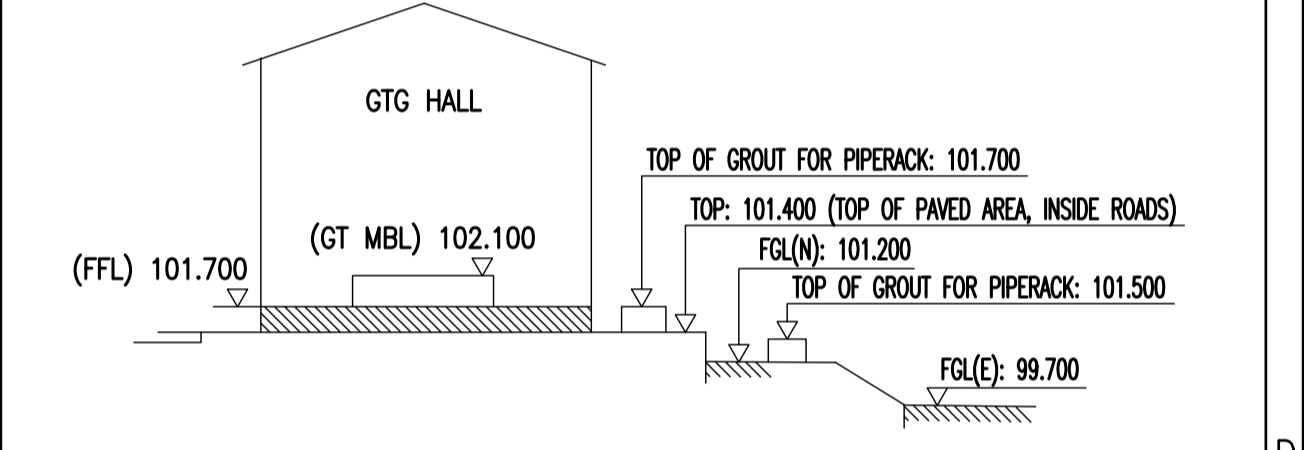
SECTION: A-A



SECTION: B-B



- NOTES:
1. ALL CO-ORDINATES & ELEVATIONS ARE IN METERS.
 2. ALL DIMENSIONS ARE IN MM.
 3. EL. 99.700 FGL OF EXISTING PLANT, WHICH CORRESPONDS TO RL.6.00 ABOVE MEAN SEA LEVEL.
 4. EL. 101.20 REFER TO FGL OF CAPP AREA WHICH CORRESPONDS TO RL.7.50 ABOVE MEAN SEA LEVEL.
 5. THE DETAILS OF SHED SHOWN ARE INDICATIVE. RESPECTIVE CIVIL DESIGN DRAWING SHALL BE REFERRED FOR ACTUAL DETAILS.
 6. SCREEN CAP OF MESH 1 INCH SHALL BE PROVIDED ON PUMP SUCTION.
 7. SHEETING SHALL BE PROVIDED ON THREE SIDES OF THE SHED AS MENTIONED IN PLAN VIEW UPTO EL. 101.850 M.



REFERENCE LEVELS OF FLOORS/FOUNDATIONS

- HOLD:
1. CENTERLINE OF PUMPS, VALVES, SUCTION STRAINER & EXPANSION JOINT DIMENSIONS.

EQUIPMENT LIST

| SL.No. | DESCRIPTION | SIZE (MM) | WEIGHT(KGS) | QTY |
|--------|------------------------------|---------------|-----------------|-----|
| 01 | COOLING WATER PUMP | 3500* X 1200* | 5000 (FLOODED)* | 03 |
| 02 | AUXILIARY COOLING WATER PUMP | 2500* X 1000* | 3000 (FLOODED)* | 02 |
| 03 | GA OF COOLING TOWER | 4800 X 16000 | -- | 01 |

DIMENSION INDICATED WITH "*" IS PRELIMINARY, SHALL BE FINALISED AFTER RECEIPT OF PROJECT SPECIFIC DATA.

REFERENCE DRAWINGS

| SL.No. | DESCRIPTION | DRAWING No. |
|--------|-------------|----------------|
| 01 | PLOT PLAN | 0-381-01-01570 |

PROJECT: 1X51 MW COMBINED CYCLE COGENERATION CAPTIVE POWER PLANT

CLIENT: OIL AND NATURAL GAS CORPORATION LTD. AT HAZIRA PLANT, GUJARAT.

CONSULTANT: FICHTNER Consulting Engineers (India) Private Limited, Bangalore.

EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LTD HYDERABAD

| DRN. | SVNR | NAME | SIGN. | DATE | NO.OF VAR. |
|-------|------|------|-------|----------|------------|
| CHD. | CS | | | 06.07.15 | NA |
| APPD. | SBR | | | 06.07.15 | NA |

| DEPT. CODE | UNTOL. DIMS. GR. g/M/f | SCALE | WEIGHT (KG) | REF. TO ASSY. DRG. | ITEM NO. | NO.OF ITEMS NA REV. |
|------------|------------------------|-------|-------------|--------------------|----------|---------------------|
| 450 | | 1:75 | NA | NA | NA | NA |

TITLE: CW & ACW PUMP HOUSE AREA LAYOUT

CARD CODE: N.A.

DWG NO: 1-381-01-06543

REV. 00

SHT. No 02 NO. OF SHT. 02

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GENERAL DIMENSIONAL LIMITS, FITS & TOLERANCES AS PER HY0230261

| INVENTORY NO | SIGN. AND DATE | REF. DRG. NO. |
|--------------|----------------|---------------|
| | | |

INSTRUCTIONS TO BIDDERS FOR PREPARING TECHNICAL OFFERS
CHECK LIST FOR RCC COOLING TOWER OFFER

Note: Bidder to note that Check List shall be completely filled and the data required in-line with Check List shall be submitted along with their Offer to enable Purchaser to evaluate the offer submitted.

| <u>S.No.</u> | <u>Description</u> | Enclosed or [Yes/No] | Remarks/Comments By Bidder |
|---------------------|--|---------------------------------|-----------------------------------|
| 1 | Bidder to confirm compliance with PEMC-05255 and its annexures without any deviations. | | |
| 2 | Bidder has raised pre-bid queries (if any) on Purchase specification for RCC Cooling Tower. | | |
| 3 | Bidder to Confirm Compliance with scope, terminal points and exclusions for Mechanical/Electrical/C&I Sub-Sections of Purchase Specification. | | |
| 4 | Bidder to design (Thermal Calculations) the cooling tower in accordance with Fulkerson's Handbook in-line with (Section-II) of DETAILED TECHNICAL SPECIFICATION-MECHANICAL of Job Specification for RCC Cooling Tower, Doc. No. PEMC-05255. | | |
| 5 | Bidder shall design the Cooling Tower based on the design data furnished elsewhere in the specification. | | |
| 6 | All the instrumentation indicated for Cooling Tower is included in bidder's scope of supply in-line with P&ID for Condenser Cooling Water System (Refer 2-38101-04546) | | |
| 7 | Bidder shall ensure that necessary handling arrangement, electrical hoist, monorails etc to handle the equipment (CT Fan/Motor and Screens/Gates) are included in-line with purchase specification. | | |
| 8 | Bidder to ensure that the MOC of all equipment shall be in-line with purchase specification. | | |
| 9 | Bidder to ensure the following 1) Frame & guides are HDG Steel. 2) Screen Mesh is SS316 | | |
| 10 | Bidder Shall submit completely filled following Annexures enclosed with Technical Purchase Specification PY 51016, Rev01 along with their offer Annexure-I: Key Information Annexure-II: Guaranteed Datasheet Annexure-III: List of Recommended Spare Parts Annexure-IV: Special Tools and Tackles Annexure-V: List of Deviations(Kindly submit the format with NO Deviations) | | |
| 11 | Bidder to comply compliance with list of sub-vendor | | |

| | | | |
|----|--|--|--|
| | indicated in Job Specification for RCC Cooling Tower, Doc. No. PEMC-05255. | | |
| 12 | Bidder to ensure that the design pressure of Hot Water Header and Flow Control Valves in riser pipes shall be in-line with the P&ID for Condenser Cooling Water System / Doc no. PEMC-05255. | | |
| 13 | All the instruments required for conducting PG Test shall be in Bidder's Scope of Supply in-line with Cl. No. 1.5 of Technical Purchase Specification PY 51016, Rev01. | | |
| 14 | Bidder to ensure that all the above ground earthing and lightning is included in their scope in-line with Job Specification for RCC Cooling Tower, Doc. No. PEMC-05255. | | |
| 15 | Bidder to submit completely filled in Cooling Tower Datasheet (Annexure C) enclosed with Job Specification for RCC Cooling Tower, Doc. No. PEMC-05255 along with their offer. | | |
| 16 | Bidder to fill and sign on the technical suitability list for civil design of cooling tower (Annexure 5) | | |
| 17 | Bidder to ensure that the Design Data indicated (Refer Page 8) enclosed with Job Specification for RCC Cooling Tower, Doc. No. PEMC-05255 is considered during the design of Cooling Tower. | | |
| 18 | Bidder to furnish Thermal Calculation and Fan power Calculations for Cooling Tower along with their offer. | | |
| 19 | Typical GA Drawing of Cooling Tower is enclosed with offer | | |
| 20 | Tentative Electrical Load List is enclosed with offer. | | |
| 21 | All the Data required in-line with Cl. No. 1.5 (Refer Page 5) of Job Specification for RCC Cooling Tower, Doc. No. PEMC-05255 is enclosed with their offer. | | |
| 21 | As per Cl. No. 1.7.3 (Refer Page 7) of PY 51016, Bidder to ensure any UPS requirement is furnished in their offer. | | |
| 22 | Bidder shall furnish the list of Erection and commissioning spares along with their offer. | | |
| 23 | Bidder to furnish the Off-Design Conditions of Cooling Tower in-line with Job Specification for RCC Cooling Tower, Doc. No. PEMC-05255. | | |
| 24 | All the performance curves are enclosed with offer in-line with Cl. No. 4.0(Refer Page 11) of Technical Specification for RCC Cooling Tower, Doc. No. PY-51016 | | |
| 25 | Following are included in Bidder's Scope 1. Cage Ladder 2. Hand Rail on periphery of the deck | | |
| 26 | Bidder shall quote one set of Special Tools and Tackles in-line with Specification for RCC Cooling Tower. | | |
| 27 | All the Cable Trays required for Power, control and | | |

| | | | |
|----|---|--|--|
| | signal cables are included in Bidder's Scope and the same shall be terminated at the ground level in-line with Cl. No. 1.2.0 of DETAILED TECHNICAL SPECIFICATION-ELECTRICAL of Job Specification for RCC Cooling Tower, Doc. No. PEMC-05255 | | |
| 28 | LPBS for each Fan Motor is included in Bidder's Scope in-line with Cl. No. 1.7.2 of Specification for RCC Cooling Tower, Doc. No. PY 51016 | | |
| 29 | Drain valve will be provided by Bidder with a spindle to operate from ground level. | | |
| 30 | Bidder shall furnish Quality Plan [Supply Quality plan as well as Erection & Commissioning Quality Plan] to BHEL along with offer in their standard own format for review by BHEL. | | |

 BIDDER'S STAMP & SIGNATURE

DOCUMENT TRANSMITAL - RCC CT ONGC HAZIRA

| System: | Drg./Doc. | | Cat | | Submission status | | | | | | | |
|------------------------|---------------------------------------|--------|--------|-----|-------------------|-------|-------|-------|-------|-------|--------|---------|
| Mech./Elec. | Drg./ Doc. Name | Number | No. of | A/I | Scheduled Date | Rev.0 | Rev.1 | Rev.2 | Rev.3 | Rev.4 | | |
| Instrum./Civil/General | | | sht | | | Date | Date | Date | Date | Date | Status | Remarks |
| MECHANICAL | | | | | | | | | | | | |
| M.01 | SCHEMATIC VIEW & GA OF CT | | | | 2 weeks from PO | | | | | | | |
| M.02 | DATASHEET FOR COOLING TOWER | | | | 2 weeks from PO | | | | | | | |
| M.03 | DATA SHEET OF AXIAL FLOW FAN | | | | 2 months from PO | | | | | | | |
| M.04 | DATA SHEET OF GEAR BOX | | | | 2 months from PO | | | | | | | |
| M.05 | DATA SHEET OF DRIVE SHAFT | | | | 2 months from PO | | | | | | | |
| M.06 | DATASHEET FOR SLUICE GATE VALVE | | | | 3 months from PO | | | | | | | |
| M.07 | DRIFT ELIMINATOR LAYOUT FOR CT | | | | 2 weeks from PO | | | | | | | |
| M.08 | FAN CYLINDER ACCESS DOOR INSTALLATION | | | | 2 weeks from PO | | | | | | | |
| M.09 | FILL LAYOUT FOR COOLING TOWER | | | | 2 months from PO | | | | | | | |
| M.10 | GA OF CW BASIN FOR CT | | | | 2 weeks from PO | | | | | | | |
| M.11 | GA DRG AND DATASHEET FOR BF VALVE | | | | 2 months from PO | | | | | | | |
| M.12 | GA DRG FOR AXIAL FLOW FAN | | | | 2 months from PO | | | | | | | |
| M.13 | GA DRG FOR GEAR BOX for CT | | | | 2 months from PO | | | | | | | |
| M.14 | GA DRG FOR DRIVE SHAFT for CT | | | | 2 months from PO | | | | | | | |
| M.15 | GA OF SCREEN ASSEMBLY | | | | 2 months from PO | | | | | | | |
| M.16 | GA DRG FOR SLUICE GATE | | | | 2 months from PO | | | | | | | |

DOCUMENT TRANSMITAL - RCC CT ONGC HAZIRA

| System: | Drg./Doc. | | Cat | | Submission status | | | | | | | |
|------------------------|---|--------|--------|-----|-------------------|-------|-------|-------|-------|-------|--------|---------|
| Mech./Elec. | Drg./ Doc. Name | Number | No. of | A/I | Scheduled Date | Rev.0 | Rev.1 | Rev.2 | Rev.3 | Rev.4 | | |
| Instrum./Civil/General | | | sht | | | Date | Date | Date | Date | Date | Status | Remarks |
| M.17 | GA DRG FOR SLUICE VALVE | | | | 2 months from PO | | | | | | | |
| M.18 | GA OF ISOLATION VALVE | | | | 2 months from PO | | | | | | | |
| M.19 | GA OF EQUIPMENT HANDLING FACILITY | | | | 2 months from PO | | | | | | | |
| M.20 | HOT WATER MANIFOLD DETAILS | | | | 2 months from PO | | | | | | | |
| M.21 | HOT WATER PIPING LAYOUT AND DISTRIBUTION WITH INTERFACE DETAILS | | | | 2 months from PO | | | | | | | |
| M.22 | INSTALLATION OF DRIFT ELIMINATORS | | | | 2 months from PO | | | | | | | |
| M.23 | MECHANICAL EQUIPMENT LAYOUT FOR CT | | | | 2 months from PO | | | | | | | |
| M.24 | MECH EQUIP. LUBE LINE INSTALLATION | | | | 2 months from PO | | | | | | | |
| M.25 | MECH EQUIP.INCLUDING MOTOR REMOVAL DETAILS | | | | 2 months from PO | | | | | | | |
| M.26 | P & I D FOR COOLING TOWER SYSTEM | | | | 2 weeks from PO | | | | | | | |
| M.27 | PERFORMANCE CURVES FOR AXIAL FLOW FAN | | | | 2 weeks from PO | | | | | | | |
| M.28 | PERFORMANCE CURVES FOR COOLING TOWER | | | | 1 month from PO | | | | | | | |
| M.29 | OVERFLOW PIPE LAYOUT AND DETAILS | | | | 2 months from PO | | | | | | | |
| M.30 | SIZING CALCULATION FOR CT | | | | 2 weeks from PO | | | | | | | |
| M.31 | SIGHT GLASS ASSY DRAWING | | | | 2 weeks from PO | | | | | | | |
| M.32 | THERMAL CALCULATIONS FOR COOLING TOWER | | | | 2 weeks from PO | | | | | | | |
| M.33 | UTILITY CONSUMPTION DATA | | | | 2 weeks from PO | | | | | | | |

DOCUMENT TRANSMITAL - RCC CT ONGC HAZIRA

| System: | Drg./Doc. | | Cat | | Submission status | | | | | | | |
|------------------------|--|--------|--------|-----|--------------------|-------|-------|-------|-------|-------|--------|---------|
| Mech./Elec. | Drg./ Doc. Name | Number | No. of | A/I | Scheduled Date | Rev.0 | Rev.1 | Rev.2 | Rev.3 | Rev.4 | | |
| Instrum./Civil/General | | | sht | | | Date | Date | Date | Date | Date | Status | Remarks |
| M.34 | DRG INDICATING VIBRATION CUT OFF SWITCH | | | | 1.5 months from PO | | | | | | | |
| M.35 | DRAWING INDICATING LEVEL SWITCH ON LUBE OIL SUMP | | | | 1.5 months from PO | | | | | | | |
| ELECTRICAL | | | | | | | | | | | | |
| E.01 | GA OF FAN MOTOR | | | | 2 months from PO | | | | | | | |
| E.02 | DATA SHEET OF FAN MOTOR | | | | 2 months from PO | | | | | | | |
| E.03 | PERFORMANCE CURVE OF FAN MOTOR | | | | 2 months from PO | | | | | | | |
| E.04 | DATA SHEET FOR LIGHTING FITTINGS | | | | 2 months from PO | | | | | | | |
| E.05 | LIGHTING (LUX LEVEL) CALCULATION | | | | 1 month from PO | | | | | | | |
| E.06 | EARTHING CALCULATION | | | | 1 month from PO | | | | | | | |
| E.07 | LIGHTENING PROTECTION & EARTHING ARRANGEMENT FOR COOLING TOWER | | | | 2 months from PO | | | | | | | |
| E.08 | CABLE LAYOUT & CABLE TRAY DETAILS | | | | 2 months from PO | | | | | | | |
| E.09 | CABLE INTERCONNECTION DIAGRAM | | | | 2 months from PO | | | | | | | |
| E.10 | ILLUMINATION SYSTEM ON COOLING TOWER | | | | 2 months from PO | | | | | | | |
| E.11 | GAD AND DATASHEET FOR ILLUMINATION ITEMS | | | | 3 months from PO | | | | | | | |
| E.12 | LDB PANEL | | | | 2 months from PO | | | | | | | |
| E.13 | ELECTRICAL LOAD LIST | | | | 2 weeks from PO | | | | | | | |

INSTRUMENTATION

DOCUMENT TRANSMITAL - RCC CT ONGC HAZIRA

| System: | Drg./Doc. | | Cat | | Submission status | | | | | | | |
|----------------------------|--|--------|--------|-----|-------------------|-------|-------|-------|-------|-------|--------|---------|
| Mech./Elec. | Drg./ Doc. Name | Number | No. of | A/I | Scheduled Date | Rev.0 | Rev.1 | Rev.2 | Rev.3 | Rev.4 | | |
| Instrum./Civil/ General | | | sht | | | Date | Date | Date | Date | Date | Status | Remarks |
| I.01 | DATA SHEET FOR LOW OIL LEVEL SWITCH | | | | 2 months from PO | | | | | | | |
| I.02 | DATA SHEET FOR TEMPERATURE GAUGE | | | | 2 months from PO | | | | | | | |
| I.03 | DATA SHEET FOR PRESSURE GAUGE | | | | 2 months from PO | | | | | | | |
| I.04 | DATA SHEET FOR LEVEL TRANSMITTER | | | | 2 months from PO | | | | | | | |
| I.05 | DATA SHEET FOR JUNCTION BOX | | | | 2 months from PO | | | | | | | |
| I.06 | DATA SHEET FOR VIBRATION SWITCH | | | | 2 months from PO | | | | | | | |
| I.07 | GA OF PUSH BUTTON STATION | | | | 2 months from PO | | | | | | | |
| I.08 | GA OF INSTRUMENT JUNCTION BOX | | | | 2 months from PO | | | | | | | |
| I.09 | GA OF CONTROL JUNCTION BOX | | | | 2 months from PO | | | | | | | |
| I.10 | INSTRUMENT INDEX | | | | 2 months from PO | | | | | | | |
| I.11 | I/O LIST | | | | 2 months from PO | | | | | | | |
| I.12 | CABLE SCHEDULE | | | | 2 months from PO | | | | | | | |
| CIVIL | | | | | | | | | | | | |
| C.01 | CIVIL DESIGN BASIS REPORT | | | | 1 week from PO | | | | | | | |
| C.02 | DESIGN CALCULATIONS FOR COOLING TOWER SUBSTRUCTURE | | | | 1 month from PO | | | | | | | |
| C.03 | DESIGN CALCULATIONS FOR COOLING TOWER SUPERSTRUCTURE | | | | 1 month from PO | | | | | | | |
| C.04 | CIVIL DESIGN CALCULATION FOR C. T. STAIR | | | | 1 month from PO | | | | | | | |

DOCUMENT TRANSMITAL - RCC CT ONGC HAZIRA

| System: | Drg./Doc. | | Cat | | Submission status | | | | | | | |
|------------------------|---|--------|--------|-----|-------------------|-------|-------|-------|-------|-------|--------|---------|
| Mech./Elec. | Drg./ Doc. Name | Number | No. of | A/I | Scheduled Date | Rev.0 | Rev.1 | Rev.2 | Rev.3 | Rev.4 | | |
| Instrum./Civil/General | | | sht | | | Date | Date | Date | Date | Date | Status | Remarks |
| C.05 | G.A OF COLD WATER BASIN | | | | 1 month from PO | | | | | | | |
| C.06 | CIVIL G.A OF COOLING TOWER SHOWING LONG. AND TRANS. SECTION. | | | | 1 month from PO | | | | | | | |
| C.07 | CIVIL G.A. OF COOLING TOWER SHOWING PLAN AT VARIOUS LEVEL. | | | | 1 month from PO | | | | | | | |
| C.08 | R.C DETAILS OF FOUNDATION SLAB | | | | 2 months from PO | | | | | | | |
| C.09 | SECTIONAL DETAILS OF FOUNDATION SLAB. | | | | 2 months from PO | | | | | | | |
| C.10 | R.C DETAILS OF COLD WATER BASIN SLAB. | | | | 3 months from PO | | | | | | | |
| C.11 | R.C DETAILS OF COLD WATER BASIN LEVEL BEAMS. | | | | 3 months from PO | | | | | | | |
| C.12 | R. C. DETAILS OF COLUMNS UP TO BASIN CURB LEVEL AND BASIN WALL. | | | | 3 months from PO | | | | | | | |
| C.13 | R.C. DETAILS OF COLD WATER OUTLET. | | | | 3 months from PO | | | | | | | |
| C.14 | R.C. DETAILS OF SUDGE COLLECTING CHAMBER. | | | | 3 months from PO | | | | | | | |
| C.15 | R.C. DETAILS COLUMNS ABOVE BASIN CURB LEVEL | | | | 3 months from PO | | | | | | | |
| C.16 | R.C. DETAILS OF LONG & TRANS BEAMS AT BASIN CURB LEVEL. | | | | 3 months from PO | | | | | | | |
| C.17 | R.C. DETAILS OF LONG & TRANS BEAMS AT AIR INTAKE LEVEL. | | | | 3 months from PO | | | | | | | |
| C.18 | R.C DETAILS OF LONG & TRANS BEAMS AT DRIFT LEVEL | | | | 3 months from PO | | | | | | | |
| C.19 | R.C. DETAILS OF LONG & TRANS BEAMS AT ROOF DECK LEVEL. | | | | 3 months from PO | | | | | | | |
| C.20 | R. C DETAILS OF ROOF DECK SLAB. | | | | 3 months from PO | | | | | | | |
| C.21 | R.C. DETAILS OF HOT WATER DUCT. | | | | 3 months from PO | | | | | | | |

DOCUMENT TRANSMITAL - RCC CT ONGC HAZIRA

| DOCUMENT TRANSMITAL - RCC CT ONGC HAZIRA | | | | | | | | | | | | |
|---|--|--------|--------|-----|-------------------|-------|-------|-------|-------|-------|--------|---------|
| System: | Drg./Doc. | | Cat | | Submission status | | | | | | | |
| Mech./Elec. | Drg./ Doc. Name | Number | No. of | A/I | Scheduled Date | Rev.0 | Rev.1 | Rev.2 | Rev.3 | Rev.4 | | |
| Instrum./Civil/General | | | sht | | | Date | Date | Date | Date | Date | Status | Remarks |
| C.22 | G.A OF END WALL AND CELL PARTITION WALL. | | | | 3 months from PO | | | | | | | |
| C.23 | GENERAL ARRANGEMENT OF STAIR CASE. | | | | 3 months from PO | | | | | | | |
| C.24 | R.C.DETAILS OF BRACING FROM FOUNDATION LEVEL TO BASIN CURB LEVEL | | | | 3 months from PO | | | | | | | |
| C.25 | R.C. DETAILS OF FAN CYLINDER. | | | | 3 months from PO | | | | | | | |
| C.26 | R.C DETAILS OF END WALL | | | | 3 months from PO | | | | | | | |
| C.27 | R.C DETAILS OF STAIR CASE | | | | 3 months from PO | | | | | | | |
| C.28 | G.A OF FAN CYLINDER. | | | | 3 months from PO | | | | | | | |
| QUALITY | | | | | | | | | | | | |
| Q.01 | QUALITY ASSURANCE PLAN SHOP | | | | 2 weeks from PO | | | | | | | |
| Q.02 | FIELD QUALITY ASSURANCE PLAN | | | | 1 month from PO | | | | | | | |
| Q.03 | TEST AND GUARANTEE CERTIFICATE | | | | 4 months from PO | | | | | | | |
| ERECTION | | | | | | | | | | | | |
| E.01 | INSTALLATION, OPERATION AND MAINTENANCE MANUAL | | | | 4 months from PO | | | | | | | |
| PROCEDURE | | | | | | | | | | | | |
| P.01 | PG TEST PROCEDURE | | | | 4 months from PO | | | | | | | |
| P.02 | SURFACE PREPARATION AND PAINTING PROCEDURE | | | | 4 months from PO | | | | | | | |
| P.03 | FIELD ERECTION & TESTING PROCEDURE | | | | 4 months from PO | | | | | | | |

DOCUMENT TRANSMITAL - RCC CT ONGC HAZIRA

| System: | Drg./ Doc. Name | Drg./Doc. | | Cat | Scheduled Date | Submission status | | | | | Status | Remarks |
|------------------------------|---|-----------|--------|-----|------------------|-------------------|-------|-------|-------|-------|--------|---------|
| Mech./Elec. | Drg./ Doc. Name | Number | No. of | A/I | | Rev.0 | Rev.1 | Rev.2 | Rev.3 | Rev.4 | | |
| Instrum./Civil/General | | | sht | | | Date | Date | Date | Date | Date | | |
| BOM/ BILLING SCHEDULE | | | | | | | | | | | | |
| B.01 | BILL OF MATERIAL | | | | 2 months from PO | | | | | | | |
| B.02 | BILLING SCHEDULE FOR SUPPLY | | | | 3 months from PO | | | | | | | |
| B.03 | BILLING SCHEDULE FOR ERECTION | | | | 3 months from PO | | | | | | | |
| B.04 | MANDATORY SPARES LIST | | | | 2 months from PO | | | | | | | |
| B.05 | RECOMMENDED SPARES LIST FOR 2YRS OF OPERATION | | | | 2 months from PO | | | | | | | |
| | A-Approval | | | | | | | | | | | |
| | I-Information | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | Indicates Approved | | | | | | | | | | | |
| | Indicates Pending with PCTL | | | | | | | | | | | |
| | Indicated Pending with BHEL | | | | | | | | | | | |

| TECHNICAL SUITABILITY CHECK LIST FOR COOLING TOWER CIVIL DESIGN | | | |
|---|---|---|--|
| | | Design requirement. | Bidder to confirm |
| 1 | SOIL DATA | As per preliminary soil report attached. Final soil report shall be furnished later. | |
| 2 | WIND SPEED | The basic wind speed shall be considered as 44 m/s. | |
| 3 | SEISMIC ZONE | The zone III shall be considered for seismic design. | |
| 4 | GRADE OF CONCRETE | M30 for all structures including piling | |
| 5 | GRADE OF STEEL | Fe 500 TMT/ HYSD Bars | |
| 6 | WATER RETAINING STRUCTURAL PART | AS PER IS:3370 | |
| 7 | DESIGN OF SUPERSTRUCTURE | AS PER IS:456 | |
| 8 | MEAN OF DAILY MAXIMUM TEMPERATURE | 45.6 | |
| 9 | MEAN OF DAILY MINIMUM TEMPERATURE | 4.4 | |
| 10 | TYPE OF FOUNDATION CONSIDERED (To be decided by vendor based on soil data furnished as part of NIT) | | vendor to tick(v) foundation selected and confirm the respective design requirement. |
| | | <p>RAFT</p> <p>1) in case , raft is considered, then bearing capacity to be calculated. as per soil report attached with NIT.</p> <p>2) bearing capacity based on shear shall be calculated as per IS:6403</p> <p>3) bearing capacity based on settlement shall be calculated as per IS:8009.</p> <p>4)Factor of safety for bearing capacity calculation shall be considered as 2.5.</p> <p>5) Max permissible settlement for raft shall be 40 mm.</p> <p>6) Net bearing capacity shall be minimum of 2) and 3).</p> | |
| | | <p>PILE</p> <p>1)In case pile is adopted, the capacities of pile :: vertical capacity =65 MT, Lateral Fixed Head=4.5MT,Lateral Free Head=2MT, uplift =20 MT.</p> <p>2)The number of piles to be decided based on above pile capacities meeting codal requirement.</p> | |
| NOTE | The type of foundation selected by vendor will be reviewed for suitability of design along with CT civil design during execution stage. In case the suggested foundation not meeting the codal requirement , the vendor has to change the foundation type suitability meeting codal requirement.The BOQ variation clauses as mentioned in NIT will apply. | | |

Signature of Vendor

TD-201

Rev No. 00

Form No.



PRODUCT STANDARD
PROJECT ENGINEERING & SYSTEMS DIVISION
HYDERABAD

ANNEXURE to
PEMC05255

Rev No. 00

Page 1 of 3


QAP GUIDELINES & FORMAT


(ANNEXURE TO SPECIFICATION PEMC 05255)

The QAP format and Guidelines for filling up the format shall be used by vendor for preparation and submission of QAP after order placement.

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| | | | |
|--|--|---|--------------------------|
| Form No. |  HYDERABAD | <p style="text-align: center;">PRODUCT STANDARD PROJECT ENGINEERING & SYSTEMS DIVISION HYDERABAD</p> | ANNEXURE to PEMC05255 |
| | Rev No. 00 | | |
| | Page 2 of 3 | | |
| <p style="writing-mode: vertical-rl; transform: rotate(180deg);">COPYRIGHT AND CONFIDENTIAL</p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company.</p> | <p style="text-align: center;"><u>GUIDELINES TO VENDORS FOR PREPARATION OF QUALITY ASSURANCE PLAN</u></p> <ol style="list-style-type: none"> 1. QAP shall be made in landscape mode on A4 size paper as per the format enclosed. Font size shall be minimum 10. 2. Each page of QAP shall contain the following information. <ol style="list-style-type: none"> a) Vendor's name & address. b) Customer: BHEL, Hyderabad. c) Project. d) BHEL Product Standard Number/revision number as referred in P.O. e) BHEL Purchase Order Number & Date. f) Product as per P.O. description. g) QAP Number (unique and shall not repeat)/revision number/date. h) Page number and number of pages 3. QAP shall contain four parts / stages as follows. <ol style="list-style-type: none"> a) Raw materials and bought out items. b) In process Control / Inspection. c) Final assembly, Inspection & Testing. d) Painting, preservation & packing. 4. Under 'Component', indicate name of the component (say casing, rotor, pressure gauge, etc). 5. Under 'Characteristics', indicate appropriately (say chemical analysis, mechanical properties, NDT (UT,DP etc.), hydrostatic test, calibration check etc.) 6. Under 'Class', indicate minor, major or critical depending on the importance of characteristic. 7. Under 'Type of check', indicate appropriately (say chemical, mechanical, UT, DP etc.) 8. Under 'Quantum of check', indicate appropriately (say 100%, 10%, sample, per melt, per heat, all pieces etc.) 9. Under 'Reference document' and 'Acceptance norms', appropriate National & International standards, BHEL standards, approved drawing references etc. should be indicated. It is not correct to mention as "Vendor's internal standards or Vendor's standard practice etc.". If vendors' internal standards are referred, same shall be in line with BHEL Spec. indicated in the P.O. These may require review & approval by our Engineering dept. 10. Under 'Format of record', indicate appropriately supplier's test certificate, calibration certificate, lab report, inspection report etc. | | |
| | | Ref. Doc | |

| | | | | |
|--|----------|---|--|--------------------------|
| | Form No. |  HYDERABAD | <p style="text-align: center;">PRODUCT STANDARD</p> <p style="text-align: center;">PROJECT ENGINEERING & SYSTEMS DIVISION HYDERABAD</p> | ANNEXURE to PEMC05255 |
| | | | Rev No. 00 | |
| | | | Page 3 of 3 | |
| <p style="writing-mode: vertical-rl; transform: rotate(180deg);">COPYRIGHT AND CONFIDENTIAL</p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company.</p> | | <p>11. Please refer 'Agency' in QAP format. Under P: Perform, W: Witness, V: Verify Indicate against each characteristic 1: (BHEL CQS/Nominated inspection agency), OR 2: (Vendor / Sub vendor) Note: Performing agency is normally vendor or his sub vendor (Legend 2). Where witness points are indicated in specification, P.O., Drawing etc., for such operations, under Witness (W) column use 1. Under 'Verify' column, use code 1.</p> <p>12. Under 'D' please put (<input type="checkbox"/> Tick) against each characteristic where vendor proposes to submit test certificate/report etc. OR as required as per BHEL Specification.</p> <p>13. Vendor's signature & stamp should be available on each page of QAP.</p> <p>14. Vendor should read the BHEL Product Standard thoroughly and QAP should be made only inline and relevant to the Specification & Approved Drawings.</p> <p>15. The following operations/characteristics/check points may be included (AS APPROPRIATE)</p> <ul style="list-style-type: none"> a) Visual check b) Dimensional check c) Mechanical and Chemical properties. d) Surface preparation before painting (by chemical cleaning, sand blasting, shot blasting etc. as the case may be.) e) Painting check for shade, Dry Film Thickness (DFT), Adhesion/ peel off test etc. f) Check for correctness for all components mounted as per General arrangement Drawing, Bill Of Materials (BOM), etc. for range, rating, make, color, size, location as per GA, quantity, label description including tag nos., annunciator facia, loose components, accessories, spares etc. g) Verification of test certificate for protection class for the enclosures. h) Mechanical functioning of switches. i) Continuity of earthing and provision of earth points. j) Colour coding of wiring, size, tightness & dressing of wiring. k) Review of test certificates of assembled items, raw materials, internal test reports etc. l) Witness of functional checks, which may include mechanical run & electrical run, H.V.test, IR measurement, Electrical and Mechanical tests etc. m) PQR, WPS, Welder Qualification Record, welding records (fit up, DP) etc. n) Material identification (for punch marks of serial numbers, Heat No, Melt No, Inspector's stamp etc.) o) Hydraulic Pressure Test, Pneumatic Pressure Test, Liquid Penetration Examination and other Non Destructive Tests. p) Tests on Galvanised items (Visual, Hammer Test, Knife Test, Thickness, Pierce Test (Copper sulphate test), Hydrogen evaluation test, Stripping test (for Mass of Zinc coating) q) All tests as per BHEL Product Standard & approved drawings including Type tests and Routine tests on individual items and on System as a whole. r) Packing and Preservation. | | |
| | Ref. Doc | | <p>16. <u>QAP Format enclosed.</u></p> | |

DATA SHEET TO BE FILLED BY BIDDER

| Sl. No. | Description | Unit | Data |
|--------------|---|---------------------|------|
| 1.0.0 | COOLING TOWER | | |
| a) | Design & Manufacturing standard / code | | |
| b) | Type of construction | | |
| c) | Design Cold water temperature | °C | |
| d) | Design Cooling range | °C | |
| e) | Design tower inlet air wet bulb temperature including recirculation allowance | °C | |
| f) | Recirculation allowance. | °C | |
| g) | Cycle of concentration of circulating water | | |
| | Tower Data | | |
| h) | No. of cells (including spare) | nos. | |
| i) | Flow through each cell | m ³ /hr. | |
| j) | L/G ratio | | |
| k) | Drift loss | % | |
| l) | Evaporation loss | % | |
| m) | Active tower volume | m ³ | |
| n) | Total wetted surface | m ² | |
| o) | Type of fill arrangement | | |
| p) | Type of drift eliminators | | |
| q) | Type of recovery stack | | |
| r) | No. of Distribution valves / cell and sizes | | |
| s) | Min. pressure head required at the spray nozzle header | bar(g) | |
| t) | Tower size | m x m x m | |
| | Material Of Constructions | | |
| u) | Casing | | |
| v) | Fills | | |
| w) | Louvers | | |
| x) | Nozzles | | |
| y) | Drift eliminator and its supports | | |
| 2.0.0 | FAN DETAILS | | |
| a) | Design & Manufacturing standard / code | | |
| b) | Type | | |
| c) | Design Air flow rate | m ³ /s | |
| d) | Material of fan blades and hub | | |
| e) | Speed | rpm | |
| f) | Fan Motor Power | kW | |
| g) | Temperature of outgoing mixed air | °C | |

Annexure C

| | | | |
|--------------|--|---------------------|--|
| 3.0.0 | BUTTERFLY VALVES | | |
| a) | Design & Manufacturing standard / code | | |
| b) | Location | | |
| c) | Valve sizes and Number | mm | |
| d) | Valve opening / closing time | | |
| e) | Flow- maximum / normal | m ³ /hr. | |
| f) | Maximum / normal operating pressure | bar | |
| g) | Actuator for BF valves | | |
| | Material of Construction | | |
| h) | Body | | |
| i) | Disc | | |
| j) | Shaft | | |
| k) | Companion flanges | | |