

# **DEENDAYAL PORT AUTHORITY**



**MECHANICAL ENGINEERING DEPARTMENT**

**Tender No. MS/WK/4030/VIII-EPC**

**GLOBAL TENDER FOR  
“ENGINEERING, PROCUREMENT AND CONSTRUCTION FOR  
DEVELOPMENT OF MECHANIZED FERTILIZER AND OTHER  
CLEAN CARGO HANDLING FACILITY AT BERTH NO.14 IN  
DEENDAYAL PORT, KANDLA”**

## **VOLUME-II**

**Employer's Requirements, Scope of Work, Specifications & Drawings**

---

**June 2023**

# Table of Contents

## Contents

<b>Employer's Requirements, Scope of Work, Specifications &amp; Drawings .....</b>	<b>1</b>
--	----------

<b>1. PROJECT BACKGROUND AND SITE INFORMATION: .....</b>	<b>10</b>
1.1 Introduction:.....	10
1.2 Site Location:.....	11
1.3 Meteorology.....	11
1.3.1 Winds.....	11
1.3.2 Rainfall.....	11
1.3.3 Temperature.....	11
1.3.4 Visibility.....	11
1.3.5 Relative Humidity .....	11
1.4 Road Connectivity .....	12
1.5 Rail Connectivity.....	12
<b>2. SCOPE OF WORK IN BRIEF AND DESIGN BASIS: .....</b>	<b>13</b>
2.1 Technical Scope and Specification in General: .....	13
2.1.1 Introduction.....	13
2.1.2 Standards.....	14
2.1.3 Other Requirements .....	14
2.1.4 Power & Water Sources .....	15
2.1.5 General Scope of Work .....	16
2.1.6 Battery Limits. ....	18
2.1.7 Information to Be Furnished with the Offer .....	21
2.1.8 Deviation and Exclusion.....	22
2.1.9 Priority of Requirements .....	22
2.1.10 Spares.....	22
2.1.11 Drawings and Documents.....	23
2.1.12 Tools and Tackles .....	23
2.1.13 Consumables and Operating Supplies .....	23
2.1.14 List of Preferred Make .....	24
2.1.15 Implementation/Delivery Schedule.....	24
2.1.16 Progress Report.....	24
2.2 Detail Scope of Work and System Description: .....	25
2.2.1 Engineering, Procurement & Construction Requirement .....	25
2.2.2 Operation and Maintenance Training: .....	28
2.2.3 Mobile Harbour Cranes: 2 (Two) Nos .....	28
2.2.4 Mobile Hoppers: 2 (Two) Nos.....	29
2.2.5 Receiving Conveyor System with Transfer Towers: .....	30
2.2.6 Travelling Tripper One (02) no: .....	32
2.2.7 Neem Coating System: .....	32
2.2.8 PEB Structured Closed Storage Shed -01 no. & Bagging Shed-01 no.: .....	32
2.2.9 Bucket Elevator, Bagging and stitching machine (Semi-Automatic) & Flat Conveyor with Wagon loader – 38 Sets.....	33
2.2.10 Railway siding at both sides of PEB Structured Bagging & Loading Shed:.....	34
2.2.11 Building for Substation cum Control Room / Operation Room:.....	39
2.2.12 Central water tank & Pump house for Firefighting / Potable Water .....	40
2.2.13 Toilet block in Open Yard .....	41
2.2.14 Road Connectivity with internal road network: .....	42
2.2.15 Road Entry - Exit Gate with Lane Cubicles: .....	43
2.2.16 Road Weighbridge: .....	43
2.2.17 Settling pond: .....	44
2.2.18 Fire Fighting System and Dust Extraction System:.....	44
2.2.19 Other Utilities like Compressed Air, Water, Effluent and Sewage Collection etc.....	48
2.2.20 Storm water drain: .....	48
2.2.21 Fencing Boundary for Terminal:.....	49

2.2.22	Electrical, Instrumentation & Automation Works: .....	50
2.3	Key Design Parameters: .....	52
2.3.1	Performance Parameters: .....	52
3.	Indicative Technical Specifications of MOBILE HARBOUR CRANES .....	53
3.1	<b>Overview</b> .....	53
3.2	<b>Operational Requirement</b> .....	54
3.2.1	Specification of Cargo .....	54
3.2.2	Design Vessel Size: .....	54
3.2.3	Key Performance Parameters: .....	55
3.3	<b>Scope of Work</b> .....	55
3.3.1	General.....	55
3.3.2	Work Included .....	56
3.3.3	Attached Drawings .....	57
3.3.4	Basic Data of MHC .....	57
3.4	<b>General Specifications</b> .....	60
3.4.1	Stability and Safety .....	60
3.4.2	Holding Down and Anchoring Devices .....	60
3.4.3	Design Criteria .....	61
3.5	<b>Technical Description:</b> .....	61
3.5.1	Chassis (for tyre type crane) .....	61
3.5.2	Travel Gear: .....	62
3.5.3	Driver Cabin: .....	62
3.5.4	Superstructure: .....	63
3.5.5	Housing.....	63
3.5.6	Communication System: .....	63
3.5.7	Power Supply: .....	63
3.6	<b>Four-Rope Grab Hoisting Drive:</b> .....	64
3.6.1	Lubrication: .....	64
3.6.2	Hoist Brake: .....	64
3.6.3	Hoist Control System: .....	65
3.7	<b>Slewing Gear Drive:</b> .....	65
3.7.1	Lubrication: .....	65
3.7.2	Slewing Control: .....	65
3.8	<b>Luffing Gear:</b> .....	65
3.9	<b>Luffing Drive:</b> .....	65
3.10	<b>Counterweight:</b> .....	65
3.11	<b>Tower/Boom System:</b> .....	65
3.11.1	Tower: .....	66
3.11.2	Luffing Boom: .....	66
3.11.3	Access to Tower Cabin: .....	66
3.11.4	Tower Cabin: .....	66
3.11.5	Operating and Control instruments: .....	67
3.11.6	Crane management System (CMS).....	67
3.12	<b>Load carrying device:</b> .....	67
3.12.1	Load Indicator/Overload safety Device: .....	68
3.12.2	Safety Device for Crane travelling: .....	68
3.12.3	Propping Supervisory: .....	68
3.12.4	Limit Switches: .....	68
3.12.5	Safety Valves: .....	68
3.12.6	Fire Fighting system: .....	68
3.12.7	Anemometer (Wind meter) .....	68
3.12.8	Emergency Stop: .....	68
3.13	<b>Electrical Equipment:</b> .....	69
3.13.1	Data sensing and Fault detection- Central Computer: .....	70

3.13.1 Lighting /Illumination: .....	70
3.13.3 Operating Hours meters: .....	70
3.13.4 Printer for diagnostic and production data: .....	70
3.13.5 Operating Assistance by Tele Camera: .....	71
<b>3.14 Commissioning, testing and acceptance on the Company's site .....</b>	<b>71</b>
3.14.1 Appearance inspection .....	71
3.14.2 High-tension insulation test .....	72
3.14.3 Crane performance Tests .....	72
3.14.4 Crane durable operation test (acceptance test) .....	73
3.14.5 Acceptance report .....	73
<b>3.15 G. A. Drawing &amp; Manuals.....</b>	<b>73</b>
<b>3.16 Surface protection: .....</b>	<b>73</b>
<b>3.17 Name &amp; Logo: .....</b>	<b>74</b>
<b>3.18 Optional equipment:.....</b>	<b>74</b>
<b>3.19 Reference List.....</b>	<b>74</b>
<b>3.20 Spare Parts List.....</b>	<b>74</b>
<b>3.21 Training Scheme.....</b>	<b>74</b>
<b>3.22 Delivery Schedule.....</b>	<b>75</b>
<b>3.23 Erection &amp; Unloading Plan .....</b>	<b>75</b>
<b>4. Indicative Specifications for MOBILE HOPPER WITH REVERSIBLE BELT FEEDER .....</b>	<b>76</b>
4.1 Scope of Work.....	76
4.1.1 General.....	76
4.1.2 Work Included.....	76
4.1.3 Attached Drawings .....	78
4.2 Construction.....	78
4.3 Dust Control.....	79
4.4 Electrical Equipment: .....	79
4.4.1 Power Supply: .....	79
4.5 Technical Data Sheet for Mobile Hopper with Reversible Belt Feeder:.....	80
5.1 System Description: .....	82
5.2 Flow Diagram & Go-DownArrangement .....	82
5.3 Duty.....	82
5.4 Material handling equipment and conveyor system indicative description: .....	82
5.5 Belt.....	85
5.5.1 General.....	85
5.5.2 CONSTRUCTION REQUIREMENTS .....	86
5.5.3 Idler.....	87
5.5.5 Pulleys.....	90
5.5.6 Skirt Plates.....	92
5.5.7 Deck Plate.....	93
5.5.8 Take-Up Device.....	93
5.5.9 Seal Plate.....	94
5.5.10 Drive unit.....	94
5.5.11 Reducers.....	95
5.5.12 Couplings.....	97
5.5.13 High Speed Couplings.....	97
5.5.14 Brakes.....	99
5.5.15 Bearings, Bearing Seals & PillowBlocks .....	99
5.5.16 Belt Cleaner/Scraper .....	100
5.5.17 Chute.....	102
5.5.18 Hoist.....	103
5.6 Safety Requirements .....	105
5.6.1 Stairs, Cross-Overs AndWalkways .....	105
5.7 Travelling Tripper .....	106
5.7.1 Scope of Work.....	106

5.7.2	Technical Specification (Indicative) .....	108
5.8	Conveyor Accessories.....	116
5.8.1	In-line Magnetic Separator .....	116
5.8.2	Belt weigher.....	117
5.8.3	Metal Detector.....	118
5.9	Technical Data Sheet .....	119
5.9.1	Travelling Tripper (Motorized) x 02 Nos.....	119
5.9.2	In-line magnetic separator: .....	121
5.9.3	Belt weigher: .....	122
5.9.4	Metal Detector.....	123
<b>6.</b>	<b>TENTATIVE DESCRIPTION FOR NEEM COATING SYSTEM .....</b>	<b>125</b>
6.1	Introduction.....	125
6.2	Properties of Neem Oil .....	125
6.3	Uses of Neem Oil.....	125
6.4	Benefits of Neem Coated Urea .....	126
6.5	Equipment specifications: .....	127
<b>7.</b>	<b>FERTILIZER EVACUATON EQUIPMENT(S) IN STORAGE SHED:.....</b>	<b>128</b>
7.1	Indicative System Description: .....	128
7.2	Front End Loader (On Hire Basis) .....	128
7.3	Bucket Elevator.....	129
7.4	Bagging & Stitching Machines Units.....	129
7.4.1	Major Components of Bagging & Stitching Machine .....	130
7.4.2	Slat Conveyor Unit .....	133
7.4.3	Other Essential Requirement .....	134
7.5	Bag Diverter & Horizontal Flat Belt Conveyor with Wagon Loader.....	134
7.5.1	Bag Diverter.....	134
7.5.2	Horizontal Flat Beltconveyor.....	134
7.6	Indicative Technical Data Sheet.....	140
7.6.1	Bucket Elevator.....	140
7.6.2	Semi-Automatic Bagging & Stitching System .....	141
7.6.3	Horizontal Flat BeltConveyor.....	142
7.6.4	Wagon Loader .....	143
<b>8.</b>	<b>INDICATIVE ELECTRICAL WORKS: .....</b>	<b>145</b>
8.1	DesignRequirements.....	145
8.1.1	General.....	145
8.1.2	Errors, Omissions and discrepancies .....	145
8.1.3	Other Technical Requirements.....	146
8.1.4	Power System Description .....	146
8.1.5	System Battery Limits .....	146
8.1.6	Standards and Regulations .....	147
8.2	Equipment Indicative Technical Specification .....	150
8.2.1	HT Switchgear (GIS Type) .....	150
8.2.2	Transformers.....	163
8.2.3	LT Switchgear.....	167
8.2.4	110V DC SYSTEM.....	179
8.2.5	Power, Control and Data Cables .....	184
8.2.6	Lighting System.....	186
8.2.7	High Mast Lighting System .....	191
8.2.8	Cabling and Cable Trays.....	198
8.2.9	Earthing System .....	201
8.2.10	Advance Lightning Protection System.....	206
8.2.11	415 V Silent Diesel Generator Set .....	210
8.2.12	415 V Capacitor Bank with Automatic Power Factor (PF) Correction Control Panels.....	216
8.2.13	Public Address System.....	216

8.2.14	Indicative Technical Data Sheet.....	218
<b>10.</b>	<b>CIVIL AND STRUCTURAL WORKS: .....</b>	<b>255</b>
10.10.18	Semi-Dense Bituminous Concrete .....	297
10.10.19	Bituminous Concrete .....	300
10.10.20	Dry Lean Cement ConcreteSub-Base.....	303
10.10.21	Cement Treated SoilSub-Base/Base .....	306
10.10.22	Interlock Paver BlockPaving.....	309
10.10.23	Construction of Shoulders orBerms.....	309
10.10.24	Concrete Pavement.....	309
10.10.25	Traffic Signs.....	312
10.10.26	Road Markings.....	315
10.10.27	Cement Concrete Kerb and Kerb with Channel.....	320
10.11	Analysis and Design: .....	321
10.12	Software to Be Used For Analysis and Design: .....	321
<b>11.</b>	<b>INDICATIVE RAILWAY WORKS:.....</b>	<b>322</b>
11.1	Scope of Works -Overview:.....	322
11.1.1	Approvals.....	322
11.1.2	Earthwork In Formation:.....	322
11.1.3	Level Crossings:.....	323
11.1.4	Permanent Way: .....	323
11.1.5	Signalling and Telecommunication Works: (Deleted) .....	324
11.1.6	Temporary Works: .....	324
11.1.7	Incidental Works:.....	324
11.2	General Requirements:.....	325
11.3	Design Procedure and Processes: .....	327
11.3.2	Requirements during Construction Phase:.....	328
11.3.3	Design Interfaces with Interfacing Contractors: .....	329
11.3.4	Definitive DesignSubmissions: .....	329
11.3.5	Documents: .....	332
11.3.6	Design Submissions – Good for Construction Drawings .....	333
11.3.7	Design Submissions - Review Procedures and Approvals: .....	334
11.4	Design Criteria and Specifications .....	335
11.4.2	Track Design Criteria:.....	340
11.5	Construction, Testing and Commissioning: .....	349
11.5.2	Contractor's Temporary Works Design.....	349
11.5.3	The Site: .....	349
11.5.4	Survey: .....	350
11.5.5	Safety Measures: .....	350
11.5.6	Care of the Works:.....	351
11.5.7	Damage and Interference:.....	351
11.5.8	Structures, Roads and Other Properties:.....	352
11.6	Standards.....	384
<b>12.</b>	<b>FIRE FIGHTING AND DUST EXTRACTION SYSTEM: .....</b>	<b>386</b>
12.1	Fire Fighting System:.....	386
12.2	Dust Extraction System: .....	403
13.1.1	Acceptance of Site:.....	404
13.1.2	Mobilization: .....	404
13.1.3	Access: .....	404
13.1.4	Permits and Licenses: .....	404
13.2	Temporary Works: .....	404
13.2.1	Utilities: .....	405
13.2.2	Waste and Rubbish: .....	405
13.2.3	First Aid and Fire Protection: .....	405
13.2.4	Construction Safeguards .....	406

13.2.5	Protection of the Public .....	406
13.3	Environmental Protection .....	406
13.4	Submission of Documents during ProjectExecution: .....	407
13.4.2	Operation & Maintenance Plan .....	407
13.4.3	Daily, Weekly and Monthly Progress Reports .....	407
13.4.4	Design & Drawing Submissions: .....	408
13.5	Quality Control andAssurance: .....	411
13.5.2	Improper Certification of UnsatisfactoryWork: .....	412
13.5.3	Quality Plan and Quality Procedures: .....	412
13.5.4	Submission and Certification of ConstructionDocuments: .....	412
13.5.5	Certificates for Work Item Completion: .....	412
13.5.6	Certificates for Activity Completion: .....	413
13.6	Operating Safety .....	413
13.6.2	Safety and Identification Signs .....	414
13.6.3	Noise and Protection of Workman .....	414
13.6.4	Fuel Oil Storages .....	414
<b>14.</b>	<b>QUALITY ASSURANCE AND CONTROL REQUIREMENT:.....</b>	<b>415</b>
14.1	General.....	415
14.2.1	Quality in Engineering .....	415
14.2.3	Bidder's Quality OrganizationStructure .....	416
14.3	Quality Plan.....	422
14.3.2	Field quality plan: .....	422
14.3.3	List of Qualityplans .....	422
14.4	Quality System Requirements .....	422
14.4.2	Source Approval process for bulkMaterials.....	422
14.4.3	Pre-qualification of Sub supplier.....	423
14.5	Audits.....	424
14.5.2	Audit/Assessment by independent person / third partyagency .....	424
14.5.4	Non Conformance Reports & Summary: .....	426
14.5.5	Quality certification of RA bills .....	426
14.6	Quality Control, Document Management &Submission:.....	426
14.6.1	Control of Field Inspection & Testing .....	427
14.6.2	Approved Quality Waivers, Deviation Permits & Design change Note: .....	429
14.6.3	Drawings and other Engineering deliverables with transmittal: .....	429
14.6.4	Master drawing Index & Document Control Index:.....	430
14.6.5	Approved sub-vendor/sub-vendor's list: .....	430
14.6.6	Approved material list: .....	430
14.6.7	Quality Reports.....	430
14.7	Commissioning Management .....	432
14.7.2	Mechanical completion .....	432
14.7.3	Pre-commissioning &commissioning .....	432
14.7.4	Commissioning .....	432
<b>15.</b>	<b>SURFACE PREPARATION AND PAINTING .....</b>	<b>435</b>
14.1	Scope.....	435
14.2	Reference.....	435
14.3	Procedure.....	435
15.3.2	List ofHardware .....	435
15.3.3	Blast Cleaning-Air Blast Cleaning.....	435
15.5	Repair Procedure .....	442
15.5.2	Internal.....	443
15.6	General Precautions .....	443
15.7	Over Coating Interval.....	444
15.8	Acceptance Criteria.....	445
15.9	Certification.....	445

<b>16.</b>	<b>ERECTION, PERFORMANCE TEST &amp; COMMISSIONING .....</b>	<b>446</b>
16.1	Responsibility of Contractor: .....	446
16.2	Responsibility of Employer: .....	446
16.3	Erection.....	447
16.4	Field Tests.....	448
16.4.2	General.....	448
16.4.3	Adjustments.....	449
16.4.4	No Load Tests.....	449
16.4.5	Load Tests.....	450
16.4.6	Performance Test and Commissioning of the System: .....	451
<b>17.</b>	<b>TIME SCHEDULING, PROGRESS MONITORING, COST CONTROL &amp; DOCUMENT CONTROL: .....</b>	<b>454</b>
17.1	Introduction: .....	454
17.2	Key Dates and timelines: .....	454
17.3	Contractor's deliverables: .....	454
17.4	Level of schedules: .....	454
17.5	Milestones – project & interface .....	455
17.6	Engineering schedule .....	455
17.7	Procurement schedule.....	455
17.8	Construction schedule.....	455
17.9	Planning and schedule control: .....	456
17.10	Progress measurement and control, weightages: .....	456
17.11	Reporting: .....	456
17.12	Document numbering .....	458
17.13	Document tracking and control .....	458
17.14	Reviews.....	458
<b>18.</b>	<b>SITE REGULATION .....</b>	<b>460</b>
18.1	Objective.....	460
18.2	Site Correspondence.....	460
18.3	Procedures for the Construction Site.....	460
18.4	Organization of the Construction Site .....	461
18.4.2	Subcontractor's Organization.....	461
18.4.3	Site Meetings.....	461
18.4.4	Daily Reports.....	461
18.4.5	"Kick-off" Meeting.....	461
18.5	Construction Commencement .....	461
18.6	Constructability Study .....	461
18.7	Site Access.....	461
18.7.2	Site Access.....	462
18.7.3	Material and Equipment Delivery and Return .....	462
18.8	Mobilization.....	462
18.9	Construction Site .....	462
18.9.1	First-aid Room, First Aid, Ambulance.....	462
18.9.2	Site Lighting / Illumination .....	462
18.9.3	Contractor's Site Facilities and Site Offices .....	463
18.9.4	Canteen Facilities, Drinking Water, Urinals .....	463
18.10	Erection Equipment, Implements and Erection Aids .....	463
18.11	Communication Facilities.....	463
18.12	Storing and Disposing of Hazardous Substances .....	463
18.13	House Keeping.....	463
18.14	Delimitation of Erection Areas .....	463
18.15	Obstructions by Others .....	463
18.16	Damage.....	464
18.17	Scaffolding.....	464
18.18	Protection of existing infrastructure .....	464
18.19	Working Hours .....	464
18.20	Labour Laws.....	465



18.21	Damage to property or loss of life .....	465
18.22	Erection (method statement) / Installation of Materials and Equipment .....	465
18.23	Work Safety Regulations .....	466
18.24	Acceleration / Recovery Measures .....	467
18.25	Tests, Inspections, Acceptance Tests .....	467
18.25.2	Notification.....	467
18.25.3	Documentation of Test and Inspection Results .....	467
18.25.4	Deviations.....	467
18.25.5	Acceptance.....	468
18.25.6	Final Check List.....	468
18.26	Idle Time and Lost time .....	468
18.27	Exceptionally Adverse Weather .....	468
18.28	Demobilization .....	468
18.29	Expediting and Progress Control by Contractor.....	468
18.30	Quantity Surveys, Verification of Services, Invoices .....	468
18.31	Pre-commissioning.....	468
18.32	Commissioning .....	469
<b>19.</b>	<b>HEALTH SAFETY AND ENVIRONMENT .....</b>	<b>470</b>
19.1	HSE POLICY, STANDARDS AND OBJECTIVES .....	470
19.1.3	Project HSE Objectives .....	473
19.1.4	Management Programs: .....	475
19.2	HSE Organization .....	475
19.2.2	Roles and Responsibilities.....	475
19.3	HSE Administration .....	480
19.3.2	HSE Awareness .....	480
19.3.3	Reward and Penalty .....	480
19.3.4	HSE Management .....	483
19.4	Work Permit.....	487
19.4.2	Height Work Permit .....	487
19.4.3	Confined Space Entry Permit .....	487
19.4.4	Radiography Test Work Permit .....	487
19.4.5	Electrical Work Permit .....	487
19.4.6	Excavation Work Permit .....	487
19.4.7	Hot Work Permit.....	487
19.4.8	Blasting Work Permit.....	488
19.5	Medical Requirements and Occupational Health Management.....	488
19.5.1	Medical Services .....	488
19.5.2	Pre-Employment medical Test.....	488
19.5.3	Periodic medical Test .....	488
19.5.4	Health Campaign .....	489
19.5.5	Emergency Response, first aid, medical facility & Hygiene.....	489
19.6	Work Environment Management .....	489
19.8	Hazardous Material Handling .....	490
19.8.1	Chemicals / Hazardous Substances .....	491
19.8.2	Radioactive Materials.....	491
19.9	Operations Control Procedures .....	491
19.10	Training Program, Safety Orientation And Gate Introduction.....	495
19.11	Implementation, Monitoring, Reporting And Review .....	495
19.11.2	Safety Inspection .....	496
19.11.3	Incident Reporting, Investigation and Analysis.....	496
19.11.4	Safety Audits.....	497
19.11.5	Management Review –HSE .....	497
<b>20.</b>	<b>DRAWINGS: .....</b>	<b>499</b>

# 1. PROJECT BACKGROUND AND SITE INFORMATION:

## 1.1 Introduction:

Fertilizers are a key component in the growth of India's agriculture sector, which accounts for about a seventh of the country's GDP. Therefore, it is only in keeping with the importance of the sector that India is the world's second-largest consumer of fertilizers, (China is the first), and the world's third-largest producer. As per the data of Ministry of Fertilizers, in 2017-18, the country produced 19109 thousand tons & imported 8530 thousand tons of fertilizers against forecasted demand of 51,452 thousand tons of fertilizers. The import of the fertilizer from other countries was done through sea-ports. Fertilizers are substances that supply one or more of the chemicals required for plant growth. They can be both organic and inorganic. To address the increasing food requirements of India's growing population, the consumption of fertilizers continues to increase in the country. The Government of India promotes and assists production of Fertilizers. Deendayal (Kandla) port's geographical position makes it unique to handle such imports required for the large agrarian economy of North and North West part of country which actually produces all most all the wheat required for the country.

While Kandla already handles fertilizers to a substantial extent, off-late Mundra port located very close to Kandla has developed capabilities to handle fertilizer imports with better facilities by way of mechanization of bulk imports, bagging and evacuation.

Deendayal port at Kandla is also willing to develop Full Scale Mechanized fertilizer handling facility at Kandla port for handling of Import fertilizer (Urea, MOP, DAP) & other clean cargo inside the port premises as:

- To enable efficient handling of vessels, leading to their faster turnaround time
- To enable faster turnaround time of rakes and higher productivity.
- To reduce multi handling of the cargo inside the port premises.
- Ensuring clean packed fertilizer and also clean environment.

The proposed project is designed to increase cargo handling capacity of the port, which will reduce turn-around time of ships. The improved efficiency will benefit shipping companies as well as port users by reducing costs. Increased cargo-throughput will also increase Deendayal Port's income. Hence, considering the vast hinterland that is dependent on DPA for seaborne trade and currently prevailing traffic congestion at existing facilities of DPA, capacity additions are of utmost importance at DPA for serving the economy of the influence region and in turn, the economy of the whole country in the best possible manner.

DPA in the light of increasing future demand for Mechanized Fertilizer and Clean Cargo handling facilities, in order to attract good volume of Fertilizer & clean cargo at Kandla and maintain cleanliness at the port as well, which would be better for the port in long term, envisage and proposes to undertake the project. In order to cater to the future growth in Cargo traffic, the Authority has decided to undertake Development, Operation & Maintenance for Development of Mechanized Fertilizer & other clean cargo Handling Facilities at Kandla on Berth no. 14.

The project is proposed to be executed through Engineering Procurement Construction Commissioning Contract basis. Specialized contractors shall be appointed for the components of the works. The facility shall be designed to handle import of fertilizers & other clean cargo through MHCs, hopper & conveyor system and to handle export of clean cargo through MHCs & other relevant equipments on the facility.

The tender documents for this project has been prepared and issued for NIT on web portal s like n-procure, CPP & DPAwebsite. Their bids shall be evaluated for conformity to the employer's requirements and price competitiveness. The appointed contractors shall be monitored during execution for the successful completion of the project.

This call for the bid which is being addressed to potential Contractors for the design, engineering, supply, installation, testing and commissioning contract of "Mechanization of Fertilizer handling at Berth-14 for Deendayal Port Authority at Kandla" on complete Lump Sum turnkey basis in accordance with the Contract provisions.

## **1.2 Site Location:**

Port of Kandla governed by the Deendayal Port Authority is located at the west coast of India, i s one of the 12 major ports of India and the only Major Port in the state of Gujarat. It was declared as a Major Port on April 8, 1955.

Deendayal Port is a natural harbour situated in Kandla Creek and is 90 km from the mouth of Gulf of Kutch. Geographically, the port is spread in three locations viz., Kandla, Vadinar and Tuna Tekra.

The Major Port of Kandla is situated in the Gulf of Kutch on the West Coast of India, at latitude 23° 01' North longitude 70° 13' East. The Port serves a vast hinterland covering north and north-western parts of India.

## **1.3 Meteorology**

The climate at Kandla is governed by the monsoons. In the months June-September, the south-west monsoon occurs. The later period is often indicated as the post-monsoon period.

### **1.3.1 Winds**

Non cyclonic maximum winds (30-40 kmph) occur during May-August. Wind speeds are relatively less during North East Monsoon. However, wind speeds up to 180 KMPH have been observed during cyclonic storms.

### **1.3.2 Rainfall**

Rainfall at Kandla is low. Annual average rainfall is about 322 mm per annum with the total number of rainy days of 17 per year, about 90% of which is received during the south -west monsoon season, i.e., between June and September with a maximum of 153 mm in July. April and May are dry months with average rainfall below 0.6 mm per month.

### **1.3.3 Temperature**

The mean daily maximum temperature is 34°C and with 45°C the highest occurring i n Ma y. Mean daily minimum temperature is 20°C and with 12°C the lowest occurring in January.

### **1.3.4 Visibility**

Throughout the year visibility is good as the region has zero fog days. However, during rains and squalls, the visibility deteriorates.

### **1.3.5 Relative Humidity**

Relative humidity is generally high and rises to about 80% during the monsoons in the month of August.

## **1.4 Road Connectivity**

Kandla Port is connected with National Highways NH 8A connecting Ahmedabad and Mundra/Mandvi through Gandhidham. The four lane NH 8A extends right up to the port's main gate. The port is also connected through NH 141. The port also has fully developed road network, both in and around the Port area to facilitate faster movement of cargo. The road network within the port area is as below:

- Inside Cargo jetty area: 30km
- Outside Cargo Jetty area: 31 km

## **1.5 Rail Connectivity**

Broad gauge (BG) tracks directly connect the Port at Kandla with the principal cities of Mumbai, Ahmadabad, Surat, Baroda, etc., and also Delhi, Punjab and Haryana through the route Ahmadabad – Ratlam – Kota – Mathura to Delhi. The second route is via Palanpur – Ajmer to Delhi. The nearest railway station is Gandhidham railway station is 15 km.

## **2. SCOPE OF WORK IN BRIEF AND DESIGN BASIS:**

The facilities are planned using the most modern port planning concepts so that the new facility will have the necessary operational capabilities and flexibility to attract maximum traffic, the deployment of larger vessels, the reduction or virtual elimination of demurrage payments and maximization of dispatch money earnings, etc.; all with minimal capital investment and operating costs.

The Port requires adequate equipment both on the berth and foreshore for handling the cargo at the berth as well as for onward transportation. Since the majority of the world ships of this class do not have the handling equipment, onshore equipment are deployed for this purpose. This section however would deal with the basic layout of the facility taking into account the site specific features.

### **2.1 Technical Scope and Specification in General:**

#### **2.1.1 Introduction**

This indicative specification document covers design and engineering, manufacture, supply, storage and handling at site, construction, erection, testing, commissioning and demonstration of performance guarantee of complete Bulk material handling plant. Complete system must be operated in smooth and trouble-free manner. This specification forms a part of the tender document and shall be read in conjunction with the same.

The scope covers all mechanical, civil, structural, electrical and fabricated equipment; interconnecting pipework and ducting; instrumentation and PLC / SCADA based controls; all utilities as required for completeness and successful operation of the plant.

The tender shall be complete in all respect and any equipment or accessory not covered in the specification but deemed essential for proper design, operation and maintenance of the individual equipment and plant as a whole, shall be included in the offer.

The tenderer shall study the indicative specification and satisfy him-self thoroughly regarding the workability of the system and equipment, and shall take full responsibility for the guaranteed operation of the equipment/system as regards output, performance and smooth reliable working. The facility shall be designed to handle import of fertilizers & other clean cargo through MHCs, hopper & conveyor system and to handle export of clean cargo through MHCs & other relevant equipments on the facility.

If the tenderer feels that any information and/or design data for the equipment described hereafter are in his opinion unsuitable or can be replaced, he shall indicate the same during Pre-bid meeting stage, on the basis of the design he considers suitable and capable of meeting the required operating and duty requirements in accordance with this specification.

The tenderer must visit the site to make an assessment of the availability of infrastructure at site and for any other data/information deemed necessary for submission of offer. A certificate to this effect shall be submitted with bid documents as per Form-18 of Section-IV of Vol-I.

All units mentioned in this specification are in metric system.

### **2.1.2 Standards**

The components of all equipment shall be designed, assembled and tested in accordance with the standards of the Standard Institution, Institution of Electrical Engineers and Manufacturer's Association of the country where they are manufactured. The equipment and component parts shall conform to the relevant standards published by the Bureau of Indian Standards Institution wherever available so that specific aspects under Indian conditions are taken care of. Where suitable Indian Standards are not available, other International Standards such as BS, ASTM, ANSI, ASME, AISI, and DIN may be adopted with prior approval of the EMPLOYER.

All items of equipment shall comply with the latest regulations and stipulations of Inspectorate of Factories, Controller of Explosives, DGMS and other applicable statutory bodies of Government of India and Gujarat including norms and regulations pertaining to pollution control. Where required by regulations, the successful tenderer shall have to obtain the necessary approval from the statutory authorities and other concerned agencies.

Charges for required statutory clearance from Inspectorate of Factories, Controller of Explosives, DGMS and other applicable statutory bodies of Government of India and Gujarat including norms and regulations pertaining to pollution control as per requirement, will be reimbursed to the contractor by DPAduring the contract period, on actual basis, on production of original receipts & documents of the authority. The same should be in the name of DPT.

The electrical equipment shall also conform to the latest Indian Electricity Rules as regards safety, earthing and other essential provisions specified therein for installation and operation of electrical equipment and plant. All work shall conform to relevant design basis indicated in this document.

### **2.1.3 Other Requirements**

#### **2.1.3.1 Acceptability and interchangeability**

Standardization in design and construction of equipment and system intended for identical duties shall be preferred. All like parts of similar equipment are to be interchangeable.

It is recommended that all working parts, as far as possible are to be arranged for convenience of operation, inspection, lubrication and ease of replacement with minimum downtime.

#### **2.1.3.2 Quality and workmanship**

Workmanship and materials shall be of good commercial quality suitable for the purpose intended and in accordance with the highest standards and practices for equipment of the class covered by the specification. The equipment shall be shop assembled for checking accuracy of parts except where assembling is required to be done only at site.

#### **2.1.3.3 Painting**

All items of equipment and materials will be thoroughly cleaned and painted as per the separate painting specification given in this tender document and as per employer approved painting scheme.

#### **2.1.3.4 Name Plate**

Each equipment(s) shall be provided with a name plate installed at a convenient location indicating equipment number, capacity, other operating parameters etc.

#### 2.1.3.5 Equipment Numbering System

The tenderer shall indicate equipment/component numbers of all items being considered in the offer. Equipment numbering system will be finalized in consultation with the employer.

#### 2.1.3.6 Safety

All design must comply with latest national/ international standards/practices pertaining to safety, health and environment. All equipment shall be complete with approved safety devices wherever a potential hazard to plant and personnel exists. Safe access for personnel in the plant shall be provided. These items shall include not only those usually furnished with the machinery but also cover guards, cross-overs, stairways, ladders, platforms, handrails etc. which are necessary for safe operation of the plant. Proper fire protection and firefighting arrangement wherever necessary shall be provided. Special care shall be taken to protect enclosed electrical equipment from entry of rats, lizards and other creeping reptiles which may cause electrical short circuit inside live equipment.

#### 2.1.3.7 Language of drawings and documents

All correspondence, data drawings, documents etc. shall be in English language and all technical data shall be in metric system.

#### 2.1.3.8 Pollution control

The required pollution control measures for the plant to be provided by the tenderer shall be elaborated in the offer.

#### 2.1.3.9 Design Life

The design life of material handling structural system is 30 years. The system shall be design for 24 hours per day and 365 days per year. The conveying system offered shall be designed and constructed for continuous duty at rated capacities and under climatic and ambient conditions.

### 2.1.4 Power & Water Sources

Incoming power shall be arranged by vendor for proposed new Substation of Berth-14 from existing 66KV Switch Yard. Vendor shall lay two (2) circuits of HT Power cable (Working + Redundancy) from existing 11 KV feeders placed at 66KV switch yard including LT/Control/Communication cable as per detail design and engineering. Vendor shall consider two separate Routes from 66KV switch yard to proposed substation at Berth-14. Vendor shall use existing cable trench and crossing after cleaning where ever available and new trench and crossing shall be constructed as required. Vendor shall consider cleaning of existing trench and crossing, construction, modification, repair of existing cable trench and crossing for laying of new cables. Approx. distance of 66KV switch yard to Berth-14 is 4 to 6 km, however, final length of the route shall be derived after detail route survey and engineering by successful bidder in consultation with Employer. It is recommended the vendor to visit the site and provide best optimized layout option with combination of underground and overhead installation for cable routing from 66KV switch yard to new Berth-14.

Distribution of power 11 kV, 415V & 230V for Material handling system, general power distribution & lighting.

Vendor shall responsible for installing necessary HT/ LT feeder / panels, required modification / overhauling etc. at source substation of 66KV Switch Yard to accommodate requirement of power supply for new Substation of Berth-14. Any kind of overhauling, upgradation, modification of existing source substation shall be under scope of contractor. Vendor shall submit the scheme for required changes in existing system for approval to Employer along with the schedule of shutdown required in existing system.

Water line shall be extended from the Existing main water pipeline for fire water / DSS water / Potable water tank, if available. However additional pumps and pipe required shall be laid by vendor.

### **2.1.5 General Scope of Work**

The equipment selection and design has been planned keeping in view the maximum utilization of the indigenously available components and materials required, thereby restricting the dependence of spare parts or maintenance service from outside India to the minimum.

For instance, even if the equipment is procured from abroad, it would be kept in view while making the basic design and specifications:

- Generally, all consumables are available in India,
- Servicing of all components could be easily carried out from India,
- Design and entire supply will conform to the local regulatory authorities' requirements, such as electricity authorities, dock safety, etc.

Most of the equipment used in this facility can be manufactured in India.

All design will conform to the relevant Indian Standards and Codes of Practice. In case any information is not available in the Indian Codes, equivalent codes issued elsewhere will be suitably adopted subject to approval.

Equipment shall be designed with careful consideration of the accessibility of all drives and other machinery for inspection and maintenance.

Machine components such as motors, reducers, bearings, etc., shall be standardized.

All equipment shall be suitable for heavy duty and continuous operation.

Provision of space for future requirement shall be kept wherever applicable.

#### **2.1.5.1 Design and engineering**

- a) Engineering services including (but not limited to) design and engineering of plant and equipment, technological structures and non-standard equipment, piling, if required, and civil work, excavation for foundation, building structures, electrics, instrumentation, automation, utility services, cranes and hoists, in plant roads, illumination, drainage and sewerage, water system and power system for the entire plant. Drawings and documents shall be submitted for employer's review/approval include layout, GA, assembly, P&I diagrams, SLDs, block diagrams, flow diagrams, control philosophy, functional description, test certificates, engineering and installation drawings etc. Drawings shall be submitted in PDF and AutoCAD format.



- b)** It should be noted by the bidders that the information, size, specifications, design & dimensions mentioned in this Volume and drawings, are indicative. As in EPC Contracts, the successful bidder shall workout detail design & drawings during detail engineering stage meeting the functional, operational & performance requirements & as per relevant IS standards, well within the sanctioned estimate, and submit the fresh design & drawings for approval to employer.
- c)** The project involves installation of Harbour Mobile Crane along with necessary hopper, Conveyor, for shifting of fertilizer/ clean cargo to direct automated wagon loading units; or; to the covered shed, and, when required, collection of the fertilizer/ clean cargo from shed and conveyance through truck loading to dumping points, conveyance to mechanized and automated wagon loading system. It is also envisaged that suitable dust control systems and other ancillary systems shall be provided, wherever required to mitigate completely the environmental pollution and consequential effects of the facility to comply with state and central pollution control norms. The facility shall be designed to handle import of fertilizers & other clean cargo through MHCs, hopper & conveyor system and to handle export of clean cargo through MHCs & other relevant equipments on the facility.
- d)** The tenderer shall execute the work at site as per employer's approved drawings only. Photocopies shall not be used at Site. The drawing for all the works shall be developed by the contractor and submitted to employer for approval in four copies, which will be scrutinized and corrected. After incorporating corrections indicated in corrected drawings 6 prints shall be submitted by tenderer for issuing as approved drawings which only shall be used at site for carrying construction.
- e)** The scrutiny/approval of drawings by employer does not absolve the tenderer in any manner from owning complete responsibility towards performance, safety and security of all the systems designed and constructed by them. Safety, security and adequacy of all civil structures from design, construction and erection point of view lies entirely with the contractor even after approval of drawings by purchaser.
- f)** Preparation and submission of all operating and maintenance manuals as well as 'As -built' drawings are included in the engineering services.
- g)** All erection drawings/instructions/manuals shall be submitted by vendor.
- h)** List of spares and manufacturing drawings of fastwearing parts/items.
- i)** Preparation of Project Completion Report which will include specification of plant and equipment as installed with quantity and weight, compliance of guarantee parameters, inspection certificates, reports of all critical measurement/ survey carried out during erection and commissioning, status of compliance of design and guarantee parameters.
- j)** Furnishing detailed schedule of submission of drawings and documents.
- k)** Submission of quality assurance plan.
- l)** Preparation and submission of master network (Level-1 and Level-2) and detailed network (Level-3).
- m)** Submission of weekly exception report in addition to submission of monthly progress reports with corrective measures for timely completion of the package.
- n)** Submission of construction management manual along with organization set up and responsibility of various agencies.

- o) Compliance of statutory and safety requirements as required.

#### 2.1.5.2 Supply of plant and equipment

- a) Supply and storage at site of all equipment, technological structure, non-standard equipment, plant electrics, instrumentation, automation, cranes & hoists, communication, water system, utility system, power system etc. and any other equipment which according to tenderer are necessary for completeness of the plant and for meeting the guarantee parameters.
- b) All items shall be complete with auxiliary, accessories, liners, safety items etc.
- c) Commissioning spares, special tools, tackles, foundation bolts, embedment, inserts, anchorage, first fill of oils, grease and lubricants.
- d) Tenderer shall have to ensure completeness of each unit separately and the complete plant collectively. If any item/unit is excluded from tenderer's scope but are needed for the completeness of the unit or the plant the same shall be specifically mentioned in exclusion list without which it will be construed as part of tenderer's scope.

#### 2.1.5.3 Erection, testing and commissioning

- a) Tenderer is required to quote for erection, testing and commissioning of the complete plant. Shipping with adequate packing, transportation, loading, unloading, and storage at site are in the scope of tenderer. The erection, testing, commissioning and demonstration of performance guarantee test shall be responsibility of Tenderer and carried out under expert supervision. Tenderer to submit the commissioning & load trial procedure of entire plant for employer's approval.
- b) Painting of all plant and equipment and structures are in the scope of tenderer. All equipment shall be shop painted and touch-up painting shall be done after erection. Similarly, all structures shall be erected after final painting and touch-up painting shall be done after erection.
- c) All Civil work, structural work and piling, as required.

#### 2.1.5.4 Manpower and training

Tenderer shall indicate the operational and maintenance manpower required for the plant. Successful tenderer shall have to arrange for in plant training of employer's personnel during commissioning of the plant. Tenderer shall also consider Operation & Maintenance training for Employer team or Employer designated team for TWO (2) Months after successful commissioning.

#### 2.1.5.5 Performance guarantee

Demonstration of performance guarantee test shall be as per requirement mentioned in this Tender.

#### 2.1.5.6 Relocation of affected Utilities, Roads (-Deleted-)

All utilities and Infrastructures (Road etc.) affected due to construction shall be temporarily relocated in an effective manner so that no hindrance caused to the present operation. After construction work in that particular portion, the temporary relocated utilities shall be placed in original corridor/ location.

### 2.1.6 Battery Limits.

The battery limits shall be referred with Layout diagram attached with this tender document. Bidder shall identify and consider any interface activities work required for completion of Tender scope with existing facilities i.e. Jetty, Road, Railway, Utilities, Electrical system etc. as bidder's scope of work.

Battery limit for various facilities shall be considered as described below:

#### 2.1.6.1 System battery limit

- Battery limit start from unloading of Cargo from Ship via Mobile Harbour Cranes and transfer of Fertilizer/ other clean cargo via Mobile Hopper and Conveyor system to PEB Storage Shed for storage, bagging of cargo and evacuation of fertilizer cargo via Rail Rake and or Truck or to storage shed for storage of the cargo.
- In case of other cargo (other than Fertilizer), it shall be unloaded via Mobile Harbour Crane and transfer the same to Open Stock yard using Mobile hopper and Road Dumpers / Truck to open stock yard and evacuation of cargo via railway wagons / Truck.
- The project involves installation of Harbour Mobile Crane along with necessary hopper, Conveyor, for shifting of fertilizer/ clean cargo to direct automated wagon loading units; or; to the covered shed, and, when required, collection of the fertilizer/ clean cargo from shed and conveyance through truck loading to dumping points, conveyance to mechanized and automated wagon loading system. It is also envisaged that suitable dust control systems and other ancillary systems shall be provided, wherever required to mitigate completely the environmental pollution and consequential effects of the facility to comply with state and central pollution control norms.
- All the facilities & works required to be done within Berth-14 Fencing area (as shown in attached Drawing) shall be scope of tenderer.

#### 2.1.6.2 Electrical and Automation

- Battery limit for electrical starts from 11kV Cable termination at existing 11kV Panels at existing 66kV/11kV Substation.
- Battery limit for Automation starts from existing PLC/SCADA terminal (hook up). This will include modification (hardware and software) in existing Automation system, if any.
- Vendor shall draw 11KV HT supply by laying two (2) nos. of HT cables from existing 66KV switch yard substation with necessary modification by using separate route up to proposed new substation near Berth-14. Vendor shall consider cleaning of existing trench and crossing, construction, modification, repair of existing cable trench and crossing for laying of new cables as per site condition and instruction of Employer Site In-charge.
- Approx. distance of 66kV switch yard to Berth-14 is 4 to 6 km, however, final length of the route shall be derived after detail route survey and engineering by successful bidder in consultation with Employer. It is recommended vendor to visit the site and provide best optimized layout option with combination of underground and overhead installation for cable routing from 66KV switchyard to new Berth-14.

### 2.1.6.3 Utility – Firefighting/ Dust suppression/ Air ventilation/ Utility Buildings, water tank and pump house.

- Water supply at single point near to Berth-14 boundary will be provided by Employer, if available. Else, the contractor has to arrange his own as per the requirements.
- Raw Water Characteristics: Employer will provide the Raw water of following characteristics:
  - pH: 6 to 8
  - TDS: 2000 ppm
  - TSS: 500ppm
- Vendor shall design and construct the further storage and distribution of water for following applications:
  - Firefighting Operations.
  - Dust Extraction Operations.
  - Potable water usage.
- Storm Water Drain network inside Terminal shall be constructed and connected with outfall.
- Sewage and Effluent shall be collected at single point and evacuation provision via Road Tanker shall be provided. Also, provision of connecting the collected point with existing available sewage line of DPA, if any, shall be provided.

Required Water storage tank and Pump house for above application shall be design and constructed by vendor.

### 2.1.6.4 Railway Connectivity Work:

- There is existing Railway line for 14<sup>th</sup> berth up to Terminal boundary provided by Employer.
- Vendor shall consider Take - off from Main Rail line for proposed Berth-14 Yard Railway line.
- Railway Facility is envisaged in this project, and the rail connectivity for both along sides of the bagging & rake-loading shed with their respective escape routes shall be taken from nearest available take-off point at the boundary end of the backup area towards landward side
- It is envisaged to have Two (2) nos. of Rail line from take-off point to Berth-14 back up yard. Hence, out of requirement of Two (2) railway lines, vendor shall consider extending One Railway line from Main Rail line and 2<sup>nd</sup> Rail line from Proposed Fencing Boundary of Berth-14 Back up area.
- Entire railway work within Fence boundary area of Berth-14 shall be scope of Bidder in addition to one branch line from Main Railway line to Plot Boundary.
- Bidder shall consider the preparation of DPR and other documents and all required statutory approval with applicable charges to obtain such statutory approvals.

Kindly refer Layout Drawing for further clarity on Battery limit.

#### 2.1.6.5 Road Connectivity Work:

- There is existing Four (4) Lane road connecting Berth-11 to Berth-16.
- Vendor shall consider extending and connecting Entry / Exit Road for Berth-14 Terminal from Main Port Road.
- Vendor shall also consider required modification to Road Median and turning radii from Main Port Road to new proposed Entry / Exit Road of Berth-14. Vendor shall match the existing road level while connecting with proposed entry / exit road for Berth-14.
- However, permanent Rerouting of Existing Main Port Road (due to extended plot length of Berth-14 Back up area) is excluded from scope of Bidder.

#### 2.1.6.6 Berth-14 Jetty Interface Battery Limit:

- Jetty (Berth-14) is constructed in Year 2019.
- Size of the Berth wharf is 55 mtr. X 300 mtr. wide and the backup area is 890 mtr. long X 300 mtr. width after 55 mtr. wharf. Additional pile platform of dimension 15 mtr. x 300 mtr. exists after wharf area.
- Rail Slots as provision for fixing of Rails have been provided for 14 mtr span. Successful bidder to consider the Design, Supply, and Fabrication & Fixing of Rail in provided slots and design of Equipment (Mobile Hoppers) shall be done accordingly.
- There is no Utility Ducts, Cable Trenches or Electrical Pits provided in Jetty Design. Hence, successful bidder shall consider design for Shore Power Supply i.e. Cable Drums, Trailing Cables, JBs, Electrical earthing, etc. with sufficient space and route for vehicle movement i.e. Cargo vehicles and Maintenance vehicles are available.
- There is no specific provision for foundations of Transfer Towers and Conveyors provided on Jetty. Indicative locations of Transfer Tower and Conveyor footings shown in attached Tender Drawing. Reinforcement Dowels are left as provision for Transfer Towers on Wharf area as indicated in drawing. Successful bidder shall consider usage of provided Reinforcement Dowels and Load capacity of Jetty in detail engineering and installation of Transfer Towers on Wharf area.
- There is no provision made for Conveyor footings on Jetty. Successful bidder shall consider using of Pile Junction and Design load capacity of Jetty during detail engineering and installation of Conveyor Gallery columns with appropriate methodology.
- Vendor shall refer Berth-14 Jetty Design basis report (will be provided to successful bidder) for detail engineering and installation work on Wharf area. Any modification and installation on Wharf area is subject to compliance of Design basis report of jetty and Employer approval.

#### 2.1.7 Information to Be Furnished with the Offer

The tenderer shall submit the bid section wise as per this specification complete in all respect including all technical details, drawings, sketches, and design parameters etc. which are necessary for providing clarity of the offered system/items. The general details to be provided in the offer are listed below.

- a) General description of the system along with detailed flow sheet, layout, plan and section of

each unit to enable the EMPLOYER to have a proper understanding of the system offered.

- b) List of all the equipment and facilities envisaged for the system offered for each unit, general description of the equipment offered specifying the important feature including operating parameters and materials of construction etc.
- c) Complete motor list for each unit along with electrical load list.
- d) System parameters and consumption of utilities, electric power and other media for each individual unit.
- e) P&I diagram for each section and list of instruments.
- f) Indicate separately the measures taken for fulfilling safety requirement and statutory regulations of concerned authorities.
- g) Makes of all bought-out items shall be indicated.
- h) Reference list of similar experience.
- i) List of imported equipment/components.
- j) Information on pollution norms and facilities.
- k) Information on energy saving devices.
- l) Implementation/delivery schedule.
- m) The tenderer shall also submit the information as specified in this document and Volume-1.
- n) Proposed organization structure and execution plan of the tenderer.

### **2.1.8 Deviation and Exclusion**

Generally, the tenderer shall submit his offer in line with the indicative tender specification. However, in case of any necessary deviation and exclusion, the same shall be indicated in a separate list with adequate reasons. Any deviation and exclusion not specifically mentioned in this list will not be considered. However, all such deviation and exclusion shall be discussed during Pre-Bid meeting prior to submit with bid.

### **2.1.9 Priority of Requirements**

In case of any variation and discrepancy in condition between the Job Specific Requirement, this specification and codes, order of priority shall be as under :-

- a) Special conditions
- b) This indicative specification
- c) Drawings in NIT
- d) Codes

### **2.1.10 Spares**

The tenderer shall submit with his tender, quotation for various spares in accordance with the relevant clauses of the General Conditions of Contract. Required commissioning spares shall be in tenderer's scope of supply.

#### **2.1.10.1 Commissioning spares**

Provision shall be made for all spares required for commissioning of the equipment and for its efficient operation until provisional acceptance after demonstration of satisfactory

performance and in accordance with the guarantees. These items shall be based on the tenderer's experience in commissioning similar plants in the past. The commissioning spares are to be included in the main offer along with the list and must be at site along with the main equipment. The successful tenderer shall be responsible for having the required items at site in sufficient quantities which shall be finalized with them. All the left over commissioning spares shall be handed over to the Employer without any extra charges.

#### **2.1.10.2 Spare parts for two (2) years' normal working**

The list of recommended spare parts for two (2) years' normal working of the plant shall be submitted in accordance with the relevant clauses of the General Conditions of Contract however required commissioning spares shall be in tenderer's scope of supply.

#### **2.1.10.3 Drawings for Wearing Parts**

Tenderer should include the manufacturing drawings of fast wearing parts/items under the scope of engineering.

### **2.1.11 Drawings and Documents**

- a) All data, drawing, documents, calculations, manuals, instructions etc. shall be in English language and in metric units.
- b) Tenderer shall submit a list of categories of drawings and documents to be supplied by them under basic engineering scope and detailed engineering scope. The list of drawings and documents to be submitted will include general arrangement, design calculations, selection of components etc.; this complete list of deliverables shall be approved by employer.
- c) Tenderer shall submit fabrication drawings to employer / employer's engineer prior to execution for their review.
- d) Tenderer has to ascertain a required concurrence between mechanical, civil-structure and electrical engineering function during engineering of project & equally during execution at site.
- e) Drawings prepared by Tenderer shall be suitable for transmitting electronically and digitization for storage.
- f) All erection drawings shall contain relevant safety instructions "DO'S" and "DONT'S" for erection, testing and commissioning.
- g) Integrated technological shop drawings, equipment layout drawings (plan, elevation, sections) etc. shall contain all dimensions and BOM with weights and quantities.

### **2.1.12 Tools and Tackles**

The tenderer shall include in his tender special tools and tackles that shall be required for normal operation and maintenance of the equipment as per relevant clauses of the Invitation to Tender and General Conditions of Contract.

### **2.1.13 Consumables and Operating Supplies**

The offer shall include information on the specifications including equivalent brand names and quantities of all consumable materials such as lubricants, flushing oil, resins etc; required during start-up, commissioning, initial filling and yearly requirements for normal operation. Itemized unit prices shall be quoted for these items. The successful tenderer shall supply such

materials required for start-up, commissioning, and initial filling and performance tests.

#### **2.1.14 List of Preferred Make**

The equipment manufactured by the tenderer shall normally be offered for supply as a part of the system. In the event of the tenderer not having particular equipment in their range of manufacture, the same shall be offered as bought out from among the list of preferred supplier. List of preferred make of bought-out Items/components are given respective sections of this tender enquiry documents. Make of any equipment not covered in respective sections shall require approval of Employer.

#### **2.1.15 Implementation/Delivery Schedule**

The proposed plant **shall be commissioned in Fifteen (15) months** from commencement date. Tenderer shall indicate in a bar chart the implementation schedule starting from placement of order date specifically indicating the time for the following activities. However, tenderer is required to adhere to the dates mentioned against certain critical activities. The schedule shall be updated by the successful tenderer from time to time during implementation.

- a) Basic engineering
- b) Detailed engineering for proprietary and indigenous items
- c) Order Placement, Manufacture and supply
- d) Inspection by EMPLOYER/Consulting Engineers/ PMC/ TPIA
- e) Mobilization to site
- f) Civil work
- g) Structural fabrication work
- h) Structural erection work
- i) Erection of plant and Equipment
- j) Commissioning & preliminary acceptance (PAC)
- k) Final acceptance (FAC)
- l) As-built drawings, final documentation etc.
- m) Completion report
- n) Demonstration of performance guarantee to be performed within three (03) months from date of commissioning of the plant along with associated facilities mentioned in this specification.

#### **2.1.16 Progress Report**

The successful tenderer shall submit the Monthly Progress Report which shall primarily consist of:

- a) Project Time Schedule
- b) Status of Engineering
  - Basic
  - Detail



- c) Procurement Status
  - Order Plan
  - Actual Ordering
- d) Inspection and Manufacturing Status
- e) Shipping Plan
- f) Erection Status

The successful tenderer shall also submit the relevant daily/weekly progress reports for site activities. Please refer separate section for more details.

The successful tenderer shall follow Employer reporting format as provided and / or submit the reporting formats for employer approval. Vendor shall submit the native file (editable soft copy) of reports to Employer.

## 2.2 Detail Scope of Work and System Description:

The scope of work outlined in this section is for overall understanding of the works, and does not absolve the Contractor from successful commissioning and operation of the works with best available latest technology.

Brief requirement for proposed system is as mentioned below:

### 2.2.1 Engineering, Procurement & Construction Requirement

The Employer's Requirements are that the Contractor shall carry out Design, Engineering, Procurement, Manufacturing, Supply, Erection, Commissioning and Performance trial of works. Successful Tenderer shall also consider providing Operation & Maintenance training to Employer's team or to Employer's designated O&M team for Two (2) Months after successful commissioning. Contract defined hereunder including all associated works and integration with the existing plant to provide fully commissioned and operational facility that will perform as specified in the Tender documents.

- a) The scope of work outlined in the table below is for overall understanding of the works, and does not absolve the Contractor from successful commissioning and operation of the works with best available latest technology. The Contractor shall provide a complete system listed below but not limited to:

**Table 2-1: List of Minimum Facilities Required**

Sr. No.	Description	Qty
1	Mobile Harbour Cranes	2 Sets
2	Mobile Hopper with reversible belt feeder	2 Sets
3	Conveyor System with Structural gallery, Transfer Tower and required equipment complete in all respect	Complete Unit
4	Traveling Tripper with rail in Storage Shed.	2 Nos.

5	Online Mechanized Neem Coating Facility	1 Unit
6	PEB Godown for Storage and bagging shed (700m L X 55m W) and Rail siding platform of 5.31 mtr wide on both sides of the Godown.	1 Unit
7	Bucket Elevator, Bagging and stitching machine (Semi-Automatic) & Flat Conveyor with Wagon loader (2 nos per machine).	38 Sets
8	Railway line at both side of Storage Shed including Escape line and Take off with main Rail line. It shall accommodate full Rake Length. Scope includes all documentation works and required statutory approval and applicable charges for statutory approval.	As per requirement
9	Storage Shed (Min. 650 mtrs X 70 mtrs)	1 Nos.
10	Building for Substation cum Control Room / Operation with associated facilities i.e. Toilet, Pantry room, Dining area etc...(G+1)	1 Unit
11	Central water tank & Pump house for Firefighting / Potable Water	1 Set
12	Toilet block in Open Yard	1 Unit
13	Road Connectivity with Main road outside Terminal Gate and internal road network	As per requirement
14	Entry - Exit Gate with Lane Cubicles	4 Nos.
15	Road Weighbridge – 100 MT	2 Sets (1- Entry & 1- Exit)
16	Settling pond with Drain connectivity in yard.	As per requirement
17	Utilities network like, FFS, Dust Extraction System, Compressed Air, Potable Water, Effluent and Sewage Collection etc.	As per requirement
18	Storm water drain network with outfall connectivity	As per requirement
19	Electrical Works with all equipment(s) i.e. Transformers, HT & LT Panels, Structural works, Cable trays, HT & LT Cables etc. including required structure work and trenches. Scope also includes required statutory clearance and applicable charges.	As per requirement

20	Control, Instrumentation & Automation works with all respect.	As per requirement
21	Fencing boundary	2190 mtrs.

- b)** The Contractor shall provide complete Electrical, Instrumentation & Automation works for all equipment as required.
- c)** All Earthing protection works as per IS code.
- d)** Following activities/ services shall be covered with respect to this contract:
- Detailed design and engineering of all the equipment and system(s).
  - Complete manufacture including shop testing/ type testing.
  - Providing engineering data, drawings, commissioning procedures and O&M manuals, etc. for the Employer's review, approval and records.
  - Packing and transportation from the manufacturer's works to site including transit insurance, customs clearance/ port clearance, if required.
  - Pre-construction work required at site if any.
  - Receipt, unloading, storage, preservation, conservation and insurance of equipment at site.
  - Fabrication, pre-assembly (if any), erection, testing and putting into satisfactory operation of all the equipment.
  - Associated civil, structural and electrical works.
  - Installation / erection procedure.
  - Commissioning and completion of facilities and Performance Guarantee Tests after successful completion of initial operation.
- e)** The Contractor will be responsible for interconnecting the existing and proposed system with minimum possible modifications, down time & cost.
- f)** Contractor shall arrange required utilities during construction and commissioning, i.e. Construction Power, Water, Welfare facilities etc.
- g)** It should be noted by the bidders that the information, size, specifications, design & dimensions mentioned in this Volume and drawings, are indicative. As in EPC Contracts, the successful bidder shall workout detail design & drawings during detail engineering stage meeting the functional, operational & performance requirements & as per relevant IS standards, well within the sanctioned estimate, and submit the fresh design & drawings for approval to employer.
- h)** The indicative specifications provided in the tender together with enclosed drawings outlines the functional requirements and the operating characteristics which the system/ equipment must fulfil.
- i)** Any item / equipment not listed but required for completion of the works shall be considered as included in the scope of the Contractor.
- j)** The Contractor shall be deemed to have examined the site & reference drawings attached with tender and should have familiarized, study & understand with all existing site

conditions. He shall accept the site in the existing condition at the time of award of the Contract and throughout the execution period of contract. The Successful Tenderer shall consider designing of system with respect to site condition.

- k) Load-Testing of the facility in accordance with the mutually agreed program shall be undertaken for which cargo will be arranged by the EPC contractor. The contractor shall give written request upon readiness of entire system in totality for requirement of Cargo Vessel for Performance-Tests. Employer will arrange the Cargo vessel for performance-tests based on availability. The contractor shall ensure unloading of cargo from vessel as per Port / Employer guideline and predefine time line, it is to be noted that in case of delay in unloading of cargo from Vessel, applicable demurrage / penalty charges will be charged to the contractor same will be deducted from the contractor payment.
- l) The Contractor shall adhere to and honors the Conditions of Contract in all respects up to satisfactory completion of the contract.
- m) A list of the Start-up spare parts and adjustment tools for maintenance, along with quantities shall be provided with the Tender.
- n) Defect Liability Period shall be provided as per the Contract Conditions.

**NOTE:**

Upon successful completion of installation, Dry / No Load Test of entire system, for Internal tests and Load testing, the sufficient cargo will be arranged by the EPC contractor on prior approval of employer. However, in case, employer i.e. Deendayal Port Authority arranges the cargo for Internal & Load tests depending on the availability, the contractor has to bear any penalty / demurrages arises (if any) due to failure / non-performance of the system / plant / equipment. After load- tests, for Performance test with minimum 03 full ship as in proposed tender docs, cargo would be arranged by the Traffic Deptt. of DPA by directing the 03 Nos. Ship of full fertilizer (as per availability) to Berth No.14. In this case also, the contractor has to bear any penalty / demurrages arises (if any) due to failure / non-performance of the system / plant / equipment and same will be deducted from the contractor payment.

### **2.2.2 Operation and Maintenance Training:**

The contractor has to provide operation and maintenance training to Employer's staff or to Employer's designated O&M team for **TWO months** after successful commissioning of the plant.

Contractor needs to deploy sufficient skilled man power for supervision and training for Operation and Maintenance of system atleast for 2 (TWO) months duration.

### **2.2.3 Mobile Harbour Cranes: 2 (Two) Nos**

The vessel size of 35,000 DWT to 75,000 DWT will arrive at the Berth 14. The cargo shall be received from vessels through the two mobile harbour cranes. Size of the Berth-14 is 300 mtr Long X 55 mtr wide with 14 mtr Draft. Refer Berth GA and Section drawing for further details.

The Berth-14 is proposed to be equipped with **Two nos Rubber Tyred Mobile Harbour Cranes**. These cranes shall move on berth on both directions as required. Both cranes are of same capacity cranes for reasons of higher through put for bigger vessels and matching conveyor capacity. The MHCs, if required, are to be mobilized by the EPC contractor from inside Port to Berth-14 area and vice-versa.

The tyre mounted Mobile harbour cranes have travelling, slewing and boom luffing motions similar to the general arrangement.

These cranes are electrically operated with high tension shore power and have on -board diesel engine to execute operations in case the main power fails.

The both MHC trailing cable will be sized to allow the machine to operate over the full range of Berth with full capacity operation of crane.

The equipment shall comprise a main portal gantry / base frame supporting a slewing superstructure with machinery house, boom and lifting arrangements.

The crane shall be equipped with an operator's cabin in accordance with the requirement . The operator safety shall be considered in the design.

The equipment will load/unload material from ship to shore and vice versa. Vendor shall arrange the Power supply to the Mobile Harbour Cranes as per specification provided in this document and complete in all respect.

There are no Utility ducts, no Cable trenches or no Electrical Pit provided on Jetty, hence Contractor shall consider appropriate arrangement for Shore power supply i.e. trailing cable drums, JB, Panel and earthing for Mobile Harbour Cranes. All electrical and earthing arrangement shall be made in such way that sufficient space and route available for vehicles movement for Cargo operations and maintenance (Trucks, Dumper, Pay loaders, Hydra & other Maintenance equipment(s)).

#### **2.2.4 Mobile Hoppers: 2 (Two) Nos**

Mobile Hopper with reversible belt feeder arrangement will receive the material from Mobile Harbour Cranes. The material shall be unloaded into a mobile hopper through Mobile Harbour Cranes and moves on the rail. There shall be a provision in the mobile hopper to transfer the material to dumper underneath through a chute below or transfer the material to the elevated conveyor on the rear side through a reversible belt feeder conveyor. Mobile hoppers are to be connected to harbour cranes and signal of the same to be conveyed to crane or to the CCR. Vendor shall provide Mobile Hoppers as per specification provided in this document and completed in all respect.

The Successful bidder shall consider design and size of Jetty (Berth-14) and Mobile Hoppers shall be designed according to the design and size of Berth-14.

There are no Utility ducts, no Cable trenches or no Electrical Pit provided on Jetty, hence Contractor shall consider appropriate arrangement for Shore power supply i.e. trailing cable drums, JB, Panel and earthing for Mobile Hoppers. All electrical and earthing arrangement shall be made in such way that sufficient space and route available for vehicles movement for Cargo operations and maintenance (Trucks, Dumper, Pay loaders, Hydra & other Maintenance equipment(s)).

Kindly note that Two nos of Rail Slots with Centre to Centre distance of 14 Meters have been provided on Jetty as provision for fixing and laying Rail. Vendor shall consider the design, supply, fixing of suitable Rails for Two nos. of Mobile Hoppers. Earthing provision shall be extended from Backup yard as earthing provision is not available in Jetty.

Mobile hopper with Reversible Belt feeder is considered to feed the cargo either to Conveyor system or to Dumper on Wharf area. However, vendor shall consider the best possible arrangement for evacuation of cargo from Mobile hopper to Dumper on Wharf area and

continuation of Vessel unloading operation in case of failure of Reversible Belt feeder.

## **2.2.5 Receiving Conveyor System with Transfer Towers:**

### **2.2.5.1 Scope of Work:**

This section of Technical Specification covers design, engineering, procurement, manufacture, supply, storage and handling at site, fabrication, assembly, erection, testing and commissioning including establishment of performance guarantee tests of conveyor system with associated equipment for handling Finished Fertilizers from proposed Mobile Harbour Cranes and Mobile Hoppers on Berth-14 to Proposed storage shed. Belt conveyors shall be with associated electrical, auxiliaries and facilities to make the system complete in all respects.

Associated equipment [In-line Magnetic Separator (ILMS), Suspension Magnet (SM), Belt Weigher, Metal Detectors, Diverter Gates, Movable Head etc.) as per requirement and specification provided in this document.

Vendor to offer the material handling system to deliver the desired capacity for handling of Finished Fertilizer.

The Tenderer shall study the Specification and satisfy himself thoroughly on the requirements covered herein and shall take full responsibility for guaranteed operation of the entire system as regards performance and smooth reliable working. If the Tenderer feels that any design data/technical particular/ layout drawing for the conveyors, equipment included is in his opinion unsuitable to meet the specification requirements, he shall indicate the same in his offer and submit an alternative proposal with layout, relevant details and associated drawings on the basis of the system design he considers suitable and capable of meeting the required operating parameters.

The Successful bidder shall consider design and size of Jetty (Berth-14) and Conveyor system shall be designed according to the design and size of Berth-14.

It is envisaged to have conveyor in two parts, Wharf Conveyor on Berth-14 and Yard conveyor transferring cargo to Storage shed.

Regarding Wharf conveyor, it is to be ensured that design of Transfer Tower and Conveyor Gallery structures are in line with Load capacity of Jetty (Berth-14). Foundations and Structure column shall be positioned / design so as load distributed on Pile Junctions instead of Slab of the Jetty.

It is to be noted that there are no Utility ducts, no Cable trenches or no Electrical Pit provided on Jetty, hence Contractor shall consider appropriate arrangement for Shore power supply and earthing for Conveyor system. All electrical and earthing arrangement shall be made in such way that sufficient space and route available for vehicles movement for Cargo operations and maintenance (Trucks, Dumper, Pay loaders, Hydra & other Maintenance equipment(s).

Wharf conveyor system shall be designed such way that sufficient height clearance available below Conveyor Gallery for Cargo and Maintenance vehicles i.e. Trucks, Dumpers, Hydra, Pay Loaders etc.

Conveyor Gallery shall be considered to be fully covered appropriately.

### **2.2.5.2 Scope of Supply**

All items of the belt conveyor system, associated equipment is section of Technical Specification shall be complete in all respects and any item or accessory not specifically mentioned/covered, but essential for proper design and operation, shall be deemed to be included under the scope of work by the Tenderer.

The Tenderer shall quote for the equipment considering the makes of components as listed in other respective sections of this tender. The Employer reserves the right for selecting the manufacturer of items/components from a particular source for the sake of standardization and the Successful Tenderer shall supply the item of that make if so required.

### 2.2.5.3 Standards

In general, the conveyor system, associated equipment and its components shall conform to the relevant.

Standards published by The Bureau of Indian Standards (BIS). The mobile storage yard equipment and wagon loader shall also be designed as per relevant Indian Standards as applicable. For details refer other section in this tender.

Wherever Indian Standards, do not exist, the equipment and its components shall be designed, assembled and tested in accordance with the latest international standards published by The International Organization for Standardization (ISO) or National Standards Institution (NSI) of the country, where the items/ components shall be manufactured or procured from.

All equipment and installations shall comply with the statutory requirements of the Government of India and the Government of Gujarat. Wherever required by regulations, the Successful Tenderer shall have to obtain Factory Inspector's approval of relevant as appropriate. Any change required by the said Inspection Agencies shall be carried out by the Successful Tenderer and expenditures, if any, in this regard shall be to his account only. The same condition shall also be applicable for obtaining the approval of other statutory authorities.

### 2.2.5.4 Brief System Description

The Capacity of the conveyor system from berth to stockyard end shall be 2200 TPH (designed). Fertilizer unloaded from vessel shall be transferred to conveyor belt FBC-1 on Jetty via mobile hopper reversible conveyor. FBC-1 will transfer to fertilizer to conveyor belt FBC-2 via TT1 at end of Jetty.

At transfer tower TT neem coating facility for urea shall be provided in the connecting chute of conveyor FBC-1 & FBC-2. The cargo shall be stacked in the Godown through a travelling tipper install at the conveyor FBC-3 at a height of about 15 m from the floor level, or else, as per the requirement, the cargo shall be send to the Bagging & rake loading equipments via conveyor FBC-2 to either side via sub-conveyors i.e., FBC2A & FBC2B. Further, the cargo stored in Storage shed shall be transferred to the Bagging & Rake loading shed through dump pit and conveyor FBC4. Conveyor layout drawing shall be referred for reference.

As indicated in drawing, one conveyor FBC-1 planned on Jetty between transfer tower T-1 and TT-1 and second conveyor FBC is in between transfer tower TT-1, TT, T-2 etc.

Vendor shall provide the conveyor system with transfer towers, equipment(s), and accessories as mentioned in the indicative specification provided in this document and complete in all respect.

### **2.2.6 Travelling Tripper One (02) no:**

Travelling Tripper shall be installed on FBC-2 & FBC-3 with rail. The cargo shall be stacked in the Godown through a travelling tripper install at the conveyors FBC-2 & FBC-3.

Vendor shall provide the Travelling Tripper system with equipment(s), and accessories as specified in specification provided in this document and complete in all respect.

Vendor shall consider providing control operation of Travelling Tripper so as to have control pile stacking in side Storage Shed.

### **2.2.7 Neem Coating System:**

At transfer tower TT neem coating facility for urea shall be provided in the connecting chute of conveyor FBC-3 & FBC-2.

Requirement of Neem coating facility for urea fertilizers will be as follow:

- 2 Nos. of storage tank for neem oil with the capacity of coating urea of at least one parcel size i.e. One (1) tank with the capacity of 20,000 T with the heater which heat neem oil up to 40 deg. to achieve better viscous flow.
- 1 No. of intermediate tank with the heating capacity of 60 deg. Neem oil transfer from main storage tank to intermediate tank.
  - Oil is further pump up to the height of the chute of conveyor FBC-2 where urea will transfer to Conveyor FBC-2 after TT. Nozzle of capacity of 35 ltr. / hour is installed to spray neem oil at urea cargo in the fog form. Total 64 (operating) + 10 (standby) nozzles are required to match the capacity of 2200 TPH. Nozzles are sync with the belt weigher installed at conveyor FBC-2 and release neem oil based on the reading received from belt weigher. If less capacity is coming from belt conveyor then neem oil will also spray in that rate only from nozzle. Chute will have deflector plate in between to make the flow direction linear and to accommodate 75 number of nozzle at least 5 m extra space is needed in the chute vertically. This system will be closed when MOP and DAP will transfer from the same chute and deflector plate will rise above in the chute itself.
- Above listed requirement is indicative for reference, vendor shall design the system to meet the performance requirement. Any deviation or changes required may be discussed during Pre-Bid Meeting.

### **2.2.8 PEB Structured Closed Storage Shed -01 no. & Bagging Shed-01 no.:**

The scope of design under this document includes Civil, Architectural, Structural design and services of building envisaged. This document is in relation to the basis of indicative design of the Storage & Bagging shed envisaged for the operational and service requirements of the port & terminal.

The Storage Godown shall be sized 650 m x 70 m wide for storage of Fertilizers and Bagging Godown shall be sized 700 m x 55 m with Rail siding plate on either side form across the length of 5.31 mtr.

The methodology of storage cargo in the shed (different user & type of cargo based) and their distribution to Bagging unit spread across the shed – length should be optimized & accordingly sufficient space to be planned for movement of dumpers and pay loaders within the shed on



both the sides.

- The overall stacking width of about 35 m at the base level and a height of 12 m minimum could be achieved in the storage Godown.
- Stacking shall be done like wise to accommodate material of various users.

Pre Engineered Building Structure shall be considered for the storage & bagging shed of the Cargo. Design & construction of Storage & bagging shed consisting of sufficient spaces with clear plan dimension mentioned against them. This Storage & bagging shed consist of PEB steel structure with 1.0m height RCC peripheral wall & top roof shall be cladded with pre-coated galvalume sheet with all the required finishing and architectural items (i.e.- inside-outside plaster of peripheral RCC wall, colour and floor finishing, door, window, ventilators, rolling shutter, plumbing works inside the shed etc.).

Floor has to be designed for stacking of Fertilizer & other clean Cargo, Vehicular movement, and equipment's for evacuation of Cargo.

Platform shall be provided at both side of the Bagging Godown to accommodate Flat Conveyor and Wagon loader equipment(s) and length of platform shall be sufficient to accommodate full rake length on both sides of the Godown.

While orienting and designing a schematic, the desired indoor quality of environment shall be kept in mind and certain key features shall be combined along with functional requirements, Architecture, Open areas, closed areas, ventilation, glazing etc.

Once the primary functional needs and schematic design is completed, the building is shaped and idealized for architectural purposes based on the latest code provisions. The look, feel, shape and finishes are given due value to arrive at a sustainable Architectural design.

**Utilities and Services:** Various utilities for this building such as MEP (Plumbing i.e.- water supply & sewage lines , firefighting, FDA & PA systems) shall be designed & constructed in accordance with relevant IS & other codes.

Vendor shall design the Godowns to meet the Key performance parameter described in this document and complete in all respect. It is expected that proposed Godowns shall eliminate the contamination of Fertilizer / clean Cargo (inside Storage Shed) from external dust.

Vendor shall consider the providing appropriate canopy across the length of Bagging & storage Shed Platform on either side so to provide protection to equipment and Cargo from Rain Water. Projection of Canopy shall be sufficient (minimum up to centre line of Rake Wagon) to enable uninterrupted wagon loading operations & water-seepage during Rain.

Vendor shall consider appropriate illumination in the Sheds for Night operations.

Vendor shall consider sufficient care in detail engineering to ensure sufficient space for movement of cargo handling equipment's i.e. Front End Loaders, Dumpers, Maintenance Vehicles, Operation Staff Vehicles movement considering highest possible volume Stack piles of Cargo inside both the sheds.

## **2.2.9 Bucket Elevator, Bagging and stitching machine (Semi-Automatic) & Flat Conveyor with Wagon loader – 38 Sets**

Reclaiming cargo shall be carried out by using pay loader. Pay loader reclaim the cargo and feed into the bagging machine via Bucket Elevator install in the Godowns across the length of the Bagging Godown. Similarly, the cargo stored in Storage shed shall be reclaimed by

using pay loader to dump pit directly or via dumpers, which shall be connected to Bagging shed conveyor. There shall be 19 nos. of Semi auto bagging and stitching unites installed on either sides of Godown (total 38 nos). Pay loaders inside the Bagging shed shall feed the cargo to Bucket Elevator using receiving hopper. Bucket Elevator shall feed the cargo to Bagging and stitching machine.

Bagging and stitching station consists of 50 kg weigh hopper, bagging and stitching machines. This system is a semi-automatic type system which requires minimum two skilled labours to assist. One to put the empty bag at the opening of incoming 50 kg cargo and other one to hold the bag when stitching is in process. After stitching, bag will automatically transfer through bagging conveyors to the spout and loaded manually in wagons or stored at platform.

19 nos. of Horizontal flat belt conveyor with wagon loader (2 Nos for each Flat Belt Conveyor) shall install on either side of platform (total 39 nos) to feed 45/50 kg bags from bagging and stitching machine to nearby wagon mouth.

Delivery height for Cargo Bag in to Wagon shall be variable and shall be able deliver the bag upto shoulder of the labor handling the bag in side Wagon.

Overall capacity for evacuation and semi-auto bagging and stitching machine shall be 1200 Bags/ hr per machine.

Vendor shall design the Bagging and Wagon loading system in such way that Flat Conveyor and Wagon loader shall be able to cater all the Wagons without moving of Rack. It shall be suitable to cater various types of Rack such as BCN, BCNA & BCNHL with provided mechanization. Kindly Note that Rack position once placed on respective platform shall not be moved unless all Wagons of the Rack are loaded checked and sealed. Vendor is suggested to visit the Bagging & Rake loading plant (20 Units) recently installed at Port Godown No.34 for more realization of the system.

Vendor shall provide the above specified system with necessary equipment's, and accessories as mentioned in indicative specification provided in this document and complete in all respect.

#### **2.2.10 Railway siding at both sides of PEB Structured Bagging & Loading Shed:**

The Contractor shall undertake the Railway Detail Project Report (DPR), Design, construction, manufacture, supply, installation, testing and commissioning of the Civil, Structure and Track works of the proposed rail system as defined in Tentative Layout drawing of Tender Document. The work includes without limitation, the design, construction and removal of any temporary works required for successful commissioning of the proposed rail system.

Railway line needs to be laid at both side of the Godown which shall be extended from the existing main railway line. A total platform length of about 700 m is envisaged for accommodating a complete rake. The width of the Godown / Platform shall be adequate for bagging / stitching machines and transit storage of bags for loading to the rakes on both sides.

As indicated in drawing Vendor shall provide one no. of Rail line for cargo and one no of escape line for Rake at both side of Godown. Vendor shall carry out necessary site survey, geotechnical data, details of LC, details of utility crossings etc. to design the system.

Vendor shall ensure hook up with Main railway line. Rail crossing check rails and utility crossing provision shall be provided as per Railway standards. Rail connectivity for both along sides of the bagging & rake-loading shed with their respective escape routes shall be taken

from nearest available take-off point at the boundary end of the backup area towards landward side.

Vendor shall provide Rail Entry - Exit Gate as per Railway Statutory Guidelines.

Vendor shall design and construct Railway lines as per reference drawing, operational requirement and specification provided in this document and complete in all respect.

**Vendor shall prepare Railway DPR and obtain necessary statutory approval prior to commencement of work. All applicable charges for statutory approval and Codal Charges shall be part of Bidder's Scope of work.**

**Proposed Railway work shall be in line with DFC (Dedicated Fright Corridor) requirement.**

**NOTE: OHE, S&T and Inline Motion Weighbridge work is not considered as part of vendor scope.**

#### 2.2.10.1 Scope of Work:

##### 2.2.10.1.1 Survey, Investigation, Design, Setting out and As Built Drawings

S.N.	Item	Indicative Qty.
1.	Site Survey, Geotech-Investigation, verification and finalization of alignment	LS
2.	Preparation, submission and Railway Approval of DPR, Definitive/ IFC Design Drawings for following works:  Formation, drain, retaining structures etc.  Culverts - (If required)  Track Works  S&T Works (Deleted)	LS
3.	Preparation, submission and Railway Approval of As-Built Drawings for following works Formation, drain, retaining structures etc.  Culverts other misc. drawings  Track Works  S&T Works (Deleted)	LS

#### Notes:

##### a) List of Drawings (Definitive/ IFC Design /As-Built):

- Railway DPR
- ESP
- L-Section and Cross-section drawing of alignment
- SIP
- Modification in existing General Power Supply Cum Sectioning Diagram

- LOP
  - EIG Drawing
  - All track drawings i.e. LWR, SWR, LC Drawing, Index plan, Index section, Curve board, Gradient board, & Hectometer/Kilometer post etc.
  - All Civil drawings like Box Culverts, Pipe Culverts, RCC Drain and any other drawing required for successful completion & commissioning of the project.
  - All Other S&T drawings like Cable corege plan, route plan, location plan, ST, LT, panel diagram, wiring diagram, SWR, SWRD and any other drawing required for successful completion & commissioning of the project.
- b) The Contractor is responsible for getting the statutory / all necessary approvals from concerned Authority Indian Railway including all test certificates as per RDSO guidelines, for all the above drawings not limited to, for successful completion and commissioning of the Project / Rail system.
- c) Approved existing drawings ESPs, SIPs, LOPs & Sectioning diagram shall be shared by DPAt to the Contractor as per availability.
- d) Available Geotech Data (BH data) shall be shared by DPAt to the Contractor if available.
- e) Proposed Indicative lay out plan for the proposed works shall be shared by DPAt to the Contractor.
- f) Final approved as built drawings ESPs, SIPs, LOPs & Sectioning diagram shall be provided by vendor.
- g) All the charges payable for statutory clearance i.e. Codal charges shall be part of Bidder's scope of work.

#### 2.2.10.1.2 Earth Works

S.N.	Item	Indicative Qty.
1.	Ground improvement work, Stone column as per requirement based on Soil investigation report.	LS
1.	Earthwork in filling in embankment by dredged sand/ good earth	LS
2.	Earthwork in cutting	LS
3.	Providing and laying Blanketing material	LS

#### Notes:

- a) The Formation shall be designed for HM loading as per RDSO Guidelines and Specifications for Design of Formation of Heavy Axle Load i.e. RDSO/2007/GE: 0014.
- b) Supply in Contractor's scope:

- Suitable blanketing material for formation
- Other materials (aggregate, sand, water etc.)
- All other materials not limited to above mentioned items from ii (a-b), required for successful commissioning of the Rail system.

#### 2.2.10.1.3 Culverts and Other Miscellaneous Works (If required)

S.N.	Item	Indicative Qty
1.	Extension of Hume pipe Culverts	LS
2.	Extension of RCC Box Culverts	LS
3.	RCC Drain in DTY.	LS

#### Notes:

- a) The Structure works shall be designed for HM loading

#### 2.2.10.1.4 Track Works

Sr.No	Item	Indicative Qty
1	Laying LWR BG track on 60 kg PSC sleepers with Sleeper density of 1660 Nos./km for Main Line and 1540 Nos./Km for Loop Lines and ballast cushion of 300mm under the rail seat with all fittings & fastenings	LS
2	Supply & Laying 60 kg, 1 in 12 Turnouts with all fittings and fastenings.	LS
3	Supply & Laying 60 kg, 1 in 8 ½ Turnout with all fittings and fastenings.	LS
4	Supply & Laying 60 kg, 1 in 8 ½ Derailing Switch with all fittings and fastenings.	LS
5	Supply & Laying of SEJs 60Kg	LS
6	Dismantling of Existing Track	LS
7	Supply and Spreading of Ballast	LS
8	Extension of Un-Manned LC	LS
9	Extension of Manned LC	LS

#### Notes:

- a) The Track structure shall be designed for 25 Tonne Axle load.

- b) Rail welding: Alumino-thermit weld.

- c) Sleeper density: 1660 Nos. /Km for Main Line and 1540 Nos./km. for Loop Line
- d) All required materials shall be supplied by contractor but not limited to;
- 60kg Rails. (For Track, Check rails, guard rails, DE, Rail post, Creep post)
  - PSC Sleepers. (Plain track sleepers, Turnout Sleeper Set, Trap Point Sleeper Set, SEJ Sleeper Set, Other Special sleepers like LC, Guard Rail Sleeper, Curve Sleeper with and without check rail arrangement for curve)
  - All track Fittings & Fastenings (ERC, Liner, GRSP, Fish plate, Joggle fist plate, Fish bolt etc.)
  - All types of Turnout Sets 1 in 8 ½ & 1 in 12 (Switch, Lead rail, crossing body and Point machine) with all fittings complete including Self-Reversing Spring box for non-interlocked Turnouts
  - Derailing Switch with all fittings complete including Self-Reversing Spring box
  - SEJs with all fittings complete
  - All other special fittings for LC check rail, curve check rail, guard rail fittings
  - Anti-corrosive paint as per IRS guidelines
  - Portion, Moulds and other material for Alumino-thermit welding
  - Ballast
  - M-50 grade & 80 mm thick Paver block for LCs
  - The limit of paving the LC is 3m either side from center of outermost track
  - Fencing at LCs as per RDSO drawings
  - 60 kg Glued insulated Rail joints
  - All types of Sign Boards
  - Building materials (aggregate, sand, water etc.)
  - All other fittings not limited to above mentioned items from v (a -n), required for successful completion and commissioning of the proposed Rail system.
  - All materials shall be certified by RITES/RDSO as per the applicability under guidelines of RDSO

## **2.2.11 Building for Substation cum Control Room / Operation Room:**

### **2.2.11.1 Sub Station Building - Ground Floor**

#### **a) Introduction**

The scope of design under this document includes Architectural, Structural design and services of buildings envisaged. This document is in relation to the basis of design of the Substation building envisaged for the operational and service requirement of the port.

#### **b) Description and Scope of Structure**

Design & construction of Utility Buildings consisting of following spaces with clear plan dimension mentioned against them. These Substation buildings are SMRF concrete structures of ground floor only. Roof height shall be around 4.5 mtrs (FFL to Bottom of Beam) and finished floor level of building shall be 500 mm above FGL. The building shall be provided with firefighting system (Fire extinguishers). Inlet and outlet Cable trench/ cable cellers (approximately 3m height) shall be considered for S/S room. Air Conditioning of adequate capacity shall be provided in VFD room, RIO room and PLC-UPS room. Panel bottom entry shall be considered. Civil details shall cater to bus duct of Distribution/ Power/convertor duty transformer. Civil and structural details shall consider pressurised ventilation system for areas other than VFD panel room, PLC-UPS room and RIO panel room.

#### **c) Indoor Environment and Quality Standards**

While orienting and designing a schematic, the desired indoor quality of environment shall be kept in mind and certain key features shall be combined along with the Architecture. Open areas, closed areas, glass areas etc. are the important things that are kept in mind

#### **d) Architecture:**

Once the primary functional needs and schematic design is completed, the building is shaped and idealized for architectural purposes based on the latest codal provisions. The look, feel, shape and finishes are given due value to arrive at a sustainable Architectural design. The Landscaping in and around the building shall be combined with the building to give it a natural existence.

#### **e) Utilities and Services:**

Various utilities for building projects in terms of various services related to buildings such as MEP (Mechanical, Electrical & Plumbing), HVAC (heating ventilation & air conditioning), Firefighting, Fire alarm system, IT/ELV systems with required public address system, acoustical requirements Etc shall be designed in accordance with relevant IS & Other codes.

User input shall be taken for the layout & IT systems. The utilities and services shall include all services pertaining to complete building for occupancy.

Storm water drainage shall be provided to drain the runoff to the nearby storm water drain.

### **2.2.11.2 Operation and Control Station building (First Floor):**

#### **a) First floor of the building is to be utilized for office space and control room operational space.**

- b) Here the floor would be bifurcated into operational and functional zones with toilets, pantry, server room, meeting rooms, ups/it room as common utility space.
- c) Panels for Operational area and functional area must be within the zones.
- d) The floor will be well ventilated and illuminated mechanically as well as naturally.
- e) Fire safety and fire escape routes must be provided for emergency situation.
- f) Raised floor must be provided for Server and operational rooms.
- g) Health hygiene of the employees must be taken care of.
- h) Interior paints, flooring, exterior cladding, glass partitions, ventilators, windows must be provided as per standards and specification mentioned under relevant sections of this tender.
- i) False ceiling, HVAC, Utility ducting, Rain water harvesting, waste disposal, interior partitions for cubicles and workstations and other must be provided as a part of interior furniture.
- j) Surveillance system for the operation rooms must be provided.

## **2.2.12 Central water tank & Pump house for Firefighting / Potable Water**

### **2.2.12.1 Introduction**

The scope of design under this document includes Construction, Architectural design, Structural design and services of pump house & water tank envisaged. This document is in relation to the basis of design for the pump house & water tank envisaged for the operational and service requirement of the port. The tentative scope includes Potable Water Pipeline (HDPE Pipeline of 6" Dia with all valves and accessories), Excavation & refilling of pipe trench, Providing, Lowering, Laying, Jointing & Hydrotesting of 6" dia HDPE pipe (PE100, PN10) Pipe (O.D) including pipe fittings, IS - 4984 / 1995, Providing & fixing of Valves NRV & instrument with Accessories, Potable Water Pump (Pump with all accessories, Valves, instrument, fittings & RCC foundation) capacity 5 m<sup>3</sup>/hr, 50m head.

### **2.2.12.2 Water Tank:**

Vendor shall consider one number of water tank of suitable capacity for various applications i.e. Firefighting operations, Potable water use, horticulture use etc.

Vendor shall consider suitable numbers of partition in tank for different application. Water tank shall be well collected with Pump house. Necessary instruments and automation shall be provided for Water tank.

### **2.2.12.3 Pump House:**

Pump house Building should be adequately sized to accommodate pumps for various applications such as, Fire Fighting, Potable water use, horticulture use etc. with rolling shutter, door, window, Monorail of suitable capacity and ventilators.

Plan area of the pump house building with water tank shall design by vendor. A pump house shall be constructed having one common wall with service water tank to house, pumps & motor and accessories viz. electrical & instrumentation panel, cable tray, cabling, Level gauge/level transmitter, pressure gauges/transmitters, local control system, pressure switch, earthing system, flow indicator, ultrasonic sensor suction and delivery pipes, pipe sleeves, puddle flanges, pipe fittings, valves, pressure vessel, Adequate space shall be kept inside the



pump house for maintenance of pumps and storage of spares etc. Monorails shall be provided in pump house as per requirement. Electrical cable trenches shall be provided as per layout & requirement.

All electrical works for pumps cable including wiring, illumination of pump house, earthing of the equipment etc required for the pump operation shall be done by the contractor. Electrical panel shall have provision for lighting, welding socket & single phase utility socket etc for maintenance. Necessary automations shall be done to facilitate operation of water pumps and service water pump house from the central control room (CCR) in addition to the operation inside pump house.

Pump house MCC, PLC Panel and field instruments shall be hooked up with central control room (CCR). Standard communication mode (wireless/ fiber optic) shall be used with suitable communication protocol for communication. Cables and accessories required for smooth and efficient communication shall be provided by the contractor.

### **General Utility**

Storm Water System: Storm water drainage will be provided to drain the runoff to the nearby storm water drain.

### **Indoor Environment Quality Standards**

While orienting and designing a schematic, the desired indoor quality of environment shall be kept in mind and certain key features shall be combined along with the Architecture. Open areas, closed areas, glazing etc.

### **Architecture**

Once the primary functional needs and schematic design is completed, the building is shaped and idealized for architectural purposes based on the latest codal provisions. The look, feel, shape and finishes are given due value to arrive at a sustainable Architectural design. The Landscaping around the building shall be combined with the building to give it a natural existence.

### **Utilities and Services**

Various utilities for building projects in terms of various services related to buildings such as Plumbing, Firefighting, FDA & PA system shall be designed & Constructed in accordance with relevant IS & Other codes. The utilities and services shall include all services pertaining to complete building for occupancy.

## **2.2.13 Toilet block in Open Yard**

### **2.2.13.1 Introduction**

The scope of design under this document includes Architectural, Structural design and services of building envisaged. This document is in relation to the basis of design of the Toilet block for workers envisaged for the operational and service requirement of the port & terminal.

### **Description & Scope of Structure (Indicative)**

Design & construction of Toilet block for workers consisting of following spaces with clear plan dimension mentioned in GA drawing. Toilet block of approx. 10.5 x 5m area with minimum 7 Nos of water closet, 8 Nos urinals, 4 Nos wash basin is suggested.

This Toilet block for workers (250nos. user/day capacity) is of frame concrete structure with masonry infill wall with all the required finishing and architectural items (i.e. - inside-outside plaster, colour and floor finishing, door, window, water proofing at terrace and in wet areas, etc.) of ground story only. Roof height from FFL (i.e.-top of floor finish) to RC slab top 2.4m and finished floor level of building shall be 450 mm above FGL.

Plumbing inside the building as per employer's requirement and specifications.

#### **Indoor Environment Quality Standards**

While orienting and designing a schematic, the desired indoor quality of environment shall be kept in mind and certain key features shall be combined along with the Architecture. Open areas, closed areas, glass areas etc. are the important things that are kept in mind.

#### **Architecture**

Once the primary functional needs and schematic design is completed, the building is shaped and idealized for architectural purposes based on the latest codal provisions. The look, feel, shape and finishes are given due value to arrive at a sustainable Architectural design. The Landscaping and area development in and around the building shall be combined with the building to give it a natural existence.

#### **Utilities and Services**

Various utilities for this building such as MEP (Plumbing i.e:- water supply & sewage lines, firefighting, FDA & PA systems) shall be designed & constructed in accordance with relevant IS & other codes.

### **2.2.14 Road Connectivity with internal road network:**

#### **2.2.14.1 Scope of Work**

- a) Internal yard roads are proposed for accessibility in yard area for service vehicles, Trucks, Dumpers, and Yard equipment(s).
- b) Main Entry and exit road shall be minimum 7.5-meter-wide of bituminous road; main road shall be connected with existing Port Road outside terminal boundary. Necessary modification of port road and median shall be done. Terminal internal road shall design to provide smooth connectivity to all the facilities envisaged inside terminal.
- c) Cross roads along with stock pile are to be provided in the yard area with granular top.
- d) Average Width of proposed road is 4m.
- e) Necessary Hume pipes of NP4 grade and required diameter/underground RCC trench for vehicular movement shall be provided at required depth for utilities to cross the road and road crossings. Decision on type of crossing shall be taken in consultation with employer/user.
- f) All required road furniture, road signage, safety signage, Cat eye, thermostatic paint shall be design and provided by vendor as per latest applicable code.

#### **2.2.14.2 Battery limit**

- a) Roads are proposed to join with existing peripheral road.
- b) Layout drawing no M-002 is attached for reference.

### 2.2.14.3 Documentation

Documents for employer review and approval

- Execution drawings with Road cross section & layout
- BOQ for road work
- Documents for information and record
- Final BOQ for road work
- As built drawing.

### 2.2.15 Road Entry - Exit Gate with Lane Cubicles:

There shall be 1 No. of gate with closed terminal fencing boundary. There shall be 2 nos of Entry lanes and 2 nos of Exit Lanes along with porta cabins at each entry & exit lanes . Gate shall be with provision of RFID / OCR controller. Boom barrier shall be provided for each entry and exit lanes.

Entry & Exit lane area shall be well connected with Terminal internal road with adequate sized divider curbing. Porta cabins for lane shall be sized as per final architecture drawings.

In addition to Lane cubical one Container cabin cum office shall be provided for Security operations. This shall be equipped with all necessary set up, working stations, IT connectivity for Security operations.

Necessary Hume pipes of NP4 grade and required diameter/underground RCC trench for vehicular movement shall be provided at required depth for utilities to cross the road and road crossings. Decision on type of crossing shall be taken in consultation with employer/user.

Design and detailing of medians, crash barriers, utility chambers, road crossings, conduits to convey services like IT, Electrical, illumination etc. shall be as per architectural and functional requirements and latest standard code as applicable.

- No. of lanes with electric boom barriers: 2nos (3.5M wide) for Entry and 2 nos (3.5M wide) for Exit.
- No. of Porta Cabin: 4nos (1.5M x 2.4M) at Each Entry & Exit area.
- No. of medians: as per operational requirements at each entry and exit.
- No. of swing gates: 2 nos (double leaf gate) each of suitable size for Entry and Exit.

#### **IMP. Note:**

- a) Dimensions mentioned in technical scope & tender drawings are indicative and may change during detail design.
- b) Scope of Architectural canopy will be decided by user at later stage (i.e. - Canopy requirement/ size.)
- c) Suitable arrangements for storm water drainage shall be provided in the area to get water logging free area.

### 2.2.16 Road Weighbridge:

Vendor shall provide 1 no of Weighbridge for vehicle Entry and 1 no of Weighbridge for vehicle exit from terminal with One no of Operator Cabin.

**Capacity of Weighbridge:** 100 MT Each

Vendor shall consider all civil concrete work, electrical connectivity, IT connectivity related to Weighbridge. Necessary civil and structural works for weighbridge, civil foundation, ramps, pit-less type & all other necessary requirement shall be carried out with reinforced concrete as a material.

### **2.2.17 Settling pond:**

To mitigate environmental degradation as well as to reduce the siltation of nearby, the run-off from stockyard will be provided a primary treatment in the form of a settling process before disposal. Since the run-off generating from stockyard will contain silt and dust of other dry bulk / Minerals etc. depends on type of cargo stored in open yard. It will require a settling treatment only for two days detention time. This will allow the dust particles to settle and clear water run out from the pond. To maintain the proper slope for natural drainage, the total storm run-off from stockyard i.e. from open drain and underground drain will be collected into settling ponds provided at the end of stockyard.

All drains from stock pile area shall discharge to the settling basin and outlet from settling basin shall be connected to sea outfall drain.

Settling basin shall have RCC sloped side and key wall, bottom PCC with 4mm dia weld mesh (approx 100mm x 100mm sq. opening), inlet and outlet arrangement, ramp for vehicular entry to pond for desilting.

**Unless specified otherwise, settling basins to be of (indicative):**

- Top (excluding pathway), bottom & clear depth dimension – To design requirement
- Width of Pathway along periphery – 1 mtr
- Width of Ramp for Pay loader – 5 mtrs
- Side Slope – 2 H: 1V and Slope of Ramp 8H:1V
- Hand rails along periphery of pond for safety purposes

### **2.2.18 Fire Fighting System and Dust Extraction System:**

#### **2.2.18.1 Fire Fighting System:**

##### **2.2.19.1.1 Scope of Work (indicative):**

<b>Sr. No.</b>	<b>System</b>	<b>Area</b>	<b>Broad Scope</b>
1	Fire escape Hydrants(FEH)	Each floor of Transfer tower & building.	Tapping from fire water main Wet riser, Fire Escape hydrants (Hydrant valves, Isolation Valves, fire hoses, Hose Boxes, Branch pipes)

3	Yard Hydrants	Stock pile area and Jetty.	Yard hydrants (Hydrant valves, Isolation Valves, fire hoses ,Hose Boxes, Branch pipes)
4	Fire Extinguishers	Transfer Tower, Building & Substation, Mobile Harbour Crane and Mobile hoppers.	4.5Kg CO2 extinguishers 5Kg ABC type extinguishers
5	Firefighting Pump house, Pumps & Piping	Pump house for fire water pumps	New pump house in the back up yard for Firefighting, pump sets and accessories. New fire water pumping system with Working pump/s Standby pump/s Jockey pump/s MCC & Cabling Piping , Valves & strainers
6	Fire Water Piping	Stock pile area, Jetty, transfer towers & buildings.	Fire water ring main Terminals
7	Replacement of existing feeder main pipe from Pond existing fire pump	Feeder main from pond to fire water Pump sump	Replacement of existing pump & feeder main from pump at pond to Fire water tank with 355 mm dia HDPE PE 100, PN 10 Pipe and fittings.
8	Design & engineering	--	Analysis / Simulation (using Pipe net software) of firefighting system for stock yard & jetty. Fire water pump house Fire Water pumps capacity & head Water storage tank

In addition to the above, scope of work shall also include engineering design, procurement, supply, erection, testing & commissioning oh the following listed items for full proof firefighting system inside the battery limit in accordance to TAC norms.

- a) Piping, valves, and other accessories
- b) Valve Chambers
- c) Under Ground and Above Ground piping for Yard Hydrants and fire escape hydrants
- d) Yard Hydrants and Fire Escape Hydrants with accessories
- e) Fire extinguishers

- f) Hydrant, Jockey Pump and accessories
- g) FSS Panels
- h) Automation system for fire fighting
- i) Dewatering Pump, pipe line and required automation
- j) Testing and Commissioning

#### 2.2.19.1.2 Raw Water Characteristics

- pH: 7 to 8.5
- TDS: 2000 PPM
- TSS – 100

#### 2.2.19.1.3 Documentation

##### Submission for employer Review and Approval

- Documents under approval category Basic layout (General arrangement Drawing)
- Detailed Engineering Report including Basic input files of STAAD Pro, design calculations, CAD files, excel spread sheets
- Design Basis report, Detailed Engineering Design Report
- Process calculation
- P & I, HFD and PFDDiagram
- SLD and Control wiring
- Piping Drawing
- QAP
- Data Sheet and Technical Specifications of Electromechanical Items
- GAD of all equipment, electrical and Civil items
- IDC check (Mechanical, Electrical, Piping and Instrumentation) for ensuring foul check
- Structural Drawing of civil items
- Operation Philosophy and Automations

##### Submission for employer Information and

##### Record

- Bill of quantity
- MTO
- O & M Manual
- As erected drawings.

#### 2.2.18.2 Dust Extraction system

#### 2.2.19.2.1 Scope of Works

Sr. No.	System	Area	Broad Scope
1.	Installation of DES and pumps at the yard DES Pump house	In Back up yard	Common pump house to accommodate air compressors, DE pump. DES pumps Air compressors Piping for DES pumps, accessories and flow control valves, Nozzles etc.
2	Dust Extraction system	Mobile Hoppers, Transfer Towers, tail houses, drive houses, Travelling Trippers	Dust extraction system with bag filter arrangement shall be provided for all the discharge and receiving point of conveyors and mobile hoppers. The dust extraction system shall be designed by EPC contractor based on input data of MHS system mentioned elsewhere in the tender specifications. The dust extraction system shall be suitable for fertilizers, food grains, minerals, salt etc. EPC contractor shall provide calculation and detailed specification of dust extraction system for employer's review and approval in detailed engineering

In addition to the above, scope of work shall also include engineering design, procurement, supply, erection, testing & commissioning of the full proof dust extraction system inside the battery limit in accordance to CPCB norms and prevailing statutory regulations, as applicable.

#### 2.2.19.2.2 Documentation

##### Submission for employer Review and Approval

- Documents under approval category Basic layout (General arrangement Drawing)
- Detailed Engineering Design Report
- Process calculation
- P & I, HFD and PFDDiagram
- SLD and Control wiring
- Piping Drawing
- QAP
- Data Sheet and Technical Specifications of Electromechanical Items
- GAD of all equipment, electrical and Civil items
- Structural Drawing of civil items
- Operation Philosophy and Automations

##### Submission for employer Information and record

- Bill of quantity

- MTO
- IDC check (Mechanical, Electrical, Piping and Instrumentation) for ensuring foul check
- O & M Manual
- As Built Drawing

### **2.2.19 Other Utilities like Compressed Air, Water, Effluent and Sewage Collection etc.**

Vendor shall provide various utilities as per requirement. Minimum requirement for the terminal are envisaged as per below;

- Compressed Air / Instrument Air as per requirement of various equipment(s).
- Potable Water connectivity at all buildings.
- Sewage and Effluent Collection system as per requirement for various buildings and equipment(s).
- Rain Water Harvesting as per statutory requirement.

Sewage pumping stations (SPS) and collection stations, Manholes, Valve chambers, Inspection chambers, Storm water drains, Rain water harvesting, and Other Miscellaneous elements' necessary civil and structural works for storm water drains, civil and structural pipe supports, manholes and valve chambers (for water supply, water distribution, firefighting system etc.) shall be carried out with reinforced cement concrete as a material.

Specifications for the materials and elements shall be as per the standards provided in respective section of this tender document.

Sewage pumping stations and elements of Sewage system in contact of water, waste water and water vapour shall be designed as per specifications provided for clear water tank.

Necessary Hume pipes of NP4 grade and required diameter/underground RCC trench for vehicular movement shall be provided at required depth for utilities to cross the road and road crossings. Decision on type of crossing shall be taken in consultation with employer/user.

Rain water harvesting scheme shall be provided as required to meet statutory compliance as per regulations.

### **2.2.20 Storm water drain:**

#### **Grading Plan:**

Grading plan to be fixed considering the existing yard, railway level for smooth drainage of area;

- a) Yard to be sloped in transverse direction from centre line towards drain.
- b) Ground between stacker and drain shall be sloped towards drain
- c) Other areas, buildings etc. shall slope towards drain

#### **Storm Water Drainage:**

Storm Water drainage network shall be planned, designed and constructed for efficient drainage of water from the plot under consideration (i.e. stock yard, road, railway and other



areas) of approx. 2500 Rmt. With indicative Average size - 1m W X 1m D, in a holistic manner incorporating the drains and drainage system of existing area.

- a) All drainage networks shall be designed for flow under gravity.
- b) Yard side Drain wall to be raised by 1000 mm above the finished ground level to restrict entry of spillage into the drain.
- c) 100 mm dia Circular pipe Openings shall be provided at every 1000 mm interval in the drain wall at finished ground level for entry of water into the drain. Pipe opening shall be covered with wire mesh to avoid choke-up.
- d) Runoff from the process area (cargo affected) area to be drained to the existing settling pond inlet.
- e) Drains from Non processing area to be drained towards outlet drains as per layout.
- f) Yard Drain – Open Rectangular RCC Drain, However Provisions to be made in drain wall for putting cover slab in future. However, necessary cross over shall be provided at regular intervals.
- g) Road Side Drain - RCC Rectangular Drain with Precast cover.
- h) RCC box Culvert/ Pipe Culvert shall be provided for road, Railway crossing.
- i) Minimum cover to pipes at rail crossing shall be as per railway norms

#### **Documents for employer review and approval**

- Grading Plan
- Basic layout drawing of Drains,
- Design calculations
- R.C details of Drains, culverts
- General Arrangement of New Settling Pond
- Inlet and Outlet arrangements
- General arrangement & Specifications for Thimble mounted gates

#### **Documents for information and record**

- MTO
- BoQ
- IDC check (Mechanical, Electrical, piping and instrumentation) for ensure foul check
- As built drawing.

### **2.2.21 Fencing Boundary for Terminal:**

Proposed Terminal shall be isolated by surrounding facilities and terminal by a appropriate Fencing Boundary.

Terminal fencing shall be Precast Wall fencing with posts & barbed wire as per drawing, specifications and as directed by engineer in charge.

Proposed terminal fencing shall be connected with existing fencing boundary of Berth-13 & Berth-15 to have close loop. Necessary rectification and modification of existing fencing shall

be done as per requirement.

### **2.2.22 Electrical, Instrumentation & Automation Works:**

The project scope for electrical includes detail engineering / Design, Procurement, Construction/Erection/Fabrication and Commissioning of following systems;

- Vendor shall draw 11KV HT supply by laying two (2) nos of HT cables from existing 66KV switch yard substation with necessary modification by using separate route up to proposed new substation near Berth-14. Vendor shall consider cleaning of existing trench and crossing, construction, modification, repair of existing cable trench and crossing for laying of new cables.
- Modification/Extension/Installation of existing 11kV breaker panel at 66 KV Switch Yard substation.
- Step down & Distribution of power for Material handling system and general power & Lighting.

The scope of works for Electrical & Automation system mainly comprises of;

#### **a) External power**

- Vendor shall draw 11KV HT supply by laying two (2) nos of HT cables from existing 66KV switch yard substation with necessary modification by using separate route up to proposed new substation near Berth-14. Vendor shall consider cleaning of existing trench and crossing, construction, modification, repair of existing cable trench and crossing for laying of new cables.
- Step down & Distribution of power at 3.3KV and 415V for Conveyors, Cranes & Equipment and other related auxiliaries, general power & Lighting.

#### **b) New 11 kV Substation**

- Incoming power supply from existing 11 kV Source located at existing 66 KV Substation in Port up to 11 kV Breaker panel of proposed Substation.
- HT Breaker panel, Power & Control cabling.
- Power Transformers, Distribution Transformers, and Lighting Transformer
- HT APFC
- PCC
- MCC
- MLDB
- ACDB & LDB
- Battery & Battery charger with DCDB
- UPS system
- Building, Operational, (Conveyor Gallery/ Walkway/Platform etc.) and area lighting
- Safety equipment
- Civil for electrical
- Fabrication work for electrical

- Pressurization system
  - Fire detection and alarm system
  - Fire-fighting / suppression system for substation and transformer yard
  - PLC system & control room
  - Communication system (Telephone & Public Address)
  - Security system (CCTV and Access Control System)
- c) Power distribution network for back up yard & Illumination of open area/roads/transfer towers/conveyor galleries/various structures, Substation building & other utility building lighting. Dock area lighting/illumination should be complied by considering the dock safety regulation
- d) Any steel fabrication work related to electrical equipment installation.
- e) Testing and Commissioning of HT & LT motors including motor
- f) Earthing of motors and equipment supplied and installed by the others.

## 2.3 Key Design Parameters:

Fertilizer & clean cargo mechanization system shall be design to handle **5.11 MMTPA** of finished fertilizer & other clean cargo. The cargo characteristics to be considered for the design of Mechanization of handling of fertilizer are given in Table below:

**Table 2-2: Cargo Characteristics**

Material	Average Bulk Density (T/cum)	Angle of Repose (degrees)	Size (mm)
Muriate of Potash (MOP)	1.1	35	(0.25-1.7 mm) 65%
Di-ammonium Phosphate (DAP)	0.95	35	(1-4 mm) 95% -granules or in powder form
Urea	0.8	34	(1- 2.8 mm) 98% -granules
Other clean cargo	Sugar, salt, silica sand/ china clay, food grains like wheat maize etc., fertilizers & other similar cargo.		

### 2.3.1 Performance Parameters:

Key performance parameters for design of system are mentioned in Table below:

**Table 2-3 Key Performance Parameters**

Description	Parameter
Maximum ship size	35,000 to 75,000 DWT
Total Dry Bulk Cargo Handling Capacity (Starting from unloading, conveying, storage, Bagging, loading and evacuation by Rack)	5.11 MTPA
Operating days per annum	365
Design unloading rate	2200 TPH
No. of Rakes shall be handled per day. (Two racks simultaneous)	6 Nos.
Material Can be Handled per day (Two racks simultaneous)	20880 TPD
<ul style="list-style-type: none"><li>System shall be designed for 6 Rakes will load in one day when 2 rakes will load simultaneously on either side of the Godown. For one railway siding 3 rakes will load.</li><li>One full rake shall be loaded in 6 hours (including pre &amp; post loading operations).</li><li>For one single stream 10440 TPD.</li><li>Mechanization shall be designed for 5.11 MTPA operating capacity.</li></ul>	

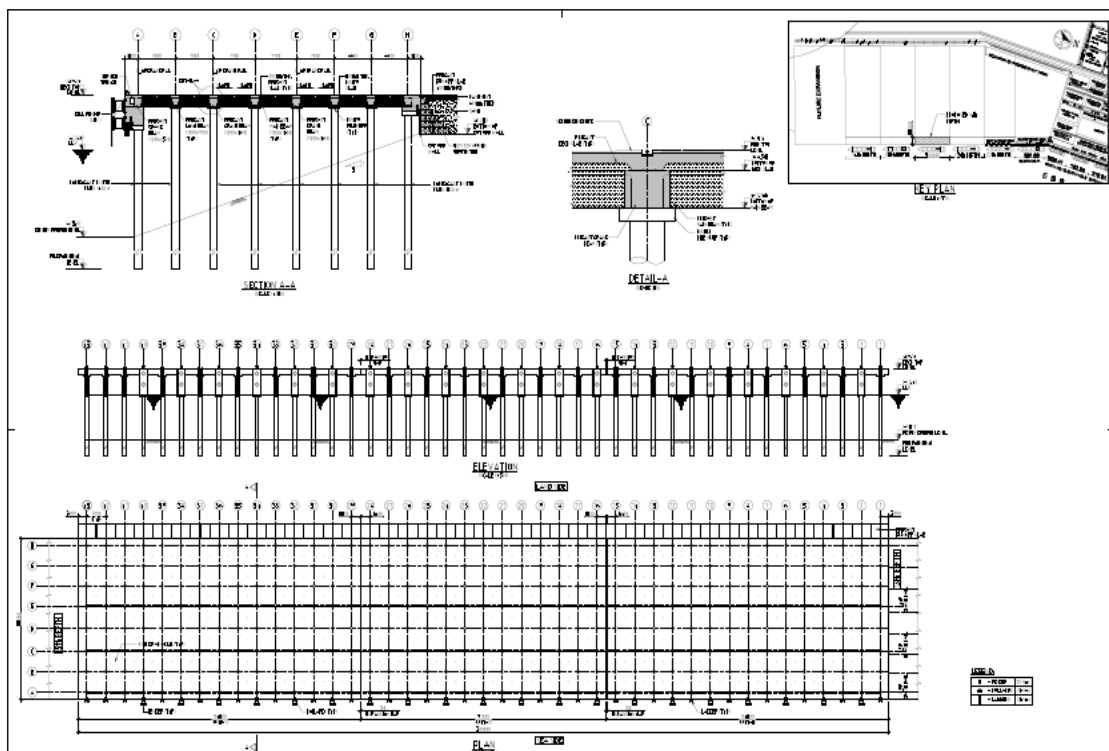
### 3. Indicative Technical Specifications of MOBILE HARBOUR CRANES

#### 3.1 Overview

Deendayal Port Authority is one of the major ports among 13 declared major ports of India and situated along the Western bank of Kandla creek. Deendayal Port Authority has decided to undertake the development, operation and maintenance of Dry bulk cargo handling facility at Berth-14 inside Port on EPC basis. The proposed terminal is located at western bank.

The Deendayal Port Authority has decided proposed development of Dry bulk cargo handling facility by maximum vessel size of 75,000 DWT with (-) 14 m CD dredged depth. Keeping these factors in view and logistic support required for deep draft berth in terms of backup space, railway tracks, road, etc., the proposal is to develop the dry bulk cargo handling facility for 4.5 MMTPA cargo.

The tyre mounted cranes placement on the wharf is to utilize maximum. The Jetty drawing below is for clear understanding.



The Berth-14 shall be equipped with two rubber tyre cranes. These cranes shall move on berth on both directions as required. Both cranes are of same capacity cranes for reasons of higher through put for bigger vessels and matching conveyor capacity.

The tyre mounted harbour crane shall have travelling, slewing and boom luffing motions similar to the general arrangement.

These cranes are electrically operated with high tension shore power and have on-board diesel engine to execute reduced capacity of operations in case the main power fails.

The both MHC trailing cable will be sized to allow the machine to operate over the full range of Berth with full capacity operation of crane.

The equipment shall comprise a main portal gantry / base frame supporting a slewing superstructure with machinery house, boom and lifting arrangements.

The crane shall be equipped with an operator's cabin in accordance with the requirement. The operator safety is considered in the design.

The equipment will load/unload material from ship to shore and vice versa

The guidelines in this document set the scope, philosophy, equipments quality, and standards to ensure that the equipment projects requirements are met. The design criteria in this document establish the basis for the design of the equipment and are minimum standards that guide:

- Equipment(s) specification and their functions usage.
- Safety features and maintenance facilities.
- Operating Performance.
- Standardization
- Environmental design features.
- Selection of code, law and regulations.

## 3.2 Operational Requirement

### 3.2.1 Specification of Cargo

Typical characteristics of the cargo to be handled are given below. Depending upon the source, the characteristics may vary.

**Table 2-1:** Cargo Characteristics

Material	Average Bulk Density (T/cum)	Angle of Repose (degrees)	Size (mm)
Muriate of Potash (MOP)	1.1	35	(0.25-1.7 mm) 65%
Di-ammonium Phosphate (DAP)	0.95	35	(1-4 mm) 95% -granules or in powder form
Urea	0.8	34	(1- 2.8 mm) 98% -granules
Other Clean Cargo	As per actual	37	Generally within 0.5-50 mm

**Grab Operation** -: As mention in above table characteristic.

**Hook Operation** - Suitable for break bulk and dry bulk commodities.

### 3.2.2 Design Vessel Size:

Bidder shall consider vessel size while selecting and designing the Mobile Harbour Crane.

Type of vessels	Carrying capacity (DWT)	Displacement (T)	Overall Length (m)	Length between perpendiculars (m)	Beam (m)	Draft (m)

Bulk Carriers	75,000	90,000	240	216	40	14
---------------	--------	--------	-----	-----	----	----

### 3.2.3 Key Performance Parameters:

Bidder shall consider following key performance parameters while selecting and designing the Mobile harbour crane.

Maximum ship size	35,000 DWT to 75,000 DWT
Total Dry Bulk Cargo Handling	5.11 MTPA
Operating days per annum	360
Unloading Conveyor Design unloading rate	2200 TPH
<p><b>a)</b> Number of Unloaders required to achieve the overall unloading capacity depends on various factors, out of which the following are relevant.</p> <ul style="list-style-type: none"> <li>• Cargo density</li> <li>• Ship sizes</li> </ul> <p><b>b)</b> Unloader capacity (considering two unloaders per ship as maximum for the ship size under consideration) <b>c)</b> 2200 TPH</p> <p><b>d)</b> Since unloader of such large capacity for fertilizer is not practical, two unloaders of 1100 TPH. Assuming all ships will be in the range of 35,000 DWT to 75,000 DWT. In case of lower size ships, i.e. below 45,000 DWT, overall unloading efficiency is expected to be lower than 60%.</p>	

## 3.3 Scope of Work

### 3.3.1 General

- The equipment specified herein shall be designed and built mainly for the above specified cargo.
- The equipment and materials covered by this specification are subject to the referenced attachments. The tenderer shall be responsible for and governed by all the requirements of this specification and General Conditions of Contract which shall be a part of this document.
- The Scope of Work is for the engineering, design, manufacture, delivery to site, erection, testing and commissioning upto handing over of the following equipment.

Sr.No	Item Description	Qty
1	Rubber tyred Mobile Harbour crane electrically driven by High Tension shore power and equipped with on board Diesel engine Power for full speed operation when shore power system fails.	2 Nos

- d) The equipment described and specified herein is electric powered, rubber tired type for handling dry bulk and break bulk materials as specified. The interfaces with the overall bulk material handling facilities are described within this specification.
- e) The equipment shall be complete and shall include everything necessary to provide fully commissioned and operational machines that will perform as specified. Overall dimensions (boundary dimensions) and functional requirements as shown on the drawing(s) and/or specified shall be adhered to as far as possible unless in the opinion of the tenderer it is necessary to change the dimension(s) to meet the operational requirement.
- f) All works incidental to the above including additions, substitutions and modifications, if any.
- g) Consider the Tenderer as a potential party for annual maintenance contract to be entered at a later date.
- h) Tenders based on International sources shall have due consideration for maximizing components, which have service / support in India. Tenderers shall list out the availability of such facilities and the details of arrangement the Tenderer could arrange in the event of award.
- i) Accessories like CRD along with power cable, Grab, attachment for break bulk cargo handling is in the scope of supplier.

### **3.3.2 Work Included**

Work shall include, but not be limited to the following:

- a) All technical information required by others, for the design and installation of civil, structural, mechanical and electrical work at the equipment interfaces, and in accordance with the Documentation Schedule.
- b) Management, coordination, planning of the work at all locations of the work including occupational health and safety, quality control, cost control, design, manufacture, delivery, inspection, erection, testing, commissioning and training.
- c) Supply, erection and delivery of all temporary structures, tools, rigging, erection, machinery, temporary power for erection, testing, adequate site lighting, temporary water supplies, transport logistics, etc.
- d) Supply of all engineer and labour for design, manufacture, delivery, erection, testing and commissioning of equipment, including transportation as required, housing, security, temporary sanitation and safety requirements, up to handing-over of equipment.
- e) All consumable materials including filters, lubricants, hydraulic fluids, electrical fuse, temporary loads; up to equipment handing-over.
- f) Cleanup at site of all debris and temporary structures on a daily basis and final cleanup at handing over.
- g) All electrical safety requirements during erection, testing and commissioning, including adequate earthing of erection equipment and machines.
- h) Proper safe storage of all equipment and materials delivered at site, in areas designated by the Engineer/Employer in line with customs regulations if applicable.
- i) Labour tools and materials for connection of equipment to permanent power and yard controls.
- j) End stops at the end of travel matching the equipment mounted buffers on the berth.
- k) Manuals for installation, operation, maintenance spares, along with drawings as required.
- l) Operation and Maintenance Training to Employer's personnel and O&M Contractor's Personal (appointed by Employer) shall be provided.



- m) Supply of spare parts as required upto Performance Guarantee Test and Taking-over and for two years operation after Taking-over.
- n) Civil works up to and including the equipment support and structures as required for anchoring the equipment during non-operating conditions.
- o) Trailing power and control cable support and trays.
- p) All HT / LT Power and control cables works.
- q) Foundations for anchoring devices, jack-up points and end buffers.
- r) Supply of water pipeline.
- s) Other than on-board Fire Fighting and Dust Suppression System.

**Note:** Design load details and typical arrangement drawings shall be furnished by this Contractor(s) to the Engineer/Employer within 30 days of award of the contract for all the interfaces.

### 3.3.3 Attached Drawings

Berth Layout and cross-section drawings are attached here with to get the overall view of handling system.

### 3.3.4 Basic Data of MHC

Sr. No	Description	Technical Parameters
1	Type	Rubber Tyred Mobile Harbour Crane electrically Operated with High tension voltage shore power and equipped with on board Diesel Power for 100% speed for one crane and 50% reduce speed operation for 2nd crane when shore power system is fails.
2	Quantity	02 nos Rubber Tyred type.
3	Material to be handled	Coal, Fertilizer & other break bulk cargo by Grab Bucket & hook for other commodity.
4	Free digging Unloading rate, TPH / Crane	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
5	Min. req. Crane with grab operation. (four rope Grab)Load on rope.	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
6	Min. req. Crane with hook operation.	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
7	Propping base	Party to check wharf design for load transfer. Propping pad designed such a way to transmit load on piles/rail beam and cross beam of the wharf only.  <b>Propping base = 13.5 m x 13.5 m</b>

8	Length of the chassis without stabilizer pads	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
9	Width of the chassis without stabilizer pads	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
10	Size of the stabilizer pads	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
11	Portal Clearance	Party to furnish suitable for vessel size, Jetty Design and operational requirement. Minimum requirement; 8.5 m (Approx)
12	Wheel Load	Party to furnish suitable for vessel size and Jetty Design Max Pad loading = 261.8 T Max area pressure = 26.4 T/m <sup>2</sup> Propping base = 13.5 m x 13.5 m Pad Size = 5.5m x 1.8m
13	Tail radius	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
14	Height of the boom fulcrum point	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
15	Viewing height of the crane operator	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
16	Boom length	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
17	Lifting height above quay	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
18	Lifting height below quay	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
19	Counterweight	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
20	Total weight of fully rigged crane	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
21	Type of drive system	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2

22	Climbing ability	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
23	Axles and Tyres	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
24	Turning radius	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
25	Maximum Outreach	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
26	Minimum Outreach	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
27	Hoisting / Lowering speed	Indicative requirement; For 75 T =60 m/min. For 63 T=73m/min. For 50 T=90 m/min. For 32 T=120m/min. The deviations on speed accepted if free digging calculation justifies the capacity.
28	Slew speed range	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2. Minimum Requirement. 0-1.6 rpm; 280m/min. at boom head (max.); 360 deg. Unlimited range.
29	Luffing speed	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2. Minimum requirement. 46 sec. (with full load from max. to min. working) 50 m/min. average horizontal speed. (Approx)
30	Travelling speed	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2. Reference requirement. 0 to 5 Km/Hr without load.
31	Wind condition- Crane in operation Crane out of operation	24 m/s. 50 m/s.

32	Utilization of tipping Load: General cargo operation Heavy load operation Grab operation	Party to furnish suitable for vessel size, Jetty Design and operational requirement as per CI-3.2
33	Crane and Mechanism Group classification to:	Authorities, Regulations EN, FEM, DIN, VDE, VDI, IEC, ISO FEM 1.001- 1998.
34	Steel structure Hook operation SWL>70T SWL<70T Grab Operation SWL>63T SWL <63T	A3 A6 A7 A8
35	Machinery- Hoisting gear (SWL<75T)	M8
36	Slewing GEAR	M7
37	Luffing Gear	M7
38	Travelling Gear	M4
39	CRD cable	Power + control +FO
40	Cable Reeling Drum	Mono spiral Type CRD with composite cable

### 3.4 General Specifications

#### 3.4.1 Stability and Safety

The superstructure consisting of boom, counter weight, connecting structural elements shall comprise a completely stable self-supporting structure seated on the crane.

The equipment design shall ensure stability for all conditions including vessel through faulty operation or any other circumstances.

#### 3.4.2 Holding Down and Anchoring Devices

Holding down anchor units shall be provided for holding the equipment during storm condition having wind velocity upto 50 m/sec as an additional safety. It shall be suitable for fixing manually to anchor points provided at the parking place. Anchor points shall be of rapid fixing type by an operator and shall be suitable to the design and construction details of the berth (by others). Limit switches shall be provided for electrically interlocking the holding down device with the long travel drives to ensure that the long travel motors cannot be started with holding down device activated. Vertical drop-in type holding down device will be preferred at the berth.

The Tenderer shall confirm the arrangement, locations and the forces considered for the respective supply in the bid. The successful tenderer shall reconfirm the forces along with relevant details.

### **3.4.3 Design Criteria**

Equipment shall be stable under all operating conditions including when some portion of the machine touches the ground or the ship. Stability for other conditions shall meet the minimum requirement of FEM and wind conditions specified herein.

Suitable crane or monorail with electric hoist shall be provided to handle items requiring maintenance/replacement on the machine.

Common cable reeling drum for Control and Power Supply shall be provided and shall be mounted on the equipment structure.

Buffers shall be installed at end of long travel track. The buffers shall be rubber/ spring operated and designed in such a way as to ensure that the collision forces are distributed. Buffers installed on the crane structure shall be hydraulically dampened.

Anti-collision limit switches shall be installed on each crane for precaution of collision between equipment during any two in operation or one crane in operation mode and the other one in non-operating / maintenance mode.

Sufficient information and drawings showing static and dynamic loads shall be supplied to the Engineer/Employer to design and construct necessary foundation work falling under scope of others

## **3.5 Technical Description:**

### **3.5.1 Chassis (for tyre type crane)**

The Mobile Harbour crane shall have multi axle chassis with wide spacing of wheel axles for optimum stability during travelling on rubber tyres. The steel structure shall be welded torsion resistant steel in box type construction suited to take up loads and shocks caused by crane and travel operation. The appropriate transport lugs of suitable capacity shall be provided on the chassis structure. **Two** access stairways on front end and at rear end to the super structure from the ground shall be provided on the Chassis structure.

#### **1.1.1.1 Propping System:**

The rubber tyred crane shall be equipped with suitable propping system. The outrigger beams shall extend and retract hydraulically by means of extension cylinders. The stabilizer pads shall be lowered to prop the crane and raised hydraulically by means of a jack cylinder located in each beam. All the extension cylinders can be extended or retracted together and all the jack cylinders can subsequently be lowered/raised in automatic mode or individually in manual mode.

The stabilizers shall be able to adjust themselves automatically to level the crane. The final adjustment shall be carried out by means of pushbutton in the tower cab control panel. A bubble-type leveling device shall be provided next to the Cabin control to help level the crane precisely.

The crane shall have additional control levers near to stabilizer beams in order to adjust the stabilizers when required. The Hydraulic pressure shall be generated through hydraulic pump which shall be located suitably at machinery house on super structure.

#### 1.1.1.2 Stabilizer pads:

The stabilizer pads shall be hinge mounted cardanically on the jack cylinders. The pads can easily removable type and fixing without much effort. The **stabilizer pads shall be configured in such a manner that the corner load of the crane shall be transmitted on the pile and cross beam only**. Please refer the wharf drawing for arriving the best configuration of Stabilizer pads.

### 3.5.2 Travel Gear:

The crane shall able travel fully rigged. The hydraulically drive motors and axles to be designed in such a manner to have torque distribution evenly with drive and driven axles.

The axles shall be designed suitably for easy removable of wheel tyres. A suitable differential gears and if required planetary gears shall be provided in the system. The axles shall be mechanically suspended in equalizer systems to allow an individual vertical wheel movement. The system shall be designed so that the load of the total weight equally distribute to all axles irrespective of the ground conditions.

The steering system shall design in such a manner so that simultaneous steering is possible. The Crane shall be steered from the tower cab or from the chassis cab.

The travel gear shall be incorporated with proven brake system. The brakes shall be hydraulically operated. The crane shall also be equipped with parking brake and applies automatically after the crane travel motion is stopped.

The travel shall be controlled from the tower cab and the cab on the chassis. This shall include but not limited to travel drive, steering, braking as well as lowering the crane from the propped position onto the rubber tyres. The crane shall be capable of accelerate smoothly up to maximum speed in both directions.

The crane shall be fitted with warning light and audio alarm on the chassis structure. During travelling the yellow flasher lights shall blinks and audio buzzer shall activate.

Mobile hopper attached De-attached limit switch with crane shall be provided and must be taken in to the programming for the operational healthiness.

### 3.5.3 Driver Cabin:

The crane shall be equipped with a front mounted weather proof cabin which shall offer excellent view for the crane operator (driver). This cabin shall be fitted at the chassis. The cabin shall be equipped with

- Adjustable driver/operator seat.
- Safety Glass
- Windscreen wipers.
- Ventilation system.

**The cabin shall also have the control system as**

- Switch to start and shut off the main controller
- Switch to start and shut off the auxiliary engine
- Travel control lever
- Steering control lever
- Braking control lever
- Emergency stop.

- Stabilizer control.

### **3.5.4 Superstructure:**

The crane shall have superstructure comprises a heavy torsion resistant steel construction in platform design providing optimum stability to absorb all stress caused during operation and allowing spacious access to all electrical, mechanical and hydraulic equipment for maintenance purpose.

The superstructure shall provide the houses for the auxiliary Diesel engine power set, the hoist drive, the slewing gear drive, the hydraulic system, the electrical room, the tower and the counterweights. The superstructure shall have good designed (fatigueless) stairways to provide convenient access to the superstructure.

### **3.5.5 Housing:**

The superstructure equipment shall be placed under the environment protected compound sheet metal machinery house. The house paneling shall be so designed that it allows partly dismantled, if required for maintenance. Doors shall be provided to free access to the machinery and electric room.

The Machinery house shall be fitted with fluorescent tube lighting. The adequate lights shall be made as emergency lighting.

The machinery house shall divide into three separate rooms:

- Auxiliry Diesel engine room
- The drive assembly room and
- The electrical room.

The Programmable logic control unit with supervisory drive control and the electrical panels are housed in the electric room. The electrical room shall be fitted with suitable size of split type air conditioner to control the temperature inside the e-room as per requirement of IEC code.

The hoist rope outlet shall be protected against rainfall and dust by means of rubber seals.

Any ventilation force draft air system shall not be allowed to have bottom opening/suction type design. The bottom suction may contaminate the house as the wharf is full of bulk cargo during crane operation. A suitable top air entry with primary and secondary replaceable air filters to be designed to have clean air.

### **3.5.6 Communication System:**

The crane shall be equipped with Intercom system with headphone/microphone sets for communication between the machinery room, engine room, superstructure electrical room and the tower cabin. The crane shall have Public addressing system also. The PA system consist of loudspeaker, amplifier and microphone shall be placed at tower cabin.

The software and CMS of the crane shall be communicated to employer Central control room. Required hardware and software license shall be established by the crane supplier.

### **3.5.7 Power Supply:**

The crane shall be equipped with composite Cable Reeling Drum. Vendor shall made arrangement for the trailing cable from the CRD with guide arrangement properly as there is no under deck cable trench made available on the wharf. The guide shall be so designed to have +/- 100 mm track tolerance of crane travelling track to cable trench. The guide shall not offer any obstruction to the movement of the crane forward/backward and propping/un-propping operations.

The shore power shall be of 11 KV +/- 10%, 3PH, 50Hz, +/- 3% AC available and terminated in the junction box mounted in the crane power. The trailing cable passed through cable guide arrangement and funnel to tension relieve drum to junction box. The crane shall have suitable rating dry type transformer which can further step-downs the voltage to require voltage to operate the crane. The high tension breaker vacuum contactor type shall be mounted on the chassis structure. The trailing cable shall have power leads, earthing lead for crane earthing and FO.

Arrangement for Trailing Cable guide, CRD and JB's shall be made by contractor in such way that there is no obstruction for Vehicle movement on Wharf area. Contractor shall consider sufficient space and route for free movement of Cargo vehicles and Maintenance vehicles from back up to Wharf and Wharf to back up area.

The Diesel engine mode of operation uses the Diesel engine system when shore power is under shut down condition. The on board system operates the system at full and reduced load condition as mentioned earlier. The Diesel engine system shall remain same for all the 2 cranes. (Hence One crane can work at full capacity and 2nd crane shall work at reduced capacity).

Capacitor bank for the power factor controller shall be provided by crane supplier.

### 3.6 Four-Rope Grab Hoisting Drive:

The crane shall be equipped with a 4-rope grab hoist unit, comprising two separate hoists in modular construction. Each hoist consists of an electric motor/hydraulic motor with brake system and fully enclosed gearbox and machine grooved rope drum.

One hoist shall act as holding winch whereas the other acts as closing hoist. Synchronization of both hoists shall be controlled electrically/hydraulically.

The two ropes shall be wound in one single layer on the drum to reduce the excessive wear. The four rope ends will be connected directly to either a lifting beam (Hook) or mechanical 4-rope grab. **The ballast chain** shall be provided which help for replacing the Grab/Hook without holding the ropes. The rope reeving shall offer the hook speed equals line speed. The rope reeving of the hoist ropes between tower and boom head shall be such a way to offer level luffing load path. **The holding rope and opening/closing rope shall be so configured that it can able to operate different grab having different rope dimension without any difficulties.**

The grab shall have capacity controller by means of adjustable spill plate design and stroke limiter of the grab opening so that different density material can be handled without over loading the crane. The Grab shall also have the 4 safety latches type hooks on the outer surface of the grab to lift the Hatch coaming equipment. The each hook capacity shall be 10 T each.

The grab shall have 4 fall reeving system and have bottom as well as side over lapping knives for extra sealing.

#### 3.6.1 Lubrication:

The gearbox shall run in oil-bath and the oil-level shall be controlled. Auto lubrication shall be considered for all drive and pinions.

#### 3.6.2 Hoist Brake:

The hoisting motion shall be braked electrically or hydraulically of the hoist motor drive. The brakes are fail safe design and act as emergency brake in the case when power is failed. 150% torque must be generated by the brake in full load lowering condition.



### **3.6.3 Hoist Control System:**

The mechanism shall be designed with hydraulically operated or electrically operated. The hoisting speed shall be variable type and provides full range control mechanism. The maximum possible hoisting speed shall automatically increase with reduced load.

The acceleration and deceleration shall be smooth and minimum possible to have shock proof motion.

## **3.7 Slewing Gear Drive:**

The slewing gear drive shall design with modular design consists of a electric motor/hydraulic motor, couplings, brake, fully enclosed reduction pin wheel gear which meshes with the inner gear of the slew rim. The slew bearing shall be heavy duty type and L10 life shall confirm to FEM standard.

### **3.7.1 Lubrication:**

Oil bath shall be designed for the gearing and Auto pressurized grease system for slew bearing with sensing devices for grease movement. The slew rim and pinion shall have grease lubrication. The Sheave blocks bearings and wheel bearings are also require auto lubrications with sensing devices for grease movement.

### **3.7.2 Slewing Control:**

The slew drive shall design to have electric drive/hydraulic drive and have smooth acceleration and deceleration control. The maximum speed varies with the boom outreach and shall be regulated automatically. The slewing gear shall have failsafe designed brake system and acts automatically as emergency brake in the event of a power failure.

## **3.8 Luffing Gear:**

The boom shall be luffed in and out by means of a differential hydraulic cylinder, which holds the boom in any desired position. The cylinder shall be mounted in such a manner so that the boom may be lowered to the ground for maintenance purpose. Suitable brake valves shall be designed and put in the system for controlling the cylinder movement and safety of the boom system.

## **3.9 Luffing Drive:**

The superstructure oil pressure unit shall supply pressurized oil to the luffing cylinder. The luffing motion shall be controlled smoothly and infinitely variable by varying the fluid flow and valves. The luffing motion shall be break by means oil flow reduction and control valve actuation.

## **3.10 Counterweight:**

The counterweight shall be placed at the rear of the superstructure so as to require minimum radius of turning without obstructions. The counter weight design and placement in such a way that during operation, the crane movement is possible without removal of counterweight.

## **3.11 Tower/Boom System:**

The tower shall be fixed in a nearly vertical position on the superstructure. The Boom shall be mounted such a manner to enable the crane to position itself close to the ship without endangering the ship structure.

The operator cabin shall be positioned such a way to offer an optimum view of the working area and into the ship's hold.

### **3.11.1 Tower:**

The tower shall be comprised of a welded steel structure in box and beam type design or circular tube design with connecting points for Boom, Rope pulleys, stairs and platform and tower cabin.

A rope pulley block shall be provided in the tower head. The pulleys shall run on antifriction bearings and shall nearly maintenance free. The size of the sheaves (pulleys) shall confirm the mechanism standard. The party shall specify the size chosen with respect to wire rope and submit the life of the component. The rope pulleys shall be fitted with grease nipples for lubricating the bearings. The pulleys shall be fitted with rope guards to prevent the ropes from jumping off. A suitable access with maintenance platform shall be provided for the maintenance of pulley blocks.

### **3.11.2 Luffing Boom:**

The luffing boom shall be designed with 3-chord tubular lattice type construction with torsion resistance design.

A rope pulley block shall be provided in the boom head. The rope pulleys shall be designed and placed in such a manner that it restricts the swinging of the load. The rope reeving shall have lead angle minimum as per the standard and sufficient to restrict the negative impression on the pulleys. The pulleys size shall confirm the mechanism.

### **3.11.3 Access to Tower Cabin:**

Access to tower cabin shall be provided via convenient and safe stairs and spacious platforms. Intermediate platforms will be provided to reach service points.

### **3.11.4 Tower Cabin:**

The tower cabin shall be suspended in a raised position to provide the crane operator with optimum visibility of the ship hatches and the working area.

The cabin shall largely space and glazed with large safety windows. All windows shall be so arranged to have cleaning possible from inside and outside.

Non-glazed walls of the tower cabin shall be insulated, panelled on the outside with stainless steel plates and on the inside with aluminium plates lined with hard easy to clean plastic.

The Cabin shall equip with:

- Tinted glass windows with inbuilt glass heater.
- Noise insulated inner panelling; maximum db(A) shall not be more than 75.
- Adjustable operator's chair for height wise (vertical), backward and forward direction.
- Adjustable air nozzles.
- Operating and control panels.
- Air conditioner.
- Electrical Heater
- Screen washers and wipers for front and roof screens.
- Interior lighting.
- Bubble type levelling device.

- Electric sockets
- Electric horn.
- Internal and external communication system.
- Radio and MP-3 music system.

### **3.11.5 Operating and Control instruments:**

The operating and control instruments for all crane functions shall be located on the control panels on both sides of the operator seat and on the function keys of the monitor. The operating instruments shall comprise of control levers and controllers for all main and auxiliary crane functions and light switches. The controls shall comprise of pilot lights to provide feedback on the crane functions; the safety devices and anemometer (windmeter).

### **3.11.6 Crane management System (CMS).**

A monitor in the tower cabin near the operator seat shall display all crane functions required to operate and to check the crane. The following information shall be available in form of colour images in this system but not limited to:

- Conditions to fulfil to travel, prop and operate the crane.
- Actual and limit values for safe working load, radius, hoisting high, wind speed, Current drawing (power), Fuel level, status of lifting gears, such as HOOK/ Spreader/Grab. Main power plug "ON" and "OFF", Auxiliary power on/ off.
- Fault indication. Support for troubleshooting and maintenance diagnostic system. This also include printer for fault diagnostic and production data.
- Any special software shall require for retrieval of data shall be part of the scope of supply including licence key and password if any.
- The production data and fault data to be sent to Central control room via FO cable or wi-fi system. The coding de- coding for such data up to control room PC is under the scope of the supplier.

## **3.12 Load carrying device:**

The scope includes the supply of standard lifting hook consists of a traversal beam and bearings for mounting hook for general cargo. The hook shall be free wheeling or locked type.

The four rope grab shall be easily attached directly with the ropes and chain ballast. The ropes shall be spaced to have easy and balanced connection with grab holding and opening/closing ropes. Probable list of grabs for fixing with this crane is also specified earlier.

### **Safety Precautions:**

The crane shall have safety precautions in accordance with the common regulations and standards. The crane shall required to get compliance of Indian electricity rules and regulations for using High tension power. The crane shall also required to get compliance of Indian Dock safety rules. Party shall submit the required drg and documents for getting the statutory compliance certificate. Any statutory compliance arises due to this shall be part of the scope of supplier without any cost impact to employer.

### **3.12.1 Load Indicator/Overload safety Device:**

The crane shall be equipped with an automatic safe load indicator which ensures that the crane is operated safely and indicates the actual load on the hook/grab/spreader and boom at current radius.

At the time of overloading the crane operation logic shall function; As soon as the safe working load is exceeded, hoisting up and luffing out motions are disabled and all load reducing movements may be carried out.

### **3.12.2 Safety Device for Crane travelling:**

The crane operating logic such a way that the maximum safety shall observe during travelling. The superstructure and the chassis are locked together mechanically. As soon as both parts are interlocked and boom in correct position, crane travel operation is enabled and the slewing gear is disabled.

### **3.12.3 Propping Supervisory:**

The crane shall have safety measures as follow:

Crane operation, opening of chassis and superstructure interlocking and slewing is disabled until the stabilizer beams are extended and the stabilizer pads are properly propped.

The stabilizer pads can only be retracted in correct travel position with the superstructure interlocked with the chassis.

### **3.12.4 Limit Switches:**

The following shall be considered but not limited to:

The hoist limit switches limit the hoist and lowering motions when the maximum and minimum hook height has been reached. Prior to switch-off through end limit switches, the pre-limit switches reduces the hoisting speeds.

The boom limit switch switches off the luffing motion when the boom is at the minimum or maximum boom radius respectively. The luffing speed is also reduced before the limit position by means of a pre-limit switch.

### **3.12.5 Safety Valves:**

The luffing cylinder and stabilizer cylinders shall be equipped with safety lock valves to ensure that the hydraulic cylinders maintain their position in the event of pipe or flexible tube gets damaged. The pressure limiting valves shall be installed in the hydraulic circuits to prevent overload.

### **3.12.6 Fire Fighting system:**

A suitable fire fighting system shall be equipped in the crane. The design in such a way that the operator can have safe access to exist in case of fire broke out.

### **3.12.7 Anemometer (Wind meter)**

An Anemometer (wind meter) shall place on the top of the tower. The wind speed shall be indicated in the tower cabin and an acoustic signal is given when the maximum allowed wind speed value is exceeded.

### **3.12.8 Emergency Stop:**

The emergency off/stop shall be applied when the crane or personnel working in the operating area of the crane are endangered. The emrgency pushbuttons shall be installed in the operator cabin, the machinery

house and the electrical room. If one emergency off button is pressed, all crane motions come to a sudden stop. During emergency stop PLC shall remain ON and display the status of the position emergency switch activated.

Emergency stop pushbuttons shall fitted at the ground level on each end of the chassis shall stop only travel operation

### **3.13 Electrical Equipment:**

The crane shall uses the shore power for main power source. The down stream of the drive may be electrical drives or Hydraulic drives. The down stream drive mechanism shall have adequate control and design features to have smooth motion of all the crane mechanism. This shall includes the acceleration and deceleration of drive smooth and without jerks.

An air conditioner arrangement in the electrical room shall prevent possible problems caused by humidity and ensuring the maintenance in all weather conditions.

The all field instruments shall be of IP 65 class and junction boxes of Stainless steel SS-304 and class IP 65.

a) System Fault Level Current shall be taken to be 26.3 KA for 3 sec @ 11KV bus.

- All 11 panel bus bar and switch gear to be select as per above fault level.
- The rated working voltage of the main circuit including ACB: 415 V AC 3 phase, 4 wire, 50KA for 1 sec.
- There must be minimum 20% margin in selecting all Electrical Equipment (e.g. switchgear, motor, transformer, cable etc.

b) Motor selection

- All motors should conform to energy efficiency class EEF1.
- Motors with ratings 30 KW and more should be provided with space heaters.
- Motors with 90 KW and more should be provided with three RTDs, one at each phase for temperature detection.
- Motors with rating more than 160 KW should be provided with RTDs for measurement of temperature of bearings
- Minimum rating of power & aux. contactors should be 16 & 10 Amp respectively. Spare N.O & N.C aux. contacts should be available with each contactor.

c) List of drawings to be forwarded which should include at least the following:

- Single Line Diagram
- Power & Control schemes of HT & LT Switchgear Panels
- Layout of Electrical Equipment.
- Wiring Diagram
- Cable Layout
- Earthing Diagram
- Lightning Protection System
- Scheme of Power factor improvement

- Lighting Distribution System
- Fire detection system
- PLC system configuration drawing with I/O list

**d)** Calculation to be submitted which should include at least the following:

- Bus bar size calculation
- Sizing calculation of Transformers
- Size of earthing grid conductors & earth electrode
- Capacitor bank rating
- Cable size selection chart with voltage drop calculation
- VFD rating selection supported by catalogue
- Motor frame selection supported by catalogue

### **3.13.1 Data sensing and Fault detection- Central Computer:**

The monitoring programmable logic control shall install in the superstructure electrical room which senses and monitors all the electrical signals as well as detects any faults or malfunctions over a bus system. The same system shall function as a communication between unit, crane drives and operator's cabin via a high speed bus system. If party is using other than these please submit the document accordingly for approval.

### **3.13.1 Lighting /Illumination:**

The crane shall have adequate number of lighting points including emergency lights also; this includes lighting in the Tower cabine, machinary house, auxiliary diesel engine room, electrical room, on accesses, stairways and platforms.

For night operations, suitable floodlights shall be designed to incorporate at following area but not limited to:

Underneath the tower cabine and luffing jib suspended type for area lighting:

- 1 x metal vapour light under boom head.
- 2 x floodlights under boom.
- 3 x floodlights, two at the front under the cabin and one at the rear of the superstructure.
- 2 x floodlights at the tower sides.
- 1 x aviation warning lights.

### **3.13.3 Operating Hours meters:**

The crane shall be equipped with hours meters of all crane motions. This includes hoisting mechanism, slewing mechanism, luffing mechanism and gantry mechanism. The hours meter records the usage of respective mechanism. The hour meter shall have capacity at least three times more than the mechanism life considered as per the designed.

### **3.13.4 Printer for diagnostic and production data:**

The crane shall be equipped with a printer which attached to the PLC PC. The printer shall reccord all diagnostics and production data which indicated on the monitor in the tower cabin during operation. This

data also shall be extracted on a file. If require a special soft ware for extracting the file, same shall be under the scope of supplier with license key and password.

### **3.13.5 Operating Assistance by Tele Camera:**

To assist the crane operator working in hatches or in ship cells the crane shall be equipped with a camera system. This consists of a very high resolution type tele camera suspended in the top of the boom and a monitor placed in the cab within the visual range of the operator.

## **3.14 Commissioning, testing and acceptance on the Company's site**

Various tests of the Crane specified in this tender documents and subsequences amendment shall be conducted at the Supplier's terminal before shipment. The Crane shall be delivered to the Company's terminal as fully erected. In 3 months before shipment Supplier shall:

- Notify predicted ship schedule and relevant matters;
- Provide shipment and erection procedure of the Crane (crane supposed to be semi erected but assembly of boom and reeving of wire rope is etc. to be carried out at site).
- Provide Test program and detailed field test and test record forms.

The following data shall be submitted before field testing and commissioning:

- Test reports and qualification certificates of various materials used for the Crane;
- Test reports and qualification certificates of purchased mechanical and electrical equipment;
- Test reports and qualification certificates of main load bearing elements such as high-strength bolts, wire rope fittings etc.
- Qualification certificates of welds;
- Qualification reports of assembly quality;
- Painting qualification certificates.

### **3.14.1 Appearance inspection**

Visual inspection includes conformity of the following items with the technical specifications and provisions. These items are:

- Every main Crane movement mechanism electrical equipment safety devices, brakes, control valves, lighting and inter-communication system;
- Structural members and connections, stairs and ladders, walkways, operator's cab and platforms;
- All the protection devices;
- Cargo hook beam, Grab, fittings and connections;
- Wire rope and its fittings for secure;
- Sheave blocks shafts and fasteners, connection plate system etc.

Visual inspection also includes if all necessary certificates have been submitted and reviewed;

Crane visual inspection may be accepted if the following attached:

- Correct installation position and complete with all necessary parts;
- Structure without any deflection and/or damage;

- Painting meets specifications requirement with uniform color and acceptable durability;
- Secure installation of all devices and standardization;
- Piping arranged neatly;
- Without any external oil leakage;
- All identification marks are clearly visible.

### **3.14.2 High-tension insulation test**

The Company's electrical Power Administration Department will perform high-tension insulation tests.

### **3.14.3 Crane performance Tests**

#### **3.14.3.1 Static load test**

The purpose of static load test is to examine the load bearing capability of the Crane and its structural members and components. The test is considered successful if the test result shows that there is no any crack, permanent deformation, painting peeling off and/or any damage that affect the Crane performance and safety, not any loosening or damage at joints and connection is found after test.

- a) Before static test the crane shall be loaded 0.75P at specified radius and carrying out the operation at 0.75V for several times to ensure readiness of the test.
- b) Position the crane at above mention radius and add gradually the load from 0.75P to 1.4P without any shock or impact. The load shall be lifted to 100~200 mm above ground and is hold for 10 min. The deflection of boom shall be measured and record for no any permanent deformation.

#### **3.14.3.2 Dynamic load test**

The purpose of the dynamic load test is to verify the Crane operation and performance as well as capability of every movement and brakes. The test shall be considered successful if no permanent deformation of structure, no abnormal activation of protection devices, any loosening or damage at joints and connections found and all electrical switches are activated normally after the test. During test the Crane shall be operated in accordance with normal operation procedure and at the speed, acceleration and deceleration adjusted within normal operation range.

- a) Each motion operated individually  
Main hoisting is tested with rated load P and load of 1.2P respectively at the three different radiuses. The load is lifted and lowered and repeated for 3 times and relevant data shall be recorded.
- b) Simultaneous operation test  
Main hoisting, slewing and luffing are simultaneously operated with rated load P.  
Records shall be made, and measure relevant data of electrical equipment.
- c) Measure Crane operation cycle time.  
The Crane operation cycle shall be performed in the specified load handling paths. The measured time for each path shall be filled in the table chart.
- d) Brake performance test.  
Examine whether braking torque of the brake reaches 150% of rated load torque by using motor analogy method.



#### **3.14.4 Crane durable operation test (acceptance test)**

The purpose of this test is to examine the motor temperature rise and operating current, reliability of every mechanism and component continuous operation, measure noise level at the same time.

During the crane trial run a bunch of load 80% of the rated load is picked up at 25 m radius on the wharf. The load is lifted up about 20 m and slewing and luffing to have 30 m radius at 90 degree to the wharf on sea side. The weight shall be lowered down to 20 m and weight for 20 sec. Again load to be hoisted up to 25 m and slewing and luffing to 25 m radius on the same place of the jetty. The load shall be lowered down to wharf and weight for the 20 sec. Again cycle is repeated. Such operation shall be carried out continuously for 5 hrs. After 5 hrs, the crane shall be propped up and travel about 50 m about 2times (total 200m). Again crane shall be propped and carried out above operations, till cycle of 8Hrs. is completed. Such 3 cycles of 8 hrs shall be completed without cumulative stoppages of 30 min. (stoppages attributed due to crane faults only). During such cycles, the detail monitoring of the equipment is carried out and observations shall be noted. Any correction requires shall be carried out and that time is considered as down time and add in to cumulative total. The crane shall be considered o.k. once it passes the endurance test successfully.

Power supply to the Crane for commissioning is free of charge to the Supplier at site.

#### **3.14.5 Acceptance report**

After the above stated tests have all been successfully completed an acceptance report shall be prepared and the tests results and conclusion shall be listed.

The report shall include the Crane performance test, date of test, testing place and the witness (es)' name. The report shall be prepared jointly.

### **3.15 G. A. Drawing & Manuals**

The supplier shall submit G.A drawing of the Crane, and grab along with the tender.

The supplier shall submit 02 soft copies and 06 Hard copies of The G.A drawing of the Crane, grab and Operation Maintenance manuals with crane delivery.

### **3.16 Surface protection:**

The crane shall be surface protected by paint system designed based on European rust grade system Re-3 for 10 years. The party shall submit the details of the surface protection considered in the offer. The following final colour shed shall be considered:

- Chassis- RAL 7001 Gray.
- Rims, outriggers, staircases--- RAL 5015 blue
- Superstructure with housing----- RAL 5015 blue.
- Tower complete with staircases---- RAL 5015 blue.
- Luffing cylinder----RAL 5015 blue.
- Boom—RAL-5015 blue
- Rope Pulleys (jib head)-----RAL 1003 yellow
- Driver Cabin-----RAL 1003 Yellow
- Tower Cabin-----RAL 1003 Yellow
- Counterweight---RAL 5015 Blue.

- Warning stripes outriggers black/ yellow----RAL 9005/RAL 1003
- Warning strips counterweight black/ yellow—RAL 9005/RAI 1003
- Wheel boggy: RAL 1003 Yellow, front and rear boggy with black strips RAL9005/RAL1003.

### 3.17 Name & Logo:

The company (Employer) name and Logo of suitable size shall be placed on the machinery house. The logo and Name shall be submitted during the detail designing time. The Color shed as mentioned above for the crane may change and finalized during detail designing stage.

### 3.18 Optional equipment:

Party shall submit the offers for optional equipment such as CRD at boom head for handling motor grab, Rotator, Tendum operation & system to control the swing movement of the grab.

### 3.19 Reference List

The supplier shall submit reference list for the same type of equipment.

### 3.20 Spare Parts List

A complete list of spare parts and replacements as recommended inventory for two years operation, i.e. two years after taking-over of the equipment and the commissioning spares, i.e. spares required upto successful Performance Test shall be given in the following format.

Description	Qty.	Manufacturer
<b>A. Operating Spares</b>		
<b>B. Commissioning Spares</b>		

### 3.21 Training Scheme

The Tenderer shall describe in detail the training scheme that he is proposing for the Operators, Technicians and Supervisory Personnel, if any, for efficient functioning, i.e. operation and maintenance of all equipment to be supplied by him. The scheme shall indicate the nature of training required for respective operation, the duration of training for each function, etc. The Tenderer shall identify the critical areas which need special attention and shall elaborate his proposal for the same.

The following particulars shall be furnished in the format given below:

Sr.No.	Description of the Function – Equipment wise	Type of Training (Class Room, Field Visit, Hands-on, etc.)	Duration for each function and Type	No. of Personnel to be Trained	No. of Personnel, Proposed to be engaged by the Tenderer


### 3.22 Delivery Schedule

The Supplier shall confirm the delivery time for the equipment at Site in line with overall project schedule. The Supplier shall indicate his delivery schedule accordingly in a bar chart.

### 3.23 Erection & Unloading Plan

If the Equipment is delivered in disassembled condition than,

The Supplier shall submit an erection plan along with the tender for the plant & equipment under his scope of supply.

The plan shall outline:

- The erection techniques to be employed.
- Resources planning:
- Requirement of construction power, water and storage needs.
- Deployment of erection machineries.
- Deployment of manpower of specific trade and requisite skill.
- Equipment delivery planning
- Erection material planning
- Sequencing of erection to avoid accumulation / underutilization of resource & to achieve better progress.
- Action plan for completing critical work

#### Deployment of erection machineries

The Supplier shall submit along with the tender the following:

- List of various erection equipment such as cranes, winches etc. planned to be mobilised and indicate specification and quantity of each item.
- List of machinery, tools and tackles such as welding transformers, welding generators / sets, gas cutting sets, drilling machines, chain pulley blocks, survey instruments, etc. and indicate specification and quantity of each item.

#### Deployment of manpower

The Supplier shall submit along with the tender a list showing deployment of manpower of the following categories indicating number of personnel, schedule and duration of their posting at site, educational background, experience etc.

- Engineers and supervisory personnel directly attached to site work i.e. erection, testing, Commissioning and demonstration of performance guarantee values.
- Project organization set-up, preferably with job responsibility
- Organization (proposed) for implementation of the package.

## 4. Indicative Specifications for MOBILE HOPPER WITH REVERSIBLE BELT FEEDER

### 4.1 Scope of Work

#### 4.1.1 General

- a) The equipment specified herein shall be designed and built mainly for the cargo specified in this document.
- b) The equipment and materials covered by this specification are indicative. The tenderer shall be responsible for and governed by all the requirements of this specification and General Conditions of Contract which shall be a part of this document.
- c) The Scope of Work is for the engineering, design, manufacture, delivery to site, erection, testing and commissioning upto handing over of the following equipment.

Sr.No	Item Description	Qty
1	Rail mounted, Electrical operated Self Driven, Mobile Hoppers	2 Nos

- d) The equipment described and specified herein is electric powered, Rail mounted Mobile hopper for handling dry bulk and break bulk materials as specified. The interfaces with the overall bulk material handling facilities are described within this specification and operational requirements.
- e) The equipment shall be complete and shall include everything necessary to provide fully commissioned and operational machines that will perform as specified. Overall dimensions (boundary dimensions) and functional requirements as shown on the drawing(s) and/or specified shall be adhered to as far as possible unless in the opinion of the tenderer it is necessary to change the dimension(s) to meet the operational requirement.
- f) All works incidental to the above including additions, substitutions and modifications, if any.
- g) Consider the Tenderer as a potential party for annual maintenance contract to be entered at a later date.
- h) Tenders based on International sources shall have due consideration for maximizing components, which have service / support in India. Tenderers shall list out the availability of such facilities and the details of arrangement the Tenderer could arrange in the event of award.
- i) Accessories like CRD along with power cable, Grab, attachment for break bulk cargo handling is in the scope of supplier.
- j) Mobile hopper with Reversible Belt feeder is considered to feed the cargo either to Conveyor system or to Dumper on Wharf area. However, vendor shall consider the best possible arrangement for evacuation of cargo from Mobile hopper to Dumper on Wharf area and continuation of Vessel unloading operation in case of failure of Reversible Belt feeder.

#### 4.1.2 Work Included

Work shall include, but not be limited to the following:

- a) All technical information required by others, for the design and installation of civil, structural, mechanical and electrical work at the equipment interfaces, and in accordance with the Documentation Schedule.
- b) Management, coordination, planning of the work at all locations of the work within India including occupational health and safety, quality control, cost control, design, manufacture, delivery, inspection, erection, testing, commissioning and training.
- c) Supply, erection and delivery of all temporary structures, tools, rigging, erection, machinery, temporary power for erection, testing, adequate site lighting, temporary water supplies, transport logistics, etc.
- d) Supply of all engineer and labour for design, manufacture, delivery, erection, testing and commissioning of equipment, including transportation as required, housing, security, temporary sanitation and safety requirements, up to handing-over of equipment.
- e) All consumable materials including filters, lubricants, hydraulic fluids, electrical fuse, temporary loads; up to equipment handing-over.
- f) Cleanup at site of all debris and temporary structures on a daily basis and final cleanup at handing over.
- g) All electrical safety requirements during erection, testing and commissioning, including adequate earthing of erection equipment and machines.
- h) Proper safe storage of all equipment and materials delivered at site, in areas designated by the Engineer/Employer in line with customs regulations if applicable.
- i) Labour tools and materials for connection of equipment to permanent power and yard controls.
- j) End stops at the end of travel matching the equipment mounted buffers on the berth.
- k) Manuals for installation, operation, maintenance spares, along with drawings as required.
- l) Training of Employer's personnel.
- m) Supply of spare parts as required upto Performance Guarantee Test and Taking-over and for operation after Taking-over.
- n) Civil works up to and including the equipment support and structures as required for anchoring the equipment during non-operating conditions.
- o) Trailing power and control cable support and trays.
- p) All HT / LT Power and control cables works.
- q) Foundations for anchoring devices, jack-up points and end buffers.
- r) Supply of water pipeline.
- s) Other than on-board Fire Fighting and Dust Extraction System.

**Note:** Design load details and typical arrangement drawings shall be furnished by this Contractor(s) to the Engineer/Employer within 30 days of award of the contract for all the interfaces.

### 4.1.3 Attached Drawings

Berth Layout and cross-section drawings are attached here with to get the overall view of handling system.

### 4.2 Construction

- a) An approx. 100 T capacity hopper shall be provided for receiving fertilizer/ other dry bulk cargo discharge from the grab of the unloading crane. The hopper shall mount on the rails and connected to the trolley of the unloading crane to synchronize the movement of the hopper with that of the crane. The rails shall be laid on the coal / fertilizer unloading berth.
- b) The hopper shall be fabricated with not less than 12 mm thick M.S plate, with adequate stiffeners welded on. The hopper shall be welded structure and shall be provided with necessary cleats for attachments to supports. Hoppers shall be designed with a valley angle of not less than 65° to the horizontal. The required flanged opening shall be provided for attaching shut-off gates. The design of the hopper shall be such that the problems of formation of arch are eliminated. All steelwork required for support and access for opening and maintenance shall be provided. This shall include platform, grating, ladders, hand railing etc.
- c) The grids of the hoppers shall have square opening with adequate designed flats and rods supported on the steel beams. The grids shall be arranged in removable sections.
- d) The entire unit shall be built with low center of gravity so that the unit travels effortlessly.
- e) Suitable local control panel shall be provided to control the various functions so that the Mobile Hopper/ belt feeder work smoothly in conjunction with the Mobile Cranes & berth conveyor.
- f) The hopper shall discharge other dry bulk cargo onto belt feeder below it. Suitable discharge chute at feeder end shall be provided so that it can feed smoothly the berth conveyor. Also for maintenance of belt feeder, suitable rod gate shall be provided at the bottom of the Hopper. Belt feeder shall be reversible type so that in case of need it can discharge to truck loading system i.e. hydraulic operated sector gate.
- g) Reversible Belt Feeder shall be designed as per Indian / international standard and calculations shall be submitted for engineer's approval.
- h) Reversible Belt feeder shall discharge on one end to Jetty conveyor and other discharge shall to truck feeding chute having hydraulically operated sector gate. The chute at truck discharge shall have adequate chute volume for truck changeover.
- i) Belt feeder shall have hydraulically operated Take-Up unit.
- j) Tie rod (free issue part) shall be provided between Crane and Hopper for the movement of hopper with crane during operation. Appropriate arrangements shall be made in movable hopper.
- k) Long Travel drive of movable hopper shall be selected so that 50% of travel drive can able to move the hopper. Travel speed shall be variable from 0-20 meter/min. Clutch mechanism shall be provided to disengage the Long Travel Drive during operation.
- l) 2 nos. Of replaceable type Grizzly shall be provided as below:

- 1 no. With 400mm X 400mm opening
  - 1 no. With 200mm X 200mm opening
- m) Vendor shall consider the Berth-14 Jetty Design load capacity while designing the equipment(s).

### 4.3 Dust Control

- a) The dust control system shall be suitable for different type of materials i.e. fertilizer, Food Grains, Salt etc.
- b) Provision of space shall be kept for dust Extraction system.
- c) Hose along with reeling drum shall be provided at suitable location having minimum 60m of reach.
- d) Ship unloading is especially susceptible to the creation of dust as the systems are not totally enclosed. The hoppers are designed to suit the characteristics and flow properties. Typically, the dimensions at the top will be suitable for accommodating the grab in the fully open position while discharging. The hopper design will take into account the key function of providing a high-capacity dust free interface between ship and shore systems.
- e) Dust Extraction system at hopper top shall synchronize with grab operation to optimize operation.
- f) At Belt feeder discharge and hopper discharge dry fog type dust Extraction system is to be arranged.

### 4.4 Electrical Equipment:

The Mobile Hopper shall use the shore power for main power source. The downstream of the drive may be electrical drives or Hydraulic drives. The downstream drive mechanism shall have adequate control and design features to have smooth motion of all the Mobile Hopper mechanism. This shall include the acceleration and deceleration of drives smoothly and without jerks.

All field instruments shall be of IP 65 class and junction boxes of Stainless steel SS-304 and class IP 65.

#### 4.4.1 Power Supply:

The Mobile Hopper shall be equipped with composite Cable Reeling Drum. Vendor shall make arrangement for the trailing cable from the CRD with guide arrangement properly as there is no under deck cable trench made available on the wharf. The guide shall be so designed to have +/- 100 mm track tolerance of crane travelling track to cable trench. The guide shall not offer any obstruction to the movement of the crane forward/backward and propping/un-propping operations.

The shore power shall be made available and terminated in the junction box mounted in the crane power. The trailing cable passed through cable guide arrangement and funnel to tension relieve drum to junction box. The trailing cable shall have power leads, earthing lead for earthing and FO.

Arrangement for Trailing Cable guide, CRD and JB's shall be made by contractor in such way that there is no obstruction for Vehicle movement on Wharf area. Contractor shall consider sufficient space and route for free movement of Cargo vehicles and Maintenance vehicles from back up to Wharf and Wharf to back up area.

#### 4.5 Technical Data Sheet for Mobile Hopper with Reversible Belt Feeder:

Sr.No	Description	Detail
1	Designation No.	MH
2	Type	Self-Driven with arrangement for attachment with crane.
3	Capacity of Hopper (each)	Approx. 100 tons of Fertilizer and / or other dry bulk cargo (Live Capacity)
4	Qty	2 Nos.
5	Location	On Berth adjacent to Mobile Cranes (Grab type)
6	Material of Construction	Mild Steel (IS: 2062 Grade-B Steel), 12mm thk Mother plate lined with SS-409M Liner, 12mm thk (minimum)
7	Reversible Belt Feeder Details	
7.1	Belt Width, mm (min)	2400mm
7.2	Capacity	2000 TPH
7.3	Belt Speed	~0.5 m/sec
7.4	Skirt Board	As per spec. of conveyors. Continuous skirt board shall be provided.
7.5	Other components including Chute	To confirm to requirement of as specified for belt conveyors/ chutes.
8	Rail and Rail span	CR-100 and 14 m (Jetty drawing attached)
9	Top opening	Approx. 9 m X 8 m
10	Overall Height	14.5 m max. (Same shall be confirmed and in line with Mobile Harbour Crane Supplier)
11	Drive	VVVF or hydraulic drive shall be provided for belt feeder and long travel application.
12	Rod gate	Rod gate shall be provided at the bottom opening of



		hopper. Weight of individual rod shall not be more than 16kg for ease of handling.
13	Handrail	Collapsible hand rail shall be provided at the top of hopper along with platform on three side of hopper.
14	Power supply	Composite Mono Spiral CRD cable (Power/Control/VVF power supply) with flexible cable, suitable for the total travel considering the jetty layout.
		Any MCC fitted required to be completely double door design having IP-65 grade and bottom entry. All corrosion protection on the MCC and structure must be high quality due to the position and distance from salt water.
15	Air Blaster system	Complete Air Blaster system is to be arranged including compressor and piping requirements to suit the site condition with required electrical and instrumentation.
16	Bogie configuration	Min 4 wheel/ corner of 630 dia shall be considered.
		Bogie configuration shall be finalized in consultation with Jetty design and approval of employer, to ensure the proper load distribution on jetty rail. Bogie wheels shall forged volumetric hardened with 300BHN tread hardness.
17	Other ancillaries	Manual tie down, storm anchor and rail clamps shall be provided on the hopper for the safety point of view during cyclonic condition. Vendor shall consider design, supply and fixing of storm anchor and tie down shall be provided by supplier. Also if embedded part is required for mounting of above assembly than same are in the scope of supplier.

## **5. INDICATIVE SPECIFICATIONS FOR CONVEYING SYSTEM AND EQUIPMENT(S)**

### **5.1 System Description:**

Proposed system description is briefed here below.

- a) Mobile Harbour cranes will unload the bulk material into mobile hoppers placed on the berth. The conveyor FBC-1 will receive the material from mobile hopper through reversible belt feeder.
- b) The Capacity of the conveyor system from berth to stockyard end shall be 2200 TPH (designed). Fertilizer unloaded from vessel shall be transferred to conveyor belt FBC-1 on Jetty via mobile hopper reversible conveyor. FBC-1 will transfer to fertilizer to conveyor belt FBC-2 via TT1 at end of Jetty.
- c) At transfer tower TT neem coating facility for urea shall be provided in the connecting chute of conveyor FBC-1 & FBC-2. The cargo shall be stacked in the Godown through a travelling tipper install at the conveyor FBC-3 at a height of about 15 m from the floor level, or else, as per the requirement, the cargo shall be send to the Bagging & rake loading equipments via conveyor FBC-2 to either side via sub-conveyors i.e., FBC2A & FBC2B. Further, the cargo stored in Storage shed shall be transferred to the Bagging & Rake loading shed through dump pit and conveyor FBC4. Conveyor layout drawing shall be referred for reference.
- d) As indicated in drawing, one conveyor FBC-1 planned on Jetty between transfer tower T-1 and TT-1 and second conveyor FBC is in between transfer tower TT-1, TT, T-2 etc.
- e) The cargo storage shall be as per operation guideline to suit their operation requirement. The cargo will be evacuated from go-down by rake in bag form.
- f) Vendor shall provide the conveyor system with transfer towers, equipment(s), and accessories as mentioned in the indicative specification provided in this document and complete in all respect.

### **5.2 Flow Diagram & Go-Down Arrangement**

The material flow and typical arrangement with all mechanization facility is depicted in flow diagram and applicable **Drawing M-001 to M-007**.

### **5.3 Duty**

All equipment(s) including belt conveyors shall be designed and built to operate under outdoor conditions at Design capacity furnished in this specification considering continuous duty of 24hr/day, ambient temperature up to 50° C and under climatic and ambient conditions at site.

### **5.4 Material handling equipment and conveyor system indicative description:**

- a) Conveyors will be designed in accordance with IS 11592: 2000.
- b) Conveyors must be capable of starting under all operating conditions, including plugged chute condition.
- c) Belt drift times shall be considered for emergency stop scenarios.

- d) Belt Conveyors shall be complete in all respects and shall include but not limited to idler rolls with supports, pulleys, drive units with base frames, belting, head and tail frames, take-up units including winch (take-ups as applicable) including tensioning winches, skirt boards, scrapers, transfer chutes, stringer frames, short supports, deck plates, gates, etc. and all bolts including anchor bolts.
- e) All conveyors have been planned with normal speed as specified in annexure attached with this technical specification and accordingly adopting artificial co-efficient of composite conveyor friction as 0.022 considering energy optimized belting.
- f) Belt sag on the carrying side shall not exceed 1.5% of idler spacing. Maximum operating tension in the belt shall not exceed eighty (80) percent of maximum allowable working tension of the belt at the specified load. Sag value should be considered in the starting and stopping and braking condition also. Selection of counter weight should meet the sag value limit specified above and also meet the braking force required for coasting time calculation.
- g) The drive unit components of belt conveyor shall be designed so as to be able to start the conveyor with material load either at any zone of the belt conveyor or with material lying on the entire length of the belt conveyor. Minimum angle of wrap of belt on drive pulley shall preferably be kept 210 degree. However for the design purpose maximum wrap angle of 210 degree shall be considered. The diameter of drive pulley shall be sufficient enough to accommodate the above wrap angle maintaining normal carrying belt to return belt distance of the conveyor.
- h) Motor rating shall be selected with 10% of margin over absorbed power.
- i) The drive unit location shall be selected such that the maximum belt tension of the conveyor is limited to optimum/ minimum value unless such location is disadvantageous from layout point of view. Normally, the belt conveyor shall be of single pulley drive. However, where larger wrap angle is required and for long distance conveyors, multiple pulley drives shall be used. Arrangement of multiple pulley drive shall be such that only clean side of the belt is wrapped with the drive pulleys and the drive pulleys shall preferably be driven by separate motors coupled electrically for same rotational speed, starting and stopping characteristics. The drive unit shall be selected such that the starting tension of belt does not exceed 150% of allowable belt tension.
- j) The conveyor shall be designed such that similar components are interchangeable as far as possible. Special emphasis shall be given for standardization of pulleys, idlers/ rollers, bearings for idlers/ rollers and pulleys, gearboxes, hold backs, couplings and brakes. Idlers/ rollers shall be identical for same belt width.
- k) Conveyor frames shall be made of joists and/or channels suitably stiffened and braced. The spacing of supports shall suit to gallery profile. Generally spacing shall be kept ~3000 mm. Frames shall be connected to floor beams of junction house by bolting.
- l) The drive base frame, preferably common for motor, gear box, brake and coupling guard, shall be made of welded steel rolled sections and plates. The top surface of the drive base frame shall be made from single piece plate properly machined, after fabrication of the complete frame, to facilitate proper sitting and alignment of the components. Base frame shall be stress relieved prior to machining operation. Packing plates/ strips shall be used as required for true alignment of the drive unit components.

- m)** Sizing of brake, counter weight and flywheel is very important and due consideration shall be given in the design of conveyor to avoid the slip, spillage of material and avoid operational problems.
- n)** All Chutes shall have flow model analysis and submitted for review. Liners are designed and arranged such that to allow free unrestricted flow across coal size spectrum and moisture of respective Dry bulk cargo. All chutes shall be inspected for defects by employer, such as gaps between liners, liners are flat & uniform or not, no raised edges should be there etc. Nuts shall not be used for levelling; shims shall be used & grouted when finished.
- o)** All technological structures (all pulley frame, take-up tower & platforms, stand & short support etc.) shall be design with structural analysis (STAAD model) and submitted for review.
- p)** All conveyors brake & counter weight shall be design with coasting time calculations & selection shall be in line with the requirements. Concrete block shall be housed in Counter weight box only.
- q)** All Skirt design shall be Modular type and spill free assembly only.
- r)** For all conveyors starting & stopping curve with Brake & without Brake shall be submitted for review.
- s)** Mechanical design and mechanical components shall be rated for continuous heavy duty operation with due consideration to impact, possible overheads, environmental conditions, cycles of stress application and physical properties of the material (especially ductility, toughness, endurance limit and stress concentration due to geometric shape of components) and maintenance access.
- t)** All equipment must comply with the codes and standards applicable for the occupational health, industries safety and protection of the environment.
- u)** The equipment must be of proven design and not be prototypes.
- v)** The mechanical components must be specified for heavy duty service.
- w)** All mechanical equipment must be sized to satisfy the operating conditions without overloading and conserving the design safety factors.
- x)** All equipment must be shop assembled as much as practical. There should be minimum assembly on site.
- y)** The design must consider the frequent stoppages and starts of equipment.
- z)** All fabricated steel including supports, frames, and equipment bases and siding elements must be prepared and covered according to the project technical specifications before transporting.
- aa)** Machinery that produced vibration must be designed such that the construction system eliminated the transmission of undesirable movement and noise to the structural supports. Where required, shocks absorbers shall be provided that reduce the amplitude of vibration generated by these equipments.
- bb)** All equipment shall be provided, as minimum requirements, with seals to control dust around all moving parts. Where required, oil seals shall be supplied to retain lubrication and prevent

the entrance of contaminants to the internal parts.

- cc)** Bearing rating must be according to the latest edition of the ANSI B 3.15 and B 3.16 specifications and the life (L10) shall be not less than 60,000 hours with the velocity and design loads. It shall be fitted using hydraulic nuts on taper sleeve arrangements.
- dd)** Field assembly must be maintained to the minimum required.
- ee)** Equipment access doors or openings in the sides of structures must be provided with a landing on the exterior of the opening for the full width with removable handrail sections & with ease of maintenance & cleaning in mind.
- ff)** All drive floors shall be RCC type.
- gg)** All chutes are properly designed with DEM and feeding of material in the receipt conveyor is such that there should not be any impact and also least acceleration of material. Spoon feeding shall be considered in the all chute design. Spoon shall be adjustable.

## **5.5 Belt**

### **5.5.1 General**

- a)** Belting shall be N-N / Steel cord type suitable for heavy duty application having Oil resists, DIN-G Cover Grade. Bottom cover shall be E.O.B. The Belting shall be of molded edge construction. Belting shall conform to IS: 1891 (Part-I) / International Standard. All fabric belting shall be minimum 4 ply belt. Steel cord belts shall confirm to IS 15427:2004.
- b)** Belt covers shall be made of synthetic rubber The rubber used for cover shall be of high quality which has a tensile strength of not less than 2.5 kg/mm<sup>2</sup> and an ultimate elongation of not less than 450%. All belting shall be pre-stretched. Belt construction shall be such that in case of edge damage, ingress of moisture does not occur.
- c)** Belt shall not blister or separate in the plies or at the seams. It shall not stretch more than 2.5% for N-N and 0.25% for Steel Cord of their original length within one year of installation under normal operation. Belt construction shall be such that in case of edge damage, ply separation and ingress of moisture do not occur.
- d)** Belt Joining Procedure approval from employer is mandatory before starting belt jointing. Belt joint shall be properly vulcanized and finished. Belt shall have hot vulcanized joints after erection. Vulcanizing shall be done on single setting. Vulcanizing chemicals, splicing tools and equipment shall form part of the belting supply. A length allowance for field joints and also for test samples shall be added to all belt lengths. Joint efficiency of fabric belt shall not be less than 80% & 100% for steel-cord belt. A Procedure shall be qualified for belt jointing for Pull off test.
- e)** Ratio of maximum breaking strength to working tension shall be minimum 9 for nylon-nylon belt & minimum 7 for steel-cord belts. Belt rating shall satisfy the requirement of trough ability & load support.
- f)** No longitudinal joint shall be permitted in belts.
- g)** Top cover thickness shall be minimum 6 mm & bottom cover thickness shall be minimum 3 mm, however for steel cord belting the cover thicknesses shall be kept as required according to relevant Indian/International standard for selected steel cord diameter. For conveyor

having short length e.g. Belt Feeder and shuttle conveyor Top Cover thickness shall be minimum 10mm.

- h) The belt Supplier shall design the splice and recommend the minimum splice dynamic efficiency. Splice design shall be warrantable by the Supplier for 70% fatigue strength efficiency with respect to the belt's breaking strength for no less than 15,000 load cycles. Supplier is encouraged to provide belt reels that minimize field splices. Racetrack and double reel cassette type rolls can be quoted for the longer belts. All the belt splices shall be identifiable with Date, Splice No., Vulcanizer's initial.

## **5.5.2 CONSTRUCTION REQUIREMENTS**

### **5.5.2.1 Belt Dimensions**

- a) **Belt Width:** Supplier shall provide a full belt width as manufactured in one fabricating press. The slitting of fabricated belt to a lesser stock width or making of two belts in one belt press is not acceptable. The belt shall have molded edges. The manufactured belt width tolerance shall not exceed +25 mm/-0 mm within a roll
- b) **Belt Thickness and Weight** Belt thickness and weight will be dependent on selected cable sizes and top and bottom cover requirements. The Supplier is required to provide revised values for the estimates of these dimensions given in the Design Data Sheets. New belt thickness may vary by + 0.15 mm to – 0.00 mm from nominal total thickness defined by Nominal total thickness = cable dia. + top cover thickness + bottom cover thickness. Thickness of nylon type belting shall be measured in accordance with IS:1891 / International standard.
- c) As per IS 15427:2004 for Steel Cord, belting shall primarily consist of one layer of longitudinal steel cords embedded in elastomeric compounds. Additional transverse reinforcements may be included. The whole belt shall be cured or vulcanized together in accordance with the best manufacturing practice. The belt edges shall be completely sealed against ingress of moisture by elastomeric compounds.
- d) The surface of finished belting shall be free from blisters, pitting or other major surface flaws and shall be completely sealed against ingress of moisture.

### **5.5.2.2 Rubber Covers**

- a) Top cover minimum thickness is 6 mm (min) and bottom cover 3 mm (min). These thicknesses shall be reviewed by the Supplier in regards to warranted wear requirements. The belt cover thickness and physical properties shall be sufficient to meet the structural requirements and wear criteria set forth in this specification.
- b) Since the cover rubber wear is mainly due to abrasion damage from rock impact and sliding damage at the transfer-loading station, the Supplier is encouraged to provide the best compound that meets the tonnage warranty. A natural rubber shall be specified with superior tear and abrasion resistance. Bottom rubber compound shall be Energy efficient and result into reduction the energy consumption.
- c) Supplier has to provide the RRF curve with tan delta at 10 Hz and 2% strain at every 5 deg temp interval.

### 5.5.2.3 Rubber Properties

Belt covers shall have the following minimum properties at 20°C:

- a) Tensile Strength DIN 53504 25 N/mm<sup>2</sup>
- b) Hardness DIN 5350560 ±5 Shore A
- c) Tear resistance DIN 53507 15 N/mm
- d) Abrasion Resistance AS 1683-21 100 mm<sup>3</sup> (max)
- e) Elongation @ Break exceeds 450%
- f) Cover Separation Strength DIN 22131 15 N/mm (min.) (Cover to bonding rubber)

**Note:** Manufacturer may recommend alternative specifications to these stated values that result in verifiably superior performance for guaranteed life of top cover and low rolling resistance of bottom cover. Belt cover grade shall be approved for mine service with a minimum DIN-X rating. Mildew and ozone protection shall be included in the rubber compounding. Surface blemishes must be minimized. Excessive blemishes indicate poor quality and may compromise the belt life and necessitate added maintenance. Supplier shall provide a description of the build-up on idler shells from press release compound (silicon, etc.) and/or agents that will plate on roll surface during normal operation (i.e. waxes, oils, etc.). Plating of press release agents, waxes, plasticizers, etc. onto idler rolls shall not exceed 0.5 mm thick. Manufacturer shall be responsible for cleansing rolls where belt residue plating or build-up exceeds 0.5 mm. Splicing of cover sheets, after curing, shall not be obvious to the eye. Manufacturer shall warranty for life of belt against de-lamination of cover sheets and of separation of joint seams. Manufacturer shall state, with bid, corrective action if flaws occur.

### 5.5.2.4 Spool Core Diameter

Shipping spool diameter shall be a minimum of 80 times cable diameter.

## 5.5.3 Idler

- a) Idler & Idler Assembly includes idler roll with frame and support bracket for belt widths stipulated. The idler assembly shall comprise of;
  - Carrying Idlers Assembly:
  - Transition Idlers Assembly:
  - Impact Idlers Assembly:
  - SA Idler Assembly (carrying side) / True Track:
  - Return Idler Assembly:
  - SA Return Assembly / True Track:
  - Self-cleaning return disc assembly
  - Belt Scale Idler Assembly shall be balanced as per ISO 1940 G16.
- b) Shell thickness shall be kept minimum 4.85 mm (after machining) for roll diameter up to 139.7 mm. The shell thickness shall be minimum 5.4 mm (after machining) for roll diameters above 139.7 mm.

- c) The idler unit shall be extra heavy duty type and shall be suitable for continuous operation at high capacities. The Troughing idlers having rolls of equal length, the rolls as well as the roll components shall be interchangeable.
- d) Idler rolls shall not exceed the T.I.R value more than 0.6mm for carrying side roller & 0.8mm for return roller and weigh class idler it should be less than 0.3mm. Standard idlers must comply fully with the 0.6mm run out. The supplier shall test 100% of the supply to ensure this criterion is met or bettered. Employer's QA shall random test 25% of each size supplied; if any discrepancy are found to spec. the supplier shall correct this at his cost.
- e) Self-cleaning return idler - 1 number near discharge pulley having same specification of impact idlers.
- f) All idlers shall be fitted with either heavy-duty deep grooved ball bearings or seize resistant ball bearings taper roller bearing. The bearings shall be held positively on the spindle.
- g) Multi-labyrinth seals shall be used for retention of grease. All bearings shall be greased and sealed for life against ingress of dust, water and escape of grease.
- h) Idler bearings shall be either SKF or FAG make only.
- i) Flat return idlers only shall be used under the "V" scrapers and in high-tension areas.
- j) Other conveyors are with fixed idler in carrying and return. Belt tracking idlers are provided in all conveyors at following locations:
  - After loading point at carrying side
  - Before drive pulley at carrying side
  - Before take-up pulley at return side
  - Before tail pulley at return side
- k) All idlers shall be made out of ERW tube and shall conform to IS: 8598 . Mechanical properties of ERW tube shall be equal to or better than YSt 210 grade [IS: 9295]. Idler drag value shall not be more than 3.4 N/roll at 650 rpm, 20deg C as per DIN 22112. For standardization of idlers, all rollers shall be identical and interchangeable type for the same category. Idlers shall be easily removable type. Idler Spacing for carrying Idlers shall be 1.1m & for return idlers spacing shall be 3.3 m.
- l) Idler bearings shall be 'sealed and lubricated for life' provided with double labyrinth seal and rain cap to prevent entry of dust & moisture. Deep groove ball bearing (630 series) with nylon cage of SKF/FAG make only shall be used. The bearings shall be chosen for life L-10 of 60,000 hours minimum. Deflection for idler spindle shall be less than 5mm under full load condition.
- m) Sufficient number of adjustable type transition idlers with 10-degree steps, shall be provided adjacent to terminal pulleys. Minimum three trough (transition) idlers shall be used at the head end of each conveyor. Transition length shall be provided as recommended by the belt manufacturer.
- n) Suitable deflector roller of at least 250 mm OD on 90mm dia.[min] shaft at hub mounted on Plummer block and lagged with 6mm thk. Neoprene rubber lagging shall be provided for each conveyor at discharge end.



- o)** At convex curve; spacing shall not exceed 50% of the normal idler spacing.
- p)** Minimum of six (6) set of impact idlers shall be provided at each loading point of the conveyor with maximum spacing of 400 mm.
- q)** The internal rolling friction co-efficient of the idler unit shall not exceed 20 to 30% of the composite friction factor 'C' which is taken as 0.022 for normal speed conveyors. Weight of revolving parts of the idler shall be kept to minimum.
- r)** The Tenderer shall submit the sample manual calculations for shaft/spindle, bearing diameter and idler frame on the basis of provided technical data and a computer printout of other idler on similar basis for Engineer's consideration.
- s)** All Idler Rolls shall be free in rotation.
- t)** Idler Frame shall be made from rolled sections. The plate thickness shall be minimum 10mm.
- u)** Idler Roll shall be tested for Run out, Friction, Dust proof (Cargo fine dust) & Water proof test as per employer QAP approved by Engineer.

**5.5.3.1** Following idler test shall be carried out.

- a)** Idler friction factor test
- b)** Dust (With cargo fine dust) and Water proof test. (Employer approved Closed chamber with sufficient pressure and fine dust)
- c)** Diametric run-out check
- d)** Bearing Noise Check and Physically verification by random idler destructive testing.
- e)** Any other tests as per relevant codes & standards. (DIN 22122)
- f)** Balancing wherever applicable
- g)** For weigh class idlers ISO: 1940 G16 to be followed.

**5.5.3.2** Carrying Idler Assembly [Garland type/45° troughed]

- a)** Idlers shall be minimum 152.4 mm dia. three roll in line and interchangeable rolls garland type having freedom of movement in both vertical and horizontal directions.
- b)** Quick release suspension shall be provided to allow the idlers to be lowered away from belt contact for replacement idlers. Idlers shall be assembled with frames.

**5.5.3.3** Carrying Idler Assembly [Fixed idler, 3 rolls, Min. 152.4 mm dia. 100 to 45° troughed]

All roller brackets shall be fabricated from steel plate sections of adequate strength. Brackets shall be mounted on inverted steel channel frame. Adequate arrangement for proper alignment of the brackets over supporting steel frame shall be provided. Fixing arrangement of roller with brackets shall be drop in slot type. Idlers shall be assembled with frames.

**5.5.4.1** Impact idlers: FIXED Impact Idlers (Retractable Modular type):

- a)** Idlers shall have heavy duty bearings.

- b) Idlers shall be removable without removal of skirt plate for ease of maintenance & replacement.
- c) Impact type idlers shall be provided with number of tough rubber discs with minimum shore hardness of 55 to 60 deg on shore 'A' scale.
- d) Impact idler frame shall be inverted channel only. Rubber ring dia. shall be 190 mm O.D., ERW tube shall be 139.7 mm.
- e) Idlers shall be assembled with frames; idler frames shall be retractable type so that idler replacement / maintenance can be done without dismantling of skirt board system.

#### 5.5.4.2 Return idlers

- a) Garland Return idlers: It shall be V type, minimum 139.7 mm dia. two rolls, with minimum 15° incline to the horizontal with articulated joints with freedom of movement in both vertical and horizontal directions.
- b) Additional clit shall be provided for the mounting of return idler for the belt training purpose.
- c) Flat idler wherever required in the return side at Tail and take-up shall be provided as per the conveyor profile and design requirements to suit V-Plough.
- d) Fixed return idler: Standard fixed frame return idlers shall be V type mounted on fixed supports. For both types the rolls shall be identical. (minimum 139.7 mm dia, two rolls, 15 deg T.A)
- e) 8 Non-magnetic idlers made of aluminum tube lagged with 5mm neoprene rubber lagging shall be provided in conveyor portion where inline magnetic separator is magnetic zone. Rubber lagging hardness to be mentioned.

#### 5.5.5 Pulleys

- a) Pulley assembly shall be complete with pulley, Plummer block, adopter sleeve, bearings, keys etc. required for its completeness.
- b) Pulleys shall be engineered class suitable for use with NN/EP/Steel Cord conveyor belt as applicable and designed for a fatigue life of 20 years. Pulley diameters including lagging shall be within the tolerance limit as per IS 8531:1986. Pulleys and shafts shall be designed in such a manner that they can safely withstand the maximum inclusive transient forces that are imposed during acceleration and braking. Maximum deflection shall be in accordance with the requirements of the shaft locking assembly.
- c) Pulley face width will be belt width plus 200mm. The tolerance of pulley along the face width shall be +3/-0 mm on the nominal width.
- d) All pulleys shall conform to the requirement of IS: 1891/ IS: 8531. Pulleys shall be of welded steel construction (MS: IS: 2062 Grade B Killed) having continuous rim and two end discs fitted with hubs and the internal stiffeners. The use of approved type of clamping hubs ((Imported Ring feeder type of Ring Feeder make 7015.0, Bikon / Dobikon type 1015.0)) allowing easy removal of shaft from the pulley assembly is required for all pulleys.
- e) Pulley assemblies are having turbo diaphragm i.e. end disc made from one piece of steel -

steel castings. "T"- bottom full penetration weld onto shell shall be done.

- f)** Welding on the pulley shell shall be tested radiographically or by ultrasonic method. Pulley shafts shall be ultrasonically tested.
- g)** All fillet welds of pulley shell to diaphragm shall be of bevel fillets to ensure minimum joint efficiency. All but joints shall be R.T/ultrasonic tested and fillet joint must be MPI and D.P tested
- h)** Pulleys shall be duly stress relieved before machining. Hubs shall be of forged steel. Hubs and end discs shall be accurately machined for concentricity. All pulley shafts shall be EN-8 (subjected to fine grain control and Normalized, hardened and tempered minimum) or equivalent.
- i)** All pulley shafts shall be designed in accordance with CEMA (latest Edition) considering minimum service factor of 1.5 for bending and 1.0 for torsion. Shaft deflection shall not exceed eight (8) minutes for non-drive pulley and five (5) minute for drive pulley and five (5) minute where pulley is to be assembled through clamping hub. The deflection slope of pulley shaft at bearings shall be restricted to 1/2000 under rated load condition. All shafts shall be tested independently mechanically; charpy values may be taken as 15 joules at 0 deg C.
- j)** All pulley shafts shall not have step down more than 10% and to have better stress concentration factor all step down shall have concave and convex radius machining for smooth profile.
- k)** All pulleys shall be straight faced and pulley faces shall be lagged with hot vulcanized rubber lagging as follows:
  - l)** All drive pulleys/ discharge pulleys shall have 16 mm thick herring bone grooved lagging at 120o, 6 mm wide x 6 mm deep spaced at 30 mm centers around the circumference. The apex of the herringbone grooving should be in the direction of the belt travel. The rubber hardness shall be IRHD 60(55-65 shore A).
  - m)** All non-drive pulleys shall have plain lagging of minimum 12 mm thick. The rubber hardness shall be IRHD 45(40-50 Shore A).
  - n)** Pulley assemblies shall be statically balanced and run concentric when mounted on shaft. Balancing weight shall not exceed 0.5 percent. Out of roundness of any pulley shall be within  $\pm 0.5\%$  of diameter without lagging. All drive pulleys shall be dynamically balanced as per ISO 1940-1 and ISO 1940-2 G40.
  - o)** All pulleys shall be shop assembled with shaft, bearings, Plummer blocks etc. and shipped as complete assemblies.
  - p)** One longitudinal weld on pulley shell per pulley shall be permitted and the weld shall be R.T and ultrasonically tested.
  - q)** In case of turbo pulley circumferential weld shall be ultrasonically tested.
  - r)** The shafting shall be supported by heavy duty antifriction -double row self-aligning spherical roller bearings with adaptor sleeve (SKF / FAG make only) with double labyrinth with synthetic seals and grease nipples suitable for use in saline atmospheric condition. Bearings shall be housed in

horizontally split type Plummer block (SKF / FAG only) equipped with four fixing bolts and complete with side covers. Plummer blocks shall (Plummer blocks with minimum 04 nos. bolts) be of cast steel construction with suitable provision of greasing nipple. Minimum 2 nos. of adjustable screw and lock nut shall be provided on one side of Plummer block for alignment purpose. Vendor shall ascertain pulley diameter, shell thickness and shaft diameter and suitable calculations shall be submitted for approval during detailed engineering. Pulleys shall be standardized to the extent possible and the relevant details furnished. Life of bearing shall be 60000 hrs. Minimum.

- s) The shell of drive/head pulleys having overhead inline magnetic separator [if provided] shall be made out of non-magnetic material that is Stainless Steel SS-304 of minimum 12 mm thk.
- t) Pulley Bearing Centers for Drive & Non Drive pulley shall be identical. Bend/Tail/ Take-up pulley shall be kept identical in all respects.
- u) Necessary safety guard of exp. metal shall be provided for the pulleys. Pulley guard shall have adequate opening to allow greasing of pulley bearings.
- v) Pulleys to be standardized in dimensions as far as possible to keep the pulleys across the plant to one-six types for a specified width of the belt.
- w) Maximum permissible stress for shaft design :
  - Shear stress : 600 Kg/cm<sup>2</sup>
  - Bending stress : 840 Kg/cm<sup>2</sup>
  - Bending stress for plates : 948 Kg/cm<sup>2</sup>
  - For Key Way reduce above values by 25%
- x) All plummer block shall have four bolt mounting arrangement. All plummer blocks shall be supplied with base plates and locking screws, either SKF or FAG types are preferred. The base plates shall be minimum 20 mm thick with M16/M24 locking screws two number each side of each plummer block.
- y) Tenderer shall submit the sample manual calculation for Shaft diameter at hub, shaft diameter bearing, and Diaphragm & Shell thickness on the basis of provided technical data for Engineer's consideration and proof checking. Detail FEM analysis for each type of pulley with maximum load case shall be submitted.
- z) All assembly nut and bolts fasteners shall be hot dip galvanized with coating 60-80 micron and screw shall be min cadmium coating of 20 micron. Fasteners min grade should be mentioned
- aa) Torque testing shall be carried out for assembly tightening.
- bb) Pulleys shall be stress relieved in closed furnace.

### 5.5.6 Skirt Plates

- a) Skirt board of 12 mm thk. MS lined with 10 mm thk. SS 309. Length [at each loading point] shall be five (5) times of belt width, to accommodate the dust Extraction system in covered skirt boards. Minimum height of skirt plate shall be 800 mm. Inside Clear width between skirt boards shall be 2/3rd of belt width. Skirt shall be of modular design.
- b) Skirt board shall be covered from top and provided with necessary flanges for connecting to feed chute. 5mmthk MS cover plate along with 3mmthk neoprene rubber gasket, bolted to

skirt flanges shall be provided for dust tightness. Rubber curtain shall be fixed at skirt board end for reducing dust nuisance.

- c) The skirt board shall be totally covered and shall be provided with heavy duty sealing arrangement for the gap between the skirt and the belt shall be closed or controlled. Rubber sealing shall be minimum 175 mm deep x 20 mm thk modular mono block type such that one person can replace and adjust mono block. The rubber sealing shall be held in position by steel clamps on the outside of the skirt box and have quick release fixtures for ease of maintenance. The rubber sealing shall be adjustable for minimum height of 100 mm. The skirt rubber sealing shall have 50-60-degree durometer hardness on shore 'A' scale. The fixed liner in skirt shall be 20 mm clear from belt.
- d) It shall have vertical rubber curtains at 1000 mm interval along the length to arrest fugitive dust.
- e) Continuous skirt boards shall be provided suitably for adjacent loading points /shuttle Conveyor and belt feeders. Conveyor structure shall be suitably strengthened in the loading point area.
- f) The lower edge of the Skirt boards shall have 25 mm clearance between the metal part of the skirt and the belt surface.
- g) Distance between steel clamps shall not exceed 300mm.
- h) Liner of skirt boards shall be fixed with button head Allen bolts in countersunk drilled liners.
- i) The skirt board shall be complete with its mounting bracket and fixing accessories in modular construction.
- j) All skirt boxes are required to be spillage free.

### **5.5.7 Deck Plate**

Continuous deck plate- self-cleaning inverted V- deck type made out of 3.15 mm thick MS sheet for full length of jetty, tripper and yard conveyors and road crossings. For other conveyors deck seal plate shall be provided at loading point only. Suitable ribs for adequate stiffness of deck plate shall be provided.

### **5.5.8 Take-Up Device**

- a) Each belt conveyor shall be provided with a gravity/motorized winch take-up as per system design requirements.
- b) The take-up shall include the counterweight or winch assembly, sheaves, steel wire rope, attachments etc. to maintain the required belt tension under all operating conditions. Wire rope shall be from employer approved vendor and breaking testing shall be witnessed. Standardization for wire rope sheaves & pin shall also be taken in to consideration. Sheaves shall be supported on Ball / Roller bearings.
- c) For Gravity/winch T.U device, Take-up travel shall be 0.25% minimum for steel cord belting and 2.5% minimum for nylon belting.
- d) All Take-ups shall be design to accommodate the elastic & permanent stretch of the belt, allowance shall be made for sufficient movement for splicing.

- e) Suitable exp. metal guards and access platform & stair with handrails shall be provided for maintenance. To measure Counter wt. Travel, suitable scale shall be provided in addition to limit switches for T.U travel.
- f) The pulley slide frame shall be self-cleaning type. The pulley slide carriage shall be equipped with Vee type wheels [attached to shaft] running on guide rails. Suitable guide wheels shall also be provided to arrest uplift of carriage. Buffers/limit switches shall be provided at both ends of take-up travel.
- g) All areas shall be freely available for maintenance and should the counterweight be suspended adequate access must be installed for maintenance purposes to ensure a safe working area.
- h) Counter weight shall be arranged having units of identical mass and geometry systematically arranged in side counterweight box having top covered to avoid ingress of foreign particles which may add on undesirable weight. Total weight must be clearly marked on the box. In all cases space shall be provided in counter weight box for an addition of 25% of the design counter weight.
- i) All take-up towers shall have duly arranged with motorized winch system to lift the counter weight box.
- j) All guides shall on piece of steel, no raise joints shall allowed.

#### 5.5.8.1 Vertical Gravity Take-up

- a) Counter weights shall be made out of C.I with standardized denominations. Weight of individual piece shall not exceed 30kg. In all cases space shall be provided in counter weight box for an addition of 25% of the design counter weight. Provision shall be made for dismantling the counter weight or relieving the tension in the belt. Height of the take-up guide steel sections frame shall be sufficient to allow the take-up main pulley at the time of belt jointing to get the required loop.
- b) Each gravity take-up unit shall have a 0.75 m deep sand pit provided under the counter weight. The area below the counter weight shall be guarded to a height of 1.8 m above any access level by suitable fence. Where it is not feasible to provide sand pit suitable impact beam shall be provided below the counter wt. box in addition to safety guard
- c) The design of the counter weight assembly shall have a self-cleaning top
- d) A lifting beam of capacity about twice the total weight of counter wt unit shall be provided, located on the center line of the take-up unit.
- e) All guides shall on piece of steel, no raise joints shall be allowed.

#### 5.5.9 Seal Plate

5mm thk. -Seal plate shall be provided where conveyor gallery crosses roads, buildings, and railway tracks extending an additional three (3) meters on both sides of crossing. 5mm thkx3m long seal plate for gallery shall also be provided at entry/exit of transfer tower also.

#### 5.5.10 Drive unit

- a) The drive shall be complete with motor, gear reducer, L.S & H.S. coupling with guards, hold back device, brake [as applicable] etc. mounted on steel fabricated base frame. All components of drive unit shall be designed based on 50°C (maximum) ambient temperature and continuous duty of 24hrs operation per day with temperature rise less than 30° above ambient.
- b) Drive unit shall have common base frame of welded steel construction, designed with sufficient depth and stiffness to ensure rigidity of drive assembly. Base frame shall be fabricated to achieve accurate alignment of the various components of drive unit. All machinery mounting surfaces shall be machined after duly stress relieved. Base plates shall be suitable for erection on both concrete and structural steel base. Base plates shall be provided with lockable adjustment screws to facilitate alignment of heavy gear reducers and motors in the horizontal plane. All equipment shall be totally enclosed and completely sealed against dust & moisture. Necessary Electric hoist with monorails for lifting of drive unit components/drive pulley shall be provided. Equipment shall be designed to operate with a noise level not exceeding 80 db measured at a distance of 1 Meter in any direction and vibration level not exceeding satisfactory limits of ISO / International standards. Drive unit with its base frame shall be mounted on heavy concrete block. Only high tensile bolts (Grade 8.8/10.9 with 60-80 Micron Hot dip galvanized) shall be used for fixing drive component to base frame and base frame to the concrete block or steel surface.
- c) The type and horse power rating of drive units for all the equipment shall conform to the load and duty requirements.
- d) Drive train of the equipment should be analyzed for critical speeds, and any coincidence with operation speeds should be avoided. If necessary, anti-vibration blocks / isolators are to be installed.

#### **5.5.11 Reducers**

- a) Bevel-helical gearbox, natural/fan cooled and of reputed & approved make shall be provided for conveyor drive. Make of all bearings shall be SKF /FAG only. Water –cooled gearbox will not be accepted. Bevel Helical /Helical type gear box shall be decided by Engineer/Consultant during detail Engineering.
- b) Service life for gears (G1) and bearings (L10) shall be minimum 100,000 hours. Speed reducers shall meet or exceed the requirements of AGMA Standard 6010-E88, or its latest edition. The maximum noise emission at 1 m distance shall be below 85 dB (A) when measured by the methods of AGMA Standard 297, latest edition.
- c) Gearbox mechanical power rating shall not be less than 1.6 times of the motor name plate rating (KW). Thermal rating shall be adequate and if required only fan cooling shall be provided. All gear boxes shall be selected for continuous 24 hours operation and AGMA standards. Gear box shall be design to operate from creep speed to 100% speed; lubrication system should also be design accordingly. If required forced lubrication system shall be installed to meet the requirement of lubrication to operate the conveyor at slow speed, this shall be achieved via flow transducer by interlocking with conveyor. This is subject to purchaser's approval. Input kW rating/Thermal rating/Reduction ratio/selection calculation's etc for gearboxes shall be submitted for approval by Engineer/Consultant. Splash type lubrication shall be provided for gear box. Thermal rating of gear box shall be more than motor

KW.

- d) Gear Box Casing shall be of steel fabricated construction duly stress relieved. Casings shall be sufficient to ensure effective cooling. Suitable ribs shall be placed under the bearing seats for strength to withstand the most severe stress encountered during operation. Gear box shall have oil filling cap, adequate air breathing arrangement, visible oil indicator & oil drain plug, inspection openings, lifting lugs. All bearings shall be splash lubricated and gear box casing shall have adequate oil reservoir. The base of the housings shall be machined and shall be suitable for bolting to base plate. All speed reducers shall be equipped with temperature gauges and Resistant Temperature Detectors. Over temperature shall signal an alarm.
- e) Gear & pinions shall be manufactured out of high tensile carbon/alloy steel, duly hardened and ground to withstand operating conditions. Forged/Alloy Steel shafting to suit shall be provided. Shaft ends shall be properly sealed for protection from any ingress of dust. Antifriction ball/roller bearing of ample size shall be incorporated.
- f) Hold back device external to gear box built in with gear box shall be provided for all incline conveyors. Where ever the rating of hold back is very high for high inclined conveyor, external hold back mounted on pulley shaft shall be provided. Hold back service factor shall be min 1.5 based on max torques from driven equipment.
- g) Hold backs shall be fully enclosed roller or sprag type. The design of the hold back shall be such that its operation is not affected by dust, grease, moisture and extreme temperature conditions.
- h) Back stops shall be mounted on drive pulley shaft, opposite to drive end,
- i) The base of the housings shall be machined level and shall be suitable for bolting to a base plate.
- j) Bearings shall have labyrinth seals (Taconite type) to prevent oil leakage and ingress of contaminants into the bearings. All bearings shall be SKF/FAG make only.
- k) Recommendation of Lubrication oil.
- l) Back lash and contact pattern shall be recorded & witnessed by employer or their representative.
- m) Vibration acceptance limit shall be in-line with satisfactory limits of ISO / International Standards during No-load testing, load testing & Pre commission / commissioning / Operation at Employer's place.
- n) Following construction features shall be taken care over and above all.
  - Conveyors shall be driven through totally enclosed fan cooled / fan with cooling coil reduction gearing having anti-friction bearings with oil seals at shaft projection. Necessary measures shall be provided to prevent ingress of dust and water.
  - Oil temperature shall not exceed 80°C.
  - The transmission efficiency of the gearing shall not be less than 0.98 per stage.
  - All gearboxes shall have permanent magnet plugs.
  - Fluid coupling / scoop coupling between motor and gear box and Geared coupling between gear box and drive pulley have been envisaged. Gear boxes and shaft



projection beyond casing shall be suitable for the above purpose.

- Gear box housing shall be split horizontally at each shaft centre line & fastened and arranged so that the top half can be removed for inspection and repair without disturbing the bottom half. The joints of the casing and bearing hub covers shall be oil tight and dust proof.
- The gear boxes shall be provided with breathervents, oil level indicators, dip stick inspection covers, dowel holes. These items shall be suitably placed for better functioning and easy accessibility. Dowel pins shall be supplied with gear boxes.
- Radial clearance between the gear box inner surface and the outside diameter of the gears shall be at least 1.25 times the depth of the largest gear tooth inside the gear box or 20 mm whichever is higher. The facial or side clearance between the inner surface of the gear box and the face of the gear or pinion shall be at least 20 mm.
- All gear boxes shall have machined footing.
- Gear boxes shall be provided with heavy duty lugs (minimum two) for handling by the hoists.
- The design, manufacture & performance of the gear boxes shall comply with all currently applicable statutes, regulations & safety codes in the locality where the equipment will be installed. The gear boxes shall also conform to the latest applicable Indian or International Standards. Copies of International Standards intended to be used shall be furnished in English language along with the offer.

All relevant tests to be performed under various load conditions for gear box acceptance as per employer's requirement.

### **5.5.12 Couplings**

- a) All couplings shall provide for lateral, angular and longitudinal misalignment of shafts.
- b) Couplings requiring lubrication shall have protection against dirt and dust incorporated in the design.
- c) Hydraulic couplings shall be equipped with adjustable controlled torque transmission and remote/auto device. It shall be possible to start the drive on no load. It shall be possible to stop and re-start the driven machine keeping the motor running.
- d) Particular attention shall be given in selection of casing material of hydraulic coupling in view of chemical properties of different materials to be handled.
- e) All the couplings shall be of heavy duty, shock absorbing and shall satisfy the kW requirements of the particular drive.

### **5.5.13 High Speed Couplings**

#### **5.5.13.1 Flexible Type**

- a) High speed couplings shall be flexible type. The coupling shall have a torque service factor of 2 with respect to the motor's nameplate.
- b) High speed couplings shall be selected of a natural frequency such that no resonance can

occur at any operational speed.

- c) Non lubricated SAMI FLEX or WRAP FLEX couplings shall be preferred.

#### 5.5.13.2 Scoop Controlled Fluid Coupling:

- a) For conveyors having above 160 Motor KW, Scoop Coupling shall be provided.
- b) Fluid couplings shall be suitable for providing controlled starting for conveyor driven by direct online squirrel cage induction motor. Starting torque applied to conveyor shall at no time exceed 140% of the torque corresponding to the full load belt kW. Actuator operated scoop type fluid coupling, shall be equipped with adjustable controlled torque transmission and remote/auto device. It shall be possible to start the drive on no load. It shall be possible to de clutch the driven machine keeping the motor running. Particular attention shall be given in selection of casing material of Fluid coupling in view of chemical properties of materials to be handled by the conveyor.
- c) Running slip vs torque characteristic Curve of fluid coupling shall be such that slip across the coupling is not more than 3%.KW. Rating of fluid coupling shall not be less than the connected motor kW rating.
- d) Coupling shall be dynamically balanced as per ISO1940.
- e) Housing shall be so designed that effective cooling can be ensured. Provision shall be kept so that oil quantity inside housing can be adjusted at site. Water-cooling is not acceptable.
- f) The equipment shall be suitable for full load, part load and no-load starting of the drive equipment without hampering safety of the motor and rate of acceleration.

#### 5.5.13.3 Slow Speed Couplings

- a) Low speed coupling shall be mounted on conveyors drives between gear box output shaft & drive pulley. The selection of couplings shall be done keeping in view of application of the same. The couplings are to be supplied with finished bore and key way.
- b) The low speed coupling shall be maintenance free voith BR type (preferred) or a Geared Couplings or equivalent connecting the reducer shaft directly to the pulley.
- c) The coupling is thermally hydraulically applied and removed. The necessary tools and fittings are provided with the coupling from the manufacturer. The mechanical service rating is 2 times the motor nameplate torque.
- d) Coupling shall be able to absorb parallel and angular misalignment.
- e) Coupling shall have crowned external teeth, which engage, with the straight internal teeth of the sleeve. The pressure angle, the amount of crowning & backlash value shall be selected to achieve the best results in load carrying capacity.
- f) Lubrication arrangement shall be adequate to ensure silent operation and minimum wear of gear teeth. Coupling shall be dust proof and suitable sealing device shall be provided. Permissible parallel & angular misalignment shall be within 0.3-0.5mm & (+/-) 1.5 degree respectively.
- g) Service factor shall not be less than 2.0 times of motor name plate.

#### **5.5.14 Brakes**

- a) Hydraulically operated Thruster brake or disc brake [mounted on brake drum coupling] shall be provided, based on the costing time requirement and braking torque required to stop the conveyor.
- b) Brakes shall be equally effective in both directions of shaft rotation and shall be progressive type.
- c) Brakes shall generally be mounted outside either on HS coupling or on high speed shaft of reducer. If required brakes can be mounted on tail pulley shaft based on the sag generated during braking of conveyor.
- d) Rating of brakes for conveyor drives shall be adequate to stop a fully loaded conveyor belt before the successive conveyor stops. While computing conveyor coasting time least practicable resistance shall be considered.
- e) Hydraulic Thruster operated brakes shall be spring set double shoe floating type. Barring any specific requirements all brakes shall be thruster type.
- f) The thermal capacity shall be adequate to limit the contact surface temperature within the permissible limit recommended by brake liner manufacturer for similar application.
- g) Suitable devices/Proximity switches shall be incorporated to ensure that motor does not start before the brake is released.
- h) Brakes for drive units other than conveyor drives shall be capable of exerting a restraining torque of minimum 150% full load motor torque.
- i) All pins to be of stainless steel because of corrosive properties of cargo in coastal regions.

#### **5.5.15 Bearings, Bearing Seals & Pillow Blocks**

- a) Wherever practicable, bearings shall be of the antifriction type, with a minimum life expectancy compatible with the class of the mechanism with which they are used, unless specified otherwise.
- b) Suppliers shall be SKF or FAG.
- c) On shafts supported by two bearings, one bearing shall be fixed type and the other floating type to allow for thermal expansion of the shaft
- d) All bearing housings and pillow blocks shall be fitted with labyrinth-type seals, suitable for operation in an atmosphere containing very fine and abrasive dust and saline water spray.
- e) All spherical roller bearings in pillow blocks shall have taper bores and adapter sleeves for locating on shafts.
- f) Pillow blocks shall be of cast steel construction. Base plates for pillow blocks shall be provided with lockable adjusting screws for accurate bearing alignment.
- g) Plain bearings shall have bronze bushings. The bearing pressure on plain bearings shall not exceed the manufacturers recommended ratings for the material used and the application conditions.

- h) The plain bearing shall have grease grooves and preferably a labyrinth type of seal to prevent entry of dust particles to the bearing.
- i) The conveyor drive units generally as shown on the drawings shall comprise driving motor, speed reducer, flexible coupling base frame along with anchor bolts and safety covers. Brakes and hold backs as required shall also be provided to meet the operational requirement.
- j) The mounting base shall be rigidly constructed and stress relieved before machining, adequately braced and provided with finish pad for mounting the motor with separate reducer unit.

### **5.5.16 Belt Cleaner/Scraper**

To ensure proper cleaning of belt, belt cleaners shall be provided as stated below. Each belt cleaner shall be of tested and proven design suitable for belt conveyors handling Fertilizer. All belt cleaner/scrapers shall be modular design easy to replace for maintenance, supported in India and spare parts readily available in India. All the Belt cleaners shall have 95 to 100% efficiency.

#### **Primary & Secondary Scraper**

- a) The Cleaners shall be located beneath the overhang defined by the discharge pulley drum. It engages the curved surface of the conveyor belt passing around the drum directly on the face of the pulley.
- b) The scraper shall be positioned in such a way that all material from both the primary and secondary scrapers fall directly into the chute below.
- c) All scrapers shall have ample access to maintain from outside the chute without creating spillage.
- d) The cleaners shall consist of adjustable frames, rigidly mounted to the conveyor. It shall have two transverse support bars and a number of diagonally extending cleaning members between the bars. The uppermost support bar is located inwardly of the over-hang portion of the pulley and the lower support bar is located near the tangent of the belt and the pulley.
- e) A flexible cleaning member shall be used so that the elastic tension in the flexible cleaning member translates to a thrust on the conveyor belt surface.
- f) The primary scraper (Pre Cleaner) shall be provided for removing the heavy residue of materials adhering to the belt surface on the return side of belt.
- g) The blades of primary scraper shall be made of abrasion resistant polyurethane material, inclined against the direction of belt travel, ensuring maximum cleaning with minimum wear and tear of belt surface.
- h) The primary scraper shall be self-adjusting, compatible with reversible belt, easy to install and minimum maintenance.
- i) The secondary scraper (Main Scraper) shall be provided with automatic adjustment function

(Elastomount) which helps in maintaining permanent contact with the belt.

- j) The cleaning member of secondary scraper shall comprise of a series of scraper elements of tungsten carbide, threaded onto stainless steel flexible base. The scraper elements are separated by stainless steel spacer springs so that the scraper elements are kept perpendicular to the belt surface but allow the elements to deflect to permit obstructions, such as mechanical fasteners, to pass without snagging and damaging the belt or the scraper assembly.

The belt cleaners shall be designed considering the following:

- Operate on the face of the discharge pulley.
- Compatible with reversible belt.
- Withstand temperature as specified.
- Withstand corrosion.
- Resilient to obstructions and safe for the belt.
- Large number of small, thin blades.
- Ensure contact of the blades at all points across the dirty section of the belt.
- Simple to maintain and maintenance free for a minimum period of 6 (six) months. Shall be easily maintainable from outside without any interference with the chute arrangement and assembly.
- The modular units shall be easily replaceable.
- Efficient at variable belt speeds and at any moisture content.
- The wear and tear of the top belt cover shall be minimum so that belt life is enhanced.
- Abrasion resistant
- Self-adjusting.
- Easy to install.
- No carry-over from secondary scraper.

#### 5.5.16.1 V-Plough (Internal Scraper)

The V-Plough (internal) Scrapers shall be fitted in front of tail pulley and take-up pulley to prevent the material which is falling on the top surface of return belt. This scraper should be V-type with 60° included angle and vertex should point to the head-end of the conveyor. It should ride on and be supported by the conveyor belt.

V-Plough (internal for cleaning the interior surface of the belt shall consist of following:

- Elastomount arrangement fitted with an automatic locking device to prevent the rigid cleaner parts from coming into contact with the belt and damaging it after the cleaner blade is worn away.
- Self-adjusting torsion arms to maintain cleaning pressure.
- Suspension arrangement to keep the plough parallel to the belt.

- Easily replaceable cleaning blade – Polyurethane.
- Provision of chain to maintain constant pressure and contact with the belt.
- Provision should be made so that the metallic parts do not touch the belt in case of belt worn out.
- Arrangement of scrapper should be such that, after wearing out of plough supporting steel section should not touch/damage the belt.
- Additional safety chains to be fitted to support the scraper in the event of the scraper fixtures failing.

### 5.5.17 Chute

- All chutes shall be properly designed with Flow model analysis (flow dynamics). Due care shall be taken while designing the chute, to avoid the impact of material on the receipt belt and also least acceleration of material at receipt point.
- All Chutes shall be welded steel construction. The material of construction shall be as per Data Sheet below. Curved deflector plate/curved chute piece (spoon type) at chute bottom shall be provided for each discharge chute and it should be fully adjustable.
- Liners shall enhance the flow and prevent blockages taking into consideration of cargo type and fines. The Liners/ceramics shall be maintainable and follow the curve of chute. Liners shall be provided at all the sides of chute.
- Each chute shall have adequate cross sectional area with minimum sloping angle of 60° degrees or more to ensure smooth flow of material. Belt loading chute shall be designed so as to ensure centralized loading of material on the receiving belt to prevent off centre loading/excessive swaying of belt.
- Each chute shall be made in a suitable number of units complete with matching flanges. These units shall be suitably bolt jointed. Minimum bolt size shall be 16mm or spacing shall be less than or equal to 125mm C-C. Each joint shall be made dust leak proof by providing rubber gaskets. Dust tight-hinged inspection doors/bolted removable covers/manhole covers at strategic locations shall be provided to facilitate inspection and to clear jammed cargo in the chute.
- Chute plug switch shall be provided at proper location.
- Chute brackets shall be welded to the main plate and suitably anchored to the floors/platforms.

Technical Data	Description
Location	As per flow diagram and Scope Work
Material of Hood above C.L. drive/ head pulley/	5 mm thk, MS (IS: 2062 Grade B Killed)
Material of parent plate	Min.10 mm thk, MS (IS: 2062 Grade B , Killed)
Liner for Chute	16mm thk Mn Liner to be bolted with counter sunk bolt. Weight of each liner plate shall not be more than 20 kg.

- h) In chute layout- inspection door, poking holes etc. shall be provided suitably, inspection doors especially at head area & discharge area shall be provided, doors should be of robust hinges & lined if required. The discharge chute shall enclose the snub pulley preferably. Otherwise separate dribble chute shall be provided (5mm thk, MS, IS: 2062 grade B killed) below snub pulley so as to direct the scrapped material into the main chute.
  - i) Where inline magnetic separator is provided, chute made out of nonmagnetic material (parent plate) of minimum 8mm thk SS-304 steel for a distance of 1.5m [minimum] from magnet face shall be provided.
  - j) Adjustable baffle plates shall be provide at the discharge of every transfer point.
  - k) The weight of any one plate of liner shall not exceed 20 kg. The liners shall be fixed to the chute by countersunk hot dip galvanized/ Cadmium coating screw. Maximum size of the liner shall be mentioned and it should be such that if it falls off it shall pass through system without jamming.
  - l) Drip pan and collection chutes to be provided wherever necessary for collecting dirty water at every floor of each building for discharging the dirty water either to drainage system or to sump pit. Drip pans and collection chutes to be made of structural steel. Collection pipe shall be extended up to the ground level.
  - m) Suitable openings shall be provided for connecting dust Extraction system where necessary.
  - n) The discharge chute of a conveyor to extend backward to contain both belt scrapers and snub pulley if used, to collect the dribble released by the snub pulley, return belt if any.
- If found necessary, the conveyor elevations shall be suitably modified.

### 5.5.18 Hoist

**General:** Each Hoist shall be sturdy, compact unit complete with all the needed accessories and shall conform to duty Class-II as per relevant Indian Standards. Each Hoist shall be tested as per relevant Indian Standards. Hoist for Suspended Magnet shall be complete with festooning arrangement and shall be certified.

Monorail Hoists/Cranes shall be provided in towers, transfer towers, drive houses, and other areas, as required, where equipment parts heavier than 200 Kg are to be handled for maintenance. Units shall be certified & tested to designed weight, beams to be marked with S.W.L. prior to handover.

The lifting hook of the cranes/hoists shall as far as possible be able to reach vertically above the components to be handled. The cranes/hoists shall be able to lift/lower the components from/to the ground up to/from the required floor.

As far as possible the lifting tackles shall be standardized.

Hooks shall be forged with ultrasonic and DP tested and hook shall be proof load tested, after proof load testing respective hook shall be UT, MPI and DP testing. All beams to be load tested and certified beams to be clearly marked with SWL.

Manual or electric hoist along with its monorail shall be provided as stated below:

- If unit load is equal to or more than 3T, provide electric hoist.

- If lift for unit load is equal to or more than 10m, provide electric hoist.
- If unit load is less than 3T & lift is less than 10m, provide manual hoist.

#### 5.5.18.1 Electric Operated Hoists:

Type	: Electrically operated Hoist & Trolley with Pendant switch, pendant to be of DEMAG plastic type, control cables to have moulded catenary wires in sheath.
Class/ Duty	: Class 2, Indoor, IS: 3938
Mono rail size/Travel length	: To suit
Hoist Speed	: 3.15 M/Min (min)
Carriage travel speed	: 10 M/Min (min)
Brake type	: To suit duty and of adequate rating
Brake for Hoist & Trolley	: To be provided
Bearing	: Ball/ Roller of reputed make viz. SKF/FAG/NTN Subject TO vendor evaluation.
Lubrication	: Oil/Grease
Motor	: Suitable for hoist duty, 415V+/- 10%, 50Hz+/- 5%, 3 phase AC supply
Type of power feeding arrangement	: Festoon cabling.
Type of limit switch	: Over lowering and over hoisting and for over travel at end position
Control Station	: Weather and dust proof with specified Degree of protection in electrical specification, DEMAG type
Pendent Cable	: Pendent cable with moulded catenary wires for support.
Necessary Electrical Protective devices provided:	Yes, to be provided
Tests	: All tests as per relevant codes and Standard, manufacturer's standard shall be Conducted Over load test (125% min of SWL) as per IS:832 shall be conducted.

#### Material of Construction:

Drum	: M.S. as per IS: 3938
Sheave	: Cast Steel as per IS: 3938
Load Hook	: As per IS: 3815
Wire rope	: Construction 6x37 as per IS: 3938 with Hemp core regular lay with min. Strength of 160-175 kgf/sq.mm
Gear	: Forged / Cast steel



#### 5.5.18.2 Chain Operated Hoist (Manual Hoist):

- a) Steel frame made out of steel plates to support all gears and ensuring alignment shall be provided. Rigid pressed steel covers for inspection and gear lubrication shall be provided. Graded cast iron trolley wheels having inbuilt gear teeth and medium carbon steel pinion with Hob cut teeth shall be provided.
- b) Alloy steel load chain conforming to IS: 6216 Grade T (8), hooks made out of forged steel having high ductility and toughness as per IS: 8610 Grade M & P shall be provided. Hook shall rotate through 360 deg. and shall be mounted through ball bearing to enable rotation of hooks at full load without twisting the load chain.
- c) The automatic brake for the lifting gear shall always be in action. It shall be either of screw and friction disc type, self-actuating load pressure brake or of any other standard design. The brake shall offer no resistance during hoisting.
- d) Load wheel, main arm holding upper hook and bottom hook holding block shall be of steel casting with minimum En 9 material. Hand chain shall be made out of standard quality steel and shall be provided with suitable guarding to prevent fouling of chain.
- e) All the gearing shall be generally enclosed type. Gears shall be cut from solid cast or forged steel blanks. Pinions shall be of forged carbon or heat-treated alloy steel. Proper lubricating arrangement shall be provided for bearings and pinions.
- f) Chain must be without joint / welding.

### 5.6 Safety Requirements

#### 5.6.1 Stairs, Cross-Overs And Walkways

Inclined walkways shall utilize grating 100x40 with high grip bars to prevent slips and falls. Walkways friction shall not change significantly within any direction of travel. Access shall be provided to both sides of the conveyor. Width of walkways shall be considered minimum 800 mm minimum having toe guard, hand railing etc. along with safety and protection sign shall be provided at appropriate place. Consideration to be taken into account for maintenance access and physical working in and around the equipment is a must. Cross over shall be provided as per IS: 11592.

##### 5.6.1.1 MINIMUM CLEARANCE

The following minimum clearance shall be generally applicable. Any reduction in clearance requires prior approval.

##### Vertical Clearance

Drives	:	3000 mm
Walkways, platforms	:	2500 mm
Vehicle	:	7000 mm

### **Horizontal Clearance**

Drive end of equipment	:	1500 mm
Non-Drive end of equipment	:	1000 mm
Central Walkways, Platforms	:	1000 mm
Vehicle	:	4000 mm

#### **5.6.1.2 Machinery Guards**

Rotating & moving machinery hazards shall be prevented with bolt-on guards. Guards shall be painted as per standard painting specification. Bright orange and be user friendly as in weight and handling e.g. one man operation. They must not hamper visual inspection of equipment being guarded.

Guards shall be applied to:

- Take-up Counterweight,
- Take-up carriage, surrounding all motion,
- Pulley nip point, where operator access permits,
- High speed and low speed drive/brake shaft access areas,
- Non-driven pulley access
- Couplings

**Note:** Cut outs are provided in the guards where required for access and mounting of proximity sensors and belt slips switches.

Walkways and platforms shall be protected from spillage from overhead conveyor spills.

#### **5.6.1.3 Signs**

Warning and protection signs shall be placed on guards, fences and hazardous areas, such as counterweights, nip areas and stored energy.

#### **5.6.1.4 Name Plate / Tag**

Each item of equipment shall have a stainless steel name plate tag, 1 mm thick, affixed in a conspicuous location showing name and address of manufacture, model, serial number, date of manufacture, weight if over 50 kg and other significant facts for operator safety and that the manufacturer considers necessary. The tag specification callouts shall be a minimum of 12 points pica capital size embosses or larger for clarity with painted letters.

### **5.7 Travelling Tripper**

#### **5.7.1 Scope of Work**

The scope of work of the tenderer shall consist of design, engineering, manufacture, painting, inspection, packing, loading, transportation, erecting, testing, commissioning and handover of 1 (one) number of Travelling Tripper as per indicative technical features mentioned in subsequent pages.

The travelling tripper shall be complete with

- a) Moving tripper assembly
- b) Structural frame.
- c) Buffers having adequate size to absorb kinetic energy of moving tripper. Maximum force exerted on end buffer shall be limited to design of stationary end buffer & structure, without damage to the structure.
- d) Idler & idler frames, (shall be same as FBC-2 conveyor)
- e) Discharge & bend pulleys with rubber lagging, (shall be same as discharge pulley of FBC -2 conveyor)
- f) Plummer block, (Make : SKF or FAG or MASTA )
- g) Reversible belt assembly (Shuttle Conveyor)
- h) Three way Discharge chute,
- i) Two Hydraulically operated flap gate for three way discharge chutes,
- j) LT drive system complete with brake, VFD drive, variable speed motor, bevel helical gear box /geared motor.,
- k) Crossover platform, maintenance platform & walk ways on inclined tripper structure.
- l) Power & control supply system through cable reeling drum or through sliding arrangement
- m) Limit switches, control switches, tripper position indicating switch etc. Junction box shall be fabricated from stainless steel 304 having IP65 rating, only magnet switches shall be used.
- n) Rail, rail supporting structures for travelling tripper and end stopper.

Electrical panel housing, main power disconnecting switch with fuses, main line contactor, control transformer with cut outs on primary & secondary sides, individual mechanism motor control units and set of power & control terminals, to IP55 minimum.

Tripper shall be operated in covered Godown. For the major maintenance purpose tripper can be travel outside the godown at designated maintenance area.

Suitable system for monitoring position of tripper shall be provided. In addition, travel end limit switches and end stops shall also be provided. Tripper shall slow down before it reaches to operational end limit, three switches in total, op slowdown, op stop and e/stop over travel.

Item-wise rate of supply of spares required for 2 years trouble free operation shall be submitted separately.

Necessary tools and tackles required for maintenance. The list of such tools shall be furnished along with the quotation.

Erection instructions / manual, Spare parts manuals, all other drawings & documents as required by the purchaser / his consultant. Drawing shall include BOM fully documented and linked to all GA drawings.

Items to be fully described, manufacture's part no., no in-house and or vague description.

The scope of work shall stand supplement by such details as are given in specification or purchase order or contract or general specifications.

## **5.7.2 Technical Specification (Indicative)**

### **5.7.2.1 Mechanical**

The tripper shall be designed as per IS: 14386-1996. Pulleys, idlers, belt cleaner, gear box, motor, wheel and axles, brake, guards, hood and chute, hand rails, platform etc shall be as per specification for "Belt conveyor System" unless otherwise specified in this specification.

Travel drive of trippers shall have individual wheel drive, independent of the main conveyor drive and shall be through electric motor, bevel / helical gear box or bevel helical geared motor having integral AC brake per driving wheel. Chain drive shall not be used. Tripper shall be provided with A.C. integral brake for stopping the same at desired location. Travel speed of trippers shall not exceed 20 m/min.

The traveling tripper shall consist of one primary and one secondary belt scrapper with adjustable wear strip, rubber lagged discharge and bend pulleys complete with shaft bearings, chutes, stops and limit switches, brakes etc.

The tripper shall have reversible belt assembly (Shuttle Conveyor) alongwith three-way discharge chute which shall be capable of discharging the incoming material to either side of belt conveyor all along tripper travel or bypass to head pulley of conveyor. The three-way discharge chute will be provided with two motorized flap gate for diverting the material into the dedicated path.

Traveling trippers shall be of adequate length with proper slope of conveyor idlers to match with the flow properties of material being handled. The maximum inclination of the conveyor belt on the tripper shall not be more than 140.

Tru-track type idlers shall be provided to control sway and holding down pulley to control uplift of the belt in unloaded condition.

Wheels shall be single flanged with taper parallel tread running on anti-friction bearings and shall have minimum hardness of 350 BHN. Material of wheel shall be forged steel / cast steel. Rail size shall be given by tripper supplier.

Traveling trippers shall be equipped with manually operated rail clamps, rail cleaners and jacking pads. Jacking points to be clearly marked on both the drawings and structure.

Power supply to the tripper shall be given through motorized Cable Reeling Drum (CRD) or through sliding arrangement with trailing cables, cable trays for resting the trailing cables and end limit switches for protection against over travel of the tripper. CRD shall be mono spiral the cable reeling drum and trailing cable of each tripper shall be suitable for the entire length of Godown including maintenance space. The cables shall have copper conductors, proper insulating material and braided armouring in accordance with IS: 691.

Position indicators shall be provided as per requirement of control logic so that the tripper can be stopped at discrete location through limit switches (preferably magnetic switches) and starting upon manual, local or remote signal. Operating push buttons for local control and emergency stop shall be within easy reach of the operator on the main conveyor walkway.

The rating of tripper travel motor shall be adequate to move the tripper smoothly either in forward or opposite direction to belt direction under fully loaded conditions. Coefficient of friction for rail adhesion shall be taken as maximum 0.12.

Minimum two drive axles (4 driven wheels) shall be provided for tripper travel. In case of failure of one drive, the tripper shall be in position to travel. Provision shall be made without affecting operation the removal of one drive per side.

Arrangement shall be provided at the starting point of the tripper to avoid folding of belt.

In case of tripper running at a speed more than its rated speed due to chutes jamming or other reason, conveyor shall trip and annunciation shall appear.

The supporting structures for the rails with necessary end stops shall be supplied by purchaser.

Suitable belt hold down guide pulley shall be provided over the concave curve of belt over tripper.

Suitable dust cover shall be provided over tripper discharge pulley. Serrated rubber seal shall be provided at open side to prevent dust nuisance. Suitable dust tight access doors shall be provided. One primary and one secondary external belt cleaner shall be provided at tripper discharge pulley to clean carrying side of the belt.

The tripper shall run on rails (minimum 60 lbs/yd). Rails for tripper shall be mounted on supporting structure of respective conveyors and will be provided by purchaser.

Suitable system for monitoring position of tripper shall be provided (on non-drive wheel). In addition, travel end limit switches and end stops shall also be provided.

Suitable access platform of hot dip galvanized grating 50x50 with ladders, hand railings and walkways on both sides shall be provided for access / maintenance of equipment on tripper. Also crossover platform shall be provided with tripper so that operator can cross the belt through the same. Needed guide rollers, bearings, brackets, safety guards etc. shall be provided by the tenderer.

Suitable rail cleaners shall be provided on leading and trailing edge of tripper for either track. These should be applied to rail by self-weight. Minimum 4nos rail cleaners are required to run on rails.

The traveling tripper shall consist of spring bladed belt scrapper with adjustable wear strip, rubber lagged head and bend pulleys complete with shaft bearings, flap gate (if any), chutes, stops and limit switches, brakes etc. The tripper shall have three-way discharge chute which shall be capable of discharging materials into either side of conveyor or bypass to head pulley of conveyor.

#### 5.7.2.2 Reversible belt assembly (Shuttle Conveyor) alongwith Discharge Chute

The Reversible belt assembly (Shuttle Conveyor) alongwith three way discharge chute assembly for tripper shall be provided with flap gates. This assembly shall consist of a structural assembly of rolled steel section of St-42 Fe-410 WA quality conforming to IS: 2062. The chute wall shall be of minimum of 10 mm thickness and shall be lined with minimum, 10mm thick SS-304 / 25mm thick UHMWPE. Chute shall be design and guaranteed for spillage

free and blockage free operation for the fertilizer

### 5.7.2.3 Hydraulically operated flap gates

Hydraulically operated flap gate shall be complete with hydraulic cylinders, power pack, pipe and pipe fittings, solenoid operate valves, operating console or self-contained hydraulic actuator etc. The gates shall be of robust construction and suitable for trouble free operation. The flap gate shall be used to divert the flow of material received from feeding conveyor. A hydraulic cylinder shall operate the gates. The actuators / cylinders shall be mounted on the chute body / or on a working / maintenance platform.

The gate shall be fabricated out of 10-mm thick MS plates and shall be lined with minimum, 10mm thick SS-304 / 25mm thick UHMWPE (material handled fertilizer). The gate shall be capable of changing the direction of material on remote mode of control even when the material is being discharged from the feeding conveyor pulley. Preferably the gates and its hydraulic actuator or cylinder shall be mounted on the operating floor and shall be fully accessible.

The equipment shall be capable of being operated for at least 15 switching/hour at rated load and thrust and shall be suitable for 10 numbers consecutive switching at rated load and thrust. The equipment shall be shop tested to prove the requirement. Hydraulic actuator / cylinders shall be so selected as to provide sufficient thrust (minimum 2500 kg) for operation of the gates against the moving weight of material and/or flap gate. The flap gate travel shall be in the range of 60°. Proximity switches having not less than IP65 protection shall be provided to indicate extreme positions. Lever arm shall be provided between actuator / cylinders and the gate shaft for obtaining required thrust. Each gate shall be provided with a shaft, a hand lever and self-aligning type anti-friction bearings with adequate sealing for dust proofing.

The actuators / cylinders shall be capable of preventing any over travel. Suitable travel dependent proximity switches controlling the travel of the gate on either direction shall be provided. These shall be placed internal to the cylinders and shall be completely dust-proof. The proximity switches shall be capable of adjustments to vary to total length of travel of the gates.

Suitable stiffening arrangement shall be provided between the two faces of the gate plate. At the end of the travel the total length of edge of the gate shall rest on a suitable projected surface from chute to prevent leakage of material through the available clearance between chute and flap gate. Suitable self-aligned double row ball bearings of approved make in dust tight housing shall carry the gate shaft. Suitable provision for re-greasing shall be provided.

For standardization purposes, only one standard type of hydraulic actuator hydraulic cylinders (Min. 2500 kg thrust load) of flap gates shall be provided. Flap gate hydraulic actuator / cylinders as a whole and individual component wise shall be completely interchangeable (in case more than one gate is considered).

The material of shaft shall be EN-8 or equivalent material. The diameter of the shaft shall be suitable for motor stalled conditions and associated twisting.

### 5.7.2.4 Idlers / Idlers Support:

Idler and idler supports shall be in line with specification followed for belt conveyor system and shall same as belt conveyor FBC-2.

#### 5.7.2.5 Pulleys

Pulleys shall be in line with the specification for belt conveyor system and shall same as Head pulley of conveyor FBC-2.

#### 5.7.2.6 Gear Box

Traveling tripper shall be driven through bevel helical geared motor with integral brake.

#### 5.7.2.7 Coupling

Motor shaft shall be connected to the gearbox-input shaft through flexible shock absorbing coupling. Use of pin bush type coupling is not acceptable.

The couplings shall be made of cast or wrought steel and are to be designed to suit the maximum torque required to be transmitted or to suit the total braking torque of the mechanism whichever is higher. 3.15-mm thick sheet steel hinged covers for safety shall suitably cover rotating parts. Coupling shall be WRAPFLEX or SAMIFLEX only should the geared motor not be feasible.

#### 5.7.2.8 Safety Features

Detachable safety guards shall be provided for pulleys, couplings, drive etc.

#### 5.7.2.9 Lubrication

Manual lubrication of the bearings in different location.

#### 5.7.2.10 Structural

##### **Tripper Frame**

A structural assembly of rolled steel section of St-42 Fe-410 WA quality conforming to IS: 2062. FEA analysis for complete tripper structure shall be furnished for EMPLOYER'S review.

##### **Ladder & Platform Assembly:**

Platform and approach ladder shall be provided on to the belt tripper to facilitate approach for operation and maintenance purpose and shall be consisting of a structural assembly of rolled steel sections and tubular. Checkered plate shall be provided to the maintenance platform.

##### **Stability**

The belt tripper shall be stable both during operation & movement. Successful bidder shall submit the stability calculations for purchaser's approval.

#### 5.7.2.11 Electricals

The standard supply voltage 415V  $\pm 10\%$ , 50Hz  $\pm 5\%$ , 3 Phase 4 wire solid earthing shall be adopted for travelling tripper.

Power supply to the tripper shall be given through cable reeling drum arrangement and

necessary electrics for traveling trippers such trailing cables, cable trays for resting the trailing cables and end limit switches proximity type 25 mm sensing gap for protection against over travel of the tripper. CRD shall be mono spiral. The trailing cable of each tripper shall be suitable for the entire length of travel.

The cable reeling drum will be complete with stalled torque motor, suitable slip ring and brush assembly, cable guides for proper paying in / paying off cables, protection against over-tension, under tension of cable of cable, limit switches, end limit switch for CRD, etc.

Slip-ring and brush-gear assembly of cable reeling drums will have dust and wear proof enclosure having inspection window suitably located.

The cable reels shall be actuated automatically as soon as the travel drive is active.

Position indicators shall be provided as per requirement of control logic by the purchaser. However the tripping lever to be located in the tripper car shall be provided by the supplier and its location to be finalized during commissioning. Operating push buttons for local control and emergency stop shall be within easy reach of the operator on the main conveyor walk way or on the travelling tripper is preferable.

The rating of tripper travel motor shall be adequate to move the tripper smoothly either in forward or opposite direction to belt direction under fully loaded conditions.

Minimum two drive axles (4 drive wheel) shall be provided tripper travel.

### **Standards**

The equipment shall be selected as per the guide lines provided in the latest edition of the relevant Indian Standards. The equipment shall also conform to the latest Indian Electricity Rules & Regulations as regards to safety requirements, earthing and other essential provisions specified therein.

### **Power supply collection & distribution**

Incoming power supply from purchaser's power outlet shall be made available in shop.

### **Limit switches**

Travel motion shall be provided with magnetic switches to limit the position. Travel control shall be operational slow down, operational stop and emergency over travel at each end.

### **Motors**

Motor shall conform to separate specification for motor all motors shall be totally enclosed fan cooled enclosure IP-54 squirrel cage induction type. It shall be ensured that these are special

motors suitable for 150 starts/hr crane duty with pull out torque of not less than 275% of the rated torque.

The cycle duty factor for each motor shall not be less than 40%. The motor selected shall be for frequent reversal, braking & acceleration. Motors shall have class "F" insulation with max. Utilization to within class "B" admissible temperature rise corresponding to ambient air temperature.

Each motor shall have a robust terminal box accurately fixed to the frame. Each Terminal box shall have ample room for termination of the aluminium conductor cables.



## **Brakes**

Brake shall be integral to geared motors. Brakes shall be connected so as to apply automatically when power supply fails or when the push button is released or with adjustable delayed time lag preceded by electrical braking when the push button is released.

## **Wiring**

All cables shall be installed with adequate protection against mechanical damage & damage from weather. Alternatively, multi-core armored power & control cables, suitably clamped, may be used. Suitable clamping lamps should be provided at both ends of each multi-core cable.

All power & control cables shall be tagged at both ends (as per approved drawings) for quick identification. The cables & wiring system for each motion shall be independent & common runs shall be avoided. Power cables & control cables shall be effectively separated & all connections shall be terminated to terminal box suitable for outside connections.

Cable runs shall be avoided, at locations where high temperature & mechanical damage are likely to be experienced under service conditions.

## **Cables**

The cables for power connection up to electrical panel shall comprise multi-strand PVC insulated & sheathed, copper conductor, 1.1 kV grade cables. Solid or single strand conductor cable shall not be acceptable. The conductor sizes shall be selected after derating for the high ambient temperature, grouping & deposition of cables & keeping the voltage drop within the permissible limits & shall have a minimum cross sectional area of 2.5 mm sq. copper.

Conductor for control cables from electrical panel shall be made of copper with standard construction & with a sectional area not less than 1.5 mm sq. Festoon flexible cables for power & control applications shall have butyl rubber / EPR insulation & CSP sheathing

Flexible cables shall be of finely stranded copper conductor having a min. conductor section of 2.5 mm sq. copper for power circuits & 1.5 mm sq. for control circuits.

All cables shall be adequately protected against mechanical damage, radiant heat and oil as applicable.

## **Power collection system for Traveling Tripper control unit**

Travelling trippers and its control unit shall be through cable reeling drum system shall be mono spiral. The necessary electrics for traveling trippers shall be trailing cables, cable trays for resting the trailing cables and end limit switches proximity type 25 mm sensing gap for protection against over travel of the tripper. The trailing cable of each tripper shall be suitable for the entire length of the bunker bay.

One end of the cable shall terminate in main cable junction box. The other end shall terminate on to the main power disconnecting switch located in the control panel. The trailing cable shall have ample length to cover full track length.

The above arrangement shall be guaranteed for 24 months of trouble free operation. Alternatively, vendors have to quote power / control CRD arrangement.

## **Earthing**

TN-CS type of earthing shall have provided. This would require a separate earth conductor in the power cables, both for fixed wiring as well as for CRD. Earth connection shall be a cross every mechanical pivot to ensure good earth across the entire structure.

#### 5.7.2.12 Inspection and Testing

Inspection & testing of equipment shall be carried out by Purchaser or an authorized agent of Purchaser at the works of supplier during manufacturing and on final product to ensure conformity of the same with the acceptable criteria of technical specification, approved drawings, authenticated manufacturing drawings and reference national / international standards.

The Purchaser or any one or more authorized by him, shall have the right to visit contractor's / sub-contractor's premises to check the physical progress of work, inspection, testing etc., of the contract items or any part thereof at any time during all stages of manufacture. The contractor shall extend all necessary facilities for carrying out such inspection and check of progress of work.

Inspection of equipment by the purchaser / engineer shall be only with a view to ensure that the equipment is fabricated / manufactured, assembled, tested as per approved drawings and prescribed specifications. Inspection by the purchaser / his representative shall in no way relieve the supplier of his responsibility as per the contract and shall be in no way binding on the purchaser / engineer.

Immediately after approval of drawings / documents, the supplier shall give six (6) sets of all such drawings / documents along with the soft copy to the purchaser to enable the purchaser / engineer to carry out inspection of the equipment.

Purchaser / Engineer may reject the whole or any part of the equipment at any time if after inspection / testing. Purchaser / engineer at their discretion determine the equipment or any part thereof to be unsatisfactory or does not fulfill the terms of the contract, purchaser's / engineer's decision regarding rejection shall be final and binding on the supplier.

Vendor to perform a mechanically run performance test to verify capacity at his workshop. Vendor shall notify EMPLOYER'S prior to the test and submit test procedure for review. EMPLOYER'S shall reserve the right to witness such test and request copies of the test results.

Manufacturer's test certificates shall be furnished by the supplier for all bought out materials, components etc.

Wherever such test certificates are not available, the item shall be got tested by the supplier at his own expense at government recognized authority on mutually agreed upon.

#### 5.7.2.13 Delivery

All the equipment covered under this specification shall be delivered to site stores of EMPLOYER'S and as per the address and delivery schedule to suit commissioning of plant.

##### **Identification, tagging, marking, packing and storing**

Inscription on equipment (labels) shall be in English.

Unless requested by Purchaser, supplier shall dispatch equipment with all its attachments , parts, components, spares, documents etc as a single lot with logical identification of packing.

All items supplied shall be packed for a long storage under the climatic conditions prevailing at the site. Each item shall be clearly marked with its description, purpose and plant designation code as applicable. When more than one item packed in a single case a general description of the contents is to be shown on the outside of each case and detailed list to be enclosed. All cases and other packages must be suitably marked and numbered for identification purpose.

**Preparation for shipment:**

The Tenderer shall be responsible for ensuring that all accessories of Travelling tripper are carefully and / or suitably packed for shipment, so that they arrive at site in good conditions and remain so during storage at site.

Tenderer will be responsible for all damage due to improper preparation of the goods for shipment. All openings shall be covered or plugged to prevent entering of dirt and moisture to interior. Threaded connections shall have thread protectors that will exclude dirt and moisture.

**5.7.2.14 Painting:**

Shall be as per employer's approved scheme.

**5.7.2.15 Workmanship and Performance Guarantee**

The material used shall be new and best of its kind available and shall conform to relevant latest Indian and international standards.

The warrantee shall cover faulty design / material / workmanship. All rectifications or replacement under the warrantee shall be done by the supplier free of cost.

The supplier shall warrantee for satisfactory performance of the facilities for a period of 18 months from the date of receipt at site by the purchaser or 12 months from the date of commissioning whichever is earlier.

The tenderer shall prepare and submit draft performance test procedure for approval.

**5.7.2.16 Special Instructions to Tenderer**

The vendor shall design the equipment considering the "site conditions" and for indoor installation.

Metric system shall be followed and English shall be the language of all communication.

The tenderer shall satisfy the Purchaser that he possesses the necessary technical experience and qualification and that he has at his disposal suitable modern facilities and staff of specialized employees to ensure that his contract work is of best quality and workmanship, according to the latest engineering practice. The tenderer shall furnish necessary particulars in this behalf with tender.

The vendor will be fully responsible for both the product and its relevant compliance with the present specification. All provisions included in the present specification will not be limitative to the scope of supply. The vendor will provide for those further activities in order to improve the quality of the product.

In case the equipment mentioned in this specification use imported equipment, component & / or spares for installation of the equipment, the tenderer should indicate the foreign

exchange component along with the expenditure involved. In case of need, the tenderer shall make arrangement of foreign exchange for them.

The successful tenderer shall communicate, prior to award of contract the names of sub-contractors/ suppliers proposed to be engaged by him for approval by Purchaser. The successful tenderer shall also intimate the Purchaser the names of his personnel (including sub-contractors/suppliers) and their addresses with telephone/telex number from whom information/data can be obtained by purchaser regarding progress of works, arrangement of inspection, testing and all other work in respect of the contract.

The break-up of plant and equipment shall be indicated in the following two broad categories.

- Those to be manufactured in India.
- Those to be procured from the foreign sources.

In both cases where the equipment is to be procured from India or abroad, the successful tenderer shall be responsible for design, generation of all data and design drawings required by him for manufacture/fabrication.

No foreign exchange and import license for import of technical know-how or equipment, components, spares or materials will be arranged or provided by the Purchaser

The tenderer shall separately quote for all the bought out items other than his manufacture.

In case of usage of special motors are involved in the system/package, same shall be in the scope of the tenderer.

All bought out items shall be as per the preferred makes of PURCHASER / Engineering Centre.

## **5.8 Conveyor Accessories**

### **5.8.1 In-line Magnetic Separator**

- a) Magnetic separator shall be electromagnetic type, with oil-cooled design. All equipment shall be totally enclosed. Magnet Circuit comprising of insulated copper adequately impregnated with epoxy resin making it impervious to moisture shall be provided. One Electric Hoist with monorail beam shall be provided suitable for handling/ removal of magnetic separator for maintenance. Tramp iron chute are required along with ILMS
- b) Each Magnetic Separator shall provide for continuous and automatic extraction and discharge of tramp metal (magnetic pieces) from cargo mass on the given belt conveyor (refer Data Sheet).
- c) The magnetic separator unit shall be mounted from structural member from the top. The required turnbuckle arrangement to facilitate the necessary adjustments during operation shall be provided. The unit shall be complete in all respects including all electrical ancillaries, viz. local control panel, ON/OFF control push buttons and indicating lamps etc.
- d) Magnet core material shall be of pure annealed iron or equivalent having high magnetic permeability. The coil shall be of copper wire with Class 'H' insulation.
- e) Dimensions and shape of the core and side poles shall be optimized to obtain wider, deeper field ensuring large force index to effect higher lifting capacity over wide area.

- f) Magnetic pieces picked by magnetic separator shall be discharged into tramp metal chute located suitably.
- g) Suitable arrangement shall be provided in the magnet for keeping the coil of magnet dry from atmospheric condition when the magnetic separator is not in use.
- h) The other mechanical components of the Magnetic Separator like pulleys, bearing blocks, drive, belt etc. shall be liberally designed to ensure trouble free operation. The motor and gear reduction unit for driving the belt shall be adequately sized.
- i) The separator belt shall be designed to withstand high temperature at the bottom of the magnet and also to withstand impact of the sharp edges of the tramp iron pieces. The belt shall be provided with suitably spaced built in ribs.
- j) Belt protection devices for belt sway shall be fitted.
- k) All the equipment and accessories shall be proven design and manufactured to the best engineering practice.
- l) Each magnetic separator shall be suitable to lift the following tramp iron piece from the given belt.
  - MS cube of 20 mm size
  - 250 mm x 250 mm x 50 kg. M.S. plate
  - MS round bar of 50 Kg with L/D ratio of 5(min)
  - MS Bolt of M12, M16, minimum length equal to 5 times the size
  - Shovel teeth & spikes.

### **5.8.2 Belt weigher**

- a) The belt weigher shall consist of the carriage/ weighbridge assembly, belt speed sensor and the electronic cabinet (Totalizer or Integrator Unit). The weighbridge shall be of multi idler system. Frictionless pivots-trunnion type suitably sealed shall be provided which shall be impervious to vibration, moisture and material deposits. The weighbridge shall be of rigid frame type having no moving parts and it shall maintain alignment permanently. It shall be of unitized construction for quick and easy installation in the field.
- b) The speed sensor mechanically connected to tail pulley/deflector roller shall provide a stream of pulses, frequency of the pulse stream being proportional to belt speed. The Totalizer Package (Integrator Unit) shall provide the necessary intelligence to the system. The integrator receives the output signal from the weighbridge & the speed sensor and adds them to the total on the Master Counter. Flow rate is displayed by computation against a time base. The Integrator shall have feature such as automatic span and zero calibration and self-diagnostics facility.
- c) The digital speed sensor shall be packaged in rugged cast aluminum housing suitable for outdoor installation. The speed-sensing element shall employ a brushless pulse generator producing a stream of pulses, frequency of pulse stream being proportional to true belt speed. The pulse output is fed to the Integrator Unit.

- d) All idlers shall have T.I.R. not greater than 0.3 mm. All rolls shall be “weigh class” and confirm to ISO 1940=G16 on both the bed & the scales. Lead in bed frames not less than 5. Lead out frames not less than 5. Idler frames to be of robust construction and fully supported so that under full load condition the bottom span does not deflect more than 0.6mm. Weights and dimensions are critical, spacing center to center require to be exact having maximum deviation of 0.5mm. Weigh Idler Frame shall be approved before manufacturing.
- e) The Electronic Cabinet shall comprise of the Totaliser Rate Indicator etc .having microprocessor based integrator. Total material weight, the material flow rate etc. shall be displayed on eight (8) digits LED. It shall have facility such as Run/Set up/Lamp test/Auto zero/Auto Span/Enter etc. The Electronic Unit shall have facility of digital processing, tantalization of data etc. And shall have bright easy to read digital display of flow rate of material and total tonnage passed etc. Electronic cabinet shall be rugged design with IP -55 degree of protection.
- f) High precision load cell of strain gauge type or transducer fully temperature compensated shall be provided.
- g) Belt weigher shall be calibrated with static and dynamic loads and shall offer an accuracy of  $\pm 0.25\%$ .
- h) The accuracy shall be guaranteed within ( $\pm$ ) 0.25 percent for all belt weighers except boom belt weigher. All electronic equipment used shall be suitable for service in dust-laden atmosphere and shall be actually tested, checked as per applicable standards to ensure continued reliability.
- i) Load cell calibration certificates to be submitted and calibration shall be checked by employer.
- j) Belt weigher simulation and integration shall be checked at manufacturer place.

### **5.8.3 Metal Detector**

- a) Each metal detector would comprise of:
  - 1 No. Search coil,
  - 1 No. Electronic cabinet
  - 1 No. Signal horn
  - 1 No. Signal lamp
- b) Search coil unit houses an oscillator coil and a receiver coil, Oscillator coil sets up electromagnetic field which is concentrated in aperture of the search coil. In normal condition when there is no tramp metal the receiver coil is so arranged that the output from it is extremely small. When a tramp iron piece is passing through the coil, it disturbs the flux distribution and this induces a voltage in the receiver coil. This voltage is then processed in the electronic unit and a DC voltage proportional to the size and type of metal is obtained. This voltage is compared with a threshold setting voltage which is used to set sensitivity of detection. When a metal of required size passes through the coil a switching signal is available at the output of the above comparator, which drives a monostable ckt. This monostable ckt actuates the relay for a fixed time and returns back after that time. Thus a momentary change over contact is available from this relay. The contacts of this relay are rated 5A/220V AC. Suitable spark suppression is also incorporated.

- c) The metal detector shall operate on a principle that tramp metal causes a reaction in the sensing device of the detector unit, in case, tramp metal passes through without being lifted, the metal detector on sensing the tramp metal will activate the signal light and operate the sand marker device to indicate location of metal piece and will also simultaneously stop the belt. The hook of the sand bag marker is lowered by means of a relay contact. The sand bag is dropped on or near the approx. location of the metal piece. Additional security circuit is provided so that the conveyor will not start unless, the sand bag is put back again on hook of the marker.
- d) Auto testing device checks the sensitivity of the metal detector at the interval of every 3 to 4 seconds and signal for malfunctioned/loss of sensitivity of the metal detector.
- e) Metal detector shall be capable to detect ferrous metal piece of 40 cubic mm and nonferrous, metallic piece of 60 cubic mm.
- f) Functional test shall be carried out at manufacturer place in complete simulation and integration condition.

## 5.9 Technical Data Sheet

Salient features of conveying system & equipment envisaged in the facility are mentioned in Indicative 'Technical Data Sheet' below for each tripper.

### 5.9.1 Travelling Tripper (Motorized) x 02 Nos.

Sr.No	Description	Details
1	Material handled & size	Fertilizer Bulk density 600-900 kg/m <sup>3</sup> Surcharge Angle: 20 degree (Refer: Table-2.2 for Cargo Detail)
2	Location	On conv. FBC-2
3	Hour of operation / day	24
4	Belt	To be finalized during detail Engineering
5	Belt thickness	Min As per FBC-2 Belt Specification
6	Number required	1
7	Belt width	Around 1600 mm
8	Capacity	2200 TPH (Design)
9	Speed of belt (m/s)	3.2
10	Moisture content (maximum)	

11	Idlers : Shall be identical to Idlers for conveyor FBC-2	
12	Specification	IS-8598 & IS-9295
13	Troughing angle of carrying conveyor	450
14	Number of rolls	3 (three)
15	Roll diameter (mm)	152.4
16	Spacing (mm)	1100
17	Bearing	Antifriction ball / roller
18	Method of lubrication	Life lubricated
19	Pulleys	
19.1	Specification	Same as Head pulley of conveyor FBC-2
19.2	Hold down pulley to prevent lifting of belt at conveyor starting to be provided?	Yes
20	REVERSIBLE BELT ASSEMBLY (Shuttle Conveyor) WITH DISCHARGE CHUTES	
20.1	Type	Reversible belt assembly (Shuttle Conveyor) with Three way discharge chutes
20.2	Material of specification	As per specification
20.3	Type of flap gates	Operated by hydraulic actuator / cylinders.
20.4	Material of construction	As per specification
20.5	Liner plate	As per specification
20.6	Minimum valley angle	550
21	TRIPPER DETAILS	
21.1	Type	Motor driven type rail mounted.
21.2	Drive	Individual wheel drive (independent of the main conveyor) through electric motor, bevel / helical gear box & geared couplings.



21.3	Tripper speed (m/min)	5 – 20 (variable speed)
21.4	Type of brake	As per specification
21.5	Travel limit switch	To be provided on both side of travel.
21.6	Tripper angle	140 (max.)
21.7	Rail & end stop	To be provided by the purchaser.
21.8	Tripper Travel (in m)	(~) 700
21.9	Wheels	Single flanged
21.10	Rail clamp	Manually operated.
21.11	Belt scraper at discharge pulley	Sprung bladed scrapper. 1 primary and one secondary (Scrapped material must fall inside the collecting chute)
21.12	Power feeding arrangement	Through flexible cable on cable reeling drum.
22	Flap Gate	
22.1	Gate plate	Gate plate - 10 thk MS conforming to IS: 2062.  Liner Plate – 10mm thick SS-304 / 25mm thick UHMWPE.
22.2	Shaft	C-45
22.3	Drive	Hydraulic actuator / cylinder operated. With power pack
22.4	Effort on manual operation	25 Kg (maximum)
22.5	Type of bearing	Roller bearing.

#### 5.9.2 In-line magnetic separator:

Sr.No	Description	Details
1	Type of Magnetic Separator	In Line Magnetic Separator. Oil cooled type electromagnet with self-cleaning arrangement complete with local panel. Tramp Metal collecting chute to be provided for each Magnetic Separator. Recommendation of oil for coo

2	Equipment Designation	ILMS
3	Location	TT-1
4	Conveyor Capacity (TPH)	2200 TPH
5	Belt Width (mm)	1600 mm
6	Belt Speed (m/s)	3.2 m/s
7	Troughing Angle	45°
8	Operating Height (approx.)	500 mm
9	Flux Density (Minimum)	1000 Gauss at operating height specified above
10	Force Index	100000
11	Degree of Protection	IP 65
12	Magnet Core Material	Pure annealed iron/ eq. having high magnetic permeability, IS 4491
13	Coils	Cooper wounded coils with class “H” insulation
14	Rectifier	3 ph., full wave bridge using Silicon Diodes forming rectifier set
15	Separator Belt	N/N Type of M-24Grade complete with built – in ribs and zero speed switch. Geared motor drive shall be provided.
16	Wear plate	Stainless Steel SS-304 shall be provided at Electromagnet surface.

### 5.9.3 Belt weigher:

Sr.No	Description	Detail
1	Type of Belt Weigher	Electronic Load Cell Type, Microprocessor based
2	Designation No.	BWS

3	Number to be furnished	1
4	Location	FBC-1
5	Capacity of conveyor (TPH)	2200 TPH
6	Weighing range	10% to 120%
7	Belt width (mm)	1600 mm
8	Accuracy over full weighing Range	Within $\pm 0.25\%$
9	Belt speed (m/sec)	As per conveyor speed
10	Totalizing Unit	To be Provided
11	Type	Eight digits, digital totalizer
12	Location	Control Room
13	Rate indicator	Both Local as well as remote to be provided
14	Type	Digital type
15	Location of display	Local to be provided Remote at Control Room (on mimic panel) shall be provided.
16	Calibrating instruments as required	To be Provided Master Weight to be used for calibration) .weighing clearance scope to be defined.

#### 5.9.4 Metal Detector

Sr.No	Description	Detail
1	Equipment Designation	MD
2	Location	FBC-1 & FBC-2
3	Quantity, no.	2

4	Belt Width (mm)	1600 mm
5	Capacity (TPH)	2200 TPH
6	Troughing Angle	45°
7	Belt Speed(approx.), m/s	As per conveyor speed
8	Material to be examined	Fertilizer
9	Detector type and capacity	Electronic solid-state type, single channel suitable to detect 20mm dia. aluminium ball and MS nut of size M-20. Each unit shall be complete with search coil, electronic cabinet, signal lamp, signal horn, sand bag marker, and provision for testing the unit.
10	Annunciation/Hooter provided	Yes
11	Audible range of hooter	300 m
12	Indication type	Audio and visual
13	Power supply	230V±15%, 50 Hz±2%, Single phase, A C Supply

## 6. TENTATIVE DESCRIPTION FOR NEEM COATING SYSTEM

### 6.1 Introduction

The extensive laboratory and field studies have shown that the new product produced with a thin film of Neem oil-water emulsion of specified concentration would increase the shelf life of product.

It will reduce caking during storage and also improve availability of nitrogen to crops at the time of growth. It will also result in better crop yield. The price of Neem-coated urea will be marginally higher than the cost of normal urea. The results obtained under the general parameters have shown an increase in crop yield and efficient pest control management with an average saving. The process will help in harnessing unique properties of Neem for regulating release of nitrogen to crops when mixed and applied with urea into soil and making available to farmers a more efficient nitrogenous fertilisers based upon the research work conducted by scientists of Indian Agriculture Research Institute, New Delhi. Urea can be used in an effective manner. Smaller quantities of urea can be more effective than normal quantities being used by farmers currently. This will especially help the paddy crop in low land conditions, During the ongoing Rabi season, the company proposes to have more field demonstrations for crops like sugarcane, potato and wheat with reduced doses of nitrogen to extent of 80 per cent through Neem coated urea as compared to full recommended dose through normal urea to establish benefits accruing in terms of increased productivity.

Neem oil or Margosa oil is botanical oil extracted from kernel of Neem tree seed by Cold Pressing or CT Cold Pressing method or Solvent Extraction. Among these methods CT cold pressing yield purest Neem oil because solvent is not used for extraction.

### 6.2 Properties of Neem Oil

Neem Oil or Neem Seed Oil is a Brownish Yellow color Liquid, with smell of Garlic. Neem

Oil is slightly soluble in water and has 6.5 to 7.5 pH value; it boils at more than 200°C and freeze at 13 °C.

Moisture	:0.2% Max.
Specific gravity	: 0.94 at 30°C
Iodine Value	: 75.57
Azadirachtin Content	: 530 ppm
Saponification Value	: 191.69
Unsaponifiable matter	: 1.91 %

### 6.3 Uses of Neem Oil

Neem Oil is used to manufacture Neem oil insecticide because it contains azadirachtin, which effects over 600 species of pests including insects, nematodes, fungi and viruses and is completely safe to non-target organisms like beneficial predators, honey bees, pollinators, fish, birds, cattle and human beings.

Azadirachtin of Neem oil is a famous natural anti-feedant, growth regulator and ovipositional repellent for insects, as a major active ingredient, which make it a perfect alternative to chemical pesticides.

Nitrogen from Urea is released in the soil and water and leached by activity of nitrifying bacteria Nitrobacter and Nitrosomonas. These bacteria turn nitrogen in nitrite and then nitrate, which are highly mobile in nature when present in soil. By these processes approximate 50% of nitrogen provided by urea is lost.

Solution to this problem of nitrogen loss of urea is to coat the urea with a substance that can prevent bacterial activity of nitrification.

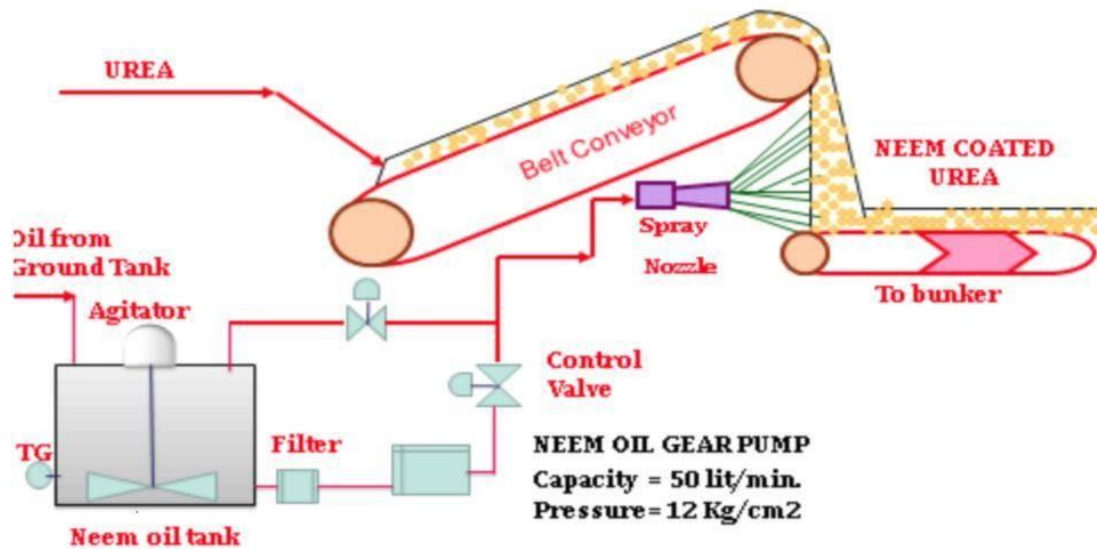
#### **6.4 Benefits of Neem Coated Urea**

- Slow down the process of nitrification of urea
- Enhance the yield by 48%
- Decrease urea requirement, hence save money

The nitrogen (N) fertilizer-use efficiency (20-50%) is low in rice fields in India. The Neem-oil coated urea can increase N-use efficiency in lowland rice, but the desirable thickness of Neem-oil coating onto urea is not known yet. Therefore, field experiments were conducted during kharif (rainy) season years 2004 and 2005 at the Research Farm of Indian Agricultural Research Institute, New Delhi to know the suitable thickness of Neem-oil coating on prilled urea (PU) for increased N-use efficiency and yield.

The treatments comprised of twelve combinations of four N sources (PU coated with Neem-oil thickness of 0, 500, 1000 and 2000 mg/kg PU) and three N levels (50, 100, and 150 kg N / ha) plus a no-N control. Prilled urea (PU) refers to the common urea available commercially in prills, which is different from urea super granules. Application of urea coated with Neem-oil thickness of 1000 mg/kg PU resulted in significantly higher growth, yield parameters, grain yield, N uptake, and efficiency of aromatic rice (*Oryza sativa* L.) over uncoated PU. Nitrogen application at 122 kg per hectare was optimum for increased yield of rice. Nitrogen-use efficiency decreased significantly and substantially with each successive increase in levels of N from 50 to 150 kg per ha.

## NEEM OIL SPRAYING ARRANGEMENT



**Figure: Equipment Requirement for Neem Coated Urea**

### **6.5 Equipment specifications:**

- a) One unloading pump, one storage tank
- b) One Gear pump for transfer self-priming with the size of 25 x 25 MOC = AISI 316, Capacity = 20 M 3 hr at 5 Kg/cm<sup>2</sup> pressure, Working Temp. = 60 degree, Viscosity = 34.8 CST
- c) Neem Oil Storage Tank, MOC = M.S., Capacity = 20,000 T
- d) Neem Oil Day Tank, MOC = M.S., Capacity = 2500 liters
- e) Neem Oil Unloading Pump: Centrifugal Pump Flow = 10 M/hr, Head = 13.6 m, Motor = 2.2 KW, 1450 rpm.
- f) Neem Oil Injection Pump, Capacity = 50 ltr/min. Pressure = 12 Kg/cm<sup>2</sup>
- g) Nozzle Specification, Capacity = 1.78 ltr/min. at 1.75 Kg/cm<sup>2</sup>, Make: Spraying system Company Vee Jet Spray Nozzle Flat Spray, MOC = SS 316, Spray angle = 110 degree

## **7. FERTILIZER EVACUATION EQUIPMENT(S) IN STORAGE SHED:**

### **7.1 Indicative System Description:**

Proposed system description is briefed here below.

- a) It is proposed to install 38 Nos. of bagging and stitching units (19 Nos. on either rake siding as per plant layout). In every bagging unit there will be one bucket elevator, one bagging & stitching machine, one flat belt conveyor with wagon loader. The design capacity of each unit is 1200 bags per hour.
- b) Fertilizer cargo stored in the shed will be reclaimed by the front end loader and feed in to the bucket elevator.
- c) Bulk cargo from bucket elevator will feed into Bagging and stitching machines. Bagging and stitching machines each with a design capacity of 1200 bags per hour will be generally operated by two persons one for feeding the empty bag (empty bag to be provided by the importer) and filling of bags through hopper. The second operator will handle the stitching machine and direct the bag onto conveyor which roughly corresponds to a wagon load. The bagged fertilizer is led by conveyors on to the bag loading flat belt conveyor which further feed bags to wagon loader to drop the bags into the wagons, where a gang of four unskilled personnel will direct the bags to form layers in an organized fashion thus filling each wagon with 1200 bags.
- d) Each bag loading machine shall be capable moving over a span of three wagons and its loading arm (wagon loader) with provision to extend and retract to enter into the wagon as required for feeding bags to inside the wagon as required.
- e) Time Required for Loading a Full rake: With a provision of 20 Bagging and stitching machines and each bagging machine feeding into a wagon loading conveyor with loading arms and each such machine feeding into 3 wagons and the system having a design capacity of 1200 bags per hour, operating with 75% efficiency, a full rake will be loaded in 4 hours.
- f) The cargo other than fertilizer such as Minerals, Salt, Raw Fertilizer, etc. can also be handled by Mobile harbour crane and hopper and then it can be transferred to open storage area near to go-down by dumpers.

### **7.2 Front End Loader (On Hire Basis)**

Front End Loaders are not part of supply scope of Bidder. However, it is provided as reference for design considerations. Vendor shall consider Front End Loaders as equipment to feed the Cargo to Bucket Elevators.

Vendor shall also define nos. of Front End Loader considered / required to meet the operational output capacity of subsequent equipment(s) i.e. Bucket Elevators, Bagging & Stitching units, Flat belt conveyor with Wagon Loaders.

The front end loader / pay loader is used heaping up the fertilizer cargo within the stockyard and drop in to the receiving hopper.

Front End Loader with bucket capacity in the range of 3 to 5 cum having front-mounted square wide bucket connected to the end of two booms (arms) to scoop up loose material from the ground and move it from one place to another without pushing the material across



the ground. A loader is commonly used to load bulk cargos from stockpile into a dumper or to the hoppers.

The general technical parameters governing the design of the pay loader shall be as follows:

- Capacity of bucket : 3 cum
- Bucket width : About 3 m
- Static tipping load : About 13 T
- Operating height : Not less than 5.4 m
- Turning radius : Not more than 6.5 m
- Dump angle : Not less than 50
- Dump reach : Not less than 2.4 m

**Note: Bidder has to arrange sufficient Front End Loaders (with required operator and fuel) as required to handle the capacity, during testing & commissioning stages and vendor to demonstrate the commissioning and Performance test trial with actual numbers of Pay loader considered in design to meet the output.**

### 7.3 Bucket Elevator

- a) Buckets elevator shall be designed, supply, erected and commissioned to suit the capacity of bagging machine. Each bucket elevator shall have hopper of adequate capacity. Pneumatically operated slide gate shall be provided between charge hopper and bucket elevator to control material flow as per bagging machine requirement.
- b) All rotating part of bucket elevator shall be covered with safety guard. Adequate access platform shall be provided around drive pulley and drive. Cat ladder shall be provided from bagging machine floor to maintenance platform of bucket elevator.
- c) Adequate size of inspection doors shall be provided nearby boot pulley and head pulley for inspection purpose. Inspection door nearby boot pulley shall be sized considering the cleaning activity of the boot part of bucket elevator.
- d) Local push button station shall be provided on the bucket elevator to start and stop the bucket elevator. Location of pushbutton shall be easily accessible. Similarly local control panel shall be provided near the pneumatic slide gate for automatic and manual operation. It shall be provided for opening and closing of slide gate during manual operation.
- e) Bucket elevator shall be self-standing type. Chute of Bucket elevator shall not be supported from bagging machine supporting structure.

### 7.4 Bagging & Stitching Machines Units

It is proposed to deploy 38 semi-automatic bagging and stitching machines along the length of bagging go-down. Each machine shall get fed from the bucket elevator. The brief system description is given below:

- a) Bagging and stitching machines shall consist of net weigher, loading spout, flat conveyor, stitching machines, etc. This system is a semi-automatic type which requires minimum two

skilled labours to assist. One to put the empty bag at the opening of incoming cargo and other one to hold the bag moving on slat conveyor for stitching.

- b) Each unit shall be complete with surge hopper, gravity feeder, net weigher, microprocessor based electronic controller for weighing, discharge chute, filling spout, stitching machine, slat conveyor & bagturner.
- c) The Surge hopper of appropriate capacity shall be provided as a surge between intermediate hoppers and the weigher. These hoppers shall be provided for smooth flow of fertilizer cargo to the gravity feeder. The gravity feeder controls and meters the flow of fertilizer cargo from the hopper to meet the specified discharge flow rate.
- d) The net weigher accurately and continuously weighs pre-selected quantities of fertilizer cargo. The main components are housing, weigh hopper, 3 load cells for accurate measuring, hopper suspension, check links and electronic measuring & control module type microprocessor.
- e) Stitching/Sewing Machine: Sewing head of higher outputs fitted with automatic pneumatic cylinder or electrically operated knives, precision built with cast iron case & fully interchangeable parts in hardened steel on high grade bronze shall be required.
- f) Heavy duty conveyor shall be required, on which bags after being filled shall be conveyed in a vertical position to stitching machine and further discharging onto the horizontal flat belt conveyor.
- g) Underneath of discharge chute at bag holder provision of sensor to control flow of material. Local control panel shall be provided to operate Bag holder. Local display shall be provided for viewing of Load cell / weigher output. Bag counter shall be considered to count total number of bags handled and provision of back-up to be considered.
- h) Stitching machine shall be considered with paddle operated and designed for double row stitching. While deciding position and arrangement of stitching machine adequate care shall be taken to avoid any frequent rupture of stitching string. Stitching machine position shall be adjustable to suit the bag size and convenient operation. Stitching speed shall be in line with the number of bagging requirement per minute and conveyor speed. Pushbutton switch station shall be provided nearby stitching machine for easy access by stitching machine operator to forward, stop and reverse bag take away conveyor for re-stitching the bag.
- i) Walkway shall be considered besides bag take away conveyor. Walkway end shall be designed such a way that blocked bags at bag diverter chute can be removed from walkway. Proper handrail shall be provided around walkway.

## **7.4.1 Major Components of Bagging & Stitching Machine**

### **7.4.1.1 Surge Hopper**

The Surge Hopper provides a surge capacity immediately above the weigher, comprising of:-

- An Isolation valve having the same flange detail as the hopper inlet enabling disconnection of the weigher.
- Roding/inspection hatch with hanged lid.

#### 7.4.1.2 Gravity Feeder

The feeder comprises of a two position radial gate to regulate main and dribble feed rates to the weigher.

- Totally enclosed housing with lift-off inspection doors for maintenance.
- Two pneumatic cylinders, mounted within dustproof enclosure, to give positive gate closure and consistent cut-off. Manual adjustment is provided for initial setting up of the system.

#### 7.4.1.3 Electronic Net Weigher - Three Load cells

The Net weigher accurately and continuously weighs pre-selected quantities of bulk material. The main components are a housing, three load cells, weigh hopper, hopper suspension, check links, and the electronic measuring and control module type Microprocessor based electronic controller.

- Three cantilever strain gauge load cell arrangement accommodates nominal loads of 100 Kg maximum.
- The weigh hopper is 80 litres approx. capacity with double flap discharge doors and also incorporates a cleaning/inspection door.
- Vendor shall consider dedicated instrument earthing for Load Cells.
- Vendor shall consider effect of machine vibration and operational vibration (due to Front End loader and other vehicle movement in shed) effect in design and equipment selection. So as overall desired accuracy can be achieved in actual operational conditions.

#### 7.4.1.4 Microprocessor Based Electronic Controller

Microprocessor-controlled weighing module in stainless steel housing with front panel, dust and water tight (IP65), installed in a control cabinet.

- Large graphic display
- Membrane keyboard
- Standard PC-keyboard connectable for easy data input.
- Error and diagnostic message in clear text
- Remote control via modem
- Entry of average tare value or automatic taring for gross weighers.
- Automatic and manual zero setting.
- Automatic zero correction, material in flight compensation and adjustment of dribble flow time, on / off selectable.
- Weight check (tolerance check), on / off selectable.
- Extensive statistics at the last batch, printable.

- Back-up supply of parameter memory at switched off control for more than 10years due to durable lithium battery.
- Vendor shall consider dedicated instrument earthing for Microprocessor.

#### 7.4.1.5 Discharge Chute

A Stainless Steel (SS 316) connecting Chute will be supplied complete with inlet to a flange to the E55 weigher flange and flanged outlet spigots to connect to the bag holder.

- Continuous welded construction, designed to reduce material hang up.

#### 7.4.1.6 Local Control Panel

This panel comprising of the following operations:-

- Start push button with green lamp indicator
- Stop push button with red lamp indicator
- Control alarm with red lamp indicator
- Emergency stop switch
- Material of Construction: Stainless steel with IP65 protection.

#### 7.4.1.7 Bird Beak Bag Holder

The Bag holder consists of a filler spout with two pneumatically operated sealing and clamping jaws which securely hold the bag.

- The two double acting air cylinders operate the clamping jaws to firmly grip the bag between them and the outer fixed jaws.
- Operation of the bag holder is by a wrist switch, which initiates the clamp closure. This ensures that the operating sequence may continue with discharge of the weigher.

#### 7.4.1.8 Sack Sealer with approx.3.0 m Long Slat Conveyor Service Requirements

Sack Sealer with Slat Conveyor comprising of the following operations:-

- Number Of Heads : 1 No.
- Stitch Type : Double Thread Interlock (Two Row)
- Thread Cutting : Automatic
- Feeding Direction : Right To Left.
- Thread Holder : Fabricated Steel Thread
- Supporting Stand : Telescopic Pillar With Adjustable Height.
- Thread Type : PP Twisted Thread

#### 7.4.1.9 Sewing Head

This is a universal Sewing Head for high outputs fitted with automatic pneumatic cylinder or electrically operated knives, precision built with Cast Iron Case and fully interchangeable parts

in hardened steel on high grade bronze. Needle, Looper and Feed mechanisms are driven by special eccentric bearings on horizontal main shaft. This main shaft is mounted on bearings (Flange bearings and Rod end bearing). Lubrication to all the components is done by a motorised lubrication system. The stitch will be double thread interlock chain stitch. This can stitch paper and HDPE woven bags etc.

Sewing Head should be design with box covered to prevent any dust ingress & conform to relevant standard like IP65 for uninterrupted operation due to dusty & humid weather condition.

#### **7.4.1.10 Pillar Unit**

Heavy duty Sewing unit, complete with Sewing Head mounted on a Pillar unit for adjusting height of the stitching head above the conveyor and fitted with a Knibbler Knife for double thread interlock stitching operating at a speed of 16.5 m/min approx.. The machine is also complete with motor, a V-belt drive and an Electrical Control circuit.

Operation through a direct-on-line Starter with the features as follows:-

- Simple design for easy operation and adjustment.
- Proven reliability in severe in Kandla conditions
- Good accessibility for maintenance.
- Automatic Motorised lubrication.

### **7.4.2 Slat Conveyor Unit**

Heavy Duty Slat Conveyor between centres, Conveyor height, Wooden Slats bolted to attachments on Roller Chains. The sprockets will be EN 8 Steel with shafting on self-aligning double row Ball Bearings in completely sealed and greased packed housing. The Conveyor is complete with frame work of the Rolled Steel Section, bag-guide to ensure smooth travel of vertical bags and geared motor.

Slat Conveyor unit shall be with provision of High Adjustment for various types of cargo bag.

#### **7.4.2.1 Operation**

The two-stage foot switch is pressed to engage the first stage, and the conveyor starts running and the filled sack placed on feeding end of the conveyor approaches the stitching head. When the bag is sufficiently near the stitching machine, the foot switch is further pressed to engage the second stage and the stitching head starts working.

The bag is guided through the stitching head and then after the bag is stitched, the thread chain is pushed into the nibbler knife, which cuts it. On release of the foot switch, its second stage disengages and stops only the sewing head switch, its second stage disengages and stops only the sewing head. The conveyor running, advancing the subsequent bags for stitching.

### **7.4.3 Other Essential Requirement**

#### **7.4.3.1 Compressed Air**

The compressed air must be without oil and water along with maintenance unit with filter, pressure reducer, manometer and oiler (FRL)

Pressure required: 5-6 bar

Compressed air shall also be used for cleaning of the bagging machines and systems before changing over from one cargo to another.

## **7.5 Bag Diverter & Horizontal Flat Belt Conveyor with Wagon Loader**

### **7.5.1 Bag Diverter**

Bag diverter chute shall be provided between bag take away conveyor installed on bagging machine and shift-able wagon loading conveyor installed on railway platform. Material of diverter chute shall be of SS409 and supporting structure of chute shall be of MS as per IS:2062 Gr.B killed.

Design and angle of chute shall be carried out keeping in view that bag shall not be damaged during transfer from one conveyor to another conveyor.

Provision of manual adjustment and locking shall be provided on Bag diver chute to suit the conveying direction of shift-able wagon loading conveyor.

Chute design shall be done such a way that it shall have provision of 50mm vertical and horizontal adjustment.

Supporting structure of Bag diverter chute shall be designed such a way that it shall not create any hindrance for movement of shift-able belt conveyor.

### **7.5.2 Horizontal Flat Belt conveyor**

#### **7.5.2.1 Duty**

Each equipment(s) including belt conveyors should be designed and built to operate under outdoor conditions at Design capacity furnished in this specification considering continuous duty of 24 hr/day, ambient temperature of 45° C and under climatic and ambient conditions at site.

#### **7.5.2.2 Belt Conveyor**

Belt Conveyors should be complete in all respects and include but not limited to idler rolls with supports, pulleys, drive units with base plate, belting, take-up units, stringer frames, short supports, etc. and all bolts.

The conveyor components required for this facility should be standardized to the extent possible.

‘Technical Data Sheet’ enclosed herewith should form the basis of the functional and design requirements of the Mechanised bagging and Rake loading of fertilizer.

The contractor to consider the provision for preventing centre misalignment of the belt during operations.

### 7.5.2.3 Design Basis

Belt sag on the carrying side should not exceed 2% of idler spacing. Maximum operating tension in the belt should not exceed eighty (80) percent of maximum allowable working tension of the belt at the specified load. All drive pulleys, Non drive pulley should be diamond knurling.

Under all operating conditions including running, starting, fully or partially loaded or empty belt, the belt should not lift off the idlers. All Conveyors should be capable of starting fully loaded.

Design capacity of each conveyor should be as per enclosed data sheet 'Technical Data Sheet'.

Selected belting, idlers, pulleys, drive motor etc. are also indicated within this 'Technical Data Sheet'. However, Tenderer should adopt these after doing necessary calculations at his end to verify these values. The drive motor of each belt conveyor should be rated for minimum 100% of actual requirement of driven equipment at motor output shaft at the specified Design Capacity of conveyors. IS: 11592-2000 should be used for KW rating calculation / selection of drive motor, belting etc. Components of belt conveyors should be standardized to the extent possible viz. belting, pulleys, bearings, geared motor to facilitate Inter-changeability.

### 7.5.2.4 Belting

- a) Belting for conveyors should be POLYESTER REINFORCED PVC COATED WITH SUPERGRIP PROFILE BELT. It should be able to withstand the tensions and support the load.
- b) Belt Fabric consist of 3 plies polyester with high lateral stability and antistatic.
- c) Total thickness of belt should be up to 6.2mm. Belt top cover should be made up of 2.2 mm Age flex 50 with super grip profile and bottom cover with fabric impregnated.
- d) Maximum Belt tension should have 2% elongation as 34N/mm.
- e) Joining of Belt should be done finger-Overlap-Finger joint
- f) Tolerance on belt dimensions should be as follows:
  - Width (mm) : +3 / -0
  - Length : +2% / -0%
  - Carcass Thickness (mm) : +0.5 / -0.0
  - Composite belt thickness (mm) : +0.5 / -0.0

### 7.5.2.5 Stringer

- a) Conveyor stringer should be formed through sheet with suitable thickness.
- b) It should have holes and slots of exact finish i.e. required holes should be cut through laser cutting machine.

- c) Slots and holes for idler mounting should include in this stringer only.
- d) No extra bracket should be used to mount idler.
- e) Conveyor stringer and other plates should be powder coated of our choice RAL code or frequently available colour.
- f) Stringer should be joined with tray alternately in between idlers.

#### 7.5.2.6 Idler Units

- a) All carrying idlers should be single roll interchangeable flat rolls fixed type.
- b) Bracket for fixed type idlers should be slot in stringer and should have ample strength and rigidity to operate under all loading conditions without vibration or chatter. Use of cast iron support brackets is not acceptable.
- c) Idlers should be finished with centralized grinding machine; Idler pipe top surface should have Zinc coating.
- d) Fixing arrangement of roller with brackets should be drop in slot type.
- e) All idlers should be made out of Seamless tube and should conform to IS codes and minimum wall thickness should be 5.05 mm for both carrying and return side. Mechanical properties of the idler tubes should be equivalent or better than YSt 210 grade.
- f) Outside diameters of carrying and return idler rolls for belt conveyors should not be less than 48 mm.
- g) All the Idlers should be designed for continuous duty and conform to latest IS 8598 or equivalent standard.
- h) Idlers should be easily removable type. For standardization of idlers, all rollers should be identical and interchangeable type for the same category.
- i) The internal rolling friction co-efficient of the idler unit should not exceed 20 to 30% of the composite friction factor 'C' which is taken as 0.022. Weight of revolving parts of the idler should be kept to minimum.
- j) Idler shaft material should be EN8 or better steel. Make of Idler Bearings should be FAG / SKF / NTN.
- k) All Idler Rolls should be free in rotation.
- l) Tolerance on diameter + 1 mm & length + 2 mm
- m) Run-out of idlers should not be more than 0.5mm.
- n) All Idlers should be pre-run in the works for even distribution of grease and also to ensure least starting resistance.
- o) All idler tubes should be of proper quality pipe and cut to size. The tube should be bored in a single setting using double headed boring machine for accuracy as also co-axiality of the bores and the perfect seating of the bearing housing.
- p) Idler shafts should be machined from tested rods and machined in a single setting. The bearing diameter should be ground to finish in a single setting to achieve the accuracy, finish and co-axiality.



- q)** Following idler test should be carried out.
- Idler friction factor test
  - Diametric run-out check
  - Bearing Noise Check
  - Any other tests as per relevant codes & standards.

#### 7.5.2.7 Pulleys

- a)** Pulleys should be made of welded steel and stress relieved before machining.
- b)** All hubs and shafts should be of forged steel. Hubs and end discs should be accurately machined for concentricity.
- c)** All pulleys should be straight faced and pulley faces should be Crowned with Diamond Knurling:
- d)** Pulley assemblies should be statically balanced and run concentric when mounted on shaft. Balancing weight should not exceed 0.25 percent of the pulley weight, preferably.
- e)** Pulley should have face run out not greater than 1.5 mm on diameter.
- f)** The pulley face width should be min. 50 mm more than the belt width. The tolerance of pulley along the face width should be + 3 mm on the nominal width.
- g)** Pulleys have been standardized to the extent possible.
- h)** All pulleys should be shop assembled with shaft, bearings, Plummer blocks etc. and shipped as complete assemblies.
- i)** One longitudinal weld on pulley shell per pulley should be permitted and the weld should be ultrasonically tested.
- j)** All pulley shafts should be EN-8 or equivalent. Tenderer may quote shaft with better material as an alternative.
- k)** Shafts should not protrude from pillow blocks with closed ends.
- l)** Bearing for Pulley should be with square flange type bearing at Head Pulley and Take up type (UCT) at Tail Pulley
- m)** Bearing should be Spherical Roller bearing of SKF/FAG make having metal cage.
- n)** All pulleys bearings will have a minimum life of 60000 hours.
- o)** In case of shaft design based on strength, the combined shock and endurance factor for bending and torsion i.e.,  $K_m$  and  $K_t$  should be 1.5 and 1 respectively. Shaft deflection limited to 1/2000 of distance between bearings and the angular. All conveyor pulley shaft should be checked for deflection i.e. deflection at pulley hub should not more than 5 mm for Drive Pulleys and 8 mm for other pulleys (In the worst loading condition).
- p)** Temperature detectors should be provided on all pulleys bearing housing size more than 100 mm to indicate / stop in case of overheating.

### 7.5.2.8 Belt Take-Up

- a) The take-up travel should be 100mm (Minimum) of the centre to centre distance of 7 M.
- b) Tightening of Belt should be by stud of min. 20mm diameter.

### 7.5.2.9 Drive Unit

#### General

- a) The type and horse power rating of drive units for all the equipment should conform to the load and duty requirements.
- b) The composite friction factor (artificial friction coefficient) of the horizontal and inclined conveyor system should be considered as 0.022.
- c) The drive unit should be complete with motor, transmission and necessary couplings to achieve the following functions:
  - Soft start of fully loaded conveyor.
  - Equal load sharing.
  - To be able to continue motor running, even during short stoppage of the conveyor.
- d) There should not be any coupling neither between Motor and Gear Box nor gear box to pulley.
- e) Geared Motor should be of hollow shaft and directly mounted on pulley shaft.
- f) Base Plate
  - All drive units should have common base plates of welded steel construction. They should be designed with sufficient depth and stiffness to ensure rigidity of drive assembly.

### 7.5.2.10 Hydraulic Cylinder and Power Pack

For raising and lowering of conveyor to change the discharge height of conveyor hydraulic cylinder should be used.

Cylinder used should be Telescopic type with lifting capacity to 3Tons.

Hydraulic power pack should consist of following parameters to have equipment minimum maintenance, less wear and tear and high load carrying capacity:

The Hydraulic Power Pack consists of a fixed displacement gear pump, driven by an electric motor, filler/breather cap, oil level indicator, pressure control/relief valve, pressure gauge, solenoid diverter valve, drain plug and connection manifold. The power pack is operated by energising the solenoid valve which directs the hydraulic oil alternately to the lower ports of the single acting cylinder. When the sampler probe is not being operated, the pump delivery is returned to the tank via the direction control valve.

Reservoir Capacity	35-40 litres
--------------------	--------------

Grade of Oil	High performance hydraulic oil with optimal anti-wear properties (AW-Additives) and high load capacity of the lubrication film  The unit should normally operate with an oil temperature below 55°C (130°F).
Design Pressure	Max 180 Bar, Normal pressure can be varied as per requirement.
Pump Capacity	6 litres/m at maximum design pressure
Electrical Power Requirements	To suit actual motor and solenoid valve supplied (Motor size 1.5KW, single or three phase)

#### 7.5.2.11 Control Panel

- Control panel enclosure should be fitted with conveyor itself, Operating panel should be at accessible height.
- Control Panel with IP 65 enclosure.
- Variable Frequency Drive of reputed make should be provided to for each conveyor separately.
- Panel enclosure should be powder coated with standard colour.
- Circuit drawing of Panel should be provided for maintenance purpose.

#### 7.5.2.12 Safety and Control Devices

Effective guards or shrouds should be provided for all rotating pulleys, shafts, gears, chains, V-belts, pinions, couplings, etc. Limit switches, and other safety and control devices should be supplied and installed complete with supports/ brackets etc.

All conveyors, unless mentioned otherwise should be equipped with:

- Pull chord switches should be installed on both sides of each belt conveyor.
- Belt side travel limit switches to stop drive unit for protecting belt from rubbing against the structural parts
- One no. Motion (zero speed) switches to stop the motor when the speed of the equipment drops below a specified value or if normal speed is not reached within a specified time, and to signal starting and stopping of preceding conveyor/ equipment.

Interlock between brake and motor wherever drive units have brakes. Interlock between metal detector and the conveyor drive (wherever applicable). Interlocks between conveyors drive unit and dust control system.

## 7.6 Indicative Technical Data Sheet

Indicative Salient features of equipment envisaged in the facility are mentioned in 'Technical Data Sheet' below and the drawings enclosed herewith.

### 7.6.1 Bucket Elevator

Description	Specification
Operating Location	At Godown (Highly corrosive)
Feed By	Wheel loader / Excavator
Discharge to	Storage hopper on bagging machine
Quantity	38 Nos.
Material to be handled	Urea, DAP, MOP
Material Angle of Repose	30°-37°
Material Particle size	-10 mm
Capacity (Bucket Elevator)	Supplier to provide in accordance to bagging machine requirement
Type of Bucket elevator	Centrifugal Belt type
Type of take-up	Screw type manually adjustable
Supporting Arrangement	Self-standing type
Charging Hopper (MOC)	Mother plate – MS Liner – SS316
Slide Gate at In-let of bucket elevator	Pneumatically operated and linked with high and low level sensor at storage hopper of bagging machine.
Ambient Temperature	50°
Material of Construction (Bucket Elevator)	Bucket & its fasteners- SS316L MS – For Body and Supporting structure
Power Supply	415 V AC +/- 5 %, 3 Phase / 50 Hz, +/- 3% With Earth and Neutral

Description	Specification
Bucket Elevator Include	Bucket elevator and its component, charge hopper with SS316 Liner, Pneumatic slide gate, discharge chute with SS316 liner, etc.

## 7.6.2 Semi-Automatic Bagging & Stitching System

Sr No.	Description	Detail
1	Application	Open Mouth Bagging Line
2	Type of Feeder	Gravity Feeder
3	Type of Weigher	Electronic Net Weigher
4	Flow Characteristics	Free Flowing
5	Material	Urea/MOP/DAP
6	Bulk Density (kg/m <sup>3</sup> )	800 - 1100
7	Weighment Size	45/ 50 kg or any other as per Govt. Amendments.
8	Output	20 bags / min
9	Accuracy	± 50 grams, 2 Sigma
10	Bag Material	HDPE/PP
11	Bag Size	Shall be furnished later
12	Type of Bag	Open Mouth
13	Area Classification	Non-hazardous - safe area
14	Environment	Dusty, Moisture & Corrosive
15	Utilities Required:	
15.1	Power	6.6 kV+ 10% / 433 V + 10%, 50 Hz + 5%, 3 Ph, 3 Wire power supply for motors drives/local panels (combined variation + 10%).
15.2	Compressed Air	Dry Air, Instrument Quality, 4-6 kg / cm <sup>2</sup> , 8 Ltr./ Weighment

### 7.6.3 Horizontal Flat Belt Conveyor

Sr No.	Description	Detail
1	Quantity	38
2	Duty	Continuous
3	Installation	Outdoor
4	Mounting	Wheel mounted
5	Construction	MS
6	Process Data	
6.1	Material to be handled	Cartons/ Bags weighing about 50 Kgs
6.2	Bulk Density	N / A
6.3	Max Operating Temp	Ambient
6.4	Min Flow Rate	Not Specified
6.5	Feed Height from Ground	1500 mm
6.6	Discharge height from Ground	1500 mm
6.7	Degree of Inclination	HORIZONTAL CONVEYOR
7	BELT Details	
7.1	Specification	6 mm thick Polyester reinforced PVC Coated Super grip belt
8	Dimension of Conveyor	600 mm Wide( Effective width 500 mm) x 25 MTR Long Horizontal
9	Drive & Driven Pulley & Idler	
9.1	Drive & Driven Pulley	Made from 4" NB MS Pipe. Diameter 114 mm
9.2	Diameter of Shaft	36 mm
10	Special Feature	
11	Painting	Conveyor Body will be powder coated as required And Support Structure will be suitably painted.

12	Support Structure	MS Square Hollow Pipe
13	Area Classification	Non-Hazardous
14	Drive Unit	Control Panel IP 65 Enclosure, RITAL make
14.1	Motor	2 HP geared motor
14.2	Output RPM	71
14.3	Belt Speed	25 Mtrs/Min
14.4	Type of Gear Box	WORM

#### 7.6.4 Wagon Loader

Sl No.	Description	Detail
1	Quantity	2 x 38 = 76 Nos.
2	Duty	Continuous
3	Installation	Outdoor
4	Mounting	Trolley Mounted
5	Construction	MS
6	Process Data:	
6.1	Material to be handled	Cartons/ Bags weighing about 50 Kgs
6.2	Bulk Density	N/A
6.3	Max Operating Temp	Ambient
6.4	Min Flow Rate	Not Specified
6.5	Feed Height from Ground	Minimum 650 mm (as per Flat Belt Conveyor)
6.6	Discharge height from Ground in to Wagon.	Up to 2.0 Mtr. (Adjustable)
6.7	Degree of Inclination	Variable
7	BELT Details	
7.1	Specification	6 mm thick Polyester reinforced PVC Coated

		Super grip belt
8	Dimension of Conveyor	600 mm wide ( Belt Width 500 mm) x 7.5 Mtr Length
9	Drive & Driven Pulley & Idler	
9.1	Drive & Driven Pulley	114 mm dia MS Pipes duly Knurling done and Zinc Plated.
9.2	Diameter of Shaft	45 MM
10	Special Feature	This conveyor is mounted on easily manoeuvrable trolley fitted with hydraulic cylinders for raising and lowering 2 HP( 2 HP Motor) Hydraulic Power Pack x 2 Ton Capacity Telescopic Cylinder.
11	Painting	Conveyor Body will be Powder Coated suitably and Support Structure will be painted with colour as per customer choice.
12	Support Structure	MS SQUARE HOLLOW SECTION
13	Area Classification	Non- Hazardous
14	Drive Unit	Control Panel
14.1	Motor	02 HP Aluminium die cast Hollow shaft Geared Motor 01 Nos.
14.2	Output RPM	71
14.3	Belt Speed	25 Mtr/Min
14.4	Type of Gear Box	Worm



## **8. INDICATIVE ELECTRICAL WORKS:**

### **8.1 Design Requirements**

#### **8.1.1 General**

The contractor shall work as per the drawings and designs described in the Tender document and the best current engineering practice. Particular attention should be paid to internal and external access to the electrical equipment in order to facilitate inspection, cleaning and maintenance. The contractor shall comply with latest code of practice published by the Bureau of Indian Standards as listed in the tender document. Care shall be taken so that materials and equipment supplied by contractor will be the standard catalogued products of manufacturers regularly engaged in the manufacture of such products and will be of the latest standard designs that conform to the specific requirements.

- a) The essence of design shall be safety, simplicity and reliability in order to give long continuous service with high economy and low maintenance cost. Particular attention should be paid to internal and external access to the electrical equipment in order to facilitate inspection, cleaning and maintenance.
- b) All equipment shall be designed to minimize the risk of fire and any damage which may be caused in the event of fire.
- c) The design shall comply with relevant codes and regulations listed.
- d) All apparatus, equipment and works shall be so designed that they provide satisfactory service and without any harmful effects for prolonged and continuous periods in the worst climatic conditions, stated hereinbefore.
- e) The reference design ambient temperature for all electrical equipment shall be taken as 50°C and appropriate derating factors shall be considered for equipment as applicable.
- f) Suitable derating shall be applied based on published data against the most severe conditions encountered in the site, by reducing the permissible temperature rise above the ambient level.

#### **8.1.2 Errors, Omissions and discrepancies**

In case of errors, omissions and discrepancies between technical specification, schedules and drawings the following order shall prevail:

- a) MOM with contractor in reverse chronological order.
- b) Technical specifications
- c) Tender drawings
- d) Schedule of Quantities
- e) Bureau of Indian Standards
- f) International Standards

- g) In all case of doubt or omissions or discrepancies noticed in any item of work any drawing, the decision of the Engineer-in-Charge shall be final and binding on the contractor.

### 8.1.3 Other Technical Requirements

The contractor shall arrange all the instruments, materials and labour involved in setting out the works to the satisfaction of the Engineer-in-Charge.

### 8.1.4 Power System Description

Above mentioned System Arrangement is shown in “**Power Single Line Diagram**”, **Drawing No.**

The voltage for the different systems shall be as under:

Voltage	:	11 KV $\pm$ 10%, 415V $\pm$ 10%
Phase	:	11KV - 3 PH 3 Wires 415V – 3 PH 4Wires
Frequency	:	50 Hz $\pm$ 5%
Combined Voltage & Frequency Variation	:	10%
Fault level	:	26.3 KA for 3 seconds at 33KV & 11kV 50 KA for 1 seconds at 415V
System Earthing:		
33kV & 11kV	:	Resistance Earthing
415 V	:	Solidly Earthed
Circuit Breaker Protection & Tripping Control System	:	110 V DC, 2 Wire, grounded

### 8.1.5 System Battery Limits

All items within the system boundary limits specified under the scope of this tender shall be included. Full support to the other contractors of the project both in the form of drawings and guidance shall also be in the scope.

- Battery limit for electrical starts from 11kV Cable termination at existing 11kV Panels at existing 66kV/11kV Substation.
- Battery limit for Automation starts from existing PLC/SCADA terminal (hook up). This will include modification (hardware and software) in existing Automation system, if any.

- Vendor shall draw 11KV HT supply by laying two (2) nos of HT cables from existing 66KV switch yard substation with necessary modification by using separate route up to proposed new substation near Berth-14. Vendor shall consider cleaning of existing trench and crossing, construction, modification, repair of existing cable trench and crossing for laying of new cables as per site condition and instruction of Employer Site In-charge.

### 8.1.6 Standards and Regulations

The design and manufacture of the electrical equipment shall conform as a minimum to applicable codes, regulations and standards published by the following bodies:

BIS	:	Bureau of Indian Standards
IER	:	Indian Electricity Rules
BSI	:	British Standard Institution
ISO	:	International Organization for Standardization
IEC	:	International Electro-Technical Commission
IEEE	:	Institute of Electrical & Electronics Engineers
NFPA	:	National Fire Protection Association
NEC	:	National Electrical Code

Following is the list of some of the directly applicable Standards particular to the equipment. Any other relevant Indian Standard, not covered shall also be applicable.

IS: 375	Marking and arrangement of Switchgear Bus
IS: 13118	Specification for high voltage alternating current circuit breaker
IS: 12729	Switchgear and Control gear for voltages exceeding 1000V - General Requirements
IS: 2705	Current transformers
IS: 3156	Voltage Transformers
IS: 335	New Insulating oils
IS: 2026	Power transformers
IS: 3639	Fittings and accessories for Power transformers
IS: 4257	Dimensions of clamping arrangement for porcelain transformer bushings
IS: 11171	Specification for Dry-Type Power transformer
IS: 10028	Code of Practice for selection, installation and maintenance of transformer

IS: 3427	A.C. Metal enclosed switchgear and control gear for rated voltages above 1kV and upto and including 52kV
IS: 8623	Specification for low voltage switchgear and control gear assemblies of switchgear & control gear for voltages not exceeding 1000V AC.
IS: 13703	Low Voltage fuses
IS: 13947	Low Voltage switchgear and control gear
IS: 1651	Stationary cells and batteries, Lead Acid Type (with tubular positive plates) – Specification
IS: 266	Specification for Sulphuric acid
IS: 3895	Mono crystalline Semi-conductor rectifier cells and stacks
IS: 4540	Mono –crystalline Semi-conductor rectifier assemblies and equipment
IEEE:484	Recommended Design for Installation design and installation of large lead storage batteries for generating stations and substations.
IEEE:485	Sizing large lead storage batteries for generating stations and substations.
IS: 1554	PVC insulated (heavy duty) electric cables for working voltages up to and including 1100 volts.
IS: 7098 -I	Cross linked polyethylene insulated PVC sheathed cables for working voltages up to and including 1100 volts.
IS: 7098 -II	Cross linked polyethylene insulated PVC sheathed cables for working voltages from 3.3 kV up to and including 33 kV.
IS: 10810	Methods of tests for cables.
IS: 418	Tungsten filament general service electric lamps
IS: 1777	Industrial luminaire with metal reflectors.
IS: 1947	Flood Lights
IS: 10322	Luminaires for street lighting.
IS: 1944	Code of practice for design of Street lighting
IS: 2206	Flame proof electric lighting fittings
IS: 2215	Starters for fluorescent lamps.

IS: 2418	Tubular fluorescent lamps for general lighting services
IS: 4013	Dust-light electric lighting fittings
IS: 8224	Specification for Electric Lighting fittings for Division 2 areas
IS: 9583	Emergency lighting units
IS: 9900	High-pressure mercury vapour lamps
IS: 9974	High Pressure sodium vapour lamps
IS: 2713	Specification for Tubular Steel Poles for Overhead Power Lines
IS: 1255	Code of practice for installation and maintenance of power cables up to and including 33 kV rating.
IS: 732	Electrical wiring installation (system voltage not exceeding 1100 V).
IS: 2309	Code of practice for the protection of building and allied structures against lightning.
IS: 3043	Code of practice for earthing.
IS:15885 (Part2/Sec13)	2012 Safety of Lamp Control Gear, Part 2 Particular Requirements Section 13 d.c. or a.c., Supplied Electronic Controlgear for LED Modules
IS:16101: 2012	General Lighting - LEDs and LED modules – Terms and Definitions
IS:16102 (Part 1) : 2012	Self- Ballasted LED Lamps for General Lighting Services Part 1 Safety Requirements
IS:16102 (Part 2) : 2012	Self- Ballasted LED Lamps for General Lighting Services Part 2 Performance Requirements
IS:16103 (Part 1) : 2012	Led Modules for General Lighting Part 1 Safety Requirements
IS:16103 (Part 2) : 2012	Led Modules for General Lighting Part 2 Performance Requirements
IS:16104: 2012	D.C. or A.C. Supplied Electronic Control Gear for LED Modules - Performance Requirements
IS:16105:	Method of Measurement of Lumen Maintenance of Solid State Light (LED)

2012	Sources
IS:16106: 2012	Method of Electrical and Photometric Measurements of Solid-State Lighting (LED) Products
IS:16107 (Part 1) : 2012	Luminaires Performance Part 1 General Requirements
IS:16107-1: 2012	Luminaires Performance Part 2 Particular Requirements Section 1 LED Luminaire
IS:16108: 2012	Photo biological Safety of Lamps and Lamp Systems
IS:60470-2000	High-Voltage Alternating Current Contactors

In addition to Codes and standards, the installation works shall also conform to the requirements of following:

- a) Indian Electricity Act and Rules
- b) Fire insurance regulations
- c) Regulations laid down by Chief Electrical Inspector of Gujarat.
- d) Regulations laid down by the Factory Inspector
- e) Regulations for the electrical equipment of Tariff Advisory committee
- f) Any other regulations laid down by the authority
- g) Regulation of Pollution Control Board of Gujarat.

#### 8.1.6.1 Standardization

Care shall be taken so that the materials and equipment are standard catalogued products of manufacturers regularly engaged in manufacture of such products and shall be of the latest standard designs conforming to specification requirements. Design shall also be based on similar types of electrical equipment supplied from one manufacturer, utilizing interchangeable parts wherever practicable. Materials and equipment incorporated shall be of a type for which spare parts and replacements are readily available in India.

## 8.2 Equipment Indicative Technical Specification

### 8.2.1 HT Switchgear (GIS Type)

#### 8.2.1.1 Introduction

This specification covers the requirements of 11kV Extension Panel complete with all accessories.

### 8.2.1.2 General Requirements

The switchgear shall comprise of feeder(s) as per the Single Line Diagram M-010. Continuous current rating of the Switchgear shall be based on the name plate rating of the connected equipment with 20% margin, rounded off to the next higher standard rating. 11kV HT Switchgear shall be rated for short circuit withstands capacity of 26.3 kA for 3 seconds.

Bus bars, breakers and other components shall be designed for continuous operation at rated current considering temperature inside the cubicle. The inside cubicle temperature shall be considered as design ambient temperature of 50°C for maximum continuous operation rating of the equipment. For breaker control, 110 V DC supply shall be considered.

Each breaker module shall be provided with multifunction numerical relay for protection with RS 485 port for communication. Switchgear shall be provided with separate earthing trucks for cable earthing and bus earthing. The earthing truck shall be so designed that it is impossible to earth a live. It shall be provided with capacitive voltage divider and complete with audio visual annunciation.

### 8.2.1.3 Switchgear Construction

The switchgear shall be indoor, single front, single tier, metal-clad, floor mounted roll on floor type, fully draw-out with VCB breaker. Design and construction shall be such as to allow extension at either end.

Switchgear cubicle shall be so sized as to permit closing of the front access door when the breaker is pulled out to Test position. The working zone shall be restricted within 750 mm to 1800 mm as from floor level.

Circuit breakers, instrument transformers, bus-bars, cable compartment, auxiliary control devices etc., shall be housed in separate compartments within the cubicle complying with loss of continuity LSC2B classification as per IEC 62271-200. The design shall be such that failure of one equipment shall not affect the adjacent units.

The circuit breaker and bus voltage transformers shall be mounted on withdrawable trucks. . All the HV compartment design i.e. Busbar compartment, VCB compartment and Cable compartment should ensure conformity to IEC 62271-200 and must be type tested individually for Internal Arc Test for AFLR 26.3 KA for 1 second for 11 KV Panel.

All relays, meters, switches and lamps shall be flush mounted on the respective cubicle door or on a control cabinet built on the front of the cubicle. Panel supplier should be the manufacturer of Vacuum Interrupter, relay and meter.

The trucks shall have distinct 'Service', 'Test' and 'Isolated' positions. The switchgear assembly shall be designed to achieve IP 4X degree of protection, with the truck in any position 'Service', 'Test' and 'Isolated' and all doors and covers closed. Relaying and Metering compartment shall also have degree of protection IP4X.

Enclosure shall be sheet steel construction Aluzinc not less than 2.5 mm for load bearing and 2 mm for non-load bearing. The switchgear shall be cooled by natural airflow. Forced cooling shall not be accepted. The Breaker and the auxiliary compartments provided on the front side shall have strong hinged doors. Breaker compartment doors shall have locking facility.

#### 8.2.1.4 Bus and Bus Taps

The main buses and connections shall be of high conductivity Aluminium, sized for specified current ratings with maximum temperature shall be as per IEC 60694. The bus bars shall be designed for a short circuit rating of 26.3 KA for 3 sec for 11 KV panel. Voltage level shall be 11 KV for all and fault level shall be of 26.3 KA for 3 Sec.

All bus connections shall be silver plated. Adequate contact pressure shall be ensured by means of two bolts connection with plain and spring washers and lock nuts. Bimetallic connectors shall be furnished for connections between dissimilar metals.

Busbar insulators shall be epoxy cast resin type designed to withstand stresses due to maximum short circuit current.

Busbars and connection shall be fully insulated for working voltage with adequate phase/ground clearances. Insulating sleeves for busbars and cast-resin shrouds for joints shall be provided. Cross section of the main horizontal busbar shall be uniform throughout the switchboard and continuous in one transport unit. All buses and connection shall be supported and braced to withstand stresses due to maximum short circuit current and also to take care of any thermal expansion.

Busbars shall be colour coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear, when viewed from front of the switchgear assembly. The busbar chamber shall be provided with inter panel barrier with epoxy case seal-off bushings which the buses shall pass through so as to prevent fire from one panel to another.

#### 8.2.1.5 Circuit Breaker

Circuit breaker shall be triple pole, single throw Vacuum Circuit breaker. It shall be restrike free, trip free type. Breakers shall be suitable for switching transformers at any load. Rate of operating duty shall be O-0.3sec-CO-3min-CO. Short circuit withstand/interrupting capacity shall be 26.3 kA for 3 sec for 11KV.

Circuit breakers shall be draw-out type, having SERVICE, TEST and DISCONNECTED positions with mechanical positive indication for each position. Operating mechanism shall be stored energy type.

Protection must be taken from protection core 3P and metering core shall be only use in measurement.

Circuit breakers of identical rating shall be physically and electrically interchangeable.

Each breaker feeder shall be provided with the following:

- An anti-pumping relay.
- Motor charged spring operating mechanism.
- Manual spring charging
- Mechanical indication of spring charge
- Mechanical position indicator (to show whether the breaker / contactor is 'ON' or 'OFF' in the service, test and disconnected positions)



- Closing coil (100% continuous rated)
- Shunt trip (100% continuous rated)
- Manual trip pushbutton
- Operation counter,
- Locking facility to prevent breaker/contactors from being closed when it is open.
- Pressure relief device
- Safety shutters for power contacts
- Interpole insulators

For motor wound mechanism, spring charging shall take place automatically after each breaker closing operation. One open-close-open operation of the circuit breaker shall be possible after failure of power supply to the motor.

Robust fail-safe mechanical and electrical interlocks shall be provided to prevent the following situations:

- Move the breaker unit from the service or disconnected position while the unit is closed.
- Move the breaker from the disconnected position to the service position while the earthing switch is closed.
- Close the earthing switch when the breaker unit is in service position or between the service and disconnected position.
- The operation of the circuit breaker while the truck is not properly installed in the service, test or disconnected position.

The closing coil and spring charging motor shall operate satisfactorily at all values of control supply voltage between 80 and 110 percent of the rated voltage. The shunt trip coil shall operate satisfactorily at all values of control supply voltage between 70 and 110 percent of the rated voltage.

For breakers spring charging motor shall be provided with overcurrent protection. Motor windings shall be provided with class B insulation or better.

Circuit breaker shall not produce any harmful over-voltage during switching off induction motors. Surge protective devices to limit over voltage shall be included in the scope of supply for all motor feeders.

#### 8.2.1.6 Current Transformer

The CTs shall be mounted on the switchgear stationary parts. CT secondary current shall be 1A. For metering separate core shall be provided. Core balance CT shall be provided for all the outgoing feeders. Accuracy class of the current transformer shall be:-

- a) Class PS/ 5P20 for differential relaying and REF protection (Based on type of relay)
- b) Class 5P20 for other relaying
- c) Class 0.5 and ISF < 5 for metering

**d) Class 0.2S for Energy Accounting & Audit meters**

For metering separate core shall be provided. Core balance CT and associated relay combination shall be such as to ensure a pick up sensitivity of 10A primary ground fault current for all the outgoing feeders.

Facilities for easy shorting and grounding the terminals shall be provided at the terminal block. All terminal blocks shall be of stud type with marking strip.

**8.2.1.7 Voltage Transformer**

Voltage Transformer shall be cast-resin, draw-out type and shall have an accuracy class of 0.5. Voltage Transformer mounted on breaker carriage is not acceptable in case of BUS PT. Rated secondary voltage shall be 110V centre-tapped. Accuracy class for metering core shall be 0.5, protection core shall be 3P and 0.2 for energy accounting & audit meters. High voltage windings of voltage transformer shall be protected by current limiting fuses. Fuse failure relay shall be provided on the secondary side of all voltage transformers to monitor failure of fuses. The following over voltage factor shall be considered for PT.

- 120% for continuous duty.
- 150% for 30 sec ( for 415V solidly grounded system )

High voltage windings of voltage transformer shall be protected by current limiting fuses. The voltage transformer and fuses shall be completely disconnected and visibly grounded in fully draw-out position.

Low voltage MCB's, sized to prevent overload, shall be installed in all ungrounded secondary leads. MCB's shall be suitably provided with auxiliary contacts.

MCB's auxiliary contacts connected suitably through relay shall be provided on the secondary side of all voltage transformers to monitor failure or trip of MCB's. The relay shall initiate alarm and block the tripping etc. which shall operate in case of VT MCB trip or failure.

**8.2.1.8 Relays**

Numerical multifunction relays shall be provided for all feeders. Numerical relay shall have trip circuit supervision.

All protective relays shall be of modular design, suitable for flush mounting and fitted with dust tight covers. All relays shall have built-in testing facilities. Small auxiliary relays may be of non-draw-out type and mounted within the cubicle. Relays shall have lock-out facility with manual reset. Each feeder shall be complete with necessary auxiliary relays, timers, etc., to meet the circuit requirement.

Under voltage relays shall be provided in the bus PT circuit.

Relays shall be rated for operation on 110V VT secondary voltage and 1A CT secondary current. The switchgear shall be provided with DC fail relay and DC fail indication lamp for each DC control supply incoming. DC isolation switch for each feeder shall be provided with backup HRC fuse.

Breaker auxiliary contacts used for interlocking purposes shall be multiplied using electrically latched relay.

Relay shall be considered as ABB (REF 615 RET 615), Siemens (7SJ80, 7SJ81).

Outgoing transformer feeders shall have the following minimum protection relays.

- Numerical protection relay having Instantaneous Over Current protection (50) on all the three phases, IDMT Over Current protection (51) on all the three phases, Instantaneous earth fault protection (50 N).
- Instantaneous ground fault protection through CBCT (50 G).
- Latched Lock out relay (86).
- Trip circuit supervision relay (95)
- Gas operated relay (63)
- Thermal overload relay (49)
- REF protection (64R) relay (For 16MVA)

Self-reset auxiliary relays with hand reset flag indicator shall be provided for contact multiplication of the following:

- Transformer winding temperature indicator alarm and trip contacts.

Incomers and Tie feeders shall have the minimum following protection relays.

- Numerical protection relay having Instantaneous Overcurrent protection (50) on all the three phases, IDMT Over Current protection (51) on all the three phases, Instantaneous earth fault protection (50 N).
- Latched Lock out relay (86).
- Trip circuit supervision relay (95)

Bus PT shall have the following protections.

- Under voltage relay
- Overvoltage relay
- MCB trip

#### 8.2.1.9 Control Switches

Circuit breaker control switches shall be 3-position spring return to 'neutral' from both close and trip positions. They shall have 'Pistol Grip' handle.

The contacts shall be of silver plated, air break type. The continuous current and breaking capacity of the contacts shall be adequate for the duty involved.

#### 8.2.1.10 Indicating lamps

Indicating lamps shall be of the panel mounting, LED type. The lamps shall have escutcheon plates marked with its function, wherever necessary. Lamps shall have translucent lamp covers of the following colors, as warranted by the application. Bulbs and lamp covers shall be easily replaceable from the front of the cubicles. Low Voltage Glow Prevention (LVGP)

feature shall be provided for indicating lamps. The colour of indication lamps shall be as follows:

- GREEN : Breaker Open
- RED : Breaker Closed
- AMBER : Auto trip & all Alarm conditions
- BLUE : Spring Charged
- WHITE : For all healthy conditions (e.g. Trip coil healthy & Control supply healthy).

For each breaker feeder, Panel indication lamps shall be provided as follows:

- Breaker Open
- Breaker Closed
- Auto trip
- Motor Spring Charged
- Trip coil healthy
- Control supply healthy
- Breaker in service position
- Breaker in Test position
- Lockout relay healthy
- Any other indication, as required

For incomer & Bus, indicating lamps for R, Y, B phase shall be provided.

#### 8.2.1.11 Meters

All Indicating meters shall be digital type, 96 x 96 mm size, suitable for flush mounting with constant accuracy for the entire range of respective parameters with an inbuilt provision for calibration verification. The instruments shall have an accuracy class of 1.0. All Multifunction meters shall have digital display and communication port with true RMS measurement facility with minimum 1% accuracy level. All digital meters shall be with RS485 communication port.

For incomers following Meters and transducers shall be provided:

- Ammeter
- Voltmeter
- Multifunction meter with digital display and communication port for kW, kVAR, kWh and power factor measurement.

For outgoing transformer feeders following Meters and transducers shall be provided:

- Ammeter
- Multifunction meter with digital display and communication port for kW, kVAR, kWh measurement.

#### 8.2.1.12 Secondary wiring

The Switchgear shall be fully wired at the factory to ensure proper functioning of control, protection, transfer and inter locking schemes. Fuse and links shall be provided to permit individual circuit isolation from bus wires without disturbing other circuits. All spare contacts of relays, switches and other devices shall be wired up to terminal blocks.

Wiring shall be done with flexible, 1100V grade, PVC insulated switchboard wires with stranded copper conductors of 2.5mm<sup>2</sup> for current circuits and 1.5 mm<sup>2</sup> for voltage circuits. Each wire shall be identified, at both ends, with permanent markers bearing wire numbers as per Contractor's wiring Diagrams.

Wire termination shall be made with crimping type connectors with insulating sleeves. Wires shall not be spliced between terminals. All external cable terminations shall be accessible while the breaker is in service position

#### 8.2.1.13 Terminal Blocks

Terminal blocks shall be 1100V grade box-clamp type with marking strips. CT shorting links, Drop link type terminals shall be provided for CT secondary leads. Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished. Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.

#### 8.2.1.14 Cable Termination

Switchgear shall be designed for cable entry from the bottom. Sufficient space shall be provided for ease of termination and connection. All provision and accessories shall be furnished for termination and connection of cables, including removable gland plates, cables supports, and crimp type tinned copper lugs, brass compression glands with tapered washer and terminal blocks.

#### 8.2.1.15 Name plates

Name plates of approved design shall be furnished at each cubicle and at each instruments & device mounted on or inside the cubicle. The material shall be lamicoid or approved equal, 3 mm thick with white letter on black background. The material shall be held by self-tapping screws. Nameplate size shall be minimum 20 X 75 mm for instrument device and 40 X 150 mm for panels. Caution notice on suitable metal plate shall be affixed at the back of each vertical panel.

#### 8.2.1.16 Space heaters and plug sockets

Each cubicle shall be provided with thermostat controlled space heaters and cubicle lamp with door switch suitable for operation from 240 V, single phase AC supply and 5A, 3 pin plug socket. The space heater shall be located at the bottom of each switchgear compartment. Cubicle heater, Motor heater, Plug/socket circuits shall have individual MCB units. In addition, motor feeder cubicle shall be wired-up for feeding the motor space heater through suitable rated breaker auxiliary NC Contact and/or contactor.

#### 8.2.1.17 Testing and Inspection

Switchgear and all its components should have been type tested and proven type. Type test certificates shall be furnished for Purchaser's review. Switchgear and its components shall be subjected to routine tests as per applicable Indian Standard. In addition, any special tests required shall also be performed. Test reports shall be submitted for approval.

#### 8.2.1.18 Tests

The design of circuit breaker shall be proven through all the routine and type tests in accordance with IS IEC 62271-200 and any amendment thereof. Photocopy of all the test reports must be enclosed with the tender. Type test report earlier than 5 years from the date of tender opening shall not be acceptable.

The Bidder shall submit the type test reports of following type tests for approval of the Purchaser

- a) Short circuit duty test on circuit breaker, mounted inside the panel offered.
- b) Short time withstand test – on circuit breaker, mount inside panel offered.
- c) Power frequency withstand test on breaker and panel.
- d) Lightning impulse withstand test on breaker and panel.
- e) Temperature rise test on breaker and panel together.
- f) Measurement of resistance of main circuit.
- g) Mechanical endurance test on breaker.
- h) Mechanical operation test.
- i) Internal arc current (IAC) test on individual compartments i.e. Busbar, VCB and cable compartment.

#### 8.2.1.19 Spares List

Suitable number of commissioning and successful running for 2 years spares list shall be submitted for approval.

#### 8.2.1.20 Indicative System Parameters

1	Nominal System voltage	11 KV
2	Highest System voltage	12 KV
3	Rated Frequency	50Hz
4	Number of phases/ poles	Three
5	System neutral earthing (As per requirement)	As per Vector Group of Transformers
6	One minute power frequency withstand voltage	28
7	1.2/50 microsecond Impulse withstand Voltage	75 kV (peak)

8	Short time rating for bus bars, CB, CT and switchgear Assembly.	26.3 kA (rms)
9	Dynamic withstand rating	62.5 kA (peak)
10	IAC Rating	-----
11	Control supply voltage:	110VDC
11.1	Trip and closing coils	supply
11.2	Spring charging motor	AC supply
12	Maximum ambient air temperature	40 deg. C
13	Degree of Protection	IP65
13.1	HV-live parts (for SF6 Vessel)	_____
13.2	For balance of SF6 enclosed Vessel	_____

**a) Circuit Breaker:**

1	Rated Voltage	11 KV
2	CB rated Current	
A	Incomer Breaker	1250 A
B	Outgoing feeder Breaker	630 A
3	Short circuit breaker Current:	
A	A.C. component	
B	D.C. component	As per IS:13118 or IEC62271
4	Short Circuit making Current	62.5 kA (peak)
5	Out of phase breaking Current capacity	As per IEC

6	Rated line/cable charging Interrupting current at 90° Leading power factor Angle	As per IEC
<b>Note:</b> Given details of CB, SW, Breaker voltage indicative. Some change be further finalized during the detailed engineering. Vendor shall submit the technical particular specific documents for approval.		
8	Rated small inductive current Switching capability with over Voltage less than 2.3 Pu	As per IEC
9	First pole to clear factor	1.5
10	Operating Duty	O-0.3 Sec-CO-3 Min-CO
11	Total break time	less than 5 cycles
12	Total make time	Less than 4 Cycles
13	Reclosing	3 phase auto Reclosing
14	Max. difference in the instants of closing/opening contact between poles at rated control Voltage and rated operating and quenching media pressures	As per IEC
15	Auxiliary contacts	8NO+6NC for future use besides scheme requirement
16	Operating Mechanism	Motor wound Spring charged stored energy type as per IEC-62271

**b) Current Transformer (Incomer and Bus coupler Feeder):**

1	Rated primary voltage	11KV
2	Rated primary current	1000/1A
3	Type of CT	1-Phase
4	Max temp rise	As per IEC:60044-1



5	Class of Insulation	Class E or better
6	One minute power frequency withstand voltage between secondary terminal & Earth	3 kV
<b>Note:</b> Given details of CT, PT, Breaker are indicative. Same shall be further finalized during the detail engineering. Vendor shall submit the technical particular specific documents for approval.		

**c) Current Transformer (Line Feeder/ trafo feeder):**

1	Rated primary voltage	11KV
2	Rated primary current	200/1A
3	Max temp rise	As per IEC:60044-1
4	Class of Insulation	Class E or better
5	One minute power frequency withstand voltage between secondary terminal & Earth	3 kV
6	No. of Secondary cores	2 Nos

**Note:** Given details of CT, PT, Breaker are indicative. Same shall be further finalized during the detail engineering. Vendor shall submit the technical particular specific documents for approval.

**d) Voltage Transformers:**

1	Rated primary voltage	11KV
2	Type	1-phase
3	Voltage ratio (kV)	$(11/\sqrt{3})/(0.11/\sqrt{3})$
4	Rated voltage factor	1.2 continuous and 1.5 for 30 seconds
5	Nos. of Secondary cores	2
6	Accuracy of Secondary core	1
7	Class of insulation	Class E or better
8	Rated output burden	50VA or cater to

	(Minimum) or to cater all Connected burdens of meters & relays.	connected load as per clause no 11.4
--	--	--

**e) Bus-Bar Rating:**

1	Current rating of Bus bars	1250 A
2	Current rating of Bus Coupler	1250 A

**8.2.1.21 Input Signal to System (IfRequired):**

The following digital input of 11kV Indoor switchgear bays shall be provided through IEDs in the SCADA system:

- a) All status of CB, Isolator, Earth switch
- b) CB trouble
- c) CB operation/closing lockout
- d) Trip circuit faulty
- e) Bus VT FUSE Fail
- f) Back-up over current & earth fault protection Operated
- g) DC source fail

Above detail is indicative only, vendor shall submit the further detailing during engineering and submit for approval. Control On / Off function shall also be provided in SCADA with all the interlocks of field.

**8.2.1.22 Multifunction Meter**

The Multifunction meter shall have feature to measure KV, I, KWh, Kvar, PF, Kwhr, Kvarh with accuracy class of 0.5. Further, multifunction meter shall have bi-directional feature to register/record Kwhr values. RS 232 or RS 485 port.

**8.2.1.23 Tests:**

**a) Type Tests**

The contractor shall submit the reports for the following type tests on the equipment to be supplied under the contract:

**b) Switchgear Panel (with Circuit Breaker installed)**

- Short circuit duty test
  - Short time and peak withstand current test
  - Power frequency withstand test
  - Lightning impulse withstand test
  - Temperature rise test
  - Internal Arc Test as per IEC 62271-200 (for 1 second)
  - Measurement of resistance of main circuit
  - Test to verify pressure relief operation of the panel **(During internal arc test)**
  - Cable charging test
  - Short circuit withstand test of earthing device
  - Degree of protection test as per IEC
- c) Seismic Test Circuit Breaker
- Mechanical Endurance Test
- d) Routine Tests

All acceptance and routine tests as per the specification and relevant standards IEC 62271-200 & IEC 62271-100 shall be carried out. Charges for these shall be deemed to be included in the equipment price.

## 8.2.2 Transformers

### 8.2.2.1 Dry Type Transformers

This specification covers the requirements of 11/0.433 KV distribution dry type transformers complete with all accessories. The Cast resin dry type transformers shall be capable of operating continuously at its rated output without exceeding the temperature limits specified.

The transformers shall be suitable for connection to the system having short circuit level and short circuit duration as specified. The transformers shall be capable of withstanding without injury, the thermal & magnetic stresses caused by faults on any of the winding /through faults. Calculation shall be submitted along with the offer to prove that thermal as well as mechanical withstand capacity of the transformer is as per Indian Standards in the event of short circuit to the specified duration. Transformers shall be designed to withstand the thermal and dynamic stresses due to Short circuit at the terminals for 5 seconds duration with respect to fault level specified.

The impedance of the transformer shall not be less than as stated in Indian Standard at a reference temperature of 75°C.

The transformers shall be capable of delivering the rated output at any particular tap without exceeding the specified temperature limits under the following operating conditions.

- Voltage variation of  $\pm 10\%$  of rated voltage of that particular tap.

- Frequency variation of +3% to -5% of rated frequency.
- Combined voltage and frequency variation of 10% (absolute sum).

The transformers shall be free from annoying hum and vibration when it is in operation, even at 110% rated voltage. The noise level at rated voltage and frequency shall be as per NEMA-TR1 standard.

The transformers shall be suitable for over-fluxing (due to combined effect of voltage & frequency) up to 10% on any tapping without injurious heating at full load condition. The maximum flux density in any part of core and yoke under such condition shall not exceed 1.9 Tesla.

Generally, the Transformer shall have total efficiency not less than 98% at full load condition. Transformer shall be fitted with diagram and rating plates. The diagram plates shall show the winding connections and tapings in tabulated form.

Salient parameters of the transformers are as follows:

Nominal system voltage (HV / LV)	:	11/0.433K V
Vector group	:	Dyn11
Temp rise in winding by resistance method:	:	60°C over 45°C ambient
Parallel operation of transformer	:	Yes, only momentary
Short circuit withstand duration	:	2 seconds
11kV System fault level	:	26.3kA for 3 sec
415V System fault level	:	50kA for 1 sec

#### 8.2.2.2 Windings

Transformers shall be connected as specified in design requirements. Winding shall comprise of high conductivity copper conductors completely impregnated and cast under vacuum in epoxy resin, fully insulated (with glass fibre reinforced epoxy insulation of very good electrical and mechanical quality), and shall be suitable for the highest system voltage. Winding shall be concentrically wound on the core, and shall be braced to withstand shocks, which may occur through rough handling during transport, switching and other transient condition during service, and also to reduce to a minimum the damage arising from stresses due to an internal fault. All windings shall be subjected to vacuum drying.

#### 8.2.2.3 Core

Cores shall be built from best quality, low loss, cold-rolled, grain oriented electrical steel laminations conforming to relevant Indian Standard. All core sheets shall be to reduce the core loss to a minimum. The flux density in core shall not exceed 1.6 Tesla under over voltage conditions and to this effect calculations shall be submitted. Maximum current density shall not exceed 2.5A per sq.mm. All joints shall be interleaved and the core shall be securely clamped so as to ensure that the noise level and the vibration are maintained at a minimum. All clamps shall be adequately insulated. The complete core shall be coated with special resin as a protection against corrosion.

#### 8.2.2.4 Temperature Indicators

For measuring hot spot temperature in the winding, 150 mm dia dial type winding temperature indicator (WTI) with adjustable potential free alarm and trip contacts, maximum reading pointer and resetting device shall be provided. Temperature sensing element shall be complete with image coil, bushing CT etc. Accuracy class of WTI shall be  $\pm 2^{\circ}\text{C}$  or better.

#### 8.2.2.5 Bushings

All bushings shall be homogenous, non-porous porcelain type, uniformly glazed and free from blisters, burns and other defects complete with suitable terminal connectors of adequate capacity. Bushings located inside cable boxes / bus-duct flanges can be epoxy-moulded types. Bushing CTs shall be provided as per system requirement. Secondary leads of CTs shall be wired upto-marshalling box. The arrangement shall be such that the CT can be removed from the transformer without removing the tank cover. Current transformers shall be cast resin type with Class E or better insulation.

#### 8.2.2.6 Terminal Arrangement

Type of terminal connection shall be by Cables on both HV & LV side. The cable box shall be suitable for the working pressure of cable with which it is associated and shall have adequate clearances for the specified voltage and cable termination kits. For cable termination, terminals of transformer shall be brought out through side wall mounted bushings to a detachable cable box with disconnect link. The cable box shall be self-supporting, weather proof, air filled type complete with all hardware such as undrilled gland plates, etc.

The design of the box shall be such as to preclude the access of water to the box. An adequate space shall be provided within the box so that the cable cores may be formed into the lugs without undue bending or stress on the lugs, and adequate clearance shall be preserved between live metal and frame such that the electrical pressure tests specified in Indian Standard are satisfied. Flexible links shall be provided between transformer terminals and cable lugs. Cable box shall have IP 55 degree of protection.

#### 8.2.2.7 Marshalling Box

Marshalling box shall be sheet steel enclosed with IP 55 degree of protection alarm & trip contacts of all the fittings & accessories and secondary leads of CTs shall be wired up to marshalling box. Cable gland plate shall be of removable type. The marshalling box shall have isolating switch & MCB for incoming power supply. Cubicle illumination lamp with door switch and space heater with thermostat and ON/OFF switch shall be provided. The marshalling box shall have 10% additional set of control terminals.

#### 8.2.2.8 Grounding

Two grounding pads, located on the opposite sides shall be provided for connection of station ground mat / overall earthing for each transformer. Grounding pads shall have clean buffed surface with tapped holes. M10 GI bolts, nuts and spring washers. Two ground terminals each shall be provided on marshalling box & cable box. For neutral connection,

two ground copper conductors of specified size shall be provided, supported on pin insulators (provided on tank) from neutral bushing to the bottom of the tank for connection to station ground.

#### 8.2.2.9 Off Circuit Tap Changer

Off Circuit tap changers shall be provided on HV winding with +/- 10% range of taps in steps of 2.5%. The tap changing shall be affected by an external 3 phase gang operated tap change switch. The operating handle shall be padlocked at any position. The mechanism shall be provided with a mechanical tap position indicator, mechanical stop to prevent over cranking of mechanism etc. A warning plate indicating 'For de-energised operation only' shall be fitted.

#### 8.2.2.10 Wiring and Terminal Blocks

All control cabinets, marshalling boxes, etc. shall be fully wired at the factory to ensure proper functioning of the control, protection and interlock schemes. All spare contacts of switches, relays and other devices shall be wired upto the terminal block.

Wiring shall be done with flexible 1100V grade HR PVC cables with stranded copper conductor of minimum size 2.5 sq.mm. Wiring shall be identified at both ends with ferrules bearing wire numbers as per approved drawings. Wire termination shall be made with crimping type connectors with insulating sleeves. Wires shall not be spliced between terminals.

Terminal blocks shall be of 1100 V grade suitable for terminating required cable size. Terminals for CT secondary shall have provision for shorting. Not more than two wires shall be connected to any terminal. 20% spare terminals shall be provided. All devices and terminal blocks within the panel shall have identification numbers as per schematic diagram.

#### 8.2.2.11 Nameplate

Each transformer shall be provided with a nameplate of weather-resistance material fitted in a visible position showing all the 'information and additional information' as per IS: 1117.

#### 8.2.2.12 Fittings & Accessories (whichever is applicable for Dry type)

Each transformer shall be supplied with the following as a minimum:

- Two nos. Stainless steel Rating & Diagram (Hindi & English), terminal marking and danger plates.
- 3 earth terminals per transformer, each suitable for earth conductors of size 2 numbers 75x10mm GI strip for earthing of the body of the transformer and its enclosure.
- Lifting lugs for complete transformer and Core-coil assembly
- 6 numbers PT100 RTDs with Winding temperature indicator (WTI) display
- 4 nos. Jacking Pads
- 4 nos. Bi-directional Rollers / flanged wheels with stopper arrangement to lock transformer in required position

- 4 nos. Cover lifting eyes
- Marshalling box
- Cable box
- 1 no. off circuit tap changer
- 3 nos. HV Bushings with terminal connectors
- 3 nos. LV Bushings with terminal connectors
- 1 no. LV Neutral Bushings with terminal connectors
- Platform mounting channel
- 1 set LV Neutral Bushing CTs
- 2 nos. Inspection covers
- 2 nos. supports for HV cable box
- 1 Lot Interconnecting cables

#### 8.2.2.13 Testing and Inspection

Transformer and all its fittings should have been type tested and proven type. Type test certificates shall be furnished for Purchaser's review. Transformer and all its fittings shall be subjected to routine tests as per applicable Indian Standard. In addition, a ny spe ci al tes t required shall also be performed. Test reports shall be submitted for approval.

#### 8.2.2.14 Spares List

Suitable number of commissioning and successful running for 2 years spares list shall be submitted for approval.

### 8.2.3 LT Switchgear

#### 8.2.3.1 Introduction

This specification covers the requirements of 415V Power Control Centre complete with al l accessories. The LV main switchboards shall be type tested assemblies (TTA) all type tests as defined in IEC 61439-1&2, built up from compartments housing circuit breakers, Control gear, relays, bus bars, controls and other items of equipment. The design of the switchboard shall be tested design from the main switchgear manufa cturer and manufactured under license agreement with the main switchgear manufacturer.

#### 8.2.3.2 General Requirements

The scope of supply covers design, manufacture, testing and supply, Installations, test ing & commissioning of LV PCC Panels. Panels must conform to Totally Type Tested (TTA) as per IEC 61439. Type Test Certificates for short circuit withstand of 50kA 1 sec along with ACB mounted in the Switchboards is mandatory for submission.

Switchboard shall be suitable for Seismic Zone V as per IEC 60068-3-3. This secti on cove rs the detailed requirements of low voltage switchboard for 415 volts, 3 phase, 50 Hz, 4 wi re system.

Distribution Panels shall be covered under this section. Panels shall be suitable for operation on 3Phase/single phase, 415/240 volts, 50 cycles, 4 wire system with neutral grounded at transformer. All LT Distribution panels shall be design and manufactured by an approved manufacturer. When the switchgear is to be provided as an integrated switchboard/MCC, this specification reference is made to “specified elsewhere or as specified”.

#### 8.2.3.3 Requirement for proposed 1kV LT Panel:

Kindly refer tender SLD for requirement.

#### 8.2.3.4 Codes & Standards:

Switchgear shall be designed, manufactured and tested in accordance with the latest Relevant international Standards and Electricity Rules and Regulations and shall be as per latest applicable sections of the IEC codes. The latest edition shall always be used. Switchgear manufactured in India shall be designed, manufactured and tested in accordance with either IEC codes or standards.

#### 8.2.3.5 Service Conditions

The Switchgear (including the electronic sub-assemblies used in control/ monitoring /measurement circuits in the control compartments, etc) will be installed in a ventilated building. Where it can be demonstrated that:

The switchgear, when derated for an ambient temperature of 45°C will not meet the specified duty, or the design life of the electronic sub-assemblies is significantly reduced at an ambient temperature of 45°C then the requirement for additional cooling or air conditioning shall be clearly stated or the equipment shall be rated to this effect. Switchgear shall have a design life of at least 20 years.

#### 8.2.3.6 Construction

MLTP, Main Distribution Board, Sub Distribution and Meter Boards shall be metal enclosed, indoor, floor mounted free standing type made up of the required vertical section, which when coupled together shall form continuous dead front Distribution Board. Main Distribution Board/Sub Distribution Board shall be dust and damp protected the degree of protection being no less than IP-54 to IEC.

All Panels & Main Distribution Board shall be extensible on both sides by the addition of side section after removal of end covers. Main Distribution Board/Sub Distribution Board shall be fabricated with a framed structure with rolled/folded sheet steel channel section of minimum 2mm thickness, doors and covers shall be of minimum 2mm thick sheet steel. Sheet steel shroud and partitions shall be of exterior of Main Distribution Board/Sub Distribution Board shall be smoothly finished, levelled and free from flaws. The corners to be rounded. Front and rear doors to be fitted with dust excluding neoprene gasket with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be ensured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

Following minimum clearances to be maintained after taking into account connecting bolts, clamps etc.



- Between Phases - 25 mm
- Between Phases and neutral - 19 mm
- Between Phases and earth - 19 mm
- Between neutral and earth - 19 mm

All insulating materials used in the construction of the equipment shall be of non- hygroscopic materials, duly treated to withstand the effect of high humidity, high temperatures, tropical ambient service conditions. Functional units such as fuses / switch fuse unit/ moulded case circuit breakers shall be arranged in multi-tier formation but All ACB panels shall be single tier only. ACB mounted in double tier is not acceptable. The design of the Main Distribution Board/Sub Distribution Board shall be such that each fuse switch/switch fuse units/MCCB shall be fully compartmentalized. Panel height shall not exceed 2300mm including base frame

Insulated barriers shall be provided with a vertical section and between adjacent section to ensure prevention of accidental contact with main busbars and vertical risers during operation, inspection or maintenance of functional units. All doors/covers providing access to live power equipment/circuits shall be provided with tool operated fasteners to prevent unauthorized access. The panel shall be so constructed that the cable alley shall be sufficient enough to accommodate all the outgoing and incoming cables. For each cable, there shall be separate cable gland plate of detachable type at the bottom and/or top of the panel as required. Gland plate shall be as per Panel manufacturer & should be suitable for cable sizes as mentioned in the single line diagram.

Phase separation space shall be provided with adequate space between two feeders, two phases or for two conductors. Bus bar must be insulated with high voltage sleeve.

Panel shall be provided with proper operating knob and with proper opening / closing arrangement. Bolting doors on front shall be avoided. It is to be provided with metal knob. All internal cables shall be used of FRLS only.

#### 8.2.3.7 Metal Treatment and Finishing

All metal work used in the construction of the main Distribution Board/Sub Distribution Board should have undergone a rigorous metal treatment process as follows:

- a) Effective cleaning by hot alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution.
- b) Pickling in dilute Sulphuric acid to remove oxide scales & rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.
- c) A recognized phosphating process to facilitate durable coating of the paint on the metal surfaces and also to prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.
- d) Passivating in de-oxalate solution to retain and augment the effects of phosphating.
- e) Drying with compressed air in a dust free atmosphere.

- f) Primer coating with two coats of a highly corrosion resistant primer, applied wet on wet and stove dried under strictly controlled conditions of temperature and time.
- g) A finishing coat of staving synthetic enamel paint of gray color of approved color / or powder coating.

#### 8.2.3.8 Busbars:

The busbars shall be air insulated and made of high conductivity, high strength Aluminium alloy complying with the requirement of grade of IEC. Busbars shall be colour coded for ready identification of phases. The Busbar sizes shall be determined taking into consideration the continuous rating and fault level of 50 KA (1 sec) without exceeding the final temperature of 105 C under rated current.

The neutral as well as the earth bar should be capable of withstanding the above level. Ridges shall be provided on the SMC supports to prevent tracking between adjacent busbars. Large clearances and creepage distances shall be provided on the busbar system to minimize the possibility of fault. The main phase busbars shall have continuous current rating throughout the length of the panel. The cross section of neutral busbars shall be same as that of the phase busbar for busbars of capacity up to 500 Amp., for higher capacities, the neutral busbar shall not be less than half (50%) the cross section of that of the phase busbars. Connections from the main busbars to functional circuits shall be so arranged and supported to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents. Busbars shall be colour coded with PVC Sleeves.

The Main Distribution Board/Sub Distribution Board shall be designed that the cables are not directly terminated on the terminals of switch fuse/fuse switch etc. but are terminated on cable termination links. Vendor shall submit all following type test report which are less than 5 years old and as per latest & IEC Standards:

- Short Circuit withstand test for main Busbar and 100% neutral Busbar
- Temperature rise test
- IP test
- Seismic test
- Dielectric Test
- Continuity of Protective Circuits
- Clearance & Creepage distance
- No. Of Mechanical Operations

#### 8.2.3.9 Switchboards (TTA Assembly)

The LV main switchboards shall be type tested assemblies (TTA) all type tests as defined in IEC 61439-1 & 2, built up from compartments housing circuit breakers, Control gear, relays, bus bars, controls and other items of equipment. The design of the switchboard shall be tested design from the main switchgear manufacturer and manufactured under license agreement with the main switchgear manufacturer.

The LV main switchboards and the associated equipment, including switchgear, control gear and bus bar assemblies shall be certified for the category of duty specified. The LV Main Switchboard shall be identical in mechanical construction to the LV Switchboard which had been type-tested by an acceptable, accredited and independent testing laboratory for the fault conditions, temperature rise limits. Any manufacturer not having the above will not be considered for supply. The main circuits of the LV main switchboards shall have an insulation voltage of 1000 V AC.

The protective earthing configuration shall be TN-S unless otherwise specified. The design temperature for the equipment provided in the main low voltage switchboards shall be + 50 °C. The relative humidity shall be 75% at a temperature of + 50 °C.

The secure service life of equipment used for switchboards, sub-assemblies and components shall be at least 30 years. Where armoured multicore cables terminate inside the switchboard enclosure, glanding plates or glanding brackets shall be provided for securing the cables to the switchboard. Glanding plates, glanding brackets and extension boxes shall be removable and shall be of adequate size for the particular cables to be terminated. Separate current transformers shall be provided for each protection device and for instrumentation. The switchgear assembly/sub-assemblies or panels shall be termite and rodent proof. The sub-assemblies of similar equipment shall be interchangeable.

The designs of the switchboards should be with switchgear manufacturer, and all the mechanical drawings must be available in the factory beforehand. Switchboards shall have a short circuit level withstand as per Schedule of Quantities and drawings.

The enclosures shall be designed to take care of normal stress as well as abnormal electro-mechanical stress due to short circuit conditions. All covers and doors provided shall offer adequate safety to operating persons and provide ingress protection of IP 54 unless otherwise stated. Ventilating openings and vent outlets, if provided, shall be arranged such that same ingress protection of IP 54 is retained.

Switchboards shall also have test certificate for Seismic withstand upto Zone V. The switchboard along with ACBs and connections should have been type tested design at CPRI/ERDA /Independent international test house for short circuit, temperature rise, protective earth short circuit test and dielectric tests of the ratings required .

For operator safety IP2X (touch proof) protection to be available even after opening the feeder compartment door. The compartmentalization to be achieved by using metal separators, use of PVC sheet / Hylem sheets shall not be allowed.

As specified in the BOQ the switchboard shall be form 4b. For form of separation only metallic covers shall be used. Hylem / PVC sheets shall not be allowed. Manufacturers should submit the Type Test reports atleast 5 years old and One manufacturer will be able to submit the quote with Single Make Switchgear.

### **Switchboard Configuration**

The Switchboard shall be configured with Air Circuit Breakers, MCCB's, MCB's and other equipment as called for in the schedule of quantities.

The MCCBs shall be arranged in single-tier formation whereas the Air Circuit Breakers shall be arranged in Single tier formation only to facilitate operation and maintenance.

The Switchboards shall be of adequate size with a provision of spare space to accommodate possible future additional switch gear.

### **Constructional Features**

The equipment shall be arranged within each compartment such that all normal maintenance can be carried out through hinged access doors or removable covers, and where possible from the front. The switchboard shall have a rated short time withstand current of 50 KA for 1 second and a fault withstand classification of Class 3 for a supply voltage of 415V AC between phases at 50Hz.

Protection against shock in normal service shall be achieved by the provision of barriers or enclosures both vertical and horizontal and between adjacent units to ensure segregation and prevent accidental contact with live parts, or by complete insulation of all live parts. Control cables shall be segregated from primary conductors.

The Switchboards shall be metal clad totally enclosed, floor mounted free standing type of modular extensible design suitable for indoor mounting. Switchboards construction shall employ the principle of compartmentalized and segregation for each circuit.

The LVSBs shall be provided with front and back access and the maximum height shall not exceed 2.60 m. All relays and indicating instruments shall be at least 500 mm and not higher than 1.8 m above floor level. The clearance in front, back and side of all assemblies of switchgear and control gear shall be generally not less than 1.2 metres. The switchgear shall be considered in the fully drawn out condition for this purpose.

Incomer and bus section panels or sections shall be separate and independent and shall not be wired with sections required for feeder. The incomer panel shall be suitable for receiving bus trunking or MV cable of size specified. Switchboards shall be made up of requisite vertical sections, which when coupled together, shall form continuous dead front switchboards.

Switchboard shall be readily extensible on both sides by addition of vertical sections after removal of the end covers. The switchboards shall be designed for use in high ambient temperature and humid tropical conditions as specified. Ease of inspections, cleaning and repairs while maintaining continuity of operation shall be provided in the design.

Metal based neoprene gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust and vermin proof to provide a degree of protection of IP 54 as stipulated in schedule of quantities. The unused openings within the switchboards shall be closed using suitable grommets. Special care to be taken to ensure effective earthing of the frame and doors of the switchboards.

Each vertical section shall be provided with a rear or side cable chamber housing the cable end connections and power/control cable terminations. There should be generous availability space for ease of installation and maintenance with adequate safety for working in one vertical section without coming into contact with any live parts. The design of the switchboard shall allow standard extension chambers if required to accommodate cables. Some switchboards may be required to be installed against the wall, for such applications documented designs shall be available.

Switchboard panels and cubicles shall be fabricated with CRCA Sheet Steel of thickness not less than 2.0 mm and shall be folded and braced as necessary to provide a rigid support for all components. The doors and covers shall be fabricated from CRCA sheet steel of thickness not less than 2 mm. Joints of any kind in sheet metal shall be seam welded and all welding slag ground off and welding pits wiped smooth with plumber metal.

All panels and covers shall be properly fitted and square with the frame. The holes in the panel shall be correctly positioned. Switchboard shall be provided with "Danger Notice Plate" conforming to relevant Indian Standards.

Bus bars shall be made of high conductivity, 99.9% purity, high strength Copper of ETP grade or copper, Oxygen Free, Bus bars shall be of rectangular cross sections, not less than 10mm thickness better suitable for full load current for phase bus bars and full rated current for neutral bus bar or as stipulated in schedule of quantities. Busbar shall be suitable to withstand the stresses of fault level as specified in schedule of quantities.

The LVSBs shall be mounted on a robust base frame made up of steel channels with a minimum height of 100mm. The base frame shall be able to withstand the static and dynamic loads of the LVSBs. The steel channels shall be painted with epoxy polyester paint. Non-magnetic gland plates of not less than 3.2mm thick shall be provided at the top and bottom of the LV main switchboards for the termination of incoming and outgoing power cables or bus-ways.

#### **Switchboard Dimensional Limitations**

The overall height of the switchboard shall be limited to 200 mm for all the Busbar ratings and type of switchboards. Panel should have integral base frame of 75mm, hence total panel height should not be more than 2400mm. The height of the operating handle, push buttons etc shall be restricted between 300 mm and 2000 mm from finished floor level. Other dimensional limits if any are specified separately.

#### **Switchboard Compartmentalization**

For compartmentalized switchboards, separate totally enclosed compartments shall be provided for horizontal busbars, vertical busbars, ACBs, MCCBs, and cable alloys. The main board shall be with Form 4b Construction. Earthed metal or insulated shutters shall be provided between draw out and fixed portion of the switchgear such that no live parts are accessible with equipment drawn out. Degree of protection within compartments shall be at least IP 2X.

Sheet steel hinged lockable doors for each separate compartment shall be provided and duly interlocked with the breaker in "ON" and "OFF" position. For all Circuit Breakers separate and adequate compartments shall be provided for accommodating instruments, indicating lamps, control contactors and control MCB etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, busbars and connections.

For Some MCCB feeders for critical loads like UPS it may be required to have operation only after opening the door, all MCCB shall have pad lockable rotary handle. Each switchgear cubicles shall be fitted with label in front and back identifying the circuit, switchgear type, rating and duty. All operating device shall be located in front of switchgear only. A

horizontal wire way with screwed cover shall be provided at the top to take interconnecting control wiring between vertical sections.

Separate cable compartments running the height of the switchboard in the case of front access boards shall be provided for incoming and outgoing cables. Cable compartments shall be of adequate size for easy termination of all incoming and outgoing cables entering from bottom or top. The construction shall include necessary and adequate and proper support shall be provided in cable compartments to support and clamping the cable in the cable alley / cable chamber.

### **Switchboard Bus Bars**

Busbars and busbar connections shall be constructed in accordance with the requirements of IEC 60439-1&2. The short-time withstand current rating shall be at least 50 kA for 1 second at 415 V.

Busbars shall be of rectangular section hard drawn high conductivity copper adequately rated and supported by non-tracking moulded insulators spaced at suitable intervals. The complete assembly shall be capable of withstanding the maximum mechanical stresses to which it may be subjected to under fault conditions.

Connection shall be made with double split cast brass clamps. Drilling of the Main bars will not be permitted. Busbar, busbar connection and conductors forming part of the equipment of the switchboards shall comply with IEC 61439-1&2 on current carrying capacity and limits of temperature rise.

The main busbars shall be so positioned and arranged that all busbar risers and droppers can be brought onto the main busbars without undue bending. Busbars shall be separated and supported with appropriate clearances in air in addition to the requirement of providing full insulation. Separate insulating covers shall be installed over all bus-bars and incoming bus-bars in accordance with BS EN 60216, IEC 60085 and IEC 60216-1. The insulating covers shall withstand fire or excessive heat caused by internal electrical phenomenon. Busbars shall be coloured black with colour coded for phase identification. The material for phase identification shall be non-colour fading and use of adhesive label shall not be acceptable.

All conductors between the busbars and the switchgear shall be of high conductivity copper bar, having a current rating of not less than that of the frame size of the switchgear to which they are connected. The conductors shall be insulated and colour coded for phase identification.

The busbars shall be extendible from both ends. The maximum temperature of the bus-bars and the bus connections shall not exceed 90 °C. The temperature rise tests shall be carried out at full rating of rated current for all busbars. Type test certificates for temperature rise shall be given for acceptance in the event of order.

Connections: All the incoming / outgoing terminations shall be extended via fully insulated copper connections into a separate termination chamber adjacent to the rear of the switchboard. When busbars are used between switchboards, the internal busbars of the switchboard shall be in fully insulated copper bars of the same size as the switchboard busbars. No linking with cables shall permit in this case.

The bus bar system may comprise of a system of main horizontal bus bars and auxiliary vertical bus bars run in bus bar alloy on either side in which the circuit could be arranged with front access for cable entrances

Auxiliary buses for control power supply, space heater power supply or any other specified service shall be provided. These buses shall be insulated, adequately supported and sized to suit specific requirement. The material for auxiliary supply bus will be insulated electrolytic copper wires.

Clearances between phases should be in line with IEC.

### **Switchboard Interconnection**

All connection and tap offs shall be through adequately sized connectors appropriate for fault level at location. This shall include tap off to feeders and instrument/control transformers.

For unit ratings up to 100 amps, PVC insulated 105 deg C withstand, copper conductor wires of adequate size to carry full load current shall be used. The terminations of such interconnections shall be crimped. Solid connections shall be used for all rating of above 100 amps.

All connections, tapings, clamping, shall be made in an approved manner to ensure minimum contact resistance. All connections shall be firmly bolted and clamp with even tension. Before assembly joint surfaces shall be filed or finished to remove burrs, dents and oxides and silvered to maintain good continuity at all joints. All screws, bolts, washers shall be zinc plated. Only 8.8 grade nuts and bolts shall be used for busbar connections.

### **Draw out Features**

Air Circuit Breakers shall be provided in fully draw-out cubicles, unless otherwise stated. These cubicles shall be such that draw-out is possible without disconnection of the wires and cables. The power and control circuits shall have self-aligning and self-isolating contacts. Mechanical latches shall be integrated in ACB at service, test and isolated position to ensure that Breaker is firmly latched in respective position. It shall not be possible to move the breaker from the position unless latch is manually operated.

### **Instrument Accommodation**

All voltmeter and ammeter and other instruments shall be flush mounted type of size 96 sq. mm conforming to IEC for accuracy. All voltmeter shall be protected with MCB's. Instruments and indicating lamps shall not be mounted on the Circuit Breaker Compartment door for which a separate and adequate compartment shall be provided and the instrumentation shall be accessible for testing and maintenance without danger of accidental contact with live parts of the Switchboard.

For MCCBs, instruments and indicating lamps can be provided on the compartment doors. The current transformers for metering and for protection shall be mounted on the solid copper busbars with proper supports. On all the incomers of switch boards ON/OFF indicators lamps shall be provided suitable for operation on AC 230 volts supply. All 11 amps shall be protected by MCBs.

For Incomer and important outgoing feeders comprehensive digital power meters with LCD Display shall be provided which shall display A, V, Pf, Hz, Kw, KVA, KVAR, Kwh, Kvarh, average and maximum values, demand values, THD on current and Voltages. Also add on modules for communication, programmable contacts, analogue output etc to link to BMS/SCADA system.

### **Wiring**

All wiring for relays and meters shall be with FRLS/ZHFR copper conductor wires. The wiring shall be coded and labelled with approved ferrules for identification. The minimum size of copper conductor control wires shall be 2.5 sq. mm. Runs of wires shall be neatly bundled and suitably supported and clamped. Means shall be provided for easy identification of wires. Identification ferrules shall be used at both end of wires. All control wires meant for external connections are to be brought out on a terminal board. The cables and control wires shall be suitable for withstanding 105 deg C.

### **Space Heaters**

Anti- condensation heaters shall be fitted in each cubicle together with an ON/OFF isolating switch suitable for electrical operation at 230 volts A.C 50 Hz single phase of sufficient capacity to raise the internal ambient temperature by 45 C. The electrical apparatus so protected shall be designed so that the maximum permitted rise in temperature is not exceeded if the heaters are energized while the switchboard is in operation. As a general rule, the heaters shall be placed at the bottom of the cubicle.

### **Ventilation Fans**

The Switchboard shall be provided with panel mounting type ventilation fans in each panel with switchgear rated for 4500 amp and above. The fan shall be interlocked with switchgear operation. The degree of enclosure protection to be maintained even with Fans.

### **Earthing**

Continuous earth bus sized for prospective fault current to be provided with arrangement for connecting to station earth at two points. Hinged doors / frames to be connected to earth through adequately sized flexible braids.

### **Sheet Steel Treatment and Painting**

Sheet steel used in the fabrication of switchboards shall undergo a rigorous cleaning and surface treatment seven tank process comprising of alkaline degreasing, descaling in dilute sulphuric acid and a recognised phosphating process after which a coat of primer paint comparatively with the final paint shall be applied over the treated surface. Final paint coat of oven baked powder coating, of minimum 50-60 micron thickness, of sheet approved by Engineer-in-Charge shall then be provided.

### **Name Plates and Labels**

Suitable engraved white on black name plates and identification labels of metal for all Switchboards and Circuits shall be provided. These shall indicate the feeder number and feeder designation. Nameplate shall carry the name of the original switchgear manufacturer and also the manufacturing franchise partner.

### **Type test reports.**



Total type test assembly (complete type test switchgear as well as enclosure of Switchboard configurations offered shall be CPRI/ERDA/Independent international test house tested for all the tests as per IEC61439-1&2. The material and the spacing of the Bus bar supports should be same as per the type tested assembly. Copies of the test certificates shall be submitted in the event of order.

### **Testing at Works**

Copies of type test carried out at ACB/ MCCB manufacturers works and routine tests carried out at the switchboard fabricators shop shall be furnished along with the delivery of the switchboards. Engineer-in-Charge reserves the right to get the switchboard inspected by their representative at fabricators works prior to dispatch to site to witness the followings.

- Physical variation and dimensional check
- Verification of bill of material
- Functional check
- HV test
- IR test

Before fabrication the contractor will submit a detailed dimensional drawing indicating general layout of ACBs/ Switches/ MCCB's bus-bars, Cable alleys etc. for approval by the engineer in charge. At fabrication stage the panel will be got inspected at the factory also.

Earthing System shall be as per CPWD General Specification for electrical Works (Part-I for internal Works) 2013 and as amended upto date. All the incomer ACB / MCCB and ACBs/ MCCBs as coupler should be interlocked mechanically as well as electrically in a manner as mentioned in the BOQ.

**Auto change over for bus shall be required. In case of failure of any incomer, second incomer shall be ON with immediate effect.**

### **8.2.3.10 Measuring Instruments for Metering:**

#### **Multifunction meter**

##### **a) Applicable Standards**

The meters shall conform in all respects to International standards – IEC 61557-12, IEC 62053-22, IEC 62053-23 or the relevant Indian standards with latest amendments thereof.

##### **b) General Requirements**

- The meter shall be suitable for operation in 3 - phase networks, balanced as well as unbalanced load.
- CT polarity correction should be possible through Energy Meter for each phase.
- Import/ Export measurement for KWH/ KVARH is required.
- It shall be possible to use the multifunction meter directly in 480V networks
- The current inputs shall be configurable at site for measuring x/5 A current transformers

- The multifunction meters shall be suitable for operation upto 55 Deg C
- The meters shall be suitable for operation with AC auxiliary power and shall have wide tolerance band of 100V to 240 V ( $\pm 10\%$ )
- The multifunction meters shall have high degree of protection (IP65 from the front) against ingress of dust & water
- The multifunction meters shall have backlit LCD display with adjustable contrast
- The meter shall be tamper-proof (password protected) to avoid mishandling by unauthorized person

**c) Measured Values requirement**

All metered values will be in "true RMS" values. The monitor shall include a keypad allowing for the viewing of different selected values. The monitor shall display the following values

Voltages	Phase-phase / phase-neutral
Currents	Per phase / neutral
Apparent, active and reactive power	Per phase and total
Power factor	Total
Frequency	45...65 Hz
Min. / max. values	Voltage - phase-phase, phase-neutral/ Current/ Neutral current/ Power/ Power factor/ Frequency
Active energy	Import/ export/ net
Reactive energy	Import/ export/ net
Energy demand per measuring period	Three phase average rating for active and reactive power: 1 to 60 min.
Min. / max. rating values within the measuring period	Should be possible to be measured

**d) Measurement Accuracy**

The multifunction meters shall be of high accuracy type and shall have the following levels of accuracy. (Accuracy class in accordance with IEC 61557-12:2007-08)

- Voltage            Class 1
- Current            Class 1
- Power              Class 1

- Power factor Class 2
  - Active energy Class 1 in accordance with IEC62053-22:2003-01
  - Reactive energy Class 3 in accordance with IEC 62053-23:2003-01
- e) The meter shall have at least 2 Digital Input and 2 Digital Output as standard for the communication of Circuit Breaker's Status.
- f) Communication

The meters shall have inbuilt RS485 MODBUS RTU. It shall be possible to parameterize the device either by the keys on the device or through parameterization software.

#### 8.2.3.11 Miscellaneous

Control switches shall be of the heavy duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting. Indicating lamps shall be of the filament type of low watt consumption, provided with series resistor where necessary, and with translucent lamps covers. Bulbs & lenses shall be easily replaced from the front.

Push buttons shall be of the momentary contact, push to actuate type fitted with self-reset contacts & provided with integral escutcheon plates marked with its functions.

#### 8.2.3.12 Testing and Inspection

Switchgear and all its components should have been type tested and proven type. Type test certificates shall be furnished for Purchaser's review. Switchgear and its components shall be subjected to routine tests as per applicable Indian Standard. In addition, any special tests required shall also be performed. Test reports shall be submitted for approval.

#### 8.2.3.13 SPARES LIST

Suitable number of commissioning and successful running for 2 years spares list shall be submitted for approval.

### 8.2.4 110V DC SYSTEM

#### 8.2.4.1 Introduction

This specification covers the requirements of 110V DC Batteries, Chargers and DC Distribution Board.

#### 8.2.4.2 Design

The function of the 110V DC Power Supply System is to provide the normal source of power to the 110V DC loads, such as Control Supply to Switchgears / Panels.

The 110V DC Power Supply System shall also be capable of constantly supplying emergency loads for a period of 1 hour when AC supply to Charger fails.

The duty cycle imposed on the battery shall include the following.

- Continuous loads (indicating lights, continuously energized coils, Control Panels, Relays)

- Momentary loads (switchgear operation (Trip coil/Closing coil), which exist for a period of less than 1 min period)

The 110 VDC Power Supply System shall be operated as an ungrounded system; that is, the negative terminal or ground reference terminal is not connected to the station ground grid. A DC ground monitoring system on the DC systems shall be provided and any DC ground fault shall be alarmed.

Batteries shall be sized in accordance with IEEE-485. The battery shall be sized with a 10% design margin and an ageing factor of 1.25

110V DC Power Supply System consists of 1X100%, 110V batteries, 1X100% 110V battery chargers and DC Distribution Boards. End Cell Voltage of Lead Acid Plate battery is 1.85 V / Cell and Nickel cadmium battery is 1.14V / Cell

During Normal operating condition, batteries shall be supplied from two (2) 100 percent battery chargers. The chargers are supplied power from PCC/ MCC's. The battery chargers shall supply the 110V DC loads and, at the same time, shall continuously float charge fully charged batteries. Both the chargers shall have dedicated incoming AC supply from MCC/PCC.

During Emergency operation the battery shall supply the DC load when there is a loss of all auxiliary AC power supplies and/or a loss of power from the battery chargers. Batteries shall normally be permanently connected to the load in parallel with a charger and shall supply the load during emergency condition when AC supply is lost.

The Charger shall be float cum boost type Chargers suitable for float charging both the batteries and supply load simultaneously. Chargers shall boost charge fully discharged batteries in 12 hours. Design margin of minimum 20% shall be considered in charger sizing for either mode of operation.

Charger protections such as DC-O/V & U/V, AC U/V, E/F, S/C protection etc. shall be considered.

#### 8.2.4.3 Construction of Battery

Lead Acid (Valve regulated) sealed maintenance free Plate type batteries shall be float charged at 2.15 to 2.20 Volts per cell and chargers shall also be capable of boosting charging the associated DC battery up to 2.7 Volts per cell at the desired rate. Batteries shall be rated for 10 hour discharge rate (C10) as per manufacturer data.

Containers shall be made of suitable glass fibre reinforced plastics or Polypropylene. Containers shall be robust, heat resistance, leak proof, non-absorbent, acid/alkaline resistant, non-bulging type and free from flaws such as wrinkles, cracks, blisters, pin holes etc.

Batteries shall have thick plates designed for maximum durability during all service conditions including high rate of discharge and rapid fluctuations of load. The separators shall maintain the electrical insulation between the plates and shall allow the electrolyte to flow freely. Separators should be suitable for continuous immersion in the electrolyte without distortion. The positive and negative terminals shall be clearly marked.

Each cell shall be separately supported on porcelain insulators fixed on to the racks with adequate clearance between adjacent cells. Breathers/Vent plugs etc. shall be provided for each cell. It shall be anti-splash type and having more than one exit hole to allow the gases to escape freely but prevent the acid spray from the battery.

Lead coated copper inter-cell connectors shall be used for connecting up adjacent cells and rows. Bolts, nuts and washers shall be effectively lead coated to prevent corrosion. All the terminals and cells, interconnections shall be fully insulated or have insulation shrouds/covers.

End take off connections from positive and negative poles of batteries shall be made by single core cables having stranded copper conductors and PVC/XLPE insulation. Necessary supports and lugs for termination of these cables on batteries shall also be supplied. All connectors and lugs shall be capable of continuously carrying the 60 minute discharge current of the respective batteries and through fault short circuit current which the battery can produce and withstand for the period declared. Anti-corrosive gel shall be applied at the Battery terminals.

Wooden racks shall be provided for batteries for multi-tier installation. These racks shall be made of good quality first class seasoned teak wood. They shall be free standing type mounted on porcelain insulators. Numbering tags, resistant to acid for each cell shall be attached on to the necessary racks. The bottom tier of the stand shall not be less than 150 mm above the floor.

The following accessories shall be provided with batteries.

- Syringe type Hydrometer : 2 Nos per Battery
- Thermometer with specific gravity correction scale : 2 Nos per Battery
- Cell testing voltmeter 3-0-3 volts : 2 Nos per Battery
- Acid resistant funnel : 2 Nos per Battery
- Acid resistant jug. : 2 Nos per Battery
- Rubber apron and gloves : 2 sets per Battery
- Spanners : 2 sets per Battery
- Wall mounted teak wood rack for above items : 2 Nos per Battery

The following maintenance spares shall be provided as a minimum

- Inter cell connectors : 10 Nos.
- Inter row connectors : 2 Nos.
- Battery stand insulators : 2 Nos
- Cell insulators : 2 Nos
- Nuts, bolts & washers : 10 pieces each
- Vent plugs : 10 Nos.
- Spare dry cell : 4 Nos.

Fuse box for each battery shall be provided in the battery room and shall comprise the following:

- DP Fuse Switch unit
- HRC Fuses with striker pin & aux contact for remote alarm
- FRP enclosure.

Discharge resistor made of punched stainless steel grid enclosed in sheet steel enclosure shall be provided for discharge testing of Battery.

Battery cell voltage in any discharge condition shall not be less than 1.75 V.

#### 8.2.4.4 Construction of Battery Charger

During float charging, each charger shall feed the respective DC Distribution board and as well as float charge its own batteries and shall maintain a DC voltage that shall pass the minimum current through the cells to keep them charged without overcharging. In case of mains failure to charger or charger failure, battery shall supply the full load. While boost charging of respective battery, DCDB shall be isolated from the Charger and shall be fed from other Charger.

Each Battery charger should meet the Trickle requirement of both banks (under emergency) and boost requirement of each bank. During boost charging, the battery charger shall operate on constant current mode (when automatic regulator is in service). It shall be possible to adjust the boost charging current continuously over a range of 50 to 100 % of the rated output current for boost charging mode. During boost charging the Boost charger shall recharge the completely discharged battery to full capacity in 10 hours.

When on automatic control mode during float charging, the charger output voltage shall remain within  $\pm 1\%$  of the set value for AC input voltage variation of  $\pm 10\%$ , frequency variation of  $\pm 5\%$ , a combined voltage and frequency (absolute sum) variation of 10 % and a continuous DC load variation from zero to full load. Uniform and step less adjustments of voltage setting (in both manual and automatic modes) shall be provided on the front of the charger panel covering the entire float charging output range specified. Battery chargers shall have a selector switch for selecting the battery charging mode i.e. whether float or boost charging.

All battery chargers shall be provided with facilities such as automatic voltage regulator (AVR) for both automatic and manual control of output voltage and current.

The chargers shall be of self-regulating, natural air cooled, static type provided with suitable double wound transformer, full wave thyristor type rectifiers, filter circuits, DC & AC Switchgear. Chargers shall be metal enclosed, fixed type, suitable for indoor mounting on floor. Panel frame shall be fabricated using cold rolled sheet steel of thickness not less than 2.0 mm. The frames shall be enclosed by cold rolled sheet steel of thickness not less than 2.0 mm. Suitable synthetic rubber gaskets shall be provided to achieve a degree of protection of IP54.

Rectifier transformer shall be continuously rated, dry type, class F insulation, epoxy resin impregnated, A.N. cooling and with adequate number of taps. The rating of rectifier transformers shall correspond to the rating of the associated rectifier assembly.

All the charger panels shall be provided with an illuminating CFL lamp, a 5 Amp socket and space heaters with thermostat. Toggle switches and MCB's shall be provided separately for each of the above fittings. Space heaters "ON" indication to be provided. Two separate grounding pads shall be provided. Locking facilities shall be for locking float / boost selector switch in the float position only.

Digital type Window annunciator shall be provided for alarm annunciation with acknowledge, test and reset push buttons and a buzzer for the following conditions.

SCR fuse fail Battery / DC system under voltage

- DC system overvoltage
- DC over load
- Output fuse blown
- AC supply fail
- AC undervoltage
- Battery earthfault
- Filter fuse failure
- Battery on Float / Boost
- Charger fail/Battery on discharge
- Any other annunciation, as required

Remote alarm contacts for hooking up to PLC shall be provided. For each charger, current & voltage transducer shall be provided for remote monitoring of DC voltage and Current at PLC. Protection features, indications, meters and alarms shall be provided for each charger. Protection features shall include the following as minimum.

- Overload Protection
- Phase failure protection
- Voltage unbalance protection
- Fuse failure protections for SCR and filter circuit

Suitable potential free contacts for remote indication of above abnormal conditions shall be provided. However the requirements / design shall be firmed up during the detailed engineering stage.

Vendor shall consider two independent sources of AC supply and change over shall be considered accordingly in panel. Battery charger must have one or two exhaust fan for the air circulations.

#### 8.2.4.5 Testing and Inspection

Battery & Charger and all its components should have been type tested and proven type. Type test certificates shall be furnished for Purchaser's review. Battery & Chargers shall be subjected to routine tests as per applicable Indian Standard. In addition, any special tests required shall also be performed. Test reports shall be submitted for approval.

#### 8.2.4.6 Spares List

Suitable number of commissioning and successful running for 2 years spares list shall be submitted for approval.

### 8.2.5 Power, Control and Data Cables

#### 8.2.5.1 Introduction

This specification covers the requirements Power & Control cables.

#### 8.2.5.2 Design

Power cables shall be sized to satisfy the following Criteria:

- Short circuit withstand capacity for applicable fault current and duration.
- Full load current carrying capacity under installation conditions considering Site ambient temperature & site installation (Grouping) conditions based on Manufacturer's recommendation.
- Permissible voltage drop limits under steady state/transient state as applicable.

Power cables shall withstand the fault current of the circuit for the duration not less than the max. time taken by the primary protective system to isolate the fault. Cables shall be sized for the following short circuit rating.

- Outgoing cables from 11kV Switchboards: 31.5 kA for 0.16 sec.
- Incoming cables to 415V PCC (Breaker operated): 50 kA for 1 sec.
- Incoming cables to 415V MCC (Breaker operated): 50 kA for 0.5 sec.
- Incoming cables to 415V MCC/DB (MCB protected): Fuse cut-off current for 10m.sec
- Cables from 415V MCC to Motors: 50 kA for 0.16 sec ACB operated
- Feeders from MCC/DB (MCB protected): Fuse cut-off current for 10 m.sec

To maintain voltage at motor terminals / equipment end within desirable limit, it is proposed to limit the voltage drop in the cables within the following limits:

- Steady state Voltage drop (Continuous running condition) : 2.5%
- Transient state voltage drop (During Motor Starting) : 10 %

All cables shall be suitable for laying on racks, in ducts, trenches with chances of flooding by water and shall also be suitable for directly buried installation. All the cables shall be flame retardant low smoke (FRLS) type designed to withstand mechanical, electrical and thermal stresses developed under steady state and transient operating conditions.

The minimum size of LV power cable shall be of 2.5 Sq.mm for Copper. Power cables shall have copper conductor for sizes up to 10 sq.mm. For higher sizes, Aluminum conductor shall be provided. The minimum size of control cable shall be of 1.5 Sq.mm copper. For CT/VT circuits, minimum 2.5 sq.mm copper cable shall be provided. Conductor of Copper cables shall have plain annealed copper. All the conductors shall be multi-stranded.



Power cables shall be XLPE insulated. Control cables shall be PVC insulated. PVC insulation shall be suitable for continuous conductor temperature of 70°C and short circuit conductor temperature of 160°C. XLPE insulation shall be suitable for continuous conductor temperature of 90 °C and short circuit conductor temperature of 250°C.

The cable cores shall be laid up with fillers between the cores wherever necessary. All the cables shall have distinct extruded PVC inner sheath. For single core armoured cables, armouring shall be of copper wire. For multicore armoured cables, armouring shall be of galvanised steel strip/wire as per applicable IS.

Outer sheath shall be of PVC black in colour having following FRLS properties.

- Oxygen index of not less than 29.
- Acid gas emission of max. 20%
- Smoke density of not more than 60%

The cables shall meet flammability test as per IEEE – 383. All the cables shall be protected against rodent and termite attack. Necessary chemicals shall be added in to the PVC compound of the outer sheath.

### 8.2.5.3 Construction

#### a) HT cables

Cables shall be extruded XLPE (dry cured) insulated, screened, PVC inner sheathed (extruded), armoured (round wire), non-conducting water swellable tape of thickness approx. 0.3 mm. applied over armour, FRLS PVC outer sheathed, compacted Aluminium conductor conforming to IS: 7098 Part-II. 33/11 kV cables shall be suitable for unearthed system. The conductor screen and insulation screen shall both be of extruded semi-conducting compound and shall be applied along with the XLPE insulation in a single operation of triple extrusion process. The metallic screen of each core shall consist of copper tape with minimum overlap of 20% copper screen which shall be capable of carrying the system earth fault current for 2 seconds. Outer sheath shall be FRLS PVC.

#### b) LV Power cables

LV Power cables shall be of 1.1 kV grade, XLPE insulated, PVC inner sheathed (extruded), armoured, FRLS PVC outer sheathed, compacted copper conductor conforming to IS: 7098 Part-I.

#### c) Control cables

Control cables shall be of 1.1 kV grade, multicore, PVC insulated, PVC inner sheathed, armoured, FRLS PVC outer sheathed stranded copper conductor conforming to IS:1554 Part-I. Up to 5 cores it shall be colour coded and above 5 cores shall be numbered.

#### d) Trailing cables

Trailing cables / Flexible cables shall be rubber insulated with copper conductor as per applicable standards. The minimum size of LV power cable shall be 4 Sq.mm for Copper.

#### 8.2.5.4 Cable identification system

Cable Identification tags shall be provided at every 5 meters interval incorporating the following marking shall also be embossed over outer sheath.

- Cable size and voltage grade.
- Feeder Details
- Word 'FRLS' at every 5 metre.
- Sequential marking of length of the cable in meters at every one metre.

The embossing shall be progressive, automatic, in line and marking shall be legible and indelible.

#### 8.2.5.5 Cable drums

Cables shall be supplied in wooden or steel drums of heavy construction. The surface of the drum and the outer most cable layer shall be covered with waterproof layer. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/rubber caps, secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS 10418.

#### 8.2.5.6 Testing and Inspection

Cables offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished. Routine tests, Acceptance tests and all special tests for FRLS properties shall be carried out for all the cables as per applicable standards. The sample shall be drawn at the rate of one per type and size for every lot offered for inspection.

##### **Special Tests**

The following tests as applicable to FRLS sheathed cables shall be conducted as type tests on each size of each lot.

- Oxygen index test
- Temperature index test
- Acid gas generation during fire
- Smoke generation test under fire
- Swedish chimney test for class F3 as per SS : 4220 14 : 75
- Under fire conditions for bunched cables as per IEEE std. 383 / 74

#### 8.2.5.7 Spares List

Suitable quantity of commissioning and successful running for 2 years spares list shall be submitted for approval.

### **8.2.6 Lighting System**

This specification covers the requirements of Illumination system.

The lighting system includes

- 100% Normal AC lighting for substation building
- Internal Lighting Load 100% on DG set & 20% external (High Mast Load) on main power failure
- Emergency lighting shall consist of aesthetically designed rechargeable 5 Watt LED lantern with dimming and SOS feature in selected areas of the plant during plant emergency conditions.

Normal AC Lighting shall be energized from 3-phase, 4-wire, 440 V main lighting distribution board. These MLDBs shall feed Lighting Distribution Boards (LDB) for each individual area. Dry type lighting transformers of voltage ratio 1:1 shall be provided for reducing fault level in MLDB. The single phase voltage level considered for lighting system & fixtures shall be optimally arrived to achieve energy efficiency without sacrifice in the illumination level. Lighting transformer tap range & tap step to be designed accordingly.

Emergency lighting shall be provided in specific areas such as workshop and other strategic areas during AC supply failure. Emergency lighting shall normally be “off,” and upon loss of normal AC supply, emergency lights shall be turned “on” in auto mode. Emergency lighting units with integral batteries shall be used. Emergency lighting unit shall provide light for one hour when the normal power source is lost. Each emergency light unit shall be provided with battery, battery charger and one number 5 watt LED lamps. Exit light fixtures shall be LED and provided in all the Building at exit doors.

LED lamps shall be used as light sources in the lighting system.

Fixtures considered shall be energy efficient type with low loss & low harmonics (less than 10%) and with higher lumen / watt.

Emergency lighting luminaries shall be supplied to ensure a safe exit in case of power failure. Emergency light shall be with dimming and SOS feature. Each shall be connected to the 240 V supply system and shall automatically switch to the battery in case of power supply failure. The battery shall be able to supply power to the lamps for a minimum of 1.0 hour.

Enclosure of all fittings shall be of weather & dust-proof construction and consist of cast aluminium body able to withstand direct hosting. AC lighting fixtures and accessories shall be suitable for operation on 240 V AC, 50 Hz supply with supply voltage variation of  $\pm 10\%$ , frequency variation of  $+3\%$  to  $-5\%$  and combined voltage and frequency variation of absolute sum of 10%.

Lighting level design shall include a Maintenance factor as follows to account for lamp lumen depreciation, luminaries surface dirt and room surface dirt, etc.

- Air conditioned areas : 0.8
- Non-Air conditioned areas : 0.7
- Dust prone outdoor Areas : 0.6

All receptacles shall be of high quality Polyamide P-6 body (shock proof, rust free, corrosion free, acid and chemical resistant, fire retardant, having high impact, made of halogen and silica free recyclable material) & terminals with Solid high-quality turned contacts made of

copper alloy (Brass). All steel components (screws, springs etc) shall be Zinc plated & blue-chromed or nickel plated. For each contact double screws shall be available to give better cable strain relief. It shall be heavy duty type, IP67 suitable for fixing on wall/column and complete with individual switch.

In general the receptacles to be installed shall be of the following type:

Power Socket - 15A, 230V, 2 pole, 3 pin type with third pin grounded, metal clad with gasket having 19 mm conduit entry and a metallic screwed cover tied to it with a metallic chain and suitable for indoor installation in Substation.

Welding Socket - 63A, 440V, 3 Ph, 4 Wire, 5 pin interlocked plug and switch with earthing contact to be used in workshop. Other requirements shall be same as type RA. Welding sockets shall not be connected to lighting distribution board and shall get supply from feeders in the MCC/ACDB/PDB.

Suitable number of 63 ampere, 3 phase, 440 volt AC welding receptacles shall be provided. Welding receptacles shall be placed near all major equipment and minimum 2 numbers on each floor in all the buildings. 15A, 240V, Single phase convenience receptacle with switch shall be provided in all the rooms. The convenience outlets shall be spaced to provide access to any point with a 15 meter extension cord. Receptacles shall be served from an earth leakage circuit breaker (ELCB).

Welding sockets shall be fed from ACDB / PDB. Number of receptacles per circuit shall not be more than 2. Each welding receptacle unit shall have dedicated MCB installed adjacent to the receptacle with IP55 type enclosure.

The light fixtures shall be circuited so that adjacent fixtures are connected to alternate phases of a 3-phase circuit. Auto-timed switching may be considered with manual bypass mode for indoor lighting system. The lighting for enclosed areas within the buildings shall be manually switched 'on' and 'off' at local light switches near personnel entrance doors. Wall mounted switches shall be provided at the entrance to battery room and equipment/office rooms.

Electric power to light fixtures located outdoors shall be switched with photoelectric controllers and timers. Outdoor lighting shall have auto/manual mode of operation. Provision shall be made to bypass the photoelectric controller and timer.

Switches shall be sized maximum of 80 percent of the light switch ampere rating with enclosures suitable for the location in which they are installed. Load on each lighting circuit and single phase receptacle circuit shall be limited to 2000 W.

For areas illuminated by more than one circuit, the adjacent circuit shall be fed from different phase. Load balance on all the 3 phases to be envisaged for lighting as well as 1-ph power distribution circuit. Wiring for indoor lighting installation shall be carried with PVC insulated wire with following sizes laid in conduit.

- Lighting Panel to lighting Fixtures : 2.5 sq.mm copper
- Switch box to lighting Fixtures : 2.5 sq.mm copper
- Lighting Panel to Sockets : 4 sq.mm copper

For Area lighting, PVC insulated, PVC inner sheathed, armored, FRLS PVC outer sheathed Copper conductor cables shall be provided. Wiring for lighting circuits of Normal AC system and DC system shall run in separate conduits. Wiring for Lighting fixtures and receptacle units shall be fed from different circuits and shall run in separate conduits. Two different phase circuits shall not be laid in the same conduit.

All conduits shall be surface mounted in general. Conduit fill criteria shall be 40%. Conduits should have the minimum number of bends in their run with pull boxes at suitable locations. Conduits shall be sloped & drained to avoid water accumulation & draining into the equipment at its end. Conduits shall be galvanized steel except in corrosive areas, where it shall be epoxy painted.

#### a) Receptacles

Power Socket - 15A, 230V, 2 pole, 3 pin type with third pin grounded, metal clad with gasket having 19 mm conduit entry and a metallic screwed cover tied to it with a metallic chain and suitable for indoor & outdoor installation in workshop building.

Welding Socket - 63A, 440V, 3 Ph, 4 Wire, 5 pin interlocked plug and switch with earthing contact to be used in Workshop building. Other requirements shall be same as type RA. Welding sockets shall not be connected to lighting distribution board and shall get supply from feeders in the MCC/ACDB/PDB. All receptacles shall be provided with matching plug-tops. All hardware shall be of Stainless steel type only including the mesh of well glass luminaries, nut, bolts, washers, etc.

#### b) Installation of Light Fittings

Mounting height of centre-line of the various lighting equipment from FFL/Working platforms or finished grade level shall be as noted below unless otherwise specified in corresponding lighting layout drawings:

- Lighting panels/control gear boxes : 1500 mm
- Switch boxes : 1500 mm
- Receptacle boxes (Indoor) : 500 mm
- Receptacle boxes (Outdoor) : 1000 mm
- JB on poles/Masts : 750 mm

Lighting fixtures to be mounted on ceiling/platforms having considerable vibrations which can cause damage to the fixtures shall be suitably supported with rubber pads to limit vibrations in the fixtures. Where conduit wiring is adopted, an earth continuity conductor of 12 SWG galvanized steel wire shall be provided for earthing the lighting fixtures, switch boxes, etc. The earthing conductors shall be run along the entire length of the conduits and shall be securely connected and terminated at the junction boxes/control gear boxes/lighting panels. The earth connection shall be properly secured with bolts, nuts and washers. For outdoor lighting installations, an earth continuity conductor of at least 25 x 3 mm galvanized steel flat shall be used for earthing the lighting masts/poles.

While designing the lighting circuit, the cables shall be sized such that the farthest loop from the supply receives no less than 95% of its nominal voltage, in addition it must be assumed that all the light fittings are energized while this design calculation is made. LED lights should

be chosen & located carefully where they illuminate rotating shafts, so as to avoid stroboscopic effect. Fittings made from Aluminium and its alloys should be avoided because the oxide that invariably forms after a time is considered as a potential source of sparks caused by mechanical impact. All fittings shall be installed at a safe height for maintenance & effective illumination. All lighting controls shall be from a non-hazardous area, using double pole, switches, the supply neutral should be switchable along with the phase.

#### 8.2.6.1 Main Lighting Distribution Board / AC Distribution Board

Main Lighting distribution board (MLDB) shall be totally enclosed, sheet steel, indoor, dust tight, vermin proof and floor mounting type. The sheet metal thickness shall be 2mm. MLDBs shall be provided with separate chambers for (i) bus bars (ii) outgoing feeders (iii) incoming feeders (iv) cabling chamber. MLDBs shall have degree of protection of IP-54 for indoor and IP-55 for outdoor installation.

AC distribution board (ACDB) shall be totally enclosed, sheet steel, indoor, dust tight, vermin proof and floor mounting type. The sheet metal thickness shall be 2mm. ACDB shall be provided with separate chambers for (i) bus bars (ii) outgoing feeders (iii) incoming feeders (iv) Dry type transformer (v) cabling chamber. ACDB shall have degree of protection of IP-54 for indoor and IP-55 for outdoor installation.

ACDB shall be provided with 415/415V, 3 phase dry type transformer of suitable capacity to obtain 3 phase, 4 wire system and to limit the fault level to 3KA. The capacity of the transformer shall be decided such that there is at least 20% margin over the total lighting load.

MLDB & ACDB shall be provided with one TPN MCCB for incomer feeder and required number of 3phase outgoing feeders with TPN MCB's and two Nos. Spare feeders. CT operated ammeters and Voltmeter and indicating lamps shall be provided for incomers.

All the JB's and panels for outdoor application must be of SS 316 with powder coating thickness of 120 -160 micron minimum.

#### 8.2.6.2 Lighting/Power Distribution Boards

For lighting circuits, Lighting Distribution Boards (LDBs) shall be provided. For welding receptacle circuits, separate Power Distribution Boards (PDBs) shall be provided. LDBs shall be provided with suitable rating TPN MCB/MCCB for incomer and required number of suitable rating SPN outgoing feeders with MCBs and ELCBs with neutral links for each circuit distributed over three phases. Maximum lighting load on any one circuit shall be restricted to 1500 watts.

PDBs shall be provided with suitable rating TPN MCB/MCCB and required number of suitable rating TPN outgoing feeders with MCBs and ELCBs with neutral links for each circuit distributed over three phases. Maximum welding receptacle load on any one circuit shall be restricted to 2000 watts.

All the JB's and panels for outdoor application must be of SS 316 with powder coating thickness of 120 -160 micron minimum.

LDBs shall be provided with 415/415V, 3 phase dry type transformer of suitable capacity to obtain 3 phase, 4 wire system and to limit the fault level to 3KA. The capacity of the

transformer shall be decided such that there is atleast 20% margin over the total lighting load.

a) Testing and Inspection

Equipment of Illumination system should be type tested and proven type. Type test certificates shall be furnished for Purchaser's review. Equipment shall be subjected to routine tests as per applicable Indian Standard. Test reports shall be submitted for approval.

b) Spares List

Suitable quantity of commissioning and successful running for 2 years spares list shall be submitted for approval.

## 8.2.7 High Mast Lighting System

### 8.2.7.1 Design Criteria

The lighting design shall be in accordance with IS:3646. The selection of lamps and luminaire types shall be based on high efficiency, good glare control and illuminance level required.

Luminaires, mast and brackets shall be selected to suit the harsh environmental conditions specified. Luminaires shall have high power factor (0.85 or higher) control gear. Any apparatus, appliance or material or services which may be necessary to make the system complete and perfect in all respects even if not particularly specified shall be furnished, without any additional expense to the Employer.

Details not usually shown or specified, but necessary for the proper installation and operation of the work shall be included.

### 8.2.7.2 Fittings

Lighting fittings selected shall be LED type only.

### 8.2.7.3 Light Switching Philosophy

Each High Mast shall have two separate circuits.

Security Lighting Circuit, controlling 20% of the light fittings on High Mast. This circuit shall be controlled by a photoelectric cell located in substation so that the security lights turn on automatically depending on pre-sunset solar radiation level. Manual override facility shall also be available in the switchboard located at the base of the high mast.

Main Lighting Circuit No. 1, controlling another 40% of the light fittings on High Mast. This circuit shall be push button controlled from the system control panel. Manual override facility shall be available in the Switch Board located at the base of the High Mast.

Main Lighting Circuit No. 2, controlling another 40% of the light fittings on High Mast. This circuit shall be push button controlled from the system control panel. Manual override facility shall be available in the Switch Board located at the base of the High Mast.

### 8.2.7.4 Location of High Masts

High Mast locations shall be as shown in the **Overall Cable & High Mast Layout** attached with specifications. It is anticipated that the high mast positions as shown on the Drawings

will provide sufficient coverage to obtain the specified illumination. Minor re-sitement may be permitted in case it is absolutely essential to achieve optimum results.

#### 8.2.7.5 Detailed Lighting Plan

Detailed lighting distribution plans of the entire area along with Lux level plot plans shall be provided for approval of the Employer.

#### 8.2.7.6 High Mast

##### a) General

The High Mast at the proposed locations in the plant area shall have adequate height to achieve the required illumination. Top level of high mast foundations shall be as per the approval from the engineer-in-charge. All High Mast of similar height shall be identical in construction to allow possible future relocation of High Masts within the area.

A High Mast Switchboard is required to be installed at the base of each High Mast. The High Masts are expected to be fabricated out of steel. They shall have a door at the base with hinges and a lock. The size of this door shall be a minimum of 1.00 m x 0.50 m. The bottom of the door shall be located at a height of 0.50 m from the base of the High Mast.

The High Mast shall be designed for the number of light fittings determined by the Lighting Design based on the average 30 lux (with minimum 10 lux) of illumination plus two additional fittings to allow for possible future modifications/expansion. The High Mast shall be designed for the worst sail area resulting from the most adverse configuration. The High Mast shall be designed to withstand loads from fabrication, handling, erection, and for the dynamic loading outlined below.

##### b) High Mast Head frames

Each High Mast shall be fitted with a headframe, which shall be capable of being lowered and raised by means of a winch or other similar mechanical mechanism for the lowering and raising of the headframe. The winch shall be able to be operated by use of a power tool. Each High Mast shall be provided with internal power tool complete with drive motor and drive assembly of suitable rating. The power for the drive motor of power tool shall be from the respective high mast switchboard.

The headframe shall be of durable steel construction fitted with light and gear fixings and junction box. It shall be in single piece for maximum strength. The headframe shall also act as an electrical conduit with cable holes protected by grommets. The headframe shall incorporate arrangements to prevent damage to the galvanizing of the High Mast.

##### c) Mechanical Arrangement – Lowering and Raising Headframe (Ring) System

For installation and maintenance purpose, it is required that the headframe (ring) be able to be raised or lowered using a winch or approved lowering device to the base of the High Mast. The steel wire rope supporting the headframe shall be kept in balance and horizontal at all times.

A device, suitably protected from corrosion, shall be incorporated to ensure that the tension rope cannot accidentally or manually be released without a service tool.

##### d) Top Pulley Assembly – Lowering and Raising Headframe (Ring) System



The pulleys for the lowering and raising of the headframe system shall be of non-corrodible material and shall run on self-lubricating bearings with stainless steel axles. They shall be of sufficient diameter so as to enable multicore flexible cables to be used. Arrangements shall be provided to ensure that the electric cables and steel wire ropes are separated before passing over their respective pulleys and close fitting guides shall protect the pulleys to prevent ropes and cables leaving the pulley grooves. It is intended that there will be 2 cables from the High Mast Distribution Board at the base of the High Mast to the junction box on the headframe. Individual cables will then run from the junction box to each light fitting. This cabling arrangement will need to be considered in the design.

The pulleys shall be housed in a chassis integral with a sleeve which slips over the top of the High Mast and is secured axially and in azimuth. Guides and stops shall be provided for locking the headframe and an anchor point shall be securely welded to the assembly to receive the safety maintenance equipment. The complete chassis assembly shall be hot dip galvanized after fabrication. The pulley assembly shall consist of safety brake capable of immediate stopping of the raising and lowering device even in the extreme case of hoisting cables breaking.

The pulley assembly shall be protected by a galvanized steel/aluminium or other approved weatherproof cover.

#### e) Winches – Lowering and Raising Head frame System

Winches shall be completely self-sustaining without the need for brakes, springs or clutches which require adjustment and shall be designed to be installed or removed through the door opening.

Termination of the winch ropes shall not involve distortion or twisting of the rope structure. A minimum of four turns of the rope shall remain on the drum when the lantern carriage is fully lowered. Winch drums shall be grooved to ensure a tidy rope lay. A test certificate issued by an independent test house shall be supplied with each winch. The capacity and operating speed of the winch shall be clearly marked on each winch on an indelible label together with the Specification of the recommended lubricant. Each winch shall be supplied with a fitted canvas cover.

#### f) Lightning Protection and Earthing System

Each high mast shall be provided with lightning protection and earthing system which shall be installed and tested as per BS:6651, BS:7430 and TR7, ILE, UK, and IS:2309 & IS: 3043.

#### g) Openings

Any openings in the High Mast for the feeding of cables/stainless steel rope in and out of the High Mast require coverings/ capping so as to prevent the intrusion of rain water into the High Mast.

#### h) Dynamic Loading

All High Masts shall be designed for maximum reaction arising from basic wind speed of 180 km/hr and factors K1, K2, K3 as per IS:875 (Part III) for design wind speed. The minimum design life shall be 30 years. The High Masts shall be designed in accordance with relevant Indian earthquake standard.

The design shall be such that wind excited oscillations are damped as much as possible and an adequate allowance shall be made for the stress due to these oscillations. The method of damping shall be stated.

Full calculations of the forces involved shall be submitted for approval. The analysis shall show the resultant loadings, deflection and stresses in all three principal axes at a minimum of 500 mm increments over the total length of the High Mast. In addition, the High Mast structures shall have adequate strength to resist fabrication, handling and erection loads without becoming overstressed or deflecting excessively.

i) High Mast Construction

All steel used in the construction of the High Mast, including welding shall comply with relevant Indian or British standards for Structural Steelwork.

The High Mast shall be constructed from mild steel plates, of grade and thickness as determined in the design. The minimum steel plate thickness shall be 6 mm. An appropriate corrosion allowance shall be used in the design. The high mast shall be cut and folded to form a polygonal/circular section. Adjoining sections of the High Mast shall be jointed by taper slip fit jointing. No site welded joints will be permitted.

All High Masts shall have a close fitting weatherproof door at the base with hinges and a heavy duty lock. The lighting distribution board shall be placed inside the High Mast base at this location. The size of the door is expected to be approximately 1.00 m x 0.50 m in size but may vary according to each design. The bottom of the door shall be located at a height of 0.50 m from the underside of the base plate of the High Mast. The door opening shall be reinforced where required to prevent buckling. The reinforcement being designed to suit the width of the door opening under the designing loading specified. Ten (10) sets of keys shall be provided for each type of lock.

The baseplate shall be free from laminations and the welded connection to the High Mast shall fully develop the strength of the section. In addition supplementary gussets shall be provided between bolt holes. On the completion of fabrication, all High Masts and headframes shall be hot dipped galvanized both internally and externally to a minimum thickness of 100 microns.

j) Foundations

The Foundation for the high masts is covered in the scope of this contract.

The design and layout of each type of High Mast shall be furnished. The design shall be based on the foundations not resting on bedrock & shall be carried to a depth of at least 2.0 m below final grade. Settlement shall not exceed 25 mm, unless specified otherwise and the structural arrangement and design shall be such as to withstand such settlements. The top level of the concrete pedestal shall be as per the approval of the engineer-in-charge.

The footings for the High Mast including holding down anchor bolts with nuts and washers shall be supplied and installed under this contract.

k) Wire Ropes

Wire rope system shall be suitable for maintaining the lighting fixtures/control gear from the ground level in spite of crash barriers around the mast.

Wire ropes shall be flexible stainless steel type. Thimbles and terminals shall be of compatible material. Ropes with hemp cores will not be permitted. In the event of failure of one rope the other rope shall hold the lantern carriage. Wire rope must be capable enough to take the entire load in case of failure of the other wire rope.

l) Materials

All materials shall comply to the relevant Indian or British Standards.

All steel conduits, metal work, angle iron brackets, suspension rods etc shall be hot dipped galvanized to a minimum thickness of 100 microns. Where galvanizing has been damaged this shall be repaired with an approved two pack zinc rich epoxy finish.

m) Luminaires

Luminaires shall be standard industrial type Bajaj 14252 BARFEG 350W LED for each High Mast degree of protection and confirm to relevant IS specifications. The lamp shall be easily replaced from rear without disturbing the aiming position. The luminaires shall be tested as per Indian Standard and shall be suitable for installation on high mast.

Bajaj luminaires must be with the over voltage or under voltage protection based. It shall be considered with surge arrester.

n) Aviation Light

GLS/LED type aviation light shall be provided at each mast.

o) Power Tools

This is a geared motor with suitable torque limiter, industrial duty type. The motor is mounted on MS hot-dip galvanized plate inside the mast with a possibility of adjustment in its position.

However, the adjustment shall be so arranged that it cannot be altered easily during normal use of tool at site.

p) High Mast Switch Boards

These boards shall be free standing pad mounted type. The boards shall be designed for the number of circuits as required. The boards shall include miniature circuit breakers/ELCB, Contactor, ON-OFF Control Switch and all other required accessories as required.

The cubicle shall be designed for mounting over RCC pad of 300 mm thickness minimum and shall be capable of withstanding the vibrations normally experienced due to vehicular traffic. The top cover of the enclosure shall have slope to prevent accumulation of rainwater. A gland plate shall be provided at the bottom of the switchboard.

An incandescent lamp shall be provided inside the switchboard, with door switches on both doors, so as to switch 'ON' when the door is open.

q) High Mast System Control Panel

The panel shall be wall mounted type. The circuit wiring shall be as required.

**Construction**

- **Metal Work:** System control panel shall be fabricated out of CRCA sheets – 2 mm thick for structural components and 1.6 mm thick for covers and doors & hot dip galvanized after fabrication. High mast switch board shall be fabricated out of stainless steel of grade SS 316 with powder coating of minimum 120 to 160 micron to prevent corrosion.
- **Degree of Protection:** The HMSB shall be sized to allow for heat generated and design includes for dissipation of heat and shall be IP 65 degree of protection plus canopy, whereas system control panel shall have minimum IP 65 degree of protection.

Each board/panel shall be provided with hinged door with gaskets. 230V AC auxiliary and control supply copper bus bars shall be provided through control transformer of adequate capacity in system control panel.

The Board/Panel shall have earth bus bar running through the whole length of the board. All equipment mounted in the board shall be directly connected to this earth bus.

### **Wiring**

The wiring shall be complete in all respects so as to ensure proper functioning of control, protection and interlocking schemes.

The control wiring shall be of PVC insulated stranded, copper conductor of 2.5 sq.mm cross section. Each control wire shall be identified at both ends with wire designations in accordance with the relevant Indian Standards. All wire terminals shall be with compression or clamp type connectors. Wires shall not be spliced or tapped between terminal points. Designation ferrules will be interlocking type with designation engraved with indelible ink. Not more than two wires shall be connected to one terminal.

Power and control wires shall be neatly bunched, separately and adequately supported so as to prevent sagging and strain on termination.

Terminal blocks for power and control wiring shall be provided with adequate clearances. All wiring must be of FRLS.

### **Component Specification**

- **Contactors:** Contactors for AC shall be 3 pole air-break electromagnetic types suitable for making and breaking locked rotor current of the motor which is equal to around six (6) times the full load current. Contactor shall have minimum 2 Nos. auxiliary contacts.

Minimum rating of power contactor shall be 16 Amps.

Contactors shall be suitable for uninterrupted duty as per IS 2959 and utilization category shall be AC3 as per IS:4064. The contact material of the contactors shall have anti-weld properties. Insulation class of the operating coils shall be class E or better. Operating coils of AC contactors shall be suitable for 230 V  $\pm 10\%$ , 50  $\pm 3\%$  Hz, AC supply. The contactors in general shall not drop out at voltage on and above 65% rated control supply voltage.

- **Photo Electric Switch:** A photo electric cell/switch operating on 230 Volt AC shall be provided for automatic group control switching operation based on solar radiation levels.

- **Auxiliary Contactors:** The auxiliary contactors and no volt relay will be provided as per circuit requirement. The contact rating shall be 10 Amp for AC. The auxiliary contactors shall have at least 8 contacts in contact combinations as per the requirement.
- **Control Terminal Blocks:** Control terminal blocks shall be of 650 volts grade, rated for 10 amps and in one piece moulding. It shall be complete with insulation barriers, clip on type terminals and identification strips. Marking on terminal strip shall correspond to the terminal numbering on wiring diagrams.

At least 20% spare terminals for connections shall be provided and these spare terminals shall be uniformly distributed on all terminal blocks. All terminal blocks shall be suitable for terminating on each side, two (2) Nos. of 2.5 mm<sup>2</sup> size stranded copper conductors.

All terminals shall be numbered for identification and grouped according to the function. Engraved white-in-black labels shall be provided on the terminal blocks. Wherever duplication of a terminal block is necessary it shall be achieved by solid bonding links.

Self-aligning, spring loaded, silver plated, sliding contacts for proven design shall be provided as control terminals for withdrawable / drawout modules. Detachable plug and socket type control terminals shall also be acceptable.

- **Indicating Lamps:** The indicating lamps shall be panel mounting large industrial cluster LED type and shall be interchangeable. Indicating lamps shall be with translucent lamp covers. The lamp covers shall be mounted flush on the front panel door and shall be replaceable from the front of the cubicle.

#### 8.2.7.7 Installation

Mounting height of centre line of the various lighting equipment from FFL/Working platforms or finished grade level shall be as noted below unless otherwise specified in corresponding lighting layout drawings.

- Lighting panels/control gear boxes : 1500 mm
- Switch boxes : 1500 mm
- Receptacle boxes (Indoor) : 500 mm
- Receptacle boxes (Outdoor) : 1000 mm
- JB on poles/Masts : 750 mm

Lighting fixtures to be mounted on ceiling/platforms having considerable vibrations which can cause damage to the fixtures shall be suitably supported with rubber pads to limit vibrations in the fixtures.

Where conduit wiring is adopted, an earth continuity conductor of 12 SWG galvanized steel wire shall be provided for earthing the lighting fixtures, switch boxes, etc. The earthing conductors shall be run along the entire length of the conduits and shall be securely connected and terminated at the junction boxes/control gear boxes/lighting panels. The earth connection shall be properly secured with bolts, nuts and washers.

For the outdoor lighting installations, an earth continuity conductor of at least 25 x 3 mm galvanized steel flat shall be used for earthing the lighting masts/poles.

While designing the lighting circuit, the cables shall be sized such that the farthest loop from the supply receives no less than 95% of its nominal voltage, in addition it must be assumed that all the light fittings are energized while this design calculation is made.

Fluorescent lights should be chosen & located carefully where they illuminate rotating shafts, so as to avoid stroboscopic effect. Fittings made from Aluminium and its alloys should be avoided because the oxide that invariably forms after a time is considered as a potential source of sparks caused by mechanical impact.

All fittings shall be installed at a safe height for maintenance & effective illumination. All lighting controls shall be from a non-hazardous area, using double pole switches, the supply neutral should be switchable along with the phase.

#### 8.2.7.8 Testing and Inspection

Equipment of Illumination system should be type tested and proven type. Type test certificates shall be furnished for Purchaser's review. Equipment shall be subjected to routine tests as per applicable Indian Standard. Test reports shall be submitted for approval.

#### 8.2.7.9 Spares List

Suitable quantity of commissioning and successful running for 2 years spares list shall be submitted for approval.

### 8.2.8 Cabling and Cable Trays

#### 8.2.8.1 Introduction

This specification covers the requirements of cable trays, support structures, cabling, termination, earthing and lightning protection system.

#### 8.2.8.2 General Requirements

While finalizing Cable routing layouts, consideration shall be given to the requirements of Safety, Reliability and Convenience of cable laying and termination.

Where duplicate drives/auxiliaries are provided for reliability, cable routing shall be segregated to the extent practically possible.

In cable trenches, distance between bottoms most tier and bottom of trenches shall be 150 mm and clearance from top most tray to top of trench cover shall be 400 mm. Distance between two tiers shall be minimum 250 mm.

PCC flooring of built-up trenches shall be sloped in longitudinal and also in transverse direction for effective drainage system. Other than cable vault & cable trenches, Cable trays shall be laid in vertical formation to avoid dust accumulation in areas.

In cable spreader room a clear access passage of at least 800 mm wide shall be provided along the cable ways. Wherever passage is through cable routes, a clear height of not less than 2.0 M shall be provided. Cables should not be laid directly in the trench floor. Cable trenches should be provided with strong & effective covers with water & fire proof sealing arrangement at trench entry & exit points.

Cables of different voltages shall be laid in separate racks. Minimum distance of 250 mm shall be maintained along the routes between various types of cables. In case of horizontal formation, the highest voltage cables shall be laid in the top most position in the tray stack followed by other grades as follows in the descending order.

- 11 kV Power cables (Bottom Tier)
- 3.3kV Power Cables (Above Bottom Tier)
- 1.1kV Power cables (Above 3.kV HT Tier)
- Electrical Control Cables (Above LT Tier)
- Instrumentation/Signal cables (Top most tier)

Cable laying tier position indicated above is for ready reference; however, same shall be finalized as per site condition during detail engineering and execution.

On cable trays all the multicore power cables can be laid in touching formation. Single core cables shall be laid in trefoil formation with the spacing equal to twice the diameter of the cable. Control cables shall be laid in not more than two layers.

Cables shall be terminated using double compression cable glands suitable for the voltage grade of cables. Cable glands shall be heavy duty brass. Cable lugs for power and control cables shall be tinned copper solderless crimping type conforming to IS 8309.

All joints and terminations, except for separable insulated connectors shall be of the heat-shrink, cold-shrink, or cold-applied polymeric type design, manufactured and tested to meet the requirements of the relevant Standards, and shall be suitable for application to 3.3 kV, 11kV and 3.3kV cables as described in this section.

Power & Control cables shall be laid on ladder type trays. Instrumentation & Signal cables shall be laid on perforated type trays. Cable trays shall be of galvanized steel. Cable trays shall be supported at an interval of 1500 mm approximately. Vertical runs shall be supported at an interval of 1000 mm approximately. Cable tray support system shall be of site fabricated, welded and painted steel supports.

Cable tray support system shall consist of ISMC channel as vertical support & ISA as horizontal arm. Horizontal arm is welded to the vertical support MS channel.

Fire barriers/ Fire stops shall be provided for all fire rated wall and floor penetrations and for all direct cable entries into electrical Switchgear / Panels from Cable Vault. Fire barriers/ Fire stops shall provide a fire endurance rating of at least 2 hours. The fire sealing materials shall be non-hygroscopic, mechanically steady, non-toxic and physically & chemically stable under fire conditions. Fire barriers/ Fire stops shall be either of the following methods:

- Panel sealing method comprising Encasing Panels, Cavity fill material & Sealant
- Mortar sealing method comprising Mixing Mortar curing with water.

### 8.2.8.3 Design and Construction

#### a) Cable trays, Fittings & Accessories

Cable trays shall be ladder/perforated type as specified prefabricated made out of hot/cold rolled mild steel sheets, complete with matching fittings (like elbows, bends,

reducers, tees, crosses, etc.), accessories (like side coupler plates, Tray cover etc.) and hardware (like bolts, nuts, washers, GI strap, hook etc.) as required. All the items (including hardware) shall be hot dip galvanized. Thickness of galvanizing shall be not less than 610grams/sq.M. The size of the trays shall be selected on the basis of maximum 40% fill criteria.

Cable trays shall be standard width of 150mm, 300mm & 500mm and standard lengths of 2.5 M or more. Minimum thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2mm. Rung spacing shall be 250mm maximum. The thickness of side coupler plates shall be minimum 2.5mm and of tray covers shall be minimum 1.6mm. Cable Trough shall be required for branching out few cables from main cable route. These shall be fabricated of mild steel sheets of minimum thickness 2mm and shall be hot dipped galvanized. Troughs shall be of standard width of 50mm & 75mm and 25mm height.

**b) Conduits/Pipes, Fittings & Accessories:**

Conduits/pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.). The size of the conduit/pipe shall be selected on the basis of maximum 40% fill criteria.

Hume pipes shall be of reinforced concrete conforming to class NP3 for road crossings as per IS: 458. GI pipes shall be of medium duty as per IS: 1239. Rigid steel conduits conforming to IS: 9537 Part-I & II shall be suitable for heavy mechanical stresses, threaded on both sides and threaded length shall be protected by zinc rich paint. Conduits shall be smooth from inside and outside. Fittings and accessories shall also be hot dip galvanized.

Flexible conduits where required, near equipment terminations, shall be made with bright, cold rolled, annealed and electro-galvanized mild steel strips. Flexible conduits shall be supplied with suitable end coupler nipple and check nut. In corrosive areas, epoxy coated conduits shall be provided.

**c) Clamps**

Trefoil clamps for single core cables shall be pressure die cast aluminium or fibre glass or nylon and shall include necessary fixing accessories like GI nuts, bolts, washers etc. Trefoil clamps shall have adequate mechanical withstand capability in case of a fault and shall be tested and proven type. For clamping the multicore cables self-locking, de-interlocking type nylon clamps shall be used.

#### 8.2.8.4 Cabling Installation

The work shall be carried out in the best workman like manner in conformity with relevant specifications / code of practices of the Bureau of Indian Standards. In addition, work shall also confirm to the requirements of latest editions / amendments of the following:-

- Indian Electricity Act and rules framed thereunder.
- Fire Insurance Regulations
- Regulations laid by the office of the Chief Electrical Inspector to Government.
- Any other regulations laid down by the local authorities.



Support system shall be so designed that it is able to withstand weight of the cable trays, Weight of the cables (75 Kg/metre run of each cable tray), Concentrated load of 75 Kg between every support span without any permanent deflection. Factors of safety of at least 1.5 shall be considered. Cable tray mounting structure shall be welded / bolted to the plate inserts or to steel structure and the type of welding shall be of fillet type of at least 6mm size.

All cable way sections shall have identification, designations as per cable way layout drawings and painted/stencilled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted / stencilled with identification numbers at every floor.

Tray covers shall be provided for overhead cable trays on top most tier. The cable risers or vertical raceways shall also be covered by cable tray covers upto 1.5 metres from respective floor for mechanical protection. The sheet cover shall be of removable type.

### **8.2.9 Earthing System**

The complete earthing system shall conform to the provision of Indian Electricity Rules, and applicable code of practice for earthing IS: 3043, however for chemical earthing IEEE:80- 2000 shall also be followed. Working layout drawings shall be prepared by the successful Contractor. Value of earth resistivity shall be considered as per the areas indicated in IS:3043 or the actual value as obtained from the site from previous records available with the employer, if any.

#### **8.2.9.1 Earthing Below Ground**

- a) The main earthing grid shall be buried below ground unless required otherwise. For crossing any trench or under-ground pipe minimum earth coverage of 500 mm shall be provided over the earthing conductor.
- b) Where the earthing conductor passes through reinforcement or steel plate it shall be bonded to the same.
- c) All building steels and columns shall be bonded directly to the earthing grid.
- d) The riser/pigtails from earthing grid shall project 600 mm above grade/concrete level unless shown otherwise.
- e) All earthing conductor connections shall be made by electric arc welding or by nuts and bolts using plain washers and spring washers.
- f) All arc welding shall be carried out with low hydrogen content electrode.
- g) All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. No artificial cooling should be adopted to cool welded joints.
- h) The welding required for earthing shall serve the following three purposes (i) sufficient mechanical strength between the jointing materials (ii) sufficient electrical area for the flow of system short circuit current and (iii) sufficient electrical area available after commissioning during the life time of the plant.

- i) Before welding, the earth conductors shall be clamped tightly to ensure good surface contact at welding points.
- j) Before applying bitumen compound two coats of red oxide primer shall be applied to risers and exposed portion of earth grid, if any. Construction joints shall be given treatment with Barium Chromate before applying red oxide paint and bitumen.
- k) Earthing shall be mechanically robust and all joints shall be capable of retaining low resistance even after passages of many fault current.
- l) All the connections are to be made carefully and properly. Improper/poor connections are to be remade at the cost of Contractor.
- m) Welded areas of risers/pigtail shall be thickly coated with bitumen compound to prevent corrosion.
- n) Earthing pits/conductors shall be laid in field to avoid fouling with concrete foundations and in consultation with the Employer at site.
- o) Trenches shall be filled up with 'Free of Stones' earth after laying earth conductor. After filling up of trenches the earth shall be rammed carefully.
- p) The successful Contractor shall submit detailed working drawings of earthing grid for approval by Employer prior to construction of the grounding system.
- q) The rate quoted shall be inclusive of cost of all materials, labour required for excavation, backfilling, welding, cutting, bending, placing of GI strips etc. complete as per specification.
- r) All tests as per relevant standards shall be conducted to certify the effectiveness and other requirements of the earthing grid.
- s) Depth of laying of earth conductor for earth grid, ring and inter-connections shall generally be min. 500 mm from ground level and 300 mm below all foundations.
- t) Erection of earth pits shall include making of masonry enclosure and supply of chemical and other materials.

#### 8.2.9.2 Earthing Above Ground

- a) The successful Contractor shall lay the above ground earthing conductors inside the buildings and on various structures for connection to various equipment/ drives etc. The earthing conductors may be installed within the cable trays in the form of runway conductors. The connection to equipment shall be tapped from these runway conductors at suitable locations. One runway conductor shall be provided for each side of cable trench/tray.
- b) The neutral points of all earthed system of different voltages, all equipment frame works, other non-current carrying metallic structures and equipment such as motor frame enclosures of MCCs, panel boards, cable armour, cable trays, sheaths etc. shall be earthed by a minimum of two separate and distinct connections.
- c) Armor of all power and control cables shall be earthed at both ends through gland earth ring provided with the cable glands.

- d) All cable trays and supporting structure are to be earthed. All cable tray sections shall be bonded with each other for continuity.
- e) All earth leads and riser connections shall be as short as possible.
- f) Metal pipes and conduits through which cables run shall be effectively bonded and earthed.
- g) Neutral connection shall not be used for equipment earthing.
- h) All connections to earth conductors shall be welded/bolted type. Earthing connections to all equipment shall be bolted type.
- i) Earthing conductor along their run on steel columns, beams etc. shall be tack welded at intervals of 1000 mm.
- j) All joints in earthing conductor shall be welded type. All joints shall be welded with an overlap of 65 mm. Joints shall be thoroughly cleaned before welding. Welding is to be done around joint completely. All joints shall be given two coats of anti-corrosive paint (Red Oxide) to a thickness of 3-5 mils, followed by a coat of bitumen paint. Joints shall be thoroughly cleaned before applying paints.
- k) All nuts, bolts washers etc. shall be cadmium plated or zinc passivated. Generally, earthing studs and terminals shall be provided on all equipment. In such cases, where it is not provided the Contractor shall have to drill and tap the equipment for deriving earth terminals.
- l) Connections of earthing conductors to the main earthing loops or to equipment shall generally be made by means of cable lugs in case of round conductors, solid or stranded and directly in case of strips. Devices like spring washers and lock washers must be used to ensure that the connections are vibration proof.
- m) Laying of earthing conductor shall include fabrication and fixing of clamps, cleats and supply fixing device i.e. nuts, bolts, washers as also civil work such as preparation of floor surface and finishing them to the finished floor level after installation of earthing strips.

### 8.2.9.3 Earth Electrodes

All GI pipes comprising an earth system shall be connected together with a continuous ring of earth tape. After installation, test shall be made to ascertain that the earthing resistance hereinafter specified is obtained. If the required resistance value cannot be obtained, sufficient number of additional pipes shall be installed, until the resultant resistance not exceeding the specified value can be obtained.

In all cases the pipes shall be driven such that their zones of earthing do not overlap. Earth electrodes for Body Earth pits and Instrument earth pits shall be minimum 65mm diameter, 6mm thick, 3m long GI pipes, whereas for Neutral earth pits of Transformers, DG etc. plate electrodes of Copper 600mm x 600mm x 6mm thick shall be used as per IS:3043.

Each earth electrode / plate shall be connected to its associated earth tape through a linked connection. The link shall be installed as close to the earth electrode as possible. Each earth electrode shall be enclosed together with the link in a reinforced concrete hand-hole with cast iron cover, which shall be set flush with the ground. Electronic earthing shall be completely isolated from the Plant earthing system.

#### 8.2.9.4 Earth Pits for Earthing and Lightning Protection Systems

Earth pits shall be based on High Conductivity Technology. In this technology of chemical earthing, a compound of high electrical conductivity shall be filled up in the space around the ground electrode, so that the earth resistance value would decrease appreciably. The high Conductive Compound shall be able to perform in any weather and soil Conditions and shall have following properties;

- a) It shall have high electrical conductivity, which should remain constant and unaffected by changes in temperature & moisture.
- b) It shall permanently remain embedded and should neither dissolve in and swept away by water.
- c) It shall have an ability to absorb large amount of water and retain the same over a long periods of time.
- d) It shall decrease earth pit resistance with passage of time.
- e) Solubility: Shall be partly miscible; so that it does not dissolve fully like common salt and thus increasing the Earth Pit Life.
- f) The pH value shall be near neutral so that it does not pollute soil or water and also does not corrode earth electrode.
- g) It shall be maintenance free Compound so that there shall be no need of extra water pouring at regular interval as in conventional earthing material, because it should retain the moisture.
- h) Chemical Compound shall be thermally conductive, in order to maintain a constant Earth resistance in temperature range of -50 to +60 degree Celsius.
- i) The Compound shall have relatively High conductivity so that it can create very low resistance even in rocky areas.
- j) It shall have low earth resistance, carries high peak current repeatedly.
- k) It shall have a Long and reliable life.
- l) It shall be easily installed in any soil conditions.
- m) Earth pit identification boards to be provided with the details of Individual Resistance, Combined Resistance, date of testing, due date etc.

Minimum Electrode size shall be as per the latest amendments of IS:3043. Earth electrodes / plates for body earth, DG & transformer neutral, Instrumentation earthing and Lightning earth pits shall be selected as per the latest amendments / requirements of IS:3043.

All earth electrodes comprising an earth system shall be connected together with a continuous ring of earth tape. After installation, test shall be made to ascertain that the earthing resistance hereinafter specified is obtained. If the required resistance value cannot be obtained, a sufficient number of additional pipes shall be installed, until the resultant resistance not exceeding the specified value can be obtained.

In all cases the pipes shall be driven such that their zones of earthing do not overlap. Each earth electrode shall be connected to its associated earth tape through a linked connection.

The link shall be installed as close to the earth electrode as possible. Each earth electrode shall be enclosed together with the link in a reinforced concrete hand-hole with cast iron cover, which shall be set flush with the ground.

#### 8.2.9.5 Earth System

The Contractor shall furnish and install a 75 x 8 mm GI strip as the main grid. The resistance between any point on each earthing system and the earth electrode shall not exceed 0.1 ohm. The overall resistance between the earthing installation and the general mass of earth shall be less than 1 ohm.

The main earthing bars shall be so placed that earthing terminals of major equipment and where required cable sheaths to be earthed, can be readily connected to them. Branch connections from the main earth bars shall be provided to all switchboards, power transformers, capacitors, Control Consoles, distribution boards, etc. The bonds shall be made to the cable glands on which the lead sheath shall be plumed and the armour clamped. All steelwork supporting electrical equipment shall be bounded to the main earthing bars.

The Sizes of GI earth bus and earth wires shall be as follows:

**Table 8-1 Earthing Size**

Main earthing grid	75 x 8 mm GI strips
Riser upto ground level	75x8 mm GI Strip
HT & LT boards, PCC/MCC panels, Cable trays(HT & LT)	40 x 6 mm GI strip
High Masts Earthing	40 x 6 mm GI strip
Transformers and DG Neutral Earthing	50 X 6 mm Cu Strip
LDB, Weld socket, Cable tray	25 x 6 mm GI strips
Control & Instrumentation	25 X 6 mm Cu Strip
Lighting panels, Distribution Boards etc.	25 x 6 mm GI strips
Junction boxes, field instruments, gland earthing Lighting fixtures, 15A switch sockets	8 SWG GI Wire

**Note:** Above listed size of Earthing stripe / cable are indicative, successful bidder shall submit the detail calculation with drawing to employer for final sizing and MOC of earthing material.

Joints, termination, fixing of the earth bars and their protection from corrosion shall be in accordance with the recommendation given in the aforementioned code of practice subject to the additional requirements specified herein. GI tapes shall be secured at intervals not exceeding 1m by means of single-screw fixing purpose made gunmetal saddle of a pattern approved by the Employer. The tapes shall run in square and symmetrical lines. Links shall be provided in the system adjacent to all junctions to enable tests to be carried out from time to time. All links shall have high tensile steel bolts and the nuts shall be tightened by means of a torsion spanner. All joints in exposed sections

shall be protected against moisture and corrosion by the application of two coats of an anti corrosive paint and shall be taped with self-adhesive PVC tape.

#### 8.2.9.6 Earthing of Equipment

- a) All lighting panels, junction boxes, receptacles, fixtures, conduit etc. shall be grounded in compliance with the provision of I.E. rule.
- b) Ground connections of sub-station and meter room shall be made from nearest available 75 x 8 mm ground grid. All connections to ground grid shall be done by arc welding.
- c) Lighting panels shall be directly connected to ground system grid by two nos. 25 x 6 mm GI strip at two different locations.
- d) A continuous ground conductor of 8 SWG G.I. wire shall be run all along each conduit run and bended at every 600mm by not less than two turns of the same size of wires. This conductor shall be connected to panel ground bus.
- e) All junction boxes, receptacles, lighting fixtures, etc. shall be connected to this 8 SWG ground bus.
- f) Earthing of High Mast light towers shall be done by connecting 2 nos. of 40x6 GI strip at two different places.

### 8.2.10 Advance Lightning Protection System

#### 8.2.10.1 Scope of Work

The lightning protection system should comply in accordance with NFC 17-102 standard and shall be installed strictly to the manufacturer's instructions.

The advance lightning protection system shall include components as follows:

- ESE Air Terminal (For Non-building application) / Conventional Air Terminal (Building application)
- Mechanical Supports
- Down Conductors
- Lightning Strike Recorder
- Maintenance free chemical gel earthing system

The LPS shall be designed by a company engaged in the manufacturing and development of advanced lightning system components, of types, sizes and ratings as shown, who can show evidence or support that their products have been in satisfactory service for not less than 10 years. The advanced lightning protection system shall be installed strictly to the manufacturer's instructions.

#### 8.2.10.2 Standards

Complete installation shall be engineered and constructed in accordance with the latest revision of the following:

- NFC 17 102

- IEC 61024
- IEC 60-1:1989

### 8.2.10.3 Test Certificates & Approvals:

- Country of Origin Certificate:** Country of Origin issued by the respective country's "Chamber of Commerce & Industry" duly acknowledging the serial number of the lightning arrester exported from their country.
- CPRI:** The ESE air terminal should be tested & certified by CPRI (Central Power Research Institute, Govt of India) for a minimum impulse current of 45 KA (8/20 micro sec) with 5 positive & 5 negative impulse.
- IEC certificate:** As per IEC 60-1:1989, the ESE air terminal should successfully withstand a current impulse equivalent to 200 KA (8/20 micro sec waveform).
- NF C 17 102 certificate:** As per NF C 17 – 102, the ESE air terminal should be tested with the "Switching Impulse Voltage" of -700 KV & "Direct Voltage" of -70 KV. The test report shall have reference wave in accordance with 650 microsecond standardized wave according to clause 4.2 of NF C 17 102.

The details of the lightning protection system shall also confirm to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this specification and drawings, whichever is more stringent and acceptable to the engineer.

### 8.2.10.4 ESE Air Terminal

The stormmaster ESE air terminal shall be of the type that responds dynamically to the appearance of a lightning downloader by creating free electrons between outer floating four panels and an earthed central finial rod. The lightning air terminal shall be configured as a spheroid which is comprised of separate electrically isolated panels surrounding an earthed central finial. The central finial shall be elevated above the spheroid to a length of 90 mm. The Insulation material used to electrically isolate the panels shall be comprised of a base polymer which provides high Ozone & UV resistance with a dielectric strength of 24-38 KV/mm tested as per NFC 17-102 & IEC 60-1:1989

The unit shall detect the lightning when it approaches and emit the streamer within few microseconds. ESE air Terminals shall be manufactured as per NFC 17 -102 standard. A dedicated wired ESE tester should be available for maintenance purpose after a certain period of time as advised by the manufacturer. The ESE manufacturer shall be ISO 9001 certified. Performances of the air-termination should have been tested in the international laboratories as per IEC 60-1:1989.

The air terminal should work under Early Streamer Emission (ESE) Technology and the attractive radius of the air termination shall be traceable to known and acceptable lightning research and statistics. The ESE air terminal should have no moving parts, no electronic circuits and will have no dependence on external power supply or batteries. The ESE air terminal shall not have any solar panels, no inbuilt batteries, no usage of any degradable ceramics like transducers, etc.

The stormaster ESE air terminal should deliver a unique gain time in efficiency, anticipating the natural formation of an upward leader. The ESE air terminal generates a leader that propagates rapidly to capture the Lightning stroke and conduct it towards the ground. Arcing is not to be continuous and shall only occur during the progress of the lightning leader. The air termination shall not cause high frequency radio interference except during the millisecond intervals associated with the progress of the lightning leader and during the main return strike of lightning events in the region.

The protective zone provided by the air termination shall be such that it becomes the preferred strike point for all discharges exceeding a peak amplitude return strike current of "X" kA according to the statistical level "Y" per IEC61024. The design shall take account of upward leader competing projections on the structure.

Strike Current (X)	Level of Protection (Y)	Exceedance Probability
2.9 KA	Protection Level I - Very High	99%
5.4 KA	Protection Level II - High	97%
10.1 KA	Protection Level III - Medium	91%
15.7 KA	Protection Level IV - Standard	84%

The stormaster ESE air terminal shall be tested & certified by CPRI (Central Power Research Institute, Govt of India) for a minimum impulse current of 45 KA (8/20 micro sec) with 5 positive & 5 negative impulse.

The stormaster ESE air terminal serial number which is displayed on the lightning arrester shall be mentioned on the "Country of Origin" certificate issued by the respective country's (where the lightning arrester is manufactured) "Chamber of Commerce & Industry".

The materials of the air termination shall be non-corroding in normal atmosphere. The height of the air terminal support mast should be minimum 2 meters and the height will be increase as per the coverage design. The support shall be securely installed and guy wires shall be used where necessary to enable the air termination and mast system to withstand maximum locally recorded wind velocities.

#### 8.2.10.5 Air Termination Support (Mast)

The air termination shall be fixed at the top of a GI rod pole so as to be at least 2 meters above the top of the structure to be protected. The elevation pole should have a minimum diameter of 35 mm to 50 mm with a thread at the top to fix the unit. Grid shall be constructed.

The support shall be securely bolted to other mast materials with guy wires used where necessary to enable the air termination and mast system to withstand maximum locally recorded wind velocities.

##### a) Down Conductor:



The down conductor for the lightning arrester shall be of 70 sq.mm PVC insulated flexible copper cable or 25 x 3 mm (copper/G.I) strip along with the fixing accessories. The down conductor shall be installed in accordance with the manufacturer's instructions and should not be subject to bends of less than 0.5 metres radius.

The down conductor after routing must be kept in constant physical contact with the structure via conductive clamps. The top 10% of the installed length from the terminal must be anchored at least every 1 metre. The lower must be anchored at least every 2 metres.

b) Lightning Strike Recorder:

Each protection system shall be supplied with Lightning strike recorder. The lightning strike recorder shall be of mechanical type and non-resettable with 7 digits. LCD screen is not permitted; because the display depends upon the battery and battery life is not reliable.

The lightning strike recorder shall be tested & certified by CPRI (Central Power Research Institute, Govt of India) for a minimum impulse current of 45 KA (8/20 micro second) with 5 positive & 5 negative impulse. The lightning strike recorder shall be tested & certified in series with the lightning arrester by CPRI.

The recorder shall have a register that activates one count for every discharge where the peak current exceeds 1500A at the 8/20 micro second waveform and a maximum of 220 KA. The lightning strike recorder shall be robust and easy to install. The counter should operate from the energy of the lightning discharge and should not work on external or battery power to operate.

The lightning strike recorder shall be tested and certified as per IEC 60-1:1989 standard in line with the lightning arrester for a impulse current of more than 450 KA (8/20 micro second). The lightning strike recorder shall be installed to the manufacturer's instructions in a readily accessible manner (always 2 mtrs above the ground) so that reading can be taken at regular intervals.

c) Earthing:

The lightning arrester grounding system reading shall not exceed 10 ohms static impedance except with prior approval by the specifying engineer or manufacturer of the lightning protection system. The backfill compound should be tested & certified from any international laboratory for the resistivity of the material parameter of less than 0.2 ohm- mtr.

As per the international standards, radial shallow earthing system is a preferred design for lightning protection. The earth electrode shall be of UL listed 10 feet long 17 mm dia 250 microns copper bonded steel rod. The UL listing shall be marked on the rod for the physical verification at site.

The electrode shall be surrounded by reslow grounding minerals. The grounding minerals shall contain a compound with a base electrolyte when mixed with other compounds produces an earth gel which provides good earthing gel.

Reslow grounding minerals provide high conductivity in the electrode – ground contact area and improves the absorbing power and humidity retention capability. A gelatinous mass within the surrounding ground soil which will not wash away. A high conductive mass allowing for the effective dissipation of electrical surges and faults.

A high conductive mass that is hygroscopic in nature and does not reduce, contract or separate from the accompanying ground electrode. A high conductive mass which does not contaminate ground water. When the products employed react, they shall produce compounds with high conductive power and decrease the resistance of the earth, mainly in those with salts deficiency. Higher doses may be necessary for optimum results in high resistance soil or rocky areas.

As per IEEE 80-2000 (Clause 14.5 d), the resistivity of the grounding minerals is less than 0.12 ohm-mtr. The compound is tested & certified from an international laboratory to confirm the ohmic value (high conductivity) of not less than 0.12 ohm-mtr.

The earth pit shall be suitable covered with the man hole chamber for the testing purpose with the heavy duty weather proof environment friendly polyplastic earth pit chamber with cover of auto-locking facility with the following dimensions - 254 mm dia (top), 330 mm dia (bottom) and 260 mm height. 4 knock-out openings are provided for the easy interconnection of earth strips between the earth pits to form a grid.

The contents of the chemical compound used for back filling around the earth electrode shall be duly tested and certified by any International accredited and BIS (Bureau of Indian Standards), Govt of India accredited laboratory. The testing laboratory should be an ISO 9001 & ISO 14001 certified.

#### **8.2.10.6 Testing and Inspection**

Equipment offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished. Routine tests shall be carried out for all the equipment as per applicable standards.

Test link box shall be provided on two end of the structure. Further insulator shall be added for the separation of the circuit to the strip.

#### **8.2.10.7 Spares List**

Suitable quantity of commissioning and successful running for 2 years spares list shall be submitted for approval.

### **8.2.11 415 V Silent Diesel Generator Set**

#### **8.2.11.1 General**

The output from the unit shall be 200KVA (at alternator output), 415 volts, 3 ph, 50 Hz, 0.8 power factor.

Obtaining statutory approval from the electrical Inspectorate and other statutory approvals for the installation / commissioning of the system including preparation of required drawings etc. shall be the scope of successful bidder. The acoustic enclosure should be supplied along with DG set from the manufacturer outlet itself as per CPCB norm.

Design, supply and construction for requirement of Foundation and Anti-Vibration Footing specifications etc. is part of bidder scope of work.

### 8.2.11.2 Environment Conditions

DG set shall be required to operate as standby unit under the following environmental conditions:

- Ambient temperature 45°C
- Relative humidity Above 90%
- Altitude Sea-level

### 8.2.11.3 Diesel Engine

#### a) General:

- The engine shall comply with the requirements of relevant BS 649/BS 5514.
- Engine shall be designed for maximum reliability ensuring uninterrupted operations.
- Engine shall be capable of delivering 10% overload for a period of one hour in any consecutive twelve (12) hour period.
- The values of rating, rotative speed and brake mean effective pressure (BMEP) for a specific engine design will not be accepted unless they are published as catalogue data.

#### b) Engine Type:

- The engine shall be heavy duty, industrial type four stroke delivering matching BHP at 1500 rpm, turbo charged radiator coded suitable for standby duty.
- The engine and auxiliary system shall be designed for safe start, stop and running on high speed diesel (HSD).
- The engine performance shall confirm to ISO:3046/BS:5574.

#### c) Engine Governor

The engine governor shall be electronic.

#### d) Load Acceptance

The set shall be capable of accepting at least 60% of rated load in a single step from an initial start-up condition.

#### e) Filters

Filters of the replacement element type shall be provided on the engine for fuel oil, lubrication oil and air intake.

#### f) Starting System

Engine starting shall be 24 V DC battery system designed so that at least two separate attempts can be made, to prevent the complete loss of starting capacity in one attempted engine start.

Sizing of starting system should be in accordance with the engine manufacturer's recommendations, but in no case should the storage capacity be less than 30 seconds of cranking.

An automatic static battery charger which possesses characteristics of "Zero-float" and positive charging shall be used. An engine-driven battery-charging generator is not acceptable. Batteries shall be maintained in a warm (20°F to 110°F) atmosphere to assist in quick starting. The battery system shall be of lead acid automotive type.

**g) Flywheel Guards**

Flywheel guards should be provided as required.

**h) Engine Control Unit**

An engine control unit free from vibrations comprising of the following devices with sensors (mounted at engine) shall be provided as minimum:

- Water temperature gauges for jacket water temperature
- Water pressure gauge
- Tachometer for engine speed
- Lubricating oil, pressure and temperature gauges
- Automatic shutdown and indication for low lubricating oil pressure, over crank, low coolant level, high cooling water temperature and engine over speed.

**i) Engine Auxiliaries**

- Cooling System
- Cooling system shall be radiator type.
- Anti-freeze liquids and corrosion inhibitor as recommended by engine manufacturer shall be used to obviate the danger of damage occurring from the use of incompatible or improper liquids or inhibitors.

**j) Intake and Exhaust System**

- A residential type exhaust silencer of suitable size for exhaust run shall be provided complete with all support frames etc. to reduce engine exhaust noise. It should be kept as straight as possible.
- Dry type air-inlet filter, exhaust manifold, mufflers shall be used. Type of filter selected shall be to fit the environmental conditions at the site.
- Combustion air shall be taken directly from outside.
- The air-intake and exhaust shall be so located as to preclude the contamination of fresh air with exhaust gases.
- To dispose of the radiant heat given off by the exhaust pipe, sheet metal ductwork shall be supplied with 50 mm of space between the ductwork and the exhaust pipe.

**k) Fuel Oil System**

The fuel-injection system shall be complete with PT fuel pump, injectors, fuel filters and self-contained piping.

The system shall generally comprise of

- Day tanks capacity shall be for 10 hour running at 75% load.

- Pumps required for conveying fuel from day tank to engine. Critical pumps should be provided in sets (1 working + 1 standby)
- The day tank shall also act as a relief and by-pass tank for fuel oil that is circulated to the injectors whereupon any excess fuel is by-passed back to the day tank.

#### Fuel Filtering System

- The primary filtering system shall be located at day tank inlet.
- In addition the engine shall have secondary filtering system.

Both filters shall be capable of absorbing water.

#### l) Lubricating Oil System

The pressure lubrication system shall be used. The filter shall be of simplex type with parallel element. The full flow lubricating oil filter can be mounted on the lubricating pump or remote mounted with flexible lines.

#### m) Piping and other Associated Connections

All piping, flexible connections, flange valves, seals, fittings etc. shall be supplied by the Contractor for all the associated auxiliaries of equipment.

### 8.2.11.4 Alternator

#### a) General Requirements

- **Type:** The Generator shall be air cooled, brushless, 3 phase, fan ventilated, synchronous type fitted with heavy duty, long life ball or roller bearing with forced lubrication or lubricant packed for approximately 4000 hours of running without attention. The alternator shall be manufactured in accordance with BS 2613 IEE-341 or as per relevant BIS, ISO, DIN, NEMA, standard. The unit shall be horizontally mounted.
- **Protection:** Enclosure shall possess minimum IP23 degree of protection.
- **Insulation:** Insulation throughout shall be class H, temperature rise by resistance. All windings shall be impregnated to allow operation in climatic conditions specified in this volume.
- **The Alternator shall be provided with following minimum accessories:**
  - Resistance temperature detectors
  - Bearing temperature detectors
  - Space heaters.

#### b) Basic Ratings

The basic ratings of the Alternator shall be as follows:

- Rated voltage : 415 Volts
- Speed : 1500 rpm
- Rated power output : As specified (Continuous rating)

- Frequency : 50 Hz
- Number of phases : Three
- Power Factor : 0.8
- Type : Brushless, synchronous, self-excited self-regulated
- Neutral Earthing : Solid grounding
- Voltage regulation : +1% of rated voltage from no load to full load at any power factor between 0.8 lagging and unity
- Type of cooling and : Self cooled fan ventilated ventilation

**c) Metering and AMF Control Panel**

This is intended for operation of DG set in auto mode. The panel shall be sheet steel construction and arranged for free standing, floor mounting, bottom entry with front and rear access. The interior wiring of the cubicle shall be looped and clipped and all wire ends are to be clearly identified. Any printed circuit boards shall be tropicalized.

Following metering and protection devices as a minimum requirement shall be included in each panel:

- Metering Instruments
  - Voltmeter with selector switch
  - Ammeter with selector switch
  - Frequency meter
  - KW meter
  - Battery voltmeter
  - Power factor meter
  - Hours run indicator
  - KWH meter
  - KVAR meter
  - Excitation current ammeter
  - Excitation voltmeter
  - Engine Speed Indicator
- Push Buttons
  - Engine start PB.
  - Engine Stop PB.
  - Lamp Test PB.
  - Reset PB.
  - Emergency Trip PB.

- Indication Lamps
  - DG set on
  - Load on DG set
  - Set running
  - Mains available
  - Mains failure
  - Start failure
  - Generator over current
  - Generator high voltage
  - Generator low voltage
  - Earth fault
  - High engine speed
  - Low engine speed
  - Low fuel level
  - High fuel level
  - Charge failure
  - Generator winding temperature high
  - High bearing temp.
  - Low lubricating oil pressure
  - High lubricating oil temp.
  - Engine jacket water temp. high
  - Engine jacket water pressure low
  - Reverse power
  - Low fuel oil pressure
  - Rotor diode failure
- Protective Relays
  - IDMT relay (Over current and earth fault)
  - Over voltage relay
  - Under voltage relay
  - Reverse power relay
  - Field failure relay
  - Differential relay
  - Phase failure relay

- MFT
- Voltage – Ph-to-Ph & Ph-to-N
- Current –line to neutral
- Power – kW, kVAH, kVAR (Avg. & Ph. wise)
- Energy – kWH, kVAH, kVARH
- Power Factor – Average & Ph. wise.
- System frequency
- Import & export kWH & kVARH.
- RS 485 MOD BUS

### **8.2.12 415 V Capacitor Bank with Automatic Power Factor (PF) Correction Control Panels**

415 V Automatic Power Factor Control Panels shall comprise of 415V circuit breaker, PF Meter, Automatic PF Correction Relay with Capacitor Banks of suitable rating as indicated in the attached Single Line Diagram. Ratings shown in the SLDs are indicative. Contractor shall perform their own calculations to verify the size and submit the same to Employer for verification. Number of steps shall be based on 10kVAR power step minimum. The capacitor banks ratings shall be finally selected to provide a power factor of 0.95 lag on the bus. Zero step shall also be provided.

Harmonic Filters for Automatic Power Factor correction shall be provided. The Harmonic Filters shall be designed in such a way that the THD shall be less than 8%. Capacitor duty contactors to be installed for capacitor banks. Capacitor bank shall be of phase cap type construction gas filled capacitors.

### **8.2.13 Public Address System**

#### **8.2.13.1 General**

- a) The system shall be distributed amplifier type for indoor/outdoor usages
- b) The nominal voltage of the system shall be 240V, single phase 50 Hz except that power supply of reduced voltage is specified for certain purposes. All the equipments and materials shall be suitable for the system voltage unless otherwise specified.
- c) The design of the Communication System shall be in accordance with the requirements of this specification and the best current engineering practice, together with the following general requirements:
- d) The minimum enclosure protection degree of the system components shall be in accordance with IEC 529 as follows:
  - Outdoor IP 55.
  - Indoor IP 41



### 8.2.13.2 Operational Feature

The basic system shall incorporate the following operational features:

- a) It shall be possible to make announcements by lifting any of the microphone hand sets and speaking into the mouth piece. The announcement shall be heard over all the speakers within the area.
- b) It shall be possible for the called party to reply by moving to the nearest microphone hand set station and lifting the microphone hand set off the hook switch. The conversation now shall proceed between the caller and called party over the channel. This shall be heard over all the loud speakers. The system shall be of common talking type allowing any handset station to take part in the conversation.
- c) Lifting of a handset off the hook shall automatically mute the adjacent loudspeaker. This is required to prevent the acoustic coupling and feed back to the local handset mouthpiece transmitter.
- d) Facilities shall be provided to generate a 400 Cycles signal which will be used as siren during emergency. This tone signal shall also be used to test all amplifiers and loudspeakers circuits. A tone/test switch shall be provided on the amplifiers rack to initiate the siren. Provision shall be made for testing all microphones and associated circuits.
- e) The Contractor shall propose a suitable scheme to overcome the problems generally associated with long distance propagation of voice signal and paging and shall submit the details of offered scheme showing schematic diagram, system write-up and other necessary details.

### 8.2.13.3 Component Specification

#### f) Amplifier

The rated output power of the inbuilt amplifiers in any handset station shall be adequate to cater to microphone handset and specified number of loudspeakers. If the amplifier has sensitivity sufficient to operate only from the highest input voltage likely to be met with, the same has to be supplemented with pre-amplifier for use with source at lower voltage. The frequency response, harmonic distortion and the signal to noise ratio shall be as per the relevant standards. Amplifiers shall incorporate safeguards against excessive voltage or current rise in case of open circuit conditions or short circuit conditions respectively, in the output circuit. Volume and tone control shall be provided.

#### g) Loudspeakers

The loudspeakers shall be of high efficiency, high peak power drive units in weather-proof design of rugged metal construction designed for non-ringing and shall deliver clear, faithful voice reproduction through any degree of noise level.

Facilities shall be provided for easy orientation of the speaker units over wide horizontal and vertical plane after the assembly has been mounted. Suitable means for locking in any position shall be provided on each speaker. Electrical filter at the line matching transformer shall be incorporated to cut off low frequencies to avoid damage to the voice coil at low frequencies. The power handling capacity of the transformer shall be not less than the power to be absorbed by the speaker. The transformer primary and secondary shall have

suitable caps to match the voltage tap at the amplifier output transformer and loudspeaker impedance respectively. Volume control shall be provided in horn type and cone type loudspeakers; no provision shall be kept in bidirectional horn type loudspeakers.

Loudspeakers shall preferably be rated for 15 W and shall be suitable for outdoor operation in areas with high ambient noise level. These speakers shall have good directional properties and high acoustical efficiency. The driver impedance matching transformer and all other accessories shall be housed in steel enclosure designed for wall or steel structure mounting. All necessary accessories shall be dust, vermin and weather-proof provided with neoprene gasket covers. Necessary provision shall be made for terminating incoming cable. Loudspeakers suitable for indoor use shall be rated for 6 watts. These shall be cone type and suitable for wall mounting. These shall be provided with buffer of thick plywood. Enclosure interior shall be padded with suitable lining for damping.

#### **h) Hand Set Station**

Each hand set station shall comprise of a microphone hand set unit. Handset station shall be wall mounting type.

Handset microphones shall be of low impedance, dynamic type, with highly directional characteristic designed for close talking and minimum acoustic coupling and feedback. The handset shall pick up only the operator's voice and shall shield out extraneous noise.

Handset shall be provided with special neoprene covered shielded, retroactive coiled core type cable of length not less than 3 metres to provide freedom of movement.

Handset mouth pieces shall be protected from dirt and other foreign particles by means of filters.

The handset shall be equipped with locking type plug and socket to permit easy removal and replacement of handset when desired, without disturbing the soldered connection.

Handset stations and all associated equipment shall be completely assembled and wired at factory on a conduit core ready for mounting on conduit box and attached directly to field conduit. In case of handset stations for outdoor locations robust, weather-proof enclosures designed for direct connection to field conduit shall be provided.

#### **i) Signal Cable**

The signal cable shall be annealed, high conductivity bunched copper conductor, twisted, PVC insulated, colour coded, PVC sheathed and armoured cables.

### **8.2.14 Indicative Technical Data Sheet**

#### **8.2.14.1 General:**

- a)** Tenderer shall provide all information requested in this schedule and in the specification. The items requiring description shall not be limited by the list that follows. The Tenderer shall ensure that the variation in data furnished now and after detail design stage shall be within +10 % in respect of cases such as weight, loads in different conditions, etc.
- b)** Any deviation from the technical specifications shall be clearly indicated under a separate heading "DEVIATION FROM TECHNICAL SPECIFICATIONS" otherwise it will be construed that there is no deviation from the technical specifications.

### 8.2.14.2 HT Switchgear (All ratings)

<b>A.</b>	<b>Switchgear Panel</b>	
1.	Make and type designation	
2.	System :	
	a) Rated voltage	kV
	b) Highest system voltage	kV
	c) Number of phases and rated frequency	
3.	Service	Indoor/Outdoor
4.	Enclosure :	
	a) Thickness of sheet steel	
	b) Degree of protection offered by enclosure	
5.	Number of circuits	
6.	Busbars :	
	a) Busbar material and grade	
	b) Cross-section of busbars and rated busbar current	sq.mm. & ...Amp.
	c) Minimum phase to phase clearance	mm
	d) Minimum phase to earth clearance	mm
	e) Temperature rise over 40 deg.C ambient	deg.C
	f) Disposition of busbars	
	g) Earth Bus :	
	• Size	
	• Material	
7.	Rated power frequency withstand voltage	kA
8.	Rate short circuit breaking current	

9.	Rated short time current & duration	kA
10.	Total VA burden (for all panels) to be considered for battery AH calculations	
11.	Tests :	
	a) Routine tests : (Confirm whether the following are covered)	
	i) Power frequency voltage withstand on main and auxiliary circuits	
	ii) Operation check for proper functioning of control switches, meters, relays, indicating lamps and safety interlocks	
	iii) Insulation resistance measurement before and after power frequency voltage withstand	
	b) Type tests: (Type test certificates to be furnished for tests conducted on switchgear having busbar and connections of the same cross-section)	
	i) Power frequency withstand voltage	
	ii) Short-time current and dynamic withstand	
	iii) Temperature-rise	
	iv) Test to establish degree of protection offered by enclosure	
12.	Dimensions (WxDxH)	
	a) 33 KV Circuit Breaker Panel	
	b) 11 KV Circuit Breaker Panel	
13.	Approximate weight :	
	a) 33 KV Circuit Breaker Panel	
	b) 11 KV Circuit Breaker Panel	
14.	Painting :	
	a) Type	
	b) Outer Finish	

	c) Inner Finish	
	33 KV/11 KV Circuit Breakers (Data to be provided for each rating)	
1.	Make and Type designation	
2.	Type of circuit breaker	
3.	a) Rated voltage and frequency	kV/Hz
	b) Maximum continuous service voltage	kV
	c) Rated Current :	
	i) Under normal condition	A
	ii) Under site condition	A
	d) Short-time current rating 1 sec.	kA
	e) Breaking symmetrical current	kA
	f) Making capacity	kA peak
4.	Operating time :	
	a) Closing time	ms
	b) Opening time	ms
	c) Arc duration at 100% rated breaking current	
5.	a) Type of operating mechanism :	
	i) Closing	
	ii) Tripping	
	b) Power required at rated supply :	
	i) Closing coil	
	ii) Tripping coil	
6.	Rated operating sequence	

7.	a) Dry one minute power frequency withstand voltage	kV rms
	b) Full wave 1.2/50 micro sec. impulse withstand voltage	kV peak
8.	Minimum clearance in air :	
	a) between phases	
	b) live parts to earth	
	c) centre to centre distance between phases	
9.	Weight of circuit breaker	
10.	Dimensions (WxDxH)	
11.	Tests :	
	a) Routine test : (Confirm whether the following are covered)	
	i) Measurement of resistance of main circuit	
	ii) Operation test	
	iii) One minute power frequency voltage withstand test on main circuit	
	iv) One minute power frequency withstand test on auxiliary circuit	
	v) Measurement of insulation resistance before and after power frequency voltage withstand test	
	b) Type tests : (Type test certificates for tests conducted on identical circuit breakers shall be furnished)	
	i) Temperature rise measurement of main circuit	
	ii) Temperature rise measurement of auxiliary circuit	
	iii) Measurement of resistance of main contacts	
	iv) Operating test	
	v) Mechanical endurance	
	vi) Impulse voltage withstand	
	vii) One minute power frequency withstand	

	viii) Test for short circuit conditions	
--	---	--

#### 8.2.14.3 HT Cables (All voltage grades):

<b>A.</b>	<b>General</b>	
1.	Name of Manufacturer	
2.	Address of Manufacturer	
3.	Locations of major works	
4.	Service facilities	
<b>B.</b>	<b>General Cable Data</b>	
1.	Standards to which the cables are quoted	
2.	Voltage Grade	
3.	Type of cable	
4.	Conductor :	
	a) Material of conductor	
	b) Special treatment on conductor, if any	
	c) Nominal number of strands per conductor	
	d) Nominal diameter of each strand in mm.	
	e) Nominal cross section area of conductor in mm.	
	f) Reactance per phase at 50 C/S-ohm/km	
	g) Shape of conductor	
	h) Maximum resistance of conductor at 20 deg.C ohm/km. (DC resistance)	
5.	Insulation :	
	a) Composition of insulation and type	
	b) Minimum thickness of insulation-in mm and method of drawing viz. by extrusion	
	c) Specific insulation resistance of the insulating material at 60°C -in ohm-cm.	
	d) Minimum insulation resistance of the finished cable per km. at 20°C in megohm	

	e) Maximum conductor operating temperature under normal (continuous) operation- deg.C and min. tensile strength - kg/cm.sq.	
	f) Minimum elongation (Normal)	
	g) Maximum conductor temperature under short circuit - deg.C	
6.	Inner Sheath :	
	a) Composition of inner sheath and type	
	b) Thickness of inner sheath and method of drawing, viz. by extrusion	
	c) Diameter of cable over inner sheath but below armour wire in mm.	
7.	Armouring and Bedding :	
	a) Material of the armour	
	b) Type of armouring (round wire required)	
	c) Dimensions of armour wire	
	d) Whether single layer or double layer armour	
	e) Minimum tensile strength of armour wire kg./sq. cm.	
	f) Diameter of cable over armouring - mm	
	g) Bedding particulars viz. material, thickness, method of drawing etc.	
8.	Non-conducting water swellable tape	
	a) Material of the tape	
	b) Thickness of the tape	
9.	Outer Sheath :	
	a) Composition of outer sheath material and type	
	b) Thickness of outer sheath and method of drawing viz. by extrusion	
	c) Diameter over outer sheath in mm.	
10.	Current Ratings : Continuous current carrying capacity for conditions of installations stand below shall be stated clearly:	
	a) Maximum conductor temp	



	b) Ambient air temp	deg.C
	c) Depth of laying	cm
	d) Thermal resistivity of soil	cm/W
	e) Method of installation For conditions of installations different from that of basic assumptions sufficient and suitable rating factors shall be furnished and shall be according to relevant standard, if any.	
11.	Weights and Dimensions	
	a) Approx. net weight of cable - kg/km.	
	b) Maximum overall diameter of cable - mm	
	c) Normal delivery length of cable - meter	
	d) Approx. gross weight per drum - kg.	
	e) Size of drum Approx. flange diameter - mm.	
	f) Minimum bending radius of finished cable	

#### 8.2.14.4 3.0 L.V. Panels:

<b>A.</b>	<b>Construction</b>	
1.	Make	
2.	Type	
3.	Whether single/double front construction	
4.	Type of mounting	
5.	Degree of protection of enclosure	
6.	Sheet steel thickness (mm)	
7.	Dimensions of each vertical section panel (mm)	
8.	Whether suitable for busduct termination at top	YES/NO
9.	Dimensions of cable alley (mm)	
10.	Whether space heaters provided in each vertical section complete with switch fuse and terminal blocks	YES/NO

11.	Whether extension facility is provided on both ends of the SWITCHGEAR	YES/NO
12.	Whether locking facility for each module provided	YES/NO
13.	Overall dimensions (L x W x H)	
14.	Weight	
<b>B)</b>	<b>Operating Conditions</b>	
1.	Short circuit rating (in kA)	
2.	Time of duration for short circuit current (sec.)	
3.	Temp. rise allowed based on site ambient temperature (50deg.C)	
	- Busbar chamber	
	- Cable alley and wire way	
	- Individual feeder module	
	- Busbar	
<b>C)</b>	<b>Busbars</b>	
1.	Material	
2.	Grade and composition	
3.	No. of busbars	
	- Main horizontal busbars	
	- Vertical dropper busbars	
4.	Continuous current rating of busbar and temp. rise over 50 deg.C ambient	
5.	Phase to phase and phase to earth clearances	
6.	Whether sleeving or shrouding provided for busbar	YES/NO
7.	Whether separate earth bus provided	Yes/No
8.	Earth bus size	
<b>D)</b>	<b>Power cable connection :</b>	

1.	Type, make and material of power cable terminals	
2.	Whether power cable terminating arrangement suitable for termination of cables specified	Yes/No
<b>E)</b>	<b>Control Cable Connection :</b>	
1.	Type, make material for control terminals	
2.	Type of control connection from the withdrawable unit to the fixed portion	
3.	Cable size of control wiring	
<b>F)</b>	<b>Switchgear Equipment</b>	
1.	<b>Air Circuit Breaker/MCCB</b>	
	a) Rated operational voltage	
	b) Rated insulation voltage	
	- Main circuit	
	- Auxiliary circuit	
	c) Rated current	
	d) Rated making capacity (peak)	
	e) Rated breaking capacity (r.m.s.)	
	f) Rated peak withstand current	
	g) Rated Short time current and its duration	
	h) Voltage rating of motor drive	
	i) Overload/short circuit/earth fault releases	
	j) Auxiliary contacts	
	k) Make	
2.	<b>Overload Relay</b>	
	a) Type and make	
	b) Whether ambient temperature compensated	

	c) Whether handreset type	Yes/No
	d) Whether single phasing protection provided	YES/NO
3.	<b>Push Button</b>	
	a) Type & make	
	b) Contact rating at 110V, 50 Hz A.C.	
	c) Whether 'stop' (red) push button is provided 'unshrouded' type	Yes/No
	d) i. Whether separate "Yellow" push button provided for overload reset.	Yes/No
	ii. Whether separate white push button is provided for single phase protection reset	Yes/No
	e) No. of 'NO' & 'NC' contact in a standard stack.	
4.	<b>Meters</b>	
	a) Type & make	
	b) Range of meters	
	c) Instrument accuracy class as per relevant IS	
	d) Whether suppressed scale ammeters are provided for motor starting current in motor feeders.	
5.	<b>Current Transformers</b>	
	a) Type & Make	
	b) Voltage class	
	c) Accuracy class of C.T.	
	d) V.A. Burden	
6.	<b>Potential Transformers</b>	
	a) Type & make	
	b) Voltage class	
	c) VA burden	
	- Whether leaflets and catalogues for the following showing the technical particulars, characteristic curves,	YES/NO

	contact numbers and rating etc. enclosed herewith	
	▪ Combined over current and earth fault relay	
	▪ Under voltage relay	
	▪ Over voltage relay	
	▪ Motor protection relay	

#### 8.2.14.5 L.V. Cables (Power and Control):

1.	<b>General</b>	
	a) Name of Manufacturer	
	b) Address of Manufacturer	
	c) Locations of major works	
	d) Service facilities	
2.	<b>General Cable Data</b>	
	a) Standards to which the cables are quoted	
	b) Voltage Grade	
	c) Type of cable	
	d) Conductor :	
	i) Material of conductor	
	ii) Special treatment on conductor, if any	
	iii) Nominal number of strands per conductor	
	iv) Nominal diameter of each strand in mm.	
	v) Nominal cross section area of conductor in mm.	
	vi) Reactance per phase at 50 C/S-ohm/km	
	vii) Shape of conductor	
	viii) Maximum resistance of conductor at 20 deg.C ohm/km. (DC resistance)	
	e) Insulation :	

	i) Composition of insulation and type	
	ii) Minimum thickness of insulation-in mm and method of drawing viz. by extrusion	
	iii) Specific insulation resistance of the insulating material at 60 deg C-in ohm-cm.	
	iv) Minimum insulation resistance of the finished cable per km. at 20deg. C in megohm	
	v) Maximum conductor operating temperature under normal (continuous) operation- deg.C and min. tensile strength - kg/cm.sq.	
	vi) Minimum elongation (Normal)	
	vii) Maximum conductor temperature under short circuit - deg.C	
	<b>f) Inner Sheath</b>	
	i) Composition of inner sheath and type	
	ii) Thickness of inner sheath and method of drawing, viz. by extrusion	
	iii) Diameter of cable over inner sheath but below armour wire in mm.	
	<b>g) Armouring and Bedding</b>	
	i) Material of the armour	
	ii) Type of armouring (Whether round wire or flat wire)	
	iii) Dimensions of armour wire	
	iv) Whether single layer or double layer armour	
	v) Minimum tensile strength of armour wire kg./sq. cm.	
	vi) Diameter of cable over armouring - mm	
	vii) Bedding particulars viz. material, thickness, method of drawing etc.	
	<b>h) Outer Sheath :</b>	
	i) Composition of outer sheath material and type	
	ii) Thickness of outer sheath and method of drawing viz. by extrusion	
	iii) Diameter over outer sheath in mm.	

	<b>i) Current Ratings :</b>  Continuous current carrying capacity for conditions of installations stand below shall be stated clearly:	
	i) Maximum conductor temp	
	ii) Ambient air temp	deg.C
	iii) Depth of laying	Cm
	iv) Method of installation For conditions of installations different from that of basic assumptions sufficient and suitable rating factors shall be furnished and shall be according to relevant standard, if any.	
	<b>j) Weights and Dimensions</b>	
	i) Approx. net weight of cable - kg/km.	
	ii) Maximum overall diameter of cable - mm	
	iii) Normal delivery length of cable - meter	
	iv) Approx. gross weight per drum - kg.	
	v) Size of drum Approx. flange diameter - mm.	
	vi) Minimum bending radius of finished cable	

#### 8.2.14.6 Transformers (All Ratings):

1.	a) Manufacturer's Name	
	b) Whether all type test conducted on an identical transformers	YES/NO
	c) Whether Technical leaflets/ catalogues enclosed	YES/NO
2.	<b>Technical Data (All Ratings)</b>	
	a) Service	Indoor/Outdoor
	b) kVA rating	
	c) Rated Voltage :	
	i) HV winding	Kv
	ii) LV winding	kV
	d) Rated frequency	Hz

	e) Number of phases	
	f) Connections :	
	i) HV winding	
	ii) LV winding	
	g) Connection symbol/vector group and reference temperature	
	h) Tapping :	
	i) Range	
	ii) Number of steps	
	i) Type of cooling	ON AN
	j) Temperature rise over 45 deg.C ambient	
	i) Winding (Temperature rise measured by resistance method)	deg.C.
	k) Total loss at rated voltage at principal tapping and frequency	kW
	l) Component losses	
	i) No load loss at rated voltage on principal tapping and rated frequency	kW
	ii) Load loss at rated current at principal tapping at 75 deg.C	kW
	m) Impedance voltage at rated current for principal tapping	%
	n) Reactance at rated current and frequency	%
	o) No load current at rated voltage and frequency	%
	p) Insulation level :	
	i) Separate source power frequency voltage withstand	
	▪ HV winding	kV rms
	▪ LV winding	kV rms
	ii) Induced over voltage withstand	
	▪ HV winding	kV rms
	▪ LV winding	kV rms



	iii) Full wave lightning impulse(1.2/50 micro second) withstand voltage on HV winding	kV peak
	q) Efficiency at 75 deg.C at unity power factor :	
	i) At full load	%
	ii) At 3/4 full load	%
	iii) At 1/2 full load	%
	r) Regulation at full load at 75 deg.C :	
	i) At unity power factor	%
	ii) At 0.8 power factor lagging	%
	s) Terminal arrangement :	
	i) HV side	
	ii) LV side	
	iii) Neutral	
	iv) Creepage distance	mm
	t) Insulation	
	u) Approximate weight :	
	i) Core and winding	kg
	ii) Tank, fittings and accessories	kg
	iii) Total weight	kg
	v) Approximate overall dimensions	
	iv) Length	mm
	v) Breadth	mm
	vi) Height	mm
	w) Untanking Height	mm
	x) Whether outline dimensional drawing of transformer enclosed	YES/NO
	y) - Conductor material HV/LV	

	Max. current density	
	Core Material	
	Max. flux density	
<b>3.</b>	<b>Fittings :</b> (Out of following, list out fittings covered in offer)	
	a) Sampling valve	
	b) Air release plug	
	c) Double flanged valve in feed pipe to gas and oil actuated relay	
	d) Explosion vent	
	e) Dehydrating breather	
	f) Dial type thermometer	
	g) Winding temperature indicator	
	h) Separate neutral bushing	
	i) Neutral current transformer	
	j) Jacking pads	
	k) Lifting lugs for active parts	
	l) Marshalling box	
	m) Disconnecting chamber on HV side	
	n) Cable box with cable glands & lugs	
	o) HV bushings with arcing horns	
	p) HV & LV bushings	
	q) Earthing pads with clamps	
	r) Bidirectional wheels	
	s) Diagram and rating plate	

#### 8.2.14.7 Battery, Battery Charger and DC Distribution Board:

<b>1.</b>	<b>Battery :</b>	
-----------	------------------	--

	a) Make and type designation	
	b) Type of Battery	
	c) Rating :	
	i) Battery voltage	VDC
	ii) Number of cells	
	iii) Nominal cell voltage	VDC
	iv) Ampere hour rating at one hour discharge	A
	v) Reference ambient temperature	deg.C
	d) Reference standards	
	e) General arrangement drawing	
<b>2.</b>	<b>Battery Charger :</b>	
	a) Make and type designation	
	b) Rating :	
	i) Output voltage and nominal DC current rating V/A DC	
	ii) Float voltage variation as a percentage of output voltage setting for:	
	▪ a load current	%
	▪ a variation in AC supply	+%
	▪ range of ambient temperature	deg.C
	c) AC rms ripple current as a percentage of nominal DC current rating	%
	d) Charging modes, float/boost	
	e) Charging input voltage ranges of:	
	▪ float	V to V
	▪ boost	V to V
	f) Diagram of charger	
	g) Reference standards	

<b>3.</b>	<b>DC Distribution Board</b>	
	a) Make and type designation	
	b) System :	
	i) Nominal system voltage	V
	ii) Highest system voltage	V
	c) Circuits :	
	i) Number of circuits	A
	ii) Circuit rating	A
	iii) Circuit breaker rating	A
	d) - Busbar rating	sq.mm.
	- Cross section of busbar	
	- Material of busbar	
	- Temperature rise over reference ambient of 45 deg.C	deg.C
	e) Enclosure :	
	i) Thickness of sheet steel	
	ii) Degree of protection offered by enclosure	
	f) General arrangement drawing	
	g) Reference standards	

#### 8.2.14.8 Capacitor Bank:

<b>1.</b>	<b>Capacitor</b>	
	a) Rated voltage	
	b) Rated output	
	c) Rated current	
	d) Rated frequency	
	e) Type	Indoor/Outdoor

	f) Bank arrangement	
	g) Connection type	
	h) Number of units per bank	
	i) Bank protection (internal fuse/ external fuse)	
	j) Loss	W KVAR
	k) Bank mounting arrangement	
	l) Power frequency withstand voltage	kV rms
	m) Impulse withstand voltage	kV peak
<b>2.</b>	<b>Series Reactor</b>	
	a) Rated voltage	
	b) Rated kVAR	
	c) Rated current	
	d) Type	
	e) Reactance per phase	

#### 8.2.14.9 NGR:

1.	Rated Voltage	
2.	Rated Duty	
3.	Rated Current	
4.	Rated Resistance	
5.	Temp. rise over ambient	

#### 8.2.15 List of Approved Makes

Make of the equipment under supply items shall be selected as per the following list. Employer, however, reserves, the right to select the particular make during detailed engineering for uniform design and inventory. Approval of makes for items not mentioned in this list shall be obtained from Employer/Employer's Representative Engineer before initiating procurement action.

S. No.	Equipment / Component	Preferred Makes
--------	-----------------------	-----------------

S. No.	Equipment / Component	Preferred Makes
1.	Power Transformer	ABB/VoltAmp/Bharat Bijlee/Schneider
2.	Dry Type Transformer	Pete Transformer/ VoltAmp / T&R / Schnieder
3.	HT Switchgear Panel	ABB/Schneider/Siemens
4.	LT Switchgear Panel (Indoor)	ABB/Schneider/Siemens/L&T/ SS Control / Akshar Pyrotech/ Horizon / Authorized partners for OEMs (Neptune/Enerlec/Ambit)
5.	LT Switchgear Panel for CSS (Outdoor)	ABB/Schneider/Siemens/L&T/ SS Control / Akshar Pyrotech/ Horizon / Authorized partners for OEMs (Neptune/Enerlec/Ambit)
6.	Distribution Boards	Legrand / Havells/Adlec
7.	Compact Substation (CSS)	ABB/Schneider/Siemens
8.	HT cables	Ravin/ CCI/ Finolex/Torrent/KEC International-RPG/ Universal
9.	LT Power cables	Havells/Ravin/CCI/KEI/Finolex/Torrent/KEC International-RPG/Universal / Avocab
10.	Control Cables, Wires & Flexible cables	Havells/Ravin/Finolex/Torrent/KEC International-RPG/Universal/Apar / Avocab/Thermo cab/ Lapp
11.	Cable Glands/Lugs	Jainsons / Dowells
12.	Cable Trays	Ercon / Indiana / Industrial Perforation / Sintex / MM Engineering /OBO /EPP/Sumip/Ercon
13.	Capacitor Panel with Banks and other related accessories	L&T / EPCOS / Schneider / ABB
14.	Battery	Exide / Amco / HBL
15.	LED Lighting fixture (Indoor)	Bajaj / Philips / Syska / Havells / Surya
16.	High Mast with LED Lighting fixture	Bajaj /Philips/CGL/Lighting Technologies
17.	Plate-Switches & Sockets, Boxes	MK / Crabtree (Havells) / Anchor/Roma/Legrand
18.	VCB	ABB / Schneider/Siemens
19.	ACB	ABB / Schneider/Siemens
20.	MCCB	ABB / Schneider/Siemens / L&T
21.	MCB / ELCB / RCB / MPCB	Schneider/Siemens / L&T/Legrand/ABB
22.	Fuse/Link	Siemens / L&T / Schneider
23.	Indicating Lamps / Push buttons	Siemens / Schneider / Teknic / Kaycee / L&T
24.	Meters (digital) MFM	Schneider(Conzerv)/ Secure/ABB/Siemens
25.	Voltmeter / Ammeter / PF Meter / Frequency Meter/ KWH Meter	AEI / Rishabh
26.	Selector Switch	L&T / Siemens / Schneider

S. No.	Equipment / Component	Preferred Makes
27.	Auxiliary Contactors/ Relays	L&T / Siemens
28.	Protective/ Auxiliary Relays	Siemens / ABB
29.	Terminal Blocks	Elmex / Connect Well
30.	Current Transformer/ Potential Transformer	AE / Kappa / Precise/ Neptune
31.	Power & Welding Sockets	Hensel/Mennekes/Neptune-Bals
32.	PVC Conduit and accessories	BEC / Polypack / Precision /AKG
33.	Cable Termination Kits & Straight Through Joints	Raychem / M-Seal (3M) (For 33kV & above : Only Raychem)
34.	Chemical Earthing	Indelec / JMV/OBO/Uniearth/Any CPRI approved
35.	Lightning Protection (ESE Terminal)	Indelec/ Protek / Uniearth / APS
36.	Fibre Optic Cable	D-Link / Finolex / RPG Cables Ltd.

## 9. INSTRUMENTATION AND CONTROL

### 9.1 PLCs

The programmable controllers shall be of rugged design and quality to meet the functional requirements, capable of withstanding/bypassing high electric noise, electromagnetic interferences, vibrations etc.

The microprocessor based systems shall be of modular design and suitable for mounting in standard racks. Each module including rack/mount base shall be individually meta l e n c l o s e d dust and vermin proof for withstanding worst environmental and ambient conditions etc. Remote input/output cabinets shall be suitable for mounting on walls/columns in transfer towers or conveyor galleries and shall be in IP-65 degree of protection enclosures.

RTD (0-20mA) signals shall be processed in the PLC through an analog input card which wil l b e programmed for alarm and tripping the relevant drives in case of abnormal temperature of a n y RTD. Winding temperatures shall also be available on colour monitor VDU (in the fault w i n d o w ) when required by the operator. The scan rate for all RTD channels shall not be more than 2 ms.

The analogue module system shall also have provision to accept signals from the belt scales and other subsystems generating 4-20mA analogue signals. Proper conversion to standard units shall be done by control software.

The memory shall be EEPROM type and sufficient battery backup must be provided. The execution cycle of the PLC shall meet the functional requirement of plant.

In event of power failure during battery replacement the memory contents shall not be lost for at least 30 minutes. Battery down alarm/indication shall be available at least 20 days in advance both at the CCO and at the Maintenance Workshop.

The memory capacity of the PLC shall be adequate to perform the required functions satisfactorily and with 100% spare capacity for use in the future.

Dual redundancy (100% hot standby) shall be provided in the PLC's such that in case of failure of any of the processors, the hot stand by processor shall take over automatically. The changeover shall be smooth. Redundancy shall be provided for complete the processor subsystem including CPU, memory, power supply.

Each CPU shall be complete with required number of modules, main power supply unit, marshalling box, interconnection cables etc. and shall have screw type terminals for I/O connections.

A processor failure condition shall be indicated in the CCR and the Maintenance Workshop and change over to redundant systems shall be smooth. Extensive diagnostics shall be available for all intelligent modules of the system. The processor shall execute the programme for the plant operation at very high speed.

Input/output units shall be capable of accepting discrete, analog and digital i n p u t a n d o u t p u t devices. If the number of slots for input and output modules in the controller rack is not sufficient expansion units shall be connectable to the CPU by means of interface modules.



Signals to each remote interface unit shall be transmitted by means of the network.

I/O modules shall have status indications to indicate the proper functions of the modules and scanning of signals by the processor.

Each Input and Output module shall be electrically isolated from the controllers through opto-couplers or isolation transformers and shall withstand severe voltage transients without damage or adverse effect on the controller. Output modules shall incorporate self-contained damping networks and voltage limiting devices to prevent false triggering of outputs and to suppress line voltage spikes.

Each output card shall have fuses to protect its circuitry from over current and overloads.

PLC power supply units must have self-test facilities for detecting under voltage and also must be able to give alarm and switch over to UPS mode in case the output voltage is + 20% above the normal value.

The status indications for power 'ON', control supply healthy, overloads, by means of LED's should be available on the power supply unit. The equipment must be capable of accepting wide voltage fluctuations + 10% voltage + 3% frequency.

The Contractor shall furnish the power load details of his system and shall keep 30% spare capacity in the power supply excluding allowances for transformers, cable losses etc.

The Contractor shall provide separate grounding system for the PLC based control system equipment supplied with independent earth pits and earth grid of 8 SWG G.I. wire with PVC sleeve.

## 9.2 Remote Interface Units:-

It shall have mini processor, shall also perform the logical operation. It shall accept the command from main PLC; also it shall send and receive the data from CCO-PLC. It shall have RS-485 port interface to communicate with bought out panel/controllers (by others).

### a) Digital Input Module

#### Indicative Technical Specifications

Supply Voltages	DC 24 Volt Reverse Polarity Protection
Current Consumption	10mA
Isolation	Isolation should be checked with 500V DC (isolation by opto-couplers)
Dimensions(Max)	As per standards
Operating Condition	Temperature : 8°C-65°C Humidity : 8% -80%

Input Voltage For signal "0" For signal "1"	-6 to 6 V DC -15 to -57.6 V DC  Or other approved to meet the operational requirements
Input Current	7mA at 24 V DC

**b) Digital Output Module**

**Indicative Technical Specifications**

Supply Voltages	DC 24 Volt Reverse Polarity Protection
Short circuit protection of the output	As recommended per channel
Isolation	Isolation should be checked with 500V DC (isolation by opto-couplers)
Dimensions(Max)	As per standards
Operating Condition	Temperature : 8°C-65°C Humidity : 8% -80%
Output Voltage For signal "1"	24 +(-1.0 )V DC or any approved to meet the operational requirement
No. of Channels	8 per Group
No. of Groups	4

**c) Analog Input Modules**

**Indicative Technical Specifications**

Supply Voltages	DC 24Volt Reverse Polarity Protection
-----------------	--

Current Consumption	225 mA
Isolation	Isolation should be checked with 500V DC
Address space per module	4 byte
Dimensions(Max)	As per standards
Operating Condition	Temperature : 8°C - 65°C Humidity : 8% - 80%
Measurement Type/range	Deactivated/ 4 to 20 mA
Overflow / underflow	Disable/enable
Errors/accuracies Temperature errors	+ 0 to 2% K
No. of Channels	2/4 input channels
Conversion time (per channel)	55/65 ms
Cable length	With 1.5 sq.mm CU maximum up to 400 meters
Status information/alarms/diagnostics	Process alarm (yes)
Cycle time (all channels)	0.25 ms

**d) RTD Modules:-**

To read the temperature values from 6 RTDs from motor winding and 2 RTDs from motor bearing temperature

**Indicative Technical Specification**

Supply Voltages	DC 24Volt Reverse Polarity Protection
Current Consumption Isolation	225 mA Isolation should be checked with 500V DC
Address space per module	4 byte

Dimensions(Max)	As per standards
Operating Condition	Temperature : 8°C - 65°C Humidity : 8% - 80%
Overflow / underflow	Disable/enable
Errors/accuracies Temperature errors	+ 0 to 2% K
No. of Channels	2/3/4 wire RTDs(PT 100 tyoe)
Conversion time (per channel)	20/30 ms
Cable length	With 2.5 sq.mm CU maximum up to 400 meters
Status information/alarms/diagnostics	Process alarm (yes)
Cycle time (all channels)	0.25 ms

### 9.3 Uninterrupted Power Supplies (UPS)

These shall be provided for components/locations as indicated on HIPL 1-432 EC-01 R1, with rated output powers to suit the load in each case.

#### Indicative Technical Specifications

Rated output power	To serve the loads for 30 minutes
Input	230 Volts, AC + 10% at 50 Hz + 5%
Output	230 Volts, AC, 50 Hz
Output Tolerance	+ 1 % (Steady state)
Switch over Time	Less than 10 milliseconds
Design Reference Ambient Temperature	45 deg C

Stationary type Ni-Cd storage battery units(SMF) with closed top cells of capacity to meet the 60 minutes UPS backup requirements shall be complete with all accessories and devices. While sizing each battery the following factors shall be taken into consideration:

- Aging factor as 0.8

- Temperature correction factor
- Backup period - 30 minutes
- Power Factor - Unity

(Non-bypass mode)

## 9.4 Software

### 9.4.1 In General

Software provided shall be based to the maximum extent on standard packages to minimize complex programming tasks and facilitate support, maintenance and upgrading. Software shall be "user friendly".

The development of the application software shall be done in consultation with the Engineer in a number of stages (requirements definition, functional specifications, design, implementation and testing, maintenance and training) with each stage to the Engineer's approval. The final version of the software will be subject to the approval of the Owner.

The software shall meet the requirements of this specification for all of the management and control system functions and operations, and it shall be possible to develop it in further detail on site to meet the management and operating needs of the Owner.

Programs shall be rationally structured, well readable, easily revisable, and with man-machine interfaces displayed in English.

The software shall be suitable for use with multiple methods of English character input.

Manuals will be provided for all software in English

Proprietary software packages forming part of the software provided will include permanent run-time licences. If any part of the software requires annual licence fees, the cost of such fees will be indicated in the bid.

In any case the Owner shall have the right to freely develop, modify, maintain the application software, and shall provide the source code and all relevant manuals and information needed for this purpose.

Utility programmes shall be included in the software supply, including network management, multi-level password protection, on-line help, virus protection, and back-up and archiving, word processing, statistics, simulation and data communication.

Whenever an operator input data, a text window will be prompted on the display.

### 9.4.2 Control Software

The control software shall be used mainly to:

- Control the process flow operations
- Process operating instructions

- Control operating cycles and interlocking sequence logic
- Collect data automatically on equipment status and fault indication
- Collect and process data in real-time
- Transmit data and communicate with RIO s/subsystems/associated control devices/VFDs
- Receive input data on trains, trucks and ships
- Automatically diagnose faults in the complete system
- To provide a human interface for the operators
- Update the software programmes

The PLC programming language shall be of ladder type, functional block description, or other approved standard type. It shall be possible to program the system on-line. Facilities shall be provided to monitor the system on-line in addition to programming, using either mounted on PLC hardware or separately through a programming workstation so that forcing of I/Os, changing of timer/counter values, contact monitoring, error analysis etc are possible. The PLC/PCs shall read or write data from/to the RIO, workstations, VFD drives, associated control devices indicated on the Control Architecture Drawing and elsewhere in this specification.

A human interface/graphics package shall be part of the control software and shall communicate with the large VDUs and the operator's colour graphics workstations/PC's required. The databases shall be updated continuously in real time in not more than 1 second. All displays shall be dynamic and updated continuously, irrespective whether they are actually shown on the screens or not at the time. All page/graphic displays shall be programmable so they can be changed at any time to add additional information needed by a software engineer at the site off-line.

The software shall display the fault and alarm status of the plant components and shall be available in the data base at all times. The fault and alarm status shall be transferred to maintenance operator automatically.

The data base and data formats in the control system shall be identical to the management system databases.

## 9.5 Central Control Room and Related Rooms

The CCR will be housed on the second floor of the Substation 1 (SS1), which will house the CCR, a control equipment room, a computer room, UPS room, and offices.

In CCR the following equipment will be installed:

- Control desk for operation and monitoring;
- PC workstations;
- Printers;

- Public address system station;
- Central control console;

The consoles will be low profile, laid out ergonomically in an arc shaped pattern, to accommodate the equipment and the operators to permit efficient operations with a minimum of fatigue. The layout will be subject to the approval of the Engineer. Appropriate non-glare lighting shall be provided in the CCR, which shall be fully air conditioned and shall have sound absorbing paneling ceilings and walls.

The control equipment room will house equipment such as PLC panels, relay panels, distribution panels, control power panels, PA system amplifiers. The computer room will accommodate the network file servers, network devices; system engineers work station and printer. The UPS and associated batteries will be in a separate room. False floors shall be used in the CCR and the computer room to accommodate cabling and connections. The Contractor shall supply six revolving, ergonomic office chairs, media storage, bookcases for manuals, and filing cabinets.

## 9.6 Associated Control Devices/Sub-Systems

### 9.6.1 Introduction

Associated control devices are mainly individual equipment level control devices. One group of such devices shall be supplied and installed by the Contractor under this Contract. Another group of such devices or sub-systems shall be supplied and installed by others. The Contractor shall be responsible for the interconnection of **all** such devices/sub-systems with the control system under this specification and their integration with the software supplied by the Contractor. Please note that the interconnections shall be such that the **status** of all devices/sub-systems shall be transmitted to the control network irrespective of whether a motor drive is in the "local" or "auto" mode.

### 9.6.2 Control Devices by the Contractor

The following items shall be furnished, installed, connected, and integrated into the system by the Contractor in accordance with these specifications.

#### 9.6.2.1 Local Control stations

All local control stations shall be of SS 316 with powder coating up to 120 - 160 micron.

#### a) Conveyor Motor

Each electrical drive motor shall have two modes of operation; 'Local' and 'Auto', manually selectable by a three position selector switch "Local-Off-Auto". Each heavy duty selector switch shall be located close to and within view of each drive motor.

In the cases of conveyors with multiple motor drives, a *single* L-O-A switch shall be provided per conveyor near only one of the drive motors. However:

A maintained contact emergency stop switch shall be provided near the other drive motor(s).

The emergency stop switch shall have at least three sets of NC/NO potential free contacts rated

10amp at 110V DC in an IP-65 protected enclosure. A red mushroom type of actuator shall be used. There shall be two cable entries suitable for double compression glands (or better) for up to 10 x 2.5 sq mm copper conductor armored control cable. Earthing terminals shall be provided on the enclosure.

**b) Scoop coupling**

Each electrical actuator shall have three modes of operation; 'Local' and Remote and mechanically selectable by a three position selector switch with IN and OUT Push button for actuator. Each Local control station shall have Two indication lamps, to be provided for position of actuator 0 % or 100 %.

**c) Movable Head pulley and Flap gate**

Each Gate motor shall have two modes of operation; 'Local' and Remote selector switch with Forward and Reverse Push button. Each Local control station shall have indication lamps provided for position of gate

**d) Winch Motor**

Each Winch motor shall have two modes of operation; 'Local' and Remote selector switch with Forward and Reverse Push button.

**e) Pull Cord Emergency Switches**

Heavy duty enclosed epoxy painted dust and vermin proof Pull Cord Switches with IP-65 degree of protection shall be provided on both sides of conveyor at intervals of about 50 metres. The switches shall have a vertical lever with a suitable rope clamping device. It shall be feasible to actuate the switch in a maintained mode by pulling on the rope from either side of its normal vertical axis. A manual resetting lever shall be provided to reset the switch to its normal position. The switch shall have 2 NO + 2 NC potential free contacts suitable for 10 Amp at 110 V DC and a built in terminal box complete. Two numbers of earthing terminals suitable for 8 SW G I wire shall be provided on the body of the switch.

The Contractor shall ensure that the voltage drop at the receiving end of the control cable connections is within acceptable limits to ensure reliable operation and that delay in delivery of a stop signal to the drives is the minimum. (30 milliseconds or less)

**f) Belt Side Travel Switches (BSTS):-**

Heavy duty long vertical roller lever type belt side travel switches in epoxy painted IP 65 protected enclosure, shall be provided on both sides of Belt Conveyors at both ends. Sufficient over travel shall be provided to avoid damage during impact of the belt. This switch shall be a momentary contact/self-reset type. Each switch shall have 2 NO + 2 NC potential free contacts suitable for 10 Amp at 110V DC and shall be wired to an internal terminal block. Two numbers of earthing terminals suitable for 8 SW G I wire shall be provided on the body of the switch. These switches shall operate only in the Auto mode and shall stop the drive only after an adjustable time delay.

**g) Zero Speed Switches**



A non-contact electronic type Zero Speed Switch shall be provided on a tail end pulley of each Belt Conveyor. The switch shall have a sensing device and a monitoring unit. The switch shall serve to interlock the feeding conveyor and stop it or prevent it from starting if the pulley is not rotating at a preset speed (only in the automode). Suitable control cable shall be provided for connection between the sensor and the monitoring unit. 240 Volt AC power supply shall be provided for the monitoring unit. The actuator shall also be in the scope of supply and shall be mounted on the tail pulley. Each switch shall have 2 NO + 2 NC potential free contacts suitable for 10 Amp at 110VDC and shall be wired to internal terminal blocks. Three nos. cable entries suitable for double compression cable glands shall be provided in the monitoring unit. Two numbers earthing terminals suitable for 8SWG GI wire shall be provided on the enclosure of monitoring unit. The component enclosures shall meet IP: 65 protection standards.

#### **h) Belt Take Up Switches**

These switches shall be provided and installed so as to be actuated by an extreme movement of the conveyor belt take up should the belt tension not be adequate for any reason. Each switch shall be dust and vermin proof and shall have a degree of protection IP65. Each switch shall have 2 NO + 2 NC potential free contacts suitable for 10 Amp at 110V DC and shall be wired to an internal terminal block.

#### **i) Transfer Chute Blockage Switches**

These switches shall be provided in the transfer chutes at the head end of each conveyor and shall operate in both the local and auto modes. They shall be pressure plate type level indicators or rotary "Bin Indicator" types, or other approved types, which shall be actuated and maintain the switch contact on a "chute blocked" condition until the level of the material is reduced. It shall be an important requirement to ensure that these switches will not be affected by dusty conditions, will not be damaged by the material flow, and will survive being buried temporarily in the material. These switches shall be dust and vermin proof and shall have IP: 65 degree of protection. Each switch shall have 2 NO + 2 NC potential free contacts suitable for 10 Amp at 110V DC and shall be wired to an internal terminal block. One or two number of cable entries suitable for double compression cable gland for 5\*2.5sq.mm/ copper conductor armoured cable shall be provided together with grounding lugs.

#### **j) Field Hooters**

These shall give an audible alarm before a conveyor, or movable head pulley commences to move; both in the auto and local mode. The hooters shall be capable of sounding continuously for a pre-settable interval. The alarm/ siren shall be motor driven. It shall work on 220 V AC, 1 phase.

More than one will be needed for long conveyors. Adequate numbers/conveyors shall be provided to ensure their audibility along-side the full conveyor length. The Contractor shall indicate the numbers required, the db ratings and the spacing to suit the db ratings proposed in his bid.

The housing of the hooters shall be IP-65 protected and shall have the appropriate terminals, cable connectors and grounding lugs.

#### **k) Heavy Duty Limit Switches**

Heavy duty Limit Switches shall be provided at every travel end of moveable head pulleys/winch drives. The enclosure shall be IP-65 degree of protection. It shall work in dusty and humid environment. The Contractor shall supply, install and terminate to respective MCC and nearby RIO.

## 9.7 Standards

### 9.7.1 In General

The design, manufacture and testing of equipment shall be carried out as per the latest Indian Standards, Indian Electricity Rules, Tariff Advisory Committee Regulations for Electrical Equipment, Statutory acts and rules as made by the Government of India or Government of Gujarat.

Where Indian Standards do not exist, the relevant applicable standards from the following codes shall apply:

- IEC : International Electro Technical Commission;
- ANSI : American National Standard Institute
- DIN : Deutsche Institute for Norms
- JIS : Japanese Industrial Standards
- ISO : International Organisation for Standardization
- IEEE : Institution of Electrical and Electronics Engineers

All electrical equipment and components shall be provided with dust proof, sealed and salt spray proof enclosures.

In places with dust hazard danger classified as Zone 21 and Zone 22 as per IEC standards, the electrical components shall be dust hazard proof.

For Zone 21 a minimum of IP6X, for Zone 22 a minimum of IP5X to IEC standards shall be required. Equipment and components supplied for use in dust explosion hazard areas will be marked in accordance with the standards and "Codes of Practice" of IEC or equivalent/approved standards of the country of origin.

For non-dust hazard areas the protection class for enclosures of electrical components will be at least IP4X for indoor installation and IP55 for outdoor installation, subject to the location and the working environment, or as called for in the specifications.

### 9.7.2 Applicable Standards

Some of the relevant Standards for equipment covered under this specification are given below:

IS: 5	Colour Codes of Paint
IS: 375	Marking of Busbars

IS: 694	PVC insulated cables for working voltages upto and including 1100 Volts, AC
IS: 1248	Indicating Instruments
IS: 2147	Degree of Protection for enclosures
IS: 2208	HRC cartridge fuse link upto 500 Volts
IS: 2419	Panel mounted indicating and recording electrical instruments
IS: 2959	Contactors
IS: 3202	Climate proofing of electrical equipment
IS: 4064	Air Break Switches
IS: 4237	General Requirements for Switchgear and Control gear for voltages not exceeding 1000 V AC
IS: 6005	Code of practice of phosphating iron and steel
IS: 6875	Control Switches
IS: 8623	Factory Built Assembly of Switchgear and Control gear
IS: 8828	Miniature Circuit Breaker
IS: 9224	Low Voltage Fuses
IS: 325	Three Phase Induction Motor
IS: 900	Code of Practice for installation and Maintenance of Induction Motor
IS: 1231	Dimensions of three phase foot mounted Induction Motor
IS: 4029	Guide for testing three phase Induction Motor

IS: 4691	Degree of Protection provided by enclosures for rotating Electrical machinery
IS: 4722	Rotating Electrical Machines
IS: 4728	Terminal Marking and direction of rotating electrical machinery
IS: 4889	Methods of determination of efficiency of rotating electrical machines
IS: 6362	Designation of method of cooling for rotating electrical machines
IS: 7816	Guide for testing Insulation resistance for rotating machines
IS: 12065 & BS: 4999	Permissible Noise levels
IEC: 72	Dimension of Induction Motor
IEC: 34	Three Phase induction Motor
IS: 8789	Values of performance characteristics for three phase induction motor
IS: 12075	Limits of Vibration severity
IS : 2026	Power Transformers
IS : 2099	Bushing for Alternating Voltage above 1000 Volts
IS : 3639	Fittings and Accessories for Power Transformers
IS : 2147	Degree of Protection for enclosures.
IS : 2705	Current Transformers
IS: 3156	Potential Transformers
IS: 6236	Ammeters.

IEEE C57.18.10	IEEE Standard Practices and Requirements for Semiconductor Power Rectifier Transformers.
IEC 61378	Converter Transformers
IEC 60204	Safety of Machinery
IEC-60056	Switchgear
IEEE-519	Recommended Practices for Harmonic Control in Electrical Power Systems.
IEC 6034	Guidance for the Design & Testing of AC Motors for Converter Supply
IEC 61800	Adjustable Speed Electrical Power Drive Systems

### 9.7.3 System Voltage Standards

The primary distribution at the port will be at 11 kV to the power distribution substations and to the primary of the VFD transformers. The system voltages at the receiving side shall be as follows:

Motor Control Centre and Distribution Boards	690/415 V, AC, 3 Ph, 50 Hz, 4 Wire grounded
Small Power and Miscellaneous Supplies	415/240V, AC, 4/2 Wire grounded
Control Circuits:	
Sequence Interlocking Control System	24V DC/48V DC, 110VDC AC 220V(direct wiring) 110 V, AC, 2 Wire grounded
Circuit Breaker Protection & Tripping Control System	110 V DC, 2 Wire grounded
Motor Control Centre	110 V AC, 2 Wire grounded DC 24/48/110/220 V

MCU, LDP, F.I (Remote) I/O	240 V, AC, 1-Phase, 50 Hz All equipment shall have internal close loop regulation & spike arrestors
VDU, Keyboard, Printer	240 V, AC, 1-Phase, 50 Hz All equipment shall have internal close loop regulation & spike arrestors
UPS System	Primary 240 V + 10%, AC, 50 HZ +/- 5%, 1 Ph, 2 Wire
Field Hooters Power Supply	240 V, 1 Ph, 50 Hz, AC

In case any other special voltages are required for his equipment it will be the responsibility of the contractor to generate the same in his own power distribution board.

## **10. CIVIL AND STRUCTURAL WORKS:**

### **10.1 Introduction**

The Kandla phase expansion of port is planned within the existing port limits. This note covers the Indicative basis of civil design for conveying system. Design basis for mechanical equipment or structural systems of the conveying system are not included in this document.

### **10.2 General**

The Scope of this document is intended to cover the design of all civil engineering work for various structure included under the Fertilizers MHS.

This document covers the General Description of:

- Structural framing system.
- Applicable latest Standards, Codes & Recommendations of the Bureau of Indian Standards Specifications / Indian Road Congress and Specifications published by Ministry of Road Transport and Highways (MORTH).
- All structures shall be designed for the most critical combinations of dead loads, live (imposed) loads, equipment loads, crane loads, wind loads, seismic loads, Design Parameters.
- Design methodology.
- Characteristics of construction materials to be adopted for the project.
- This DBR has been developed on the basis of relevant parts of the Technical specifications. In the absence of any particular aspects of structural Design of the element, suitable IS Specification and Codes of Practice, other recognized International Standards, Codes and Practices will be followed.

### **10.3 Site Information:**

#### **10.3.1 Site Location:**

The Major Port of Kandla is situated in the Gulf of Kutch on the West Coast of India, at latitude 23° 01' North longitude 70° 13' East. The Port serves a vast hinterland covering north and north-western parts of India. The Port is situated in the Kandla Creek and is 90 kms. from the mouth of Gulf of Kachchh.

#### **10.3.2 Seismic condition:**

The project site lies in the Seismic Zone–V as defined in IS 1893 (Part I): 2002

#### **10.3.3 Wind Condition:**

Kandla has a tropical humid climate with hot summers and the region is characterized by one seasonal monsoons:

- The South-West Monsoon extends from June to September is characterised by occurrence of rain, with predominantly south westerly winds.
- Basic Wind speed: 50 m/sec as defined in IS 875 (part III) -1998 (Cyclonic Condition).
- Operating Wind speed: 22 m/sec.

### **10.3.4 Rainfall**

Rainfall at Kandla is low. Annual average rainfall is about 322 mm per annum with the total number of rainy days of 17 per year, about 90% of which is received during the south-west monsoon season, i.e., between June and September with a maximum of 153 mm in July. April and May are dry months with average rainfall below 0.6 mm per month.

### **10.3.5 Temperature**

The mean daily maximum temperature is 34°C and with 45°C the highest occurring in May. Mean daily minimum temperature is 20°C and with 12°C the lowest occurring in January.

### **10.3.6 Visibility**

Throughout the year visibility is good as the region has zero fog days. However, during rains and squalls, the visibility deteriorates.

### **10.3.7 Relative Humidity**

Relative humidity is generally high and rises to about 80% during the monsoons in the month of August.

### **10.3.8 Cyclone**

In general the west coast of India is less prone to cyclonic storms compared to the east coast. It is observed from the cyclonic tracks in the Arabian Sea that only 6 storms endangering the Kandla coast have occurred till date with maximum speed recorded was 100 kmph. However, in 1998 a severe cyclone hit the Kandla Port with a wind speed of 150 kmph resulting in high tidal waves of 10.5m causing extensive damage to port installations.

### **10.3.9 Reference level:**

- a) Jetty for Berth-14 is under construction and proposed Jetty Top Level is - +9.14.
- b) Back up area filling and development has been done. Ground level is in slope, GL at Berth-14 end of the plot is +9.14 m and GL at entry side fencing gate is +8.6 m. Existing GL and Proposed Railway RL mentioned are indicative for reference. Bidder shall visit site and collect desired information as per requirement.
- c) Proposed Railway line work is in progress. Proposed Rail top level is - +9.29

## **10.4 References, Codes and Standards:**

The design and drawings will be developed on the basis of the standard codes and documents as:



Reference Code	Description
<b>IS:456 : 2000</b>	Code of Practice for Plain and Reinforced Concrete
<b>IS:875 : 1987</b>	Code of Practice for Design Loads for Building and Structures Part 1 – Dead Loads Part 2 – Imposed Loads Part 3 – Wind Loads Part 5 – Special Loads and Combinations
<b>IS:1080</b>	Code of Practice for Design and Construction of Shallow Foundation on Soils (other than raft, ring and shell)
<b>IS: 1786</b>	High Strength Deformed Steel Bars & Wires for Concrete Reinforcement.
<b>IS: 800 : 1984</b>	Code of practice for general construction in steel
<b>IS: 801: 1975</b>	Code of practice for use of cold formed light gauge steel Structural member in general building construction.
<b>IS 1893: Part 1: 2002</b>	Criteria for Earthquake Resistant Design of Structures Part I – General Provision and Buildings.
<b>IS 4326: 1993</b>	Code of Practice for Earth Quake Resistant design and construction of buildings.
<b>IS:2950</b>	Code of Practice for Design and Construction of Raft Foundations
<b>IS:2911:2010</b>	Part1 / Sec2 - Code of Practice for Design and Construction of Pile Foundations - Bored Cast in situ piles
<b>IS: 13920</b>	Code of Practice for Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces.
<b>IS:3370</b>	Code of Practice for Design and Construction for the liquid storage structures. Part I to IV.
<b>IS:1904</b>	Code of Practice for Design and Construction of Foundations in Soils – General Requirements

<b>SP16</b>	Design Aids to IS: 456
<b>SP24</b>	Explanatory Handbook on Indian Standard Code for Plain and Reinforced concrete.
<b>SP34</b>	Handbook on Concrete Reinforcement and Detailing

Whenever Deemed necessary, the stipulations of ISO, ACI, AISC or BS codes shall be used in design as supplement to IS code.

## 10.5 Loads and Load Combinations:

Port will be used to handle the following materials with its Characteristics to be considered as:

<b>Material</b>	<b>Average Bulk Density (T/cum)</b>	<b>Angle of Repose (degrees)</b>	<b>Size (mm)</b>
Muriate of Potash (MOP)	1.1	35	(0.25-1.7 mm) 65%
Di-ammonium Phosphate (DAP)	0.95	35	(1-4 mm) 95% -granules or in powder form
Urea	0.8	34	(1- 2.8 mm) 98% -granules
Other Clean cargo	As per data sheet	As per data sheet	0.5-50 mm

### 10.5.1 Design Life of the Structures

As a general guideline design life of minimum 50 years shall be considered for the permanent structure unless mentioned otherwise.

Following table indicates specific design life corresponding to the type of structure:

**Table 10-1 Design Life of the Structure**

<b>Type of structure</b>	<b>Design life of the structure (years)</b>
All the pavements	50
All the pits	50
All civil structures to support electrical and IT	50
All buildings	50
Workshop	50
Toilet Block and Shed for rest	50
Water tanks	50

Gate Complex and barriers	50
Compound wall	50
Fencing	10

### 10.5.2 Types of loads

#### 10521 Dead Loads (DL):

Dead loadson the structure shall include self-weight of the complete structure with:

- a) Flooring, finishingand fixtures
- b) Partitions, wall panels
- c) All equipment weights and its supportingstructures
- d) Roofing material
- e) Piping
- f) Cable trays

The following unit weightsof the material shall be considered for computation ofloads. IS 8 75 (Part I): 1987 will be used for the materialweight as:

Material	Unit weight
Plain Cement concrete	: 24.0 kN / cu.m.
Reinforced Cement Concrete	: 25.0 kN / cu.m.
Cargo for Load calculations	: 11.5 kN / cu.m.
For Volume calculations	: 8.0 kN / cu.m.
Floor finishes	: 24.0 kN /cu.m.
Brick /block work	: 20.0 kN / cu.m.
Structural Steel	: 78.50 kN / cu.m.
Roof treatment (at RCC roofs for buildings)	: 21 kN /cu.m.

All likely dead loads to be experienced by the structure during its life time. Vendor specific d at a shall be used for unit weight of the material for which data is not available in IS: 875 (Part-1 ) o r relevant Indian Standards.

#### 10522 Imposed Loads ( IL):

The Imposed loadsare those loads produced by:

- a) Live loads,
- b) Dust / spillage loads,

- c) Minor equipment loads
- d) Cable trays
- e) Small pipe racks /hangers,
- f) Erection loads,
- g) Operation/ maintenance loads, etc.

Floors and supporting members of different areas which may be subjected to heavy equipment live loads shall be designed on the basis of weight of equipment OR specifically defined live loads, whichever is greater. The loads considered shall not be less than that specified in IS: 875 (Part II).

#### 10523 Indicative Live Loads (LL)

- Sloped Roof: 75 KG/m<sup>2</sup> with reduction for slope as per IS 875.
- Live load on Flat roof shall be 0.75 kN / m<sup>2</sup> for Non-accessible roofs
- Live load on Flat roof shall be 1.5 kN / m<sup>2</sup> for accessible roofs plus dust Load as 0.75 kN / m<sup>2</sup>.
- Building floors :
 

Control room / MCC floor	: 10 kN/ m <sup>2</sup>
Pump House / operating floor	: 5 kN /m <sup>2</sup>
Toilet areas	: 2 kN /m <sup>2</sup>
- Floors where equipment is not located : 3 kN/m<sup>2</sup>
- Stair area : 5 kN /m<sup>2</sup>
- Gallery /open truss walkways : 4 kN/m<sup>2</sup>
- Chequered plate flooring : 5 kN/m<sup>2</sup>
- Cargo spillage load on gallery walkway: 0.5 kN/m<sup>2</sup>
- For open truss gallery walk ways : 0.25 kN/ m<sup>2</sup> is considered ( min)

In addition to above live loads, cable trays shall be considered as 0.50 kN/m as min. On each of the walkway members and Handrail load shall be applied at Walk way sides.

#### **Note:**

For special use areas, live loads shall be revised upward as necessary as per the technical requirement.

Reduction of L.L shall be made in accordance with the provisions of IS: 875 and IS: 1893 in case of seismic analysis.

#### 10524 Consideration of Material, Equipment, Monorail and erection Loads:

- Load per unit length of each conveyor due to material on belt as: (design capacity / maximum speed) in kN / m.

- Static and dynamic loads of major equipment shall be based on manufacturer's data. Equipment load e.g. Pulley weight, motor and assembly weight, electrical hoist including belt and idler weight etc. shall be considered as applicable.
- Hoist / monorail load shall be as per Mechanical Load data and needs.
- Floor beams directly supporting drive machinery like head - tail end / drive pulleys, motor and gear boxes etc. impact factor shall be to mechanical load data.
- In case the erection load on any particular area is higher than the specified live load of that area then the structure design shall be based on erection loads.

**Impact Factors: -**

- For belt tension at start = 1.5
- Electrically operated crane = 1.25
- Manually operated crane/Hoist = 1.1

**10525 Indicative Wind Loads:**

The design wind load shall be calculated as per provisions of IS: 875 (Part-III).

The Basic Wind Speed for the project site:

- Basic wind speed under cyclonic condition ( $V_b$ ) : 50 m/sec
- Basic wind speed under operating condition : 22.4 m/sec
- The Design wind speed to be obtained from the formula given below:

Design Wind Speed,  $V_z = k_1 \times k_2 \times k_3 \times k_4 \times V_b$

Where,

$k_1$  = Risk Coefficient = 1.0 (Table 1)

(Unless mentioned specific value for the structure)

$k_2$  = Terrain, Height and Structure size factor

(Category 2, Class A, B or C, based on dimension of the structure (Table 2))

$k_3$  = Topography factor = 1.0 (Clause: 5.3.3.1)

$k_4$  = Importance Factor for Cyclonic Region  $k_4 = 1.0$

**10526 Load combination for footing design & frame elements (For Wind Load Governing Case)**

- DL + LL
- DL + or - WLX
- DL + or - WLY
- DL + LL + or - WLX

- DL + LL + or - WLY

The wind analysis shall consider the wind direction relative to structure and both external and internal pressure applied to the windward and leeward sides of the structure.

#### 10527 Seismic Loads:

Seismic Loads (SL): Design for seismic loads shall be done in accordance with IS: 1893 – 2002.

The Seismic Zone for the project site is zone-V

- Type of frame : Special Moment Resisting Frame (SMRF)
- Zone factor (Z) : 0.36 (Zone V for Kandla)
- Importance factor (I) : 1.0
- Response reduction factor : 5
- Seismic co-efficient :  $A_h = Z I S_a / 2 R g$

$$= \frac{0.36 \times 1.0 \times S_a}{2 \times 5 \times g}$$

$$= 0.036 S_a / g$$

Reduction in LL shall be considered IS: 1893 -2002 (part I)

#### 10528 Load combination for footing design (For Seismic Load Governing Case)

- DL + LL
- DL + EQX
- DL + EQY
- DL + LL + EQX
- DL + LL + EQY

#### 10529 For frame elements (beams and columns) the following combinations are considered.

(As per IS: 1893:2002, Part – I, Cl. 6.3.1.2)

- 1.5DL+ 1.5LL
- 1.2DL+1.2 LL+1.2EQX
- 1.2DL+1.2LL+1.2EQY
- 1.5DL+1.5EQX
- 1.5DL+1.5EQY
- 0.9DL+1.5EQX

- $0.9DL+1.5EQ$

Wind and Earthquake load shall be assumed not to act simultaneously. The total shear at base due to wind and seismic shall be compared and the governing shear load only shall be used for the design of structural members.

#### 105210 Earth Pressure Loads

Earth pressure for all underground structures shall be calculated using coefficients of earth pressure (active/passive). In addition to earth pressure and ground water pressure, a minimum surcharge load of 1000 kg/sqm at ground level shall also be considered for the design of all underground structures to take into account the vehicular traffic in the vicinity of the structure, if applicable.

#### 105211 Load cases and Combinations

Basic load cases to be considered for the analysis

- Dead Load : DL
- Live load on floor/walk ways : LL
- Equipment Loads : EL
- Conveyor Belt tension : BT
- Wind Load : WL
- Seismic Load : EQ

#### 105212 The load Combinations:

Critical load combinations from various loads as stated above shall be considered.

- $DL + LL + BT + \text{Equipment Load and monorail}$
- $DL + LL + WL + BT + \text{Equipment Load and monorail}$
- $DL + 0.5LL + EQ + BT + \text{Equipment Load and monorail}$
- $DL + WL/EQ + BT + (\text{Without Material})$
- $0.9DL + EQ + BT + \text{Equipment Loads and monorail}$
- $-0.8DL + WL$
- $DL + EQ$

Basic structure shall be designed for worst combinations of loadings as per IS: 875 Cl. 8 of (Part – V) / IS: 1893.

The individual members of the frame shall be designed for the worst combination of forces such as bending moment, axial forces, shear force and/or torsion to condition.

Separate load combinations shall be taken for Operating and Non-Operating conveyor condition for wind load case combination along with Belt Tension.

Dynamic Belt Tension is considered while operating condition and for Non-Operating Condition Belt tension shall be considered as per mechanical load data.

105213 Permissible Stresses and Increase in Permissible Stresses for design:

Permissible stresses for different load combinations shall be taken as per IS 875 (part V) and other relevant IS codes. The increase in permissible stress for member shall be as per Latest Version of IS code.

## 10.6 Indicative Design Criteria

### 10.6.1 Yard

10611 Back up area structures:

10612 Civil Structure to support Electrical works and components

#### **High mast foundation**

The structure shall be made of minimum M40 grade of reinforced cement concrete. Foundation shall be designed in accordance with the loading supplied by electrical contractor during detailed design and operation/functional requirements. Design and procurement of foundation bolt and templates shall be in the scope of high mast supplier.

However following loads may be considered for preliminary design of high mast foundation;

40 m high mast: Bending Moment	:	552.39 kNm
Horizontal shear	:	32.01 kN
Vertical load	:	44.7 kN
30 m high mast: Bending Moment	:	294.17 kNm
Horizontal shear	:	21.22 kN
Vertical load	:	27.7 kN

\*Above load is preliminary and shall be reviewed during detail design based on input from high mast system vendor.

#### **Pits and cable trenches for electrical/IT cable pulling and Foundation for Compact Substation**

Structure shall be made of minimum M40 grade of reinforced cement concrete. The top of pits shall be made flush with the FGL. A heavy duty removable RCC cover shall be provided on the pit. Refer IRC loading for the design loads of the pits. The foundation for compact substation shall be designed as per loading specified by the electrical contractor/vendor.

#### **a) Conduits for Electrical/IT Cable Laying**

HDPE DWC pipes shall be used for electrical (minimum 175 mm OD) and IT cable laying. Class and strength of the conduit shall be proposed by contractor for approval of employer considering loading mentioned in the design basis.

#### **b) Earthing Pits**

Two types of earth pits shall be provided to meet earthing requirement in yard components.

- Reinforced concrete earth pits in traffic areas of yard
- Masonry type earth pits in non-traffic areas of yard



Yard lighting for loading and passing lanes (if applicable – it may happen during detail design that may compensate the lighting requirement through yard highmast)

The structure shall be made of minimum M40 grade of reinforced cement concrete. Foundation shall be designed in accordance with the loading supplied yard lighting vendor during detailed design and operation/functional requirements.

### 10.6.2 All Buildings, Sheds & Other Infrastructure

Design loads will comply with the requirements of IS: 875 (Parts 1 to 5) & IS: 1893 as a minimum unless more stringent requirements are specified herein.

The following loads will be considered in general for the analysis and design of structures and foundation:

#### c) Loading and Load Combinations

- Live Load

Terrace floor (roof accessible)	1.5 KN/m <sup>2</sup>
Terrace floor (roof Non-accessible)	0.75 KN/m <sup>2</sup>
Live Loads due to further floor loading for office space usage and other purpose, if any shall be consider as per IS: 875	

- Seismic Load

Type of frame : Special Moment Resisting Frame (SMRF) Response

reduction factor, R 5

Importance factor, I : 1.5 Or 1.0 (Same may vary based on type of building and suggestion from Independent engineer, if any)

- Soil Parameters

The soil parameters will be considered as per soil investigation report. The groundwater table shall be considered as per soil investigation report.

- Load Combinations

In general, below listed basic loads and load combinations will be considered in design of structures:

Basic load cases:

- Dead Load DL
- Live Load LL
- Seismic Load EQ
- Wind Load WL

Load combination for footing design (As per IS 1893- 2002, Part – I Cl. 6.3.1.2)

- DL + LL
- DL + EQ<sub>x</sub>
- DL + EQ<sub>z</sub>

- DL + WLx
- DL + WLz
- DL + LL + EQx
- DL + LL + EQz
- DL + LL + WLx
- DL + LL + WLz

For RC frame elements (beams and columns) the following combinations are considered. (As per IS: 1893:2002, Part – I, Cl. 6.3.1.2)

- 1.5DL+ 1.5LL
- 1.2DL+1.2LL+1.2EQX
- 1.2DL+1.2LL+1.2EQY
- 1.5DL+1.5EQX
- 1.5DL+1.5EQY
- 0.9DL+1.5EQX
- 0.9DL+1.5EQY

Required all governing Load combinations shall be considered for footing & design frame elements as per latest versions of Indian standards.

#### d) Design Philosophy

Design of all RCC structures, shall be carried out by Limit State of Collapse as per IS: 456-2000. Design strength of material and design loads will be calculated using appropriate partial safety factors over characteristic strength and characteristic loads as per IS: 456:2000.

Foundation design will be as per Limit State of Serviceability with forces as per load combinations mentioned and then multiplied by appropriate factor.

#### e) Design Parameters

- Concrete

Following grades of concrete shall be used in RCC structures:

Usage	Concrete Grade
<b>R.C.C. Substructure</b>	
Piles, Pile Caps, Isolated footing/ strip footing, columns & beam up to plinth level.	M30
Grade Slab	M25
<b>R.C.C. Super structure</b>	
Columns	M30
Beams and slabs	M30

- Clear Cover

Minimum clear concrete cover (From face to main steel) shall be as follows:

Structural Element	Min cover (mm)
<b>Sub structure of bldgs.</b>	

Pile	60
Pile Cap	75
Isolated footing/ strip footing	50
<b>Super structure of buildings.</b>	
Slab	30
Columns	45
Beams, wall faces exposed to soil	40
Beams , Wall faces not exposed to soil	30

- Foundations

Final dimensions and founding level of shallow or strip footing or Bored cast-in-site or pre cast pile foundation shall be determined during the detailed design based on the actual super- structural loading. The piles are supposed to be socketed into the stiff silty clay layer available at an available depth below the natural ground level. Final dimensions and founding level of piles shall be determined during the detailed design based on the actual superstructure loading. The piles shall be designed as per the Cole and Stroud method as specified in IS 2911(Part-1/Sec-2): 2010.

### 10.6.3 Central Water Tank & Pump House Building

Design loads will comply with the requirements of IS: 875 (Parts 1 to 5) & IS: 1893 as a minimum unless more stringent requirements are specified herein. The following loads will be considered in general for the analysis and design of structures and foundation.

#### a) Loading and Load Combinations

- Indicative Live Load

Terrace floor (roof accessible)	1.5 kN/m <sup>2</sup>
---------------------------------	-----------------------

Apart from this in case of pump house due consideration shall be given to the Pump dynamic weight, piping weight, Cable Weights & Cable Tray weights as applicable.

- Seismic Load

Seismic loads are considered as per IS: 1893. The parameters for seismic force areas under:

- Zone factor (Z) : 0.36 (Zone V for Kandla)
  - Importance factor (I) : 1.5

#### b) Special loads for water tank & pump house:

In addition to above mentioned loads pump house & water tank shall be designed for water load & Soil pressure. Tank shall be designed for worst combination of loading that produces worst effect on the structure shall be considered for design. All possible load cases and combinations shall be used.

#### c) Load Combinations

In general, below listed basic loads and load combinations will be considered in design of structure (Pump house):

Primary load cases:

- 1. Dead Load DL
- 2. Live Load LL
- 3. Seismic Load EQ

Load combination for footing design (As per IS 1893- 2002, Part –I Cl. 6.3.1.2)

- DL + LL
- DL + EQx
- DL + EQz
- DL + LL + EQx
- DL + LL + EQz

For frame elements (beams and columns) the following combinations are considered. (As per IS: 1893:2002, Part – I, Cl. 6.3.1.2)

- 1.5DL+ 1.5LL
- 1.2DL+1.2 LL+1.2EQX
- 1.2DL+1.2LL+1.2EQY
- 1.5DL+1.5EQX
- 1.5DL+1.5EQY
- 0.9DL+1.5EQX
- 0.9DL+1.5EQY

All the special load combinations shall be considered along with special loads (I.e.-soil & water pressure) as per codal provision and design engineer should consider all possible governing load combinations.

**d) Soil Parameters**

The soil parameters shall be considered as per soil investigation report. The ground water table shall be considered as per soil investigation report.

**e) Design Philosophy**

The Water Tank shall be designed as liquid retaining structure using Limit state method in accordance with IS 3370: 2009. Cracked width for water tank shall be limited to 0.2 mm as per code provision. Crack width calculations shall be provided.

Design of all pump house shall be carried out by Limit State of Collapse as per IS: 456-2000. Design strength of material and design loads will be calculated using appropriate partial safety factors over characteristic strength and characteristic loads as per IS: 456:2000.

Foundation design will be as per Limit State of Serviceability with for forces as combinations as mentioned and then multiplied by appropriate factor (With addition of water load).

Frame elements are designed for load combinations as mentioned.

**f) Design Parameters**

- Concrete

The following grades of concrete shall be used in RCC structures:

Usage	Concrete Grade
<b>R.C.C. Substructure</b>	
Piles, Pile Caps, Isolated footing/ strip footing, columns	M30
Grade Slab	M30
<b>R.C.C. Super structure</b>	

Columns	M30
Beams and slabs	M30

- Clear Cover

Minimum clear concrete cover (From face of concrete to steel) shall be as follows:

Structural Element	Min cover (mm)
<b>Sub structure</b>	
Pile	60
Pile Cap	75
Bottom layer of raft	50
Top layer of raft	45
Isolated footing/ strip footing	50
<b>Super structure</b>	
Wall without liquid contact	40
Wall or any other element with liquid contact	45
Slab	30
Columns	45
Beams face exposed to soil	40
Beams Wall face not exposed to soil	35

- Foundations

Final dimensions and founding level of Raft shallow or strip footing or bored cast-in-site or precast pile foundation shall be determined during the detailed design based on the actual super structure loading. The piles are required to be socketed into the highly weathered to weathered rock layer. Final dimensions and founding level of pile shall be determined during the detailed design based on the actual superstructure loading. The piles shall be designed as per the Cole and Stroud method as specified in IS 2911 (Part-1/Sec-2): 2010.

## 10.7 Foundations:

### 10.7.1 Geotech Investigation and sub structure design:

The subsoil investigation has been carried out for the proposed site location. The Geotechnical investigation report is available for various areas as investigated by Geotech soil testing laboratory. The Sub structures shall be designed to have adequate design strength to withstand safely all loads likely to act on it throughout its life in accordance with Working stress Design method as defined in IS: 800 -2007 good engineering practice. Consideration would be undertaken for moving heavy items of equipment into place and consider loading when mounting or replacing heavy items of equipment.

### 10.7.2 Founding structures:

Foundations for structures and equipment shall be proportioned to resist the critical load combinations obtained from the analysis of super structure. All foundations will be designed in accordance with relevant parts of IS 2974, and IS 456-2000. Provisions given in IS: 1904 will be considered to soil condition.

It is envisaged to have deep foundation in the form of RCC Pre cast / bored cast in situ piles which support the pile cap and columns. It is expected that pile foundations for structures like Transfer Towers, Overhead conveyor gallery, other utility structures, will be provided. The pile capacities will be considered to Geotech investigations.

If suggested in the soil investigation report, isolated or strip foundations shall be considered only for light structures like Open ground conveyor gallery, Cable supporting structures and minor structures like single storied

buildings.

The foundation depth shall be determined based on loadings on foundation, safe bearing capacity at the founding level, constructional and technological requirements.

However, any other type of foundations which may be economical, without compromising the safety aspects, will be designed and suggested.

### **10.7.3 Pile foundations:**

Based on the sub soil strata per-cast driven piles / bored cast in place are recommended for onshore plant structures. The piles are in general supposed to be rested on stiff silty clay layer available at a n available depth below the natural ground level. The pile capacity will be to Geotech report design recommendation.

### **10.7.4 Bearing stress and increase in stress:**

The maximum allowable bearing pressure for design of foundation shall correspond to values confirmed by result of detailed soil investigation taking into account limits of allowable settlement considered for design of structures and equipment.

Safe bearing capacity of soil / pile capacity will be increased by 50% under seismic and 25% under wind load conditions. In working stress design, the allowable stress in concrete and reinforcements steel under wind (or seismic) in combination with other loads shall be increased by 33%. In case of limit state of design, load factors to IS 456-2000 shall be considered.

In case the structure permits higher lateral deflection at pile level based on the serviceability criteria, the pile capacity can be increased.

Capacity of single pile bearing stress and increase:

Both side tied single pile with pile head as fixed will be considered as to standards and to design loads.

### **10.7.5 Stability:**

The stability checks of foundations shall be done as per IS 456:2000, cl. 20. Only vertical weight of soil within the plan of structure shall be considered for the stability calculation.

### **10.7.6 Foundation settlement:**

For Open foundation, the permissible settlement and differential settlement shall be governed by IS: 1904 and based on geotechnical report. However, the settlement shall be restricted to lower value, if necessary as per system requirement.

In case of pile foundation, this type of settlement issue is not anticipated in design as the pile capacity is defined in view of bearing and/or friction capacity to cut off level of pile and the pile diameter as considered.

### **10.7.7 Site Grading**

In this project site the existing ground levels varies. Ground level is in slope, GL at Berth-14 end of the plot is +9.14 m and GL at entry side fencing gate is +8.6 m. Existing GL and Proposed Railway RL mentioned are indicative for reference. Bidder shall visit site and collect desired information as per requirement.

The grade filling material shall be granular, non-cohesive nature and shall be free from organic and deleterious matter and shall have the following properties;

- Maximum particle size of : 200mm
- % maximum particle size : 10%

- % passing 60 micron sieves : 10% Max.
- Liquid limit : 35% Max.
- Plasticity index : 6% max.

The material shall properly spread in the reclamation area in layers and compacted to 95% maximum dry density.

### 10.7.8 Ground Improvement Works

Based on the port requirement there are two kind of stockpile embankment i.e., Dry Bulk Cargo stockpile, Operation buildings and settling pond. The layout indicates that the stock height is of 10 m.

Considering the soil properties, slope stability analysis may be carried out for the stockpile with grade filling. In case the analysis reports indicates the slip occurs in the soft clay layer, to avoid the shear failure and excessive settlement and to safety factor needs, ground treatment by geo tech analysis will be suggested and implemented.

### 10.7.9 Machine Foundations:

The design of machine / equipment foundation will be as per IS: 456 and IS: 2974. Frequency and amplitude criteria shall meet the requirement as laid down by the relevant codes or machine manufacturers. Foundations of equipment subjected to dynamic loading shall be isolated from adjoining floors / foundations to prevent propagation of vibration to adjoining structures.

#### 10.7.9.1 Vibration:

Vibration check shall be done to ensure the separation of the fundamental mode structural frequency from the machine frequency such as conveyor supporting trusses or beams, structure supporting vibrating equipment, etc. The recommended values are as follows:

- Structural frequency  $\geq 0.66 \times$  machine frequency
- Structural frequency  $< 1.5 \times$  machine frequency

## 10.8 Material and basic environmental condition consideration:

### 10.8.1 Cement and RCC Material:

- All RCC structures except structures storing water etc. shall be designed based on cracked section as per IS: 456:2000 (Limit state method).
- All water storing structures shall be designed as per IS 3370.
- Cement shall be of grade 43 / 53.
- All reinforcements shall be of grade Fe 500/ 500D of IS-1786. All bars shall be of tested quality.
- No special type of Cement like SRC, Pozzolanic, etc. has been envisaged.
- AGGREGATE: Aggregates shall be natural or crushed gravel or crushed rock and free from deleterious material. It shall comply with the requirements of IS-383. All fine and coarse aggregate shall be tested for susceptibility to Alkali Silicate reaction in a laboratory approved by the Engineer.

### 10.8.2 Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 100 mm will be termed as Coarse Aggregate. Only Coarse Aggregate from approved quarries and conforming to IS:383 will be allowed to be used on the works. Aggregates shall be washed to make it free from deleterious materials, if necessary. The grading of coarse aggregates by

sieve analysis shall be as per IS: 383. If by the analysis the deficiency of a particular grain size is found, which could affect the density of the concrete, the Engineer may ask the contractor to avoid such quantities of aggregate of the particular size or and such quantity of aggregate of any particular size to achieve the required grading as per IS:383.

### 10.8.3 Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS:383 is termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used on works.

### 10.8.4 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts or other impurities. Normally potable water is found to be suitable. Generally, IS:3550 will be followed for routine tests. Acceptance test for water shall be as per IS:3025, and Table-I of IS:456.

In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by compressive strength and initial setting time tests as per method of tests in accordance with the requirements of IS-516 & IS- 4031 respectively. The P H value of water shall generally be not less than 6.

### 10.8.5 Concrete Mix:

The following grades of concrete shall be used in RC structures:

Concrete Grade and cube Strength

Usage	Concrete Grade	Cube strength at 28 days
Raft – Pile foundation	M30 -M35	30-35 N/mm <sup>2</sup>
Columns	M30- M35	30-35 N/mm <sup>2</sup>
Beams, slabs	M25- M30	25-30 N/mm <sup>2</sup>

Grade for PCC will be M15. Min. thickness of PCC will be 75 mm. This will be for below foundation, trenches, Underground structures and mass filling.

Grade for of M20 will be for any plinth protection, base plate encasement, D.P.C. screed of concrete and minor R.C. structures.

In most case, minimum grade of concrete for all reinforced concrete work will be as per above table. M 30 and M 35 as higher grade of concrete, if required in design, specific condition as per code provision will be specified otherwise. Environmental and design needs will be reviewed to requirements.

### 10.8.6 Minimum Cover:

Minimum clear concrete cover to Reinforcement shall be:

As per IS: 456 – 2000. Environmental condition will be considered for the provision.

Structure	Top (mm)	Bottom (mm)	Sides (mm)
Foundation	50	50	50



Pile / Pile cap	-	-	60 / 75
Column	-	-	40
Pedestal	-	-	40
Beams	30	30	25
Slab	20	20	20
RC Wall	Not exposed to soil		30
RC Wall	Face in contact with soil		40

Fire rating as 1 hr will be considered for the concrete cover to fire protection.

#### 10861 Minimum cover to foundation Bolts:

Min. Distance from centreline of foundation bolts / anchor bolts to the pedestal edges shall be maximum of followings:

- Clear distance from edge of base plate / base frame to the outer edge of pedestal shall be min. 50 mm.
- Clear distance from face of pocket to outer edge of pedestal shall be 100 mm.

### 10.8.7 Reinforcement

For all RCC works, the reinforcement steel to be adopted shall be as: HYSD – TMT Bars (Fe-415) as per IS: 1786 – 1985 and / Or HYSD bars conforming to IS: 432 grade Fe 500 on availability to design.

### 10.8.8 Brick / block Masonry:

All masonry works will be designed in accordance with relevant IS Code as applicable. Generally all brick walls shall be non-load bearing walls of 1 brick / block thick. Partitions as non-load bearing walls shall be of half thickness.

We have assumed that only brick surfaces will be plastered with internal plastering of 12 mm thick CM 1:5 and external plastering 18mm thick CM 1:6.

## 10.9 Conveyor Structures and Supporting Trestles:

The effect of inclination of conveyors shall be taken into account for design of structures. The inclination shall be as per conveyor layout. End portal of structures shall be designed to transfer all vertical and lateral loads to supporting trestles / junction tower.

Loads due to temperature effect, if any, wind loads and effect of gravity take-up along with other loads combinations shall be considered for the design.

Cross-over, in case required, shall be provided only at the location of fixed trestles, or as suggested in the mechanical design criteria.

All ground trestles shall be out of rolled ISMB / plate section, RHS, SHS, CHS or spiral welded pipes.

The lattice girders supporting the conveyor shall be suitably braced at top and bottom chord levels to transfer the wind load to the end portals connected to trestles.

In between transfer house / buildings four legged trestles shall be placed at maximum interval of 90m. The Engineering, Procurement and Construction for Development of Mechanized Fertilizer and Other Clean Cargo Handling Facility At Berth No.14 In Deendayal Port, Kandla (Vol-II)

arrangement shall be such as to ensure that force in longitudinal direction of conveyer gallery of length not more than 90m will be transferred to four legged trestle. Two legged trestles at regular interval may be placed between four legged trestles. The end supporting resting on the four legged trestles can have either ends hinged or one end hinged and the other on slide type as per system requirement. Slide type support shall be with PTFE or other equivalent bearing to allow both rotation and movement. End of conveyer gallery which will be supported over transfer points, shall be so detailed that only vertical reaction is transferred from gallery and no horizontal force in longitudinal direction is transferred from gallery to transfer points and vice-versa.

In conveyor structure design the load due to cables, light fitting and water pipes shall satisfy to approved load list as per Mechanical & electrical.

Base plate for trestles shall be designed as gusseted base considering all axial loads and moments, if any. Shear lugs shall be provided below the base plate to take up all horizontal loads. Anchor bolts shall be designed for maximum uplift for the worst combination of loads.

Walkway of conveyor structure shall be of Hot dip galvanized (with coating min 910 GSM and painted with etch primer -15-25 micron, Epoxy polyamide /HBMIO-200 Micron Total DFT Plus zinc- 305 Micron) steel grating or chequered plate. However, where the conveyors cross the railway line a seal plate of adequate thickness to the design requirement will be provided below the conveyor to cater for a spillage load.

Toe guard shall be provided on sides of walkway as a safety measure.

Hand railing shall be provided on one side of walkways or as indicated in the mechanical design criteria.

### **10.9.1 Junction houses**

Junction houses shall be designed with structural steel framing satisfying technological requirements. Design shall be done as per worst load combination considering cyclonic wind + non-operating belt tension and operating wind + maximum belt tension.

Design shall also be carried out for the case of one belt at starting condition and the other belt in running condition along with operating wind/ seismic load in combination with other load cases.

Chute loads on floors shall be evaluated duly considering the chutes are fully plugged with material for its entire height.

Toe guards and hand railings shall be provided around all clear openings.

All floors shall be of chequered plate construction resting over steel beams. Maintenance platforms for gates and flow divider shall be of structural steel and chequered plate construction. Except where head / tail pulley / drives are provided, the entire floor will be of RCC Construction.

Drive units shall be mounted on concrete pedestals for dampening the vibration with local RCC flooring in that area. Necessary Deck sheets to design load can be planned to act as a shuttering for the construction and better finishing.

### **10.9.2 General considerations for Conveyor Structure and Junction Houses**

Angle sections shall not be used as flexural members except for roof trusses, purlins, side girts and walkway runners.

Where floor beams form part of the vertical bracing system, additional loads from floor beams transferred to bracing shall be considered in the design.

As far as possible, it is advisable to use Star pattern sections instead of back to back in order to achieve the painting to all surface for maintenance and better performance.

For Column Design, moments due to eccentricity of floor beam connections shall be duly considered.

Box section should be covered with end plates.

### 10.9.3 Stair Case:

Minimum width of main staircase shall be 1000 mm. Staircases shall be provided with hand railing. Staircase will be made out of gratings. Stair case shall be of galvanized steel gratings or as specified in mechanical design criteria.

### 10.9.4 Hand railing:

Conveyor galleries shall have only top handrail out of MS pipes of medium class conforming to grade  $Y_{st} 210$  of IS:1161-1979 with threaded ends and necessary bends, tees, elbows, sockets etc. Top Rail & Vertical posts shall be of 32(M) NB MS pipe and mid rail shall be of 25(M) NB MS pipe. It shall be located 1000 mm above the walkway with supports on the verticals and diagonals of the gallery girder.

Hand railing in junction houses shall have two horizontal rails, one at 500 mm and the other at 1000 mm above the base level along with vertical posts spaced at not more than 1200 mm centres. Top rail and mid rail shall be out of NB pipes of medium class respectively conforming to grade  $Y_{st} 210$  of IS: 1161-1979 with threaded ends and necessary bends, tees elbows, socket s etc. Vertical posts shall be made of suitable IS angles or NB medium class pipe. Necessary toe plate shall be provided to specification and standard regulations.

### 10.9.5 Grating:

Electro-forged galvanised M.S. Grating with main bars will be 25X5 thick spaced at approx. 41 mm & secondary members 6 mm square bar spaced at 100 mm will be provided for spans not more than and including 1500mm. Hot dip Galvanizing shall be in accordance with IS 4759. For the Galvanizing thickness refer QA/QC specification.

### 10.9.6 Cladding & Roofing:

- a) Cladding & Roofing sheet: Permanently colour coated hi-rib metal sheet of 0.55mm TCT (Total coated thickness), coating class Az150 (min. 150gm/sqm Zinc Aluminium alloy coating mass, total both side, 550 MPa Yield strength) conforming to AS 1397 / IS15961.
- Coating of exposed side : 20micron finish coat over 5 micron primer coat
  - Coating of inner side: 10micron finish coat over 5 micron primer coat.
- b) Cladding shall be considered up to last working floor and equipment mounting location. Cladding shall be projected 1000mm beyond floor level. However where ever there is drive or any other equipment on ground floor cladding shall be provided up to ground level.

### 10.9.7 Loads and Load Combinations:

#### 10.9.7.1 Types of loads:

##### 10.9.7.1.1 Dead Loads (DL):

Dead load on the structures shall include self-weight, weight of floor/roof materials including all other likely dead loads to be experienced by the structures during its lifetime.

The unit weights of the material shall be considered for computation of loads. IS 875 (Part I): 1987 will be used for the material weight.

##### 10.9.7.1.2 Imposed Loads (IL):

The Imposed loads are those loads produced by:

- Live loads,
- Dust / spillage loads,
- Minor equipment loads
- Cable trays
- Small pipe racks / hangers,
- Operation/ maintenance loads, etc.

Floors and supporting members of different areas which may be subjected to heavy equipment live loads shall be designed on the basis of weight of equipment OR specifically defined live loads, whichever is greater. The loads considered shall not be less than that specified in IS: 875 (Part II).

### 10.9.7.13 Live Loads (LL):

The following minimum live loads shall be adopted for design of structures.

▮ Live load on Flat roof shall be 0.75 kN / m<sup>2</sup> for Non-accessible roofs

▮ Live load on Flat roof shall be 1.5 kN / m<sup>2</sup> for accessible roofs

- |                                     |  |
|-------------------------------------|--|
| ▮ Floors of Junction                | : 5 kN / m <sup>2</sup>                              |
| ▮ Chequered plate flooring          | : 5 kN / m <sup>2</sup>                              |
| ▮ Gallery / open truss walkways     | : 4 kN / m <sup>2</sup>                              |
| ▮ Walkways of Conveyor structure    | : 4 kN / m <sup>2</sup> (Inclusive of spillage load) |
| ▮ For open truss conveyor walk ways | : 0.25 kN / m <sup>2</sup> is considered (min) , On  |

Conveyor belt Shall be based on Mechanical load data

▮ Building floors:

- |                                   |   |
|-----------------------------------|---|
| - Control room / MCC floor        | : 10 kN / m <sup>2</sup>                |
| - Pump House / operating floor    | : 5 kN / m <sup>2</sup>                 |
| - Toilet areas                    | : 2 kN / m <sup>2</sup>                 |
| - Stair area                      | : 5 kN / m <sup>2</sup>                 |
| - Cable rack and Water pipe lines | : As per load list in approved drawing. |
| - Equipment loads                 | : As per load list in approved drawing. |

Reduction of L.L shall be made in accordance with the provisions of IS: 875 and IS: 1893 in case of seismic analysis.

For special use areas, live loads shall be revised upward as necessary as per the technological requirement.

▮ Dust load:

- |   |                            |
|---|----------------------------|
| - Sloping roof of Conveyor structure:   | 0.50 kN / m <sup>2</sup>   |
| - Flat roof of Junction Houses          | : 0.75 kN / m <sup>2</sup> |
| - Floors at Junction house and gallery: | 1.0 kN / m <sup>2</sup>    |

For conveyor galleries, either spillage load or dust load will be considered.

#### 1097.14 Consideration of Material, Equipment and Monorail Loads

- Load per unit length of each conveyor due to material on belt as:
- (Design capacity / maximum speed) in kN / m.
- Hoist / monorail load shall be as per Mechanical Load data and needs.
- Static and dynamic loads of major equipment shall be as per approved vendor data. Equipment load e.g. Pulley weight, motor and assembly weight, electrical hoist including belt and idler weight etc. shall be considered as applicable.
- Floor beams directly supporting drive machinery like head - tail end / drive pulleys, motor, and gear boxes etc. impact factor shall be to mechanical load data.
- Impact factor
  - Design of Monorails, Hoists etc.
    - An impact factor of 1.1 for manually operated hoist.
    - An impact factor of 1.25 for electrically operated hoist.
  - Design of Floor beams supporting drive machinery like head end/ tail end drive pulley, motors, gearboxes etc.: Load along with Impact factor shall be considered as per Mechanical Load Data Drawings. No additional factor shall be applied while actual design.
  - Else 1.50 multiplying factor shall be considered if not considered in Mechanical Load Data.

#### 1097.15 Wind Loads:

The design wind load shall be calculated as per provisions of IS: 875 (Part-III). The Basic Wind Speed for the project site:

- $V_b = 50$  m/sec for non-operating Cyclonic condition
- $V_b = 22$  m/sec for operating conditions, load combinations.
- Category of terrain as = Category 2
- Probability factor "K1" as = 1.08 to Table 1 of the code.
- Coefficient "K2" as = Ref. Table 2 of the IS code to structure height.
- Coefficient "K3" as = 1.0 as per IS code as Topography factor

The wind analysis shall consider the wind direction relative to structure and both external and internal pressure applied to the windward and leeward sides of the structure as per code.

#### 1097.16 Seismic Loads (SL):

Design for seismic loads shall be done in accordance with IS: 1893– 2002. The Seismic Zone for the project site is zone-V.

- Zone factor (Z) : 0.36 (table 2 cl.6.4.2)
- Importance factor (I) : 1.5 (table 6. Cl. 6.4.2)
- Response Reduction factor (R) : 5.0

(Considering steel moment frames resisting frames-Braced System) Reduction in LL shall be considered IS 1893 -2002 (part I)

## 10.9.8 Loadcases and Combinations

### 10.9.8.1 Basic load cases to be considered for the analysis

- Dead Load : DL
- Imposed load ( Including MLL ) : IL
- Equipment Loads : EL
- Conveyor Belt tension : BT
- Wind Load : WL
- Seismic Load : EQ

### 10.9.8.2 The load Combinations:

Critical load combinations from various loads as stated above shall be considered.

- DL + IL + BT + Equipment Load and monorail
- DL + IL + WL + BT + Equipment Load and monorail
- DL + 0.5IL + EQ + BT + Equipment Load and monorail
- DL + WL/EQ + BT + (Without Material)
- 0.9DL + EQ + BT + Equipment Loads and monorail
- -0.8DL + WL
- DL + EQ

Basic structure shall be designed for worst combinations of loadings as per IS: 875 Cl. 8 of (Part V) / IS: 1893. The individual members of the frame shall be designed for the worst combination of forces such as bending moment, axial forces, shear force and/or torsion to condition.

Separate load combinations shall be taken for Operating and Non-Operating conveyor condition for wind load case combination along with Belt Tension.

Dynamic Belt Tension is considered while operating condition and for Non-Operating Condition Belt tension shall be considered as per mechanical load data.

### 10.9.8.3 Stresses and Increase in Permissible Stresses for structure design:

Permissible stresses for different load combinations shall be taken as Latest Version of IS codes. IS 800: 2007, Clause 11.1.4 and or IS 1893: 2002.

## 10.9.9 Analysis -Design and Deflection:

### 10.9.9.1 Analysis and Design:

All the structures shall be designed as per the stipulations indicated here and relevant I.S. codes. The design of steel structures shall be done as per IS: 800:2007, section 11 to working state Design and using appropriate design tables. Where there is no Indian Standard in existence then only the relevant BS or other recognized standards

shall be used with prior approval of the Purchaser. The same will be analysed as frame structure using STAAD software for the loads and its combinations as specified. Element design may be carried out either manually or by standardized in-house excel sheets or to the STAAD software design module. Appropriate partial safety factor over characteristic strength and loads to IS 800: 2007 will be considered for design material strength and design loads.

Dynamic analysis shall be carried out for beam supporting vibratory equipment and conveyor supporting beams in gallery for maximum motor rpm and belt speed. The ratio of operating frequency of idlers to the natural frequency of the beam shall be outside the range of 0.8 to 1.2 so as to avoid the resonance.

For designing of junction towers possibility of conveyor operating and not operating is to be considered in STAAD by hiding belt tension etc. for one conveyor.

#### 10.9.9.2 Slenderness Ratios (IS 800 : 2007 Clause 3.8)

The slenderness ratios for axially loaded members shall not exceed following:-

- ▮ Main compression members  
(columns, frames, principal diagonals and struts for trusses) : 180
- ▮ Tension members : 180
- ▮ Secondary compression members (diagonals and braces) : 350

Built-up compression members: The ratio for members consisting of individual shapes or bars connected together with intermittent plates or bars shall be calculated for the member at the minimum cross section and the unconnected free length of the individual component. The ratio in this case shall not exceed 50 for the individual member. The ratio for the member as a whole shall be as stated previously.

#### 10.9.9.3 Minimum Thickness:

The minimum thickness of material for main structural elements shall be as follows unless otherwise specified:

- For steel fully accessible for cleaning and repainting – not less than 8 mm.
- For steel not accessible for cleaning and repainting – not less than 10 mm.
- Minimum thickness of chequered plate – 6 mm
- For axially loaded members in framework, minimum angle section to be used shall be ISA 50 x 50 x 6.
- Gusset plate to be provided with minimum thickness for connections to be 8 mm.

#### 10.9.9.4 Deflections:

The deflection of various structural members shall not impair the smooth working of conveyor system, junction houses and top housing of rapid loading structure and shall not exceed the following limits. (AS per IS 11592: 2000, Clause 8.1.4.5)

- Conveyor structure : Span/500
- Conveyor crosses beams directly supporting : Span/500
- Conveyor short posts.
- Trestle supporting conveyor in transverse direction : Height/1000
- Floor/roof beams of Junction House

- and walkway beams of conveyor structure : Span/325
- Floor beams directly supporting drive machinery, motor
- and gear boxes : Span/500
- Monorail track beams : Span/500
- End portal of conveyor structure girder : Height /325
- Frames of Junction towers and crusher house : Height /1000\*\*

\*\* This is applicable only at the conveyor entry point and that too in the direction perpendicular to the centre line of conveyor in the same plane. In all other cases and other heights, this shall be restricted to H/325.

All trusses shall be fabricated with a camber equal to the sum of the dead load and 50% of Imposed load deflections.

#### 10.9.5 Connections:

- In general, connections would be shop welded and site bolted.
- Bolted connections shall be of bearing type only.
- Bracings may be adopted as bolted in view of erection philosophy.
- End connections for rolled beams will be designed for a minimum of 60% of their shear capacity and built-up beams for 80% of their shear capacity or actual forces whichever is more.
- Column splices will be designed for 80% strength of the flange and web plates of the column.
- All bracing and truss members connections will be designed for 75% of the tension/member capacity or 1.1 times actual force whichever is greater.
- Beam moment connection if any will be designed for 80% moment capacity of weakest connected member.
- Shop connections shall be welded, unless otherwise approved.
- In case erection bolts are used, the contact surfaces will be welded at site to design strength after final alignment and before hand over with proper paint application.
- Major Field connections shall be bolted, with mating bearing surfaces milled or machined with adequate tolerances to ensure contact is maintained. Joints shall be designed as pre-tensioned by means of high strength bolts
- Splice joints or splits in individual components made due to transportation purpose shall be welded at site as per specific work instruction and with 100 % UT keeping all control dimensions within tolerance.
- Field weld connections shall not be used, where there is any likelihood of distortion induced by welding causing misalignment of bearings and machined surfaces.
- A secondary field connection is defined as connections for conveyor deck platforms, walkways, stairs, purlins and girts. They shall be designed as bolted.
- Bolted connections shall incorporate a minimum of two bolts for angles and four bolts for structural tees, universal columns, beams & channel over 150 mm deep.
- Where pinned connections are employed in main joints, internal lubrication points shall be provided. Where bushings are used in pinned connections, bushings shall have internal lubrication patterns and shall be provided with the necessary wall thickness to prevent elastic and thermal distortion under load. Thin walled bushings are not acceptable.



- For pin connections, minimum standard structural bushings shall be manganese bronze, press fitted into suitable housings.
- Shear keys shall be provided to all base plates subject to shear load from the effects of belt tension or where shear load on the base plate including wind effects exceeds 100 kN working load.

#### 10.9.9.6 Considerations for Detailing:

- All steel work welding shall be as per approved QAP.
- Structural design and detailing shall be such as to produce a structure of modern appearance without any pockets that will hold dust or water. The design shall minimize welded or other connections that can produce stress concentrations.
- For individual member designs, rolled shapes or heavy-duty tubular sections will be preferred, and a lattice type fabrication will not be acceptable.
- Any built-up sections of beams, angles or channels shall be spaced to enable easy inspection and maintenance of all surfaces. Sections shall not be connected to form battened or starred struts.
- Irrespective of load carrying requirements, all welds shall be continuous and fully sealed joints. The ends of tubular or other hollow sections shall be completely sealed.
- The structure shall be designed so as to easily facilitate maintenance and painting.
- Access holes shall be minimized. Any detail deemed to require holes for assembly shall be shown on the shop drawings for approval prior to fabrication. In general access holes, where permitted, shall be left open and the holes shall be at least 50 mm diameter.
- For fillet welded details the fillet weld shall be returned through the hole to meet the fillet weld on the other side of the plate.
- For complete penetration weld details, care must be taken to ensure acceptable weld profiles inside the hole (UT & MPI shall be carried out for Full penetration weld, MPI & DP shall be carried out for fillet weld).
- The hole shall be dressed to the same finish as for plate edges.

#### 10.9.10 Material And Basic Construction Specifications:

Weldable steels with the yield strength in the range 250 – 350 mpa shall be used for structural components.

##### 10.9.10.1 Type of Construction:

All steelwork shall be of welded shop and site construction as far as practicable except that site connections for secondary members like purlins, side girts, staircase, stringers, walkway runners of conveyor structure etc. shall generally be bolted construction. For any structural steel member, a minimum of 2 nos. 16 mm dia bolts of grade 4.6 shall be used for permanent bolted connection and site welded connection.

##### 10.9.10.2 Materials Specifications assumed for Design and Construction:

Where a brittle fracture may cause a failure and influence the safety of the machine as a whole or the safety of personnel, brittle materials shall not be used. Materials shall be deemed to be brittle if the following properties are not achieved, with the orientation of test specimens selected so as to result in the least favourable results:

- The average of three Charpy Impact test specimens for the lesser T design values of – 10°C and 0°C shall be greater than 1.4 x (ultimate tensile strength, in mpa) 0.5, in joules.

- The minimum of three Charpy Impact test specimens for the lesser T design values of – 10°C and 0°C shall be greater than (ultimate tensile strength, in mpa) 0.5, in joules.
- The minimum ductile fracture area on any Charpy test specimen for the lesser T design values of – 10°C and 0°C shall be more than 75%.
- The minimum elongation at 20°C is more than 10% and the minimum reduction in area is greater than 40%.
- Special attention shall be given to through-thickness properties and material ductility where members may be loaded as a result of a collision.
- Structural steel plates shall conform to IS: 2062-2006, Fe 410W, Grade-B (killed) with minimum Y<sub>st</sub> 250 mpa for all thickness and shall be free from lamination.
- Structural steel rolled sections shall conform to IS: 2062-2006, Fe 410W, Grade-A.
- In case of for Hollow Sections, the minimum thickness shall be 4mm and weld size shall be 4mm
- Electrodes for mild steel shall conform to IS: 814-1991 & ASME Sec II C (Latest). The electrodes shall be chosen according to the welding procedure to be adopted and quality of metal to be welded. The strength of weld metal and of the parent metal in the heat affected zone shall not be less than that of parent metal.
- Purlins, girts, stair treads, handrails shall be fastened by M12 bolts of 4.6 grade.
- Minimum size of fillet weld shall be as per recommendation of IS: 9595-1980. Structural welding shall not be lower than 6 mm as continuous welding. However, for nominal fillet weld as required, for example, between chequered plates and their stiffeners or supporting members, hand railing junction etc. the leg size shall not less than 4 mm.
- All structural Bolting shall be of Grade 8.8 as per IS: 1367 with minimum two bolts of 16 mm dia. unless noted otherwise. Bolts shall be Hot dip galvanized with min 80 Micron and painted after erection with etch primer -15-25 micron, Epoxy polyamide /HBMIO- 200 Micron Total DFT Plus zinc- 305 Micron.
- Hexagonal head bolts & units shall generally conform to the property class as specified in IS: 1379 (part-3)-1991 as per design requirement otherwise noted.
- Hand rail Pipes shall be to IS: 1161/ IS: 1239 with minimum 240 mpa yield strength.
- Foundation bolts and minor connections (like hand railings) shall be of Grade 4.6 as per IS: 1367. Foundation bolts shall be Hot Dip Galvanized with min coating 80 Micron After erection Foundation bolts shall be painted with etch primer -15-25 micron, Epoxy polyamide /HBMIO-200 Micron Total DFT Plus zinc- 305 Micron.
- All grating and chequered plates shall be of mild steel quality.
- Hook bolts for corrugated sheet coverings shall be of aluminium.

### 10.9.11 Paints:

For structural steel paints, provision shall be made for three coats of paints as applicable as per manufacturer's specifications considering exposure condition to weather and seafront areas are as follows:

#### 10.9.11.1 Prime Coat

The prime coat shall be 75 micron dry coat of zinc paint, applied in accordance with the manufacturer's recommendation and specifications.

### 10.9.11.2 Intermediate Coat

Intermediate paint (MIO) high build two component epoxy of 150 micron DFT.

### 10.9.11.3 Top Coat

- The top coat shall be 70 micron of aliphatic polyurethane paint. Due to low volume solid, two coats of 35 micron DFT may apply in accordance with manufacturer's recommendations and specification.
- Before application of paint surface shall be shot blasted (Swedish standard specification Sa 2 ½) or Use of scraper wire brush and pig hammer is acceptable wherever shot blasting is not possible due to lack of access. And as per NIT specification all precautions shall be done for preparation of surface for paints. For corrosive protection provision shall be applicable as per NIT specifications.

## 10.9.12 Inspection and Erection

- All structures shall be offered for inspection at the fabrication shop before painting. Material certificate for the fabricated structures shall be provided.
- Erection shall be carried out as per applicable standards, drawings, specifications, and regulations. The erection tolerance shall be within the standard specified limits.

## 10.10 Road

### 10.10.1 Indicative Scope of Work

This specification covers the requirement for providing material, labour, equipment, Construction and workmanship for roads, pavements and paver blocks.

- Internal yard roads are proposed for accessibility in yard area for service vehicles, Cargo vehicles and Maintenance vehicles.
- Cross roads along with stock pile are to be provided in the yard area with granular top.
- Main terminal Entry exit Road shall be of Two Lane Bituminous Road of 7.5 mtr Width.
- Internal Peripheral Road shall be of 4 mtr wide Bituminous Road.

### 10.10.2 Assumptions

- Roads are proposed with Bituminous top considering service vehicle movement, Cargo vehicle movement and Maintenance vehicle movements.

### 10.10.3 Documentation

Documents for employer review and approval

- Execution drawings with road cross section & layout
- BOQ for road work
- Documents for information and record
- Final BOQ for road work
- As built drawing.

### 10.10.4 Tender Drawings

- Overall Layout Terminal layout with Road network Drg No: M-002.

### 10.10.5 Applicable Codes

**Note:** - Wherever reference is made to IS Codes, on any page of this Technical Specification, applicable year of publication of IS Code should be considered as latest one at time of award of contract.

The Indian Standard Codes applicable to this section shall include but not limited to the following:

IS 73 : Specification for paving bitumen. IS 215:

Specification for road tar.

IS 217 : Specification for cutback bitumen.

IS 1200 (Part-I) : Method of measurement of building and civil engineering works: Part-I Earthwork.

IS 1200 (Part-17) : Method of measurement of building and civil engineering works: Part-17 Roadwork including air field pavements.

IS 2386 (Part-1) Methods of test for aggregate of concrete: Part-1: Particle size and shape.

IS 2386 (Part-3) Methods of test for aggregate of concrete: Part-3: Specific gravity, density, voids, absorption and bulking.

IS 2386 (Part-4) Methods of test for aggregate of concrete: Part-4: Mechanical properties. IS 2430 Methods of sampling of aggregate for concrete.

IS 2720 (Part-2) : Methods of test for soils: Part-2 Determination of moisture content.

IS 2720 (Part-5) : Methods of test for soils: Part-5 Determination of liquid and plastic limit.

IS 2720 (Part-8) : Methods of test for soils: Part-8 Determination of moisture content - dry density relation using heavy compaction.

IS 2720 (Part-28) : Methods of test for soils: Part-28 Determination of dry density of soils, in place, by the sand Replacement Method.

IS 2720 (Part-29) : Methods of test for soils: Part-29 Determination of dry density of soils, in place by core cutter method.

IS 6241 : Method of test for determination of stripping value of road aggregate. IS 15658 :

Specification Precast concrete blocks for paving.

IRC 15 : Standard specifications and code of practice for construction of concrete roads

IRC SP 063 : Guidelines for the use of interlocking concrete block pavement IS 456 : Code of practice for plain and reinforced concrete

MORTH : Specification for road and Bridges, 5th revision of MORTH

### 10.10.6 Subgrade

Subgrade shall be free of roots and soft spots, rubbish or organic deleterious material and boulders and rolled to an even firm foundation.

Subgrade shall be true to required line and grade as shown on the drawings or as directed by the Engineer-In-Charge. Subgrade preparation shall include earthwork excavation in existing soil, filling to depth as shown on the drawings or as directed by the Engineer-In-Charge.

Surplus excavated earth shall be disposed of outside the site limits as directed by the Engineer-In-Charge.

Compaction shall be carried out with 10 tonne rollers or mechanical compactor. During rolling the surface shall be checked for grade and camber. Any irregularities in the surface shall be corrected by loosening the Subgrade material and removing or adding fresh material. Compaction shall continue until the density is achieved to at least 90% of the standard proctor density.

The prepared subgrade shall be cleaned of all foreign substance accumulation, prior to construction of sub-base.

Should the subgrade at any time become soft or get churned up with the soling, the CONTRACTOR shall, remove the mixture from the affected portion, reshape and compact the subgrade and replace the removed section in accordance with the foregoing requirements.

### 10.10.7 Earth Work in Filling

#### 10.10.7.1 Materials and Procedure:

Materials and procedure shall be as per Standard Engineering Specification for Earthwork Grading and Banking.

The materials satisfying the density requirements given in Table of MORTH shall be employed for the construction of the embankment, shoulder and the subgrade of road and pavement.

**Table 10-2 -Density Requirements of Embankment and Sub-grade Materials**

Sr.No	Type of Work	Maximum laboratory dry unit weight when tested as per 15:2720 (Part 8)
1	Embankments up to 3 m height, not subjected to extensive flooding.	Not less than 15.2 kN/cu.m
2	Embankments exceeding 3 m height or embankments of any height subject to long periods of inundation.	Not less than 16 kN/ cu.m
3	Subgrade and earthen shoulders/verges /backfill	Not less than 17.5 kN/cu.m

#### Notes:

- This Table is not applicable for lightweight fill material, e.g., cinder, fly ash, etc.
- The material to be used in subgrade shall be non-expansive and shall satisfy Design CBR at the specified dry density as per Table and moisture content.
- In case the available materials fail to meet the requirement of CBR, use of Stabilization methods in accordance with Clauses 403 and 404 of MORTH or by any stabilization method approved by the Engineer shall be followed.

#### 10.10.7.2 Tolerance

Embankments and shoulders for road and pavement works shall be carried to within a tolerance of 3cm from final lines but shall be to required grades and slopes.

### 10.10.8 Filling With Sand/ Murrum

- a) Sand for filling shall preferably be locally available sand, clean and free from any chemical or other impurities. Murrum for filling shall be clean and well graded. Sand/ murrum shall not contain any vegetation, organic, clayey or other material and shall be obtained from a source approved by Engineer-In-Charge PMC/

TPIA.

- b) Murrum/ sand shall be spread not exceeding 15cm in loose thickness over the areas. Each layer shall be uniform in density, quality of material and moisture content before compaction. The moisture content shall be within two percent of the optimum moisture content as per IS: 2720 Part 8.

In case of pure sand, flooding with water is permissible.

- c) The compaction shall be ensured that the subgrade material when compacted to the density requirements as in Table shall be yield the design CBR value of the subgrade.

**Table 10-3 Compaction Requirements for Embankment and Sub-grade**

Sr.No	Type of work/material	Relative compaction as percentage of max. laboratory dry density as per IS:2720 (Part 8)
1	Subgrade and earthen shoulders	Not less than 97%
2	Embankment,	Not less than 95%
3	Expansive Clays a) Subgrade and 500 mm portion just below the subgrade b) Remaining portion of embankment	Not allowed 90-95%

- d) Compaction of each layer shall be by mechanical means as per directions of Engineer-In-Charge. Only inaccessible reaches shall be worked manually. Each layer shall be uniformly compacted to obtain 90% of maximum laboratory dry density of the material. If the material fails to achieve the required density, the layer shall be reworked with necessary alteration in compaction, so that the required compaction is obtained. A minimum of one test per 500m<sup>2</sup> area for each layer shall be conducted.
- e) Subsequent layers shall be placed only after the layer already laid has been compacted to the required density and approved by Engineer-In-Charge.
- f) The finished surface must be dressed to required grade and slope. Excess material must be removed from compaction site, as directed by Engineer-In-Charge.

#### **10.10.9 Earthwork In Box Cutting**

- a) Construction procedures and quality control of all materials shall be confirming to relevant clause of MoRTH specification.
- b) Excavation works shall be commenced and carried out as per program of work front to be approved by the Engineer-In-Charge. Setting out and line out for excavation shall be done by the CONTRACTOR and excavating shall be started only after approved by the Engineer-In-Charge.
- c) Excavation shall be carried out in all types of soils including clay, and stiff clay, murrum sand and sand with admixture, and excluding soft/ hard rock.
- d) Excavated material shall not be deposited within 1.5m from the top edge of the excavation or within a distance equal the depth of excavation, whichever is higher. Surplus excavated soil shall be transported to the dumping area or as directed by Engineer-In-charge.
- e) Any excavation beyond permissible dimensions or slopes shall not be paid for. If CONTRACTOR excavates beyond the specified depth, the over excavated portion shall be filled back only with 1:2:4 nominal mix at his

own expense and well compacted until it is brought upto the proper level.

If actual excavation is less than the specified dimensions, payment shall be made only for the quantity excavated.

- f) Any obstacle encountered during excavation shall be reported immediately to the Engineer-in-Charge and shall be dealt with as instructed.
- g) The CONTRACTOR shall maintain excavated box in a dry and trim condition.
- h) The exposed surface shall be rolled with at least 3 passes of a 10 tonnes road roller and properly consolidated. Any soft patches shall be further excavated and filled back with sand or selected and approved earth obtained from excavated earth and the patch thoroughly compacted to obtain the same density as of adjoining areas. Necessary camber and super elevation shall be obtained in the consolidated soil surface.

#### 10.10.10 Granular Sub-Base (GSB)

This work shall consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

The material to be used for the work shall be natural sand, crushed gravel, crushed stone, crushed slag, or combination thereof depending upon the grading required.

The material shall be free from organic or other deleterious constituents and shall conform to the grading Table and physical requirements given in Table-2.

**Table 10-4 - Grading for Granular Sub-base Materials**

IS Sieve Designation	Percent by Weight Passing the IS Sieve					
	Grading I	Grading II	Grading III	Grading IV	Grading V	Grading VI
75.0 mm	100	-	-	-	100	-
53.0 mm	80-100	100	100	100	80-100	100
26.5 mm	55 -90	70-100	55-75	50-80	55-90	75-100
9.50 mm	35-65	50-80	-	-	35-65	55-75
4.75 mm	25 - 55	40-65	10-30	15-35	25-50	30-55
2.36 mm	20- 40	30-50		-	10-20	10-25
0.85 mm	-	-	-	-	2-10	-
0.425 mm	10-15	10- 15	-	-	0-5	0-8
0.075 mm	<5	<5	<5	<5	-	0-3

**Table 10-5 Physical Requirements for Materials for Granular Sub-base**

Aggregate Impact Value (AIV)	IS:2386 (Part 4) or IS:5640	40 maximum
Liquid Limit	IS:2720 (Part 5)	Maximum 25
Plasticity Index	IS:2720 (Part 5)	Maximum 6
CBR at 98% dry density (at IS:2720-Part 8)	IS:2720 (Part 28,31	Minimum 30 unless otherwise specified in the Contract

#### 10.10.11 Laying And Compaction Of GSB

Immediately prior to the laying of sub-base, the subgrade already finished, the subbase material of the grading specified in the Contract and water shall be mixed mechanically by a suitable mixer equipped with provision for controlled addition of water and mechanical mixing. So as to ensure homogenous and uniform mix. The required water content shall be determined in accordance with IS:2720 (Part 8). The mix shall be spread on the prepared subgrade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation, or other means as approved by the Engineer.

Immediately after spreading the mix, rolling shall be done by of a vibratory roller of minimum 80 to 100 kN static weight capable of achieving the required compaction. Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material determined as per IS:2720 (Part 8).

#### 10.10.12 Wet Mix Macadam (WMM) Sub-Base/Base

This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared subgrade/ sub-base/ base or existing pavement as the case may be in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as necessary to lines, grades and cross-sections shown on the approved drawings or as directed by the Engineer.

The aggregates shall conform to the physical requirements set forth in Table below. If the water absorption value of the coarse aggregate is greater than 2 percent, the soundness test shall be carried out on the material delivered to site as per IS:2386(Part 5).

**Table 10-6 Physical Requirements of Coarse Aggregates for Wet Mix Macadam for Sub- base/Base Courses**

Sr.No	Test	Test Method	Requirements
1	Los Angeles Abrasion value	IS:2386 (Part-4)	40 percent (Max.)
	Or Aggregate Impact value	IS:2386 (Part-4) or IS:5640	30 percent (Max.)
2	Combined Flakiness and Elongation indices (Total)	IS:2386 (Part-1)	35 percent (Max.)*

If the water absorption value of the coarse aggregate is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS: 2386 (Part-5).

**Table 10-7 Grading Requirements of Aggregates for Wet Mix Macadam**



IS Sieve Designation	Percent by weight passing the IS Sieve
53.00 mm	100
45.00 mm	95-100
26.50 mm	-
22.40 mm	60-80
11.20 mm	40-60
4.75 mm	25-40
2.36 mm 15	15-30
600.00 micron	8-22
75.00 micron	0-5

Materials finer than 425 micron shall have Plasticity Index (PI) not exceeding 6. The final gradation approved within these limits shall be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa.

#### 10.10.13 Preparation of mix

Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/positive mixing arrangement like pug mill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the Engineer may permit the mixing to be done in concrete mixers.

Optimum moisture for mixing shall be determined in accordance with IS: 2720 (Part- 8) after replacing the aggregate fraction retained on 22.4 mm sieve with material of 4.75 mm to 2.4 mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.

#### 10.10.14 Laying and compaction of wet mix macadam

The mix may be spread either by a paver finisher or motor grader. For portions where mechanical means cannot be used, manual means as approved by the Engineer shall be used. The motor grader shall be capable of spreading the material uniformly all over the surface.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. The layer may be tested by depth blocks during construction. No segregation of larger and fine particles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

Immediately after spreading the mix, rolling shall be done by a vibratory roller of minimum 80 to 100 kN static weight capable of achieving the required compaction. In portions in camera, rolling should begin at the edge with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the centre parallel to the centre line of the road uniformly overlapping each of

the preceding track by at least one-third width until the entire surface has been rolled. Rolling shall be continued until the density achieved is at least 98 per cent of the maximum dry density for the material as determined by the method outlined in IS: 2720 (Part-8).

### 10.10.15 Prime Coat

#### 10.10.15.1 General

This work shall consist of application of single coat of low viscosity liquid bituminous material, as a surface preparatory to a subsequent bituminous treatment.

#### 10.10.15.2 Material

Bituminous primer shall be medium curing cutback produced by fluxing, in approved manner, bitumen of 80/100 penetration grade with kerosene.

**Table 10-8 Viscosity requirement and quantity of liquid bituminous primer**

Type of surface	Kinematic Viscosity of Primer at 60°C (Centistokes)	Quantity of Liquid Bituminous Material per 10 Sq.m.(kg)
Low porosity	30-60	6 to 9
Medium porosity	70-140	9 to 12
High porosity	250-500	12 to 15

The primer shall be bitumen emulsion, complying with IS 8887 of a type and grade as specified in the Contract or as directed by the Engineer. The use of medium curing cutback as per IS 217 shall be restricted only for sites at sub-zero temperatures or for emergency applications as directed by the Engineer.

#### 10.10.15.3 Preparation of surface

- a) The existing WET MIX macadam road surface shall be thoroughly swept and scraped clean of dust, loose material, caked mud and other foreign matter with the help of wire brush, chisel, picks, etc, before the application of prime coat.

Construction procedures and quality control of all materials shall be confirming to relevant clause of MoRTH specification.

- b) Large irregularities, pot holes, depressions etc shall be filled with premix chipping and well rammed.
- c) The underlying surface shall be dry prior to application of the primer coat.

#### 10.10.15.4 Application

- a) After the base has been prepared as described above, the primer shall be uniformly applied over the surface using mechanical sprayers. Rate of application shall be 10kg/10m<sup>2</sup> areas.
- b) The spraying shall be carried out using sprayer mounted on distributor truck or with hand sprayer using mechanical pump. Hand held containers shall not be used.
- c) Temperature of application shall be high enough to permit the primer to be sprayed effectively through jets of the spray bar and to cover the base course area effectively.
- d) The primed surface shall be allowed to cure fully. No traffic shall be allowed over the primed surface for 24 hours.

- e) Any excess primer, which does not get completely absorbed by any part of the base course surface during the curing period, shall be carefully swept over the adjacent surface and then a light sand blotter course applied. The amount shall be just sufficient to blot up the excess bitumen and prevent it being picked up under traffic.

All loose sand shall be swept from the base course surface, prior to any subsequent bituminous treatment.

#### 10.10.16 Tack Coat

##### 10.10.16.1 General

This work shall consist of application of a single coat of low viscosity liquid bituminous material, to the prepared surface preparatory to receive bituminous construction over it.

##### 10.10.16.2 Material

The binder used for tack coat, shall be bitumen of grade 80/100, conforming to IS: 73 to be heated to 177°C – 188°C.

##### 10.10.16.3 Preparation of Surface

The surface on which the tack coat is to be applied shall be cleared of dust and any extraneous material, before the application of binder, by using a mechanical broom or any prior approved equipment or method. The underlying surface shall be dry prior to application of the tack coat.

##### 10.10.16.4 Application

The application of tack coat shall be at the rate specified in the Contract, and shall be applied uniformly. If rate of application of Tack Coat is not specified in the contract then it shall be at the rate specified in Table of MORTH. The normal range of spraying temperature for a bituminous emulsion shall be 20°C to 70°C and for a cutback, 50°C to 80°C if RC-70/MC-70 is used.

**Table 10-9- Rate of Application of Tack coat**

Sr.No	Type of Surface	Quantity of Liquid bituminous material in Kg per sq.m. area
1	Normal bituminous surfaces	0.20 to 0.25
2	Dry and hungry bituminous surfaces	0.25 to 0.30
3	Granular surfaces treated with primer	0.25 to 0.30
4	Non bituminous surfaces	0.35 to 0.40
	Granular base (not primed) Cement concrete pavement	0.30 to 0.35

##### 10.10.16.5 Curing of tack coat

The tack coat shall be left to cure until all the volatiles have evaporated before any subsequent construction is started. No plant or vehicles shall be allowed on the tack coat other than those essential for the construction.

#### 10.10.17 Dense Graded Bituminous Macadam (DGBM)

#### 10.10.17.1 General

This clause specifies the construction of Dense Graded Bituminous Macadam, (DBM), for use mainly, but not exclusively, in base/binder and profile corrective courses. DBM is also intended for use as road base material. This work shall consist of construction in a single or multiple layers of DBM on a previously prepared base or sub-base. The thickness of a single layer shall be 50mm to 100mm.

#### 10.10.17.2 Materials

##### a) Bitumen:

The bitumen shall be paving bitumen of Penetration Grade complying with Indian Standard Specifications for "Paving Bitumen" IS: 73, and of the penetration indicated in Table for dense bitumen macadam, or as otherwise specified in the Contract. Guidance on the selection of an appropriate grade of bitumen is given in The Manual for Construction and Supervision of Bituminous Works.

##### b) Coarse aggregates:

The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on the 2.36 mm sieve. They shall be clean, hard, durable, of cubical shape, free from dust and soft or friable matter, organic or other deleterious substances. The aggregates shall satisfy the physical requirements specified in Table, for dense bituminous macadam.

Where crushed gravel is proposed for use as aggregate, not less than 90% by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.

##### c) Fine aggregates:

Fine aggregates shall consist of crushed or naturally occurring mineral material, or a combination of the two, passing the 2.36mm sieve and retained on the 75 micron sieve. They shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or other deleterious matter.

The fine aggregate shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS: 2720 (Part 37).

The plasticity index of the fraction passing the 0.425 mm sieve shall not exceed 4. When tested in accordance with IS: 2720 (Part 5)

**Table 10-10 Physical requirements for coarse aggregate for dense graded bituminous macadam**

Property	Test	Specification
Cleanliness	Grain size analysis	Max 5% passing 0.075mm sieve
Particle shape	Flakiness and Elongation Index (Combined)	Max 30%
Strength*	Los Angeles Abrasion Value	Max 35%
	Aggregate Impact Value	Max 27%

Durability	Soundness: Sodium Sulphate Magnesium Sulphate	Max 12% Max 2%
Water	Water absorption	Max 2%
Stripping	Coating and Stripping of Bitumen Aggregate Mixtures	Minimum Retained Coating 95%
Water Sensitivity**	Retained Tensile Strength	Min 80%

\* Aggregate may satisfy requirements of either of these two tests.

\*\* The water sensitivity test is only required if the minimum retained coating in the stripping test is less than 95%.

#### d) Filler

Filler shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement approved by the Engineer.

The filler shall be graded within the limits indicated in Table below:

**Table 10-11- Grading Requirements for Mineral filler**

IS Sieve (mm)	Cumulative per cent passing by weight of total aggregate
0.6	100
0.3	95-100
0.075	85 - 100

The filler shall be free from organic impurities and have a Plasticity Index not greater than 4. The Plasticity Index requirement shall not apply if filler is cement or lime. When the coarse aggregate is gravel, 2 per cent by weight of total aggregate, shall be Portland cement or hydrated lime and the percentage of fine aggregate reduced accordingly. Cement or hydrated lime is not required when the limestone aggregate is used. Where the aggregates fail to meet the requirements of the water sensitivity test in then 2 per cent by total weight of aggregate, of hydrated lime shall be added without additional cost.

#### 1010.173 Aggregate Grading and Binder Content

When tested in accordance with IS: 2386 Part 1 (wet sieving method), the combined grading of the coarse and fine aggregates and added filler for the particular mixture shall fall within the limits shown in, for dense bituminous macadam grading 1 or 2 as specified in the Contract. The type and quantity of bitumen, and appropriate thickness, are also indicated for each mixture type.

**Table 10-12 -Composition of Dense Graded Bituminous Macadam pavement**

**layers**

Grading		2
Nominal aggregate size	40mm	25 mm
<b>Layer Thickness</b>	80-100 mm	50-75 mm
IS Sieve <sup>1</sup> (mm)	Cumulative % by weight of total aggregate passing	
45	100	
37.5	95 - 100	100
26.5	63 - 93	90 - 100
19		71 - 95
13.2	55- 75	56- 80
9.5		-
4.75	38- 54	38- 54
2.36	28- 42	28- 42
1.18	-	-
0.6	-	-
0.3	7 - 21	7 - 21
0.15	-	-
0.075	2 - 8	2 - 8
Bitumen content % by		
mass of total mix <sup>2</sup>	Min 4.0	Min 4.5
Bitumen grade (pen)	65 or 90	65 or 90

**Notes:**

- The combined aggregate grading shall not vary from the low limit on one sieve to the high limit on the adjacent sieve.
- Determined by the Marshall method.

**10.10.174 Mixture Design**

Requirement for the mixture: Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table-9.

**Table 10-13 Requirements for dense graded bituminous macadam**

Minimum stability (kN at 60 °C)	9.0
Minimum flow (mm)	2
Maximum flow (mm)	4
Compaction level (Number of blows)	75 blows on each of the two faces of the specimen
Per cent air voids	3-6
Per cent voids in mineral aggregate (VMA)	See Table below
Per cent voids filled with bitumen	65-75

The requirements for minimum per cent voids in mineral aggregate (VMA) are set out in Table below:

**Table 10-14 -Minimum per cent voids in mineral aggregate (VMA)**

Nominal Maximum Particle Size (mm)	Minimum VMA, Per cent Related to Design Air Voids, Percent		
	3.0	4.0	5.0
9.5	14.0	15.0	16.0
12.5	13.0	14.0	15.0
19.0	12.0	13.0	14.0
25.0	11.0	12.0	13.0
37.5	10.0	11.0	12.0

#### **Binder content**

The binder content shall be optimized to achieve the requirements of the mixture set out in Table and the traffic volume specified in the Contract. The Marshall method for determining the optimum binder content shall be adopted as described.

**Table 10-15-Permissible variations from the job mix formula**

Description	Permissible Variations	
	Base/binder course	Wearing
Aggregate passing 19mm sieve or larger	± 8%	± 7%
Aggregate passing 13.2mm, 9.5mm	± 7%	± 6%
Aggregate passing 4.75mm	± 6%	± 5%

Aggregate passing 2.36mm, 1.18mm, 0.6mm	± 5%	± 4%
Aggregate passing 0.3mm, 0.15mm	± 4%	± 3%
Aggregate passing 0.075mm	± 2%	± 1.5%
Binder content	± 0.3%	± 0.3%
Mixing temperature	± 10°C	± 10°C

### **Laying Trials:**

Once the plant trials have been successfully completed and approved, the Contractor shall carry out laying trials. The area of the laying trials shall be a minimum of 100 sq.m. of construction similar to that of the project road, and it shall be in all respects, particularly compaction, the same as the project construction, on which the bituminous material is to be laid.

The Contractor shall previously inform the Engineer of the proposed method for laying and compacting the material. The plant trials shall then establish if the proposed laying plant, compaction plant, and methodology is capable of producing satisfactory results. The density of the finished paving layer shall be determined by taking cores, no sooner than 24 hours after laying, or by other approved method.

Once the laying trials have been approved, the same plant and methodology shall be applied to the laying of the material on the project, and no variation of either shall be acceptable, unless approved in writing by the Engineer, who may at his discretion require further laying trials.

## **1010175 Construction Operations**

### **a) Preparation of base:**

The base on which Dense Graded Bituminous Material is to be laid shall be prepared as directed by the Engineer. The surface shall be thoroughly swept clean by a mechanical broom, and the dust removed by compressed air. In locations where mechanical broom cannot access, other approved methods shall be used as directed by the Engineer.

### **b) Prime coat**

Where the material on which the dense bituminous macadam is to be laid is other than a bitumen bound layer, a prime coat shall be applied, as specified.

### **c) Tack coat:**

Where the material on which the dense bituminous macadam is to be placed is a bitumen bound surface, a tack coat shall be applied as specified.

### **d) Rolling**

The compaction process shall be carried out by the same plant, and using the same method, as approved in the laying trials, which may be varied only with the express approval of the Engineer in writing.

### **e) Opening to Traffic**



The newly laid surface shall not be open to traffic for at least 24 hrs after laying and completion of compaction, without the express approval of the Engineer in writing.

### 10.10.18 Semi-Dense Bituminous Concrete

#### 10.10.18.1 General

This clause specifies the construction of Semi Dense Bituminous Concrete, for use in wearing/binder and profile corrective courses. This work shall consist of construction in a single or multiple layers of semi dense bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 25mm to 100mm in thickness.

#### 10.10.18.2 Materials

##### a) Bitumen:

The bitumen shall be paving bitumen of Penetration grade complying with Indian Standard Specification for Paving Bitumen, IS: 73 and of the penetration indicated in Table for semi dense bituminous concrete, or as otherwise specified in the Contract. Guidance on the selection of an appropriate grade of bitumen is given in The Manual for Construction and Supervision of Bituminous Works.

##### b) Course aggregates:

The coarse aggregates shall be generally as specified in Clause 10.10.17.2 – b) except that the aggregates shall satisfy the as per Table of Physical requirements for coarse aggregate for semi dense bituminous concrete pavement layers.

##### c) Fine aggregates:

The fine aggregates shall be all as specified in Clause 10.10.17.2 – c).

##### d) Filler:

Filler shall be generally as specified in Clause 10.10.17.2 – d), where the aggregates fail to meet the requirements of the water sensitivity test in Table of Physical requirements, and then 2 per cent by total weight of aggregate, of hydrated lime shall be added without additional cost.

##### e) Mixture Design

Requirements for the mixture: Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table below.

**Table 10-16 -Physical requirements for coarse aggregate for semi dense bituminous concrete pavement layers**

Property	Test	Specification
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075mm sieve
Particle shape	Flakiness and Elongation Index (Combined)	Max 30%

Strength*	Los Angeles Abrasion Value Aggregate Impact Value	Max 35% Max 27%
Polishing	Polished Stone Value	Min 55
Durability	Soundness : Sodium Sulphate Magnesium Sulphate	Max 12% Max 2%
Water Absorption	Water absorption	Max 2%
Stripping	Coating and Stripping of Bitumen	Minimum Retained Coating
	Aggregate Mixtures	95 %
Water Sensitivity**	Retained Tensile Strength	Min 80 %

\* Aggregate may satisfy requirements of either of these two tests.

\*\* The water sensitivity test is only required if the minimum retained coating in the stripping test is less than 95%.

#### **Binder content:**

The binder content shall be optimized to achieve the requirements of the mixture set out in Table below and the traffic volume as specified in the Contract. The Marshall method for determining the optimum binder content.

**Table 10-17 -Composition of semi dense bituminous concrete pavement layers**

Grading	1	2
Nominal aggregate size	13 mm	10 mm
Layer Thickness	35-40 mm	25-30 mm
IS Sieve1 (mm)	Cumulative % by weight of total aggregate passing	
45		
37.5		
26.5		
19	100	
13.2	90-100	100
9.5	70-90	90-100
4.75	35-51	35-51
2.36	24-39	24-39
1.18	15-30	15-30

0.6	-	-
0.3	9-19	9-19
0.15	-	-
0.075	3-8	3-8
Bitumen content % by mass of the total mix	Min 4.5	Min 5.0
Bitumen grade (pen)	65*	65*

**Table 10-18- Requirements for semi dense bituminous pavement layers**

Minimum stability (kN at 60 oC)	8.2
Minimum flow (mm)	2
Maximum flow (mm)	4
Compaction Level (Number of blows)	75 blows on each of the two faces of the specimen
Percent air voids	3-5
Percent voids in mineral aggregate (VMA)	See Table below
Per cent voids filled with bitumen	65-78

### 10.10.18.3 Construction Operations

**a) Preparation of base:**

The surface on which the Semi Dense Bituminous material is to be laid shall be prepared in accordance with Clauses of MORTH as appropriate, or as directed by the Engineer. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air. In locations where a mechanical broom cannot access, other approved methods shall be used as directed by the Engineer.

**b) Tack coat:**

Where specified in the Contract, or otherwise required by the Engineer, a tack coat shall be applied in accordance with the requirements of Clause 503 of MORTH.

**c) Rolling:**

The compaction process shall be carried out by the same plant, and using the same method, as approved in the laying trials, which may be varied only with the express approval of the Engineer in writing.

**d) Opening to Traffic**

The newly laid surface shall not be open to traffic for at least 24 hours after laying and the completion of compaction, without the express approval of the Engineer in writing.

## 10.10.19 Bituminous Concrete

### 10.10.19.1 General

This clause specifies the construction of Bituminous Concrete, for use in wearing and profile corrective courses. This work shall consist of construction in a single or multiple layers of bituminous concrete on a previously prepared bituminous bound surface. Single layers shall be 25mm to 100mm in thickness.

### 10.10.19.2 Materials

#### a) Bitumen:

The bitumen shall be paving bitumen of Penetration grade complying with Indian Standard Specification for Paving Bitumen, IS: 73 and of the penetration indicated in Table, for bituminous concrete, or as otherwise specified in the Contract. Guidance on the selection of an appropriate grade of bitumen is given in The Manual for Construction and Supervision of Bituminous Works.

#### b) Coarse aggregates:

The coarse aggregates shall be generally as specified in Clause, except that the aggregates shall satisfy the physical requirements of Table.

#### c) Fine aggregates:

The fine aggregates shall be all as specified in Clause 10.10.17.2

#### d) Filler:

Filler shall be generally as specified in Clause Where the aggregates fail to meet the requirements of the water sensitivity test in Table-15, then 2 per cent by total weight of aggregate, of hydrated lime shall be added without additional cost.

Aggregate grading and binder content: When tested in accordance with IS: 2386 Part 1 (Wet grading method), the combined grading of the coarse and fine aggregates and added filler shall fall within the limits shown in Table for grading 1 or 2 as specified in the Contract.

### 10.10.19.3 Mixture Design

Requirements for the mixture: Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table below:

#### Binder content:

The binder content shall be optimized to achieve the requirements of the mixture set out in Table and the traffic volume as specified in the Contract. The Marshall method for determining the optimum binder content shall be adopted as described

**Table 10-19 -Physical requirements for coarse aggregate for bituminous concrete pavement layers**

Property	Test	Specification
----------	------	---------------

Cleanliness	Grain size analysis	Max 5% passing 0.075 mm sieve
Particle shape	Flakiness and Elongation Index (Combined)	Max 30% (Combined) <sup>2</sup>
Strength*	Los Angeles Abrasion Value <sup>3</sup> Aggregate Impact Value <sup>4</sup>	Max 30%
Polishing	Polished Stone Value <sup>5</sup>	Min 55
Durability	Soundness: 6 Sodium Sulphate Magnesium Sulphate	Max 12% Max 18%
Water Absorption	Water absorption <sup>7</sup>	Max 2%
Stripping	Coating and stripping of Bitumen Aggregate Mixtures <sup>9</sup>	Minimum retained coating 95%
Water Sensitivity**	Retained Tensile Strength <sup>8</sup>	Min 80%

The water sensitivity test is only required if the minimum retained coating in the stripping test is less than 95%.

**Table 10-20 -Composition of bituminous concrete pavement layers**

Grading	1	2
Nominal aggregate size	13 mm	10 mm
Layer Thickness	35-40 mm	25-30 mm
IS Sieve <sup>1</sup> (mm)	Cumulative % by weight of total aggregate passing	
45		
37.5		
26.5	100	
19	79-100	100
13.2	59-79	79-100
9.5	52-72	70-88
4.75	35-55	53-71

2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-37	26-38
0.3	10-20	18-28
0.15	5-13	12-20
0.075	2-8	4-10
Bitumen content% by mass of total mix <sup>2</sup>	5.0 - 6.0	5.0 - 7.0
Bitumen grade (pen)	65	65

**Notes:**

- a) The combined aggregate grading shall not vary from the low limit on one sieve to the high limit on the adjacent sieve.
- b) Determined by the Marshall method.

**Table 10-21 -Requirements for bituminous pavement layers**

Minimum stability (kN at 60 oC)	9.0
Minimum flow (mm)	2
Maximum flow (mm)	4
Compaction level (Number of blows)	75 blows on each of the two faces of the specimen
Per cent air voids	3-6
Per cent voids in mineral aggregate (VMA)	See Table below
Per cent voids filled with bitumen (VFB)	65-75
Loss of stability on immersion in water at 60oC (ASTM D 1075)	Min. 75 per cent retained strength

#### 10.10.19.4 Construction Operations

**a) Preparation of base:**

The surface on which the bituminous concrete is to be laid shall be prepared in accordance with Clauses 501 and 902 as appropriate, or as directed by the Engineer. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air. In locations where a mechanical broom cannot access, other approved methods shall be used as directed by the Engineer.

**b) Tack coat:**

Where specified in the Contract, or otherwise required by the Engineer, a tack coat shall be applied in accordance with the requirements of Clause 10.10.17.2.

**c) Opening to Traffic:**

The newly laid surface shall not be open to traffic for at least 24 hours after laying and the completion of compaction, without the express approval of the Engineer in writing.

## **10.10.20 Dry Lean Cement Concrete Sub-Base**

### **10.10.20.1 General**

The work shall consist of construction of dry lean concrete subbase for cement concrete pavement in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer. The work shall include furnishing of all plant and equipment, materials and labour and performing all operations, in connection with the work, as approved by the Engineer. The design parameters of dry lean concrete sub-base, viz., width, thickness, grade of concrete, details of joints, if any, etc. shall be as stipulated in the Contract drawings.

### **10.10.20.2 Materials**

**a) Cement**

Any of the following types of cement may be used with prior approval of the Engineer:

Ordinary Portland Cement	IS: 269
Portland Slag Cement	IS: 455
Portland Pozzolana Cement	IS: 1489

If the subgrade is found to consist of soluble sulphates in a concentration more than 0.5 per cent, cement used shall be sulphate resistant and shall conform to IS: 6909.

Cement to be used may preferably be obtained in bulk form. It shall be stored in accordance with stipulations contained in Clause 10.14 and shall be subjected to acceptance test prior to its immediate use.

**b) Aggregates**

Aggregates for lean concrete shall be natural material complying with IS: 383. The aggregates shall not be alkali reactive. The limits of deleterious materials shall not exceed the requirements set out in IS: 383. In case the Engineer considers that the aggregates are not free from dust, the same may be washed and drained for at least 72 hours before batching, as directed by the Engineer.

**c) Coarse aggregate**

Coarse aggregate shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone or crushed gravel and shall be devoid of pieces of disintegrated stone, soft, flaky, elongated, very angular or splintery pieces. The maximum size of the coarse aggregate shall be 25 mm. Fine aggregate: The fine aggregate shall consist of clean, natural sand or

crushed stone sand or a combination of the two and shall conform to IS : 383. Fine aggregate shall be free from soft particles, clay, shale, loam, cemented particles, mica, organic and other foreign matter.

The coarse and fine aggregates may be obtained in either of the following manner:

- In separate nominal sizes of coarse and fine aggregates and mixed together intimately before use.
- Separately as 25 mm nominal single size, 12.5 mm nominal size graded aggregates and fine aggregate of crushed stone dust or sand or a combination of these two.

The material after blending shall conform to the grading as indicated in Table of MORTH

**Table 10-22 Aggregate gradation for dry lean concrete**

Sieve Designation	Percentage passing the sieve by weight
26.50 mm	100
19.00 mm	80-100
9.50 mm	55-75
4.75 mm	35-60
600.00 micron	10-35
75.00 micron	0-8

**d) Water**

Water used for mixing and curing of concrete shall be clean and free from injurious amounts of oil, salt, acid, vegetable matter or other substances harmful to the finished concrete. It shall meet the requirements stipulated in IS: 456.

**e) Storage of materials**

All materials shall be stored in accordance with the provisions of Clause 10.14 of MORTH and other relevant IS Specifications.

Proportioning of Materials for the Mix The mix shall be proportioned with a maximum aggregate cement ratio of 15: 1.

**f) Moisture content**

The right amount of water for the lean concrete in the main work shall be decided so as to ensure full compaction under rolling and shall be assessed at the time of rolling the trial length. The optimum water content shall be determined and demonstrated by rolling during trial length construction

**g) Cement content :**

The minimum cement content in the lean concrete shall not be less than 150 kg/cu.m. of concrete.

**10.10.20.3 Concrete strength:**



The average compressive strength of each consecutive group of 5 cubes made in accordance with Clause shall not be less than 10 MPa at 7 days. In addition, the minimum compressive strength of any individual cube shall not be less than 7.5 MPa at 7 days. The design mix complying with the above Clauses shall be got approved from the Engineer and demonstrated in the trial length construction.

#### 10.10.20.4 Subgrade

The subgrade shall conform to the grades and cross sections shown on the drawings and shall be uniformly compacted to the design strength in accordance with these Specifications and Specification stipulated in the Contract.

#### 10.10.20.5 Construction

##### a) **Batching and mixing:**

The batching plant shall be capable of proportioning the materials by weight, each type of material being weighed separately in accordance with Clause The cement from the bulk stock shall be weighed separately from the aggregates. The capacity of batching and mixing plant shall be at least 25 per cent higher than the proposed capacity for the laying arrangements. The type and capacity of the plant shall be got approved by the Engineer before commencement of the trial length. The weighing balances shall be calibrated by weighing the aggregates, cement, water and admixtures physically either by weighing with large weighing machine or in a weighbridge.

##### b) **Transporting:**

Plant mix lean concrete shall be discharged immediately from the mixer, transported directly to the point where it is to be laid and protected from the weather by covering the tipper/dumpers with tarpaulin during transit.

##### c) **Placing:**

Lean concrete shall be laid/placed by a paver with electronic sensor. The equipment shall be capable of laying the material in one layer in an even manner without segregation, so that after compaction the total thickness is as specified. Transverse and longitudinal construction joints shall be staggered by 500-1000 mm and 200-400 mm respectively from the corresponding joints in the overlaying concrete slabs.

##### d) **Compaction**

The compaction shall be carried out immediately after the material is laid and levelled. In order to ensure thorough compaction, which is essential, rolling shall be continued on the full width till there is no further visible movement under the roller and the surface is closed. The minimum dry density obtained shall be 97 per cent of that achieved during the trial length construction. The densities achieved at the edges i.e 0.5 m from the edge shall not be less than 95 per cent of that achieved during the trial construction.

The spreading, compacting and finishing of the lean concrete shall be carried out as rapidly as possible and the operation shall be so arranged as to ensure that the time between the mixing of the first batch of concrete in any transverse section of the layer and the final finishing of the same. Double drum smooth-wheeled vibratory rollers of minimum 80 to 100 kN static weight are considered to be suitable for rolling dry lean concrete.

The final lean concrete surface on completion of compaction and immediately before overlaying, shall be well closed, free from movement under roller and free from ridges, low spots, cracks, loose material, pot holes, ruts or other defects.

**e) Joints**

Contraction and longitudinal joints shall be provided as per the drawing.

At longitudinal or transverse construction joints, unless vertical forms are used, the edge of compacted material shall be cut back to a vertical face where the correct thickness of the properly compacted material has been obtained.

**f) Curing;**

As soon as the lean concrete surface is compacted, curing shall commence. One of the following two methods shall be adopted:

The initial curing shall be done by spraying with liquid curing compound. The curing compound shall be white pigmented or transparent type with water retention index of 90 per cent when tested in accordance with BS 7542. Curing compound shall be sprayed immediately after rolling is complete. As soon as the curing compound has lost its tackiness, the surface shall be covered with wet hessian for three days.

Curing shall be done by covering the surface by gunny bags/hessian, which shall be kept continuously moist for 7 days by sprinkling water.

**g) Trial Mixes**

The Contractor shall make trial mixes of dry lean concrete with moisture contents like 5.0, 5.5, 6.0, 6.5 and 7.0 per cent using cement content specified and the specified aggregate grading but without violating the requirement of aggregate-cement ratio specified in Clause. Optimum moisture and density shall be established by preparing cubes with varying moisture contents.

**h) Trial Length**

The Engineer shall also approve the location and length of trial construction which shall be a minimum of 60 m length and for full width of the pavement. The trial length shall contain the construction of at least one transverse construction joint involving hardened concrete and freshly laid sub-base. A few cores may be cut as per the instructions of the Engineer to check segregation or any other deficiency.

**i) Traffic**

No heavy commercial vehicles like trucks and buses shall be permitted on the lean concrete sub-base after its construction. Light vehicles if unavoidable may, however, be allowed after 7 days of its construction with prior approval of the Engineer.

## **10.10.21 Cement Treated Soil Sub-Base/Base**

### **10.10.21.1 General**

This work shall consist of laying and compacting a sub-base/base course of soil treated with cement on prepared subgrade/sub-base, in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

## 10.10.21.2 Materials

### a) Material to be stabilized:

The material used for cement treatment shall be soil including sand and gravel, laterite, kankar, brick aggregate, crushed rock or slag or any combination of these. For use in a sub - base course, the material shall have a grading shown in Table it shall have a uniformity coefficient not less than 5, capable of producing a well-closed surface finish. For use in a base course, the material shall be sufficiently well graded to ensure a well-closed surface finish and have a grading within the range given in Table. If the material passing 425 micron sieve is plastic, it shall have a liquid limit not greater than 45 per cent and a plasticity index not greater than 20 per cent determined in accordance with IS: 2720 (Part 5). The physical requirements for the material to be treated with cement for use in a base course shall be same as for Grading I Granular Sub-base.

### b) Cement:

Cement for cement stabilisation shall comply with the requirements of IS: 269, 455 or 1489.

**Table 10-23 Grading limits of material for stabilization with cement**

IS Sieve size	Percentage by mass passing base	
	Finer than:	Within the range:
53.0mm	100	100
37.5mm	95	95-100
19.0mm	45	45-100
9.5mm	35	35-10
4.75mm	25	25-100
600 micron	8	8-65
300 micron	5	5-40
75 micron	0	0-10

### c) Lime:

If needed for pre-treatment of highly clayey soils, Clause shall apply.

### d) Quantity of cement in stabilized mix:

The quantity of cement to be added as per cent by weight of the dry soil shall be specified in the Contract. Also if lime is used as pretreatment for highly clayey soils, the quantity as per cent by weight of dry soil shall be specified in the Contract. The mix design shall be done on the basis of 7-day unconfined compressive strength (UCS) and/or durability test under 12 cycles of wet-dry conditions. The laboratory strength values shall be at least 1.5 times the minimum field UCS value stipulated in the Contract.

### e) Water:

The water to be used for cement stabilization shall be clean and free from injurious substances. Potable water shall be preferred.

### 10.10.21.3 Construction Operations

#### a) Weather limitations

Stabilization shall not be done when the air temperature in the shade is less than 10°C.

#### b) Degree of pulverization

For stabilization, the soil before addition of stabilizer, shall be pulverized, where necessary, to the extent that it passes the requirements as set out in Table-20 when tested in accordance with the method described in Appendix.

**Table 10-24 Soil pulverization requirements for cement stabilization**

IS Sieve designation IS sieve	Minimum per cent by weight passing the
26.5 mm	100
5.6 mm	80

#### c) Moisture content for compaction:

The moisture content at compaction checked vide IS: 2720 (Part 2) shall not be less than the optimum moisture content corresponding to IS: 2720 (Part 8) nor more than 2 per cent above it.

#### d) Rolling:

Rolling shall apply except that care shall be taken to see that the compaction of cement stabilized material is completed within two hours of its mixing or such shorter period as may be found necessary in dry weather.

#### e) Curing

The sub-base/base course shall be suitably cured for 7 days. Subsequent pavement courses shall be laid soon after to prevent the surface from drying out and becoming friable. No traffic of any kind shall ply over the completed sub-base unless permitted by the Engineer.

#### f) Strength

Control on the quality of materials and works shall be exercised by the Engineer in accordance with clause.

Cement treated soil sub-base /base shall be tested for the unconfined compressive strength (UCS) value at 7 days, actually obtained in situ. In case of variation from the design UCS, in situ value being on lower side, prior to proceeding with laying of base/surface course on it, the pavement design shall be reviewed for actual UCS value. The extra pavement thicknesses needed on account of lower UCS shall be constructed by the Contractor at his own cost.

#### g) Arrangements for Traffic

During the period of construction, arrangement of traffic shall be maintained in accordance with Clause 112.

### **10.10.22 Interlock Paver Block Paving**

The precast concrete paver block shall be conforming to IS15658. The paver blocks shall be laid as guidelines given IRC SP 063.

The size and pattern of paver block shall be as per OWNER's requirement.

### **10.10.23 Construction of Shoulders or Berms**

After the WBM course is laid and compacted, the existing surface at side berms or shoulders of the roadway shall be scarified. Fresh quantity of approved earth shall be spread in layers for building up of berms upto the required level and scope.

The earth shall be consolidated by at least 3 passes of 10 tonnes roller. The edges must be well consolidated by suitable means to prevent edge slips and the work properly trimmed and dressed.

The specification for excavation, subgrade and rubble packing shall be followed as already mentioned elsewhere in this specification.

After the rubble packing work is over, a single coat surface dressing shall be laid over it.

For single coat surface dressing, the binder shall be straight run bitumen of a suitable grade as directed by Engineer-In-Charge.

The stone chippings shall be of nominal size 12mm, all passing through 20mm sieve and retained on 10mm sieve. They shall consist of fairly cubicle fragments of clean hard, tough and durable rock of uniform quality throughout. The chippings shall be free of elongated or flaky pieces, soft or disintegrated stones, salt, alkali, vegetable matter, dust and adhere nt coatings.

The quantity of binder for this course shall not be less than 1.8 kg/m<sup>2</sup> of road surface and that of stone chipping shall not be less than 0.15m<sup>3</sup> per 10 m<sup>2</sup> of road surface.

The base on which surface dressing is to be laid shall be prepared, shaped and conditioned to the specified lines, grades and cross section as directed and approved by Engineer-In-Charge.

Binder shall be heated to 163° to 177°C and sprayed on the dry surface in a uniform manner. Immediately after the application of binder, stone chips shall be spread uniformly on the surface. Entire surface shall be rolled with a 10 tonnes roller, so that all aggregate particles are firmly bedded in the binder and present a uniform closed surface.

### **10.10.24 Concrete Pavement**

#### **10.10.24.1 Materials**

##### **a) Cement, Aggregate and Water**

Cement, Aggregate and water shall be as per clause 602 of MORTH and IRC 15.

Grade of concrete shall be as per IRC 15.

##### **b) Rebar**

These shall conform to the requirements of IS: 432, IS : 1139 and IS : 1786 as relevant. The dowel bars shall conform to Grade S 240 and tie bars to Grade S 415 of I.S.

### **c) Formwork**

Formwork shall be as per 'Standard Engineering Specification for Form'. Additional requirements are stated below.

All side forms shall be of mild steel. Use of wooden sections may be permitted subject to approval of Engineer-In-Charge. The steel forms shall be of mild steel sections of depth equal to the depth of the pavement.

The forms shall be provided with ample bracing and supports to prevent the springing of the forms under the pressure of concrete or thrust of machinery operating nearby.

The forms shall be in sufficient number and they shall not be removed until concrete has hardened sufficiently and subject to approval of Engineer-In-Charge.

### **d) Joint Sealing Compounds**

Approval Bitumen joint sealing compound shall conform to IS 1834.

Approved two part polysulphide sealing compound shall conform to IS 12118.

#### **10.10.24.2 Preparatory Works**

Preparatory works such as preparation of subgrade, rubble soling, WBM etc shall be as per the details given elsewhere, under this specification.

#### **10.10.24.3 Preparation, placing and curing of concrete**

Preparation, placing and curing of concrete shall be as per Standard Engineering Specification for Concrete Work.

#### **10.10.24.4 Compaction and Finishing**

### **a) Compaction**

The surface of the pavement shall be compacted either by means of power driven finishing machine or by a vibrating hand screed. For areas where width of the slab is very small hand consolidation and finishing shall be done as per the subsequent paragraphs.

- Concrete as soon as placed, shall be struck off uniformly and screeded to the crown and cross section. It shall be to such level above the base, that when compacted and finished, the pavement shall conform to the grade and cross section indicated by the drawings. The entire surface shall then be tamped until a close knit dense surface is obtained.
- The tamper shall rest on the side forms and shall be drawn ahead with a swing motion in combination with a series of lifts and drops alternating with lateral shifts. The aim of this operation being compaction and screening to the approximate level required, until a level and dense surface is obtained.
- If directed by Engineer-In-Charge, hand operated vibrating tamper consisting of normal type of hand tamper, attached to a pneumatic or electric vibrating unit shall be used for compaction.
- Segregated particles of coarse aggregate which collect in front of the tamper shall be

thrown outside the forms.

- Compaction by tamping shall be carried on till the mortar in the mix just works upto the surface. The surface shall be examined after compaction, correction if needed shall be made by adding or removing concrete followed by further compaction and finishing.

**b) Floating**

As soon as practicable, after concrete has been struck off and compacted, it shall be further smoothed and compacted by means of a longitudinal float 1200mm long and 75mm wide operated from a foot bridge.

**c) Straight Edging**

After floating is completed and excess water removed, while concrete is still plastic the slab surface shall be tested for trueness with a straight edge and rectified if necessary.

**d) Brooming**

After belting and as soon as surplus water has risen to the surface the pavements shall be given a broom finish to produce corrugations of uniform appearance.

**e) Edging**

Before the concrete has its initial set the edges shall be carefully finished with an edge of the radius required and pavement edge shall be left smooth and true to line.

#### 10.10.24.5 Final Surface Test

The surface test shall be made after the curing period and after the removal of the material for curing. The surface shall be of correct alignment, grade and contour specified. Any spot higher than 3mm and not higher than 6mm above the correct surface, as shown by the 3.0M straight edge and the wedge gauge, shall be ground down with an approved grinding tool to the required level. In case of spot > 6mm, it shall be removed and relaid with fresh mix and compacted at no extra cost. Area for removal shall be as per the direction of Engineer-In-Charge.

#### 10.10.24.6 Separation Membrane

A separation membrane shall be used between the concrete slab and the subbase. Separation membrane shall be impermeable plastic sheeting 125 microns thick laid flat without creases. Before placing the separation membrane, the sub-base shall be swept clean of all the extraneous materials using air compressor. Wherever overlap of plastic sheets is necessary, the same shall be at least 300 mm and any damaged sheeting shall be replaced at

the Contractor's expense. The separation membrane may be nailed to the lower layer with concrete nails.

#### 10.10.24.7 Joints

- a) Expansion joints and construction joints shall be provided as per details indicated in the drawing and as directed by Engineer-In-Charge.

**b) Sealing of Joints**

- After the curing, the temporary seal or other intruded materials in all expansion and construction joints shall be removed completely and filled with approved joint sealing compound.
- The edges of the joints shall be thoroughly cleaned and primed with a thin bituminous paint which shall be allowed to dry before the sealing compound is applied.
- The primer shall be applied with a brush.
- Care shall be taken to ensure that the sealing compound is not heated above 200°C and the temperature does not exceed 180°C for long periods. In case of Polysulphide Sealant, primer is not required to be applied.
- Sealing compound shall be poured into the joint opening in such a manner that the material will not be spilled on the exposed surface of the concrete.

#### 10.10.24.8 Opening to Traffic

Traffic shall not be allowed for a period of 28 days after laying of concrete.

Before opening the roads to traffic, all joints shall be filled and trimmed or topped out as required.

### 10.10.25 Traffic Signs

#### 10.10.25.1 General

The colour, configuration, size and location of all traffic signs for highways other than Expressways shall be in accordance with the Code of Practice for Road Signs, IRC: 67 or as shown on the drawings.

The signs shall be either reflectorized or non-reflectorized as shown on the drawings or as directed by the Engineer.

#### 10.10.25.2 Materials

- a) Concrete : Concrete shall be of the grade shown on the Contract drawings or otherwise as directed by the Engineer.
- b) Reinforcing steel : Reinforcing steel shall conform to the requirement of IS: 1786 unless otherwise shown on the drawing.
- c) Bolts, nuts, washers: High strength bolts shall conform to IS: 1367 whereas precision bolts, nuts, etc., shall conform to IS: 1364.



- d) Plates and supports : Plates and support sections for the sign posts shall conform to IS: 226 and IS: 2062 or any other relevant IS Specific, lions.
- e) Aluminium : Aluminium sheets used for sign boards shall be of smooth, hard and Corrosion resistant aluminum alloy conforming to IS: 736-Material designation 24345 or 1900.
- f) Signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5 mm thick. All others shall be at least 2 mm thick. The thickness of the sheet shall be related to the size of the sign and its support and shall be such that it does not bend or deform under the prevailing wind and other loads.
- g) In respect of sign sizes not covered by IRC: 67, the structural details (thickness, etc.) shall be as per the approved drawings.
- h) Traffic Signs Having Retro-reflective Sheeting:
  - i) General requirements: The retro-reflective sheeting used on the sign shall consist of the white or coloured sheeting having a smooth outer surface which has the property of retro-reflection over its entire surface. It shall be weather-resistant and show colour fastness.
  - j) High intensity grade sheeting: This sheeting shall be of encapsulated lens type consisting of spherical glass lens, elements adhered to a synthetic resin and encapsulated by a flexible, transparent water-proof plastic having a smooth surface. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection (determined in accordance with ASTM Standard E: 810) as indicated in Table.

**Table 10-25 -Acceptable minimum coefficient of retro-reflection for high intensity grade sheeting (candelas per lux per square metre)**

Observation angle (in degrees)	Entrance Angle (in degrees)	White	Yellow	Orange	Green / Red	Blue
0.2	-4	250	170	100	45	20
0.2	+30	150	100	60	25	11
0.5	-4	95	62	30	15	7.5
0.5	+30	65	45	25	10	5.0

When totally wet, the sheeting shall not show less than 90 per cent of the values of retro-reflectance indicated in Table. At the end of 7 years, the sheeting shall retain at least 75 per cent of its original retro-reflectance.

Engineering grade sheeting: This sheeting shall be of enclosed lens type consisting of microscopic lens elements embedded beneath the surface of a smooth, flexible, transparent, water-proof plastic, resulting in a non-exposed lenoptical reflecting system. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum coefficient of retro-reflection (determined in accordance with ASTM Standard: E-810) as indicated in Table

**Table 10-26-Acceptable minimum coefficient of retro-reflection for engineering grade sheeting (candelas per lux per square metre)**

Observation angle (in degrees)	Entrance Angle (in degrees)	White	Yellow	Orange	Green	Red	Blue
0.2	-4	70	50	25	9.0	14.5	20
0.2	+30	30	22	7.0	3.5	6.0	11
0.5	-4	30	25	13.5	4.5	7.5	7.5
0.5	+30	15	13	4.0	2.2	3.0	5.0

When totally wet, the sheeting shall not show less than 90 per cent of the values, of retro-reflection indicated in Table. At the end of 5 years, the sheeting shall retain at least 50 per cent of its original retro-reflectance. Colour:

Unless otherwise specified, the general colour scheme shall be as stipulated in IS: 5 "Colour for Ready Mixed Paints", viz.

- Blue - IS Colour No. 166: French Blue
- Red - IS Colour No. 537: Signal Red
- Green - IS Colour No. 284: India Green
- Orange - IS Colour No. 591: Deep Orange.

The Colours shall be durable and uniform in acceptable hue when viewed in day light or under normal headlights at night.

#### **Adhesives:**

The sheeting shall either have a pressure-sensitive adhesive of the aggressive-tack type requiring no heat, solvent or other preparation for adhesion to a smooth clean surface, or a tack free adhesive activated by heat, applied in a heat-vacuum applicator, in a manner recommended by the sheeting manufacturer.

#### **Fabrication:**

Surface to be reflectorized shall be effectively prepared to receive the retro-reflective sheeting. The aluminium sheeting shall be de-greased either by acid or hot alkaline etching and all scale/dust removed to obtain a smooth plain surface before the application of retro-reflective sheeting.

#### **Installation:**

Sign posts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or displacement by vandalism. Normally, signs with an area upto 0.9 sq. m. shall be mounted on a single post, and for greater area two or more supports shall be provided. Sign supports may be of mild

steel, reinforced concrete or galvanised iron (G.I.) Post- end(s) shall be firmly fixed to the ground by means of properly designed foundation. The work of foundation shall conform to relevant Specifications as specified.

## **10.10.26 Road Markings**

### **10.10.26.1 General**

The colour, width and layout of road markings shall be in accordance with the Code of Practice for Road Markings with paints, IRC: 35, and as specified in the drawings or as directed by the Engineer.

### **10.10.26.2 Materials**

Road markings shall be of ordinary road marking paint, hot applied thermoplastic compound, or reflectorized paint as specified in the item and the material shall meet the requirements as specified below.

#### **a) Ordinary Road Marking Paint**

Ordinary paint used for road marking shall conform to Grade 1 as per IS: 164.

The road marking shall preferably be laid with appropriate road marking machinery.

Laying thickness of road marking paint shall be as specified by the Engineer.

### **10.10.26.3 Thermoplastic Material**

#### **a) General :**

The thermoplastic material shall be homogeneously composed of aggregate, pigment, resins and glass reflectorizing beads.

#### **b) Requirements :**

- **Composition:** The pigment, beads, and aggregate shall be uniformly dispersed in the resin. The material shall be free from all skins, dirt and foreign objects and shall comply with requirements indicated in Table below:

**Table 10-27-Proportions of constituents of marking material (Percentage by weight)**

Component	White	Yellow
Binder	18.0 min.	18.0 min.
Glass Beads	30-40	30-40
Titanium Dioxide	10.0min.	-
Calcium Carbonate and Inert		

Fillers	42.0 max.	Sec
Yellow Pigments	-	Note

**Note:** Amount of yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, provided all other requirements of this Specification are met

- **Properties:** The properties of thermoplastic material, when tested in accordance with ASTM D36/BS-3262- (Part I), shall be as below:
  - **Luminance :**

White : Daylight luminance at 45 degrees-65 per cent min. as per AASHTO M249

Yellow : Daylight luminance at 45 degrees-45 per cent mm. as per AASHTO M249
  - **Drying time :**

When applied at a temperature specified by the manufacturer and to the required thickness, the material shall set to bear traffic in not more than 15 minutes.
  - **Skid resistance:** not less than 45 as per BS 6044.
  - **Cracking resistance at low temperature :** The material shall show no cracks on application to concrete blocks-
  - **Softening point:** 102.5 to 9.5o C as per ASTM D 36.
  - **Flow resistance :** Not more than 25 per cent as per AASHTO M 249.
  - **Yellowness index (for white thermoplastic paint):** not more than 0.12 as per AASHTO M 249
- **Storage life:** The material shall meet the requirements of these Specifications for a period of one year. The thermoplastic material must also melt uniformly with no evidence of skins or unmelted particles for the one-year storage period. Any material not meeting the above requirements shall be replaced by the manufacturer/ supplier/Contractor.
- **Reflectorisation:** Shall be achieved by incorporation of beads, the grading and other properties of the beads shall be as specified in Clause 803.4.3.
- **Marking :** Each container of the thermoplastic material shall be clearly and indelibly marked with the following information:
  - The name, trade mark or other means of identification of manufacturer
  - Batch number
  - Date of manufacture
  - Colour (white or yellow)
  - Maximum application temperature and maximum safe heating temperature.
- **Sampling and testing:** The thermoplastic material shall be sampled and tested in accordance with the appropriate ASTM/BS method. The Contractor shall furnish to the Employer a copy of certified test reports from the manufacturers of the

thermoplastic material showing results of all tests specified herein and shall certify that the material meets all requirements of this Specification.

#### 10.10.26.4 Reflectorizing glass beads

##### **General:**

This Specification covers two types of glass beads to be used for the production of reflectorized pavement markings.

Type 1 beads are those which are a constituent of the basic thermoplastic compound vide Table and Type 2 beads are those which are to be sprayed on the surface vide Clause.

The glass beads shall be transparent, colourless and free from milkiness, dark particles and excessive air inclusions.

These shall conform to the requirements spelt out in Clause

#### 10.10.26.5 Specific requirements

- a) **Gradation:** The glass beads shall meet the gradation requirements for the two types as given in Table

Sieve size	Per cent retained	
	Type 1	Type 2
1.18 mm	0 to 3	-
850 micron	5 to 20	0 to 5
600 -do-	-	5 to 20
425 -do-	65 to 95	-
300 -do-	-	30 to 75
180 -do-	0 to 10	10 to 30
Below 180 micron	-	0 to 15

- b) **Roundness:** The glass beads shall have a minimum of 70 per cent true spheres.
- c) **Refractive index:** The glass beads shall have a minimum refractive index of 1.50.
- d) **Free flowing properties:** The glass beads shall be free of hard lumps and clusters and shall dispense readily under any conditions suitable for paint striping. They shall pass the free flow-test.
- e) **Test methods:** The specific requirements shall be tested with the following methods:
- Free-flow test: Spread 100 grams of beads evenly in a 100 mm diameter glass dish. Place the dish in a 250mm inside diameter desiccator, which is filled with n 25 mm

of the top of a desiccator plate with sulphuric acid water solution (specific gravity 1.10). Cover the desiccator and let it stand for 4 hours at 20 to 29 degree C. Remove sample from desiccator, transfer beads to a pan and inspect for lumps or clusters. Then pour beads into a clean, dry glass funnel having a 100 mm stem and 6 mm orifice. If necessary, initiate flow by lightly tapping the funnel. The glass spheres shall be essentially free of lumps and clusters and shall flow freely through the funnel.

- The requirements of gradation, roundness and refractive index of glass beads and the amount of glass beads in the compound shall be tested as per BS 6088 and BS 3262 (Part I).
- The Contractor shall furnish to the Employer a copy of certified test reports from the manufacturer of glass beads obtained from a reputed laboratory showing results of all tests specified herein and shall certify that the material meets all requirements of this Specification. However, if so required, these tests may be carried out as directed by the Engineer.

#### **Application properties of thermoplastic material**

The thermoplastic material shall readily get screeded/ extruded at temperatures specified by the manufacturers for respective method of application to produce a line of specified thickness which shall be continuous and uniform in shape having clear and sharp edges.

The material upon heating to application temperatures, shall not exude fumes, which are toxic, obnoxious or injurious to persons or property.

#### **Preparation:**

- The material shall be melted in accordance with the manufacturer's instructions in a heater fitted with a mechanical stirrer to give a smooth consistency to the thermoplastic material to avoid local overheating. The temperature of the mass shall be within the range specified by the manufacturer, and shall on no account be allowed to exceed the maximum temperature stated by the manufacturer. The molten material should be used, as expeditiously as possible and for thermoplastic material, which has natural binders or is otherwise sensitive to prolonged heating, the material shall not be maintained in a molten condition for more than 4 hours.
- After transfer to the laying equipment, the material shall be maintained within the temperature range specified by the manufacturer for achieving the desired consistency for laying.

#### **Properties of finished road marking:**

- The stripe shall not be slippery when wet.
- The marking shall not lift from the pavement in freezing weather.
- After application and proper drying, the stripe shall show no appreciable deformation or discolouration under traffic and under road temperatures up to 60°C.
- The marking shall not deteriorate by contact with sodium chloride, calcium chloride or oil drippings from traffic.

- The stripe or marking shall maintain its original dimensions and position. Cold ductility of the material shall be such as to permit normal movement with the road surface without chopping or cracking.
- The colour of yellow marking shall conform to IS Colour No. 356 as given in IS: 164.

#### 10.10.26.6 Reflectorized Paint

Reflectorized paint, if used, shall conform to the Specification by the manufacturers and approved by the Engineer. Reflectorizing glass beads for reflectorizing paints where used shall conform to the requirement of Clause

##### **Application:**

Marking shall be done by machine. For locations where painting cannot be done by machine, approved manual methods shall be used with prior approval of the Engineer. The Contractor shall maintain control over traffic while painting operations are in progress so as to cause minimum inconvenience to traffic compatible with protecting the workmen.

The thermoplastic material shall be applied hot either by screeding or extrusion process. After transfer to the laying apparatus, the material shall be laid at a temperature within the range specified by the manufacturer for the particular method of laying being used. The paint shall be applied using a screed or extrusion machine.

The pavement temperature shall not be less than 10°C during application. All surfaces to be marked shall be thoroughly cleaned of all dust, dirt, grease, oil and all other foreign matter before application of the paint.

The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line of compatible material. Such new material shall so bond itself to the old line that no splitting or separation takes place.

Thermoplastic paint shall be applied in intermittent or continuous lines of uniform thickness of at least 2.5 mm unless specified otherwise. Where arrows or letters are to be provided, thermoplastic compound may be hand-sprayed. In addition to the beads included in the material, a further quantity of glass beads of Type 2, conforming to the above noted Specification shall be sprayed uniformly into a mono-layer on to the hot paint line in quick succession of the paint spraying operation. The glass beads shall be applied at the rate of 250 grams per square metre area.

The minimum thickness specified is exclusive of surface applied glass beads. The method of thickness measurement shall be in accordance with Appendices B and C of BS - 3262 (Part 3).

The finished lines shall be free from ruggedness on sides and ends and be parallel to the general alignment of the carriageway. The upper surface of the lines shall be level, uniform and free from streaks.

## **10.10.27 Cement Concrete Kerb and Kerb with Channel**

### **10.10.27.1 General**

This work shall consist of constructing cement concrete kerbs and kerbs with channel in the central median and/or along the footpaths or separators in conformity with the lines, levels and dimensions as specified in the drawings.

### **10.10.27.2 Materials**

Kerbs and kerb with channel shall be provided in cement concrete of Grade M20 in accordance with Section 1700 of MoRTH Specifications.

### **10.10.27.3 Type of Construction**

These shall be cast-in-situ construction with suitable kerb casting machine in all situations except at locations where continuous casting with equipment is not practicable. In those situations, precast concrete blocks shall be used.

### **10.10.27.4 Equipment**

A continuous kerb casting equipment of adequate capacity and controls, capable of laying the kerbs in required cross-sections and producing a well-compacted mass of concrete free of voids and honeycombs, shall be used.

### **10.10.27.5 Construction Operations**

Kerb shall be laid on firm foundation of cement concrete of M10 grade cast in-situ or on extended width of pavement. Before laying the foundation of lean concrete, the base shall be levelled and slightly watered to make it damp.

In the median portions in the straight reaches, the kerb shall be cast in continuous lengths. In the portions where footpath is provided and/or the slope of the carriageway is towards median (as in case of super elevated portions), there shall be sufficient gap/recess left in the kerb to facilitate drainage openings.

After laying the kerbs and just prior to hardening of the concrete, saw cut grooves shall be provided at 5 m intervals or as specified by the Engineer.

Kerbs on the drainage ends such as along the footpath or the median in super elevated portions, shall be cast with monolithic concrete channels as indicated in drawings. The slope of the channel towards drainage pipes shall be ensured for efficient drainage of the road surface.

Vertical and horizontal tolerances with respect to true line and level shall be  $\pm 6$  mm.

#### **NOTE:**

- Construction procedures, quality control of all materials and other parameters shall be confirming to relevant clause of MoRTH specification for road and area paving items.



- General civil specification should be preferred for cement concrete paving and structural steel works.

#### **10.11 Analysis and Design:**

All the structures shall be designed as per the stipulations indicated here and relevant I . S. codes. The design of RCC structures shall be done as per IS: 456 using Limit state method and using appropriate design tables. The same will be analysed as frame structure using STAAD software for the loads and its combinations as specified. Element design may be carried out either manually or by standardized in house excel sheets or to the STAAD software design module. Appropriate partial safety factor over characteristic strength and loads to IS 456-2000 will be considered for design material strength and design loads.

#### **10.12 Software to Be Used For Analysis and Design:**

The following software programs shall generally be used for carrying out the analysis and design works.

- STAAD Pro.
- EXCEL SPREAD SHEETS
- AUTO CAD
- SAFE software
- ETABS /SAP

## **11. INDICATIVE RAILWAY WORKS:**

### **11.1 Scope of Works - Overview:**

The Contractor shall undertake the DPR, Design, construction, manufacture, supply, installation, testing and commissioning of the Civil, Structure, and Track works of the proposed rail system as defined in this Section-and Overall Layout drawing no- M-002 of Tender Document. The work includes without limitation, the design, construction and removal of any temporary works required for successful commissioning of the proposed rail system.

Vendor shall carry out necessary site survey, details of road crossing, bridges, survey data, geotechnical data, details of LC, details of utility crossings etc. prior to design of Railway System.

Contractor shall validate the indicative plan provided by the Employer by carrying out necessary topographic survey, geotechnical investigations and other site investigations. Based upon the survey the Contractor, upon approval from the Employer, can modify /change the plan and profile so as to get the best fit designed but remaining within the land boundaries set by the Employer and matching with existing Railway Alignment at Tap-off point.

All site investigations, geotechnical surveys, bore holes, interfacing, ancillary works, communication, record keeping, material testing, inspection reports, correspondence etc. shall form part of the "Scope of Works" for successful commissioning of the Rail system.

#### **11.1.1 Approvals**

- The scope of Contractor in respect of approvals shall include all kind of approvals. The Employer shall only provide support with necessary formal communication to the concerned authorities, if required.
- All expenses in connection with approvals and incidental charges shall be borne by the Contractor.

#### **11.1.2 Earthwork In Formation:**

Earthwork in formation as per approved plan and profile of the alignment should be done as per the RDSO guidelines and Specifications for Design of Formation for Heavy Axle Load report No. RDSO/2007/ GE: 0014(Nov-2009). The EPC contractor needs to design and get all necessary approvals from Employer and Railway required for successful construction, completion & commissioning of earthwork. Construction of Earthwork in formation shall include:

- Ground improvement work including Stone Column shall be considered by vendor as per requirement on basis of Soil investigation reports.
- Earthwork in embankment and cutting compacted mechanically as per the cross-section and methodology approved by the Engineer In charge.
- Provision of longitudinal and cross drains, Nalla (open drain) diversions, protection work and pitching on the approaches of the bridges wherever required, turfi ng on the embankment / cutting slope etc.

- Provision of blanket and sub-grade in formation, compacted mechanically as per the cross-section and methodology approved by the Engineer.
- The contractor shall take all necessary safety provisions while performing above works. The contractor shall carry out necessary site survey to determine the location of existing S&T/Telecom/Power cable or other utilities like High mast lying on the approved railway alignment. Necessary measures shall be taken by the Contractor for shifting these existing S&T/Telecom/Power cables or other utilities like High mast to other location as approved by the Engineer.
- All types of taxes, levies, Royalty of the all types of material supplied to perform the Earthwork in formation shall be borne by the Contractor.

### **11.1.3 Level Crossings:**

The work includes extension of existing LC and construction of new LC as proposed by the Employer in the indicative plan. The details are listed in "Site Details". The EPC contractor needs to design and get all necessary approvals from Employer and Railway required for successful construction, completion & commissioning of the work. All necessary modifications to the existing level crossing gates as also construction of new infrastructure and diversion of road, if any, shall be under scope of this work.

### **11.1.4 Permanent Way:**

The Permanent Way layout of the Works shall generally be based on the provisions contained in Indian Railway Permanent Way Manual, Track Manual, LWR / HWR Manual & relevant IRS specifications with latest amendments/ corrections. The EPC contractor needs to design and get all necessary approvals from Employer and Railway required for successful construction, completion & commissioning of the P-Way work.

Permanent Way Work includes:

- Laying & Linking of LWR track with 60/52 kg Rail on 60kg PSC Sleeper with 1540/1660 Sleeper density and 250 / 300 mm ballast cushion. The scope includes supply of all track fittings & fastenings including ERC, GRSP, GFN/MS Liner, fish plate, joggle fish plate, fish bolt, welding moulds, portion, track signages, buffer stop, Fouling Mark, Glued insulated joint if required with all fittings etc. completed to make track fit for 15 to 30 kmph. The scope also includes supply of all required material to complete the work.
- Laying of Turnout Set (1 in 8 ½ or 1 in 12) & Derailing Switch including supply of PSC Sleeper set, switches, crossing body, Lead rails, all fittings, elastic fastenings, Fish plates, Joggle fish plate, Hand lever box, supply and spreading of ballast etc. complete.
- All track dismantling work if required.
- The scope includes execution of all track works in both block and non-block conditions / situations.

### **11.1.5 Signalling and Telecommunication Works: (Deleted)**

Design, Supply, Erection, Testing and Commissioning of Signalling and telecommunication works for New Line in Berth-14 yard. The Contractor need to get approval of all definitive and as-built drawings from concerned Railway authority for successful commissioning of the Rail system. Any modification in the existing S&T system, if required, needs to be carried out for successful commissioning of the works.

Scope includes design, supply, erection and commissioning of signalling & telecommunication system Panel Interlocking- PI (RDSO approved) route setting type catering incremental/additional loop lines with all signalling and telecommunication (S&T) works with electrically operated Points and Crossing with Multi Aspect Colour Light signal (MACLS) with LED light at Crossing Stations, Loading and Unloading Yard which shall be centrally operated from individual Domino type Control cum Indication Panel with railway approved interlocking arrangement, operation of interlocked manned Level Crossing (LC) gate, signal, operation of train movement between adjacent station/yard in absolute type block working through lock and block instrument with last vehicle verification device, fault analysis and recording of data of interlocking system through data logger, provision for voice and data communication between all stations/yard and with manned LC gates through underground signalling cable(QUAD Cable) and OFC cable and communication facilities at station/yard with ground staff and guard/driver through VHF set.

### **11.1.6 Temporary Works:**

The Contractor shall execute all temporary works required to facilitate construction and the cost thereof shall be included in the overall bid proc. All temporary arrangements and works shall be designed and necessary drawings shall be developed to ensure that these remain safe during the construction. As a rule temporary works shall be subsequently dismantled and removed by the Contractor after construction at its own cost.

### **11.1.7 Incidental Works:**

In addition to above the Contractor shall undertake various incidental works to complete the entire project successfully. The Contractor shall include cost of such incidental works in its bid price. Some of the incidental works are listed as under:

- HSE Compliance: The Bidder shall submit a HSE plan which shall include Site Safety Plan, First Aid Base and Environmental Protection Requirements. These plans should include HSE procedures and regulations to be developed by the Contractor and the mechanism by which these will be implemented for ensuring the HSE compliance.
- Quality Assurance: The Bidder shall submit Quality Assurance Plan which shall include Quality Assurance procedures and regulations to be developed by the Contractor and the mechanism by which these will be implemented for ensuring the Quality compliance.
- Interface Management: The Contractor shall also acts as an Interface Manager for the whole works and shall bear the overall responsibility for the interface management with other Contractors and agencies. After award of work the Contractor shall submit an Interface Management Plan which shall include

procedures and regulations to be developed by the Contractor and the mechanism by which effective interfacing will be implemented during the project period.

- Integrated Testing and Commissioning: the Contractor for this Work shall be required to conduct integrated test for the Entire System in coordination with other Contractors and agencies.
- While working out in the close proximity of the existing running lines, the Contractor shall obtain permission for Works with or without block from concerned department/interfacing agencies of DPT. Employer shall assist the Contractor in obtaining such permits. Extra precautions and safety measures to be observed by the Contractor while working in close proximity of the existing running lines.
- Benchmarking, Setting out, photography, videography, report submission, permanent markers like, signages, boards etc. As Built drawings, Inspection books, registers for record and maintenance of culvert/ track/ alignment/ S&T.
- The Contractor fully responsible for obtaining the necessary approvals of all the drawings including General Arrangement Drawings (GADs), all As –Built Drawings from the concerned Railway authority.

## **11.2 General Requirements:**

### **f) Civil, Structures, Track, S&T Design and Construction Phases:**

The Contractor shall execute Civil, Structures, Track and S&T works in four (04) phases:

- Phase 1: The Design Phase.
- Phase 2: The Construction Phase.
- Phase 3: Testing, Commissioning and Acceptance Phase.
- Phase 4: The Defect Liability Phase.

The Design phase shall begin upon the Commencement date of the Contract. The phase shall include preparation, submission and approval of:

- The Definitive Design and Drawings for Civil (Earthwork, Bridges / Culverts, Buildings, Other structures), Track and S&T.

The scope includes approvals of design & drawings from Employer and Railway required for successful completion & commissioning of the project.

The Construction phase for the whole or a part of the Works shall commence immediately upon the issue by the Engineer by a notice in respect of the relevant Drawings submission.

However, the construction shall not commence until the original copies of the appropriate Definitive Design and Drawings have been endorsed by the:

- Contractor as “Good for Construction”;
- Engineer that he has no objections to these drawings.

The Construction phase shall also include the completion and submission of the Final Design and the preparation and submission of the As Built Drawings and other Records as specified.

### **g) Specifications:**

- The Technical Specifications for the Works shall comply with Standards and Design Codes which are in accordance with or defined and listed in the Design Criteria and also the outline materials and workmanship specifications if any.
- In accordance with these provisions of the documents, the Contractor shall develop the Technical Specifications during the Design stage and submit it as part of the Definitive Design submissions.

**h) Units of Measurement:**

- The Contract shall utilize the SI system of units.

**i) Material to be Supplied by the Contractor:**

- All material, tools, tackles etc. required to complete the work shall be supplied by vendor.
- All materials shall be procured from RDSO approved Vendor and necessary test / inspection certificate from the concerned authority acceptable to Railways shall be submitted to the Employer.

**j) Survey and Site Investigation:**

- The Contractor shall carry out all further site investigations as necessary for the design of the Permanent Works. It shall be the Contractor's responsibility to find out the material sources outside the Employer's land boundary. This could be materials for earthwork, aggregate for concrete manufacture, stone for track ballast etc. and it is his responsibility to obtain all necessary approvals and permissions from the land owner, Local, State or Central Government authorities for the extraction, reconstitution and transportation of such materials to the relevant worksite.

**k) Alignment:**

- The proposed alignment, yard plans, survey data and geotechnical data on alignment route listed in "Site Data" are based on the preliminary investigations carried out by the Employer and are for reference purpose only.
- The Contractor shall review, verify and revalidate all relevant factors which could have an impact on the Design and Construction of earthwork including but not limited to topography, subsurface conditions, ground water levels, Temporary works, dewatering, drainage, climatic conditions, the availability or lack of access, working space, storage, accommodations, the proximity of adjoining structures and roads and any other limitations imposed by the site and its surroundings, for the satisfactory completion of works meeting with performance requirements in the stipulated time.
- It will be presumed that Contractor has taken note of all effects of these constraints on his construction operation to ensure on time completion of Works.
- No claim by the Contractor on the grounds of lack of foresight or knowledge of the site conditions or any unknown parameters shall be considered.
- The Contractor is permitted to propose very minor deviations in alignment to suit his construction proposals, but he must demonstrate that any such deviation shall

comply with good design practice and the alignment requirement of the Design criteria.

**l) Standards:**

- Equipment, material and system shall be designed, manufactured and tested in accordance with the latest issue of approved and recognized codes and standards.

### **11.3 Design Procedure and Processes:**

#### **11.3.1 Requirements During The Design Phase:**

- a) The principal requirements of the Design Phase are the production of the documents by the Contractor, which shall fully describe the Works and include the Definitive Design and “Good for Construction Drawings”.
- b) The volume and contents of the documents shall be in accordance with the applicable regulations/legislation in India, existing codes, manuals and standards applicable on Indian Railways.
- c) The Contractor shall obtain all necessary approvals and agreements for his designs on his account in accordance with the applicable legislation in India & current practices.
- d) General construction, manufacture, installation, testing and commissioning methodologies and documentation needed to develop the Definitive Design shall be submitted.
- e) The Definitive Design shall accord with and incorporate the Contractor's Proposals and shall be the design developed to the stage at which all elements of the structures, track, S&T are fully defined and specified. In particular the Definitive Design shall be complete when:
  - all calculations and analyses are complete including verification;
  - all main and other significant elements are defined;
  - all tests, trials and selection of materials and equipment are complete;
  - The effects on the Permanent Works of the proposed methods of construction, installation, testing and commissioning and of the Temporary Works are assessed.
  - The definitive design will be prepared by the Contractor after giving a due cognizance of the comments / modifications suggested by the Engineer, if any, during the scrutiny of Designs.
- f) For the preparation of the Definitive Design, all surveys, investigations and testing, which may become necessary to satisfactorily complete the Design of the Permanent & Temporary Works shall be undertaken by the Contractor.
- g) The Contractor shall sub-divide the proposed Definitive Design into Design Packages which shall be clearly identified in the Design Submission Programme.
- h) The Design Packages shall facilitate the review and understanding of the Definitive Design as a whole and shall be produced and submitted in an orderly, sequential and progressive manner for the Definitive Design Submission.
- i) Four hard copies and one soft copy of these Design Packages shall be submitted for approval to the Engineer.

- j) On receipt of “No Objection” from the Employer’s representative the Contractor will submit the drawings to Railway through the Independent Engineer appointed by the Employer.
- k) The contractor shall develop an effective liaison with Railway to bring timely approvals of all designs & drawings.
- l) Definitive Design Submissions shall also be prepared for those major elements to be procured through sub-contract.
- m) Where such work is to be procured by the Contractor on the basis of outline design, design briefs and performance specifications, all such documents may be submitted as Definitive Design Submissions.
- n) Upon receipt of approvals of definitive drawings from Railway, the Contractor shall complete the Design in all respects and produce the Good for Construction Drawings, the purpose of which is to illustrate all the Permanent Works and to be the drawings governing the Construction.
- o) These drawings shall fully detail the Construction of the elements covered by the Definitive Design, and shall show in full, the Works to be constructed. These will also include the drawings and calculations for the temporary works required to be erected by the contractor for successful completion of the permanent works.
- p) The Definitive Design shall be prepared in accordance with the requirements for technical design in the codes, manuals & standards applicable on Indian Railways, applicable regulations/legislation in India and existing international norms/standards as agreed with the Employer/Engineer.
- q) All technical solutions, schemes, structures, materials should be fully compatible with requirement of Employer and should not be in conflict with the applicable rules/codes/manuals & standards as well as the legislation in India.
- r) The Contractor shall prepare the necessary sets of his designs in English for submitting to the relevant authorities responsible for the approvals in accordance with the contractual provisions & the applicable legislation in India.

### **11.3.2 Requirements during Construction Phase:**

- a) The principal requirements relating to the Contractor’s documents during the construction Phase are the production by the Contractor of Working Drawings and documents, the preparation of technical submissions as required under the Contract, the compilation of the final design and the production of the As-Built Drawings and final documentation.
- b) Working Drawings and documents shall be prepared as required under the Contract.
- c) The Contractor shall endorse the Working Drawings and documents as being in accordance with the Definitive Design and Good for construction drawings.
- d) The Contractor shall endorse the submissions required under the contract that “all effects of the designs comprising the submission, on the design of adjacent or other parts of the works have been fully taken into account in the design of these parts”.
- e) Contractor shall submit a schedule for As-built Drawings 1 months prior to the anticipated time of completion of the Works.



- f) The final design is the design of the Permanent Works embodied in:
- The latest revisions of the documents comprising the Definitive Design, taking account of comments in the schedules appended to Notices of No Objection;
  - The latest revisions of all the drawings;
  - The calculations; and
  - Such other documents as may be submitted by the Contractor at the request of the Employer/ Engineer to illustrate and describe the Permanent Works and for which a Notice has been issued.
- g) The Contractor shall maintain all records necessary for the preparation of the As -Built Drawings and documents.
- h) Upon completion of the Works or at such time as agreed to or required by the Engineer, the Contractor shall prepare drawings which, subject to the Engineer's agreement, shall become the As-Built Drawings and final documents.
- i) All such drawings and documents shall be endorsed by the Contractor as true records of the construction of the Permanent Works and of all Temporary Works that are to remain on the site.
- j) The Contractor shall maintain all records necessary for the financial completion and commissioning. These records shall form part of completion report and shall consist of a minimum:
- The implemented work according to activities, places and price;
  - Used materials –type, name of manufacturer along with batch No., place & price etc.;
  - Any other records as required.

### **11.3.3 Design Interfaces with Interfacing Contractors:**

- a) The Contractor shall be responsible for all co-ordination of all design and installation work with the various interfacing parties including interfacing contractors, to establish the Co-ordinated Installation Plan (CIP).
- b) The CIP shall be prepared by the Contractor in a format acceptable to the Engineer.

### **11.3.4 Definitive Design Submissions:**

The Definitive Design Submission shall be a complete set of Contractor's documents, properly consolidated and indexed and shall fully describe the proposed Definitive Design. In particular, and where appropriate, it shall define but not be limited to:

- a) General:
- The dimensions of all major features, elements and members;
  - Schedules of all materials;
  - Potential forces and movements due to all possible loadings and actions on the structures, and their accommodation;

- All stress calculations due to secondary loading;
- Standard details;
- Proposed Good for Construction drawings pertaining to each component for consideration of the Engineer;
- Erection methods;
- Utilities to be diverted /supported;
- Interface recommendations;
- Report on interfacing contracts;
- Provisions and proposals for construction interfacing with the Interfacing Contractors;
- Maintenance report;

**b) Alignment & Field Survey:**

- Final location survey, geometry (vertical and horizontal) and setting-out of all main elements and features of alignment including horizontal and vertical curves, transitions, grade compensations etc. complete with corresponding calculations and layouts;
- Standard details on updated alignment.
- Final geotechnical report with field data and samples;

**c) Earthwork**

- Earthwork design including sub-soil suitability/availability, slopes stability analysis, adequacy of blanketing material used and prepared subgrade etc. complete with calculations;
- Cross section of the proposed embankment/cutting at specified intervals (at 20m in straight and 10m on curve) indicating thickness of different layers with specification details;
- Final geo-technical report with field data and samples;
- Borrow pit locations with lead diagrams of cut/ fill / borrow;
- Schedules of all equipment;
- Testing proposals;

**d) Track**

- Survey of the existing track layout with recommendations where connections between existing Railway track are to be done;
- Track design including design of curve including calculations for the length of each transition curve, the required cant for each curve and the detailed curve calculations.
- Level crossing arrangements with detailing.

- Methodology of track construction in detail;
- Signage requirements and plan;
- Schedules of all machines and equipment;
- Testing and commissioning proposals;

**e) Signalling & Telecommunication (S&T)**

- Design of Signalling plans
- Development of other drawings like Cable corege plan, route plan, location plan, ST, LT, panel diagram, wiring diagram, SWR, SWRD and any other drawing required for successful completion & commissioning of the project

**f) Drawings**

The Definitive Design Submission shall include proposed Good for Construction Drawings that shall illustrate the proposed Definitive Design. After these are agreed by the Engineer, Contractor shall endorse these as Good for Construction. These shall in particular include, but not be limited to:

- General arrangement drawings;
- Location plans, geometry (vertical & horizontal), yard plans, yard diagrams and setting out drawings;
- Structural drawings of bridges/ culverts and other structures within the project; if required.
- Layouts and details of structural elements;
- Associated fittings;
- Slopes and earthworks;
- Access roads and temporary road works;
- Dumping & borrow areas;
- Catch-water and surface drainage;
- Existing and proposed utilities;
- Track layouts (Horizontal & Vertical Alignment) – the commencement and end of all transition curves must be indicated on the plans;
- Engineering scale Plan (ESP)
- LWR plans including those in the loops;
- Signal Interlocking Plan (SIP)
- Sectioning Diagram
- LOP
- Temporary construction / store depots;
- Station yard layouts;

- Track components' details;
- Equipment schedules;
- Electrical equipment layouts;
- Wiring diagrams;

### **11.3.5 Documents:**

#### **a) Technical specifications**

- The Specifications included in the Contractor's technical proposals together with the Design criteria shall be amplified so as to comprehensively specify the design and construction of the Works.

#### **b) Design manual**

- The Design Manual shall incorporate all design requirements, standards, codes and all other documents or matters which are relevant to and govern the design.
- In addition it shall refer to all materials, codes and standards used, making clear their specific applications.
- The Design Manual shall be produced so that it can be used by those involved in the preparation or review of the design of the Permanent Works as a comprehensive reference text and efficient working document.

#### **c) Testing and commissioning reports**

The report shall include details of proposals for testing and commissioning procedures for all relevant elements and equipment contained in the Permanent Works.

#### **d) Maintenance reports**

The report shall be updating the statement of maintainability in the Contractor's technical proposals and detailing maintenance routines necessary for the achievement of the required life of the various elements of the Works.

#### **e) Construction Method Statements**

A report shall provide sufficient information on the methods of Construction / Installation of the Contractor's Equipment to allow the Engineer to assess their effects on the Permanent Works and to enable these to be taken into account in the review of the Definitive Design. This shall include the temporary works required to be erected by the Contractor for successful completion of the work.

#### **f) Final geotechnical report**

The report shall include site investigation and laboratory test results covering the geotechnical interpretation of site investigation work including that undertaken by the Contractor in sufficient detail to confirm and justify parameters used in the cuts, foundation and geotechnical designs.

The report shall also include the full logs and descriptions of confirmatory boreholes drilled by the Contractor, statistical analysis of samples.

#### **g) Survey report**

The report shall cover all survey work undertaken by the Contractor, including checks on mapping, survey stations, co-ordinates and setting-out.

Updated topographical and survey drawings shall also be included.

**h) Utilities report**

The report shall furnish details of arrangements and working methods in respect of the existing utilities (chartered and unchartered) and shall be including protection measures, diversions/shifting, reinstatements and programme allowances.

**i) Project schedule review**

- The Contractor shall, prior to submitting the Definitive Design Submission, review the project schedule against the current version of the Design Submission Programme.
- The Design submission programme should be in accordance with the Project Schedule.

### **11.3.6 Design Submissions – Good for Construction Drawings**

These drawings shall form part of the Working Drawings to be used for construction purposes.

- a)** On the issue of a Notice in respect of the Good for Construction Drawings, the Contractor shall produce the proposed Working Drawings.
- b)** These shall either be identical to the Good for Construction Drawings or shall be further drawings and documents developed in accordance with these drawings such as fabrication and shop drawings, construction installation and erection sequences and the like and all such drawings shall comply with the requirements of the Contract.
- c)** Prior to submission of the proposed Working Drawings, the Contractor shall endorse the appropriate original paper drawings as "Good for Construction".
- d)** If the Engineer so requires, the endorsed original shall be submitted to the Engineer who shall, if he has no objection to the contents of the submission, further endorse the original by stating that he has no objection to the use of the original drawings as a Working Drawings.
- e)** On the endorsement by the Engineer, the original will forthwith be returned to the Contractor as the Working Drawings.
- f)** Only the Working Drawings endorsed as above or those that the Engineer has expressly stated as not requiring his endorsement shall be issued to the Site and the construction of the Works shall be strictly in accordance with these Working Drawings.
- g)** The Contractor shall finalise details of the proposed method of construction and/or installation and submit such finalised details to the Engineer for review.
- h)** As-Built Drawings and documents, endorsed by the Contractor shall be submitted to the Engineer.

### **11.3.7 Design Submissions - Review Procedures and Approvals:**

- a) Design submissions shall be reviewed by the Employer / Independent Engineer (IE) as appointed by the Employer who shall coordinate the design review and communicate the decision within 15 days of receipt of complete information on the subject matter.
- b) The Contractor shall, prior to the submission of the Design Data, obtain all required and/or statutory approvals that relate to that submission including, where appropriate, the approval of the concerned government authorities and DPT authorities and utility undertakings, and demonstrate that all required approvals have been obtained.
- c) All submissions for Temporary and Permanent Works shall be accompanied by four (04) original copies signed by the Contractor and the Designer.
- d) As-built Drawings and documents in 4 (four) hard copies and 1 (one) soft copy shall be submitted to the Independent Engineer / Employer for approval within the time period as mutually agreed by the Engineer and the Contractor.
- e) **Approval of all Definitive Design and Drawings and all As Built Drawings from concerned authority be it Employer / Independent Engineer or Zonal Railway shall be Contractor's responsibility.**

### **11.3.8 Design Submission Programme**

- a) The Contractor shall prepare the Design submission programme which should clearly bring out the Contractor's anticipated programme for the preparation, submission and review of the design packages, the Definitive Design Submission and the Good for Construction Drawings submission.
- b) The Design submission programme should be compatible with the Project Schedule.
- c) The Design Submission Programme shall:
  - Be consistent with and its principal features integrated into the Works Programme, and show all relevant Milestones and Key Dates;
  - Identify subjects and dates for which the Engineer's decisions should be made;
  - Make adequate allowance of 15 days for review by the Engineer and other review bodies;
  - Make adequate allowance of 15 days for the Design and development of specialist works;
  - Indicate the Design Interface and Co-ordination periods for each Interfacing Contractor.
- d) The Contractor shall submit the Design Submission Programme to the Employer / Engineer within fifteen (15) days of the Commencement Date.
- e) The Construction and Defect Notification Period shall be as indicated in the Conditions of Contract. The Contractor shall be required to plan the various components of work in such a sequence that the entire work is completed within this time frame. Defect Notification Period shall commence after issue of Taking over Certificate by the Engineer. Before commissioning of the complete rail system, Integrated Testing of the complete rail system

will be done, as mentioned in the Contract. Contractor's Design submission programme shall consider all these aspects.

- f) The Contractor shall submit complete set of approved "As-Built" Drawings and certificates for conclusion of any legislative procedures.

## **11.4 Design Criteria and Specifications**

### **11.4.1 Earthwork**

#### **11.4.1.1 Scope:**

- a) This section provides the requirements for the design and construction of formation earthwork, drainage and erosion control.
- b) These requirements include the following components of work which are to be carried out in accordance with the conditions of contract:
- Investigation and testing of borrow areas and additional geotechnical investigations to supplement and/or confirm the subsurface conditions along the alignment.
  - Clearing and grubbing the site
  - Design, construction and testing of earthwork in excavation and embankment
  - Design, construction and testing of any treatment/ modifications as required
  - Construction and testing of prepared sub-grade and blanket layers
  - Design and construction of erosion control measures for fill and cut slope surfaces
  - Design and construction of side drains and catch water drains for proper drainage of the formation

#### **11.4.1.2 General:**

##### **11.4.1.2.1 Terminology and definitions**

The following terms appearing in these specifications will have the following meaning:

- a) Blanket: A layer of select clean and well-graded granular material of specified gradation and properties and designed thickness provided over the full width of the formation just below the ballast.
- b) Formation: A general term which refers to the whole of blanket, prepared sub-grade, embankment fill and sub-soils below the ballast
- c) Formation level: The design level of the formation at the top of the blanket
- d) High Embankment: Embankment having height more than 4.5 meters above toe of the bank on either side of the bank.
- e) Prepared sub-grade: A layer of soil of superior specifications, which is provided below the blanket
- f) Sub-grade: The part of the formation which is below the prepared sub-grade and which may comprise of embankment fill or sub-soils

- g)** Sub-soils: Soils of natural ground below embankments or prepared sub-grade in cuts

#### **11.4.1.2.2 Submittals**

Prior to the start of construction operations, the Contractor shall submit to the Engineer all relevant documents, drawings, calculations and data including, but not limited to the following, and shall obtain the approval of the Engineer for the proposed materials, design, construction methods and quality control procedures.

- a)** Geotechnical investigation reports and evaluation of sub-surface conditions along the alignment.
- b)** Geotechnical investigation reports for borrow areas.
- c)** Details of earthwork balance (cut & fill), properties of materials to be imported/ exported, and management of excess materials Material test reports for embankment fill, prepared sub-grade and blanket.
- d)** Slope stability calculations. Analysis of the stability and settlement of formation and design of remedial measures if required. Details of earthwork design solutions and criteria used.
- e)** Details of proposed instrumentation and monitoring
- f)** Details of construction equipment.
- g)** Construction quality control plan.
- h)** Design Alignment including deviations adopted by the Contractor within the land acquired or proposed to be acquired by the Employer.
- i)** Proposed Good for Construction drawings including longitudinal and cross- sections of formation based on final design of alignment.
- j)** Proposed Good for Construction drawings including plan, longitudinal sections and cross- sections of the formation at an interval of 20m in the block sections and 10m in the DFCC and Indian Railway yards.
- k)** Detailed drawings of the drainage works, retaining walls, erosion control and ground improvement (if any).

#### **11.4.1.3 DESIGN**

##### **11.4.1.3.1 Designed Alignment**

- a)** The alignment details are given in Drawing of Bidding Document. However, the Contractor is required to review and revalidate it with respect to his own Design and Construction proposals and shall satisfy himself that there is no conflict in regard to new constructions proposed and existing structures to be preserved.
- b)** The Contractor is permitted to propose very minor deviations in alignment to suit his construction proposals but he must demonstrate that any such deviations shall comply with good design practice and the alignment requirement of the Design Criteria of bank fulfilling the following conditions:-
  - There is no extra cost to the Employer.



- Changes proposed are essentially required to suit the Contractor's specific design and shall be accommodated within right of way as shown in the bidding document.

#### 11.4.1.3.2 Geometric and Cross-Sectional Features

- a) The width of formation (measured at the top of the blanket) on straight alignment shall be as follows:

Items	Dimension
Single line:	
Minimum width in Embankment	8100 mm
Minimum Width in Cutting (excluding drain)	7500 mm

Note: All cuttings and embankments shall have provision for trolley refuges as per IR standards / as approved by the Engineer.

- b) Contractors shall follow RDSO GE: 0014 issued in Nov. 2009 for 25 tonnes axle load "Guidelines and specifications for design of formation of heavy axle load" with the following changes:-

- Width of formation shall be as per clause 8.4.1.3.2 (a).
- Minimum layer of 1.0 meter of embankment fill above HFL have been indicated. These provisions are not mandatory. For exceptional locations prone to flooding, the Engineer may call for the stability analysis of banks.
- Wherever the height of bank is more than 6.0 m, berms of 1.5 m width shall be provided on either side at every 6.0 m from top of blanket layer.

- c) The Contractors may please note that the width of formation on curves shall be as per para 1.11.3 of the schedule of dimensions 2013;

- The Contractors may please note that a uniform total thickness of formation layers of 1.75 m should be provided including blanket, prepared subgrade & top layer of embankment fill etc. (Ref foot note 3 on page 33 of 75 and page 34 of 75 of RDSO "Guidelines and specifications for design of formation of heavy axle load Nov. 2009 (2.0 metre has been changed to 1.75 metre). In case the difference between formation level and ground level is less than required the existing ground will have to be excavated to provide the formation layers of requisite thickness and specifications as mentioned in the said specifications. In case, however, the existing ground soil at a particular level satisfies the specifications of the formation layers at that level, the existing ground is not required to be cut to provide total thickness.
- Minimum height of embankment shall generally be 1.0 meter except at obligatory points like level crossings, junction yards, bridge approaches etc.
- Geometrical requirements (except for the formation width as specified in clause 2.3.2 (1) shall be as per RDSO: GE -0014 Guidelines and specifications for design of formation for heavy axle load for 32.5 tonnes axle load.

- d) Formation levels shown on the longitudinal section sheets furnished as part of the bidding documents shall be reviewed, verified and corrected by the Contractor on the basis of his own surveys and in compliance to the provisions of the Indian Railway Manuals and specifications.

#### 11.4.1.3.3 Geotechnical Investigations

- a) The Contractor shall carry out additional subsurface investigations along the alignment which may include boring, sounding, trial pits, sampling, field and laboratory testing etc. as required to supplement and confirm the geotechnical information furnished in Site Details; of the Bidding Documents.
- b) The additional investigations shall be sufficiently detailed in scope to allow a reliable and comprehensive assessment of the subsurface conditions in accordance with the requirements of design and construction.

#### 11.4.1.3.4 Retaining structures

Where space limitations or other constraints do not permit provision of a stable slope for the formation, retaining walls, Reinforced Soil Walls/Slopes shall be provided to safely retain and support the formation, ballast and the track structure. Such situations may include the following:

- On parallel sections, where the formation level of the proposed track is at a higher elevation than the existing track formation and the space available between the embankments is not sufficient.
- Locations where the embankment height is large and the right-of-way is not adequate.
- Retaining walls shall be designed in accordance with accepted engineering practice to resist the lateral earth pressures resulting from weight of retained soil and applied dead and live load surcharges to ensure a minimum factor of safety of 1.5 against sliding, 2 against overturning and 2.5 against bearing failure.
- The structure shall be safe against overturning and sliding forces.
- Materials, structural design and detailing of structural components shall conform to the requirements of relevant IS, Indian Railway or equivalent codes. Equivalent codes will be those proposed and agreed during the Stage 1 Procurement discussions and Agreements.
- The details of the back fill and the drainage for the retaining wall shall be an integral part of structural drawing submitted by the Contractor.
- Weep holes of suitable diameter shall be provided at suitable spacing to prevent development of excess hydro-static pressure on the lining. Weep holes shall have an adequate filter zone to prevent erosion of soils.

#### 11.4.1.3.5 Drainage

- a) RCC open drain shall be provided at defined locations by the Employer where the alignment is parallel to the existing track formation to ensure satisfactory drainage of the area between

the proposed and existing formation. These drains shall be designed and shall consist of suitable shape and dimensions to provide adequate flow capacity and permit easy maintenance as per the approval of the Engineer. As per site requirements the se shall be linked with cross drains at suitable intervals wherever required.

- b)** At other locations where the distance between the centre lines of tracks is less than 6.0 m (a situation which may arise in existing yards) and provision of open drains is not feasible, alternative drainage arrangements in the form of suitably designed drains using good engineering practices and technically sound systems such as perforated pipes etc. should be used with the approval of the Engineer. It should be functional throughout the year and amenable to user-friendly maintenance.
- c)** When the formation is in cutting or where the bottom of the blanket is below the existing ground level, Pucca (concrete) side drains shall be provided at suitable distance for the proper drainage of the formation, the invert level of the drains shall be at least 300 mm below the bottom of the blanket at the edge of formation. Such side drains shall be of suitable shape and dimensions to provide adequate flow capacity permit easy maintenance and shall have a uniform adequate longitudinal gradient. The lining shall be reinforced cement concrete of adequate thickness to prevent erosion and caving. Alternative Designs for this item can also be suggested by the Contractor.
- d)** For deeper cuttings the provision of catch water drains would be required to tap the water flowing towards the cutting from the hill slope. Such locations would be identified by the Contractor and suitable profile of the catch water drains would be proposed by the Contractor and approved by the Engineer.
- e)** The Contractor shall be responsible for installation of a good track drainage system and its connection to main drainage system.
- f)** The side drains shall be extended as necessary to lead the water clear of the Works to natural drainage courses, culverts or any other suitable outlets.

#### 11.4.1.4 Materials

##### 11.4.1.4.1 General

- a)** Materials to be used in the work shall conform to the requirements laid down in the Design and drawings agreed by the Engineer.

##### 11.4.1.4.2 Borrow Areas

- a)** The borrow areas shall be located outside the DPA's land premises and shall be sufficiently away from the project limits so as not to have any adverse impact on the project.
- b)** The Contractor shall arrange the necessary permission from property owners and the required clearances from all pertinent government departments and municipal bodies and shall comply with all applicable rules and regulations.
- c)** The Contractor shall carry out a satisfactory geotechnical investigation of the borrow areas to evaluate the suitability of the materials for construction and submit the same for approval of the Engineer.

- d) The Contractor shall take all reasonable precautions to avoid any damage to adjacent property or structures, minimize the adverse impact of the excavations on the environment and inconvenience to the local inhabitants.

#### 11.4.1.4.3 Blanket, Prepared Sub-grade, Embankment Fill

- a) Material for blanket, prepared sub-grade, embankment, formation fill shall be conforming to the specification of material as detailed in the relevant specifications of formation.

### 11.4.2 Track Design Criteria:

#### 11.4.2.1 General

- a) The track alignment for the proposed doubling should be designed keeping minimum distance required from Platform to track center as per guideline.
- b) The track layout shall be based on the provisions contained in Indian Railways Permanent Way Manual, Track Manual & relevant IRS specifications with latest amendments/corrections or any other alternative specification which has been agreed during Technical bid evaluation by the Employer.
- c) Where the design features any deviations from such provisions these are to be fully justified based upon acceptable international practice and agreed by the Engineer.
- d) The alignment as shown in project sheets is to be considered only indicative and the Contractor is required to verify the alignment in the field and to check its conformity to the site conditions.
- e) The final designs of the track layouts, including horizontal and vertical alignment, station yard layout, LWR plans, etc. should have the approval of the Independent Engineer/ Railway before execution.
- f) The Contractor shall carry out necessary interlocking of switches, earthing and bonding of electrical circuit arrangements in the track.

#### 11.4.2.2 Track Gauge

- a) The nominal track gauge shall be 1676 mm measured at 14 mm below the top of the rail.

#### 11.4.2.3 Horizontal Curves

- a) The horizontal curves for proposed track should be designed in line to the curves in the existing line.
- b) Horizontal curve in the tracks shall be circular with transition curves at either end of such circular curves.
- c) The horizontal curve radius is measured on the track center line between the two rails. The tracks will have concentric curves unless otherwise approved by the Engineer.
- d) All circular curves including their transitions shall be designed for a speed as per RDSO guideline.

- e) The maximum actual cant shall be limited to 165mm.
- f) The maximum cant deficiency shall be 75mm.
- g) All curves on mainlines shall be provided with transition curves and shall be in a shape of cubic parabola conforming to the equation  $y = x^3 / 6RL$ .
- h) The minimum length of the transition shall be the maximum length obtained from the following equation:  

$$L = 0.008 * Ca * V$$

$$= 0.008 * Cd * V$$

$$= 0.72 Ca$$

Where, Ca & Cd = Value of actual cant & cant deficiency respectively in mm

V = Maximum permissible speed in km/h

- i) For the design of transition length, the value of Ca shall be calculated for speed of 100 km/h with Cd = 0, and V shall be taken as 100km/h, where it is not practical to use 100km/h a reduced speed may be utilized with the approval of the Engineer.
- j) Transitions between reverse curves may adjoin each other if the rate of change of cant and the cant gradient are constant through both transitions.
- k) As far as possible, the turnouts should be avoided in the circular curves. Turnouts are not permitted in the transition curves.

#### 11.4.2.4 Gradients

- a) The gradient of the proposed doubling should be in accordance with the gradient of the existing line to have an economical design
- b) The ruling gradient of the section on the main line shall be 0.5% (1 in 200) compensated. The alignment shall be so designed by the Contractor to avoid frequent changes of gradient as far as possible.
- c) The gradients shall be compensated for curves @ 0.04% per degree of curve and the maximum gradient shall not be steeper than the ruling gradient of the section.
- d) Maximum gradient in the yards shall be governed as per Schedule of Dimensions for BG track of Indian Railway.
- e) No change of gradient is permissible within a turnout.

#### 11.4.2.5 Vertical Curves

- a) A vertical curve is to be provided when the algebraic difference in change of gradient at the locations is more than 0.4%.
- b) Minimum radius of vertical curve shall be 4000 m.

#### 11.4.2.6 Formation levels

- a) The formation levels at various chainages along the alignment are indicated in the project sheets for the guidance of the Contractors. These shall be verified and corrected in the final alignment Design in conformity with the provisions in the bidding documents, IR's manuals and specifications and to ensure adequate clearances/free board under the bridges.
- b) The formation levels at the level crossings, where the track is running parallel to the existing tracks, shall be checked and modified as per the actual site conditions so as to keep the rail level of the new track the same as that of the existing tracks/as provided in IRPWM.
- c) Construction shall only commence after the approval of final track design by the Engineer.

#### 11.4.2.7 Track Layouts

- a) The Contractor shall design and prepare the scale plans of track layout mentioned above, incorporating all the requirements considered necessary for safety as per IRPWM provisions and overall operational considerations of DPA.
- b) Contractor shall prepare the detailed yard plans for obtaining the approval of the concerned Railway authority / IE. Track layout attached with the Bid Document is indicative and Contractor will ensure the compliance of SOD / Code / Manuals and any other modifications required for efficient operation of the yard.

#### 11.4.2.8 Rails

- a) Types of Rail Section are listed below for reference.

Sl.No.	Line Type	Specification
1	Mainline	UIC 60 - 880 grade, 60 kg/m, Class A, Prime Quality Rail
2	Yard lines	UIC 60 - 880 grade, 60 kg/m, Class A, Prime Quality Rail

#### 11.4.2.9 Short Welded Rail Track:

##### 11.4.2.9.1 General

- a) SWR track with 3 Rail panel shall be designed for track structure inside port bulb for which the Contractor shall prepare the layout plans for the approval of the Engineer in advance under design submission schedule in accordance with the design principles/provisions contained in P-Way Manual.
- b) LWR track shall be designed for proposed line for which the Contractor shall prepare the LWR plans for the approval of the Engineer in advance under design submission schedule in accordance with the design principles/provisions contained in LWR Manual.

##### 11.4.2.9.2 Rail Laying Temperature

- a) The project length falls in temperature zone IV in India as per fig.1.7 in LWR Manual. The de-stressing temperature will be determined on the basis of the data furnished in figure 1.7 of LWR Manual.

- b) LWR track lengths installed outside this temperature range shall be de-stressed before the laying and final setting of Switch Expansion Joints (SEJ) at the end of breathing length.
- c) Neutralization of the stresses in the rails during construction shall be carried out as required by the provisions of the LWR Manual.
- d) Rails after de-stressing shall be checked by a non-destructive rail stress measuring equipment to verify the correctness of the de-stressing temperature. Contractor shall arrange such testing equipment in adequate numbers on its own, which shall also be made available to the Engineer for this purpose. The details of the equipment and its performance characteristics will be submitted to the Engineer and his approval obtained before it is put to use.
- e) The Contractor shall submit detailed process of neutralization of stresses in the rails during construction ensuring that the rails in track remain de-stressed in the prescribed temperature range and shall form part of CWR plans submitted by the Contractor in accordance with para mentation above.

#### 11.4.2.9.3 Welding of Rails

- a) Three rail panel shall be produced by through in-situ Alumino thermic welding
- b) Conversion of single rails to 39m long panel shall be done through in-situ Alumino thermic as per the provision of Indian Railway's Manual for Fusion Welding of Rails by Alumino Thermic Process-2006.
- c) The use of rails with holes shall not be allowed unless specifically permitted by the Engineer for specific locations. Drilling of holes of different sizes would be required for the purpose of earthing, bonding etc. These holes would be drilled by the Contractor. Wherever holes in the rails are made, they shall be suitably hardened for its fatigue improvement by the Contractor using well established cold rail hole expansion technology. The methodology for the same shall have the prior approval of the Engineer.

#### 11.4.2.10 Turnouts And Derailing Switches

##### 11.4.2.10.1 General

- a) On the proposed rail system modern turnouts and derailing switches shall be used with following parameters:

Sl.No.	Item	Specification	Ref.
1	Design Axle Load	25.0 tonnes	
2	Rail profile	52 / 60 kg	
3	Gauge	1676 mm	
4	Crossing angle	1 in 12 (4°-45'-45'') 1 in 8 ½ (6°-42'-35'')	

4	Speed potential on main lines	100 kmph Max	
5	Speed potential on turnout side	1 in 12 - 30 kmph 1 in 8 ½ - 15 kmph	
5	Speed on sidings with dead end	15 kmph	
7	Type of web	Ordinary OR Tongue Rail	
8	switch entry angle	1 in 12 (0°-20'-00'') 1 in 8 ½ (0°-46'-35'')	
9	Maximum cant deficiency	75 mm	
10	1 in 12 Turnout - Layout	Fan shaped on PSC Sleeper	RDSO Drg. No. T-4218
11	1 in 12 Switch Sub Assembly - Layout	Fan shaped on PSC Sleeper	RDSO Drg. No. T-4219
12	1 in 12 Crossing Sub Assembly - Layout	Fan shaped on PSC Sleeper	RDSO Drg. No. T-4220
13	1 in 8 ½ Turnout - Layout	Fan shaped on PSC Sleeper	RDSO Drg. No. T-4865
14	1 in 8 ½ Switch Sub Assembly - Layout	Fan shaped on PSC Sleeper	RDSO Drg. No. T-4966
15	1 in 8 ½ Crossing Sub Assembly - Layout	Fan shaped on PSC Sleeper	RDSO Drg. No. T-4967
16	Fabrication of Switches	As per the IRS specifications T-10-2000	R13

- b)** The Contractor shall be responsible for the procurement and supply of the turnouts and derailing switches suitable for above requirements. The Contractor shall also be responsible for supply and installation of track fixture required for the interlocking arrangements.
- c)** The Contractor shall procure the turnout sets from RDSO approved manufacturers having a "Quality Assurance Programme" which shall be submitted for prior agreement of the Engineer.
- d)** The Contractor shall submit all necessary inspection certificates from the relevant authority like IR/ RITES/ Zonal Railway.



#### 11.4.2.10.2 Rails for Turnouts

- a) For manufacturing stock, lead, intermediate sections and closure rails, 90 UTS (UIC 60 kg/m) section with IRS: T-12-2009 specifications of rail shall be used.
- b) For switch rails, thick web section manufactured out of asymmetrical rail section shall be used. Both switch & stock rails shall be of special grade steel (minimum 880 grade as per IRS: T-12-2009) and have hardened heads for better life.
- c) The rails, for the turnouts, shall have no drilled holes. Drilling of holes will be required for connecting the interlocking arrangements and will be done by the System Contractor at appropriate locations. Contractor shall provide necessary interfacing arrangements in this regard.
- d) Turnouts shall not be manufactured from any larger sections of rail and all rails so used shall be defect free rails.

#### 11.4.2.10.3 Switch Assembly

- a) Each thick web switch device shall consist of 2 stock rails, one left hand and one right hand and two switch rails, one left hand and one right hand, complete set of PSC sleepers along with all fittings e.g. slide chairs, base plates/special base plates, brackets, rail pads, insulating bushes, washers, all stretcher bars, various blocks, bolts and nuts, any special fittings like spring setting device etc.
- b) The switch rail shall be one piece without any weld or joint within the switch rail length.
- c) The end of the asymmetrical switch rail shall be forged to UIC 60 rail profile and shall be suitable for welding or for installation of insulated glued joint.
- d) The switch shall provide suitable flange way clearance, between the stock rails and switch rail at the end of the head in open position as specified by the Engineer.
- e) The turn-out system shall be designed to prevent the switch lifting.
- f) The manufacturer shall be responsible to make provisions in switches (stock rail and switch rail) for all the required connections for point machine, clamp lock and any other provisions necessary for connecting the signalling equipment.

#### 11.4.2.10.4 Intermediate Section

- a) The fittings for intermediate rails shall be suitably designed & procured to ensure full compatibility and effective fixation of the rails with PSC sleepers with the desired toe load as that of the elastic fastenings in the main line.

#### 11.4.2.10.5 Crossing Assembly

- a) Standard fixed nose CMS crossings shall be provided on all crossings.
- b) All crossings shall be 1 in 12 / 1 in 8 ½ weldable Cast Manganese Steel (CMS) {manufactured from Austenitic Manganese steel as defined in IRS: T-29-2000} crossing for the turnouts.
- c) Check rails in all turnouts shall have the facility for the adjustment of check rail clearances up to 10 mm over and above the initial designed clearance.
- d) Each check rail end shall be properly flared by machining.

#### 11.4.2.10.6 Elastic Fastenings for turnouts

- a) Fastenings for the turnouts shall be elastic type and compatible with the main line rail to sleeper fastenings system.
- b) The design of the fastenings for the turnouts shall be suitable for 25 Tonne axle loads and 52/60kg (UIC 60 kg/m) section of rails laid on PSC sleepers.

#### 11.4.2.10.7 PSC Sleepers for Turnouts and DS

- a) PSC sleepers for in 12 turnouts in accordance to RDSO.
- b) PSC sleepers for in 8 ½ turnout in accordance to RDSO.
- c) The layout of PSC Sleeper for 1 in 12 turnout shall be Fan shaped and in accordance to RDSO.
- d) The layout of PSC Sleeper for 1 in 8 ½ turnout shall be Fan shaped and in accordance to RDSO.
- e) PSC sleepers for in Derailing Switch in accordance to RDSO.
- f) The layout of PSC Sleeper for DS shall be perpendicular and in accordance to RDSO.
- g) PSC Sleeper set for SEJ.

#### 11.4.2.11 Pre-stressed Concrete Sleepers

##### 11.4.2.11.1 General

- a) Mono-block pre-stressed precast concrete sleepers shall be provided by the Contractor on tracks for main lines, loop lines, yards, conforming to the following general requirements and parameters.
  - Gauge (measured at 14 mm from the top of the rail) 1676 mm.
  - Maximum speed of trains 100 km/h
  - Traffic Density >50 GMT per year
  - Maximum Axle Load 22.5 tonnes
  - The track shall be track circuited for which adequate electrical resistance as stated in IRS:T-39-1995 required
  - Type of traction 2 x 25 KV electric
  - Rail section to be catered for is 52 / 60 kg/m (UIC 60 kg/m)
  - Sleeper Density in main lines, shall be 1660 per km with 1540 per km in loop lines and other yard lines.
  - Fastening (rail to sleeper) are to be a self-tensioning elastic fastening system,
  - Ballast cushion below bottom of sleeper is to be a minimum of 250 / 300mm. Slope of ballast profile below the sleepers shall be taken as H:V = 1.5:1
  - Design life 40 years
  - The PSC Sleeper shall comply with the Specifications as IRS T-45-1996

b) Following Mono-block pre-stressed precast concrete sleepers shall be supplied by the Contractor:

- Track Main and Loop Line Sleeper.
- PSC Sleeper for Level Crossing.
- PSC Sleeper for Curve Sleeper with check rail.
- PSC Sleeper for Curve Sleeper w/o check rail.
- PSC Sleeper set for 1 in 12 turnout.
- PSC Sleeper set for 1 in 8 ½ turnout.
- PSC Sleeper set for SEJ.
- PSC Guard rail sleeper.

#### 11.4.2.12 Rail to Sleeper Elastic Fastening System

a) All ballasted tracks, laid on PSC sleepers shall be equipped with self-tensioning elastic fastening system, similar to that being used on Indian Railways, having the following components:

- **Elastic Rail Clip (ERC):** Fastening clip compatible with the rail/ sleeper assembly having a nominal toe load on the rail of 850 - 1045kg of appropriate international standard. The ERC shall be procured by the Contractor in accordance to RDSO from RDSO approved Vendors. The Contractor shall submit all necessary inspection certificates from the relevant authority like IR/ RITES/ Zonal Railway. The GRSP shall comply with the Specifications in accordance to IRS T-31-1992.
- **Grooved Rubber Sole Plate:** The GRSP shall be procured by the Contractor in accordance to RDSO from RDSO approved Vendors. The Contractor shall submit all necessary inspection certificates from the relevant authority like IR/ RITES/ Zonal Railway. The GRSP shall comply with the Specifications in accordance to IRS T-47-2006.
- **GFN Liner:** The GFN Liner shall be procured by the Contractor in accordance to RDSO from RDSO approved Vendors. The Contractor shall submit all necessary inspection certificates from the relevant authority like IR/ RITES/ Zonal Railway. The GFN Liner shall comply with the Specifications in accordance to IRS T-44-1995.
- **Metal Liner:** The Metal Liner shall be procured by the Contractor in accordance to RDSO from RDSO approved Vendors. The Contractor shall submit all necessary inspection certificates from the relevant authority like IR/ RITES/ Zonal Railway. The Metal Liner shall comply with the Specifications in accordance to IRS-provisional - 1995-Amendment 2001

#### 11.4.2.13 Insulated Glued Joints (If required)

a) Insulated glued joints will be provided on in interlocked turn out zone in yards. All Insulated Glued Joints (IGJs) shall be factory manufactured to be compatible with the UIC 60 rail of 880 grades.

- b)** The Glued Insulated Rail Joints shall comply with the requirements of RDSO's Manual for Glued Insulated Rail Joints of 1998 with latest amendments up to the base date.
- c)** The Contractor shall procure Insulated Glued joint in accordance to RDSO approved Drawings from RDSO approved Vendor. The Contractor shall submit all necessary inspection certificates from the relevant authority like IR/ RITES/ Zonal Railway.
- d)** To ensure the desired service life in the heavy haul operating environment following measures shall be taken as is being done on advance railway systems:
  - Head hardening of Rail ends
  - High quality polymer for end post and bushes
  - Superior glue technology
  - Cold expansion of bolt-holes for improving fatigue life
  - Forged fishplates of thicker section and superior steel
  - Improved thermite welding techniques

#### 11.4.2.14 Switch Expansion Joints

- a)** Switch Expansion Joints (SEJs) shall be manufactured from rail compatible with the rail proposed for the CWR.
- b)** The Contractor shall procure Insulated SEJ in accordance to RDSO approved Drawings from RDSO approved Vendor.
- c)** The Contractor shall procure SEJ with all corresponding fittings, fastenings and fixtures as required for easy installation into the track.
- d)** PSC Sleepers for SEJ shall be supplied by Contractor.
- e)** The Contractor shall submit all necessary inspection certificates from the relevant authority like IR/ RITES/ Zonal Railway

#### 11.4.2.15 Ballast

- a)** Contractor shall procure the ballast from approved queries by the Engineer.
- b)** All ballast shall be machine crushed and comply with the specifications set out in IRS GE 1 June 2004.
- c)** When transported by road vehicle all ballast shall be dampened prior to leaving the quarry.

#### 11.4.2.16 Fish Plates and Fish Bolts

- a)** The Contractor shall procure Fish plates and fish bolts for UIC 52 / 60 rail shall be of the 6 bolt type in accordance to RDSO Drawing respectively, from RDSO approved Vendor.

The Contractor shall submit all necessary inspection certificates from the relevant authority like IR/ RITES/ Zonal Railway.

## **11.5 Construction, Testing and Commissioning:**

### **11.5.1 Contractor's Superintendence**

- a) The Contractor shall submit a staff organization plan in accordance with the bidding document along with the details of the qualifications and experience of all proposed staff to the Engineer for his approval. This plan shall be updated and resubmitted whenever there are changes.
- b) The plan shall show the management structure and state clearly the duties, responsibilities and authority of each staff member.

### **11.5.2 Contractor's Temporary Works Design**

- a) The Contractor shall, prior to commencing the construction of the Temporary Works, submit a certificate to the Engineer signed by him certifying that the Temporary Works have been properly and safely designed and checked and that the Contractor has checked the effect of the Temporary Works on the Permanent Works and has found this to be satisfactory.
- b) The Contractor shall prior to commencing the construction of temporary works submit a drawing and calculations depicting the safety of the temporary works and seek the approval of the Engineer.

### **11.5.3 The Site:**

#### **11.5.3.1 General**

- a) Site details furnished by the Employer in this tender document.

#### **11.5.3.2 Use of the Site**

- a) All sites located on the Employer's land as well as Contractor's equipment shall not be used by the Contractor for any purposes other than for carrying out the Works, unless otherwise consented in writing by the Engineer.
- b) Rock crushing plant, if considered essential shall be located with the prior approval of the Engineer. No rock crushing plant shall be used on the site in violation of local bye laws.
- c) The location and size of each stockpile of materials, including excavated materials, within the Site located Employer's land shall be as permitted by the Engineer. Stockpiles shall be maintained at all times in a safe and stable condition with all documentary records.

#### **11.5.3.3 Clearance of The Site**

- a) All Temporary Works which are not to remain on the Site after the completion of the Works shall be removed after approval by the Engineer. The dismantling of the Temporary works would be done in accordance with the detailed programme and methodology submitted by the Contractor to the Engineer and his approval thereon.
- b) The Site shall be cleared and reinstated as stated in the Contract.
- c) Any IR material lying on the ground causing an obstruction to the temporary / permanent works shall be removed by the Contractor, transported and stacked to a location identified by the Engineer. Nothing extra would be payable for this.

#### **11.5.4 Survey:**

- a) A site survey shall be carried by the contractor for entire Site to establish its precise boundaries and the existing ground levels and features within it.
- b) This survey shall include a detailed topographic survey sufficient to provide a full record of the state of the Site before commencing the work with particular attention paid to those areas where reinstatement will be carried out later on.
- c) The survey shall be carried out before the site clearance wherever possible and in any case prior to the commencement of work in any Works Area.
- d) The plan for survey as well as the final report of the survey shall be made by the Contractor and agreed by the Engineer.
- e) The Contractor shall relate the construction of the Works to the site grid. To facilitate this, survey reference points have been established and the Engineer will provide benchmarks/survey points in the vicinity of the site. Upon handing over of site to the Contractor, the maintenance of survey reference points will become the responsibility of the Contractor.
- f) Before the Contractor commences the setting out of the Works, the Engineer will approve a drawing, provided by the Contractor, showing the position of each survey reference point and bench mark, together with the co-ordinates and/or level assigned to each point.
- g) The Contractor shall carefully protect all the survey reference points, bench marks, setting out points, observation towers and the like from any damages and shall maintain them and promptly repair or replace any points damaged from any causes whatsoever.
- h) The Contractor shall maintain all the survey reference points to ensure that no disturbance is caused to the points and would also permit the Engineer to regularly recheck the position of all setting out points, bench marks and the like to the satisfaction of the Engineer.
- i) The Contractor shall ensure that these survey points continue to remain consistent with the bench marks.
- j) The checking of any setting-out or of any line or level by the Engineer shall not in any way relieve the Contractor of his responsibility for the accuracy or correctness thereof and the Contractor shall carefully protect and preserve all bench-marks, sight-rails, pegs and other things used in setting out the Works.

#### **11.5.5 Safety Measures:**

- a) The Contractor shall be fully responsible for the safety of the Works, his personnel, sub contractors' personnel, the public and all persons directly or indirectly associated with the Works or on or in the vicinity of the Site.
- b) The Contractor shall treat safety measures as a priority in all his activities throughout the execution of the Works.
- c) The Contractor shall set out standards in the project Site Safety requirements and Contractor's Site Safety plan shall be regarded as the minimum to be achieved and shall not relieve the Contractor of any of his statutory duties or his responsibilities under the Contract.

- d) The provisions of the Contract regarding safety shall apply to and be binding upon the Contractor for any part of the Works and the persons employed by sub-contractors of any tier.
- e) The Contractor shall ensure that the requirements of the Contract in respect of safety are included in all sub-contracts placed by him.
- f) The Engineer reserves the right to order an immediate removal and replacement of any item of Contractor's equipment or Temporary Works which, in his opinion, is unsatisfactory for its purpose or is in an unsafe condition.

### **11.5.6 Care of the Works:**

#### **11.5.6.1 General**

- a) The Works, including materials for use in the Works, shall be protected from damage due to exposure of weather condition, including ingress of water.
- b) Water on the Site and water entering the Site shall be promptly disposed of at a location or locations to which the Engineer has given his consent.
- c) The methods used for keeping the Works free of water shall be such that no damage is caused to new and existing structures.

#### **11.5.6.2 Protection Of The Works**

- a) Work shall not be carried out in weather conditions that may adversely affect the Works unless proper protection is provided to the satisfaction of the Engineer.
- b) Permanent Works, including materials for such Works, shall be protected from exposures of weather conditions that may adversely affect such Permanent Works or materials.
- c) The Contractor at all times shall plan and execute the Works and make all protective arrangements such that the Works can be made safe in the event of storms.

#### **11.5.6.3 Protection Of The Completed Work**

- a) The finished works shall be protected from any damage that could arise from any activity on the adjacent site/ works, water inflow etc.

### **11.5.7 Damage and Interference:**

- a) Work shall be carried out in such a manner that there is no damage to or interference with:
  - watercourses or drainage systems;
  - utilities especially those pertaining to train operations of DPA's existing rail system like signalling, telecommunication, civil, mechanical, electrical etc.;
  - structures (including foundations), roads, or other properties;
  - public or private vehicular or pedestrian access;
  - monuments, trees other than to the extent that is necessary for them to be removed or diverted to permit the execution of the Works and for which an approval has been taken from Engineer in advance.

- b) The Contractor shall inform the Engineer as soon as practicable of any items which are not stated in the Contract to be removed or diverted but which the Contractor considers need to be removed or diverted to enable the Works to be carried out.
- c) Such items shall not be removed or diverted until the consent of the Engineer to such removal or diversion has been obtained.
- d) Items which are damaged or interfered with as a result of the Works and items which are removed to enable work to be carried out shall be reinstated to the satisfaction of the Engineer restoring them to the condition as existed before the work started.
- e) Contractor shall use cable route locator to identify cables within the zone of construction, and ensure its safety during construction activity. If required these be relocated/removed.
- f) Any claims by utility agencies due to damage of utilities by the Contractor shall be borne by the Contractor. The Contractor shall negotiate a settlement in respect of such claims and indemnify the Engineer and the Employer in respect of all claims, proceedings, damages, costs, charges and expenses in relation thereto.

### **11.5.8 Structures, Roads and Other Properties:**

#### **11.5.8.1 General**

- a) The Contractor shall immediately inform the Engineer of any damage to structures, roads or other properties.

#### **11.5.8.2 Access**

- a) The works will be executed in a manner so as not to infringe or block the existing access to various locations. However, if for executing the works, it becomes necessary to temporarily block or divert the existing access, the Contractor may be permitted to do so with approval from the Engineer. In such an event, the existing access shall be immediately restored after the need for the same is fulfilled. The ground shall be restored and reinstated in the form which existed before taking up the activity of blocking/diversion.
- b) The responsibility of providing and maintaining a proper access to the site devolves on the Contractor. The work for such an access would be provided by the Contractor with the approval of the Engineer.
- c) Where ever required service road for construction activity, connectivity to the existing road network for the sake of Works has to be made by the Contractor and no extra payment shall be made for the same.
- d) Proper signage and guidance shall be provided for the traffic / users regarding diversions.

#### **11.5.8.3 Trees**

- a) Trees falling in the alignment shall be removed after necessary approval from the concerned authority. The responsibility of getting the approval lies with the Contractor.

#### **11.5.8.4 Protection of the Adjacent Structures and Works**

The Contractor shall take all necessary precautions to protect the structures or works being carried out by others adjacent to and, for the time being, within the Site from the effects of



vibrations, undermining and any other earth movements or the diversion of water flow arising from its work.

All operations for the execution of the Works shall be carried out so as not to interfere unnecessarily with the convenience of the public or the access to public or private roads or footpaths or properties owned by the Employer or by any other person.

If during the execution of the Works, the Contractor receives any claim arising out of the execution of the Works in respect of damage to any adjacent structures / works etc., he shall immediately report the facts to the Engineer. The Contractor shall negotiate a settlement in respect of such claims and indemnify the Engineer and the Employer in respect of all claims, proceedings, damages, costs, charges and expenses in relation thereto.

### **11.5.9 Use of Roads and Footpaths**

#### **11.5.9.1 General**

- a)** Roads and footpaths on the Site in which the work is not being carried out shall be maintained in a clean and usable condition.
- b)** Measures shall be taken to prevent the excavated materials, silt or debris from entering gullies on roads and footpaths; entry of water to the gullies shall not be obstructed.
- c)** Surfaced roads on the Site and leading to the Site shall not be used by tracked vehicles unless protection against damage is provided.
- d)** Contractor's equipment and other vehicles leaving the Site shall be loaded in such a manner that the excavated material, mud or debris will not be deposited on roads.
- e)** All such loads shall be covered or protected to prevent dust being emitted.
- f)** The wheels of all vehicles shall be washed when necessary before leaving the Site to avoid the deposition of mud and debris on the roads.

#### **11.5.9.2 Reinstatement of Roads and Footpaths**

- a)** Temporary diversions, pedestrian access and lighting, signing, guarding and traffic control equipment, if any, shall be removed immediately when they are no longer required.
- b)** Roads, footpaths and other items affected by temporary traffic arrangements and control shall be reinstated to the same condition as existed before the work started or as permitted by the Engineer immediately after the relevant work is complete or at other times permitted by the Engineer.
- c)** The Contractor shall submit his design for the reinstatement to the relevant authorities and obtain their prior clearances to carrying out the work.
- d)** Reinstatement works shall include:
  - Footpath and Kerbs
  - Road Signage
  - Street Lighting
  - Landscaping

- Traffic Lights and Control Cable
- Road Painting
- Telecommunication Tower/ Cables

#### **11.5.10 Site Establishment**

##### **11.5.10.1 Site Laboratories**

- a) The Contractor shall provide, erect and maintain in a clean, stable and secure condition a laboratory, equipped for the routine testing of concrete, soil and other construction materials.
- b) This laboratory shall be at a location agreed to by the Engineer.

##### **11.5.10.2 Contractor's Site Accommodation**

- a) The Contractor shall provide and maintain its own site accommodation at locations consented to by the Engineer. Offices, sheds, stores, mess rooms, garages, workshops, latrines and other accommodation on the Site shall be maintained in a clean, safe and secure condition.
- b) The Contractor shall be responsible for providing water, electricity, telephone, sewerage and drainage facilities for all site accommodation, structures and all such services that are necessary for satisfactory performance of the Works.
- c) Land required for the contractor's site accommodation shall be arranged by the contractor at his cost. However, the Employer may permit the use of his land free of charge depending upon the availability.
- d) Since the most of the permanent works need to be carried out inside DPA Port gate, necessary permit / gate pass from concerned DPA authority shall be arranged by the Contractor for his working labours/staff.

##### **11.5.10.3 Contractor's Labour Camp**

###### **11.5.10.3.1 General**

- a) The Employer will not provide living accommodation for the use of the Contractor or any of his staff or labour employed on the Works.
- b) Living accommodation shall not be established on any land provided to the Contractor by the Employer without prior approval of the Engineer.
- c) It should be ensured by the Contractor that the camp area is cleared of the debris and other wastes and upon completion of construction, the land should be restored back to its original form.
- d) Land required for the contractor's Labour Camp shall be arranged by the contractor at his cost. However, the Employer may permit the use of his land free of charge depending upon the availability.

#### 11.5.10.3.2 Provision of Labour Camp

- a) The Contractor shall make adequate arrangements for the housing, supply of drinking water and provision of bathrooms, latrines and urinals, with adequate water supply, for his staff and workmen as per prevalent labour laws.
- b) No labour camp shall be allowed at any unauthorised place.
- c) The Contractor shall maintain all camp sites in a clean and hygienic condition.
- d) The Contractor shall obey all health and sanitation rules and regulations, and carry out all health and sanitary measures that may from time to time be prescribed by the local/medical authorities and permit inspection of all health and sanitary arrangements at all times by the Employer, Engineer and the staff of the local municipality or other authorities concerned.
- e) Should the Contractor fail to provide adequate health and sanitary arrangements these shall be provided by the Employer and the cost recovered from the Contractor.
- f) The Contractor shall provide first aid and medical facilities at the labour camp and at work sites on the advice of the medical authority in relation to the strength of the Contractor's staff and workmen, employed directly or through sub-contractors.
- g) The Contractor shall provide the following minimum requirements for fire precautions:
  - Portable Fire Extinguishers.
  - Making and marking exit plan at locations for exit during fires.
- h) The Contractor shall provide necessary arrangements for keeping the camp area sufficiently illuminated to avoid accidents to the workers.
- i) Periodic health checkups may be conducted. These activities may be provided by the construction Contractor in consultation with State Public Health Department
- j) The Contractor shall ensure that electrical works are executed by trained electricians and these installations shall be maintained and daily maintenance records be made available for inspection of the Engineer.

#### 11.5.10.3.3 Camp Discipline

- a) The Contractor shall take requisite precautions, and make best endeavors to prevent any riotous or unlawful behavior by or amongst his workmen, and others, employed directly or through sub-contractors.
- b) These precautions shall be for the preservation of peace and protection of the inhabitants and to secure property in the neighborhood of the Works.
- c) The sale of alcoholic drinks or other intoxicating drugs or beverages upon the work, in any labour camp, or in any of the buildings, encampments or tenements owned or occupied by, or within the control of, the Contractor or any of his employees directly or through sub-contractors employed on the work, shall be forbidden, and the Contractor shall exercise his influence and authority to secure strict compliance with this condition.
- d) The Contractor shall also ensure that no labour or employees are permitted to work at the Site in an intoxicated state or under the influence of drugs.

- e) The Contractor shall remove from his camp such labour and their families, who refuse protective inoculation and vaccination when called upon to do so by the Engineer on the advice of the medical authority.
- f) Should cholera, plague or any other infectious disease break out, the Contractor shall burn the huts, bedding, clothes and other belongings of or used by the infected parties.
- g) The Contractor shall promptly erect new accommodation on healthy sites as required by the Engineer, within the time specified by the Engineer, failing which the work may be done by the Engineer and the cost recovered from the Contractor.
- h) Identification card/ badges incorporating the name and photograph of the person and the name of the direct employer (Contractor, Sub-Contractor, etc.) shall be provided to all staff.

#### 11.5.10.3.4 Labour Accommodation

- a) The Contractor shall provide living accommodation for all staff employed by himself or his sub-contractors as per the prevalent labour laws.
- b) The buildings shall be constructed so as to have a minimum life of not less than the length of the Contract.
- c) The roofs shall be watertight and laid with suitable non-flammable materials permissible for residential use under local regulations and for which the consent of the Engineer has been obtained.
- d) Each unit shall have suitable ventilation with all doors, windows and ventilators provided with security latches and fasteners. Back to back units are to be avoided as far as possible.
- e) The minimum height of each unit shall be 2.10m and each shall have a separate cooking place.
- f) The Contractor may provide a common cooking place.
- g) A suitable number of common toilet/bath shall be provided with separate toilets for ladies.

#### 11.5.10.3.5 Water Supply

- a) The Contractor shall provide an adequate supply of water in the Camp.
- b) Where piped water supply is available, supply shall be at stand posts and where the supply is from wells / river, storage tanks shall be provided.
- c) The Contractor shall also make arrangements for the provision and laying of water pipe lines from the existing mains wherever available.

#### 11.5.10.3.6 Drainage and Sanitation

- a) The Contractor shall provide efficient arrangements for draining away surface water so as to keep the camp neat and tidy.
- b) Surface water shall be drained away from paths and roads and shall not be allowed to accumulate into ditches or ponds where mosquitoes can breed.
- c) The Contractor shall make arrangements for conservancy and sanitation in the labour camps according to the rules and regulations of the local public health and medical authorities.

- d) The Contractor shall provide a sewage system that is adequate for the number of residents in the camp, and which meets the requirements of the municipal authorities.
- e) The Contractor shall provide latrines and wash places for the use of its personnel and all persons who will be on the Site.
- f) The size and disposition of latrines and wash places shall accord with the numbers and dispositions of persons entitled to be on the Site, which may necessitate their location on structures and, where necessary there shall be separate facilities for males and females.
- g) The Contractor shall arrange regular disposal of effluent and sludge in a manner that shall be in accordance with local bye-laws/ regulations.
- h) The Contractor shall be responsible for maintaining all latrines and wash places on the site in a clean and sanitary condition and for ensuring that they do not pose a nuisance or a health threat.
- i) The Contractor shall also take such steps and make such provisions as may be necessary or directed by the Engineer to ensure that vermin, mosquito breeding etc. are at all times controlled.

#### **11.5.11 Security**

- a) The Contractor shall be responsible for the security of the Site for the full time the Site is in his possession.
- b) The Contractor shall always maintain all Site boundary fences in good condition. However, the fencing or other security measures taken by the Contractor should not infringe the existing drainage arrangements natural or otherwise for the area.
- c) Notices shall be displayed at intervals around the Site to warn the public of the dangers of entering the Site.
- d) During the progress of the Works the Contractor shall maintain such additional security patrols over the areas of the Works as may be necessary to protect its own and its sub-contractor's work and equipment and shall co-ordinate and plan the security of both the work under this Contract and the work of others having access to and across the Site and the Works.
- e) The Contractor shall liaise with the sub-contractors and the contractors responsible for the adjacent and other interfacing contracts and ensure that co-ordinated security procedures are operated, in particular in respect of vehicles permitted to pass through the Site and/or the adjacent sites in the latter periods of the Contract.

#### **11.5.12 Construction-Earthworks**

##### **11.5.12.1 General**

- a) Prior to the commencement of construction operations, the Contractor shall obtain all necessary clearances from the concerned authorities.
- b) Prior to the commencement of any site work, the Contractor shall submit and obtain approval of relocation/ removal of all types of utilities as required.

#### 11.5.12.2 Access Road to the Site of Construction

- a) The Contractor will conduct a detailed site survey and will identify the locations where approach road is required for enabling access to labour, equipments & machineries to the site.
- b) The Contractor at his own cost will develop necessary approach road wherever required for enabling construction of works.

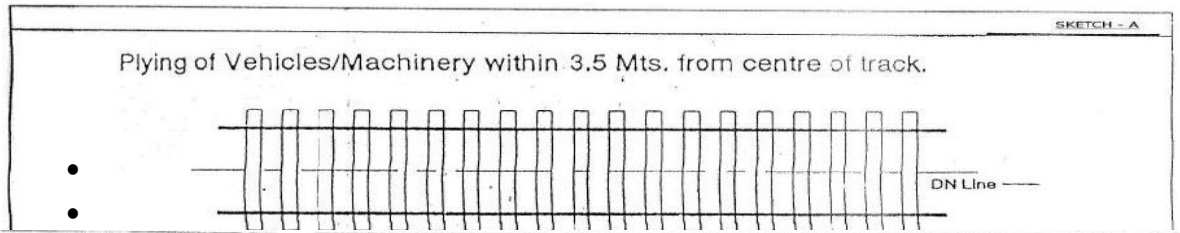
#### 11.5.12.3 Precautions While Working In Close Proximity Of Existing Railway Track

- a) Works being executed outside running lines are further divided into following 3 sub-groups depending upon their distance from the existing DPA track:-
  - works being done within 3.5 meters from centre of track.
  - works being done between 3.5 meters and 6 meters from centre of track.
  - works being done beyond 6 meters from centre of track.

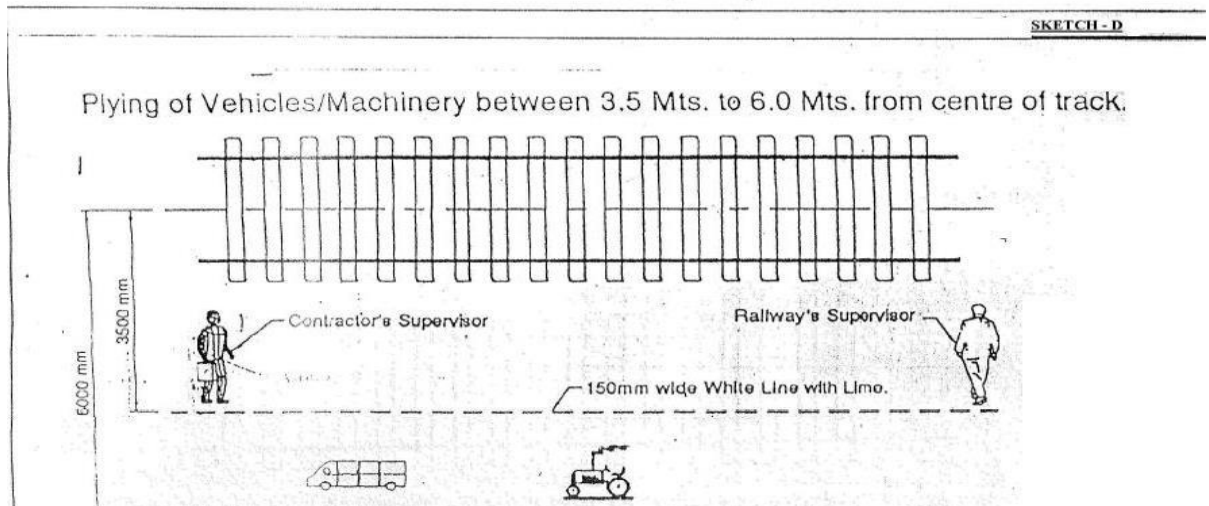
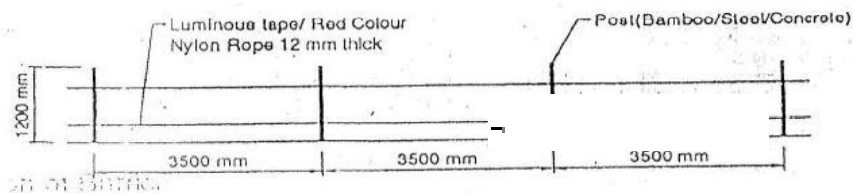
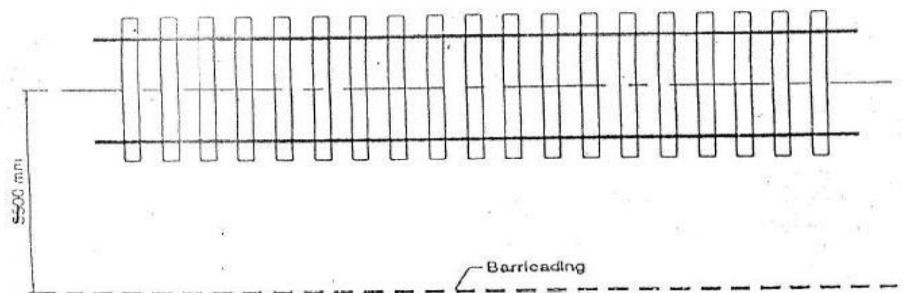
If a work site is located far away from the existing track but the vehicles in connection with the work are required to ply within the distance from centre of track as mentioned above, it will be construed that the work is being executed under above classification. This includes even occasional plying of vehicles/ machineries for short durations.

- b) Works being done within 3.5 meters from centre of track.
  - All works planned within 3.5 meters from centre of running line or which involve working of machineries and vehicles within this zone, are to be done essentially under block protection and necessary safety precautions for protection of track as per para 806 and 807 of IRPWM be taken.
- c) Works being done between 3.5 meters and 6 meters from centre of track.
  - Before start of work demarcation should be done parallel to running track at a distance of 3.5 meters from centre of track in advance, as per sketch B, by 150 mm wide white line of lime. Any work or movement of machinery infringing this line will need block protection. Barricading should be put up at such locations as per sketch C to ensure that even by carelessness or oversight, vehicles do not infringe fixed dimensions. Barricading design shall be approved by the Engineer.

## SAFTY/PROTECTION ARRANGEMENT SKETCHES



Provision of Barricading.



- In case vehicles have to ply or machineries have to work within this zone, railway's and contractor's supervisors be positioned as shown in sketch D except for the following:
- Instead of a Railway supervisor it would be a responsible and trained staff of the Contractor as mentioned in para above.
- Additional trained staff of the Contractor shall be posted where turning of vehicles is required during working.

e.g. earth work, bridge work, ballasting etc. Location for reversing vehicles should be nominated and it should be selected in such a way that there is no danger to running trains at such a location. Such trained staff of the Contractor should be available with hand flags so that vehicles do not come closer to track by 3.5 meters. Wherever vehicles have to take turn, it should be done in such a way that the driver is invariably facing the running track at all times.

- Look out men should be posted along the track at a distance of 800 meters from location of work with red flag and to whistle in face of road vehicles and approaching trains. Look out men shall also be suitably trained staff of Contractor as mentioned in para above.
- In addition to look out men, caution order needs to be issued to trains and speed restrictions imposed wherever considered necessary through Employer.
- Arrangements should be made to protect the track in case of emergency at work site.
- All temporary arrangements required during execution should be done in a manner that moving dimension is not fringed.
- Individual vehicle/machinery shall not be left unattended at site of work. If it is unavoidable and essential to stable it near running track, it shall be properly secured and manned even during non-working hours with all arrangements to protect the track from infringement.
- Any materials unloaded or shifted along the track should be kept clear of moving dimensions and stacked at a specified distance from running track.
- Movement of vehicle/working of machineries should be prohibited at night. However, in case of emergency when night working is unavoidable, adequate lighting shall be provided with all protection measures as mentioned above in full force. All night working near existing track shall require Engineer's prior approval.
- The work site should be suitably demarcated to keep public and passengers away. Necessary signages, boards, such as "work in progress" etc should be provided at appropriate location to warn public/passengers.
- Contractor's drivers/operators handling vehicles/machineries shall be issued a fitness certificate by the safety officer of the Contractor after educating them about safety norms and after taking assurance in writing for working within vicinity of railway's track.

**d) Works being done beyond 6 meters from centre of IR track.**



- No precautions are needed except in cuttings or where the work can affect train running in any way.

#### 11.5.12.4 Clearing And Grubbing

- Unless otherwise directed by the Engineer, the area to be cleared is that which is occupied by the completed works and stockpile sites, plus a clearance of 2m beyond the toe of embankments and top of cuts.
- The Contractor shall ensure that the operations are only carried out within the project right-of-way limits and only such methods, tools and equipments which will not affect the property outside the limits shall be employed.
- The area within the specified limits shall be cleared and grubbed of all trees, shrubs, vegetation, stumps, stones, debris, trash, organic matter, any other objectionable materials or obstructions except those designated to remain as stated in the contract documents or as directed by the Engineer.
- Any depressions and holes shall be filled with suitable soils and compacted.
- All materials arising from site clearance and preparation work shall be the property of Employer and the same except objects/materials designated to remain or specified for reuse or salvaging or as otherwise specified by the contract documents or directed by the Engineer shall be removed from the site as the work progresses and shall be disposed of in a satisfactory and acceptable manner in locations outside the project limits with the approval of Engineer. Such materials should not be permitted to accumulate and the site shall be maintained in a safe and workmanlike condition at all times
- Obtaining of all necessary consents, permits and clearances for clearance and disposal shall be the sole responsibility of the Contractor.

#### 11.5.12.5 Setting Out

- The Contractor shall be responsible for the true and proper setting out of the Works and for the correctness of the position, alignment, levels and dimensions of all parts of the Work.
- The Contractor shall establish a system of horizontal and vertical controls in relation to the reference bench marks and coordinates as specified by the Engineer, as required for the setting out and verifying the position, line, levels and dimensions of the earthworks and drainage works during the execution.
- The Contractor shall keep updated schedules and drawings of such information and shall submit the same to the Engineer as the setting out proceeds.
- All bench marks and control points shall be of robust construction, facilitate easy identification and shall be checked regularly for accuracy, carefully protected and maintained in good working condition to the satisfaction of the Engineer, till the completion of the contract.
- If any of the bench marks or permanent ground markers become displaced or damaged during the Contract, the Contractor shall re-establish them immediately to the satisfaction of the Engineer and provide the Engineer with the amended position and level details.

- f)** The Contractor shall not commence any construction activity at the site before obtaining the approval of the Engineer to the setting out of the Site boundaries.
- g)** The checking of any setting out or any line, level or dimension by the Engineer or the Engineer's representative shall not in any way relieve the Contractor of his responsibility for the correctness thereof.

#### **11.5.12.6 Excavation**

- a)** With a view to ensure the safety of the adjacent structures, it should be ensured at all times to take suitable precautions against any soil erosion and water pollution
- b)** Excavations shall be carried out to the lines, levels, dimensions and slopes as shown on the drawings or as directed by the Engineer.
- c)** The Contractor shall not excavate outside the limits set by the Engineer. Undercutting of slopes will not be permitted under any circumstance.

#### **11.5.12.7 Filling**

- a)** Materials arising from site clearance and preparation work shall be subject to relevant acceptability tests to assess its suitability for re-use on site or landfill waste acceptance criteria if applicable. The fill material shall be placed, spread, graded and compacted in layers of uniform quality and thickness, parallel to the camber and grade for the full width of the cross-section unless specified otherwise or approved otherwise by the Engineer.
- b)** The movement of all construction vehicles and other traffic shall be distributed over the full width of the filling area, so as not to damage or overstress the construction.
- c)** Damage by construction plant and other vehicular traffic shall be repaired by the Contractor to the satisfaction of the Engineer. Successive layers shall not be placed until the layer under construction has been thoroughly compacted, tested and passed by the Engineer.
- d)** Additional filling width of 500 mm shall be placed on either side to ensure proper compaction of the fill at the edges, with the extra soil later cut and dressed to avoid any loose earth on the slopes.
- e)** In the absence of field compaction trials, the maximum compacted lift thickness shall be limited to 200mm.
- f)** The Engineer may allow higher lift thickness, provided the Contractor satisfactorily demonstrates the efficacy of the compaction equipment and methodology through field compaction trials.
- g)** Field compaction trials shall be in accordance with Annexure-IV of RDSO GE: G-1.
- h)** Moisture content of fill materials as placed shall be uniform throughout the lift and shall be within the limits specified in accordance with IS:2720:Part 8: 1983 or approved Design and Drawings of formation.
- i)** Each lift of fill shall be compacted using appropriate equipment and standard procedures as agreed with the Engineer, so that the specified relative compaction is achieved uniformly and throughout the full depth of the layer.

- j) For formation, the minimum relative compaction with respect to the maximum dry density shall be determined in accordance with IS: 2720: Part 8:1983 or approved Design and drawings of formation.
- k) In case any lot or part of the earthworks has failed to meet the acceptance criteria during quality control checks, the entire lot or part shall be rectified to the satisfaction of the Engineer.
- l) The Contractor shall investigate all such instances of poor quality of work, identify the reasons and shall take the necessary corrective action.
- m) In case a layer or portion of the earthworks which has been completed and accepted by the Engineer is subsequently damaged or deteriorated at any time till the completion of the contract, the same shall be rectified by the Contractor to the satisfaction of the Engineer.

#### 11.5.12.8 Prepared Sub-Grade

- a) The construction procedures for prepared sub-grade are similar to that used for embankment fill, with the additional requirements of higher relative compaction and frequency of quality control testing.
- b) For prepared sub-grade, the minimum relative compaction with respect to the maximum dry density determined in accordance with IS:2720: Part 8:1983 shall be as per GE - 14 or as per the approved Design and Drawings of formation.

#### 11.5.12.9 Blanket

- a) The construction procedures for blanket are similar to that for embankment fill, with the additional requirements of higher relative compaction and frequency of quality control testing.
- b) For blanket, the minimum relative compaction with respect to the maximum dry density determined in accordance with IS: 2720: Part 8:1983 shall be as per GE - 14 or as per the approved Design and Drawings of formation.

#### 11.5.12.10 Finishing

- a) The top surface and side slopes of the formation shall be shaped, dressed and finished to conform to the alignment, levels, cross-sections, dimensions and cross slopes shown on the approved construction Drawings and to the requirements and tolerances stated in this specification. Ballast bed shall be laid only after the top surface has been cleared by the Engineer.

#### 11.5.12.11 Retaining Structures

- a) Method and sequence of construction of retaining walls, drainage bay and backfilling shall be in accordance with approved Design and Drawings for this purpose.
- b) The sequence of activities shall be well-coordinated with the construction of earthworks.
- c) Quality control of concrete shall conform to the requirements of IS 456.

#### 11.5.12.12 Erosion Control

- a) All erosion control arrangements including revetment/ sodding - type of soil, source of sods, anchoring arrangements, fertilizer usage (if any), small gap filling arrangement etc. shall form part of Design of Embankment/formation and approved before execution at site.
- b) The surface to be sodded shall be checked to ensure that it has been constructed to the required slope and cross-sections.
- c) The surface shall be freed of all stones larger than 50 mm, and any other undesirable objects or materials.
- d) Where the surface to be sodded consists of soils suitable for sustaining vegetation, the soil should be scarified in a direction parallel to the alignment to a depth of about 50mm.
- e) Where the surface to be sodded consist of soils which cannot be improved sufficiently to support good plant growth by the addition of fertilizers and/or other additives, the surface shall be scarified and a 75 mm thick layer of topsoil shall be placed and compacted using a light-weight compactor.
- f) The surface of the top soil shall be scarified in a direction parallel to the alignment to a depth of about 50mm.
- g) Where ever required fertilizer and additives like lime etc. shall be spread uniformly on the prepared surface and worked into the soil. The type and quantum of fertilizer and any other additives and method of application shall be suitable for the sods.
- h) Immediately prior to implanting sods, the soil shall be uniformly moist to a depth of 150 mm.
- i) If this condition is not met by natural means, the Contractor shall carryout watering as directed by the Engineer.
- j) The final prepared surface shall be made slightly rough to ensure a good penetration of roots into the soil.
- k) Sodds once harvested or delivered from a nursery, shall not be allowed to dry out. Sodds shall be planted within 24 hours of being removed from the soil or growing medium, unless proper storage arrangements can be made by the Contractor.
- l) Sodds shall be laid in regular rows with staggered joints and with individual pieces closely butting against each other without any openly visible gaps or any overlaps between pieces.
- m) The first row of sods, where it is possible, shall be laid in a straight line and starting at the bottom of the slope.
- n) Any gaps shall be planted with a sod cut to the gap size or, filled with top soil.
- o) Sodds shall be suitably tamped to ensure a good bond with the underlying soil.
- p) Where the slope is 2 (horizontal) to 1 (vertical) or steeper, the sods shall be secured against slippage by anchoring them with stakes, pegs or pins driven almost vertically into the soil to be almost flush with the sods.
- q) The type, length and spacing of the anchoring fixtures shall be chosen by the Contractor to ensure stability of slopes.

- r) After completion of planting, the surface shall be cleaned off all excess soil, sods and any other undesirable objects or materials.
- s) The sods shall be well-watered after planting and not be allowed to deteriorate due to lack of moisture.
- t) The Contractor shall maintain the sodded areas by watering, fertilizing, replanting etc. as required establishing a uniform and healthy turf free of eroded or bare areas until the completion of the contract period.
- u) For High Embankment or at certain location, earth slopes may warrant revetment works which shall be carried out as per the approved Drawings and methodology as per above.

#### 11.5.12.13 Drainage

- a) Methodology, construction and sequence of construction of side drains shall be carried out in accordance with Good For Construction Drawings.
- b) The level at any point on the surface of the lining shall be within  $\pm 20\text{mm}$  of the design levels.
- c) When a 3m long straight edge is laid on the surface of the lining, parallel to the direction of flow, the surface shall not vary more than 10mm from the edge of the straight edge.
- d) Unless otherwise shown on the Good For Construction Drawings:-
  - Contraction joints shall be provided at intervals of 3m for a minimum of 50% of the cross-sectional area
  - Concrete linings shall conform to the profile of the ditch with weep holes provided at intervals not exceeding 2.0m.
  - Expansion joints of 15mm width for the full depth of the lining shall be provided at intervals not exceeding 15m.
- e) For other types of drains, the construction shall be carried out as per the Drawings along with methodology agreed by the Engineer.

#### 11.5.12.14 RCC Pipes for Signaling and Communication Cables and utilities

- a) While doing earthwork Contractor shall make provisions of suitable RCC pipes at the following locations at his own cost including pipes:-
  - At Level Crossing Gates
    - 2X200mm dia RCC pipes across the formation near the gate lodge.
    - 1X200mm RCC pipe across the road surface on both sides near the lifting barriers.
  - At DTY Stations
    - 2X200mm dia RCC pipes across the formation near the centre line of the station yard.
    - 1X200mm RCC pipe at both ends of the station yard near the facing points for the loop lines.

### **11.5.13 Quality Control**

#### **11.5.13.1 General**

- a)** The Contractor shall be responsible for quality control including all testing, checking and measurement.
- b)** The Employer or the Engineer may carry out independent quality control tests through his own personnel or other agencies.
- c)** The Contractor shall provide all necessary assistance and cooperation to the Employer and the Engineer in obtaining samples for laboratory tests or carrying out field tests.

#### **11.5.13.2 Field Geotechnical Engineering Laboratory**

- a)** The Contractor shall establish and operate or hire approved field geotechnical laboratories adequately equipped to carry out all required in-situ and laboratory tests to assess the nature and properties of the sub-soils, monitor and control the properties of the blanket and borrow materials and finished earthworks which are of significance to design, construction and performance of the formation and earthworks.
- b)** The number and location of the laboratories shall be finalized in consultation with the Engineer on the basis of the volume of earthworks, schedule of completion, frequency of testing etc.
- c)** The laboratories shall have all the required facilities, equipment and competent staff for carrying out all the tests which are required for purpose of quality control.
- d)** The number of sets of equipment for each test and the number of staff deployed shall be adequate to ensure the specified frequency of testing without adversely impacting the time schedule of construction.
- e)** All equipment and accessories shall conform to the appropriate Indian or approved international standard, from a reputed manufacturer and shall be in good working condition.
- f)** Wherever applicable, the equipment or parts shall be calibrated in accordance with established standards and practices.
- g)** Each laboratory shall be furnished with an original set of the latest version of all relevant standards for all the required test methods.
- h)** Contractor shall systematically maintain records of all tests in a format approved by the Engineer.
- i)** The Contractor shall ensure unhindered access at all times to Employer, Engineer or their representatives to inspect the laboratory, equipment and samples, to witness the tests and to verify the records.
- j)** Employer and the Engineer shall have the right to use the field laboratory to make independent assessments of the accuracy and repeatability of the tests and verification of the results by their personnel or representatives from time to time.

### 11.5.13.3 Quality Check On Materials

- a) The tests to be conducted and their frequency for materials used as blanket, prepared sub-grade, formation etc. shall be as specified in IS 2720.

### 11.5.13.4 Quality Control Of Compaction

- a) Control on compaction shall be exercised on each lift of compacted materials by taking measurements of the dry density and moisture content of the compacted fill at representative locations selected at random.
- b) Each sample constituting a set of measurements representing a part or lot of the lift shall comprise a minimum of 6 individual test locations (which may be increased to 10 if considerable variations in individual test results are observed).
- c) The frequency of sampling will be as per approved specification of earthwork.
- d) The benchmark test method for dry density shall be the sand replacement method in accordance with IS:2720: Part-28.
- e) The benchmark test method for moisture content shall be oven-drying in accordance with IS:2720: Part 2.
- f) Calcium carbide gas pressure moisture tester may be used subject to the condition that reliable soil-specific correlations are established with results obtained in accordance with IS:2720: Part 2
- g) Nuclear gauge method may be used for the determination of both density and moisture content subject to the following conditions and with prior approval of the Engineer:
- The test is performed by a qualified and competent operator well-trained in the use of the equipment;
  - Reliable soil-specific correlations are established with density measurements in accordance with IS:2720:Part-28 and moisture content measurements in accordance with IS:2720: Part 2;
  - The equipment is standardized and calibrated in accordance with standard procedures;
  - The method shall not be used in locations close to objects or structures which can induce incorrect readings.
- h) Use of any methods other than listed above shall be only with the permission of the Engineer and provided that the method is demonstrated to be suitable for the soil types and compaction methods used, gives reliable results consistently and offers significant advantages over the standard methods in terms of speed, frequency of sampling, automation, safety etc.
- i) Control shall not be based on the result of any one individual test but based on the mean value obtained for a sample (comprising a set of minimum of 6 to 10 individual test locations)

#### 11.5.13.5 Tolerances for Finished Works

- a) The top width of the formation (measured at the top of the blanket) and the bottom width of cuttings shall not be less than the specified width
- b) The finished surface of the formation (top of blanket) shall be constructed to the following tolerances:
  - The finished level shall be within +0mm and -25mm of the level shown on Drawings
  - The deviation of the finished surface from a 3m straight edge laid on the surface parallel to the alignment shall not exceed 15mm.
  - The deviation of the finished surface from a 3m straight edge laid on the surface perpendicular to the alignment shall not exceed 15mm.
  - The cross-slope of the formation shall not deviate from the cross-slope shown of the drawings by more than 3mm per metre.
- c) The cross-slope of the finished surface of cuttings shall not deviate from the cross-slope shown of the Drawings by more than 3 mm per meter.
- d) Side slopes of fills and cuts shall not be steeper than the slopes shown on Drawings
- e) The finished surface of the prepared sub-grade and blanket shall not have depressions or ridges which could hold water or prevent proper drainage

#### 11.5.13.6 Completion and Acceptance

- a) The Contractor shall complete the earthworks, erosion control and drainage works in accordance with the drawings agreed by the Engineer.
- b) The Contractor shall carry out a final survey of the completed earthworks to certify that the earthworks have been placed within the specified tolerances to the design alignment and grades and furnish the results to the Engineer.
- c) The Contractor shall provide As-Built Drawings for the earthworks, erosion control and drainage works
- d) The Contractor shall maintain the earthworks, erosion control and drainage works for the Defect Notification Period as specified in the contract.
- e) The Contractor shall provide a handover package containing, but not limited to, the following data:
  - Subsoil investigation reports
  - All records related to material testing and quality control including request for inspections and test reports.
  - Construction records and feedback reports, instrumentation and performance monitoring details.

#### 11.5.14 Construction-Culverts

- a) The design shall be capable of allowing the construction to be carried out in the minimum time possible and to the required quality standard.



- b) Construction methodology for construction / extension of Culverts Box / Pipe shall be detailed and carried out in a sequence so as to cause minimum disruption to road traffic.
- c) Where track closures (traffic blocks) are required for construction, the Contractor is responsible for the coordination with DPA and will be assisted as applicable by the Employer/Engineer. The methodology followed by the Contractor shall be such so as to complete the work in minimum possible blocks of the track.
- d) When the Design has assumed a particular sequence of construction in order to account for the construction load effects, the same sequence is to be followed during the construction.
- e) Concreting process of all structures including insitu, transported, ready mix concrete, batch mixing plant etc. for manufacturing, supplying, placement and testing shall always comply with the provisions of IS 456 or other applicable codes. Any deviation shall have prior consent of the Engineer. Curing of concrete shall be ensured as per the applicable codes of practice.

### **11.5.15 Construction-Track**

#### **11.5.15.1 General**

- a) The installation of all machinery and equipment shall be undertaken at all times by suitably trained and competent employees of the Contractor and to the satisfaction of the Engineer.
- b) The Contractor shall, prior to starting any installation and construction work, identify any possible hazards, and implement measures of eliminating and/or controlling such potential hazards, inline with safe working practices.
- c) The Track construction work pertaining to this contract shall include, but not limited to the following:
  - Survey on site, review and confirm the technical requirements shown in this contract and the Reference Drawings.
  - Finalization of the construction and installation program.
  - Production of the calculation sheets and construction drawings for Site works and installation.
  - Construction and Installation in accordance with the finalized construction Drawings.
  - Co-ordination with various designated contractors, if any.
  - Obtaining clearances from various stakeholders and authorities.
  - Submission of the construction and installation reports and records.
  - Testing and commissioning as per finalized protocol and programme.
  - Production of As Built Drawings, documents, calculation sheets and records.

#### **11.5.15.2 Survey on Site**

- a) The alignment has been staked at site and the alignment data, as available with Employer, shall be made available to the Contractor as guidance.

- b) The setting out of the correct alignment for track construction shall however, be the responsibility of the Contractor.
- c) As such the alignment and related data, as provided by Employer to the Contractor is to be checked and verified by appropriate survey and setting out of Works by surveyors of experience and qualification.
- d) The Engineer may carry out random checks to verify the accuracy of the setting out and contractor's compliance of the completed works with given alignment and the requirements, however, full responsibility lies with the Contractor for the accuracy of line and level of the tracks.
- e) The Contractor shall develop a detailed „surveyed track analysis“ spread sheet on Microsoft EXCEL or similar program. This shall be submitted to the Engineer for acceptance at least one month prior to the commencement of track laying.
- f) The surveyed track analysis spread sheet shall tabulate against chainage, the vertical difference (high or low) and horizontal difference (left or right) between the actual surveyed track center line position and the design alignment computed from alignment geometry in the project sheets as already available.
- g) Derived cant, gauge and twist values shall also be compared against design values on the same spread sheet.
- h) It shall be contractor's responsibility to protect and preserve the integrity of the all control markers, grid points, setting out points etc.
- i) The Contractor shall establish physically on site such setting out points that may be grid or offset points to be used as the reference system for the track work.
- j) At each site, the position of the site main reference setting out points shall be maintained throughout construction period.
- k) Such markers shall be checked against the survey control markers by the Contractor at regular intervals to ensure reliability of subsequent works.
- l) The track shall be sited on the basis of corrected and approved project sheets, both as regards the longitudinal section and the layout.
- m) The track siting marks corresponding to both the theoretical centre of the track and to the theoretical level of the track running surface, as defined by the relevant project sheets relating to track layout shall be marked in the straight portion and at the beginning and end of each circular curve, transition curve and vertical curve both in the longitudinal and cross directions.
- n) The said markings shall be put in:
 

1	In straight sections:	every 200-m,
2	In curved sections:	every 50-m.
- o) The track siting marks for the center of the track shall be shown by angle plates embedded in concrete foundation or plates or nails sealed on the bridge spans, on the upper surface of the slabs as approved by Engineer.

- p) They shall be referenced by the Cartesian co-ordinates of each point identified in this manner, and registered in the topographical logbook.
- q) Should there be any discrepancy found by the Contractor with reference to the geometry of civil structure, the same should be brought to the notice of the Engineer for his final decision.
- r) The inner rail for curve and any rail for straight shall first be set out in its absolute position from setting out points using co-ordinates computed from the alignment geometry, the elevation of the rail shall be checked using a level, the other rail shall be set correctly relative to the first rail.

### 11.5.15.3 Temporary Works

- a) Any temporary arrangements and works, as required to carry out the track work such as temporary connection and access tracks from IR's system, temporary track depots to handle and stack the track materials, temporary stores, offices, fencings etc. shall be done by the Contractor at his own cost.
- b) The programme and scheme and design of all such temporary works with full justification of the requirement and the approximate period for which these will be needed, shall be submitted to the Engineer for prior approval.
- c) Construction / Store Depot
  - The Contractor will be required to establish at least one temporary construction /store depot at the site of works where track materials and equipments etc. could be stored for the construction purposes.
  - The capacity of the depot should be such that it should be able to store Turnout sets, Turnout Sleepers, Track fittings etc.
- d) In case spare land is available with the Employer the same can be handed over to the Contractor free of cost for the purpose of establishing temporary construction depot(s). However, whenever Employer requires this portion of land back, the same shall be handed over to the Employer with a month's notice at no extra cost/compensation to the Contractor.
- e) The land, as required for all the temporary arrangements and works including the requirement of borrow pits, quarrying, etc. shall be arranged by the Contractor at his own cost. While extracting material from the borrow pits he shall ensure compliance of applicable provisions as per Environment Laws & guidelines.
- f) All temporary works shall be removed on completion of permanent works, or as directed by the Engineer.

### 11.5.15.4 Construction Methodology

#### 11.5.15.4.1 General:

- a) The Contractor shall plan and work out the methodology of track construction in various stages as per the requirements detailed in the following paragraphs in consultation and

approval of the Engineer taking into account the contractor's co-ordination and integration responsibilities with the interfacing contractors.

- b)** The track construction shall be done by using semi-mechanized track laying method. This shall mean laying of LWR rail panels, with in-situ Alumino thermic welding. Track laying at site will be carried out deploying track labours, tamping tools, shoulder ballast compactors etc.

#### **11.5.15.4.2 Construction of Ballast Bed**

- a)** The ballast duly inspected by the Engineer shall be brought at site such that it is free from quarry dust and any other contamination.
- b)** Ballast bed shall be laid directly on to the prepared formation and support structure like bridge deck slabs, using methods that keep the amount of road traffic over the formation and support structures to a minimum and that make no damage to the utilities and other structures as existing at or near the site.
- c)** The ballast shall be laid in loose layers of maximum 100mm thickness each and compacted by a minimum of 4 passes of a smooth vibrating roller having a minimum static load of 4 kN per 100mm of width or similar.
- d)** The ballast bed shall be laid so as to make an initial neat ballast cushion of 200mm below the bottom of the sleepers after the required rolling. This has to be finally brought up to the desired approved designed level.
- e)** The ballast bed shall be neatly dressed up so that there is no obstruction to working of the plant and machinery for further activities of rail spreading, sleeper laying etc.
- f)** On completion of the ballast bed a survey shall be undertaken to demonstrate the acceptability of the ballast for track laying. No track laying shall commence until the prepared ballast bed has been inspected and approved by the Engineer.

#### **11.5.15.4.3 Handling and Spreading of Rails**

- a)** The Contractor will be responsible for transportation of the free rail from Employer's nominated store to its site through special vehicles and shall procure on his own the required equipment, machinery etc. for this purpose.
- b)** The rails be handled at the construction site in a manner so as to avoid any defects like dents / grip marks, notching or cuts, permanent bends, damage at the ends etc.

#### **11.5.15.4.4 Rail Cutting and Drilling**

- a)** The cutting of rails shall be bare minimum and shall be carried out under the supervision of Engineer. Rails shall be cut by using abrasive rail cutting machine only.
- b)** The drilling of holes in rails shall be bare minimum and shall be carried out under the supervision of Engineer as per the process detailed in Bidding Document.
- c)** Any holes if required for signal and traction bonds shall be performed by designated contractors but with prior approval of the Engineer.

#### 11.5.15.4.5 Handling and Laying of PSC Sleepers

- a) The PSC sleepers duly inspected by the Engineer's inspector, shall be carefully handled by mechanized means and transported to the site thereby avoiding any damage to the sleepers by way of any cracks, chipping of concrete, dents over the concrete surface etc.
- b) The PSC sleepers shall be laid over the prepared ballast bed evenly at the design spacing through a mechanized process.

#### 11.5.15.4.6 Threading of Rails to Sleepers

- a) The rails, if already spread along the alignment shall be threaded/ mechanically lifted to lay sleepers through the semi-mechanized process.
- b) The manual handling of rails for this activity shall be such that it should ensure that no damage to the rails occurs.

#### 11.5.15.4.7 Fixing Elastic Fastening System

- a) After threading of rails, elastic fastening system consisting of rubber pad, rail liner and elastic clip shall be fixed systematically.

#### 11.5.15.4.8 Top Ballasting, Tamping and Lining

- a) Prior to the placing of top ballast the track shall be marked in preparation for tamping and lining operations with the following information:
  - All horizontal and vertical tangent points
  - Transition curve details
  - Circular curve details
  - Cant details
  - Chainages
- b) The ballasting of cribs and shoulders shall be done before tamping of newly laid tracks. Once the top ballast is adequately regulated, the track shall be lifted, levelled and aligned as required.
- c) The top ballasting, regulating, tamping and lining shall be repeated in stages of maximum 50 mm lift until the track is at the designed horizontal and vertical alignment and desired ballast cushion below the sleeper with the desired profile as specified in "Site data" is achieved.
- d) Concurrent with the tamping and lining, the ballast shoulders and the sleeper cribs shall be compacted with suitable equipment as approved by the Engineer.

#### 11.5.15.4.9 Welding and Destressing

- a) The welding of rail joints to convert the track into LWR/SWR shall be done in accordance with the provisions in Para 3.9.3 of Volume 4, Section II, Bidding Documents followed by destressing where needed as per the temperature records maintained at site at the time of threading.

#### 11.5.15.4.10 Installation of Turnouts, Derailing Switches and Switch Expansion Joints

- a) The assembly sequence of turnouts, derailing switches and rail expansion joints shall be submitted for Engineer's approval as part of the overall method statement for preassembly, handling, storage, transportation, unloading and installation
- b) All turn-outs, derailing switches and SEJs shall be fully assembled on track as per the specifications of the manufacturers duly approved by the Engineer.
- c) The Contractor shall provide all gauges and measuring equipment and assistance required for complete check of assembled lay-outs.
- d) All turn-outs and derailing switches laid in track shall comply with the provisions given in Para 12.40 of Indian Railway Signal Engineering Manual. The Contractor shall interface and ensure the designed switch opening while fixation of the first stretcher bar by designated signaling contractor.
- e) The gap at SEJs shall be adjusted after necessary destressing of LWR/CWR on either side and as per the provisions in IR manual.

#### 11.5.15.4.11 Installation of Glued Insulated Railjoints

- a) The glued insulated rail joints, manufactured in the plant as per approved design specifications shall be laid in track at predetermined locations in consultation with designated signaling contractor and as approved by the Engineer in Working Drawings.
- b) Except in the case of Glued Insulated rail joints in the turn-out zone, its positioning shall be such as to keep a minimum distance of 6.00m from an adjacent weld in the rail.

#### 11.5.15.4.12 Connection to Existing Track

- a) Contractor may be required to dismantle the existing track as per the approved yard plan and lay new railway track at no extra cost to the Employer. Before approaching the existing track, specific written approval of Engineer shall be obtained so as not to cause unsafe working in the contiguous area.

#### 11.5.15.4.13 Track at Special Locations

- a) Provisions of IRPWM and LWR Manual, shall be followed while laying track at special locations like sand humps in yard, bridge approaches, approaches to yards, SEJ locations, level crossings, Insulated glued joints in LWR/CWR portions etc.

#### 11.5.15.4.14 Track Drainage

- a) The drainage scheme/arrangement shall be constructed as per the agreed Drawings and methodology.

#### 11.5.15.4.15 Dressing Of Ballast And Cleaning Of Tracks

- a) On completing the track works and after making up the desired track geometry up to laid down standards, the ballast in track shall be properly dressed up in the sleeper cribs and in shoulders as per the IRS standards for LWR/CWR track.

- b)** The track and cess shall be thoroughly cleaned to a standard acceptable to the Engineer, immediately after installation and as required thereafter to maintain the standard until the arrangement of service trials.
- c)** All side drains along track for drainage purpose shall be cleaned off the debris etc. so as to provide clear water-way.

#### 11.5.15.4.16 Permanent Markers

- a)** Upon completion of the track installation following permanent markers shall be provided as per IRPWM and prior approval by the Engineer of their information, plates/boards, colour scheme and fixation arrangement:
  - Kilometre markers;
  - Change of gradient markers;
  - Curve reference markers;
  - LWR/CWR reference markers;
  - SEJ markers including its reference markers;
  - Fouling point markers;
  - Turnout markers.
  - Land boundary pillars
  - Level crossing markers
  - Mandatory “W” boards for level crossings
  - Bridge boards/signage
  - Fog signal locations
  - All markers required to be painted on rails for curves, turnouts and SEJs etc. shall be paint marked by the Contractor as per IRPWM.

#### 11.5.15.5 Inspection and Acceptance

##### 11.5.15.5.1 General

- b)** A thorough track inspection shall be carried out jointly by the Contractor and the Engineer prior to acceptance of the Works.
- c)** The proforma for the measurement of the track parameters to be submitted by the Contractor shall be as per the provisions of IRPWM in this regard.
- d)** The proforma shall show the design requirement against actual and the differences.
- e)** Other than meeting the mandatory requirements of track parameters in floating condition of track stipulated, the track shall also fulfill the requirements of riding quality stipulated vide para 17.5.3 below, before declaring as acceptable.

#### 11.5.15.5.2 Tests

- a) The Contractor shall propose the various forms of test and obtain the approval of the Engineer prior to the commencement of the testing, keeping in view the provisions of IRPWM in this regard.

#### 11.5.15.5.3 Track Tolerances

- a) The track parameters for the completed track works shall be measured by the Contractor and confirmed by the Engineer in a format acceptable to the Engineer. Track tolerances as indicated in point (3) below are for measurements taken in floating condition of the track.
- b) All the track measurement shall be taken in the floating condition by methods and equipment approved by the Engineer prior to the commencement of the measurements.
- c) The dimensional tolerances shall comply with the following:
- Maximum difference of any point in relation to the design:
    - Vertical:  $\pm 10\text{mm}$
    - Horizontal:  $\pm 10\text{mm}$
  - Gauge with reference to 1676mm
    - Maximum variation over the prescribed track gauge +3mm to 0mm
    - Maximum variation in track gauge from sleeper to sleeper 1mm/sleeper
    - Average track gauge over 100m length +1.8mm to 0 mm
  - Misalignment:  $\pm 5\text{mm}$  on 20m chord base
  - Unevenness: +2mm to -1mm on 10m chord base.
  - Maximum deviation of versine on a 20.0 metres chord:  $\pm 5\text{mm}$
  - Cant/Cross Level:
    - Straight and curved track  $\pm 3\text{mm}$ ;
    - Sleeper to sleeper variation of cant/cross level  $\pm 1\text{mm}$
  - Twist:
    - On straight or circular curved track:  $\pm 1\text{mm/m}$
    - On transition curves: +0.5 mm/m over design value
  - Turnouts
    - Stock rail joint in the longitudinal section:  $\pm 15\text{mm}$ ;
    - Nose to nose of Xings in a cross over:  $\pm 10\text{mm}$
    - Flange way clearance at the end of the switch planning : + 5.0mm to - 0.00mm;
    - Switch Toe opening: +1.0mm to -0.0mm;
    - Switch Toe squareness: 5.0mm;



- Deviation of measured versine over the design value for the switches, intermediate track and curved crossings (measured over a 6.0 metre overlapping chord): +/- 3.0mm;
- Sleeper spacing: +/-10mm;
- Sleeper out of square: +/- 5.0mm
- Fishplate joint squareness across the track: +/- 10mm;
- Gauge at SEJs: +/-1.0mm;
- Gap at the opening of the SEJs: +/- 2.0mm;
- Out of squareness of switch rails of SEJs: +/- 2.0mm.

**d)** The base of the measurement shall be as below:

- Gauge checked every ten (10) sleepers at 14mm below the head of the rail;
- Cross level, twist and cant measured every 3.0 metres;
- Versines in the lead portion of turnouts every 3.0 metres;
- Versines in horizontal curves and transitions every 10.0 metres with an overlapping 20.0 metre chord;
- Vertical curves will be checked with a 10.0 metre overlapping chord.

**e)** No individual component shall exceed the track tolerance limit.

### **11.5.16 Testing and Commissioning**

#### **11.5.16.1 General**

- a)** The Contractor shall provide and perform all forms of testing procedures applicable to the Works and various components including all necessary factory, site and acceptance tests required therein and for the interfacing of the Works with the other Contract works. Until the time the Works are taken over by the Employer, Contractor shall maintain the same in a manner so as to continuously meet the acceptance criteria for all aspects, as per the requirements mentioned in the Employer's Requirement, Section II of Bidding Documents. Contractor shall make a consolidated list of all the tests required for Testing and Commissioning along with the testing procedures and applicable codes/ manuals and submit the same to the Engineer for enabling a joint program of testing.
- b)** All testing procedures shall be submitted at least Seven (07) days prior to conducting any test. The testing procedures shall show unambiguously the extent of testing covered by each submission, the method of testing, the acceptance criteria, the relevant drawing (or modification) status and the location.
- c)** The Engineer, the Employer's Personnel and authorized agencies shall at all reasonable times:
  - have full access to all parts of the Site and to all places from which natural Materials are being obtained, and

- During production, manufacture and construction (at the Site and elsewhere), be entitled to examine, inspect, measure and test the materials and workmanship, and to check the progress of manufacture of Plant and production and manufacture of Materials.
  - The Contractor shall give them full opportunity to carry out these activities, including providing access, facilities, permissions and safety equipment. No such activity shall relieve the Contractor from any obligation or responsibility. They shall be provided the facilities for monitoring all tests and have access to all testing records.
- d) Ample time shall be allowed within the testing programmes for necessary alterations to equipment, systems and designs to be undertaken, engagement of Engineer, together with re-testing prior to final commissioning.
- e) All costs associated with the testing as above shall be borne by the Contractor, unless otherwise specified, including the services of any specialised personnel or independent assessors concerned to the work done by him. The Contractor shall also bear any expenses incurred due to replacement necessitated by defects or failure of equipment to meet the requirements of the Contract. .
- f) All testing equipment shall carry an appropriate and valid calibration labels.
- g) Examination of Works before covering up: No work or part of work shall be covered up or put out of view, without the prior approval of the Engineer or the Engineer's Representative. The Contractor shall uncover any part or parts of the Works, or make openings in or through the same, as the Engineer may from time to time direct, and shall reinstate and make good such part or parts, to the satisfaction of the Engineer.
- h) If any defect or damage is one requiring immediate attention from a safety, environment or operational aspect, the Engineer has the authority to proceed with the rectification in any manner suitable and deduct the cost from the next due interim payment.

#### 11.5.16.2 Batches, Samples and Specimens

- a) A batch of material is a specified quantity of the material that satisfies the specified conditions.
- b) If one of the specified conditions is that the material is delivered to the Site at the same time, then material delivered to the Site over a period of a few days may be considered as part of the same batch if in the opinion of the Engineer there is sufficient proof that the other specified conditions applying to the batch apply to all of the material delivered over the period.
- c) A sample is a specified quantity of material that is taken from a batch for testing and which consists of a specified amount, or a specified number of pieces or units, of the material.
- d) A specimen is the portion of a sample that is to be tested.

#### 11.5.16.3 Samples For Testing

- a) Samples shall be of sufficient size and in accordance with relevant standards to carry out all specified tests.

- b) Samples taken on the Site shall be selected by, and taken in the presence of, the Engineer/ PMC/ TPIA and shall be suitably marked for their identification. An identification marking system should be evolved at the start of works in consultation with the Engineer.
- c) Samples shall be protected, handled and stored in such a manner that they are not damaged or contaminated and such that the properties of the sample do not change.
- d) Samples shall be delivered by the Contractor, under the supervision of the Engineer, to the specified place of testing. Samples on which non-destructive tests have been carried out shall be collected from the place of testing after testing and delivered to the Site or other locations instructed by the Engineer.
- e) Samples which have been tested may be incorporated in the Permanent Works provided that;
  - the sample complies with the specified requirements;
  - the sample is not damaged; and
  - the sample is not required to be retained under any other provision of the Contract.
  - Engineer is in agreement with the proposal of Contractor.
- f) Additional samples shall be provided for testing if in the opinion of the Engineer;
  - material previously tested no longer complies with the specified requirements; or
  - material has been handled or stored in such a manner that it may not comply with the specified requirements.

#### 11.5.16.4 Testing

- g) The Contractor shall be responsible for all on-site and off-site testing and for all in-situ testing.
- h) All appropriate laboratory tests shall be carried out in the Contractor's laboratory, unless otherwise permitted or required by the Engineer.
- i) Where the laboratory is not appropriately equipped and/or staffed for some tests, or if agreed to by the Engineer, tests may be carried out in other laboratories provided that;
  - they are accredited for the relevant work to a standard acceptable to the Engineer and
  - Particulars of the proposed laboratory are submitted to the Engineer for his consent.
  - Prior intimation to the Engineer shall be given regarding the date/time and location of testing.
- j) In-situ tests shall be done in the presence of the Engineer.
- k) Equipment, apparatus and materials for in-situ tests and laboratory compliance tests carried out by the Contractor shall be provided by the Contractor.
- l) The equipment and apparatus shall be maintained by the Contractor and shall be calibrated before the testing starts and at regular intervals as permitted by the Engineer.

- m)** The equipment, apparatus and materials for in-the situ tests shall be removed by the Contractor as soon as practicable after the testing is complete.
- n)** The Contractor shall be entitled in all cases to attend the testing carried out in the other laboratories, to inspect the calibration certificates of the testing machines and to undertake the testing on counterparts samples.
- o)** Testing of such samples shall be undertaken in laboratories and particulars of the laboratory proposed shall be submitted to the Engineer for consent prior to the testing.
- p)** Attendance on tests, including that by the Engineer, Contractor and Designer, shall be as laid down in the Quality Assurance procedures.

#### 11.5.16.5 Records of Tests

- a)** Records of in-situ tests and laboratory compliance tests carried out by the Contractor shall be kept by the Contractor on the Site and a report shall be submitted to the Engineer within seven (7) days, or such other time stated in the Contract or in the Quality Assurance Programme, after completion of each test.
- b)** In addition to any other requirements, the report shall contain the following details:
  - material or part of the Works tested;
  - location of the batch from which the samples were taken or location of the part of the Works;
  - place of testing;
  - date and time of tests;
  - weather conditions in the case of in-situ tests;
  - technical personnel supervising or carrying out the tests;
  - size and description of samples and specimens;
  - method of sampling;
  - properties tested;
  - method of testing;
  - readings and measurements taken during the tests;
  - test results, including any calculations and graphs;
  - specified acceptance criteria; and
  - other details stated in the Contract.
- c)** Reports of tests shall be signed by the Contractor's Site Representative or his assistant, or by another representative authorized by the Contractor.
- d)** If requested by the Contractor records of tests carried out by the Employer's staff or by the Engineer shall be given to the Contractor.

#### **11.5.16.6 Post Installation Tests (On Site)**

- a)** During and on completion of the installation, the Contractor shall undertake testing of all points and crossings, glued joints, derailing switches, switch expansion joints, buffer stops and other devices, in a progressive sequence and in accordance with the overall testing programme.
- b)** These tests shall culminate in functional tests to verify the correct operation of full apparatus and, where appropriate, correct response to the respective control and physical operation of the device/ components.

#### **11.5.16.7 Acceptance Tests**

- a)** The Contractor shall prepare and organise a comprehensive programme of acceptance tests to demonstrate to the Engineer that all systems, sub-systems and apparatus defined under the Contract meet the specified performance requirements in all respects.
- b)** These tests shall be conducted by the Contractor in the presence of the Engineer.

### **11.5.17 Records**

#### **11.5.17.1 Drawings Produced By the Contractor**

- a)** Drawings produced by the Contractor including Drawings of Site layouts, Temporary Works, etc. for submission to the Engineer shall generally be to ISO A1 size.
- b)** They shall display a title block with the information as detailed in the standards format as described in the IRS Engineering code, required for submission and approval from Railway.
- c)** The number of copies to be submitted to the Engineer shall be as stated in the Contract, or as required by Engineer.
- d)** The Contractor shall provide five sets of As Built Drawings along with read only electronic version of the same on CD/DVD to the Engineer.

#### **11.5.17.2 Progress Photographs and Videography**

- a)** The Contractor shall provide monthly progress photographs which have been properly recorded to show the progress of the works to the Engineer.
- b)** The photographs, of not less than 20 in number per month, shall be taken on locations agreed with the Engineer to record the exact progress of the Works. All important events shall be photographed.
- c)** Two sets of photographs shall be provided on CD ROM format with two sets of colour prints of 175 mm x 125 mm size in albums duly labelled.
- d)** The Contractor shall mount each set of each month's progress photographs in a separate album of a type to which the Engineer has given his consent, and shall provide for each photograph two typed self-adhesive labels, one of which shall be mounted immediately below the photograph and one on the back of the photograph.
- e)** Each label shall record the location, a brief description of the progress recorded and the date on which the photograph was taken.

- f) The Contractor shall ensure that no photography is permitted on the Site without the consent of the Engineer.
- g) Important events, construction activities, site visits of VIPs, working of new machinery, weather effects or any occasion advised by the Engineer shall be video graphed. The recording shall be done or converted to .avi format and presented in a CD/DVD with appropriate voice recording describing the event.
- h) The Engineer may specify any particular activity at the site to be video-graphed. The Contractor shall comply with the request at no extra cost to the Employer.

#### 11.5.17.3 Records of Wage Rates

- a) The Contractor shall keep monthly records of the average, high and low wage rates for each trade/tradesman employed on the Site and records shall be made available to the Engineer during inspection.

#### 11.5.17.4 Registers for Maintenance

- a) After completion of works, Contractor shall produce the following registers similar to the ones in use over IR and as per IRPWM, IRPWWM as under:-
  - Culvert / Bridge Register (2 sets)
  - Level Crossing
  - Points and Crossing
  - LWR
  - Ballast
  - Zero Missing Fitting
  - L-Section
  - Index Plan and Section
  - Curve Register
  - Gradient Register
  - SEJ Register
  - Track Diagram
  - Yard Plan
  - Yard Diagram
  - Earthworks
  - Any other registers as directed by Engineer to be used during maintenance.

#### 11.5.18 Materials

- a) Materials and goods for inclusion in the Permanent Works shall be new unless the Engineer has consented otherwise. Preference shall be given to local materials where available.

- b) Certificates of tests by manufacturers which are to be submitted to the Engineer shall be current and shall relate to the batch of material delivered to the Site.
- c) Certified true copies of certificates may be submitted if the original certificates could not be obtained from the manufacturer.
- d) Parts of materials which are to be assembled on the Site shall be marked to identify the different parts.
- e) Samples of materials submitted to the Engineer for information or consent shall be kept on the Site and shall not be returned to the Contractor or used in the Permanent Works unless permitted by the Engineer.
- f) The samples shall be used as a mean of comparison which the Engineer shall use to determine the quality of the materials subsequently delivered. Materials delivered to the Site for use in the Permanent Works shall be of the same or better quality as the samples which have received consent.

#### **11.5.19 Provision and Disposal of Earthworks Material**

- a) For fill or dumping sites, the Contractor shall prepare a land plan with details of surface drainage requirements, final formation levels, spreading and compaction of the fill during dumping acceptable to the Engineer.
- b) The Contractor shall also provide security for such sites. The dumping sites to be used by the Contractor shall be as directed by the Engineer.
- c) All excavated material, excluding waste material, bentonite fluid and bentonite contaminated material shall be disposed of at the appointed site only.
- d) This material shall be placed and compacted in accordance with the construction specification for earth works or as otherwise directed by the Engineer's representative.
- e) The disposal of waste material, bentonite fluid and material contaminated with bentonite shall be the sole responsibility of the Contractor and these materials shall be disposed off by the Contractor at an approved location at his own cost.
- f) The dumping sites provided by the Engineer, if any, shall not be used for disposal of waste material, bentonite fluid or material contaminated with bentonite.
- g) Rock deposited as fill material at the dumpsites shall be capable of compaction with single pieces no larger than 300mm.

#### **11.5.20 Defect Notification Period**

- a) After the Works are taken over by the Employer in terms of General conditions of Contract it will be followed by the Defect Notification Period of two years.
- b) During this period Contractor shall replace/ remedy the defects occurring under normal usage of Works by the Employer, except for normal wear and tear under such usage.
- c) Maintenance activities to be done during Defect Liability Period shall be done by the Employer at its own cost and through separate agency.

## 11.6 Standards

Following is the indicative list of Design standards. Any other applicable code, circular, instructions of UIC are to be referred with the approval of the Engineer.”

In case of any contradiction in the various codal provisions, the order of precedence shall be as follows:

- Specific provisions in Part 2 Employer’s Requirements.
- IRS codal provisions
- IRC codal provisions
- IS (BIS) codal provisions
- Provisions in other foreign codes.

However, in case of road related structures, IRC codal provisions shall prevail over IRS codal provisions.

### a) Earthworks

- IS:2720 Part 2 Determination of water content.
- IS:2720 Part-4 Grain size analysis.
- IS:2720 Part-5 Determination of liquid and plastic limits.
- IS:2720 Part-8 Determination of water content – dry density relation using heavy compaction.
- IS:2720 Part-16 Laboratory determination of CBR.
- Ministry of Railways guidelines and Specifications Design of Formation for Heavy Axle Load, Report No. RDSO/2007/GE:0014.
- Ministry of Road Transport and Highways Specification for Bridge Works, 4th edition.
- Report on “Guidelines for Use Of Geosynthetics On Railway Formation Including Specifications” (Provisional) Report No. RDSO/2007/GE:G- 0009(D) July 2008
- Concept And Design Of Reinforced Earth Structures Report No. GE: R – 73 June – 2005. Ministry of Railways guidelines for Earthwork in railway Projects, guideline No. GE: G-1.

### b) Civil Structures

- 32.5 Tonne Axle Loading Standards.
- IR Bridge Rules.
- IR Code of Practice for the Design of Substructures and Foundation of Bridge (Bridge Substructure and Foundation Code).
- IR Manual of Design and construction of Pile and Well Foundations.
- IR Code of Practice for Plain and Reinforced Concrete Bridge Construction (Concrete Bridge Code).
- DFC Schedule of Dimensions.



- Indian Railway Schedule of Dimensions.-to be consulted with the approval of Engineer where provisions in DFC schedule of dimensions do not cover the particular situation.
- Indian Railway Works Manual.
- Indian Railway Bridge Manual.
- IS 456- Code of Practice for Plain and Reinforced Concrete.
- IS 2911 (all Parts) Code of Practice for Design and Construction of Pile Foundations.
- IS 1493- Design of Bored and Cast in Situ Piles Founded in Rock.- Guide lines.
- IS 1893- Indian Seismic Code
- IS 1343 – Code of Practice for Pre-stressed Concrete.
- Section VII – Foundation and Substructure.
- UIC 774-3R- Track / Bridge Interaction.
- Code of practice for Ready-mix concrete – IS
- MMD of Western DFC

**c) Track**

- Indian Railway Permanent Way Manual.
- IRS T 12-2009 for UIC60KG/m.
- UIC Leaflet 860 8th edition.
- Manual of Instructions on LWRs of IR.
- IR Manual for Flash Butt Welding of Rails 2004.
- IR Standards Specification for Fusion Welding of Rails Alumino-Thermic Process.
- IRS T 29 2000 Cast manganese Steel Crossings.
- IRS T 39 1985 Pretress Concrete Sleepers
- IS:1785-Part 1 High Tensile Steel Wire.
- IRS GE 1 June 2004 Ballast specification.
- IRS T 1966 Fish Plates and Fish Bolts

## 12. FIRE FIGHTING AND DUST EXTRACTION SYSTEM:

Vender shall consider requirement for appropriate firefighting system and dust Extraction system suitable for bulk material handling system.

### 12.1 Fire Fighting System:

Provide and maintain adequate firefighting system for single risk fire including water tank and pump house, fire water pumping system, hydrant system, fire-water network complete with all accessories required. All the statutory requirements of IS Code/ NFPA / local authority shall be followed.

#### 12.1.1 Basis of Design

It is proposed to install Fire Fighting System, which shall be designed to give adequate fire protection for the facility based on Indian Standard or equivalent and shall conform to the provisions of the Tariff Advisory Committee's Fire Protection Manual. The Fire Hydrant System shall be installed at the following locations:

- Proposed Yard
- Transfer Towers
- Jetty
- Utility building

The Fire Hydrant System shall be designed to ensure that adequate quantity of water is available at all times, at all areas of the facility where a potential fire hazard exists. Each Hydrant connection shall be provided with suitable length of hoses and nozzles to permit effective operation.

As far as possible Hydrant mains shall be laid underground and the depth shall not be less than 1 (one) m below the ground level. In case of mains above ground, they shall be adequately supported with successive spans not exceeding 3.5 m. The spacing between Fire Hydrants shall not be more than 45 m.

#### a) Portable Fire Extinguishers

Portable Fire Extinguishers as per the TAC guidelines are proposed to be placed at strategic positions across the entire facility.

#### b) Hydrant System (Fire escape hydrants & Yard Hydrants):

As per TAC norms, considering **ordinary hazard** category, system design to cater 3.5 kg/cm<sup>2</sup> for hydrant & 7.0 kg/cm<sup>2</sup> for water monitor at remotest area. The yard pipe lines are designed to limit the velocity in pipe within 3m/s to 6m/s as per TAC guidelines.

Single headed Hydrant valve shall be provided in the yard area to meet the TAC requirement. The same are provided at every 45 mtrs. of perimeter of unit battery limit. Yard hydrants shall be provided at ground level to ensure the coverage as per TAC.

Hydrant Valve shall cover the area of 30 meters radius horizontally and 15 Mtr. Vertically from its location.

Near every yard hydrant point a hose box along with accessories (2 x 15 m long hoses, 1 no's branch pipe with nozzles) to be placed pedestal mounted.

The Piping Network for fire escape and yard Hydrant System shall consist of underground piping with yard Hydrants / Monitors at proposed Open storage yard & building and fire escape hydrants with wet riser at, Transfer Towers, tail house, Drive house.

To cater to external yard hydrants 2 nos. horsebox shall be strategically located in proposed area for utility building and for Track hopper stair). Hose box contain minimum of two 15 M hoses, 1 nozzle & couplings, hammers, spanners etc.

Each Internal hydrant for Transfer Tower would have hose cabinets containing 2 lengths of 7.5 M long Hose fitted with Instantaneous coupling.

### 12.1.2 System Operation

The hydrant system for the proposed area shall be designed as per TAC guideline.

In case of fire, hoses have to be fitted with branch pipes and nozzles, connected to the hydrant valves through instantaneous couplings and hydrant valve to be opened for directing water to seat of fire.

Opening of the hydrant/water monitor on the hydrant system causes a faster and larger drop in pressure in the header. Care should be taken in design that minimum pressure required maintained in all the conditions.

#### a) Fire Extinguisher:

Fire extinguishers shall be provided in all the Transfer Tower, Track hopper & utility building, pump house as per TAC Guideline requirement. 5 Kg Dry Chemical Powder and 4.5 Kg Carbon di Oxide extinguisher shall be provided with Sand Buckets.

#### b) Dewatering Pump:

A dewatering slurry pump shall be kept at the pump pit in Pump house for dewatering of any water accumulated in the pit due to leakages or maintained. etc. The out let pipe of the pump shall be taken outside by anchoring the pipe with wall of pump house and out let shall be left at the nearby storm water drain. The pump shall start/ stop when the water level in the sump exceeds predefined value.

#### c) Water tank and Pump House

The Hydrant pumps shall be stationed at pump house and draws water from the FFS compartment of the water tank. The water tank shall be fed from the utility water line with separate inlet to all tanks. Entry of water to the tank is controlled by putting float valve/ any other suitable arrangement.

### 12.1.3 Indicative Technical Specification for Fire Fighting System

#### 12.1.3.1 GENERAL

Equipment and materials covered in the specifications are subject to the referenced attachments. Contractor shall be responsible for design, procurement, fabrication, erection, installation and testing as per the Specifications.

All designs, drawings, specifications and other technical data shall be based on the metric systems of measurement.

The system (as specified) shall be based on Tariff Advisory Committee or equivalent and the local fire authorities and shall form the basis of design of the Fire Fighting System.

#### 12.1.3.2 Hand Appliances

Hand appliances shall be provided and installed as per TAC / IS: 15683/2878/10658. The number of extinguishers shall be according to the classification of the fire hazard of the area as per National Building Code and TAC.

#### 12.1.3.3 Hydrant Mains

- Hydrant mains shall be carbon Steel ERW pipes as per IS:1239 Part - I "Heavy" grade and fittings as per IS:1239 part –II for pipes up to 150mm dia. For pipes 200mm or above, IS: 3589 and minimum thickness of 6.35 mm shall be used.
- Hydrant mains in the stockyard, where raw water shall be used as firefighting media, shall not have any internal lining or coating. All the above ground mains shall be externally painted as specified in Section on "Surface Treatment & Coating".
- The hydrant mains shall be suitably sized such that the minimum pressure available at the hydraulically farthest end is 7.0 Kg/cm<sup>2</sup> for water monitor and 3.5 Kg/ Sq. Cm. for hydrant.
- The hydrant mains on the deck of berth shall be supported on the Conveyor gallery. The hydrant mains in other locations shall be underground as far as possible. The underground pipes shall be laid as specified in Specification for Corrosion protection.

#### 12.1.3.4 Hydrant Posts

- Hydrant Posts shall conform to IS: 908 "Specification for Stand Post Type Hydrants." Hydrants shall be provided with SS 304 Landing Valves as per IS:5290 Type "A"
- Spacing of hydrant posts shall not exceed 45m.
- Orifice plates shall be provided in all fire hydrant posts having pressure in excess of 7 Kg/Sq. Cm.
- The orifice plates provided on hydrants shall be fabricated from 6mm thick stainless steel plates. The bore of the orifice shall be designed to give 3.5 Kg/Sq. Cm pressure at the landing valve inlet.

#### 12.1.3.5 Hoses

- The fire hoses shall be RRL Type -A of 63mm dia.
- The fire hoses shall be supplied with instantaneous spring lock (male & female) type couplings of 63 mm dia. and branch pipes (nozzles) not less than 16mm and more than 25mm diameter. Wherever required, jet nozzles shall be provided. The jet nozzle shall be as per IS: 903.
- The couplings, branch pipes shall be as per IS: 903 and shall be made of SS-304.

- Hose cabinets with hoses, couplings and branch pipes shall be installed near the middle of each stockpile in the open stockyard and in the middle of berth. The fire hose cabinet shall be rectangular box to accommodate 2 hose pipes of 15m length each with couplings; one set of branch pipes and one jet nozzle.
- The hose cabinets shall be made of minimum 16 gauge MS sheets. Necessary arrangements, as shown in the drawing, shall be provided for mounting hose cabinets on column/ pedestals.

#### 12.1.4 Technical Data Sheet

##### 12.1.4.1 Pipes & Fittings

SL No	Item	Description
1	Under Ground Pipes	
1.1	Pipe specification	IS: 1239 (part I) – Heavy grade ERW MS Black pipes for sizes 150 NB and below. IS : 3589 – Grade 410 (wall thickness min. – 6.35mm) Heavy Grade ERW MS Black pipes for sizes 200 NB & Above size
1.2	Pipe to pipe joints	Butt welded for sizes 50 mm NB & above. And socket welded for sizes 40 mm NB and below.
1.3	Pipe fittings	Fittings shall be as per ASTM A105 / ASTM A234 Gr. WPB. (Miter bend and fabricated Tee Joints are not acceptable)
1.4	Bolts, nuts & washers	Hot dip galvanized MS as per IS 1367. Bolt as per IS 1364, Nuts as per IS 1364
1.5	Corrosion protection	Internal cement mortar lining , collar on joints and external as per Employer specification for Corrosions Protection
2	Above Ground Piping	
2.1	Pipe specification	IS: 1239 (part I) – Heavy grade ERW MS Black pipes for sizes 150 NB and below. IS : 3589 – Grade 410 (wall thickness min – 6.35mm) Heavy Grade ERW MS Black pipes for sizes 200 NB & above
2.2	Pipe to pipe joints	Butt welded for sizes above 50 mm NB and socket welded for sizes less than 40 mm NB and below.
2.3	Pipe to valve joint	Flanged and drilled to ANSI 150# B16.5 with neoprene black rubber gaskets between flanges for sizes 50NB & above.

		Screwed for sizes below 50NB.
2.4	Pipe fittings	Fittings shall be as per ASTM A105 / ASTM A234 Gr. WPB.
2.5	Bolts, nuts & washers	Hot dip galvanized MS as per IS 1367. Bolt as per IS 1364, Nuts as per IS 1364
2.6	Corrosion protection	Internal cement mortar lining , collar on joints and external as per Employer specification for Corrosions Protection
2.7	End Protection	End caps for pipes less than or equal to 200NB
2.8	End Connection	Plain end / Bevel end

#### 12.1.4.2 Gate Valves

1	C.I. Gate Valves for suction side of pump	
1.1	Type	Rising spindle type
1.2	Sizes	Above 50 NB up to 350 NB
1.3	Rating	PN 1.0
1.4	End connection	Flanged and drilled to ANSI 150# B 16.5, Flat Face
1.5	Code / Standard	IS 14846 for sizes 50 to 1200mm
1.6	Material of construction	
	Body	CI IS 210 Gr. FG 260
	Bonnet	CI IS 210 Gr. FG 260
	Stem	Stainless Steel to AISI-410 13% Cr St as per ASTM A276
	Wedge disc	CI IS 210 Gr. FG 260
	Body seat ring	13% chrome steel to AISI-410
	Back sheet	13% chrome steel to AISI-410
	Stem packing	Renewable, expanded PTFE

	Body Seating	Renewable type
	Hand wheel	CI IS 210 Gr. 260
	Bonnet bolts & nuts	CS IS 1367
	Bonnet gasket	CAF IS 2712
1.7	Testing	As per IS : 14846
1.8	Test pressure	Body - 24 kg/cm <sup>2</sup> Seat - 16 kg/cm <sup>2</sup>
1.9	Approval	ISI marked

#### 12.1.4.3 Butterfly Valve

<b>1</b>	Butterfly Valves	
1.1	Type	Wafer type to fit between two flanges. Valves up to 150 mm dia. shall be lever operated , 200 mm dia. & above shall be gear operated
1.2	Size	100 NB and above
1.3	Rating	PN 1.6
1.4	End connection	Suitable for Flanged drilled to ANSI 150# B 16.5
1.5	Code / Standard	BS 5155
1.6	Material of construction	
	Body	SA 216 Gr. WCB, casting
	Shaft	SS 316, stub shaft
	Disc	SA 216 Gr. WCB, casting
	Disc retaining ring	SS 316
	Body seat "O" ring	Nitrile rubber
	Bush	PTFE

	Hand wheel / lever	CS
	Studs	SA 193 Gr.B7
	Nuts	SA 194 Gr.2H
1.7	Testing	AWWA-C 504
1.8	Test pressure	Body - 24 kg/cm2, Seat - 16 kg/cm2
1.9	Approval	As per BS / IS
1.10	Operation	Up to 150 NB – by hand lever 150NB & Above – by hand wheel through gear box
1.11	Accessories	hand lever / wheel, b) position indicator

#### 12.1.4.4 Non returnvalve

1	C.I. Reflux Valves (Non Return Valve)	
1.1	Type	Swinging disc type
1.2	Size	Above 50 NB up to 200 NB
1.3	Rating	PN 1.6 or as required as per shut off head of pump
1.4	End connection	Flanged and drilled to ANSI 150# B 16.5
1.5	Code / Standard	IS - 5312 / BS-1868
1.6	Material of construction	
	Body	CI IS210 Gr. FG 260
	Cover	CI IS210 Gr. FG 260
	Disc	CI IS210 Gr. FG 260
	Hinge bracket	CI IS210 Gr. FG 260
	Body seat ring	13% chrome steel to AISI-410
	Flap seat ring	13% chrome steel to AISI-410



	Hinge pin	H.T brass IS : 320 HT-2
	Gasket	CAF IS 2712
	Bolt, nut & studs	CS IS 1367
1.7	Testing	As per BS : 5153
1.8	Test pressure	Body : 24 kg/cm <sup>2</sup> , Seat : 16 kg/cm <sup>2</sup>
1.9	Approval	ISI marked

#### 12.1.4.5 Hydrant valve

<b>1</b>	Hydrant Valve	
1.1	Type	Single headed female oblique type
1.2	Code / Standard	IS : 5290, type A
1.3	End connection	
	Inlet	Flanged and drilled to ANSI 150# B 16.5 Outlet Female instantaneous coupling with spring lock type coupling with blank cap & chain. Inlet of 75mm
	Outlet	
1.4	Size	63 mm
1.5	Flow	900 LPM @ 3.5 Kg/cm <sup>2</sup>
1.6	Testing	As per IS : 5290
1.7	Test pressure	Body - 21 kg/cm <sup>2</sup> Seat - 14 kg/cm <sup>2</sup>  Flow Test: 900lpm@7 kg/cm <sup>2</sup>
1.8	Working pressure	7 kg/cm <sup>2</sup>
1.9	Design pressure	14 Kg/cm <sup>2</sup>
1.10	Material of construction	
	Body	SS-304
	Female outlet	SS-304

	Stop valve	SS-304
	Blank cap	SS-304
	Bonnet	SS-304
	Gland	SS-304
	Gland packing	Non-asbestos
	Gland nut	SS-304
	Check nut	SS-304
	Seat	SS-304
	Spindle	SS-304
	Hand wheel	CI IS 210 Gr. 200
	Spring	Phosphor bronze to IS : 7608
	Washer & rubber seat	Rubber to IS : 937
	Companion flange at stand post	ASTM A105, 80mm dia. SOFF drilled as per IS:6392
	Painting	Valve top except face of flange and instantaneous outlet – Fire red, IS 5, shade 536 Hand wheel - black
1.11	Approval	ISI marked

#### 12.1.4.6 Water monitor

<b>1</b>	Water Monitor	
1.1	Type	Horizontal and vertical swivel type & stand Post type
1.2	Size	Inlet 75mm, 4" NB inlet (ANSI B 16.5) outlet of 38mm nozzle.
1.3	Code / Standard	IS : 8442 Type-I

1.4	Working pressure	7.0 kg/cm <sup>2</sup>
1.5	Design pressure	14.0 Kg/cm <sup>2</sup>
1.6	Testing	
1.6.1	Test pressure	23 kg/cm <sup>2</sup> for 5 min.
1.6.2	Flow & throw test With water flow at 7 kg/cm <sup>2</sup> (LPM) Horizontal throw (m) at 30degree	2580 60m at 7 kg/cm <sup>2</sup> in still air
1.7	Discharge capacity at 7 kg/cm <sup>2</sup> pressure (LPM)	2580
1.8	Throw with water Min. Horizontal (M) Min. Vertical (M)	60 Mtr. at 7 kg/cm <sup>2</sup> in still air at 30 degree 30 Mtr. @ 30 deg.
1.9	Rotation (Horizontal & Vertical)	360 deg horizontal in either direction & 80 deg to -45 deg
1.10	End connection	Flanged and drilled to ANSI 150# B 16.5
1.11	Material of construction	
	Water barrel (75 NB)	CS Seamless conforming to IS : 1239 (Part I)
	Wire braided hose	PVC
	Nozzle (38mm bore)	CS Seamless IS 1239 (Part 2)
	Handle	MS to IS : 1732
	Base flange	CS ASTM A101 Drilled to ANSI 150# B 16.5
	Reducer & 90° Elbow	Seamless ANSI B 16.9 / IS 4310
	Swivel joints (horizontal & vertical)	Bronze IS 318 LTB-2
	(Horizontal / vertical) rotation lock	Brass IS 319
	Grease nipple	Brass

	Drain cock	Bronze IS 318 LTB - 2.
1.12	Approval	ISI marked
	Painting	MS components hot dip galvanized to 0.012 micron. Body & parts to be painted with 2 coats of fire red colour as per IS 5 shade 536.
	Stand post Size	100mm Dia.
	Accessories	Nozzle & Blank cap

#### 12.1.4.7 Branch pipe & Nozzle

1	Branch Pipe & Nozzle	
1.1	Size	63 NB inlet with 20 NB nozzle
1.2	Nozzle Type	Hexagonal, detachable
1.3	Code / standard	IS : 903-1995
1.4	Material of construction	
	Branch pipe / nozzle	SS-304
	Spanner	Steel of grade C-40 to IS: 1570 (Part 5) chromium or zinc plated.
1.5	Testing	As per IS : 903, Test pressure 21 kg/cm <sup>2</sup>
1.6	Approval	ISI marked
1.7	End Connection	Instantaneous male.

#### 12.1.4.8 Hose coupling

1	Hose Coupling	
1.1	Type	Instantaneous male and female
1.2	Size	63 NB
1.3	Code / standard	IS : 903

1.4	Material of construction	
	Female half coupling	SS-304
	Male half coupling	SS-304
	Seal washer	Rubber
	Outer disc	SS-304
	Self-locking nut	Steel
	Locking latch	SS-304
	Spring	Phosphor bronze as per IS 7608
	Guide disc	SS-304
	Knob	SS-304
1.5	Testing	As per IS : 903
1.6	Approval	ISI marked
	Hydro test	21 kg/cm <sup>2</sup> for 2 ½ min

#### 12.1.4.9 Fire hose

1	Fire Hose	
1.1	Type	Reinforced Rubber Lined (RRL) type
1.2	Size	63 mm
1.3	Code / standard	IS:636 Type A
1.4	Length	15 m for external
1.5	End fittings	Instantaneous spring lock type coupling at both ends.
1.6	Testing	As per IS : 636
1.7	Hose weight (gm/m)	AS per IS : 636
1.8	Bursting pressure	As per IS : 636

1.9	Proof pressure	As per IS : 636
1.10	Kink test pressure	As per IS : 636
1.11	Change in length test pressure	As per IS : 636
1.12	Change in diameter test pressure	AS per IS : 636
1.13	Approval	ISI marked

#### 12.1.4.10 Hose Cabinet

1	Hose Cabinet	
1.1	Type	Fabricated out of 16 G MS sheet as per IS 2062
1.2	Size	Approx. 750 x 600 x 250
1.3	Mounting	Pedestal mounted for external hydrant
1.4	Special requirement	(i) Each cabinet shall accommodate 2 nos. of 15 m long hoses and 1 no. branch pipe & nozzle. (ii) Cabinet to have double door having toughened glass panel (3 mm) with rubber lining and marked 'Fire' on it. (iii) Lock with duplicate keys kept wired in a break glass key cabinet in the hose box itself. (iv) A spanner and a set of spare rubber rings packed in fresh chalk to be kept inside the hose box. (v) Clamp for holding branch pipe (vi) Canopy
1.5	Painting	Internal: White rust resisted  External: Fire red as per IS 5, shade 536

#### 12.1.4.11 Y strainer

1.0	Y and T type Strainers	
1.1	Sizes	65 NB to 350NB

1.2	End connector	Flanged and drilled to ANSI 150# B 16.5, SORF
1.3	Screen open area to pipe room sectional area ratio(Free flow area)	4:1
1.4	Material of construction	
	Body	MS to IS : 2062  100 NB to 150NB as per IS 1239 Part 1, Shell – 200NB as per IS 3589 fe410
	Screen	Stainless Steel to SS:304
1.5	Screen mesh	30 mesh 34 SWG
1.6	Max. Pressure Drop (MWC)	
	100% Clean condition	
	150 NB	0.471
	100 NB	0.400
	80 NB	0.284
	50 NB	0.120
	50% Choked condition	
	150 NB	3.74
	100 NB	3.0
	80 NB	0.31
	50 NB	1.0
1.7	Testing pressure  Pressure rating  Service  Painting	1.5 times design pressure  PN 1.0  Water  2 coats of heavy duty bituminous paint, 1 coat of

		red oxide primer, 2 coats of synthetic enamel paint shade 536 of IS:5
--	--	--

#### 12.1.4.12 Carbon Di-Oxide type Fire Extinguishers

1	CARBON DI-OXIDE TYPE PORTABLE FIRE EXTINGUISHERS	
1.1	Type	Carbon Di-Oxide type
1.2	Design Standard	IS : 15683
1.3	Quantity	As Required
1.4	Guaranteed performance	Yes
A	Capacity	4.5 Kg
B	Max. effective range when tested in still air	2M
C	Min. period during which the continuous jet shall be maintained.	8 Sec
D	Maximum period for discharge of 95% of the charge.	18Sec
1.5	Constructional features	As per design code
1.6	Material of construction	As per design code
1.7	Accessories	
A	Chemical charge	Yes
B	Mounting brackets complete with all hardware	Yes
C	Carrying Handle	Yes
D	Liquid level indicator	Yes
E	Any other as per design code	Yes
1.8	Approvals	ISI Marked



1.9	Painting and testing	As per design code
-----	----------------------	--------------------

#### Dry chemical powder type

1	DRY CHEMICAL POWDER TYPE PORTABLE FIRE EXTINGUISHERS	
1.1	Type	Dry chemical powder type
1.2	Design Standard	IS : 15683
1.3	Quantity	As Required
1.4	Guaranteed performance	Yes
a	Capacity	5 Kg
b	Max. effective range when tested in still air	2M
c	Min. period during which the continuous jet shall be maintained.	8 Sec
d	Maximum period for discharge of 95% of the charge.	18Sec
1.5	Constructional features	As per design code
1.6	Material of construction	As per design code
1.7	Accessories	
A	Chemical charge	Yes
B	Mounting brackets complete with all hardware	Yes
C	Carrying Handle	Yes
D	Liquid level indicator	Yes
E	Any other as per design code	Yes
1.8	Approvals	ISI Marked

1.9	Painting and testing	As per design code
-----	----------------------	--------------------

### 12.1.5 Approved List of Makes

Sr. No.	ITEM	Makes
1	Pumps	Mather & Platt / Kirloskar/ Wilo/ Flowmore
2	Motor	ABB / Simens / CGL
3	Diesel Engine	Cummins / KEOL
4	M.S. ERW Pipes	Jindal / Surya Roshni / TATA / Welspun
5	Pipe Fitting	Tube Products / Teekey Tubes / Pipe fit/ Topaz / Tube Product / Fit Tech
6	Strainer	GujaratOtofilt / Flair / Jaypee
7	Gate valve	H sarkar / KBL / Advance / Audco / BDK/ Leader
8	Globe valve	Leader / Sant
9	Butterfly Valve	Intervall / Advance / Audco/ Leader
10	Non return Valve	H sarkar / Advance / KBL/ Leader
11	Wrapping coating	Pypecote
12	Primer & Paint	Jotun /Sigma / Akzonoble
13	Hydrant Valve	SBJ / Winco / Sukan
14	Branch pipe with Nozzle	SBJ / Winco / Sukan
15	Fire hose	CRC / Jay Shree
16	Hose Coupling	SBJ / Winco / Sukan
17	Water Monitor	HD / SBJ / Winco
18	Pressure Gauge	H Guru /General Instruments/ Indfos / Denfoss
20	Fire Extinguishers	Safex / Zenith / Kanex
21	Level Transmitter & Level switch	Sigma / Levcon
22	Welding rod	Ador / Esab
23	HDPE Pipe	Duraline/Dutorn / Jain irrigation / Parixit

Note : Vendor shall offer makes from List of Approved Makes. Any make other than list needs prior approval from employer.

## **12.2 Dust Extraction System:**

Provide and maintain adequate Dust Extraction system including all accessories required. All the statutory requirements of IS Code/ NFPA / local authority shall be followed.

Dust Extraction System shall be suitable for the cargo i.e. Fertilizer via MHC, Mobile Hopper and Conveyor system, and other clean dry cargo, Minerals, Salt, Raw Fertilizer etc., via MHC and Mobile Hopper. The dust extraction system to be designed based on input data like quantum of cargo, MHS conveyor technical details etc.

Dust extraction system with bag filter arrangement shall be provided for all the discharge and receiving point of conveyors and mobile hoppers i.e. Mobile Hopper, Transfer Tower, Travelling Tripper etc. The dust extraction system shall be designed by EPC contractor based on input data of MHS system mentioned elsewhere in the tender specifications. The dust extraction system shall be suitable for fertilizers, minerals, salt etc. EPC contractor shall provide calculation and detailed specification of dust extraction system for employer's review and approval in detailed engineering.

### **12.2.1 List of Makes for Dust Extraction System**

Bidder shall submit the proposed vendor / manufacturer list for Dust Extraction System for Employer approval.

## **13. GENERAL REQUIREMENTS:**

### **13.1 Site Acceptance and Mobilization:**

The scope shall include Design, Manufacturing/Fabrication/Construction, delivery to site, storage, erection, installation, testing, commissioning, performance testing of the system including all civil, mechanical and electrical/control works. General requirements are described.

#### **13.1.1 Acceptance of Site:**

In accordance with these specifications, the Contractor shall have examined the site and familiarized himself with all existing conditions. He shall accept the site in its existing condition at the time of award of contract and also during whole contract period.

#### **13.1.2 Mobilization:**

Upon award of the Contract and within a reasonable time. Contractor shall mobilise all such labour, equipment and materials that are necessary to complete the project in due time.

#### **13.1.3 Access:**

The Contractor shall provide and maintain adequate access to the project site and all are as related to the works at his expense. If existing roads are to be used for access to the site, the Contractor shall maintain such roads for the duration of their use.

#### **13.1.4 Permits and Licenses:**

Except as expressly stated in the Employer's Responsibilities, the Contractor shall obtain all permits and licenses necessary for the execution and completion of the Works. The Contractor shall pay all associated fees including royalty. He shall also give the Employer a copy of all relevant correspondence and other documents relating to the Contractor's permits and licenses.

### **13.2 Temporary Works:**

The Contractor shall design, install and maintain all temporary facilities required for the construction of facilities under this contract Package, which he requires on or at the site throughout the execution of the work, and remove the same on completion of the works.

The Contractor shall submit his plan for temporary works to the Employer, for approval, within 30 days of award of contract.

Temporary construction shall be adequate for intended uses and for all loads imposed without excessive settlement, deflection or deformation. All parts and members shall be properly strengthened to prevent displacement or failure.

Before or upon completion of work, unless otherwise required or directed, preparatory structures, installations and utility services shall be disconnected and removed from the site.

### **13.2.1 Utilities:**

Temporary utilities used for construction shall have to be adequate for the intended use s and not to be overloaded or otherwise used or arranged in any manner endangering persons, premises or works. Connections shall be properly made, lines and wiring s e c u r e l y anchored in place and protected against accidents.

#### **a) Water:**

The Contractor shall provide his own arrangements for sourcing and for distribution adequate supply water for the Project including:

- Drinking water: providing and maintaining canisters, coolers or connected dri nking fountains of sufficient number to reasonably serve the Project.
- Construction water: providing and maintaining temporary water service and distribution of adequate capacity for construction

#### **b) Electricity:**

The Contractor shall make his own arrangement for power supply.

If found necessary, the Contractor shall provide and maintain generators including a stand - by generator of adequate capacity to meet his additional Project requirements.

The Contractor shall make his own arrangements as outlined hereunder:

- Distribution of adequate capacity for power, lighting and other construction needs.
- As necessary to properly and safely perform work at enclosed spaces or under hazardous conditions. Likewise, providing lights for night work/protection as necessary.

Temporary electrical systems shall comply with the local codes and regulations.

### **13.2.2 Waste and Rubbish:**

The Contractor shall provide regular daily clean-up and removal of trash, waste, scraps, construction debris, etc. from site and temporary work yard and shall arrange for disposal of waste and rubbish to disposal areas approved by the Employer.

### **13.2.3 First Aid and Fire Protection:**

#### **a) Emergencies:**

The Contractor shall maintain the lists of nearest available police, hospital or medical services at the Contractor's Site Office and the same are to be displayed at a number of locations & work places.

#### **b) Fire Protection:**

The Contractor shall establish and submit the following measures to the Employer.

- Establish appropriate emergency escape routes and procedures;
- Maintain fire extinguishers, connected hoses and other facilities necessary for reasonable fire-fighting action at the site and temporary work yard;

- Provide and maintain a first aid kit containing bandages, medicines and sterilized materials for first aid treatment of minor injuries at the Contractor's Site Office.

#### **13.2.4 Construction Safeguards**

##### **a) Excavations**

Trenches intersecting roads shall have to be provided with crossings suitable to carry the type of traffic involved. Vehicular curbs and pedestrian railings shall be provided as necessary. Open pits and in openings in floors and other accessible surfaces shall be protected by barricades or railings.

##### **b) Access**

Access to structures such as scaffolds, ladders, ramps, hoists etc. shall be provided, maintained and operated as necessary.

##### **c) Storage Areas**

Storage and shop areas shall be provided, arranged and maintained at approved locations as necessary to properly store, handle and fabricate the various materials and equipment required.

#### **13.2.5 Protection of the Public**

The Contractor shall provide barricades and enclosures as necessary for public protection.

### **13.3 Environmental Protection**

The Contractor shall comply with all the conditions stipulated by the relevant statutory and regulatory organisation of Govt. of Gujarat/Govt. of India.

##### **a) Fires:**

Fires and burning of rubbish on the Site are not permitted except when authorised by Employer.

Where fires or burning is permitted, the Contractor shall prevent the structures which are to be preserved from staining and smoke damage. The Contractor shall restore, clean and make good stained or damaged work to new condition.

##### **b) Disposal of Waste and Cleanliness**

The Contractor shall not bury rubbish and solid waste materials on the Site and he shall not dispose of waste or volatile materials, such as mineral spirits, oil or paint thinner into the waterways, storm water drainage or sanitary sewers.

The Contractor shall keep all pavements and areas leading to and from the site, clean and free of mud, dirt, and debris at all times for movement of vehicles and pedestrians.

##### **c) Drainage:**

The Contractor shall provide temporary drainage and pumping facilities as necessary to keep the adjoining areas of work site free from water logging and flooding.

##### **d) Pollution Control:**

The Contractor shall cover or wet down dry materials and rubbish to prevent blowing dust and debris, and provide dust control for temporary roads and yards.

The Contractor shall take all measures necessary to ensure that no pollution of the waterways or any land areas occurs as a result of his activities. He shall undertake at his own expense all measures necessary to clean up or otherwise rectify any pollution arising from his activities under this Contract to the satisfaction of the Employer.

e) Environment:

The Contractor prior to the commencement of works, shall prepare and implement an Environment Management Programme. The Contractor shall deploy most suitable construction equipment to minimise the suspension of fine sediments at the work site.

### **13.4 Submission of Documents during Project Execution:**

#### **13.4.1 Program of Works:**

The Contractor shall prepare and submit (both hard copy and soft copy) to the Employer within 30 days of receipt of Letter of Award the following:

- HSE Plan
- Quality Management Plan
- Organization Chart for Head office and Site team for this project.
- Detailed CPM Schedule showing the various activities of the Work using MS Project in soft copy (editable).
- List of designs/drawings/documents along with their schedule of submission.
- List of Vendors/ Suppliers of Bought-out items

The above shall be updated every month and submitted to the Employer.

#### **13.4.2 Operation & Maintenance Plan**

##### **13.4.2.1 General**

The Contractor shall prepare operation & maintenance plan covering all aspects of the works for the review of the Employer. This plan shall be prepared to ensure that the design life periods stated are met in full and where no design life periods are stated, the maintenance plan shall be prepared to maximize the serviceable life. Operation plan show operation methodology which contractor adopt while operating.

##### **13.4.2.2 Maintenance Document**

The Contractor shall provide three copies of the maintenance plan and manuals to the employer to retain by the Employer upon the request of the Employer or following receipt of attention to the Employer's comments.

#### **13.4.3 Daily, Weekly and Monthly Progress Reports**

The Contractor shall maintain a daily log describing the important events pertaining to the Works, *(the working hours, the number of labourers employed, effective operation time of*

*equipment, overtime hours*), progress made in the Works. This daily log shall be submitted to the Employer by 1:00 PM of the following day. Compilation of these logs and their summary shall be submitted to the Employer as Weekly Progress Report in three (3) copies by middle of the next week.

The monthly progress reports shall include progress photographs taken at a fixed point and angle. The photographs shall be sufficient in numbers and locations to record the exact progress of works. The colour photographs shall be in size 200 mm x 250 mm and the CD containing the digital version of the same shall be provided.

The Contractor shall furnish the Employer with five (5) copies of the monthly progress reports within seven (7) days after the end of every month.

#### **13.4.4 Design & Drawing Submissions:**

##### **13.4.4.1 Design Submissions – General:**

The scope drawings listed in this Volume is issued for information and guidance to the extent mentioned in the Tender document. Contractor shall make all arrangement and design drawings to suit his equipment and submit the same for approval to the Employer. Detailed Engineering shall be done by the Contractor. It shall be the responsibility of the contractor to take approval on his design and drawing submissions. The contractor shall not be entitled to any extension of time for completing commissioning or any other relief on account of delay caused due to providing any clarifications or in resubmitting any designs and drawings.

It should be noted by the bidders that the information, size, specifications, design & dimensions mentioned in this Volume and drawings, are indicative. As in EPC Contracts, the successful bidder shall workout detail design & drawings during detail engineering stage meeting the functional, operational & performance requirements & as per relevant IS standards, well within the sanctioned estimate, and submit the fresh design & drawings for approval to employer.

The Contractor shall submit for the approval of Employer, progressively from the date of receipt of the Letter of Award, Five (5) copies of the following:

- Layout and flow diagram of Mechanization of handling of fertilizer at Berth 14 with capacity.
- General arrangement of the berth and back up area showing entire facilities.i.e. Cranes, Mobilehoper, Conveying System/ Sub-system/ Equipment involved, Storage shed, open storage yard, Water tanks, Buildings, Railway lines etc.
- Cross sections and other details showing important particulars such as overall dimensions, clearances,etc.
- Specification/catalogues of all standard bought-out items.
- All drawings other than shop fabrication/manufacturing drawings. These will include, but not be limited to assembly, sub-assembly, key components, etc. However, one week prior to fabrication, fabrication and part drawings shall be made available to the Employer.
- Power Requirement (installed and peak demand loads)



- Wiring drawings and equipment inter-connection diagrams of local control panels & Single Line Diagram of facility power distribution.
- Other interface details in a progressive manner
- All design calculations pertaining to conveyor system, equipments, and other sub-systems/components.

A further digital copy (in AutoCAD format) of the submission shall be given on compact disc. This digital copy shall include the full submission with scanned copies of any documents prepared by hand.

#### 13.4.4.2 Submission of Calculations:

All calculations submitted for the Employer's approval shall comply with the following:

- a) Each calculation page shall be uniquely numbered.
- b) Each section of calculations shall have a cover sheet, listing the subject of the calculations, document number and date of submission, name and qualifications of the Designer(s), the name and qualifications of the Design Verification engineer(s), and the relevant Indian/other Standards, books and drawings which are the basis of the calculations.
- c) Each section of calculations shall have a Table of Contents, including page numbers.
- d) Calculations shall be accompanied by all necessary sketches or extracts from drawings.
- e) Calculations shall include introductions explaining the purpose of the calculations and the methods and design philosophies adopted. This shall clearly state the Standards on which the calculations are based.
- f) Equations and values from Standards and Codes of Practice are to be clearly referenced. Extracts from publications other than Indian Standards or International Standards which are used in the design shall be attached to the submission. The relevant Indian/other Standards forming the basis of the design shall be quoted.
- g) Where values used in the calculations are brought forward from previous calculation pages, the page reference shall be included.
- h) At the end of each section there shall be a summary, listing the conclusions of the calculations, and referring to construction drawings.
- i) If calculations are revised due to design changes or corrections or comments of the Employer, the calculations sheets shall be clearly marked with a revision letter.
- j) All calculations shall be signed / approved by the designer and design verification engineer.
- k) The design calculations shall be written in English. In case any software is utilized to perform the calculations a sample set of manual calculations with references of various formulae used shall also be submitted for proper verification.

#### 13.4.4.3 Submission of Drawings:

All drawings submitted for the Employer's approval shall comply with the following:

- a) All drawings shall be in metric millimeter dimensions, and be finally prepared in ink with legible lettering on either A0 1189mm x 841mm using AutoCAD format compatible with

AutoCAD 2016 or lower version. The submitted prints shall be clearly legible throughout and there shall be no ambiguity.

- b) All drawings shall be submitted in digital format on compact disc, as well as three paper prints.
- c) Drafting Standards employed in the preparation of all drawings shall be sufficient to produce legible 297mm x 420mm (A3) reduced drawings.
- d) Drawings from various sub-contracting services, specialist suppliers etc. shall also be presented in a similar manner (identical title blocks/format etc.) to provide a matched set of drawings.
- e) All drawings shall clearly show the status and revision of the drawings. Revised drawings shall clearly indicate the nature and details of the revision work and also revision cloud & revision mark shall be marked wherever revised.
- f) All drawings shall clearly identify the drafts-person responsible together with the identity of the drawings checker.
- g) Each drawing shall show the scale(s) of the components illustrated by the drawing related to the original drawing size, A0, A1, A3 etc.

#### 13.4.4.4 Inspection of Drawings at Site:

The Employer shall have the right at all reasonable times to inspect all drawings at the premises of the Contractor or call for any drawing to be given to Employer's office.

#### 13.4.4.5 Manuals and Technical Data:

##### a) Manuals:

The Contractor shall supply Five (5) hard copies along with One (1) soft copy (in editable format) of Erection & Installation Manuals, Operation Manuals, Spare Parts Manuals and Inspection and Maintenance Manuals prior to the starting of erection. Recommendations of the manufacturer in respect of preventive maintenance, trouble shooting, and breakdown maintenance and overhaul shall be brought out in the inspection and maintenance manuals. Soft copies of all drawings shall be supplied.

##### b) Technical Data:

On completion of the works and before handing over possession to Employer, the Contractor shall supply Five (5) hard copies together with One (1) soft copy of the following:

- Shop drawings of all wearing parts and also major assemblies and minor assemblies which require unit replacement;
- All "As Built Drawings of equipments, conveyors, civil / structural, electrical items etc.
- On completion of the work and before handing over the system to DPA, Contractor has to supply five (05) sets of completion drawings, assembled drawings of various components, technical literature, maintenance manuals, spare parts catalogue etc., along with soft copy of the same. PLC software of Automation, Auto-cad drawings (with licensed version) in form of DVD with Two

(2) new latest version Laptops.

Complete technical data and dimensional drawings of all bought out product/ items such as bearings, seals, couplings, gear reducers, brakes, valves and such other items etc. in the system, shall be furnished - Six (6) hard copies together with One (1) soft copy of the following:

- List of recommended spare parts.
- Parts catalogues in the case of all equipment /assemblies illustrated with part numbers in drawings both for electrical and mechanical items.

#### 13.4.4.6 Tools and Maintenance Equipment:

A list of complete set of tools/tackles and instruments required to be provided for satisfactory maintenance of the Works shall be furnished.

#### 13.4.4.7 As Built Drawings, Design and Final Report:

Before submitting a request for commissioning Certificate, the Contractor shall ensure that it has furnished to the Employer all required documents including but not limited to two (2) sets of as-built drawings, final design in the supporting of as-built drawings and a final construction report as draft. And within thirty (30) calendar days after receipt of comments from the Employer, the Contractor shall submit five (5) sets of the Final Construction Report and five (5) sets of Final As-built drawings & Design documents. As-built drawings of the works consists of two (2) sets of original size copies (white print) and six (6) sets of bound copies reduced to A3 size. All documents and drawings will be also delivered on CDs (drawings in Auto-CAD format, documents in other required formats and soft copy of the file used in software on which design was carried out).

On completion of the work and before handing over the system to DPA, Contractor has to supply five (05) sets of completion drawings, assembled drawings of various components, technical literature, maintenance manuals, spare parts catalogue etc., along with soft copy of the same. PLC software of Automation, Auto-cad drawings (with licensed version) in form of DVD with Two (2) new latest version Laptops.

Before submitting a request for commissioning Certificate, the Contractor shall ensure that it has furnished to the Employer all required documents including but not limited to five copies of manuals for installation, commissioning, operation and maintenance and the drawings/ documents etc., covering all aspects of the Works for the review of the Employer. This plan shall be prepared to ensure that the design life periods stated are met in full and where no design life periods are stated, the maintenance plan shall be prepared to maximize the serviceable life. In the event the Contractor makes any changes effecting such submission the Contractor shall submit afresh such document duly revising to that extent.

### 13.5 Quality Control and Assurance:

#### 13.5.1 General:

The Contractor will be required to adopt a system of self-certification in accordance with his general quality plan and the appropriate detailed quality procedures. The quality system shall comply with Standards of ISO 9001.

The Contractor shall monitor his performance of executing his Works against two levels of

certification:

- The completion of individual work items and
- The completion of activities listed in the Programme.

In addition to the certification of the completion of work items and activities, the Contractor shall be required to issue the Quality Assurance (QA) certificates concerning the Quality Plan, Quality Procedures and Construction Documents.

The Employer may monitor the Contractor's work against the Contractor's Quality Plan and Quality procedures. The Employer may do this by spot checks, and/or by continuous monitoring of the work. The Employer may also do this by carrying out compliance audits periodically against the Contractor's Quality Procedures. The frequency and intensity of such checks will depend on the proven reliability of the Contractor as work progresses. Each non-compliance with the Quality Plan shall be notified promptly to the Employer by the Contractor, together with proposals for remedy of the non-compliance. The absence of monitoring of or commenting on quality aspects as above by the Employer shall not absolve the Contractor from any of its contractual obligations and/or shall not entitle the Contractor for any claim.

#### **13.5.2 Improper Certification of Unsatisfactory Work:**

If the Contractor or its personnel repeatedly confirms/declares a work as being satisfactory when such work is not satisfactory, the Employer may reject such work any time during the currency of the Contract and instruct the Contractor to re-execute such work in full or a part thereof without any implication of time or cost to the Employer. In case of improper certification and/or Contractor's failure to rectify, the Employer may proceed as per the Contract including terminating the Contract.

#### **13.5.3 Quality Plan and Quality Procedures:**

The Contractor will be required to submit his complete General Quality Plan to the Employer within four weeks of the Commencement Date. A designer's quality plan will be accepted as an interim measure to permit design work to be started in advance of the preparation of the General Quality Plan.

Detailed Quality Procedures for each element or item of work must be submitted to the Employer for review at least four weeks before that work is due to commence. Detailed Quality Procedures are required for all items manufactured prior to delivery to site.

#### **13.5.4 Submission and Certification of Construction Documents:**

The Contractor shall submit a Design Certificate (in duplicate) and Design Check Certificate whenever he is submitting Construction Documents to the Employer for review. Construction Documents submitted without the relevant Design Certificate will not be reviewed.

The Contractor is to ensure that all Construction Documents submissions are in a form that enables the Employer to review the Construction Documents as required by the Contract without delaying completion of the Works.

#### **13.5.5 Certificates for Work Item Completion:**

Readily identifiable Work Items must be certified as checked and found satisfactory by

- Contractor's surveyor responsible for checking.
- Contractor's supervisor responsible for checking temporary works, material cleanliness, dimensions (not checked in (a) above), workmanship and all other matters to enable him to certify that the item of work complies in every respect to the contract.

The Work Item Completion Certificate shall be checked and approved by the Contractor's Quality Manager.

Each Work Item Completion Certificate must be identified by a unique and appropriate reference number.

If the Employer is not satisfied that the works have been carried out satisfactorily as certified, the Employer shall raise a non-conformance report to which the Contractor shall respond stating his proposals for rectifying the non-conforming item and what action will be taken to prevent recurrence. The Employer may reject such work any time during the currency of the Contract and instruct the Contractor to re-execute such work in full or a part thereof without any implication to the Employer. In case of recurrence/failure of the Contractor to rectify, the Employer may adjust the Contract price by deducting the value of such work.

Any consequences in respect of any revisions arising out of Work Item Completion Certificates being returned with comments shall not be treated as a compensation event.

### **13.5.6 Certificates for Activity Completion:**

When a section of work has been completed satisfactorily, the Contractor shall certify that the activity has been completed in accordance with the Contract.

The Activity Completion Certificate shall be checked by the Contractor's Quality Manager and confirmed by the Contractor. The Designer's Representative shall also certify that the activity has been completed in conformance with the relevant Documents and the Employer's Requirements.

The Activity Completion Certificate shall list the reference numbers and dates of Work Item Completion certificates that have been relied upon by the signatories to the Activity Completion Certificate.

Each Activity Completion Certificate shall have attached to it, copies of any material test certificates which were received after signing the relevant Work Item Completion Certificates and which have not been submitted to the Employer under separate cover during the period between the signing of the Work Item Completion Certificate and the preparation of the Activity Completion Certificate.

## **13.6 Operating Safety**

### **13.6.1 General**

In the design and fabrication of the equipment all normal safety provisions shall be observed. It shall be the responsibility of the Contractor to ensure that the equipment satisfies in every respect the statutory requirements of the following:

- Indian Factories Act

- Indian Electricity Rules
- Indian Electricity Act
- Indian Dock Labourer's Act
- Tariff Advisory Committee as required
- Other relevant safety standards as per ISCodes

All materials shall be installed in accordance with the requirements of above and/or any other statutory body having jurisdiction over the site. The Contractor shall be responsible for getting all type of approvals for his installation from the concerned authorities /regulatory bodies.

### **13.6.2 Safety and Identification Signs**

Necessary Safety and Identification signs shall be placed on equipment, piping and other work areas. All signs shall be painted on 2.5mm minimum thickness brass/ stainless steel sheet.

Identification signs shall be black lettering (minimum of 50mm high) on a white background. Each item of equipment shall be clearly identified with a minimum of two signs.

All equipment and work areas shall have signs for:

- Hearing protection
- Warning the "equipment may start without noise";
- High voltage
- Direction of rotation wherever applicable
- Eye protection
- Other safety signs as required by local codes.

### **13.6.3 Noise and Protection of Workman**

All equipment used for the construction activity shall be properly maintained to ensure least generation of noise, and also workers shall be protected with ear muffs. The moving parts of the machines shall be properly oiled and greased to reduce noise generation. The workmen with loose fitting garments shall not be permitted and all workmen shall be provided with protective clothing, helmets, protective goggles and appropriate shoes and gloves etc., wherever required.

### **13.6.4 Fuel Oil Storages**

The construction equipment vessels and vehicles used in construction work and for transport of material require fuel oils. There shall be a storage facility for such fuel oils, well designed, and protected against fire hazards and provided with a compound wall, to prevent access to unauthorized elements. All surfaces run off from such storage areas shall pass through oil water separator, before it finds access to any storm water drainage course or sea.

## **14. QUALITY ASSURANCE AND CONTROL REQUIREMENT:**

The Successful Bidder shall establish the Project Quality Plan (PQP) in line with the Deendayal Port Authority Quality Policy and requirements.

The Bidder shall prepare the draft Project Quality Plan and submit the same to the employer's Quality team for validation & approval.

Review /approval of the Project Quality Plan (for his scope of work) by the employer shall not dilute the responsibility of the bidder for adherence to the Quality requirements during execution and or the DPA Quality policy requirements from time to time.

### **14.1 General**

Objective of this document is to provide a guideline & framework to help the bidder to achieve construction quality, across the life cycle of the project in line with the employer's requirements.

This document outlines the activities & requirements to be adopted and adhered by the Bidder during the execution phase to ensure compliance to approved drawings, technical specifications and quality management systems.

The Bidder will be responsible for ensuring quality of construction carried out by them/their approved sub-contractors in accordance with the following

- a) Technical specifications
- b) Applicable Codes & Standards.
- c) Contract conditions
- d) Approved drawings &
- e) QA/QC procedures

Bidder shall also be responsible to set-up material testing facility / laboratory at site as required by employer.

**Note: Review/approval of the Bidder's activities by Employer shall not dilute the responsibility of the Bidder for maintaining quality.**

### **14.2 Basic Requirements**

The Scope for Construction Quality Control activities for an EPC contract involves the role of bidder's engineering quality and is broadly envisaged as executor in inspection of critical activities as identified and communicated including enabling & coordinating planned & unplanned auditing/assessment & surveillance by employers Quality Manager & its team from time to time.

#### **14.2.1 Quality in Engineering**

The bidder shall ensure that all Technical specifications submitted to employer's engineering are validated by the employers quality team and inputs sought before actual approval.

The bidder's design function shall be subjected to audit /assessment for the following by the employer's assessment team for all engineering deliverables

- Assessment as per engineering quality plan
- Assessment for Safety in Design

**Note1:** The bidder shall ensure that the engineering quality plan is approved by the employer's quality team before the kick of meeting.

### **14.2.2 Quality in Procurement & Construction**

All work/services to be performed by the Bidder under this contract shall be of specified / approved quality and the bidder shall have a QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) system during the performance of various activities at Construction Site and during the manufacturing of materials and equipment covered under the scope of the project/package.

Bidder shall develop a detailed Field Quality plan for the scope of work and submit the same for discussion and agreement during the pre-bid meeting and obtain the approval of the same from employer's quality team for implementation.

The Quality Assurance System plans / procedures of the Bidder shall be furnished in the form of a QA manual before the pre bid meeting and approval of employer's quality team shall be obtained before the kick of meeting as applicable.

The following shall be compiled by bidder in general.

- This document should cover details of the personnel responsible for the quality assurance, plans or procedures to be followed for quality.
- Various tests/inspections to be carried out as per the requirement of these Specifications and standards mentioned therein with applicable Codes & standards including the specified norms & acceptance criteria.
- Quality practices and procedures followed by bidder's (Contractor's) Quality Control Organization
- The relevant reference documents and standards and acceptance norms etc. during all stages of material procurement, manufacture, assembly and final testing/performance testing.
- Method of vendor's qualification and approvals including the product inspection and acceptance procedures.
- Details of Quality inspection records preparation and maintenance.
- Various stages of inspections w.r.t methods for check with points and type of witness.

### **14.2.3 Bidder's Quality Organization Structure**

The project quality organization structure of the Bidder shall be proposed as part of the bid with the submission of project/package organogram & finalized during the pre bid meeting in discussions with the employer's quality team.



The minimum requirement being an dedicated quality-in-charge capable of implementing the Quality requirements as defined by employer which shall include, but not be limited to, the following:-

- Preparation, submission, and obtain Employer's approval of various QA documents.
- Functional & administrative control of field laboratory ensuring timely tests.
- Preparation and submission of all test & inspection records duly approved by Employer.
- Ensuring calibration of all measuring & test equipment.
- Test materials from approved independent labs as required by Employer.
- Conduct specialized field tests (NDT, etc.) from approved agencies as required by Employer.
- Conducting training internally to quality & construction teams of Bidder.
- Face quality audits conducted by Employer & close the NCRs identified.
- Closely coordinate with quality personnel of Employer & ensure compliance to various quality requirements of Employer.

**Note:** Bidder shall ensure that his quality-in-charge is adequately supported by a team of QA/QC staff to take care of the tests and inspections both at field lab as well as construction sites which shall also include quality personnel at manufacturing/fabrication at external site

#### **14.2.4 Bidder's communication procedure**

The communication procedure with the Employer's quality team to be followed by the Bidder shall be a seamless flow of information and eliminate communication gaps resulting into delays & re-works.

##### **14.2.4.1 Communication procedure for prequalification of Sub-supplier**

Bidders shall generally engage sub-suppliers which are approved by employer in reference to the list of approved supplier / sub-supplier enclosed with the Tender document or provided by employer during discussions during the Pre-award stage.

In specific cases where bidder wants to engage non-listed supplier / sub-supplier the bidder shall submit details of such proposed supplier / sub-supplier in approved formats to employer and obtain approval during the pre-award stage.

Bidder shall coordinate with Quality Manager of employer for obtaining such approvals which may involve the site/facility visits of the proposed supplier / sub-supplier by employer's Quality team.

Bidder shall coordinate & support the prequalification process including site/facility visits as required by employer.

**Note:** Decision of approval or rejection of such supplier / sub-supplier shall be the sole discretion of Employer and the decision shall be binding on Bidder.

#### 14.2.4.2 Communication procedure during Pre-Order stage

Bidder may hold discussions for any clarification required from the employer's Quality team during the pre-bid meetings.

During such meetings bidder shall communicate directly with employer's nominated Quality Manager regarding inputs like

- a) Clarifications on Technical specifications
- b) Specific QA requirements mentioned in the Tender
- c) In case any concessions/deviation required by them with respect to QA requirements.
- d) Clarification regarding tests & inspections,
- e) Nature of documentation required form & formats
- f) Mode of submission soft /hard / key in data in employer's system

**Note:** It shall be responsibility of the bidder to understand & freeze the requirements, in concurrence with employer's quality team, for smooth implementation during post order or execution stage.

#### 14.2.4.3 Communication procedure during Post-Order stage

Bidder shall submit an exhaustive list of bought-out materials duly categorized before the pre-bid meeting.

Source inspection of the brought out material shall be mandatory by employer's quality engineer as per approved categorization plan irrespective of the bought-out materials being procured from approved vendors or being pre-inspected from agencies like "RITES" and or Independent engineer (appointed by port authority) .

Bidders shall coordinate with employer's commercial & quality team and freeze the Categorization plan and obtain approval of employer before kick off meeting.

The categorization plan for the bought-out materials shall be of A, B, C categories as per inspection requirements as detailed below

- **Category-A:** Materials which shall be inspected by Employer (or TPIA nominated by him). The consignment items shall also be included in this category apart from other identified materials. Acceptance shall be based on IR & MDCC from Employer.
- **Category-B:** Materials which shall be inspected at source by bidder himself. Acceptance shall be based on inspection reports from bidder.
- **Category-C:** Materials which shall not require source inspection. Acceptance shall be based on document review only.

#### 14.2.4.4 Communication procedure during Post-Order (Construction)

##### 14.2.4.4.1 For Routine construction works:

Employer's Quality Manager shall communicate up-front all hold points to Bidder in line with approved field quality plan or inspection & test plan (FQP/ITP) .

Bidder shall intimate all field inspection requirements to Employer's quality team in form of Request for Inspection (RFI).

In case employer's quality manager communicates to waive off the inspection at his level, bidder shall proceed with the work after duly inspection from his side and shall communicate the inspection results to employer's quality manager in all such cases.

For material testing at Field Lab bidder's quality shall inform employer's quality for witnessing the tests as specified in the quality plan.

Bidder shall intimate all quality issues & deviations to employer quality as & when they occur preferably on the same working day.

Bidder shall also make note & take action on quality issues identified by way of employer's surveillance and inspections.

Routine non-critical quality issues shall be notified to bidder by means of field notes or e-mails or through employer's functional module or by oral communications from employer's quality team mentioning the rectifications and or corrective measures. These shall be closed by communication between bidder and employer's quality with execution teams from both ends in the communication loop.

Issues which may essentially lead to following shall be **reported through NCRs**

- a) Process and/or Product /Structure failure,
- b) May have potential threat of product/structure failure

Bidder shall follow the below process as part of NCR reporting

- a) Employer auditor /assessor shall issue NCR to Bidder's auditee/assesse in specified format.
- b) Bidder shall coordinate with employer and respond & agree upon corrective action within three working days, this shall be treated as part of acceptance of NCR.
- c) Employer's quality team shall communicate all deductions and hold amounts from Bidder's RA bills with back-up (NCRs, Field notes, inspection reports, e-mails, etc.) through employer's area manager.
- d) Bidder's auditee/assesses shall propose the preventive action in the NCR after understanding the root cause of the issue /observation
- e) Employer's quality team and or the auditor shall perform the verification and shall initiate closure of NCR
- f) Bidder shall ensure that the employer's execution team is looped in all communications regarding the NCR.

#### 14.2.4.4.2 For source inspection of Contractor supplied bought-out materials

- a) Bidder shall ensure MQP's (Manufacturing Quality Plans) for brought out material supplied under his scope are approved from the employer's quality team much before the manufacturing starts at vendor/suppliers works.

- b) Bidder shall submit the MQP (Manufacturing Quality Plans) based on the approved categorization plan for materials which shall be source inspected by Employer's quality team or his representative.
- c) Bidder's quality engineer shall coordinate directly with Employer's quality team and obtain approval of the MQPs.
- d) Employer's quality team shall directly communicate with bidder and his Vendor, as required, for various QA requirements (MQP, Data sheets, Manufacturing drawings, etc.).
- e) In specific cases Bidder's vendors may directly communicate with Employer's quality team and submit the required documents for validation /inspection & approval under intimation to Bidder.
- f) However this does not dilute or eliminate the responsibility of the bidder to submit all documents and provide inputs for approval of vendor /supplier MQPs.
- g) Bidder shall coordinate with their Vendors /suppliers and submit inspection calls directly to employer's quality manager with intimation to the Project manager of Employer.
- h) On completion of inspection employer's quality inspector shall submit MDCC & IR to the vendor & inform the bidder regarding the clearance.
- i) Employer shall instruct his vendor to dispatch the materials as per clearance received through MDCC.
- j) Contractor to submit original inspection reports along with original test report / certificates to employer and three more copies at the time of handover.

#### 14.2.4.4.3 For receipt inspection of materials at site

On receipt of the material at site bidder's Quality team shall ensure that the material is inspected with respect to quality requirements as per its technical specification/ standards and terms and conditions of PO/ TCs/ MTC/ MDCC.

He shall intimate Employer's quality personnel for joint inspection of the items received.

Employer's quality engineer shall carry out inspection to his discretion and accept the materials accordingly.

Any quality issue, if detected at receipt inspection, shall be immediately intimated to Employer's quality team.

Materials found defective in receipt inspection shall be segregated and rejected/repared by Bidder & his vendor's team as advised by Employer's quality.

#### 14.2.4.5 Communication procedure for approvals of quality deviations

There shall be absolutely no deviations from the specified technical & quality requirements as per the contract, however, in exceptional cases where compliance to all such requirements may not be possible due to genuine reasons beyond control of the bidder, then a waiver/deviation permit process shall be initiated, and properly documented in specified format, by the Bidder for approval of deviations.

The communication process for approval of quality deviations for material & construction are detailed below:

**a) For Materials:**

If any deviation for the specified quality parameters for the materials is proposed by bidder then he shall immediately intimate the same to Employer's quality manager and the concerned site head & project head along with his proposed alternative scheme.

For the purpose bidder shall submit all required supporting documents like drawings, technical data sheets, test & inspection reports, etc. to employer's quality manager for review.

Employer's quality manager shall accord the approval of such deviation requests at his discretion after assessing the reasons of deviations sought as well as the adequacy of the alternative proposal of Bidder.

However if Employer's quality manager feels the requests are not valid he may reject the request in which case bidder shall either implement the original specified requirements or submit an alternative scheme and implement same subject to approval of employer's quality manager.

**b) For Construction:**

During execution of construction work, bidder shall raise request for waiver of applicable specifications only in case where genuine constraints are encountered, beyond his control, depending on site conditions.

In all such cases bidder shall immediately intimate the constraints and the deviation he seeks to employer's quality manager and the site & project head along with his proposed alternative scheme.

Bidder shall also submit all required supporting documents like drawings, technical data sheets, test & inspection reports, etc. to employer's quality manager for review.

Employer's quality manager shall review the requested waivers and shall approve the same, if considered in his opinion justified with respect to quality, operability and stability of the product/ component.

In case the employer's quality manager feels the requests are not valid he may reject the request in all such cases bidder shall either implement the original specified requirements or submit an alternative scheme and follow the same approval process with the employer's quality manager.

In both above cases bidder shall document the Waiver/Deviation Permit in specified formats as approved by employer and shall submit a copy of all such approved deviations to employer's quality manager. Also Bidder shall maintain the approved waiver log in chronological order clearly mentioning the updated status.

## **14.3 Quality Plan**

### **14.3.1 Manufacturing quality plan:**

Bidder shall submit MQPs (Manufacturing Quality Plans) for various materials and machines in his scope, for which source inspection (Inspection at vendor's site) is applicable prior to manufacturing starts.

Approval of Employer's quality manager shall be mandatory for all MQPs & for commencement of manufacturing for such source inspected material.

Based on the approved MQP the inspection shall be performed.

### **14.3.2 Field quality plan:**

Bidder shall submit FQPs (Field Quality Plans) which includes inspection & test plans for all incoming construction materials (civil / Electrical / Mechanical) and construction works. Approval of Employer's quality manager shall be mandatory for all FQP's before commencement of works.

### **14.3.3 List of Quality plans**

Successful bidder to submit the discipline wise templates, FQPs & MQPs to be deployed, which shall be submitted by the bidder as per his scope for discussion in detail with the employer's quality team during the kick off meeting before implementation.

Bidder shall ensure to get the approval of all the FQPs & MQP's from the employer's quality manager before the implementation.

## **14.4 Quality System Requirements**

### **14.4.1 Deployment of Quality system procedures**

The Employer has detailed processes developed in line with leading practices and are being implemented as part of the project management in the organization.

A project quality plan is developed & approved by the bidder's quality manager and submitted to the employer's quality team; further the employer's quality manager consolidates the same in consensus with all the contractors /bidders at the early stage of the project for preparation of the PQP for the project.

### **14.4.2 Source Approval process for bulk Materials**

The Bidder shall develop list(s) defining the items to be procured by him along with likely Vendors for approval of Employer.

The vendor list shall be in line with the contract document and approved technical specification.

In case, no vendor list exists in the contract for a particular item, the Bidder will propose a list of Vendors for the item.

Bidder has to satisfy himself with the capability of the vendor to deliver the product in time with quality before proposing him as a prospective vendor.

Bidder shall submit the QA/QC plans for all major items and carry out their procurement in line with approved plans.

The Bidder can either provide his own adequate qualified staff for inspection or employ a separate third-party inspection agency to carry out these functions.

***Third-party inspection agency appointed by Bidder shall be subject to approval by employer.***

The scope of Involvement of employer in the inspection activity shall be defined in the quality plan and agreed upon before approval.

All the raw materials which are naturally available and which will be used in the respective works shall be identified by bidder and approved by employer on the request of Bidder.

Bidder shall locate sources of raw materials for all works which conforms to the specified requirements as per approved plan and applicable Codes & Standards.

The source(s) shall be capable of consistently giving good quality materials meeting to the requirements, and supplying without interruption the entire quantity required for the works.

After getting approval of the source/vendor only the material shall be brought to the work site.

Without approval of the source/material/vendor, the material shall not be procured by the contractor or received at the site .

Bidder shall act as required by Employer's quality manager regarding source approval of their construction raw materials which may include joint visit to quarry, borrow areas, and other such source.

Joint sampling & submission of samples to approved laboratory as advised by employer's quality manager is done.

Employer's quality manager is the single point of contact for approval of the source based on satisfactory test results.

In case available raw materials do not comply with the specified requirements bidder shall propose alternate materials, which comply with the technical and quality requirements, and obtain approval of employer's quality manager after demonstration of its suitability by the required tests and submission of reports.

All raw material / manufactured materials shall be procured from Employer's approved sources.

#### **14.4.3 Pre-qualification of Sub supplier**

If there is any deviation from the approved vendor list given in the contract, specific approval from Employer shall be taken in the proper format.

For any bought out items where approved vendor list is not given in the contract and which are readily available in market, reputed vendors/brand/product shall be identified by bidder and approval for the same shall be taken from Employer before their procurement.

## **14.5 Audits**

### **14.5.1 Project Quality & Technical Compliance audit by Employer's Quality team**

Quality audits shall be conducted by employer's quality team periodically for quality and technical compliance for the bidder's scope of work.

Employer's quality team shall intimate bidder regarding the audit /assessment planned and shall communicate the schedule and specific areas of assessment reasonably well in advance.

Bidder shall participate and provide full support to the audit /assessment team and furnish all documents/reports/records as desired by the audit/assessment team.

Employer shall submit audit findings in form of a report, which shall brief the observation with identification of conformance /NC /AOI to the bidder apart from issuing the below reports subsequently.

#### **a) Non Conformance Report**

Where ever there is a strong evidence that the process deviation and or product deviation in terms of Good construction practices (GCP) specific NCR are given to the bidder for planning corrective & preventive measures .

#### **b) Areas of Improvement**

Where ever the auditor /assessor feels the findings are required to be highlighted as they can result in planning "Areas of improvements" the same is identified and formally issued for planning corrective & preventive measures.

#### **c) Conformance**

Where ever the auditor finds conformance the same are highlighted in the audit finding observation.

The bidder shall take all actions required to comply with the findings of the Audit Report and issue regular Compliance Reports for the same to Employer till all the findings of the Audit Report are fully complied.

### **14.5.2 Audit/Assessment by independent person / third party agency**

Employer reserve the right to appoint an independent person/Third Party Agency to conduct systems audit for full/part of the facilities being executed by the employer.

This audit will be in addition to the audits described above and may be carried out intermittently/continuously for all or part of the facilities being executed.

The programme, along with the scope of such audits, will be informed to the bidder well in advance. Bidder shall participate and provide full support to the Audit Team and furnish all documents/reports/records.

Nonconformities identified shall be communicated to the auditees with intimation to Project Manager of Employer.

Auditor shall prepare audit report and submit same to Employer's HQ for discussion.



Root-cause analysis shall be done in discussion with Bidder & Employer's quality manager and corrective actions shall be mutually agreed upon by both auditor & the auditee.

The corrective actions & the target dates shall be communicated to Bidder through proper channel.

Bidder shall ensure that all corrective actions finalized are implemented as required.

Employer's quality manager shall verify the corrective actions and shall intimate the concerned quality auditor about the closure of the non-conformities which shall be verified in the follow-up audit.

***Note: There shall also be unplanned audits & Surveillance based on the requirement by the employer from time to time.***

### 14.5.3 Control of non-conformance

Bidder shall be responsible for identifying and closing all non-conformances with respect to incoming materials as well as construction & installation activities.

NCs shall be broadly classified into two categories namely:

- **Category-I:** (NCs which have direct bearing on structural stability and/or has appreciable impact on cost, quality and time of the project with reference to the end user's requirement).
- **Category-II:** (All other NCs not covered under Category-I. These are basically the noncritical defects which are rectified at verbal/field-note intervention without escalation. These have negligible or no impact on cost, quality and time of the project with reference to the end user's requirement).

Issues of moderate and high criticality shall be reported through NCRs and closed.

Employer shall issue NCR to Bidder in specified format.

The NCR shall be issued to defined recipients depending on the stages/ phases of the project.

The corrective action for each NC shall be proposed by Bidder in discussion with the concerned area manager & project/site head.

The proposed corrective action shall be reviewed and approved by Employer's quality manager.

Corrective action shall be jointly agreed upon by Bidder & Employer mentioning the methodology and timeline of disposition.

Decision & instruction of Employer's quality manager regarding the corrective & preventive actions shall be final and binding on Bidder for closing NCs.

All NCs which demand dismantling of structures shall be done immediately without delay by bidder as per the requirement of the employer's area manager & quality manager.

Wherever inputs of Engineering function are required, for finalizing the corrective action bidder shall obtain engineering inputs duly approved by bidder's project engineering manager and submit the same to the auditor /assessor.

Employer's quality manager shall verify the corrective actions taken and shall validate the closure of the NC if found complying with the agreed terms of NC closure.

Employer's quality manager shall communicate all deductions and hold amounts from Bidder's RA bills with back-up (NCRs, Field notes, inspection reports, e-mails, etc.) through Employer's Execution In-charge.

#### **14.5.4 Non Conformance Reports & Summary:**

All NCRs shall be maintained by employer as mentioned above in a traceable manner.

This shall include the NCRs issued internally by Bidder's Quality function also.

The corrective & preventive actions against each NCR shall be properly documented including the updated status and the closure verification records of Employer in the specified format.

All NCRs shall be closed by Bidder as per the terms agreed upon and shall be as required by Employer.

Bidder shall submit copies of all closed NCRs to Employer's quality manager as soon as they are closed.

Bidder shall maintain a NC log duly updated and submit same to Employer's quality manager regularly as required by him.

#### **14.5.5 Quality certification of RA bills**

Bidder's RA bills shall be subject to quality certification by Employer's quality team at site.

Employer's quality team shall be authorized to hold or deduct suitable amounts from RA bills as per his discretion on account of open NCRs, quality issues, and finishing issues and other defective works or lapses in quality compliance.

All open NCRs which are pending closure beyond specified timelines or not closed satisfactorily as required by Employer's quality team shall attract penalty in form of deduction/hold of suitable amounts from RA bills as decided by Employer's quality.

All the RA bills shall be submitted with relevant reports and certificates, no RA bills shall be processed without relevant reports.

Cost of all tests & inspections conducted by Employer at the cost of, or on behalf of bidder, shall be recovered from Bidder's RA bills for which the amount shall be at the discretion of employer.

### **14.6 Quality Control, Document Management & Submission:**

Bidder shall be fully responsible for all quality control activities including creating and preserving all quality documents to ensure that the entity has fulfilled the requirements for quality.

All such documents shall be in hard as well as soft form, in a traceable manner, duly approved by employer as required by him.

Bidder is required to prepare and submit documents as evidence of the tests & inspections performed and quality of works to employer as per the contract.

This also includes preparation or keying in the required data in the employers system as part of documentation on day to day basis.

All Inspections and QA/QC test records are to be kept up to date by the Bidder and shall be made available to Employer, whenever requested.

These documents shall be handed over to employer by the bidder progressively as well as finally compiled as Project Dossier on completion of commissioning or as required by employer.

As applicable, depending on the nature of the documents, bidder shall obtain approval of Employer of all such documents where joint signature of employer is required.

The documents shall be compiled and submitted to employer's quality manager at a regular frequency as required by him.

With the objective of effective traceability of documents a suitable document numbering system shall be implemented by Bidder in line with the discussion during the Kick-off meeting which shall be applicable for all permanent quality records.

#### **14.6.1 Control of Field Inspection & Testing**

The QA plans for execution (FQP) shall be developed by the Bidder. Employer's approval shall be taken well before start of the work for the same.

The final Inspection & Test Plans (ITPs) shall be developed by Bidder as per contract specifications, drawings, applicable Codes & Standards and shall be subject to approval by Employer.

For the activities which are identified as Witness or Hold point, specific inspection calls shall be raised by Bidder with Employer in the requisite format (RFI) well before time.

Bidder shall be completely responsible for management of approved quality plans and Employer's involvement will be only be limited to surveillance in nature with random check of activities at selective/critical junctures.

Employer's role shall be to monitor that the Bidder is executing the quality plans as per the specified requirements, employing adequately qualified staff and other resources for various items of works.

Any deviation to the specifications shall be brought to the notice of Employer in proper formats by Bidder for approval.

Bidder will carry out tests & inspection, Non-destructive Tests, analyse and obtain acceptability of all materials and construction & installation works in accordance with approved Field Quality Plans (FQP), agreed procedures, specified technical standards & quality requirements and guidelines and shall carry out validation tests as required by Employer from time to time.

**The validation tests may or may not be specified in approved FQP.**

All lab tests and field inspections shall be conducted by Bidder as per the approved FQP in specified methodology and frequency.

Bidder shall intimate all field inspection requirements to Employer's quality personnel in form of RFI (Request for Inspection) for witnessing.

In case Employer's quality manager communicates to waive off the inspection at his level, bidder shall proceed with the work and inspect himself.

In all such cases bidder shall communicate inspection results to Employer's quality manager.

All QC hold points shall be cleared through inspection by Employer's quality team.

No work shall proceed beyond QC hold points unless written clearance is provided by Employer's quality.

No concreting works shall be allowed without approved pour-cards in defined formats duly filled up by Bidder and approved by Construction site engineers/QC engineers of Employer, as the case may be.

Bidder shall stop the work immediately if there is a quality concern detected by him or if instructed by employer quality manager.

Corrective action as required by employer's quality team shall be done within the specified time and the work shall be offered for re-inspection to employer quality team.

For material testing at Field Lab Bidder's quality manager shall directly communicate with employer's quality for witnessing.

In case Employer's quality decides not to witness he shall communicate the same to bidder's quality manager to proceed with the test and the bidder shall communicate such results to employer's quality.

All test & inspection reports shall be properly documented in approved formats and submitted to Employer's quality manager regularly as required by him.

Bidder shall also conduct specific tests through approved agencies (NDT, and other such validation tests) as required by employer's quality from time-to-time and submit reports to him.

Alternately employer may also conduct certain validation test himself at his discretion if required by him.

Such tests shall be conducted with prior intimation to bidders who shall be responsible to provide all infrastructural and incidental support required for successful completion of the tests.

The bidder must arrange & organize the access for employer's representative at any time to place where the equipment is being manufactured or at location where the work is being performed in order to inspect the progress and the manner of manufacturer or construction, provided that the employer gives the bidder reasonable prior notice.

The employer's representative will have the right to examine and have access to documents relating to the manufacture and assembly of the equipment including the quality control and inspection documentation.

In case if any of the system/subsystem/ equipment or any part of work fails to pass any test and inspection, the Bidder must either rectify to the employer's satisfaction or replace such

system/subsystem/ equipment or part of the work and must repeat the test and inspection upon giving a notice.

No part of the work shall be considered to be completed unless and until the required test and inspection required are carried out under this contract and or the quality plan.

Bidder must give reasonable notice to the employer whenever any parts of the works are ready or about to be ready for test and inspection.

If required for re-confirmation the employer may request the bidder to uncover certain works or open up the completed work for inspection & tests.

All such works & openings shall be put in place as per the requirement of the employer's quality engineer and applicable standard & code and or contract.

In certain cases it is likely that the bidder may engage sub-contractor(s)/vendors for enhanced performance of the work, in such cases the sub-contractor(s)/vendors selection shall be done after evaluation by the Bidder in-line with contract requirements and shall be approved by employer's quality team before engaging them for the works.

Bidder shall be responsible for ensuring the implementation of approved QA plan, contract specifications and contract conditions through their sub-contractors to achieve the quality during all stages of construction.

It shall be the responsibility of the Bidder to ensure proper coordination between his sub-contractor(s) and other agencies working at site.

#### **14.6.2 Approved Quality Waivers, Deviation Permits & Design change Note:**

Bidder shall record & maintain all quality waivers & deviation permits in specific formats for the project.

This shall include the **"approved design change notes (DCN) .**

The bidder shall submit the following to the employer's quality team on approval

- The Quality waivers & deviation permits
- Design Change Notes

Bidder shall also maintain a log of all quality deviations and DCNs (both proposed and approved) duly updated and submit the same to employer's quality team as required from time to time.

#### **14.6.3 Drawings and other Engineering deliverables with transmittal:**

All GFC drawings, data-sheets, soil investigation reports, Material Take-off, item-wise Bill of Quantities, and other engineering deliverables shall be submitted regularly by bidder as follows:

- In Format as required by the employer's engineering team.
- GFC drawings shall necessarily be submitted along-with transmittal sheets.
- All engineering deliverables shall be submitted with 6 copies until otherwise specified by the employer's engineering team.

Bidder's engineering team shall also maintain drawing issue records clearly indicating the drawing-wise revisions issued in approved format. Such records shall be regularly submitted to Employer.

#### **14.6.4 Master drawing Index & Document Control Index:**

Bidder shall maintain updated Master drawing Index & Engineering Document Control Index in specified formats as required by employer's engineering team. These records shall be regularly submitted to employer after updating as required by him.

#### **14.6.5 Approved sub-vendor/sub-vendor's list:**

Bidder shall submit list of the proposed sub-supplier specified format for employer's approval.

The profiles of potential sub-supplier shall be submitted by bidder in specified formats.

In case the vendor is previously approved by the employer's organization the bidder shall submit the list of all such approved sub-suppliers, along with Employer's approval note.

#### **14.6.6 Approved material list:**

Bidder shall submit a list "for materials scope" applicable for the project along with Bid.

Bidder shall obtain prior approval of such materials & manufacturers from employer's quality team.

Subsequently Bidder shall submit a comprehensive "list of approved vendors for specific materials" applicable for the project.

#### **14.6.7 Quality Reports**

##### **a) Source inspection reports:**

Bidder shall submit to Employer's quality team all IRs (Inspection Reports) against all stage & final inspections of bought-out materials & machines done at source for all applicable materials as mentioned above in this document.

##### **b) Material Dispatch Clearance Certificate (MDCC):**

Subsequent to source inspections employer's quality inspector shall issue MDCC if materials are cleared in the inspection.

Copies of MDCC shall be maintained by Bidder and shall be sent to site along with each material consignment dispatched.

MDCC shall form a supporting document for billing for the supply wherever applicable as per Contract.

##### **c) Material receipt & Inspection reports (MRIR):**

Bidder shall conduct receipt inspection of all bought-out items received at site irrespective whether it is inspected at source or not.

Receipt inspection shall be done jointly with employer's quality engineer and Bidder shall record the receipt inspection reports in specified format of MRIR.

Bidder shall prepare & submit all MRIRs duly approved by employer's quality engineer regularly as required .

Corresponding MDCC, IRs, Manufacturer Test Certificates & lab test reports as applicable, shall be preserved with proper traceable link as required by Employer.

**d) Field inspection & test reports:**

Bidder shall record and maintain all field inspection & test reports (as per FQP) which shall consist of the following

- Laboratory test reports
- Field inspection reports of various construction activities
- NDT, and all validation test reports conducted by employer

Bidder shall ensure that reports are duly certified by employer's quality & compiled properly and submitted to the employer on a weekly basis, or as required by him.

All such compilations shall be monitored & reported indicating the inspections & tests planned for the period vis-à-vis achieved.

**e) Punch list:**

Punch list is generally a list of un-attended works or minor defects, pending rectification for work nearing completion.

Scope of issuing punch list is covered broadly during pre-commissioning, commissioning and handover/ start-up phases of the project.

During above mentioned phases of work, bidder shall ensure that the punch list is prepared by him internally covering all defects and deficiencies with a schedule of liquidation.

This internal punch list shall be submitted to employer for monitoring of their liquidation.

Further Employer shall also issue punch list to Bidder based on his own inspection. Bidder shall consolidate the list & close all the punch-points (both at mechanical completion as well as commissioning stages)

Bidder shall maintain records of punch list in a traceable manner with their updated status and submit the document to Employer as when required.

**f) As-built drawings:**

Bidder shall submit as-built drawings of all packages on completion of works to Employer's quality team.

Final bills shall be submitted along with As Built drawings and documents. Final As Built drawing shall be available during Final Load trial run of the system.

**g) Quality dossier (Hand-over document submittals) :**

Bidder shall be responsible for submitting a compilation of quality documents required for handing over to User at the end of the project execution.

The contents and format shall be as required by Employer depending on the type of project documentation required to be handed over and other regulatory requirements of Users.

## **14.7 Commissioning Management**

### **14.7.1 Preparation of commissioning plan**

Bidder shall prepare a commissioning plan which shall also include trial run, testing & commissioning schedule in coordination with Employer's Project Manager and Quality-in-charge before the commencement of the commissioning phase and obtain approval of Employer.

The schedule shall be prepared taking into account liquidation of all construction punch-points.

Bidder shall incorporate all quality requirements in the testing & commissioning schedule as required by Employer's quality-in-charge.

### **14.7.2 Mechanical completion**

As soon as the bidder declares the system/subsystem/equipment as mechanically complete, he shall give a notice to the Employer's representative for inspection and punch listing for validating the mechanical completion.

The Employer's representatives shall inspect the works & either issues a certificate compliance/completion stating that the system/subsystem/equipment has reached mechanical completion & notify the Bidder of any defects and /or deficiencies detailing the same as "punch list" as the case may be.

In case of receipt of punch list the Bidder must then correct those defects and or deficiencies shall close all the punch points and offer for inspection by Employer.

The procedures described above must be repeated until the Employer issues a certificate of mechanical completion FORMAT B

After inspection of Employer and receipt of intimation on successful completion of punch points mechanical completion shall be declared by Employer.

The Bidder shall proceed for the pre-commissioning & commissioning process only when all the mechanical completion related documents have been completed including the checklists.

### **14.7.3 Pre-commissioning & commissioning**

Pre-commissioning essentially involves all test & checks which are required to ensure that the system/ sub system /equipment are ready for commissioning. Each compliance confirmation checklist for pre-commissioning is to be designed by the bidder and approved taken before implementation.

### **14.7.4 Commissioning**

Commissioning includes no load, load & the Performance tests be conducted by the Bidder as per approved commissioning schedule to ascertain whether the system/subsystem/equipment can achieve completion and to ascertain whether the facility can meet the performance guarantees.



All performance tests must be conducted in a professional, timely, safe and environmentally responsible manner and in accordance with the schedule of scope of work and the schedule of tests, all other terms and conditions of this contract, applicable standards, laws, government approvals and must be accomplished at no additional cost or expense to the Employer. The system/subsystem/equipment must not be operated during any performance test in excess of the following:

- The limits allowed by any manufacturer to maintain its warranty.
- The limits imposed by the law and government approvals applicable standards.
- The limits stated in the schedule of tests.

If a performance test is interrupted or terminated for any reason, such performance test, must be re started from the beginning, unless otherwise approved by the Engineer in Charge. The Owner or the contractor is entitled to order the cessation of any performance test if any of the following occurs:

- Damage to the works, the facility or other property or personal injury.
- Breach of the conditions specified in the relevant environmental laws or government approvals, is likely to result from continuation.

If the Bidder fails to pass a performance test (or any repetition in the event of prior failure) or if a performance test is stopped before its completion, such performance test shall be repeated subject to 24 hours' prior notice having been given by the Bidder to the Employer and the lenders' representative.

All appropriate adjustments and modifications are to be made by the Bidder with all reasonable speed and at its own expense before the repetition of any performance test.

The results of the performance tests must be presented in a written report, produced by the Bidder and delivered to the Employer's representative within 2 days of the completion of the tests. Those results will be reviewed & evaluated by the Employer's representative for their approval.

After the testing & trial run and joint inspection of Employer and Bidder a commissioning stage punch-list is prepared by the Bidder.

Liquidation and closure validation of same is done in the same process as in case of mechanical completion.

During commissioning of the system manuals, commissioning spares and commissioning protocols shall be submitted.

**Note: Inspection by the Employer's Engineer does not release the Bidder from any other responsibilities & obligations under this contract, including meeting the performance guarantees.**

#### **14.7.5 Project Close Out and hand-over documents**

As soon as the facility has passed the performance tests and the in the opinion of the Employer, the facility has reached the contractor must give a notice to the Employer for issuing a commissioning / completion certificate.

The Employer's representative shall issue a certificate of completion stating that the facility has reached completion after finally inspecting the created facility and the commissioning & acceptance tests reports.

The issue of any certificate of completion in accordance with this clause will not operate as an admission that all the requirements of completion have been met and do not prejudice any of the Employer's rights, including the right to require the Bidder to satisfy all these requirements.

Bidder shall be responsible for compiling and hand-over of all documents as required by Employer in terms of the content and formats. Details have been mentioned in SI . No. 4 . If required by Employer the Bidder shall submit a Project Closure Report for which the contents and the template shall be as required by Employer.

Despite any other provision of this contract, no partial or entire use or occupancy of the site, the works or the facility by the owner, whether during the performance tests or otherwise , in any way constitutes an acknowledgment by the owner that final completion has occurred, nor does it operate to release the contractor from any of its warranties , obligations or liabilities under this contract including the satisfactory performance of its obligations during the defects liability period, the carrying out of the performance tests and meeting the performance guarantees and the emissions guarantee.

Vendor shall submit Four sets of hard copies and soft copies during the handover of the system.

**List of important documents to be submitted by the bidder to the employer's team**

- a) Field Quality Plans
- b) Manufacturing Quality Plans
- c) Engineering Quality Plans
- d) Project Quality Plan/Manual
- e) Construction Management Plan
- f) Project Execution Plan
- g) Engineering Management Plan
- h) Commissioning Plan
- i) Approved Vendor list
- j) Approved material list/Make
- k) Source approval list for all bulk material
- l) Approved Method statements
- m) Approved Level four checklist /templates for recording test results
- n) Approved compliance confirmation checklist including commissioning checklists.

## **15. SURFACE PREPARATION AND PAINTING**

### **14.1 Scope**

This document describes the procedure to be followed for surface preparation, paint application and inspection for MHS (Conveyor and all supporting manufacturing bought outs) structures during Manufacturing and erection.

In case of conflict between this procedure and contract specification the later shall govern.

### **14.2 Reference**

ASTM D 3359, ASTM D 4541, NACE SP0188, IS: 1477-PART-1, PART-2, ISO-12944-4, ISO-8505, ISO-8501-1, ISO-8502-4, Customer technical specification.

### **14.3 Procedure**

#### **15.3.1 Paint Material:**

Paint material shall be identified as per Material receipt inspection procedure and Paint Manufactures shall be as per **Jotun/Akzonobel/Sigma/Hempel**.

Following details shall be checked by QC Inward, before accepting the paint materials.

- Specification
- Manufacturer
- Batch Test Certificate
- Storage life period /Expirydate
- Storage area

#### **15.3.2 List of Hardware**

- Compressor along with hose and nozzles
- Hoppers
- Paint agitators
- Paint spraying equipment

#### **15.3.3 Blast Cleaning-Air Blast Cleaning**

To provide a surface which will ensure optimum coating performance, preparation is required to remove surfaces which have a sharp edge. These include, but are not limited to, plate edges, and plate lamination surfaces.

- Oil or grease, salts, dirt's, chalk marks and similar contaminants shall be removed as far as possible ,prior to surface preparation using an appropriate method in accordance to ISO12944-4.
- Sharp edges, Weld spatter, cavities and deformation are to be removed in accordance with ISO 8501-Table-3.
- Assess the steel surfaces for rust grade as per ISO-8501-1.

- Surface shall be cleaned by abrasive blast cleaning (ISO 12944-4 Cl 6.2.3.1.2) in accordance with ISO8504-2(Cl 5.1.2). Copper slag shall be used for surface preparation. Size of copper slag must be 0.5 mm to 2 mm max.
- External area, surface cleanliness shall be as per Sa2.5 and surface profile shall be 50 to 75 microns in accordance with ISO 8502-4.
- Internal area surface cleanliness shall be as per Sa2 or Sa2.5 and surface profile shall be 40-65 microns depending on the access area. If the area not assessable, then prepare the substrate with St2 or St3 method.
- Surface Salt concentration (e.g. Chloride deposits) shall be 5 µg/cm<sup>2</sup> prior to painting .If the value exceeds acceptable limit, surface to be cleaned using high pressure water cleaning 34-70 Mpa.Washing to be followed by drying and sweep blasting to required standard.
- Abrasive used for blasting should be dry and free from dirt, oil, grease or contamination and have content of water soluble matter not exceeding 0.05%. It's selection for type and size adequate to give required surface finish.
- The abrasive must be capable of producing the standard of cleanliness and surface profile specified (Sa 2.5 and profile of 50 to 75 microns). Visual appearance white metal or near white metal.
- The size of copper slag shall be between 0.5 to 2 mm.
- Abrasives should not be recycled and should not be contaminated with soil.
- The surfaces shall be blast cleaned using abrasives specified above at pressure of 7 kg/cm<sup>2</sup> (100 lbs. per sq. Inch) at appropriate distance and angle depending on nozzle size maintaining constant velocity and pressure.
- Compressed air shall be free from moisture and oil. On completion of blasting operation, the blasted surface shall be clean and free from any scale or rust and must show a grey white metallic luster.
- Blasting can be done up to Rh value of 80% and where the location not met the requirement shall be reblasted to obtain the required surface.
- Primer or first coat of paint shall be applied within 4 hours of surface preparation. Blast cleaning shall not be done outdoors in bad weather without adequate protection or when there is dew on the area which is to be cleaned.
- Surface profile shall be uniform checked by profile gauge and should not exceed the range as specified above or in the contract specification.
- All the machined surfaces are not allowed for blasting and all the machined surfaces to be protected with grease or any appropriate suitable method.
- The surface where set of matching holes (HSFG connection) are observed should be free from paints and following procedure to be followed. (Any doubt the application contractor to clarify from engineer concern prior to start surface preparation)
  - Blast the surfaces as specified above and should be same as job requirement.

- Mask the holes area (HSFG area) by masking tape including adjacent area (Take matching plate size for adjacent area) on both the sides.
- After painting remove the masking tape (Masked area-holes area) and protect the blasted surfaces with polyurethane sheet covered with masking tape on both the sides.
- For splice plates – Blast the surfaces as specified above and should be same as job requirement and protect the blasted surfaces with polyurethane sheet covered with masking tape on both the sides.

**Special Note: Painting not allowed on HSFG connections and Splice Plates.**

## 15.3.4 Painting Application

### 15.3.4.1 Weather Conditions

Surfaces to be coated must have a temperature at least 3 °C (5°F) above the dew point, immediately following blasting and priming, intermediate and top coat application, and must also remain in this condition during curing of the coatings.

As a guide, relative humidity levels of 25-80 % give optimum painting conditions, although some applications may be carried out up to 85 % relative humidity.

Painting should not carry out during windy conditions.

### 15.3.4.2 General Site Conditions

Prior to any work being carried out there are a number of conditions which must be met.

#### a) Cleanliness

Any contaminants which may come in contact with the substrate (even before surface preparation comments) can compromise the performance protective coating system, and as such all effort must be made to keep the working area clean. It is good working practice to establish a clean area where painting is being done. Cleanliness must be maintained throughout all stages of the application.

#### b) Weather Shelters

Weather shelters should be made available to cover application equipment during mixing and application of material.

#### c) Paint storage facility

All paints should be stored ideally between 10 °C (50°F) and 30°C (86°F) and facilities may be needed to store the materials in correct temperature range prior to mixing and application.

### 15.3.4.3 Stripe Coating

Stripe coating is an essential part of good working practice, and stripe coats are highlighted in the detailed product specification sheets.

Stripe coats are applied to areas where it is difficult to get the required coverage including but not limited to:

- Plate edges
- Difficult access areas
- Weld area.

Strip coats are normally applied to a specified firm thickness range via a combination of narrow angle airless spray and brush methods. Over coating intervals for the s t r i p e coats should be strictly adhered to as per individual product data sheet.

#### 15.3.4.4 Painting System

##### 15.3.4.4.1 External Surface

For Painting system for external, the surface profile should achieve 50 to 75 microns

Primer Coat –External-1 x 75  $\mu$

(Two Component Zinc Rich Primer Based on Zinc Powder, Epoxy Resin and Polyimide-90% Zinc Content.)

Application: Airless Spray or Pressure pot (1:45 airless machine would be ideal)

Mixing Ratio: 4:1 by volume (Base: Hardener)

Mixing the base using a power agitator Add C/A slowly during mixing and mix well for 5 minutes. Ensure complete mixing of base and C/A. If 10 litres complete mixing is not possible then proper measuring jars should be employed to ensure accuracy.

##### **For Airless Spray**

- Tip size 0.43-0.53mm (17-21 Thou).
- Output fluid pressure at spray tip: Not less than 176 kg/cm<sup>2</sup> (2500 PSI).
- Thinner (use only when required).Do not thin more than 10 %.
- Check WET during application using comb gauge.
- For 75 $\mu$  DFT the WET shall be 125 $\mu$ .Check and record.
- For air assisted spray application following WET film thickness to be maintained for various thinner quantities.

Over coating interval –min 8 hrs and max extended @25 °C. This will changed on the environment condition. (For complete details of the product we need to refer the product data sheet).

##### **a) Intermediate Coat –External-1 x 150 $\mu$**

(Two Component High Build Epoxy Polyamide polymer MIO coat)

Application: Airless Spray or Pressure pot (1:45 airless machine would be ideal)

Mixing Ratio: 4:1 by volume (Base: Hardener)

Mixing the base using a power agitator Add C/A slowly during mixing and mix well for 5 minutes. Ensure complete mixing of base and C/A. If 20 litters complete mixing is not possible then proper measuring jars should be employed to ensure accuracy.

- For Airless Spray
- Tip size 0.53-0.66mm (21-25 Thou).
- Output fluid pressure at spray tip: Not less than 176 kg/cm<sup>2</sup> (2500 PSI).
- Thinner (use only when required).The Thinner consumption should not exceed more than 20 %.
- Check WET during application using comb gauge.
- For 150μ DFT the WET shall be 188μ. Check DFT and record.
- Over coating interval –min 5 hrs and max extended @25 °C. This will be changed on the environment condition. (For complete details of the product we need to refer the product data sheet).

**b) Top Coat –External-1 x 70 μ (2X35 Micron may be apply as per employer instruction)**

(Two component Top Finishes based on aliphatic acrylic polyurethane and hydroxyl containing resins.)

Application: Airless Spray or Pressure pot (1:45 airless machine would be ideal)

Mixing Ratio: 6:1 by volume (Base: Hardener)

Mixing the base using a power agitator Add C/A slowly during mixing and mix well for 5 minutes. Ensure complete mixing of base and C/A. If 20 liters complete mixing is not possible then proper measuring jars should be employed to ensure accuracy.

**For Airless Spray**

- Tip size 0.33-0.45 mm (13-18 Thou).
- Output fluid pressure at spray tip: Not less than 155 kg/cm<sup>2</sup> (2205 PSI).
- Thinner (use only when required).The Thinner consumption should not exceed more than 10 %.
- Check WET during application using comb gauge.
- For 70μ DFT the WET shall be 122μ. Check DFT and record.

Over coating interval –min 6 hrs and max extended @25 °C. This will be changed on the environment condition. (For complete details of the product we need to refer the product data sheet).

**Total DFT= 295 Microns Min , Tolerance +10%, No negative tolerance acceptable.**

#### 15.3.4.4.2 Internal surface

(Applicable for box/closed structure surface profile 40 to 75 microns and wherever non accessible areas the surface profile to achieve minimum 40 microns)

**Primer Coat –Internal –Surface Tolerant Primer with Aluminium pigment -1 x 100 μ**

Application: Airless Spray or Pressure pot (1:45 airless machine would be ideal)

Mixing Ratio: 5.67:1 by volume (Base: Hardener)

Mixing the base using a power agitator Add C/A slowly during mixing and mix well for 5 minutes. Ensure complete mixing of base and C/A. If 10 litres complete mixing is not possible then proper measuring jars should be employed to ensure accuracy.

**For Airless Spray**

- Tip size 0.45-0.58mm (18-23 Thou).
- Output fluid pressure at spray tip: Not less than 176 kg/cm<sup>2</sup> (2500 PSI).
- Thinner (use only when required). Do not thin more than 10 %.
- Check WET during application using comb gauge.
- For 100  $\mu$  DFT the WET shall be 145 $\mu$ . Check and record.
- For air assisted spray application following WET film thickness to be maintained for various thinner quantities.

Over coating interval –min 10 hrs and max extended @25 °C. This will be changed on the environment condition. (For complete details of the product we need to refer the product data sheet).

**a) Intermediate Coat –Internal -1 x 150  $\mu$**

(Two Component High Build Epoxy Polyamide polymer MIO coat)

Application: Airless Spray or Pressure pot (1:45 airless machine would be ideal)

Mixing Ratio: 4:1 by volume (Base: Hardener)

Mixing the base using a power agitator Add C/A slowly during mixing and mix well for 5 minutes. Ensure complete mixing of base and C/A. If 20 liters complete mixing is not possible then proper measuring jars should be employed to ensure accuracy.

**For Airless Spray**

- Tip size 0.53-0.66mm (21-25 Thou).
- Output fluid pressure at spray tip: Not less than 176 kg/cm<sup>2</sup> (2500 PSI).
- Thinner (use only when required). The Thinner consumption should not exceed more than 20 %.
- Check WET during application using comb gauge.
- For 150  $\mu$  DFT the WET shall be 188 $\mu$ . Check DFT and record.
- Over coating interval –min 5 hrs and max extended @25 °C. This will be changed on the environment condition. (For complete details of the product we need to refer the product data sheet).

**Total DFT= 250 Microns Min , Tolerance +10%, No negative tolerance acceptable.**

## **15.4 Inspection**

Following points for Inspection and checking shall be taken into Account.

Application Contractor to carry out stage wise Inspection before proceeding with the next stage.



Application contractor to Maintain daily log book for the following

- Air temperature
- Humidity condition
- Surface roughness
- Pressure at out let.

Surface preparation can be inspected with the help of comparator by comparing the visual picture shown in the ISO 8501-1:1988. For measuring the profile of the surface, profile meter will be used. The profile shall be within the permitted range as specified above.

All painting materials shall be accompanied by manufacturer's test certificates. Paint formulations without certificates are not acceptable. The painting work shall be subject to inspection by Engineer-in-charge/Paint manufacturer representative at all times. In particular, following stage wise inspection will be performed and application contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage.

Stages of inspection are as follows:

- Surface preparation
- Profile Verification with Surface Comparator
- Primer application
- Each coat of paint
- WFT (wet film Thickness).

Any defect noticed during the various stages of inspection shall be rectified by the application contractor to the entire satisfaction of Engineer-in-charge/paint manufacturer representative before proceeding further.

Wet Film Thickness and Dry film thickness (DFT) shall be checked and recorded by application contractor after application of each coat in the painting log book and mist coat can be applied to get the required DFT. (Minimum 10 Nos reading of DFT shall be verified for each one sq. Meter area.)

The following test needs to be conducted by Paint manufacturer along with application contractor for conformity at the yard.

- Dry Film thickness (Maximum of +20 % from the specification is acceptable) and DFT reading to be recorded.
- Cross cut adhesion test based on ASTM D 3359.
- Random Pull off Adhesion tests based on ASTM D 4541, as per employer recommendation.
- Salt Contamination test at Random as per employer recommendation.
- Random Holiday Detection test based on NACE SP0188, as per employer recommendation.

## 15.5 Repair Procedure

The repair procedure recommended will depend upon the extent of damage involved but can be split into:

- Repairs of Major /Minor areas when the primer paint is affected.
- Repairs when primer is intact & the second coat is damaged.
- Repairs when primer and second coat is intact but the third coat is damaged.

### 15.5.1 External:

#### a) Repairs of Minor/Major areas when the primer paint is affected.

A major repair should essentially be dealt with as if the project were beginning. The recommendations given earlier for steel preparation, coating application etc., must all be adhered to. The original complete coating scheme should be applied. This is specific when the primer is damaged.

- After ensuring necessary surface preparation as above.
- Apply Primer, Intermediate and Final coats same as specified in original system.

#### b) Repairs when primer is intact and the intermediate coat is damaged.

Under this heading are repairs to areas damaged either at the initial coating stage or caused during service. Mechanical damages, handling damages etc, the principle requirements are

The area to be repaired must be fresh washed and dry.

Remove any corrosion by means of either:

- Vacuum blasting
- Hand tool i.e. Disc sander and grinder.

Abrade area immediately surrounding repair to provide key for subsequent paint application.

Apply suitable repair primer (High build epoxyprimer MIO with Aluminium pigment) to 150 microns and final paint to 70 microns.

If small areas are involved and application is by brush, several coats may be required to achieve the correct dry film thickness. If the area is large then airless/air spray has to be employed. A full recoat would be required to maintain aesthetics.

#### c) Repairs when primer and intermediate coat is intact but the finish coat is damaged.

Under this heading are repairs to areas damaged either at the initial coating stage or caused during service, mechanical damage, handling damages etc, the principle requirements are;

- The area to be repaired must be fresh water washed and dry.
- Remove any corrosion by means of either
  - Vacuum blasting
  - Hand tool i.e. disc sander and grinder.

Abrade area immediately surrounding repair to provide key for subsequent paint application.

Apply suitable repair primer (High build epoxyprimer MIO with Aluminium pigment) to 75 microns and final paint to 75 microns.

If small areas are involved and application is by brush, several coats may be required to achieve the correct dry film thickness. If the area is large then airless/air spray has to be employed. A full recoat would be required to maintain aesthetics.

### **15.5.2 Internal**

**a) Repairs of Minor/Major areas when the primer paint is affected.**

A major repair should essentially be dealt with as if the project were beginning. The recommendations given earlier for steel preparation, coating application etc., must all be adhered to. The original complete coating scheme should be applied. This is specific when the primer is damaged.

After ensuring necessary surface preparation as above.

Apply Surface tolerant Primer and Intermediate coats same as specified in original system.

**b) Repairs when primer is intact and the intermediate coat is damaged.**

Under this heading are repairs to areas damaged either at the initial coating stage or caused during service. Mechanical damages, handling damages etc, the principle requirements are;

- The area to be repaired must be fresh water washed and dry.
- Remove any corrosion by means of either:
  - Vacuum blasting
  - Hand tool i.e. Disc sander and grinder.

Abrade area immediately surrounding repair to provide key for subsequent paint application.

Apply suitable repair primer (High build epoxyprimer MIO with Aluminium pigment) to 150.

If small areas are involved and application is by brush, several coats may be required to achieve the correct dry film thickness. If the area is large then airless/air spray has to be employed. A full recoat would be required to maintain aesthetics.

## **15.6 General Precautions**

The following precautions to be followed by Application contractor

- Thinner will be used as per Manufacturer recommendation.
- Type of thinner will be used as per manufacturer's recommendation
- The left out paint will be preserved in a drum with tight cover.
- Only paint brands and colour as per customer approved painting schedule shall be followed for painting.

- Material test certificate for each batch of primer and paint will be submitted for review.
- In addition to above recommendation the paint manufacturer's recommendation also shall be considered for mixing, thinning, storage, application of paint, drying time and weather condition.
- If there is rain just after application, before drying then protection will be done by covering tarpaulin.
- **Area not to be painted, like HSFG connection and Site weld joints of the product.(PAINTING NOT ALLOWED IN THIS AREA)**
- Surface shall not be coated in rain, wind, fog, mist or in areas where injurious air borne elements exist. When the steel surface temperature is less than 3 °C above dew point, and when the relative humidity is greater than 85%, the surface shall not be coated.
- Blast cleaned surfaces shall be coated with one complete application of primer as soon as practicable or within 4 hours after the surface blasted.
- Each coat shall be in proper state of dryness before the application of primer as soon as practicable but in no case later than the same day as sandblasted.
- Each coat shall be in proper state of dryness before the application of succeeding coat.
- Paint film thickness shall be maintained as specified in painting schedule and the painted surface shall be within allowable defects as specified above.
- All runs and sags shall be brushed out immediately or the paint shall be removed and surface re-painted.

#### 15.6.1 Safety Cautions:

- PPE shall be used during blasting and painting operations.
- Paint material shall be kept away from hot work areas.
- Material data sheets shall be made available at all times in the working area.
- Required permits shall be obtained during work progress.

### 15.7 Over Coating Interval

The coating has been applied at the normal recommended thickness.

Environmental condition both during and after applications were as recommended for that particular coating, especially in respect of temperature, relative humidity and ventilation.

The condition of the primer coating to be over coated must be in intact, tightly adherent, clean, dry and free from all contaminants. It should be recognised that the level of inter-coat adhesion obtained is also dependent upon the chemistry of the top coat.

If the over coating interval exceeds after 1st coat, whether it a repair or large area needed to prepare the substrate by ST2 or ST3 and apply the 2nd coat system.

Over coating intervals must be as per manufacturer recommendations only.

## 15.8 Acceptance Criteria

- Salt Contamination :  $\leq 5 \mu\text{g}/\text{cm}^2$
- Pull off Dolly Values :  $\geq 5 \text{ MPA}$  (ASTM D4541)
- Cross Hatch Test : Min 4 A Trace peeling or removal along incisions or at their intersection (4A rating as per ASTM D3359)
- Holiday Test : No holiday should present on the substrate.

## 15.9 Certification

Continuous Monitoring and inspection of surface preparation and painting shall be done by paint manufacturer.

Paint manufacturer to deploy competent and qualified personnel for inspection as specified in the above procedure also paint manufacturer to perform necessary testing as specified in the above procedure with free of cost.

Paint manufacturer to certify the each and every product conformity of surface preparation and painting.

- a) Employer approved all drgs/data sheets/ Tech specification/QAP/ITP/Check list/ protocol etc.
- b) This Procedure/QAP is for reference only, above requirements are minimum requirements. Specific requirements shall be included at the time of finalization of specific QAP/Procedure submitted by vendor.
- c) This procedure/QAP shall be read in conjunction of relevant standards/Codes/Specification/Employer approved QAP/ITP/Procedure /Drawings/Datasheets /protocol/Contract technical specification/any communication/Good engineering practices adopted by world wise best industries.
- d) In case of any conflict only stringent references and acceptances, standards & codes shall be applicable
- e) In case any dispute or conflict employer decision will be the final decision, will be taken on the basis of practices adopted by world's best industries for the same product/component/activity delivery.
- f) This QAP/Procedure is subjected to change in case of any significant change observed in material requirement, operational requirement and specification requirement.

## **16. ERECTION, PERFORMANCE TEST & COMMISSIONING**

### **16.1 Responsibility of Contractor:**

The contractor shall make following arrangement (but not limited to) during Erection, No Load Test, Load Test, Performance Test and Commissioning of system, O&M Training and Handing over of the system;

- a) All kinds of required manpower including operational staff starting from Erection till completion of Performance Test.
- b) General and special Tools and tackles.
- c) Construction Power.
- d) General and special equipment(s) and vehicles starting from Erection till completion of Performance Test.
- e) Front End Loader & Dumpers with operator and fuel duration of Load Testing, Commissioning and Performance Test.
- f) Testing kits & equipment(s) throughout the project.
- g) Required drawings and documents.
- h) Charges for required statutory clearance i.e. Railway clearance for commencing of operation etc. as per requirement starting from Design till commence of Railway operation, will be reimbursed to the contractor by DPA during the contract period, on actual basis, on production of original receipts & documents of the authority. The same should be in the name of DPA.
- i) Required illumination at site.
- j) Required utilities and welfare facility at site.
- k) Communication arrangement at site.
- l) Transportation arrangement at site.
- m) HSE and Emergency requirement at site including Ambulance (Emergency vehicle) and First Aid Kits.
- n) It will be responsibility of contractor to arrange the Cargo for internal testing and Load testing of the System. However, in case, employer i.e. Deendayal Port Authority arranges the cargo and rakes for internal & load test depending on the availability, the contractor has to bear any penalty / demurrages arises (if any) due to failure / non-performance of the system / plant / equipment. Also refer Clause no-16.2 (f).

### **16.2 Responsibility of Employer:**

The employer shall make following arrangement up on request and satisfactory compliance from the contractor and in line with the terms of the contract;

- a) Permission of site access to the Contractor personals.
- b) Work permit to the contractors.
- c) Main Electrical power supply at 66kV Switch Yard;
  - For charging and testing of substation and electrical equipment(s) after installation.

- Operational power supply for No Load Testing, Load Testing, Performance Test and Commissioning of System and O&M Training.
- d) Water supply at Battery limits tapping point.
- e) Ensure timely deploying of Employer personals for necessary inspection and monitoring at appropriate milestone or as per request from the contractor and in line with the terms of contract.
- f) Arrangement of Cargo during Internal & Load Trials: Upon successful completion of installation, Dry / No Load Test of entire system, for Internal tests and Load testing, the sufficient cargo will be arranged by the EPC contractor on prior approval of employer. However, in case, employer i.e. Deendayal Port Authority arranges the cargo for Internal & Load tests depending on the availability, the contractor has to bear any penalty / demurrages arises (if any) due to failure / non-performance of the system / plant / equipment. After load-tests, for Performance test with minimum 03 full ship as in proposed tender docs, cargo would be arranged by DPA by directing the 03 Nos. Ship of full fertilizer (as per availability) to Berth No.14. In this case also, the contractor has to bear any penalty / demurrages arises (if any) due to failure / non-performance of the system / plant / equipment and same will be deducted from the contractor payment. The contractor shall ensure unloading of cargo from vessel as per Port / Employer guideline and predefine time line. In case of any penalty related to cargo wastage, contamination etc. from Cargo importer during Load Trials, and Performance Test same will be pass on to the contractor.
- g) Arrangement of Railway Wagon Rake for testing of Cargo Evacuation Mechanization System: Upon successful completion installation, Dry / No Load Test & Load tests of entire system, the contractor shall give written request for requirement of Railway Wagon Rake with detail schedule (including numbers of Rake) for Performance Tests. Traffic Deptt. of the employer will arrange the Railway Wagon Rake from Railway Authority based on availability at Berth-14 back-up yard. The contractor shall ensure readiness of Railway work, statutory clearance for starting Railway Operation. The contractor shall also ensure cargo bags loading into Railway wagon as per Port / Employer & Railway guideline and within stipulated time line. It is to be noted that in case of delay in Rake Wagon Loading and releasing of Rake from Berth-14 back-up yard due to system fault, breakdown etc. or any reason which is not attributed to Employer, applicable demurrage / penalty charges will be charged to the contractor and same will be deducted from the contractor payment.

### 16.3 Erection

- The Contractor shall submit Construction, Erection & Commissioning Schedule along with list of Erection Equipment / Machinery / Tool / Tackles etc., to the Employer for their review/approval, prior to commencement of above work at Site. The Contractor shall strictly adhere to the approved Construction & Erection Schedule.
- All equipment under storage/erection shall be in the custody of Contractor's Watch and Ward. All equipment/material shall be taken care of by the Contractor himself.
- Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour, supervisor for erection & construction work and all other items/fittings etc. required for completion of his work. The required operators and personnel including watch and ward personnel, up to handing over of the

system to the Employer shall be provided by the Contractor as per the site requirement.

- After installation of the entire System at site, each equipment/ item shall be thoroughly checked & inspected for correctness and its completion.

## **16.4 Field Tests**

### **16.4.1 Tests**

The tests shall comprise the following but not limited to:

- o) Equipment / Unit assembly test.
- h) Adjustments, alignments and settings.
- i) Satisfactory completion of No Load Tests for each equipment's in the system.
- j) Final operational tests such as Performance Test and Commissioning of System.
- k) For carrying out tests, readiness of works supplied by other Contractor(s) interfaced with the equipment to be tested will be essential.

Before any electrical system is put to use, the Contractor shall carry out the tests, as detailed in Electrical section, to the satisfaction of the Employer.

### **16.4.2 General**

Contractor(s) shall be responsible for testing individual components / equipment, commissioning of the system as a whole.

For the period of adjustments and setting, the Contractor(s) shall provide services of adequate number of teams of personnel which shall include, but not be limited to, Engineer, foremen, fitters, welders, electricians, etc., who apart from their technical experience are well acquainted with all the machinery and equipment.

All tests shall be carried out in the presence of the Employer and any corrections found necessary shall be approved by the Employer and the Contractor(s) shall be responsible for producing all necessary work sketches and drawings for the approval of the Employer. The Contractor(s) shall be responsible for obtaining the services of sub-contractors (as and when necessary).

Final operational tests by the Contractor(s) with the cargo will depend on the availability of material and interfacing equipment/system falling under the scope of the EPC contractor. The Employer will set the date for operational tests after receipt of the notice (s) from the Contractor(s) and the Contractor(s) will be informed of this date in advance. The Contractor(s) shall be responsible for any adjustments or corrections found necessary during these tests.

Employer will ensure that interfacing equipment/system (by others), are ready to work in conjunction with the system falling under the scope of the Contractor(s).

The Contractor(s) shall be responsible to coordinate/exchange of technical inputs, as may be found necessary during load trials with the other Contractors.

Interruption/delay due to malfunctioning/adjustments in the system by other Contractor(s)



during commissioning may occur. The Contractor(s) shall account for such interruptions/delay during the tests (except the Performance Tests).

The Contractor(s) shall during the period of Field Tests instruct the Employer's staff in the operation of the conveyor system and acquaint them with the adjustments that are made. The Employer's staff shall be given reasonable opportunity to become conversant with the operating features of the equipment.

### **16.4.3 Adjustments**

Contractor(s) shall be responsible for all necessary alignment and adjustment of machinery and equipment to obtain efficient operation.

All critical and specialized adjustments shall be carried out in the presence of the Employer. Procedures and necessary precautions in regard to such adjustments shall be conveyed to the Employer in writing.

Special attention shall be given to final adjustment of:

- Load sharing by individual drives
- Brakes, Back-stops (if any), couplings
- Lubrication System
- Various interlocks and safety devices
- Proper tensioning of take-up arrangement
- Belt training

### **16.4.4 No Load Tests**

- Employer shall provide electricity for conducting the no-load tests at single point (Proposed Substation). However, contractor need to give written requirement for power supply in advance to Employer with reports of completion of installation work, testing and necessary statutory approval from respective Government Body and employer personal.
- After completion of the erection the works under this contract shall be tested. The facility shall be run without load and all necessary adjustments shall then be completed. The no load tests are intended to demonstrate that all components will function successfully, separately and as components of an integrated facility in accordance with the requirements of the contract documents.
- After completion of erection, the entire system shall be tested individually and with related equipment by the respective Contractor(s) (in case of more than one Contractor). The system shall be operated ensuring that individual equipment supplied under the contract are functional while operating in conjunction with equipment.
- Each individual equipment shall be checked for the No load trial for 4 hrs minimum. Transformer shall be charged and put for No load test for 24 hrs.
- No load trials of system (individual or in group) shall be checked for 08 (eight) hrs with all safety device in place and with the communication established. No load test

of 08 hrs to be taken with the vibration, temperature and relevant current, feed rate data.

#### **16.4.5 Load Tests**

Load Tests shall be undertaken in two phases:

##### **a) Phase A (Without Cargo)**

System testing of all components shall be conducted as a dry run. Each system or component shall first be run individually under manual control, then in automatic mode to check interlocks and the associated schematics, if any.

At this stage each equipment shall be completed in all respects excluding minor items like painting, etc.

##### **b) Phase B (With Cargo)**

When Phase 'A' is completed to the satisfaction of the Employer, the Employer on being intimated by the Contractor and subject to all statutory clearances obtained by the Contractor(s), Cargo shall be furnished by the EPC Contractor (Also refer Clause 16.2 (f) above) and the equipment / facility interfaced with the conveyor system for carrying out the following tests:

- Wherever possible, all equipment's shall be tested independently / simultaneously. Contractor to show the capacity test with respect to design. Graphical representation shall be submitted for the reference document. Load test of 08 hrs to be taken with the vibration, temperature and relevant current, feed rate data.

If the Employer's obligations under the above sub-clause are fulfilled, Contractor(s) shall commence Load Trial under the supervision of the Employer. The Contractor will be responsible for co-ordination with all Contractors concerned.

Load Trial by the Contractor(s) shall include but not necessarily be limited to the following:

- a) Check that all system is complete, clean and clear of obstructions and ready to test.
- b) Limit switches checked for location and that they operate satisfactorily adjust as necessary.
- c) Conveyor belts to be run and tracking of belt checked and corrected where necessary.
- d) All controls, monitoring devices, safety devices, visual and audible indications, etc., to be tested for successful operations.

However, a detailed programme for testing shall be submitted by the Contractor for Employer's approval including, check sheets, data log sheets etc.

Records shall be kept of the tests carried out, faults/defects noticed and corrections made, and four copies of such records shall be submitted to the Employer by the Contractor.

In the event of the equipment put into commercial use before the actual commissioning / completion of work as per the Contract, the Contractor shall be eligible for substantial completion. However, a pre-defined period (say 2 months) shall be granted to the contractor to complete the balance minor works as per the list of pending works as on the date of substantial completion. If the contractor completes all the works within the predefined period, the date of taking over shall be the date of substantial completion. Otherwise date of taking over shall be date of completion of all works.

#### 16.4.6 Performance Test and Commissioning of the System:

Contractor shall prepare and submit the Detail Performance Test Procedure and methodology including Check lists, Data Log sheets, resource plan etc.

- a) Performance Test shall be conducted within Two (2) months from the date of successful completion of Load Test. Performance tests shall be equivalent to 3 full ship load of cargo.
- b) When the facility has operated under stable conditions, the Contractor(s) shall give the Employer a notice that the Facility is ready for Performance Test.
- c) Performance tests shall be conducted as per the mutually agreed testing procedure.
- d) Immediately after the notice above, the Performance Test shall be conducted by the Contractor(s) provided it is agreed by the Employer.
- e) The Performance Test shall be carried out in parts, if required.
- f) After successful completion of the Performance Test the Contractor(s) shall give Notice to the Employer for Taking-over with a copy to the Employer.
- g) During Performance Testing, the Contractor shall ensure that the material handling system shall deliver the guaranteed discharge as given below, in case of shipping stream is achieved for 8 continuous effective working hours. Continuous 8 hours means a period of 8 effective working hours excluding minor stoppages.

Sr.No.	System Description	Desire Output
1	Ship Unloading - Receiving conveyor system – Stacking/ Bagging in Godown for 3 (three) full ships.	2200 TPH
2	Bagging & Stitching machines for Wagon loading of 4 nos (four) of Rakes.	1200 Bags of 50 Kg / Hour
3	Flat Belt conveyor and Wagon Loading System for 4 nos (four) of Rakes	One Full Rake to be loaded in 4 hrs with 1 hr for pre and 1 hr for post operations i.e., total 06 hrs.  Total 4 Rakes to be loaded using Wagon loading system installed on either sides of the Godown.

- h) Levels of Performance Guarantee acceptable by the Employer and commercial implications arising due to non-fulfilment of the Performance Guarantee shall be as under:

Sr.No.	Performance Parameters	Penalty
--------	------------------------	---------

1	For an average output of not less than 90% of the 100% guaranteed discharge.	NIL
2	For an average output of less than 90% and not less than 85 % of the 100% guaranteed discharge.	0.2% for every 1% reduction from the 100% guaranteed output
3	For an average output of less than 85% and not less than 80% of the 100% guaranteed discharge.	0.25% for every 1% reduction from the 100% guaranteed output.
4	For an average output of less than 80% and not less than 75% of the 100% guaranteed discharge.	0.3% for every 1% of reduction from the 100% guaranteed output.

**Note:** Above Penalty will be in addition to the levy of demurrage etc., if any, levied by the Indian Railways / any other authorities.

- i) If the capacity achieved during the performance test is less than 75% of the guaranteed Capacity, the Employer will be entitled to reject the equipment/ system and claim refund of all the payments received by the Contractor together with interest thereon. However, the Employer shall not be entitled for any consequential or indirect damage.
- j) The above test will be carried out by the Contractor in the presence of the Employer.
- k) After successful completion of the Performance Test, the Contractor shall give Notice to the Employer for Taking-over of the Material Handling System with a copy to the Employer.
- l) Within 10 days of the Notice to the Employer for Taking-over, the Employer shall list out the minor shortcomings, if any. These shortcomings have to be set right by the Contractor without any cost implications to the Employer within an agreed schedule.
- m) Employer shall issue "Commissioning/Taking-over Certificate" to the contractor after successful completion of Performance Test and compliance of Quality, Quantity and Contractual requirement mentioned above and employer satisfaction.
- n) Subsequent to the 'Commissioning/Taking-over Certificate' of the Material Handling System under this Contract to the Employer, the Performance Guarantee will be applicable.

**Notes:-**

- a) Detail procedure for the performance test shall be prepared by contractor and submitted to Employer for approval.
- b) Performance Test shall be done with minimum man power requirement considering normal (routine) operation scenario.
- c) Generally minor shortcomings shall be those which, according to the Employer shall not affect safe operation and achieving peak output. Items which could be considered 'minor' would depend on the nature of malfunctioning and such decisions shall be taken solely by the Employer after completion of the Performance Tests.
- d) While conducting the tests mentioned in this section/specification and/or any other test(s)

mutually agreed upon prior to the beginning of such test, the performance of other systems like, field devices, etc., shall also be tested both in manual control and in central-control modes, as long as the connected system will be in operation.

- e) The Contractor shall arrange for responsible representatives and competent engineers to be present throughout the tests.
- f) The Contractor shall have the option to carry out the tests/trials/handling of cargo during non-tests/trial period upto taking-over mentioned herein either entirely with his own personnel or assisted by the Employer's personnel. In either case Employer shall be informed in advance.
- g) All materials and equipment which fail the tests during various tests shall be replaced by the Contractor without any extra cost to the Employer and the tests shall be repeated on the new equipment/item unless it is agreed otherwise by the Employer. All instruments and tools required for tests shall be supplied by the Contractor at no extra cost to the Employer.
- h) Weigh Scales shall be used for weighment record unless agreed otherwise by the Employer. The Weigh Scales will be calibrated and Stamping certificate to be obtained from Legal Metrology, Weights & Measure Deptt. Govt. of Gujarat, prior to commencement of the Performance Test. The Employer at their discretion may get the Weigh Scale recalibrated by the Contractor/Supplier either during the Test or at the end of the Test. The Employer at their discretion may take note of the corrective factor for calculating the capacity of the respective equipment during Performance Guarantee Test.
- i) In case, in the assessment of the Employer, the tests are unreasonably delayed or prolonged after commencement of testing, the Employer may discontinue the tests and instruct the Contractor to reschedule fresh tests.

## **17. TIME SCHEDULING, PROGRESS MONITORING, COST CONTROL & DOCUMENT CONTROL:**

### **17.1 Introduction:**

This section of tender document indicates employer's minimum requirement in terms of Time Scheduling, Progress Monitoring, and Document Control etc. Requirements indicated in this document are minimum and indicative only. Employer may, at any stage of the project, add further requirement or alter these requirements on above aspects of the project management and contractor shall adhere to all such requirements without any kind of resistance / claim of whatsoever nature.

### **17.2 Key Dates and timelines:**

Contractor shall, at all times, put all their efforts to adhere to the project timelines and key dates defined in the project schedule. Contractor shall provide to employer information about status of and issues related to such key dates during various project progress reporting.

Overall completion timelines for this package is **15 months** from effective date of contract. Contractor shall prepare detailed project schedule based on provided timeline.

### **17.3 Contractor's deliverables:**

This clause is pertaining to contractor's deliverables. Contractor shall submit various kinds of deliverables during execution of the project for employer's approval / review / records etc. purpose. Contractor shall submit all the deliverables as specified by employer in this tender document without any deviation.

### **17.4 Level of schedules:**

Contractor shall prepare integrated project schedule in MS Project Latest version software. Contractor shall share native file of the project schedule with employer minimum on monthly basis. Contractor shall prepare the schedule based on schedule hierarchy agreed with employer.

As a general guideline, contractor shall prepare milestone level L1 schedule and submit the same for employer's review within 15 days of award of the contract. Milestone level L1 schedule should be submitted to employer at least 2 days prior to the project kick off meeting. Contractor shall prepare Early Work Schedule covering various activities including mobilization, infrastructure setup, approvals, engineering, procurement and construction function to be taken up for immediate execution till next level (L3) of schedule is finalized. Early Work Schedule will form the basis for project monitoring till next level of schedule is in place. Contractor shall prepare and submit Early Work Schedule for employer's review within 15 days of kick off meeting.

Contractor shall prepare WBS level L2 schedule within 15 days of kick off meeting and submit the same for employer's review. Contractor shall prepare activity based L3 schedule within 60 days of kick off meeting and submit the same for employer's review. Contractor shall prepare activity level, quantity loaded L4 schedule within 90 days of kick off meeting and submit the same for employer's review.

## **17.5 Milestones – project & interface**

Over all completion timelines for this package is 15 months from effective date of contract. Various milestones shall be defined for this package. As a minimum requirement, 3 to 4 key milestones per month covering Engineering, Procurement, Construction and Commissioning activities should be defined, monitored and reported by the contractor during all kind of progress reports / review meetings. Contractor shall prepare their details project schedule based on these key dates.

Apart from these milestones, a detailed milestone schedule shall be prepared and agreed upon for facilitating monthly payments to the contractors against various monthly milestones. LD shall be applicable for not achieving milestones defined which a separate LD milestone schedule shall be prepared and followed.

Apart from these milestones, contractor shall identify key interfaces for the project. The interfaces should include all internal as well as external interfaces of the project. Interfaces should be captured in sample interface management document enclosed with this section, monitored by contractor on continual basis and reported to employer on monthly basis as minimum. Interfaces shall be reviewed by employer during various review meetings. All major interfaces should be captured by contractor in the project schedule.

## **17.6 Engineering schedule**

Contractor shall prepare and submit detailed engineering schedule listing all applicable deliverables for the project. All deliverables shall be further broken down into various progress milestones. Each milestone shall be having Plan, Actual and Forecast dates. DCI shall be updated and submitted to employer on weekly basis. Contractor shall provide forecast dates for all backlog and future milestones. Format for DCI shall be provided by employer upon award of contract.

## **17.7 Procurement schedule**

Contractor shall prepare and submit detailed procurement schedule listing all service orders and material order which are required to be issued to complete the scope of work assigned. All orders shall be further broken down into various progress milestones. Each milestone shall be having Plan, Actual and Forecast dates. Procurement schedule shall be updated and submitted to employer on fortnightly basis. Contractor shall provide forecast dates for all backlog and future milestones. Format for procurement schedule shall be provided by client upon award of contract.

## **17.8 Construction schedule**

Contractor shall prepare and submit detailed construction schedule listing all packages, structures and substructures for all disciplines for complete scope of work. These packages, structures and substructures shall be further broken down into various associated construction activities. Quantity based weekly liquidation chart for all construction activities shall be prepared for progress computation and monitoring. Construction schedule shall be updated and submitted to client on weekly basis. Contractor shall provide forecast dates and catch up plans for all backlog activities on monthly basis.

## 17.9 Planning and schedule control:

Contractor shall prepare detailed integrated activity level project schedule covering all aspects of the project (i.e. preconstruction activities, approvals, interferences, engineering, procurement, construction, pre-commissioning, commissioning and handover etc.) in MS Project software with latest version.

As a mandatory requirement, contractor will not modify / alter integrated project schedule once approved by employer without written consent of employer. Schedule approved by employer shall be the basis for project monitoring / review by employer.

Integrated MS Project schedule shall be updated, as a minimum requirement, on monthly basis and updated schedule shall be shared with employer in native file format. Upon updating the progress in integrated project schedule, contractor shall also provide critical path for the project schedule. Contractor shall provide detailed root-cause analysis for activities on critical path along with their impact of overall project schedule; catch up planning with resource management, forecast dates etc. and the same shall be discussed with employer.

## 17.10 Progress measurement and control, weightages:

Contractor shall adopt a Progress Measurement Philosophy and weightages for various functions and activities as per guidelines given by employer. In general, weightages of Engineering, Procurement and Construction function in the overall project weightages shall be 10%, 50% & 40% respectively. Engineering weightage shall be further divided into disciplines and deliverables based on criticality and efforts. Procurement weightage shall be further divided into various packages and bought out items based on criticality and value. Construction weightage shall be further divided into various packages, structures and sub-structures based on criticality and efforts. Contractor shall finalize above weightages and the same shall be submitted to employer along with their basis for employer's approval. Approved weightages shall be used for computing and reporting progress of the project. Project progress computed based on approved progress measurement philosophy shall be included in the monthly progress report.

## 17.11 Reporting:

Project reporting includes various kinds of report to be generated time to time on predefined periodic frequency basis for monitoring and reporting of the project status, risks, issues etc. Contractor shall adhere to standard project reporting philosophy approved by employer. Contractor shall submit various kinds of progress report in native / editable format.

A list some of the formats is appended below for contractor's ready reference. Contractor needs to follow the same during executing of the project. The list is indicative, non-exhaustive and shall be reviewed / amended during execution of the project based on the project requirement. Employer can ask contractor to provide various additional status reports / data at any stage of the project as per project requirement.

Sr. No.	Template Name
	Project Management



1	Project Management Plan
2	Risk Management
3	Progress measurement philosophy - Weightage distribution
4	Project Review Calendar
5	Weekly project report
6	Detailed Monthly Project Progress Report
7	Milestone, L3/L4 Project Schedule on Monthly Basis.
8	Plan Vs Actual Payment Milestone Schedule Monthly Basis.
	<b>Engineering</b>
9	Document Control Index
10	Engineering Status Report
	<b>Procurement</b>
11	Material requirement list
12	Procurement status report
13	Procurement expediting report
14	Bulk material status report
	<b>Construction, Pre-commissioning, Commissioning</b>
15	Contractor DPR format
16	Equipment deployment plan
17	Manpower deployment plan
18	Commissioning plan
19	Project close out report

- All daily reports shall be submitted to employer before 11:00 am of the following day
- All weekly reports shall be submitted to employer before 11:00 am of following Monday
- All monthly reports shall be submitted to employer before 11:00 am of 2<sup>nd</sup> of every month.

### **17.12 Document numbering**

Contractor shall adopt employer's standard document numbering system for all the project deliverables. All deliverables being submitted to employer shall bear document numbering as per given numbering system, not adhering to the same may call for disapproval of the deliverable by employer. Employer's document numbering system shall be shared with contractor for implementation in the project upon finalization of the contract. The contractor shall be given the Employer's standard Drawing Title Block (template) wherein the contractor shall incorporate employer's document number as well as Contractor's document number, if any.

### **17.13 Document tracking and control**

Employer recognizes that effective and consistent document tracking and control system are extremely important for the project. Contractor shall maintain proper document tracking and control set up for easy and timely tracking and retrieval of various project documents. Contractor shall demonstrate such document tracking and control system to client during kick off meeting. As a standard operating procedure, contractor shall adopt following document submission procedure for smooth tracking of the documents.

The Contractor shall submit all the project related deliverables such as drawings and documents to the Document Controller, who in turn shall distribute to the respective internal engineering discipline personnel. The details of document controller shall be informed to the contractor during kick-off meeting.

All the initial submissions for the purpose of comments / approval, the contractor shall submit the documents in soft copy (pdf format). Once the documents are approved, the contractor shall submit requisite number of hard copies which shall be finalised at the time of kick-off meeting. In case of soft copy requirement in auto cad or any other native format as applicable by employer on a case to case basis, the same shall be provided by the contractor.

Once the project is completed, the contractor shall submit the requisite number of final documentation in soft & hard copies, which includes QC dossiers (containing all approved QAPs, drawings, test reports, inspection reports, material despatch clearance certificate etc.) along with equipment installation manuals, whichever is applicable. The same shall be intimated to the contractor at a later stage.

Similarly the contractor shall intimate their single point contact person to employer during kick - off meeting, so that the document controller shall interact with him on a regular basis to expedite the drawing / document submission / approval.

### **17.14 Reviews**

Project progress shall be reviewed by employer at predefined periodic frequency basis. Contractor shall provide all relevant data and detail information to employer before such reviews to the satisfaction of employer. Over and above employer review, contractor shall conduct their internal review sessions at predefined periodic frequency basis.

Contractor shall prepare a Project Review Calendar and submit the same to employer for approval. Contractor shall perform internal periodic reviews as defined in the Project Review Calendar. All project reviews shall be conducted based on set agenda and record notes of all

such internal / external reviews shall be circulated to all concerned stake holders including employer.

As a minimum requirement, following periodic reviews shall be conducted for the project. Employer at any stage of the project, depending upon the project requirement, may call for further reviews.

**a) Contractor's internal review**

- Engineering –Weekly
- Procurement –Weekly
- Construction –Daily
- Cross functional – Fortnightly
- Pre-commissioning –Daily
- Commissioning –Bi Daily

**b) Employer review**

- Engineering –Weekly
- Procurement –Weekly
- Construction –Daily
- Cross functional – Fortnightly/Monthly
- Pre-commissioning –Weekly
- Commissioning –Weekly

## **18. SITE REGULATION**

### **18.1 Objective**

Object of this section of the tender document is to indicate employer's minimum requirement in terms of Site Regulations, Construction, Pre-commissioning and Commissioning activities during execution of the project. Requirements indicated in this document are minimum and indicative only. Employer may, at any stage of the project, add further requirement or alter these requirements on above aspects of the site management and contractor shall adhere to all such requirements without any kind of resistance / claim of whatsoever nature.

### **18.2 Site Correspondence**

All site related correspondence should be addressed to employer's designated Project Manager / Area Manager as per communication matrix.

### **18.3 Procedures for the Construction Site**

#### **18.3.1 Contractor's general obligations during construction**

At all times the contractor shall keep itself familiarized with the terms and conditions imposed on or applicable to Deendayal Port Authority in relation to the existing Bulk Terminal, whether by any Government Authority or by any other person. The contractor will keep himself familiarized with the design and layout of the Bulk Terminal and the Project Facilities, the various Equipment used / to be used in the Bulk Terminal and the climatic and hydrological conditions affecting the Deendayal Port, Kandla Area or Port Limits or developing around the Port Area or Port Limits, or any Force Majeure Event affecting or threatening the Bulk Terminal, the Port Limits. The contractor may obtain all such information during site visit before submission of offer.

Ensure co-ordination with all staffs, operators, personnel and / or sub-contractors of ancillary services to ensure that the incoming and outgoing cargo at the Bulk Terminal and incoming and outgoing vessels at the Bulk Terminal are able to proceed seamlessly with minimum interruptions and within the timelines agreed for such movement in the Operations, Maintenance, Safety and Performance Standards. The Contractor shall ensure that appropriate systems, checks and balances are ensured and regular training of personnel is undertaken to eliminate any damage to, and/or theft. Detail Coordination procedure required for smooth execution of project & operations shall be finalized with user during Kick-off meeting.

Ensure nil disturbances to all employees / agencies engaged in the running of existing port or project facilities. Minimize disruption to traffic in the event of accidents or other incidents affecting the safety and use of the Project Facilities by providing a rapid and effective response and maintaining liaison with emergency services of appropriate agencies, including any Government Authority and neighbouring ports.

Extend all co-operations to all Persons representing any Government Authority, or any lender of employer or any Person authorized by employer in any site visits, inspections, or discussions.

## **18.4 Organization of the Construction Site**

### **18.4.1 Contractor's Organization**

Contractor shall deploy manpower as per work involvement. Manpower deployed by contractor should have sufficient relevant educational qualifications and experience. Contractor shall submit the organization chart for manpower to be deployed for the project assignment along with curriculum vitae of key personnel along with bid document for employer's review and approval.

### **18.4.2 Subcontractor's Organization**

Contractor shall submit list of proposed subcontractors along with their credentials in bid document. Contractor shall obtain employer's approval for any subcontractor prior to the deployment on project assignment.

### **18.4.3 Site Meetings**

In general, site meetings shall be conducted on daily basis for reviewing the progress of day to day site activities. In addition to daily meetings, weekly, fortnightly and monthly review meeting shall be conducted for review of progress with respect to specific planned activities and milestones.

### **18.4.4 Daily Reports**

Contractor shall provide Daily Progress Report (DPR) in the format approved by employer. DPR shall cover all the areas / structures / fronts of the construction activities.

### **18.4.5 "Kick-off" Meeting**

Apart from project kick off meeting, a separate site kick off meeting shall be conducted at project site. Timeline and agenda for the same shall be decided after award of contract.

## **18.5 Construction Commencement**

Commencement of construction activities should be strictly as per milestone schedule. Contractor to ensure mobilization of adequate resources and infrastructure set up is done as per plan before commencement of construction activities.

## **18.6 Constructability Study**

Contractor should ensure that constructability aspect is taken care during engineering stage. This should be ensured by involvement of contractor's as well as employer's construction team during finalization of various construction drawings. Apart from regular interactions with construction team during engineering stage, a planned meeting between engineering and construction team should at regular interval of engineering completion.

## **18.7 Site Access**

### **18.7.1 Site Access for Vehicles**

The work site is located in a high security area that is controlled by the Port Security Division.

All are to respect/ obey the Deendayal Port Authority security policy. Contractor's vehicles

shall be provided access to required areas only and permission for the same need to be obtained from authorities

### **18.7.2 Site Access**

Deendayal Port Authority (DPA) being operational site, contractor need to ensure that there are no hindrances to operational activities. Contractor to provide barricading of required nature around their battery limit / work area. Contractor shall be provided free access to their working areas only. Contractor shall issue identity cards to their staff / workers to ensure proper safety of the Port.

On arrival at DPA, the contract employees will be expected to pass through the company's security screening procedure. The contractor shall arrange the gate pass for all the contract labours with the help of the department head and the Security Officials of the Port. No person will be allowed to work without valid gate pass. Before leaving site they will be required to once again pass through the security screen.

It is mandatory to obtain police verification of all employees and workers prior to their involvement in the work. The contractor shall surrender to the Pass Issuing authority all the gate passes issued for a particular job after completion of the job. And no payment will be made to any contractor(s) who fail to comply with this.

DPA reserves the right to search any vehicles, person or property, on a random basis, while entering on or leaving DPA premises including the Contractor's personnel, vehicles or property.

### **18.7.3 Material and Equipment Delivery and Return**

Contractor shall follow DPA's rules and regulations prevailing time to time for entry and exit of various constructions and enabling materials.

## **18.8 Mobilization**

Contractor shall provide detailed site mobilization and infrastructure set up plan to client within 30 days of award of contract. As a minimum requirement, mobilization and infrastructure set up plan should include manpower, plant & machinery etc. Contractor should also submit proper plan for demobilization of various resources as required.

## **18.9 Construction Site**

Construction site will be provided to contractor on as is where basis is. Contractor shall develop the site as per his requirement.

### **18.9.1 First-aid Room, First Aid, Ambulance**

Contractor should set up adequate medical / first aid and ambulance facilities for their staff / workers as per prevailing regulations.

### **18.9.2 Site Lighting / Illumination**

The contractor shall in connection with the works provide and maintain at his own cost all lights, guards, fencing and watching when and where necessary or as required by the Project Manager / Area Manager for the protection of the workers or for safety and convenience of

the public or others. The contractor shall be responsible for all damages and accidents caused due to negligence in this regard.

It will be the entire responsibility of the contractor to protect the work(s) carried out by them including the fittings, fixtures and other accessories provided by them till the entire work is satisfactorily handed over to the employer.

### **18.9.3 Contractor's Site Facilities and Site Offices**

Contractor shall set up adequate site facilities required for timely execution of the project at designated area provide by employer. Upon completion of the work, contractor should ensure that no debris left out at site of work. All debris shall be disposed-off in the manner advised by the Project Manager / Area Manager, within 15 days from the date of completion of the work of each area. In case the contractor fails to comply with the requirements of this clause, the employer shall have the right to get this work done at the cost and risk of the contractor. Before taking such action, employer will give seven days' notice in writing to the contractor.

### **18.9.4 Canteen Facilities, Drinking Water, Urinals**

Contractor shall set up and operate at its own cost, necessary canteen, drinking water and urinal facilities for their staff and workers.

## **18.10 Erection Equipment, Implements and Erection Aids**

All erection equipment, implements and aids used shall comply with applicable safety rules and regulations.

## **18.11 Communication Facilities**

Contractor at its own cost shall set up adequate communication facilities for effective and hassle-free communication at work site during execution of the project.

## **18.12 Storing and Disposing of Hazardous Substances**

Any hazardous material being stored, handled or disposed-off by contractor should follow applicable rules and regulations of respective authority / DPA.

## **18.13 House Keeping**

Contractor shall ensure proper housekeeping are maintained at all the work places and site office at all the times. All unwanted material lying in and around work site should be removed and stored properly at designated location.

## **18.14 Delimitation of Erection Areas**

Contractor should ensure necessary demarcations / barricading, required safety precautions at the erection areas at all times as instructed by Project Manager / Area Manager.

## **18.15 Obstructions by Others**

DPA being operational port, there may be obstruction by other agencies operating at the port / project site. Contractor should co-operate with employer / other agencies in this regard.

### **18.16 Damage**

The contractor shall be responsible for any damage of property or loss of life happens due to the act of contractor's negligence. The contractor shall make well at his own expense all losses or damages whether the loss happened to the Contractor itself or DPA / DPA employed any other agency. DPA is not responsible for any loss of life or property whatsoever may be the cause in connection with or as a result of the execution of works until the completed work has been taken over by DPA. Any cost and compensation towards loss or damages (including that payable under the provisions of the Workmen's Compensation Act or any statutory amendments thereof) to any person or persons sustaining damage because of the contractor are to be borne by the contractor.

### **18.17 Scaffolding**

Scaffolding includes raised platforms and related structures for holding workers and/or materials. The complete scaffolding material supply (As applicable) and erection & dismantling of scaffolding with necessary resources will be under the scope of the contractor. No final certificate of completion shall be issued, nor shall the work be considered to be completed until the contractor shall have removed from the premises on which the work shall be executed, all scaffolding, required for his/their work.

### **18.18 Protection of existing infrastructure**

DPA being operational port, contractor should ensure to protect all existing infrastructure and facilities of the operational port / project site. In case of any damage to such facilities, contractor shall be responsible for repair / replacement of the same at its own cost and risk.

### **18.19 Working Hours**

From the commencement of installation of the Facilities at the Site until Operational Acceptance, the Contractor's Representative shall appoint a suitable person as the construction manager (hereinafter referred to as "the Construction Manager"). The Construction Manager shall supervise all work done at the Site by the Contractor and shall be present at the Site throughout normal working hours except when on leave, sick or absent for reasons connected with the proper performance of the Contract. Whenever the Construction Manager is absent from the Site, a suitable person shall be appointed to act as his or her deputy.

Contractor shall follow the normal shift working hour norms prevailing at DPA. However, contractor, if wishes to work for extended hours / round the clock basis, shall inform DPA in writing and obtain permission from relevant authorities in advance.

The Employer may by notice to the Contractor object to any representative or person employed by the Contractor in the execution of the Contract who, in the reasonable opinion of the Employer, may behave inappropriately, may be incompetent or negligent, or may commit a serious breach of the Site regulations provided in tender document. The Employer shall provide evidence of the same, whereupon the Contractor shall remove such persons from the Facilities. If any representative or person employed by the Contractor is removed in accordance with this clause, the Contractor shall, where required, promptly appoint a replacement.



Contractor shall follow holiday calendar issued by employer time to time. Contractor shall intimate employer in written about any kind of holiday being observed by contractor's site team well in advance.

### **18.20 Labour Laws**

The contractor shall ensure strict compliance with all labour related laws & acts not limited to the followings. DPA has the rights to ask for all relevant documents related to these laws . In case of non-compliance contract is liable for termination.

- The Contract Labour Regulation & Abolition Act 1970.
- The Payment of Wages Act 1936
- The Minimum Wages Act 1948
- The Bonus Act 1965
- The Provident Fund & Miscellaneous Act 1952
- The Gratuity Act 1972
- The Industrial Dispute Act 1947
- Industrial Establishment (National & Festival Act) 1969. EPF Act 1952 EPS (Employee Pension Scheme) -1995, Minimum Wages Act 1948.
- Indian Labour Act
- The Public Liability Act, 1991
- Public Liability Insurance Act, 1991

### **18.21 Damage to property or loss of life**

The contractor shall be responsible for any damage of property or loss of life happens due to the act of contractor's negligence. The contractor shall make well at his own expense all losses or damages whether the loss happened to the Contractor itself or DPA / DPA employed any other agency. DPA is not responsible for any loss of life or property whatsoever may be the cause in connection with or as a result of the execution of works until the completed work has been taken over by DPA. Any cost and compensation towards loss or damages (including that payable under the provisions of the Workmen's Compensation Act or any statutory amendments thereof) to any person or persons sustaining damage because of the contractor are to be borne by the contractor.

### **18.22 Erection (method statement) / Installation of Materials and Equipment**

Contractor shall follow all safety regulations / guidelines imposed by DPA or any other regulatory authority time to time. Contractor should submit method statement for all erection / installation activities and obtain employer's approval for the same before erection / installation work.

## **18.23 Work Safety Regulations**

### **18.23.1 Construction Site Emergency Response Plan**

Following safety regulations of the Port are mandatory & in case of non-compliance the contract shall be terminated.

- a) Personal Protective Equipments to all workmen shall be provided by the contractor.
- b) Speed limit of 30KMPH should be ensured.
- c) No mobile phones to be used by any employee during working & driving.
- d) In respect of all labour, directly or indirectly employed in the work for the performance of Contractor's part of this agreement, the contractor shall at his own expense arrange for all the safety provisions as per;
  - The Dock Workers (Safety, Health & Welfare) Regulations/act.
  - The Electricity Act
  - The Motor Vehicle Act
  - Labour Laws and Regulations,
  - The Building & other construction workers (Regulation of employment & Conditions of service) act 1996 & rules 1998 as applicable.
  - Workmen compensation act.
  - The gas cylinder rules
  - The hazardous wastes Rule
  - The environment protection Rule & Act
  - Safety Code of DPA and Rules and order made there under and such other acts as applicable. The contractor may obtain the document/ information during site visit.
  - Rules & Orders made there-under
- e) The Contractor shall observe and abide by all fire and safety regulations of the DPA. Before starting any work, contractor shall consult DPA's Safety Department & Engineer In-charge.
- f) The contractor shall ensure that all equipment, plant, machinery and apparatus brought onto or used on the port is safe and without risk to health, safety, or the environment and is maintained to an acceptable standard. All necessary test and examination certificates must be available for inspection at all times.
- g) DPA retains the right to stop any construction activity or erection of plant/equipment etc., if it is considered that there is a hazard to the safety and health of site personnel (or others) or the possibility of environmental or ecological damage.
- h) Contractor shall abide the Safety code provision as per Dock Workers (Safety, Health & Welfare) Regulations, ILO code of practice (Safety & Health in Port), Indian Standard Safety & DPA safety Code framed from time to time.

## **18.24 Acceleration / Recovery Measures**

Contractor shall, in case of any back log in the project progress with respect to plan, prepare a detailed catch up plan for accelerating the progress with proper back up for adequate resource and material planning. Such catch up plan shall be finalized in consultation with employer and progress of such catch up plans shall be reported to employer on regular basis.

## **18.25 Tests, Inspections, Acceptance Tests**

### **18.25.1 Performance of Tests and Inspections**

The Contractor shall at its own expense carry out at the place of manufacture and/or on the site all such tests and/or inspection of the Plant and Equipment and any Part of the facilities as are specified in the contract. The employer and the Project Manager / Area Manager or their designated representatives shall be entitled to attend the aforesaid test and/or inspection, provided that the employer shall bear all costs and expenses incurred in connection with such attendance including, but not limited to, all travelling and boarding & lodging expenses.

The Project Manager may require the Contractor to carry out any test and/or inspection not required by the Contract, provided that the Contractor's reasonable costs and expenses incurred in the carrying out of such test and/or inspection shall be added to the Contract Price. Further, if such test and/or inspection impede the progress of work on the Facilities and/or the Contractor's performance of its other obligations under the Contract, due allowance will be made in respect of the Time for Completion and the other obligations so affected.

### **18.25.2 Notification**

Whenever the Contractor is ready to carry out any such test and/or inspection, the Contractor shall give a reasonable advance notice of such test and/or inspection and of the place and time thereof to the Project Manager. The Contractor shall obtain from any relevant third party or manufacturer any necessary permission or consent to enable the Employer and the Project Manager (or their designated representatives) to attend the test and/or inspection.

### **18.25.3 Documentation of Test and Inspection Results**

The Contractor shall provide the Project Manager with a certified report of the results of any such test and/or inspection. If the Employer or Project Manager (or their designated representatives) fails to attend the test and/or inspection, or if it is agreed between the parties that such persons shall not do so, then the Contractor may proceed with the test and/or inspection in the absence of such persons, and may provide the Project Manager with a certified report of the results thereof.

### **18.25.4 Deviations**

If any Plant and Equipment or any part of the Facilities fails to pass any test and/or inspection, the Contractor shall either rectify or replace such Plant and Equipment or part of the Facilities and shall repeat the test and/or inspection upon giving a notice.

### **18.25.5 Acceptance**

Acceptance of any / all items / structures / substructures / assets shall be based on technical specifications and other parameters indicated in relevant sections of this tender document. Contractor shall adhere to acceptance procedure indicated in relevant sections of this tender document or issued by employer time to time.

### **18.25.6 Final Check List**

Contractor shall adhere to the final check list format as provided by employer time to time.

### **18.26 Idle Time and Lost time**

Deendayal Port Authority being operational port, contractor shall plan his various construction activities at micro level in consultation with employer for smooth execution. Any idle or lost time claim of whatsoever nature / type from contractor shall not be entertained by employer.

### **18.27 Exceptionally Adverse Weather**

Deendayal Port Authority being located on western coast and prone to cyclones and other adverse weather conditions, contractor shall take appropriate measures for safety and security of all materials and properties during such conditions. Contractor shall adhere to instructions issued by DPA authorities during such conditions.

### **18.28 Demobilization**

Contractor shall prepare demobilization plan for various resources like manpower, plant & machinery etc. and submit the same for employer's review. Such demobilization plans shall be reviewed by employer on periodic basis. Contractor shall adhere to all procedures prevailing at DPA time to time for taking resources out of DPA premises.

### **18.29 Expediting and Progress Control by Contractor**

Contractor shall adopt a robust mechanism for expediting the progress whenever there is a backlog with respect to planned progress. Contractor shall prepare a detailed catch up plan indicating resource and material allocation and monitor & report to employer progress of such catch up plan on regular basis.

### **18.30 Quantity Surveys, Verification of Services, Invoices**

Contractor shall deploy adequate manpower in terms of quantity surveying, verification of completed work and processing of contractor's invoices for smooth, hassle-free and timely processing of various invoices.

### **18.31 Pre-commissioning**

As soon as installation of the Facilities or any part thereof has, in the opinion of the Contractor, been completed as specified in the Technical Specifications, excluding minor items not materially affecting the operation or safety of the Facilities, the Contractor shall so notify the Employer in writing. After checking of such facilities by employer's representative and attending punch points raised by him, contractor shall obtain employer's permission for pre

- commissioning of such facility and commence pre-commissioning of the Facilities or the relevant part thereof in preparation for Commissioning. Contractor shall follow guidelines provided in other sections of this tender document for detailed pre-commissioning procedure. A detailed plan and procedure for pre-commissioning activities shall be prepared by contractor as per guidelines given by employer and submit the same for employer's approval and follow the same during pre-commissioning stage.

### **18.32 Commissioning**

As soon as all works in respect of Pre-commissioning are completed and, in the opinion of the Contractor, the Facilities or any part thereof is ready for Commissioning, the Contractor shall commence Commissioning of the facilities. As soon as Commissioning is satisfactorily completed, the Contractor shall so notify the employer in writing. Commissioning of the Facilities or any part thereof shall be completed by the Contractor as per procedures detailed in the Technical Specifications. Contractor shall follow guidelines provided in other sections of this tender document for detailed commissioning procedure. A detailed plan and procedure for commissioning activities shall be prepared by contractor as per guidelines given by employer and submit the same for employer's approval and follow the same during commissioning stage.

## **19. HEALTH SAFETY AND ENVIRONMENT**

The Bidder shall establish the construction HSE Plan in line with the Employer's HSE Policy requirements including the content detailed below which essentially cover the following:

- a) Construction Site HSE Plan
- b) Construction Site Emergency Response Plan
- c) HSE Project Strategy
- d) Applicable Legal & Regulatory requirements

The Bidder shall prepare the draft HSE Plan and submit the same to the Employer's HSE team for validation & approval.

Review /approval of the PHSE Plan (for his scope of work) by the Employer shall not dilute the responsibility of the Bidder for adherence to any of the legal & regulatory requirements during execution and or the HSE policy requirements from time to time.

### **19.1 HSE POLICY, STANDARDS AND OBJECTIVES**

#### **19.1.1 Project HSE Policy**

The HSE policy of the Employer contains the overall intentions and directions of Top Management with regards to HSE Management system implementation and is approved by Top Management.

**The Bidder shall establish the HSE Policy in line with employer policy.**

#### **19.1.2 Project HSE Standards, PPE, Waste Management & House keeping**

##### **19.1.2.1 Performance Standards**

Project HSE standards are to be established for the project Site by the Bidder in line with requirements & the scope of work awarded, each person undertaking work at project Site must work to meet the standards outlined in the Project HSE Plan submitted by the Bidder before award of Contract to protect himself from hazards and risks associated with project activities.

The specific safety standards applicable to are indicative and are for the Bidders reference and are not limited to:

- a) The Building and Other Construction Workers Act 1996 & The Building and Other Construction Workers Rules 1998
- b) Indian Electricity Act (amendment) 2004 &
- c) The Indian Electricity Rules, 1956
- d) Central Motor Vehicles Act 1988 &
- e) Central Motor Vehicles Rules, 1989 /amended 2001
- f) The Environment (Protection) Act 1986 amended 1991 &
- g) The Environment (Protection) Rules 1986, amended 2004

- h)** Hazardous Wastes (management, handling and trans-boundary movement) Rules 2008 / 2009
- i)** The Air (Prevention and control of Pollution) Act, 1981
- j)** The Water (Prevention and Control of Pollution) Act, 1974
- k)** The Chemical Accidents (Emergency Planning, Preparedness & Response) Rules, 1996 / 2000
- l)** Manufacture, Storage and Import of Hazardous Chemicals Rules 1989
- m)** Noise Pollution (Regulation & control) Rules, amended 2010
- n)** The Batteries (management & handling) Rules 2001 / amended 2010
- o)** Biomedical Waste (management & handling) Rules 1998/ amended 2003
- p)** The Explosive Act 1884. & The Explosive Rules, 1983.
- q)** The Explosives substance Act 1908.
- r)** The Static and Mobile Pressure Vessel (unfired) Rules, 1981
- s)** The Gas Cylinder Rules 1991, amendments 2004.
- t)** The Petroleum Act 1934 & Petroleum Rules 1976
- u)** The Public Liability Insurance Act 1991
- v)** The Workmen's Compensation Act 1923
- w)** The Contract Labour (Regulation & abolition) Act, 1970
- x)** The Child Labour (Prohibitions & Regulations) Act, 1986 and Rules 1950
- y)** The Minimum Wages Act, 1948 and Rules 1950
- z)** Employee State Insurance (Central Rules), 1950
- aa)** The Recycled Plastic Usage Rules, 1998
- bb)** Notification, Central Ground Water Board, Act January 1997
- cc)** Notification on Control of Noise from Diesel Generator (DG) sets, 2002
- dd)** Notification on Fly ash utilization, Sept 1999 as amended in August 2003
- ee)** National Building Code, 2005
- ff)** Indian Road Congress Code IRC: SP: 55-2001 'Guidelines on Safety in Road Construction Zones
- gg)** OSID - Guidelines 156 (Oil industry Safety Directorate), Fire Protection Facilities for port oil terminals.
- hh)** Guidelines Fire Advisor, CCE & DG FASLI, Government of India.
- ii)** National fire Codes (National Fire Protection Association -USA)
- jj)** Drill manual for the Fire Service of India.
- kk)** ISPS ( International Ship & Port Facility Security) code (2003 Edition)

#### 19.1.2.2 International Standards, Guidelines & Certifications

- a) The works should be undertaken in accordance with the applicable international guidelines, standards and specifications on IMS.
- b) The important Indian Standards and British Standards as applicable to the work of the specific Contract.
- c) Bidder shall participate and comply for requirements asked by owner to fulfil Integrated Management System requirements.
- d) Every Contractor shall aim to achieve certifications listed below during the execution:
- e) OHSAS 18001:2007 Occupational Health and Safety Management System and / or
- f) ISO 14001:2004 Environment protection standard

#### 19.1.2.3 Personnel protective equipment

The Bidder at all times should keep & maintain adequate supply of suitable standard (IS) personnel protective equipment which shall be readily available for use at all times at Site which shall include among others the following items

- a) Safety helmets
- b) Hearing protections
- c) Respiratory protections
- d) Eye protections
- e) Protective gloves
- f) Safety Footwear
- g) High visibility clothing
- h) As guided by product manual and MSDS

Minimum PPEs applicable at Site would be hard hat, safety boots and high visibility clothing; Bidder must keep sufficient stock to issue to all workmen & staff including the visitors.

The Bidder shall ensure to maintain PPE standards at Site and defaulter must be removed from the Site.

#### 19.1.2.4 Waste Management and Environmental Standards

The Bidder shall ensure the impact of waste on the environment shall be minimized firstly by elimination, otherwise by recycling and reuse or finally by treatment and disposal.

The details of the waste management process shall be defined clearly by the Bidder and followed for his scope of work and shall be in line with legal requirements and policy.

The Bidder shall ensure that at the end of each shift, or on task completion it is the responsibility of each line supervisor to ensure that all scrap material has been collected in dustbins / scrap containers. Bidders shall arrange for collection and safe disposal of waste / scrap generated in their respective work area.



#### 19.1.2.5 House Keeping:

**Cable Management (Power and IT):** Bidder's Construction Manager shall ensure & make provision for the routing and support of cables and hoses in use in each area. The endeavour is to keep all walkways and access ways clear and free from trip hazards. For Mechanical/Electrical phases of the project, facilities will be placed that enable all temporary cables to be strung out in a safe manner.

The Bidder shall ensure basics of housekeeping by creating awareness & deploying the 5 S concept, in brief housekeeping means a place for everything and everything in its place in an orderly manner.

Good housekeeping practices are an essential safety function that contributes to efficient operations, better productivity and reduction in accidents, improving the environment and enhancing workers moral.

**Other Aspects of House Keeping, which need to be ensured by the Bidders' are:**

- a) Keep the work place clean and orderly at all times.
- b) No pipe line, power cable or hoses shall run across path ways thus creating a tripping hazard.
- c) Unwanted materials should be removed from workplace.
- d) Oil rags, cloths soaked in oil should be put into waste bins/drums provided in work Site. Separate bins/drums are provided at Site for segregating the waste. Use them properly.
- e) Do not leave tools, tackles, nuts, bolts and other equipment in walkways, staircases or any vulnerable place wherefrom it can fall or create trip hazard.
- f) Materials shall not be stored close to any edge of a floor, platform or on any opening of floor as to endanger persons below.
- g) Do not throw material from high elevation. Always lower it by means of a rope.
- h) Separate areas should be earmarked for storing gas cylinders, fuel and combustible items.
- i) Provide a tray to collect the leads of welding rod while welding at Site.
- j) Follow the procedure regarding stacking & Un-stacking of materials.
- k) Separate areas should be earmarked for storing gas cylinders, fuel and combustible items.
- l) Electrical systems shall be laid as per safe work methodology.
- m) Adequate firefighting facilities and equipment must be available in working condition at the Sites.
- n) Toilets should be maintained clean always.

#### 19.1.3 Project HSE Objectives

Project HSE objective is to achieve industry best HSE performance through the following which the Bidder shall ensure to implement for his scope of work:

- a) Apply a "zero tolerance philosophy" as the standard for health, safety and the environment.
- b) Continuously develop a HSE culture to reduce human error and focus on individual commitment, responsibility and accountabilities.

- c) Encourage open communication and employee participation in all activities related to improvement and fulfilment of all Health, Safety and Environmental issues.
- d) Seek continuous improvement to achieve “best practice”.
- e) Identify and analyze all hazards to personnel, working environment, external environment and Employer assets, initiate corrective actions and verify that corrective actions are effective.
- f) Maintain a system in compliance with statutory requirements,
- g) Ensure that a process of continual improvement is achieved through periodic objective setting, auditing and performance reviews.

Activity specific HSE Objectives can be established after reviewing the Hazard Identification and Risk Assessment. Identify the areas where there is a scope for improvement and establish HSE Objectives & Management programs.

The Bidder can use following guideword to establish HSE Objectives & Management program.

- a) **Eliminate:** Eliminate the hazards altogether or combat the risk at source, (Eliminate all hazardous events, usage of hazardous substances, unsuitable equipment).
- b) **Provision of Substitution:** Use of safe substances or defining the method statements defining alternative ways of carrying out field tasks to ensure safety.
- c) **Provision of Engineering Controls:** Machine guarding, proper platforms, acoustic enclosures, automation instead of manual operations.
- d) **Increase / Improvement:** Near miss reporting, awareness through training, use of personal protective equipment, compliments /awards incentives, appoint safety stewards across all the activities.
- e) **Sustain / Continue:** Work place inspections, Cross functional audits, Vendor audits. Periodic Campaigns and Safety Patrols.
- f) **Reduce:** Hazardous conditions, (e.g. Relating to slips/trips and falls), Exposure to hazardous substances. (Specify quantitative target with defined time frame).
- g) **Introduce:** Risk Assessments, Emergency Plan, Active Monitoring system, Work Permit system for specified tasks. Training etc. (Specify a date for achievement).

While establishing the objectives and programs the following is to be considered:

- a) Legal and other requirements
- b) HSE risks
- c) Technological options
- d) Financial requirements
- e) Operational and business requirements
- f) Views of interested parties
- g) Potential emergency situations

HSE Objectives shall be documented and shall indicate the time frame for achieving the targets. HSE Objectives and targets shall be Specific, Measurable, and Achievable and shall be in line with the HSE Policy.

HSE Objectives shall be established at relevant levels and functions depending upon the complexity and nature of activities involved along with the Employer's HSE Team.

Responsibility for achieving the Objectives shall be clearly specified and agreed upon by the Bidder and the Employer.

#### **19.1.4 Management Programs:**

Bidder's HSE team shall identify action plan for management program for each HSE objective identified along with Employer's HSE team.

- a) These programs shall clearly indicate the various action plans for achieving the defined objective, responsibility and timeframe for completion of each action plan.
- b) Programs shall be reviewed by Employer's Project Head and update the progress / status of action plans as may be relevant.
- c) Progress / Status of HSE objectives will be reviewed by Project Head along with Site Safety Head, concerned HODs/ area managers of both Bidder & Employer's side at least once in 6 months and the status of HSE objectives shall be discussed in the Management Review Meeting with representation from the Bidders team.

### **19.2 HSE Organization**

#### **19.2.1 Organization**

Bidder shall identify the Organization structure & get the same approved from the Employer's HSE team before award of the Contract which shall be relevant & depending up on the size & nature of the project Site & the Bidder's scope, The Bidder's Project Head will lead the Project Organization and Site safety Head will lead the Site Safety Organization.

#### **19.2.2 Roles and Responsibilities**

Bidder's Project Head has ultimate responsibility for Health, Safety and Environment with delegation to appropriate Functional Managers who are responsible to providing HSE leadership in their respective areas. They will ensure implementing program to satisfy HSE requirements of established HSE Plan.

Joint responsibilities of Site management:

- Provide leadership, resources and commitment
  - Promote safety and health awareness and motivation
  - Ensure risks are managed so as to bring within acceptable level
- a) Project Head has overall responsibility for HSE on project Site, Include:
- Ensure compliance with all relevant regulatory and legislative HSE requirements
  - Implement the project HSE policy objectives

- Identify legal responsibilities associated with the workplace activities
  - Providing HSE leadership promoting a HSE culture across the Project Site and driving continual improvement in the project HSE performance.
  - Coordinating the preparation and Implementation of the project safety plan.
  - Identify potentially hazardous activities of project Site and Implement appropriate procedures & controls.
  - Assigning and documenting written HSE responsibilities to all project personnel.
  - Ensure sufficient resources are provided to implement HSE programs, including Emergency response & evacuation.
  - Authorizing Project specific HSE procedures.
  - Participating in Project HSE meetings and programs and review the HSE plan.
  - Review of accident & incident reports, meeting minutes, HSE audit / Inspection reports for the Project.
  - Support Site team (including Department head, managers, supervisors etc.) for implementation of HSE plan.
  - Ensuring appropriate first-aid equipment and amenities at the Project Site are available and maintained.
- d) Bidder's Site Safety Head shall be responsible to the Project head for the implementation of HSE plan on project Site, Include:**
- Developing, implementing and continuously Improving HSE policies and systems.
  - Promotion of HSE awareness.
  - Monitoring and benchmarking HSE performance.
  - Driving continuous improvements in HSE performance through, for example, transfer of lessons learnt between other project Sites and adopting appropriate best practices.
  - Organize HSE Committee' meeting for reviewing safety performance of project.
  - Ensuring the HSE of all visitors to the Site.
  - Conducting HSE Induction program for all Site personnel & visitors
  - Ensuring appropriate HSE training is provided to all employees.
  - Assessing sub-Contractor compliance with HSE Plan.
  - Assessing sub-Contractor work practices and HSE performance.
  - Initiation of accident & incident investigation and maintain injury register.
  - Ensuring access is available to qualified HSE professional at all times and that the availability is known by all project personnel.
- e) HSE Supervisors shall be responsible to the Site Safety Head for the implementation of HSE plan on project Site, Include:**

- Implementation of HSE Plan.
  - Promotion and stimulate high level of HSE awareness at all the time.
  - Assisting sub-Contractors and employees with the provision of HSE advise.
  - Assess the planned work for potential hazards in consultation with employees
  - Assisting in identification and preparation of project specific HSE procedures.
  - Participating in HSE meeting and HSE Programs.
  - Daily inspection of project activities and suggest corrective measures.
  - Take part in accident investigation.
- f) Head of Departments shall be responsible to the Project head for the day to day operation of the project Site or delegated areas include.**
- Understanding and assisting role of line management in the implementation of project HSE plan / other requirements.
  - Regularly identifying workplace HSE hazards and taking appropriate corrective measures.
  - Ensuring implementation of SOPs, HSE procedures and work permits.
  - Planning of work activities to ensure the identified hazards will be effectively controlled.
  - Reporting and investigating all incidents, accidents and near-misses.
  - Effectively communicating HSE requirements and procedures to all employees and Contractors.
  - Ensure appropriate additional controls where safety critical jobs are performed;
  - Reviewing with Project head and Site Safety head accident / incident investigation reports.
  - Reviewing with Project head and Site Safety head sub-Contractor compliance.
  - Participating in HSE meeting and HSE Programs.
  - Assisting inspection and auditing activities.
  - Ensuring safe plant and equipment is provided and maintained.
  - Maintaining records, documents, procedures, work instructions and other essential information e.g. MSDS at work place for easy reference.
- g) The following additional personnel will also be responsible for ensuring compliance to Safety guidelines at ProjectSite:**

Bidder's Construction Manager is the overall in-charge for execution of construction activities of the project and coordinates with various agencies. He has to ensure the practical implementation of the construction safety programme and will specifically be responsible for the following:

- Ensure that the safety resources provided on the project meet the needs of the project in terms of personnel and organization
  - Ensure that an effective co-ordination process exists between disciplines and other Contracting parties to ensure that all interface problems are recognized and resolved
  - Ensure that all employees have been made aware of their roles and responsibility with regard to this plan and the safe working requirements of the project construction work
  - All supervisory staff and workers are assigned on job after Safety induction and training.
  - Co-ordination of key construction personnel and their work activities, with endeavour of minimizing interface problems.
  - Attend and chair the construction safety committee meetings.
  - Ensure that a mechanism is in place for developing, reviewing and approving work method statements and risk assessments.
  - Personally review and approve all critical operations that have a high-risk potential e.g. heavy lifts.
  - Initiate investigation process of incidents/accidents occurring at Site to find out basic causes and remedial measures for implementation. He will approve all the FARs and implement remedial measures to prevent recurrence.
  - All such incidents /accidents and near miss cases shall be reported immediately latest by at the end of the shift to safety head in writing in established templates.
  - All major & fatal accidents are to be reported immediately to project head & the HSE head immediately.
  - Set a personal example and promote the enthusiasm necessary for providing a good safety performance
- h) Construction Engineers will be responsible for safety at Site for all jobs carried out under their supervision. They will ensure that all jobs are carried out after proper planning and establishing safe work methods based on risk assessment. They will have following responsibilities:**
- To organize an introductory meeting with major Contractors involving safety Department.
  - To ensure that Contractor's safety induction is done
  - To ensure safety induction / training of Contractor's supervisory staff and workers before assigning them on job
  - To review/approve risk assessments/work methods and execution plan for work being carried out in their area. They will authorize jobs under their supervision at construction Site and use work permit system
  - Monitor various Site activities in their respective areas

- Carry out weekly audits of the areas under their control with the Site Safety Department and liaise regularly with the safety officer/manager for joint inspections
  - To observe that approved procedures, proper work methods are used and proper tools /machinery are deployed by the Contractors and ensure safety compliance at work.
  - To co-ordinate with the safety department for safety meetings that involve personnel and supervisors working in their areas and attend safety meetings.
  - To participate in the investigation of any incident/accident that result in serious injuries or serious property damage occurring in areas under their control.
  - To set a personal example and assist in the proactive promotion of safety as a personal objective.
- i) Safety Inspectors (Site) shall be responsible to the Site Safety Head for the day to day operation of the project Site or delegated areas including:
- Assisting field HSE Supervisors and Contractors in safe execution of jobs.
  - Monitoring safety compliance at Site and ensure that corrective actions by area construction engineers/Contractors are taken.
  - Carrying out field inspections to identify unsafe conditions /unsafe practices and to get them corrected.
  - Keeping a record of activities and safety violations/unsafe conditions which are not corrected and follow up for compliance.
  - Participating in safety talks /tool talk programs at Site.
  - Validating and signing work permits/and checklists where applicable.
  - Interacting with Contractor workers and field supervisors to help them in promoting safe work practices.
  - Recording information/facts on incident/accident at Site, (if any) and reporting to the HSE Head (both Bidder & Employer).
  - Helping Site workmen in emergency response, in case of any emergency.
- j) Bidder shall nominate a rigging/Heavy Lift Manager who shall be working with the Construction Managers and will have the following responsibilities:
- Shall implement a system that evaluates and tests all cranes and lifting equipment being brought to Site.
  - Will keep a record of all certification of such lifting equipment used on Site.
  - Will establish a schedule of inspections for monitoring the cranes brought on Site.
  - Will evaluate the competency of equipment operators and where necessary they shall be removed or retrained.
  - Review and approve heavy lift plan.

- k) Plant Operations Manager, will have the following responsibilities at the time of starting commissioning/start up activities:

- Ensure that all equipment, ready for Start-up are clearly marked and that controls are in place to ensure that unauthorized personnel are kept away from the area.
- Ensure that all pressure test, pump runs etc., are carried out in accordance with the permit system and barriers/warning signs erected.
- Co-ordination with the HSE to discuss the start-up programme and the establishment of safe working procedures.
- Liaise with the Area Construction Manager and co-ordinate with them start-up activities and ensure that interface problems are resolved before work commences.
- Plan the work in a manner that ensures that all equipment necessary for the safety of personnel and plant is provided and available on Site.
- Coordinate with HSE and Fire services for smooth start-up and emergency preparedness.

### **19.3 HSE Administration**

#### **19.3.1 HSE Committee**

The objective of the Bidder's HSE committee shall be to promote a safe and healthy work environment for the project Site by creating a strong awareness of environment safety & health and reducing or eliminating accidents, injuries, and illnesses throughout the completion of scope of work.

The HSE committee represents the mutual interests of all project participants in completing the work with zero injuries.

**Note:** Bidder's HSE committee shall attend all meetings of the HSE committee and update them on all concerns regarding HSE including the actions taken and or to be taken.

**Progress Review Meetings:** Safety will be an agenda in the Fortnightly and Monthly Progress Review meetings. All meetings shall begin with the HSE Status and Concerns for the Project. The Minutes of Meeting will be as per format agreed between Employer and Bidder.

#### **19.3.2 HSE Awareness**

The Bidder shall ensure to establish an awareness program consistent with the HSE awareness campaign (e.g. Display of policy, Posters, stickers, signs, banners, and Bulletin boards). This program promotes worker awareness of safety goals and daily risks, hazards, and exposures in the field.

#### **19.3.3 Rewards and Penalty (-Not Applicable-) (Latest Dock Safety rules applicable)**

This procedure includes all applicable penalty obligations; this shall be applicable to Bidder. Employer will reserve all rights to impose those penalties (as applicable and agreed between Employer and Bidder) in case of non-compliances.



### PENALTY FOR VOILATION OF OHS NORMS

SN	Topic	Safety Violation	Financial Penalties
1	Working at Height / Ladders and Scaffolds	Not use of Full body harness / Fall arrestors and Non anchoring of full body harness No protected against falling of person by suitable means	Rs.10,000 per violation
2	Lifting Appliances and Lifting Gears	Use of Lifting Appliances without Third party inspection certification under the Act.	Rs.10,000 per violation
3	Personal Protective Equipment	Not wearing / using PPE required for the Job. Using damaged PPE. Using wrong PPE. Using PPE without conform to BIS Std.	Rs.200 per single violation
4	Traffic Management	Over loading of vehicles Unfit Drivers or Operators Unlicensed vehicles	Rs.5,000 per first violation and Rs.10,000 for subsequent violations
		Absence of Reversing Alarm or Absence of fog light (at winter) or Hand brakes not in working condition. Mishandling/ Splashing of material on roads Non-cleaning of Vehicles and thereby creating a traffic safety hazard to road User	Rs.1,000 per first violation and Rs.2,000 for subsequent violations
5	Occupational Health / Others	Violation of any clause as described in Factory Act & Rules Dust control measures at sites not practiced.	Rs.5,000 per single violation Compounded to a maximum of Rs.25,000 at any single instance
6	Injury and Incidence Reporting	Fatal accidents	Rs.5, 00,000 or 5% of the Contract value, whichever is less, for first fatality,  Rs.10, 00,000 or 10% of the Contract value, whichever is less, for second and their after Owner may at its discretion impose appropriate penalty or may terminate/reject the

			Contract at the risk & cost of the Contractor
		(b) Grievous Injury (Grievous Injury as defined by Workmen Compensation Act)	Rs.3,00,000 or 3% of the Contract value, whichever is less, for first injured person and Rs.5,00,000 or 5% of the Contract value, whichever is less, for every subsequent grievously injured person
		(c) Dangerous Occurrence	Rs.1,00,000 or 1% of the Contract value, whichever is less, for first violation and Rs.2,00,000 or 2% of the Contract value, whichever is less, for subsequent violations
		(d) Any Incident Involving injury to the Public	Rs.50,000 or 5% of the Contract value whichever is less for first violation and Rs.1,00,000 or 1% of the Contract value whichever is less for subsequent violations
7	Electrical Safety	Non-compliance of Electrical safety norms Exposed electric lines fermentative damage and circuits in the workplace. Inserting of wires directly into the socket. Improper grounding for electrical appliance Electrical cables running on the ground	Rs.2,000 per single violation Compounded to a maximum of Rs.50,000 or 5% of the Contract value, whichever is less, at any single instance
8	Welding & Cutting Safety	Flash back arrester, NR valve and regulator not present or not in working condition. Fail to put cylinders in a cylinder trolley. Damaged hose and fail to use hose clamps. Using Domestic LPG cylinders Isolating switch not provided on Welding m/c Improper grounding and return path.	Rs.5,000 per single violation Compounded to a maximum of Rs.20,000 at any single instance

		Damaged / Bare welding cable.	
--	--	-------------------------------	--

**Consolidated penalty shall be maximum limit of 10% of the contract value.**

Penalties once deducted can be reversed partial or full to bidder as reward, if owner's safety representative and site head monitor good safety implementation maintained by bidder afterward. Final approval for any such reward will be approved by competent authority from employer.

### **19.3.4 HSE Management**

#### **19.3.4.1 Hazard Identification Risk Assessment and Controls (HIRAC) / Job Safety Analysis (JSA)**

The Bidder shall establish the procedure for HIRA and JSA in line with procedure detailed below:

- a) Identify Occupational Hazards and Associated Risks.
- l) Evaluate the Occupational Health and Safety risks of all activities, products and services.
- m) Identify the Significant / Unacceptable hazards.
- n) Identify and implement necessary controls for Significant / Unacceptable hazards.
- o) Keep information up-to-date in respect of HSE Hazards and Risks.

The basic steps for process of Hazard identification and risk assessment are as follows:

Respective Areas within the Construction core team shall list out routine and non-routine activities/ processes in their department / area / function and gather the following information for each work activity.

- Nature of Activities being carried out; their duration and frequency.
- Location / s where the activity is carried out?
- Who normally carries out the activity?

Hazards and associated risks at each step in respect of activities, products and services executed directly or through agencies and monitored by the departments are documented.

#### **Sequence of Risk Control Activities**

- a) Classify work activities
- b) Identify Hazards
- c) Determine Risk
- d) Qualitative risk assessment

- e) Quantitative riskassessment
- f) Assess the level of significance
- g) Determine the Existingcontrol
- h) Prepare Risk controlplan
- i) Establish controlmeasures
- j) Review and Update as relevant

Procedure for Hazard Identification, Risk Analysis and Control (HIRA) and Job Safety Analysis (JSA) shall be applicable to Bidder to Project Site.

#### 19.3.4.2 Aspect-Impact analysis, and register of regulations

The Bidder shall establish the procedure for Aspect Impact analysis and to maintain a register of applicable rules and regulations line with procedure detailed below:

- a) Identify environmental aspects and it's impacts with using analysis as set by Employer or as per ISO 14001 standard.
- b) Bidder has to identify EMPs to maintain and manage risk within limit.
- c) Optimization of environmental resources must be in line with 3R principles as reduce, reuse and recycle.
- d) Bidder shall establish emergency management plan to address emergency leak/spill control and to encounter post incidental measures.
- e) Keep information up-to-date in respect of latest applicable legal requirements.
- f) Bidder shall establish procedure of keeping all legal requirements in a register, and to update this on regular interval with having legal audits.

#### 19.3.4.3 Design Safety Review

- a) Bidder's HSE Manager will work towards ensuring HSE compliance at project Site for his scope of work; he will also be responsible for safety of plant design for safe operations. Ensuring the safety of engineering design is the joint responsibility of Project Engineering Manager (PEM) and Project HSE Manager. Design safety will be enforced on the project primarily through Design Safety Checklist (DSC).
- b) As part of the engineering management process, the PEM will create a checklist that covers necessary items for HSE compliance. This checklist needs to be jointly reviewed with the HSE Manager so that project and Site specific requirements are identified and listed.
- c) Once agreed, the final checklist needs to be approved by HSE Manager before it is used by engineering team.
- d) It is the responsibility of PEM and Discipline Leads (DL) to ensure complete compliance to DSC before approving and releasing any deliverable. No deliverable should be approved/ released without ensuring compliance to DSC. The DSC also provides a mechanism for the HSE manager to review/ audit the adherence DSC during design stage.

#### 19.3.4.4 Contractor HSE Evaluation

The Bidder shall ensure that following are submitted along with the bid in case the same is not submitted during prequalification for evaluation.

These documents shall also be submitted to Employer's HSE team for evaluation during sub-Contractor pre-qualification.

- Safety statistics of last 5 years
- Safety Policy
- Safety Organization
- HSE Management system accreditation (if any)
- Safety equipment etc.

#### 19.3.4.5 Meeting

Meetings are required to ensure that Bidders understand the HSE requirements for project work, including expectations for safety and health performance and to review project safety philosophy, principles, and Parsons' requirements with all prospective of Bidders. Although, all this information is included in the bid, the meeting reinforces the messages.

#### 19.3.4.6 Submission & Review of Bidder's HSE Plan

Successful Bidders must submit HSE Plan to the Employer's Site Safety Head for review after award of the Contract and ensure getting the same approved before the execution start on Site.

The Employer's Project Director and Project Safety Manager will review the approved Contractor's construction HSE Plan to ensure that it meets Project HSE requirements to be implemented at the execution stage.

The Bidder's construction HSE Plan must address all the elements as defined in the table of content including the following:

- a) Safety policy, Safety Organization, Role & Responsibility, Safety Communication
- b) Hazard Identification & Risk Assessment confirming OHSAS 18001 (latest version)
- c) Specific activity hazards analysis (AHA).
- d) Aspect – Impact assessment confirming ISO 14001 (latest version)
- e) Legal register
- f) JSA of all activities
- g) Accident investigation & reporting, Hazard correction
- h) Training and instruction, record keeping
- i) Employee orientation program- Includes location specific safety & health issues
- j) A Site-specific emergency action plan that includes a list of key management contacts
- k) Safe operating procedures in editable format
- l) Welfare facilities, provision of toilets, rest shelters and accommodations

- m) A Site-specific medical emergency plan that lists qualified first aid personnel etc.

\*Above documents shall be produced to Employer in editable format.

#### 19.3.4.7 Kick off & Mobilization including sub-Contractor's introduction

The Project Director may hold a pre-construction safety meeting before the execution work begins at Site.

This may be included as part of the Project Kick off/ Mobilization meeting.

The meeting includes Bidder's & sub-Contractor representatives, Head of Department or Manager (representatives) from all disciplines, including Employer's safety.

#### 19.3.4.8 HSE Personnel competency & evaluation

All Bidders must submit approval form for deployment of HSE Officer at project Site for HSE implementation.

The minimum qualification and no of staff requirement will be as follows:

Safety staff Deployment requirement:	Safety Officer	Safety supervisor
CLASS – A: Deployed employees more than 200 Nos. or/and Contract Value above Rs . 100 Lac in a year.	Minimum One	Plus One for Every 100 employee
CLASS – B: Deployed employees more than 100 up to 200 Nos. or/and Contract Value above Rs.50 Lac up to Rs. 100 Lac per year.	Nil	Minimum One and thereafter additional One for every 100 employee.
CLASS – C: Deployed employees up to 100 Nos. or/and Contract Value up to Rs. 50 Lac in a year	Nil	Minimum One and thereafter additional one for every 100 employee
<p><b>Safety Officer:</b> Minimum qualification B.SC. With Diploma in Industrial Safety from recognized institute &amp; good communication skill with an attitude to implement safety at his Site. Safety Officer shall have minimum 3 years of experience in similar jobs.</p> <p><b>Safety supervisor:</b> minimum qualification Intermediate with good communication skill. He shall have experience as Safety Supervisor for a period of minimum 3 years in similar jobs.</p>		

#### 19.3.4.9 Consequence management action policy

Bidder shall frame and communicate a policy to his employees and to his subcontractor's stating consequences action apply towards major incident resulting LTI, fatality, major fire, environmental loss, legal consequences, permanent and or partial disabilities happened due to gross negligence of responsible employee.

## **19.4 Work Permit**

### **19.4.1 Objective of Work permits**

Certain types of work are not to be started until approval is given in the form of a signed permit.

Bidder shall implement the work permit at the construction Site which is basically a written, properly authorized permit required before beginning of any specific high risk activities.

Detailed work permit procedure shall be provided to Bidder at the time of Kick-off meeting.

### **19.4.2 Height Work Permit**

Required before starting of any Height work on above 2 meter elevated location (have potential of fall hazard) on project Site.

### **19.4.3 Confined Space Entry Permit**

**Required before entering into Confined or enclosed space includes Storage** Tanks, Tankers, Process Vessels, Bins, Ventilation or exhaust ducts, Tunnels, Silos, Sewers, Underground Utility Vault / Chambers, Pipelines, Pits, & open top spaces more than four feet in depth. (Open top space having depth of more than the height of working personnel)

Confined Space means any space (any unclosed or partially closed space) having restricted access or egress and/or which may be subjected to the toxic or flammable contaminants or an oxygen deficient atmosphere that have been under construction or in service or connected to operating process equipment and may contain potentially hazardous atmospheric conditions.

### **19.4.4 Radiography Test Work Permit**

Required before starting of any Radiography test work (have potential of radiation hazard) on project Site.

### **19.4.5 Electrical Work Permit**

Required for the service and maintenance of electrical system and equipment in which the unexpected energization (have potential of electrical hazard) or start-up of the machines or equipment, or release of stored energy could cause injury to workers on project Site.

### **19.4.6 Excavation Work Permit**

Required before starting of any excavation work at a depth greater than one meter to minimize hazards arising during excavation work and ground breaking operations, specifically when a machine or hand tools are used.

### **19.4.7 Hot Work Permit**

Required before any flame or spark producing activity can begin in any production, operating, or some construction areas of the project Site.

This includes, but is not limited to:

- a) Any welding and /or cutting working scrap / stores / Cooling Tower having PVC material or fines / storage of Chemicals / Gas cylinder storage / other areas containing hazardous or flammable materials or the area where hazardous or combustible or flammable materials is likely to be present.
- n) Any hot work on carbon steel pipe lines, vessels, equipment, etc. that may have contained Sulphuric acid will not be permitted without extensive review with project and plant personnel due to the possible generation of hydrogen gas.

#### **19.4.8 Blasting Work Permit**

Required before starting of any Blasting work (have potential of explosion hazard) on project Site. Detailed procedure shall be provided to Bidder upon request.

### **19.5 Medical Requirements and Occupational Health Management**

The Bidder shall ensure that following medical requirements are implemented in accordance with the Legal & statutory requirements

#### **19.5.1 Medical Services**

The Bidder's Project manager along with the HSE Head shall ensure the following necessary Medical facilities as prescribed under law to treat emergency and non-emergency work-related injuries and illnesses such as:

- a) Medical service providers / Qualify medical physician and paramedical staff
- b) Emergency First Aid Centre
- c) Ambulance

Employer have defined detailed medical procedure which shall be provided at the time of kick-off meeting and the same shall be applicable to Bidder for maintaining all medical requirements to project Site.

#### **19.5.2 Pre-Employment medical Test**

The Bidder's Project Manager along with the HSE Head shall establishes Pre-employment medical test certification procedure as per Legal requirement and in Performa prescribed (under the act & rules) from medically qualified physician (under the act & rules) is compulsory prior to engaging any personnel either Bidder's employee or Contractor / sub- Contractor employees on the project Site for work.

Outcome of the Project Site specific Risk analysis issues relative to health shall be considered for pre-employment medical test criteria.

#### **19.5.3 Periodic medical Test**

The Bidder's Project manager along with the HSE Head shall establishes Periodic medical test survey procedure as per Legal requirement and in Performa prescribed (under the act & rules) for personnel either Bidder's employee or Contractor / sub-Contractor employees working on the project Site.



#### 19.5.4 Health Campaign

The Bidder's Project manager along with the HSE Head & Doctor / physician on project Site shall conduct Health campaign, where necessary for personnel either Bidder's employee or Contractor / sub-Contractor employees working on the project Site.

#### 19.5.5 Emergency Response, first aid, medical facility & Hygiene

The Bidder's Project Manager along with the HSE Head in consensus with the Employer's Site head & HSE Head shall establish the emergency response plan, identify team who will be responsible & organise mock drill to ensure the effectiveness of the preparedness during emergency.

Emergency Response, first aid, medical facility & Hygiene procedure shall be applicable to Bidder for preparing and maintaining all emergency response requirements to project Site. Employer shall share detailed Emergency Response, first aid, medical facility & Hygiene procedure at the time of kick-off meeting or upon request from Bidder.

### 19.6 Work Environment Management

The Bidder shall take responsibility to implement the work environment control and occupational health measures to provide for a safe working environment, as well as to provide safety and health protection to the construction workers.

Work Environment Management Procedure shall be applicable to Bidder for maintaining all industrial hygiene requirements to project Site. Detailed Work Environment Management Procedure shall be shared with Bidder at the time of Kick-off meeting.

#### Minimum illumination intensities

Illumination level in Lux	Area of operation
54	General construction areas; concrete placement, excavation and waste dumping areas; access ways; active storage areas; loading platforms; refuelling and field maintenance areas.
54	Indoors, Warehouses, Corridors, hallways and exit ways.
108	General construction plant and shops (for example, batch plants, screening plants, mechanical & electrical equipment rooms, carpenter shops, rigging lofts, active store rooms, barracks or living quarters, locker or dressing rooms, mess halls and indoor work rooms).
325	First aid Stations, infirmaries and Offices.

### 19.7 HSE Procedure for Plant & Machinery: Usage & Maintenance

Bidder shall ensure that relevant information relating to any equipment, machines or plants

that is used by personnel on the project Site should be maintained in relevant register, along with necessary fitness certification, licenses / Legal forms under the rules & regulations where necessary.

It is necessary that all critical equipment, (i.e. Lifting tools & tackles, power tools, etc.) machines (i.e. Lifting machines such as Hydra, cranes, elevated work platforms, etc.) or Plants (i.e. mobile Boiler plant, etc.) have operating manuals and maintenance records available on Site, which reflect the requirements by the manufacturer.

The indicative Plant and Machinery requirements for construction Site are given below for reference:

- a) Crawler Crane – Third Party Inspection Certificate, Valid Insurance Certificate and Operator License/Authorization Letter
- b) Hydra – Third Party Inspection Certificate, Valid Insurance Certificate, Operator License, and Pollution Under Control (PUC) Certificate,
- c) Tandem lifting with using two of more hydra and similar pick n carry cranes is prohibited, however a plan with JSA and work permit ensuring safe lifting can be permitted by Employer's Site head in case of emergency.
- d) Use of Diesel generators sets without confirming acoustic enclosures are prohibited, Bidder shall ensure consent to establish and consent to operate.
- e) Tyre Mounted Crane – Third Party Inspection Certificate, Valid Insurance Certificate, Operator License, Registration Certificate, and PUC Certificate
- f) Transit Mixer/Dumper/Tripper– Valid Insurance Certificate, Operator License, Registration Certificate, and PUC Certificate
- g) JCB – Valid Insurance Certificate, Operator License, Registration Certificate, and PUC Certificate
- h) Excavator – Valid Insurance Certificate and Operator License
- i) Daily checklist shall be furnished by Bidder and it's Employer to maintain safety and maintenance of all lifting machinery.

Bidder shall provide "Fit For Purpose" certificate of competent authority for all major construction equipment before deploying at works.

Please note that the Bidder shall submit the medical fitness certificate of all the operators and drivers at Site prior to engaging them.

## **19.8 Hazardous Material Handling**

Relevant information relating to all hazardous substances that is stored, handled and used by personnel on the project Site should be maintained in relevant register, along with necessary Material Safety Data Sheets (MSDS).

It is necessary that all hazardous substances that are stored having necessary MSDS and approved storage accordance with Legal licenses / form under the rules & regulations where necessary.

Hazardous Material applicable to the project is indicated below:

### **19.8.1 Chemicals / Hazardous Substances**

Prior to bringing on Site any chemical agent that constitutes a hazard to health, the Procurement Department will submit a copy of the material safety data sheet to the Safety Manager for his review. Considerations will include:

Procedure shall be applicable to Bidder for maintaining all chemical handling requirements to project Site. Detailed Procedure shall be shared with Bidder at the time of Kick-off meeting.

### **19.8.2 Radioactive Materials**

The Bidder shall establish a procedure for the control and use of radioactive materials that includes consideration for NDT use as well as process instrumentation that may be installed. Control measures to be implemented will include:-

NDT Contractor will be asked to produce a copy of his local rules and emergency procedure.

Procedure shall be applicable to Bidder for maintaining all Radiation safety requirements to project Site. Detailed policy shall be shared with Bidder at the time of Kick-off meeting.

## **19.9 Operations Control Procedures**

The Bidder shall establish & display Operational Control Procedures which are aimed to minimizing the HSE risks at work place. These procedures are applicable to all operations and activities carried out at the Project Site.

Operations Control Procedures provides relevant information and work procedures to be followed by Bidders and monitored by Project execution Site engineer & HSE team in order to create safe workplace & safe activities without any posing any Health and safety risks.

Operation Control Procedure must address the following elements:

- Purpose
- Scope,
- Responsibility,
- Procedure,

The specific Operations Controls Procedures are listed as below; Bidder shall follow all standard procedures available with Employer.

Procedures required as per the list below shall be produced to Employer for his approval and review.

- 1 OHS-01 OHS plan and policy
- 2 OHS-02 Employee involvement program
- 3 OHS-02A-Hazard Reporting
- 4 OHS-02B-Safety Committee

- 5 OHS-02C-Safety Ambassador
- 6 OHS-02D-Safety Poster display-Rotation
- 7 OHS-02E-Safety Rule chanting at the gate
- 8 OHS-02F-Reward and recognition
- 9 OHS-02G-Safety Mela
- 10 OHS-02H-Safety Kumbh
- 11 OHS-02-I-Safety Virus
- 12 OHS-03 Safe working procedures
- 13 OHS-03A-Abrasive Blasting
- 14 OHS-03B-Blasting operation (Rock)
- 15 OHS-03C-Chlorine handling
- 16 OHS-03D-Concrete constriction and steel erection
- 17 OHS-03E-Critical interlock bypass
- 18 OHS-03F-Drilling Piling operation
- 19 OHS-03G-Flammable & combustible
- 20 OHS-03H-Gas cylinder
- 21 OHS-03I-H<sub>2</sub>S handling
- 22 OHS-03J-Hand and Power tools
- 23 OHS-03K-Ladders and scaffolds
- 24 OHS-03L-Laser Safety
- 25 OHS-03M-Lead safety
- 26 OHS-03N-Machines & Machine guarding
- 27 OHS-03O-Mine safety
- 28 OHS-03P-Office safety management
- 29 OHS-03Q-Outdoor work, under the sky

- 30 OHS-03R-Port and Dock Safety
- 31 OHS-03S-Powered industrial trucks, forklift
- 32 OHS-03T-Pressure vessel management
- 33 OHS-03U-Sign, Signals and Barricades
- 34 OHS-03V-Site traffic Management
- 35 OHS-03W-Smoking in Workplace
- 36 OHS-03X-Spray painting and powder coating
- 37 OHS-03Y-Storage and warehousing
- 38 OHS-03Z-walking working surfaces
- 39 OHS-03AA-Welding & Gas cutting
- 40 OHS-03AB-Work on or near water
- 41 OHS-03AC-Working in Isolated area (Lone)
- 42 OHS-04 –Incident Reporting, Investigation & Follow-up
- 43 OHS-05- Induction and Training
- 44 OHS-06- Planned Safety inspections
- 45 OHS-07 -Personal Protective Equipment
- 46 OHS-07A- Respiratory PPE
- 47 OHS-08 -Contractor safety
- 48 OHS-09 -Emergency Preparedness
- 49 OHS-10 -Fire Prevention and protection system management
- 50 OHS-11- Job Safety analysis & Risk assessment
- 51 OHS-12- Permit to work system, High risk activity- High risk Process management
- 52 OHS-12A-Hotwork
- 53 OHS-12B-Confined space
- 54 OHS-12C-Work at height- fall protection

- 55 OHS-12D-Excavation Trenching
- 56 OHS-12E- Radiation safety
- 57 OHS-12F-Electrical safety
- 58 OHS-12G- Lockout- Tagout
- 59 OHS-12H- Crane and Rigging
- 60 OHS-12I-Restricted work Authorization
- 61 OHS-12J- Equipment decontamination, cleaning.
- 62 OHS-13-Management of change Review
- 63 OHS-14-Chemical Management
- 64 OHS-14A-Transport of hazardous material/ goods
- 65 OHS-14B- Underground and overhead storage tanks of hazardous material
- 66 OHS-15-Industrial Hygiene
- 67 OHS-15A- Asbestos Safety
- 68 OHS-15B- Hearing conservation
- 69 OHS-15C- Lead Safety
- 70 OHS-15D–lighting and illumination
- 71 OHS-15E–vibration control
- 72 OHS-15F- Air quality and ventilation
- 73 OHS-15G–Work place stress
- 74 OHS-15H-Fiber and dust inhalation control
- 75 OHS-15I-Food, water safety & hygiene
- 76 OHS-16-Ergonomics
- 77 OHS-16A-Manual material Handling
- 78 OHS-17- Motor Vehicle Safety
- 79 OHS-18-Medical Services

- 80 OHS-18A- Blood borne pathogen control
- 81 OHS-18B- Epidemic- Infectious disease control
- 82 OHS-18C- Fitness check for hazardous work
- 83 OHS-19-legal Compliance Assessment
- 84 OHS-19A-Insurance and Risk cover
- 85 OHS-19B-Product Safety- stewardship
- 86 OHS-20-Program Evaluation

## **19.10 Training Program, Safety Orientation And Gate Introduction**

### **19.10.1 Training to Contractor's & sub Contractor's workers/employees**

- a) It shall be the responsibility of Bidder to impart job training and safety training to all his workers /employees including his sub-Contractor's workers /employees.
- b) Each worker shall be issued a safety training card duly signed by the trainer in confirmation of safety training to worker.
- c) No worker will be assigned to work without safety training. The workers shall be visiting Employer's Safety Education Centre on scheduled dates and times or as per plan (to be discussed with safety Dept.).
- d) Visit to Safety Education Centre is compulsory by all workers.
- e) Procedure attached as OHS-05 shall be applicable to Bidder for maintaining all training related requirements to project Site.

## **19.11 Implementation, Monitoring, Reporting And Review**

### **19.11.1 HSE Monitoring**

Bidder shall establish a mechanism for monitoring of Project Health, Safety and Environmental Objectives (proactive and reactive both) which are essential to confirm that activities are being performed at the construction Site are in accordance with the project HSE plan and regulatory requirements.

This also ensures HSE Objectives are being achieved and as a means of measuring and improving health & safety performance, this shall be undertaken regularly for the duration of the project.

Monitoring activities shall include such activities as:

#### **a) Proactive Monitoring**

- Site inspections, including inspections of premises, plant, equipment and instrumentation;

- Risk based safety tours;
- Direct observation of work & behaviour of workforce against procedures, rules & standards
- Questioning of relevant individuals and examination of documents and records;
- A review of reports to establish safety statistics related to accident, incident and dangerous occurrence and sickness and absences;
- A review of system management processes/procedures
- A review of feedback/complaints from the public and other parties.

#### **b) Reactive Monitoring**

- Investigating accidents, incidents and dangerous occurrences following an accident, incident or near miss
- Investigating sickness absence
- Investigating safety concerns raised by project staff
- Investigating complaints

The Bidder shall ensure that the monitoring performance shall be reported through monthly MIS to Employers Project Head and Safety Heads every month.

Project HSE performance, HSE Objectives achievement, compliances of legal requirements and non-compliances are reviewed by Top Management in Management Review meeting half yearly.

### **19.11.2 Safety Inspection**

Safety inspections shall be conducted by the Bidders Site Engineer/ HSE personnel daily to ensure that workplaces are adequately maintained to minimize risk of incidents; employees are performing work activities with use of necessary personal protective equipment and safety devices.

The observed unsafe act / unsafe condition should be entered in the format and it should be rectified within an appropriate period.

The Engineer-In-Charge, responsible for the compliance of HSE observations shall review and monitor compliances and close observation in system or report to the HSE manager.

The Daily Inspection Format is shall be shared to Bidder at the time of kick-off meeting or upon request.

### **19.11.3 Incident Reporting, Investigation and Analysis**

The Bidder shall thoroughly investigate every incident, regardless of severity, to determine the actual causes, and to determine potential corrective actions to prevent future incidents.

Procedure shall be applicable to Bidder for maintaining all incident reporting requirements to project Site. Detailed Procedure shall be shared with Bidder at the time of Kick-off meeting.



#### 19.11.4 Safety Audits

Bidder shall allow the Employer and /or his representative to perform assessment as part of Safety audit (Internal & External audits) periodically, to determine compliance status of project HSE Plan with respect to the following

As whether or not it,

- Conforms to planned arrangements including the requirements of the HSE specifications and relevant legislature requirements.
- Has been properly implemented and maintained.
- Is effective in meeting the HSE policy and objectives.
- Review the results of previous audits and
- Provide the information on the results of audit to the Management.

##### a) Internal audit

The Employer plans the internal audit normally with a frequency of six months. The frequency and coverage of HSE audits are linked & related to the risks associated with the failure of the various elements of the HSE management system, the output from management reviews and the extent to which the HSE management system in which it operates are subjected to change.

##### b) External audit (Third party audit)

The Employer plans the internal audit normally with a frequency of once in a year. The frequency and coverage of HSE audits are linked & related to the risks associated with the failure of the various elements of the HSE management system, the output from management reviews and the extent to which the HSE management system in which it operates are subjected to change.

The Employer shall notify the internal audits program to the Bidder at least a week in advance, the audit plan covering the date of the audit, name of the department to be audited & name(s) of auditor(s)

One or more trained personnel, independent of the areas being audited are designated to carry out audit.

Prior to the audit, the internal auditor gives an overview of the audit to be performed including the focus regarding the objectives and the methodologies to be adopted for assessment.

#### 19.11.5 Management Review – HSE

The Employer shall review the project HSE plan periodically to ensure its continuing suitability, adequacy and effectiveness, set objectives for continual improvement of HSE performances through Bidder's project manager & HSE head, the management review shall preferably be as follows.

- a) **Monthly review:** Project HSE performance reported by Bidder through MIS are reviewed by Employers Site Head and Safety Heads every month.

b) **Six Monthly:** Project HSE performance, HSE Objectives achievement, Compliances of legal requirements, and Non compliances are reviewed by Employers Site Head and Safety Heads

- Management Review Meeting (MRM) shall be held at least once in 6 months and chaired by Employer's project head.
- The Management Review Meeting (MRM) shall be attended by, Site Safety Head and any other relevant Department heads or members from the Employer & Bidder's team .
- Site Safety Head shall collect all information that has to be brought to the MRM for review.
- The agenda for the MRM shall include the following:
  - Follow up actions from previous Management reviews.
  - Results of Internal audits.
  - Results of evaluation of Compliance to Legal and other requirements.
  - Results of participation and consultation.
  - Communication from external interested parties, including complaints.
  - HSE performance indicators (Results of monitoring and measurements).
  - The extent to which HSE Objectives are met.
  - Status of Incident investigation, Corrective / Preventive actions.
  - Need for changes to HSE policy, Objectives / management programs.
  - Changing circumstances, including developments in Legal and other requirements related to HSE.
  - Recommendations for improvement.

The output of Management reviews shall contain the decisions, action plans for improvement, Responsibility and time frame for completion of action plans. All shall be recorded in the minutes of Management review meeting and maintained.

## 20. DRAWINGS:

Following listed drawings are attached with Tender.

S. No.	Drawing number	Drawing Description
1.	M-001	Indicative Process Flow Diagram
2.	M-002	Terminal GA Layout
3.	M-003	Berth-14 GA Layout for Mechanization
4.	M-004	Berth-14 Cross Section for Mechanization
5.	M-005	Berth-14 Civil Construction General Arrangement, Plan, Elevation and Section
6.	M-006	Storage Shed Plan & Elevation
7.	M-007	Storage Shed Cross Section
8.	M-008	Conveyor FBC-1 Profile Drawing
9.	M-009	-Not Applicable- (Deleted)
10.	M-010	Electrical HT Single Line Diagram

**Note:**

- a) Above drawings are indications of minimum requirement of Employer.
- b) Above drawings are just for reference and understanding of Bidder. Bidder shall prepare his own drawings and detail for bidding purpose.
- c) It should be noted by the bidders that the information, size, specifications, design & dimensions mentioned in this Volume and drawings, are indicative. As in EPC Contracts, the successful bidder shall workout detail design & drawings during detail engineering stage meeting the functional, operational & performance requirements & as per relevant IS standards, well within the sanctioned estimate, and submit the fresh design & drawings for approval to employer.