



CONSTRUCTION OF CITY GATE STATION CUM CNG STATIONS & DAUGHTER BOOSTER STATIONS AT EAST AND WEST GODAVARI DISTRICTS

Document Title : TECHNICAL SPECIFICATION – DISTRIBUTION BOARD

Document No. : 16017-E-DB-0800-01

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GODAVARI GAS PRIVATE LIMITED

CLIENT REF:

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CONSULTANT:

KAVIN ENGINEERING & SERVICES
PRIVATE LIMITED

KAVIN REF:

KIP-16017





 GAPL GODAVARI GAS PRIVATE LIMITED	TECHNICAL SPECIFICATION – DISTRIBUTION BOARD	Doc No : 16017-E-DB-0800-01 Rev : C Page : 2 of 10
 KAVIN™		

TABLE OF CONTENTS

- 1.0 SCOPE**
 - 2.0 CODES AND STANDARDS**
 - 3.0 GENERAL REQUIREMENTS**
 - 4.0 SITE CONDITIONS**
 - 5.0 DESIGN AND FABRICATION REQUIREMENTS**
 - 6.0 EQUIPMENT SPECIFICATION**
 - 7.0 INSPECTION, TESTING AND ACCEPTANCE**
 - 8.0 PACKING AND DESPATCH**
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 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION – DISTRIBUTION BOARD	Doc No : 16017-E-DB-0800-01 Rev : C Page : 3 of 10
 <p>KAVIN</p>		



1.0 Scope

This specification covers the requirement of design, fabrication, testing, packing and supply of sheet steel distribution board in single front execution required for receipt, control and distribution of power to various medium voltage & low voltage loads.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of latest revision of following standards issued by BIS unless otherwise specified.

IS: 772AC	Electricity Meters
IS: 1248	Direct acting electrical indicating instruments
IS: 2705	Current transformers
IS: 2824	Method for determining the comparative tracking index of solid Insulating materials under moist conditions
IS: 3156	Voltage transformers
IS: 3231	Electrical relays for power systems protection
IS: 3618	Phosphate treatment of iron and steel for protection against corrosion
IS: 5082	Material data for aluminium bus bars
IS: 5578	Guide for marking of insulated conductor
IS: 6005	Code of practice of Phosphating of iron and steel
IS: 8623	Factory built assemblies of switchgear and control gear for voltages Up to and including 1000 V AC and 1200 V DC. Part -II particular requirements for bus bar trucking systems (bus ways)
IS: 11353	Guide for uniform system marking and identification of conductors and apparatus terminals
IS: 13703	Low voltage fuses.

 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION – DISTRIBUTION BOARD	Doc No : 16017-E-DB-0800-01 Rev : C Page : 4 of 10
 <p>KAVIN™</p>		

IS: 13947 LV Switchgear and control gear (Part-1 to Part-5)

- 2.2 In case of imported equipment standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.
- 2.3 The equipment shall also conform to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.
- 2.4 In case Indian standards are not available for any equipment, standards issued by IEC/BS / VDE/ IEEE/ NEMA or equivalent agency shall be applicable.
- 2.5 In case of any contradiction between various referred standards / specifications / data sheet and statutory regulations the following order of priority shall govern:

- Job specification
- This specification
- Codes and standards

3.0 GENERAL REQUIREMENTS



- 3.1 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.
- 3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment at least for 15 years from the date of supply.
- 3.3 Vendor shall give a notice of at least one-year to the end user of equipment and WGI before phasing out the product/spares to enable the end user for placement of order for spares and services.

4.0 SITE CONDITIONS

- 4.1 The DBs shall be suitable for installation and satisfactory operation in a substation with restricted natural air ventilation in tropical, humid and corrosive atmospheres. The DBs shall be designed to operate under specified site conditions. If not specifically mentioned altitude not exceeding 1000 meters above mean sea level shall be considered.

Ambient Temp : 18°C (min) / 48°C (max)

- 4.2 All the equipment described in this specification is intended for continuous duty at
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 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION – DISTRIBUTION BOARD	Doc No : 16017-E-DB-0800-01 Rev : C Page : 5 of 10
 <p>KAVIN™</p>		

the Specified ratings under the specified ambient conditions unless indicated otherwise.

5.0 DESIGN AND FABRICATION REQUIREMENTS



The distribution board shall meet following requirements of this specification in addition to the general requirements as per latest editions of applicable Indian standards.

- 5.1 The distribution board shall be suitable to operate at 415V AC 3ph, four wire, 50Hz and it shall be free standing, suitable for wall/floor mounting, with complete front access for operation and maintenance. The distribution board shall be fixed type in single front execution, assembled in single line up, metal enclosed, fully compartmentalized, totally segregated compartments for feeders, cables and bus bar, dust and vermin proof suitable for indoor installation.
 - 5.2 Distribution board enclosure shall provide a degree of protection not less than IP-54 as per applicable IS.
 - 5.3 The Distribution board shall be assembled out of vertical panels of uniform height not exceeding 2200 mm for floor mounted and 800mm for wall mounted installation. The maximum height of the operating handle/switches shall not exceed 1900 mm and the minimum height not below 300 mm.
 - 5.4 The distribution board shall be designed to ensure maximum safety during operation, inspection, and connection of cables, relocation of outgoing circuits and maintenance with the energized bus bar system and without taking any special precautions. The switchgear shall permit maximum interchangeability and shall be extensible on either side.
 - 5.5 The distribution board shall be sheet steel clad with the frame fabricated out of 2mm cold rolled sheet steel and doors/covers out of 1.6mm cold rolled sheet steel, having heavy duty integral base frame for each vertical panel.
 - 5.6 All hardware shall be corrosion resistant. All joints and connections of the panel members shall be made of galvanized, zinc passivated or cadmium plated high quality steel bolts, nuts and washers, secured against loosening.
 - 5.7 All openings, covers and doors shall be provided with neoprene gaskets around the perimeter to make the distribution board dust and vermin proof. Suitable lifting hooks shall be provided and each shipping section for ease of lifting of distribution board.
 - 5.8 All metal surfaces shall be thoroughly cleaned, degreased to remove mill scale, rust, grease and dirt. Fabricated structure shall be pickled and then rinsed to
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 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION – DISTRIBUTION BOARD	Doc No : 16017-E-DB-0800-01
 <p>KAVIN™</p>		Rev : C Page : 6 of 10

remove any trace of acid. The under coat shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The distribution board shall be powder coated. Pre-treatment of the distribution board shall be done by 7 tank process before powder coating. The final paint shade shall be as per manufacturer standard unless specified otherwise.



- 5.9 The distribution board shall be suitable for bottom cable entry unless specified otherwise and shall be provided with removable gland plates unless otherwise specified. The distribution board shall have a separate cable alley for each vertical panel with cable tying arrangement. The width shall be sufficient to accommodate the required number of cables. However, in any case it shall not be less than 200mm width. The cable alley shall be provided with a suitable hinged door. Required number of single compression nickel plated brass cable glands and tinned copper compression type lugs for all power and control cables shall be included in the vendor's scope of supply.
 - 5.10 The distribution board shall comprise of incoming load break switch/MCCB/Switch Fuse Unit Panel, Contactor, outgoing switch fuse/MCCB, MCB/ contactors feeders, motor starter feeders, control supply transformers, both power and auxiliary/control bus bars, cable termination compartment etc. All these shall be housed in independent compartments separated from each other by metallic barrier.
 - 5.11 Main horizontal bus bars shall be provided at the top in separate compartment. Vertical bus bars required for connection between main bus bars and outgoing feeders shall be in separate vertical chamber. One set of vertical bus bars can be provided for feeding outgoing feeders in two panels on either side of the vertical bus bar.
 - 5.12 All components including bus bars and cable termination shall be accessible only from the front side for repair and maintenance.
 - 5.13 Each outgoing feeder shall be in multitier arrangement and all feeders shall be of modular design with height in multiple of standard unit size.
 - 5.14 Number and rating of feeders shall be as per electrical load list/single line diagram. The components rating and type for various types of outgoing feeders such as motor feeders shall be selected based on package requirement and shown in SLD.
 - 5.15 All auxiliary devices for control, indication, measurement and protection except the bimetallic relays shall be mounted on the front side of the respective compartment. Components requiring frequent inspection during operation shall be easily accessible.
 - 5.16 Main bus bars shall be of high conductivity Electrical Grade Aluminum/copper as mentioned in SLD having uniform current rating throughout their length. Horizontal and vertical bus bars shall be sized depending upon the maximum expected current and to limit the specified maximum operating temperature at specified design ambient temperature.
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 <p>GGPL GODAWARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION – DISTRIBUTION BOARD	Doc No : 16017-E-DB-0800-01 Rev : C Page : 7 of 10
 <p>KAVIN</p>		

- 5.18 The maximum operating temperature of bus bars including joints at the maximum design temperature inside the panel shall not exceed 95°C under normal operating conditions.
- 5.19 Minimum clearance between live parts, between live parts/neutral to ground shall be 20 mm.
- 5.20 No separate auxiliary copper bus bars shall be provided for control supply and metering requirements and control supply shall be taken from main bus bar. Necessary tee-off connections shall be used for distributing auxiliary supply to each vertical panel.
- 5.21 All horizontal and vertical bus bars shall be insulated with heat shrink PVC sleeves of 1100 V grade and removable shrouds shall be provided for joints. All bus bars shall be prominently marked with Red; Yellow and Blue colour rings for easy phase identification at regular interval and at every power tap off point and designed to withstand specified short circuit currents for one second.
- 5.22 Copper earth bus of 25x3 mm size shall be provided throughout the length of the distribution board with provision for interconnection to earthing grid at two ends. All non-current carrying metallic parts of the mounted equipment shall be earthed. Doors and movable parts shall be earthed using flexible copper connections.
- 5.23 Inside the distribution boards, the wiring for power, control, signaling protection and instrument circuits shall be done with PVC insulated copper conductors having 660/1100 V grade insulation.
- 5.24 Minimum size of control wire shall be 2.5 mm² coppers for all control. Each wire shall be identified at both ends by self-sticking wire marker tapes or PVC ferrules. Transparent shrouds shall be used on outgoing power terminals.
- 5.25 Clamp type terminals shall be acceptable for wires up to 10 sq.mm size, for conductors larger than 10 sq.mm bolt type terminals with crimping lugs shall be provided. Each wire shall be terminated at a separate terminal. A minimum of 10% spare terminal shall be provided on each terminal block. Shorting links shall be provided for all CT terminals.

6.0 EQUIPMENT SPECIFICATION

- 6.1 The contactors shall be air break type having AC-3 duty rating as per package requirement. All contactors shall be provided with 1 NO + 1 NC potential free spare auxiliary contacts wired to the terminal block for owner use.
- 6.2 All current more than 10A shall be measured through CTs. All phases shall be provided with CT of minimum burden of 10VA with 5A secondary. The CTs shall

 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION – DISTRIBUTION BOARD	Doc No : 16017-E-DB-0800-01 Rev : C Page : 8 of 10
 <p>KAVIN</p>		

conform to the relevant IS. The design and construction shall be dry type, epoxy resin cast and suitable for withstanding thermal and dynamic stresses during short circuit conditions.

6.3 The secondary terminal of the CT shall be brought out suitably to a terminal block which shall be easily accessible for testing. The protection CTs shall be of accuracy class 5P10 and that for the measurement shall be of accuracy class 1.

6.4 The ammeters and voltmeters shall be of taut band of square shape with 240° deflection type. The voltmeter /ammeter for incoming circuit shall be of 144 x 144 mm and that for the outgoing feeders shall be of 96x96 mm. size. Ammeter for motor circuit shall be of suppressed scale type. Voltmeter shall be provided through protection fuses. Ammeter shall be provided in each motor feeder.

6.5 All selector switches shall be rotary back-connected types having a cam operated contact mechanism with knob type handle. Ammeter selector switch shall have make before break feature on its contacts.

6.6 Indicating lamps shall be suitable for 6.0 V AC, complete with built in 240/6V transformers. Lamps shall be provided with translucent covers to diffuse light. Alternately clustered LED type indicating light with minimum 8mm-diameter size shall be considered. The following indicating colors shall be used.

Phase indication	:	Red, Yellow, Blue
Close/on	:	Red
Open/off	:	Green
Fault trip	:	Amber
Control supply on	:	White



Push button (if any) colours shall be as follows:

Stop/ open/emergency	:	Red
Start/close	:	Green
Reset/test	:	Yellow/Black/White

'Stop' push buttons for motor control feeders shall have stay put feature.

All motor starter feeders shall have Stop and Reset push buttons and On and Trip indication lamps.

6.7 A centrally located engraved nameplate shall be provided for the distribution board. Each module shall have engraved *nameplate-bearing data* as per approved drawings. Name plate or *polyester* adhesive stickers shall be provided for each equipment mounted on the distribution board. Identification tags shall be provided inside the panels. Special warning labels shall be provided on removable covers or doors giving access to cable terminals and bus bars.

 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION – DISTRIBUTION BOARD	Doc No : 16017-E-DB-0800-01 Rev : C Page : 9 of 10
 <p>KAVIN</p>		

6.8 At least 20% spare feeders of each rating of outgoing feeders subject to a minimum of one feeder of each rating shall be provided in the switchboard.

6.9 All sheet steelwork shall undergo a process of degreasing, pickling in acid, cold rinsing, and phosphating, passivating (seven tank processing) and then painted with electrostatic paint (Powder coating). The colour of panel inside / outside shall be RAL 7032.

7.0 INSPECTION, TESTING AND ACCEPTANCE

7.1 In addition to the expediting/inspection activities being undertaken by the package vendor, distribution board shall be subject to inspection by WGI/Owner or by an agency authorized by the owner. All necessary information concerning the supply shall be furnished to WGI/Owners inspectors. Two weeks notice shall be given to WGI/owner for witnessing the final testing of the complete assembly to ensure satisfactory operation of all components.



7.2 Tests shall be carried out at the manufacturer works under his supervision and at his cost.

7.3 All routine tests as specified by the applicable standards and codes shall be conducted. Type tests certificates of a recognized testing organization shall be furnished with the bids. The vendor shall also submit the guaranteed technical particulars with the bids.

7.4 In addition, specified tests shall be conducted to check mechanical and electrical operation and the control wiring to specification and schematic drawings.

7.5 Acceptance tests shall be as follows:

- A general visual check shall be carried out. This shall cover measurement of overall dimensions, location, number, and type of devices and their ratings as per bill of materials, terminal blocks, location and connection of terminals.
 - Manual and electrical operation of switches, contactors, relays etc. under various conditions of supply voltage.
 - Insulation resistance of the main and auxiliary circuit shall be checked.
 - Operation check for each control function as per the schematic diagram by manually simulating the actual operating conditions.
 - Primary injection test to check winding of current transformers, ammeter, ammeter selector switch and correctness of wiring connection between them.
 - Relays shall preferably be tested with secondary injection test equipment.
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 GAPL GODAVARI GAS PRIVATE LIMITED	TECHNICAL SPECIFICATION – DISTRIBUTION BOARD	Doc No : 16017-E-DB-0800-01 Rev : C Page : 10 of 10
 KAVIN™		

- 7.6 For equipment bought from other sub-suppliers certified test reports of tests carried out at the manufacturer's works shall be submitted. Normally all routine tests as specified in the relevant standards shall be conducted by the sub-supplier at his works. In addition type test if specified shall be additionally carried out and witnessed by the owner at CPRI/approved testing authority.

8.0 PACKING AND DESPATCH

The equipment shall be properly packed for transportation by ship/rail or trailer. The panels shall be wrapped in polyethylene sheets before being placed in wooden crates /cases to prevent damage to the finish. Crates /cases shall have skid bottoms for handling. Special precaution notations such as Fragile, This side up, center of gravity, weight, Owner's particulars, Purchase number etc. shall be clearly marked on the package together with other details as per purchase order. The equipment may be stored outdoors for long periods before installation. The packing should be suitable for outdoor storage in areas with heavy rains and high ambient temperature unless otherwise agreed.



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Document Title : TECHNICAL SPECIFICATION FOR UPS

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 GAPL GODAVARI GAS PRIVATE LIMITED	TECHNICAL SPECIFICATION FOR UPS	Doc No : 16017-E-DB-0800-02
 KAVIN™		Rev : A Page : 2 of 9

TABLE OF CONTENTS

- 1.0 SCOPE**
 - 2.0 CODES AND STANDARDS**
 - 3.0 SITE CONDITIONS**
 - 4.0 DESIGN AND FABRICATION REQUIREMENTS**
 - 5.0 CONSTRUCTIONAL DETAILS**
 - 6.0 EQUIPMENT SPECIFICATION**
 - 7.0 PAINTING**
 - 8.0 INSPECTION, TESTING AND ACCEPTANCE**
 - 9.0 SPARES**
 - 10.0 PACKING AND DISPATCH**
 - 11.0 DEVIATIONS**
-

 <p>GGPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR UPS	Doc No : 16017-E-DB-0800-02
 <p>KAVIN</p>		Rev : A Page : 3 of 9

1. SCOPE

1.1. The specification covers the design, manufacture, testing at works and dispatch in well packed condition of Uninterrupted Power Supply System required to supply AC power for non linear loads.

1.2. The scope shall include the following:

- i) Online UPS system including converter, inverter, static & maintenance switches
- ii) in-built bypass unit
- iii) Sealed lead acid battery (1x 100% for 4 hours back up)
- iv) Interconnecting cabling between various units of UPS and batteries
- v) All other items required, but not specified for safe and reliable operation of UPS system.

2. CODES & STANDARDS

2.1. The equipment shall conform to the latest issue of the following and relevant Indian Standard specifications or equivalent specification of the country of origin or IEC specifications.

2.2 The equipment offered shall generally conform to the following codes / standards:

IS: 13314 – Solid state inverters run from storage batteries.

IS : 11260 -- Stabilized power supplies AG output.

IEC: 146 -- Solid state inverters.



2.3 The equipment shall also conform to the provision of Indian Electricity Rules, Indian Supply Act and any other statutory regulations in force from time to time.

3. AMBIENT CONDITIONS

Ambient Air Temperature :

Maximum - 48 °C

Minimum - 18 °C



 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	<p align="center">TECHNICAL SPECIFICATION FOR UPS</p>	<p>Doc No : 16017-E-DB-0800-02</p>
 <p>KAVIN</p>		<p>Rev : A</p> <p>Page : 4 of 9</p>

4. DESIGN AND OPERATIONAL REQUIREMENTS.



SYSTEM OPERATION

- 4.1. The UPS unit and its associated equipment shall be suitable for operating at the specified rating continuously with the specified voltage and frequency variations under the ambient conditions without exceeding the temperature rise limits specified in relevant standards and without any detrimental effect on any part.
 - 4.2. The UPS system shall be based on latest generation of IGBT based, pulse width modulated (PWM) design with proven performance. The system should be able to communicate with RTU's on modbus protocol and provided with multi-dropping facility.
 - 4.3. Single UPS with by-pass

In UPS system having this configuration a single rectifier and inverter shall be provided. Under normal conditions when AC mains power is available, the rectifier shall simultaneously feed DC power to inverter as well as for float/rapid charging of the battery. The AC supply to loads shall be fed from inverter output. In case of any fault of the inverter, the load shall be automatically transferred to stabilized bypass supply and retransfer of load from stabilized bypass supply of the inverter shall be possible in auto as well as in manual mode.
 - 4.4. In case of AC input power failure or battery charger failure. the battery shall supply power to inverter without any interruption. The charger shall be designed for simultaneously feeding complete inverter load and for float/rapid charging the battery to its rated capacity. Charger shall be equipped with 'On Line' automatic as well as manual charging facility.
 - 4.5. The UPS unit shall be suitable for 0.7 lagging to unity power factor loads. The overall load power factor may be taken as 0.8 lagging.
 - 4.6. The maximum waveform distortion of the output voltage shall not exceed 5% r.m.s for linear load and 10% r.m.s. for non-linear loads. The UPS unit shall be suitable for operation for non-linear loads having crest factor of 3.
 - 4.7. The inverter steady state output voltage and frequency (free running) variation shall not exceed $\pm 1\%$ for specified input power supply condition and no-load to full load condition.
 - 4.8. Voltage dip/rise on sudden application / throw of 100% load or on changeover from inverter to bypass or vice versa shall not exceed 15% and shall be recovered within 100 m.sec. to rated voltage.
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 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR UPS	Doc No : 16017-E-DB-0800-02 Rev : A
 <p>KAVIN</p>		Page : 5 of 9

- 4.9. UPS shall be designed for overload of 125% for 10 min. and 150% for 10 sec. After which drooping characteristic shall come into operation.
- 4.10. On failure of the main supply, inverter unit shall continue to supply rated load from the battery bank for 4 hours duration.
- 4.11. Charger shall simultaneously supply entire power necessary for inverter and to keep the battery of required capacity in fully charged condition. Provision for automatic charging in both float and boost shall be made.
- 4.12. Battery shall be sealed lead acid battery. The battery capacity shall be decided considering load power factor as 0.8, derating factor for ageing 0.8 and derating for minimum ambient temperature as applicable.
- 4.13. The ventilation fans, if provided shall be supplemented by 100% redundant fan in normal operation. Normal and redundant fan shall run together. The power supply for fan shall be tapped from the inverter output. It should be possible to operate inverter even after the failure of the fan without temperature rise inside the inverter cubicle exceeding the safe operating temperature limits for 2 hours with alarm for fan failure.
- 4.14. In case of inverter failure due to any reason or overload, affected unit should be isolated and changeover to other inverter or to bypass should take place automatically.
- 4.15. Noise level at a distance of 1m from UPS panels shall not exceed 60 dB.
- 4.16. UPS system shall be provided with necessary control, protection, metering, indication, alarm & annunciation for reliable and safe operation of the system.
- 4.17. All semi-conducting devices shall be protected by fast acting semi-conducting fuses.
- 4.18. The battery may be taken out of service for maintenance during which period it shall be possible for the inverter to continue operation taking power from the rectifier. The input filter of the inverter shall be suitably designed to take care of this operational requirement.
- 4.19. It shall be possible to vary the output voltage steplessly within $\pm 5\%$ of the specified output voltage. This adjustment shall be possible to be made when UPS is in operation.
- 4.20. UPS system shall be suitable for both floating output or earthing of one leg in case of single phase system / star-point in case of three phase system.
- 4.21. The UPS system shall have very high system of reliability having minimum MTBF of 50,000 hrs. Vendor shall furnish the value of MTBF, MTTR and availability factor.
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 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR UPS	Doc No : 16017-E-DB-0800-02
 <p>KAVIN</p>		Rev : A Page : 6 of 9

5. CONSTRUCTIONAL DETAILS

- 5.1. The equipment shall preferably be supplied in enclosed, dust & vermin proof, floor mounted, sheet steel enclosure. In case, it is necessary to provide opening for ventilation, this should be closed by fine mesh. Minimum degree of protection for enclosure shall be IP-41 as per IS-13997.
- 5.2. All the live parts which are accessible after opening the front cover / back cover shall be properly insulated or provided with insulating barrier to prevent accidental contact. Bus bars of distribution boards shall be PVC sleeved.
- 5.3. Smaller size UPS can be directly placed on floor or fixed on the mounting stand support.
- 5.4. Battery banks shall be mounted on racks in proper manner. Vendor shall supply rack arrangement, connecting cables and all accessories required for proper mounting and operation of battery banks.

6. EQUIPMENT SPECIFICATION

- 6.1. All components shall conform to relevant IS/IEC standards and shall be of reputed make. Makes of all components shall be subject to purchaser's / consultant's approval.
 - 6.2. THYRISTORS, DIODES AND TRANSISTORS.
The thyristors, diodes and transistors shall have adequate safety margins to withstand specified operating conditions. A factor of safety of minimum 4 shall be taken against voltage surges.
 - 6.3. PCBs
All electronic control & monitoring printed circuit boards shall be fixed type on ceramic insulators to avoid loose contacts due to vibration/long usage. Failure of each PCB shall be indicated by visual alarm and indication. The visual fault diagnostic shall preferably indicate fault into various sections of the cards. All printed circuit board shall be mounted on fixed ceramic insulator.
 - 6.4. ELECTROLYTIC CAPACITORS
These may be polarized aluminium type I, suitable for long life and category I, as per IS: 4317 or equivalent IEC. The capacitor shall preferably be self-healing type. These shall be so located in inverter panels that the operating temperature does not exceed 65°C maximum.
 - 6.5. TRANSFORMERS AND CHOKES
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 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR UPS	Doc No : 16017-E-DB-0800-02 Rev : A Page : 7 of 9
 <p>KAVIN</p>		

All transformers and chokes shall be of dry type and air cooled. This shall be class 'H' insulated, vacuum impregnated. Class F / Class B insulated cast resin transformers and chokes are also acceptable.

6.6. STATIC SWITCHES

Static switches shall be naturally commutated type with parallel inverse connected thyristors. These shall be rated for continuous duty for 100% load. Short time rated static switches are not acceptable.

6.7. MCB

For isolating devices of various equipment, MCB shall be used. These shall be provided with overload and short circuit protective devices and shall conform to IS: 2516.

Battery Circuit Breaker shall have under voltage trip and reverse polarity protection device.

7. PAINTING

7.1. The enclosure after pre-treatment, shall be painted with two coats of anti-rust paint followed by two coats of anticorrosive paint.

7.2. All paints shall be carefully selected to withstand tropical heat and extremes of weather. The paint shall not scale off, crinkle or be removed by abrasion due to normal handling.



7.3. Unless otherwise specified, the finishing shade shall be light grey Shade No. 631 as per IS:5 or as per manufacturer's standard.

7.4. Electrostatic powder paint shall be preferred.

8. INSPECTION, TESTING AND ACCEPTANCE

8.1. The UPS units shall be subjected to test as per relevant standards. The test shall include, but not limited to the following :

- i) Rectifier & inverter soft starting
 - ii) Regulation test
 - iii) Heat run test for 8 hours
 - iv) Overload test
 - v) Test for changeover time in synchronised and desynchronised mode.
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 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR UPS	Doc No : 16017-E-DB-0800-02 Rev : A Page : 8 of 9
 <p>KAVIN</p>		

- vi) Test for dynamic response and transient performance
- vii) Sequence & transfer test
- viii) Noise level measurement
- ix) Test to check the selectivity of protective devices
- x) Alarm test (simulation of various fault conditions)
- xi) Measurement of harmonic distortion
- xii) Ventilation test (operation without redundant fan)
- xiii) Insulation test

8.2. All the above tests shall be carried out in presence of purchaser's representative. In addition, the equipment shall be subjected to stage inspection during process of manufacture at works and site inspection.

8.3. These inspections shall however, not absolve the vendor from his responsibility for making good any defects, which may be noticed subsequently.

9. SPARES

9.1. Vendor shall provide all MANDATORY SPARES along with main equipment.

9.2. Any other spare parts required, but not specified, shall also be offered.

10. PACKING AND DISPATCH

10.1. The UPS & battery banks shall be properly packed before dispatch to avoid damage during transport, storage and handling.



10.2. The packing box shall contain a copy of the installation, operation and maintenance manual.

10.3. A sign to indicate the upright position of the panels to be placed during transport and storage shall be clearly marked. Also proper arrangement shall be provided to handle the equipment.

10.4 Minimum 2 years warranty shall be provided for UPS and battery system.

11. DEVIATIONS

11.1. Deviations, if any, from this standard shall be clearly indicated in the offer with

 GGPL GODAVARI GAS PRIVATE LIMITED	TECHNICAL SPECIFICATION FOR UPS	Doc No : 16017-E-DB-0800-02
 KAVIN™		Rev : A Page : 9 of 9

reasons thereof. Deviations from the data indicated in specification shall be shown clearly by encircling it and indicating the revised data in specification.



CONSTRUCTION OF CITY GATE STATION CUM CNG STATIONS & DAUGHTER BOOSTER STATIONS AT EAST AND WEST GODAVARI DISTRICTS

Document Title : SPECIFICATION FOR LT POWER & CONTROL CABLES

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GODAVARI GAS PRIVATE LIMITED

CLIENT REF:

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CONSULTANT:
KAVIN ENGINEERING & SERVICES
PRIVATE LIMITED

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 GAPL GODAVARI GAS PRIVATE LIMITED	TECHNICAL SPECIFICATION FOR LT POWER & CONTROL CABLES	Doc No : 16017-E-DB-0800-03
 KAVIN™		Rev : A Page : 2 of 14

TABLE OF CONTENTS

1. SCOPE
 2. STANDARDS
 3. GENERAL CONSTRUCTION
 4. CABLES ACCESSORIES
 5. INSPECTION, TESTING AND ACCEPTANCE
 6. MISCELLENOUS MATERIAL SPECIFICATIONS
 7. CABLE LAYING
 8. TERMINATIONS
 9. TESTING
 10. PACKING AND DESPATCH
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 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR LT POWER & CONTROL CABLES	Doc No : 16017-E-DB-0800-03 Rev : A Page : 3 of 14
 <p>KAVIN</p>		



1.0 SCOPE

This specification along with data sheets covers requirements for design, manufacture, testing at works and supply of Flame Retardant Low Smoke (FRLS) XLPE cables and cable terminating accessories for medium voltage systems.

2.0 STANDARDS

2.1 The cables and cables jointing & terminating accessories shall comply with the latest edition of the following standards as applicable:

IS: 1554 [Part-I]	PVC insulated (heavy duty) Electric cables.
IS: 7098	Cross-linked polyethylene insulated PVC sheathed
IS: 8130	Conductors for insulated electric cables and flexible cords
IS: 3975	Mild steel wires, strips and tapes for armouring of cables
10810(Part 41)	Methods of test for cables: Mass of zinc coating on steel armour.
IS: 209	Specification for zinc
IS: 10418	Drums for electric cables
IS: 10810 (Pt-58)	Oxygen Index test
IS: 10810 (Pt 61)	Flame Retardant test
IS: 10810 (Pt 62)	Fire resistance test for bunched cables
IEC: 60332-3	Tests on electric cables under fire conditions.
IEC: 60502	Extruded solid dielectric insulated power cables for rated Voltages from 1 KV up to 30 kV
IEC: 60540 & 60540A	Test methods for insulation and sheaths of electric Cables
ASTM: D2863	Standard method of test for flammability of plastics using oxygen index method.
IS: 10810	Method of Test for cables; Part 43 Insulation resistance
IS: 10810	Method of Test for cables: Part 45 High voltage test.
OISD 147	Inspection and safe practice during electrical installation

 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR LT POWER & CONTROL CABLES	Doc No : 16017-E-DB-0800-03
 <p>KAVIN</p>		Rev : A Page : 4 of 14

2.2 In addition to the above it shall be ensured that the installation conforms to the requirements of the following as applicable:

- Indian Electricity Act and Rules.
- Regulations laid down by CEA/Electrical Inspectorate.
- Regulations laid down by CCE/DGMS (as applicable).
- The petroleum rules (Ministry of Industry Government of India).
- Any other regulations laid down by central/state/local authorities and Insurance agencies.

2.3 The cables and accessories shall also conform to the provisions of Indian Electricity Rules and other statutory regulations, as applicable.

3.0 GENERAL CONSTRUCTION

3.1 The cables shall be suitable for laying in trays, trenches, ducts, and conduits and for underground-buried installation with uncontrolled backfill and possibility of flooding by water and chemicals.

3.2 Outer sheath of all PVC cables shall be black in colour and the minimum value of oxygen index shall be 29 at $27 \pm 2^{\circ}$ C. In addition suitable chemicals shall be added into the PVC compound of the outer sheath to protect the cable against rodent and termite attack.

3.3 All cables covered in this specification shall be Flame Retardant Low Smoke (FRLS) unless specified otherwise. The outer sheath of XLPE cables shall possess flame propagation properties meeting requirements as per IS-10810 (Part-62) category C1.

3.4 Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter. The embossing / engraving shall be legible and indelible.

3.5 The overall diameter of the cables shall be strictly as per the values declared by the manufacturer in the technical information subject to a maximum tolerance of ± 2 mm up to overall diameter of 60mm and ± 3 mm for beyond 60mm.

3.6 PVC / Rubber end caps shall be supplied free of cost for each drum with a minimum of eight per thousand meter length. In addition, ends of the cables shall be properly sealed with caps to avoid ingress of water during transportation and storage.

3.7 The cables used in installations under the jurisdiction of Director General of Mines

 <p>GGPL GODAWARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR LT POWER & CONTROL CABLES	Doc No : 16017-E-DB-0800-03 Rev : A Page : 5 of 14
 <p>KAVIN</p>		

and Safety (DGMS) shall be of copper conductor only, and shall have valid DGMS approvals for the specified locations. The word "Mining Cable" shall be embossed / engraved on the cable outer sheath as per the applicable Indian Standards

3.8 XLPE cables

3.8.1 All power/control cables for use on medium voltage systems shall be heavy-duty type, 650/1100 V grade with aluminium / copper conductor, XLPE insulated, inner-sheathed, armoured and overall PVC sheathed FRLS unless specified otherwise.

3.8.2 The conductors shall be solid for conductor of nominal area up to and including 6 mm² and stranded beyond 6mm². Conductors of nominal area less than 16 mm² shall be circular only. Conductors of nominal area 16 mm² and above may be circular or shaped as per IS 8130.

3.8.3 The core insulation shall be with XLPE compound applied over the conductor by extrusion and shall conform to the requirements of Table-1 of IS: 7098 Part-1. The average thickness of insulation shall be not less than nominal value specified in Table-3 of IS: 7098 Part- 1. Control cables having 6 cores and above shall be identified with prominent and indelible Arabic numerals on the outer surface of the insulation. Colour of the numbers shall contrast with the colour of insulation with a spacing of maximum 50 mm between two consecutive numbers. Colour coding for cables up to 5 cores shall be as per Indian standard.

3.8.4 The inner sheath shall be applied over the laid-up cores by extrusion and shall be of PVC conforming to the requirements of Type ST2 PVC compound as per IS: 5831. The minimum thickness of inner sheath shall be as per IS: 7098 (Part-I). Single core cables shall have no inner sheath.

3.8.5 If armouring is specified for multicore cables, the same shall be by single round galvanised steel wires where the calculated diameter below armouring does not exceed 13 mm and by galvanised steel strips where this dimension is greater than 13 mm. Requirement and methods of tests for armour material and uniformity of galvanisation shall be as per IS - 3975 and IS -10810 (Part 41). The dimensions of Armour shall be as per of IS - 7098 (Part -1). If armouring is specified for single core cables, the same shall be with H4 grade hard drawn aluminium round wire of 2.5 mm diameter.

3.8.6 The outer sheath for the cables shall be applied by extrusion and shall be of PVC FRLS compound conforming to the requirements of type ST-2 compound as per IS: 5831. The minimum and average thickness of outer sheath for unarmoured cables and minimum thickness of outer sheath for armoured cables shall be as per IS: 7098 (Part -1).

3.9 Control Cables:

Control cables shall be 1100 Volt Grade, 2.5 mm² copper conductor XLPE insulated PVC sheathed FRLS, single wire armored with an overall PVC sheath, as per IS: 7098 part- I.

 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR LT POWER & CONTROL CABLES	Doc No : 16017-E-DB-0800-03 Rev : A Page : 6 of 14
 <p>KAVIN</p>		

4.0 CABLE ACCESSORIES

- 4.1 The termination and straight through jointing kits for use on the systems shall be suitable for the type of cables offered as per this specification.
- 4.2 The accessories shall be supplied in kit form. Each component of the kit shall carry the manufacturer's mark of origin.
- 4.3 The kit shall include all stress grading, insulating and sealing materials apart from conductor fittings and consumable items .An installation instruction sheet shall also be included in each kit.
- 4.4 The contents of the accessories kit including all consumable shall be suitable for storage without deterioration at a temperature of 45° C, with shelf life extending to more than 5 years.
- 4.5 Terminating kits


The terminating kits, if used, shall be suitable for termination of the cables to indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer / motor. For outdoor terminations, weather shields / sealing ends and any other accessories required shall also form part of the kit. The terminating kits shall be from one of the makes / types mentioned in the data sheet.

- 4.6 Jointing kits

The straight through jointing kits if used shall be suitable for installation on overhead trays, concrete lined trenches, and ducts and for underground burial with uncontrolled backfill and possibility of flooding by water and chemicals. These shall have protection against any mechanical damage and suitably designed to be protected against rodent and termite attack. The inner sheath similar to that provided for cables shall be provided as part of straight through joint. The jointing kits shall be from one of the makes / types mentioned in the data sheet.

5.0 INSPECTION, TESTING AND ACCEPTANCE

The cables shall be tested and inspected at the manufacturer's works. All the materials employed in the manufacture of the cable shall be subjected, both before and after manufacture, to examination, testing and approval by EIC / owner. Manufacturer shall furnish all necessary information concerning the supply to EIC / owner's inspectors. The inspector shall have free access to the manufacturer's works for the purpose of inspecting the process of manufacture in all its stages and he will have the power to reject any material, which appears to him to be of unsuitable description or of unsatisfactory quality. The vendor shall give at least 2 weeks advance notice to the purchaser, regarding the date of testing to enable him or his representative to witness the tests.

 <p>GAPL GODAWARI GAS PRIVATE LIMITED</p>	<p align="center">TECHNICAL SPECIFICATION FOR LT POWER & CONTROL CABLES</p>	<p>Doc No : 16017-E-DB-0800-03</p>
 <p>KAVIN</p>		<p>Rev : A</p> <p>Page : 7 of 14</p>

5.1 Cables

- 5.1.1 After completion of manufacture of cables and prior to dispatch, the cables shall be subjected to type, routine, acceptance and special tests as detailed below. EIC/ Owner reserve the right to witness all tests with sufficient advance notice from vendor. The test reports for all cables shall be got approved from the Engineer before dispatch of the cables.
- 5.1.2 All routine tests, acceptance tests, type tests and additional type tests for improved fire performance shall be carried out as listed in IS: 7098 (Part-I), and IS: 7098 (Part-2) on XLPE insulated cables.
- 5.1.3 The test requirements for XLPE insulation and sheath of cables shall be as per latest revision of IS: 5831
- 5.1.4 Acceptance tests as per IS-7098 (Part-2) and the following special tests to be performed on the cables. These tests are required to be witnessed by EIC/owner before dispatch of cables.
- a) Oxygen index test as per ASTM D-2863-77 at 21°C
 - b) Temperature index test as per ASTM D-2843-77 at 21% of oxygen
 - c) Smoke density test as per ASTM D-2843-77
 - d) Flame retardant test as per IEC 60332 part-1

5.2 Cable Accessories

Type tests should have been carried out to prove the general qualities and design of a given type of termination / jointing system as per IS-13573. The type test certificates from independent testing laboratory shall be submitted before dispatch.

6.0 MISCELLANEOUS MATERIAL SPECIFICATIONS


All materials and hardwares to be supplied by the contractor shall be new, unused and of best quality and shall conform to the latest specifications of Bureau of Indian Standards.

6.1 Cable Trays:

Cable tray shall be ladder type or perforated trays as mentioned in drawings and shall be of prefabricated hot dip galvanized iron trays comply with specifications of Bureau of Indian Standards.

Pre-fabricated hot dipped galvanized trays

The cable trays shall comply with the requirements specified in EIC installation STD.

 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR LT POWER & CONTROL CABLES	Doc No : 16017-E-DB-0800-03 Rev : A Page : 8 of 14
 <p>KAVIN</p>		

Cable ladders/ Trays are to be manufactured from hot dip Galvanised material with UV protection features. They are heavy duty type having loading criteria and fire withstanding capacity.

Ladder type tray shall be used for Power and control cables, perforated type tray shall be considered for instrument cables. However perforated tray for power cable shall be considered if cable size & quantity is less.

Outdoor cable trays shall run in RCC trench/ on pipe sleepers/ on dedicated supports. Overhead cable trays if any shall be installed 2700 mm (minimum) above grade level and 300 mm above FGL. However Overhead cable tray shall be avoided as can as possible in dispensing station area.

6.2 Cable Glands:

Cable glands shall be of nickel plated brass unless otherwise specified. The industrial type double compression type cable glands shall be used for indoor panels/equipment (e.g. substation, control room etc). The cable glands for outdoor terminations shall be weather protected, flameproof, double compression type and shall have PVC shroud for additional weather protection. Cable glands forming a part of relevant FLP enclosure shall be FLP type, tested by CMRI or any other recognized independent testing laboratory and approved by CCE/DGMS or any other statutory authority as applicable. Indigenous FLP glands shall have valid BIS license as per the requirements of statutory authorities. The size of cable glands supplied shall be appropriate to the size of cable so that flame proof property of glands is retained.

Entry thread of cable gland shall be compatible to NPT the entry thread provided in the equipment as applicable. If required, suitable reducers/adopters shall be used.

6.3 Connectors:


Power cable terminations shall be made with crimped type tinned copper/aluminium solder less lugs which shall be suitable for the cable size mentioned in cable schedule.

6.4 Ferrules:

Ferrules shall be of approved type and of size to suit core size mentioned and shall be employed to designate the various cores of control cable by the terminal numbers to which the cores are connected, for ease of identification.

7.0 CABLE LAYING

7.1 General

 <p>GGPL GODAWARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR LT POWER & CONTROL CABLES	Doc No : 16017-E-DB-0800-03 Rev : A Page : 9 of 14
 <p>KAVIN</p>		

Cable installation shall include power, control, lighting etc. cables. These shall be laid in trenches/ cable trays as detailed in the cable layout drawings. Cable routing given on the cable layout drawings shall be checked in the field so as to avoid interference with structures, heat sources, drains, piping, air-conditioning duct if any etc. Any change in routing shall be done to suit the field conditions wherever deemed necessary, after obtaining approval of Engineer-in-charge.

- 7.1.1 LT power and control cables shall be laid in a same cable tray unless otherwise specified as shown on layout drawings/installation standards. If details of cable routes and cable spacing is not shown in detail on drawing, it shall be determined by the contractor and approved by the engineer in-charge.


When single core cables are laid in flat formation, the individual cable fixing clamps and spacers shall be of non-magnetic material. As a general practice, the sheath of single core cables shall be earthed at one point to keep sheath at earth potential unless otherwise stated. Single core cables, when laid in trefoil formation shall be braced by suitable clamps at a distance, not exceeding 3 meters along the cable routing.

The Telephone, Communication and Fire alarm cables shall run on instrument trays. Minimum 300mm space clearance shall be maintained between electrical and instrument cable trays.

- 7.1.2 The lengths indicated in the cables schedule are only approximate. The contractor shall ascertain the exact length of cable for a particular feeder by measuring at site. All cable routes shall be carefully measured. Before the start of cable laying, the contractor shall prepare cable drum schedule and get that approved by Engineer-in -charge to minimise/avoid straight through joints and then the cables cut to the required lengths, leaving sufficient lengths for the terminations of the cable at both ends. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. Extra loop length shall be given for feeder cables where required as per the directions of Engineer-in-charge to meet contingencies

Cables shall be laid in RCC trench with cable trays (underground trench) or in directly buried trench as shown on cable layout drawings. Both electrical and instrument trays shall be run in same trench in different levels.

- 7.1.3 Cables shall be neatly arranged in the trenches / trays in such a manner that criss-crossing is avoided and final take off to the motor / switchgear is facilitated. Arrangement of cables within the trenches / trays shall be in line with cable layout drawings. Cable routing between cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size wherever applicable. Pipe sleeves shall be laid at an angle of maximum 45° to the trench wall. Bending radii of pipes

 <p>GGPL GODAWARI GAS PRIVATE LIMITED</p>	<p align="center">TECHNICAL SPECIFICATION FOR LT POWER & CONTROL CABLES</p>	<p>Doc No : 16017-E-DB-0800-03</p>
 <p>KAVIN</p>		<p>Rev : A</p> <p>Page : 10 of 14</p>

shall not be less than 8D. It is to be ensured that both the ends of GI pipe sleeves shall be sealed with approved weather proof sealing plastic compound after cabling. In places where it is not possible, cables shall be laid in smaller branch trenches.

- 7.1.4 All cables shall be identified close to their termination point by cable tag numbers as per cable schedule. Cable tag numbers shall be punched on aluminium straps (2mm thick, 20 mm wide and of enough length) securely fastened to the cable and wrapped around it).

Each underground cable shall be provided with cable tags of lead securely fastened every 30 m of its underground length with at least one tag at each end before the cable enters/leaves the ground. In unpaved areas, cable trenches shall be identified by means of cable markers as per installation drawing. These cable markers shall be placed at location of changes in the direction of cables and at intervals of not more than 30 m and also at cable straight through joint locations.

- 7.1.5 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of cables shall be taped with an approved PVC end cap or rubber insulating tape.


- 7.1.6 Each row of cables shall be laid in place and before covering with sand incase if buried trench. All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/lined trench. Every cable shall be given an insulation test in presence of Engineer-in-charge/Owner before filling the cable trench with sand Any cable which is found defective shall be replaced.

- 7.1.7 Where cables pass through foundation walls, the necessary openings shall be provided in advance for the same. However, should it become necessary to cut holes in existing structures for example floor slab etc., the electrical contractor shall determine their location and obtain approval of the Engineer-in-charge before carrying out the same.

- 7.1.8 Cables for road crossings shall be taken through ERC (Electrical Road Crossing) as shown in the cable layout drawings.

At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.

- 7.1.9 Ends of cables leaving trench shall be coiled & capped and provided with protective cover till such time the final termination to the equipment is completed.

 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR LT POWER & CONTROL CABLES	Doc No : 16017-E-DB-0800-03 Rev : A Page : 11 of 14
 <p>KAVIN</p>		

7.2 Cables laid direct in ground

Cables shall be laid underground in excavated cable trenches where specified in cable layout drawings. Trenches shall be of sufficient depth and width for accommodation of all cables. Cables shall be properly spaced and arranged with a view of heat dissipation and economy of design. Maximum number of cable layers in trench shall be preferably limited to 5 layers.

Minimum depth of cable trench shall be 750 mm for LT Cables. The depth and the width of the trench shall vary depending upon the number of layers of cables as per EIC installation Standards

Cables shall be laid in buried trenches at depth as shown in the cable layout drawings. It is to be insured by the contractor that the bottom of buried trenches shall be cleared of all rocks, stones and sharp objects before cables are placed. The trench bottom shall be filled with a layer of sand. This sand shall be leveled and cables laid over it. These cables shall be covered with 150mm of sand on top of the largest diameter cable and sand shall be lightly compacted. A flat protective covering of 75 mm thick second class red bricks shall then be laid and the remainder of the trench shall then be back -filled with soil, rammed and leveled.

7.3 Cables laid in concrete trench

Cables shall be laid in cable tray with 3 tiers maximum in concrete trench as shown on layout drawings. RCC covers of trenches shall be effectively sealed to avoid ingress of chemical and oil in process area. Removal of concrete covers where required for the purpose of cable laying and reinstating them in their proper position after cables are laid shall be done by electrical contractor.

All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water.

7.4 Above ground cables

7.4.1 Cable laid on supporting angle in structures, columns and vertical run of cable trays shall be suitably clamped by means of G.I. saddles / clamps, whereas cables in horizontal run of cable trays shall be tied by means of nylon cords. Distance between supporting angles shall not exceed 600 mm.

7.4.2 All cable trays (other than galvanised trays) and supporting steel structures shall be painted before laying of cables. The under surfaces shall be properly degreased, de-rusted, de-scaled and cleaned. The painting shall be done with one coat of redoxide zinc chromate primer. Final painting shall be done with two coats of approved bituminous aluminium paint unless otherwise specified.

7.4.3 Where cables rise from trench to motor, lighting panel, control station, junction

 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR LT POWER & CONTROL CABLES	Doc No : 16017-E-DB-0800-03 Rev : A Page : 12 of 14
 <p>KAVIN</p>		

box etc., they shall be taken in GI pipe for mechanical protection upto a minimum of 300 mm above grade. Cable ends shall be carefully pulled through conduit to prevent damage to cable.

- 7.4.4 All G.I. Pipes shall be laid as per layout drawings and site conditions. Before fabrication of various profiles of pipes by hydraulically operated bending machine (which is to be arranged by the contractor) all the burrs from the pipes shall be removed. GI Pipes having bends shall be buried in soil/concrete in such a way that the bend shall be totally concealed. For G.I. pipes buried in soil, bitumen coating shall be applied on the buried lengths, Installation of G.I. pipes shall be undertaken well before paving is completed and necessary coordination with paving agency shall be the responsibility of Electrical Contractor.

Following guide shall be used for sizing of G.I. pipe.

- a) 1 cable in a pipe - 53% of pipe cross-sectional area occupied by cables.
- b) 2 cables and above cables in a pipe - 40% of pipe cross-sectional area occupied by cables.


- 7.4.5 After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/bitumen/suitable sealing compound. Alternatively rubber bushes shall be employed for the purpose of sealing.

8. TERMINATIONS

- 8.1 All XLPE cables up to 1100V grade shall be terminated at the equipment by means of compression type cables glands suitable for the cable size. They shall have a screwed nipple with conduit electrical threads and check nut. The cables shall be identified close to their termination points at both the ends of cable(cable numbers shall be punched on aluminium straps 2 mm thick and securely fastened to the cable, wrapped around it) and also along the route at recommended intervals, by cable tag numbers.

All cable entries for outdoor termination shall be preferably through bottom. Outdoor cable termination through top of equipment shall not be permitted.

- 8.2 Power cables cores wherever colour coding is not available shall be identified with red, yellow and blue PVC tapes. Where copper to aluminium connections are made, necessary bimetallic washers shall be used.
- 8.3 In case of control cables, all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules suitable for core size. Wire numbers shall be as per manufacturer's schematic/ wiring/inter-connection diagram. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends, for future use.


 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR LT POWER & CONTROL CABLES	Doc No : 16017-E-DB-0800-03 Rev : A Page : 13 of 14
 <p>KAVIN</p>		

For trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/ Control panels and Control Switches.

- 8.4 Contractor shall drill holes for fixing glands wherever necessary. Gland plate shall be of non- magnetic material/ aluminium sheet in case of single core cables. All unused cable entries on equipment/panels shall be plugged/sealed.
- 8.5 The cable shall be terminated at electrical equipment/switchboards through glands of proper size. The individual cores shall then be dressed and taken along the cables ways or shall be fixed to the panels with polyethylene straps . The cable glanding shall be done as per manufacturer's instructions. Cable armour shall not be exposed after termination is complete. In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom close fit holes shall be drilled in the gland plate for all the cables in one line, then gland plate shall be split in two parts along the centre line of holes. After fixing bottom plate, uncovered cable holes/gaps shall be sealed with cold setting compound.
- 8.6 Crimping of lugs to cable leads shall be done by hand crimping / hydraulically operated tool as per requirement. Insulation of the leads shall be removed before crimping. Conductor surface shall be cleaned and shall not be left open. Suitable conducting jelly shall be applied on the conductor lead. Lugs shall enclose all strands of cable core. Cutting of strands shall not be allowed.
- 8.7 The contractor shall bring to the notice of Engineer-in-charge any mismatch in cable glands, lugs provided with the equipment vis-a-vis to the cable size indicated in cable schedule for taking corrective action.
- 8.8 The cable joints in power and control cables shall be avoided as far as possible. In case a joint is unavoidable, the following shall be insured:
- The number of joints shall be restricted to minimum as far as possible.
 - The location of joints shall be identified with permanent markers.
 - No joints shall be allowed in hazardous areas without the approval of Engineer-in- charge.

The jointing and termination of medium voltage power cables shall be carried out by trained personnel only. Jointing and termination of high voltage cables shall be done by skilled and experienced jointer duly approved by Engineer-in-charge. Only type tested termination kits of approved make shall be used.

- 8.9 No unauthorized repairs, modifications shall be carried out on the hazardous area equipment terminal boxes and junction boxes. Damaged enclosures of hazardous area equipment shall be brought to the notice of Engineer-in-charge by contractor. After
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 <p>GAPL GODAWARI GAS PRIVATE LIMITED</p>	<p align="center">TECHNICAL SPECIFICATION FOR LT POWER & CONTROL CABLES</p>	<p>Doc No : 16017-E-DB-0800-03</p>
 <p>KAVIN</p>		<p>Rev : A</p> <p>Page : 14 of 14</p>

termination is complete, all the bolts, nuts, hard wares of terminal box shall be properly placed in its position and tightened.

9. TESTING AND COMMISSIONING

- 9.1 Field testing and commissioning of electrical installation shall be carried out as per specification and relevant Indian standards.
- 9.2 Before energizing, the insulation resistance of every circuit shall be measured from phase to phase, phase to neutral and from phase/ neutral to earth.
- 9.3 Where terminations are required in circuits rated above 650 volts, insulation resistance of each length of cable shall be measured before terminating. After completion of terminations measurements shall be repeated.
- 9.4 For cables up to 1.1 kV grade 1000 V Megger shall be used.
- 9.5 Cable schedule, cable layout drawings, Interconnection drawings shall be marked by contractor's 'AS BUILT STATUS' and two sets of copies shall be submitted to EIC/Owner.

10. PACKING AND DESPATCH

- 10.1 Cables shall be dispatched in non-returnable wooden or steel drums of suitable barrel diameter, securely battened, with the take-off end fully protected against mechanical damage. The wood used for construction of the drum shall be properly seasoned, sound and free from defects. Wood preservatives shall be applied to the entire drum. Ferrous parts used shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage.
- 10.2 On the flange of the drum, necessary information such as project title, manufacturer's name, type, size, voltage grade of cable, length of cable in meters, drum no., cable code, BIS certification mark, gross weight etc. shall be printed. An arrow shall be printed on the drum with suitable instructions to show the direction of rotation of the drum.
- 10.3 A tolerance of ± 3 % shall be permissible for each drum. However, overall tolerance on each size of cable shall be limited to ± 2 %. Offers with short / non-standard lengths are liable for rejection. If non-standard drum lengths are specified in the data sheet, the same shall be supplied.



CONSTRUCTION OF CITY GATE STATION CUM CNG STATIONS & DAUGHTER BOOSTER STATIONS AT EAST AND WEST GODAVARI DISTRICTS

Document Title : TECHNICAL SPECIFICATION FOR LIGHTING SYSTEM

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 GAPL GODAVARI GAS PRIVATE LIMITED	TECHNICAL SPECIFICATION FOR LIGHTING SYSTEM	Doc No : 16017-E-DB-0800-04 Rev : A Page : 2 of 10
 KAVIN™		

TABLE OF CONTENTS

- 1.0 SCOPE**
- 2.0 STANDARDS**
- 3.0 EQUIPMENT SPECIFICATION**
- 4.0 LIGHTING SYSTEM**
 - 4.1 General**
 - 4.2 Conduit System**
 - 4.3 Hazardous Area**
 - 4.4 Building Lighting**
 - 4.5 Street Lighting**

- 5.0 TESTING AND COMMISSIONING**

 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR LIGHTING SYSTEM	Doc No : 16017-E-DB-0800-04 Rev : A Page : 3 of 10
 <p>KAVIN</p>		

1.0 SCOPE

This specification defines the requirements for the supply of equipment, materials, installation, testing and commissioning of the lighting system (lighting fixtures, lighting/ power distribution etc.).

2.0 CODES AND STANDARDS



- 2.1 The work shall be carried out in the best workmanlike manner, in conformity with this specification WGI Installation Standards, and the relevant specifications/ codes of practice of the Bureau of Indian Standards.
- 2.2 In addition to the above it shall be ensured that the installation conforms to the requirements of the following as applicable:
- a) Indian Electricity Act and Rules.
 - b) Regulations laid down by CEA/Electrical Inspectorate.
 - c) Regulations laid down by CCE/DGMS (as applicable).
 - d) The petroleum rules (Ministry of Industry Government of India).
 - e) Any other regulations laid down by central/state/local authorities and Insurance agencies.

3.0 EQUIPMENT SPECIFICATIONS

All materials, fittings and appliances to be supplied by the contractor shall be new, unused and of the best quality and shall conform to the specifications given hereunder. These shall be manufactured in accordance with the latest revision of the specifications of Bureau of Indian Standards/International standards. In the absence of any specifications for a particular item, contractor shall bring material samples along with proven track record to site and get the same approved by Engineer-in-Charge/Owner before installation.

3.1 Lighting and Power Distribution Board

Lighting and Power DBs shall be of sheet steel construction (2mm thickness) and shall be dust and vermin proof, suitable for surface or flush mounting on wall surface type. The DBs shall be indoor type. Indoor type DBs shall have IP54 degree of protection. The LDBs shall be of reputed make and MCBs used shall be of reputed make as per the approved list of the Makes. The MCBs shall be rated for 10 kA fault rating. Each LDB shall be provided with ELCB and MCB of adequate rating and type (TPN/DP as required) on the incoming side and required nos. of MCBs on the outgoing side. Minimum 20% spare MCBs shall be provided on the outgoing side. All metal surfaces shall be cleaned free of rust, given a coat of red-oxide primer and finished with two coats of epoxy based paint of shade 632 of IS 5.

 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR LIGHTING SYSTEM	Doc No : 16017-E-DB-0800-04 Rev : A Page : 4 of 10
 <p>KAVIN</p>		

Lighting and Power DBs shall have FP incoming feeder and single/three phase outgoing feeders. Lighting circuit feeders shall be rated for 10/16 amps and power circuit feeders shall have current rating of 16Amps. DBs shall be equipped with phase and neutral bus bars of required current carrying capacity. The outgoing feeders shall be provided with single pole miniature circuit breakers (MCBs) for safe areas and double pole MCBs for hazardous areas. Miniature circuit breakers shall be mounted in such a way that the operating levers shall not be projected outside the door cover. Only the indication lamps and meters and pushbuttons shall be projected outside or mounted on the panel door. A hinged door to cover the operating knobs shall be provided. In addition, a circuit diagram indicating incoming details and outgoing details viz. Circuit number, circuit rating, load connected and details of the load shall be pasted inside the panel. Also a laminated copy of the diagram shall be provided inside the panel in a suitably designed pocket. Two external earthing studs for connection to the plant earthing grid shall be provided on the panel. Further, the panel shall be provided with an earth bus bar with terminal studs for connection to the third core of each outgoing circuit. Each circuit phase and neutral shall be given ferrule numbers. Complete wiring inside the panel, shall be neatly bunched with PVC tape and button. Sufficient terminals shall be provided in the terminal block so as to ensure that no more than one wire (core) is connected to a terminal. The panel shall have knock out holes or removable gland plate for the entry of incoming and outgoing conduits or cables from bottom.



Wherever the size of incoming cable to lighting, power DBs is more than 35 sq. mm a suitable cable adapter box shall be provided and attached to the panel. The incoming cable leads shall be connected to terminal block (bolted type terminals) of required size. This terminal block shall be connected to FP incoming unit through separate PVC insulated copper conductor wires/bus bars. Sufficient space shall be provided (200 to 250mm) between gland plate and the bottom of terminal block for easy termination.

3.2 Lighting fixtures

The types, makes and catalogue numbers of various types of industrial/flameproof lighting fixtures shall be selected suitable for this project application (CNG stations) from the approved or reputed vendors. The electrical contractor shall provide the catalogues & data sheets for the selected light fitting for the approval of EIC before purchasing it. LED lighting fixtures shall be complete with ballast, starters and capacitor, as required. The fixtures shall be of high power factor type i.e. at least 0.9 or more.

3.3 Switches

Switches, manufactured in accordance with IS: 13947 shall be used for non hazardous areas. Switches in areas where concealed wiring has been adopted,

 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR LIGHTING SYSTEM	Doc No : 16017-E-DB-0800-04 Rev : A Page : 5 of 10
 <p>KAVIN</p>		

shall be flush mounting piano type unless otherwise specified. For surface conduit wiring, piano type switches in surface mounted box shall be provided.

3.4 Outlet Boxes

The outlet boxes used as point outlets shall be prefabricated type 65mm deep junction boxes. Outlet boxes custom fabricated for fixtures shall be made of M.S. Sheet having minimum thickness of 1.6mm. Outlet boxes shall be galvanized after fabrication. These shall be complete with terminal block suitable for connection of wires up to 4 sq. mm. Front cover plate shall be of 3mm thick bakelite / PE sheet. The sheet shall extend at least 2 mm on all sides of outlet box. Cover plate shall be fixed by cadmium plated brass screws and cup washers. Outlet boxes shall be provided with adequate number of knock outs on all the sides for ease of wiring either with conduits or without conduits.

3.5 Conduit and Accessories

Conduits for Electrical installations shall conform to IS: 9537. The type of conduit is GI. GI conduit shall be of 1.6mm thick and concealed type shall be used.

3.6 Lighting Poles

Lighting poles shall be fabricated (as per installation Drawing) from steel tubular pipes of specified section, with joints, swaged together when hot and bevelled on outside edges. Poles shall be coated with bituminous preservative solution on the ground portion of the outside surface. Remainder of the outside surface shall be given one coat of red oxide primer and finished with two coats of aluminium paint. A flameproof marshalling box/ junction box shall be fixed near the bottom for lighting fixture cable entry looping in and looping out connection.

3.7 Wires



Wires shall be FRLS XLPE insulated and shall be of 660/1100 Volts grade as per IS:7098. Conductor shall be of stranded copper and size shall be minimum 2.5 Sq. mm for lighting. Red/Yellow/blue wires for phases, black wire for neutral and green wire for earth shall be used (size of earth wire shall be same as for phase and neutral size). Wire size for air conditioning circuit feeders shall be as indicated in the SLD/cable schedule.

4.0 LIGHTING SYSTEM

4.1 General

4.1.1 The lighting fixtures in the plant shall be fed from lighting DB. All outdoor lighting shall be group controlled manually or through synchronous timer.

4.1.2 The lighting layouts furnished by owner will indicate approximate locations of

 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR LIGHTING SYSTEM	Doc No : 16017-E-DB-0800-04 Rev : A Page : 6 of 10
 <p>KAVIN</p>		

lighting fixtures. The electrical contractor shall determine, with approval of Engineer-in-Charge, the exact locations of each fixture in order to avoid interference with piping or other mechanical equipment and also with a view to obtain as much uniform illumination as practicable, and to avoid objectionable shadows. Conduits/cables shall be laid out by the contractor to suit field conditions and as per directions of the Engineer-in-Charge.

4.1.3 The minimum height of any lighting fixture shall be preferably not less than 6.0 meters above the ground level in outdoor plant area.

4.1.4 All outdoor cable terminations to DBs shall be through bottom . Top entries for cables shall be avoided to avoid water entry. All cable glands for outdoor terminations shall be double compression type and the gland shall be covered with PVC or rubber boot shroud. All unused cable entries shall be plugged with suitable blanking plugs.



4.1.5 Mounting height of equipment shall be as under:-

Top of Switch Box	:	1200mm	from	FFL
(Finished floor level) Top of Lighting/power DB	:	1800 mm	from	FFL.
5/15 Amp. Receptacle	:	1200 mm	for process areas and industrial sheds	
Lighting fixture	:	As indicated in layout drawing		

4.1.6 For indoor building, fixtures shall be suspended from concrete surfaces with the help of anchor fasteners. In such cases special care shall be taken to see that anchoring is firm. In places where ceiling fans are provided, lighting fixtures shall be suspended below the level of fan to avoid shadow effect.

4.1.7 Circuit cables in a group shall be cleated to structure by using galvanised strip clamps or cable run in cable trays wherever trays are available. Spacers and cleats shall be of required size to accommodate the cables. All hardware shall be galvanised or zinc passivated. Underground lighting cables (in paved areas) shall be taken in suitable G.I. sleeves buried at a minimum depth of 300mm from FFL. GI pipe sleeves shall be extended to 300mm above FFL. For plant areas, lighting cable shall be directly buried and shall be taken out to the pole JB through pipe sleeve embedded in pole concrete foundation. Exact termination/layout of G.I. pipes (for protection of cables) shall be decided at site as per site convenience in consultation with Engineer-in-charge.



4.1.8 Wiring for all outlet sockets shall be done with 3 cores of equal sizes for phase, neutral and earth. The terminals of switch sockets shall be suitable to receive the size of wire specified.

 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR LIGHTING SYSTEM	Doc No : 16017-E-DB-0800-04 Rev : A Page : 7 of 10
 <p>KAVIN</p>		

- 4.1.9 All lighting fixtures shall be provided with terminal block with required terminals suitable for connection of wire up to 2.5 sq. mm copper conductor.
- 4.1.10 The cable shall be straightened after unwinding it from the drum. All cables be clamped/laid in straight run without any sag and kink.
- 4.1.11 For location where fan points are shown, fan hooks with junction box shall be provided during concreting. Where fan hooks and J.Bs. are provided separately JB shall be located within a distance of 300mm from hook for mounting of ceiling rose.
- 4.1.12 Industrial type plug sockets with 25A MCB or rating shall be provided at a height of 500mm from FFL for window AC units. Socket outlets and plugs for installation in electrical building, workshop, maintenance shop etc. shall be of industrial metal clad type.

4.2 Conduit System

- 4.2.1 Concealed conduit system of wiring shall be adopted, as specified in the drawings. Required number of pull boxes shall be used at intervals to facilitate easy drawing of wires. Separate conduit shall be run for lighting and power circuits. Conduit layout shall be decided at site as per site conditions. Drop conduits for switch boards shall be decided by contractor as per wall locations shown in Architectural drawings.
- 4.2.2 Only threaded type conduit fittings shall be used for metallic conduit system. Pin grip type or clamp type fittings are not acceptable. Conduit ends shall be free from sharp edges or burrs. The ends of all conduits shall be reamed and neatly bushed.
- Conduit shall be of minimum 25mm dia. Maximum number of wires permissible in a conduit shall be seven/nine for wire size of 2.5 sqmm/1.5 sqmm. respectively.
- 4.2.3 The conduit shall not be exposed anywhere in the building. In canopy area, conduit shall be concealed type.
- 4.2.4 Where concealed wiring is done, junction boxes (65mm deep) shall be used so as to rest on shuttering properly. Conduits shall be laid above reinforcement. All conduit connections shall be properly screwed and Junction box covers shall be properly fitted so as to avoid entry of concrete slurry.
- 4.2.5 Where concealed wiring is to be adopted, conduits shall be laid in time before concreting of the slab. Pull wire (GI or steel) shall be provided inside conduit for the ease of wire pulling. The contractor shall coordinate his work with other agencies involved in the civil works in such a way, that the work of the other agencies is not hampered or delayed. Vertical conduit runs shall be made in wall
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 <p>GGPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR LIGHTING SYSTEM	Doc No : 16017-E-DB-0800-04 Rev : A Page : 8 of 10
 <p>KAVIN™</p>		

before plastering is done so as to avoid chasing. Where chases are made for conduit run contractor shall fill these chases or any other openings made by them after completing the work and patch the surface. During installation, care shall be taken to see that proper covers are provided to prevent rusting of conduits. Locations of all point outlets, junction boxes shall be marked with brick powder or sand so that these are easily identified after shuttering removal. As built conduit layout drawing shall be submitted by contractor after completion of the work.

4.2.6 All bends and other accessories shall be of the same material as that of conduit and shall have the same protective coatings. All junction boxes shall be MS chromium plated.

4.2.7 The conduit system shall be tested, for mechanical and electrical continuity and shall be permanently connected to earth by means of approved type of earthing clamps.



4.3 **Hazardous Area**

4.3.1 Wiring in hazardous area shall be done by using minimum 2.5mm² copper conductor FRLS, XLPE armoured cable. Circuit wiring feeding hazardous areas shall be controlled by two pole switches/MCBs (for phase as well as neutral isolation).

4.3.2 Correct type of lighting equipment (fixtures and JBs) with regard to hazardous protection as specified in the drawing, shall be installed for the areas classified as Zone I, Zone 2 etc.

4.3.3 Hazardous area yard lighting shall be pole mounted type. Lighting pole shall be steel tubular swaged type same as pole used for street lighting fixtures. The terminations in the junction boxes and the lighting fittings shall be done avoiding possibility of loose connections due to vibrations. After the terminations are made the cover of the junction boxes and the lighting fittings shall be closed properly with all bolts and hard wares in correct position, retaining its explosion and weather protections.

4.3.4 Cable glands for terminating cable on flameproof equipment shall be of double compression FLP type. Any material/equipment specified to be supplied by contractor for installation in hazardous areas, shall be tested by CMRI and duly approved by C.C.E. or DGMS or any other applicable statutory authority. All indigenous FLP equipment shall also have valid BIS license as required by statutory authorities.



 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR LIGHTING SYSTEM	Doc No : 16017-E-DB-0800-04 Rev : A Page : 9 of 10
 <p>KAVIN</p>		

4.4 **Building Lighting**

- 4.4.1 The type of wiring system shall comprise surface/concealed conduit system or cable wiring as specified on layout drawings.
- 4.4.2 All lighting fixtures in indoor building shall be ceiling mounted. Mounting details of fixtures shall be indicated on the drawings.
- 4.4.3 Wiring in areas above false ceiling shall be done in Surface Conduit (25mm dia GI conduit) suitably clamped to the true ceiling. Vertical drops from true ceiling for DBs, switches, receptacles etc. shall be taken in 25mm dia PVC conduit concealed in walls up to switchboards/DBs. Lighting fixtures shall be supported from true ceiling. Exact location of fixtures shall be finalized in co-ordination with air-conditioning layout, DBs layout and false ceiling grid layout. To facilitate easy maintenance 'Looping back system' of wiring shall be followed throughout. Accordingly supply tapplings and other interconnections including for earthing are made only at fixture connector blocks or at switch boards. Required number of junction boxes shall be used at intervals for wire pulling and inspection.
- 4.4.4 All wires in conduit shall be colour coded as specified. Each circuit shall have independent phase neutral and earth wire. However when group of circuits are run in a single conduit the earth wire can be common.
- 4.4.5 Building conduit lighting system of wiring where measurement is done on point wiring basis generally consists of two parts. The first part is the circuit wiring which includes the work necessary from lighting panel up to switch box and from switch box to another switch box .. The second part is the point wiring which shall include the work necessary from tapping point in the switch box upto various fixtures or fan outlets/ceiling roses.
- 4.4.6 In no case, two different sources or two different phases of supply shall be combined in one switchboard.
- 4.4.7 Switches for light fixtures/exhaust fans in battery room shall be provided outside the Battery room.

4.5 **Street Lighting**

- 4.5.1 Street lighting poles to be located on road side shall be installed at a minimum distance of 300mm from the edge of the walkway of the road. Size of wires from marshalling box / Junction box up to fixture shall be min. 2.5mm², copper conductor XLPE insulated FRLS.
- 4.5.2 Each pole shall be earthed at one point by connecting to the plant earth grid as shown on Installation standards.
- 4.5.3 Street lighting fixture shall be mounted on steel tubular poles as per
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 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION FOR LIGHTING SYSTEM	Doc No : 16017-E-DB-0800-04 Rev : A Page : 10 of 10
 <p>KAVIN</p>		

standard drawings. The foundation for the street lighting poles will be made by electrical contractor. Street lighting poles shall be supplied with a base plate.

4.5.4 The poles shall be numbered as per the drawings/ directions of Engineer in-charge.

5.0 TESTING AND COMMISSIONING

5.1 Lighting installation shall be tested and commissioned by installation contractor as per Owner's specifications.

Pre-commissioning checks and tests, shall include but not be limited to the following:

- a) The insulation resistance of each circuit without the lamps (load) being in place shall be measured and it should not be less than 500,000 ohms. (Between phases, phases to neutral, phase/neutral to Earth).
- b) Current and voltage of all the phases shall be measured at the lighting panel bus bars with all the circuits switched on with lamps. If required load shall be balanced on the three phases.
- c) The earth continuity for all socket outlets shall be checked. A fixed relative position of the phase and neutral connections inside the socket shall be established for all sockets.
- d) After inserting all the lamps and switching on all the circuits, minimum and maximum illumination level shall be measured in the area and recorded.
- e) It shall be ensured that switch provided for ON/OFF control of point (light/fan/socket) is only on phase (Live) side.
- (f) Operation of ELCB's shall be checked.
- (g) Contractor shall duty fill in all the above test results and submit the test reports to Engineer-in-Charge in triplicate.

5.2 All lighting layout drawings shall be marked by contractor for 'AS BUILT STATUS' and two sets of copies shall be submitted to Owner/EIC.



CONSTRUCTION OF CITY GATE STATION CUM CNG STATIONS & DAUGHTER BOOSTER STATIONS AT EAST AND WEST GODAVARI DISTRICTS

Document Title : TECHNICAL SPECIFICATION EARTHING SYSTEM

Document No. : 16017-E-DB-0800-05

REV.	DATE	DESCRIPTION	BY	CHECKED	APPROVED
A	16-DEC-2016	ISSUED FOR REVIEW	MSG/RAJ	AD/MSR	AKN/BSK

PROJECT DOCUMENTS ARE CONTROLLED DOCUMENTS.

REVISIONS ARE DENOTED | IN RIGHT HAND MARGIN

CLIENT:

GODAVARI GAS PRIVATE LIMITED

CLIENT REF:

-

CONSULTANT:

**KAVIN ENGINEERING & SERVICES
PRIVATE LIMITED**

KAVIN REF:

KIP-16017





 GAPL GODAVARI GAS PRIVATE LIMITED	TECHNICAL SPECIFICATION - EARTHING SYSTEM	Doc No : 16017-E-DB-0800-05
 KAVIN™		Rev : A Page : 2 of 9

TABLE OF CONTENTS

- 1.0 SCOPE**
 - 2.0 CODES AND STANDERDS**
 - 3.0 MATERIAL SPECIFICATIONS**
 - 4.0 EARTHING NET WORK**
 - 5.0 INSTALLATION OF EARTH ELECTRODE**
 - 6.0 CONNECTION**
 - 7.0 TESTING AND COMMISSIONING**
 - 8.0 TEST PROCEDURE**
 - 9.0 EQUIPMENT EARTHING CONDUCTOR SIZES**
-

 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION - EARTHING SYSTEM	Doc No : 16017-E-DB-0800-05 Rev : A Page : 3 of 9
 <p>KAVIN</p>		

1.0 SCOPE

This specification defines the requirements for the supply of earthing materials and installation of the earthing systems.

2.0 CODES AND STANDARDS

2.1 The work shall be carried out in the best workman like manner / conformity with this specifications, owner's installation Standards, layout drawings, the latest edition of relevant specifications, codes of practice of Bureau of Indian Standards and OISD Standards listed below:

SP: 30 (BIS)	Special Publication – National Electrical Code
IS: 2309	Protection of buildings and allied structures against lightning.
IS: 3043	Code of practice for earthing
IS: 7689	Guide for control of undesirable static electricity.
OISD 110	Recommended practices on static electricity
OISD 147	Inspection and safe practice during electrical installation.

2.2 In addition to the above it shall be ensured that the installation conforms to the requirements of the following as applicable:

- Indian Electricity Act and Rules.
- Regulations laid down by CEA/Electrical Inspectorate. Regulations laid down by CCE/DGMS (as applicable).
- The petroleum rules (Ministry of Industry Government of India).
- Any other regulations laid by central/state/local authorities and Insurance agencies.



3.0 MATERIAL SPECIFICATIONS

3.1 All materials and hardwares to be supplied by the contractor shall be new, unused and of best quality and shall conform to the specifications given here under and to latest specifications of Bureau of Indian Standards. Contractor shall bring material samples to site and get it approved by Engineer-in-charge before installation.

3.2 The main grid conductor shall be hot dip galvanized G.I. strip. Sizes for main conductors shall be marked on the drawings. Thickness of hot dip galvanizing shall not be less than 75 microns. Earth electrodes shall be as per owner's standard drawing.

4.0 EARTHING NETWORK

4.1 This consists of main earth conductor (grid conductor) forming a closed ring network with required number of earth electrodes connected to it to provide a



 <p>GAPL GODAWARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION - EARTHING SYSTEM	Doc No : 16017-E-DB-0800-05 Rev : A Page : 4 of 9
 <p>KAVIN™</p>		

common earth for electrical devices and metallic structures. From each earth electrode two distinct connections shall be made to the main earth conductor. The earth plates shall be used for taking multiple earth connections to two or more equipment.

- 4.2 The main earth conductor shall be directly buried or laid along cable trays/cable trench as indicated on the earthing layout drawing. Where installed in lined cable trenches, it shall be firmly cleated to the sidewall of concrete trenches using GI clamps at interval of 400 mm to 500 mm and near to the termination end. The earthing conductor shall run in trench along cable trays route. The cable trays on the same cable route shall be earthed at a regular interval of 10 meter. The earthing for equipment shall be tapped from the main earth conductor and not from cable tray support structure. Earth conductor when laid underground shall be at a depth of 600 mm below finished grade level.
- 4.3 Joints and tapping in the main earth loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below grade shall be welded and shall be suitably protected by giving two coats of bitumen and covering with Hessian tape. Earth strip laid above ground shall be welded across straight through joints and joints shall be suitably protected by giving two coats of bitumen to avoid oxidation and insulation film formation of the strip surface. When two earth strips are to be jointed by means of welding, lap welding with an overlapping of strip equivalent to double the width of the strip and all four sides shall be continuously welded. All joints at tapping above ground shall be by means of connector/lugs. A minimum of two bolts of adequate size shall be used for this purpose. Earthing strip joints at earth plate and equipment shall be through GI bolts, nut etc.

5.0 INSTALLATION OF EARTH ELECTRODE

- 5.1 Earth electrodes shall be installed as shown in the earthing layout drawing and in accordance with the standard drawings. Earth pits shall be constructed & located as per the IS: 3043 and consist of 3m long, 65 mm N.B (76mm outer dia) GI pipe electrode and their location shall be marked to enable accurate location by permanent markers.
- 5.2 All earth electrodes shall preferably be driven to a sufficient depth to reach permanently moist soil. Electrodes shall preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as tightly as possible. Wherever practicable, the soil shall be dug up, all lumps broken and stones removed from the immediate vicinity of the electrodes. Earth pit with all accessories shall be provided as per drawings.
- 5.3 All earth electrodes shall be tested for earth resistance by means of standard earth test meter. The tests shall take place in dry months, preferably after a protracted dry spell.
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 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION - EARTHING SYSTEM	Doc No : 16017-E-DB-0800-05 Rev : A Page : 5 of 9
 <p>KAVIN</p>		

- 5.4 The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of poor conductivity.
- 5.5 Earth electrodes shall be located avoiding interference with road, building foundation, column etc.
- 5.6 The disconnect facility shall be provided for individual earth pits to check their earth resistance periodically.
- 5.7 The distinct No. shall be provided on all earth electrode as per approved drawing. Earth resistance, date shall be marked on a plate above grade level.

6.0 CONNECTION

All electrical equipment is to be suitably earthed. The earth system connections shall generally cover the following:



- Equipment earthing for personnel safety.
- System neutral earthing
- Static and lightning protection

6.1 The following shall be earthed.

- System neutral - should not be connected to
- Current and potential transformer secondary neutral
- Metallic non-current carrying parts of all electrical apparatus such as transformers, switchboards, bus ducts, motors, neutral earthing resistors, capacitors, UPS, battery charger panels, welding receptacles, power sockets, lighting/power panels, control stations, lighting fixtures etc.
- Steel structures/columns, rail loading platforms etc.
- Cable trays and racks, lighting mast and poles
- Storage tanks, spheres, vessels, columns and all other process equipment.
- Fence and Gate for electrical equipment (e.g. transformer, yard etc.)
- Cable shields and Armour
- Flexible earth provision for Wagon, Truck

Conductor size for branch connection to various equipment shall be as per Owner's Installation Standards unless otherwise stated on earthing layout drawings.

- 6.2 All process pipelines shall be bonded and earthed at the entry and exist points of battery limit of hazardous area.
- 6.3 Steel pipe racks in the process units and offsite area shall be earthed at every 25 meters.
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 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION - EARTHING SYSTEM	Doc No : 16017-E-DB-0800-05 Rev : A Page : 6 of 9
 <p>KAVIN</p>		

6.4 Equipment foundation bolts shall not be used for earthing connection.

6.5 LIGHTNING PROTECTION

Lightning protection shall be provided for the equipment, structures and buildings as shown on layout drawing. An independent earthing network shall be provided for lightning protection. Lightning protection system shall generally comprise lightning finials (air terminals), roof conductors, down conductors, test links, and earth electrodes. The number, types, materials and sizes shall be in accordance with the drawings. Air terminals shall be mounted on top of buildings or structure as required. All air terminals shall be inter-connected with roof conductors, pipes, hand rails or any other metallic projection above the roofs shall also be bonded to the roof conductors. Down conductors from air terminals or from roof conductors shall be routed as directly as possible to the test links on earth buses, with minimum bends. All provisions regarding connections of conductors for equipment earthing system shall also apply to lightning protection system. In corrosive atmospheres, plumbing metal for corrosion protection shall cover lightning finials or air terminals.

Self conducting structures having metal thickness of more than 4.8mm may not require lightning protection with aerial rod and down conductors. They shall, however, be connected to the earthing system, at least, at two points at the base of equipment. All major structural steel, stacks, vessels and process equipment likely to become charged with static electricity shall be solidly connected to the earthing system. Lightning protection is provided for building and structures whose risk index is more than 10^{-5}

6.6 The main earthing network shall be used for earthing of equipment to protect against static electricity.

6.7 All medium and high voltage equipment (above 250V) shall be earthed by two separate from the electrical earthing system.



6.8 Plant instrument system clean earthing shall be separate from the electrical earthing system.

6.9 All paint, scale and enamel shall be removed from the contact surface before the earthing connections are made.

6.10 All earthing connections for equipment earthing shall be preferably from the earth plate mounted above ground wherever provided.

6.11 Earth connections shall be made through compression type cable lugs/by welded lugs/bolted connection as indicated in drawing .

6.12 All hardware used for earthing installation shall be hot dip galvanized or zinc



 <p>GGPL GODAWARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION - EARTHING SYSTEM	Doc No : 16017-E-DB-0800-05 Rev : A Page : 7 of 9
 <p>KAVIN</p>		

passivated. Spring washers shall be used for all earthing connections and all connections adequately locked against loosening.

- 6.13 Lighting fixtures and receptacles shall be earthed through the extra core provided in the lighting circuit/cable for this purpose.
- 6.14 The reinforcements of electrical building and the electrical building floor shall be connected to main earth grid.
- 6.15 In electrical room an earth grid shall be formed using GI flat to which each equipment earth strips will be connected. The GI flat shall be taken out of the room and connected to the raisers provided. These raisers shall be taken out from the below ground buried main earth grid formed by means of connecting all earth pits

7.0 TESTING AND COMMISSIONING

- 7.1 Earthing systems/connections shall be tested as follows:
 - 7.2 Resistance of individual earth electrodes shall be measured after disconnection it from the grid by using standard earth test meggar.
 - 7.3 Earthing resistance of the grid shall be measured after connecting all the earth electrodes to the grid. The resistance value of an earth grid to the general mass of earth shall be as follows:
 - Earthing resistance of the grid shall be measured after connecting all the electrodes to the grid.
The resistance between any point on the metallic earth grid and the general mass of earth shall not exceed 1 ohm.
 - For lightning protection, the value of 5 ohms as earth resistance shall be desirable, but in no case it shall be more than 10 ohms.
 - 7.4 The resistance to earth shall be measured typically at the following points:
 - a) At each electrical system earth or system neutral earth.
 - b) At each earth provided for structure lightning protections.
 - c) At one point on earthing system used to earth electrical equipment enclosures.
 - d) At one point on earthing system used to earth wiring system, enclosures, such as metal conduits and cable sheaths or Armour.
 - e) At one point on fence enclosing electrical equipment.
 - 7.5 All earthing layout drawings shall be marked by contractor for 'AS BUILT STATUS' and two sets of copies shall be submitted to EIC/Owner.
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 <p>GAPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION - EARTHING SYSTEM	Doc No : 16017-E-DB-0800-05 Rev : A Page : 8 of 9
 <p>KAVIN</p>		

8.0 TEST PROCEDURE



The Contractor shall fill up the Test Report after the completion of the tests and shall submit it to the EIC/Owner duly signed for his approval and acceptance.

INSTALLATION TESTING REPORT - EARTHING INSTALLATION

- 1.0 Earthing System Data
 - 1.1 Type of Electrodes
 - 1.2 Total number of electrodes
 - 1.3 Main earth grid size
 - 1.4 Material
- 2.0 General Checks (Tick if it is in order Otherwise give details)
 - 2.1 Construction of earth pits and Installation of ground electrodes as per layout drawing
 - 2.2 Size of earth conduct for various Equipment as per layout drawing
 - 2.3 Minimum distance kept between Two electrodes
 - 2.4 Welding at the joints are properly made:
- 3.0 Tests
 - 3.1 Measured earth resistance of each electrode in Ohms
 - No.1
 - No.2
 - No.3
 - No.4
 - No.5
 - 3.2 Measurement of earth grid resistance (with all electrode connected to grid) :
 - a) At each electrical system or System neutral earth
 - b) At one point on each earthing system used to earth electrical Equipment enclosure.

9. EQUIPMENT EARTHING CONDUCTOR SIZES

Required sizes for earthing conductors shall have to be established by design calculations. An earthing schedule giving the type/ sizes of earthing conductors for different equipments is given below. The sizes given below are indicative and minimum only.

 <p>GGPL GODAVARI GAS PRIVATE LIMITED</p>	TECHNICAL SPECIFICATION - EARTHING SYSTEM	Doc No : 16017-E-DB-0800-05 Rev : A Page : 9 of 9
 <p>KAVIN</p>		

TYPE OF EQUIPMENT	CONDUCTOR SIZE
Main buried/above ground Earth grid	50mm x 6mm GI Strip
Transformer	50mm x 6mm GI Strip
LV switchboard	50mm x 6mm GI Strip
Distribution boards, UPS, Battery rack	25mm x 3mm GI Strip
Motors up to 3.7 kW	25mm x 3mm GI Strip
Motors above 3.7 kW to 110 kW	25mm x 3mm GI Strip
Motors above 110 kW	40mm x 5mm GI Strip
Tanks, vessels, Columns, Heat Exchangers & other major process equipment	40mm x 5mm GI Strip
Push button stations	25mm x 3mm GI Strip
Street light poles	25mm x 3mm GI Strip
Lighting transformer	25mm x 3mm GI Strip
Bonding of pipe	25mm x 3mm GI Strip
Bonding between cable trays	25mm x 3mm GI Strip
Lighting fixtures, sockets	25mm x 3mm GI Strip
Compressor skid	40mm x 5mm GI Strip
Cascade/ Dispenser	25mm x 3mm GI Strip

NOTE:-

1. Green color sleeving (about 50mm length) shall be provided at both ends to denote earthing.