POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT
for
Procurement
of

Design, Supply, Installation, Testing and Commissioning of Capacitor bank with associated switchgear for Mymensingh region on turnkey basis.

Issued on: 19 July,2020

Invitation for Bid No.: 27.21.0000.101.07.137.20.2882

Employer: Power Grid Company of Bangladesh Ltd. (PGCB)

Country: The People's Republic of Bangladesh

Volume 2 of 3

INDEX TO VOLUMES

Volume 1 of 3

Volume 2 of 3

Volume 3 of 3

POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT
FOR

Design, Supply, Installation, Testing and Commissioning of Capacitor bank with associated switchgear for Mymensingh region on turnkey basis.

SECTION 1

SCOPE OF WORK AND DESIGN DATA

SECTION 1

SCOPE OF WORK AND DESIGN DATA

1.1. GENERAL

This Turnkey Bidder is for designing, manufacturing, factory testing, packing for export, shipping, delivery to site, complete erection and installation as well as including site testing, (pre)commissioning, training at site, quality assurance & warranty for a period of defect liability period (as mentioned in General/Special condition of Contract) after commissioning for all equipments and all civil works.

The work covered by this Bid and Specification is outlined below for installing 36kV capacitor bank including protection & control at five (5) identified substations and civil works. The identified substations as specified hereunder:

Sl no.	Name of Substations	Proposed compensation Block (MVar)	Proposed Compensation Block (MVar)
1.	Kishoregang 132/33kV	3x15	45
2.	Netkrona 132/33kV	3x15	45
3.	Bhaluka 132/33kV	2x15	30
4.	Mymensingh 132/33kV	3x15	45
5.	Tangail 132/33kV	3x15	45

Required works shall be in accordance with this section and drawings. In this section being Scope of Works are listed herewith. The “Schedule of requirements” for equipment, materials and services, detailed technical specifications of equipment, materials and price schedule included in the bidder document shall be read in conjunction with the scope of work described herein. The drawings provided in the bidder document are being indicative only and hence the entire scope of work is not fully reflected in those drawings.

Even though miscellaneous works are not fully specified in this section, those works shall be deemed fully to be included in the scope of works. And also all details, accessories etc. required for the complete installation and satisfactory operation of the works not specifically mentioned in this specification are deemed to be included in the Contract Price.

Coordinates of above mentioned sites are given below-

Sl no.	Name of Substations	GPS Coordinates
1.	Kishoregang 132/33kV	24.418875 N, 90.789942 E
2.	Netkrona 132/33kV	24.867208 N, 90.698081 E
3.	Bhaluka 132/33kV	24.381350 N, 90.377712 E

4.	Mymensingh 132/33kV	24.734281 N, 90.421401 E
5.	Tangail 132/33kV	24.277038 N, 89.921682 E

The Contractor is responsible for ensuring that all or any items of work required for the safe, efficient and satisfactory completion and functioning of the works.

Bidders should submit their offer to make shunt compensation with capacitor banks at five (5) identified substations in all respects to make it fully operational.

The program of works shall be as shown in schedule C of times for delivery and completion. Within one month of acceptance of the Bid, the contractor shall submit a program chart detailing times required for the design, manufacture, testing, delivery and erection for the complete work.

1.2. SCOPE OF WORKS

The scope of this project is to provide newly installed 36kV capacitor bank at each identified substations and in some case supplements shall be included for extension from existing bus section. Details are described in the schedule A of the Volume 3.

Fourteen (14) capacitor banks and associated switchgears shall be designed as outdoor type.

Following works are to be included in the scope of this project but shall not be limited to completion of this turnkey project.

The detailed requirements are listed in the Technical Specification, Technical Particulars & Guarantee Schedule and Price schedule.

1.2.1 SPARE PARTS

In order to maintain the facilities and system reliability adequate amount and kind of spare parts shall be provided with the project implementation. Detailed items can be found in the Schedule B: Price Schedule of the Volume 3.

1.2.2 DOCUMENTATION

1). Furnish Monthly / Quarterly Progress Report.

2). Supply 2(two) sets of Operating Instructions/ Manuals, Maintenance Manuals, Spare Parts Catalogue, Technical Specification, Drawings, Booklets for each equipment and materials to be supplied to Project (TEI), PGCB and 1 (one) set of the same for each substation to be supplied to the respective substation.

3). As-Built Drawings in 6 (six) printed copies and CD of the each substation.

4). Test report for each equipment and Materials.

5). Testing & commissioning Report of each equipment and the capacitor bank installation as a whole.

1.3. REFERENCES

1.3.1 CODE, REGULATIONS AND STANDARDS

All equipment designed, manufactured, tested and supplied under this specification shall in accordance with the latest applicable international Electro- technical commission (I.E.C) standards. Where inconsistency between standards is discovered, the most stringent criteria shall apply. The bidder shall inform the inconsistencies and request for clarification.

The Contract works shall comply with the relevant standards as specified. Provided that there is no conflict with the standards, and unless otherwise stated, all parts of the works shall comply with the relevant international standards and design codes. Where suitable international standards do not exist, internationally accepted national standards or other approved standards shall apply.

Recently published main IEC standards are as follows (but not limited followings):

IEC 60871-1 Ed. 3.0 b	2005	Shunt capacitors for a.c. power systems having a rated voltage above 1000 V - Part 1: General
IEC/TS 60871-2 Ed. 2.0 b	1999	Shunt capacitors for a.c. power systems having a rated voltage above 1 000 V - Part 2: Endurance testing
IEC 60871-4 Ed. 1.0 b	1996	Shunt capacitors for AC power systems having a rated voltage above 1000 V - Part 4: Internal fuses
IEC 60038 Ed. 6.2 b	2002	IEC standard voltages
IEC 60059 Ed. 2.0 b	1999	IEC standard current ratings
IEC 60417-DB-12M Ed. 1.0 b	2002	Graphical symbols for use on equipment
IEC 60071-1 Ed. 8.0 b	2006	Insulation co-ordination - Part 1: Definitions, principles and rules
IEC 60071-2 Ed. 3.0 b	1996	Insulation co-ordination - Part 2: Application guide
IEC 60289 Ed. 2.0 b	1988	Reactors
IEC 60044-1 Ed. 1.2 b	2003	Instrument transformers - Part 1: Current transformers
IEC 60044-2 Ed. 1.2 b	2003	Instrument transformers - Part 2 : Inductive voltage transformers
IEC 60099-4 Ed. 2.1 b	2006	Surge arresters - Part 4: Metal-oxide surge arresters without gaps for a.c. systems
IEC 62271-1 Ed. 1.0 b	2007	High-voltage switchgear and controlgear - Part 1: Common specifications
IEC 62271-100 Ed. 1.1 b	2003	High-voltage switchgear and controlgear - Part 100: High-voltage alternating-current circuit-breakers
IEC 62271-102 Ed. 1.0 b	2003	High-voltage switchgear and controlgear - Part 102: Alternating current disconnectors and earthing switches
IEC 60529 Ed. 2.1 b	2001	Degrees of protection provided by enclosures (IP Code)
IEC 60549 Ed. 1.0 b	1976	High-voltage fuses for the external protection of shunt power capacitors
IEC 60947-1 Ed. 4.0 b	2004	Low-voltage switchgear and controlgear - Part 1: General rules
IEC 60947-2 Ed. 4.0 b	2006	Low-voltage switchgear and controlgear - Part 2: Circuit-breakers

IEC 60694 Ed. 2.2 b	2002	Common specifications for high-voltage switchgear and controlgear standards
IEC 60168 Ed. 4.2 b	2001	Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1000 V
IEC/TS 60815	2008	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions
IEC 60137 Ed. 6.0 b	2008	Insulated bushings for alternating voltages above 1 000 V
IEC 60255	-	Electrical relays
IEC 60298	1990	Alternating current metal enclosed switchgear controlgear for rated voltages above 1kV and up to and including 52kV
IEC 61936-1 Ed. 1.0 b	2002	Power installations exceeding 1 kV a.c. - Part 1: Common rules

1.3.2 SUBSTITUTION OF STANDARDS & DESIGN CODES

The Contractor may offer Works which comply with international standards, or internationally recognized national codes or standards, which differ from those specified. However the contractor may offer works which comply with the different standards or codes only if, when requested by the Employer, he is able to demonstrate to the Employer's satisfaction that the works offered are equal or superior to that which would have resulted had the specified code or standard been used. This substitution of codes or standards for those specified will only be acceptable if the manufacturing organization in question has extensive experience with the alternative code or standard offered.

Any Contractor offering Contract Works or part of those Works to standards and codes which differ from those specified shall declare the fact to the Employer. If requested to do so by the Employer, the Contractor shall declare the fact to the Employer, at his own cost, two copies in English of the relevant code or standard, which he proposes to substitute for, that specified.

Where equipment is specified to a particular standard, the contractor may supply equipment of an equivalent standard for approval by the Employer.

1.3.3 PRIORITY OF DOCUMENTS

In the event of any conflict in standards, the hierarchy of standards shall be as follows, with the standards occurring first in the list taking precedence over any standards later in the list:

1). This document (Section 1. Detailed Scope of Work & Design Data of Volume 2)

2). International Electrotechnical Commission (I.E.C)

3). Other Standards approved by the Employer (Design, PGCB)

1.3.4 LANGUAGE AND MEASUREMENT SYSTEM

All drawings, technical specification/documents, drawings, test report and instruction manual shall be in English. Nameplate and labels on equipment also written in English. All dimensions, capacities, indicators on the device, apparatus shall be SI units.

1.4. SYSTEM CONDITIONS

Equipment supplied under this Contract shall be suitable for the followings system conditions.

Nominal system voltage between phases	kV	:	33
Highest voltage for equipment	kV	:	36
System frequency	Hz	:	50
Power frequency withstand voltage, 1 minute	KV	:	70
Lighting impulse withstand voltage	kV	:	170
Symmetrical short-circuit current (1 sec)	KA	:	31.5

High voltage current carrying equipment should be capable of carrying the three phase fault levels for a period of 3 (three) seconds.

2.1. SYSTEM EARTHING

The extension of existing substation shall be earthed. The every new installation shall have to be earthed solidly

3.1. MINUMUM SUBSTATION CLEARANCES

Air insulated bus bars and connections shall have electrical clearances as listed in the following table:

Nominal system voltage between phases	kV	:	33
Minimum clearances between live metal and earth	mm	:	380
Minimum clearance between live metal	mm	:	430
Minimum safety clearance between ground and the nearest point not at earth potential of an insulator.	mm	:	2500
Minimum safety clearance between ground and the nearest live unscreened conductor. (BS 7354 ' Safety Working Clearance)	mm	:	2740
Minimum creepage distance	mm / kV	:	25

4.1. LOW VOLTAGE AC SYSTEM

System Configuration			3 phase/4 wires
Rated service voltage	Volts	:	400V or 380V
Tolerance on rated voltage	%	:	$\pm$ 10%
Switchgear symmetrical breaking capacity, 3 sec.	kA	:	31.5

5.1. DC SYSTEM

For DC motor driven auxiliaries, relays, tripping, indicating lamps and controls.

Normal battery voltage, nominal for substation	Volts	:	110V or 125V(as per existing)
Tolerance on rated voltage	%	:	± 1.0%

6.1. CLIMATIC CONDITIONS

All plant and equipments supplied under the contract shall be entirely suitable for the climatic conditions prevailing at site.

The project area and vicinity is close to sea level and is in a tropical climate. The ambient shade temperature variation is between 3°C and 45°C with periods of high humidity.

Between May and November low lying areas are subject to flooding.

The flooding can be taken advantage of at certain Sites in that the heavy loads may be floated on barges to close proximity to the Sites.

The project area is designated a zone of moderated intensity for earthquakes.

Atmospheric pollution is moderate and special insulator design or washing is not required. The area is subject to high winds of typhoon strength. .

Maximum ambient shade temperature	:	45°
Minimum ambient shade temperature	:	4°
Maximum daily average temperature	:	45°
Maximum annual average temperature	:	25°
Maximum wind velocity	:	160 km/h
Minimum wind velocity for line rating purposes	:	3.2 km/h
Solar radiation	:	100 m W/sq.cm
Rainfall	:	2.5 M/annum
Relative humidity, maximum	:	100%
Relative humidity, average	:	80%
Altitude (No ice or snow expected)	:	less than 150 m
Atmospheric Pollution	:	Highly polluted.
Soil type	:	Alluvial
Soil temperature resistively	:	1.5 °m/W
Isokeraunic Level (Thunderstorm days/year)	:	80

The information in this Clause is given solely for the general assistance of Bidders and no responsibility for it will be accepted or any claim based on this Clause considered by the Employee.

7.1. SEISMIC CONDITION

Electrical equipment shall be capable of withstanding without damage horizontal and vertical acceleration of 0.2g for frequency variation from 0.2 to 20 Hz.

POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT
FOR

Design, Supply, Installation, Testing and Commissioning of Capacitor bank with associated switchgear for Mymensingh region on turnkey basis.

SECTION 2

ANCILLARY MECHANICAL AND ELECTRICAL APPARATUS

SECTION 2

ANCILLARY MECHANICAL AND ELECTRICAL APPARATUS

2.1. SCOPE

This section of the Technical Specification describes the general requirements for mechanical and electrical designs of all the plant being supplied under the Contract, electrical aspects being covered in another Section of the Specification. It shall be read in conjunction with the General Conditions, Drawings, the Schedules and other sections of the Technical Specification covering particular aspects of the plant and in the event of conflict between the General and Definite Contract Requirements, then the latter shall take precedence

2.2. DEFINITION OF TERMS

The definition of terms shall be as set out in the General Conditions of Contract.

2.3. STATUTORY REGULATIONS

The Works and all equipment and materials forming part of this Contract shall comply in all respects with any relevant statutory regulations, by-laws or orders currently in force in Bangladesh.

2.4. DESIGN STANDARDS AND CODES

2.4.1 General Compliance with International Standards and Codes

The Contract Works shall comply with the relevant standards as specified. Provided there is no conflict with the standards, and unless otherwise stated, all parts of the Works shall comply with the relevant international standards and design codes. Where suitable international standards do not exist, internationally accepted national standards (which ensure equivalent or higher quality than specified standard) or other approved standards shall apply.

2.4.2 Standards Named in Specification

Although the Works shall generally comply with international standards, any instruction in this Speification that a particular aspect of the Works shall comply with a named code or standard shall take precedence, and that particular aspect of the Works shall comply with the named code or standard.

2.4.3 Hierarchy of Standards

In the event of any conflict in standards, the hierarchy of standards shall be as follows, with the standards occurring first in the list taking precedence over any standards later in the list:

i) Statutory regulations of Bangladesh
ii) Standards named in the Specification
iii) International Standards
iv) Other standards approved by the Employer

Where equipment is specified to a particular standard, the Contractor may supply equipment of an equivalent standard, if approved by the Employer.

2.4.4 Substitution of Standards and Design Codes

The Contractor may offer Works which comply with international standards, or internationally-recognized national codes or standards, which differ from those specified. However the Contractor may offer Works which comply with the different standards or codes only if, when requested by the Employer, he is able to demonstrate to the Employer's satisfaction that the Works offered are equal or superior to that which would have resulted had the specified code or standard been used. This substitution of codes or standards for those specified will only be acceptable if the manufacturing organization in question has extensive experience with the alternative code or standard offered.

Any Contractor offering Contract Works or part of those Works to standards and codes which differ from those specified shall declare the fact to the Employer. If requested to do so by the Employer, the Contractor shall supply to the Employer, at his own cost, two copies in English of the relevant code or standard which he proposes to substitute for that specified.

2.5. ERECTION MARKS

All members comprising multiparty assemblies - e.g., steel frameworks, piping installations, etc. - shall be marked with distinguishing numbers and/or letters corresponding to those on the approved drawings or material lists. These erection marks, if impressed, must be completed before painting or galvanizing shall be clearly readable afterwards.

Color banding to an approved code shall be employed to identify members of similar shape or type but of differing strengths or grades.

2.6. CLEANING AND PAINTING

2.6.1. GENERAL

Following award of the Contract, the Contractor shall submit the name of the proposed paint supplier and applicator, together with a quality assurance programme, for approval. All paints for the outdoor equipment on the Contract shall be provided by one manufacturer and preferably shall be manufactured in one country to ensure compatibility. All painting of outdoor equipment shall be carried out strictly in accordance with the paint system manufacturer's recommendations and the application shall be checked and approved, in writing, by an authorized representative of the paint manufacturer.

The painting of the plant shall be carried out in accordance with the appropriate schedule later in this Section. The work is generally covered by the Schedules but where particular items are not referred to specifically, they shall be treated in a manner similar to other comparable items as agreed with the Employer.

The Contractor shall ensure that precautions are taken in packing and crating, to avoid damage to the protective treatment during transportation to the site. Any damage to paintwork which occurs during transport shall be made good at Site.

The schedules indicate standards of surface preparation and painting which are intended to give a minimum life of 10 years in a severe environment, with need for only minor remedial work in that period.

Steel sections and plate shall be free from surface flaws and laminations prior to blast cleaning and shall not be in worse condition than ISO 8501-1.

Where paint coatings are proposed for the protection of surfaces of equipment exposed to corrosive conditions, such as plant items exposed to brine or sea water, or immersion in liquids or wet gases, the coatings shall be formulated to be suitably corrosion resistant and shall be high voltage spark tested at works and at Site prior to commissioning. The test procedure shall be based on the use of a high voltage direct current. The voltage used shall be 75% of the breakdown voltage of the coating. This breakdown voltage shall first be separately determined using test plates coated with the specified coating formulation and thickness. The coating on the test plate shall also be micro-sectioned by the applicator to show that it is free from vacuoles and other defects likely to invalidate the test procedure.

If the defects revealed by the above test procedure do not exceed one per 5 m^2 of coating surface, the coating need not be re-tested after the defects have been repaired. If the defects exceed one per 5 m^2 of coating surface, the repairs shall be re-tested after any curing is complete, and this procedure shall be repeated until the defects are less than one per 5 m^2 of coating surface. After repair of these defects, the equipment can be placed in service without further testing.

All coatings proposed for the internal protection of domestic water storage tanks and desalination plants shall be certified by an approved independent Authority as suitable for use in potable water installations and shall meet the non-tainting requirements of BS 3416.

The Employer will consider alternative paint schemes to meet the requirements of fabrication using modern automated materials handling systems, provided that the Contractor is able to demonstrate that they offer the same standards of surface protection and service life as those intended by the Schedules.

All paints shall be applied by brush or spray in accordance with the schedule, except for priming coats for steel floors, galleries and stairways where dipping will be permitted.

Where paint is to be applied by spray, the applicator shall demonstrate that the spray technique employed does not produce paint films containing vacuoles.

All planished and bright parts shall be coated with grease, oil or other approved rust preventative before dispatch and during erection and this coating shall be cleaned off and the parts polished before being handed over.

Where lapped or butted joints from part of an assembly which is assembled or part assembled prior to final painting, the jointed surfaces shall be cleaned free from all scales, loose rust, dirt and grease and given one brush applied coat of zinc phosphate primer before assembly.

Paint shall not be applied to surfaces which are superficially or structurally damp and condensation must be absent before the application of each coat. Painting shall not be carried out under adverse weather conditions, such as low temperature (below 4˚C) or above 90% relative humidity or during rain or fog, or when the surfaces are less than 3˚C above dew point, except to the approval of the Employer or his duly appointed representative.

Priming coats of paint shall not be applied until the surfaces have been inspected and preparatory work has been approved by the Employer or his duly appointed representative.

No consecutive coats of paints, except in the case of white, shall be of the same shade. Thinners shall not be used except with the written agreement of the Employer.

On sheltered or unventilated horizontal surfaces on which dew may linger, more protection will be needed and to achieve this an additional top coat of paint shall be applied.

The schedules differentiate between "Treatment at Maker's Works" and "Treatment at Site after Completion of Erection" but the locations at which different stages of the treatments are carried out may be modified, always providing that each change is specifically agreed to by the Employer and the painting is finished or made good at Site to the Employer's satisfaction.

The schedules also refer to "Indoor" and "Outdoor" locations. In this context the interiors of all buildings without air conditioning, heating or forced ventilation shall be treated as "Outdoor".

All paint film thicknesses given are minima and refer to the dry film condition. All thicknesses shall be determined by the correct use of approved commercial paint film thickness measuring meters.

All outdoor painting shall be checked prior to issue of the final certificate and no visible corrosion or spotting shall be present. Slight loss of gloss may acceptable. In the event of visible corrosion being present, the Employer will retain the right to withhold such an amount from the Contractor as may be necessary to repaint the entire exterior part of the works.

The painting requirements shall be interpreted in accordance with the requirements and recommendations of the Standards and Codes of Practice referred to and the paint manufacturer's special instructions where applicable, colours being in accordance with BS 1710 and BS 4800, or equivalent material standards.

2.6.2. SCHEDULES OF INDOOR FINISHES

2.6.3. Instrument Panels, Relay Panels, Control Panels, 415V AC Boards, 110V/125V D.C. Boards, Battery Charger Cubicles, Switchgear.

TREATMENT AT MAKERS WORKS	TREATMENT AT SITE AFTER COMPLETION OF ERECTION
Acid pickle or blast cleans to 1st quality BS 7079. Then apply : 1st coat zinc chromate primer (30 microns) Stop and fill. Then apply : 2nd coat alkyd undercoat (30 microns) Rub down with fine abrasive paper. 3rd coat alkyd undercoat (30 microns) Rub down with fine abrasive paper Then apply : 4th coat alkyd matt (25 microns) 5th coat alkyd matt (25 microns) 6th coat alkyd matt (25 microns) Total film thickness (125 microns).	Touch up if necessary and burnish.

2.7. SCHEDULES OF OUTDOOR SURFACES

2.7.1 GENERAL

1). Structural and supporting steelwork, plant items above ground, tank external surfaces. All not above 950 C (or 650 C for chlorinated rubber finishes).

TREATMENT AT MAKERS WORKS	TREATMENT AT SITE AFTER COMPLETION OF ERECTION
Blast cleans to BS 7079 2nd quality (SA2.5) profile amplitude 40-75 microns. Then apply within 4 hours one coat (13microns) weldable holding primer for 6 months Protection or (25 microns) weldable holding primer for 6 months Protection. After protection period, thoroughly clean to remove oil, grease and dirt and apply one coat (50 microns) of two pack epoxy zinc phosphate primer followed by two coats two pack epoxy micaceous iron oxide (250 microns total) followed by two coats two pack epoxy micaceous iron oxide (250 microns total).	Thoroughly clean to remove oil, grease and dirt. Paint coats to be touched up where necessary. Then apply one tie coat to finish (30 microns) and one coat alkyd gloss (25 microns).

2). Steel floors, checker plates, galleries, stairways, treads, kick stops

TREATMENT AT MAKERS WORKS	**TREATMENT AT SITE AFTER COMPLETION OF ERECTION**
Galvanized to BS 729	Thoroughly clean to remove oil, grease and dirt. Where galvanizing is damaged wire brush to BS 7079 3rd quality (SA2) and apply I coat zinc rich epoxy primer (50 microns) Then apply: 1st coat epoxy etch primer 2nd coat epoxy zinc chromate (30microns) 3rd coat two pack epoxy micaceous iron oxide (100 microns) On galleries and stairways top surfaces apply 4th coat non skid epoxy deck paint (30 microns).

3). Galvanized iron and steel requiring paint finish.

TREATMENT AT MAKERS WORKS	TREATMENT AT SITE AFTER COMPLETION OF ERECTION
Galvanized to BS 729	Thoroughly clean to remove oil, grease and dirt. Then apply : 1st coat etch primer. 2nd coat epoxy zinc chromate (30 microns). 3rd coat alkyd undercoat (30 microns). 4th coat alkyd gloss(25 micron).

4). Stainless steel, Aluminum alloys and non-ferrous alloys requiring paint finish

TREATMENT AT MAKERS WORKS	TREATMENT AT SITE AFTER COMPLETION OF ERECTION
Not applicable	Thoroughly clean to remove oil, grease and dirt. Then apply : 1st coat alkyd undercoat (30 microns). 2nd coat alkyd gloss (25 micron) coat non-skid epoxy deck paint (30 microns).

2.7.2 BRIGHT PART

TREATMENT AT MAKERS WORKS	TREATMENT AT SITE AFTER COMPLETION OF ERECTION
Coat with a mixture of oil, grease or approved proprietary inhibitor.	Clean & polish

2.7.3 Instruments Panels, Control Panels, Marshalling Kiosks, Lighting and small power distribution boxes and junction boxes etc.

TREATMENT AT MAKERS WORKS	TREATMENT AT SITE AFTER COMPLETION OF ERECTION
Blast clean, prime, undercoat and paint in accordance with the painting schedule for structural and supporting steel work, with finish coat of paint applied at manufacturer's works.	Clean and touch up as necessary.

2.8. RATING PLATES, NAME PLATES AND LEVELS

2.8.1 GENERAL

The Contractor shall supply and install all levels, name, rating, instruction and warning plates necessary for identification and safe operation of the works. Samples may be requested for the approval of the Employer.

Name plates or levels shall be of non-hygroscopic, non-deteriorating and non-warping material with engraved lettering of contrasting color with black lettering engraved thereon. While no-rusted material shall be used to the outdoor subject to harsh operating conditions as engraved chromium plated brass or stainless steel nameplates or levels with engraving filed with black enamel.

Individual plant items and all relevant areas within the contract works where a danger to personnel exists shall be provided with plentiful, prominent and clear warning notices.

All the above levels and plates shall be securely fixed to items of plant and equipment with stainless steel rivets, plated self tapping screws or other approved means. The use of adhesives will not be permitted.

Warning notice shall draw attention to the danger or risk with words in the language specified which attracts attention and summarize the type of risk or danger. The notices shall also carry a large symbol, which graphically depicts the type of risk.

All equipment within panels and desks shall be individually identified.

Items of Plant, such as valves, which are subject to handling, shall be provided with nameplates with permanent inscriptions thereon.

2.8.2 RATING PLATES

Each main and auxiliary item of plant shall have attached to it in a conspicuous position, a rating plate upon which shall be engraved all appropriate technical data and any identifying name, type or serial number, and the requirements of the standard specific to the item of plant. In addition the Employer may require to be included details of the loading conditions under which the item of plant in question has been designed to operate, such as short-time rating of switchgear.

2.8.3 CIRCUIT LABELS

Each main item of plant shall be provided with an identification plate. The Employer shall approve the inscriptions.

In addition the device number allocated by the Employer to each item of plant shall be displayed in text height 30 mm on all operating mechanisms and 60 mm or larger in height on principal items of Plant, e.g. bus bars, Transformers etc. The same device number shall be displayed on control cubicles in text height 10 mm or larger as may be required by the Employer.

2.9. ENVIRONMENTAL PROTECTION & TROPICALISATION

2.9.1 GENERAL

All equipment shall be designed to operate in the environmental conditions specified. Outdoor Equipment shall be designed so that water cannot collect at any point. The undersides of all tanks shall be ventilated in an approved manner to prevent corrosion.

Where applicable, equipment should tolerate the effects of freezing and air pollution.

Outdoor plant shall be rated and constructed so that its performance, operation, reliability, maintenance and or life shall meet the specified design and operating conditions.

Where the performance, reliability or life of the plant would be adversely affected by solar Radiation, including the effects of prolonged exposure to ultra violet light, suitable sunshades shall be provided. Such sunshades shall be constructed from materials that are able to withstand the effects of the ambient conditions on site without suffering any deterioration in material strength or effectiveness.

Sunshades need not be provided on outdoor plant or equipment provided the manufacturer can satisfy the Employer that the materials employed will not be adversely affected or the temperature rise due to internal heat generation plus that due to solar radiation will not exceed the equipment design temperature. However equipment requiring manual operation shall be provided with sunshades to ensure that surface temperatures will not exceed 50°C.

Sunshades shall protect plant and personnel when the sun is more than 45°C above the horizon. They shall not impede the operation or maintenance of the plant or the movement of ventilating air and shall include adequate artificial light as necessary.

Facilities such as lighting, lifting beams and rainwater drainage shall be provided wherever necessary to the approval of the Employer as an integral part of the sunshade structure.

2.9.2 TROPICALISATION

In choosing materials and their finishes, due regard shall be given to the humid tropical conditions under which equipment shall work, and good proven practices shall be followed unless otherwise approved by the Employer. Some relaxation of the following provisions may be permitted where equipment is hermetically sealed but it is preferred that tropical grade materials should be used wherever possible:

Metal :

Iron and steel are generally to be painted or galvanized as appropriate. Indoor parts may alternatively have chromium or copper-nickel plating or other approved protective finish. Small iron and steel parts (other than stainless steel) of all instruments and electrical equipment, the cores of electromagnets and metal parts of relays and mechanism shall be treated in an approved manner to prevent rusting.

Screws, Nuts, Springs, Etc:

The use of iron and steel shall be avoided in instruments and electrical relays wherever possible. Steel screws shall be zinc, cadmium or chromium plated, or when plating is not possible owing to tolerance limitations, shall be of corrosion-resisting steel. Instrument screws (except those forming part of a

magnetic circuit) shall be of brass or bronze. Springs shall be of non-rusting material, e.g., phosphor bronze or nickel silver, as far as possible.

Rubber :

Neoprene and similar synthetic compounds, not subject to deterioration due to the climatic conditions, shall be used for gaskets, sealing rings, diaphragms, etc.

2.9.3 NUTS, BOLTS, STUDS AND WASHERS

The threads and other details of fasteners shall comply with the relevant ISO Standards for metric series fasteners.

Nuts and bolts for pressure parts shall be of the best quality steel.

Nuts, bolts, studs and washers shall be of materials most suitable for the service operating conditions and designed to ensure the stresses arising in normal operation shall not exceed those necessary to ensure that the specified plant life is achieved.

Fitted bolts shall be a driving fit in the reamed holes they occupy, shall have the screwed portion of a diameter such that it will not be damaged in driving and shall be marked in a conspicuous position to ensure correct assembly at Site.

Stud holes in those parts of the plant, which are subjected to heat in use, shall be adequately vented.

The threaded portion of any bolt or stud shall not protrude more than 1.5 threads above the surface of its mating nut.

Where practicable the use of slotted head screws shall be avoided in machinery component assemblies, hexagon socket screws being preferred.

On outdoor equipment all bolts, nuts, and washers shall be of non-rusting material where they are in contact with non-ferrous parts in conductor clamps and fittings and elsewhere where specifically required by the Employer.

All washers shall be included under this Contract, including locking devices and anti-vibration arrangements, which shall be subject to the approval of the Employer. Taper washers shall be fitted where necessary.

2.9.4 GENERAL WELDING REQUIREMENTS

2.9.4.1 General

All welding shall conform to the relevant British Standards, or other British or National Standard Specification as agreed by the Employer.

Where there is a conflict between Codes and/or Standards the Employer's decision will prevail.

2.9.4.2 General Fabrication

The Employer shall be notified at least two days prior to commencement of any assembly or fabrication work on site.

The C02 and flux-cored welding process will not be acceptable for site welding.

2.9.4.3 Weld Procedure Documents

Complete and fully detailed weld procedure documents shall be kept by the Contractor and these shall be made available to the Employer on request.

Prior to commencement of welding the Contractor shall submit to the Employer for approval the welding procedures to be used in the fabrication of the relevant sections of work.

The weld procedure documents shall be fully detailed and each shall indicate clearly which item it is intended to cover. The procedures shall be in accordance with the requirements of BS 499 Part 1, Appendices A-G.

2.9.4.4 Weld Procedure Qualification Tests

Weld procedure qualification tests shall be carried out in accordance with the requirements of BS EN 288, or agreed National Standard for the item of Plant under consideration.

Provided that the Contractor confirms that the basic parameters of the procedure have not been changed since approval, the results of weld procedure qualification tests previously carried out under the supervision of an internationally recognized inspecting authority may be accepted by the Employer.

The Contractor shall inform the Employer of any proposed changes to the welding procedures before such changes are implemented. If in the opinion of the Employer a further qualification test is required as a result of such changes, then the Contractor shall perform the required test without additional charge.

The results of all tests shall be made available, for examination by the Employer, if required.

2.9.4.5 Welder's Qualification Tests

All welders and welding operators shall be qualified for the work and shall hold current welders' qualification certificates in accordance with BS EN 287, BS 4872 or agreed National Standard for the work.

All welders' tests shall be witnessed and/or approved by the Employer before the welder or operator is permitted to work. The decision of the Employer regarding the acceptability of any test or existing qualification tests, shall be final.

Records showing the date and results of the qualification tests performed by each welder and weld operator, together with the identification number assigned to him, shall at all times be available for scrutiny by the Employer.

2.9.4.6 Storage of Welding Consumables

Welding consumables shall be stored in a manner that will protect them from all forms of deterioration prior to use and shall be properly identified.

Gas cylinders for use with burning or welding equipment shall be marked in accordance with the requirements of BS 349 or IS0448. Site storage procedures for gas cylinders will require the approval of the Employer.

2.9.4.7 Welding Equipment

Any welding equipment which, in the opinion of the Employer, is unsuitable or unsatisfactory for the purpose for which it is being used, shall be replaced by the Contractor.

2.9.4.8 Visual Weld Inspection

Each weld shall be subjected to a stringent visual inspection and shall be free from undercut, excessive spatter, craters, cracks, porosity and other surface imperfections. Welds shall be of regular contour, even weld ripple and indicative of good workmanship.

Fillet welds shall be checked for dimensional tolerance and form using a fillet weld gauge. Fillet welds should be slightly concave in form and each leg of the weld shall have equal length.

2.9.4.9 Internal Examination

The internal root bead of tube butt welds shall be examined by intrascope or other suitable optical device.

2.9.4.10 Non-destructive Examination

All non-destructive examinations shall be supervised by a fully qualified and experienced specialist appointed by the Contractor. Individual operators in each of the respective techniques shall be qualified and trained in the respective subject and shall have reached a standard comparable with the Certification Scheme of Weldment Inspection Personnel in the United Kingdom.

Testing shall be in accordance with the requirements of BS 709 "Methods of Testing Fusion Welded Joints and Weld Metal in Steel" or an agreed National Standard.

2.9.4.11 Ultrasonic Examination

Ultrasonic examination of welds shall be carried out in accordance with BS 3923 Part 1 Part 2 and any other relevant British Standards or agreed National Standards.

2.9.4.12 Magnetic Crack Detection

Magnetic crack detection shall be carried out in accordance with BS 6072 or an agreed National Standard.

2.9.4.13 Dye Penetrant Tests

Dye penetrant tests shall be in accordance with BS 6443 or any other relevant British or agreed National Standards.

2.9.4.14 Quality Requirements for Welds

All welds subjected to non-destructive tests shall be entirely free from cracks or crack like defects, lack of root fusion, lack of sidewall fusion, root bum through, or tailed pores. The standard for porosity and slag inclusions will be as indicated in the agreed standards for design and welding.

2.9.4.15 Weld Repairs

The Employer's approval shall be obtained prior to commencement of any repair or rectification work.

Weld repairs shall be made to the same procedure as for the original weld. All tests shall be repeated after the repair has been completed and reports on radiographic and ultrasonic tests shall be marked to indicate that the report refers to a repaired weld.

2.9.4.16 Mandatory Inspections

All transition welds between dissimilar materials, such as high alloy steels to carbon steel, or austenitic steels or non ferrous materials to steels, shall be subjected to 100% ultrasonic examination or crack detection wherever practicable. In addition, all butt welds between dissimilar materials shall be subjected to 100% radiographic examination.

All welds in ferritic alloy steels, e.g. having a carbon equivalent value in excess of 0.40%, and high yield-strength steels, e.g. having a yield strength greater than 300 MPa, shall be subjected to 100% ultrasonic examination and crack detection wherever possible. In addition, all butt welds in these materials shall be subjected to 100% radiographic examination.

A minimum of 10% of all butt welds on all classifications of work shall be radiographically examined, unless otherwise agreed with the Employer.

2.10. GALVANIZED WORK

All materials to be galvanized shall be of the full dimensions shown or specified and all punching, cutting, drilling, screw tapping and the removal of burrs shall be completed before the galvanizing process commences.

All galvanizing shall be done by the hot dip process with speller, not less than 98% of which must be pure zinc and in accordance with BS 729 or BS 443 as applicable. No alternative process shall be used without the approval of the Employer. Bolts shall be completely galvanized including the threads, but the threads of nuts shall be left un-coated and shall be oiled.

The zinc coating shall be uniform, clean, smooth and as free from spangle as possible.

Galvanized steel shall be treated after galvanizing with Sodium Dichromate solution or Pretan W20 to prevent formation of white storagstan. In addition, plastic or other non-metallic non-hygroscopic spacers shall be used between packed members to facilitate ventilation of the zinc surface during shipping.

All galvanized parts shall be protected from injury to the zinc coating due to abrasion during periods of transit, storage and erection. If, in the opinion of the Employer, the extent of the damage found on Site to a galvanized part appears to be capable of repair the Contractor may, after receiving such agreement, attempt to effect a repair by approved methods. The agreement to attempt the repair shall not bind the Employer to accept the repaired part when this is re–offered for inspection.

Should an emergency arise on Site necessitating drilling, cutting or any other process likely to damage the protective zinc surface, this will be permitted only in extreme circumstances and with the Employer’s express authority. In such a case, the bared metal will be coated with an approved zinc rich paint of not less than 92 percent zinc content.

2.11. CHROMIUM PLATING

The chromium plating of those components of the Plant where specified and where offered by the Contractor shall comply with the requirements of BS 1224.

2.12. LUBRICATION

The Contract is to include for the supply of flushing oil for each lubrication system when the item of plant is ready for preliminary tests and the first filling of approved lubricants for the commercial operation of the plant.

A schedule of the oils and other lubricants recommended for all components of the Contract Works is to be submitted to the Employer for approval. The number of different types of lubricants is to be kept to a minimum. Copies of this schedule shall be included in both the draft and final copies of the operating and maintenance instructions. In the case of grease lubricated roller type bearings for electric motors a lithium based grease is preferred.

The Contractor is to supply at least one grease gun equipment for each type of nipple provided. Where more than one special grease is required, a grease gun for each special type is to be supplied and permanently labeled.

2.13. OIL LEVEL INDICATORS

Oil level indicators of approved design are to be fitted to all oil containers such as transformer tanks etc.

The indicators are to show the level at all temperatures likely to be experienced in service, are to be marked with the normal level at 20°C clearly visible from normal access levels and are to be easily dismantled for cleaning. In addition, the normal filling level of all removable containers is to be marked on the inside.

2.14. PRESSURE GAUGES

Pressure gauges are to comply with the requirements of BS 1780.

All pressure gauges are to be fitted with stop cocks immediately adjacent to each gauge and all pressure gauge piping is to be fitted with an isolating valve at each point of connection to the main system. Where pressure gauges are mounted on panels, the stop cocks are to be suitable for the connection of a test gauge.

Gauges shall be calibrated to read pressure at the tapping point and a sealed pressure transmitting system shall be used.

All pressure gauges are to be clearly identified by means of labels of approved type and lettering.

All pressure gauge piping is to be of corrosion resistant steel or copper tube.

2.15. THERMOMETER POCKETS

Thermometer pockets and instrument connections of an approved pattern are to be fitted in such positions as may be determined to suit the operation and testing of the plant to the approval of the Employer. A thermometer pocket is to be fitted adjacent to each point of connection for distant remote temperature indication unless specifically stated to the contrary. Where necessary, the pocket is to be of approved alloy material suitable for the required service.

All thermometer pockets are to comply with the requirements of BS 2765.

2.16. GAUGE CUBICLES AND PANELS

Gauges and instruments are to be grouped whenever possible and housed in suitable cubicles. Where circumstances do not justify cubicle accommodation, they may be secured to flat back panels but in such cases the approval of the Employer is first to be obtained.

Cubicles are to be sheet metal having a thickness of 3mm. The construction shall employ folding technique with the use of standard rolled sections or other reinforcement where necessary. The stiffness shall be such as to prevent maloperation of relays or other apparatus by impact. The front of the panel is to have a smooth well finished surface and, if of the "desk" type, the desk is not to protrude so far as to hinder the easy reading of instruments and the operation of the controls.

2.17. LOCKING FACILITIES

Locking facilities including padlocks shall be provided under this Contract for:

(a) Control position selector switches in all positions provided.

(b) Marshalling, operating and terminal kiosks or cubicle access doors and panels.

(c) Isolating valves in open or closed positions.

Locking facilities shall be of an approved dead latch type. Three keys shall be supplied for each lock and all locks and keys shall be non-interchangeable.

Where a set of locks is provided under a particular section of the Plant, a group master key shall be supplied in addition.

A schedule of locks and keys shall be submitted to the Employer for approval.

All locks and padlocks shall be of brass and where they are fitted to switchboards or similar cubicles shall have the visible parts chromium plated.

Where a group of locks is supplied under any part of the Contract, a rack or cabinet of approved design shall be supplied for the accommodation of all padlocks and/or keys while not in use. The padlocks and keys shall be engraved with an agreed identifying code or inscription and this shall be repeated on the racks or cabinets on engraved labels.

Where a mechanism is to be locked in a specific position, provision shall be made at that part of the mechanism where the operating power is applied and not to remote or ancillary linkages.

Provision for locks shall be designed, constructed and located on the equipment so that locks will remain serviceable in the climatic conditions specified without operation or maintenance for continuous periods of up to two years and with suitable maintenance shall be fit for indefinite service.

2.18. ELECTRICAL EQUIPMENT

2.18.1 General

The works shall be designed to ensure continuity of operation under all working conditions obtaining at the Site as the first consideration and to facilitate inspection, maintenance and repairs. All reasonable precautions shall be taken in the design of equipment and of the works, to ensure the safety of personnel concerned with the operation and maintenance of the works.

Outdoor equipment shall be designed so that water cannot collect at any point. The undersides of all tanks shall be ventilated in an approved manner to prevent corrosion.

Mechanisms shall be constructed to prevent sticking due to rust and corrosion and the bearings of exposed operating shafts shall be designed so as to prevent moisture seeping along shafts into the interior of equipment.

Corresponding parts of similar equipment and equipment liable to renewal, shall be fully interchangeable and the Contractor will be required to demonstrate this feature to the Employer's and Employer's satisfaction.

All equipment shall operate without undue vibration and with the least practical amount of noise.

All equipment shall be designed to minimize corona or other electrical discharges, to comply with local electromagnetic compatibility (EMC) standards and in accordance with IEC standards 801 and 1000.

All electrical components shall be adequately rated for their most onerous duty and the specified ambient temperature. When equipment is mounted in panels, cubicles etc., due account shall be taken of any heat generated by the equipment therein and the components shall be appropriately selected, rated or derated as necessary to suit the most onerous operating temperatures within the enclosure.

Except where a different meaning is stated in an equipment standard, the term "low voltage" (LV) shall refer to voltages up to and including 1 kV and "high voltage" (HV) shall refer to all voltages exceeding 1 kV.

Fuses, circuit-breakers and other electrical switchgear components shall comply with the relevant clauses for low voltage ac switchgear.

2.18.2 Electrical Equipment Enclosures

Equipment enclosures for electrical equipment shall comply with IEC 79, IEC 298, IEC 529 and IEC 947-1 as applicable. Equipment enclosures for use in hazardous areas other than explosive gas atmosphere shall comply with National and Local Regulations relating to this application.

Unless otherwise specified, minimum equipment enclosure classifications for non-rotating electrical equipment shall be as follows:

a)	Indoors only in totally enclosed rooms with provision for limiting ingress of dust.	IP 32

b)	Outdoors and indoors in areas subject to Water spray, or heavy condensation.	IP 54

The enclosure classification of main and auxiliary cable boxes with the cable(s) terminated shall not be less than that of the associated equipment, subject to a minimum classification of IP54.

2.19. CURRENT RATINGS

2.19.1 NORMAL CURRENT RATINGS

Current ratings in accordance with IEC 60059 shall be adopted, unless otherwise agreed with the Employer.

Every current carrying part of the equipment shall be capable of carrying its site rated current continuously under the site ambient conditions as specified and shall not be rated on the basis of air conditioned rooms even when these are specified. In no conditions shall the specified maximum temperature be exceeded.

The current ratings specified are the continuous current ratings required at the Site, under the specified maximum temperature conditions.

2.19.2 TEMPERATURE RISE

Full provision shall be made for solar heat gain on all outdoor apparatus and any differential temperatures attained as a result of the impingement of solar heat.

The allowable temperature rise shall be in accordance with the relevant Standard, except where the ambient temperature rise shall be reduced by one degree Celsius for every degree Celsius the maximum ambient temperature exceeds the maximum permitted in the Standard.

In such cases where the Contractor is unable to guarantee the permitted maximum temperature reached under site conditions, taking account of solar heating, then sunshades shall be provided to the Employer's approval.

The maximum temperature attained by components to the Employer to prove that all Plant has been sufficiently derated to suit the site conditions and any changes required by the Employer shall be made at no extra cost.

2.19.3 SHORT-TIME CURRENT RATINGS

Electrical equipment shall be adequately supported and braced to withstand the forces associated with the maximum short-circuit currents specified or pertaining, whichever is the greater and assuming that the inception of the short-circuit is at such a time that gives maximum peak currents. No provision for current decrement shall be made unless specifically permitted by the appropriate Standard or elsewhere in this Specification.

Equipment shall be so constructed as to withstand the specified maximum short-circuit currents for the time specified in the schedules without the temperature exceeding the specified maximum short-time temperature or value stated in the relevant standard, under these conditions. The equipment shall be considered as being operated at the maximum permitted continuous temperature prior to inception of the short circuit.

The final temperature attained as a result of the passage of short-circuit current shall not cause permanent damage, or deterioration sufficient to reduce the normal operating characteristics below the specified or most onerous operating requirements, whichever is the highest.

2.20. VOLTAGE RATINGS

2.20.1 NORMAL VOLTAGE RATINGS

Unless otherwise specifically stated, any reference to voltage rating shall be deemed to refer to the nominal rated voltage or voltages of electrical equipment. Standard voltage levels in accordance with IEC 60038 shall be adopted unless otherwise specified by or agreed with the Employer.

All electrical equipment shall except where otherwise specified, be capable of continuous operation at a voltage in the range of $\pm$10% of the nominal voltage and at a frequency in the range of 47 to 51 Hz coincidentally without deterioration.

The temperature rise of electrical equipment continuously operating at the specified extreme voltage and frequency shall not exceed the temperature rise when operating at nominal voltage and frequency by more than 50 °C.

2.20.2 SHORT-TIME VOLTAGE RATINGS

All electrical equipment shall be so designed such as to withstand abnormal system voltages as required by the applicable IEC.

2.21. ELECTRICAL INSULATION

Insulating materials shall be suitably finished so as to prevent deterioration of their qualities under the specified working conditions. Account shall be taken of the IEC 60085 recommendations.

Ebonite synthetic resin-bonded laminated material and bituminised asbestos cement-bonded panels shall be of suitable quality selected from the grades or types in the appropriate IEC.

The insulation of all machine windings, solenoids, etc. other than those immersed in oil or compound, shall be of Class F materials, unless otherwise specified elsewhere.

All cut or machined surfaces and edges of resin-bonded laminated materials shall be cleaned and then sealed with an approved varnish as soon as possible after cutting.

Linseed oil and untreated materials of fibre, leatheroid, presspahn, asbestos or other similar hygroscopic types of materials shall not be used for insulation purposes. Untreated leatheroid and presspahn may be used for mechanical protection of winding insulation.

The use of asbestos is not permitted without the permission of the Employer.

Wherever practicable, instrument, apparatus and machine coil windings, including wire wound resistors, with the exception of those immersed in oil or compound, shall be thoroughly dried in a vacuum or by other approved means and shall then be immediately impregnated through to the core with an approved insulating varnish. Varnish with a linseed oil base shall not be used.

No material of a hygroscopic nature shall be used for covering coils. Where inter-leaving between windings in coils is necessary, only the best manila paper, thoroughly dried, which permits penetration by the insulating varnish or wax, shall be used.

Polychlorinated Biphenyl (PCB) type materials shall not be used anywhere in the equipment or in any component.

2.22. INSULATING OIL

Insulating oil shall comply with the requirements of IEC 60296. Insulating oil shall be provided by the Contractor for all oil-filled apparatus and 10% excess shall be provided for topping up purposes in sealed drums. The Contractor shall provide at no additional cost any oil treatment facilities he may require for his own use in order to ensure that insulating oil meets the requirements of the specification.

2.23. PANELS, DESKS AND CUBICLES

Unless otherwise specified, panels desks and cubicles shall be of floor-mounted and free-standing construction and be in accordance with the enclosure classification specified elsewhere. All control and instrumentation panels in any one location shall be identical in appearance and construction. Where new panels in appearance, arrangement and devices and colour finishes. Panels shall be rigidly constructed from folded sheet steel of 3 mm minimum thickness to support the equipment mounted thereon, above a channel base frame to provided a toe recess.

Overall height, excluding cable boxes, shall not exceed 2.5 m. Operating handles and locking devices shall be located within the operating limits of 0.95m and 1.8m above floor level. The minimum height for indicating instruments and meters shall be 1.5m unless otherwise approved by the Employer.

Panels shall be mounted on an approved form of anti-vibration mounting whenever necessary.

All panels, desks and cubicles shall be vermin-proof. All cable entries to equipment shall be sealed against vermin as soon as possible after installation and connecting-up of the cables to the approval of the Employer.

All cubicles, desks and panels shall be provided with a natural air circulation ventilation system. All control equipment shall be designed to operate without forced ventilation.

For outdoor equipment, metal or metal joints shall not be permitted and all external bolts or screws shall be provided with blind tapped holes where a through hole would permit the ingress appropriate in accordance with Clause 2.9.2.

Door sealing materials shall be provided suitable for the specified site conditions. Doors shall be fitted with handles and locks. Where walk-in type panels are supplied the door shall be capable of being opened from inside the panel without the aid of a key after they have been open, to lie back flat so as not to restrict access. Means shall be provided for securing the doors in the open position.

Cubicles and cubicle doors shall be rigidly constructed such that, for example, door mounted emergency trip contacts can be set so that mal-operation will not be possible due to any vibration or impacts as may reasonably be expected under normal working conditions.

The bottom and/or top of all panels shall be sealed by means of removable gasket steel gland plates. Gland plates for bottom entry shall be at least 250 mm above the floor of the cubicle.

Panels shall be suitably designed to permit future extension wherever appropriate or specified.

Each panel shall include rear access doors internal power sockets and door-operated internal lighting and be clearly labeled with the circuit title at front and rear, with an additional label inside the panel. Panel sections accommodating equipment at voltages higher than 125V (nominal) shall be partitioned off and

the voltage clearly labeled. Each relay and electronic card within panels shall be identified by labels permanently attached to the panel and adjacent to the equipment concerned. Where instruments are terminated in a plug and socket type connection both the plug and the socket shall have permanently attached identifying labels.

Instrument and control devices shall be easily accessible and capable of being removed from the panels for maintenance purposes.

Terminations, wiring and cabling shall be in accordance with the requirements of this section of the specification.

For suites of panels internal bus wiring shall be routed through apertures in the sides of panels and not via external multicore cabling looped between the panels.

All panels, whether individually mounted or forming part of a suite, shall incorporate a common internal copper earthing bar onto which all panel earth connections shall be made. Suitable studs or holes to the Employer's approval shall be left at each end of the bar for connection to the main station earthing system and possible future extension.

Earth connection between adjacent panels shall be achieved by extending the bar through the panel sides and not by interconnecting external cabling.

Where intrinsically safe circuitry is routed from a hazardous area to a safe area instrument panel, it shall be connected through Zener Barriers located in the safe area (instrument panel) of suitable rating and mounted on an insulated earthing bus bar having facilities for connection of a separate dedicated outgoing cable to a "clean earth" system.

Control supplies in desks, panels and cubicles shall be derived from a duplicate standby/ UPS system, except if specified otherwise in this specification. The following alarms shall be provided to monitor the systems: voltage high, voltage low, no volts and earth fault. The alarms shall be signaled to the Control Room.

Instruments having pressure pipe connections containing oil, water, steam or flammable or toxic fluids shall be excluded from the Control Room.

All cubicles, desks and panels shall be painted externally with a high gloss paint of Munsell 5Y-7/1 colour. The interiors of all cubicles, desks and panels painted matt white.

All cubicles or panels shall be fitted with thermostat controlled anti-condensation space heaters inside those equipment.

2.24. INSTRUMENT TRANSFORMERS OF SWITCHGEAR

All instrument transformers must be suitable for continuous operation when installed on switchgear under the ambient conditions as well as under all rated and short-circuit conditions stated in the data sheets.

Toroidal current transformers of the single or multi-ratio type, mounted inside the high-voltage enclosure with grounded cores are preferred.

The current transformer data are listed in single line diagram. The rated secondary current of current transformers shall be 5 A or 1 A as per existing substation condition.

Current transformers must have secondary terminals outside the high-voltage enclosure, Mounted in suitable, accessible terminal boxes. All secondary leads of all current transformers must be wired to shorting-type terminals on the terminal strip in the local control cubicle of each bay.

Voltage transformers shall be of the metal-enclosed, oil or cast resin insulated inductive type. They are to be mounted as per specification.

The voltage transformer data are stated in the single line diagram.

The secondary terminals must be located in accessible, grounded terminal boxes on the voltage transformer itself. The secondary connections must be wired to a terminal strip in the local control cabinet.

2.25. LOW VOLTAGE EQUIPMENT AND CONTROL CIRICUIT

All control circuits shall be manufacturer's standard for the application on hand, but shall be approved by the purchaser. Special functions shall be included if indicated in the single line diagram.

All local control functions such as:

- Switchgear interlocking functions
- Fuses or MCB's for Low voltage equipment
- Local operation of the switchgear
- Indicating and measuring equipment

must be located in the local control cubicle.

All control and monitoring equipment for the circuit breaker and its accessories shall be installed in a local drive control cubicle. The related control wiring shall be wired to plug-in connectors. The cabinet must have degree of protection IP 32 at least.

Finely stranded copper wire of at least 1.5 sq.mm cross-section shall be used within the control cabinet for all control wiring. Manufacturer's standard crimp-type terminations and screw line-up terminals suitable for a cross-section of at least 2.5 sq.mm proofed against creepage currents shall be used. All interconnecting wiring must be suitably protected against mechanical damage, e.g. by routing them in protective channels or pipes.

Each control circuit except the tripping circuit shall be protected by a miniature circuit-breaker with an auxiliary contact. The auxiliary contacts of all MCBs shall be monitored as a common alarm.

Anti-condensation heaters shall be provided in the control cabinets, in the operating Mechanism housings of disconnectors, earthing switches and circuit-breakers.

The feeder bay or panels LV compartment shall be completely enclosed by steel sheets of 2 mm minimum thickness and shall be separated from the other sections. It shall provide a protection degree IP54, to accommodate protection relays and auxiliary devices. It shall have a separate access door with key-locks provided.

In each LV compartment a main terminal board shall be provided to which all incoming auxiliary cables are connected.

Mimic diagram, all instruments, operating elements and indicators of the switchgear, DC trip circuit test facilities, push buttons and lamps shall be mounted on the front of this compartment.
Indicating instruments shall be included for the functions.

All control circuits shall be according to the specified standards and designed for the application as required and shall be subjected to the approval of the Employer

.

All necessary auxiliary contacts shall be provided to enable remote control, remote alarm, and indication of the position/state of any circuit breaker, isolator and earthing device. In addition, two potential-free NO and NC contacts shall be provided for the above purposes each and the contacts shall be connected to the terminal board and to the control room where specified.

Each control circuit shall be protected by a two-pole miniature circuit breaker with auxiliary NC contact. The auxiliary contacts of all MCB's of the same circuit type, e.g. breaker motor control, alarm, space heater, trip, etc. shall be wired in series to suitable group alarm terminals.

Control wiring shall be executed with finely stranded copper wires of at least 2.5mm2 cross-sections, insulated with flame-retardant PVC or TEFLON.

Wherever terminals are not marked permanently and conspicuously, each end of each control wire shall be permanently marked with plastic ferrules (closed ring type) and terminated with crimp-type pin or plug terminators.

Identification of control wires and terminals must conform to the symbols used in the circuit diagrams. All control wiring shall be installed such that the likelihood of damage during normal operation, maintenance and fault conditions is minimized.

Terminal strips for different voltage levels must be physically separated from each other and suitably identified. Terminals carrying dangerous voltages even when the main breakers are off must be marked with a particular color and carry suitable warning labels.

Further terminals shall be provided for the current transformers, which shall permit instruments to be connected without interrupting the secondary current transformer circuits.

Voltages for control, trip and alarm shall be monitored by built-in normally energized auxiliary relays, separate for each bus or feeder section. These relays shall be time delayed on drop-off and their contacts shall be wired to group alarm terminals.

Space heaters shall be installed in each low voltage cabinet to prevent condensation. Each heater element shall have an integral thermostat for control. Each switchgear section shall have a common space heater feeder, fed from a separate power source, and protected by a two-pole MCB with auxiliary NC contact wired to a group alarm terminal.

2.26. CONTROL AND SELECTOR SWITCHES

Control switches shall be of the three position type with a spring return action to a central neutral position and without a locking feature.

Circuit breakers shall have control switches which shall be labeled open/N/close or (O/N/I) and arranged to operate clockwise when closing the circuit breakers and anti-clockwise when opening them.

Control switches of the discrepancy type shall be provided where specified. Such discrepancy control switches shall be arranged in the lines of the mimic diagram. Such switches shall include lamps and be of the manually operated pattern, spring loaded such that it is necessary to push and twist the switch past its indicating position for operation. The lamp shall be incorporated in the switch base and shall flash

whenever the position of the controlled device is at variance with the position indicated by the control switch. Hand dressing of the control switch to the correct position shall cause the lamp to extinguish.

Pushbutton test switches shall be provided along the control panel which will illuminate all indicating discrepancy lamps as well as spare lamps on the control panels. The scheme shall be complete with all necessary diodes and other equipment required for satisfactory operation.

Switches for other apparatus shall be operated by pushbuttons, shrouded or well recessed in their housings in such a way as to minimize the risk of inadvertent operation.

Multi-position selector switches shall have a lockable stay put action. Each position of the selector switches shall be suitably labeled to signify the functions in accordance with the approved wiring diagrams. The switch handle shall be of the pistol grip spade type to the approval of the Employer.

It shall not be possible at any time to close any switching device from more than one location simultaneously and suitable lockable selector switched shall be provided to meet this requirement. Tripping signals from all locations shall function at all times.

Particular variations of the above requirements may be agreed with the Employer for special instrument or control equipment, viz. Main control room desks and panels and electrical equipment cubicles.

The contacts of all control and selector switches shall be shrouded to minimize the ingress of dust and accidental contact and shall be amply rated for voltage and current for the circuits in which they are used.

2.27. INSTRUMENTS & METERS

2.27.1 INDICATING INSTRUMENTS (IN CASE OF ANALOG TYPE)

All indicating instruments shall be of the flush mounted pattern with dust and moisture proof cases.

Instrument dials in general should be white with black markings and should preferably be reversible where double scale instruments are specified.

Scales shall be of such material that no peeling or discoloration will take place with age under humid tropical conditions.

The movements of all instruments shall be of the dead beat type.

Wherever possible, instruments shall be provided with a readily accessible zero adjustment.

2.27.2 ELECTRICAL METERS

All electrical meters shall comply with IEC 687 &1037 and unless otherwise specified, shall be of accuracy Class 0.5. Accuracy class of Tariff meter shall be of accuracy class 0.2. Three-phase power measuring instruments shall be of the three-phase unbalanced load pattern wherever the current and voltage references permitting. Static, programmable type energy meters.

Where precision grade metering is specified meters shall be calibrated to precision grade accuracy to IEC 627& IEC-1037. Due allowance shall be made for the errors of current and voltage transformers with which they shall work and whose accuracy class shall be Class 0.2 and 0.5 respectively.

Where commercial grade metering is specified the meters shall be calibrated to commercial grade accuracy to IEC 687 and IEC-1037.

Meters shall be single directional and shall be fitted where required with suitable devices for the transmission of impulses to a summator. Var-hour meters shall be complete with phase shifting transformers as necessary.

Front of panel test terminal blocks shall be provided for all meters.

Summators shall be equipped to summate the circuits specified and shall be equipped where required with suitable contacts for the re-transmission of impulses to a printometer. They shall register in kilowatts the value of the impulses received from each kilowatt-hour meter. Printometer shall be of an approved type having the specified demand interval.

2.27.3 INDICATING LAMPS AND FITTINGS

All indicating lamps shall be adequately ventilated and as far as practicable, lamps of a common type and manufacture shall be used throughout the Contract.

Lamps shall be easily removed and replaced where possible from the front of the panel by manual means preferably not requiring the use of extractors.

Where specified every circuit breaker panel shall be equipped with one red and one green indicating lamp, indicating circuit closed and circuit open and an amber lamp for indicating 'auto-trip'. Where specified for in the lines of mimic diagrams, indicating lamps may be of the three-lamp single-aspect type.

The variety of indicating lamps provided shall be rationalized to reduce maintenance and spares requirements.

The lamps shall be clear and shall fit into a lamp holder. The rated lamp voltage shall be at least 20% in excess of nominal supply voltage, whether a/c or d/c The lamps shall have an operating life of at least 10,000 hours, under site conditions. In the event that other indicating devices, such as light emitting diodes, are used in place of lamps then these shall have the same life expectancy and performance capability as the lamps then replace.

The lamp glasses shall comply with IEC 73 and be in the standard colours, red, green, blue, white and amber. The colour shall be in the glass and not an applied coating. Transparent synthetic materials may be used instead of glass.

Where illuminated pushbuttons are used for control purposes, the illuminated pushbuttons shall be engraved with a clear instruction such as 'push to open' or 'push to close', and the lamp shall illuminate in accordance with the above colour code after the instruction has been carried out and the device has operated.

Unless otherwise agreed with the Employer all lamp colours shall conform to the following practice:-

Red	–	energized or operative position
Green	–	de-energized or inoperative position
Amber	–	fault or abnormal condition
White	–	healthy or normal condition
Blue	–	healthy trip

Lamp test facilities shall be provided for all switchboards, control panels etc. to enable all lamps to be tested whilst the equipment is in service. Operation of the lamp test facility shall not cause any other device to operate.

Indication circuits shall be fused.

2.27.4 ANTI-CONDENSATION HEATERS

All switchboards, panels, cubicles and the like shall incorporate thermostat controlled electric heaters capable of providing movement of sufficient heated air to avoid condensation. The apparatus so protected shall be designed so that the maximum permitted rise in temperature is not exceeded if the heaters are energized while the apparatus is in operation.

The switchboard anti-condensation heaters shall be fed from an LV single phase and neutral supply, manually switched by a two-pole switch with red lamp, mounted on the back of the board, panel or cubicle and bus wired through the board. Labels shall be provided on the switch stating “Heater Supply”. Heater terminals shall be shrouded and labeled “Heater”.

Motor anti-condensation heaters where fitted shall be fed from a LV single phase and neutral supply bus wired through the board. The supplies shall be individually fused and will be switched by auxiliary contracts on the contractor and isolated by auxiliary contents on the contractor isolator.

2.28. CONTROL AND INSTRUMENT PANEL WIRING, CABLE TERMINATIONS AND TERMINAL BOARDS

2.28.1 GENERAL

All electrical equipment mounted in or on switchgear, panels and desks, shall have readily accessible connections and shall be wired to terminal blocks for the reception of external cabling.

All wiring shall be adequate cross sectional area to carry prospective short circuit currents without risk of damage to conductors, insulation or joints.

The following classes of copper conductor, as defined in IEC 228, shall be used for panel wiring:

a) Class-1 conductors up to a maximum of 0.9 mm diameter where necessary for wire-wrapped terminations and similar techniques,

b) Class-2 conductors except where specified otherwise,

c) Class-5 and class 6 conductors between points subject to relative movement.

The following minimum conductor sizes shall be used :

a) 2.5 mm^2 for current transformer secondary circuits with a rated secondary current of 0.5 A or greater.

b) 1.5 mm^2 except where specified otherwise.

c) 0.5 mm^2 for alarm and indication circuits with a continuous or intermittent load current not exceeding 1 A.

Where an overall screen is used, this shall be a metallic screen or low resistance tape, with a drain wire as above.

Wiring shall be supported using an insulated system, which allows easy access for fault finding and facilitates the installation of additional wiring.

Small wiring passing between compartments, which may separated for transport shall be taken to terminal blocks mounted separately from those for external cable connections.

Connections to apparatus mounted on doors or between points subject to relative movement shall be arranged so that they are subjected to torsion rather bending.

Ribbon cable or similar preformed cables with plug and socket connectors may be used for light current wiring. Plug and socket connectors shall be polarized so that they can only be inserted in to one another in the correct manner.

If so required, the Contractor shall submit for the Employer's approval samples of the types of wire, numbered ferrules, and terminal washers or lugs as appropriate which he propose to use.

2.28.2 IDENTIFICATIONS OF WIRES

All wiring and cores in control and instrument cables shall be identified in accordance with the associated schematic and/or wiring diagrams either by means of discrete wire numbers or wire colours, except when an automatic or proprietary system of wiring is used, e.g. point-to- point wiring on a mother board.

When a wire numbering system is used, it should be in accordance with one of the main marking systems described in IEC 391 or with a functional marking system. Both ends of every wire and core in control and instrument cables shall be fitted with interlocking ring ferrules of white insulating materials indelibly marked with back characters. Heat shrink marking sleeves may be used but adhesive markers are not acceptable.

When plug and socket connectors are used, they shall be uniquely identified as mating pairs and each connector pin shall be numbered. Wiring which is permanently connected to plugs or sockets need not be identified.

Each core of multipair wiring shall be identified by colour and terminal block identification together with an identification tracer per bundle.

Permanent identification of all terminals, wires and terminal blocks shall be provided.

A consistent system of wiring numbering shall be used throughout the plant, and it shall be agreed with the Employer at the start of the Contract.

2.28.3 TERMINALS AND TERMINAL BLOCKS

Terminal blocks shall have separate terminals for internal and external connections, and not more than one wire shall be connected to each terminal.

Adjacent terminals to which wires of different voltage, polarity or phase are connected shall be separated by a protruding insulating barrier. This requirement also applies to terminals carrying wires of the same voltage but originating from different sources.

Trip circuit wiring and instruments transformer secondary wiring shall be connected using hook type crimped terminations in screw clamp, spring loaded insertion type terminals.

Where clamp type terminals are used, Class 1 and Class 2 conductors may be terminated without lugs. Crimp lugs shall be used for class 5 and class 6 conductors. Means shall be provided for retaining the

identifying ferrules of the wire end when it is disconnected. Pinch screw type terminals shall not be permitted.

Subject to approval of the Employer, “wire-wrap”, “term-point” or equivalent methods of terminations of single strand conductors may be used.

Wires shall be grouped on the terminal boards according to their functions.

All terminal blocks shall provide a degree of protection of not less than IP2X when correctly installed, either inherently or by provision of insulating covers.

Terminal boards shall be mounted vertically, not less than 150mm above the gland plates, and spaced not less than 100mm apart, on the side of the enclosure and set obliquely towards the rear doors.

Sufficient terminals shall be provided to permit all cores on multicore cables to be terminated. Terminals for spare cores shall be numbered and be located at such position as will provide the maximum length of spare core. At least 10% spare terminals shall be provided in all cases.

The tails of multicore cables shall be bound and routed so that each tail may be traced without difficulty to its associated cable. All spare cores shall be made off to terminals.

When two lengths of screened cable are to be connected at a terminal block (i.e. junction box) a separate terminal shall be provided to maintain screen continuity.

In the main and local control and equipment rooms means shall be provided on the terminal blocks of panels, desks, cubicles, etc. for testing all the instrument circuits without the need to remove the internal or external wiring from the block.

The Contractor shall submit full details and specification of the proposed means of termination where wire wrapping, soldering and similar methods are used. The adopted methods shall be to the Employer’s approval.

The contractor shall identify all special tools, such as wire wrapping tools required for termination, and shall make provision for their supply in sufficient numbers.

The use of pre-formed factory tested cable connections to field mounted marshalling boxes shall be to the Employer’s approval.

2.29. JUNCTION AND MARSHALLING BOXES

Junction and marshalling boxes for use in non-hazardous areas shall be of substantial sheet aluminium anodised coating construction to prevent corrosion, having an enclosure classification in accordance with the requirements of clause 2.27.2. They shall be fitted with external fixing lugs and finished in accordance with the requirements of the specification for cleaning, painting and finishing. The boxes shall allow ample room for wiring, with particular regard to the routing of wires from the point of entry. Boxes made from aluminium shall be subject to agreement with the Employer.

Outdoor boxes shall have an anti-condensation finish and all boxes shall be designed such that any condensed water cannot affect the insulation of the terminal boards or cables. No cables shall be terminated into the top of outdoor boxes unless specifically approved by the Employer.

All outdoor kiosks, cubicles and panels shall be provided with sun/rain shades. All kiosks, cubicles and panels not in air-conditioned rooms shall be provided with thermostat controlled anti-condensation heaters.

All kiosks, and cubicles shall be fitted with door operated internal illumination lamps.

All necessary gland plates shall be provided undrilled.

Boxes shall be complete with suitably inscribed identification labels.

Boxes for use in hazardous areas shall have all entries factory pre-drilled. Every unused screwed entry shall be sealed by means of a tamperproof screwed plug in accordance with IEC 60079.

Hazardous area boxes with bolted or screwed lids shall require the use of special keys or spanners, for lid removal.

Where weatherproof types of hazardous area boxes are not available, the gaps should be protected against the ingress of moisture, by an approved means, compliant with local standards.

All box covers are to be arranged for padlocking and padlocks with keys shall be supplied.

All boxes shall be provided with adequate earthing bars and terminals.

2.30. CONDUIT AND ACCESSORIES

Conduit installations shall comply with IEC standards 364, 621, 981 and 1035. Installations shall also be compliant with local regulations, unless otherwise approved by the Employer.

All conduit and conduit fittings shall comply with IEC 423 and IEC 614. Unless otherwise approved, all conduit and conduit fittings shall be threadable steel conduit with minimum enclosure classification IP 55, heavy mechanical protection and high resistance to corrosion inside and outside.

No conduit smaller than 20 mm diameter shall be used.

Standard circular boxes or machined face heavy duty steel adaptable boxes with machined heavy type lids shall be used throughout. For outdoor mounting all boxes shall be galvanized, weatherproof and fitted with external fixing lugs.

Where conduit is terminated so that the bare end of the conduit is exposed the conduit end shall be fitted with a brass bush.

The use of running threads, solid elbows and solid tees will not be permitted.

Conduit ends shall be carefully reamed to remove burrs. Draw-in boxes shall be provided at intervals not exceeding 10 m in straight-through runs.

Conduit runs shall be either the vertical or horizontal direction, unless otherwise approved, and shall be arranged to minimize accumulation of moisture. Provision for drainage shall be made at the lowest points of each run.

Conduit runs shall be in either the vertical or horizontal direction, unless otherwise approved, and shall be arranged to minimize accumulation of moisture. Provision for drainage shall be made at the lowest points of each run.

Conduit shall be supported on heavy galvanized spacer saddles so as to stand off at least 6 mm from the fixing surface.

All conduits run in any circuit are to be completed before any cables are pulled in.

Flexible metallic conduit shall be used where relative movement is required between the conduit and connected apparatus, and a separate earth continuity conductor shall be provided.

2.31. MINIATURE CIRCUIT BREAKERS, FUSES AND LINKS

Facilities shall be provided for protection and isolation of circuits associated with protection, control and instruments. They shall be of approved type and grouped, as far as possible, according to their functions. They shall be clearly labelled, both on the panels and the associated wiring diagrams.

Facilities shall be provided to enable the control circuits for any circuit-breaker to be individually isolated for maintenance purposes.

Facilities for protection and isolation of control and tripping circuits are preferably to be mounted on the outside of control panels in approved positions.

All fuses shall incorporate HRC cartridges to BS 88 or IEC 60269.

Fuse holders shall be designed to lock the cartridges firmly into position without the use of screw clamping devices.

Miniature circuit-breakers (MCB's) shall comply with IEC 60898.

Where MCB's are used on control, protection and alarm supplies, tripping shall cause an alarm to be displayed.

2.32. ARTHING AND BONDING

The main earthing conductors for connection to all electrical equipment, motors, panels, etc., shall be provided for connection to the main earthing system.

All non-current carrying metal parts of electrical equipment shall be bonded to an earth terminal or terminals mounted on the equipment and readily accessible.

All equipment terminals provided for an external earth connection shall be identified by indelible means unless such terminals are directly and visibly mounted on metallic equipment frames or earth bars, when such marking may be omitted. The earth bars shall be installed on the metallic parts with insulator.

Identification marks for earth terminals shall comprise the colours green or green/yellow in combination or a reproduction of the symbol no. 5019 in IEC 417.

Assemblies containing electrical equipment, including switchboards, control boards and controls desks, shall be provided with a separate copper earth bar running the length of the assembly. All metal parts and the earth terminal or terminals shall be bonded to this earth bar. Earthing connections shall not depend upon the bolting of steel/steel joints, between adjacent panels or Switchgear/ cubicles.

Earth bars shall be of adequate size and suitably supported and braced to carry the rated short circuit current for the associated electrical circuits for the rated short-circuit current duration, without damage or excessive heating likely to damage joints, associated or adjacent components.

Switchgear and control gear assemblies shall be provided with two or more earth terminals unless otherwise specified. The copper earth bar shall be sized to withstand the maximum system earth fault current for three seconds without deterioration.

The size of the copper earth bar in control panels, control desks or similar enclosures containing low voltage apparatus shall be such as to comply with the specified requirements for withstanding prospective short-circuit currents. The size of this bar shall be a minimum of 100 sq. mm cross- sectional area, providing that sufficient mechanical integrity is provided by adequate supports and terminals, and also providing this size is not less than the size of the largest incoming power supply conductor.

The metal cases of all instruments, relays and the like shall be connected to the panel earth bars by copper conductors of not less than 1.5 sq. mm cross-sectional area.

If the plant contains electronic equipment which is vulnerable to possible conductive interference, or if the equipment generates electrical noise, which could interfere with other plant or equipment, then separate earth's may be supplied and the actual means of interconnecting with the station earth system.

POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT
FOR

Design, Supply, Installation, Testing and Commissioning of Capacitor bank with associated switchgear for Mymensingh region on turnkey basis.

SECTION 3

36KV SWITCHYARDS & SWITCHGEAR

SECTION 3

36KV SWITCHYARDS & SWITCHGEAR

3.1. GENERAL

This Specification covers the design, manufacture, per-assembly and acceptance testing in the Contractor's workshops as well as the supply, delivery; unloading, erection, adjusting, painting, identification, commissioning and acceptance testing of 33 kV switches and indoor switch gears within identified existing substations complete in every respect and suitable for satisfactory operation.

The contract shall design the layout of the layout of the capacitor bank and related system in such manner that easy to access to system and installation is insured. Drawings in these specifications are tentative and do not relieve the Contractors from the responsibility of the design with requirements of this Contract.

The switches shall be suitable for the specified location and capable of continuous operation under the climatic conditions existing at site and complete in every respect with all necessary ancillary plant installations whether specified in detail or not.

The Contractor shall demonstrate that the switchgear has been designed, built and installed in accordance with the relevant international standards and the specification. It shall also operate and perform on a site in accordance with the requirements of the specification and in the environment defined therein.

The design shall be proven by the submission at the time of Bidding of test certificates covering all specified tests deemed to be pertinent to the plant and to the conditions in which it will operate.

The bidder shall present layout drawings of equipment it intends to use complete with dimensions. These drawings shall include all distances, clearances, service roads, etc. as necessary and as may be required by applicable standards.

All changes of equipment or services that do not comply with the specification shall be indicated in the Schedule of deviations and shall be given in writing.

The basic technical design date for the 33 kV equipments and installations shall be as follows:

The Contractor shall ensure that the complete capacitor bank and associate equipment shall satisfy the requirements of these Specification and the appropriate parameters, including insulation, fault level, mechanical stresses, etc., and any additional equipment found to be necessary to obtain the conditions shall be deemed to have been included in the tender price.

3.2. SCOPE OF SUPPLY AND SERVICES

This Subsection sets out the scope of installations covered by this Specification as well as the requested supplies and services, including all necessary auxiliary units and accessories for a reliable continuous operation even if this is not expressly stated in this specification.

The requirement for switchgear spares, tools and appliances, related services, test, maintenance and handling equipment shall be as stated in the Bid document. All devices necessary for operation and earthing shall be provided within the Contract Price.

3.3 Basic Technical Design Data

Nominal system voltage (r.m.s. phase-to-phase voltage)	kV	:	33
Highest voltage for equipment	kV	:	36
System frequency	Hz	:	50
Power frequency withstand voltage, 1 minute	KV	:	70
Lighting impulse withstand voltage	kV	:	170
Symmetrical short-circuit current (3 sec)	KA	:	31.5
System configuration		:	3Phase/4Wire
Grounding		:	Solidly grounded
Coefficient of grounding		:	0.8
Minimum clearances between live metal and earth	mm	:	380
Minimum clearance between live metal	mm	:	430
Creepage distance	mm/kV	:	25

3.4. RERERENCES

3.4.1 IEC Standards

IEC 62271-100	HV AC circuit breakers
IEC 60060	High Voltage test techniques
IEC 60071	Insulation Co-ordination
IEC 60099	Surge arresters
IEC 62271-102	AC Dis-connectors (isolators) and earthing switches
IEC 60044-1	Current transformers
IEC 60044-5	Voltage transformers
IEC 60059	IEC Standard current rating

IEC 62155	Tests on hollow insulators for use in electrical equipment
IEC 62271-103	HV switches
IEC 60273	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V
IEC 60305	Insulators for overhead lines with a nominal voltage above 1000V Ceramic or glass insulator units for ac systems – Characteristics of insulator units of the cap and pin type
IEC 60383	Insulators for overhead lines with a nominal voltage above 1000V

3.4.2 British Standards

BS 7884	Specifications for hard-drawn copper and copper cadmium conductors for overhead power transmission purposes.
BS EN 60383-2	Insulators for overhead lines with voltage greater than 1000V.
BS 159	Specifications for HV busbar and busbar connections.
BS 215S	Specifications for aluminum conductors for overhead transmission.
BS EN 13600	Specifications for high conductivity copper tubes for electric purposes.
BS 2898	Specifications for wrought aluminum for electrical purposes. Strip with drawn or rolled edges.
BS 3288	Insulator and conductor fittings for overhead power lines.
BS EN 60044-1	Specifications for current transformers.
BS EN 62271-102	Specifications for AC disconnections and earthing switches.
BS EN 62271-100	Specifications for HV AC circuit breakers
BS 6651	Lightning Protection
BS 7354	Code of practice for design of HV open terminal stations.

3.5. 33kV Outdoor Switchyard

3.5.1 General

The switches shall be suitable for outdoor location and capable of continuous operation under the climatic conditions existing on site. It shall be designed to comply with this Specification and relevant IEC and British Standards where applicable.

In all cases the ancillary plant necessary to complete installation of the equipment shall be included in

the Contract.

The disposition of plant in any substation is to be such that the operation of any item of plant under the specified service conditions shall in no way create a condition that could adversely affect the performance of adjacent circuit breakers or any associated equipment.

Current Ratings

Every current-carrying part of the switchgear including current transformers, busbar, connections, contacts and joints shall be capable of carrying its specified rated current at rated frequency continuously, and in no part shall its temperature rise exceed that specified in relevant standards.

Corona

Equipment shall be designed so as to minimize corona or other electrical discharge and radio interference. Tests for corona and radio interference shall be carried out by the Contractor at his Works and on Site as required by the employer.

Temperature rise

Each current carrying component of the equipment supplied shall be capable of continuous operation at the specified ratings without exceeding the maximum temperature rises stated in the specifed IEC ratings.

Insulators

All types of insulators shall be of brown glazed porcelain, toughened glass or polymeric type capable of withstanding the specific climatic and service conditions. The strength of insulators as given by the Electro-mechanical test load shall be such that the factor of safety when supporting their maximum working loads shall be not less than as specified.

Designs shall be such that stresses due to expansion and contraction in any part of the insulators and fittings do not lead to development of defects.

Arcing horns are not required on post type and string insulators.

Porcelain, polymeric and toughened glass insulators shall be in accordance with IEC 137 and 273 where applicable. Porcelain shall be sound, free from defects and thoroughly vitrified and the glaze shall not be depended upon for insulation.

Each insulator shall have marked on it the manufacturer's identification name or trademark and any such other marks as may be approved to assist in identifying the representative batches for the purpose of type test certificates.

Each porcelain insulator, in addition, shall be marked to indicate the date of firing; tension and suspension insulators shall also be marked and not impressed. For porcelain insulators, the marks shall be imprinted before firing and shall be clearly legible after firing glazing. Glass insulators shall be similarly marked in an approved manner. Type Test Certificates complying with relevant IEC Standard shall be submitted.

3.5.2 Circuit Breakers

3.5.2.1 Type

The circuit breaker shall be of the SF6 gas / vacuum type and shall have spring charging operation mechanism.

3.5.2.2 Design and construction

The power circuit breaker shall be new and a current standard production model. Liberal factors of safety shall be used through out, especially in the design of all parts subject to reversal of stress or shock. They shall be designed, rated, tested and manufactured in accordance with applicable portions of IEC and BS or approved equivalent standards, unless otherwise specified.

Each power circuit breaker shall be of the 3 pole outdoor type, trip free, suitable for remote electrical closing and tripping and furnished complete with operating mechanism and other accessories. The circuit breaker control system shall be completed with the anti-pumping circuit.

The breakers will be required to break capacitor current, small inductive current and line charging current without causing excessive over voltage and charging current without re-strike as a frequent breaking type as specified in IEC. The breaker shall also be required to handle evolving faults and meet the requirements regarding partial discharge, radio interference, etc. as specified in relevant IEC and BS standard

3.5.2.3 Operating Duty and Performance

i) General

The requirement of IEC62271-100 in respect of type tests, service operation and the making and breaking of fault currents shall apply to all types of circuit-breakers. Designs shall be suitable for interrupting estimated any type of system fault.
Hence the breaker is applied for capacitor bank switching; the breaker shall be capable of required conditions for the switching: frequent breaking, re-strike free and other conditions specified in the IEC and BS standard.

ii) Test Certificates

Circuit-breakers shall be covered by type test certificates issued by an internationally acknowledged independent short-circuit testing station certifying the operation of the circuit-breaker at duties corresponding to the rated breaking capacities of the circuit-breakers. The test duty shall not be less onerous than the requirements of IEC 62271-100. Test certificates shall be submitted with the Bid.

iii) Rate-of-Rise of Restriking Voltage

Attention is drawn to the requirements of the minimum inherent rates of rise of restriking voltage of BS and IEC standards test plant arrangements. Where not specifically stated in the test certificates submitted with the Bid, the Bidder shall certify that the TRV to which the circuit-breaker was subjected during the short circuit tests was the most server condition that could be imposed by the available test plant for a first phase-to-clear factor of 1.5.

Any device incorporated in a circuit breaker to limit or control the rate of rise of restriking voltage

across the circuit breaker contacts shall likewise be to the Employer's approval and full descriptions of any such device shall be given. Drawings with the rate of rise of restriking voltage of including the transient recovery voltage (TRV), voltage system, current system, arc current, arcing time shall be submitted as per requirement of IEC Standard.

iv) Interrupting Duties

In addition to the requirement of IEC 62271-100 for interrupting terminal faults, circuit-breakers shall be capable of coping with the interrupting duties produced by the switching of low inductive currents associated with reactors or by the switching of capacitor currents associated with capacitor banks as may be applicable. Circuit-breakers for these duties shall be of the restrike-free type only.

Circuit-breakers shall be capable of interrupting currents associated with short-line faults and the out-of-phase switching conditions that may occur in service.

Bids should include a statement of the accumulative breaking capacity which the circuit-breakers are capable of before maintenance is required.

3.5.2.5 Operating Mechanisms

Circuit-breaker mechanisms shall be "trip free" as defined I IEC Publication IEC 62271-100 and BS 5311:1976.

The operation mechanism shall be trip free.

Each mechanism shall have an operation counter. The operation mechanism shall be mounted and enclosed in a weather-proof housing whose doors are so arranged as to make accessible parts of the mechanism usually requiring inspection or maintenance.

For purposes of inspection and adjustment, means shall be provided for safe manual closing of the breaker at a conveniently accessible place. The maintenance closing device shall be provided for each circuit breaker and so designed that the contacts can be operated slowly by one man to adjust the breaker when it is not in service.

Motor-operated Spring Charged Mechanism

A complete and separate spring operating system shall be furnished and installed for each three pole breaker or for each single pole breaker. This spring operation system shall be in accordance with applicable portion of NEMA standard.

Each operating mechanisms shall be provided with its own motor spring charged equipped with a common control cabinet and shall be provide for:

i) The time required to charge the closing spring after the closing operation shall not exceed 15sec.

ii) Under voltage alarm relay with contact suitable for operation on 125Vdc circuit to permit remote indication of loss of potential on the supply to the spring charged motor and its controls.

iii) Spring charged indicator to indicate the stage of energy stored in the spring.

iv) Means shall be provided to prevent the operation of the mechanism when maintenance work is being done. The mechanism shall be so arranged that emergency manual charging and released of the spring is possible without electrical means. Hand crank shall be provided for each circuit breaker.

The spring charged motor shall be rated along with substation DC source

The manual spring charged hand crank shall be provided for each circuit breaker

3.5.2.6 Name plate

Circuit breaker and its operating device shall be provided with rating plate/s made out of corrosion proof metal, marked with the following data. The data shall be either punched or engraved on the plate/s.

Each circuit breaker must have its own rating plate with information according to IEC 60056. At least the following items shall be included:

i) Manufacturer's name or trade mark by which he may be readily identified
ii) Serial number and type designation of circuit breaker & operating mechanism
iii) Year of manufacture
iv) Rated Voltage
v) Rated lightning impulse withstand voltage
vi) Rated normal current
vii) Rated short circuit breaking current
viii) Rated duration of short circuit
ix) Mass of circuit breaker with support structure
x) Rated auxiliary DC supply voltage of closing and opening devices
xi) Rated out of phase breaking current
xii) Rated AC supply voltage of auxiliary circuits
xiii) Rated insulation level
xiv) Rated frequency
xv) Rated line charging breaking current
xvi) Rated single capacitor bank breaking current
xvii) Rated back-to-back capacitor bank breaking current
xviii) Rated capacitor bank in rush making current

The rating plates shall be installed in such positions that the same are clearly visible to a man standing on ground.

3.5.2.7 Control Cabinet

A control cabinet shall be furnished with each breaker. This cabinet shall have a blank, removable, accessible steel plate, with a gasket, through which the control and power leads will enter the bottom of the cabinet. All material necessary to interconnect the various components of the circuit breaker, including control and operating mechanism facilities shall also be furnished. Each control cabinet shall be equipped with lighting; outlet and suitable heater complete with miniature circuit breaker, and shall be designed to maintain the temperature rise inside the cabinet within 5 degree above the surrounding temperature.

A 25mm wide x 6mm thick copper ground bus with 4mm drilled and taped holes shall be provided

near the bottom of the control cabinet and/or operating mechanism for cable shield grounding. The ground bus shall be solidly bolted to the steel framework as to make good electrical contact. The holes shall be spaced on 20mm centre-lines minimum. A 10mm long binding neat screw or screw with bronze spring washer shall be provided in each hole. The ground bus shall have a minimum of ten holes and screws for control cable shields and shall be solidly connected to ground terminal connector located the control cabinet housing.

3.5.2.8 Supporting Structures

The breaker supporting structure shall be hot-dip galvanized after fabrication, in accordance with ASTM specification. All necessary galvanized bolts, nuts and washers to complete the erection shall be furnished, including embedded anchor bolts for securing the supporting structure to the concrete foundation.

The zinc coating shall be uniform clean of a standard thickness on the entire surface of all materials.

3.5.3 Disconnector

Disconnecting shall be in accordance with IEC 62271-102. The disconnector shall be three phase gang operated vertical type.

Disconnector shall comply with the requirements of IEC 60060 in respect of lightning impulse voltage tests.

Circuit isolating switches shall be rated not less than specified. Bus section/coupler isolating switches shall be rated not less than the associated busbars.

Isolating switches shall be designed for live operations and will not require to switch current other than the charging current of open busbars and connections or load currents shunted by parallel circuits. Main contracts shall be of the high pressure line type and arcing contacts, if provided, shall be to the Employer's approval.

3.5.4 Lightning Arresters

For protection of the various switchgear and capacitor bank installations lightning arresters shall be installed at both ends of the 33 kV cables which connect the existing outdoor switchyard with the new indoor switchgear. Single phase non-linear metal oxide resistor type arresters without spark gaps are to be used of the heavy duty type (Class A) with 10 kA discharge current and a maximum continuously operating voltage of 30 kV r.m.s.. The ratings of the lightning arresters shall be selected under consideration of capacitor banks and high isokeraunic level. Voltage rating and protective level shall be selected by the Contractor. The voltage rating should be higher than the dynamic over voltage during a single line to ground fault.
The Contractor is responsible for calculation and fixing of the parameters for the lightning arrestors.

Suitable pressure relief device is to be designed according to IEC 99-1, 1A, 2 and all other relevant IEC standards.

All lightning arresters are to be provided with surge counters to register the number of operations. The arrestors are to be connected directly to the earthing system in the shortest way. Earthing

connections via steel support is not acceptable.

All steel supports and structures for erection of the lightning arresters shall be supplied and installed. Corrosion protection must be provided.

The lightning arresters at the outdoor cable sealing ends have to be provided with suitable clamps for connection to an aluminum conductor, Bi-metal sheets should be used for connection between copper and aluminum.

The contractor has to prove whether the protection range of the lightning arresters will be sufficient for protecting all the associated high voltage equipment.

If additional lightning arresters are necessary then these arresters are within the scope of this Contract.

Fire-proof closure to the floor of the switchgear and control/protection panels for sealing the outgoing cables.

3.5.5 Instrument Transformer

All current and voltage transformers must shall be correspond to the design short-circuit level of the switchgear. In case of indoor switchgear, the instrument Transformers shall be mounted in the fixed part of the switchgear.

All instrument transformers must be suitable for continuous operation for 20 % overload when installed in the switchgear under the ambient site conditions and for service under all rated and fault conditions.

Accuracy classes and burdens shall be in accordance with IEC 60044-part 1, IEC 60186 and schedule B of the tender document for current- and voltage-transformers.

Current transformer ratios (secondary side) shall be as indicated in the Price Schedule

Current transformers must have shorting type secondary terminals. The current transformer rating plate and the terminals must be accessible after power cables have been installed.

Voltage transformers must be able to withstand the full rated power frequency withstand and lightning impulse capability.

Current transformers

Current transformer should be installed in accordance with design requirements for each capacitor bank. Each CT incorporates with 2 core CT, metering and protection respectively.

- Requirements for measurement — Class 0.2/15VA
- Requirements for protection — 5P20/30VA

Voltage transformers (only if required)

If available, for measurement and protection, existing bus voltage transformer can be used. If new bus voltage transformer is necessary, the requirements are as follow:

- 33000V/√3 : 110//√3 : 110//√3
- Class : 0.2
- Burden : 100VA/100VA

3.5.6 Interlocking Facilities

Disconnector, circuit breakers, etc., shall be provided with an interlocking system which ensures safe operation of the equipment under all service conditions.

The interlocking scheme shall be designed to match with the existing switchyard arrangement. The items of plant supplied under this Contract shall be complete with all interlocking facilities with the existing arrangement.

Where mechanical key interlocks are employed, they shall be effective at the point where hand power is applied so that stresses cannot be transferred to parts remote from that point.

Tripping of the circuit breaker shall not occur if any attempt is made to remove a trapped key from the mechanism. Emergency tripping devices shall be kept separate and distinct from any key interlocking system and shall be clearly labeled, suitably protected from inadvertent operation but readily accessible.

Circuit breakers shall be interlocked so that, except under maintenance conditions, it is not possible to close a circuit breaker unless the selected busbar and circuit disconnector are closed.

Except as stated below, disconnector shall be so interlocked that they cannot be operated unless the associated circuit breaker is open.

Provision for on load transfer of feeder circuits from one busbar to another shall be made possible by interlocks which ensure that the section disconnector, bus coupler and its disconnector are closed.

All electrical interlocks shall so function as to interrupt the operating supply and an approved system of interlocks shall be provided which shall cover the emergency hand operation of apparatus which is normally power-operated. Failure of supply (or its restoration after an outage) or of connections to any electrical interlock shall not produce or permit faulty operation. Electrical bolt interlocks shall be energized only when the operating mechanism is being operated. Visible indication shall be provided to show whether the mechanism is locked or free. Approved means, normally padlocked, shall be provided whereby the bolt can be operated in the emergency of a failure of interlock supplies.

3.5.7 Auxiliary Switches and Contactors

Circuit breakers, disconnector and earthing devices and circuit selector disconnector shall be provided with suitably rated auxiliary switches and contactors, where permitted, to relay circuit information for the purpose of control, protection, indication and metering at the substation site as required by the relevant section of the Specification. In addition they shall be provided with auxiliary contacts for position indication to the control system control room via the remote supervisory system. Disconnector auxiliary switches are not the be used for current transformer switching circuits.

Auxiliary contactors shall be provided only where the circuit requirement cannot be met by the auxiliary switch arrangements and multiple contactors and relays will not be accepted in lieu of the auxiliary switches except as specifically approved by the Employer. Auxiliary switches and contactors shall comply with the requirements of the Specification and in particular shall be capable of operation within the same voltage limits as specified for the associated circuit breaker close and trip coils.

The connections of all auxiliary switches, including spares, and contactors as well as the associated coil connections and interconnections between auxiliary switches, shall be wired to a terminal board located in the operating cubicle or other approved position.

Auxiliary switches and contactors shall be mounted in an approved accessible position clear of the main operating mechanism but with a minimum of additional

mechanical linkages and housed in a substantial weatherproof enclosure. Where adjustable linkages are provided to facilitate the timing of the auxiliary switches with respect to the main equipment, approved locking devices shall be fitted.

Auxiliary switch contacts shall be positively operated, make with a wiping action and, where necessary, discharge resistors shall be provided to prevent to arcing when breaking inductive circuits.

Except for the contacts employed for control and interlocking, the requirements for auxiliary switches in respect of timing shall be as follows:

Circuit Breakers

Normally open contacts, with the exception of two sets of this type, shall close in about 10 milliseconds after the making of the main circuit breaker contacts and shall open in about 10 milliseconds before the separation of the main circuit breaker contacts whilst the two remaining sets shall close in about 5 milliseconds before the making of the main circuit breaker contacts and open simultaneously with the main circuit contacts.

Normally closed contacts shall close 10 milliseconds after the opening of the main circuit breaker contacts and open at least 10 milliseconds before the making of the main circuit breaker contacts.

Disconnector

The operating sequence of any disconnector auxiliary switches used in D.C. circuits shall be such that the auxiliary switches operate:

i) Before reaching the pre-arcing distance on closing the disconnector

ii) After the pre-arcing distance has been exceeded on the opening of the disconnector.

Auxiliary switches shall be adjustable from normally-open to normally-closed or vice-versa.

Any deviation from the above should be stated in the Schedule F of Deviations from Specification.

3.6. Indoor Metal Clad Switchgear and Construction Requirement (Not Applicable)

3.6.1 General

In case of Indoor switchgear, same manufacture's equipment with existing system shall be installed to avoid any technical inconstancies. Basic information of existing system can be found the Schedule A herewith. Necessary spare parts and maintenance tools shall be provided combined with switchgear.

The Bidder may also propose to supply the above equipment from the manufacturer not same as existing system, but in this case the manufacturer shall have to be confirmed that the new switchgear will be directly compatible with existing equipment without an adopter panel. If the proposed equipment does not compatible with the existing equipment during execution then the above equipment shall be supplied from same manufacturer's equipment with existing system in same quoted price.

The associated breakers shall have equivalent or higher performance for capacitor bank switching without re-strike as a frequently breaking type as specified in IEC standard.

The 36 kV voltage Switchgear design has to meet the requirements of the latest edition of IEC 62271-200 as metal clad or metal enclosed compartmented switchgear for indoor free standing installation. The feeders shall be prefabricated, completely wired with all instruments and equipment installed and tested at the factory.

The 36 kV indoor switchgear shall be installed in buildings connecting with the outdoor capacitor banks. The design temperature indoor shall be 45^{o}C for all equipment.

The feeders have to be compartmented into low voltage, busbar, cable and circuit breaker compartments so that each compartment (except the busbar compartment) can be maintained separately, ensuring that the service of other feeders can be continued. By this limitation of access errors of personnel will be minimized.

The cable compartments of the 36 kV switchgear have to be suitable to accommodate the feeder cables provided by the Contractor under the corresponding subsection of this contract.

For maintenance purposes easy direct access form outside has to be possible to each compartment.

The switchgear cubicles shall have a minimum protection class of IP 51. All live parts within the switchgear (busbar, tie-off connections, circuit breaker connections, connections to voltage and current transformers, etc.) shall be fully insulated to avoid internal arcs caused by vermin (snakes, lizards etc.)

Separating walls between the compartments shall provide complete protection against contact of live parts in neighboring compartments. Each of the circuit breaker, cable and busbar compartments will be equipped separately with an adequately sized pressure relief to the top of the feeder (if necessary, a chimney has to be provided for the bottom compartment).

To fulfill the high safety requirements for personnel, the switchgear installation has to be designed to provide the best possible protection in the event of an arc fault. Therefore, for the design of the medium voltage switchgear, Appendix A, Internal Fault of IEC 298 (1981), has to be applied especially. In case of an internal are in one compartment the effect of the arc shall be limited to the compartment concerned, i.e. no hot gases shall escape into other compartments, the separating walls shall withstand the pressure and shall not blow, no secondary are shall occur in another compartment. This makes sure that the effect of a fault is limited to the compartment

concerned and gives utmost safety to anybody inside the switchgear room. The contractor has to provide type test certificate of an independent institute to prove that the offered switchgear will meet the above mentioned requirements. These type test certificates have to be enclosed to the bid.

The circuit breakers are to be of the withdrawal type. The circuit breaker shall be generally operated by a spring mechanism that is rewound by a d. c. motor but also manual operation in emergency cases shall be possible. When the c. b. is in its defined test position, the contact parts of the busbar have to be covered by automatic shutters.

The shutters shall be marked as follows:

Busbars - painted Red and marked BUSBAR

Feeders - painted yellow and marked FEEDER

The circuit breaker shall be particularly suitable for switching capacitor banks without re-strike.

The paralleling of capacitor banks shall be considered, i.e. adequate design of current limiting reactors.

The design of the circuit breakers of the same rating and the secondary wiring must be such that the respective circuit breaker trucks can be interchanged with any other circuit breaker of the rating.

In addition to the necessary auxiliary contacts the following spare auxiliary contacts shall be provided per circuit breaker:

- Normally open 10 Nos
- Normally closed 10 Nos

Each circuit breaker must have a rating plate fixed such that it can be read with the circuit breaker in the normal service position.
The following details must be given on the rating plate:

Manufacturer's Name
Circuit Breaker Type and Serial No.
Rated Voltage
Rated Lightning impulse withstand voltage
Rated power frequency withstand voltage for 1 minute
Rated Frequency
Rated Normal Current
Rated Short Circuit Breaking Current
Rated Duration of Short Circuit
Rated Making capacity
Rated Supply Voltage of Opening Device
Rated Supply Voltage of Auxiliary Circuits
Rated Supply Voltage of drive
Rated Power of Drive
Number of IEC Standard.

Each circuit breaker and low voltage compartment has to be provided with a door. The door shall be provided with a window so that when the circuit breaker is in service position and the door is closed

the indications on the circuit breaker can be read from outside the cubicle without opening the cubicle door. To open the door of the circuit breaker compartment shall be possible only if the circuit breaker truck is in the test – or isolated position, i.e. if the shutters are closed.

The arrangement of all the current and voltage transformers as well as the other data may be seen, which is the basis for the equipment of the 36 kV switchgears. All ratings and ratios are to be justified by the Contractor.

Any formation of condensation water must be prevented by appropriate heating in each compartment of a switchgear cubicle controlled by one surface humidity control device. One heating power supply of 400/230 V AC shall be provided for each cubicle.

Particular value is to be placed on straightforward and modest maintenance requirements. The operating side of switchgear must have a straight course, a displacement of the front of switchgear cubicles is not acceptable.

The Contractor has to ensure that after commissioning at least 15% of fully installed spare terminal board capacity is available in each cubicle.

The final paint colour for the new switchgear shall be in accordance with a colour scheme to be proposed by the Contractor subject to the approval of the Employer. Free choice of any colour must be given.

Bulk-heading

The individual cubicles are to be bulk-headed from one another by double sheet metal partitions or fiber reinforced insulating material.

Installation

All the switchgear cubicles must be mounted on sub-frames specially provided for this purpose. The sub-frames and fixing material shall be delivered by the Contractor at a reasonable time prior to dispatch of the switchgear cubicles. The cubicles are to be so arranged that they can be installed freely in the room with the possibility for extension on both sides.

Maintenance

Tenderers must include with the tender documents details of recommended maintenance periods based on:

1) Time in normal service or number of trips in normal service.
2) Number of trips under system fault conditions at full short-circuit rating of the C. B.
3) Details of the maintenance to be carried out must be submitted.

3.7 Spare Parts

The Bidder is requested to supply a list of recommended spare parts for at least five years of normal operation. The recommended spare parts shall be quoted in schedules. The Bidder shall guarantee at least ten years counting from the end of guaranteed period of supply of spare parts respective replacement parts or complete bays for future extensions for the Gas Insulated Switchgear with full compatibility to the originally installed system.

3.8 Documentation

The switchgear supplied under this Contract shall be documented to the extent as to allow the Employer, as well as the operator, to fully understand the product, its theory of operation, its application and performance. Furthermore, it must enable the Employer to efficiently communicate with the manufacturer about all aspects of operating, maintaining and servicing the switchgear.

The following documents must be submitted to the Employer
- final drawings and documents as per requirements of this Specification, plus:
  - field wiring schedules, including identification of all wires, terminals
  - complete schematic circuit diagrams
  - device location drawings
  - spare parts location, identification and price list
  - installation, operation and maintenance instructions.

Prior to shipment, copies of all routine test certificates shall be made available to the Employer. If, during testing, changes are made to the equipment, these deviations must be corrected in the drawings submitted, to reflect the accurate "as built" condition of the switchgear on the stage of delivery.

All drawings and documents provided for shall show the equipment as specified and ordered. Typical drawings are not acceptable unless they are revised to show only the equipment being furnished. The format, standards, and quality and quantities of drawings shall be manufacturer's standard, but shall be subject to the Employer's approval as per the requirements of this Specification.

Language in all documents and drawings shall be English; dimensions shall be in metric SI-units only.

2.4 Test

2.4.1 Circuit Breaker

Type Tests

Type test report of offered type circuit breaker shall be submitted as per relevant clause of Schedule G. Type test items as per as per relevant clause of Schedule G (performed in accordance with IEC 62271-100) shall be submitted.

Routine Tests

All circuit breakers shall be routine-tested in accordance with IEC 62271-100, Clause 7. The test may be witnessed by the Employer.

The circuit breakers shall not be dispatched until approval of the routine test results has been signed in writing.

The routine tests required include the following;

(a) Dielectric tests on the main circuit

(b) Tests on auxiliary and control circuits

(c) Measurement of the resistance of the main circuit

(d) Tightness test

(e) Design and visual checks

(f) Mechanical operation tests (including resistance and current measurements of closing and trip coils and checking anti-pumping function)

2.4.2 Disconnector

Type Tests

Type test report of offered type disconnector shall be submitted as per relevant clause of Schedule G. Type test items as per as per relevant clause of Schedule G (performed as per procedure of IEC 62271-102) shall be submitted.

Routine Tests

The routine test shall be carried out in accordance with Clause 7 of IEC 62271-102.

The routine tests required include the following;

(a) Dielectric tests on the main circuit

(b) Dielectric tests on auxiliary and control circuits

(c) Measurement of the resistance of the main circuit

(d) Mechanical operation tests : Three-pole disconnector shall be assembled completely in the factory and tested.

2.4.3 Current Transformer

Type Tests

Type test report of offered type current transformer shall be submitted as per relevant clause of Schedule G. Type test items as per as per relevant clause of Schedule G (performed as per procedure of IEC 61869-2) shall be submitted.

Routine tests

The routine tests shall be carried out in accordance with IEC 61869-2.

(a) Measurement of Secondary winding resistance

(b) Measurement of magnetizing current characteristics

2.4.4 Surge Arresters

Type tests

Type test report of offered type current transformer shall be submitted as per relevant clause of Schedule G. Type test items as per as per relevant clause of Schedule G (performed as per

procedure of 60099-4) shall be submitted.

Routine Tests

The routine test shall be carried out in accordance with clause 9.1 of IEC 60099-4,

The Bidder shall provide details of all quality control checks/routine tests which will be performed on the porcelain housing, on individual ZnO blocks (including verification that the material is homogeneous) and on complete arresters with a minimum requirements being the following;

(a) Measurement of reference voltage

(b) Residual voltage test for lightning impulse current in the range between 0.01 and 2 times the nominal discharge current

(c) Partial discharge test on complete arrester

(d) Housing seal test

(e) Current distribution test for multi-column arresters

(f) Verification of surge counter operation

2.4.5 Metalclad Switchgear (Not Applicable)

Each metalclad switchgear shall be completely assembled and adjusted at the factory and given the manufacturer's routine Shop Tests and also other test as specified herein. All parts shall be properly marked for ease of assembly in the field. All routine tests required herein shall be witnessed by the Employer or his authorized representative unless waived in writing, and no equipment shall be shipped until released for shipment by the Employer or his authorized representative.

The metalclad switchgears offered shall have been fully type tested to prove their capability to meet or exceed the requirements of the Technical Specification, Technical Data Sheet and in all other respects, the requirements of IEC standard.

The type test shall have been carried out at an independent testing station or alternatively shall have been witnessed by a representative of an independent testing authority or other independent witness.

The Contractors shall list for each type test performed, the test specification, location and date of testing and the Type Test Certificates/Report No. In addition the Contractors shall submit with proposal a copy of each Type Test Certificate/Report which shall incorporate full details of test parameter and results and shall state by whom the tests were witnessed.

POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT
FOR

Design, Supply, Installation, Testing and Commissioning of Capacitor bank with associated switchgear for Mymensingh region on turnkey basis.

SECTION 4

36 KV CAPACITOR BANKS

SECTION 4

36 KV CAPACITOR BANKS

4.1. GENERAL

This Specification covers the design, manufacture, pre-assembly and acceptance testing in the Contractor's workshops as well as the supply, delivery, unloading, erection, adjusting, painting, identification, commissioning and acceptance testing of 36 kV capacitor banks for identified substations for each Lot, complete in every respect and suitable for satisfactory operation.

4.2. LAYOUT

Capacitor banks installation layout and scopes including additional works shall be referred to Schedules and drawings which are attached. The location to be installed of the 36 kV capacitor banks can be observed by field visit is strongly recommended to reduce deviations of related estimation and clarify any possible mistakes during bidding process.

4.3. SCOPE OF SUPPLY AND SERVICES

This Subsection sets out the scope of installations covered by this Specification as well as the requested supplies and services, but without excluding other necessary components and services not mentioned. The relevant "Prices for Equipment and Spare Parts" can be found in Price Schedule.

The following main equipment has to be provided:

36 kV capacitor banks for outdoor installation, composed of ungrounded double-Y-connected capacitors, sized of 15 MVar (Operation output at 33kV) with fully insulated neutrals and current transformers for unbalance protection and series connected inrush current limiting (damping) reactors.

Technical requirements of capacitor bank are as follows:

- Normal system voltage : 33 kV
- Highest system voltage : 36 kV
- Highest voltage for equipment : 36 kV
- Maximum system voltage unbalance : 2%
- Ambient air temperature : -5/C (50C)
- Minimum reactive power at normal system voltage : 15 MVar as per schedule
- No of phase : Three (3)
- Frequency : 50Hz +/- 0.5
- Capacitor tolerance : 0 to 10%
- Discharge time : <75V within 600 seconds
- Case : Stainless steel or Mild steel
- Paint : Epoxy coated double layer

- Bushing : Two porcelain bushings
- Dielectric : All polypropylene synthetic film
- Impregnate : Non PCB
- Connection of capacitor bank : Double star with neutral floating
- Rating of capacitor unit voltage : M.R
- kVar rating of capacitor unit : M.R
- Fuse type : Internal fuse
- Power frequency withstand voltage (rms) : 70kV
- Basic impulse withstand voltage (peak) : 170kV
- Symmetrical short circuit level : 31.5kA

The total reactive power with this is 210MVar and number of capacitor banks to be installed at the individual substations and parallel operation group shall be as follows:

Sl no.	Name of Substations	Proposed Compensation Block (MVar)	Proposed Compensation Block (MVar)
1.	Kishoregang 132/33kV	3x15	45
2.	Netkrona 132/33kV	3x15	45
3.	Bhaluka 132/33kV	2x15	30
4.	Mymensingh 132/33kV	3x15	45
5.	Tangail 132/33kV	3x15	45

The supply shall include all necessary structure and accessories i.e. clamp connectors, bus extension work, wiring etc.

4.4. CONSTRUCTION REQUIREMENTS

4.4.1 GENERAL

The 36 kV capacitor bank design has to meet the requirements of the latest edition of IEC 60871.

4.4.2 CAPACITOR BANKS

Each capacitor bank shall comprise of disconnect switch, dedicated circuit breaker, current transformer, surge arrester, inrush current limiting reactor, capacitor unit, neutral current

transformer, support insulator, busbar, interconnection cable, terminal connector and structure with associated hardware and accessories. When it is required to be made for the existing bus extension, all necessaries for the complete work shall be include as well.

Each capacitor bank shall have a reactive power of 15 MVar at 33 kV, 50 Hz with considerations of inductive reactive losses of the current inrush current limiting reactors, that means the reactive power of the capacitors must be increased corresponding the losses of the current inrush current limiting reactors to ensure that a nominal/rated reactive can be fed into the network.

The capacitor units of a capacitor bank shall be connected as three phase, double star, and neutral tied together with neutral ungrounded.

The capacitor bank shall operate at the voltage specified in technical specification and relevant drawing and shall be switched on and off by respective circuit breakers at the substation. The design shall ensure that the required total capacity shall not below at nominal voltage.

Each capacitor bank shall comprise a suitable number of two bushing single phase units in series and parallel combination connected in an ungrounded double star configuration to facilitate incorporation of a capacitor unbalance detection scheme.

Individual capacitor voltage rating shall be selected by contractor to form an economical and compact design; however, number of parallel units in each of the series string shall be such that at least two (2) elements faults shall not create an overvoltage on the units in parallel with it. Contractor shall inform the numbers of fault elements for the alarm setting and trip setting of capacitor bank.

Layout of the equipment shall be arranged to occupy the minimum practical space, however, all components shall be readily accessible for inspection, cleaning and repairs.

Design shall incorporate all necessary precautions and provisions for the safety of those concerned in operation and maintenance of the apparatus.

The capacitor banks shall be installed in the locations stated in sub clause 4.3 of this section, The Contractor shall optimize the design of the capacitor banks which is subject to approval of PGCB.

4.4.3 CAPACITOR UNITS

The capacitor units shall be modern designed and shall be in accordance with relevant latest standards described in Section 1. All capacitor units shall be single phase with identical voltage and kVar ratings.

The capacitor shall have two bushings and clearance between two terminals shall be 220mm or more for the 2 series connection & 320mm or more for the one series connection.

Each unit shall satisfactorily operate at 130% of rated current including harmonic currents as per IEC. Units shall be capable of continuously withstanding satisfactorily any overvoltage up to a maximum of 10% above rated voltage as per IEC.

4.4.4 CONTAINERS

All Capacitors shall be hermitically sealed and bushing shall be assembled on the top of the case in a welding process.

The containers of the capacitor units shall be made of stainless steel. The containers shall withstand all stresses which may occur during service (normal conditions and internal faults) without bursting. Capacitor units shall be treated suitable anti corrosion protection. A painting system for containers shall be proposed by the Contractor and will be subject to the approval of PGCB.

4.4.5 CAPACITOR ELEMENTS

All capacitor elements shall be synthetic film (polypropylene) with aluminum electrode. The aluminum foil shall be edge folded type.

All the capacitor elements shall be dry voltage withstand tested before assembly made.

The individual elements shall be of the all-film type. The maximum element voltage shall not exceed 2000V at rated voltage. In case of all-film capacitors the dielectric stresses shall not exceed 60V/micron at rated voltage. Information about the connections of capacitor elements (number of parallel/series connected elements) shall be included to the tender documents by the contractor.

4.4.6 INTERNAL FUSES

The capacitor units shall have internal fuses to protect each element. Type test protocols according IEC 60871-4 shall be enclosed to the tender.

Capacitor unit shall be of internally fused type. All internal fuses shall be withstood for the inrush current.

4.4.7 IMPREGNANT

The capacitor elements shall be vacuum dried inside the case prior to impregnation with the dielectric fluid. The capacitors shall be dehydrated under high vacuum and temperature not to leave any gas or impurities in the case, which may cause deterioration of the dielectric.

Impregnation fluid is forbidden using polychlorinated biphenyl (PCB). The manufacturer shall submit certificate to demonstrate Non PCB type fluid and fluid characteristics data. Detail information and test results of the impregnant offered shall be supplied with the bidder. The impregnation fluid shall be biodegradable and after impregnation the capacitor unit shall be sealed immediately upon removal impregnant reservoir.

4.4.8 DISCHARGE RESISITORS

The capacitor units shall be supplied with discharge resistors inside the containers to discharge the capacitors from rated voltage to 75 V within 10 minutes. This requirement must be fulfilled under consideration that three capacitor units are connected in series. If this cannot be achieved by internal discharge resistors additional external discharge devices shall be installed.

4.5. DESIGN TEMPERATURE

The capacitors shall be designed according the following temperatures:

Lowest ambient air temperature: - 5 ℃.

Upper limit of temperature category: +45 ℃.

4.6. TOLERANCES

The capacitor units of a capacitor bank shall be selected in such a way that the tolerances of the individual capacitor units shall be within -0% ~ +10% of the rated capacitance and the tolerances of the total capacitance of different phases shall be less than +5%.

4.7. EVALUATION OF LOSSES

The loss of capacitor should not exceed 0.2 Watt/kVar. Evaluation price of the capacitor bank will be equal to total offered cost (CIF) of capacitor bank + monetization cost due to total losses of capacitor bank.

Guaranteed values for losses of capacitor bank in Watt shall be stated in Schedule E of Particulars and Guarantees by the Bidder.

The cost on losses will be monetized as follows:

Monetization cost due to total losses of capacitor bank = Tk. 200 x total losses in Watt

The acceptance of capacitors yielding losses higher than the guaranteed values shall be governed by either of the following:-

(a) Losses in excess of guaranteed values but within 0.2 Watt/kVar.

Capacitors shall be acceptable subject to full compliance with all technical particulars, and subject to the Bidder accepting deduction from the Contract Price of charges for each Watt thereof of losses in excess of the guaranteed values, at the above evaluation rates.

(b) Losses in excess of guaranteed values and exceeding 0.2 Watt/kVar.

The acceptance of capacitors shall be entirely at the discretion of the Employer and subject to the Bidder accepting the deduction from the Contract Price of charges for each Watt thereof of losses in excess of the guaranteed values, at the above loss evaluation rates.

In the event of total losses which are either equal to or below the guaranteed values, the Bidder will not be entitled to any premium in respect of reduction in losses below the guaranteed values.

4.8. VOLTAGE OF CAPACITOR BANKS/CAPACITOR UNITS

The rated voltage of Capacitor Banks shall be 33kV and the maximum permissible voltage shall be 36kV. The maximum permissible voltage of the capacitor bank units shall be 36 kV plus the voltage increase due to inrush current limiting reactors.

4.9. INRUSH CURRENT LIMITING REACTOR

Inrush current limiting reactors shall be provided for each capacitor bank. The contractor shall provide information and calculation that the selected reactor meets the requirements of the capacitors and 33 kV switchgear. The reactor shall be capable to withstand the same over-current as the capacitor bank.

4.10. NEUTRAL CURRENT TRANSFORMERS

Neutral current transformer should be installed on neutral point of each double Y capacitor connection for unbalance protection. Relevant technical parameter are as follow:

- Accuracy class 5P10

-	Burden	15VA
-	Rated current	5A or 1A (as per existing)
-	Test voltage	70 /170kV

4.11. CAPACITOR BANK CONNECTIONS

All live parts of the capacitor banks (busbar, connections etc.) shall be fully insulated to avoid short circuits caused by vermin (snakes, lizards etc.). All exposed capacitor terminals and cable between capacitor units shall be shrouded or covered with PVC insulation. Each terminal shall be provided with a parallel groove clamp suitable for conductor of up to 2 x 12mm diameters with plain washer, spring washer, nut.

4.12. HARMONIC MEASUREMENT

To consider the effect of harmonic currents all electrical equipment shall be designed for a continuous current of 1.43 times the rated capacitor bank nominal current.

The contractor shall measure the actual harmonic components at the step of installation and commissioning, related study report also shall be submitted. Details refers to the Schedule A and B of the Volume 3.

4.13. LIFTING DEVICE FOR CAPACITOR UNITS

Each capacitor unit shall have two lifting device shall be installed on both narrow side for erection of capacitor banks and for maintenance (exchange of capacitor units).

The contractor shall include in his offer documentation about the proposed lifting device.

4.14. NAME PLATE

Name plate shall be stainless steel material to prevent rust. Name plate shall have all items described in IEC 60871.

i) Manufacturer
ii) Identification number and manufacturing year
iii) Rated output
iv) Rated voltage
v) Rated frequency
vi) Temperature category
vii) Discharge device
viii) Insulation level
ix) Internal fuses (if any)
x) Applied standard

4.15. DOCUMENTATION FOR CAPACITOR BANK

The followings shall be included with the offer.

i) Completely filled in technical data schedule.
ii) Supply record with documentary evidence of the offered capacitor bank for last 10 years mentioning Purchasers name, quantity, year of supply.

iii) Printed catalogue indicating the offered type capacitor bank shall be submitted along with the Bid.

Bids not mentioning the technical specification of the tender or not fulfilling the requirements of serial No. 2 & 4 shall be rejected.

4.16. TYPE TEST AND ROUTINE TEST

4.15.1 Type test report of offered type capacitor unit shall be submitted as per relevant clause of Schedule G.

4.15.2 Type test items as per as per relevant clause of Schedule G (in accordance with IEC 60871) shall be submitted.

4.15.3 Every capacitor units shall be routine tested by supplier and contractor shall submit routine test report with test values at the time of delivery. Routine test report shall have following items as a minimum:

a). Capacitance measurement

b). Tangent of dielectric loss angle

c). Voltage test between terminals

d). Voltage test between terminals and container

e). Test of internal discharge device

f). Sealing test

g). Discharge test on internal fuses

Every capacitor units shall be partial discharge tested as a acceptance test and testing values shall be included in routine test report.

4.16 SERIES REACTOR

4.16.1 Generally Inrush suppression series connected reactors are required to protect the capacitor bank form inrush current due to switching. Air cored, air cooled, dry type, aluminum wound outdoor reactor is envisaged to limit the inrush current. The normal current rating of the reactor shall be 143% of rated continuous current of the capacitor bank. The voltage rating of the base insulators shall be of 36kV. The Basic Impulse level shall follow the range of capacitor bank.

If it is required to change the type of the reactor based on the specified study (clause 4.11 herewith) then follow the statement of the Schedule A and price rate of the Schedule B.

4.16.2 For both capacitor and reactor, the method of mounting and minimum clearance required for, live parts shall be indicated clearly and shall be as per IEC 60071-2. The mounting structure arrangements for the reactor shall have consideration for the magnetic clearance between reactors and/or reactor and any metallic parts, covering in any design cases.

4.16.3 The reactor shall be free from annoying hum or vibration. The design shall be such as not to cause any undesirable interference with radio or communication circuits.

4.16.4 The complete assembly of the capacitor bank shall be on a hot dip galvanized steel structure. The details of mounting structure connections with relevant drawings shall be furnished. The mounting structure details for mounting the two groups of capacitor with neutral CTs and inrush current limiting reactor has to be furnished. The bottom most portion of the lowest post insulator shall follow the IEC 60071 and 61936, from the ground level. The two groups shall be mounted suitably ensuring sufficient clearances.

4.16.5 Test

The test items as per IEC 60289 and 60076-6 included in type test as per relevant clause of Schedule G.

4.16.6 Every reactor units shall be routine tested by supplier and contractor shall submit routine test report with test values at the time of delivery. Routine test report shall have following items as a minimum

Routine Test

(a) Measurement of winding resistance
(b) Measurement of inductance
(c) Separate source voltage withstand test
(d) Induced over voltage test

POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT
FOR

Design, Supply, Installation, Testing and Commissioning of Capacitor bank with associated switchgear for Mymensingh region on turnkey basis.

SECTION 5

PROTECTION, METERING & CONTROL

SECTION 5

PROTECTION, METERING & CONTROL

5.1. PROTECTION, CONTROL AND MONITORING EQUIPMENT PART

5.1.1 GENERAL

This section is intended for the design of the protection, control and monitoring equipment and as for as applicable for interfaces. Requirement for technical performance of the equipment are stated in this Section.

Protection, Control & monitoring functions shall be incorporated in one single panel. Meters, mimic diagram & control switches, voltage & current test terminal and system monitoring devices shall be equipped.

Panel shall be installed for each capacitor bank respectively. However, when two capacitor bank feeders are connected with main circuit breaker, three panels shall be installed: one main panel and two feeder panels. Type of panel shall be simplex which incorporate all specified function in front. A Typical protection and control function arrangement refers to bid drawing.

For standardization of operation performance, facilities and spare requirements, the protection relays to be supplied under this project shall comprise GE France/UK , ABB Switzerland/Sweden, Siemens Germany, Schneider France/UK, SEL USA, NR Electric, China make manufacture.

The contractor shall be responsible for ensuring the correct operation of the protective equipment and shall submit for approval recommended relay setting supported by design calculation for all protective equipment been supplied.

The contractor shall be responsible for ensuring the correct operation of the protective equipment and shall submit for approval recommended relay setting supported by design calculation for all protective equipment been supplied. The engineer reserves the right to ask the Contractor to get the design calculation approved by the manufacturer of the Protective equipment and/or get the confirmation for the suitability do the particular protective relay for the proposed application. In case the proposed Protective relay is not suitable for the proposed application the Contractor shall change to a suitable relay as recommended by the manufacturer without any cost implications to the Employer.

5.1.2 EQUIPMENT GENERAL REQUIREMENTS

The requirements are to be strictly observed with regard to design and execution.

The control and monitoring equipment to be provided shall be suitable for faultless and safe control and supervision of the entire substation during all phases of operation.

As a general rule, measuring points and measuring equipment for interlocking and protection purposes shall be separate and not be combined with measuring equipment for the automatic control

equipment. Signal to be processed in several systems, e.g. remote and manual controls, event recording system etc. shall be suitable repeated and mutually decoupled to avoid interaction.

The material of all equipment shall fully meet the requirements regarding safety and operational conditions of the parameters to be measured. Instrument piping to dedicated control and measuring panel shall be of stainless steel.

All the equipment shall be suitable for the location in which it is to be mounted and in particular all outdoor equipment shall be suitable for the climatic conditions of the site.

The spare-free space capacities listed below shall be provided for the following items:

1) Panels	15% space for modules within each frame 15% space for terminal block frames within each cubicle
2) marshalling rack	15% of space and terminals
3) multi-core control cables	15% of number of conductors.

The above spare capacities shall be available after final commissioning of the substation and shall be suitably distributed over the operating surface of the panel or cubicle in such a way that additional indicators, control equipment or modules may be added to any group of controls.

Each control or relay panels shall be provided with a copper earth bar of not less than 150sq.mm cross section and arranged so that the bars of adjacent panels can be joined together to form a common bus.

5.1.3 PANELS

Panels shall be free standing and shall be constructed of adequate thickness to provide rigid support for the control and monitoring equipment which shall be mounted there.

Panels shall be mounted on channel base frames which shall provide at bottom recess. Panels Doors shall be provided with a lock which may be opened by a person within the panel without the use of a key.

The overall height of panels housed in the relay room shall not exceed 2.25m and the color shall be same as existing ones.

All instruments and control devices shall be easily accessible and capable of being removed for maintenance purposes.

Cable connections to panels must be equipped with suitable seals so as to prevent the ingress of dust or vermin or the propagation of possible fires. During installation, a provisional sealing of cable penetrations is required.

Panels which are installed in non air-conditioned rooms shall be provided with thermostatically controlled heating device. Each thermostat shall have an adjustable set-point which shall be adjusted during the commissioning period to such a value that no moisture shall occur on the equipment but also so that during periods of high ambient temperature the temperature rating of the equipment is not exceeded.

5.1.4 POWER SUPPLIES AND FUSING

All monitoring and control equipment inside the substations shall preferably be connected to the d. c. system of the existing substation.

The contractor must however ensure that plant mounted equipment is not adversely affected by the long cable runs, particularly to the more distant unit.

Basically each panel should be supplied power via independent power distribution switch located station power distribution board. Interconnection and link from adjacent panels are not allowed.

If the Contractor needs a different control voltage but nothing available to use, contractor must design, supply and install all the necessary equipment.

The main power supply fuses (of any other type of current breaking equipment) shall be located in functional groups within separate power distribution panels.

Fuse ratings and time characteristics shall be such that in all cases, a fault within an individual item or module will cause the fuse associated with that item, to rupture and thus disconnect that item from the power supply, before the main fuse is affected.

5.1.5 INDICATION INSTRUMENT AND METERS

Terminals and connecting cables from voltage and current transformers up to and including the meter (including all termination between voltage/current transformers and the meter) shall be made inaccessibility by sealed cover.

All indicating instruments shall be of the flush mounted pattern with dust and moisture proof cases complying with IEC 60051-1. Unless otherwise specified, all indicating instruments shall have 96mm or 144mm square cases or equivalent circular cases.

Instrument dials in general should be white with black markings and should preferable be reversible where double scale instruments are specified. Front of panel test terminal blocks shall be provided for all meters.

All electrical meters shall be of accuracy of 0.2

For capacitor bank, 33kV three phase voltages & current and reactive power, power factor meters shall me mounted on front panel. Power factor meter shall indicate factor of 33kV bus point.

5.1.6 SWITCHES AND RELAYS

Switches mounted in the control panels shall be clearly shown. Discrepancy switches shall be provided for the operation of switchgear and the initiation of drives. Discrepancies between the switch position and the plant state shall be indicated by an integral light which shall illuminate the switch in a flashing mode of operation.

5.1.7 ALARM ANNUNCIATION

The alarm system which has to be accepted by the PGCB shall consist of an initiating device, a display unit and front-mounted push buttons together with a continuously rated audible warning device and relays, The relays shall, wherever possible, be mounted inside the same panel.

Where it is necessary to differentiate between the urgency of alarms then various approved alarm tone devices shall be provided. In addition and where specified an alarms beacon shall be provided.

The Contractor shall be responsible for providing all the alarms required for the safe and efficient operation. General descriptions of alarm requirements are given in the specification, and the Contractor shall include any other alarms that he considers necessary.

The alarm annunciator unit shall be of electronic design and shall employ solid state technology. Printed circuit card modules of the plug-in type shall be used. The window of each fascia shall be translucent; the legend shall be inscribed on the inner surface and shall only be distinguishable when the alarm is activated.

The changing of annunciator fascia lamps shall be easily carried out from the front of the fascia, and failure of a fascia lamp shall not result in the loss of optical signal from that alarm. Two lamps per fascia may be used for this purpose.

Separate, clearly distinguishable optical signals are to be displayed for the following situations:

annunciation arrives, not acknowledged
annunciation is present, acknowledged
annunciation disappears, not acknowledged
annunciation disappears, acknowledged

The following requirements shall be fulfilled:

connection of audible alarms with horns or buzzers lamp check circuits are to be divided in such a way that the power supply will not be over loaded.easy forming of group signals in the input circuits of the unit

pushbuttons for tasks such as:

to silence horn
to acknowledge annunciation
to cancel annunciation
to check lamps

are to be installed in a suitable divided way in the control desk or panel. It shall not be possible to cancel the optical signal light unless the audible signal has been cancelled.

Alarm fascias are to be arranged in the control panels.

All alarms fascias shall, where possible, be located adjacent to the control and monitoring equipment of the plant with which they are associated. Panel mounted alarm fascias must be easily readable.

5.1.8 WIRING, CABLING TERMINALS

In particular wiring within panels etc. shall be supported on trays and shall be segregated according to voltage level. Wire carrying a.c. and d.c. voltage shall also segregated.

Spare cores shall be terminated at terminal strips in such a way so as to give a maximum length of core and shall be ferruled in such a way so as to indicate that are spare cores.

Terminal strips at the transmitters shall be of the screw type. Screw type terminals shall have a metal insert between screw and conductor. In the electrical, relay and control rooms advanced semi-automatic connection techniques, like termination-point, wire-wrap is preferred. Wire wrap and termination point connections shall be performed using an approved semiautomatic or automatic, power operated hand tool.

Terminal strips within panels shall be set at an angle to afford easy identification and access.

5.1.9 LABELING AND SCALES

The identification and lettering of scales and dials shall be in English.

The metric system shall be used for all scales according to the 'General technical requirements'.

The identification and classification of all measuring points, must be shown on diagrams to be produced by the Contractor and entered in the respective lists.

Each cubicle is to be clearly labeled. Each measuring point, transducer, binary transmitter etc. is to be provided with a firmly attached weather and temperature proof plate.

All such plates and cubicle labels shall be inscribed in English. All modules within the panels shall be inscribed in English.

5.1.10 PAINTING

The requirements specified have to be considered.

However, panels, control equipment are to be supplied with the final painting, whereby external surfaces shall be semi-gloss.

Local mounted panels, housing control and monitoring equipment shall be protected against rust and corrosion by a protective coating such as galvanized zinc, which shall be applied as a first factory coat.

In all cases where site erection work exposes bare metal, such as the drilling or punching out of holes for cable or pipe entry, these areas shall be protected by the immediate application of a protective first coat similar to the original.

The shade and grade of paint are to be agreed to by the Employer and must harmonize with the overall architectural design.

Any machined or bright faces and parts which are not painted must be protected against corrosion by suitable agents prior to installation.

After completion of installation and commissioning, but before Taking over the Contractor shall make good all marks, scratches and damage to the painted surface of all equipment supplied under this contract irrespective of the cause. The Contractor shall also take every reasonable precaution to prevent damage to panels and panels during the course of erection and commissioning. Repairs to panel and cubicle paintwork shall be carried out in such a way so as to restore the equipment to is its original factory condition and shall be to the satisfaction of the Engineer.

5.1.11 DIAGRAMS, LISTS AND CHARTS

5.1.11.1 GENERAL

The preliminary ‘drafting and numbering procedure', the final version will be made available to the Contractor.

5.1.11.2 INSTRUMENT LIST

This list shall contain all primary sensors, instruments and signal processing equipment in the plant including but not limited to

local measurements
remote measurements
binary transmitters
limit switches
test measuring points

With all necessary design date such as text-in-clear, measuring ranges, settings, displays.

5.1.11.3 LIST OF DOCUMENTATION

5.1.11.4 LIST OF RECORDERS/SELECTOR SWITCHES

This list shall be used for the allocation of measuring points to recorders, measuring points selector switches, automatic measuring point selector switches (scanners).

5.1.11.5 LOGIC DIAGRAM

This kind of diagram shall as far as applicable be used for representation of remote and logic controls and interlocking circuits.

5.1.11.6 Block Diagram

This kind of diagram shall indicate in a simplified manner the function of closed-loop control
This is a simplified diagram of the essential electrical equipment and its connections. All circuits are represented by a single line only. In addition this diagram shall contain all required technical information on the equipment represented, e.g. voltage, ampere, output, code designation etc.

5.1.11.7 SINGLE LINE DIAGRAM

Single line diagrams shall be drawn in a way easy to survey and shall contain as far as possible all technical information of the equipment represented. Except for the general single line diagram showing the basic design and connections all diagrams shall be prepared according to the classification system.
Standard symbols shall be used for the individual kinds of components and modules. The components or modules and the working principles shall be clearly explained in the diagram and in an attached description with legend.

5.1.11.8 CIRCUIT DIAGRAM

This diagram is resolved into separately drawn “current paths” each showing all its components. The individual circuits shall be drawn in a straight line sequence.

Wherever applicable, schematic and circuit diagrams shall be combined in one drawing.

5.1.11.9 INTERNAL CONNECTION DIAGRAM

This diagram represents the wiring connections either within one apparatus or between several apparatus of one group. It shall contain the single components or apparatus of one group arranged in the proper positional order including terminal and terminal strips.

5.1.11.10 EXTERNAL CONNECTION DIAGRAM

This diagram represents the wiring connections between groups of apparatus inside an installation or between sections of the installation. External and internal connection diagrams shall always show the full terminal strips with all terminals in the correct sequence.

The terminal connection diagram as described above shall contain but not be limited to the following information:

Terminal numbers of technical strip with targets (terminal numbers and current paths) or incoming and outgoing cables.
- Cable designation
- Type of cable
- Number and cross section of conductors
- Assignment of conductors
- Number of spare conductors

5.1.11.11 INSTALLATION DIAGRAM

This diagram represents the routing of cables and the position of associated equipment (e. g. lighting fixtures, socket outlets, loudspeakers, telephones, primary elements, transmitters, terminal junction boxes, etc.) according to their correct position in the building plan or arrangement drawing.

5.1.11.12 TERMINAL CONNECTION DIAGRAM

The terminal connection diagram used for terminal boxes, marshalling racks, switchboards etc. shows the terminals and/or terminal strips properly numbered in relation to the incoming and outgoing power and control cables.

5.1.11.13 WIRING LIST

The wiring list contains all connections within one apparatus (cubicle etc.) including all terminal numbers to be connected, the wire code and size and the bundle code.

5.1.11.14 CABLE SCHEDULE

The cable lists contain all required information for the design, erection and routing of all power, communication and control cables.

For easy reference the HV and LV power cables shall be listed in a Cable Schedule containing the following information:

- All types of cable used
- Insulation level
- Operating voltage
- All load reduction factors
- Permissible continuous load of all cables, taking into consideration the various load reduction factors
- Cross-section of all cables and number of cores
- Outer diameter of all cables

In connection with the general schedule, raceway diagrams shall be produced showing routing of cable racks and trays at different elevations, suitably sectionalized and numbered.

In addition, cable lists shall be provided for all power and control cables containing at least the following information:

- Cable designation
- Cable routing (from – to, via raceway)
- Type of cable, cross section and number of cores
- Permissible continuous load or burden (for measuring transformers) and load reduction factor.
- Length

5.1.11.15 TERMINAL LIST

The terminal list contains all connections for a terminal strip of a cubicle on both sides of the terminals, including the codes of wires and cables and their sizes.

5.1.11.16 EQUIPMENT LIST

The equipment list contains all devices to be installed within one cubicle or apparatus or one group of apparatus, but does not include fixing materials and hardware.

5.1.11.17 PARTS LIST

The parts list contains all equipment, materials and accessories installed in the respective parts of the plant.

5.2. EQUIPMENT: PROTECTION EQUIPMENT

5.2.1 GENERAL

This specification covers the design, manufacture, pre-assembly and acceptance testing in the Contractor's workshops as well as the supply, delivery, unloading, erection, adjusting, setting, identification, commissioning and acceptance testing of the protection equipment in every respect and suitable for satisfactory operation. The manufacturer of relays should be:

- ABB (Sweden, Switzerland, Finland)
- Siemens (Germany)
- Areva (UK, France)

The protection shall be sufficiently sensitive to cater for the minimum fault level condition. The protection shall also be suitable for a system fault level equal to the switchgear rating of 25kA (33kV). All current transformers shall be based on these fault level.

5.2.2 LAYOUT

All equipment specified under this sub-section, unless otherwise stated, shall be located in the relay recess compartment of respective feeder panel of the switchgear.

5.2.3 SCOPE OF SUPPLY AND SERVICES

This section sets out the scope of the installations covered by this specification as well as requested supplies and services but without excluding other necessary components and services not mentioned. Prices of the offer shall include, whether explicitly mentioned or not, all the elements necessary to ensure proper function of the supplied protective and synchronizing equipment, coordinated with existing similar and related equipments. Faulty elements of the system shall be selectively isolated before mechanical or electrical damages or power system stability loss occurs.

Relay coordination study shall be conducted for the supplied protective relaying installations with existing (or under delivery in parallel works) protective equipment at all interface levels.

5.2.4 REQUIREMENTS

5.2.4.1 GENERAL REQUIREMENT

The protection equipment requirements for the specified new installations are to be provided. Detailed relay requirements are described below for each type of protected primary equipment.

If not stated otherwise following basic design data apply:

DC control: 110V/125 V
VT phase secondary voltage: 110/√3
CT secondary current:1A/ 5 A
Rated frequency: 50 Hz

Relays shall be of approved types complying with IEC60255 or BS 142 and 5992, Parts 1, 2 and 3 as appropriate, fully tropicalized, and shall have approved characteristics. The Employer may reject any design he considers unsatisfactory or having insufficient field experience.

All protective relays should be numerical type incorporated with pc interface and power & fault analysis function. Also, relevant software and operational knowledge shall be provided. Voltage, power trends, harmonics, fault results and other prime factors shall be stored and analyzed. In addition, setting should be available either the software or button on front panel.

Incorporated respective relay functions (over current relay, under/over voltage relays and unbalance relay) shall provide the selective time characteristics. The relay shall provide setting values and running power trends in real time base.

5.2.4.2 PROTECTION CONFIGURATION

1) Single CB single bank configuration (12.5MVar Bank)
(Reference diagram refers to Drawing PGCB/EEP1/RCP/12,13,14)
- phase fault: over current relay (51)
- ground fault: ground over current (51G)
- voltage protection: over voltage (59)/ under voltage relay (27)
- capacitor unbalance protection: ground over current relay (51NC)

2) Main CB + Two Feeder Configuration
(Reference diagram refers to the Drawing PGCB/EEP1/RCP/12,13,14)
For Main Protection:
- phase fault: over current relay (51),
- ground fault: over current relay (51G)
- voltage protection: over voltage(59) / under voltage relay(27)

For Capacitor Bank Feeders:
- phase fault: over current relay (51)
- ground fault: ground over current (51G)
- capacitor unbalance protection: ground over current relay (51NC)

5.2.4.3 RELAYS

1) Over current relay
The over current relay and earth fault relays shall have multi characteristics according to IEC 255.
Over current relay shall have current setting arrange form at least 50% - 200% in 25% setting steps.
Earth fault relays shall have a current setting range form at least 20% - 80% in 10 % setting steps.

2) Unbalanced protection
Unbalanced protection shall be high sensitive with harmonic filters, alarm and trip stages.

3) Overvoltage and under voltage protection
Over voltage and under voltage relay shall have voltage setting range suitable for capacitor bank. The setting shall be finalized during detailed engineering.

5.3. EQUIPMENT: CONTROL AND MONITORING EQUIPMENT

5.3.1 GENERAL

This specification covers the design, manufacture, pre-assembly and acceptance testing in the Contractor's workshops as well as the supply, delivery, unloading, erection, adjusting, identification, testing, commissioning, and acceptance testing of the control and monitoring equipment of the 36 kV switchgears complete in every respect and suitable for satisfactory operation. Control and monitoring equipment for 0.415 kV A. C. and D. C. switchgear are covered.

5.3.2 SCOPE OF SUPPLY AND SERVICES

This section sets out the scope of the installations covered by this specification as well as requested supplies and services but without excluding other necessary components and services not mentioned. The Bill of Quantity and the relevant "Prices of Equipment and "Spare Parts" can be found.

The following equipment shall be provided:

1) 33 kV control, indication and measuring equipment located in the new 36 kV switchgear panels

2) 33 kV remote control, indication and measuring equipment panels located in the existing control rooms

5.3.3 CONSTRUCTION REQUIREMENTS

5.3.3.1 GENERAL

The purpose of this equipment is to provide reliable monitoring, measurement and control facilities for the 36kV capacitor banks including all ancillary systems.

Design data:
Control voltage 110V/125 V d.c.
Auxilliary voltage 415/240 V; 50 Hz

5.3.3.2 DESCRIPTION

The control and monitoring equipment for the 36 kV switchgears/capacitor banks have to be mounted in the respective control compartments of the switchgears.

For remote control from the existing control rooms the necessary equipment shall be installed. The control, indication, metering and monitoring requirements are shown in the TABLE OF INSTRUMENTATION being part of this Subsection.

The whole of the control, monitoring and measurement equipment is to be designed in conformity with the latest relevant IEC regulations according to Section Schedule A.

The Contractor shall ensure that in the event of failure of the air-ventilation system the control system remains in full operation, the outside ambient temperature being 45℃. Suitable heating elements in the cabinet must prevent any condensation forming.

For the colour scheme of the cabinets and the switchgears, the mimic diagram and the type of labeling, the contractor must produce a concept for approval by the Engineer. The Employermust have a free choice of colors without the price being affected.

The internal wiring of the cabinets must be carried out according to the provisions of Section 4A.
All switchgear auxiliary contacts, control, signaling and measuring devices are to be wired up to a separate terminal block within the switchgear itself.

1) For each substation the necessary control and measuring cabinets, and the respective 33 kV switchgear fully wired to the terminal strips shall be equipped as a minimum in accordance with the TABLE OF INSTRUMENTATION (being part of this Subsection) with:

   a) Control-discrepancy switches with position indicator lamps with square front plate, for controlling the 33 kV circuit breakers.
   b) Position indicators with round front plate for position indication for the earthing switches and longitudinal busbar isolator of 36 kV switchgears.
   c) Change-over switches with the necessary positions and contacts for voltage and current measurements, etc.
   d) Necessary push-buttons
   e) Indicating instruments with square bezel (96 x 96) for voltage, and current having 240^{o} scale.
   f) Mimic diagram consisting of narrow strip painted
   g) Alarm/indication tableau with the necessary alarms/indications
   h) All 33 kV circuit breakers shall be equipped with an operating hour meter and counter of ON/OFF operations.

2) The necessary alarm devices completely wired to the terminal strips; equipped with the necessary:

   a) Indicators of the respective control voltage
   b) Change-over switches
   c) Push-buttons
   d) Flasher and auxiliary relay (d. c.)
   e) Horn and warning gong (d. c.)

3) The necessary metering devices in the 36 kV switchgear compartments fully wired to the terminal strips and equipped with the necessary meters.

All equipment specified under (1) – (4) are to be factory-wired, supplied completely with all necessary fittings such as M. C. Bs, auxiliary relays, switches, lamps, heating elements, small fixing parts and terminals, earthing material, etc., installed and put into operation.

All terminal strips are to be so designed that at least 15% of spare terminal capacity remains available after commissioning.

5.3.3.3 CONTROL-DISCREPANCY SWITCHES

For local operation of the 36 kV switchgears, control discrepancy switches with position indicator lamp with square front plate and the necessary contacts are to be provided for the circuit breakers.

5.3.3.4 IMPORTANT CONTROL DEVICES AND INTER-LOCKINGS

The circuit breakers, isolators and earthing switches shall be provided with an interlocking system which ensures safe operation of the equipment under all service conditions.

Mechanical interlocking shall be effective at the point where hand power is applied so that stresses cannot be transferred to parts remote from that point.

Beside normal control and interlocking facilities special attention has to be paid by the Contractor to all necessary interlocking related to the switchgears at the different substations. However, he following have to be considered, not excluding any necessary items not mentioned:

All facilities for the interlocking between isolators and associated CB's respectively between isolators and associated earthing switches in the 36 kV switchgears have to be provided.

5.3.3.5 CONTROL VOLTAGE

The control voltage shall be made available at least twice for each switchgear installation. The Contractor has to provide a diode decoupling of the control voltages.

The decoupled control voltage has to be looped from panel to panel. In each panel, the control voltage is to be safeguarded by mini circuit breakers and the tripping of these is to be indicated locally. A further potential-free set of mini circuit-breaker auxiliary contacts is to be wired as a group signal for the remote indication.

Mini circuit-breakers are to be provided for

1) Local controls, interlocks
2) Local annunciation and fault indications
3) Power supply to motor-driven stored energy mechanism
4) Heating and lightning circuits.

5.3.3.6 CONTROL OF SWITCHGEARS

The 36 kV switchgears remain normally unattended and will be supervised from the existing control rooms. The switchgears shall be automatically controlled according the reactive power requirements of the substation and the voltage conditions in the 132 kV network.

Each circuit breaker must also be capable to be operated manual, local and remote.

5.3.3.7 CONTROL

A change-over switch from automatic to manual control shall be provided for each automatic control device.

Each circuit-breaker must be capable of being operated locally by means of illuminated discrepancy switches which are covered in normal operation. If the control voltage fails, the EMERGENCY OPEN operation of the circuit-breakers must also be capable of being operated locally.

Each 33 kV switchgear cubicle shall be equipped with a change-over switch for LOCAL/REMOTE operation. All circuit breakers must be capable of being operated remotely (from the control rooms) by means of push-buttons.

5.3.3.8 SPECIAL INTERLOCKING REQUIREMENTS

Closing of the circuit breakers for the capacitor banks shall only be possible if the capacitors are discharged, i.e. the capacitor bank voltage is less than 50 V.

The circuit breakers for the capacitor banks shall trip, if no reactive power can flow into the network, i.e. if the coupling breaker (s) for coupling with the outdoor switchyard trip or the corresponding 132/33 kV step-down transformer is switched off.

5.3.3.9 Test

Type Tests

The protection relays, including control switches, winding and oil temperature indicators, meters, annunciate relays, miniature circuit breakers, humidistat, etc., offered shall have been fully type tested to prove their capability to meet or exceed the requirements of this Specification and, in all other respects, the requirements of IEC 60255.

The type test shall have been carried out at an independent testing station or alternatively shall have been witnessed by a representative of an independent testing authority or other independent witness.

The Bidder shall list for each type test performed, the test specification, location and date of testing and the Type Test Certificates/Report No. In addition the Bidder shall submit with his Bid a copy of each Type Test Certificate/Report which shall incorporate full details of test parameter and results and shall state by whom the tests were witnessed.

Routine Tests

All protection relays, including control and discrepancy switches, winding and oil temperature indicators, oil thermostats, automotive voltage regulators, meters, converters, annunciate relays, miniature circuit breakers, humidistat, etc., shall be routine-tested in accordance with IEC 60255.

POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT
FOR

Design, Supply, Installation, Testing and Commissioning of Capacitor bank with associated switchgear for Mymensingh region on turnkey basis.

SECTION 5

MEDIUM & LOW VOLTAGE CABLES

SECTION 6

MEDIUM & LOW VOLTAGE CABLES

6.1. GENERAL

This specification covers the design, manufacture, and acceptance testing in the Contractor's workshops as well as the supply, delivery, unloading, erection, adjusting, identification, testing, commissioning and acceptance testing of the high and low voltage cables within the substations, cable sealing ends, cable joints and all associated equipment, complete in every respect and suitable for satisfactory operation.

This section sets out the scope of the installations covered by this specification as well as requested supplies and services but without excluding other necessary components and services not mentioned.

High & low voltage power cable and low voltage control cable supply and laying including connections, sealing ends, trays, risers and supporting structures for connection of the switches and the capacitor banks. The route and each distance can be seen in the respective single line diagrams.

The routes for the cables have selected on preliminary bases and lengths are indicated at Schedule A while this describes the approximate distance. The tenderer is requested to check the actual cable length and to offer those quantities which are according to his estimations, necessary to perform the work properly.

The cable may be exposed to the direct rays of the sun at the terminations of gantries of the capacitor banks or switches. They shall be capable of withstanding such exposure continuously without any detrimental effect on insulation, sheathing or covering.

All cables and their accessories to be supplied shall have insulation levels able to withstand any voltage surges which are normally expected to occur in the power system in which the cable is to be employed due to switching operations, sudden load variations, faults, etc.

6.1.1 STANDARDS

The cable with cross-linked polyethylene insulation shall satisfy IEC 60502 and equivalent standards. Referred standards for power and control cable list are as follow:

IEC 60502-1, 2 XLPE Power cable under 1 kV up to 30kV

IEC 60227	PVC Insulated cables
IEC 60228	Conductors of insulated cables
IEC 60287	Calculation of the continuous current rating of cables
IEC 60060	High voltage test techniques

IEC 60183	Guide to the selection of high voltage cables
IEC 60229	Test on cable over-sheath
IEC 60811	Common test methods for insulation and sheathing materials

6.1.2 SCOPE OF SUPPLY AND SERVICES

The Contractor shall lay and assemble all specified cables completely and shall, pursuant to a final site test, hand them over in working order. The scope of works includes:

- Supply of power and control cables, as well as installation
- Survey of the cable routes which are selected by the Employer, selection of delivery cable lengths and all necessary fittings,
- Pursuant cable laying work such as trench extension, supporting structures and necessary indications and proper protection.
- Cable laying including bedding into the ground, or laying in ducts and rooms, fastening on racks, cable brackets or supporting structures, cable ducts including cable racks, as well as cable supporting structures and sealing ends and joint supports.
- Supply of all material necessary for termination and fixing the cables to the switches and capacitor bank as well as cable trays, clamps, grounding material and accessories for proper installation.

6.2. CABLES

6.2.1 36kV Power Cables

The 33 kV XPLE cables shall be cables with copper conductors and triple extruded insulation and shall comply with IEC 60502. The current capacity shall be for the following operating conditions:

- Ground temperature at 1 m depth	30°C	
- Maximum conductor temperature XLPE		90°C
- Maximum conductor temperature XLPE (short circuit)		250°C
- Average thermal resistivity of native soil		1.50K.m/W

The nominal system voltage to which the cables will be connected is U=33kV and the system maximum voltage is Um=36kV at a frequency of 50Hz.

Single core, copper conductor, XLPE insulated copper screened 500 sq.mm power cables supplied under this contract shall comply with IEC 502.

Conductor

Each conductor shall comprise stranded copper wires generally complying with the requirements of IEC-228 or BS-6360.

Conductor Screen

The conductor screen shall be comprise a layer of extruded semi conducting compound, compatible in all respects with the conductor and insulation materials. Conductor screen shall be bonded to the insulation such that no voids or discontinuities are present. The bond shall be adequate to withstand the normal electrical ad mechanical stresses in service without degradation or separation.

Insulation

The insulation shall be cross-linked polyethylene (XLPE) to the Purchaser's approval. The cable insulation shall be extruded in one operation with conductor & insulation screens. The highest possible purity of insulation material is required. The Bidder shall demonstrate that adequate precautions are taken to remove contaminants and to eliminate the introduction of particles of contaminate during material handling or the extrusion process.

The insulation materials shall consist of cross-linked polyethylene tightly extruded over the conductor screen. A cross-linked process using steam curing will not be permitted. The dry process shall be given in the tender, without which the tender will not be considered.

Insulation Thickness

The insulation thickness of the cables shall not be less than the values tabulated in IEC publication 502. Insulation thickness shall not depart from the specified nominal value by an amount exceeding the tolerance specified in IEC publication-502.

The positive tolerance shall be stated in the appropriate schedule

Insulation Screen

The insulation screen shall comprise a non-metallic semi-conducting polyethylene part in combination with a metallic part. The non-metallic semi-conducting part shall e applied directly upon the insulation of each core and shall comprised a layer of extruded semi-conducting polyethylene compound.

The conductor screen, Insulation and semi-conducting part of Insulation screen layer shall be applied to the conductor in common extrusion process with dry curing system. The metallic part shall be applied directly over the semi-conducting part. On single core cables, it shall be comprised of single layer of copper wires equally spaced apart.

Metallic Screen

The metallic Screen shall consist of a concentric layer of copper wires or a combination of copper wires and helically applied copper tape(s) as per IEC Standard.

The metallic Screen shall be so designed to carry the specified earth fault current of 31.5kA for 1 second.

Over sheath

The cable shall be sheathed overall with a MDPE outer sheath. The outer sheath shall be of smooth and uniform composition and free of holes. Cracks, blisters and imperfection.

As a protection against termite attack, the outer covering shall contain the termite repellent substance of Lead (Pb) nephthanate or cypermethrin.

The outer sheath shall be of adequate strength and thickness to withstand the test voltages and mechanical tests and shall be suitable for the ambient conditions at site.

The outer sheath material shall be capable of withstanding without damage or deformation the highest temperature achieved with the cable at its rated current and at the site ambient conditions.

Manufacturer's Identification

The manufacturer identification shall be shown the rated voltage, conductor size, the year in which the cable was manufactured and name of the manufacturer at internal of not more than 1000 mm throughout the length of the cable.

The designation of voltage and cable marking shall also be embossed on the outer polyethylene covering.

Name of the purchaser shall be embossed in the title-Bangladesh power Development Board at ever 1000mm gap.

Continuous Current Rating

The continuous rating of the cables that the bidder proposes to supply shall be calculated by means of the procedure described in IEC 287.

The bidder shall base his ratings on the site ambient conditions, with the methods of installation and bonding as specified. Due account shall be taken of the heating due to other cables or other sources of heat where these can be identified. The bidder shall state all the parameters including any assumptions that he has made in the calculation of continuous current ratings.

Details of the permissible overloads that can be applied to the cables with respect to service conditions shall be stated in the tender.

Short Circuit Rating

All cables shall be capable of withstanding without damage or permanent distortion the specified maximum short circuit currents for the specified times as under:

33 kV - 31.5 KA - 3 Sec.

The temperature of the conductors, during the passage of the specified maximum fault current for the specified time of one second shall not exceed 250^{o}C for XLPE cables.

6.2.2 Low Voltage Cables

Low voltage power cables:

The low voltage power cables shall be installed in accordance with IEC 60227.

In selecting the number of cables as well as the cable cross sections, appropriate de-rating factors shall be considered in relation to the climate conditions at site. All cables and wires shall continuously carry their rated currents under the worst temperature conditions and shall also withstand maximum fault currents without damage or deterioration. The maximum permissible voltage drop for all auxiliary power supply and control cable circuits shall be less than 5%.

The tenderer shall determine the exact lengths according to his arrangements as well as margin shall be considered.

All low voltage power cables to be supplied shall be connected to the relevant station equipment in an approved manner including necessary wiring. The spare cores shall be terminated and marked for future extensions. The cores shall be connected to terminals as such that crossovers and avoided.

The low voltage cables shall have following characteristics:
- Rated voltage : Nominal AC, DC distribution voltage
- Insulation : XLPE or extruded black flame retardant PVC

The D. C. cables are to consist, according to requirements, of single, two or four-core cables. The connections between batteries or rectifiers respectively and the D. C. switchgear should generally consist of single-core power cables.

The low voltage and D. C. cables are to be provided as follows:
Rated voltage of cables Uo/U will be 0.6/1 kV.

The star-point of the 415/240 V system is solidly earthed.

As a protective measure against excessive contact voltage, the screens of 415/240 V cables are to be connected to the neutral (protective multiple earthing).

All appropriate cable racks, pipes, supporting structures, cable terminals, connection and operation shall be included in the scope.

Instrument transformer cable:

In principle, an instrument transformer cable may transmit the current or voltage from only one transformer. If the same voltage is required for different purposes (e.g. protection, measurement, metering) each voltage transformer circuit must be wired via a separate MCB to the switchgear control cabinets.

The instrument transformer cables are to be designed for an insulation voltage of Uo/U = 0.6 kV. For instrument transformer cables laid inside buildings, a minimum cross-section of 2.5 mm^2 is required,

outside the buildings a minimum cross-section of 4 mm^2 is required. The successful tenderer has to check each connection and, if necessary, larger cross-sections have to be provided.

Cables for control, measuring and singling:

All control cables shall be of the stranded conductor type.

All control cables (including instrument, measuring and signaling cables) with stranded copper conductors, PVC insulated and PVC sheathed overall. The cable design shall generally be in accordance with IEC 60228 and 60287.

For voltages above 60 V, the cables must have an insulation voltage of Uo/U = 0.6/1kV and a minimum cross-section of 2.5mm^2

PVC insulated and sheathed cable, suitable for continuous operation at 70^{o}C (max.) is to be provided, each core with one solid round copper conductor with colored insulation.

If cables are laid to outside buildings, cables with a common core screen and induction protection shall generally be used. The screening may be omitted on cables laid inside buildings. The screen is to be earthed.

The number of cores in multicore cables shall be selected from the following: 2, 3, 4, 7, 12, 19, 27 and 37

For each type of cable 10% spare capacity shall be provided.

Cables for lighting

The lighting cables shall be standard multi-core cables with copper conductors. The common core covering shall consist of a non-hygroscopic filler If not otherwise stand, the requirements as per Schedule A shall apply.

The PVC oversheath shall be oil-resistant and treated in order to prevent the cables from spreading fire and shall be coloured block for external lighting and white for internal lighting.

Cables used in areas where there are ambient temperatures above 60^{o}C shall be heat-resistant. Heat-resistant cables must be suitable for continuous operation at an ambient temperature of 180^o C. For this reason the cable insulation shall consist of teflon or silicone.

For all auxiliary contacts between plug-in units and switchgear cubicle fixed portion plus-in connection shall be provided. The wiring of the plug-in contacts shall be such that the plug-in units of the same type are universally interchangeable without any change to the wiring.

The Contractor has to terminate all power and control cables inside the switchgear cubicle.

The minimum cable cross-sections and the colours of the wiring conductors shall be provided according to Section “General Technical Requirements”.

All cabling and wiring must be possible from the front of panels/cubicles etc.

The individual instrument transformer secondary circuits must be wired to the plug-in unit and switchgear cubicle terminal strip. In the case of current transformers the necessary terminals must be equipped with short-circuiting links.

6.3. CONSTRUCTION REQUIREMENTS

6.3.1 GENERAL

The requirements specified under other sections and Schedule A are to apply and, where applicable, further regulations from the sections of this Specification.

In general, the cables for double infeeds from switchgear, distribution boards, cubicles and cabinets must be laid separately so that in the event of a short-circuit in one infeed, the other is not affected. They must be thermally independent.
High voltage and low voltage and d. c. power cables are as a general rule to be laid in separate runs. The cables must be laid in such a manner that they can be replace or added to without difficulty.

The following minimum separations are to be observed:

300 mm, between low-voltage power cables and control, measurement and signaling cables for voltages above 60 V.

600 mm, between medium/high voltage cables and control, measurement and signaling cables for voltages above 60 V.

The Contractor has to assure that no inductions will occur by using the above spacing.

H. V. and L. V. cables having a cross section greater than 16mm2 are to be of XLPE copper cable type, L. V. cables of smaller size of PVC insulated type. All cables have to be suitable for an ambient temperature of 45^{o}C.

For cables which are subjected to ambient temperatures above 60^{o}C Teflon or silicone cables must be provided.

The cable sheathes must be resistant to solar radiation, the effect of oil, bacterial action, insects and rodents. They must be suitable for laying indoors, outdoors, underground and in water.

The individual cable lengths are to be laid in one piece.

All cables must be fitted with a number plate at each end for identification in accordance with identification system. The individual cores must be identified by numbers or a color code.

Inside substation areas cables shall be generally laid on cable trays in reinforced concreted cable ducts. Exceptions are subject to the approval of the Employer. Cables must be carefully arranged and ordered. In locations where proper positioning of the cables is not possible without securing them, quick-fastening PVC cable ties must be used.

On vertical runs, walls and ceilings, the cables must be secured by corrosion-resistant cable clips (quick-fastening cable clip with cradle). In such cases two cable clips must be used per metre of cable run where anchoring bars are used, while on vertical runs one clip per metre is sufficient. More than one cable may be secured by one clip only where it is impossible to lay the cables singly owing to the width of the run.

After the cables have been laid, the cable penetrations at the necessary fire protection walls must be sealed. This also applies to the penetrations leading to switchgear cubicles and cabinets, passages between cable ducts which can be walked through and those which cannot, at vertical runs, etc. As there is an increased fire risk during the period of construction, it is essential for cable penetrations to be sealed off at that stage. This applies especially to vertical runs.

Where the cables are not supported on cable trays or vertical runs, power, D. C. and instrument transformer cables must generally be run singly in PVC pipes. Surface-mounted pipes must be secured at least every 1.5 m.

All cables laid on the surface of walls, steel frames, etc., must be protected against mechanical damage by galvanized steel tubes or robust PVC pipes. In all areas where the cable conduits can be damaged. e.g. walk-ways, only steel tubes shall be installed.

For running out power cables, heavy screw jacks and spindles shall be used. The cable has to be continuously pulled from the upper side of the drum in the same direction and runs over rollers. The rollers. The rollers shall be placed into the trench at intervals of 4 m max. At corners or when pulling cables into ducts, special rollers have to be used. Sharp edges in the trench or at the ends of the cable ducts have to be covered in such a manner that no damage of the cable occurs.

Where cables have to pass under roads or leave buildings, cable ducting blocks and PVC pipes have to the foreseen.

When laying cables on trays, vertical runs, in cable ducts, etc. and when choosing the sizes of cables, care must be taken to ensure that adequate ventilation is guaranteed and that there is no risk of thermal overloading, undue pressure or distortion of the cables.

Where cables are installed above ground and are subjected to direct sunlight, they shall be protected by sunshields.

During the approval procedure the Contractor shall provide a cable schedule listing all cables and their destination including details with regard to number of cores, core size, cores in use and spare cores, cable length etc. for each substation.

6.3.2 LAYING DIRECT IN GROUND

Excavation of Trenches

In case of power cables between capacitor bank and switches are installed, a direct laying will be adopted. While low voltage power cables and control cable shall be installed extended or existing cable trenched.

The exact location of each trench shall be agreed at the site with the Employer before the installation work begins, Permits for excavation shall be obtained from the Employer and site engineer. Trench shall be kept as straight as possible and shall be excavation to approved formations and dimensions.

Unless otherwise agreed with the Employer, the depth of excavated trenched for the installation of HV shall be 1 meter. The contractor shall use no power excavation tools for excavation within outdoor switchyard and around any crossing area.

The contractor shall take all precautions to avoid damaging any other power cables along the cable route. All excavation, cable laying and back filling shall be carried out only under the direct supervision of a responsible officer and in the presence of representative of the Employer.

Before the cables are laid, the bottom of the trench shall be lined with approved soften sand well tamped down to a minimum depth of 50mm to form a bed. After the cable are laid, the first cover of backfill shall consist of approved soften sand, well tamped down. A minimum depth of 80 mm of backfill shall be provided over the cable. Cable protective covers shall be placed. Cable protective covers shall be of reinforced concrete (300 mm wide, 50 mm thick and 1000 mm long)

The cable duct shall be used to lay cables along the road whereas direct laying of the cable ins not possible.

6.3.3 CABLE CONNECTIONS AND SEALING ENDS.

All cables laid are to be prepared according to requirements and are to be connected to existing terminal strips, terminal screws, apparatus terminal, etc. All cables are to be fixed to the appropriate supporting structures.

Cable sealing ends for all cables supplied under this Contract shall be provided. Also provide the ones for the connection to existing outdoor switchyards.

The purpose of the cable connections is to establish electrically conducting connections between all the electrical operating equipment. The purpose of the cable sealing ends is to ensure a fully sealed cable termination and the reduction of the dynamic short circuit effects on the fanned-out cable ends.

For the connection of cable cores with a cross section of 2.5 mm^2 or above, compression cable lugs must be provided. The terminal blocks must be so designed as to ensure that the cable core to be connected cannot be pinched off. Where flexible conductor cables are used, the stripped conductor ends must be tinned before connecting.

The minimum bending radius, the maximum tensile stress rates and the cable spacing shall be taken into consideration on cable laying.

The minimum creepage distance of 2.54 cm/kV shall be considered for cable sealing ends in case of indoor and outdoor terminations cable connection hood (based on system maximum voltages phase to phase)

The bidder shall provide all material for the proper mounting and grounding of the sealing ends as well as the fastening of the cables, if necessary.

Any cable jointing sleeves which may be required must also be made of plastics. Sleeves for cable branch T-joints are to be avoided under all circumstances.
Straight through joints shall be of the heat shrinkable type.

The cable terminations and sleeves used must be made of synthetic material resistant to burning and must contain the necessary additives for reducing flammability.

The cables must always be fixed at the sealing ends to cable supports, which are to be provided, by means of corrosion resistant cable clamps.

6.3.4 CABLE TRAYS

Separate cable trays and cable risers are to be provided for the cables mentioned below, a requirement being that the cable trays and cable risers are to be marked every 10 m with the following clear visible colours:

1) Power cables above 1.000 V	red
2) Power cables below 1.000 V	black
3) D. C. power cables	yellow
4) Instrument transfer cables	green
5) Control, measuring and signaling cables above 60 V	white

The cable trays must be so designed that there remains a reserve space of 15% on all trays after commissioning and handing over.

All cable tray T-junctions, cross-overs, incoming and outgoing branches, bends, etc. must consist of prefabricated tray elements to ensure that crushing of a cable at the transition points is reliably avoided.

The space between the individual cable trays and risers must be large enough to ensure that the power, instrument transformer, control, measuring and signaling cables as well as the cables of the communication systems do not cause mutual interference.

The fixing materials for the cable trays and risers must be corrosion-resistant or at least hot-dip galvanized. The rods, brackets and risers must be fitted with appropriate support brackets to be fixed to steel rails or to plugs in walls. Welding to steel structures or the welding together of hot-dip galvanized cable laying accessories is not permitted.

6.3.5 TEST for Power Cable

Type Tests

Type test report of offered type current transformer shall be submitted as per relevant clause of Schedule G. Type test items as per as per relevant clause of Schedule G (performed as per procedure of 60502) shall be submitted.

Routine/Sample Tests

The cable shall be tested and shall satisfy the IEC 60502.

POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT
FOR

Design, Supply, Installation, Testing and Commissioning of Capacitor bank with associated switchgear for Mymensingh region on turnkey basis.

SECTION 7

LV AC/DC & LIGHTING INSTALLATIONS

SECTION 7

LV AC/DC & LIGHTING INSTALLATIONS

7.1. GENERAL

These clauses describe the General Technical Requirements for low voltage switchboards for supplies to substation service. As specified in the Schedule, additional AC/DC distribution board is required according to capacitor bank installation.

Also, the section includes required the interior and exterior lighting for capacitor bank yard, and small power systems. The lighting and small power equipment and installation shall comply with other sections of this Specification as appropriate.

All civil works associated with this section of the works shall be deemed to be included as part of the works in this section. No additional payments will be made for such requirements.

This specification covers the design, manufacture and acceptance testing in the Contractor's workshops as well as the supply, delivery, unloading. erection, adjusting, painting, identification, testing, commissioning and acceptance testing of the AC and DC installations for the substations.

7.2. LAYOUT

For each of the new 36 kV switchgear & capacitor bank installation a sub distribution board 400/230 V AC shall be installed.

These sub distribution boards shall be supplied from the existing AC main distribution boards by two infeeds.

In case that there is no space or that there are no spare feeders available in the existing main distribution board a separate auxiliary board shall be installed beside the main distribution board. From the existing main distribution board two outgoing feeders shall be disconnected and shall be used for feeding the auxiliary board. The two disconnected outgoing feeders shall be connected to the auxiliary board as well as the two feeders for the switchgear/capacitor bank installations sub -distribution board. For supply of the new 36 kV switchgears 110 V/125V batteries and battery chargers and DC distributions shall be installed if specified, otherwise existing DC system will be used for capacitor bank installation.

The AC sub distribution board to be supplied for the compensation project shall be connected to these installations.

7.3. References

IEC Standards

IEC 60269 Low voltage fuses
IEC 60439-1 Specification for low voltage switchgear and control gear assemblies
IEC 60898 Electrical Accessories – Circuit breakers for overcurrent protection for household and similar installations
IEC 60947 Low voltage switches gear and control gear

British Standards

BS 7671	Code of Practice Regulations for Electrical Equipment in Buildings
BS 6004	Specification for PVC insulated cables for electric power and lighting
BS 6346	Specification for PVC insulated cables for electricity supply
BS 6500	Specification for insulated flexible cords and cables
BS 6121	Mechanical cable glands
BS EN 60947	Specification for control gear for voltages up to and including 1000V AC and 1200V DC
BS 4533	Luminaries
BS 1362	Specification for general purpose fuse links for domestic and similar purposes
BS 4066	Test on Electric cable under fire conditions.
	Heating and Ventilation Contractors Association of U.K. specification DW/ 121

7.4. AC SWITCHBOARD DESIGN

7.4.1 GENERAL

AC switchboards MCB distribution panel for substation and building supplies will be constructed in accordance with the followings:

The classification of the main switchboards shall be:

i) The external design of switchboards shall be of the multi cubicle type
ii) Installation shall be indoors
iii) Switchboards shall be free standing and fixed to the floor
iv) Switchboard shall be of metal clad construction
v) All instrumentation and metering shall be fixed to a hinged lockable compartment
vi) Switchboards and all associated equipment shall be suitable for use on a 400/230V three phase, 4 wire, 50Hz system having the neutral solidly earthed.
vii) Each circuit shall be clearly labeled to show the destination of the associated cable and the ON/OFF positions of the switches
viii) Distribution board for exterior use shall be galvanized and waterproof

The equipment shall be of the single bus bar type with circuit equipment housed in separate compartments,

Where tow or more incoming circuit breakers are provided at substations, these shall be mechanically and electrically interlocked to prevent more than one circuit closing at the same time.

The enclosures of all switchboards shall be dustproof and vermin proof. Access doors shall be mounted using concealed hinges. All removable covers shall be fitted with captive screws. Anti condensation heaters with control switches shall be provided on switchboards. They shall be suitable for a tropical climate.

7.4.2 RATING

Incoming supplies to all switchboards shall be protected at the point of supply. All switchboards shall be suitably rated for a prospective short circuit breaking capacity of 15kA at 400V for three seconds.

7.4.3 BUS BAR

Busbars shall be capable for carrying the full rated current continuously without exceeding the maximum temperature specified ambient condition (IEC60439)

Busbars shall be of copper, individually covered with a heat resistant phase colored PVC. Busbar links between panels shall not be used. Neutral busbars shall have the same cross sectional areas as the phase busbars. Busbars shall be of the same current rating throughout their length and shall be capable of extension at both ends with the minimum disturbance to the busbar and cubicle enclosure.

7.4.4 CIRCUIT BREAKERS

All MCCB circuit breakers shall be high speed fault limiting, thermal/magnetic type with quick break, trip free mechanisms which prevent the breaker being held in against overloads or faults, shall comply with IEC60947 and fitted with overcurrent releaseds of both thermal and instantaneous type. Short circuit performance shall be to IEC60947.

Where circuit breakers incorporate thermal overload protection and short circuit protection, their settings shall be subject to agreement with the Employer.

Tripping arrangements shall be such as to ensure simultaneous opening of all phases. Arc extinction shall be by de-ionizing arc chutes.

7.5. DC DISTRIBUTION EQUIPMENT

7.5.1 GENERAL

125/110 V Battery, Chargers and Associated equipment are required to supply all loads imposed by control, indication, alarms, circuit breaker tripping and closing for the new 36 kV switchgears under normal operation for ten hours following mains failure. At the end of this period the battery shall still be capable of closing all circuit breakers individually and tripping all circuit breakers together. After such duty cycle the battery voltage shall not be less than 112.5/99 V.

The 125 V/110V battery system shall comprise 1 x 100% rated duty battery and 1 x 100% rated duty battery float/boost charger units. These shall be arranged such that under normal operation the float charger operates to supply the specified d. c. load and at the same time automatically float charge the battery to keep it fully charged within the specified voltage limit of 125V/110V d.c. plus or minus ten per cent (i.e. 137.5V/121V or 112.5V/99V).

Under boost charge conditions the charger shall be capable of supplying the full boost charge requirements.

During boost charging, counter emf cells have to be included in the circuit in order to avoid overvoltages at the consumers.

In the event of loss of a.c. supply the charger shall return automatically to the float charge position.

Selection of boost charge shall be manual and the period controlled automatically by a preset timing switch. After the end of this period the charger shall automatically be switched to float charging. A chart giving appropriate charging times shall also be provided. The boost charger shall be such that recharging the whole battery from the discharge condition to 90% of the fully charged capacity does not exceed 8 hours. The characteristic of the boost charger control shall be such that the charging rate is reduced as the battery approaches full charge and excessive gassing avoided.

The battery systems shall not be earthed at either pole.

An earth fault detection scheme shall be provided to indicate whether an earth fault has developed on the positive or negative pole of the system. The battery earth fault alarm shall be locally annunciated and a spare alarm contact shall be provided.

7.5.2 DC SWITCHGEAR EQUIPMENT

The DC distributions are to be provided as indoor, steel-enclosed cubicles and are to be furnished with permanently installed equipment and single busbar systems. The rectifiers are to be arranged in sheet steel cubicles which are to be matched to the distributions in respect of height and other dimensions.

The rectifiers should be designed for operation with natural cooling. If air cooling is required, 2 x 100% air fans with monitoring, control and alarm signal must be provided.

The main distribution 125V110V DC is to be fed by 1 x 100% battery and 1 x 100% rectifier.

The infeeds of the main distributions are to be provided as hand operated load break switches with high speed HRC fuses. The infeeds from the batteries are to be taken via isolating fuses to busbars for interconnection with the rectifier, and from there to the infeed.

The Contractor has to make sure that the battery fuses are interrupting quicker than the rectifier fuses in case of a DC busbar fault.

All outgoing feeders from the DC distribution to consumers are to be equipped with MCB's; fuses with hand operated load-break switches for plus and minus. A voltmeter, an under voltage and overvoltage relay is to be provided for each distribution or half bar.

In each cubicle all the devices such as fuse isolators, hand operated load-break switches or isolating fuse switches, fuses, contactors, shunts, converters and measuring instruments are to be installed, fixed and mounted in a clear arrangement.

The cable connections between rectifiers and/or batteries and/or busbars are to be carried out with single conductor cables.

For the individual cubicles the necessary instruments, control switchgears and switch operating devices are to be installed on the front panel.

The main busbars are to be installed in the rear upper part of the cubicle. The connections of outgoing bars to the switchgear MCB's, instrument transformers and shunts are to be led from these busbars.

The lower part of the switchgear cubicles should contain the terminal strips, the fixing construction for the cables and the necessary copper paralleling bars for the connection of multiple cables per phase.

Earthing studs are to be provided in sufficient number on the copper busbars and on the copper paralleling bars.

For earthing purposes on the main and branch busbars and also on the switchgear, there must be a sufficient number of ball-ended studs within the cubicles.

The Contractor must ensure that after handing over each switchgear installation still has a minimum of 5% fully equipped spare capacity and 15% for the terminal strips.

The Contractor shall ensure via design that, in the event of outage of ventilation systems, the DC equipment remains operational at full load, and at ambient temperature of 45 ^{o}C. Should the ventilation plant fail, any formation of condensation water is to be prevented by appropriate heating arrangements in the cubicles.

The battery room shall be ventilated.

All the cubicles must be installed on subframes specially provided for them. The subframes are to be delivered by the Contractor and shall be bedded into concrete.

The cubicles are to be so designed that they can be erected freestanding.

The switchgear must consist at least of:

1) Current and voltage metering equipment.
2) Contactors with fuses, bi-metal trip, mini circuit breaker for control voltage etc.
3) Protection relays, monitoring equipment and mini circuit breakers, switch position indications, alarm and operating devices, mimic diagrams, complete terminal boards
4) Heaters inside the panels
5) Cable paralleling arrangements with auxiliary collector bar system, connecting bars for all incoming and outgoing feeders requiring more than 2 parallel cable.
6) Fire-proof closure of the bottom of the panel units for sealing the outgoing cables.

Coloured mimic diagrams are to be provided in each case on the front of the DC equipment cubicles with the necessary switch position indicators, device symbols and alarm lamps.

The mimic diagram for the DC systems has to contain at least the following:

1) 0.4 kV busbar of the main switchgear with position indicator for the hand operated load-break switches for the rectifier supply
2) Symbols for rectifier and battery
3) Infeed and coupling circuit breakers with position indicator and the necessary operating elements
4) DC main distribution, busbar.

Mini circuit breakers are to be provided for

1) Local controls and interlocks
2) Local annunciation and fault indications
3) Power supply to motor-driven stored energy mechanism.

7.6. LIGHTING

7.6.1 GENERAL

This section provides general requirements regarding necessary lighting equipment for capacitor bank installation, bus extension and security.

All lighting fittings and all equipment comprising the lighting sub-distribution units must meet the operating requirements in full at an ambient temperature of 45 ºC and for a relative humidity of up to 100%. The lighting fittings shall be designed for an operating voltage from 230 V to 275 V, 50 Hz.

For protection against contact with live components, all lighting fixtures must be suitable for the following protection measures:

1) Protective conductor connection or Protective insulation
2) and must visible carry the accepted symbol to indicate this.

In plant areas subject to danger of explosion the necessary explosion proof lighting fittings, cable connection boxes and pushbuttons are to be used according to IEC 79. Sub-distribution units must not be installed in such rooms or areas.

7.6.2 LIGHTING FITTINGS

Illustrations and/or samples of all lighting fittings which the Contractor proposes to purchase shall be submitted to the Employer for approval before issuing any sub-orders.

Lighting fittings for interior and exterior use are to be manufactured and tested in accordance with the appropriate sections of BS 4533, IEC 162 or equivalent and together with all components are to be suitable for service and operation in the tropical climate stated.

Each fitting is to be complete with all lampholders, control gear, internal wiring, fused terminal block, earth terminal and reflectors or diffusers as specified. The design of each fitting is to be such as to minimise the effect of glare and such that the ingress of dust, flies and insects is prevented, where open type fittings are used it is to be impossible for insects to become lodged therein.

The control gear for use with fluorescent lamps is to be quick or resonant start type without starters. Chokes are to be impregnated and solidly filled with polyester resin, or other approved high melting compound, are to be manufactured to restrict the third harmonic content to less than 17% of the uncorrected current value, and are to be silent in operation.

The built-in ballast units shall comply with IEC Publication No. 82 and shall include radio interference suppressors and capacitors to correct the fitting power factor to a minimum of 0.85 lagging. Control gear noise levels shall be minimal.

Fittings shall be supplied complete with closed end vitreous enameled metal reflectors or totally enclosed opal plastic diffusers, which shall be fully interchangeable.

Dispersive reflector fittings suitable for mercury bulb fluorescent or tungsten filament lamps shall be of heavy gauge sheet steel finished vitreous enamel. They shall be fitted with anti-vibrators and arranged for conduit box mounting, direct or pendant, on galvanised ball and socket dome type lids.

Bulkhead fittings shall have cast bases tapped for conduit entry, hinged bezels, heat resisting prismatic glasses fitted with neoprene gaskets and porcelain lampholders. Circuit cable shall not be connected direct to bulkhead fittings but shall terminate in a fixed base connector mounted in a conduit box adjacent to the fitting. Final connections to each fitting shall be carried out with silicone rubber covered cable. All bulkhead fittings shall be watertight pattern.

Internal connections are to comprise stranded conductors not less than 0.75 MM2 covered with heat resistant insulation to the requirements of BS 6500 or equivalent. All internal wiring is to be adequately cleated to the fitting casing with an approved form of cleat. The finish of fittings for interior use is to be impervious to deterioration by atmospheric reaction. Fittings for exterior use shall have a vitreous enamel, natural aluminium or galvanised finish according to the manufacturer's standard product.

Lampholders for tungsten lamps up to 150 watts shall be brass or porcelain BC type and for higher ratings shall be ES or GES type according to size. Fittings for housing tungsten lamps exceeding 150 watts rating are to be provided with an approved method of dissipating heat from the lamp cap and terminal housing.

Lampholders as applicable are to be suitable for the lamp specified.

Lighting fittings are to be of the type description as generally set out in the schedule appended to this section of the Specification. The type references used are to be repeated in the Schedules and on the drawings.

7.6.3 LAMPS

The Contract includes the supply and erection of all lamps and tubes necessary to complete the installation.

Fluorescent lamps shall be manufactured and tested in accordance with BS1853, IEC 81 or equivalent, shall be bi-pin types and shall have colour rendering values of X = 0.335 and Y=
0.342 (i.e., Colour 2) on the CIE chromaticity scale.

Tungsten lamps shall be manufactured and tested in accordance with BS 161 or equivalent and shall be bayonet cap for lamps up to and including 100 watts. Lamps rated for 150 watts and higher shall have edison screw caps. Low wattage lamps used in exit signs and emergency lighting units may be small or miniature edison screw.

Discharge lamps shall be manufactured and tested in accordance with BS 3677 or equivalent. Mercury vapour lamps shall be fluorescent types having a 10% red ratio colour correction, whenever used.

7.6.4 POLES

Lighting poles shall be tapered, of hot dip galvanised steel with bituminous preservative inside and outside at the base and shall be approved by the Employer.

Each pole shall be equipped with a base section compartment of 470 mm by 150 mm to house an inspection trap, lockable door, fused cutout, cable entry and terminations for both the incoming and outgoing power cables and secondary cables feeding the light sources.

Poles for substation lighting shall support the floodlights at 11m above ground level and poles for access roadway lights shall support the lanterns at 4.5m above ground level.

The Contractor shall ensure each pole is provided with foundations suitable for the ground conditions occurring at each Site.

7.6.5 EXTERIOR INSTALLATION

For 33 kV expanded switchgear, capacitor bank, access road and security necessary boundary areas, proper lighting shall be installed onto appropriate equipment for maintenance and operation convenience. Specific locations and design shall be discussed with the Employer.

When locating the floodlights for the switchyard lighting, the Contractor shall ensure that all floodlights are outside safety clearance for the high voltage switchgear at the particular location.

Cables to exterior lighting shall be laid direct in ground, laid in concrete trenches or cleated to buildings structures as appropriate to the route requirement. The cables shall be terminated at a cut-out located at the base of each support. Wiring between the cut-out and the control gear or lantern shall be with multicore cable run within poles or with cable drawn into galvanised steel conduit attached to the supporting structure.

7.6.6 SCHEDULE OF LIGHTING REQUIREMENTS

7.6.6.1 CONTROL BUILDING

	Location	Service Illuminance (Lux)	Glare Index
(a)	Control Relay Room	400	25
(b)	Behind panels	100	-
(c)	Office	350	20
(d)	Battery Room	100	-
(e)	Toilet	100	-
(f)	Corridors, Stairs	100	20

7.6.6.2 OUTDOOR AREAS

(a)	Switchyard Floodlighting	20	-
(b)	Transformer Compounds	120	-
(c)	Roadway Lighting	20	-
(d)	Perimeter Wall Security	10	-
(e)	Control Building Exterior	15	-

POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT
FOR

Design, Supply, Installation, Testing and Commissioning of Capacitor bank with associated switchgear for Mymensingh region on turnkey basis.

SECTION 8

EARTHING AND LIGHTNING PROTECTION SYSTEM INSTALLATION

SECTION 8

EARTHING AND LIGHTNING PROTECTION SYSTEM INSTALLATION

8.1. GENERAL

This specification covers the design, manufacture, pre-assembly and acceptance testing in the Contractor's workshops as ell as the supply, delivery, unloading, erection, adjusting, painting, identification, commissioning and acceptance testing of the earthing and lightning system and of the power and lighting installations, complete in every respect and suitable for satisfactory operation.

The requirements of this Specification shall be applied for all substations.

8.2. REFERENCES

IEEE 80	IEEE guide for Safety in AC Substation Grounding
IEEE 81	IEEE Guide for Measuring Earth Resistivity, Ground
	VDE Earthing System for Power Installations with Rated Voltages above 1kV
BS EN 13601	Specification for copper for electrical purposes: high conductivity copper rectangular conductors withdrawn or rolled edges
BS EN 13601	Specification for copper and copper alloys, Tubes
BS 2874	Specification for copper and copper ally rods and sections
BS 4360	Specification for wieldable structural steel
BS 6360	Specification for conductors in insulated cables and cords
BS 6651	Protection of Structures against Lightning
BS 6747	Specification for PVC insulation and sheath of electric cables
BS 7430	Code of Practice for Earthing

8.3. SCOPE OF SUPPLY AND SERVICES

This section sets out the scope of the installations covered by this specification as well as requested supplies and services but without excluding other necessary components and services not mentioned. The relevant "Prices for Equipment" can be found in Price Schedule.

Generally the following equipment is covered by this specification:
Complete in every respect and suitable for satisfactory operation

Specifically the following main equipment is to be provided for each substation:

1) Complete earthing system for the 36 kV switchgear/capacitor bank installation,
2) Complete lightning protection system for the 36 kV switchgear/capacitor bank installation and connection to the substation earthing system.

8.4. CONSTRUCTION REQUIREMENTS

8.4.1 EARTHING AND LIGHTNING PROTECTION

8.4.1.1 GENERAL

For the new installations a meshed earth system must be installed and connected to the existing earthing system. The cross-section of the stranded copper conductor sheathed with lead at least 1 mm thick is to be chosen by the Contractor in accordance with the maximum earth short circuit currents liable to arise. The earthing system is to be calculated according to IEEE 80. For the construction of the earthing system approved standards, such as VDE 0141, shall be applied. The resistance of each substation earthing system shall be measured at selected points after installation and shall not exceed 1.0 ohms with the overhead line earth ropes disconnected. A uniform stranded conductor cross-section is to be used for the entire area under Contract. For potential grading and to offer protection against excessive contact potentials, ring earths made of stranded copper cable are to be installed around the switchgear installations and these are to be connected to the mesh earth conductors. If at the boundary of the protective area formed by the mesh earth, excessive step of contact voltages occur, these values must be reduced by grading rings.

At maximum distances of 10 meter, the ends of the stranded conductors of the mesh earth are to be taken into the inside of the buildings and connected to the internal earthing system (internal ring) with necessary calculations to be provided by the contractor.

The earthing installations of the 33 kV switchgear/capacitor bank installations are to be inter-connected with stranded copper cables to the existing earthing system.

The extension of the earthing and lightning protection system of each substation shall include but not be confined to:

1) The necessary stranded copper ropes for the indoor and outdoor earthing installations and mesh system
2) The necessary ropes for fence earthing and connection to the substation earthing system.
3) The necessary bare copper strips for the earthing ring inside the buildings.
4) Connection of PVC single-core cables being laid out of the concrete to the earthing ring inside the buildings
5) The necessary compression connectors or connections by Cadweld system (or similar) for the earthing conductor crossing point connections and junctions.
6) All connections to the housings of the electrical apparatus, steel frames, pipes, steel strips etc.
7) All necessary disconnecting points for measuring purposes which must be readily accessible
8) All the necessary lightning protection equipment for the protection of persons and structures such as lightning collectors, roof bushings, lightning rods, potential equalizing systems, spark gaps, lightning arresters etc.

9) The required connecting and fixing materials such as plugs, screws, angle pieces, expansion strips, conductor support, isolating terminals, earthing and rain gutter clamps, jumper outfits, earthing clamps etc.

8.4.1.2 MATERIAL

Whenever dissimilar materials are to be joined, the necessary transition plates are to be inserted as required to make sure that electrolytic action is avoided.

Earthing material

Stranded copper conductor is to be used as earth conductor for laying in the ground, on cable trays and for the earthing of electric equipment, steel structures and frames etc. bare copper strips should be used for the internal earthing ring inside the buildings.

Lightning protection material

Round copper rod of 8 mm diameter is generally to be used as the material for the lightning protection system. The conductor supports of the lightning protection system must be copper or bronze. Nuts and bolts at isolating or other points which are to remain detachable must be made of copper nickel-silicon-bronze.

8.4.1.3 EARTHING SYSTEM

The requirement covers all earthing installation regarding capacitor bank and related switchgear installation including panels and equipment grounding. Earthing shall be installed along with capacitor bank and extended switch bay. Appropriate conductor and device shall be used for earthing and connection to existing system.

Installations above and below 1000V shall be made safe by protective earthing. This is required to prevent the occurrence of excessive touch potentials on conducting parts of the installation which are not part of the electrical circuit.

The earthing installations must be designed and constructed in accordance with approved standards.

Generally, underneath the substation and switchgear installations a grid earth of stranded copper cable must be installed. The size of the stranded copper conductor shall be 150 mm^2. If necessary the Contractor can calculate the ground current. The size of the mesh shall be in accordance with the maximum occurring earth leakage current to meet the requirements for earthing according to IEEE 80 and IEC 621. The size of the stranded copper conductor s used must be uniform throughout the area under Contract as far as possible. For controlling the potential and for protection against excessive contact potentials, encircling ring earths of stranded copper cable must be laid at a distance of 1m and a depth of 0.8m around each individual building in each sub-station.

Conductor buried in the ground shall normally be laid at a depth of 500mm in an excavated trench.

Inside the buildings encircling, bare copper strips must be installed on the walls. From the inner earthing ring the connections to the switchgear, and other electrical apparatus, cable trays, vertical cable runs,

steelwork etc. are to be made using bare copper conductor. All the electrical equipment, frames and mechanical apparatus must be fitted with earthing screws and studs.

The copper conductors can be laid and fixed on the cable trays and vertical runs for AC power cables. Where this is not possible, earthing conductor supports are to be provided, which are to be fixed in concrete or masonry by means of plugs. The bare copper strips also must be fixed with earthing support on walls.

Inside the concrete of buildings a separate round iron (reinforcement bar) mesh in walls ad ceilings for earthing purposes must be provided. The size of this mesh should not exceed 10 m x 8m. The connections of this earthing reinforcement bar should be welded. The reinforcement bar shall be connected via a flexible PVC single-core cable every 8 m to the inside earthing ring.

At a maximum distance of 10 m the inside earthing ring of the buildings must be connected with the outdoor earthing system. These connections must be provided with flexible PVC single-core cables which are to be laid through the concrete walls above the ground water level.

In buildings without a basement the internal earthing ring is to be connected by the Contractor to the outer earthing ring at maximum intervals of 10 m.

The crossing point connections of the earthing cables underneath the buildings and outside the buildings must be made by compression connectors. Connections, e.g. by Cadweld system, will also be acceptable. All other earthing conductor connections and junctions must be made in the same way to ensure secure, lasting connections having good contact.

The earthing installations of all the buildings of each sub-station must be interconnected with stranded copper cables.

The interconnections between the earthing installations of the buildings must be provided with an accessible isolating point in order to be able to measure the earthing resistance. All isolating points must be numbered consecutively in the drawings and clearly marked in the field.

At a depth of 0.8 and a distance of 1 m outside the respective sub-station fence a stranded copper rope of 120 mm^2 has to be laid for potential grading purposes. In case of metal fence the fence has to be connected to the earthing ring every 10 m at a minimum.

All facilities shall be securely connected, with minimum practicable resistance, to the common ground system. The maximum resistance to ground from the connection point in any facility shall not exceed 0.5 ohms, when measured by standard ground resistance measurement techniques.

The lightning installations for all buildings, structures, etc. must also be connected to the central earthing installation.

The effects of lightning strikes on the control and monitoring systems vary from faulty pulses in control and measurement to the destruction of electronic sub-assemblies and cables and must therefore be prevented by the earthing of screens. To this end the screens of the control cables leading from the signal transmitters, actuators etc. must be taken to the central earthing points and from there to the indoor earthing installation. They must be insulated and laid via the screen bars in subsidiary distribution boxes, intermediate terminal boxes, marshalling racks, control cabinets and DC main distribution boards.

Fence Earthing

Metallic fences shall be separately earthed unless they come within 1.8meter of any equipment of structure above the surface of the ground and which is connected to the main earthing system. If the separation of 1.8meter cannot be obtained, the fence shall be bonded to the main earthing system.

The earthing of a fence shall be provided by connecting certain metallic fence posts to an earth rod by a copper conductor. The earth rod shall be driven adjacent to the posts inside the fence line to a depth of not less than 3.0meter where no metallic posts are provided. The earth rods shall be connected directly to the metal wires, mesh or other components of the fence.

If, owing to the nature of the ground. It is not possible to dreive earth rods, then fence posts shall be connected to center point of a 20 meter length of bare coper conductor buried in the ground at a depth of 500mm, running closely parallel to the inside of the fence.

For fence earthing 75 sq.mm and more size copper conductor can be used.

8.4.1.4 LIGHTNING PROTECTION SYSTEM

All buildings and outdoor equipment are to be protected against lightning strikes by ans of lightning collectors and conductors. The collectors are to be arranged in such a way that, as far as possible, they collect all lightning strokes without these directly striking the parts to be protected. This condition is considered to have been fulfilled if no point on the roof surface is more than 10 m away from a collector. Collector lines suffice as collectors, e.g. along the ridge and at gables and eaves.

The Contactor shall propose appropriate lightning protection measures covering all equipment newly installed. Overhead grounding wire and lightning rod can be considered. In case of lightning rod, the equipment should be covered within its 45 degree protection angle when double rod. In single rod case, it is limited to 35 degree.

POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT
FOR

Design, Supply, Installation, Testing and Commissioning of Capacitor bank with associated switchgear for Mymensingh region on turnkey basis.

SECTION 8

CIVIL WORKS

SECTION 9

CIVIL WORKS

9.1. GENERAL

This section covers all earth work, foundations and associated with the project together with roads, surfacing, cable trenches, and boundary walls and so on.

The design and construction shall conform to the latest edition of the relevant codes and standards. Any proposed substitution for the listed standards by an equivalent standard will be subject to approval by the Employer.

The following sections contain the civil work required for the construction of the substations: also included is the other related civil work as described in this specification and shown on the relevant drawings, but without excluding other necessary works and services works and services not mentioned.

The construction work referred to here must be performed in such a manner that the high standards of quality and junction required in detail below, are achieved. Special attention must be paid not only to the question of basic design and construction but also to the aspects which are specific to country and climate.

The Contractor is not allowed to use the works, material or furniture or parts thereof for temporary purposes without the written consent of the Employer.

The Contractor shall be liable, within the scope of the terms of this Specification and on the basis of the applicable international standards characteristic data.

The Contractor shall assume full responsibility for:

- the use of the most suitable materials,
- appropriate design,
- competent
- full serviceability in unrestricted continuous operation
- observance of relevant specification.

9.2 DESIGN AND CONSTRUCTION STANDARDS

BS 12 Portland Cement
BS EN 124 Gully and Manhole tops for vehicular and pedestrian areas
BS 812 Testing Aggregates
BS 882 Aggregates from natural sources for concrete
BS 1377 Methods of test for soil for civil Employering purposes

BS 1722: Part10 Anti-intruder fences
BS 1881 Testing concrete
BS 2853 Design and testing of overhead runway beams
BS 3148 Methods of test for water for making concrete
BS 4449 Steel bars for the reinforcement of concrete
BS 5628 Code of practice for use of masonry
BS 5930 Code of practice for site investigations
BS 6031 Code of practice for earth works
BS 6399: Part1 Code of practice for dead and imposed loads
BS 6399 : part 2 Code of practice for wind loads
BS 6651 Code of practice for protection of structures against lightning
BS 8004 Code of practice for foundations
BS 8100 Lattice towers and masts
BS 8102 Code practice of protection of structures against water the ground structural use of concrete.
BS 8110 Structural use of concrete
BS 8215 Code practice for design and installation of damp-proof courses in masonry

9.3 LAYOUT AND ACCESS TO SITES

The new facilities are to be constructed each at a location of a existing substation. A general approach is shown on the respective annexers.

9.4 SCOPE OF SUPPLY AND SERVICES

The works to be provided within the framework of this specification comprise the planning, complete supply of material or equipment and execution of construction or erection in every respect including all the necessary calculations and documentations, prefabrication and acceptance of all civil works required for faultless operation of the substations in the following fields:

- General installations
- Auxiliary plants, foundations and structures

The extent of the civil works for the above sectors consists basically of, but is not limited to the following services:

- Soil works
- Site Leveling
- Boundary wall extension
- Fence Installation
- Foundation works
- Concrete and masonry works

- Finishing works
- Furnishings and equipment
- Access Roads
- Earth extension
- Trench Extension, etc.

The requirements specified under section “General technical requirements” are to apply even if there is no reference made to them and, where applicable, further regulations and/or cross-reference from the other sections to this specification.

The civil works are to be placed by the contractor as a subcontract with an approved local contractor and should include in his staff establishment adequate supervisory staff for the subcontractors work.

The facilities to be supplied can be seen on the Schedules.

9.5 UNFOUNDATIONS AND SITE INVESTIGATION

9.5.1 SOIL INVESTIGATION

Taking into consideration that the new facilities are to be constructed at existing substation areas the decisions are to be made as follows:

The contractor is fully responsible for the foundation design and has to base it on sufficient subsurface information:

Taken from existing substation and using similar foundation design as long as soil conditions do not change inside the extension area. The contractor has to evaluate/confirm by executing trial pits or other investigations what kind of foundation was used for existing substations, prior to starting foundation design.

Such investigations are included in the unit rates. In case of any doubt by the Employer about soil quality, such checks can be requested without additional compensation.

If the Contractor finds that the execution of boreholes is necessary to sufficiently the soil conditions (or on request of the Employer) he has to do such investigations and base his design (or confirm it) on these results. Such work has to be approved by the Employer prior to start and is extra payed, see bill of quantity. The contractor is not allowed to start any foundation work before he has investigated the subsoil conditions to the satisfaction of the Employer and the foundation design is approved by the Employer.

The investigation procedures shall be governed by international standards and codes in the latest edition thereof, especially the following:

BS5930(1981) Code of Practice for site investigations

BS1377(1975)	Methods of test for soils for civil Employering purposes
Digest250(1981)	Concrete in sulphate-bearing soils and ground waters (Building Research Establishment digest)

9.5.2 FILL SITES

Fill where required will be placed by the Contractor. However all sites may not be flat. The Contractor shall be deemed to have included in the Contract Sum for providing a level or uniform sloping site to suit his substation layout design. The final soil levels shall be stated on the site survey result.

On every fill site the Contractor shall prove that his switchyard foundation will not suffer settlement greater than 20 mm by constructing a foundation and load testing this to twice the design bearing pressure for a minimum of 20 days.

Outdoor equipment shall be provided with spread footings. The Contractor will be provided by the Employer with a survey of soil levels prior to filling. The Contractor shall impose the site layout on the survey to check for uneven depth of fill below any foundation and where uneven depth of fill exists his foundation proposals shall restrict final differential settlement to a 1 in 400 slopes.

If a fill site has not been exposed to one wet season before foundation work starts, the Contractor shall flood the site to a depth of 50 mm for 10 days .(Not required on hydraulic fill site). This requirement is because silty sands will generally compact to a denser condition on first time flooding.

On all fill sites the Contractor shall pipe rainwater from pipes down to paddy level and shall prevent water ponding in open foundations and backfill all foundations as soon as possible.

The Contractor shall monitor settlement of the fill (by placing concrete posts 50x50x750 mm deep on a 10 meter grid and taking readings) at 30 day intervals from the time he is given access to each fill site.

9.5.3 NFILLED SITES

Original delta levels are generally 4 meters below road level. Therefore most sites are historically fill sites but fill settlement can sensibly be considered complete, where fill is over 3 years old.

9.5.4 SITE INVESTIGATION AND REPORT

If required the Contractor can carry out site investigation for related switchyard and site. In the case, site investigation and analysis of the data in a final report giving full details of foundation proposals shall be completed at each site by the programmed date.

The report shall be submitted by the key date at each site given in the program. The Contractor shall submit 2 copies of the report to the Employer. The report shall propose full details of foundations and loading thereon and shall provide estimates of likely settlements and differential settlements. The report shall be the work of the Contractor's own foundation Employers.

If the Contractor uses a local site investigation contractor, he shall appoint one of his own staff to oversee the entire operation and each piece of data shall be countersigned by this person.

Where estimated settlement exceeds 25 mm , The Contractor shall construct one foundation at an early stage an test load this foundation to confirm settlement predictions.

9.6 FOUNDATIONS

The minimum depth requirement of foundations are:

- Switchyard foundations : 1.1 m
- Boundary wall foundations : 1.1 m

All formations shall be hand rammed or mechanically compacted before placing 70 mm minimum thickness of Class B concrete blinding, within 24 hours of bottoming excavation, which blinding shall project 300 mm minimum distance beyond all footings. The Employer shall inspect each footing. Where soil condition is poor (on fill sites or already filled sites) or where the Contractor leaves foundations exposed and soil conditions deteriorate, one of the following measures shall be carried out as agreed with the Employer.

a) Blinding depth and projection shall be increased

b) Soft soil shall be removed and replaced with compacted viti sand with the top 200 mm consisting of viti sand and brick chips.

The cost of this work shall be borne by the Contractor.

The Contractor shall propose the allowable bearing pressure for all foundations. This do not shall nor exceed 125 kN/m^2. Between column footings all walls, including all internal wall shall be provided with a reinforced concrete strip footing of minimum dimension 800 mm wide by 250 mm deep placed at the same level as column footings and linked structurally to the footings. In addition column footings shall be tied at foundation level and also floor level by beams to every adjacent column in both orthogonal directions. These beam shall be designed to resist 1 in 200 differential settlement without distress and shall be capable of resisting the earthquake load of 0.1 G.

The deepest parts of any foundations shall be completed first. All foundations shall be completed and backfilled , including all cable tunnel and cable trench work inside buildings, before walls are raised above floor levels. All other foundations shall be backfilled within 7 days of completing concerning.

All exposed concrete and outer surfaces of cable trenches and cable tunnels shall receive two coats of bitumastic paint before backfilling to reduce ingress of water. The Concrete surface shall be ground smooth and all air holes etc. filled (rubbed down with a cement slurry) before painting.

The Contractor shall monitor settlement of all foundations each month and report this settlement to the Employer until settlement has reduced to less than 1.5 mm in 3 months .

The tops of all foundations shall terminate 1000mm above site average finished surface level. All exposed edges shall have 20 mm x 20 mm chamfers.

Excavation shall only be carried out when the ground water table at least 1000mm below foundation level. The excavation shall be kept dry during the construction period by providing sumps and pumps as required. During the rain season, shelters shall be erected over all open excavations.

Any over excavation shall be filled with Class B concrete.

All back fill shall be completed to 95% maximum dry density as defined by BS 1377 test method. 2.5 Kg rammer.

Before starting foundation work the Contractor shall clear all sites of trees, tree roots shrubs, debrie, surplus soil, and any buildings.

Foundations shall be designed to resist uplift , assuming the water table is at ground level and the weight of soil resting on a foundation is that included within a 15^0 frustum.

On fill sites where the depth of fill exceeds 3 meters , the Contractor shall provide piled foundations in accordance with BS 8004 for control buildings. If timber piles are used, adequate strip footings shall be provided to support the structure after the timber pile has deteriorated , by which time the fill will be fully consolidated. One working pile chosen by the Employer shall be load tested at each site to 150% of design load in accordance with BS 8004.

9.7 DISPOSAL OF EXCAVATED MATERIALS

Spoils produced by excavation shall be piled, graded, sloped or disposed of at the locations specified by the Board or Employer and it shall be subject to inspection by the Employer.

In transporting the spoils, care shall be taken so as to neither hamper traffic nor cause trouble to the third party by scattering the spoil over the road.

9.8 GRAVEL LAYER

Gravel and rubble produced locally shall be used. Gravel layer shall, in principle, be laid in a single layer with no large gaps, stand on end and interstices shall be filled with granular gravel.

The compaction shall be executed by a compaction machine (rammers, etc.)

Gravel layer shall be well compacted together with covering gravel and shall be graded and finished to the designated level.

9.9 ROADS

Road extensions and access road to capacitor bank inside substation shall be ensured for maintenance and operation convenience. Constructions should be comply with internationally recognized codes and standars, also be compatible with existing road.

The road works shall comply with the local laws, rules and regulations applicable and be governed by internationally recognized codes and standards.

The layout of the roads (width, thickness/construction, surface layout etc.) shall be governed by the purpose of the road, the subsoil conditions and the existing roads. These road connections are not extra paid and therefore expenses are to be included in the unit rates.

9.10 CONCRETE WORKS

9.10.1 GENERAL

The following works are discovered by this section:

Furnishing and storage of materials
Equipment and labour for processing of aggregate, mixing, testing, conveying, pouring, vibrating, compacting, finishing and curing of concrete.

9.10.2 Materials for concrete

Quality of Materials

All materials used for concrete and reinforced concrete structures shall be of the best quality, free from defects likely to undermine the strength.

Storage and Handling of Materials

All materials shall be stored and handled in a manner that will prevent contamination and/or deterioration.

Cement

The cement used for concrete, reinforced concrete, mortar, grout and plaster works may conform to ASTM C 150 (Sulphate-resisting cement type 5), B. S. 4027 – Sulphate-resisting Portland cement or with DIN 1164 and ordinary Portland cement confirming to BS 12 or DIN 1164. (Cements with high sulphate resistance comprise Portland cements with a C3A (Tricalciumaluminat) content of not more than 5% by weight, also Portland blast furnace slag cement with not less than 70% by weight slag sand and not more than 30% weight Portland clinker).

Water

Water for preparing concrete and mortar shall be clean, fresh and free from organic and/or inorganic matter in solution or suspension in such amounts that may impair the strength or durability of the concrete. Water may be obtained from a temporary seawater desalination plant of the contractor and combined with other local sources, if any, after comprehensive testing and analysis of samples and the written approval of the Employer, see also clause “Water supply” from Section “Site development and general services”. No seawater or water from excavations shall be used.

The requirements of B. S. 3148, DIN 1164 – 1045 and 1048 or equivalent shall be applied. Water shall be stored in clean containers.

Aggregates

Materials used as aggregate shall be obtained from a source known to produce aggregate satisfactory for concrete and shall be chemically inert, strong, hard, durable, of limited porosity and free from adhering coats, clay lumps, organic impurities that may impair the strength or durability of the concrete. Aggregate may comply with and be tested in accordance with the requirements of B. S. 882, 1201 (Aggregates from natural sources for concrete), or DIN 4226, Part 1, 2 and 3 (Aggregates for concrete) or other equivalent standards and the results of such tests shall be satisfactory as per these standards.

Concrete Additives

Concrete additives approved by the Employer shall be used to improve consistency, workability, quality and strength of the concrete. Unless otherwise agreed an additive may comply with B. S. 1014; B. S. 3587; B. S. 3892 or other equivalent standard.

9.10.3 CONCRETE MIXES

The mix proportions are to be determined by proper mix design based on the requirements for strength, workability and the particular site in which the concrete is to be placed. The mix design shall be carried out by the Contractor's Concrete Employer. The design of mixes may be based on the principles of e.g B. S. C. P. 110, Part 1, DIN 1045 or equivalent other standard.

Concrete aggregates and cement shall be proportioned and batched by weight. Water and liquid additives shall be proportioned. If the Contractor wishes to use cement in bulk, his method of obtaining the correct proportions of cement shall be approved by the Employer before use. For small quantities of concrete the Employer may give permission for the use of gauge boxes for the volume batching of aggregate.

9.10.4 CONCRETING OPERATIONS

Inspection Prior to Concreting

All concreting methods shall be subject to the approval of the Employer.

Concrete placing shall not be started until the Employer or his representative has approved all preparation of forms, reinforcement, joints and all mixing, conveying, spreading, curing, finishing and protection equipment.

Placing of Concrete

Concrete shall be placed in the forms as close as possible to its final position in a single operation to the full thickness of slabs and beams and shall be placed in horizontal layers, not exceeding 30 cm deep in walls, columns and similar members.

The Contractor shall organize the pouring of concrete in such a manner that once concreting of a section has started the operation shall be continuous and each operation shall be completed prior to a stoppage. Where specified on the drawings, construction, expansion or contraction joints shall be provided and the concrete shall be poured continuously between two adjacent joints. No other joints than shown on the

drawings shall be permitted. Stoppage (cold) joints formed between two concreting operations separated by more than 6 hours time shall be subject to the same treatment as the construction joints.

Concrete which has partially hardened shall not be exposed to injurious vibration or shock, except for controlled re-vibration where specified. When concreting of a certain large structural element is specified strictly as to be poured continuously, then the concreting operations shall be organized for day and night working, in long shifts, as necessary.

Compaction and Mechanical vibration of concrete

As concrete is being placed it shall be compacted by mechanical vibrators, to obtain a dense material free from honeycombing, free from water and air holes. For compacting the concrete, internal vibrators shall be used operating within a range of 5,000 to 10,000 cycles per minute.

The Contractor shall ensure that the vibrators are used in such a manner that the reinforcement is not displaced, the formwork not damaged and no segregation caused, but complete compaction of the concrete is achieved.

9.10.5 FINISHING OF CONCRETE SURFACES

The concrete face shall have the finish indicated on the drawings or in the specifications.

All surfaces which may will come in contact with oil or oily water will have to be adequately protected (paint, etc.)

The finished surface of all concrete work shall be sound and free from defects. No plastering, cement wash or mortar shall be applied to cover defective concrete faces.

Unless instructed to the contrary, the face of the fairfaced concrete placed against shuttering shall be rubbed down with a carborundum stone immediately upon removal of the shuttering to remove fins or other irregularities. The face of the concrete for which shuttering is not provided, other than slabs, shall be smoothed with a wooden flat to give a finish equal to that of the rubbed down face where shuttering is provided. The cavities left by formwork fixing devices are to be made good closing the hole with plastic plugs and epoxy mortar.

The top or final surface of all concrete works shall be finished by screeding, or floating, or trowelling or grinding, or tooling as approved by the Employer.

9.10.6 FENCES

General

Every capacitor bank yard shall be protected with appropriate fence. Also expanded boundary wall shall be constructed in alliance with existing ones.

Fencing shall be carried out to the lines indicated on the drawings or as otherwise directed by the Employer.

Where not specifically required in the earthworks section the Contractor shall clear a strip of 1 m width before erection of the fence commences. Material arising from the excavation of fence posts and anti-burrowing kerb shall be spread along this cleared strip.

Chain Line mesh Wire Fencing

The fencing shall be of panels with black plastic coated galvanised welded mesh with 50 x 50 mm horizontal mesh size and wire gauge 5 mm vertical and 7 mm horizontal. Top rail and horizontal rails as required shall be plastic coated galvanised steel. Corrosion free fixings shall be provided suitable for panels such that the final fence is rigid and well supported.

Posts and struts shall be of galvanised black plastic coated mild steel hollow section construction. The straining and intermediate posts shal be cranked to receive three strands of barbed wire. Straining posts shall be provided at all ends and corners of fences and in straight lengths of fence at intervals not exceeding 60 m.

The Contractor shall design the fencing for wind loading in accordance with C.P.3 Chapter 5: Part 2 using a maximum 3 second gust speed 'V' of 44 m/s and shall submit all details for the Employer's approval.

Especially for capacitor bank yard fences, it shall be installed 1meter outside of the bank equipment. Each fence shall be made 2 meter width x1.8 meter height. Doors also should be installed in line with fence.

The Contractor shall also submit samples of the fencing to the Security Department of the Owner for approval.

POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT
FOR

Design, Supply, Installation, Testing and Commissioning of Capacitor bank with associated switchgear for Mymensingh region on turnkey basis.

SECTION 10

QUALITY ASSURANCE, INSPECTION, TESTING, COMMISSIONING AND WARRANTY

SECTION 10

QUALITY ASSURANCE, INSPECTION, TESTING, COMMISSIONING AND WARRANTY

10.1 SCOPE OF SECTION

The whole of the plant covered by this Contract will be subject to inspection and witnessing the tests by the Employer during manufacture, erection and on completion. The inspection and witnessing the tests at manufacturer's works may be done by the Employer or an Independent Inspection agency. The approval of the Employer/Employer or the passing of any such inspection or test will not, however, prejudice the right of the Employer to reject the plant if it does not comply with the specification when erected or when in service.

Included in the Contract Price for this lot is the cost of witnessing of factory acceptance tests by Employer's Employer (two Employers in each visit)

Within 40 days of the Letter of Acceptance for the Contract the Contractor shall submit a quality assurance programme and a work quality programme for the Employer's approval. It shall be submitted on the Employer's standard form, a sample of which is included at the end of this Section.

The Contractor shall have an approved Quality Management System complying with ISO 9001, which shall cover all activities being undertaken during the design, procurement, manufacturing, inspection, testing.

Contractor shall submit ISO 9001 or equivalent for all main equipment in the bid stage. The Employer's review may consider quality assurance in relation to the design and manufacture of plant items, but may equally investigate the Contractor's quality assurance procedures for the overall control of the wide range of design activities necessary for a complex project of this type, and the dissemination of paperwork, design drawings and data amongst the various design and manufacturing organizations within the Contract. The Contractor shall give all necessary help and assistance to the Employer in carrying out such a quality assurance review. The Contractor shall consider and discuss the results of the review and make any reasonable improvements in his procedures.

30 days before notice shall be given when the plant is ready for inspection or tests and every facility shall be provided by the Contractor and his Sub-Contractors to enable the Employer and Employer to carry out the necessary inspection and witnessing of tests.

In the cases where tests or inspection are specified as being carried out on only a sample of the total quantity of items in the Works, and where one or more items of the sample fail the test or inspection, a further batch of the items, at least equal in quantity to the proportion originally specified, shall be tested or inspected. This process shall continue until a sample proves completely acceptable.

10.2 SUB-CONTRACTS

Within two months of acceptance of the Bid and in order to facilitate the inspection of bought-out materials and plant, the Contractor shall submit to the Employer for approval three copies of all sub-orders placed by him as soon as they are issued. One copy of any drawing or schedule referred to

in the sub-order shall be submitted simultaneously unless agreed otherwise with the Employer. Any reference to price may be deleted from the copies so submitted.

The sub-orders and drawings submitted to the Employer shall cover all components which are subject to electrical and mechanical pressure or stress when the plant is in operation and also auxiliaries and spares which are to be despatched to Site direct from the Sub-Contractor's factory.

Sub-orders are to include a statement advising the Sub-Contractor that the items being ordered will be subject to inspection and test by the Employer and Employer.

The Contractor shall advise his Sub-Contractors of all the pertinent clauses in the Specification when ordering bought out plant, equipment or materials.

Every sub-order or sub-contract shall contain the following information:

(a) Main Contractor's name and sub-order or sub-contract number.

(b) Quantities and description of work.

(c) Delivery requirements.

(d) Delivery consignment instructions.

(e) Details of Employer and/or main Contractor's applicable drawing or schedule numbers.

(f) Name of the Employer.

(g) A note advising that the plant or equipment which is the subject of the order shall comply in every respect with the Employer's, Specification and shall be subject to inspection by the Employer, Employer and the Contractor.

(h) A reference, particularized in the accompanying Specification, covering the following information:

- Employer's name
- Project title
- Contract No.
- Employer's reference number
- Sub-Contractors shall comply with all the applicable requirements of this Specification and the onus is upon the Contractor to ensure that Sub-Contractors comply with these requirements.

For the purposes of this clause, inter works orders shall be treated as sub-orders.

10.3 GUARANTEES

The Contractor shall state and guarantee the technical particulars listed in the Technical Schedules and other sections as specified by the Contract for testing procedures. These guarantees and particulars shall be binding and shall not be departed from without the written permission of the Employer. The Contractor shall further guarantee that all equipment supplied complies with the Contract Documents.

The tolerances permitted in the IEC shall apply unless otherwise stated.

10.4 QUALITY AUDIT

The Quality Programme established by the Contractor shall be followed for all inspection and testing procedures.

The Employer and Employer may, from time to time, visit the manufacturer to carry out a quality audit of the manufacturer's organization.

10.5 MEASURING AND TESTING EQUIPMENT

At prescribed intervals, or prior to each use, all measuring and testing equipment used in inspection shall be calibrated and adjusted against certified equipment having a known valid relationship to internationally recognized standards.

The manufacturer shall prepare a calibration schedule showing equipment type, identification number, location, frequency of checks, method of checking and action to take when results are unsatisfactory.

10.6 INSPECTION PLAN AND PROCEDURE

The Inspection Plan, as submitted by the Contractor to the Employer for approval, shall cover the following:

(a) Relevant - International Standard. For each of the following stages of the work and following stages of the work, the acceptance criteria shall be stated.

(b) The stages of inspection which shall include but not be limited to the following:

i) Tests to review or approve certification of material;
ii) Review and approval of manufacturing procedures;
iii) Witnessing tests or review and approval of certification of operator's qualification to carry out the work required;
iv) Visual and dimensional examination of components;
v) Non-destructive examination of materials in progress;
vi) Functional tests on sub-assemblies, performance tests, on complete units;
vii) Examination of painting, packing and documentation for shipment.

The Employer will indicate the inspection requirements on the agreed inspection programme in accordance with the following.

Hold point - Requires a mandatory inspection by the Employer. This inspection or test shall be witnessed by the Employer and Employer and further progress in manufacture shall not be made until the plant is approved by the Employer.

Witness point - Inspection or test of material may be carried out by the Employer and Employer at their discretion.

Document review - Certification of material and functional test shall be approved by the Employer before despatch from the works.

10.7 TEST CERTIFICATES

Triplicate sets of all test records, test certificates and performance curves, whether or not they have been witnessed by the Employer and Employer, shall be supplied to the Employer for all tests carried out in accordance with the provisions of this Contract.

Sets of all test certificates shall be endorsed with sufficient information to identify the material or equipment to which the certificates refer, and shall carry in the top right hand comer the following reference:

Employer's name

Project title

Contract No.

Employer's reference number

All test documentation shall be in the English language.

10.8 MATERIAL TESTS

The Contractor shall provide test pieces as required by the Employer to enable him to confirm the quality of the material supplied under the Contract. Such test pieces shall be prepared and supplied free of charge and any cost of the tests shall be borne by the Contractor.
If any test piece fails to comply with the requirements of the appropriate specifications for the material in question, the Employer may reject the whole of the material represented by that test piece; the Contractor's or Sub-Contractor's designers and metallurgists will be consulted before any material is so rejected.

If the Employer is furnished with certified particulars of tests which have been carried out for the Contractor by the suppliers of material, he may, at his own discretion, dispense with the previously mentioned tests.

10.9 GENERAL REQUIREMENTS FOR TESTS AT MANUFACTURERS' WORKS

10.9.1 Testing of Plant

Tests at manufacturers' works shall include mechanical, electrical and hydraulic tests to ensure that the plant being supplied complies with the requirements of the Specification.

Works tests shall include all routine electrical, mechanical and hydraulic tests in accordance with the relevant IEC, except where departures there from and modifications there to are embodied in this Specification.

Should the plant or any portion thereof fail under test to give the required performance, further tests which are considered necessary by the Employer shall be carried out by the Contractor and the whole cost of the repeated tests borne by the Contractor. This also applies to tests carried out at the Sub-Contractors' works.

The Employer or its representative or independent inspection agency may witness the tests. Sufficient notice (minimum of 30 working days) shall be given to enable the necessary arrangements to be made.

If the plant, or any portion thereof, fails under test to give the required performance, such further tests which are considered necessary by the Employer shall be carried out by the Contractor and the whole cost of the repeated tests shall be borne by the Contractor. This also applies to tests carried out at Sub-Contractors' works.

Tests shall be conducted in accordance with the specified standards. When no standards are specified, the test procedure shall be agreed between the Employer and the Contractor.

Specific details of tests to be carried out at the manufacturers' works are defined elsewhere in this Specification.

10.9.2 Rejection of Plant

If any item fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at Site, the Employer may reject the item, or defective component thereof, whichever he considers necessary, and after adjustment or modification as directed by the Employer, the Contractor shall submit the item for further inspection and/or test.

In the event of a defect on any item being of such a nature that the requirements of this Specification cannot be fulfilled by adjustment or modification, such item is to be replaced by the Contractor, at his own expense, to the entire satisfaction of the Employer.

10.10 SPECIFIC REQUIREMENTS FOR TESTS AT MANUFACTURERS' FACTORIES

10.10.1 Relays

All relays and associated equipment shall be routine tested to prove the quality and accuracy. Routine tests shall be in accordance with IEC 60255, supplemented by additional tests as are considered necessary by the Employer. Routine test reports shall be submitted for each relay and piece of equipment. The reports shall record all measurements taken during the tests.

All relays shall be subjected to the appropriate routine tests as listed below, the individual tests being as detailed in IEC 60255 or as otherwise agreed with the Employer.

(a) Accuracy of calibrated pick-up and drop-off levels over the effective range of settings

(b) Insulation tests

(c) Accuracy of timing elements

(d) Correct operation of flag (or other) indicators

(e) Mechanical requirements, integrity/safety of draw-out units, check of contact pressure and alignment.

10.10.2 Instrument Transformers

All instrument transformers shall be routine tested as per IEC 60041-1 and 60044-2

10.10.3 Electrical Instruments and Meters

One instrument and meter of each type and rating shall be subjected to the tests as specified in IEC 60051

10.10.4 AC Switchboards

Routine tests shall include general inspection and electrical operation tests.

10.10.5 Contactors

One contactor of each type and rating shall be subjected to type tests as specified in IEC 292- 1.

10.10.6 Circuit Breaker

The remaining circuit breakers of each type shall be either fully assembled at the manufacturer's works and subjected to operation tests and power frequency tests or, where not assembled at works, separate power frequency voltage tests shall be performed on all major insulation components.

Routine tests in accordance with IEC 62271-100 shall be carried out on all circuit breakers. These shall include operation tests, milli-volt drop tests and power frequency voltage tests.

10.10.7 Disconnectors

Routine tests as per IEC 60072-102

10.10.8 Structures of Electrical Equipment

Sample tests on the assembly and galvanising of the structures shall be carried out. A mechanical type test with the structure loaded with working load multiplied by the appropriate factor of safety shall be carried out.

10.10.9 Surge Arresters

The following routine tests shall be carried out on all arrester units in accordance with IEC 60094-4.

(a) Measurement of reference voltage

(b) Residual voltage test for lightning impulse current in the range between 0.01 and 2 times the nominal discharge current

(c) Partial discharge test on complete arrester

(d) Housing seal test

(e) Current distribution test for multi-column arresters

(f) Verification of surge counter operation

10.10.10 Batteries and Battery Chargers

Battery	-	The Contractor shall demonstrate that the battery will perform the duties specified.
Battery Charger	-	Routine tests according to IEC 60335
DC Switchboard	-	Routine tests according to IEC 60439

Complete charge and discharge tests on each of the combined batteries and chargers shall be conducted and results recorded so as to permit verification of the ampere-hour capacity of the battery. During these tests the Employer shall select at random reference cells and the voltage curves thereof shall be checked when the battery is discharged over three and ten hour periods. The alarm levels and the automatic voltage control feature of the charger shall be demonstrated over the specified load range. Where load changeover facilities are included, integrity of the changeover system without break or voltage variations during loading of the standby or test charger shall be demonstrated.

10.10.11 Control Panels

Routine operation tests and insulation resistance tests shall be carried out as per IEC 60255

10.10.12 Capacitors

Refers to the IEC 60871of Capacitors, routine test categories are:

(a) Capacitance measurement
(b) Tangent of dielectric loss angle
(c) Voltage test between terminals
(d) Voltage test between terminals and container
(e) Test of internal discharge devices
(f) Sealing test
(g) Discharge test on internet fuses.

10.10.13 Series Reactor

Refers to the IEC 60289 and 60076-6 of reactor, routine test categories are:

(a) Measurement of winding resistance
(b) Measurement of inductance
(c) Separate source voltage withstand test
(d) Induced over voltage test

10.10.14 Power Cable

Routine shall be carried out as per IEC 60502.

10.11 DISMANTLING PRIOR TO SHIPMENT

After the satisfactory completion of all tests at the factory, the plant shall be submitted for the Employer's approval during dismantling preparatory to shipping. No item of plant shall be despatched to site until the Employer has given approval in writing.

10.12 INSPECTION AND TESTING DURING SITE ERECTION

10.12.1 General

The Contractor shall be responsible for the submission to the Employer of all plant supplied under the Contract for inspection and testing during site erection, to ensure correct erection and compliance with the Specification.

During the course of erection, the Contractor shall provide access as required by the Employer for inspecting the progress of the works and checking its accuracy to any extent that may be required.

The Contractor shall provide, at his own cost, all labour, materials, stores, and apparatus as may be requisite and as may be reasonably demanded to carry out all tests during erection, whether or not the tests are specifically referred to in this specification.

Tests on completion of erection shall be carried out by the Contractor in accordance with the General Conditions of Contract. The Contractor shall provide all necessary test equipment to carry out the site tests, but where required in the Schedule of Prices, shall include the cost of the equipment so that the Employer may have the option to buy the equipment on completion of the Contract.

The Contractor shall submit a written programme of tests and checks according to this Clause for the approval of the Employer.

A brief description of all tests and testing procedures shall be provided before tests commence and the method of testing, unless otherwise specified, shall be agreed with the Employer.

The Contractor shall provide experienced test personnel and testing shall be carried out during normal working hours as far as is practicable. Tests which involve existing apparatus and outages may be carried out outside normal working hours. The Contractor shall give sufficient notice to allow for the necessary outage arrangements to be made in conformity with the testing programme.

The Contractor shall advise the Employer in writing, at the time of commencement of site erection, of the site supplies which will be required for the operation of the test equipment, to enable the Employer to arrange accordingly or to agree alternative arrangements should this be necessary.

The Contractor shall record the results of the tests clearly, on an approved form and with clear reference to the equipment and items to which they refer, so that the record can be used as the basis for maintenance tests during the working life of the equipment. The required number of site test result records shall be provided by the Contractor to the Employer as soon as possible after completion of the tests.

No tests as agreed under the programme of tests shall be waived except upon the instruction or agreement of the Employer in writing.

The Contractor's test equipment shall be of satisfactory quality and condition and, where necessary, shall be appropriately calibrated by an approved authority at the Contractor's expense. Details of the test equipment and instruments used shall be noted in the test sheets in cases where the instrument or equipment characteristics can have a bearing on the test results.

The testing requirements detailed under this Specification may be subject to some variation upon the instruction or agreement of the Employer where necessitated by changed conditions at Site or by differing design, manufacture, or construction techniques.

The Bider is required to submit proposals for site dielectric tests and to include in his price the costs of such tests and of such equipment as deemed necessary.

10.12.2 Mechanical Equipment

The extent of testing during erection shall include, but not be limited to, the following:

(a) Checking the accuracy and alignment of plant erected. The accuracy shall comply with the relevant standards, the specification or the plant manufacturer's requirements as may be applicable or, where no requirements exist, to a standard to be agreed between the Employer and the Contractor.

(b) Calibration checks on all instrumentation

(c) Tests to demonstrate the correct functioning of the control loops, protective devices, interlocks and alarms.

(d) Other tests as specified which have not been previously conducted.

10.12.3 Electrical Equipment

10.12.3.1 General

A general check of all the main switchgear and ancillary equipment shall be made and shall include a check of the completeness, correctness and condition of earth connections, labelling, arcing ring and, clearances, , cables, wiring, and all other auxiliary and ancillary items. Checks shall be made for oil and gas leaks and that insulators are clean and free from external damage. A check shall be made that loose items which are to be handed over to the Employer e.g., tools, spares, are in order and are correctly stored or handed over.

The following general tests are to be carried out on electrical equipment after erection at site:

(a) Routine high voltage tests to the appropriate IEC Standard.

Where no relevant standard exists, tests shall be agreed with the Employer.

(b) Insulation resistance tests on all electrical equipment.

(c) Continuity and conductivity resistance tests.

(d) Test operation of alarm and tripping, devices to local and remote.

(e) Polarity tests on CTs and VTs.

(f) Grounding system and electrode tests.

(g) Magnetization current / voltage tests and winding resistance tests on all current transformer

(h) Primary and secondary injection tests on relays, protective devices and equipment.

10.12.3.2 Circuit-Breakers

Circuit-breakers shall be given a visual inspection.

In the case of gas type circuit-breakers testing will be required on the gas system to prove the gas pressure, quantity, dryness and dielectric strength.

Contact resistance tests shall be carried out. In the case of multi-interrupter circuit-breakers resistance tests will be required at each interrupter or pair of interrupters as well as through the series of interrupters on each pole.

Operational tests shall include local and remote trip/close.
Local air components associated with pneumatic operation, including air compressors, shall be tested and air loss measurements and pressure and alarm settings checked. Tests shall be made also on mechanical and hydraulic operating systems.

10.12.3.3 Disconnectors

Manual operation of disconnectors and earth switches shall be subject to operational tests to confirm contact pressures, contact resistances, simultaneous operation of all phases and the ease of operation.

Motorised operation of disconnectors and earth switches shall be tested to prove the motor operation, including local and remote operation, and timing tests shall also be carried out. Motor protection shall be tested.
Checks shall be made on interlocks, local and remote indications and operation of auxiliary contacts.

Earth switches shall be tested to confirm the opening and closing sequences and checks shall be made on interlocks, indications and manual locking devices.

10.12.3.4 Busbars and Connections

Flexible busbars and connections shall be tested to ensure that the correct tensions, sags and clearances will be maintained over the range of environmental conditions and loads without stress to other equipment. If dynamometers are used to check the sags and tensions, they shall be checked both before and after use.

Rigid busbars and connections shall be tested to ensure that the busbars will not cause overloading of the supporting insulators under load conditions and under the range of climatic variations applicable to

the site and that expansion and contraction of the equipment is fully accommodated by flexible connections.

Conductivity tests shall be carried out on all connections and joints which are made on site, without exception.

10.12.3.5 Earthing System

Tests shall be made on the effectiveness of the bonding and earthing which will include conductivity tests on selected joints, on the main earthing system, and at the connections to equipment and structures. Checks shall also be made on precautions taken to avoid corrosion attack on the earthing system.

Test probes at approximately 300 and 600 metres separation will normally be required to effectively test the earthing system. The use of transmission line conductors may be arranged to simplify these testing procedures.

The earth resistance shall be measured during the installation and on completion as follows:

(a) of each earth rod after driving

(b) of the earth grid after completion and backfilling of the trenches

(c) of each group of earth rods or earth point after completion of the connection from the test link terminal

(d) of the completed installation without any connections outside the substation

The tests shall be carried out by a method and with equipment approved by the Employer. All tests are to be witnessed and the equipment and method used recorded with the test results.

The Contractor may also be called upon to provide assistance in the measurement of earth resistance after earth connections to the system have been completed.

10.12.3.6 Control Relays and Metering Panels, Instruments and Protective Devices

(a) Wiring

After complete erection and cabling, all circuits shall be subjected to the high voltage test specified in the relevant IEC or approved standard.

The insulation resistance of all circuits shall be measured before and after any high voltage tests.

For AC secondary injection tests a substantially sinusoidal test supply shall be used.

The operating and resetting level (current and/or voltage) and timing of all relays shall be measured over an agreed range of settings for all relays.

For directional relays phase-shifting transformers shall be used to determine the maximum torque angle and the boundaries of operation/restraint.

Other relays shall be fully tested in accordance with the manufacturer's recommendations.

All DC elements of protection relays shall be tested for operation at 70% rated voltage.

All d.c. supplies shall be checked for severity of current inrush when energised by switching on or inserting fuses or links.

(b) Mechanical Inspection

All panel equipment is to be examined to ensure that it is in proper working condition and correctly adjusted, correctly labelled and that cases, covers, glass and gaskets are in good order and properly fitting.

(c) General

Sufficient tests shall be performed on the relays and protection schemes to:

i) establish that the equipment has not suffered damage during transit.

ii) establish that the correct equipment has been supplied and installed.

iii) confirm that the various items of equipment have been correctly interconnected.

iv) confirm performance of schemes designed on the bases of calculation e.g. differential protection.

v) to provide a set of figures for comparison with future maintenance values allowing the condition of the equipment to be determined.

(f) DC Operations

Tests are to be carried out to prove the correctness of all DC polarities, the operating levels of DC relays and the correct functioning of DC relay schemes, selection and control switching, indications and alarms. The correct functioning of all isolation links and fuses shall also be checked.

(g) Tests on Load

Tests on load shall also be done to demonstrate stability and operation of protection relays as required by the Employer.

All tripping, control, alarm and interlocking circuits shall be functionally tested to prove satisfactory and foolproof operation and/or resetting. The functional and safety aspects of all shorting and/or isolation links, fuses and switches devices shall be proved.

The total burdens connected to all voltage transformer circuits shall be measured and recorded.

The total capacitance of all wiring and apparatus connected to the negative pole of each main tripping battery shall be measured and recorded; the value shall not exceed 10 microfarad.

The continuous current drain of all trip circuit supervision relays shall be measured and shall not be greater than half the minimum current required for tripping. The supervision current shall be measured with the circuit-breaker (or other device) both open and closed.

10.12.3.7 Batteries and Chargers

Tests shall be carried out on the batteries and chargers to confirm the charger ratings and adjustment, the battery and charger alarm systems and battery capacity.

The open-circuit cell voltages of the batteries when fully charged shall be recorded.

The insulation to earth of the complete DC installation shall be tested.

10.12.3.8 Power Cables

Each completed circuit shall be tested for continuity and insulation resistance.

10.12.3.9 Current Transformers

A magnetisation curve shall be obtained for each current transformer in order to:-

(a) Detect damage in transit or installation

(b) Prove that the correct cores have been wired out to the relevant terminals

(c) For high impedance relay schemes, to confirm that correct relay settings have been calculated.

The DC resistance of each current transformer secondary winding shall be measured and also the transformers and connecting leads, each item being recorded separately.

The insulation resistance of all secondary circuits shall be measured at 1000 volt and recorded.

Primary current injection tests shall be conducted on all current transformers using adequate primary current to prove correct ratio, polarity and, for differential protection schemes, to prove the correct relative polarities of all current transformers of each scheme.

10.12.3.10 Voltage Transformers

The transformer ratio and polarity shall be checked using a primary voltage high enough to give a clearly measurable secondary voltage or by using rated primary voltage and comparison with an already proven voltage transformer.

10. 12.3.11 Control and Instrumentation Equipment

The following general tests shall be performed on control and instrumentation equipment at site:

(a) High voltage testing of all circuits, as specified in the relevant IEC or approved standard.

(b) Insulation resistance testing of all circuits.

(c) Functional tests of all tripping, control, alarm and interlocking circuits.

(d) The testing of all equipment in accordance with the manufacturer's instructions or as advised by the Employer.

10.13 STAFFING

During pre-commissioning the Contractor shall provide all necessary supervisory and operating staff. The only involvement of the Employer's staff will be in accordance with the training and instruction as in this specification.

During the commissioning phase, the Employer's operating staff will operate plant and equipment under the supervision of the Contractor's supervisors.

The Contractor shall have satisfied himself as to the capability of the Employer's operators to carry out such operations as he may direct and shall remain responsible for the successful performance of such operations. Throughout the whole of the Commissioning Period the Contractor shall provide suitably qualified and experienced operating staff, who shall instruct the Employer's staff in the correct operating procedures.

The Contractor shall provide a team of suitably qualified and experienced Employers and technicians to pre-commission and commission the overall plant. The Contractor shall also ensure that a suitably qualified commissioning Employer from the respective manufacturer's own service organisation shall visit the site to check the erection or installation of each significant plant item, and to supervise the commissioning of the plant item until the basic functioning of the item has been demonstrated to the Employer's satisfaction.

At all times the Contractor shall ensure that his staff and any Sub-Contractor's or seconded staff, observe all prescribed safety rules and permit systems.

10.14 ENGAGEMENT OF THIRD PARTY INSPECTION COMPANY/AGENCY:

10.14.1 General

It is to be agreed by the Contractor that they, with the concurrence of the Employer (mentioned in the Contract), shall be responsible for the engagement of an internationally accredited, independent & reputed inspection company/ Agency (Category A) as Third Party Inspector to conduct/witness the

Factory Acceptance Test of the Equipment/ Materials/ Goods (selected for Factory Acceptance Test in Schedule A or elsewhere in the Contract) along with the Employer's witnessing team at the manufacture's Premises. The Contractor shall furnish/provide all reasonable aid and assistance required by the Employer's witnessing team / Engineer or Third Party Inspection Company for the proper Factory Acceptance Tests and examinations of the Items and all parts thereof as per the relevant International standard followed by the Contract Document. All the cost related to the Third Party Inspection Company for carry out the aforementioned inspection(s) shall be borne by the Contractor and the cost to be incurred shall have to be included in the Contract Price.

The Contractor shall propose 4 companies from following 2 Groups (At least 3 (three) Companies from Group A and 1(one) Company from Group B) to BPDB PGCB after signing of the EPC Contract:

Group A:

3 (three) Companies to be proposed from the following List:
1. BUREAU VERITAS, 2. SGS, 3. Black and Veatch, 4. TUV SUD, 5. Lloyd Inspection Agency, 6. Mot Macdonald, 7. Intertek group

The Employer reserve the right to revise the above list.

Group B:
Fulfilling the following Criteria, 1 (one) Company will be proposed:

The Inspection Company/ Agency must be independent reputed company (Category A) with global presence and must have minimum 15 years of experience as Third Party Inspection Company/ Agency and related activities in the major Engineering Industries. In addition, Inspection Company/ Agency must be a member of the International Federation of Inspection Agency (IFIA), must have valid accreditation certificate for ISO 9001 and ISO/IEC 17020 and experience in successful completion of the similar activities of High Voltage Plant Project. The company shall have a good financial track record.

In this regards, the Contractor shall has to submit related experience documents, Audited Financial statement, valid accreditation certificates, valid membership certificates of International Federation of Inspection Agency (IFIA) & company profile of the proposed Inspection Companies/ Agencies along with their proposal to the Employer after singing of the Contract for High Voltage project. The Employer reserves the right to approve the Third Party Inspection Company/ Agency for the mentioned task. Without prior approval of the Employer, the Contractor shall not be allowed to engage any Third Party Inspection Company/ Agency for these purposes.

10.14.2 Scope of the Services

The scope of the proposed Inspection Agency service shall include but not be limited to the followings:

1. Unless otherwise specified, as per the Contract Document, relevant IEC/ IEEE/ ASME/ ASTM/ API/ other International recognized Standard and OEM guideline, 3rd (Third) Party Inspection Company will be responsible to prepare a testing protocol for the above mentioned Equipment/ Material/ Goods and shall submit it to the Employer for subsequent approval.
2. Conduct/ witness Factory Acceptance Test of the Equipment/ Materials/ Goods (selected for Factory Acceptance Test in Schedule A or elsewhere in the Contract) along with the Employer's witnessing team as per approved test protocol. The company shall have to

depute at least two (2) Inspectors (at least B.Sc engineering or Equi. Degree) for each inspection. Inspectors shall be well experienced (min. 5 years in the relevant field) on respective Equipment/ Materials/ Goods and qualified according to relevant services.

3. Review the different reports (Type, sample, routine, FAT & others tests) and submit the comprehensive report with recommendation for the shipment of the Equipment/ Material/ Goods based on satisfactory test result within seven (7) days after the completion of the respective inspection.
4. Transfer of Technology and Technical know-how regarding Equipment, parameters and testing procedure including familiarization/ testing of equipment to Employer's witness team during witness Factory Acceptance Test.
5. Inspection Company shall conduct/ witness Factory Acceptance Test in case of non-availability of the Employer's witness team on time due to unforeseen reasons and shall submit a comprehensive report with recommendation accompanied with photograph and video clips of the item inspected within seven (7) days after completion of respective inspection/ Test.
6. The inspections/ Tests shall be performed on as-needed basis as per schedule provided by the respective manufacturers.
7. The third party inspection agency must not be involved in design, procurement, fabrication, construction and installation of the Contract.

Notes:

1. The Contractor shall furnish all reasonable aid and assistance required by the Employer's witness team / Engineer or Third Party Inspection Company, for the proper factory tests, inspection and examination of the Work and all parts thereof. The payments to be made to the Third party inspection Company / agency shall be borne by the Contractor. The total responsibility related to Inspection/ tests in all respect shall be included in the scope of the Contractor. The cost of subsequent inspection(s) due to Rejection /additional re-testing of items shall also to be borne by the Contractor.
2. The Contractor shall be responsible for all sort of coordination with the Employer, Respective manufactures and the Third Party Inspection Company to perform the tests on time and timely delivery of all the items / equipment meeting the specified quality criteria and completion schedule of the project.
3. Even if the inspection and tests are fully carried out, the Contractor shall not be absolved from its responsibilities to ensure that the Material(s), raw materials, components and other inputs are supplied strictly to conform and comply with all the requirements of the Contract at all stages, whether during manufacture/ fabrication, or at the time of Delivery as on arrival at site and after its erection or start up or consumption, and during the defect liability period.

Although Equipment/ Materials/ Goods approved by Employer, if on testing and inspection after receipt of the Equipment/ Materials/ Goods at the location, any Equipment/ Materials/ Goods are found not to be in strict conformity with the contractual requirements or specifications, Employer shall have the right to reject the same and EPC contractor shall be responsible to supply the same with required compliance within the contractual time frame.

10.15 TAKING OVER

After satisfactory completion of the tests on completion, the Employer will issue a Taking Over Certificate for the plant. The issue of any such certificate shall not however relieve the Contractor of any of his responsibilities in respect of proving that the performance of the plant meets the guaranteed values.

The Taking Over Certificate shall make reference to a schedule of outstanding minor defects and omissions which have been accepted by the Employer as not affecting the full and safe operation of the plant. The Contractor shall rectify such defects and omissions not later than 3 months after Taking Over.

The date certified in the Taking Over Certificate shall be the date on which the tests on completion were completed.

10.16 DEFECTS AFTER TAKING OVER

In accordance with the General Conditions of Contract, the Contractor shall be responsible for making good defects or damage which may appear or occur during a 12 month guarantee period from the date certified in the Taking Over Certificate.

Following any remedial work or replacement of any component part during the 12 months, the guarantee period for such a part shall be extended, commencing from the date at which the remedial work was completed.

Immediately prior to the completion of this period the Employer reserves the right to request the Contractor to open up for inspection the whole or any part of the Plant. The Employer will provide the labour to work under the direct supervision of the Contractor's representative for the purpose of such inspection.

The Contractor shall submit for approval the arrangements he intends making under this Contract for the making good of defects and for providing the supervisory service detailed above.

10.17 FINAL ACCEPTANCE CERTIFICATE

Application for the Final Certificate may be made to the Employer after the Contractor has ceased to be under any obligation under the Contract. This shall include the submission of final contract record drawings and fully bound version of the Installation, Operation and Maintenance Manuals. If a Taking-Over Certificate has been issued in respect of any Section or Portion of the Works, only one Final Certificate will be issued after all the said obligation has ceased. Final Certificate will be issued after all the said obligation has ceased. Where the Contractor has carried out replacements or renewals to the Works, the Contractor’s obligations shall continue, but the right of the Contractor to apply for a Final Certificate other than for the replacements or renewals shall not be affected by that fact.

SECTION 10 - APPENDIX A

REF. NO.	ITEM OR COMPONENT	PROCESS	DESCRIPTION OF OPERATION	DOCUMENTATION	SPECIFICATIONS/STANDARDS	PROG DATE	ACTION BY		
							CONTRACTOR	EPL	THIRD PARTY

Quality Assurance & Inspection Dept.	Project Title:		Job No.		Legend	
	Client:		Contract No:		X1 Hold Point X2 Witness Point X3 Record Review QAS QA Surveillance	Note Certification Requirements Note Any Other Requirements
	Contractor		Contract No:			
	Author: Date	Checked by:		Approved by:	QUALITY PLAN	
	Rev.No/Date Revision	1	2	3	4	Number: Sheet

SECTION 10 - APPENDIX B

NOTIFICATION OF WORKS INSPECTION

To facilitate the handling of inspection notifications, the following procedure shall be observed.

At the commencement of all contracts, discussions shall be held with the Main Contractor's nominated representative and the Employer to establish guidelines for the handling of inspection notifications and test documentation.

The Main Contractor shall prepare a notification form which shall include, but not necessarily be limited to, the following:

1. INSPECTION NOTIFICATION NUMBER (IN)

2. PROJECT TITLE

3. MANUFACTURER AND FULL ADDRESS

4. WHERE TEST/INSPECTION WILL BE CARRIED OUT (IF DIFFERENT FROM 4 ABOVE)

5 ORDER/SUB ORDER NUMBER

6 CONTACT NAME

7 FAX/TELEPHONE NUMBER

8 DETAILS OF EQUIPMENT TO BE TESTED/INSPECTED AND WHETHER EQUIPMENT IS COMPLETE

9 SCHEDULE OF TESTS

10 MANUFACTURER'S APPROVED DRAWING NUMBER AND CORRESPONDING MEP NUMBER

11 DATE OF INSPECTION

The Main Contractor shall be responsible for recording all inspection notifications in numerical order and shall submit copies of the appropriate record at monthly intervals to the Inspection Department.

30 days notices of works inspection is normally requested.

POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT
FOR

Design, Supply, Installation, Testing and Commissioning of Capacitor bank with associated switchgear for Mymensingh region on turnkey basis.

SECTION 11

BID DRAWINGS

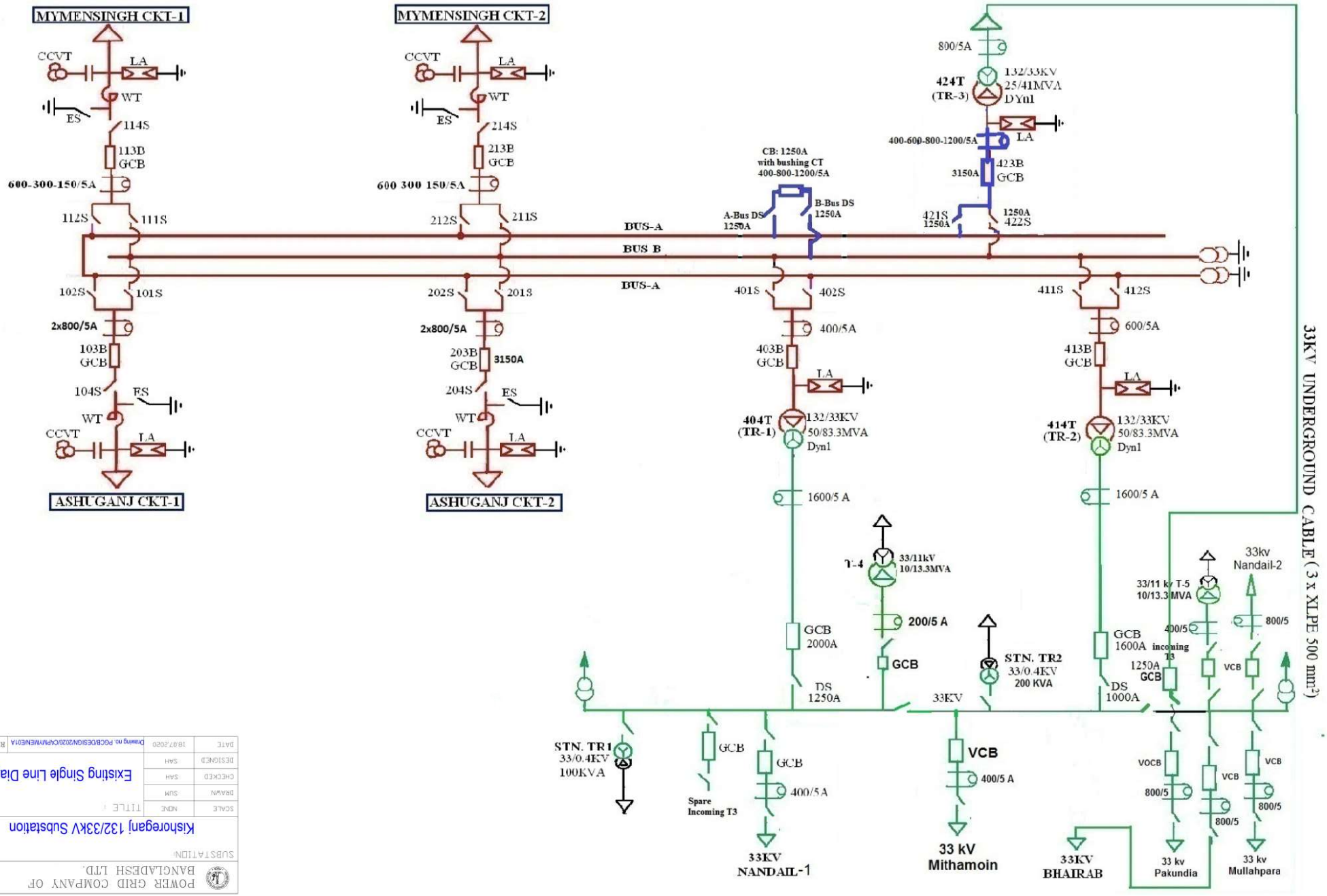
SECTION 11

BID DRAWINGS

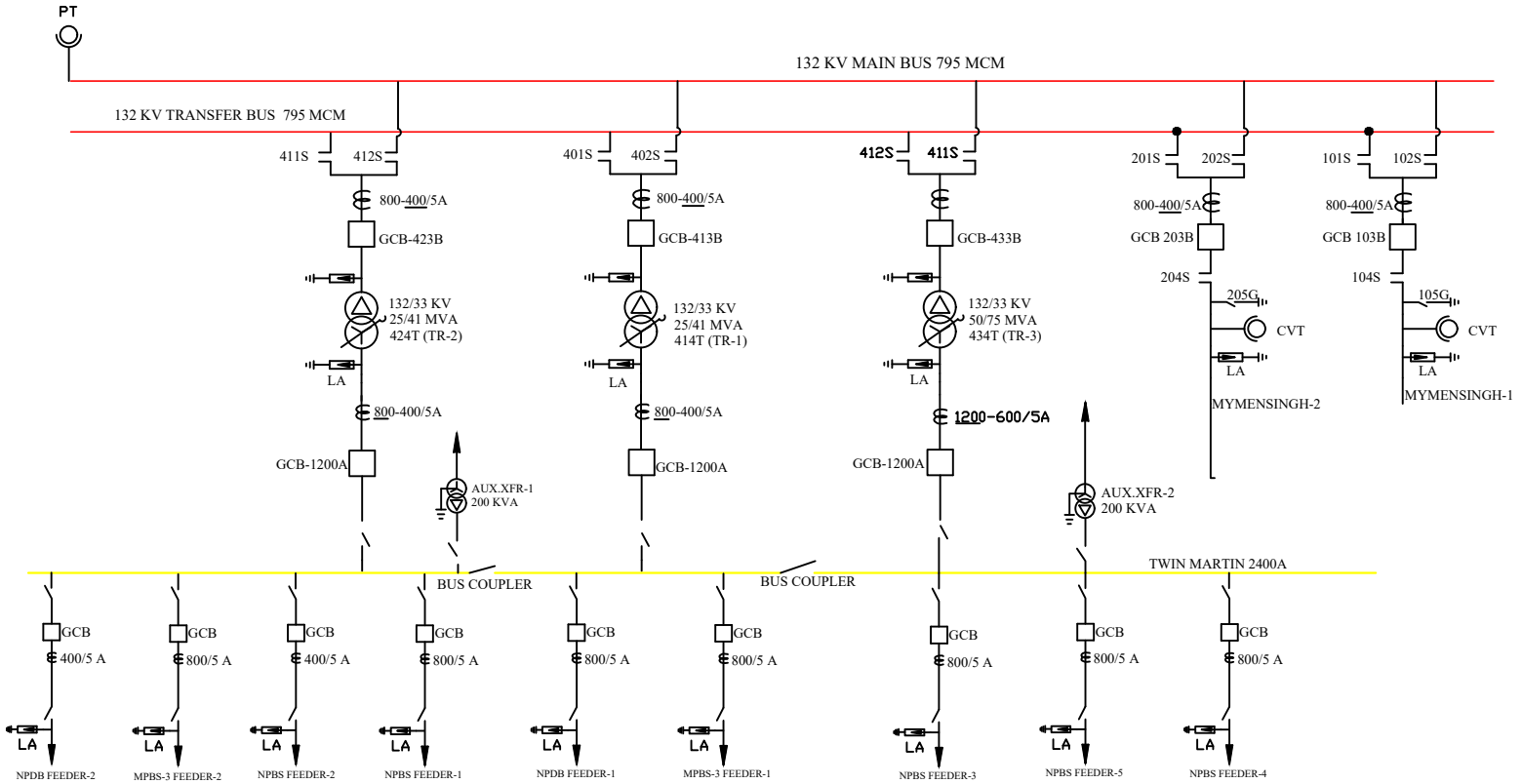
The following drawings shall form part of the Specification of the Bidding Document and shall be considered for tender purpose only. The drawings shall be finalized during detailed engineering after award of contract.

Drawing Number	**Title**
PGCB/DESIGN/2020/CAPMYMEN/E01A	Single Line Diagram of Kishoreganj 132/33kV S/S (Existing)
PGCB/DESIGN/2020/CAPMYMEN/E01B	Single Line Diagram of Netrokona 132/33kV S/S (Existing)
PGCB/DESIGN/2020/CAPMYMEN/E01C	Single Line Diagram of Bhaluka 132/33kV S/S (Existing)
PGCB/DESIGN/2020/CAPMYMEN/E01D	Single Line Diagram of Mymensingh 132/33kV S/S (Existing)
PGCB/DESIGN/2020/CAPMYMEN/E01E	Single Line Diagram of Tangail 132/33kV S/S (Existing)
PGCB/DESIGN/2020/CAPMYMEN/E02A	Layout of 132/33kV Kishoreganj 132/33kV S/S (Existing)
PGCB/DESIGN/2020/CAPMYMEN/E02B	Layout of 132/33kV Netrokona 132/33kV S/S (Existing)
PGCB/DESIGN/2020/CAPMYMEN/E02C	Layout of 132/33kV Bhaluka 132/33kV S/S (Existing)
PGCB/DESIGN/2020/CAPMYMEN/E02D	Layout of 132/33kV Mymensingh 132/33kV S/S (Existing)
PGCB/DESIGN/2020/CAPMYMEN/E02E	Layout of 132/33kV Tangail 132/33kV S/S (Existing)
PGCB/DESIGN/2020/CAPMYMEN/E03	Three Line Diagram of 15MVAR Capacitor Bank
PGCB/DESIGN/2020/CAPMYMEN/E04	Protection of 33kV Capacitor Bank with associated bay

SINGLE LINE DIAGRAM OF KISHOREGANJ 132/33KV GRID SUB-STATION



POWER GRID COMPANY OF BANGLADESH LTD.			
SUBSTATION: Kishoreganj 132/33kV Substation			
SCALE: NONE	TITLE : Existing Single Line Diagram		
DRAWN: SUM			
CHECKED: SAH			
DESIGNED: SAH			
DATE: 18.07.2020	Drawing no. PGCB/DESIGN/2020/CAP/WINDING/01A		REV : 0

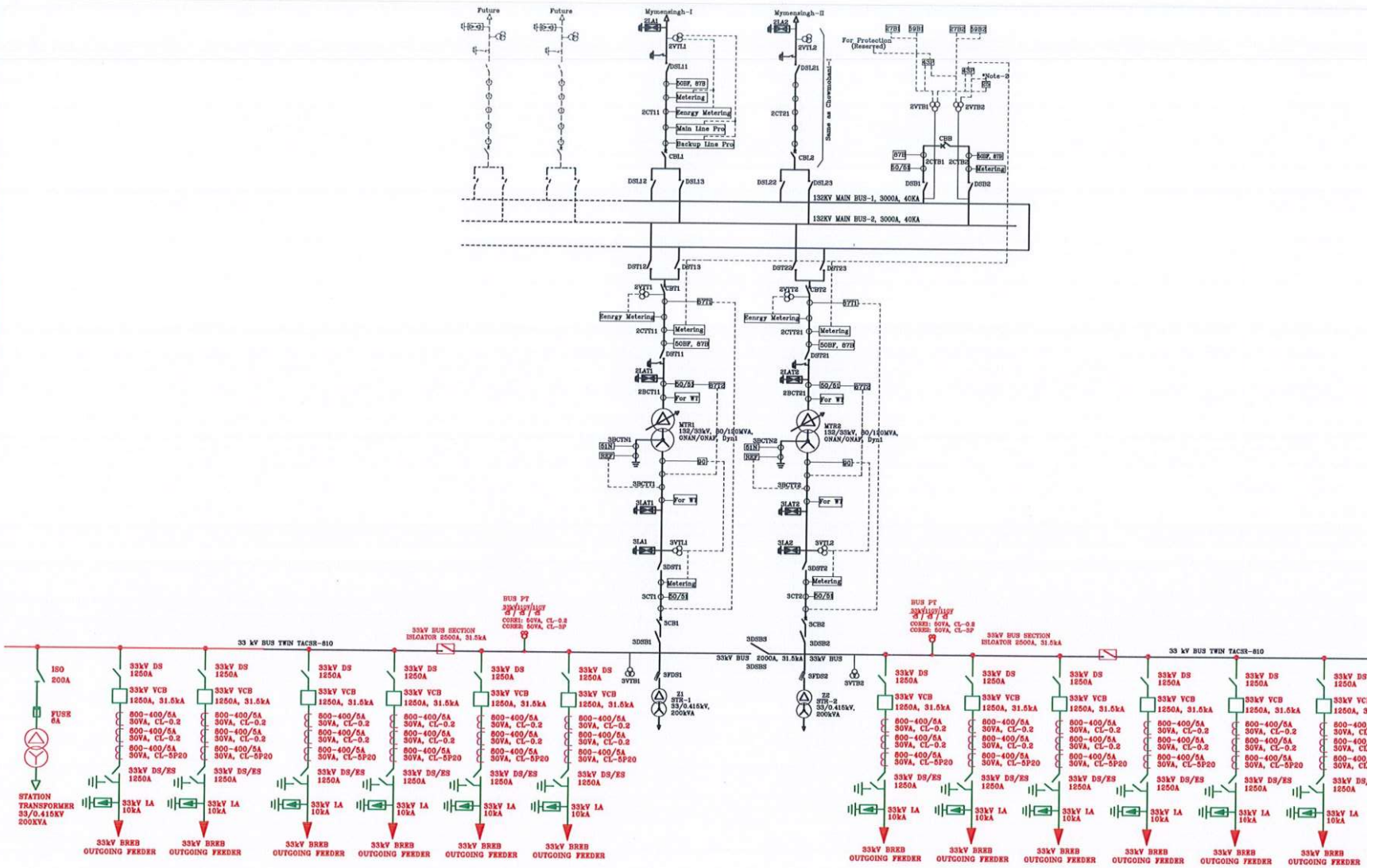


POWER GRID COMPANY OF BANGLADESH LTD.

PROJECT:

33kV CAPACITOR BANK

SCALE	NTS	TITLE : Existing Single Line Diagram of Netrokona 132/33kV SS
DRAWN	TDU	
CHECKED	SAH	
DESIGNED	SAH	DRAWING NO. : PGCB/DESIGN/2020/CAPMYMEN/E04
DATE	18.07.2020	REV : 0



POWER GRID COMPANY OF BANGLADESH LTD.

SUBSTATION: Bhaluka 132/33kV Substation

TITLE : Existing Single Line Diagram

SCALE	NONE	Drawing no. PGCB/DESIGN/2020/DAPW/NEW/SYD/ REV : 0
DRAWN	SUM	
CHECKED	SAH	
DESIGNED	SAH	
DATE	18.07.2020	

BA

PROJECT : UP-GRADATION
SYLHET DIVISION

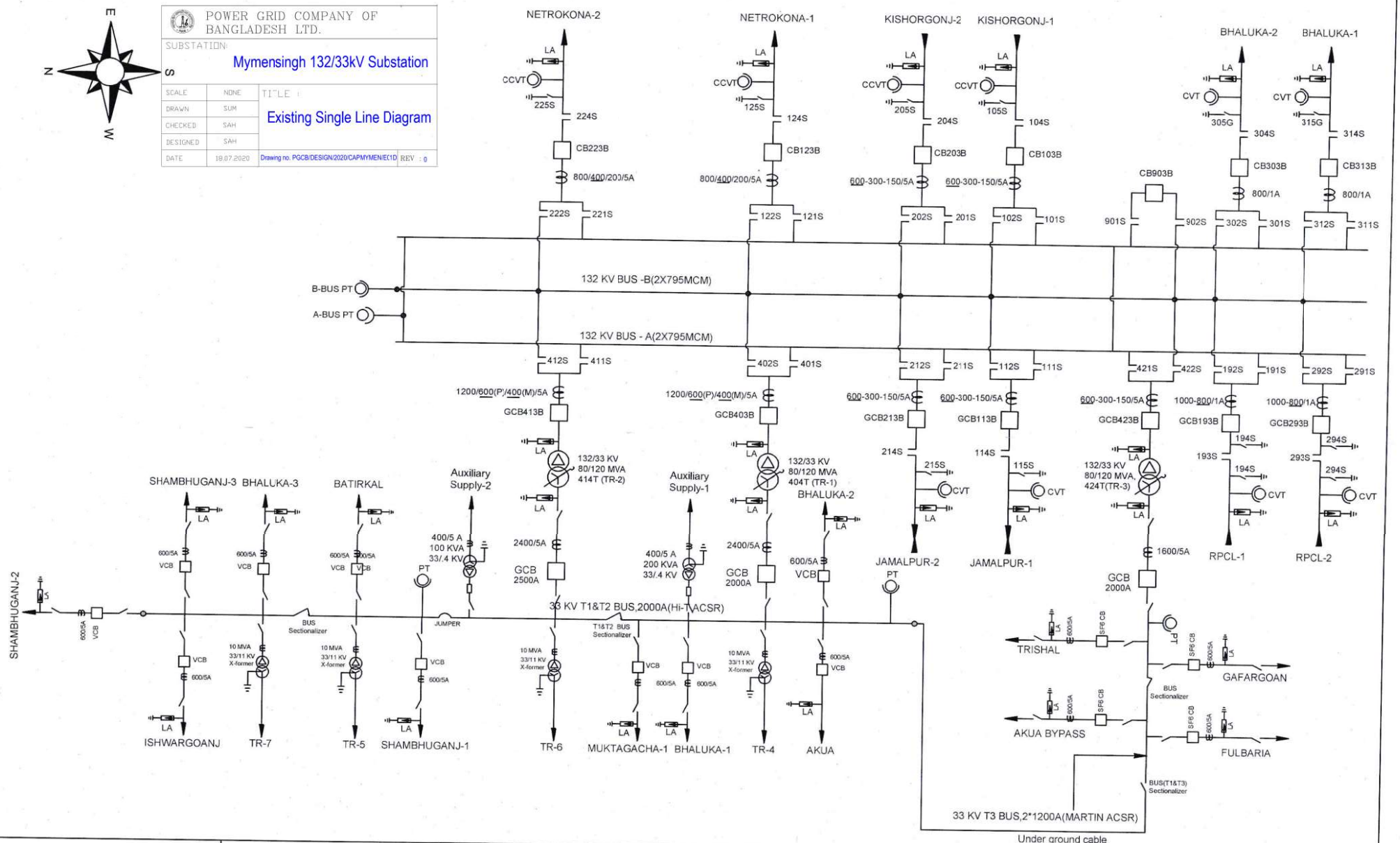
PACKAGE NO
UREDS-W-03A,
COMMISSIONING

CONTRACT NO. :

CONTRACTOR
ENERGYP

SCALE	
DRAWN	
CHECKED	
DESIGNED	
DATE	05

POWER GRID COMPANY OF BANGLADESH LIMITED.
SINGLE LINE DIAGRAM OF MYMENSINGH GRID S/S.



PREPARED BY : MD. NAZRUL ISLAM FAKIR SUB ASST. ENGINEER, MYMENSINGH S/S	CHECKED BY: MD.MOHAYMINUR RAHMAN ASSISTANT ENGINEER, MYMENSINGH S/S	APPROVED BY : ENGR. MASUDUL HAQUE EXECUTIVE ENGINEER, GMD, MYMENSINGH	MYMENSINGH 132 /33 KV GRID SUB-STATION,GMD, MYMENSINGH	DATE : 20-01-2019 PAGE : 1 OF 1

POWER GRID COMPANY OF BANGLADESH LTD.

SUBSTATION:

Tangail 132/33kV Substation

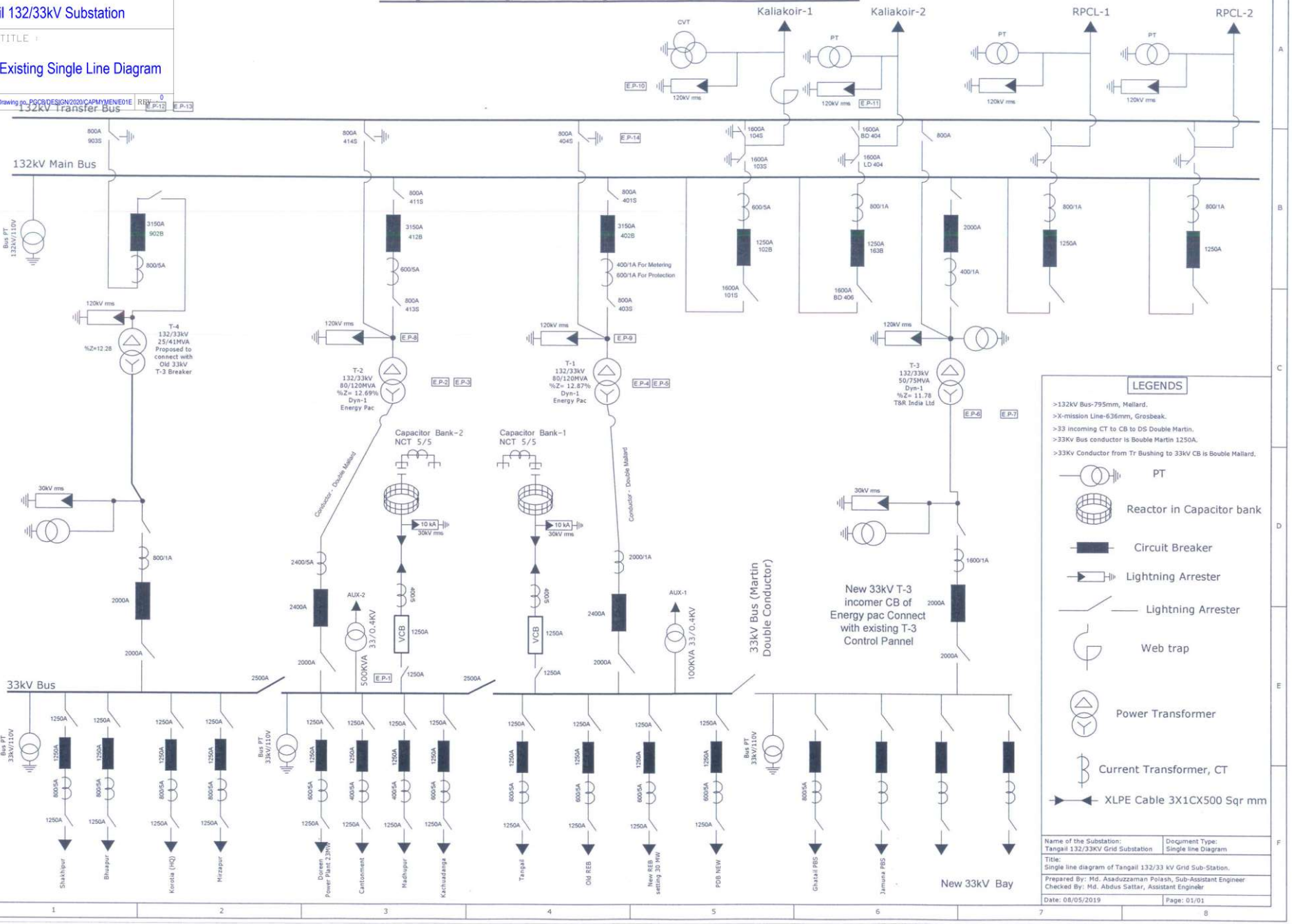
SCALE	NONE
DRAWN	SUM
CHECKED	SAH
DESIGNED	SAH
DATE	18.07.2020

TITLE :

Existing Single Line Diagram

Drawing no. PGCB/DESIGN/2020/CAPMYMEN/E01E REV 0

Single line Diagram of Tangail 132/33kV Grid Sub-Station



LEGENDS

>132kV Bus-795mm, Mallard.
>X-mission Line-636mm, Grosbeak.
>33 incoming CT to CB to DS Double Martin.
>33Kv Bus conductor is Bouble Martin 1250A.
>33Kv Conductor from Tr Bushing to 33kV CB is Bouble Mallard.

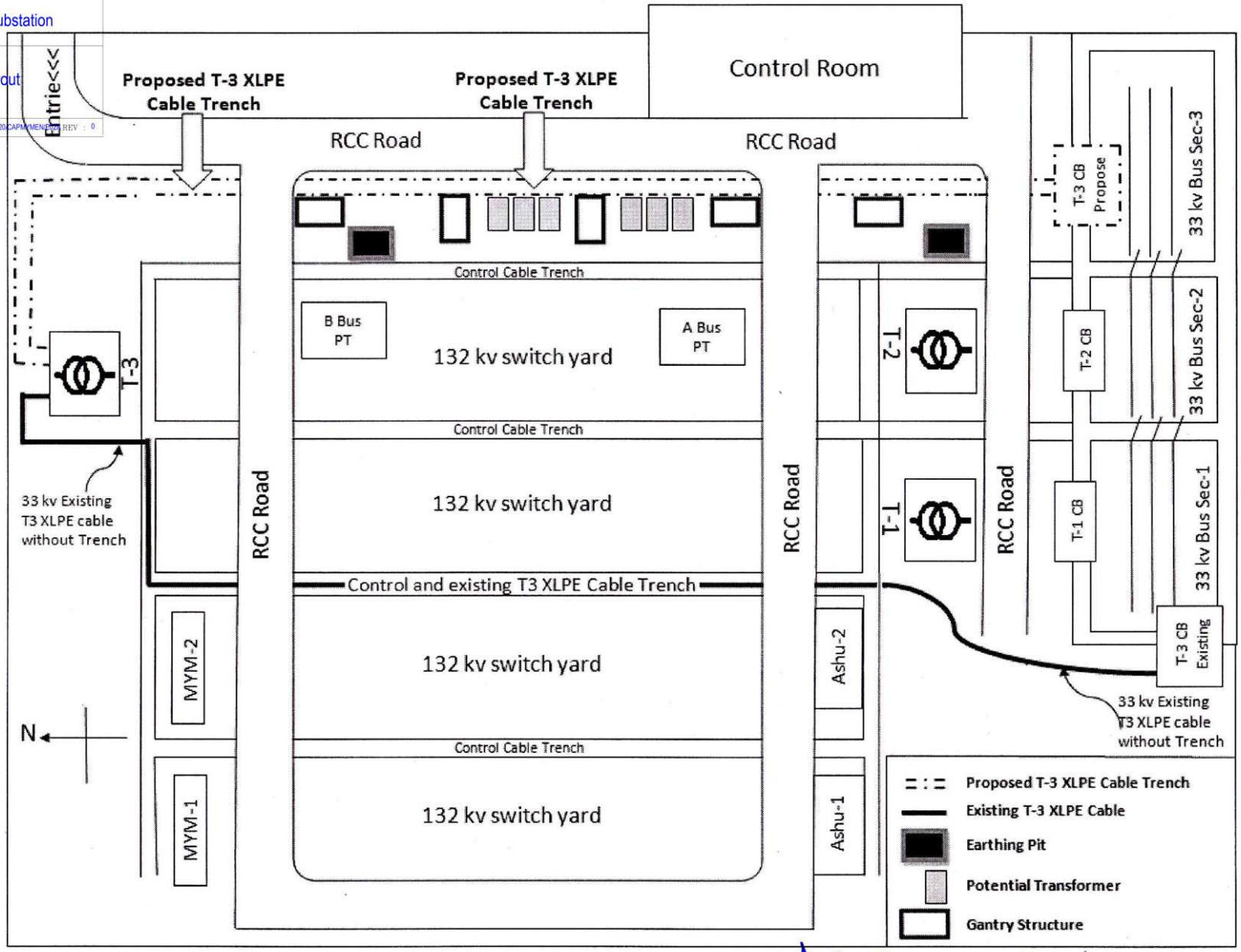
- PT
- Reactor in Capacitor bank
- Circuit Breaker
- Lightning Arrester
- Lightning Arrester
- Web trap
- Power Transformer
- Current Transformer, CT
- XLPE Cable 3X1CX500 Sqr mm

Name of the Substation: Tangail 132/33KV Grid Substation	Document Type: Single line Diagram
Title: Single line diagram of Tangail 132/33 kV Grid Sub-Station.	
Prepared By: Md. Asaduzzaman Polash, Sub-Assistant Engineer Checked By: Md. Abdus Sattar, Assistant Engineer	
Date: 08/05/2019	Page: 01/01

POWER GRID COMPANY OF BANGLADESH LTD.

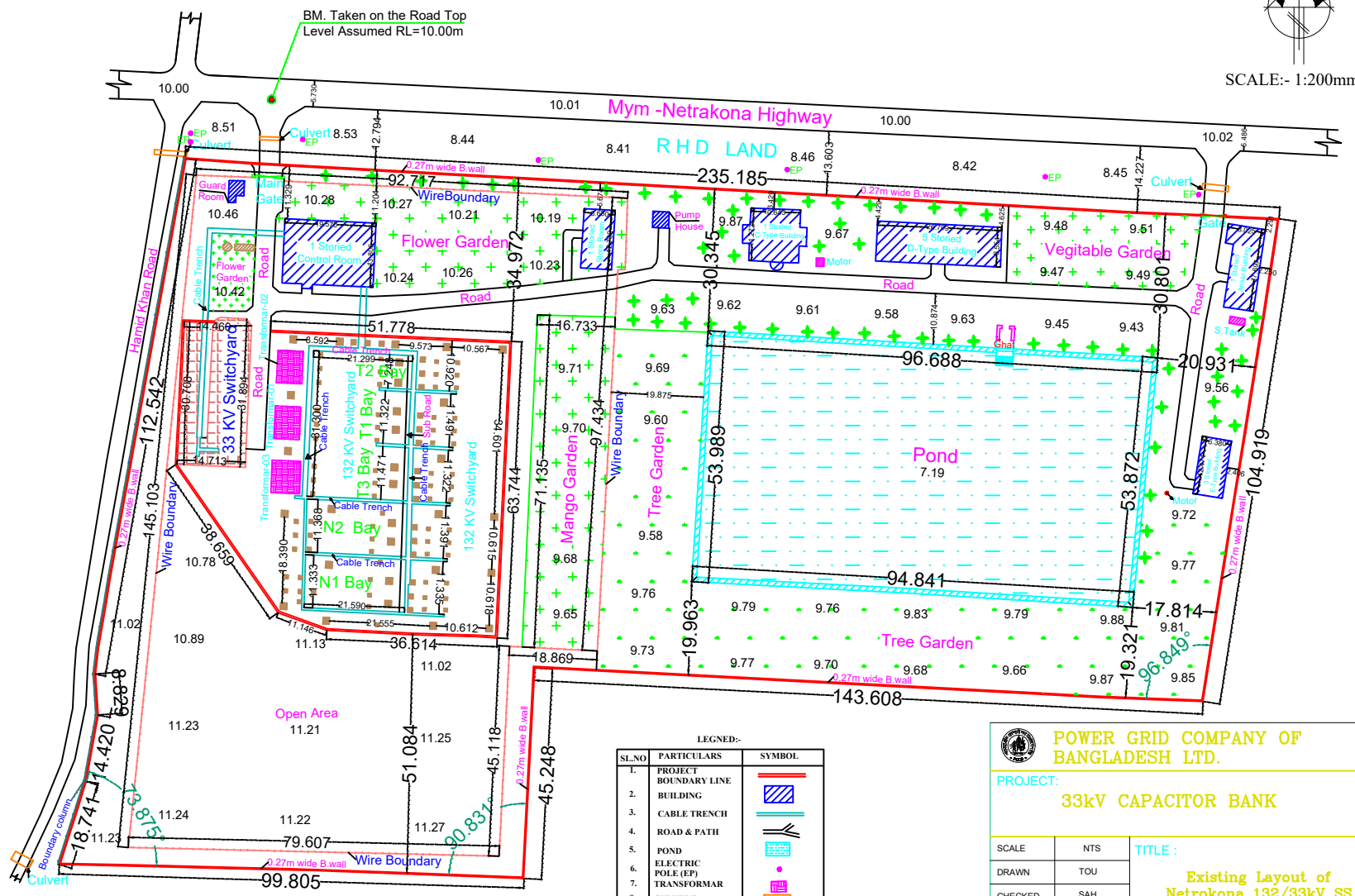
SUBSTATION:
Kishoreganj 132/33kV Substation

SCALE	NONE	TITLE : Existing Layout
DRAWN	SUM	
CHECKED	SAH	
DESIGNED	SAH	
DATE	18.07.2020	Drawing no. PGCB/DESIGN/2020/CAPM/MENDP/ REV : 0



06.11.16
মোঃ সাইফুল ইসলাম
উপ-সহকারী প্রকৌশলী
কিশোরগঞ্জ গ্রীড উপকেন্দ্র
জিএমডি পিজিসিবি, ময়মনসিংহ

06-11-16
মোঃ মেহেদী হাসান ডিহিদার
সহকারী প্রকৌশলী
কিশোরগঞ্জ গ্রীড উপকেন্দ্র
জিএমডি পিজিসিবি ময়মনসিংহ



LEGNED:-

SL.NO	PARTICULARS	SYMBOL
1.	PROJECT BOUNDARY LINE	
2.	BUILDING	
3.	CABLE TRENCH	
4.	ROAD & PATH	
5.	POND	
6.	ELECTRIC POLE (EP)	
7.	TRANSFORMAR	
8.	CULVERT	
9.	WIRE BOUNDARY	

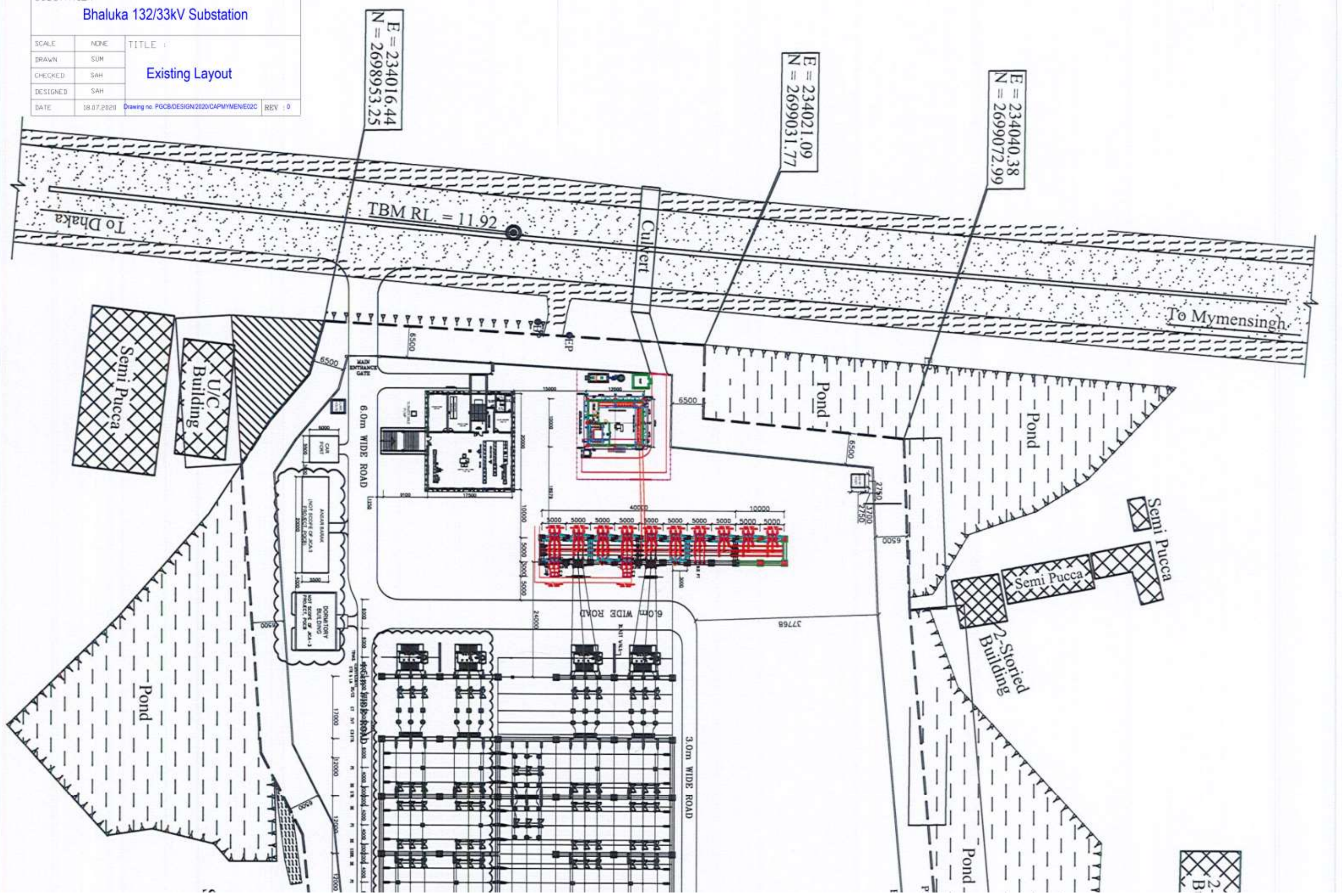
POWER GRID COMPANY OF BANGLADESH LTD.

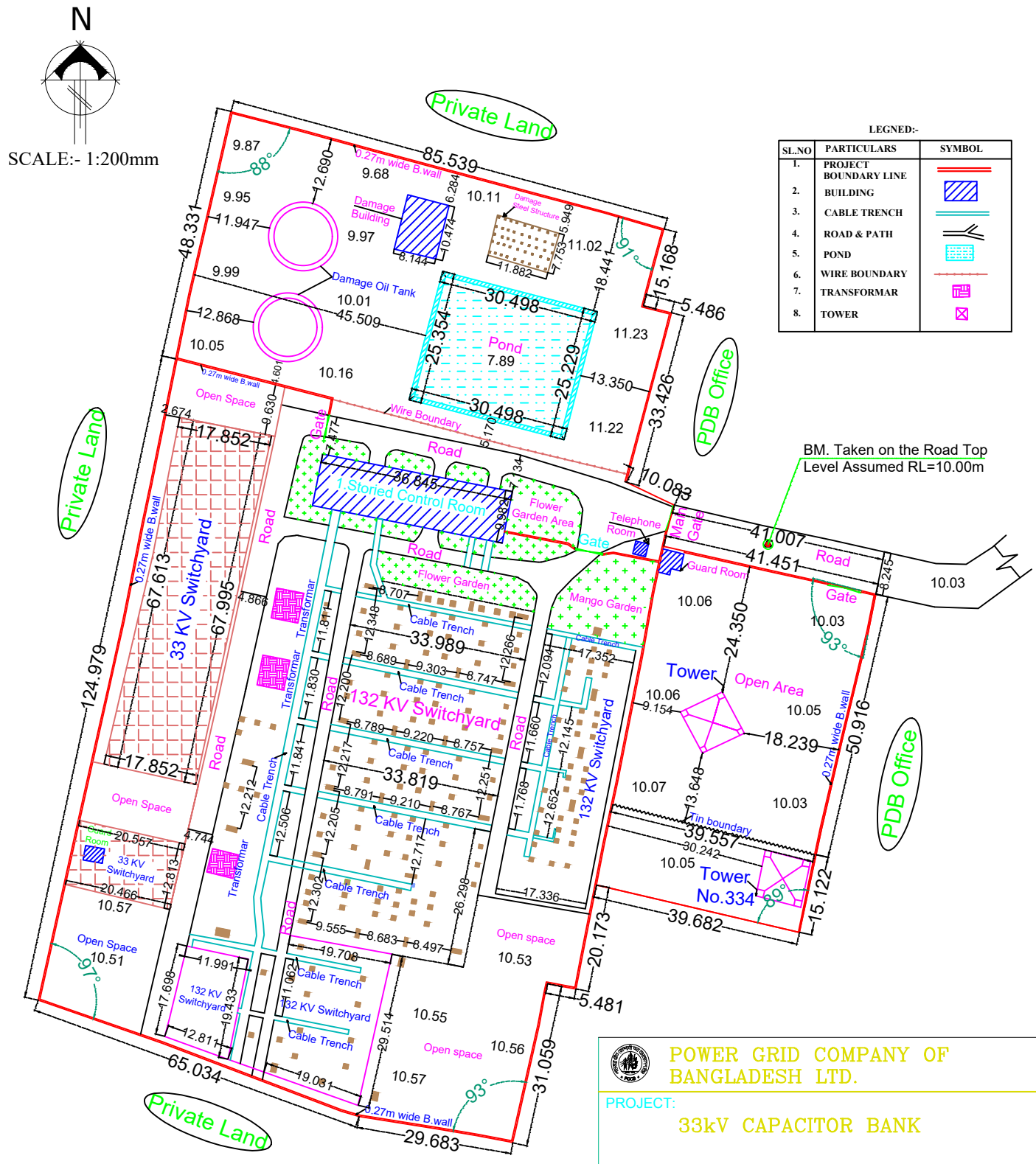
PROJECT:

33kV CAPACITOR BANK

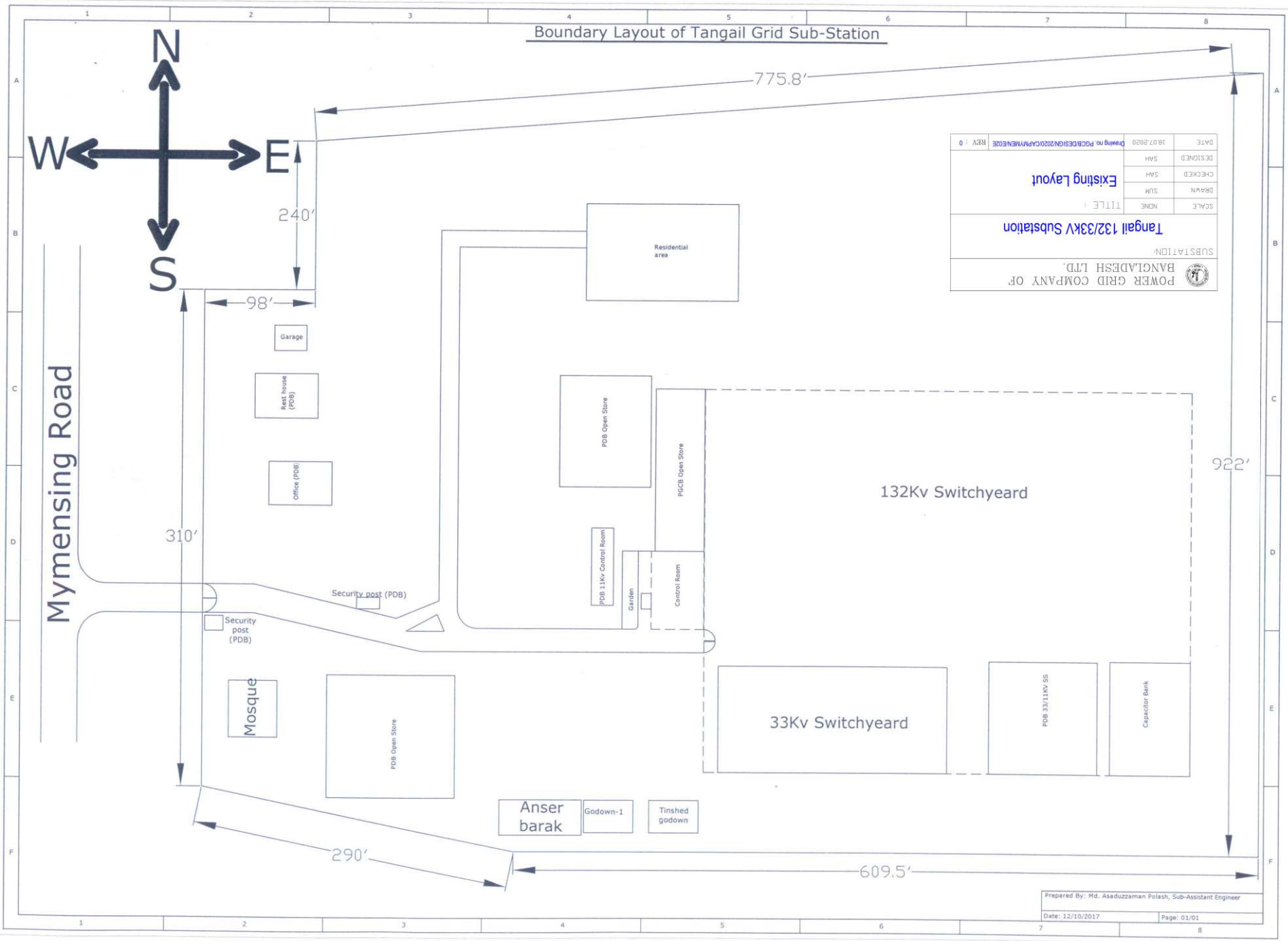
SCALE	NTS	TITLE : Existing Layout of Netrokona 132/33kV SS
DRAWN	TOU	
CHECKED	SAH	
DESIGNED	SAH	DRAWING NO. : PGCB/DESIGN/2020/CAPMYMEN/E02B
DATE	18.07.2020	REV : 0

POWER GRID COMPANY OF BANGLADESH LTD.			
SUBSTATION: Bhaluka 132/33kV Substation			
SCALE	NONE	TITLE : Existing Layout	
DRAWN	SUM		
CHECKED	SAH		
DESIGNED	SAH		
DATE	18.07.2020	Drawing no. PGCB/DESIGN/2020/CAPMYMEN/E02C	REV : 0




N
SCALE:- 1:200mm
LEGNED:-
SL.NO PARTICULARS SYMBOL
1. PROJECT BOUNDARY LINE
2. BUILDING
3. CABLE TRENCH
4. ROAD & PATH
5. POND
6. WIRE BOUNDARY
7. TRANSFORMAR
8. TOWER
Private Land
PDB Office
BM. Taken on the Road Top
Level Assumed RL=10.00m
33 KV Switchyard
132 KV Switchyard
1.Storied Control Room
Pond
Damage Building
Damage Oil Tank
Damage Steel Structure
Wire Boundary
Flower Garden
Flower Garden Area
Mango Garden
Telephone Room
Main Gate
Guard Room
Gate
Road
Transformar
Cable Trench
Open Space
Open space
Tower
Open Area
Tower No.334
Tin boundary
0.27m wide B.wall
85.539
48.331
124.979
65.034
29.683
67.613
67.995
17.852
30.498
25.354
25.229
33.426
15.168
5.486
10.083
41.007
41.451
50.916
15.122
39.682
20.173
5.481
31.059
24.350
18.239
39.557
33.989
33.819
POWER GRID COMPANY OF BANGLADESH LTD.
PROJECT:
33kV CAPACITOR BANK
SCALE NTS
DRAWN TOU
CHECKED SAH
DESIGNED SAH
DATE 18.07.2020
TITLE :
Existing Layout Mymensingh 132/33kV SS
DRAWING NO. : PGCB/DESIGN/2020/CAPMYMEN/E02D
REV : 0

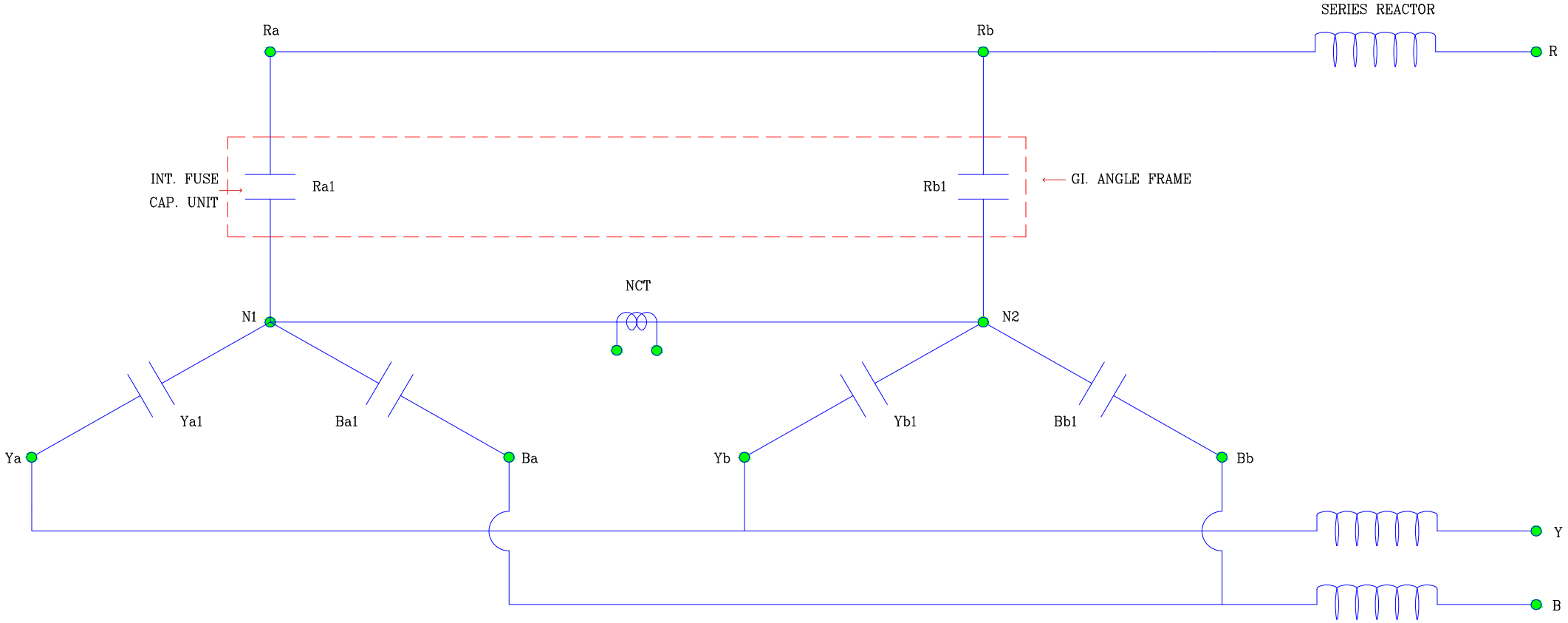
Boundary Layout of Tangail Grid Sub-Station



POWER GRID COMPANY OF BANGLADESH LTD.		
SUBSTATION:	Tangail 132/33kV Substation	
TITLE :	Existing Layout	
SCALE	NONE	
DRAWN	SUM	
CHECKED	SAH	
DESIGNED	SAH	
DATE	18.07.2020	
Drawing no. PGCB/DESIGN/2020/CAP&VMEN/E02E		REV : 0

Prepared By: Md. Asaduzzaman Polash, Sub-Assistant Engineer

Date: 12/10/2017 | Page: 01/01



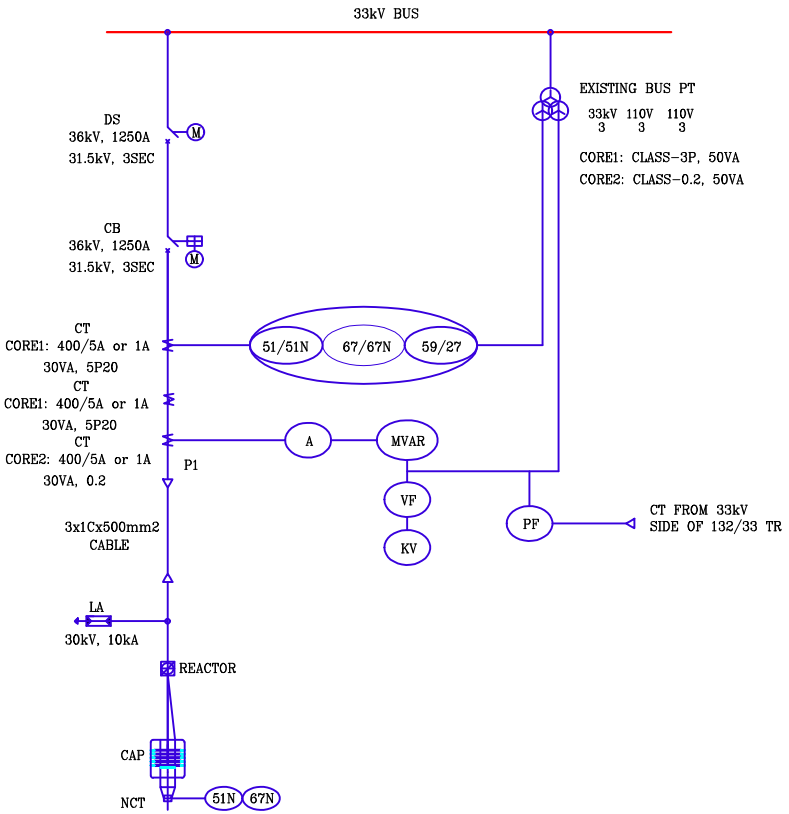
TENDER PURPOSE ONLY

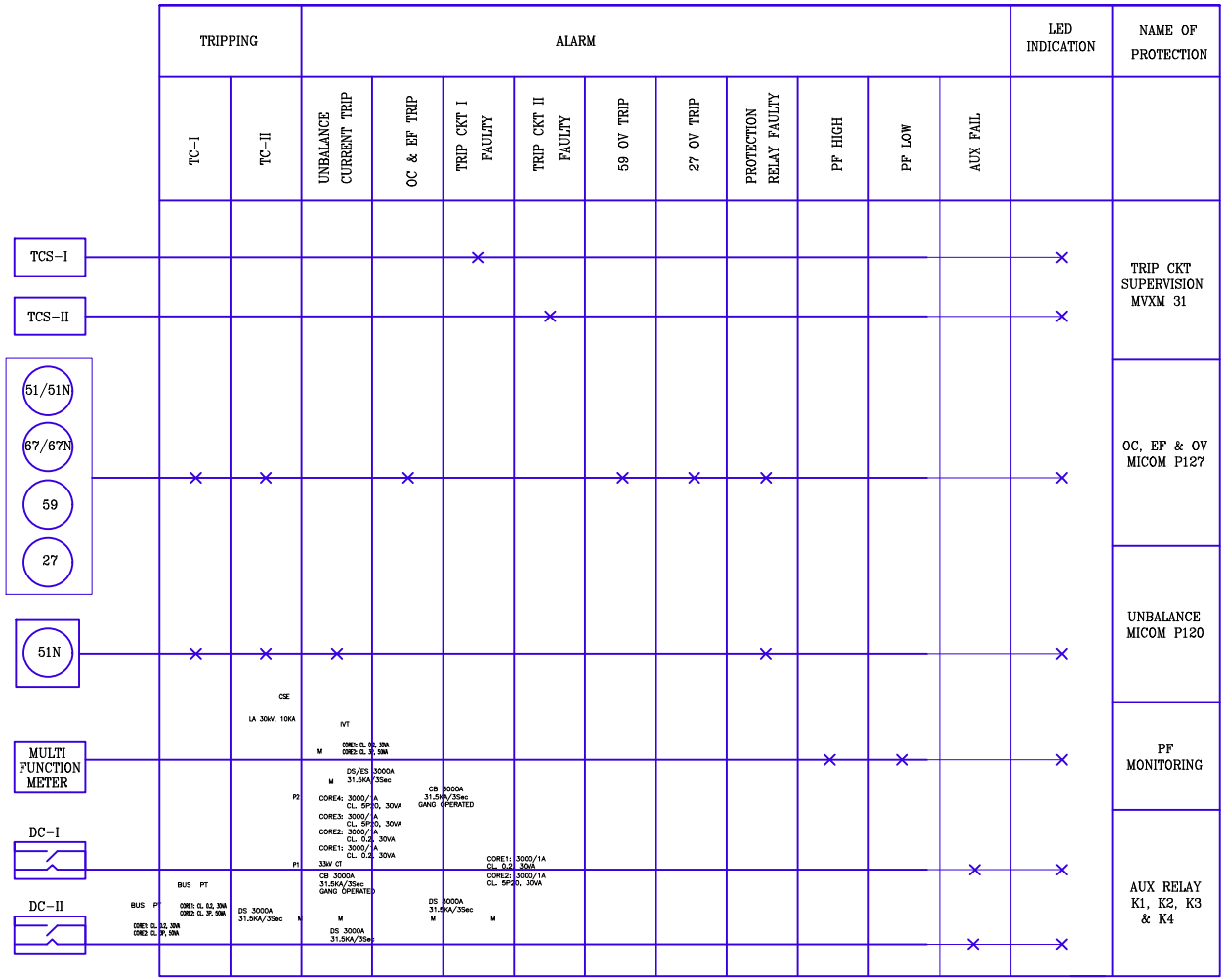
L E G E N D		
SL.NO.	FIGURE	FIGURE NAME
01		CAP. UNIT
02		SERIES REACTOR
03		NCT

POWER GRID COMPANY OF BANGLADESH LTD.

PROJECT:
33kV CAPACITOR BANK

SCALE	NTS	TITLE : THREE LINE DIAGRAM OF 33kV CAPACITOR BANK
DRAWN	TOU	
CHECKED	SAH	
DESIGNED	SAH	DRAWING NO. : PGCB/DESIGN/2020/CAPMYMEN/E03
DATE	18.07.2020	REV : 0





NOTE:

** Timer based lockout relay has to be provided in CB for safe discharge of capacitor bank.

LEGEND			
SL.NO.	FIGURE	FIGURE NAME	RATING
01		LIGHTNING ARRESTOR (LA)	30kV, 10kA
02		DISCONNECTING SWITCH (DS)	1250A, 31.5kA
03		CIRCUIT BREAKER (GCB)	1250A, 31.5kA
04		POTENTIAL TRANSFORMER (PT)	33kV 110V 3 3
05		CURRENT TRANSFORMER (CT)	400A/5A-1A

POWER GRID COMPANY OF BANGLADESH LTD.

PROJECT:

33kV CAPACITOR BANK

SCALE	NTS	TITLE : 33kV CAPACITOR BANK PROTECTION
DRAWN	TOU	
CHECKED	SAH	
DESIGNED	SAH	DRAWING NO. : PGCB/DESIGN/2020/CAPMYMEN/E04
DATE	16.07.2020	REV : 0