



Technical Specifications

Renovation of Science Laboratories of Al-Quds University- Abu Dis in Jerusalem (PHASE I)

Reference Number: ITB-2018-PAL-0000053045

Funded by Arab Bank for Economic Development in Africa and Aqsa Fund-
Managed by the Islamic Development Bank (IDB)

BADEA-54 & AQS-81

TECHNICAL SPECIFICATIONS

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SECTION 01010
SUMMARY OF WORK

PART 1 GENERAL

1.01 Work Covered by Contract Documents/Requirements Included

The Work of this Contract comprises but not limited to the construction, completion and maintenance of the

Al-Quds University
Renovation of Science Laboratories

1.02 Related Requirements

Instructions to Tenderers.

1.03 Contracts

The Contract Work is under a "Re measured" Contract.

END OF SECTION

SECTION 01025
MEASUREMENT AND PAYMENT

GENERAL

1.1 Section Includes

- A. Measurement and payment criteria applicable to the Work performed under a unit price payment method.
- B. Defect assessment and non-payment for rejected work.

1.2 Authority

- A. Measurement methods delineated in the individual specification sections complement the criteria of this section. In the event of conflict, the requirements of the individual specification section govern.
- B. Take all measurements and compute quantities. The Engineer will verify measurements and quantities.
- C. Assist by providing necessary equipment, workers, and survey personnel as required.

1.3 Unit Quantities Specified

- A. Quantities indicated in the specification and bill of quantities are for bidding and contract purposes only. Quantities and measurements supplied or placed in the Work and verified by the Engineer determine payment.
- B. If the actual Work requires more or fewer quantities than those quantities indicated, provide the required quantities at the unit prices contracted.
- C. If the actual Work requires a 25% or greater change in quantity than those quantities indicated, the Owner or Contractor may claim for a Contract Price adjustment.

1.4 Measurements of Quantities

- A. Measurement Devices:
 - 1. Weigh Scales: Inspected, tested and certified by the applicable state Weights and Measures department.
 - 2. Platform Scales: Of sufficient size and capacity to accommodate the conveying vehicle.
 - 3. Metering Devices: Inspected, tested and certified by the applicable State department.
- B. Measurement by Weight: Concrete reinforcing steel, rolled or formed steel or other metal shapes will be measured by handbook weights. Welded assemblies will be measured by handbook or scale weight.
- C. Measurement by Volume: Measured by cubic dimension using mean length, width and height or thickness.
- D. Measurement by Area: Measured by square dimension using mean length and width or radius.
- E. Linear Measurement: Measured by linear dimension, at the item centerline or mean chord.
- F. Stipulated Sum/Price Measurement: Items measured by weight, volume, area, or linear means or combination, as appropriate, as a completed item or unit of the Work.

1.5 Payment

- A. Payment Includes: Full compensation for all required labor, Products, tools, equipment, plant, transportation, services and incidentals; erection, application or installation of an item of the Work; overhead and profit.
- B. Final payment for Work governed by unit prices will be made on the basis of the actual measurements and quantities accepted by the /Engineer multiplied by the unit sum/price for Work which is incorporated in or made necessary by the Work.

1.6 Defect Assessment

- A. Replace the Work, or portions of the Work, not conforming to specified requirements.
- B. If, in the opinion of the Engineer, it is not practical to remove and replace the Work, the Engineer will direct one of the following remedies:
 - 1. The defective Work may remain, but the unit price will be adjusted to a new price at the discretion of the Engineer.
 - 2. The defective Work will be partially repaired to the instructions of the Engineer, and the unit price will be adjusted to a new price at the discretion of the Engineer.
- C. The individual specification sections may modify these options or may identify a specific formula or percentage price reduction.
- D. The authority of the Engineer to assess the defect and identify payment adjustment, is final.

1.7 Non-Payment for Rejected Products

- A. Payment will not be made for any of the following:
 - 1. Products wasted or disposed of in a manner that is not acceptable.
 - 2. Products determined as unacceptable before or after placement.
 - 3. Products not completely unloaded from the transporting vehicle.
 - 4. Products placed beyond the lines and levels of the required Work.
 - 5. Products remaining on hand after completion of the Work.
 - 6. Loading, hauling and disposing of rejected Products.

END OF SECTION

SECTION 01027
APPLICATIONS FOR PAYMENT

GENERAL

1.1 Section Includes

Procedures for preparation and submittal of applications for payment.

1.2 Related Sections

- A. Agreement: Contract Price , amounts of progress payments and retainages, time schedule for submittals.
- B. General Conditions: Progress payments and final payment.
- C. Section 01019 - Contract Considerations
- D. Section 01300 - Submittals: Submittal procedures.
- E. Section 01700 - Contract Closeout: Final payment.

1.3 Format

For each item, provide a column for listing each of the following:

- 1. Item Number.
- 2. Description of work.
- 3. Scheduled Values.
- 4. Previous Applications.
- 5. Work in Place and Stored Materials under this Application.
- 6. Authorized Change Orders.
- 7. Total Completed and Stored to Date of Application.
- 8. Percentage of Completion.
- 9. Balance to Finish.
- 10. Retainage.

1.4 Preparation of Applications

- A. Present required information in typewritten form.
- B. Execute certification by signature of authorized officer.
- C. Use data from approved Schedule of Values. Provide currency value in each column for each line item for portion of work performed and for stored Products.
- D. Prepare Application for Final Payment as specified in Section 01700.

1.5 Submittal Procedures

- A. Submit three copies of each Application for Payment.
- B. Submit an updated construction schedule with each Application for Payment.
- C. Payment Period: Submit at intervals stipulated in the Agreement.
- D. Submit with transmittal letter as specified for Submittals in Section 01300
- E. Submit waivers.

1.6 Substantiating Data

- A. When Engineer requires substantiating information, submit data justifying currency amounts in question.
- B. Provide one copy of data with cover letter for each copy of submittal. Show application number and date, and line item by number and description.

END OF SECTION

SECTION 01028

MODIFICATION PROCEDURES

GENERAL

1.1 Section Includes

- A. Submittals.
- B. Documentation of change in Contract Sum/Price and Contract Time.
- C. Change procedures.
- D. Construction Change Directive.
- E. Stipulated Price change order.
- F. Unit price change order.
- G. Time and material change order.
- H. Execution of change orders.
- I. Correlation of Contractor submittals.

1.2 Related Sections

- A. Agreement: Monetary values of established Unit Prices and percentage allowances for Contractor's overhead and profit.
- B. General Conditions: Governing requirements for changes in the Work, in Contract Sum/Price, and Contract Time.
- C. Supplementary Conditions: Percentage allowances for Contractor's overhead and profit.
- D. Section 01019 - Contract Considerations.
- E. Section 01300 - Submittals: Schedule of values.
- F. Section 01600 - Material and Equipment: Product options and substitutions.
- G. Section 01700 - Contract Closeout: Project record documents.

1.3 Submittals

Submit name of the individual authorized to receive change documents, and be responsible for informing others in Contractor's employ or Subcontractors of changes to the Work.

1.4 Documentation of Change in Contract Price And Contract Time

- A. Maintain detailed records of work done on a time and material basis. Provide full information required for evaluation of proposed changes, and to substantiate costs of changes in the Work.
- B. Document each quotation for a change in cost or time with sufficient data to allow evaluation of the quotation.
- C. Provide additional data to support computations:
 - 1. Quantities of products, labor, and equipment.
 - 2. Taxes, insurance, and bonds.
 - 3. Overhead and profit.
 - 4. Justification for any change in Contract Time.
 - 5. Credit for deletions from Contract, similarly documented.
- D. Support each claim for additional costs, and for work done on a time and material basis, with additional information:
 - 1. Origin and date of claim.
 - 2. Dates and times work was performed, and by whom.
 - 3. Time records and wage rates paid.
 - 4. Invoices and receipts for products, equipment, and subcontracts, similarly documented.

1.5 Change Procedures

- A. The Engineer may issue a Proposal Request which includes a detailed description of a proposed change with supplementary or revised Drawings and specifications, a change in Contract Time for executing the change with a stipulation of any overtime work required and period of time during which the requested price will be considered valid. Contractor will prepare and submit an estimate within three days.

1.5 Change Procedures (cont'd)

- B. The Contractor may propose a change by submitting a request for change to the Engineer, describing the proposed change and its full effect on the Work, with a statement describing the reason for the change, and the effect on the Contract Sum/Price and Contract Time with full documentation and a statement describing the effect on Work by separate or other contractors. Document any requested substitutions in accordance with Section: 01600.

1.6 Construction Change Directive

- A. Engineer may issue a document, signed by the Owner, instructing the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
- B. The document will describe changes in the Work, and will designate method of determining any change in Contract Price or Contract Time.
- C. Promptly execute the change in Work.

1.7 Stipulated Price Change Order

Based on Proposal Request and Contractor's estimated price quotation as approved by Engineer.

1.8 Unit Price Change Order

- A. For pre-determined unit prices and quantities, the Change Order will be executed on a fixed unit price basis.
- A. For unit costs or quantities of units of work which are not pre-determined, execute Work under a Construction Change Directive.
- C. Changes in Contract Price or Contract Time will be computed as specified for Time and Material Change Order.

1.9 Time and Material Change Order

- A. Submit itemized account and supporting data after completion of change, within time limits indicated in the Conditions of the Contract.
- B. Engineer will determine the change allowable in Contract Price and Contract Time as provided in the Contract Documents.
- C. Maintain detailed records of work done on Time and Material basis.
- D. Provide full information required for evaluation of proposed changes, and to substantiate costs for changes in the Work.

1.10 Execution of Change Orders

Execution of Change Orders: Engineer will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.

1.11 Correlation of Contractor Submittals

- A. Promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Price.
- B. Promptly revise progress schedules to reflect any change in Contract Time, revise sub-schedules to adjust times for other items of work affected by the change, and resubmit.
- C. Promptly enter changes in Project Record Documents.

END OF SECTION

SECTION 01030
ALTERNATES

GENERAL

1.01 Requirements Included

Identification and description of Alternate work.

1.02 Related Requirements

- A. Contract Documents.
- B. Sections of Specifications identified in each Alternate.

1.03 Procedures

- A. Alternates will be exercised at the option of Employer and/or the Engineer.
- B. Coordinate related work and modify surrounding work as required to complete the Work, including changes under each Alternate, when acceptance is designated in Employer-Contractor Agreement.

END OF SECTION

SECTION 01090
REFERENCE STANDARDS

GENERAL

1.1 Section Includes

Quality assurance.

2 Related Work

General Conditions: Reference standards.

3 Quality Assurance

- A. For Products or workmanship specified by association, trade, or other consensus standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard by date of issue current on date of Contract Documents.
- C. Obtain copies of standards when required by the Contract Documents.
- D. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.
- E. Should specified reference standards conflict with Contract Documents, request clarification from the Engineer before proceeding.
- F. The contractual relationship, duties, and responsibilities of the parties in Contract nor those of the Engineer shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

END OF SECTION

SECTION 01300

SUBMITTALS

GENERAL

1.1 Section Includes

- A. Submittal procedures.
- B. Proposed Products list.
- C. Shop Drawings.
- D. Product Data.
- E. Samples.
- F. Manufacturer's installation instructions.
- G. Manufacturers' certificates.
- H. Construction photographs.

1.2 Related Sections

- A. Section 01400 - Quality Control.
- B. Section 01700 - Contract Close-out.

1.3 Submittal Procedures

- A. Transmit each submittal with Form to the Engineer under an accepted form.
- B. Sequentially number the transmittal form. Revise submittals with original number and a sequential alphabetic suffix.
- C. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing and detail number, and specification section number, as appropriate.
- D. Apply Contractor's stamp, signed or initialed certifying that review, verification of Products required, field dimensions, adjacent construction Work, and coordination of information, is in accordance with the requirements of the Work and Contract Documents.
- E. Schedule submittals to expedite the Project, and deliver to the Engineer at Site Office. Coordinate submission of related items.
- F. For each submittal for review, allow 15 days excluding delivery time to and from the contractor.
- G. Identify variations from Contract Documents and Product or system limitations, which may be detrimental to successful performance of the completed Work.
- H. Provide space for Contractor and the Engineer review stamps.
- I. Revise and resubmit, identify all changes made since previous submission.
- J. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with provisions.
- K. Submittals not requested will not be recognized or processed.

1.4 Proposed Products List

- A. Within 15 days after date of Employer-Contractor Agreement, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
- B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.
- C. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment. and appliances.

1.5 Shop Drawings

- A. Submit in the form of one reproducible and the number of opaque reproductions which Contractor requires, plus two copies which will be retained by the Engineer.
- B. Shop Drawings: Submit for review. After review, produce copies and distribute in accordance with the submittal procedures article above and for record documents purposes described in Section 01700 – contract close-out.
- C. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

1.6 Product Data

- A. Submit the number of copies which the Contractor requires, plus two copies which will be retained by the Engineer.
- B. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information unique to this Project.
- C. After review distribute in accordance with the Submittal Procedures article above and provide copies for record documents described in Section 01700 – contract close-out.

1.7 Samples

- A. Submit samples to illustrate functional and aesthetic characteristics of the Product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
- B. Submit samples of finishes from the full range of manufacturers' standard colors, textures, and patterns for the Engineer selection.
- C. Include identification on each sample, with full Project information.
- D. Submit the number of samples specified in individual specification sections; one of which will be retained by the Engineer.
- E. Reviewed samples which may be used in the Work are indicated in individual specification sections.

1.8 Manufacturer Installation Instructions

- A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to the Engineer in quantities specified for Product Data.
- B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.9 Manufacturer Certificates

- A. When specified in individual specification sections, submit certification by manufacturer to the Engineer, in quantities specified for Product Data.
- B. Indicate material or Product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- C. Certificates may be recent or previous test results on material or Product, but must be acceptable to the Engineer.

END OF SECTION

SECTION 01340
SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

GENERAL

1.01 Requirements Included

Submit Shop Drawings, Product Data and Samples required by Contract Documents.

1.02 Related Requirements

- A. Definitions, and Additional Responsibilities of Parties: Conditions of the Contract.
- B. Section 01720: Project Record Documents.
- C. Designate in the construction schedule, or in a separate coordinated schedule, the dates for submission and the dates that reviewed Shop Drawings, Product Data and Samples will be needed.

1.03 Shop Drawings

Drawings shall be presented in a clear and thorough manner.

Details shall be identified by reference to sheet and detail, schedule or room numbers shown on Contract Drawings.

1.04 Product Data

- A. Preparation:
 - 1. Clearly mark each copy to identify pertinent products or models.
 - 2. Show performance characteristics and capacities.
 - 3. Show dimensions and clearances required.
 - 4. Coordinate with Electro-Mechanical contractor wiring or piping diagrams and controls.
- B. Manufacturer's standard schematic drawings and diagrams:
 - 1. Modify drawings and diagrams to delete information which is not applicable to the Work.
 - 2. Supplement standard information to provide information specifically applicable to the Work.

1.05 Samples

- A. Office samples shall be of sufficient size and quantity to clearly illustrate:
 - 1. Functional characteristics of the product, with integrally related parts and attachment devices.
 - 2. Full range of color, texture and pattern.
- B. Field samples and mock-ups:
 - 1. Contractor shall erect, at the Project site, at a location acceptable to the Engineer
 - 2. Size or area: that specified in the respective specification section.
 - 3. Fabricate each sample and mockup complete and finished.
 - 4. Remove mock-ups at conclusion of Work or when acceptable to the Engineer.

1.06 Contractor Responsibilities

- A. Review Shop Drawings, Product Data and Samples prior to submission.
- B. Determine and verify:
 - 1. Field measurements.
 - 2. Field construction criteria.
 - 3. Catalog numbers and similar data.
 - 4. Conformance with specifications.
- C. Coordinate each submittal with requirements of the Work and of the Contract Documents.
- D. Notify the Engineer in writing, at time of submission, of any deviations in the submittals from requirements of the Contract Documents.
- E. Begin no fabrication or work which requires submittals until return of submittals with the Engineer approval.

1.07 Submission Requirements

- A. Make submittals promptly in accordance with approved schedule, and in such sequence as to cause no delay in the Work or in the work of any other contractor.
- B. Number of submittals required:
 - 1. All in accordance with Contract Documents.
- C. Submittals shall contain: All in accordance with Contract Documents.

1.08 Resubmission Requirements

- A. Make any corrections or changes in the submittals required by the Supervising Engineer and resubmit until approved.
- B. Shop Drawings and Product Data:
 - 1. Revise initial drawings or data, and resubmit as specified for the initial submittal.
 - 2. Indicate any changes which have been made other than those requested by the Engineer.
- C. Samples: Submit new samples as required for initial submittal.

1.09 Distribution

- A. Distribute reproductions of Shop Drawings and copies of Product Data which carry the Engineer stamp of approval to:
 - 1. Job site file.
 - 2. Record Documents file.
 - 3. Other affected contractors.
 - 4. Subcontractors.
 - 5. Supplier or Fabricator.
 - 6. As directed by the Engineer.
- B. Distribute samples which carry the Engineer stamp of approval as directed by the Engineer.

1.10 Engineer Duties

- A. Review submittals with reasonable promptness and in accordance with schedule.
- B. Affix stamp and initials or signature, and indicate requirements for resubmittal, or approval of submittal.
- C. Return submittals to Contractor for distribution, or for resubmission.

END OF SECTION

SECTION 01400
QUALITY CONTROL

PART 1 GENERAL

1.01 Requirements Included

- A. General Quality Control.
- B. Manufacturers' Field Services.

1.02 Related Requirements

Conditions of the Contract: Inspection and testing required by governing authorities.

1.03 Quality Control, General

Maintain quality control over suppliers, manufacturers, Products, services, site conditions, and workmanship, to produce work of specified quality.

1.04 Manufacturers' Field Services

- A. When specified in respective Specification sections, require supplier or manufacturer to provide qualified personnel to observe field conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment as applicable, and to make appropriate recommendations.
- B. Representative shall submit written report to the Engineer listing observations and recommendations.

END OF SECTION

SECTION 01540
SECURITY

GENERAL

1.01 Requirements Included

Provide a project security program, to:

1. Protect Work, stored products and construction equipment from theft and vandalism.
2. Protect premises from entry by unauthorized persons.

1.02 Related Requirements

- A. Section 01200: Project Meetings.
- B. Section 01500: Construction Facilities and Temporary Controls.

1.03 Maintenance Of Security

- A. Initiate security program promptly after job mobilization, when enclosure fence and gates are installed.
- B. Maintain security program throughout construction period, until Employer occupancy or Employer acceptance precludes the need for Contractor security.

1.04 Guard Service

Employ a recognized guard service to provide a watchman service, which shall be in effect:

- At all times day or night when general construction work is not in progress.

END OF SECTION

SECTION 01600
MATERIAL AND EQUIPMENT

GENERAL

1.01 Requirements Included

- A. Products.
- B. Workmanship.
- C. Manufacturers' Instructions.
- D. Transportation and Handling.
- E. Storage and Protection.

1.02 Related Requirements

- A. Section 01010 - Summary of Work.
- B. Section 01700 - Contract Close-out.

1.03 Products

- A. Products include material, equipment, and systems.
- B. Comply with Specifications and referenced standards as minimum requirements.
- C. Components required to be supplied in quantity within a Specification section shall be the same, and shall be interchangeable.

1.04 Workmanship

- A. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.
- B. Perform work by persons qualified to produce workmanship of specified quality.
- C. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking.

1.05 Manufacturers' Instructions

- A. When work is specified to comply with manufacturers' instructions, submit copies as specified in Conditions of Contract, distribute copies to persons involved, and maintain one set in field office.
- B. Perform work in accordance with details of instructions and specified requirements. Should a conflict exist between Specifications and instructions, consult with the Engineer.

1.06 Transportation And Handling

- A. Transport Products by methods to avoid Product damage; deliver in undamaged condition in manufacturer's unopened containers or packaging, dry.
- B. Provide equipment and personnel to handle Products by methods to prevent soiling or damage.
- C. Promptly inspect shipments to assure that Products comply with requirements, quantities are correct, and Products are undamaged.

1.07 Storage And Protection

- A. Store Products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive Products in weather-tight enclosures; maintain within temperature and humidity ranges required by manufacturer's instructions.
- B. For exterior storage of fabricated Products, place on sloped supports above ground. Cover Products subject to deterioration with impervious sheet covering; provide ventilation to avoid condensation.
- C. Store loose granular materials on solid surfaces in a well-drained area; prevent mixing with foreign matter.
- D. Arrange storage to provide access for inspection. Periodically inspect to assure Products are undamaged, and are maintained under required conditions.
- E. After installation, provide coverings to protect Products from damage from traffic and construction operations, remove when no longer needed.

END OF SECTION

SECTION 01630
SUBSTITUTIONS AND PRODUCT OPTIONS

PART 1 GENERAL

1.01 Requirements Included

Furnish and install Products specified, under options and conditions for substitutions stated in this Section.

1.02 Related Requirements

- A. Section 01400: Quality Control.
- B. Section 01720: Project Record Documents.

1.03 Products List

- A. Within 30 days after award of Contract, submit to the Engineer five copies of complete list of major products which are proposed for installation.
- B. Tabulate Products by specification section number and title.
- C. For products specified only by reference standards, list for each such Product:
 - 1. Name and address of manufacturer.
 - 2. Trade name.
 - 3. Model or catalog designation.
 - 4. Manufacturer's data:
 - a. Reference standards.
 - b. Performance test data.

1.04 Contractor's Options

- A. For Products specified only by reference standard, select Product meeting that standard, by any manufacturer.
- B. For Products specified by naming several Products or manufacturers, select any one of products and manufacturers named which complies with Specifications.

1.05 Substitutions

- A. Within a period of 30 days after award of Contract, the Engineer will consider formal requests from the Contractor for substitution of Products in place of those specified.

After end of that period, requests will be considered only in case of Product unavailability or other conditions beyond the control of Contractor.
- B. Submit separate request for each substitution. Support each request with:
 - 1. Complete data substantiating compliance of proposed substitution with requirements stated in Contract Documents:
 - a. Product identification, including manufacturer's name and address.
 - b. Manufacturer's literature; identify.
 - 1) Product description.
 - 2) Reference standards.
 - 3) Performance and test data.
 - c. Samples, as applicable.
 - d. Name and address of similar projects on which product has been used, and date of each installation.
 - 2. Itemized comparison of the proposed substitution with product specified; List significant variations.
 - 3. Data relating to changes in construction schedule.
 - 4. Any effect of substitution on separate contracts.
 - 5. List of changes required in other work or Products.
 - 6. Accurate cost data comparing proposed substitution with product specified.
 - a. Amount of any net change to Contract Sum.
 - 7. Designation of required license fees or royalties.
 - 8. Designation of availability of maintenance services, sources of replacement materials.

1.05 Substitutions (cont'd)

- C. Substitutions will not be considered for acceptance when:
 - 1. They are indicated or implied on shop drawings or product data submittals without a formal request from Contractor.
 - 2. They are requested directly by a subcontractor or supplier.
 - 3. Acceptance will require substantial revision of Contract Documents.
- D. Substitute products shall not be ordered or installed without written acceptance of the Engineer.
- E. The Engineer will determine acceptability of proposed substitutions.

1.06 Contractor's Representation

In making formal request for substitution Contractor represents that:

- 1. He has investigated proposed product and has determined that it is equal to or superior in all respects to that specified.
- 2. He will provide same warranties or bonds for substitution as for product specified.
- 3. He will coordinate installation of accepted substitution into the Work, and will make such changes as may be required for the Work to be complete in all respects.
- 4. He waives claims for additional costs caused by substitution which may subsequently become apparent.
- 5. Cost data is complete and includes related costs under his Contract, but not:
 - a. Costs under separate contracts.
 - b. The Engineer's costs for redesign or revision of Contract Documents.

1.07 Engineer's Duties

- A. Review Contractor's requests for substitutions with reasonable promptness.
- B. Notify Contractor, in writing, of decision to accept or reject requested substitution.

END OF SECTION

SECTION 01700
CONTRACT CLOSE-OUT

GENERAL

1.01 Requirements Included

- A. Close-out Procedures.
- B. Final Cleaning.
- C. Systems Demonstration
- D. Warranties and Bonds

1.02 Related Requirements

- A. Conditions of the Contract.
- B. Section 01500 - Construction Facilities and Temporary Controls.

1.03 Close-out Procedures

- A. Comply with procedures stated in General Conditions of the Contract for issuance of Certificate of Substantial Completion.
- B. When Contractor considers Work has reached final completion, submit written certification that Contract Documents have been reviewed, work has been inspected, and that Work is complete in accordance with Contract Documents and ready for the Engineer's inspection.
- C. In addition to submittals required by the conditions of the Contract, provide submittals required by governing authorities, and submit a final statement of accounting giving total adjusted Contract Sum, previous payments, and sum remaining due.
- D. The Engineer will issue a final change order reflecting approved adjustments to Contract Sum not previously made by Change Order.

1.04 Final Cleaning

- A. Execute prior to final inspection.
- B. Remove waste and surplus materials, rubbish, and construction facilities from the Project and from the site. Owner will provide final cleaning after final acceptance.

1.05 Operation and Maintenance Data

Provide data as required by Contract Documents.

1.06 Systems Demonstration

Prior to final inspection, demonstrate operation of each system to the Engineer and Employer.

1.07 Warranties and Bonds

- A. Provide duplicate, notarized copies. Execute Contractor's submittals and assemble documents executed by subcontractors, suppliers, and manufacturers. Provide table of contents and assemble in binder with durable plastic cover.
- B. Submit material prior to final application for payment. For equipment put into use with Employer's permission during construction, submit within 10 days after first operation. For items of Work delayed materially beyond Date of Substantial Completion, provide updated submittal within ten days after acceptance, listing date of acceptance as start of warranty period.

END OF SECTION

SECTION 01710

CLEANING

GENERAL

1.01 Requirements Included

Execute cleaning, during progress of the Work, and at completion of the Work, as required by General Conditions.

1.02 Related Requirements

- A. Conditions of the Contract.
- B. Each Specification Section: Cleaning for specific Products or work.

1.03 Disposal Requirements

Conduct cleaning and disposal operations to comply with codes, ordinances, regulations, and anti-pollution laws.

PART 2 PRODUCTS

2.01 Materials

- A. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.
- B. Use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.
- C. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 EXECUTION

3.01 During Construction

- A. Execute periodic cleaning to keep the Work and the site free from accumulations of waste materials, rubbish and windblown debris, resulting from construction operations and/or demolition works.
- B. Provide on-site containers for the collection of waste materials, debris and rubbish.
- C. Remove waste materials, debris and rubbish from the site periodically and dispose of at legal disposal areas away from the site.

3.02 Dust Control

- A. Clean interior spaces and continue cleaning on an as-needed basis to the satisfaction of the Engineer.
- B. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on already cleaned surfaces.

3.03 Final Cleaning

- A. Broom clean exterior surfaces; rake clean other surfaces of the grounds.
- B. Prior to final completion, or Employer occupancy, Contractor shall conduct an inspection of sight-exposed interior and exterior surfaces, and all work areas, to verify that the entire work is clean.

END OF SECTION

SECTION 01720
PROJECT RECORD DOCUMENTS

GENERAL

1.01 Requirements Included

- A. Maintain at the site for the Employer one record copy of:
 - 1. Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other Modifications to the Contract.
 - 5. Engineer Field Orders or written instructions.
 - 6. Approved Shop Drawings, Product Data and Samples.
 - 7. Field Test records.
 - 8. Construction photographs.
- B. As-Built Drawings.

1.02 Related Requirements

- A. Conditions of Contract.
- B. Section 01340: Shop Drawings, Product Data and Samples.
- C. Section 01380: Construction Photographs.

1.03 Maintenance Of Documents And Samples

- A. Store documents and samples in Contractor's field office apart from documents used for construction.
 - 1. Provide files and racks for storage of documents.
 - 2. Provide locked cabinet or secure storage space for storage of samples.
- B. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
- C. Make documents and samples available at all times for inspection by the Engineer.
- E. Materials
The materials required for maintenance to be submitted after Provisional Acceptance of the work.
 - 1. Shop drawings for all the work to be submitted.
 - 2. As-built drawings/documentation shall be submitted as follows:-
 - i. One polyester copy and 6 paper copies of each drawing fully checked and approved by the Consultant.
 - ii. Diskettes of all drawings/documentation.
 - 3. Three sets each of any other documents required.

1.04 Marking Devices

Provide felt tip marking pens for recording information in the color code designated by the Engineer.

1.05 Recording

- A. Label each document "PROJECT RECORD" in neat large printed letters.
- B. Record information concurrently with construction progress.
 - 1. Do not conceal any work until required information is recorded.
- C. Drawings; Legibly mark to record actual construction:
 - 1. Depths of various elements of foundation in relation to finish first floor datum.
 - 2. Horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - 3. Location of internal utilities and appurtenances concealed in the construction, referenced to visible and accessible features of the structure.
 - 4. Field changes of dimension and detail.
 - 5. Changes made by Field Order or by Change Order.
 - 6. Details not on original contract drawings.

1.05 Recording (cont'd)

- D. Specifications and Addenda; Legibly mark each Section to record:
 - 1. Manufacturer, trade name, catalog number, and Supplier of each Product and item of equipment actually installed.
 - 2. Changes made by Field Order or by Change Order.
- E. Refer to attachment to this Section of Specifications for general guidelines in preparation of record documents.

1.06 Submittal

- A. At Contract close-out, deliver Record Documents to the Engineer and for the Employer.
- B. Accompany submittal with transmittal letter in duplicate, containing:
 - 1. Date.
 - 2. Project title and number.
 - 3. Contractor's name and address.
 - 4. Title and number of each Record Document.
 - 5. Signature of Contractor or his authorized representative.

END OF SECTION

SECTION 01730
OPERATING AND MAINTENANCE DATA

GENERAL

1.01 Requirements Included

- A. Compile product data and related information appropriate for Owner's maintenance and operation of products furnished under Contract.
- B. Instruct Owner's personnel in maintenance of products and in operation of equipment and systems.

1.02 Related Requirements

- A. Section 01340: Shop Drawings, Product Data & Samples.
- B. Section 01700: Contract Close-out.
- C. Section 01720: Project Record Documents and attachment.

1.03 Quality Assurance

Preparation of data shall be done by personnel:

- 1. Trained and experienced in maintenance and operation of described products.
- 2. Familiar with requirements of this Section.
- 3. Skilled as technical writer to the extent required to communicate essential data.
- 4. Skilled as draftsman competent to prepare required drawings.

1.04 Form Of Submittals

Prepare data in form of an instructional manual for use by Owner's personnel all in accordance with Conditions of Contract.

1.05 Content Of Manual

- A. Neatly typewritten table of contents for each volume, arranged in systematic order.
 - 1. Contractor, name of responsible principal, address and telephone number.
 - 2. A list of each product required to be included, indexed to content of the volume.
 - 3. List, with each product, name, address and telephone number of:
 - a. Subcontractor or installer.
 - b. Maintenance contractor, as appropriate.
 - c. Identify area of responsibility of each.
 - d. Local source of supply for parts and replacement.
 - 4. Identify each product by product name and other identifying symbols as set forth in Contract Documents.
 - B. Product Data:
 - 1. Include only those sheets which are pertinent to the specific product.
 - 2. Annotate each sheet to:
 - a. Clearly identify specific product or part installed.
 - b. Clearly identify data applicable to installation.
 - c. Delete references to inapplicable information.
- Drawings:
- 1. Supplement product data with drawings as necessary to clearly illustrate:
 - a. Relations of component parts of equipment and systems.
 - b. Control and flow diagrams.
 - 2. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation.
 - a. Do not use Project Record Documents as maintenance drawings.

1.05 Content Of Manual (cont'd)

- C. Written text, as required to supplement product data for the particular installation:
 - 1. Organize in consistent format under separate headings for different procedures.
 - 2. Provide logical sequence of instructions for each procedure.
- D. Copy of each warranty and bond issued.
 - Provide information sheet for Owner's personnel, give:
 - a. Proper procedures in event of failure.
 - b. Instances which might affect validity of warranties or bonds.

1.06 Manual For Materials And Finishes

- A. Submit four copies of complete manual in final form.
- B. Content; for architectural products, applied materials and finishes:
 - 1. Manufacturer's data, giving full information on products.
 - a. Catalog number, size, composition.
 - b. Color and texture designations.
 - c. Information required for re-ordering special- manufactured products.
 - 2.. Instructions for care and maintenance.
 - a. Manufacturer's recommendation for types of cleaning agents and methods.
 - b. Cautions against cleaning agents and methods which are detrimental to product.
 - c. Recommended schedule for cleaning and maintenance.
 - d. Content, for moisture-protection and weather-exposed products:
 - Manufacturer's data, giving full information on products.
 - a. Applicable standards.
 - b. Chemical composition.
 - c. Details of installation.
 - 3. Instructions for inspection, maintenance, and repair.
- C. Additional requirements for maintenance data: Respective sections of Specifications.

1.07 Manual For Equipment And Systems

- A. Submit four copies of complete manual in final form.
- B. Content, for each unit of equipment and system, as appropriate:
 - 1. Description of unit and component parts.
 - a. Function, normal operating characteristics, and limiting conditions.
 - b. Performance curves, engineering data and tests.
 - c. Complete nomenclature and commercial number of replaceable parts.
 - 2. Operating procedures:
 - a. Start-up, break-in, routine and normal operating instructions.
 - b. Regulation, control, stopping, shut-down and emergency instructions.
 - c. Summer and winter operating instructions.
 - d. Special operating instructions.
 - 3. Maintenance Procedures:
 - a. Routine operations.
 - b. Guide to "Trouble-shooting".
 - c. Disassembly, repair and re-assembly.
 - d. Alignment, adjusting and checking.
 - 4. Servicing and lubrication schedule.
 - List of lubricants required.
 - 5. Manufacturer's printed operating and maintenance instructions.
 - 6. Description of sequence of operation by control manufacturer.
 - 7. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
 - a. Predicted life of parts subject to wear.
 - b. Items recommended to be stocked as spare parts.

1.07**Manual For Equipment And Systems (cont'd)**

8. As-installed control diagrams by controls manufacturer.
9. Each contractor's coordination drawings.
 - As-installed color coded piping diagrams.
10. Charts of valve tag numbers, with location and function of each valve.
11. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.
12. Other data as required under pertinent sections of specifications.
- C. Content, for each electric and electronic system, as appropriate:
 1. Description of system and component parts.
 - a. Function, normal operating characteristics, and limiting conditions.
 - b. Performance curves, engineering data and tests.
 - c. Complete nomenclature and commercial number of replaceable parts.
 2. Circuit directories of panel boards.
 - a. Electrical service.
 - b. Controls.
 - c. Communications.
 3. As-installed color coded wiring diagrams.
 4. Operating procedures:
 - a. Routine and normal operating instructions.
 - b. Sequences required.
 - c. Special operating instructions.
 5. Maintenance procedures:
 - a. Routine operations.
 - b. Guide to "trouble-shooting".
 - c. Disassembly, repair and re-assembly.
 - d. Adjustment and checking.
 6. Manufacturer's printed operating and maintenance instructions.
 7. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.
 8. Other data as required under pertinent sections of specifications.
- D. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel.
- E. Additional requirements for operating and maintenance data: Respective sections of Specifications.

1.08**Submittal Schedule**

- A. Submit two copies of preliminary draft of proposed formats and outlines of contents prior to start of work.
 - The Supervising Engineer/Owner's Representative will review draft and return one copy with comments.
- B. Submit one copy of completed data in final form fifteen days prior to final inspection or acceptance.
 - Copy will be returned after final inspection or acceptance, with comments.
- C. Submit specified number of copies of approved data in final form 10 days after final inspection or acceptance.

1.09**Instruction Of Owner's Personnel**

- A. Prior to final inspection or acceptance, fully instruct Owner's designated operating and maintenance personnel in operation, adjustment and maintenance of products, equipment and systems.
- B. Operating and maintenance manual shall constitute the basis of instruction.
 - Review contents of manual with personnel in full detail to explain all aspects of operations and maintenance.

END OF SECTION

SECTION 06200
FINISH CARPENTRY

GENERAL

1.01 Work Included

Finish carpentry items, such as wooden counters, complete with required hardware and attachment accessories.

1.02 Related Work

Section 09900: Painting.

1.03 Quality Assurance

- A. Perform finish carpentry work in accordance with recommendations of the Millwork Standards of the Architectural Woodwork Institute (AWI).
- B. Fire retardant treatment to conform to requirements of underwriters' laboratories (UL).

1.04 Reference Standards

MILLWORK STANDARDS

- A. PS 1 - Construction and Industrial Plywood.
- B. PS 20 - American Softwood Lumber Standard.
- C. PS 51 - Hardwood and Decorative Plywood.
- D. PS 58 - Basic Hardwood.

1.05 Samples

Submit 300 mm X 200mm size sample of each type of hardwood, to receive field applied stain or natural finish indicating required grade and finish.

1.06 Shop Drawings

- A. Submit shop drawings in accordance with Section 01340.
- B. Indicate materials, component profiles, fastening, jointing details, finishes, accessories, to large scale.

1.07 Delivery And Storage

- A. Do not deliver finish carpentry items until, in the opinion of Engineer, Site conditions are adequate to receive the work of this Section. Protect materials from weather while in transit.
- B. Store indoors, in ventilated areas with a constant but minimum temperature of 16 deg. C. and relative humidity of 25 to 55 percent.

PART 2 PRODUCTS

2.01 Acceptable Manufacturers

The Contractor shall submit to the Engineer the names of three manufacturers and their products which will be acceptable under this Section. Approval of the manufacturer or product must be obtained before proceeding with associated work.

2.02 Sheet Materials

Hardwood Plywood: PS 51; graded in accordance with AWI; core material of lumber; type of bond recommended for application.

2.03 Finish Materials

Finish wooden counters as shown on drawings.

2.04 Installation

- A. Perform finish carpentry work to extent indicated in "Schedule of Items" at the end of this section. Construction joining and prefinishing of assemblies and items: Premium grade, as established by AWI.
- B. Set and secure materials and components in place, rigid, plumb, and square.
- C. Ensure all mechanical and electrical items affecting this Section of work are properly placed, complete, and have been inspected by the Engineer prior to commencement of installation.
- D. Prime paint contact surfaces of items and assemblies in contact with cementitious materials.
- E. Install hardware and accessories supplied under other sections for installation.
- F. Install hardware in accordance with manufacturer's recommendations.
- G. Apply clear lacquer paint finishes. Adhere over entire surface. Make joints and corners hairline. Match patterns. Slightly bevel arrises.

2.05 Preparation For Finishing

- A. Sand work smooth and set exposed nails and screws. Apply wood filler in exposed nail and screw indentations and leave ready to receive Site-applied finishes. On items to receive transparent finishes, use wood filler which matches surrounding surfaces, and of types recommended for applied finishes.
- B. Seal, stain and varnish concealed and semi-concealed surfaces. Brush apply only.
- C. Seal surfaces in contact with cementitious materials.

2.06 Schedule

Interior

Finish: As shown on drawing.

END OF SECTION

SECTION 08110
STEEL DOORS

GENERAL

1.01 Work Included

- A. Standard steel hollow metal doors and panels and frames, with flush faces.
- B. Standard louvered steel doors and screens.
- C. Hardware for Class "A" labeled doors and panels.
- D. Install hardware and louvers.
- E. Paint.

1.02 Related Work

- A. Section 08111: Standard Steel Frames.
- B. Section 08700: Hardware.

1.03 Reference Standards

- A. *SDI-100*: Recommended Specifications-Standard Steel Doors and Frames of Steel Door Institute.
- B. *Underwriters' Laboratories Inc.:* (UL) and Factory Manual (FM), as applicable to fire rated hollow metal doors.
- C. ASTM A525: Steel Sheet, Zinc Coated (Galvanized) by the Hot Dip Process, General Requirements.
- D. ASTM A591: Steel Sheet, Cold-Rolled, Electrolytic Zinc Coated.
- E. ASTM A366: Steel, Carbon, Cold-Rolled Sheet, Commercial Quality.

1.04 Shop Drawings And Product Data

- A. Submit shop drawings and product data in accordance with Section 01340.
- B. Indicate general construction, configurations, jointing methods, reinforcements, and locations of cut-outs for louvers.

PART 2 PRODUCTS

2.01 Acceptable Manufacturers

- A. The Contractor shall submit to the Engineer the names of three manufacturers and their products which will be acceptable under this Section. Approval of the manufacturer or product must be obtained before proceeding with associated work.
- B. Substitutions: Items of same function and performance are acceptable in conformance with Section 01630.

2.02 Hollow Metal Doors [And Panels]

Hollow metal doors shall be purpose made to the profiles and sizes shown on the drawings and obtained from an approved manufacturer. The doors shall be delivered to site complete with a factory applied anti-corrosive plastic coating, ties cast on to baks of frames for building in and rubber silencers on the locking stile.

- A. Materials and Fabrication: SDI-100 except as amended in this Section.
- B. Door Frame: (150x65x3)mm galvanized steel sheet filled with concrete.
- C. Door Leaf: : 40mm thick hollow galvanized metal steel tube as detailed, with 3mm thick steel sheet, galvanized profiled stiffener every 25 cm and mineral fiber.
- D. Louvers: Stationary and adjustable as required, and as shown on the approved Shop Drawings (45x35x2)mm.

2.03 Hardware

- A. for Class "A" labeled doors.
- B. Install butts on Class "A" labeled doors prior to delivery. Install in accordance with UL requirements.

2.04 Fabrication

- A. Mechanically interlock longitudinal seams of honeycomb core type doors and panels with mineral fiber insulations. Leave seams invisible, or weld, fill and grind smooth
- B. Reinforce and prepare doors and panels to receive hardware. Refer to Section 08700 for hardware requirements and schedules.
- C. Fill surface depressions with metallic paste filler and grind to smooth uniform finish.
- D. Touch up areas where coating has been removed due to sanding or handling.
- E. Chemically treat surfaces and apply one coat of primer.
- F. Paint.

PART 3 EXECUTION

3.01 Installation

- A. Install doors in accordance with SDI-100 except as amended in this Section.
- B. Install hollow metal doors plumb and square, and with maximum diagonal distortion of 2 mm. Install hardware in accordance with requirements of Section 08700.

END OF SECTION

SECTION 08111
STANDARD STEEL FRAMES

GENERAL

1.01 Work Included

Standard and fire rated pressed steel hollow metal door frames.

1.02 Related Work

- A. Section 08110: Standard Steel Doors
- B. Section 08210: Wood Doors
- C. Section 08700: Hardware
- D. Section 08800: Glazing

1.03 Reference Standards

- A. SDI-100: Recommended Specifications-Standard Steel Doors and Frames of Steel Door Institute.
- B. Underwriters' Laboratories Inc. (UL), and Factory Mutual (FM), as applicable to fire rated hollow metal door frames.
- C. ASTM A591: Steel Sheet, Cold-Rolled, Electrolyte Zinc Coated.
- D. ASTM A366: Steel, Carbon, Cold-Rolled Sheet, Commercial Quality.

1.04 Shop Drawings and Product Data

- A. Submit shop drawings and product data in accordance with Section 01340.
- B. Indicate general construction, configurations, jointing methods, reinforcements, anchorage methods, hardware locations and installation details.

PART 2 PRODUCTS

2.01 Acceptable Manufacturers

- A. The Contractor shall submit to the Engineer the names of three manufacturers and their products which will be acceptable under this Section. Approval of the manufacturer or product must be obtained before proceeding with associated work.
- B. Substitutions: Items of same function and performance are acceptable in conformance with Section 01630.

2.02 Hollow Metal Frames

- A. Materials and Fabrication: SDI-100 except as amended in this Section.
- B. Types: Knockdown Frames.
- C. Mortar Guard Boxes: minimum 0.76 mm thick welded in place.
- D. Door Bumpers: manufacturer's standard resilient type; removable for replacement.

2.03 Fabrication

- A. Accurately form interlocking joints of knocked down frames to maintain alignment of parts when field assembled.
- B. Accurately cope and securely weld butt joints of mullions and transoms. Grind welded joints to smooth uniform finish.
- C. Reinforce head sections where mullions occur.
- D. Reinforce frames wider than 1200 mm with 2.5 mm thick formed steel channels weld in place, flush with top of frames.
- E. Reinforce and prepare frames to receive hardware. Refer to Section 08700 for hardware requirements.
- F. Place minimum of 3 single bumpers on single door frames. Space equally along strike jambs.
- G. Place minimum of 2 single bumpers on double door frames. Place on frame heads.
- H. Provide jamb anchors: SDI-100. Weld floor jamb anchors in place.
- I. Fill surface depressions of hollow metal frames with metallic paste filler and grind to smooth finish.
- J. Touch up areas where coating has been removed due to sanding or handling.
- K. Chemically treat surfaces and apply one coat of primer, and two powder coated paint.

PART 3 EXECUTION

3.01 Installation

- A. Install door frames in accordance with SDI-100 except as amended in this Section.
- B. Install hollow metal frames plumb and square, in correct locations indicated on drawings and with a maximum diagonal distortion of 2 mm. Ensure frames are securely and rigidly anchored to adjacent construction.
- C. After installation, touch-up scratched or damaged surfaces. Use type of primer identical to that used for shop coat.

END OF SECTION

SECTION 23 07 00
HVAC INSULATION

PART 1 GENERAL

- 1.1 Scope of Work
- 1.2 Related Works Specified Elsewhere
- 1.3 Schedule of Insulation Thickness
- 1.4 Codes and Standards

PART 2 PRODUCTS

- 2.1 Duct Insulation
- 2.2 Pipe Insulation - Type B
- 2.3 Vapour Barrier Coating
- 2.4 Aluminium Cladding

PART 3 EXECUTION

- 3.1 Protection and Cleaning
- 3.2 Installation of Equipment and Duct Insulation

SECTION 23 07 00

HVAC INSULATION

PART 1 GENERAL

Works of this Section shall be governed by Conditions of Contract.

1.1 Scope of Work

- 1.1.1 Supply and install all insulation and lagging on piping, vessels or ducts as indicated on the drawings or specified to be insulated.
- 1.1.2 All insulation material shall have Zero Ozone Depletion Potential (ODP=0) and less than Five Global Warming Potential (GWP <5)..
- 1.1.3 Canvas jacket and all insulating materials shall be non-combustible, or self-extinguishing non-flame spread grade.
- 1.1.4 Insulation in exposed areas, i.e. permanently visible, shall be protected with aluminium cladding as specified herein after.

1.2 Related Works Specified Elsewhere

- 1.2.1 All items specified in this section are included in each of the following divisions, sections and sub-sections as applicable, as if repeated therein verbatim.

Section 230500	-Common Works Results for HVAC
Section 230900	-Instrumentation and Controls for HVAC
Section 232000	-HVAC Piping and Pumps
Section 233000	-HVAC Air Distribution
Section 2340 00	-Air Cleaning Devices
Section 235000	-Central Heating Equipment
Section 236000	-Central Cooling Equipment
Section 237000	-Central HVAC Equipment
Section 238000	-Decentralized HVAC Equipment

1.3 Schedule of Insulation Thickness

- 1.3.1 The thickness of the insulation applied to pipes, ducts and equipment shall be as stated hereinafter

Service	Location	Pipe Diameter inches (mm)	Insulation Thickness inches (mm)
- A/C condensate drain pipes	-	-	½ (13)
- Supply and return air ducts	In conditioned spaces	-	1½ (38)
- Ditto	In unconditioned spaces	-	2 (50)
- Untreated fresh air duct	Passing through air plenum	-	1 (25)
- Refrigerant suction and liquid lines	-	-	¾ (20)

1.4 Codes and Standards

- 1.4.1 Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing

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standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations.

Reference Code	Abbreviation	Applicable Standard	Title of Standard
National Fire Protection Association	NFPA	NFPA90A	Standard for Air Conditioning and Ventilating Systems.
		NFPA90B	Standard for warm Air Heating and Air Conditioning Systems.
American Society for Testing and Materials	ASTM	ASTME96	Test method for water vapor transmission of materials

PART 2 PRODUCTS

2.1 Duct Insulation

2.1.1 Duct insulation in air-conditioned spaces shall be blankets of fibrous glass with a density of not less than 1.5lb/ft³ (24 kg/m³) and aK-factor of not more than 0.26 Btu-in/ft² hr. deg. F(0.038 W/m deg. K) at a mean temperature of75deg. F(24deg C) for concealed insulation.

2.1.2 Duct insulation in an air-conditioned spaces, mechanical rooms, and shafts shall be rigid board of fiber glass with areas in binder and a density of not less than 4lb/ft³ (64 kg/m²) and a K-factor of not more than 0.25 Btu-ln/ft² hr. of (0.036 W/m O K) at a mean temperature of75^OF(24^OC) for outdoor application.

2.1.3 For cold air application, insulation shall be faced with factory applied reinforced foil and paper which comprises aluminum foil reinforced with fiber glass yarn mesh and laminated to 40lbs chemically treated fire retardant Kraft.

2.1.4 50x50x0.6mm galvanized sheet metal angles shall be attached at corners.

2.2 PipeInsulation-TypeB

2.2.1 This type of insulation shall apply to Refrigerant pipes and AC condensate drain pipes.

2.2.2 Insulation shall be flexible foamed closed cell elastomeric tubular form type. Insulation may be slipped over pipe or tubing before pipe connections are made, or may be slit longitudinally and snapped on to the pipe and then sealed with vapor barrier adhesive.

2.2.3 Insulation shall have a thermal conductivity not greater than 0.27 BTU /HrOF.ftsq. per inch thickness at a mean temperature of75°F.

2.2.4 The surface finish shall be an8-ounce canvas cloth embedded between 2coats of vapor barrier. Aluminum cladding shall be provided as specified.

2.3 Vapor Barrier Coating

2.3.1 The vapour barrier coating shall be tough flexible fire resistive elastomeric finish for protection of thermal insulation. It shall meet the requirements of NFPA90A and 90B and shall be UL classified.

2.3.2 The vapor barrier shall have water vapor permeability not more than 0.02perms at 0.75 mm dry film thickness when tested to ASTME96 Method.

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- 2.3.3 When tested for surface burning characteristics (ASTME84) it shall have a flame spread rating not exceeding 10 and smoke developed not higher than 15.
- 2.3.4 The vapor barrier shall be suitable for application by brush or spray. It shall be applied in 2 coats with heavy duty fire retardant canvas cloth (8ounce) embedded between the coats. Canvas over lap at joints shall be at least 50mm. The wet film thickness of each coats shall be at least 1.25mm.
- 2.3.5 Vapor barrier coating shall be applied above thermal insulation of G.I. Ducts, Water supply (hot and cold), refrigeration and condensate rain pipes.

2.4 Aluminum Cladding

- 2.4.1 Aluminum cladding shall be of 20 gauge. It shall be used as protection against weather and mechanical damage.
- 2.4.2 Aluminum cladding shall be applied on top of insulation above the canvas jacket and vapor barrier coating. It shall be held in place by means of self tapping screws and by using 38mm wide aluminum straps at 300mm centers with aluminum or stainless steel angle rib clips, all joints shall be sealed with grey colored suitable sealant. Rivets and screws shall not be used for cladding unless approved by the Engineer for use on elbows and fittings. Cladding shall be over lapping at joints, horizontal seams shall be at the bottom. Cladding on ducts shall be formed in such away to allow for rain/dew drain off.
- 2.4.3 Fabricated 20 gauge aluminum covers shall be used for valves and fittings. The covers shall be in two sections hinged together and held in place by suitable stainless steel/aluminum clasps.
- 2.4.4 Aluminum cladding shall be applied to all insulated ducts running exposed on roof, outside building, inside parking floors and in plant rooms.

PART 3 EXECUTION

3.1 Protection and Cleaning

- 3.1.1 All insulation shall have a smooth, homogenous and line able finished surface. All rigid sections shall be concentric and be accurately matched for thickness.
- 3.1.2 All surface to be insulated shall be dry and free from loose scale dirt, oil or water when insulation is applied.
- 3.1.3 Insulation shall be applied in such a manner that air circulation within the insulation or between the insulation and the pipe shall be avoided.
- 3.1.4 No surface imperfections in the insulation such as damaged edges, or ends, cracks and small voids or holes shall be accepted.
- 3.1.5 Insulation materials shall be stored and protected from weather moisture, accumulations of foreign matter, or possible damage in a dry and clean store.
- 3.1.6 Surface finishes and lagging adhesives shall not be diluted and shall be applied in accordance with the manufacturer's instructions.
- 3.1.7 Apply insulation to permit expansion or contraction of metal without causing damage to insulation or surface finish.

3.2 Installation of Equipment and Duct Insulation

- 3.2.1 Curved or cylindrical equipment shall be insulated with blocks or curved segments in one layer for thicknesses of 65mm or less and two layers for thicknesses of 76mm or more. The insulation shall be applied with joints staggered and tightly butted together and held in place with bands. Square cornered equipment such as boilers, ducts casings etc. shall be insulated with block insulation protected at corners by metal shields and held in place by bands, carried around the unit over the insulation and fastened tight.
- 3.2.2 Metal anchoring clips shall be welded to the equipment surface so that the band will pass over them and may be wired to them after insulation is in place.
- 3.2.3 Insulation in exposed areas, i.e. permanently visible, shall be protected with aluminum cladding as specified.
- 3.2.4 Any part of equipment that is normally removable for service such as heads of heat exchangers, shall be insulated separately from the equipment.
- 3.2.5 No insulation shall be applied over name plates.
- 3.2.6 Insulated ducts penetrating walls or floors shall be insulated completely thru penetration. Provide water proof calcium silicate insert, same thickness and jacketing as insulation with wall flange for fire wall or floor penetrations, or as detailed on the Drawings.
- 3.2.7 Duct insulation or lining or any type of covering together with the applied adhesives shall have a flame spread rating not over 25 without evidence of continued progressive combustion and a smoke developed rating no higher than 50, wherever the duct crosses a firewall or penetrates a roof slab.
- 3.2.8 Duct linings shall be interrupted at fire dampers and fire doors so as not to interfere with the operation of services.
- 3.2.9 All duct materials and coverings (insulation, pre-insulated panels, linings, etc.) shall meet the requirements of NFPA 90A and 90B Standards or equivalent European Standards.
- 3.2.10 Adhesives, sealants, vapour barriers, paints, etc., shall meet the requirements of NFPA 90A and 90B and shall be UL Classified.

End of Section 23 07 00.

SECTION 23 23 00**REFRIGERANT PIPING****PART 1 GENERAL**

- 1.1 Introduction
- 1.2 Related Works Specified Elsewhere
- 1.3 Pipe Identification
- 1.4 Codes and Standards

PART 2 PRODUCTS

- 2.1 Copper Pipes-CuP-Type 3
- 2.2 UPVC Pipes Type 1
- 2.3 Joints Between Dissimilar Metals (Dielectric Isolators)
- 2.4 Piping Schedule.

PART 3 EXECUTION

- 3.1 Arrangement and Alignment of Pipes
- 3.2 General Requirements for Piping Installation
- 3.3 Connection to Equipment and Control Valves
- 3.4 Installation of Unions and Flanges
- 3.5 Pipe Sleeves
- 3.6 Cleaning of Piping Systems

SECTION 23 23 00

REFRIGERANT PIPING**PART 1 GENERAL****1.1 Introduction**

1.1.1 Works of this Section shall be governed by Contract Conditions.

1.1.2 This section describes basics materials and requirements for refrigerant piping work services installations for building.

1.2 Related Works Specified Elsewhere

1.2.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

Section	23 05 00	- Common Works Results for HVAC
Section	23 07 00	- HVAC Insulation
Section	23 09 00	- Instrumentation And Controls for HVAC
Section	23 3000	- HVAC Air Distribution
Section	23 70 00	- Central HVAC Equipment
Section	23 80 00	- Decentralized HVAC Equipment

1.3 Pipe Identification

1.3.1 All pipes shall be indelibly marked at intervals of not greater than 3m. The marking shall show the manufacturer's identification, the standard name and number, and the nominal size and class. Adhesive labels alone shall not suffice. All pipes complying with British Standards shall be kitemarked.

1.4 Codes and Standards

1.4.1 Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations.

<u>Reference Code</u>	<u>Abbreviation</u>	<u>Applicable Standard</u>	<u>Title of Standard</u>
American Water Works Association	AWWA	C601-68	
		C501-67	
American Society for Testing and Materials	ASTM	ASTM A53-88a	Specification for pipes, steel, black and Hot-Dipped, Zinc-Coated, Welded and Seamless
		ASTM B280-88	Specification for seamless copper tube for A/C and refrigeration field service

		ASTM A307	Specification for Carbon Steel Bolts and Studs. 60,000 psi tensile Strength
		ASTM D1785	Specification for poly (vinyl chloride) (PVC) plastic pipe schedules 40, 80, and 120.
American Standards Association	ASA	ASA 40.1	-
		ASA B16.22	-
		ASA B1618	-
		ASA B9.1	-
		ASA B35.5	-
British Standards	BS	BS 4514	Specification for unplasticized PVC soil and venting pipes, fittings and accessories.
		BS 5255	Specification for thermoplastics waste pipe and fittings.
		BS 5254	Specification for polypropylene waste pipe and fittings (external diameter 34.6 mm, 41.0 mm and 54.1 mm)
		BS 3505	Specification for unplasticized polyvinyl chloride (PVC-U) pressure pipes for cold potable water
		BS 4346 Part 1	Joints and fittings for use with unplasticized PVC pressure pipes. Injection molded unplasticized PVC fittings for solvent welding for use with pressure pipes, including potable water supply.
		BS4346 Part 2	Mechanic joints and fittings, principally of unplasticized PVC.

		BS 4660	Specification for unplasticized polyvinyl chloride (PVC-U) pipes and plastics fittings of nominal sizes 110 and 160 for below ground gravity, drainage, and Sewerage
		BS 5481	Specification for unplasticized PVC pipe and fittings for gravity sewers
		BS 1387	Specification for screwed and socketed steel tubes and tubular and for plain and steel tube suitable for welding or for screwing to BS21 p
		BS 2871	Specification for copper and copper alloys, tubes.
		BS 864 Part 2	Specification for capillary and compression fittings for copper tubes
		BS 3601	Specification for carbon steel pipes and tubes with specified room temperature properties for pressure pipes.
		BS 21	Specification for pipe threads for tubes and fittings where pressure light joints are made on the threads.
American Society for Heating, Refrigeration and Air Conditioning Engineers	ASHRAE		-
Deutches Institute for Normung	DIN	DIN 19534	-
American National Standards Institute	ANSI	ANSI B18.2.2	-
		ANSI B31.1	
		ANSI A21, 10, 11	

PART 2 PRODUCTS**2.1 Copper Pipes-Cu P-Type 3**

- 2.1.1 Copper pipes shall be of the seamless hard drawn tubing type K or L to ASTM B280-88. Tubing, to be used, shall have been cleaned by the manufacturer and the open ends capped to preserve cleanliness.

- 2.1.2 Cup shall be designed, constructed and installed in compliance with ASA B9.1 and ASA B35.5 (safety code for Mechanical Refrigeration).
- 2.1.3 CuP shall be suitable for solder jointing with forged or wrought copper fittings.
- 2.1.4 Cast fittings should not be used because they might be porous and allow the refrigerant to leak.
- 2.1.5 Surfaces to be soldered shall be cleaned bright. The joints shall be given a thin coating of approved soldering flux and the tubing end inserted into the fitting as far as possible.
- 2.1.6 Heating and finishing of the joint shall be done in accordance with the recommendations of the manufacturer of the fittings. During the heating, the pipe and fittings must be kept full of an inert gas N or CO₂ to prevent formation of scale.
- 2.1.7 The solder metal to be used shall be a non-ferrous metal or alloy having a melting point below 800 OF(427°C) and below that of the metal being joined, an accepted solder is Sil-Fos to make copper to copper joints.
- 2.1.8 When solenoid valves are being installed, the coil should be removed, and no heat shall be applied near the bulb of the expansion valve.
- 2.1.9 CuP type 3 are allowed to be used to carry refrigerants and/or as specifically mentioned in the schedule of pipe materials.

2.2 UPVC Pipes Type 1

- 2.2.1 Polyvinyl chloride pipes (PVC) shall be of the un-plasticized rigid type and of high density and complete homogeneity material
- 2.2.2 UPVC Pipes - Type 1 shall comply with BS EN 1329-1 : 2000 specification for pipes, fittings and the system.
- 2.2.3 UPVC Pipes - Type 1 piping systems shall be used in the field of NC condensate drain.
- 2.2.4 UPVC Pipes Type 1 piping systems sockets and spigots shall be either for solvent cement joints or ring seal joints.

2.3 Joints Between Dissimilar Metals (Dielectric isolators)

- 2.3.1 Make joints between ferrous and non-ferrous screwed piping and equipment by using teflon or nylon isolating materials in the form of screwed unions.
- 2.3.2 Make joints between ferrous and non-ferrous flanged piping and equipment with insulating gaskets and "Teflon sleeves and washers between flanges, bolts and nuts.
- 2.3.3 The entire insulating joint including the dielectric material shall be suitable to withstand the temperature, pressure and other operating characteristics for the service for which they are used.

2.4 Piping Schedule

- 2.4.1 General
- 2.4.2 Piping classes are specified for each service in the following schedule. The designations indicated refer to detailed specifications for piping in this section of the specifications:

2.4.3 Piping classes

Service

- A/C Condensate drains
- A/C Condensate drain above false ceiling

Piping Class

- UPVC Type 1
- UPVC Type 2

- Refrigerant Pipes

UPVC Type 3

PART 3 EXECUTION**3.1 Arrangement and Alignment of Pipes**

- 3.1.1 Install piping in a neat, workmanlike manner and the various lines shall be parallel to building walls shall be parallel to wherever possible.
- 3.1.2 Install refrigerant pipe groups in parallel with each other.
- 3.1.3 Support, anchor all piping to preclude failure or deformation. Construct and install hangers, supports and accessories to the approval of the Engineer. Do not use wire, tape or metal bands. Supports shall be designed to support weight of pipe, weight of fluid and weight of pipe insulation.
- 3.1.4 Fasten piping securely to the structure without overstressing any portion of the supports or the structure itself. Secure pipe supports, anchors and guides to concrete by means of inserts or if greater load carrying capacity is required by means of steel fishplates embedded in the concrete.
- 3.1.5 Uninsulated copper or brass pipe and/or tubing shall be isolated from ferrous hangers or supports.
- 3.1.6 Support piping and tubing at intervals indicated in the schedule hereinafter and at all changes in direction. Maximum deflection shall not exceed 3 mm.
- 3.1.7 Furnish pipe hangers and supports complete with rods, bolts, lock nuts, swivels, couplings, brackets and all other components and accessories, to allow installation to freely expand and contract. For copper or brass pipe, use plastic sheathed hangers. Pipe hangers shall fit over insulated piping.
- 3.1.8 Provide trapeze hangers where several pipes can be installed parallel and at the same level. Trapeze shall be of steel channel sized to support load and drilled for rod hanger at each end. Provision should be made to keep the lines in their relative position to each other by the use of either clamps or clips.

3.2 General Requirements for Piping Installation

- 3.2.1 Make all changes in size and direction of piping with standard fittings ..
- 3.2.2 Make all branch connections with tees.
- 3.2.3 Use eccentric reducing fittings or eccentric reducing couplings where required by the contract documents or where required to prevent pocketing of liquid or non-condensables.
- 3.2.4 Pipes and fittings shall both be manufactured according to one single standard unit of measurement, either both English and both metric.
- 3.2.5 Wall supports - provide for supporting horizontal piping from wall with steel J-Hook for pipe located close to wall.
- 3.2.6 Vertical piping supports - support pipes at every floor unless shown otherwise.
- 3.2.7 Provide penetration shields to encase insulated pipes penetrating fire walls or floors in a 360 O, 24 gauge minimum sheet metal hanger shields. Spacing between sleeve and insulation shield, pack annular space between sleeve and shield on both ends with double neoprene coated asbestos rope. Install an escutcheon plate to completely cover the wall penetration opening and fit snugly over the pipe insulation shield. Insert shall extend at least 25mm. beyond penetrated surface and escutcheon.
- 3.2.8 Maximum horizontal spacing for hangers are as follows:

- Up to 1¼"(32 mm) copper pipe-----2.0 meter
- 1 ½" (40 mm) and over copper pipe-----3.0 meter

3.3 Connection to Equipment and Control Valves

- 3.3.1 Provide connections to equipment and control valves to facilitate dismantling. Arrange connections so that the equipment being served may be removed without disturbing the piping.

3.4 Installation of Unions and Flanges

- 3.4.1 Unions and flanges shall be installed at all equipment inlets and outlets,

3.5 Pipe Sleeves

- 3.5.1 Provide all pipe openings through walls, partitions and slabs with sleeves having an internal diameter at least 50mm larger than the diameter of the pipe for un-insulated lines or of the insulation for insulated pipes.

- 3.5.2 Install sleeves through interior walls and partitions flush with finished surfaces; sleeves through outside walls to project 15mm. on each side of the finished wall; and floor sleeves to project 25mm. above finished floors.

- 3.5.3 Set sleeves in place before pouring concrete or securely fasten and grout in with cement.

- 3.5.4 Sleeve construction:

- Interior Partitions - galvanized sheet iron.
- Interior & Exterior Masonry Walls and Floors-galvanized steel pipe.

- 3.5.5 Fill the space between outside of pipe or insulation and the inside of the sleeve or framed opening with fibrous asbestos in interior walls and floors and pack with oakum, seal with watertight mastic or asphalt in exterior walls.

3.6 Cleaning of Piping Systems

- 3.6.1 Plug all opening ends of piping, valves and equipment except when actual work is being performed to minimize accumulation of dirt and debris.

End of Section 23 23 00.

SECTION 2331 00**HVAC DUCTS AND CASING****PART 1 GENERAL**

- 1.1 Introduction
- 1.2 Scope of Work
- 1.3 Related Works Specified Elsewhere
- 1.4 Reference Standards
- 1.5 Ductwork Design Criteria

PART 2 PRODUCTS

- 2.1 Ductwork
- 2.2 Duct Hangers and Support
- 2.3 Flexible Ducts
- 2.4 Fire Rated Ductwork

PART 3 EXECUTION

- 3.1 Duct Construction
- 3.2 Protection and Cleaning
- 3.3 Access Openings in Insulated Ducts

SECTION 23 31 00**HVAC DUCTS AND CASING****PART 1 GENERAL****1.1 Introduction**

- 1.1.1 This section includes the design, supply, installation testing and commissioning of complete ductwork system for air conditioning fresh air, exhaust and ventilation systems.

1.2 Scope of Work

- 1.2.1 The contractor shall be responsible for submitting complete above works based on design consultant's approval of submitted samples, documents etc as per specifications and applicable standards.

1.3 Related Works Specified Elsewhere

- 1.3.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

Section 23 05 00	- Common Works Results for HVAC
Section 23 07 00	- HVAC Insulation
Section 23 09 00	- Instrumentation And Controls for HVAC
Section 23 20 00	- HVAC Piping and Pumps
Section 23 30 00	- HVAC Air Distribution
Section 234000	- HVAC Cleaning Devices
Section 23 70 00	- Central HVAC Equipment
Section 238000	- Decentralized HVAC Equipment
Division 25	- Integrated Automation

1.4 Reference Standards

HVAC DW 144	Sheet Metal Ductwork
NFPA 90A	Standard for the installation of air conditioning and ventilation systems
SMACNA	Sheet Metal and air conditioning contractors national association
ASHRAE	American society of heating, refrigeration and air conditioning
UL 181	underwriters laboratories
ASTM A653-99	Specification for steel sheet, Zinc-coated (Galvanized) by Hot-Dip process

1.5 Ductwork Design Criteria

- 1.5.1 AU rectangular ducts shall be of the low pressure rating and all circular round ducts shall be of the high pressure rating.
- 1.5.2 Galvanized sheet steel shall be fabricated, erected and installed in accordance with NFPA 90A and "SMACNA" sheet metal manuals.
- 1.5.3 All rectangular metal ducts shall be sealed in accordance with ASHRAE Standard 90 and SMACNA low pressure duct construction standards. All high pressure ducts shall be air tight.
- 1.5.4 Kitchen exhaust ducts shall be constructed and installed in conformance with NFPA 96 and must: Be constructed from carbon steel (for concealed ducts) with a minimum thickness of 1.4 mm and from stainless steel (for exposed ducts) with a minimum thickness of 1.1 mm.

- 1.5.5 Stair case or lift well pressurization duct shall be fire rated.
- 1.5.6 Ducts that meant to be used for smoke exhaust shall be fire rated unless:-
- 1.5.7 It doesn't cross any other fire / smoke zones, i.e. its route within the same fire / smoke zone which it serves.
- 1.5.8 It is contained solely in a fire rated shaft and no other services included in the same shaft.
- 1.5.9 All return air ducts inlets shall be fitted with stainless steel wire mesh.

PART 2 PRODUCTS

2.1 Duct work

- 2.1.1 Galvanized sheet steel ducts shall be of G90 coating designation within ASTM A653-99, standard specification for 'steel sheet zinc coated by the hot dip process'. The weight of coating on both sides of duct shall be 0.9 oz/ft² (275g/m²) as a minimum check limit triple spot test.
- 2.1.2 The ducts' gauges, thickness, type and method or jointing shall be as detailed and tabulated on the Drawings and/or in compliance with ASHRAE Standards and Handbooks.
- 2.1.3 Stainless steel ducts shall be of 316 for all Toxic exhaust air in accordance with ASTM Standards and Specifications.

2.2 Duct Hangers and Support

- 2.2.1 Supply and install steel work necessary for the support of the ductwork. Hangers shall be spaced not more than 3000 mm. apart, and at changes of direction. Types and construction of hangers shall be as detailed on the Drawings and in compliance with SMACNA recommendations.

2.3 Flexible Ducts

- 2.3.1 Ducts shall be all metal constructed of heavy gauge corrugated aluminium with water tight continuous lock seams.
- 2.3.2 Ducts shall be UL 181 Class O non-combustible and complying to NFPA 90A & 90B, or tested to BS 476 (parts 6, 7 & 20) class 1 flame spread and meets the requirements of CP 413 section A2.2.3.
- 2.3.3 For air conditioning flexible ducts shall have 25mm thick fiber glass insulation and sheathed in durable polymer vapour barrier.

2.4 Fire Rated Ductwork

- 2.4.1 2. hours fire resisting ductwork shall be installed where indicated on the drawings or mentioned in Specifications or required by Local Authorities.
- 2.4.2 Provide complete 2 hours fire rated fire resistive enclosures for smoke and pressurization systems where ductwork is located outside fire rated shaft.
- 2.4.3 Fire resisting duct and smoke duct shall be manufactured erected and tested in accordance to BS 476 Part 24 ISO 6944.
- 2.4.4 Fire resisting duct shall prove by test that its cross section area is maintained above 75% when subject to full fire temperature.
- 2.4.5 Fire resisting duct shall be constructed and protected to insure maintaining the stability, integrity insulation supports, fixing throughout the required period.

- 2.4.6 Fire resistance filling (fire stopping material) shall seal the clearances between fire resisting duct and wall to insure the stability and integrity of the system.
- 2.4.7 Fire resisting duct shall be connected to fans by fire rated flexible connectors. Flexible connectors shall be made of glass fabric coated on both sides with flame retardant silver grey polyurethane rubber tested to BS476 Part 20.
- 2.4.8 All drop rods and exposed bearers shall be insulated in accordance to manufacturer's instructions to assure its fire resistance.

PART 3 EXECUTIONS

3.1 Duct Construction

- 3.1.1 All ducts shall be constructed and erected so as to be rigid and free from sway, drumming and movement. Duct work shall be true to sizes indicated on Drawings, straight and smooth on the inside with neatly finished joints. Whenever internal acoustic lining is indicated on the Drawings, the duct sizes have to be increased to accommodate the lining.
- 3.1.2 Ductwork joints shall be square with all sharp edges removed.
- 3.1.3 The ducts shall be routed with a minimum of directional changes and abrupt transitions.
- 3.1.4 Adequate space shall be provided around ducts to assure proper support and to allow the installation of the specified insulation.
- 3.1.5 All connections between ductwork, including flexible connections, fittings and equipment, shall be made with gradually tapered transition fittings.
- 3.1.6 Whenever a flexible duct is used to correct misalignment between the supply duct and the diffuser ceiling location, the misalignment (or offset) shall not exceed one-eighth (1/8) the length of the collar (or diffuser diameter). Flexible duct length shall not exceed 30 cm.
- 3.1.7 Changes in section of ductwork shall be effected by tempering in ducts with as long a taper as possible. All branches shall be taken off at not more than 45 degree angle from the axis of the main duct unless otherwise approved by the Engineer.
- 3.1.8 The ducts shall be securely anchored to the building in an approved manner.
- 3.1.9 The ducts shall be installed as to be completely free from vibration under all conditions of operation.
- 3.1.10 The ducts and hangers shall be installed straight, plumb and level.
- 3.1.11 Wherever ducts pass thru walls or floors, a sleeve of galvanized mild steel sheet shall be provided and the space between the pre-insulated duct and the sleeve shall be caulked with lead wool and finished on each face with a mastic fill.
- 3.1.12 Flexible ducts should be kept as short as possible (maximum 30 cm) and fully extended. All slip joints shall be made in the direction of flow.
- 3.1.13 All elbows shall have a centre line radius equal to at least 1.5 times the width of the duct, otherwise turning vanes shall be installed in the elbows.
- 3.1.14 Adjustable splitters and hinged volume dampers shall be provided at every duct junction on both supply and exhaust ductwork for adjusting air volumes.
- 3.1.15 Where splitters and dampers are installed above suspended ceiling, flush-mounted controlling devices shall be used.
- 3.1.16 Connection to diffusers, grilles and registers shall be made absolutely airtight.

3.1.17 Equalizing grids or turning vanes shall be installed ahead of an air outlet whenever poor approach conditions, from the main duct to the outlet, exist.

3.1.18 In critical low noise level projects, poor approach conditions are not allowed. Where the duct is pierced for any reason, sealing compound shall be used. All joints and fittings concealed in vertical duct shafts shall be welded.

3.1.19 For duct work balancing and testing refer to Section 23 05 93 Subsections 1.3 and 1.4.

3.2 Protection and Cleaning

3.2.1 During construction, cover all open ends of ductwork with one layer of canvas.

3.2.2 Remove all foreign materials and clean the duct inside and outside.

3.2.3 Clean ducts before operating fans and filters. Never operate fans unless filters are installed.

3.2.4 Operate the fans and thoroughly blowout the interior surfaces of the duct work.

3.2.5 After tests, wash cleanable filters and replace renewable media.

3.3 Access Openings in Insulated Ducts

3.3.1 Where ducts require to be thermally insulated the door frame shall be extended beyond the face of the duct by a measurement equal to the thickness of the insulation and as arranged so that the insulation can be 'dressed' into the frame. Doors or covers shall be suitably insulated and provisions made to ensure that the seal is continuous across the whole opening. The extent of the opening shall be clearly visible or otherwise indicated. Where it is impossible to vapour seal an access opening, provision shall be made for collecting and draining condensation.

End of Section 23 31 00.

SECTION 23 33 00

AIR DUCTS ACCESSORIES

PART 1 GENERAL

1.1 Introduction

- 1.1.1 This section includes the design, supply, installation testing and commissioning of all materials for the complete installation of air distribution specialties and duct accessories for the air distribution system.

1.2 Scope of Work

- 1.2.1 The contractor shall be responsible for submitting complete above works based on design consultant's approval of submitted samples, documents etc as per specifications and applicable standards.

1.3 Related Works Specified Elsewhere

- 1.3.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

Section 23 05 00 - Common Works Results for HVAC
Section 23 07 00 - HVAC Insulation
Section 23 09 00 - Instrumentation And Controls for HVAC
Section 23 20 00 - HVAC Piping and Pumps
Section 23 30 00 - HVAC Air Distribution
Section 234000 - HVAC Cleaning Devices
Section 23 70 00 - Central HVAC Equipment
Section 238000 - Decentralized HVAC Equipment
Division 25 - Integrated Automation

1.4 Reference Standards

UL 555 Standard for fire Dampers and ceiling dampers
NFPA 90A Standard for installation of air conditioning and ventilating systems
ASTM-A525 Specification for general requirements for steel sheet, zinc-coated (galvanized), by the Hot-dip process.
BS 5588-Part 9 Code of Practice for air-conditioning and ventilation duct work

1.5 Fire Dampers - General Requirements

- 1.5.1 Fire dampers shall be provided on all duct branches which pierce fireproof floors, walls, shafts, ceilings and as required in accordance with NFPA SECTION NO. 90A.
- 1.5.2 Assemblies shall be complete with damper blades, fusible links, linkage and stops.
- 1.5.3 Dampers shall be proportioned and weighed to close at once if released from a link with spring catches and shall stay closed until manually reset.
- 1.5.4 Dampers and frames shall have suitable peep holes.
- 1.5.5 Fire damper installation shall guarantee the fire wall integrity.

1.6 Noise Attenuation

- 1.6.1 The Contractor shall supply and fix acoustic insulation and noise attenuator units where necessary

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Air Duct Accessories

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and as shown on drawings and/or required by the Specialist study to reduce the air borne noise transmission through the distribution duct system, so that the specified noise criteria levels are satisfied.

PART 2 PRODUCTS

2.1 Volume Control Dampers

- 2.1.1 Volume control dampers shall be complete with locking levers and quadrants, indicating their position.
- 2.1.2 Volume dampers shall be provided whether shown/or not on drawings in main ducts, in all branch ducts supplying three (3) or more air outlets, in all fresh air intakes etc to achieve proper system balancing.
- 2.1.3 Volume control dampers shall be of the butterfly type for ducts 15" (380 mm) in depth and lower, and multiple opposed blade type for ducts above 15" (380 mm) in depth. Maximum blade size shall be 48" x 10" (1220 x 250 mm). For ducts larger than 48"(1220 mm), multiple frame sections shall be used. Blades shall not be less than 18 gauge. Duct shall be stiffened at damper location. Volume dampers for circular ducts shall be of the multiple opposed blade type fitted in a square section.
- 2.1.4 Upon completion of the ductwork, dampers shall be adjusted and set to deliver the amounts of air indicated on the Drawings.

2.2 Gravity Dampers

- 2.2.1 Gravity dampers shall consist of:
- a. Galvanized sheet steel frame.
 - b. Aluminum blades.
 - c. Stainless steel bearing shafts and brass bearings.
 - d. Neoprene seal to withstand 120°C. air temperature.
 - e. Aluminum blade travel stop.
- 2.2.2 All blades shall be coupled together by means of an aluminum bar.

2.3 Fire Dampers (Curtain Type)

- 2.3.1 Each fire damper shall have a 2 hour fire protection rating and a 1650 F (73.9 °C) fusible link. Fire damper frame shall be constructed of 20 gauge galvanized steel channel. Blades shall be curtain type of 24 gauge galvanized steel and finish shall be mill galvanized to ASTM A525 g-60.
- 2.3.2 Each fire damper shall be constructed and tested in accordance with UL Safety Standard 555.
- 2.3.3 Fire dampers shall be equipped for vertical or horizontal installation. Horizontal mounted dampers shall be spring loaded.
- 2.3.4 All necessary accessories such as sleeves, angles etc. shall be provided for proper installation of fire damper as per manufacturer instructions and it shall finally guarantee the integrity of the fire wall.

2.4 Smoke Dampers

- 2.4.1 Furnish and install at all locations shown on plans, motorized dampers of the following specifications. Frame shall be minimum of 16 gage galvanized steel formed into a structural hat channel shape with tabbed comers for reinforcement. The blades shall be single skin 16 gage minimum galvanized with three longitudinal grooves for reinforcement. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Jamb seal shall be stainless steel flexible metal compression type.
- 2.4.2 Each damper shall be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems. The leakage rating under UL555S shall be leakage Class III (40

Mechanical Specifications

cfm/ft.at 1" w.g.).

- 2.4.3 As part of the UL qualification, dampers shall have demonstrated a capacity to operate (to open and close) under HVAC system operating conditions with pressure of at least 4" w.g. in the closed position and 2000 fpm air velocity in the open position.
- 2.4.4 In addition to the leakage ratings already specified herein, the dampers and their actuators shall be rated for the elevated temperature anticipated by the smoke but not less than 572°F (300°C). Appropriate electric actuators shall be installed by the damper manufacturer at time of damper fabrication. Damper and actuator shall be supplied as a single entity which meets all applicable UL 555S qualifications for both dampers and actuators. Factory supplied caulked sleeve shall be 20 gage for dampers through 84" wide and 18 gage above 64" wide. Damper and actuator assembly shall be factory tested to assure operation. All wiring or piping material required to interconnect the actuator with detection and/or alarm or SMS system shall be furnished under fire alarm on BMS installation as applicable.
- 2.4.5 Blade Position Indicator:- Each smoke damper shall be equipped with two position indicator switches linked directly to the damper blade to provide the capability of remotely indicating damper blade position.
- 2.4.6 For Damper actuator, refer to Section 25 50 00.

2.5 Motorized Dampers

- 2.5.1 Motorized automatic dampers shall be of the louver type with not less than 13 gauge welded steel frames and galvanized finish. Blades shall have interlocking edges, stainless steel side springs (or vinyl or neoprene gaskets), and teflon-coated stainless steel thrust washers. Blades shall be edged with neoprene if the damper is to operate in outside air service either as an intake or discharge damper. Damper blades shall have steel trunnions mounted in nylon or oilite bearings.
- 2.5.2 Dampers shall be not more than 1200mm. in length between bearings. Modulating dampers shall be of the opposed blade type unless specified otherwise. Blades shall be not over 200mm. in width and shall not be less than 16 gauge galvanized steel. Hardware shall be zinc plated. One damper actuator shall be provided for each 1.5 sq. meter of damper area.
- 2.5.3 Provide parallel blade dampers arranged for maximum turbulence and mixing of outside air with return air. Arrange dampers as necessary to prevent stratification or provide baffles necessary to correct stratification problems.
- 2.5.4 Provide dampers of low leakage construction, so designed that the maximum leakage shall be 10 cfm/ft² (0.005 m³/s/m²) of damper with 411WG. (1 Kpa) pressure differential applied.
- 2.5.5 For damper actuator specification, refer to Section 25 50 00.

2.6 Flexible Connections

- 2.6.1 Flexible connections of approved flame retardant fabric to prevent the transmission of vibration through the ducts shall be installed on both the supply and return sides of all fans and ventilating units for a maximum length of 250mm. and a minimum of 100mm. in the direction of the flow. The fabric shall have a flame spread rating of not over 25 and a smoke developed rating of not higher than 50.
- 2.6.2 Flexible connections shall connect ducts across structural expansion joints.
- 2.6.3 Cloth used for flexible connections shall be of proper weight and strength for the service required, and shall be properly fitted to render it relatively tight.
- 2.6.4 Neoprene laminated fabric, with neoprene facing on interior surface, shall be used for ducts handling other than clean dry air.
- 2.6.5 Flexible duct connection used for air conditioning, air handling units shall have vinyl coated fabric insulated with 11(25 mm) fiberglass insulation of 0.75 lbs/ft³ (12 Kg/m³) minimum density, designed to NFPA-90 or BS 5588 part 9 Standards. The connector should be pre-assembled metal

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to fabric.

2.6.6 The connector shall be 2.4 gauge galvanized zinc to ASTM-A525 G 60.

2.7 Belt Guards

2.7.1 Guards shall be provided for all belt-driven units.

2.7.2 Guards shall be made to enclose both pulleys and belts on exposed sides and shall be constructed of galvanized steel top and bottom with perforated or expanded metal front Pittsburgh-locked into the rim.

2.7.3 The entire assembly shall be rigidly supported.

2.7.4 Provision shall be made for accessibility of all points drilled to receive tachometer.

2.7.5 Provide coupling guards on direct-connected units.

2.7.6 Guards shall be designed for easy removal for service and shall comply with Underwriters' Safety Requirements.

PART 3 EXECUTION

3.1 Access Openings

3.1.1 General

3.1.1.1 Access doors shall be provided for volume damper quadrants installed in concealed spaces, for control valves, for fire dampers or as specified hereinafter.

3.1.1.2 All access openings shall be rigidly framed and made air-tight. Covers shall be simply and speedily removed and re-fixed. Multiple set screws or self-tapping screws will not be acceptable as a method of fixing. Access doors and other openings in ductwork shall be provided for the purposes given below. The number, size and locations shall be as indicated on the Drawings or as necessary to ensure adequate access to equipment and plant.

3.1.2 Access for Personnel

3.1.2.1 Access doors shall not be larger than 1350mm. high by 500mm. wide, unless essential for equipment handling. Doors shall open against the air pressure. Duct openings and the access doors shall be adequately reinforced to prevent distortion. Suitable sealing gaskets shall be provided together with sufficient clamping type latches to ensure air-tight and water-tight sealing between the door and the duct. All personnel access openings shall have latch handles on both the inside and outside of the door.

3.1.3 Access for Maintenance. Cleaning and Inspection

3.1.3.1 Inspection openings shall generally not be larger than 300mm high by 400mm. wide unless essential for access to equipment, in which case the size shall be agreed before manufacture. The opening in the duct shall be adequately stiffened and the door cover sufficiently rigid to prevent distortion. Approved sealing gaskets and suitable fastenings shall be provided to ensure air-tight sealing.

3.1.4 Test Holes for Test Equipment and Instruments

3.1.4.1 Test holes shall be provided wherever instructed by the engineer, and in all main ducts and branch ducts to correctly establish design air flows and to check the performance of fans and regulating dampers. All holes shall be 25mm. dia. and suitably strengthened. Cover plates shall be screw-fixed to the duct and sealed.

3.1.5 Access Openings in Insulated Ducts

Elite Consultants

Section 23 33 00
Air Duct Accessories

- 3.1.5.1 Where ducts require to be thermally insulated the door frame shall be extended beyond the face of the duct by a measurement equal to the thickness of the insulation and as arranged so that the Insulation can be 'dressed' into the frame. Doors or covers shall be suitably insulated and provisions made to ensure that the seal is continuous across the whole opening. The extent of the opening shall be clearly visible or otherwise indicated. Where it is impossible to vapour seal an access opening, provision shall be made for collecting and draining condensation.

End of Section 23 33 00

SECTION 23 34 00

HVAC FANS

PART	1	GENERAL
	1.1	Scope of Work
	1.2	Related Works Specified Elsewhere
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	1.4	General Requirements for Ventilating Fans
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	2.1	Centrifugal In-Line Fan (Smoke/Fume Fans)
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	2.5	Wall Propeller Exhaust Fan
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	2.10	Ceiling Mounted Exhaust Fan
	2.11	Belt Driven Wall Exhaust Fans
	2.12	Fresh Air Fans
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	2.16	Guarantee and Warranted Period

SECTION 23 34 00**HVAC FANS****PART 1 GENERAL****1.1 Scope of Work**

- 1.1.1 The works covered under this Section shall include all the supply, installation, testing and delivery in good operating conditions of a complete Ventilating system as described, shown detailed or implied in the tender documents of the project.
- 1.1.2 The Contractor shall provide all the necessary components and accessories as well as manpower, scaffolding, painting, testing facilities, etc ... at his own expense to execute a complete operable system.
- 1.1.3 The Contractor shall program his work such that it will not interfere with other trades and to suit site requirements.

1.2 Related Works Specified Elsewhere

- 1.2.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein *verbatim*.

Section 23 05 00 - Common Works Results for HVAC
 Section 23 07 00 - HVAC Insulation
 Section 23 0900 - Instrumentation And Controls for HVAC
 Section 23 20 00 - HVAC Piping and Pumps
 Section 23 30 00 - HVAC Air Distribution
 Section 234000 - HVAC Cleaning Devices
 Section 237000 - Central HVAC Equipment
 Section 23 80 00 - Decentralized HVAC Equipment
 Division 25 - Integrated Automation

1.3 Codes and Standards

- 1.3.1 Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations.

<u>Reference Code</u>	<u>Abbreviation</u>	<u>Applicable Standard</u>	<u>Title of Standard</u>
American Society of Heating Refrigeration and Air Conditioning	ASHRAE	-	-
National Electrical Manufacturers Association	NEMA	-	-
National Electrical Code	NEC	Section 424	-
Air Moving and Conditioning Association	AMCA	-	-

National Fire Protection Association	NFPA	NFPA 90A	Standard for Air Conditioning and Ventilation Systems
Underwriters Laboratories	UL	UL181	-
American Standards for Testing and Materials	ASTM	ASTM A525-75	Specification for general requirements for steel, Zinc-coated(galvanized) by the hot-dip process

1.4 General Requirements for Ventilating Fans

- 1.4.1 The fan motors and starters shall be in accordance with the Electrical division of these specifications.
- 1.4.2 Test and rate all fans in accordance with the standards of the AMCA. All fans must bear the AMCA certified rating seal.
- 1.4.3 Make appropriate allowance for the effects on fan performance of all installation conditions including plenum enclosures and inlet and discharge arrangements so that actual installed fan performance equals that specified.
- 1.4.4 Balance all fan wheels and all other moving components statically and dynamically. Where coating is specified and it affects the balance of the fan wheel, perform balancing after the coating has been applied.
- 1.4.5 Drill all fan shafts on the center line to receive a tachometer.
- 1.4.6 Belt driven fans shall be connected to the driving motor by means of an approved V-belt drive, with adjustable sheaves, unless otherwise designated. V-belt drives shall be designed for 50% overload capacity and the motors for such drives shall be equipped with adjustable bases or slide rails.
- 1.4.7 Bearings shall be self-aligning, grease lubricated, ball-bearing type, and shall be complete with grease fittings, extended for easy access where necessary.
- 1.4.8 Weather proof hoods should be provided for all motors and drives exposed to weather to the approval of the Engineer.
- 1.4.9 Back draft dampers, gravity type, shall be installed on the fan discharge of all fans discharging directly to the atmosphere except the kitchen hood fan.
- 1.4.10 Fans scheduled for the exhaust of kitchen equipment. hoods and high temperature exhaust systems shall include an up blast arrangement on the discharge with complete grease drainage and insulated heat shield to protect motor and drive, all designed for high temperature services.
- 1.4.11 Fans are to operate steadily without pulsation at design conditions. Centrifugal fan characteristic curves must be such that the fan operating point falls below the point of no flow static pressure, to the right of the point corresponding to that of maximum mechanical efficiency, and a 15% increase in static pressure over that specified results in not more than a 15% reduction in cfm and does not affect the stability of fan operation. If necessary accomplish the foregoing by modifying the width of the wheel and/or by providing inlet vanes to change the characteristic curve.
- 1.4.12 Performance curves shall be submitted for each fan for approval.
- 1.4.13 Fans power shall not exceed 2.8 Watt/Lit/Sec. or as requested by LEED/GREEN requirements.

PART 2 PRODUCTS

2.1 Centrifugal In-Line Fan (Smoke/Fume Fans)

- 2.1.1 Fan shall be of the centrifugal in-line type steel construction and shall be complete with:
- a. Electric motor mounted outside the air stream.
 - b. Metallic fixing frame and supports.
 - c. Dust proof, non fused disconnect switch under motor casing.
 - d. Belt drive and belt guard.
 - e. Vibration isolators.
 - f. All aluminium centrifugal backward inclined blades impeller with non overloading horse power characteristic.
 - g. Flexible duct connection at each end.
 - h. Fans used for smoke exhaust shall have all welded housing with motors and all parts rated for the high temperature anticipated by the smoke, but not less than 752°F (400°C).
 - i. Electric meter shall be of variable speeds if shown in capacity schedule.
- 2.1.2 Fans shall be supplied complete with minimum IP55 sheet steel control panel. The panel shall include but shall not be limited to the following:-
- a. Door interlocked disconnect switch.
 - b. Duty alternator (where needed)
 - c. Circuit breaker.
 - d. Motor starters
 - e. On/Off/Auto with pilot light
 - f. Control power transformer
 - g. Control wiring
 - h. Volt free contacts for connection to BMS
 - i. Single phasing protection
- 2.1.3 Fans shall be coated at the factory with anti corrosion coating as recommended by the manufacturer.

2.2 Centrifugal In-Line Fan (Up to 500 cfm)

- 2.2.1 Fan shall be constructed of steel with epoxy finish highly resistant against atmospheric agents. Fan shall have back inclined impeller fixed and balanced directly on the motor. Electrical connections shall be enclosed in a plastic box with IP54 protection. All fans exhausting air from the dryer shall be rated for 60 degree C air temperature.

2.3 Centrifugal Single Inlet Fans (Staircase I Lift Well Pressurization)

- 2.3.1 Pressurization fan shall be of the centrifugal single inlet backward curved blades type with two-piece housing where wheel, shaft and inlet pan assembly installed in lower housing section. Average life of fan bearing shall not be less than 200,000 hours. Fan shall be complete with:
- a. Electric motor mounted on one chassis with the fan.
 - b. Reinforced heavy gauge fan casing.
 - c. Metallic fixing frame and supports.
 - d. Dust proof, non-fused disconnect switch.
 - e. Pulleys, belt drive and belt guard.
 - f. Spring vibration isolators.
 - g. Heavy flanges on both sections of housing for assembly. Flanged joints shall be gasketed for air tightness.
 - h. Galvanized steel mesh screen.

- i. Non-return damper
- j. Fans shall be supplied complete with minimum IP55 sheet steel Control Panel (CP) as indicated in Electrical Drawings. The panel shall include but shall not be limited to the following:-

- Door interlocked disconnect switch
- Duty alternator (where needed)
- Circuit breaker
- Motor starters
- On/Off/Auto with pilot light
- Control power transformer
- Control wiring
- Volt free contacts for connection to BMS
- Single phasing protection.

2.3.2 Fans shall be coated at the factory with anti corrosion coating as recommended by the manufacturer, for outdoor use in high temperature and humid atmosphere.

2.3.3 Fans shall be interlocked with fire alarm panel to be activated in case of fire in any particular zone.

2.4 Vane Axial Fans

2.4.1 Each fan shall be of the axial type with belt driven aerofoil impeller. Casing shall be fabricated from mild steel hot dipped galvanized after manufacture.

2.4.2 Each fan shall be complete with:

- Electric motor mounted on fan casing.
- Sealed ball bearings
- V-belt with bullies keyed to the shaft.
- Belt tuner and screen.
- Integral guide vanes.
- Protection ground.
- All parts of Fan used for smoke exhaust shall be rated for the high temperature anticipated by the smoke, but not less Than 752 of (400°C).

2.5 Wall Propeller Exhaust Fan

2.5.1 Wall exhaust fan shall be of the wall or window mounted type all plastic construction. Fan shall be complete with outside plastic grille, enough length of electrical flexible cord (including ground conductor) with suitable connecting end (plug, or..) to connect to electrical outlet, and wall mounted on-off switch. Fan shall have a shutter that opens and closes automatically by means of an electromagnet.

2.6 Exhaust Fan

2.6.1 Shall be of the centrifugal single inlet backward curved blades type with two-piece housing where wheel, shaft and inlet pan assembly installed in lower housing section. Fan shall be complete with:

2.6.1.1.1 Electric motor mounted on one chassis with the fan.

2.6.1.1.2 Reinforced heavy gauge fan casing.

2.6.1.1.3 Metallic fixing frame and supports.

2.6.1.1.4 Dust proof, non-fused disconnect switch.

2.6.1.1.5 Pulleys, belt drive and belt guard.

- 2.6.1.1.6 Vibration isolators.
- 2.6.1.1.7 Heavy flanges on both sections of housing for assembly. Flanged joints shall be casketed for air tightness.

2.7 Centrifugal In-Line Fan (Not for Smoke)

- 2.7.1 Fan shall be of the centrifugal in-line type all aluminium construction and shall be complete with:
 - 2.7.1.1 Electric motor mounted outside the air stream, when air temperature inside the duct is above 200 of (93°C), otherwise inside air stream.
 - 2.7.1.2 Metallic fixing frame and supports.
 - 2.7.1.3 Dust proof, non fused disconnect switch under motor casing.
 - 2.7.1.4 Belt drive and belt guard or as stated in Capacity Schedule.
 - 2.7.1.5 Vibration isolators.
 - 2.7.1.6 Aluminium air foil blades impeller with non overload.ing horse power characteristic.
 - 2.7.1.7 Flexible duct connection at each end.

2.8 Roof Ventilators

- 2.8.1 Each roof ventilator shall be of the centrifugal vertical discharge type coupled through a belt drive to its electric drive motor suitable for roof mounting and outdoor operation.
- 2.8.2 Each roof ventilator shall be complete with:
 - 2.8.2.1 Electric motor suitable for outdoor operation.
 - 2.8.2.2 Aluminium protective cowl and body
 - 2.8.2.3 Metallic fixing and supporting frame.
 - 2.8.2.4 Weather proof non fused disconnect switch under fan cowl.
 - 2.8.2.5 Galvanized steel bird screen.
 - 2.8.2.6 Automatic shutter

2.9 Centrifugal Exhaust Ventilator (Roof Or Wall Mounted)

- 2.9.1 Fan to be spun Aluminium centrifugal exhauster belt or direct, driven, down blast or horizontal discharge and shall be wall or roof mounted as applicable and shown on drawings. Fan shall be UL listed and shall bear the AMCA certified ratings seal for sound and air performance.
- 2.9.2 The fan shall be bolted and welded construction utilizing corrosion resistant fasteners spun Aluminium structure shall be minimum 16 gauge marine alloy Aluminium. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly with vibration isolation, these components shall be enclosed in a weather tight compartment separated from airstream. Wheels shall be centrifugal backward inclined, constructed of 100% Aluminium, wheel vanes shall be welded to the inlet cone to ensure permanent wheel stability and alignment, wheels shall be balanced in accordance with AMCA standard 204-96.
- 2.9.3 Bearings shall be heavy duty with average life of 200,000 hours. Belts shall be of oil and heat resistant, non-static type. Drives shall be machined cast iron sized up to 150% of installed motor HP. Variable pitch motor drive must be factory set to the specified fan rpm.
- 2.9.4 Each fan shall be complete with:-

- 2.9.4.1 Heavy duty electric motor suitable for outdoor operation with permanent lubrication.
- 2.9.4.2 Aluminium protective cowl and body.
- 2.9.4.3 Metallic fixing and supporting frame.
- 2.9.4.4 Weatherproof non fused disconnect switch under fan cowl.
- 2.9.4.5 Galvanized steel bird screen.
- 2.9.4.6 Automatic shutter
- 2.9.4.7 Control panel.

2.10 Ceiling Mounted Exhaust Fan

- 2.10.1 Ceiling exhaust fan shall be of the centrifugal double inlet fan with bottom intake through an extruded aluminium grille, and horizontal ducted discharge. Casing shall be of rigid formed steel housing with baked enamel finish. Unit shall be complete with:
 - 2.10.1.1 Motor with vibration isolators.
 - 2.10.1.2 Enough length of electrical flexible cord with disconnect plug and integral electrical knockouts, accessible from outside ..
 - 2.10.1.3 Shutter which closes automatically by means of an electromagnet when the exhaust fan is off.

2.11 Belt Driven Wall Exhaust Fans

- 2.11.1 Fan shall be of the propeller, wall mounted, belt drive type.
- 2.11.2 Fan shall be supplied complete with the following:
 - 2.11.2.1 Totally enclosed electric motor complete with cast aluminium drive assembly.
 - 2.11.2.2 Cast aluminium bladed propeller with separate blades mounted in a cast aluminium hub, propeller shall be statically and dynamically balanced.
 - 2.11.2.3 Removable polyvinyl coated screen at inlet side.
 - 2.11.2.4 Sealed ball bearings.
 - 2.11.2.5 Motorized aluminium damper at outlet.
 - 2.11.2.6 Aluminium casing with adjustable anchor angle and aluminium frame.

2.12 Fresh Air Fans

- 2.12.1 Fan shall be of the centrifugal double inlet width, backward curved blades type with non-overloading design wheel diameters and outlets areas shall be in accordance with the standard sizes adopted by the AMCA for non-overloading fans. Inlets shall be fully stream lined and housing shall be suitably braced to prevent vibration or pulsation.
- 2.12.2 Fan shall be supplied complete with:
 - 2.12.2.1 Electric motor mounted on one chassis with the fan.
 - 2.12.2.2 Reinforced heavy gauge fan casing.
 - 2.12.2.3 Metallic fixing frame and supports.

- 2.12.2.4 Pulleys, belt drive and belt guard (of expanded metal with tachometer hole).
- 2.12.2.5 Vibration isolators.
- 2.12.2.6 Fan wheels with die formed backward curved blades designed for maximum efficiency and quiet operations. Wheels shall be statically and dynamically balanced.
- 2.12.2.7 Heavy flanges on both sides of housing. Flanged joints shall be gasketed for air tightness.
- 2.12.2.8 Fan inertia should be checked against motor capability. If fan inertia is found larger, then a centrifugal or plate clutching service should be used to enable the fan to be brought up to speed without damaging the motor.
- 2.12.2.9 Motorized damper at fan outlet to open and close with fan on/off operation.

2.13 Spare Parts

- 2.13.1 The Contractor shall provide as part of his contract a list of spare parts for all the equipment supplied sufficient for three years of operation all in accordance with the recommendations of the manufacturers of the equipment.

2.14 Special Tools

- 2.14.1 A complete set of special tools, oil and grease for all the plant and equipment supplied, adequate for 12 months operation shall be supplied by the Contractor at the completion date of the project.

2.15 Operation and Maintenance Manuals

- 2.15.1 The Contractor shall furnish and submit to the Engineer in triplicate bound, A4 size, Instruction Manuals containing the following material:-
 - 2.15.1.1 Brief description of each system and its service and basic operation features.
 - 2.15.1.2 Manufacturer's mechanical equipment parts list of all functional components of the systems listed on the Drawings, control diagrams and wiring diagrams of controllers. List shall give system No., unit no., Manufacturer's Model No., and Manufacture's Drawing no. Parts list shall include manufacturer's recommended spare parts for one year operation.
 - 2.15.1.3 Maintenance instructions for each type of equipment.
 - 2.15.1.4 Possible breakdowns and repairs for each type of equipment. List of nearest local suppliers for all equipment.
 - 2.15.1.5 Manufacturer's literature describing each piece of equipment control diagrams and wiring diagrams of controllers.
 - 2.15.1.6 Complete, as installed, colour coded wiring diagrams of all electrical motor controller connections and interlock connections of other mechanical equipment.
 - 2.15.1.7 The Contractor shall furnish all the foregoing to the Engineer for his review as to the fulfillment of the specified requirements.
 - 2.15.1.8 All items shall be available at least four weeks prior to the substantial completion date.

2.16 Guarantee and Warranted Period

- 2.16.1 All equipment and accessories supplied by the nominated Sub-Contractor under this contract shall be guaranteed for a minimum period of one year from the date of final

completion certificate.

- 2.16.2 All guarantee shall be unconditional. In the event of breakdown, the Contractor shall immediately provide and install a replacement unit of equal or superior performance until such time as the original unit is repaired. Failure by the Contractor to comply within 6 hours of notification, will entitle the Employer to purchase or hire a replacement and seek reimbursement from the Contractor for all related disbursements.
- 2.16.3 The Contractor shall guarantee every piece of equipment from any manufacturing or installation defects for a period of one year, starting from the date of issue of the substantial completion certificate.

End of Section 23 34 00.

SECTION 23 37 00**AIR OUTLETS AND INLETS****PART 1 GENERAL**

- 1.1 Introduction
- 1.2 Scope of Work
- 1.3 Related Works Specified Elsewhere
- 1.4 Reference Standards
- 1.5 Air Distribution Outlets General Requirements

PART 2 PRODUCTS

- 2.1 Square - Air Diffusers
- 2.2 Linear Diffusers
- 2.3 Linear Bar Grilles
- 2.4 Grilles and Registers
- 2.5 Fresh Air and Discharge Louvers
- 2.6 Sand Trap Louvers
- 2.7 Door Louvers
- 2.8 DRUM TYPE LOUVRES

PART 3 EXECUTION

- 3.1 Installation
- 3.2 Fixing
- 3.3 Rejected

SECTION 23 37 00**AIR OUTLETS AND INLETS****PART 1 GENERAL****1.1 Introduction**

- 1.1.1 This section of specification includes the design, supply, installation testing and commissioning of the Air inlets and outlets for the complete air conditioning and ventilating system including fresh air intakes, louvers, grilles, diffusers etc.

1.2 Scope of Work

- 1.2.1 The contractor shall be responsible for submitting complete above works based on design consultant's approval of samples, submitted documents etc as per specifications and applicable standards.

1.3 Related Works Specified Elsewhere

- 1.3.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated here in verbatim.

Section	230500	-Common Works Results for HVAC
Section	230700	-HVAC Insulation
Section	230900	-Instrumentation And Controls for HVAC
Section	232000	-HVAC Piping and Pumps
Section	233000	-HVAC Air Distribution
Section	234000	-HVAC Cleaning Devices
Section	237000	-Central HVAC Equipment
Section	238000	-Decentralized HVAC Equipment
Division	25	-Integrated Automation

1.4 Reference Standards

DW 142	British Heating and Ventilating Contractors Association Code of Practice
NP 90A	Standard for the installation of Air Conditioning and Ventilating Systems
ADC	Air Diffusion Council

1.5 Air Distribution Outlets General Requirements

- 1.5.1 All air outlets shall be of, at least the sizes indicated on the Drawings. Irrespective of the sizes indicated on drawings, diffusers/grilles shall be sized such that the noise spectrum of the supply outlets not higher than NC-25 but in all cases outlet selected shall perform within the noise level requirement of the space it is supplying. Outlets shall be supplied with foam rubber gaskets to prevent air leakage.
- 1.5.2 Where supply or return outlets are installed in continuous line, omit intermediate frames and margins. Provide guides for each element to keep adjoining lengths aligned and butted without breaks. All outlets shall be constructed of aluminum of the color specified or as selected by the Engineer.
- 1.5.3 Outlets causing excessive air movement, drafts or objectionable noise shall be replaced at no cost to the owner.
- 1.5.4 All outlets shall be powder coated, samples showing finish and color shall be submitted to the Engineer for approval prior to supplying the outlets to Site.
- 1.5.5 The Contractor shall provide in his Tender for delaying the fixing of loose grilles until all other trades have completed their work, returning to the Site to fit the grilles as and when required to do so.

PART 2 PRODUCTS

2.1 Square-Air Diffusers

- 2.1.1 Air diffusers shall be of the diffusion and air mixing type and shall be made of anodized aluminum.
- 2.1.2 Supplied air shall be diffused with no air velocities in excess of 50 FPM. (0.25 m/s) at 1800 mm height or less above the floor line. Room air shall be mixed with the primary air by induction to effect subsequent uniformity of the room temperature without stratification.
- 2.1.3 Each diffuser shall be provided with an aluminum opposed blade damper.
- 2.1.4 Diffuser shall not project appreciably below ceiling or duct.
- 2.1.5 The inner assembly of the diffusers shall be attached to the outer assembly by means of a lock permitting assembly and disassembly without the use of tools.
- 2.1.6 The noise level shall be measured at a point one meter below the diffuser.

2.2 Linear Diffusers

- 2.2.1 Continuous slim line diffusers shall have extruded white anodized aluminum vanes and frames, unless otherwise indicated on the Drawings, and shall be designed for surface mounting on wall, ceiling or sill.
- 2.2.2 Diffusers shall be capable of diffusing air in a horizontal or vertical plane, combining discharge air diffusion, 20% aspiration and secondary air motion causing the discharge air to be diffused in such a manner that the air is delivered in a multiplicity of high and low pressure air currents causing turbulent air motion and insuring complete coverage and temperature uniformity within the space served.
- 2.2.3 The diffuser shall be provided with equalizing deflector and damper to accomplish uniform distribution throughout the length of the outlet.
- 2.2.4 The noise level shall be measured at a point 1800mm below on either side of the diffuser.

2.3 Linear Bar Grilles

- 2.3.1 Linear grille shall have extruded polyester powder coated aluminum fixed bar and frames, unless otherwise indicated on the drawings and shall be designed for surface mounting.
- 2.3.2 Grilles shall be capable of diffusing air in a horizontal or vertical plane with 0° to 15° or 30° deflection. Air shall be diffused in such a manner that the air is delivered in a multiplicity of high and low pressure air currents causing turbulent air motion and insuring complete coverage and temperature uniformity within the space served.
- 2.3.3 The grille shall be provided with directional blades and damper to accomplish uniform distribution throughout the length of the outlet. All deflection bars shall be securely fixed and shall be parallel to the long dimension.
- 2.3.4 The noise level shall be measured at a point 1800mm below on either side of the diffuser.

2.4 Grilles and Registers

- 2.4.1 All grilles shall be mounted upon substantial frames connected to the ductwork, and shall be provided with soft plastic mounting rings inserted under the frame, so as to obviate leaks behind the grille.
- 2.4.2 All supply grilles and high level return grilles shall be double deflection, with horizontal face blade in the front, with air foil blade construction, with minimum of 19mm flange with gasket.
- 2.4.3 Supply registers shall be double deflection, horizontal face bars, air foil blade construction, with aluminum opposed blade, key operated volume dampers, and 19 mm minimum gasket flange.

- 2.4.4 Return grille at low levels and fresh air grilles shall be single deflection fixed blade type with 19mm. Flange with gasket where the sheet metal is visible behind the grille, paint the interior surface of the sheet metal flat black.

2.5 Fresh Air and Discharge Louvers

- 2.5.1 Louvers for fresh air intake, and for exhaust. They shall be white anodized aluminum.
- 2.5.2 Louvers shall be weather proof, with fixed blades set at 30degree and shall have a free area of 85%.
- 2.5.3 Louvers shall be furnished with ½"(13mm) mesh-bird screen secured in removable extruded Aluminum frames.

2.6 Sand Trap Louvers

- 2.6.1 Sand trap louver shall have a high degree of separation of sand and large dust particles, even in cases of high dust concentrations. The vertically arranged sections and holes for sand drainage shall ensure the sand trap louver is self-cleaning and maintenance free. The sand trap louver shall be designed to separate large particles at low air velocities, thus avoiding excessive dust loading.
- 2.6.2 The sand trap louver shall be constructed in polyester powder coated aluminum, and shall be complete with transom, sand chute and galvanized bird screen. Color shall be to Engineer's approval.
- 2.6.3 Whether shown on drawings or not, all fresh air intakes shall be with sand trap louvers, filters and volume control dampers.

2.7 Door Louvers

- 2.7.1 The door louvers shall be sized so that the face velocity does not exceed 250 fpm (1.3m/s) unless otherwise indicated on the Drawings.
- 2.7.2 The louver shall be extruded aluminum completely light proof V-Section with double frame.

2.8 DRUM TYPE LOUVRES

- 2.8.1 Drum type louvers shall be fabricated of extruded aluminum sections with felts all around the rotating drum to prevent air leakage. Louvers shall have satin anodized aluminum finish.
- 2.8.2 The louver shall be adjustable to direct the air stream at any angle up to 30 O from the louvres centerlines either by rotating the drum or by adjusting the position of the pivoted vanes.

PART 3 EXECUTION

3.1 Installation

- 3.1.1 All outlets shall be erected, leveled and accurately set in position, to ensure symmetry with other grilles, light fittings, etc. It has been arranged that final minor adjustments to suspension levels to obtain final accurate alignment between the ceiling and light fittings, diffusers, etc., shall be executed by those responsible for erecting the false ceilings.

3.2 Fixing

- 3.2.1 All outlets shall be concealed fixing type with no screws.

3.3 Rejected

- 3.3.1 Any imperfect outlet scratched or damaged surfaces of fixing screws having damaged heads, or scratched plating, will be rejected and shall be replaced satisfactorily before the Contract Works will be taken over as complete.

End of Section 23 37 00.

SECTION 2.38100

DECENTRALIZED HVAC EQUIPMENT

PART 1 GENERAL

- 1.1 Scope of Work
- 1.2 Related Works Specified Elsewhere
- 1.3 Codes and Standards
- 1.4 Design Conditions

PART 2 PRODUCTS

- 2.1 Split Systems
- 2.2 Mini-Split System
- 2.3 Air Cooled VRF High Ambient System

PART 3 EXECUTION

- 3.1 Spare Parts
- 3.2 Special Tools
- 3.3 Operation and Maintenance Manuals
- 3.4 Guarantee and Warranty Period

SECTION 23 81 00**DECENTRALIZED HVAC EQUIPMENT****PART 1 GENERAL****1.1 Scope of Work**

- 1.1.1 Units shall be completely packaged, factory assembled and factory charged, designed for such applications.
- 1.1.2 Each unit shall have multiple refrigeration systems for efficient full and part load operation as shown in the capacity schedules.
- 1.1.3 OX-Air conditioning unit shall have a minimum seasonal average COP of 3.4.

1.2 Related Works Specified Elsewhere

- 1.2.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated here in verbatim.

Section 230500	Common Works Results for HVAC
Section 230700	HVAC Insulation
Section 230900	Instrumentation and Control for HVAC
Section 232300	Refrigerant Piping
Section 233000	HVAC Air Distribution
Section 234000	HVAC Cleaning Devices
Section 237000	Central HVAC Equipment
Section 238000	Decentralized HVAC Equipment

1.3 Codes and Standards

- 1.3.1 Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations.

Reference Code

<u>Reference Code</u>	<u>Abbreviation</u>	<u>Applicable Standard</u>	<u>Title of Standard</u>
American Society of Heating Refrigeration and Air Conditioning	ASHRAE	-	-
National Electrical Manufacturers Association	NEMA	-	-
National Electrical Code	NEC	Section 424	-
Air Moving and Conditioning Association	AMCA	-	-

National Fire Protection Association	NFPA	NFPA 90A	Standard for Air Conditioning and Ventilation Systems
ARI	ARI	-	American Refrigeration institute

1.4 Design Conditions

1.4.1 The air conditioning system is based on the following conditions

1.4.1.1 Outside summer conditions

97 F (36C) Dry Bulb

70F (21C) Wet Bulb

23F (13C) Daily range

1.4.1.2 Outside winter conditions

36F (2C) Dry Bulb

1.4.1.3 The inside summer conditions are indicated on the Drawings in the units capacity schedules.

PART 2 PRODUCTS**2.1 SPLIT SYSTEMS**

2.1.1 Each split system shall consist of two major components, one condensing unit installed out door and one blower coil unit installed indoor. Both units are interconnected with copper pipes.

Each system shall be supplied complete with all necessary control wiring for its proper operation.

2.1.2 CONDENSING UNITS

2.1.2.1 General

2.1.2.1.1 Supply and install wherever shown on the Drawings condensing units of the direct expansion air-cooled type. Unit shall be factory-assembled into a compact, weather-proof cabinet with common base size. Each condensing unit shall be complete with casing, compressor, condenser, control panel, one main disconnect switch, vibration isolators and all electrical power and control wiring necessary for proper operation.

2.1.2.2 Casing

2.1.2.2.1 Casing shall be at least 18 gauge, zinc-coated steel, phosphatized and painted externally with epoxy resin primer and finished with an approved top coat. Casing shall have a removable end panel, to allow for access to all components and connections, and die formed mounting rails integrated with unit base. Casing shall be provided with drainage holes in the base pan.

2.1.2.3 Compressor

2.1.2.3.1 Compressor shall be of the hermetic, reciprocating direct drive type with crank case heater, discharge line sound muffler and suction and discharge valves. Compressor shall have internal protection devices to provide protection for motor overload, locked rotor, and excessive winding temperatures.

2.1.2.4 Condenser Coil and Fans

2.1.2.4.1 Coil shall be of the seamless copper tubes with heavy aluminum fins mechanically bonded to the tubes, coil shall be factory pressure and leak tested at not less than 400 psig(2756Kpa) air pressure. Condenser coil shall be protected by heavy-duty grille.

2.1.2.4.2 Condenser fans shall be statically and dynamically balanced of aerodynamic design, heavy duty motors. Each motor shall have built-in current and thermal overload protection and permanently

lubricated ball bearings. Fan motor shall be provided with short circuit protective device(s).

2.1.2.4.3 Propeller Type Fans shall be of the direct drive type with fan motor support mounted to cabinet top. Fan shall have rugged steel guards for protection.

2.1.2.4.4 Centrifugal Type Fan: shall be of the double inlet forward-curved blades, belt driven with adjustable pulleys. Fan motor shall be capable to overcome specified static pressure.

2.1.2.5 Control Panel

2.1.2.5.1 Condensing unit shall be equipped with a factory wired built-in control panel comprising: 24-volts control power transformer, magnetic contactors for compressor and condenser fan motors, high and low pressure cut outs, non-recycling pump down and reset relay, and all necessary timers, and control relays and protective devices.

2.1.3 BLOWER COIL UNITS

2.1.3.1 General

2.1.3.2.1 Supply, install, and connect (refrigerant piping, power and electrical wiring) wherever shown on the Drawings factory assembled blower coil units consisting of casing, direct expansion evaporator coil, fan, motor, insulated drain pan and throw away filters. Each unit shall be supplied complete with expansion valve, drier, liquid sight glass, electrical wiring and vibration isolators.

2.1.3.2 Casings

2.1.3.2.2 Casing shall be not less than 20 gauge steel with baked on enamel finish, lined with not less than 13 mm thick, neoprene coated insulation. Casing shall be provided with removable access panel for full access to all components, and shall be provided with mounting holes for suspended mounting.

2.1.3.3 Coils

2.1.3.3.1 Cooling coils shall be seamless copper tubes with heavy aluminum fins mechanically bonded to the tubes. Coil shall be complete with male couplers, and operating charge of R-22 and shall be factory pressure and leak tested at not less than 200 psig (1380 Kpa).

2.1.3.4

2.1.3.5 Fan Motors

2.1.3.4.1 Fan shall be of the double inlet centrifugal type with forward-curved blades, belt driven, with an electric 3 speed motor having permanent split capacitor (for single phase motors only) and built-in thermal over load protection. Fan and motor bearings shall be of the permanently lubricated type.

2.1.3.6 Remote Control Station

2.1.3.5.1 Supply and install a remote control station wherever shown on Drawings complete with thermostats, on/off switches, controllers and all components indicated on the Drawings together with all the control wiring and its connections to the blower & condensing unit.

2.2 **Mini-Split System**

2.2.1 Mini split system shall cover a range up to three tons of refrigeration and shall consist of a condensing unit, an evaporator blower unit, and refrigerant piping network between the blower coil and the condensing unit, reverse cycle for heating and cooling.

2.2.2 Condensing Unit

2.2.2.1 Condensing unit shall be of the air cooled type completely assembled at the factory and shall consist of the following:

- Phosphatized zinc coated steel casing.
 - Reverse Cycle for heating and cooling
 - Hermetic Compressor.
 - Air cooled condenser and condenser fan.
 - All necessary controls and accessories for automatic and proper operation.
- 2.2.3 Evaporator Blower Unit
- 2.2.3.1 The evaporator blower unit shall be installed indoors and shall be of the type indicated on the Drawings ..
- 2.2.3.2 The unit shall be complete with:
- Evaporator cooling unit.
 - Centrifugal 3-speed blower and blower motor.
 - Cleanable filter.
 - Remote thermostat, thermometer, speed selector switch and time control.
 - Decorative cabinet if installed exposed.
 - Electric heating element (if shown on Drawing).
- 2.3 Air Cooled VRF High Ambient System**
- 2.3.1 Features
- 2.3.1.1 The system shall control flow of refrigerant through indoor units, by means of an electronic expansion valve fitted in each indoor unit.
- 2.3.1.2 The system shall be capable of cooling with external ambient temperatures from -5°C to +42°C.
- 2.3.1.3 The equipment manufacturer shall be responsible for the manufacture of the compressor, refrigerant oil and refrigerant used within the system to maintain integrity of design and optimize efficiency and reliability of equipment.
- 2.3.1.4 The system shall have the ability to sustain refrigerant piping lengths of up to 165m with a level difference up to 50m between fan coil units and condensing unit if the outdoor units located above the highest level indoor unit. An option shall be available to increase the level difference of the pipe work to 90m between fan coil units and condensing unit if the outdoor unit is located above the lowest level indoor unit.
- 2.3.1.5 Each independent system shall be capable of having up to 100m of refrigerant pipe work installed. The system shall be capable of having up to 90m refrigerant pipe length from the first refnet joint to the furthest indoor unit, after incorporating relevant system design guide lines.
- 2.3.1.6 The system shall operate with Refrigerant that should provide maximum temperature glide of less than 0.17K to avoid fractionation problems and meet Estidama requirements; i.e. Ozone depletion potential (ODP) equal to zero. The unit shall be factory assembled and charged with ECO friendly refrigerant.
- 2.3.1.7 All equipment shall be run tested in accordance with the following procedures prior to leaving place of manufacture.
- 2.3.1.7.1 Choke test carried out on the refrigerant piping to detect obstacles
- 2.3.1.7.2 The pipework shall be tested to 38 bar.
- 2.3.1.7.3 Electronic leak testing shall be carried out to ensure maximum system refrigerant containment.
- 2.3.1.7.4 System vacuum test to 2 Torr

- 2.3.1.7.5 Refrigerant test to within 0.3%
- 2.3.1.7.6 Electrical tests shall include flash testing at 1440VAC to ensure that current leaks above 5mA are detected, megger test at 500VDC to ensure resistance levels are above 10 mega Ohm and earth continuity tests.
- 2.3.2 Outdoor Units
- 2.3.2.1 The units shall be heat pump air-cooled type incorporating heat exchanger coils manufactured from copper tubes and aluminum fins, factory treated to reduce the effect of atmospheric corrosion.
- 2.3.2.2 The unit casing shall be manufactured from (701-1) polyester powder coated baked enamel finish sheets tee lin or der to have a high corrosion resistance and to protect against salt laden environment.
- 2.3.2.3 The outdoor units shall have inverter drive compressor or (Variable Frequency Drive Compressors and capable of soft start compressor or shall be electronically controlled and capable of changing speed linearly to follow the variation in cooling or heating requirements.
- 2.3.2.4 The compressor shall be scroll type with fixed and orbiting scrolls. The low pressure refrigerant shall be fed directly into the scroll and the discharge refrigerant shall cool the motor windings and place the compressor shell under discharge pressure.
- 2.3.2.5 The lubrication oil of the compressor shall be fed through the centre of the crank shaft and then across the complete area of the scrolls from the centre outwards to ensure the complete contact area is positively lubricated maximizing compressor efficiency and minimizing wear and tear.
- 2.3.2.6 The outdoor unit fan motor shall be inverter driven and shall operate electronically by sensing operational temperatures, pressures and ambient temperature and monitoring the dictates of the indoor units.
- 2.3.2.7 The units shall be complete with;
- VFD compressor,
 - Electronic expansion valve(s),
 - Oil separator(s),
 - Suction accumulator,
 - High pressure switches,
 - Inverter driven fan motors,
 - Safety thermostat,
 - Over current relay,
 - Inverter overload protection,
 - Fuses,
 - Necessary solenoid valves,
 - Liquid shut off valves,
 - Gas line shut off valves,
 - Short re-cycling guard timer and all necessary sensors for optimized,
 - Safe and trouble free operation.
- 2.3.2.8 Outdoor unit access to the internal components for maintenance purposes shall be by removable panels.
- 2.3.2.9 The fan will be capable of overcoming a minimum of 80 Pascal of external static pressure..
- 2.3.2.10 The units shall be capable of being combined to provide multi systems using combinations of two or more outdoor units connected to give the capability of higher capacities.
- 2.3.2.11 The unit shall be capable of carrying out automatically the calculated required additional refrigerant charge necessary to operate the system within its optimum efficiency. This cycle shall be completely automatic and provide a warning to the service technician to indicate when charging has been completed or the charging cylinder is empty.
- 2.3.2.12 The refrigerant cycle shall not rely upon float valves, level switches or weighed input of the refrigerant.
- 2.3.2.13 The calculated refrigerant charge shall be retained within the memory of the outdoor PCB as a reference for a refrigerant containment check which can be carried out as required to verify the correct refrigerant charge remains

within the system.

- 2.3.2.14 The automatic refrigerant charging and containment check facilities shall be capable of being used at anytime during the life of the system for any alterations or service operations which may be required.

2.3.3 Indoor Units

2.3.3.1 **Ducted unit (Ceiling concealed type)**

- 2.3.3.1.1 The fan motor should be DC inverter motor. The unit static pressure should be automatically adjustable from the unit wired remote controller (service mode).

- 2.3.3.1.2 The fan external static pressure should be at least 150 Pa at highest speed. However, the unit static pressure can be adjusted in the range between 30 and 200 Pa (at various speeds) to match the static pressure of the duct connected to that unit.

- 2.3.3.1.3 Unit sound pressure level shall not exceed 45 db at high fan speed measured 1.5m distance from the unit.

- 2.3.3.1.4 A condensate lift pump shall be provided within the unit and shall be capable of discharging above the drain outlet.

- 2.3.3.1.5 The unit casing shall be manufactured from galvanized steel plate and shall be fully insulated. Facility shall be provided for duct connection for introduction of fresh air to the unit and branch duct work from the unit. The return air to the unit shall be through the back of the unit as standard.

- 2.3.3.1.6 The heat exchanger coils shall be manufactured from copper tubes and aluminum fins.

- 2.3.3.1.7 The unit shall have electronic expansion valve to control refrigerant flow rate in response to the load variation in the conditioned space. The expansion valve shall be controlled by an integral computerized PIO control system to maintain correct room temperature.

- 2.3.3.1.8 Units Sound level shall be low enough to meet the noise levels specified for the served OZ underneath areas in Section 230548.

2.3.3.2 Large Ducted Type

- 2.3.3.2.1 The unit casing shall be manufactured from galvanized steel plate and shall be fully insulated. Facility shall be provided for duct connection for introduction of fresh air to the unit and branch duct work from the unit. The return air to the unit shall be through the back of the unit as standard.

- 2.3.3.2.2 The fan shall be of the dual suction multiple type, statically and dynamically balanced to ensure low noise and vibration free operation.

- 2.3.3.2.3 The heat exchanger coils will be manufactured from copper tubes and aluminum fins.

- 2.3.3.2.4 The unit shall have electronic expansion valve to control refrigerant flow rate in response to the load variation in the conditioned space. The expansion valve shall be controlled by an integral computerized PID control system to maintain correct room temperature.

- 2.3.3.2.5 Units sound level shall be low enough to meet the noise levels specified for the served OZ underneath areas in Section 230548.

2.3.3.3 Small Ducted Type

- 2.3.3.3.1 The unit casing shall be manufactured from galvanized steel plate and shall be fully insulated. Facility shall be provided for duct connection for introduction of fresh air to the unit and branch duct work from the unit. The return air to the unit shall be through the back of the unit as standard.

- 2.3.3.3.2 The fan shall be of the dual suction multi blade type, statically and dynamically balanced to ensure low noise and vibration free operation.

- 2.3.3.3.3 The heat exchanger coils will be manufactured from copper tubes and aluminum fins.

2.3.3.3.4 The units shall have electronic expansion valve to control refrigerant flow rate in response to the load variation in the conditioned space. The expansion valve shall be controlled by an integral computerized PID control system to maintain correct room temperature.

2.3.3.3.5 UnitssoundlevelshallbelowenoughtomeetthenoiselevelsspecifiedfortheservedOZunderneathareasinSection230548.

2.3.4 Ancillary Items

2.3.4.1 Proprietary REFNET joints and headers shall be used throughout the installation to reduce imbalance in refrigerant flow between indoor units. Size to be suggested and approved by the VRF manufacturer.

PART3 EXECUTION

3.1 Spare Parts

3.1.1 The Contractor shall provide as part of his contract a list of spare parts for all the equipment supplied sufficient for three years of operation all in accordance with the recommendations of the manufacturers of the equipment.

3.2 Special Tools

- 3.2.1 Acomplete set of special tools, oil and grease for all the plant and equipment supplied, adequate for 12months operation shall be supplied by the Contractor at the completion date of the project.

3.3 Operation and Maintenance Manuals

- 3.3.1 The Contractor shall furnish and submit to the Engineer in triplicate bound, A4 size, Instruction Manuals containing the following material:-

- 3.3.1.1 Brief description of each system and its service and basic operation features.
- 3.3.1.2 Manufacturer's mechanical equipment parts list of all functional components of the systems listed on the Drawings, control diagrams and wiring diagrams of controllers. List shall give system No. unit no., Manufacturer's Model No., and Manufacture's Drawing no. Parts list shall include manufacturer's recommended spare parts for one year operation.
- 3.3.1.3 Maintenance instructions for each type of equipment.
- 3.3.1.4 Possible break downs and repairs for each type of equipment.
- 3.3.1.5 List of nearest local suppliers for all equipment.
- 3.3.1.6 Manufacturer's literature describing each piece of equipment control diagrams and wiring diagrams of controllers.
- 3.3.1.7 Complete, as installed, color coded wiring diagrams of all electrical motor controller connections and interlock connections of other mechanical equipment.
- 3.3.1.8 The Contractor shall furnish all the foregoing to the Engineer for his review as to the fulfillment of the specified requirements.
- 3.3.1.9 All items shall be available at least four weeks prior to the substantial completion date.

3.4 Guarantee and Warranted Period

- 3.4.1 All equipment and accessories supplied by the nominated Sub-Contractor under this contract shall be guaranteed for a minimum period of one year and five years for compressors from the date of final completion certificate.
- 3.4.2 All guarantee shall be unconditional. In the event of breakdown, the Contractor shall immediately provide and install are placement unit of equal or superior performance until such time as the original unit is repaired. Failure by the Contractor to comply within 6 hours of notification, will entitle the Employer to purchase or hire a replacement and seek reimbursement from the Contractor for all related disbursements.
- 3.4.3 The Contractor shall guarantee every piece of equipment from any manufacturing or installation defects for a period of one year, starting from the date of issue of the substantial completion certificate.

End of Section 23 81 00.

SECTION-16000
ELECTRICAL WORKS

PART 1 - GENERAL

ELECTRICAL SUB-CONTRACTOR

- A. The electrical work shall be carried out by an electrical sub-contractor who is on the approved list of electrical contractor's.
- B. The electrical sub-contractor must have, during the entire duration of the Contract, qualified electrical engineer and electrical supervisor for ensuring proper execution and supervision of work. The electrical engineer should be licensed & registered with the Local Engineer's Association and his name, qualifications and experience should be submitted for approval. The electrical engineer and supervisor should be available at site during all working hours.
- C. The name of the electrical sub-contractor, details of his experience and his staff qualifications and experience shall be submitted by the tenderer with his tender in accordance with form shown hereinafter which shall be filled by the tenderer and his proposed sub-contractor.

1.01 SCOPE OF WORK

- A. The Work included in these Specifications is for the complete Electrical Services for the Project. The Work described and included in this Specification is for the manufacture works, testing, supply, delivery to site, erection, connection, site testing, demonstrating, commissioning and maintaining for required duration, all equipment and installation as described in this Specifications and shown on Contract Drawings. Additionally all equipment and installation shall conform to local authorities Specifications.

Any Works whether or not shown on the Drawings and/or described in the Specifications but which can reasonably be inferred as necessary for the completion and proper operation of the works will also form part of the extent of the Contract

- B. All Electrical Works complete in all respects shall be provided in accordance with the requirements of the Contract Documents. The scope of works shall include, but not be limited to the following:

1.02 A. RELATED SECTIONS

<u>SECTION</u>	<u>Title</u>
14200	Conveiance System
16000	Electrical Works
16010	General Provisions for Electrical Work
16110	Raceways
16120	Conduits
16200	Cables and Wires
16300	Supporting Devices
16400	Main Distribution Equipment
16500	Lighting
16640	Earthing
16670	Lightning Protection system
16720	Fire Detection and Alarm System
16760	Data System
16771	Public Address /Evacuation System
16772	Audio Visual, Conference, Interpretation System
16960	Building Surveillance System (CCTV)

B. RELATED WORKS SPECIFIED ELSEWHERE

The following related service installations are specified in other divisions of the Specifications. The Contractor shall co-ordinate all his installation with the related works such as:

- Plumbing
- HVAC
- Fire Fighting
- Interior Finishes & Architectural Works
- Any other sub-contractor engaged for the project.

1.03 REGULATIONS

A. Authorities and Regulations

The Contractor shall comply with all statutory requirements and regulations issued by the local authorities within whose area of jurisdiction the site is contained.

The Contractor shall also comply with the relevant "Codes of Practice" issued by the British Standards Institution and the latest edition of the "Regulations for the Electrical Equipment of Buildings" issued by the Institution of Electrical Engineers, and any supplements thereto.

1.04 CLIMATIC CONDITIONS

- A. Extremes of temperature and humidity are experienced. Periods of high humidity has been recorded.

Sand and dust storms occur and even on comparatively still days, fine dust is carried in the atmosphere.

- B. All equipment and materials forming the electrical installation work shall be designed and constructed to provide satisfactory service without any harmful effects for prolonged and continuous use in the climate of the project. Generally, the following temperatures shall be made as design criteria:

1. 35 Deg. C if installed within buildings having good heat insulating properties and adequate ventilation.

2. 40 Deg.C if installed in well ventilated positions and shaded from direct sunlight throughout the day.
 3. 45 Deg.C if exposed to direct sunlight.
- C. Minimum Temperatures Likely to Occur are:
1. -5 Deg.C outdoors.
 2. 10 Deg.C indoor.
- D. The above temperatures do not take into consideration heat generated from the equipment itself or from any other equipment installed in the vicinity.
- E. The capacity and rating of all electrical equipment and materials given are Local rating, i.e. rating when equipment are operating under Local Climatic Conditions. Any derating factors applied should be clearly indicated.
- F. Where specific sizes are indicated e.g. cable sizes, due allowances have been made in the design for the climatic conditions of project and de-rating has been applied.

1.05 ELECTRICITY SUPPLY

- A. All electrical equipment accessories and fittings shall be designed and manufactured to operate continuously in the electricity supply system having the following characteristics: -

Voltage	415 Volts \pm 6% 3Phase 4-Wire
Frequency	50 Hz \pm 4%
Neutral	Solidly Earthed
Fault Level	31 MVA at 415 volts
Fault Duration	0.5 Seconds

1.06 STANDARDS

- A. All works contained herein shall be subject in every respect to the approval of the Engineer.

The design manufacture installation and testing of all materials and equipment shall comply with the latest Local Authorities Specifications. Where no particular item is not specified by Local Authorities Specifications, relevant recommendation of the International Electrotechnical Commission (I.E.C.) and if this is not available then with the latest relevant British

Standard Specification (B.S.S.) or other approved National Standards. Specifically the following standards/regulations/codes shall be acceptable:

- IES/CIBSE Illumination codes
- CIE International Commission on Illumination
- Relevant British Standard Codes for Practice (BSCP)
- International Commission for Conformity Certification of Electrical Equipment (CEE)
- Specifications for Installation of Telephones, issued by the Ministry Of Telecommunication.
- The latest relevant recommendations of the committee 'Consultant International Telephone and Telegraph (CCITT)
- Civil Defense Fire Department
- British Fire Officer's Committee (FOC) Rules (Latest Edition)
- National Fire Protection Association (NFPA)

- B. Standards for materials and the design of equipment are quoted throughout this specification and the Contractor shall produce copies of these Standards as required and instructed by the Engineer. If the Contractor offers equipment, which is not manufactured, in compliance with these Standards the equipment offered should be at least equal in performance and quality to that required by the relevant Standard.
- C. In the event of the Contractor offering materials or equipment which differs from that described in this Specification, the Contractor shall include for all the costs involved in checking the design, any necessary redesign, drawings and the modifications to other equipment of the affected system.
- D. While making an offer, the Tenderer should specify the name of the Manufacturer he intends to use for the supply of each equipment material/light fitting etc. In offering such material or equipment or light fitting he shall include with his tender the detailed information necessary to demonstrate quality. The presentation of such data shall take the form of a comparison sheet giving on one column the critical parameters required by the relevant Standard and/or equipment specified and an adjacent column giving the standards of the equipment offered in the Tender. Where manufacturers names are particularly specified for any item, the contractor must choose from the specified manufacturer(s).
- E. The term "materials" as used in this Specification refers to any basic engineering equipment which forms part of the installation but which in itself does not form a unit which can be specified with an output performance.
- F. Materials are related to a Standard whenever applicable and it is deemed that such reference, without further amplification, includes the whole of the current Standard. With the approval of the Engineer, alternative and

equivalent National or International Standards may be used, but these must be declared and agreed at the time of Tendering.

- G. All materials/equipments/light fittings manufacturers selected by the contractor shall have established local agents.

1.07 CAPACITIES AND DERATING FACTORS

The capacities and ratings of the equipment, electrical components and accessories shall be sufficient to give satisfactory service in the environments conditions stated herein before.

Sizes of electrical cables and wires shall be determined by suitably derating the current ratings of such cables and wires in accordance with the rating factors indicated in the I.E.E. Regulations. The attention of the Contractor is drawn to the fact that the application of derating factors for the higher ambient temperatures will not by itself render the equipment suitable for the climatic conditions of the site. Full considerations shall be given to the severe climatic conditions.

1.08 FUSING AND PROTECTION

- A. The rating (in amperes) of circuit breakers, switch fuses and circuit ways of distribution boards given on diagrams or drawings are the maximum normal (operating) rating permissible for such circuit.

On completion of the installation it shall be the responsibility of the Contractor to set the overload protection appropriate to the actual loading on each circuit.

The Contractor shall be held liable to make good any damage resulting from overloading should it be discovered that overloads were improperly set or fused incorrectly rated.

Under no circumstances shall cartridge fuse carriers be bridged with loose fuse wire. In the event of such malpractice being discovered, the Contractor will be required to replace the whole assembly if such a fuse is blown.

1.09 RADIO INTERFERENCE SUPPRESSION

- A. All electrical equipment shall be provided with suitable means of suppressing radio frequency interference fully in accordance with various requirements stipulated in relevant British Standards.

1.10 DIMENSIONS OF EQUIPMENT

- A. The Contractor shall ensure that all plant and equipment included in his offer can be accommodated in the position shown on the drawings without

structural alterations. The Engineer will not consider any claims for additional payments resulting from modifications arising from equipment of unsuitable dimensions being provided.

1.11 DRAWINGS

- A. Before signing the contract, the Contractor should obtain a set of the approved drawings by the local authorities. It shall be deemed to be understood that Contractor has taken into account the difference between Tender Document/Drawings and the approved drawings and that he shall not be eligible for any additional payments/variations etc.
- B. Refer to all other Architectural, Structural and Mechanical Drawings to verify all spaces and conditions affecting the electrical work and to ascertain the location and routes of all gas and water services, AC ducts, piping ...etc. so as to maintain adequate clearance between electrical and other services. The Drawings shall be available at the main contractor's Office. In case of discrepancy the decision of the engineer shall be final.
- C. Shop Drawings
 1. Prepare and submit for approval, before commencing any portion of the Contract work, complete shop drawings, which shall show:
 - Exact routes of cables and ducts including sizes and details of installation.
 - Cable trays and ladders giving routes, sizes and details of supports and hangers.
 - Exact runs of conduits and trunking including sizes, draw boxes and junction boxes and the number and sizes of wires in each run.
 - Switch boards and distribution boards and control panels including location, layout, dimensions, fixing details, cabling and final connection arrangement.
 - Proposed supports and hangers for cable trays, trunking, conduits, cables, light fittings ...etc. including details of materials, finish, sizes and method of fixing to structure.
 - The contractor shall submit sections and elevations as required by the Engineer to show details of installation showing plant, equipment, fixtures in true dimensions in relation to furniture and other elements in the concerned area.
 2. Shop drawings shall be made to a scale not less than 1/100 or as required by the Engineer. A detailed duly updated record shall be

kept by the Contractor of all service distribution routes and installation work during the Contract duly titled.

3. The shop drawings shall be coordinated with the work of all other Trades and shall where necessary show adjacent services to indicate satisfactory coordination. Where necessary or when requested by the Engineer, provide coordinated sections to a suitable scale to suit each condition. Drawings of other Trades which are not forming part of this Contract if required for coordination purposes will be issued to the Contractor by the Engineer.

D. Progress Drawings

1. Furnish and keep on the job site at all times, one complete and separate set of blackline prints of the Electrical Work on which shall be clearly, neatly and accurately noted, promptly as the work progress, all electrical changes, revisions and additions to work as actually installed. Wherever work is installed other than as shown on the drawings, such changes shall be noted.
2. Indicate daily progress on progress prints by colouring in the various parts of the Works as they are erected.

E. Record Drawings / As Built Drawings

1. At the conclusion of work, prepare and submit "Record Drawings" (As Built Drawings)..
2. These drawings shall be titled "Record Drawings" and shall be prepared from the marked up progress prints. Submit "Record Drawings" to the Engineer for review and approval.
3. Should there be any difference between the final "Record Drawings" and the Contract Drawings, then arrange for obtaining approval of the final "Record Drawings" from the local authorities.
4. The Contractor shall submit "As Built Drawings" as under:
 - a) 3 sets of computer compact disk (CD) prepared on AutoCAD.
 - b) 5 sets of paper prints of the "As Built Drawings" each set in binder form.

F. Approval from Authorities

The contractor shall be responsible for obtaining design and as built approvals from all local authorities, Civil Defense Fire department, etc. in respect of the following:

1. All works executed by him including any extension works added during construction.
2. Any changes made on the design during construction.
3. Any alterations, modifications made during construction.
4. Any other approvals specifically asked for in this document or B.O.Q.

1.12 DISCREPANCIES

- A. Before signing the contract, the Contractor should verify for himself any discrepancies between B.O.Q and the drawings. He may add in his offer any additional amounts that are required to meet the discrepancies. Under No circumstances he will be eligible for additional claims on account of such discrepancies

PART 2 – PRODUCT

2.01 MATERIALS

- A. All equipment and materials used in the electrical installation work shall be new and of the highest quality. They shall be suitable for operation the standard voltage and frequency in the area of the project.
- B. Unless otherwise specified, all equipment and materials shall comply as a minimum with the latest relevant recommendations of the International Electrotechnical Commission (IEC). If these are not available for any equipment or material then the latest relevant British Standard shall be followed.
- C. If standards mentioned above contradict with this Specification, then the requirements of this Specification shall prevail.
- D. Electrical equipment and material complying with other national standards may be considered for use in the work provided, the Contractor shall, at the time of submitting his offer, confirm in writing that such standards meet the requirements of IEC/BSS as regards characteristics, requirements and testing procedures as a minimum. The Contractor, if awarded the work on the basis, shall be required to substantiate this by producing all relevant data and test

certificates and, if needed, by report from an approved inspecting and testing authority confirming that the results of the tests carried out on these equipment and materials meet the requirements of IEC/BSS as a minimum. Only after the production of such evidence and subsequent approval of the Engineer should the equipment and materials be delivered to site.

- E. Submit to the Engineer full details and particulars of all equipment and materials proposed for use and no material shall be ordered, delivered or constructed without a written approval from the Engineer. Any material or equipment, which is not approved but installed, shall be removed and reinstalled with approved one at the Contractor's expense.
- F. The details of equipment and materials shall include the following:
 - 1. Full technical specifications of equipment including construction, materials, degree of protection, characteristics, curves, diagrams, ratings, dimensions, fixing details, etc.
 - 2. Relevant sheets of manufacturer's catalogues, specifications, technical data ...etc.
 - 3. Confirmation that equipment and materials offered complies fully with relevant Clauses of the Specification and, in case of deviation from the Specification, a schedule of deviations listing all points not conforming to the Specification.
 - 4. Short circuit study including all components shown on the Schematic Diagrams.
- G. Submit, at the request of the Engineer, a sample of any equipment or material for further study before approval.
- H. Manufacturers specified by name are not relieved of the responsibility for meeting Specification requirements and submittal for approval.
- I. No order shall be placed by the Contractor for major material or equipment unless written approval of the Engineer has been obtained. The Contractor shall report monthly progress of the purchase orders to the Engineer submitting to him a copy of the orders.

PART 3 – EXECUTION

3.01 WORKMANSHIP

- A. The works shall be executed in a neat, substantial and workmanlike manner. All workmanship shall be strictly first class in every respect and shall be performed only by skilled workmen.
- B. Whether or not shown on the Drawings, equipment shall be installed in such a manner that equipment, operating and control devices ...etc. are readily accessible for service and adequate access spaces are maintained.

- C. Obtain detailed information from the manufacturers of equipment as to proper method of installation and connection of these equipment.
- D. Should any portion of the Contract works which should reasonably and obviously be inferred as necessary for the complete, safe and satisfactory operation of the electrical installation as a whole, but not expressly described or specified, provide and execute such works as part of the Contract.

3.02 CONTRACTOR'S REPRESENTATIVE, STAFF AND WORKMEN

- A. The Contractor shall keep permanently on the site, a competent Senior Electrical Engineer, having an experience of not less than 10 years, as his representative fully experienced and who has executed as Superintendent of electrical installation works of the type and scale similar or larger than this Project.
- B. The Contractor shall submit to the Engineer the Schedule of Proposed Contractor's Engineers Senior Draftsmen and Senior Foremen employed for this Project stating the names, nationalities, ages, qualifications and detailed experience before proceeding with the Works. The Contractor shall from time to time supply any further personnel in addition to those proposed and approved as may be necessary to ensure the satisfactory progress of the works.

3.03 IDENTIFICATION AND LABELLING

- A. The components of all main and sub-main switch boards, all distribution boards, switches, isolators and other items of plant shall be clearly identified by means of labels secured to the external surfaces of the units designating the function of these units.
- B. The labels shall be 2mm. "Traffolite" of minimum size 50 x 20mm with 5mm black lettering on white background fixed securely to front plates of distribution boards, switches, circuit breakers, isolators, starters, push buttons, lamps instruments ...etc.
- C. In addition to this each distribution board shall also be provided with circuit schedules fixed rigidly inside the door of the board and indicating the number, rating, type of load and location of each circuit in the board.
- D. Each end of each cable shall be provided with identification labels lettered with feeder or circuit designation to the Engineer's instructions. The labels shall be permanently fixed in distribution boards, terminal boxes, isolators, ...etc.

- E. Manufacturers name plates shall include manufacturer's name, model or type number, serial number and all applicable ratings clearly marked thereon. The name plates shall be placed in a conspicuous location on the equipment.

3.04 TESTING AND COMMISSIONING

- A. On completion of the entire electrical installation work or any separate or distinct part thereof, notify the Engineer, in writing, that the completed part of the electrical work is ready for inspection. Before doing so, perform initial trial tests. Test, correct, adjust, balance, regulate, ...etc. the section concerned as necessary until required conditions are obtained.
- B. The inspection of the Contract work shall be carried out in the presence of the Engineer and in accordance with the requirements of Section 'E' of the IEE 'Regulations for Electrical Equipment of Buildings' and shall comprise of but not be limited to:
 1. Verification of polarity.
 2. Effectiveness of earthing.
 3. Insulation resistance test.
 4. Test of ring circuit continuity.
 5. Phase rotation.
 6. Operation tests of relays, interlocks and any other protective and control device to ensure correct functioning.

The results and readings obtained shall be equal or better than the requirements of the IEE and the local authorities regulations and these shall be recorded on forms similar to the ones described in the IEE regulations.

- C. Supply all instruments and tools required for carrying out the tests.
- D. In case that the above mentioned tests are satisfactory and no errors or faults appeared in the installation, submit the necessary test forms duly filled, to the local authorities and to repeat, if necessary, the tests in the presence of the local authorities Inspector.
- E. Follow-up and make all necessary arrangements with the local authorities for the purpose of providing permanent electricity supply and telephone service. Also provide all facilities and attendance to the local authorities for any other tests carried out before energizing the installation.
- F. After the connection of the supply to the installation, commission all parts of the electrical installation covered by this Specification and demonstrate to the Engineer that the entire electrical installations are in perfect working order.

- G. When equipment or services of a specialized nature are involved, and if it was found necessary, provide the services of a specialist from the manufacturer who shall be present at the time of testing and commissioning of this equipment. Include for all expenses incurred in this respect as no claim for additional payment will be entertained.
- H. Acceptance certificate will not be issued until all testing and commissioning has been carried out to the satisfaction of the Engineer and local authorities. After local authorities 's final approval microfilm of as-built drawing shall be given to the Engineer for permanent record.
- I. An amount equal to 5% of the contract value for the Electrical, Communication and Electronic works will be retained till the completion of all commissioning. This amount is in addition to the 10% retention money, which will be release after the completion of 2 years of maintenance contract.

3.05 OPERATION AND MAINTENANCE MANUALS

- A. Submit to the Engineer, at the same time of submitting "Record Drawings", properly printed and bound copies of service manuals for the electrical installations to describe the various systems in the fullest details that permit application of proper maintenance, replacement of parts and awareness of system characteristics. These shall include the following:
 - 1. Manufacturer's technical catalogues, dimensional drawings and wiring diagrams for each and every type of equipment installed.
 - 2. Operating instructions for various equipment and systems included in the installation work.
 - 3. Maintenance manuals for all equipment and systems included in the installation work, which need regular and specialized maintenance.
 - 4. Spare parts list with part numbers of various components of all equipment used in the installation work.

3.06 OPERATION AND MAINTENANCE DURING TWO YEAR MAINTENANCE PERIOD

- A. Include for Operation and Maintenance including Preventive Maintenance during the two (2) year Maintenance Period.
- B. Include all spare parts for replacements made necessary due to wear and tear of equipment, consumable parts, short life parts, oils, etc. and all maintenance tools and equipment required for proper operation and maintenance of the Works, the contractor should submit a list of spare parts to be included with his offer for each item.
- C. Include for sufficient personnels to be on call for 24 hours 7 days a week

- D. Include all routine and preventive scheduled maintenance as recommended by the equipment manufacturers to keep equipment in perfect operating condition.
- E. Keep all records, logbooks, log sheets, maintenance job cards ...etc. in neat order to the satisfaction of the Engineer. All records, log books, and log sheets, charts, maintenance job cards, ...etc. shall become the property of the Employer.
- F. Provide all necessary maintenance and operation staff experienced in both electrical and mechanical work such as engineers, foremen, operators, electricians, mechanics, helpers....etc. for effective maintenance and operation of all systems. Submit to the Engineer for approval qualification details of all maintenance and operation staff.
- G. During the Maintenance Period operate, control, maintain, replace and repair any part of plant or material within the Electrical Works Systems which may prove defective due to Contractor's design, erection, operation, performance, or workmanship, or prove defective from any act or omission that may develop from use in the Works or any section thereof.
- H. Be responsible for training the Employer's personnel in the correct operation, control and maintenance of the Electrical Works Systems. Training shall be carried out by qualified commissioning and operating staff of the Contractor.
- J. The foregoing Clauses are in addition to and in no way relieve the Contractor of his liabilities and obligations under the Contract.

3.07 GUARANTEE

- A. Manufacturer's shall provide their standard guarantees for products furnished under this Contract. However, such guarantees shall be in addition to and not in lieu of all other liabilities which manufacturers and the Contractor may have by law or by other provisions of the Contract Documents.
- B. All materials, items of equipment and workmanship furnished under this Contract shall carry standard warranty against all defects in materials and workmanship. Any fault due to defective or improper material, equipment, workmanship or Contractor's design which develop shall be made good, forthwith, by and at the expense of the Contractor, including all other damage done to areas, materials and other systems resulting from this failure.

- C. Guarantee that all elements of the systems are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.

3.08 SPARE PARTS

- A. Spare Parts during Two years Maintenance Period:
Contractor shall provide all spare parts required during the two (2) years maintenance period at NO cost
- B. In special cases the spares have been listed in the sections. In all other cases manufacturer's recommended spares shall be provided.

*** END OF SECTION ***

Section 16010
General Provisions for Electrical Work

Part 1-General

1.01 Work Included

All electrical work shown on the drawings or mentioned in B.O.Q.

1.02 Quality Assurance

- A. General Provisions contained in this section, shall apply and form a part of each and every section of specification, Division 16, Electrical.
- B. The Contractor shall verify that the materials, appliances, equipment or devices he furnishes and installs under this Contract, meet the requirements of the specified codes and standards. The label of, or listing by an independent institute will be accepted as conforming with this requirement. In lieu of the label or listing. The Contractor shall submit independent proof for review by the Supervising Engineer that the materials, appliances or devices conform to established standards, including methods of test, of the country of origin.
- C. In addition to the requirements shown or specified in the Contract Documents, all equipment shall be manufactured, tested and installed in accordance with the latest editions of the following standards as listed:
 - 1. IEC International Electrotechnical Commission.
 - 2. BS British Standards.
 - 3. ISO International Standards Organization.
 - 4. VDE Association of German Electrical Engineers.
 - 5. IES Illuminating Engineering Society.
 - 6. Municipality Regulations.
 - 7. Regulations and instructions of Civil Defense Department.
- D. Codes and Standards listed in the specification sections are intended to provide an acceptable level of quality for materials and products. The Contractor may propose alternative codes and standards provided they are of equal or better quality than the reference codes and standards and are submitted for review and approval by the Supervising Engineer.

- E. All items of labor and material required to comply with such standards and codes in accordance with the requirements of the Contract Documents shall be included. Where quantities, sizes or other requirements indicated on the drawings or herein specified are in excess of the requirements of the standards and codes, the specifications and /or drawings shall govern.
- F. The electrical drawings shall serve to indicate the general layout of the various items of equipment. However, layout of equipment, accessories, specialties and wire ways are diagrammatic unless specifically shown and /or dimensioned.
- G. The General arrangement of circuiting and equipment shall be as shown on the drawings. Detailed drawings and proposed deviations due to actual field conditions or other causes shall be submitted to the Supervising Engineer for review. The Contractor shall carefully examine all drawings and shall be responsible for the proper fitting of materials and equipment in each location as indicated, without substantial alterations. The Contractor shall carefully investigate the structural and finish conditions affecting his work and shall arrange such work accordingly, furnishing such fittings and accessories as may be required to meet such conditions.
- H. The motor and apparatus wattage ratings shown on drawings are estimated values. The corresponding sizes of feeders and other electrical equipment indicated to serve them shall be confirmed by the Contractor. Motors and apparatus with larger wattage ratings may be furnished if necessary to meet the requirements of the various sections of the specification in which they are specified. Where larger motors or apparatus with larger wattage ratings are furnished, the feeders and other electrical equipment serving them shall be suitably increased. The increase in the capacity of the feeder and equipment shall be furnished at no additional cost to the Client.

1.03 Submittals

- A. Shop Drawings: The Contractor shall submit for review by the Supervising Engineer, detailed dimensioned shop drawings as stipulated in other sections of Specification Division 16, Electrical. These drawings shall be prepared by the Contractor, shall base on manufacturers installation instructions and shall not be reproductions or tracings of the design drawings. In preparing shop drawings, lines and levels for the work specified shall be established and the drawings shall be checked thoroughly to avoid interference with structural features and the work of other trades. Shop drawings and /or data sheets shall be based on information stated in the specifications and as shown on the drawings and shall

show all pertinent information and data for the fabrication and complete installation.

Material Submittals: Shall be made for 3 different manufacturers. Energy saving equipment /materials shall be given preference.

- B. Manufacturer's Literature: Manufacturer's data sheets shall be submitted indicating the necessary installation dimensions, weights, materials, and performance information. The performance shall include complete electrical data, including power conditions and identifying types and numbers. Where pertinent, electrical diagrams shall be provided. The above information may be provided by standard sales catalogue sheets marked to indicate the specific equipment provided.
- C. Operations and Maintenance Instructions: The Contractor shall furnish data covering model, type and serial numbers, capacities, maintenance and operation of each major item of equipment or apparatus in accordance with the requirements of the Contract Documents. Operating instructions shall cover all phases of control.
- D. Spare Parts: The Contractor provide as part of this contract sufficient spare parts required for maintenance of two years of operation after handing over, together with spare parts lists in accordance with manufacturers' recommendations and as directed by the project supervisor.

1.04 Product Handling

- A. The Contractor shall be responsible for keeping stocks of material and equipment stored on the premises in a neat and orderly manner.
- B. The exposed surfaces of wire ways, conduit systems or equipment which have become covered with dirt, plaster or other material during handling and construction shall be thoroughly cleaned by the Contractor, before such surfaces are prepared for final finish, painting, or enclosed within the building structure.
- C. The Contractor shall clean and maintain the work in accordance with the Contract stipulations.

1.05 Protection

- A. The Contractor shall keep all raceways and conduit system openings closed by means of plugs or caps to prevent the entrance of foreign matter and cover all

- fixtures, equipment and apparatus as required to protect them against dirt, water, chemical or mechanical damage both before and after installation.
- B. Plugs and caps shall be of such types as to prevent transmission of flood water through any duct, conduit or raceway. Any fixtures, equipment or apparatus damaged prior to final acceptance of the work shall be restored to its original condition or replaced by the Contractor. At completion, fixtures and equipment shall be thoroughly cleaned.
 - C. The Contractor shall be held responsible for all damage done until his work is fully and finally accepted.

1.06 Coordination

- A. The Contractor shall be held responsible for the proper coordination of all phases of the work under this Contract.
- B. It shall be the responsibility of the Contractor to coordinate the work and equipment as specified herein with work to be performed and equipment to be furnished, under other sections of the specifications in order to assure a complete and satisfactory installation.

1.07 Quality of Equipment

Quality shall be of the best grade for each type or class, even though such quality may not be stated specifically in the specifications. All materials and products shall be new and manufactured by well known firms and shall be sound and uniform in quality, size, shape, color and texture and shall be free from cracks, warpage, or their defects. Energy consuming equipment shall be of the energy saving type, wherever relevant and applicable.

1.08 Temporary Power

- A. The Contractor shall furnish and install all temporary electrical facilities, including lamps, required for construction and safety operation. All such equipment shall remain the property of the Contractor and shall be removed when permanent connections have been completed. Where it is determined, during construction, that the temporary facilities, as installed, interfere with other construction operations, the Contractor shall relocate said facilities in an approved manner. No wire, bus or electrical equipment which is part of any of

the permanent electrical systems may be used for temporary electrical service for construction operations.

Temporary connections shall be safe in accordance with accepted practices. The Contractor shall be responsible for any damage or injury to equipment, materials or personnel caused by improperly protected temporary installations. All costs for materials and installation for temporary electrical facilities and energy for their operation shall be at the expense of the Contractor.

- B. Electrical welders used in the erection and fabrication of the building and its equipment shall be provided with an independent grounding cable connected directly to the structure on which the weld is being made rather than to adjacent conduit, piping, etc.

1.09 Manufacturer's Nameplates

Each major component of the equipment wherever possible shall have the manufacturer's name, address, model number and rating on a plate securely affixed in a conspicuous place. The nameplate of the distributing agent will not be acceptable. Code Ratings or other data which are die-stamped into the surface of the equipment shall be stamped in an easily visible location.

1.10 Metering

Metering shall be provided for at the locations indicated on the Drawings.

1.11 Site Service Conditions

All equipment located in air out-of doors shall be capable of operating continuously under the prevailing conditions regarding dusty atmosphere, altitude and prevailing ambient temperatures (dry bulb).

1.12 Electrical Utilities

- A. Power supply to the site will be at 400 Volts, 3 phase, 50Hz. The interface with the utility company incoming supply is the KWH meter.
- B. The Contractor shall make his interface with the incoming primary telecommunications cable(s) at the site boundary in the manner shown on the Drawings.

Part 2 Products

2.01 General

- A. Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various sections of the specification, Division 16, Electrical.

Part 3 Execution

3.01 Workmanship

Materials, products and equipment furnished by the Contractor, shall be installed and all work shall be performed in a first-class workmanlike manner, in conformity with the best trade practices and the printed directions of the applicable manufacturers; by skilled workers equipped to produce satisfactory results; in a safe, substantial manner so as to avoid undue stresses, rigid enough to prevent undue movement, so as not to interfere with work of other trades and so as to preset a neat, orderly appearance and to facilitate operating, servicing, maintaining and repairing.

3.02 Foundations and Supports

- A. The Contractor shall provide concrete pedestals, bases pads, curbs, anchor blocks, anchor bolts, slab inserts, hangers, channels, cradles, saddles, etc., for installation of equipment and apparatus shown on the drawings and specified in the various sections of specification Division 16, electrical.
- B. Concrete pads shall be 150mm high, unless otherwise indicated, complete with steel reinforcing and necessary bolts, anchors, etc. Where concrete pad is set directly on concrete floor, dowels in floor to tie base to floor shall be provided. These pads shall be extended at least 100mm beyond the equipment outline on all four sides.
- C. Individual hangers, trapeze hangers and riser clamps shall be provided for supporting conduit and all parts and hardware shall be zinc-coated (galvanized).

- D. Pipe straps and hanger rods shall be fastened to concrete by means of inserts or expansion bolts, to brickwork by means of expansion bolts and to hollow masonry by means of toggle bolts. Wooden plugs and shields shall not be used for fastening pipe strips and hangers.
- E. Under no circumstances shall duct work, piping and mechanical equipment be used for supporting electrical facilities.

3.03 Sleeves, Chases and Openings

- A. Pipe sleeves for all electrical conduit passing through walls, partitions, ceiling, floors, etc., shall be of sufficient length to extend through the full thickness of the construction, with ends flush with the finish on each side, unless noted otherwise.
- B. The Contractor shall provide necessary chases and openings in the walls, partitions and floors to accommodate his work.
- C. Chases, sleeves and openings in fire rated walls and floors (telephone, electrical closets, etc.) shall be packed with acceptable mineral wool insulation or approved flexible barriers designed for the purpose shall be used. Only UL or similar listed and certified material shall be installed. The fire rating shall not be less than the related wall.
- D. Whenever any of the work of the electrical system has to pierce any water proofing, this work shall be done with care and after the part of the system has been put in place through this waterproofing, the opening made by same shall be waterproofed and made absolutely watertight.

3.04 Cutting and Patching

- A. The Contractor shall provide chases, holes and openings for the installation purposes and carefully fit around, repair, patch and otherwise make his work acceptable.
- B. He shall furnish and install all sleeves and inserts required for this work. Cutting and patching of any part of the structure shall be done only after review by the Supervising Engineer.

3.05 Access Panels

Access panels shall be installed where indicated and as required for access to equipment and apparatus. Where, in the opinion of the Contractor access panels are required, but are not shown on the drawings, the Contractor shall provide same and relocate same on the as-built drawings.

3.06 Painting

- A. All shop fabricated and factory built equipment not galvanized, plated or provided with standard finish paint, shall be cleaned and given one shop coat of lead free primer paint, before delivery to the sit. Under no circumstances, shall the nameplate, label or tag of any equipment be covered with field painting.
- B. The exterior of electrical panels, panel boards, cabinets, switchgear, transformers and the like shall be finished in ANSI 61 gray. The interiors shall be finished in a light or white colour.

3.07 Touching Up

- A. Painting: Damaged or inadequate paint films of shop painted miscellaneous metal materials, and all accessible surfaces of field welds and connection bolts, shall be cleaned and prime painted. Touch up paint for shop primed materials and ungalvanized bolts shall be the same as that used for the shop coat.
- B. Galvanizing: Galvanizing surface scratched or otherwise damaged during delivery, unloading, or erection shall be thoroughly cleaned by wire brushing the damaged area to remove all loose, cracked or bruised galvanizing. Cleaned areas shall then be painted with zinc rich galvanizing paint of an inorganic zinc compound of zinc dust and zinc oxide, with the zinc dust content of 75 per cent or better by weight of the total nonvolatile content. Application of touch up galvanizing shall be applied at a dry film thickness of at least 0.75mm.

3.08 Tests

- A. Prior to starting the electrical installation, the Contractor shall verify the correct voltage, phases and current consumption of all utilization equipment to be connected. Branch circuit wiring, voltage and circuit breakers must be adequate in each case.

- B. The contractor shall provide any materials, equipment and labor required and make such tests as specified in the various sections of Division 16 and as deemed necessary to show proper execution of the work.
- C. Any defects or deficiencies discovered as a result of such tests shall be corrected without additional cost.
- D. After the installation is complete and properly adjusted, the Contractor shall conduct operating tests. The various equipment and systems shall be demonstrated to operate in accordance with the requirements of the Contract Document. The Contractor shall provide electric power, instruments and personnel necessary for performing the various tests.

3.09 Equipment Connections and Motor Starters

- A. In addition to electrical work, the Contractor shall make all electrical connections to mechanical and medical equipment furnished under other sections i.e. the Plumbing, Heating, Air Conditioning and Ventilation Sections of Division 15.
- B. Unless otherwise specified, the Contractor shall mount and align all starters, control devices, safety switches and other related electrical equipment whether specified in this or other sections of the specification, except where such items are factory mounted to the driven equipment. The mounting and alignment of motors, starters, control equipment etc., for which the feeders are terminated in safety switches as hereinafter specified, are included in the sections of Mechanical Sections, in which the motors etc., are specified.
- C. Unless otherwise specified, the Contractor shall furnish all wiring, including conduit, wire, junction boxes, disconnecting switches, overcurrent protection, etc., not specified elsewhere in this specification, to and between all motors, starters, control devices and related electrical equipment whether specified in this or other sections of the specification, except where such items are factory wired as well as factory mounted on the driven equipment. All wiring from the above termination points to and between motors, starters and control equipment associated with the equipment named, is included.
- D. Wiring for temperature control equipment is specified under this division.
- E. Unless otherwise specified, all wiring to motors, control equipment and related electrical equipment, shall be run in rigid metallic conduit with flexible connections where required. Conduits shall be large enough to accommodate

motor feeders, grounding conductors and control wires, whether or not so indicated on the Contract Drawings. Wire sizes shall be as shown and as required by the IEC Codes.

3.10 Equipment Erection

- A. General: All electrical equipment shall be erected or installed in accordance with the manufacturer's recommendations, good electrical engineering practice, and the relevant drawings and specifications.
- B. Location Tolerances: Equipment shall be located within 3mm of the dimensional location on the Contract Drawings, unless otherwise permitted by the Supervision Engineer.
- C. Lubrication: The Contractor shall furnish a lubrication system schedule and all oils, greases, and other lubricants in accordance with the manufacturer's recommendations, to the Supervising Engineer's approval.
- D. Insulating Oil: the Contractor shall furnish all insulating oil required for oil insulated equipment. As soon as possible after receipt of the oil, the Contractor shall sample the oil in accordance with the code for dielectric acceptance.

3.11 bolted Electrical Connections

A General:

- 1. Where bolted connections are made to aluminum surfaces, the aluminum surface shall be thoroughly cleaned with a wire brush, then coated with joint compound and thoroughly brushed again through the compound. Additional compound shall then be added and the joint together.
- 2. Where bolted connections are made between copper or brass surfaces, the metal surfaces shall be thoroughly cleaned and coated with a corrosion thoroughly inhibiting compound.
- 3. The tightness of each bolt in each factory made bolted electrical connection shall be checked during erection and connection of the equipment.
- 4. It shall be the Contractor's responsibility to certify that the tightness of each bolt in all bolted electrical connections, factory or field, is in accordance with the manufacturer's recommendations.

5. bolted electrical connections shall be tightened with manual torque wenches. Torque wenches shall be so constructed that they will visually or audibly indicate when the proper torque is reached. The accuracy of each torque wrench shall be checked by a testing laboratory acceptable to the Supervising Engineer immediately prior to its use on equipment erected under these specifications.

B. Connection Bolt Tightness Check:

1. The tightened bolts in electrical connections shall be checked at random as selected by and in the presence of the Supervising Engineer. The Contractor shall provide calibrated hand torque wrenches and the necessary platforms equipment, and personnel for the random check.
2. The number of bolts checked shall be acceptable to the Supervising Engineer based upon their observance of the quality and completeness of the tightening operations. A minimum of 10 per cent of the bolts in each connection, but not less than two bolts in each connection, shall be checked.
3. The Contractor shall be responsible for coordinating the checking of bolt tightness so that minimum interference with equipment erection and connection will be experienced. Removal of covers and similar dismantling of equipment to permit the Supervising Engineer to witness the testing of bolt tightness of enclosed connections shall be part of the work included under these specifications.
4. Checking of tightness of electrical connections in the presence of the Supervising Engineer is intended to assist the Contractor in avoiding the expense of repairing costly connection failures. This check shall not relieve the Contractor of complete responsibility for the integrity of the electrical connections.

3.12 Short Circuit and Protective Device Coordination Studies

- A. It is the responsibility of the Contractor to check the information given in the Project Documents about voltages and frequency with the Electric Power Company and confirm the data in writing to the Supervising Engineer.

- B. Conductors and equipment shall be protected against overcurrent in accordance with their rated ampacities. An overcurrent device shall be connected at the point where the conductor or equipment to be protected receives its supply.
- C. Provide four (4) brochures, each of which shall include complete short circuit and protective coordination studies, complete with device coordination time-current curves for the entire power distribution system.
- D. In the short circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, impedance diagrams, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each medium voltage switchgear line-up, unit substation medium voltage terminals, low voltage switchgear line-up, switchboard, motor control center, distribution panel board, pertinent branch circuit panel board, and other significant locations throughout the system. Provide a ground fault study for each medium voltage system, including the associated zero sequence impedance diagram. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor contribution, short circuit KVA, and symmetrical and asymmetrical fault currents.
- E. In the protective device coordination study, provide time-current curves on the Log-Log sheets indicating the coordination proposed for the system, centered on conventional full-size log-log forms. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective identifying its type, function, manufacturer, and time-current characteristic. Tabulate recommended device tap, time dial, pick-up, instantaneous, and time delay settings.
- F. Include on the curve sheets power company relay and fuse characteristics, medium voltage equipment relay and fuse characteristics, low voltage equipment circuit breaker trip device and fuse characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. Include tolerance and damage bands in plotted fuse characteristics.
- G. Show transformer full load and 150, 400, or 600 percent currents, transformer magnetizing inrush, ANSI transformer withstand parameters, magnetic inrush current point and significant symmetrical and asymmetrical fault currents.

Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed.

- H. Select each primary protective device required for a delta-star connected transformer so that its characteristics or operating band is within the transformers characteristics. Where the primary device characteristic is not within the transformer characteristics, show a transformer damage curve. Separate transformer primary protective device characteristics by a percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium voltage relay characteristic curves from curves for other devices by at least 0.4 second time margin.
- I. In each brochure, include complete sets of individual protective device time-current characteristics on transparencies.
- J. The short circuit and protective device studies may be prepared with a network analyzer, digital computer or by written computations, but must include complete fault calculations as specified herein for each proposed and ultimate source combination.
- K. The plans and specifications indicate the general requirements for the electrical equipment being provided under this contract. Changes and additions to equipment characteristics may be suggested by the results of the short circuit and protective device coordination studies. Submit any such proposed changes and additions as a part of the study brochure material. Necessary field settings of devices, and adjustments and minor medications to equipment to accomplish conformance with the approved short circuit and protective device coordination studies shall be carried out by the particular manufacturer or by the Contractor at no additional cost to the Owner.

3.13 Equipment Testing and Commissioning

- A. General: The testing of all electrical equipment shall include, but not be limited to, the items below. This shall be in addition to testing specified elsewhere in this specification.
 - 1. General Equipment check.
 - 2. Field wiring and ground system verification.
 - 3. Conductor insulation tests.
 - 4. Equipment adjustment.

The Contractor shall be responsible to make arrangements for power required for testing and commissioning purpose. The testing shall be a continuous process to maintain the construction schedule to the satisfaction of the Supervising Engineer. The Supervising Engineer shall have full access to observe all facets of the testing. All terminals, connections and attachments, all covers, insulating fittings, supports, hardware and field mounted accessories shall be checked for proper tightness.

B. Cable: Testing of all cable furnished and installed under this specification shall be in accordance with all related sections.

C. Grounding: Testing and grounding of equipment and cable, shall include, but not be limited to the tests below:

1. Earth continuity tests shall be made from each item of equipment to the appropriate main ground system and on the main ground system to the ground rods.

2. The resistance to ground for selected ground rods:

All ground resistance measurements shall be made with a three terminal "megger" type ground tester which applies alternating current to the electrodes and which gives a reading in direct current ohms. Two reference ground probes shall be used and all tests shall be made in accordance with the instrument manufacturer's instructions for ground resistance testing. Prior to connection of ground rods to the grounding system the Contractor shall obtain individual measured ground resistance data from selected ground rods as indicated on the drawings. These data shall be obtained, identified, and recorded under the supervision of the Supervising Engineer and the results sent to the Supervising Engineer within five days.

After connection of ground rods to each manhole's grounding mat, the Contractor shall obtain a ground resistance measurement from a flush ground plate. These data shall be obtained, identified, and recorded and the results sent to the Supervising Engineer within five days.

The ground resistance measurement data may indicate that additional ground rods are required. The Contractor shall furnish, install, and connect additional ground rods as the Supervising Engineer may direct.

D. Operation Control

The Supervising Engineer will establish a system of operation control as the permanent equipment and systems are completed and capable of energization.

The system will consist of placing appropriate tags on each item of equipment and each system component indicating its current status and requiring mandatory clearances from designated personnel to operate, energize or remove from service the equipment or systems. The controls established will encompass the following phases:

1. Equipment or systems completed to the point where they may be energized, pressurized or operated but not yet checked out will be tagged and the sources of power or pressure will be turned off and tagged. The affected components shall not be operated without clearance.
2. Following initial operation of the equipment or system, tagging will be performed as in 1 and the affected components shall be operated only by the personnel designated by the Supervising Engineer.
3. Equipment and systems released for service will be so tagged. Only the personnel so designated by the Supervising Engineer shall operate or remove from service such systems or equipment. When a request to remove from service is made, all controls and sources of power or pressure will be tagged out and shall be operated under any circumstances. Only the personnel originally tagging the system shall clear the system from service.

The Supervising Engineer will establish the procedures and details of the operation control system. All notification of status and requests for clearances for operations shall be made to the Supervising Engineer. The procedures established shall be followed.

*** End of Section***

SECTION-16075 ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification to identify all electrical items for easy operation and maintenance including, but not limited to the following:

1. Nameplates and labels.
2. Wire markers.
3. Colour coding of raceways.
4. Circuit identification charts.
5. Cable identification tags.
6. Cable warning tapes.
7. Cable markers.
8. Equipment warning/danger signs.

1.02 RELATED SECTIONS

- | | | |
|----|---------------|-----------------------------|
| A. | Section 09900 | Painting. |
| B. | Section 16050 | Electrical Wiring, General. |

1.03 REFERENCES

- | | |
|---------|--|
| IEC 364 | Electrical Installations |
| BS 7671 | Electrical Wiring Regulation (IEE 16th) |
| IEC 391 | Marking of Insulated Conductors |
| IEC 445 | Equipment Terminals (Identification of Equipment Terminals and Terminations of Certain Designated Conductors). |
| IEC 446 | Identification of Bare Conductors by Colors or Numerals. |

1.04 SUBMITTALS

A. Submit for complete and detailed manufacturer's catalogues and data relating which shall include, but not limited to, the following:

1. Name of the manufacturer.
2. Country of origin.
3. Method of obtaining spare parts for maintenance and list of spare parts sufficient for a 2 years period.

4. Technical performance of the equipment selected.
 5. Dimensional details needed for installation and maintenance.
 6. Delivery time from the date of orders.
 7. Copies of test reports or certificates.
 8. Control schematics and wiring diagrams.
- B. Provide samples of proposed devices together with the above submittal for approval of the Engineer.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product Testing Agency and include instructions for storage, handling, protection, examination, preparation and installation of the product.

1.05 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of items the types, sizes and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years. Preference shall be given to local manufacturers and agents/suppliers.
- B. Installer: Firms regularly engaged and qualified with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for the project.
- C. All items of Electrical Identification shall be comply with the requirements of BS and Local Standards Organization.

PART 2 PRODUCTS

2.01 NAMEPLATES AND LABELS

- A. Nameplates and labels shall be engraved on a three-layer 2 traffolyte plate having minimum thickness of 2 mm, securely screwed to the housing and have black letters on white background in Arabic and English.
- B. The name plates and labels shall be required for each electrical distribution board, control panels, equipment enclosures, substation equipment, disconnect switches and equipment cabinets.
- C. Lettering shall be block capitals standing :
 1. 6 mm high for identifying individual equipment and loads.
 2. 10 mm high for identifying grouped equipment and loads.
- D. Labels using embossed adhesive tape with 6mm white letters on black background or transparent adhesive tape with 6 mm black letters, as selected by the Engineer, shall be used for identification of individual

wall switches, receptacles, low current outlets, speakers, control device stations, junction/pull boxes, electrical boxes and fittings, etc.

2.02 WIRE MARKERS

- A. Wire markers shall be split sleeve or tubing type.
- B. The wire markers shall be required for each conductor at panelboard gutters, pull boxes, outlets, junction boxes and each load connection.
- C. All power and lighting circuits, branch or feeder circuits and control circuits shall require wire markers.

2.03 COLOUR CODING OF RACEWAYS

- A. Provide color bands with printed description of each system, minimum 75 mm wide for all cable trays/ladders and trunking runs. These color bands shall be applied at each electrical distribution/panel board, low current system control panels and junction box locations and at 15 m centers within an area.
- B. Provide color bands with printed description of each system, minimum 25 mm wide for conduits up to 25 mm in diameter and one-half the conduit diameter for larger conduits, applied at panel and pull box locations, within each room, and at 6 m centers within an area.
- C. Following color banding shall be used for the raceways of various electrical systems, however subject to final decision of the Engineer. Color bands for the electrical systems not described here shall be as agreed on site:

- 1. Lighting: gray.
- 2. Normal Power: brown.
- 3. Essential Power : black
- 4. Earthing : green.
- 5. Fire alarm : red.
- 6. Telephone : blue.
- 7. Sound : yellow.
- 8. Data : purple.
- 9. Television : rust.

2.04 CIRCUIT IDENTIFICATION CHARTS

- A. Individual circuit identification charts shall be provided for all panelboards, distribution boards, control panels, etc. giving following information as a minimum.

- 1. Circuit numbers
- 2. Phase
- 3. Load names with location.
- 4. Connected load.

5. Outgoing terminal numbers.
 6. Sizes and types of protective devices.
 7. Sizes and types of incoming and outgoing cables.
 8. Contacts location references of relays and other control devices (if any).
- B. Charts shall be typed on A4 size sheets. They shall be enclosed in a clear plastic envelope and shall be securely fixed to the inside cover of the unit. Additional copies of the charts shall be included in the Operation and Maintenance Manuals.

2.05 CABLE IDENTIFICATION TAGS

- A. All cables which exit from manholes, vaults, handholes, and transformer or switch enclosures shall be properly tagged or labeled. Tags shall be permanent, non-corrodible and clearly readable. Tags should include the information listed below for the various circuit categories:
- Primary Cables - 11 kV
Feeder Name
Voltage
Phase (for single conductor cables)
- B. Cable identification tags for wire and cable circuits shall be of an opaque nylon material arranged to include a marker plate, non-releasing nylon ties, and cable fastening tail. One side shall be roughened to hold black nylon permanent ink. Identification shall be permanent and waterproof. The holding device shall be designed to allow the fastening tail to pass around the cable through the holding device, and prevent removal of the tail without cutting it loose from the marker. Cable identification shall be inscribed in Arabic and English.

2.06 CABLE WARNING TAPES

- A. For buried LV and HV cables use warning tapes according to the standard practice of Electricity Supply Authority and applicable international standards.
- B. Cable warning tapes shall be of polythene, not less than 150 mm wide and at least 0.25 mm thick. They shall be yellow in color for LV and MV cables and bear the continuously repeated legend – "CAUTION ELECTRIC CABLE BELOW" or similar in English and Arabic, in black letters not less than 30 mm high.
- C. For buried low current/communication cables or duct banks, use warning tapes as per the standard practice of Local Telecom Supplier and applicable international standards.

2.07 CABLE MARKERS

- A. Buried cables shall be permanently identified by concrete markers. The markers shall be 600 mm square x 100 mm thick with impressed character; they shall be made of grade 20 concrete, with 10 mm aggregate. The impressed characters shall be in

English and Arabic and worded "HV CABLE" or "LV CABLE" as appropriate together with circuit details as required for proper identification. In addition, the word "JOINT" shall be added to above words, where applicable.

- B. Except where cables are buried, located in switchrooms, in ducts and spaces designated solely for electrical services, or have orange oversheaths; they shall be identified by adhesive bands colored orange, complying with standards and codes of practice mentioned elsewhere in the Specifications. The bands shall be not less than 100 mm long, located at least once within each separate compartment through which cables pass and at intervals not exceeding 12 m.
- C. Except where cables are buried or enclosed in conduit, trunking or ducting; they shall be permanently identified by discs. The discs shall be of laminated plastic materials with black character on white; character shall be not less than 3 mm high. The inscription shall indicate the nominal voltage, the designation of the load, the number and cross sectional area of cores and the rated voltage of the cable.
- D. Cables identification discs shall be attached to the cables with ties. Disc shall be located within 500 mm of terminations and joints, at least once within each separate compartment through which the cable passes, and at intervals not exceeding 24 m, they shall coincide with the colour bands.

2.08 EQUIPMENT WARNING/DANGER SIGNS

- A. For external use, pressure sensitive danger signs shall be used. Dimensions shall be as approved by the Engineer. The signs shall be heavy duty vinyl with a self-adhesive backing which can be applied to curved or irregular surfaces. Danger signs shall be weather-resistant and shall not discolor or deteriorate with age.
- B. Danger signs shall be inscribed with the equipment voltage level along with an internationally recognized danger sign.
- C. Warning/Danger signs made of red plastic (vinyl) with white letters at least 25 mm high reading "DANGER High Voltage" shall be fixed to the entrance doors of all 11 kV switchgear and transformer rooms.
- D. Warning/Danger signs made of red plastic (vinyl) with white letters at least 15 mm high reading "DANGER 380V" or "DANGER 220V" as appropriate, shall be fixed to the lids, covers or doors of any equipment which contains terminals or conductors connected to more than one phase of a low voltage supply.
- E. All signs shall be in English and Arabic.

2.09 LANGUAGE

- A. The Arabic and English languages shall be used for all labeling and charts.

PART 3 EXECUTION

3.01 PREPARATION

- A. De-grease and clean surfaces to receive nameplates and labels.

3.02 INSTALLATION

- A. Install warning and descriptive labels as follows :
 - 1. Metallic surfaces using stainless steel or chromium plated bolts and/or self tapping screws.
 - 2. Concrete surfaces or masonry walls using and brass wood screws.
 - 3. Timber surfaces using minimum 6 mm countersunk brass screws.
 - 4. All insulated enclosures using an approved plastic welding adhesive.
- B. The danger sign and identification number shall be affixed to the front or access doors of all transformers and switches. For equipment with two doors the danger sign shall be mounted on the left door with the identification number mounted on the right door. Both the danger sign and the identification number shall be centered 300 mm below the top edge of the doors and on the vertical centerline of each door.
- C. On equipment with only one access door, the danger sign and the identification number shall be centered on the vertical centerline of the door, with the horizontal centreline of the danger sign 300 mm below the top edge of the door and the horizontal centreline of the identification number 250 mm below the danger sign centerline.
- D. Locate cable markers at every point where cable(s) enter a building, sub-station, distribution/feeder pillar; at each joint, change of direction, road/pathway crossing, etc. Cable markers shall also be provided along the straight runs (route) of the cable(s) at the interval not exceeding 30 m.

*** END OF SECTION ***

SECTION 16110 RACEWAYS

PART 1 - GENERAL

1.01 GENERAL

- A. Raceways shall include all bus ducts, cable ladders, trays and cable trunking with all associated accessories, supports and fixings used for the distribution of electric power in the buildings.
- B. Raceways shall be of galvanized steel unless specifically indicated otherwise as per Specifications of local authorities : Non-Metallic Cable Trunking
- C. In general, the raceways shall conform to the following specifications :
local authorities: Steel Cable Trunking
local authorities: Cable Trays & Racks

1.02 RELATED WORKS SPECIFIED ELSEWHERE

- A. Section 16200 Cables & Wires
- B. Section 16300 Supporting Devices

1.03 SIZE SELECTION

The size of the raceways shall be selected according to local authorities regulations taking into consideration required "2D" spacing between cables (Where D is the cable diameter of the larger cable or the space factor as applicable in case of cable trunking.

PART 2 - PRODUCTS

2.01 CABLE TRAYS

- A. Cable trays shall be heavy duty, return flange, of 2mm gauge perforated type formed from sheet steel to B.S. 1449 - Part 1 and hot-dip galvanized after manufacture in accordance with B.S. 729.
- B. Cable trays shall have a minimum thickness of 1.6mm for trays upto 300mm and 2mm for wider trays.

- C. Cable trays shall be assembled complete with couplers, bends, tees, risers, reducers and all other accessories as required and these accessories shall be of the same material, thickness and finish as the trays. Manufacturer's standard accessories shall be used and site fabrication shall only be allowed where special sections are required subject to the approval of the Engineer.
- D. Mushroom head steel roofing bolts and nuts to B.S. 1494 - Part 1 shall be used to fix adjacent sections of cable trays and/or accessories. Holes cut in trays for passage of cables shall be provided with grommets and cable tray finished to G.D.C.D. standard 23rd March 1979. Cable trays shall be cut only along a line of plain metal and not through perforations. All cut edges of trays shall be prepared with burrs and sharp edges removed prior to installation and any cutting and/or damage made good with rust proofing agent and zinc rich epoxy paint.
- E. Cables shall be installed on trays in a single layer except where specified otherwise, leaving 25% of the tray width space for future use.

2.02 CABLE TRAY SUPPORTS AND RACKS

- A. Cable trays shall be fixed by support channels and hanger rods or by cantilever brackets fixed to walls or columns. Fixings shall be disposed at regular intervals not exceeding 1.0m. Joints shall be positioned as close as practicable to the tray fixing or support. Mid-span joints shall be avoided. All screw bolts and nuts used for fixing shall be zinc plated to B.S. 1706 - Class B coatings. All the supporting angles, brackets, anchors, etc. shall be of hot dip galvanized. A minimum clear space of 25mm shall remain at the wall side.
- B. Weld gun stud fixing will be allowed subject to the approval in writing of the Engineer. Drilling of building structural steelwork shall not be allowed except in special circumstances and then only with prior permission in writing by the Engineer.

2.03 CABLE LADDERS

- A. Cable ladders shall be H-type made from 2mm mild steel with 3mm coupling plates. Side channels shall be strengthened by reinforcing inserts or other means to increase torsional rigidity. Rungs shall be slotted type. Cable ladders shall be hot-dip galvanized and shall be complete with coupling pieces, bends, tees, reducers, risers, drop-outs, intersections and all other accessories as required and these shall be of the same material, thickness and finish as the ladders.

2.04 CABLE TRUNKING

- A. Cable trunking shall comply with British Standard 4678 and consists of butting sections generally not less than 2000mm long manufactured from sheet steel with stove enamel finish. The lids shall be made from the same

material and shall be removable over the whole length of the trunking and secured at centers not greater than 500mm with cadmium plated cup-headed brass screws.

These screws shall locate into tapped holes in the trunking. The trunking shall be provided with lips on its opening side to form a tray and clips shall be inserted at centers not greater than 500mm to retain the cables in position when the lid is on the side of the trunking.

The minimum thickness of metal employed in the construction of this trunking shall be 1.2mm and of the following thickness for various sizes :-

1.2mm thick - upto and including 100mm x 100mm

1.6mm thick - upto and including 150mm x 150mm

2.0mm thick - upto and including 230mm x 230mm

Adjoining sections of trunking shall butt tightly and shall be jointed by means of an internal fishplate connector attached by not less than eight cadmium plated steel cup-headed bolts and hexagon nuts, passing through clearance holes. Two pairs of bolts on either side of the joint shall be connected by tinned copper braids with split soldering washers under the nuts to provide electrical continuity across the joints. The trunking shall be mechanically and electrically continuous throughout. Where trunking is used to carry various services it shall be sub-divided into three separate compartments for power, telephones and auxiliary services.

2.05 OUTDOOR CABLE TRAYS

- A. Responsibility of supply and installation shall be as indicated on Drawings.
- B. Assemble cable trays sunshaded cable trays for outdoor complete with couplers, bends, tees, risers, reducers and all other accessories and of the same material, thickness and finish as the trays. Use manufacturer's standard accessories. Site fabrication will be allowed only where special sections are required and subject to the approval of the Engineer.
- C. Use mushroom head steel roofing bolts and nuts to B.S. 1494 part 1 to fix adjacent sections and cable trays and/or accessories. Holes cut in trays for passage of cables shall be provided with grommets to B.S. 1767, otherwise they shall be bushed or lined. Cut cable trays only along a line of plain metal and not through perforations. Prepare all cut edges of trays and remove all burrs and sharp edges prior to installation and treat with zinc rich epoxy paint.
- D. Fix cable trays by pedestals or support channels and hanger rods or by cantilever brackets fixed to walls or columns. Fixings shall be disposed at regular intervals not exceeding 1.2m and at 225mm from bends and

intersections. Avoid mid-span joints. All screw bolts and nuts used for fixing shall be zinc plated to B.S. 1706 Class B coatings.

- E. All supporting materials, angles etc. shall be hot dip galvanized.
- F. All cable trays exposed to sun shall be provided with sun-shade. Sun shade shall be supported at least 10cm above cable tray, and should have 2 side slope along the cable tray.

2.06 HANGER RODS

Galvanized steel rods of minimum 10mm dia. in one piece continuously threaded shall be adopted as hanger rods for cable trays, trunkings, ladders etc.

PART 3 - EXECUTION

3.01 GENERAL

All installation work shall be as per local authorities rules and regulations. Where no local authorities regulation is available, IEE wiring regulations shall be followed.

3.02 CABLE TRUNKING

- All trunking shall be properly aligned and shall run parallel or right angles to walls and the ceiling beam.
- The trunking shall be supported at not more than 100 Cms. All supports shall be galvanized.
- The trunking ends shall be properly closed.
- Earth continuity shall be provided at points through braided copper tape.

3.03 CABLE TRAYS

- Cable trays shall not sag more than 3 degrees between supports
- Cable trays shall be supported at not more than 100 Cms by galvanized wall brackets/supports or by stainless steel hanger rods.
- Cable trays shall not be cut through perforations

3.04 SEALING (FIRE BARRIERS)

Fire resisting caulking compound for sealing trays, trunking, conduits, cables, Ducts, pipes and sleeves shall be of a putty like consistency workable with hands. All materials for caulking and sealing shall be approved by Civil Defense wherever applicable.

3.05 RETAINERS

Cable retaining straps or cable ties shall be used as applicable to the raceways and shall generally be spaced 100cms.

*** END OF SECTION ***

SECTION 16120
CONDUITS

PART 1 – GENERAL

1.01 GENERAL

- A. PVC conduits shall generally be allowed in CAST-IN-SITU. Surface installed Conduits (below or above false ceiling) shall be rigid steel (GI). Where heavy protection against mechanical damage is required only rigid steel (GI) conduit shall be used.
- B. All conduits and conduit fittings shall comply with concerned local authorities Specifications
- C. In precast concrete slabs etc. GI conduit shall be used
- D. All conduits are fire retardant colored for all systems even if used in concrete slabs.

1.02 CONDUIT SYSTEM

Conduit system shall be provided including all necessary fittings, supports, Accessories, all other hardware complete as required.

For underground installation UPVC conduit shall be used

All materials for caulking and sealing conduits, pipes, sleeves etc through fire rated Walls or floors, shall be approved by the concerned local authorities as similarly applicable to cable trays and Trunking.

1.03 RELATED WORKS SPECIFIED ELSEWHERE

- A. Section 16200 Cables & Wires
- B. Section 16300 Supporting Devices

1.04 QUALITY ASSURANCE

- A. Relevant British Standards
- B. Concerned local authorities rules and regulations
- C. Alternative codes and standards which will satisfy the engineer that the material offered is of equal standard to that specified.

1.05 SUBMISSION

- A. Cut away samples with manufacturer's details.
- B. Shop drawings of proposed conduit layouts

PART 2 - PRODUCTS

2.01 STEEL CONDUITS (G.I Conduit)

Steel conduits shall be heavy gauge steel conduit hot dip galvanized inside and outside. The steel conduits, all junction boxes and other accessories shall be accordance with British Standard 4568 Parts 1 and 2 and shall be Class 4. The internal diameter of conduits shall be not less than 20mm.

All conduit boxes shall be constructed in malleable iron and in accordance with British Standard 31 Class B in the case of standard junctions or Class B5 where conduit is looped from point to point. All conduit work shall be so arranged to permit wiring to be drawn in after completion of conduit work. Where conduit work is concealed above suspended ceilings or in other building finishes the wiring shall be possible without disturbance to the building finishes. The conduit work at lighting points shall always be terminated in a standard or loop-in junction box and such boxes shall be firmly secured to enable the luminaire to be fixed to the lugs of the conduit box and be suspended therefrom without other support. Where conduits are terminated in a box without a screwed spout the junction shall be made by means of a coupling and an external thread brass bush with hexagon head.

In general, conduits shall be concealed within the building structure, behind suspended ceilings, within partitions, in floor screeds or plaster finishes. No conduit work shall be exposed on the surface unless this is specified or in services plant rooms. All external work shall be carried out using galvanized steel conduit and accessories. The installation shall be electrically and mechanically continuous throughout and where polyvinyl chloride conduit is utilized this shall be achieved by the use of a separate polyvinyl chloride insulated earth wire installed throughout the conduit run with terminations being made in conduit boxes or metal enclosures of apparatus. All conduit ends shall be reamed to remove sharp edges and threads shall be of sufficient length to enable conduits to butt within couplings or to the stop end in box spouts. Draw-in boxes on straight runs shall be provided at not more than 9000mm centers. Where right angle bends are formed in the circuit, draw-in boxes shall be provided at not more than 7500mm centers and not more than two right angled bends shall be employed in any one run. Where conduit work is run external to the buildings a drain hole of 3mm diameter shall be drilled in the bottom of switch boxes and other low points to drain condensation. Conduits shall be fixed by means of spacing saddles on rough concrete or brickwork. On fair faced brickwork or plaster spacer-bar saddles may be used. Saddles shall be spaced at internals of not more than 1300mm on straight runs and not more than 200mm on either side of a bend or junction box. Fixings shall be made by means of galvanized steel wood screws of not less than 3mm diameter and 40mm in length, screwed into plastic or fibre insert plugs. All lighting point boxes, switch boxes or socket outlet boxes shall be fixed by means of two 8 gauge x 40mm steel screws.

2.02 PVC CONDUITS

- A. All rigid PVC conduit and conduit fittings shall conform to British Standard 4607 are to be certified as suitable for use at ambient temperatures upto 55 Deg.C. Additionally, the material shall not soften or suffer any structural degradation at a temperature of 85 Deg.C and shall be non-hygroscopic and self extinguishing type.

All boxes and extension rings shall be fitted with brass inserts for the securing screws and with an earth terminal. Conduit fittings and accessories shall be of the same manufacture and shall be of the unthreaded type.

The internal and external surfaces of conduits shall be smooth and free from burrs and similar defects. The interior and ends of conduit fittings shall be free of sharp edges and corners and shall be smooth and well rounded to permit easy drawing in of cable and to prevent any damage to cable insulation.

Boxes in ceiling for lighting/fans etc. shall be of GI type.

All joints between conduits and fittings shall be watertight using vinyl cement recommended by the manufacturer of the conduit. A vinyl solvent shall be used for permanent joints and a cement of the type that shall remain in a sticky condition shall be used for expansion couplers.

A separate insulated earth wire shall be drawn into all PVC conduits.

The PVC conduits shall be installed generally in accordance with the requirements set out for metal conduits. Additionally the method of supporting PVC conduits shall allow for the longitudinal expansion and contraction of the conduit.

2.03 CONDUIT (FLEXIBLE CONNECTIONS)

- A. Where conduit work has to be terminated with a flexible connection, as in the case of motors, the rigid conduit shall be terminated in a box adjacent to the motor and the connection between this box and the motor junction box made in flexible conduit. This shall be a corrosion resistant flexible metal tubing with a polyvinyl chloride sheath terminated at each end by a compression gland screwed into the connection boxes. An insulated stranded copper connection of section not less than that quoted in Table 54F of the I.E.E. Regulations shall be provided in each instance to ensure earth continuity.

2.04 CONDUIT (CAPACITY)

- A. The number of polyvinyl chloride single core cables run in any one conduit shall be restricted in accordance with concerned local authorities Regulations (latest Edition).

Where three-phase circuits are run in conduit all three phases and the neutral of the circuit shall run in the same conduit.

2.05 METALLIC CONDUIT BOXES FOR EXTERIOR LOCATIONS

All boxes installed in exterior locations, plant rooms, ducts etc, shall be fitted with approved type gaskets to provide a waterproof seal between box and Cover or other item fitted to the box.

PART 3 – EXECUTION

- 3.01 PVC conduits and fittings shall be joined by using sealing cement (vinyl solvent paint) to ensure a watertight joint. The cement shall be of a type that remains in a sticky condition. When PVC conduits are embedded in concrete slabs, they shall be securely held in place by fixing to shuttering and reinforcing bars. In walls, they shall be run in cut chases and fixed by saddles or crumpets.
- 3.02 Chases shall be deep enough to allow full thickness of plaster cover to be applied. Bends in PVC conduits shall be neatly made with a proper size bending spring.
- 3.03 Except when embedded in concrete slab, all conduits shall be installed parallel to the lines of the building and at a minimum of 100mm away from pipes or other non electrical services. Boxes shall be fixed independently to the building so as not to be supported by the conduits. Empty conduits when left with ends exposed for some time shall be closed with suitable plugs to prevent entry of dirt and foreign matter.
- 3.04 Conduits shall be installed in such a manner to prevent trapped condensation. Pull boxes shall be provided as required for easy drawing of wires and shall be in readily accessible locations with covers fixed by brass screws.
- 3.05 No wire is to be drawn inside conduits until they are completely erected and approved by the Engineer. The conduits shall be swabbed through to remove any dirt or loose matter before drawing of wires.

- 3.06 The sizes of conduits shall be in accordance with the number and sizes of wires to be drawn inside them as indicated in IEE or latest concerned local authorities Regulations but no conduit smaller than 20mm. shall be used. A pull wire or tape shall be provided in all empty conduits with no less than 200mm. of slack left at each end.
- 3.07 Flexible conduits shall be used for connection of motors, HVAC equipment, recessed light fittings ...etc. Fixed conduits shall be terminated in a conduit box and flexible conduit shall then connect to the equipment.
- 3.08 For flexible conduit on earth wire shall be wound around the flexible conduit and connected at each end to earth terminal.
- 3.09 The conduit system shall, in general, be surface mounted in all plant rooms, electrical rooms and in Service Tunnel.
- 3.10 The following general rules shall be adopted.
 - B. Conduit saddles shall be used at every 50 cms where the run is straight.
 - C. Saddles shall be used on both sides of a bend or coupling.

*** END OF SECTION ***

SECTION - 16200
CABLES AND WIRES

PART 1 - GENERAL

- 1.01 All cables shall be designed for operation in systems where continuity of supply is the first consideration. They shall also be satisfactory in operation under the variations of current, voltage and frequency as may be met under fault and surge conditions on the system.

All materials shall be of the best quality and of the class most suitable for working under the particular condition of the systems. They must be capable of withstanding the normal variations of temperature and service conditions without disturbance or deterioration.

In general, cables and wires shall conform to the international standards and to the concerned local authorities Specifications.

1.02 CONDUCTORS

The conductors shall be high conductivity copper, stranded for power cables and solid for control cables' according to the type of insulation, the copper conductors will be plain or tinned.

- 1.03 Cables shall be installed on cable trays or on building structure as indicated on the Drawings. They shall be neatly fixed in straight lines. On cable trays, cables shall be fixed by cable clips or ties while, on building structure cable cleats shall be used. The spacing of cable supports shall be as indicated in I.E.E. Regulations table B.2M. The minimum radius of bends for cables shall be in accordance with table B.1M of the regulations with bends made neatly and uniformly.
- 1.04 Where single core cables are used for feeders, care shall be taken to ensure equal division of current among cables which shall be arranged in trefoil formation.
- 1.05 Proper cable glands of non ferrous material shall be used for cable entries into distribution boards and equipment.
- 1.06 Each end of each cable shall be provided with identification label lettered with feeder or circuit designation to the Engineer's instructions. The labels shall be permanently fixed in distribution boards, terminal boxes, isolators, etc. and shall be made of durable material ensuring permanent legibility.

1.07 STANDARDS

Unless otherwise specified, cables wires and terminations shall comply with the following standards as appropriate :

Cable and Wires

BS 1442	:	Galvanized Mild Steel wire for armouring cables.
BS 2897	:	Aluminium strip armour for cables.
BS 6234	:	Polyethene insulation and sheath for cables
BS 6360+IEC 228	:	Copper conduct for cables
BS 6746+IEC 540	:	PVC Insulation & Sheath for cables.
BS 6346+IEC 502	:	PVC Insulated Cables
BS 5467+IEC 502	:	Armoured Cables
BS 6004+IEC 227	:	PVC Insulated Cables for Power and Lighting
BS 6500+IEC 227	:	Insulated Flexible Cords
BS 6207+IEC 245	:	Mineral Insulated Cables

Cable Termination

BS 4579	:	Performance of Mechanical and Compression Joints for Cables
BS 6081	:	Termination of MICC Cables
BS 6121	:	Mechanical Cable Glands.

All cable terminations shall comply with the concerned local authorities requirements.

1.08 TESTS

- The cables shall be factory tested in accordance with the applicable standards, codes or recommendations.
- For each cable type, the following test certificates, providing tests have been carried out shall be submitted to the Engineer for approval.

- Mechanical properties of insulation and sheathing components.
- Resistance to cracking.
- Pressure test at high temperature.
- Resistance to flame propagation.

Final tests shall be made at site and the following routine tests will be carried out :

- Conductor resistance test.
- Insulation resistance.

1.09 RELATED SECTIONS

- | | | |
|----|---------------|--------------------|
| A. | Section 16120 | Conduits |
| B. | Section 16110 | Raceways |
| C. | Section 16300 | Supporting Devices |

1.10 SUBMITTALS

- A. Provide product data for each type of cable.
- B. Shop floor drawings showing cable routes and method of laying, spacing and space factor applied.
- C. Submit cable assembly from each reel /drum.
- D. Provide samples of cable markers, cable ties etc.

PART 2 - PRODUCT

2.01 PVC INSULATED/PVC SHEATHED CABLES

These shall be 600/1000V, single or multi-core conforming to BS 6346 with high conductivity plain annealed stranded copper conductors to BS 6360, PVC insulated with an extruded layer of PVC bedding and a final outer extruded PVC sheath. The insulation and sheath shall be to BS 6746 with insulation coloured to identify phases and neutral in accordance with BS 6746 C. Armoured sheathed cables shall have a single layer of galvanized steel wires for multi-core cables and aluminium wire or tape for single core cables.

2.02 CROSSED LINKED POLYETHYLENE CABLES

These shall be single core or multi-core cables, 600/1000V conforming to BS 5467 with high conductivity plain annealed stranded copper conductors to BS 6360, insulated with cross linked polyethylene (XLPE) to BS 6899 applied by a combined extrusion and vulcanization process to form a compact homogeneous layer, cables bedded and overall sheathed by a black PVC layer to BS 6746. Armoured cables shall have a single layer of galvanized steel wires for multi-core cables and aluminium wire or tape for single core cables.

2.03 WIRES

- A. Single core cables shall be plain annealed copper conductor to BS 6360, insulated with PVC to BS 6746, 600/1000 V grade conforming to BS 6004, single core for drawing inside conduits and trunking.
- B. Single core cables shall be continuous from outlet to outlet and no splice shall be made except within outlet and junction boxes. A separate neutral wire shall be provided for each circuit. Wires shall be left sufficiently long to permit making final connections. The colour of insulation shall be as specified in IEE regulations for different phases, neutral and earth wires.

2.04 FLEXIBLE CORDS

Flexible cords shall be circular silicon rubber insulated glass fiber braided, three core 300/500 volts and shall comply with BS 6500. The conductors shall be tinned, annealed copper and the core shall be coloured Brown, Blue, Green/Yellow for identification.

2.05 MICC CABLING/WIRING

In all hazardous areas the cabling/wiring shall be done with MICC cables/wires. The decision of the engineer in respect of choosing such areas will be final and binding. Generally such areas are gas stores, areas handling medical gases, cold stores etc. MICC cables shall be to the following standards:

Flame Proof Barrier	BS 5345 Part 1
Manufactured & Tested to	BS 6207
Quality Assurance	BS 5750
Cable Terminations	BS 6081
IEC Standards	IEC 702.1/IEC 702.2

PART 3 - EXECUTION

3.1 GENERAL

Cables/wires shall be installed as per the concerned local authorities regulations. Where no concerned local authorities regulations exist IEE regulations shall be followed.

3.2 EXAMINATION

- A. Verify that interior of the building has been protected from weather
- B. Ensure that all raceways are thoroughly cleaned.
- C. Verify that all construction works likely to damage wires /cables have been completed.

3.3 INSTALLATION

- A. Use suitable wire /cable pulling lubricants.
- B. Support cables above accessible ceiling. Do not rest cables on ceiling panels.
- C. Use suitable rollers and pulling devices.
- D. Perform field inspection and testing in the presence of the Engineer.
- E. Verify all earth continuities.
- F. Identify all circuits (Cables) with appropriate marking devices.

*** END OF SECTION ***

SECTION 16300
SUPPORTING DEVICES

PART 1 - GENERAL

1.01 VOLTAGE

All single phase devices shall be rated for 240/V 50 Hz and all three phase devices shall be rated for 415/V 50Hz.

1.02 DESCRIPTION

Provide wiring devices including switches receptacles, switchfuse units, junction boxes, control devices etc. as specified, indicated on drawings and as required for proper functioning.

1.03 RELATED WORKS SPECIFIED ELSEWHERE

- | | | |
|----|---------------|---------------|
| A. | Section 16120 | Conduits |
| B. | Section 16110 | Raceways |
| C. | Section 16200 | Cables & Wire |

1.04 REFERENCE STANDARDS

Lighting Switches	BS 3676 part 1/1989 & CENELEC PREN60669-1
Fuse Connecting unit	BS 1362
20A DP Switch	BS 3676 part1
Switch Socket Outlet	BS 1363/1984
Flux Outlets	BS 5733/1995
Dimmer light Switches	IEC 669-2-1, BSEN 50082-1
Cooker Control Unit	BS 4177/1992
Metal Clad Boxes	BS 5733
Weather Proof Socket outlets	BS 1363/1984
Sentry Socket outlet	BS 7288/199

Where No reference Standard is mentioned the applicable BS standard shall apply

PART 2 - PRODUCTS

2.01 SOCKETS

- A. Sockets shall be 250V, three pin, 16A switched type to BS 1363. Safety shutters shall cover pin holes to prevent accidental contact. Contact arrangement shall be such that contact is made on two sides of the rectangular pins of plugs.
- B. UPS Socket outlets should be differentiated from the normal supply socket outlets by color (Blue).
- C. Sockets shall be fixed inside galvanized stamped steel boxes which shall be flush mounted in walls.
- D. Pedestal mounted floor outlets shall be provided in locations where no wall or column is available
- E. Sockets shall have White moulded cover plates as approved by the engineer. The mounting heights for wall sockets shall be 300mm above finished floor level unless otherwise indicated on the Drawings.
- F. Three phase sockets shall be of 5 pin design (3 phase + neutral + earth) as per the concerned local authorities Specifications. The current rating shall be as shown on drawings. All housing parts shall be pressure die cast in zinc base alloy and finished in hammered gray stove enamel; cable grips on the plugs shall have a rubber compression ring. The weather tightness shall be ensured by the rubber gaskets between plug and socket. Socket shall be provided with a screw-on cap. Plug top shall be provided with each socket.
- G. Sockets working on normal plus emergency supply shall be provided with neon indicator which will remain illuminated even in off position.
- I. Weatherproof sockets outlets shall have the weather tightness as mentioned in paragraph 'E' above and shall comply with the concerned local authorities Specifications.
- J. Terminal shall be grouped in-line with terminal screws backed out and terminals shall be marked.

2.02 JUNCTION BOXES

The junction boxes shall be DP 250V or TP 415 with current rating as shown on drawings or indicated in schedules. DP or TP switch controlling Junction Box shall

be provided with neon lamp. Floor mounted J.B. shall be of water tight design as required by the particular equipment being fed through the J.B.

Indoor Wall mounted Junction box and its associated switch shall White moulded & provided with flex outlet.

2.03 SWITCHES

- A. Switches shall be of minimum 10A ratings unless higher ratings are shown on drawings.
- B. Switches shall generally be flush mounted and of grid type at a height of 1200mm above finished floor level, unless otherwise indicated on the Drawings. Switches shall be White moulded cover plates as required by the engineer. Wiring terminals shall be of the screw type or solder-less pressure type having suitable conductor release arrangement. Where two or more switches are located in the same position, they shall be installed in one box and covered by a multi-gang cover plate.
- C. Weatherproof switches shall have weather tightness as per Clause 2.01 (F) above.
- D. Where Modular switches are employed the cover plate shall be manufactured in die cast metal with corners of square edged profile, and finished with a durable heat cured laccure. The Modular switches shall be 1 – 8 gang as indicated in drawings.

2.04 DIMMER SWITCH FOR FLUORESCENT TUBULAR LAMP

Remote control potentiometer unit shall be used for electronic dimmable ballast shall be used. It shall have a rotary switch for 'ON\OFF' function and a control voltage range with "MAX" and "MIN" trimmings.

2.05 FUSED SWITCHED OUTLETS (If needed for any particular equipment)

These outlets shall be to BS 4662 and provided with fuse links to BS 646 or BS 1361 or BS 1362 complete as required.

2.06 MOUNTING BOXES

Mounting boxes shall be 1 gang or 2 gang as specified and shall be manufactured from hot dip galvanized steel. Each box shall have brass earth terminal fitted in base and shall include ample knockouts and adjustable lugs.

2.07 DOUBLE POLE SWITCHES

The double pole switches shall be with indication neon lamps and shall be rated 20 amps unless otherwise mentioned. The face plate shall as per the concerned local authorities Specification G.3.2 and G.3.3.

2.08 SPARKLESS SOCKET OUTLETS

All outlets shall conform to degree of protection as applicable to non sparking equipment.

2.09 SPARKLESS SWITCHES

All such switches shall conform to degree of protection as applicable to non sparking equipment.

2.10 JUNCTION & SERVICE BOXES

The Junction & Floor Service boxes shall be supplied by the system supplier namely the Under Floor trunking or the Cast-in situ system as the case may be.

2.11 UPVC TRUNKING

Where Skirting & dado application are involved UPVC trunking of elegant profile shall be used. The system shall be capable of accepting wide range of components offering wide range of configurations. It shall be possible to use flat tees or angles & various type of adapters to navigate.

The trunking system shall be manufactured with requirements of BS 4678: Part 4 & BS 4662. Copies of test certificates shall be provided by the suppliers.

2.12 ISOLATORS AND SWITCH FUSES

- A. Isolators and switch fuses, where mounted individually shall be of sheet steel/ Polycarbonate construction with /without doors and front operated handles. They shall be of the quick make, quick break type with removable shields over the fixed contacts, door interlocks and 'ON/OFF' indicators.
- B. Isolators and switch fuses shall be single or triple pole with neutral, of ratings as indicated on the Drawings and provided with earth terminals. They shall be in accordance with IEC 408. The switch fuses shall be suitable for H.R.C. type fuses of Class Q1 to B.S. 88.

- C. All outdoor isolators and switch fuses shall be in weather proof enclosures.

PART 3 - EXECUTION

3.1 MOUNTING HEIGHT

- A. All devices shall be installed at levels as per the concerned local authorities regulations.
- B. Where Outlets feed particular piece of equipment then these shall be installed as per equipment manufacturer/supplier's requirements.
- C. Where no data is available regarding the outlet for the equipment, it shall be installed at the level given by the engineer. As a guide line generally switches shall be mounted at 1350mm above finished floor level and sockets shall be fixed at 300mm above finished floor level unless otherwise required for specified uses e.g. Above bench or near the equipment etc.

3.2 FIXING

- A. Fix outlet boxes securely
- B. Fix exposed outlet boxes to permanent inserts or lead anchors with machine screws.

3.3 LIGHTING SWITCHES

Locate at the strike side of the door.

3.4 PULL BOXES /JUNCTION BOXES

- A. Fix pull boxes at minimum 10 Meter spacing and to limit the number of bends in conduit to not more than two 90 deg. Bends
- B. Locate junction boxes as inconspicuously as possible but accessible after work is completed.

3.5 SPARES

Contractor / supplier shall provide 2 % of all supporting devices to the client for future use before certificate of completion of the project.

*** END OF SECTION ***

SECTION 16400

MAIN DISTRIBUTION EQUIPMENT

PART 1 – GENERAL

All Electrical Distribution equipment should be type tested assembled by approved factory.

1.01 DESCRIPTION

- A. The main distribution equipment shall comprise main low tension switch boards, switching metering panels, main and sub-main switch boards, distribution boards, isolators, switch fuses ...etc.
- B. The supply and distribution arrangement shall be as indicated on schematic diagrams in the Drawings.
- C. The equipment shall be assembled and tested in the factory of the approved local panel builder/manufacturer. Where any equipment need to be assembled at site, a prior approval of the engineer would be necessary.
- D. Before placing any order for the supply of equipment, it shall be ensured that the physical sizes of equipment when installed shall not infringe any clearance required by the concerned local authorities regulations. Where no such regulation is available IEEE regulations shall be applied.
- E. The contractual responsibility for the supply and installation shall be as indicated on drawings.

1.02 REFERENCE STANDARDS

Switchboards and Motor Control Centers shall comply with the following as appropriate. Where no regulation / standards are mentioned latest IEC standards shall be applicable.

BS 88	Cartridge Fuses
BS142 (Latest)	Electrical Protective Relays
BS 159	Bus bar & Connections
BS 162	Electrical Power Switchgear
BS 3938 IEC 185	Current Transformers
BS 4794 IEC 337-2	Control Devices
BS 5685	Electricity Meters General
BS 89 IEC 51	Direct Acting Indicating Electrical Measuring Inst.
BS 5685 IEC 521	Electric Meters
BS 5420 IEC 144	Degree of Protection of enclosures
BS 4752 IEC 947-2	Switchgear & Control Gear
IEC 947-4	Contactors

IEC 947 (Part 1-7)	Low Voltage Switchgear & Control Gear
IEC 439 (Part 1-4)	Low voltage Switchgear & control gear assemblies

1.03 RELATED WORKS

Section 16110	Raceways
Section 16120	Conduits
Section 16200	Cables and Wires
Section 16300	Supporting devices
Section 16620	Diesel Generator
Section 16635	Earthing

1.04 SUBMISSION

A. Shop Drawings

Submit dimensional shop drawings including sections and elevations and showing positions of major components position and method of fixing and terminating cables.

B. Project Data

Submit full specifications of the enclosure and the components of the switchgear and switchboards and panels.

PART 2 - PRODUCT

2.01 MAIN LOW TENSION PANEL BOARDS

- A. The main low tension switch boards shall be of indoor construction, dead front, metal enclosed free standing, dust and vermin protected, front operated and of clean and modern appearance.
- B. The switchboards shall be assembled and coordinated by one manufacturer and shall be constructed in accordance with B.S. 5486 : part 1.1977/IEC 439.
- C. The panel shall be of the cellular cubical type class 2CC FBA and shall be of the folded sheet steel construction fabricated out of electro galvanized cold rolled sheets of minimum 2mm thickness for body and frame work and not less than 1.5mm for doors and cover plates.

- D. The panels, after fabrication, shall be thoroughly cleaned in a vapor degreasing tank to remove all traces of oil and wax and provided with a coat of electrostatic, polyester powder coating, light grey colour, shade No. 10A03 to BS 4800.
- E. All doors and removable cover plates shall be provided with neoprene gasket so as to obtain degree of protection IP53 to IEC 144.
- F. Each outgoing breaker shall be enclosed in its own compartment (cell) fitted with a hinged door interlocked with the operating handle in such a way that:
 - 1. It shall be possible to open the door only when the handle is in 'OFF' position.
 - 2. It shall not be possible to switch the unit 'ON' when the door is open.Moreover, no live parts shall be exposed when the compartment door is open.
- G. Protection against shock shall be provided in accordance with the requirement of BS 5486 Part 1.
- H. The switchboard shall be of the rear access pattern and vertical cable way shall be provided in each section of the switchboard. The cable way shall be provided with bolt-on covers. All terminals in the cable way shall be fully shrouded to prevent accidental contact when the covers are removed.
- J. All external bolts or screw heads shall be chrome or cadmium plated.
- K. The equipment in the switchboard shall be accessible with indicating instruments mounted not higher than 1.8m. And the centerlines of operating devices not higher than 1.8m. Above switchboard base. The switchboard shall be properly fixed to the floor with foundation bolts grouted in the floor or bolted to channels laid across the cable trench.
- L. The switchboards shall have top or bottom cable entry as required. Basically, main incoming cables shall be bottom entry and outgoing cables top entry.
- M. The switch boards shall contain the air circuit breakers, bus bars, bus couplers, MCCBs, instruments, earth bus, ...etc. as specified here under and as per drawings with ratings and arrangement as shown on the Drawings and shall be complete with all internal wiring and connections.

- N. The switch boards shall be tested at the manufacturer's premises as well as commissioned after installation in accordance with tests stipulated in IEC 439.
- O. Additionally, Main Low Tension Switch Board shall comply with the concerned local authority's requirements.

2.02 BUSBARS

- A. The switchboard shall be provided with fully rated Bus bars for the entire width of the board. In addition, each section or panel of the switchboard shall be provided with vertical busbars of adequate rating to provide branch connections to the outgoing breakers.
- B. The horizontal and vertical bus bars and connection shall be fully segregated such that these shall not be accessible when the compartment doors and cable way covers are opened. They shall be provided with barriers which are removable by tool or special key.
- C. The bus bars shall be made of electrolytic, hard drawn high conductivity flat pure tinned copper bars complying with IEC Standard. The whole bus bar system shall comply fully with the requirement of latest IEC standards.
- D. The bus bars shall be air insulated and shall be rigidly supported on purpose made insulators of non-hygroscopic glass fiber moldings having a tracking index of not less than 600.
- E. The Main Low Tension Panels (MLTPs) busbar together with its connections to the incoming and outgoing unit shall be suitable to withstand a short circuit of 50,000 sym. amperes and in all other cases; it shall be suitable for the fault level at that point.
The bus bars shall be provided with colored PVC sleeveings at regular intervals for phase identification. Painted bus bars may be acceptable in special cases when panels are manufactured/assembled in Jordan.

2.03 AIR CIRCUIT BREAKERS

- A. The air circuit breakers shall be of the air break trip free draw out type with the main contacts encased in a reinforced polyester casing and offer double insulation from the operators on the breaker front face. The air circuit breaker shall be fully tropicalized (T2) as defined in IEC 68.2.30 and shall have salt spray resistance as per IEC 68.2.11. The ACB shall comply with IEC 947.2 utilization category B with $I_{cs}=I_{cu}=I_{cw}$ and shall accept reverse feeding without reduction of performance. The ACB shall comply with the isolating function requirements of IEC 947.2

section 7.1.2 and shall have minimum 500 V 50Hz operational voltage, 1000 V 50 Hz rated insulation voltage and 8kV withstand surge voltage (Vimp). The 3-pole and 4-pole versions shall have ratings as shown in the drawings. In the 4 pole version the neutral pole shall have the same current rating as the other poles from 800 to 4000A . The breaking capacities shall not be less than 50 kA symmetrical for 1 sec. at 415 volt. Evidence of the service breaking capacity (Ics) shall be produced by test certificates from one of the internationally recognized testing Laboratories. (ASTA, CESI, ESEF/ASEFA, KEMA, PEHLA or SATS).

- B. Unless otherwise mentioned the ACB shall be of the O-C-O stored energy spring type with a closing time less than or equal to 80 millisecond. Electrically operated circuit breakers shall have the spring charging motor connected so that the springs remain charged always with the motor disconnected after charging. The spring charging time shall not exceed 4 seconds. A standby manual operating handle for spring charging shall be provided for operating the circuit breaker in case of power or motor failure. Antipumping shall be provided by integral devices to prevent reclosing after a close-open operation if the closing impulse is maintained after the breaker has opened. External relays are not acceptable
- C. The circuit breaker shall have three positions of the drawout mechanism, namely service position where all main and auxiliary contacts are made, test position where main contacts are open but auxiliary contacts are closed and isolated position where all contacts are open. Mechanical indication on the front of the ACB shall be provided to indicate
 - A) Main Contacts Closed 'On',
 - B) Main Contacts Open 'Off',
 - C) Springs Charged,
 - D) Springs Discharged
 - E) Service Position,
 - F) Test Position, And
 - G) Isolated Position For Drawout Mechanism.
- D. Any attempt to withdraw or insert the breaker when it is 'ON' shall trip the breaker automatically. An interlocking shall be provided to prevent insertion of a circuit breaker having a rating higher than the current rating of the ACB cradle.
- E. Insulated safety shutters shall screen all live parts in the ACB cradle when the breaker is in the isolated or racked out position.
- F. The moving contacts comprising the main and arcing contacts shall have visual wear indicator and be of the spring loaded type. The main contacts and clusters shall be site replaceable. The electrical

endurance shall not be less than 4000 operations for rating up to 3200A and not less than 2000 operations for ratings above.

- G. The circuit breakers shall have sufficient number of auxiliary contacts for interlocking system as indicated and described on the drawings and for interfacing with building automation system (BAS), with two spare sets of normally open and normally closed contacts. It shall be possible to connect all auxiliary wiring from the front face of the air circuit breakers and this wiring shall be taken through a set of disconnecting contacts, so that all auxiliary wirings are automatically disconnected in the isolated and drawout positions.
- H. The circuit breakers shall be equipped with MCR, overcurrent and earth leakage protections by means of integral self-powered microprocessor based solid state RMS sensing current relays. The long time overcurrent protection shall have a setting range between 40 and 100 per cent of sensor rating in steps of 2 per cent. The corresponding time delay shall be adjustable from 15 to 480 seconds. The short time overcurrent protection shall have a setting range from 40 per cent to 15 times the sensor rating. The corresponding time delay shall be adjustable from 15 seconds. The sort times the sensor rating. The corresponding time delay be adjustable from instantaneous to 400 milliseconds with the possibility select time inverse characteristic for improved discrimination. Instantaneous overcurrent protection shall be adjustable from 2 times the current up to the circuit breaker electrodynamic withstand. The earth protection shall have current settings from 10 per cent of the rated current 1200 A in steps of 10 per cent. The time delay setting shall be variable 100 millisecond to 400 millisec in steps of 100 millisec.
- J. The RMS value of the phase currents and interrupted current values shall be displayed on the built-in digital ammeter and the LED's shall indicate the type of fault on the front face of the trip unit. An indicator shall give indication of the main contact wear according to the number of operations and the values of the switched currents. A bar graph shall display the load indication of each phase and the highest value of phase currents shall be stored and displayed on demand. Trip unit malfunction or internal overheating shall be indicated by a self monitoring alarm.(Some features may differ from one manufacturer to another)
- K. The air circuit breaker used on bus-section shall be identical to Air Circuit Breaker specified but with only the Making Current Release (MCR) protections and instruments specified but with the following indications :
 - 1. Circuit breaker closed.
 - 2. Circuit breaker open.

3. Circuit breaker tripped.

- L. The main low tension panels shall be provided with cable boxes to suit the incoming cables from the transformer which are supplied and installed by the concerned local authorities.

2.04 CURRENT TRANSFORMERS

Current transformers shall be of Class C accuracy for indication and Class CM accuracy for metering purpose. The secondary windings shall be rated at 5A and the rated output shall be suitable for the burden.

2.05 INSTRUMENTS

- A. The measuring instruments shall include ammeter voltmeters, maximum demand indicators and selector switches as indicated on the Drawings.
- B. The instruments shall have anti-glare glass fronts, anti-parallax scales and white faces with black numerals and markings. The instrument cases shall be semi-flush mounted and shall be approximately 100 x 100mm square. Accuracy shall be one percent of full scale values. Moving elements shall be provided with zero adjustments external to the cases.
- C. Ammeters shall be moving iron type, to B.S. 89 scaled 0-2000 A for main incoming supply.
- D. Voltmeter shall be moving iron type to B.S. 89 scaled 0-500V and provided with 6-position selector switches allowing reading of line to line and line to neutral voltages.
- E. Maximum demand indicators shall be of the thermal type with a 15-minute time delay.

2.06 kWh METERS

- A. The kWh Meters for the concerned local authorities shall be suitable for operation on 415/240 volts, 3 phase, 4 wire, 50 Hz supply.
- B. The meter shall be absolutely dust and vermin proof, protected from corrosion due to high humidity and compensated against the effect of temperature upto 55 Deg.°C.
- C. The Meters shall maintain their accuracy over many years service under Jordan climatic conditions. The counters shall be of the cycle-

meter type with six digits and shall give a direct reading of power consumption to six figures, the lowest figure being units and not tenth of units. Pointer type counters are not acceptable.

- D. Multiplying factors shall not be used except for the larger size of current-transformer operated meter, where 10 and 100 may be used. The calibrating adjustments shall be operated by screw-driver only.
- E. The Meter cover and cases shall be of metal and not plastic.
- F. The ratings for direct connected whole current meters shall be 50, 75 and 125 amperes maximum per phase and the terminal holes shall not be less than 6,9 or 12mm. diameter respectively.
- K. Higher ratings meters shall have not less than 5mm. diameter terminal holes and shall be operate through current transformers with 5 amperes rating to the secondary side and the counter or the meter shall be calibrated to read the primary Kwh passing through the current transformers.
- L. The current transformers shall be of the ring or slide on busbar type.
- M. Three current transformers of 2000/5A shall be provided for each meter.
- N. All meters shall be handed over to the concerned local authorities for Calibration before final erection and connection.

2.07 FUSE SWITCHES

- A. Fuse switches shall fully comply with BS 5419 : 1977, IEC 408 : 1972 meeting all of the concerned local authorities requirements.

2.08 MOULDED CASE CIRCUIT BREAKERS

- A. The moulded case circuit breakers shall comply with IEC 947-1 and IEC 947-2 standards and shall be of the quick make and quick break type having free toggle mechanism ensuring full contact pressure until time of opening, whether actuated automatically or manually. They shall be of utilization category 'A' having rated service breaking capacity (Ics) as indicated in the drawings. The circuit breakers shall be suitable for isolation as per IEC 947-2 and shall have rated operation voltage of 500V 50 Hz, insulation voltage of 750 V, 50 Hz. The breaker shall be available in 3 or 4 pole version as per the drawing. All poles shall operate simultaneously for circuit breaker opening, closing and tripping. The mechanism shall be completely

enclosed in the compact moulded bakelite case. The moulded case circuit breaker shall provide class II insulation (according to IEC 664) between the front and internal power circuits. The breaker shall be designed for both vertical and horizontal mounting and it shall be possible to supply power either from the upstream or downstream side without any adverse effects on the electrical performance. Evidence of the service breaking capacity (Ics) shall be produced by test certificates from one of the internationally recognized High Voltage Laboratories (ASTA, CESI, ESEF/ASEFA, KEMA, PEHLA or SATS).

- B. Breakers contacts shall be made of non-welding and non-corrodible composition. Circuit breakers shall be actuated by a toggle or handle that clearly indicates the three positions 'ON', 'OFF' and 'TRIP' thus indicating clearly abnormal conditions of the circuit. In order to ensure suitability for isolation complying with IEC-947-2, the operating mechanism shall be designed such that the toggle or handle can only be in OFF position if the power contacts are all actually separated. The molded case circuit breakers shall be able to receive a locking device in the "isolated" position and there shall be a "push to trip" button in front to test operation and the opening of the poles. The circuit breaker rating, the 'push to trip' button, outgoing circuit identification and the contact position indication must be clearly visible and accessible from the front, through the front panel or the door of the switchboard. Single pole breaker with handle tie or bar equivalent construction are not acceptable for a multi-pole breaker. Molded case circuit breakers shall be the fixed type. Plug in type breaker connections are not acceptable.
- C. Breakers shall have the rating and rated service breaking capacity (Ics) as per IEC 947-2 as indicated in the drawings. The breakers shall be of current limiting type. For short circuits, the maximum thermal stress I^2t shall be limited to $10^6 \text{ A}^2\text{s}$ for ratings up to 250A and $5 \times 10^6 \text{ A}^2\text{s}$ for ratings above up to 630A.
- D. Circuit breakers shall have inverse time tripping characteristic with automatic release secured through action of a combination of thermal-magnetic or electronic trip units which shall trip free of the handle and operate in response to an overload or a short circuit.
- D. It shall be possible to equip the moulded case circuit breaker with a motor mechanism if needed and closing of mechanism shall take place in less than 80 ms. The operating mechanism shall be of the stored energy type only. The addition of motor mechanism or a rotary handle shall in no way affect circuit breaker characteristics and shall not block device settings.

- E. The MCCB's shall be designed for adding auxiliary contacts such as shunt or undervoltage releases after installation at site. The auxiliaries shall be separated from power circuits. It shall be possible to install auxiliary switches for fault/status indication in already energized MCCB without the need to trip the MCCB.
- G. It shall be possible to assemble earth fault protection of MCCB's by adding a residual current device directly to the circuit breaker case and it shall operate without an auxiliary power supply. The add on RCD's shall comply with appendix B of IEC 947-2 standard. They shall be immunised against nuisance tripping as per IEC 255 and IEC 801-2 to 801-5 standards
- H. MCCB with ratings upto 250A shall be equipped with thermal magnetic or electronic trip units which are fully interchangeable types. The breakers with ratings over 250A shall be equipped with electronic trip units which shall remain operational for ambient temperatures upto 60°C. Electronic trip units shall comply with appendix F of IEC 947-2 standard. It shall be possible to fit lead seals to prevent unauthorized access to the settings of the electronic and thermal magnetic trip units.
MCCB's equipped with thermal magnetic trip units shall have adjustable thermal protection and fixed magnetic protection for current ratings upto 160A. For current ratings greater than 160A the thermal magnetic trip units shall be adjustable from 5 to 10 times the current rating. In four pole breakers the neutral pole shall have the tripping threshold equal to that of the phases unless otherwise stated in the drawings.
- K. MCCB's upto 250A frame size equipped with electronic trip units shall sense the actual RMS values for:
 - a) long time protection from 40% to 100% of the trip unit rating,
 - b) the short time protection shall be adjustable from 2 to 10 times the thermal setting,
 - c) the instantaneous protection shall have the threshold fixed between 12 and 19 times nominal current, depending on the rating.
- L. MCCB's over 250A up to 630A frame size shall be equipped with electronic trip units shall sense the actual RMS values for: : a) long time protection from 40% to 100% of the trip unit rating, b) the short time protection shall be adjustable from 2 to 10 times the thermal setting, c) the instantaneous protection threshold shall be adjustable from 1.5 to 11 times nominal current and d) a thermal memory (in the event of repeated overloads, the electronic trip units shall optimize protection of cables and downstream devices by memorizing temperature variations). A load monitoring function shall be an integral part of the electronic trip units indicating four load levels

(60%, 75%, 90% and 105%) by LED's (with flashing LED for 105%). It shall be possible to install with the electronic trip unit a high threshold earth fault protection, load monitoring and LED's in front to indicate the cause of tripping. It shall be possible for the MCCB to communicate with Building Management System (BMS).

- M. The following frame sizes shall be adopted for different breakers:
- | | |
|----------------|---------------------|
| upto 80A | 100/125A frame size |
| 100A to 160A | 250A frame size. |
| 250A to 350A | 400A frame size. |
| 350A and above | 630A frame size |
- N. Each MCCB's shall have minimum 2 pairs of NO /NC auxiliary contacts

2.09 EARTH LEAKAGE RELAYS

- A. Earth Fault Relay
- The relays shall comply with IEC 755
 - The relays shall be protected against nuisance tripping caused by switching surges or by lighting surges.
 - The relays shall be of solid state type (mechanical type shall not be accepted), self protected from high magnitude earth faults and protected against dirt, vibration and moisture.
 - The relays shall be able to operate in the presence of fault currents with DC components.
 - Each relay shall accept a wide range of auxiliary supply voltages from 48V to 240V AC and 48V to 300V DC as per the requirement in the drawings.
 - The sensitivity of relays shall be adjustable as per the requirement in the drawings from 0.03A to onward. The relays shall have time delay option if required from instantaneous to 1 sec. using an 8 position switch.
 - The size of the relays shall be compact. They shall be suitable for mounting on symmetrical rail horizontally or vertically.
 - The relays shall be equipped with one changeover output contact. The continuity of the measurement circuit shall be monitored to ensure that the toroid circuit is not open.
- B. Current Sensors (Toroids)
- Rectangular type for busduct feeders
 - Circular type for cable feeders
 - The range of associated toroidal transformer shall be of the closed type with an inside diameter of 30 to 200 mm.
 - To have cable guides to ensure that feeder cable is centered within the sensor.

- e. The maximum link resistance from toroid to relay link must not exceed 3 ohms.
Current operated earth leakage relays shall be used either in conjunction with circuit breakers for tripping the breakers or for giving alarm signal only by an indicator lamp and alarm bell in cases of earth leakage.

2.10 EARTH BUS

The copper earth bus shall be minimum 50% of the phase conductor size extending throughout the length of the switch board and fixed to the steel members of the switch board. The earth bus shall be extended at the ends for connection to the earth electrodes and shall have provision for terminating earth continuity conductors.

2.11 MAIN AND SUB-MAIN DISTRIBUTION BOARDS

- A. The main and sub-main distribution boards shall be totally enclosed, dust protected and factory fabricated suitable for operation on 415/240 V, 3 phase, 4 wire, 50 Hz supply.
- B. Main and sub-main distribution boards shall comprise main incoming isolator, busbars, moulded case circuit breakers, earth leakage relays, earth bus etc. with ratings and arrangement as shown on the Drawings and all housed in a sheet steel panel fully rust-proofed and electro static powder coated paint; equipped with a hinder door with approved locking device.
- C. The main isolator shall be a triple pole and neutral moulded case circuit breaker without tripping element.
- D. The busbars shall be high conductivity copper bars to B.S. 159 with ratings as indicated on the Drawings for the three phases and neutral. The busbars shall be arranged and marked to the approval of the Engineer.
- E. The moulded case circuit breakers and earth leakage relays shall be as specified in paragraph 2.08 and 2.09 above.
- F. The rated service breaking capacity (ICS) of MCCBs shall be 50 KA for MLTP, 28KA for MDBE, 22 KA for MSBs and MCCs, 14 KA for SMSB and MCC fed from MSB unless indicated otherwise on the Drawings.
- G. The earth bus shall have adequate rating and length for connecting the incoming and outgoing earth wires or tapes.

- H. The distribution boards shall be complete with all necessary internal wiring and connections
- J. High conductivity copper bars or rods covered by coloured PVC sleeving for phase identification shall be employed for connections of 200A and higher. For smaller connections PVC insulated cables to B.S. 6231 shall be used with coloured insulation for phase identification.
- K. The arrangement of the boards shall be such that the main isolator and MCCBs can be operated when opening the door but to gain access to the MCCBs, cabling and terminations a second cover should be removed. There shall be ample clearance and ample space available inside the boards for cabling and terminations. Adequate clearance shall be maintained between phases and non-current carrying metal and terminals shall be so located that in the final connected positions there shall be no crowding of wires in close proximity of metal.
- L. The boards shall be complete with cable glands for convenient terminations of incoming and outgoing cables. The cable glands shall be so fixed inside the board that ample clearance exists between various feeders.

2.12 M.C.B. DISTRIBUTION BOARDS

- A. MCB distribution boards shall comprise of a totally enclosed dust and vermin protected, factory fabricated heavy gauge sheet steel enclosure of 2mm thickness and door of 1.5mm thickness and of ample size with a hinged door and approved fastening device. The enclosure shall contain an isolating switch, adequately rated busbars for phases, neutral connector blocks, earth terminal block and single or triple pole miniature circuit breakers with ratings and arrangement as shown on schedules. DB enclosures shall be suitable for 18 or 24 or 36 SPN ways, as the case may be. HRC fuses shall be provided in MCB Distribution Boards where fault level exceeds 6KA.
- B. In corridors DBs enclosure shall be housed in electrical closets. All electrical closets shall be of the same size with architectural finishes as required.
- C. All risers falling in areas like corridors or important rooms shall be provided with an hinged access door with finishes as required by architect.
- D. The main isolating switch shall be of SPN or TPN air break design. Where indicated on the Drawings, the MCBs for the lighting circuits and socket outlet circuits shall be electrically separated by the

provision of separate busbars and each section shall be protected by a separate current operated earth leakage circuit breaker. The RCCB shall afford earth leakage protection for the lighting and power sections. Fuses shall be provided for DBs wherever necessary and/or shown on drawings.

- E. The neutral and earth terminal blocks should be provided with arrangement for connecting on each block one cable for each outgoing circuit and one incoming cable of size indicated on the Drawings. The wiring between the RCCB and busbars shall be carried out with coloured PVC insulated cables with copper conductors for phase identification. The arrangement of the enclosure shall be such that the MCBs and COELCB cannot be operated without opening the hinged door but to obtain access to MCBs and COELCB, it should be necessary to remove a second cover. Adequate clearance shall be maintained between phase and non-current carrying metals. Terminals shall be so located that in the final connected positions, there shall be no crowding of wires in close proximity of live metals.
- F. MCBs shall be so arranged in the board that it shall be possible to replace a triple pole MCB with three adjacent single pole MCBs or vice versa. The board shall be flush mounted type unless indicated otherwise on the Drawings. Cable glands shall be provided where required.
- G. MCB
 MCB shall comply with EN60439-3 and shall be symmetrical rail mounted type available in one, two, three or four poles version. They shall be trip free type with quick make, quick break mechanism. The rated ultimate breaking capacity (Icu) of the MCB's shall be at least equal to the prospective fault level at the point of the distribution system where they are installed, unless cascaded with an upstream breaker. The minimum rated ultimate breaking capacity (Icu) of the MCB shall be 10 kA if not mentioned on the drawings. MCB can be reverse fed without reduction in performance. Trip setting as indicated on the schedules of points. The MCB shall have thermal overload trip to accept 5% overload and to trip at 30% of rated current as per IEC 947-2. The instantaneous magnetic trip shall operate at 5 to 10 times the rated current for 1P, 2P, 3P or 4P breakers. It shall be possible to replace 3 single phase units with one 3 phase unit. The breakers shall be of current limiting type (DIN type). The quick lag type breakers (QL/plug in type) are not acceptable. Evidence of the ultimate breaking capacity (Icu) shall be produced by test certificates from one of the internationally recognized High Voltage Laboratories (ASTA, CESI, ESEF/ASEFA, KEMA, PEHLA or SATS).
 The operating mechanism shall be mechanically trip free from the operating handle so as to prevent the contacts from being held closed

against short circuit and overload conditions. It shall be “automatic resetting type”. The individual operating mechanism of each pole of a multi pole MCB shall be directly linked within the MCB casing and not by operating handles. The operating handle shall be of the toggle type with possibility of padlocking facility and rotary handle. Each pole shall be provided with bi-metallic thermal element for overload protection and magnetic element for short circuit protection. Current discriminations tables shall be provided for each rating of the breaker. The terminals shall be of the tunnel type (IP 20) in order to minimize the risk of direct contact. It shall be possible to fit on site auxiliaries like shunt trip coil, undervoltage release, ON-OFF switch, alarm switch or residual current device 30 or 300 mA with remote tripping possibility.

The term ‘rcb’ /‘rcbo’ shall denote an mcb with built-in earth leakage protection.

H. RESIDUAL CURRENT CIRCUIT BREAKER (RCCB)

RCCB shall comply with CEE 227 or IEC 1008 standards. The RCCB shall provide the functions of isolation, switching and earth leakage protection of electrical circuits. They shall have a residual current operated electromechanical release which operates without auxiliary source of supply to an earth leakage fault between active conductors and earth. RCCBs shall incorporate a filtering device preventing the risk of unwanted tripping due transient voltage. They shall provide a high degree of protection against earth faults, fire hazards and electric shock.

RCCBs shall be available in 2 and 4 pole versions with current ratings from 16A to 100A and an earth leakage trip rating as specified in the schedule of points. They shall be suitable for operation on 415V, 3 phase, 4 wire, 50 Hz supply. They shall have an operating temperature from -5 to + 60° C. RCCB shall have a trip indication on the front face by a red mark. It shall be possible to achieve vertical discriminations with RCCBs.

RCCB alone shall have a short circuit withstand capacity of 3 KA. RCCB must be protected with short circuit protective devices installed upstream inside the DB enclosure having appropriate fault level protection.

RCCB shall consist of the following mounted in a robust body of all insulated material:

- A current transformer
- A tripping coil with contact assembly
- Main supply contact
- On/Off switch
- A test button

- A trip free mechanism

Where a RCCB is used as a separate item and not housed within a distribution or switchboard, it shall be housed in a dust protected enclosure to prevent accidental contact with live terminals.

- I. Where contactors are shown in DBs, the distribution board shall deemed to be understood as a multiple section board.
- J. All outdoor MCB distribution boards shall be in weatherproof enclosures.
- K. The term RCB shall mean an MCB with built-in earth leakage protection similar to 'Quickguard' of Square-D
- L. **CONTACTORS**

The contactors shall conform to BS 775, IEC 947-4 suitable for Class II duty and having a making and breaking capacity in accordance with utilization category AC3.

Unless specially required otherwise the operating coil shall be rated for 240V 50Hz.

Contactors shall be rated for continuous duty.

Contactors not forming a part of Distribution Board shall be housed in a purpose made enclosure having appropriate IP rating suitable to the mounting location

M PULSE RELAYS

Pulse relays shall be suitable AC or DC operation as per system manufacturer Normal practice. The operation voltage may be 240V 50Hz or 24V DC

The pulse relay shall be suitable for actuation manual through built-in Push button.

2.13 MOTOR PROTECTION

Motor Protection against the short-circuit shall be achieved by motor circuit breakers of moulded case type and the combination with control-command devices (Breaker + Contactor + Overload relay) shall be of type 2 co-ordination as defined by the IEC standards 947-4.1. The type 2 co-ordination should be tested in laboratory and the manufacturer should guarantee the same by submitting the type-2

Co-ordination tables. The co-ordination table shall indicate for each motor rating, the circuit breaker type and set up characteristics, the contactor type and the thermal relay type with its setting range.

The specifications mentioned in the MCCB's section is applicable for the breakers used in the motor protection. The moulded case circuit breakers used for motor protection shall be equipped with adjustable magnetic trip unit for short-circuit protection with settings from 6 to 14 times the nominal rating of the device.

The contactors used for Motor protection shall have contactor utilization category AC3 at 415V 50Hz as per IEC 947-4. Tripping class for overload relays used for motor protection shall be of one of the tripping class (class 10A, 10, 20, 30) as per IEC 947-4 depending on the motor starting characteristics.

2.14 ELECTRONIC SOFT STARTERS

Where these starters do not fall under the electrical sub-contractor's scope of work, the specifications may be used for all co-ordination works.

The concerned factory manufacturing the equipment must be ISO 9001 certified for quality assurance and the product supplied shall bear the CE mark.

Contractor to provide complete coordination / selection table prepared by the soft starter manufacturer and indicating clearly the recommendation components such as fuses, breakers, contactors and overload relays so as to achieve Type – 2 coordination as per IEC guidelines. These components shall be from the same manufacturer for easy substitution and consistent operational reliability of the equipment. Mixing of brands is wholly unacceptable. The soft starters in general shall comply with the following.

Enclosure

- Equipment shall be manufactured in accordance with IEC regulations.
- The enclosure used shall be adequate per EMC and Low Voltage directives. The equipment shall be CE marked.
- Units above 20A shall be fitted with adequate forced air-cooling (fan-type).

Control Circuit

The soft starter shall comprise a uP – type control arrangement (PCB based) for triggering control and offer as a minimum, the following functions, selectable using DIP-switch or settable using potentiometers:

- Start Ramp (settable) for upto 60 sec.
- Stop Ramp (settable) for upto 240 sec.
- Startup Voltage (settable) 10 to 60%
- Stop Voltage (settable) 10 to 60% (for Pump Stops)

- Current limit during start (settable)
- Energy saving feature (selectable) for optimal power factor, current and efficiency levels on a real time basis, provided with activation delay (selectable).
- Kick start function for transient high-torque condition to overcome high initial inertia/friction loads (selectable)
- High Current Trip (selectable)

Status indications shall comprise as a minimum, LED display of the following:

- Fault (internal)
- Phase Loss
- Overload
- Ready
- Running
- Ramp-up complete
- Energy Saving function active (if selected)

Further as a minimum, the following volts-free signals shall be made available:

- Fault
- Overload
- Ramp-up complete

Power circuit

The following features shall be provided as standard:

- Start and stop ramp to be achieved using reduced voltage triggering of thyristors connected in antiparallel, with each phase individually double-protected by adequate snubber circuits and varistors to withstand 4kV at 2.5Hz for 60 seconds or more.
- Diode-thyristor paralleling in unacceptable.
- Starter shall be suitable for continuous duty. Further, the circuit must be suitable for constant mains voltage, even when starter is not in use.
- Electronic overload relay to be provided as option in all ratings above 30A and as standard feature for heavy-duty applications to protect the unit from thermal overloads, phase-loss and locked rotor conditions. In addition, an option of over-current trip (selectable) shall be provided to prevent damage due to short-circuits.

External electronic or thermal overload relays may be proposed as an option.

- Adequate heat sinking shall be provided. Further, a thyristor overheat trip shall be provided for added protection.
- Adequately sized terminals shall be provided for linking to cables. Where busbars are used, terminal expansion attachments shall be provided accordingly.

Technical Support

The equipment shall be supplied complete with comprehensive documentation comprising the installation and operation instructions. In addition, the following documentation shall be provided on request and where applicable:

- Selection details including starting curves based on manufacturer's recommendations.
- Coordination tables (where used) for Type-2 coordination as per IEC.
- Connection drawings for the scheme used.
- Basic trouble-shooting guide (if not already included in the ops manual)

General

The equipment shall be compliant with the following wrt operation:

- Rated installation voltage of 690Vac.
- Starter shall be typically for minimum 6 starts per hour (subject to application type and kW rating)
- For units used in continuous running with fewer starts, a bypass contactor recommended by the soft starter manufacturer shall be used to minimize heat loss.
- Actuation of bypass contractor shall be achieved by using relay output on completion of ramp up.
- Operating temperature shall be 0oC to 50oC with adequate derating where required (application dependent). Also, the equipment shall be suitable for normal operation without derating, within an altitude range of 0-1000 meters.

2.15 ELECTROMECHANIC MOTOR STARTERS

Where these starters do not fall under the electrical sub-contractor's scope of work, the specifications may be used for all co-ordination works.

- A. Provide motor starters of electromagnetic, air break type suitable for 3 phase, 50 Hz., 415V, AC System and in accordance with IEC 947-4
- B. Starters shall be of the plug-in type mounted on withdrawable trays including power and control plug pins and earthing contact with facilities for padlocking.
- C. Starters controlling motor less than 11 KW may be of the direct on line type. For motors of 11 KW and higher ratings employ automatic star delta starters. Starters shall be provided with three phase overload relays having thermal characteristics suitable for the

associated motor and its starting characteristics and suitably compensated for ambient air temperature variation. In addition, provide single phasing protection. Means should also be inherent in the starter for automatically disconnecting the motor from the electricity supply in the event of interrupted supply or under voltage. Provide earth leakage protection for all motors.

- D. Starters shall have in addition to the auxiliary contacts required for interlocks, alarms, BAS, and controls two additional sets of normally open and normally closed contacts.
- E. Motor Protection against the short-circuit shall be achieved by motor circuit breakers of moulded case type and the combination with control-command devices (Breaker + Contactor + Overload relay) shall be of type 2 co-ordination as defined by the IEC standards 947-4.1. The type 2 co-ordination should be tested in laboratory and the manufacturer should guarantee the same by submitting the type-2 co-ordination tables. The co-ordination table shall indicate for each motor rating, the circuit breaker type and set up characteristics, the contactor type and the thermal relay type with its setting range. The specifications mentioned in the MCCB's section is applicable for the breakers used in the motor protection. The moulded case circuit breakers used for motor protection shall be equipped with adjustable magnetic trip unit for short-circuit protection with settings from 6 to 14 times the nominal rating of the device. The contactors used for Motor protection shall have contactor utilization category AC3 at 415V 50Hz as per IEC 947-4. Tripping class for overload relays used for motor protection shall be of one of the tripping class (class 10A, 10, 20, 30) as per IEC 947-4 depending on the motor starting characteristics.
- F. For each starter, provide the following :
 - 1. 1 set of 'ON' and 'OFF' push buttons for starting and stopping of motor.
 - 2. Red and Green indicating lamps to show status of motor.
 - 3. Suitably scaled ammeter with selector switch for each motor above 7.5 KW.
 - 4. All auxiliary contacts for BAS.
 - 5. Instruments for KW indication by BAS.
- G. For each motor circuit, its associated circuit breaker and its starter shall be housed in one cell or unit and interlocked so that cell door cannot be opened and started unit cannot be withdrawn unless the breaker is in the 'OFF' position.

2.16 AUTOMATIC VOLTAGE STABILISER

Wherever specified/indicated, the stabilizer shall be constructed on booster transformer principle. The rating of the stabilizer shall be as indicated on drawings or as specified in the B.O.Q

Technical Requirements

Ambient Temp.	up to 50 °C
Cooling type	Natural air cooled
Input	415V AC $\pm 15\%$ at 50Hz
Output	415V AC $\pm 2\%$ at 50 Hz

The stabilizer shall be equipped with filters for transients, compensator for unbalanced load in 3 phases, protection against faults and malfunctions. The stabilizer shall be fixed with 3 Ammeters, voltmeters

PART 3 – EXECUTION

3.01 CIRCUITS AND CONNECTIONS

- A. Provide all outgoing circuits with separate compartment and/or screen so that equipment for any one circuit can be maintained without risk of contact with line connections on any other circuit.
- B. Connect feeders, for circuits rated upto 63A, to terminal blocks located in separated compartments at top or bottom, conveniently arranged to facilitate termination of cables and suitably identified.
- C. For feeders, rated more than 63A, suitably extend copper links rigidly supported and covered with coloured PVC sleeves.
- D. Provide all feeders with cable lugs and brass cable glands.
- E. Provide removable gland plates suitable for the glands required for the specified cables. Where cables are single core, the gland plates shall be of a non-ferrous metal.
- F. Provide all small wiring of stranded copper, not less than 2.5mm² with PVC insulation to B.S. 6231. Small wiring shall be neatly bunched and cleated in harness form, or shall be enclosed in purpose made plastic trunking or troughing. Wiring cleated to metal surfaces shall be insulated from the metal. Where wiring runs through sheet steel panels, holes shall be grommeted with suitable grommets.

- G. Connect small wiring associated with external circuits to terminal strips conveniently arranged.
- H. Provide each connection with separate incoming and outgoing terminals with no more than two wires to be connected to any terminal.
- J. Wire all spare contacts to terminal strips suitably positioned.
- K. Identify all wiring using plastic ferrules at both ends

3.02 FLEXIBLE CONDUITS

- A. The final conduit/connections to motors or apparatus shall be in flexible conduits

* END OF SECTION *

SECTION 16500
LIGHTING SYSTEM

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

- A. The work of this Division shall be governed by the following documents:
 - 1. Conditions of Contract.
 - 2. Instructions to Tenderers.
 - 3. Form of Agreement.
 - 4. General and Special Conditions of Contract.
 - 5. Form of Tender.
 - 6. Appendices.
 - 7. Applicable Divisions.
- B. Comply with requirements of Section 16010 electrical General Provisions.
- C. It is the Contractors responsibility to be fully aware of and comply with all of the requirements of the above listed documents.

1.2 SCOPE OF WORK

- A. Supply all labour, tools, services and equipment and provide all the materials required to complete this section of the work.
- B. The lighting installation for this project shall consist of the following systems but shall not be limited to.
 - 1. General lighting.
 - 2. Emergency and exit lighting system as shown on drawings and luminaire schedule.
 - 3. Exterior and site lighting.
- C. Generally the lighting installation shall be carried out by installing conduits within the building structure and walls forming a flush installation in mechanical rooms, electrical switch rooms and other service areas the installation shall be on the surface.
- D. Generally some of the lighting installation may be switched utilizing programmable low voltage switching.
- E. Emergency lighting and exit signs shall be connected as shown on drawings.
- F. External lighting shall be contactor controlled incorporating scheduled BMS or KNX lighting control system

1.3 QUALITY ASSURANCE

- A. Acceptable Manufacturers.
 - 1. Subject to compliance with the requirements of the Contract documents, acceptable manufacturers are to be firm regularly engaged in the manufacture of lighting fixtures of similar quality whose products have been in satisfactory use under similar service conditions for not less than ten years.

1.4 SUBMITTALS

- A. Reference Applicable Divisions – Submittals
- B. Reference Applicable Divisions - shop drawings, products and data and samples.
- C. Submit shop drawing of:
 - Each type of lighting fixture detailing.
 - i. Catalogue illustrations of luminaire proposed for each specified application.
 - ii. Design and installation requirements.
 - iii. Photometric curves and isolux diagrams for each luminaire with indication of minimum light output ratio.
 - iv. Data indicating each luminaire type's maximum and minimum ambient operating temperatures, and special features, where applicable to withstand onerous conditions, ie. High ambient temperature, intense direct sunlight blowing sand and grit, salt laden air etc.
 - Computer print out of exterior flood lighting of the building.
- D. Samples and shop testing.
 - Fixture (Recessed type)
 - i. For the lighting fixture (recessed in F.C) the contractor shall obtain from the ceiling manufacturer a 3m x 3m sample of the ceiling assembly for the Jebsum F.C. The fixture manufacturer shall finalize the details and dimensions the fixture recessed to be co-ordinated with and accommodate the ceiling assembly.
 - ii. Inform the engineer fourteen (14) days in advance of the assembly being completed and obtain the consultant approval for the assembly.
- E. Spares
 - Provide spare luminaires, control gear, lamps and louvres as listed hereinafter.
 - Luminaires : recessed type: 50 No.

Lamps

- i. Provide 20% spare & tubes of each lamp & tube type and rating with a minimum of 10 lamps or tubes of each type and rating.

Control Gear

- i. Provide 20% control gear of each control gear type and rating with a minimum of 10 control gear per type and rating.

Louvres & Lenses

- i. Provide 5% spare lenses & louvres of each type.

Emergency conversion modules.

- i. Provide 10% of each type with a minimum of 5 modules per type and rating.

1.5 DESIGN CRITERIA

Generally, all luminaires have been selected to achieve the underlisted illumination levels for the reflectance's of surfaces applicable, and a maintenance factor of 80% - 90%:

<u>Location/Function</u>	<u>Min. Service Illuminance (LUX)</u>
Archives	500
Conference Room	500
Corridors	100
Entrance Hall	400
Mechanical Plantroom	300
Meeting room	400
Offices	500
Public Areas	200
Pump Room	200
Stairs	200
Store	300
L.V. Room	300
Pantry	150
Toilets and lockers	200
Waiting Area	300
Lounge	250

Note: Max. Service illuminance shall not exceed 20% of the above levels.

PART 2-PRODUCTS

2.1 LUMINAIRES - GENERAL

A. Standards

1. IEC Standard 61 - Lamp Caps and Holders.

B. Equipment

1. Luminaires shall be completely self contained, unless otherwise specified, and include all control gear, lamp holders, reflectors and diffusers, as required.
2. Luminaires shall be recessed, surface-mounted or suspended as indicated on the Drawings, by code reference and identified in luminaire Schedule and Data sheets.
3. All diffusers shall be of the light stabilized and non-discoloring type.
4. The design, construction and finish of all luminaires shall be entirely adequate for operation in the ambient conditions and at the supply characteristics stated in section 16010 of this specification. All luminaires shall be designed and installed to permit easy relamping.
5. Where possible a terminal block shall be provided inside each luminaire and the wiring between this terminal block and lamp holders, choke, capacitors, etc., shall be completed in heat resistant (135°C) cable of adequate size. Terminal blocks fixed to outside of luminaire housings shall be shrouded type with cable cord grip.
6. Where space is not available for the installation of a terminal block at the luminaire, a separate terminal block shall be provided in an adjacent junction box connected back to the luminaire in heat resistant (135°C) cable of adequate size.
7. All luminaires shall be suitable for connection to rigid conduit, and/or flexible circular sheathed cable.
8. all weather-proof luminaires shall be fully suitable for outdoor use and shall not deteriorate after extended use in the ambient site conditions state.
9. All mounted luminaires shall be connected to the control box in heat resistant (135°C) cable.

2.2 EXIT SIGNS

- A. Shall be bilingual, details as shown in the following documents and to the approval of Civil Defense authorities:
- Signage and Graphics
 - Luminaire Schedule
 - Electrical Drawings
 - Data Sheets included herein.

PART 3 EXECUTION

3.1 INSTALLATION GENERAL

- A. Refer to Section 16010.

3.2 INSTALLATION OF LIGHTING FIXTURES AND LAMPS.

- A. Provide all lighting fixtures and lamps shown on the drawings luminaires schedule and data sheets attached herein.
- B. Include for assembly, and mounting of all fixtures, complete with all wiring, connections, fittings, hangers, aligners, box covers and accessories which may be required for any fixture to provide a complete, safe, fully operational assembly.
- C. Generally, install fixtures in accordance with applicable reflected ceiling plans and/or as directed by the Architect. In equipment rooms, shafts and similar secondary areas, install fixtures after the mechanical and other major work is roughed-in and adjust fixture locations as required.
- D. Thoroughly review all ceiling types, construction details and mounting arrangements before placing fixture orders and ensure that all mounting assemblies, frames, rings and similar features are included for and match the requires installation.
- E. All fixtures and fixture assemblies shall be properly secured and supported. Support fixtures independent of the ceiling construction complete with all fasteners, framing and hangers. Do not secure fixtures to mechanical ductwork or other vibration producing apparatus unless specifically detailed on the drawings.
- F. Where fixtures are suspended from the structure they shall utilize self aligning box covers with an additional ground wire from the outlet through the hanger for continuity of ground.
- G. Carefully co-ordinate the fixture installation with the work of other trades ensuring that the necessary depths and mounting spaces are provided. Do not alter fixture locations unless approved by the Architect.
- H. All lamps shall be new and intact when the project is complete, and ready for acceptance.
- I. Provide safety chains on all surface mounted or suspended fixtures.
- J. The final connection to all luminaries integrated into suspended ceilings shall be by means of flexible heat resisting cable terminated at a plug and sockets ceiling rose mounted in the ceiling void directly adjacent to the luminaire. All such ceiling roses shall be appropriately rated to suit the rating of the associated sub-circuit protective device. The plug and socket ceiling rose shall be located directly above or adjacent (within a horizontal distance of 1.5m from the centre of the fixture) at the side of

luminaire such that it is readily accessible for disconnection and maintenance.

K. Earthing

1. All luminaries of metallic construction shall be suitably earthed, the earth wiring being connected by a terminal provided within each fitting specifically for this purpose.
2. Where luminaires are suspended, a cable protective conductor shall be connected between the fitting and the final sub-circuit wiring installation.

L. Luminaires Commissioning and Testing

1. At the discretion of the Engineer, make-up site test and demonstrate the operation of special application of fixtures such as building floodlights, landscape fixtures and other decorative fixtures, and adjust their locations within a reasonable distance to obtain the effects desired to the approval of the Architect. Assist in the aligning and positioning of all adjustable fixtures, and ensure that fixtures with adjustable lamp holders are properly positioned to correspond with the lamps specified.

3.3 EXIT SIGNS

- A. Provide all Exit Signs as scheduled and shown on the drawings, signage and graphics document and luminaire schedule.
- B. Directional arrows on Exit lights shall be as shown on drawings and in accordance with local Civil Defense Department requirements.

*** END OF SECTION ***

SECTION 16640
EARTHING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Grounding System including, but not limited to the following:

1. Grounding rods.
2. Grounding conductors.
3. Grounding connection bar.
4. Grounding of various systems.

1.02 RELATED SECTIONS

- A. Electrical Works, General.
- B. Electrical Identification.
- C. LV Cables and Wires.
- D. Underground Electrical Services.

1.03 REFERENCES

- A. British Standard Code of Practice CP1013 - Grounding.
- B. BS 7671 IEE Wiring Regulations, 16th Edition.

1.04 SUBMITTALS

A. Submit manufacturer's data, illustrated leaflets, dimensions, fixing details and description of the proposed products.

1.05 QUALITY ASSURANCE

A. Manufacturer's: Firms regularly engaged in the manufacture of Grounding equipment, whose products have been in satisfactory use in similar service for not less than 10 years. Preference shall be given to local manufacturers and suppliers/agents.

B. All equipment furnished under these Specifications shall conform to the requirements of BS, IEC and Local Standards Organization.

1.06 DELIVERY, STORAGE AND HANDLING

All products shall be carefully packed to avoid damage during transportation.

PART 2 PRODUCTS

2.01 GENERAL

A. All the materials required for Grounding system shall be furnished new and undamaged in accordance with the requirement stated in this section.

B. Conduct soil electrical resistivity tests at four locations (minimum) advised by the Engineer. The Grounding calculations based on the test results shall be submitted for Engineers approval, to demonstrate that the proposed design of Grounding system complies with the specifications and standards.

C. For High voltage equipment in Transformer room, a connection shall be provided from the main Grounding loop. Also Grounding pits shall be installed as per Local Electric Supplier

requirements, which will be isolated from the main Grounding loop.

D. For communication room, separate Grounding pits shall be installed as per Local Telephone Supplier requirements, which will be isolated from the main Grounding loop.

2.02 Grounding connection bar

A. For connection of MV and LV equipment, sub-station shall have high conductivity copper, Grounding connection bar with minimum dimensions of 50 x 6 mm and mounted on porcelain insulators. The bar shall be of suitable length with pre-drilled holes at a minimum distance of 50 mm between hole centres.

B. Grounding connection bars for transformer neutral and LV switchboard frame shall be separate from Grounding bar for HV and transformer frame.

C. Each Grounding connection bar shall have a permanent label to identify the connections together with the wording "Main Grounding Bar".

PART 3 EXECUTION

3.01 INSPECTION

A. Examine the area and conditions under which the Grounding systems are to be installed and correct any unsatisfactory conditions detrimental to the timely and proper completion of the work. Do not proceed with the work until the conditions are satisfactory in a manner acceptable to the Engineer.

3.02 GROUNDING CONDUCTORS INSTALLATION

A. Standard sizes of stranded copper conductor used for Grounding continuity shall be according to the requirements of IEE Wiring Regulations, 16th Edition..

B. Suitable Grounding facilities, acceptable to the Engineer, shall be furnished on electrical equipment to consist of compression type terminal connectors bolted to the equipment frame or enclosure and providing a minimum of joint resistance.

C. The conduit system shall not be considered as continuous for Grounding purposes. A separate Grounding conductor shall be installed in the same conduit with the phase and neutral conductors. The separate Grounding conductors shall be sized according to IEE Wiring Regulations, 16th Edition. requirements. No Grounding conductors shall be smaller than 2.5 mm² unless this is part of a multicore cable. Where flexible connections are made to equipment, Grounding jumpers shall be provided. All connections of heavy gauge steel conduit system shall be checked for good electrical continuity.

D. Exposed conductors shall be installed inconspicuously in vertical or horizontal positions on supporting structures. When located on irregular supporting surfaces or equipment, the conductors shall run parallel to or normal to the dominant surface.

E. Conductors routed over concrete, steel or equipment surfaces shall be kept in close contact with those surfaces by using fasteners located at intervals not exceeding 1 m.

F. Exposed Grounding conductors shall be securely fastened to the mounting surface using copper or brass straps.

G. Clamps, connectors, bolts, washers, nuts and other hardware for bolted connection to Grounding system shall be of copper.

H. Exothermic welds shall comprise moulds, cartridges, materials, and accessories as recommended by the manufacturer.

I. The Grounding conductors entering the building shall be installed in a 25 mm diameter PVC conduit. Waterproofing shall be provided at all entry of Grounding conductors, details of which shall be approved by the structural engineer.

J. Grounding conductors shall be buried at a minimum depth of 750 mm below finished grade.

K. Underground conductors shall be buried in clean sifted Grounding.

L. Except for sub-stations and electric rooms, the exposed Grounding conductor shall run in protective pipes for runs below 900 mm from floor level. Pipe

shall also be provided at locations where conduct is likely to be subject to physical damage.

M. Extensions from Grounding loop as shown on the Drawings shall be provided for connection to electrical equipment. Connect the Grounding conductor to the equipment, Grounding bus, pad or lug. In addition to the Grounding grid extension conductors, an Grounding cable to each end of the Grounding bus in each assembly of power distribution board or panel boards shall be provided.

N. Where an Grounding conductor is included with the phase conductors of power circuits, the Grounding conductor shall be connected to the equipment Grounding facilities and to the source Grounding bus. Where an grounding conductor is not included with the phase conductors, the equipment shall be Grounded by connecting a separate Grounding cable to the equipment Grounding facilities and to the tray Grounding cable or source Grounding bus. Except where otherwise shown on the Drawings, integral parts of a cable assembly shall be sized in accordance with the requirements of IEE Wiring Regulations, 16th Edition.

3.03 BUILDING SYSTEMS GROUNDING

- A. The building low current systems including communication, control and alarm functions...etc shall be provided with Grounding as shown on the Drawings and in relevant specifications.
- B. The installation of the Grounding for building systems shall be in accordance with the recommendations of standards, and the applicable provisions of this section.

3.04 SUPPLEMENTARY AND EQUI-POTENTIAL BONDING

- A. In accordance with Section 547 of the IEE Wiring Regulations 16th edition (BS 7671) bonding conductors shall be installed in appropriate locations to ensure all simultaneously accessible exposed or extraneous conductive parts are at equal potential. Undertake such tests and install such supplementary bonding conductors that are necessary to ensure compliance with these requirements.
- B. Supplementary bonding conductors shall conform to the requirements of Section 547-03 of the IEE Wiring Regulations and shall have a minimum cross-sectional area of 2.5 mm² where mechanically protected and 4.0 mm² where not so protected.
- C. Main equi-potential bonding conductors shall conform to the requirements of Section 547-2 of the IEE Wiring Regulations and shall have a minimum cross-sectional area of 6.0 mm².

3.08 FIELD QUALITY CONTROL

- A. Grounding resistance tests shall be carried out after installation of the individual Grounding systems in accordance with the Specifications. The Grounding resistance

tests shall be carried out in accordance with Section 713-11 of the IEE Wiring Regulations 16th edition and readings obtained officially recorded by all witnessing parties.

- C. Prior to connection of Grounding rods to the Grounding system, the Grounding resistance of individual Grounding rod shall be measured by using an approved type of Grounding resistance tester.
- D. After completion of all the connections of Grounding system, the Grounding resistance shall be measured from the Grounding test point in presence of the Engineer.
- E. All the Grounding resistance test reports shall be submitted for Engineer's approval.

The presence of the electrode shall be indicated in English and Arabic.

**** END OF SECTION ****

SECTION - 16720
FIRE DETECTION AND ALARM SYSTEM

PART 1 GENERAL

- 1.01 The contractor shall be responsible for the supply, installation, commissioning and servicing of the Analogue addressable fire alarm system.
- 1.02 The contractor must review the consultant's proposal for suitability to his system. All deviations should be brought to the notice of the Engineer.
- 1.03 The contractor or his representative must have, at least, 10 years experience in installing, commissioning and servicing fire detection and alarm systems, at least 5 of which must be with analogue addressable systems.
- 1.04 All equipment central to the operation of the analogue addressable systems shall be designed and manufactured by the company installing and commissioning the system. As a minimum requirement, this clause covers the following:
1. Fire Alarm Control Panel
 2. Repeat Panels
 3. Addressable ancillary equipment,
 4. Power supplies, and automatic point detection equipment.
- 1.05 The manufacturer shall be approved to BS5750 part 1 Quality system standard for the design and manufacture of the equipment referred to in clause 1.5 (ISO).
- 1.06 The main equipment proposed for use shall be approved by at least one of the following:
1. Loss Prevention Council (LPC)
 2. Underwriters Laboratories (UL)
 3. Association of German Prosperities insurance company (VDS)
- 1.07 The manufacturer shall have available a complete set of technical manuals for all equipment installed. This must cover technical specification, system design recommendations and guidelines for installation, commissioning, operating and servicing the proposed equipment.
- 1.08 The manufacturer, given reasonable notice, shall permit the buyer, or its nominated

agent, to conduct a quality audit at the premises where the proposed equipment is manufactured.

1.09 All deviations from this specification that the contractor proposes to make shall be clearly indicated in writing, referring to the relevant paragraph(s) of this specification.

1.10 The system offered shall be approved by the concerned local authorities Fire department and any changes in equipment, materials shall be incorporated at no extra cost.

1.11 Applicable Standards and Specifications

Where applicable, the fire detection and alarm system and installation shall comply fully with the British Standards or NFPA rules and regulations.

1.12 OUTPUT SIGNALS UNDER FIRE CONDITIONDS

A. Provision shall be made in the Fire Alarm Control Panel to provide the following:

1. Potential free NO/NC contacts or interface as required for the fire doors & Elevators.
2. Potential free NO/NC contacts or interface as required for shutting or starting Mechanical/HVAC equipment such as AHUs, Pumps, Dampers, Fans etc as may be required.

B. The Electrical contractor shall be responsible for providing conduiting and wiring from the fire alarm control panel up to the required equipment(s) as mentioned in paragraph 'A' above.

1.13 SYSTEM DIFFERENCE

There may be some difference between one manufacturer and another. The purpose of these specifications is to lay down the requirements in general for the fire alarm system. The system supplier shall ensure that all the functional aspects of the fire alarm system shall be achieved though the equipment specifications one manufacturer may differ from the other in some aspects. It is expected that the system supplied shall be a product of the latest technology only from the specified brands/manufacturers.

1.14 APPROVALS FROM THE CONCERNED LOCAL AUTHORITIES (i.e. CIVIL DEFENSE FIRE DEPARTMENT)

A. Before commencing any installation works, the contractor shall obtain Engineer's approval in respect of the system he is going to use. Based on the Contract Drawings the contractor shall prepare all necessary drawing with the

help of his system supplier (manufacturer). After coordinating with other trades, the contractor shall submit his drawings to obtain the concerned local authorities Fire department approval.

- B The contractor shall also be responsible for obtaining all approvals from the concerned local authorities Fire department during and after the installation as deemed necessary and as required.

1.15 SCOPE OF WORK

- A Supply, install, test and commission the fire alarm & detection system as specified, as indicated on drawings and as required as per the concerned local authorities Fire department Regulations.
- B Contractor shall install smoke detectors above false ceiling and also where false ceiling depth is 80 cms and above within contract price.
- C The electronically operated analogue addressable system including but not limited to the following items.
 1. Fire Alarm Control Panel.
 2. Fire Alarm Repeater panels (When indicated in drawings)
 3. Power supply and standby batteries with charger.
 4. Smoke Sensors
 5. Sensor Sounders
 6. Heat Sensors
 7. Beam Sensors
 8. Duct Sensors
 9. Manual Call points
 10. Audio Visual Alarms
 11. Alarm Sounders
 12. Interface units
 13. System interface with Main fire alarm panel (Where indicated)
 14. System interface with fire fighting system (Sprinkler, Fire extinguishing System)
 15. System interface with Air handling units
 16. System interface with Elevators
 17. System interface with Smoke and fresh air fans
 18. System interface with Building Management system.
 19. System interface with ATS
 20. System interface with Smoke doors

- 21. Printers
 - 22. System interface with other specified systems like Access Control etc.
- 1.16 Any additional ductwork, encasement works required shall be the responsibility of the electrical contractor. He shall not be entitled for any additional claims on these accounts.
- 1.17 It is assumed that the contractor before signing the contract has surveyed the site and ascertained the routes and hurdles.
- 1.18 RELATED WORKS
- A Section 16120 Conduits
 - B Section 16110 Raceways
 - C Section 16200 Cables & Wires
 - D Section 16300 Supporting Devices
- 1.19 SUBMITTALS
- A Shop drawings showing complete details.
 - B Manufacturer's detailed instructions
 - C Submit all shop floor and other relevant drawings to the concerned local authorities Fire department and obtain necessary approvals.

PART 2 PRODUCTS

2.01 CONTROL AND INDICATING EQUIPMENT

- A The Fire Alarm Control Panel (F.A.C.P) shall be the central processing unit of the system, receiving and analyzing signals from fire sensors, providing audible and visual information to the user, initiating automatic alarm response sequences and providing the means by which the user interacts with the system.
- B System shall be true Analogue with the ability to print the output from a fire sensor over a period of time

- C The (F.A.C.P) shall be modular in construction allowing for future extension of the system.
- D The (F.A.C.P) shall be able to be easily configured to meet the exact detection zone and output mapping requirements of the building considered.
- E The (F.A.C.P) shall be microprocessor based and operate under a multitasking software program. Operating programs and configuration data must be contained in easily up-datable non-volatile memory (EEPROM).
- F All devices i.e., Optical sensors, Heat sensors, Duct and Beam Sensors, Fire Alarm Interface units, Electronic Sounders, Manual Call Points etc, shall appear their addresses on visual display unit of the panel on request.
- G All devices shall be assigned a maximum of 32-character alphanumerical label. Incase of fire, fault or alarming, the label of devices sensing threshold shall appear on visual display unit of the panel.
- H The (F.A.C.P) shall meet the requirements of BS5839 Part 4 or NFPA 72 and shall be approved, together with associated ancillary equipment, by the Loss Prevention Council (LPC), (UL) or (VDS).
- I No more than 254 addressable input Devices shall be controlled by a single Loop processor card.

2.02 SYSTEM DESCRIPTION

- A The (F.A.C.P) Shall be capable of operating with any of the following types of automatic detection equipment:
 - Conventional detectors
 - Analogue addressable sensors.
- B The (F.A.C.P) shall be capable of operating with conventional detectors and analogue addressable detectors suitable for installation in hazardous areas.
- C Analogue Addressable devices shall be connected to loops capable of accepting up to 254 devices per loop.
- D The (F.A.C.P) shall have a minimum capacity for operating 1 fully loaded addressable loop. This shall be extendible to 32-loops.
- E Provision shall be made for each addressable loop to be sub-divided into a geographical zones. The section of wiring corresponding to each zone circuit shall be protected from faults by means of line isolator modules (built-into the detector or by means of using isolator base).
- F It shall be possible to allocate all 254 addressable devices per loop.

- G The (F.A.C.P) shall have provision to drive and monitor repeater panels providing a repeat of the indications on the (F.A.C.P) display.
- K. The system shall have two addressing methods:
 - 1. Software addressing.
 - 2. Hardware addressing.

2.03 MONITORING AND CHECKING CIRCUITS AND FAULT CONDITIONS

Facilities shall be provided to constantly monitor and check the following circuits and fault conditions.

- A The power supply on the loops
- B For open circuit, short-circuit, earth fault and any other fault condition in any segment in the loop wiring.
- C For communication failure and errors in all cord and loops.
- D For faults in Keyboard and printer circuits.
- E Monitoring of all devices status.
- F Provision shall be done at the fire alarm control panels to silence the loop powered alarm sounders but the visual indication shall remain until the system is reset.
- G It shall be possible to change the sensitivity of analogue sensors from the Fire Alarm Control panel only.

2.04 BASIC SYSTEM FUNCTIONS

- A The (F.A.C.P) shall monitor the status of all devices on the Addressable loops for fire, short-circuit fault, open-circuit fault, incorrect addressing, unauthorized device removal or exchange, pre-alarm condition and contaminated sensor detector condition.
- B In the event of a fire being reported from the smoke/heat detectors, activation of manual call points or sprinkler operation the sequence of alarm operation shall be as follows:
- C If fire condition is reported from a sensor area this should cause a fire signal to be reported at the control panel. The system should incorporate approved delay time and if the alarm is not acknowledged in this period, the evacuation message should be broadcast through the speakers automatically to the affected floor plus the floor above and below. The alert signal to other floors shall be as previously described.

- D If a Manual Break Glass Unit is activated or a sprinkler flow switch is operated, then the evacuation shall be transmitted immediately to the affected floor plus the zones required by engineer or the owner. The signal to the other zones shall be as previously described.
- E In each of the above cases, upon initiation of an evacuation signal all the electronic sounders in areas such as plant rooms and emergency staircase shall operate immediately. The signals shall not discriminate with floors.
- F Activation of the fire alarm system shall directly initiate some or all of the following to be agreed as part of the overall engineering policy.
 - 1. Signal to all elevator machine rooms indicating fire status (to control lifts)
 - 2. Release doors normally locked by magnetic devices.
 - 3. Release doors normally held open by magnetic devices.
 - 4. Shutdown mechanical equipment ventilation plant.
 - 5. Shutdown general exhaust fans.
 - 6. Start up smoke extract fans.
 - 7. Start up exhaust makes up fans.
 - 8. Start up stair vestibule pressurization fans.
 - 9. Automatically operate fire dampers.
 - 10. Initiate alert signals in all panels.
- G Supervised by the fire alarm system in Main building

2.05 MAIN FIRE ALARM CONTROL PANEL

- A The panel shall be computer controlled using analogue technique to detect smoke/ heat /fire conditions. The panel shall be complete with, but not limited to, the following elements:
- B 5.7" touch screen display unit adapted to customer-specific needs.
- C Integral sealed lead acid battery and charger, with 24-hour back up in the event of supply mains failure.
- D Essential control-sound alarms, silence alarms and reset fire. These shall be enabled by a key switch.
- E Cancel fault buzzer.
- F Fire, fault, warning and power on lamps.
- G Simple menu driven function keys with password protection shall configured in

the touch screen shall allow users to an extensive range of software-based features such as:

1. Last 150 fire and trouble events minimum
2. Current fault and warning logs
3. Analysis of analogue sensor information
4. Interrogation of sensor cleanliness
5. Enable/disable sensors, zones, sounders, interface, unit channels
6. Fire plan configuration menus
7. Outstation label changes
8. Address allocation
9. Status of outstation
10. Status of all cards
11. Printer on off, line feed and test facilities
12. Address allocation

H Up to 254-device capacity per loop.

J RS 232 /RS 485 computer communication option.

K In addition to the above, all other necessary control, elements and accessories shall be included to provide a complete and efficient panel conforming to the requirements of BS or NFPA.

2.06 SMOKE SENSORS

A These shall of addressable optical type with built-in isolator in a single head. The optical element shall monitor for visible smoke from slow smoldering fires. Smoke sensing design shall comply with BS 5445: part 7 and shall be LPCB approved or comply with NFPA – 72 and shall be UL approved or VDS approved.

B All smoke sensors shall comprise of three components.

1. Termination Plate, Electronic Module and replaceable sensor chamber. The termination plate shall incorporate the terminals for wiring. The electronic module shall plug-on onto the termination plate as a second fix item all electronic components and circuitry suitable for an Analogue addressable system.
2. This design shall allow sensing element alone to be replaced, should it become dirty almost dirty, excessively dirty, due to a build up of dust from the surrounding atmosphere. When removed, the panel shall display a fault condition with a message "Sensor chamber Removed" with a relevant

label/address. The sensor chamber shall also have viewing LED indicator.

3. Sensors mounted in the false ceilings may be provided with semi flush mounting kits if it is required by the engineer.

2.08 HEAT SENSORS

- A These shall comply with the requirements of BS 5445: Part 5: 1977 and shall be LPCB approved or comply with NFPA-72 and shall be UL listed or VDS approved. They shall be complete with other elements described for smoke sensors above, for an analogue safe addressable sensing device.
- B Sensors mounted in the false ceilings may be provided with a semi flush mounting kits if it is required.

2.09 BEAM SENSORS

- A The Beam Sensors shall detect fire by obscuration of an optical beam by smoke. It shall utilize a transmitter and receiver unit. It shall be used in areas as indicated in the drawings.
- B The Beam sensors shall be LPCB or UL approved and to BS 5839 Part 5 or NFPA-72 or VDS approved.

2.10 DUCT SENSORS

Duct Sensors shall be safe addressed, loop powered, loop signaled. They shall comprise of a sampling unit with probes extending into a straight section of the mechanical ventilation ductwork. The duct sensor shall comprise of Optical Smoke/Sensing devices.

2.11 CALL POINT

These shall comply with the requirements of BS 5839: part 2: 1983 or NFPA-72, and shall be complete with all-electronic components and circuitry for an addressable device. Polycarbonate cover type option shall also be provided if required. The unit shall incorporate glass to broken. The electronic circuitry shall have built-in line isolator.

2.12 ALARM SOUNDERS

- A The addressable Alarm Sounders shall be sited in areas as shown in the schematics and the floor layout drawings. The sounders shall be configured via software to operate individually or in sectorised groups; totally independent of the way they have been connected to the loops. The sounders shall have the

synchronization feature to ensure that all the sounders give alert and evacuate tones that are totally in phase. Conventional Sounders that “free-run” and therefore be out phase with each other will not be accepted.

- B The Sounders shall comply with BS, NFPA or VDS requirements.

2.13 INTERFACE UNITS

These shall be used to interface with the fire/fault signals emanating from the local control conventional (zonal) fire alarm control panels. These units shall also give/accept contact from other services required to be interfaced with fire alarm system with feedback ability e.g. Interfacing with AHU's BMS, Elevators, Pressurization Fans etc. It shall be installed of addressable type with all inputs and outputs are to be fully monitored for cable faults. Power Supply units if required, with the interface shall also be monitored for any faults.

2.14 REPEAT PANEL

- A The Repeat Panel shall be sites at the indicated locations. It shall consist of 5.7" touch screen for displaying and control. It shall provide system repeat facilities to repeat all the messages that appear on the main touch screen as well as the common indications. It shall have essential alarm controls and menu facilities.

PART 3 EXECUTION

3.01 INSTALLATION

- A Fire alarm components shall be installed directly to conduit outlet boxes at the following mounting height above finished floor level, measured to the center of box unless stated otherwise.
- B Fix manual call station semi-recessed at 1.50m heights above finished floor.
- C Automatic smoke and heat Sensors: Ceiling Mounted/Surface Mounted/ Above ceiling mounted
- D Alarm Sounders: 2.20m above finished floor.
- E Outdoors alarms fix where indicated by the concerned local authorities Fire department and approved by the Engineer.

3.02 TESTING AND COMMISSIONING

- A After the installation is complete, the Contractor shall conduct operating and commissioning tests. The equipment shall be demonstrated to operate in accordance with the requirements of the specification. The system installation, testing and commissioning shall be as per the concerned local authorities Fire department approval and requirements.
- B The Fire Alarm Systems shall be complete programmed in accordance with the concerned local authorities Fire department Requirements and as specialist from the manufacturer shall attend and demonstrate the complete system.
- C Fire Brigade and testing shall be the Contractor's responsibility and the Contractors shall do any requirements for approval and handing over the Fire Alarm Installation without the extra payment even in time.
- D Drawing and specification are complementary each to the other.
- E. The "CODE FOR THE SYSTEM OPERATION" shall be handed over to the Client at the completion of the maintenance period.

3.03 Shall co-ordinate with other trades for the installation of the system.

3.04 The contractor /sub-contractor will be responsible for providing all access equipment necessary to enable safe installation of the system.

3.05 The Contractor shall provide necessary training to Client's personnel to give them on job training, instructions etc. for proper operating and maintenance of the system.

3.06 The contractor will repair, correct or replace any defect of any nature that may occur for a period of 2 years from the date of issue of the certification of Completion.

3.07 Contractor shall provide a full set of manuals and operating instructions (service manual). It shall include descriptive brochures, technical manuals for all equipments forming part of the contract.

3.08 SPARES & TOOLS

Contractor shall provide manufacturers recommended spares / tools at the time of completion of the project for the use of the client. These spares / tools are not to be used by the contractor during the period of 2 years of maintenance.

* END OF SECTION *

SECTION 16760
DATA SYSTEM

Telecommunications Standards

The following standards apply to network & Telecommunications works:

1. ANSI/TIA/EIA-568-B-1: Commercial Building Telecommunications Cabling Standard
Part 1: General Requirements
2. ANSI/TIA/EIA-568-B-2: Commercial Building Telecommunications Cabling Standard
Part 2: Balanced Twisted-Pair Cabling Components
3. ANSI/TIA/EIA-569: Commercial Building Standard for Telecommunications Pathways
and Spaces
4. ANSI/TIA/EIA-758: Customer-owned Outside Plant Telecommunications Infrastructure
Standard
5. ANSI/TIA/EIA-J-STD-607-A: Commercial Building Grounding (Earthing) and Bonding
Requirements for Telecommunications
6. ANSI/TIA/EIA-606-A: Administration Standard for the Telecommunications
Infrastructure of Commercial Buildings

PART 1 GENERAL

1.01 GENERAL

- A The data System shall comprise of Supply, installation, testing & documentation
for a category 6A cabling for the mentioned project provisional.
- B Separate raceways shall be used for the data system.
- C All runs of raceways shall be accessible for modifications or maintenance.
- D Any additional ductwork, encasement works /raceways required shall be the
responsibility of the electrical contractor. He shall not be entitled for any
additional claims on these accounts.
- E It is assumed that the contractor before signing the contract has surveyed the
site and ascertained the routes and hurdles.
- F The certified installer will be fully responsible on quality of service and warranty
certificate to be submitted directly for the contractor under engineer
supervision.

1.02 SCOPE OF WORK

The contractor shall supply, install and commission as provisional items first fix of the data System as ONE package, having the following as a minimum:

- Computer cabling cabinets
- Data Outlet with RJ45 Sockets Category 6A/type 3M
- Category 6A cables
- Raceways, trunking, conduits etc
- All other components, accessories required to complete the first fix Data system.

Not all the mentioned items specified in the specification are required in the contract, some items shall be submitted and installed by others, refer to B.O.Q. for included items.

1.03 CONTRACTOR OBLIGATIONS & QUALIFICATIONS:

The contractor shall carefully examine all of the specifications to ensure that he is fully conversant therewith & has included for everything necessary therein, either expressly provided for or as would normally be expected to be provided for by a reputable specializing in the type & nature of the services Described In The Contract.

The contractor is advised that items or matters not specifically provided for, or partially described or otherwise missing from the specifications, but which are nevertheless necessary for the execution & completion of the services, shall be deemed to have been included by the contractor.

Authorized & certified installers registered with their respective manufacturers with trained & certified engineers shall execute the installation of the cabling system.

The contractor shall carry out all the necessary surveys, design & engineering so as to provide for the services, a whole & complete system to ensure full compatibility of the services with any existing facilities pertinent to the cabling system applications/operations.

The scope of the services include the provision of all material, labor, supervision, construction, equipment, tools, temporary, spares, consumable & all other things & services required to engineer, design, supply, install, test & commission the cabling system.

1.04 EQUIPMENT & MATERIAL

All equipment, material & the like shall be such so as to withstand the prevailing climatic conditions in the state of Jordan & within the parameters of an ambient temperature varying from zero (0) to plus fifty five (55) degrees centigrade & a maximum relative humidity of one hundred percent (100%).

1.05 TESTING & COMMISSIONING

Acceptance testing shall be carried out by the contractor & witnessed by the owner personnel. The contractor shall provide all necessary instruments & accessories required to perform the testing.

1.06 WARRANTY

The system supplier shall warrant to repair or replace & make good at its expense any material found defective during a period of fifteen years from the date of the acceptance certificate.

1.07 RELATED SECTIONS

- | | | |
|----|---------------|--------------------|
| A. | Section 16110 | Raceways |
| B. | Section 16120 | Conduits |
| C. | Section 16300 | Supporting devices |
| D. | Section 16200 | Cables & wires |

- 1.08 The specification and BOQ for the data system are for the guidelines of the contractor for the purpose of bidding. The contractor shall include all material and devices though not indicated but required for the proper and efficient installation of the system.

PART 2 PRODUCT

2.01 DATA BACKBONE

Technical specifications:

2.1.1 FTP CAT6A (4 PAIRS) CABLES

Installation cables category 6A, Enhanced, FTP

The pair-shielded 100ohm installation cables are suitable for voice, and data transmission at frequencies of up to 250 MHz. Dimensions: 4 x 2 x 0.58mm.

Cable construction

Sheath	Color	Conductor	Insulation
Material		Diameter (mm)	Diameter (mm)
LSOH	Grey, RAL 7035	0.58	1.04 PE

Cable Properties

Bending

Minimum bending radius, installation 8 x D

Minimum bending radius, installed 4 x D

Tensile Strength

Maximum tensile load, installation (N) 100

Maximum tensile load, installed No stretch

Temperature Range

Operation (°C) -20 to +60

Installation (°C) 0 to +50

Fire Classifications:

PVC : IEC 60332-1
 LSOH: IEC 61034, IEC 60754-1, IEC 60332-1
 Heat Release
 LSOH (MJ/km) 1030
 Electrical characteristics 20 C
 Characteristic impedance ($4 < f < 100$ MHz): 100 ± 15
 DC-loop resistance (Ω /km)
 Resistance unbalanced, max (%)2
 Optical braid overage (%)41
 Transfer impedance, IEC 96-1
 1 MHz (Ω /m) 5
 10 MHz (Ω /m) 10
 Nominal velocity of propagation (NVP)c 0.75
 Mutual capacitance, nominal (pF/m) 48
 Capacitance unbalanced, max. (pF/m) 1000

2.1.2 FTP RJ45/3M CONNECTION MODULES (FOR DATA)

The Cat. 6A connection modules are the connection modules that comply with the latest standard proposals of the international standardization bodies. They are the center piece in the realization of class E channels with up to 4 connection modules. Comply with the cat.6A components requirements of the latest standard proposals of ISO/IEC.

- Conform to Cat.6 requirements according to the EIA/TIA.
- 10dB better Next values with 100MHz
- Best transmission properties with freenet Cat.6 patch cords (R302298-R302341)
- Backwards compatible with Cat.5e and Cat.5.
- Fits into all freenet patch panels and outlets.
- Tool-free connection technique (IDC) for data cables with AWG 22-24 wire diameter.
- Allows opto-mechanical control of the connection technique.
- Error-free connection according to EIA/TIA 568A/B without pair crossover thanks to labeled wiring.
- Simple and time-saving shield contacting with integrated cable strain relief.
- Halogen-free material.
- 3P,UL,cUL certified
- Certificates available.

Electric and Transmission Data

Contact resistance < 50 milliohm (conductor - conductor)

Contact resistance < 20 milliohm (shield - shield)
Insulation resistance > 500 mega ohm (500 VDC)
Dielectric strength 1000 Veff. 50 Hz/1 min (conductor - conductor)
Dielectric strength 1500 Veff, 50 Hz/1 min (conductor - shield)
Coupling resistance IEC 96-1
1 MHz < 15 milliohm
10MHz < 100 milliohm

Mechanical Data

Material Polycarbonate, (UL 94V-0)
Mating cycles > 1000
Wire diameter 0.5 mm (AWG 24) - 0.65 mm (AWG 22)
Insulation diameter 0.8 - 1.6 mm
Mating cycles > 100
Wire strain relief Through labyrinth in IDC block
Cable strain relief Through cable ties
Shield contacting 1
Large surface contact springs (on plug)

2.1.3 DUAL FACE PLATES:

The free net dual modular outlets (voice/Data) and connection modules combine in various ways. The outlets accommodate a vast range of modules: For optical wave guides, RJ45. ISDN or analogue telephony. The modules can be linked together in a single outlet and exchanged simply without any need for tools.

To ensure a clearer distinction, individual outlets at the workstation and on the Global Rack can be mechanically and color coded.

For greater safety in the event of fire, plastic outlets manufactured to fire category VO. Cat. 5e can be fitted to Cat. 6A

Modules on the same outlet, ensuring an easy switch to a higher category - another free net plus!

2.1.4 TRUNKS

Plastic trunks with different sizes should contain all the exposed cabling installation (if any).

PART 3 EXECUTION

- 3.1 All installation work shall be as per Data Transmission rules and regulations. Where no regulation is available, IEE wiring regulation shall be followed.

- 3.2 The maximum horizontal portion of a cabling system from work area information outlet to a mechanical termination at the patch-panel in the wiring closets must not be more than 90 meters, the cable run must be free of bridges, taps & splices. Cabling shall be as per ISO /IEC IS11801 Standards.
- 3.3 Cables shall be of one continuous length. No joints are to be introduced in any circuit starting from work area outlet to a mechanical termination at the patch panels in the wiring closets.
- 3.4 Cables shall be laid with bend radii and maximum pull through forces as per manufacturer's standards.
- 3.5 Conduit and ceiling distribution shall be according to EIA/TIA 569 standards
- 3.6 Drawing and specification are complementary each to the other.
- 3.7 Shall co-ordinate with other trades for the installation of the system.
- 3.8 The contractor /sub-contractor will be responsible for providing all access equipment necessary to enable safe installation of the system.
- 3.9 Outlets shall be atleast 25cm distance from nearest electrical point.
- 3.10 Nodes shall be tested using scanner for category 6 outlets. The test shall be performed in the presence of the engineer after termination.
- 3.11 Both ends of the cable shall be labeled for identification.
- 3.12 Detailed cable routing diagram must be produced for installation. This shall be reference for future maintenance, expansion, fault tracing etc.
- 3.13 Contractor shall provide a full set of manuals and operating instructions. It shall include descriptive brochures, technical manuals for all equipments forming part of the contract.

4.4 Network cabling specification

All Cables provided must be of Category 6 Unshielded Twisted Pair (UTP) type and terminated to 568B Wiring Scheme. It is essential that the same wiring scheme is followed for the whole wiring network.



Fig2. EIA/TIA 568B Network Wiring Scheme

- All cable runs must terminate on patches in the server room on the Ground floor for both voice and data connections.
- All cable runs must be either in trunking/conduit or secured onto data basket/tray.
- All cables must be installed to avoid bearing on sharp edges or frictional overheating.
- Cable sheaths and jackets must not be damaged during installation.
- Cables must be protected where they pass through holes in walls or ceilings.
- Cable ties must be used and tightened to comfortably hold but not constrain the outer sheath of the cable to cable basket/tray.
- Cables entering the network cabinets should be securely tied to the cable tray within the cabinets, and tied and loomed neatly after termination on the patches.
- Cable should not be attached directly to the cabinet stanchions.
- No cable runs should be longer than 90 metres. It shall be the sole responsibility of the contractor to visit the site, measure all proposed containment runs and detail in writing to the Project manager all runs of cabling that will exceed 90 metres, or give written confirmation that all runs are within 90 metres. No installation cabling is to be undertaken until one of the above has been confirmed.

4.5 Trunking

- All trunking must be 3-part compartmentalised & Category 6 compliant.
- All bends, tees and crossovers should be gusseted to allow for adequate bend radii of the installed cables.
- All trunking needs to be of sufficient capacity to allow for the minimum bend radii of the copper cables.

4.6 Labelling

-
- All cable drops must be properly labelled at the workstation area and at the patch panel area in the Server room.
- Labels must be on plates, sockets and on cable in two sides
- The labels must be machine printed. Handwritten labels will not be accepted.
- The labelling schema of the outlet faceplates will be obtained from the ENGINEER office according to ANSI/TIA/EIA-606-A
- Labeling the cables:
 - Special Label must be located on 30cm at the end of the cable show where the path of the cable.
 - Examples:
 - § In the side of the patch panel the label show the floor, department and socket Number that belong to.
 - § In the side of the socket the label show the patch panel and port Number.

5.3 Verification and Testing

All cable drops must be tested for proper wire mapping.

Category 6 UTP cable testing will test each conductor for end-to-end continuity.

Each cable must be tested for correct termination on a pin-by-pin basis.

Each station must be tested with a Category 6 Fluke tester to verify compliance with EIA/TIA - 568B colour coding and pin numbering specifications.

Should any cable fail to meet the Category 6 standards outlined above, the contractor will be responsible for rectifying the fault, either by re-termination of the cable or by re-running the complete cable if necessary. In either case, the cable must be re-tested to ensure that the rectified cable meets the Category 6 standards.

8.2 Contractor Responsibilities:

- Providing all supervision, labour, tools, equipment, materials, transportation, erection, construction, unloading, inspection and inventory housing.

- Obtaining ENGINEER's permission before proceeding with any work necessitating cutting into or through any part of the building structure such as beams, concrete, tile floors or partition ceilings.
- Promptly repairing all damage to the building due to carelessness of contractor employees and exercising reasonable care to avoid any damage to the building. Reporting to ENGINEER any damage to the building that may exist or may occur during the contractor's occupancy of the building.
- Taking necessary steps to ensure that required fire fighting apparatus is accessible at all times. Flammable materials shall be kept in suitable places outside the building.
- Installing the wire, cable and hardware in accordance with EIA/TIA specifications.
- Conducting tests and inspections as specified post-installation.
- Promptly correcting all defects for which the contractor is responsible as determined by ENGINEER.
- Removing all tools, equipment, rubbish and debris from the premises and leaving the premises clean and neat upon completion of the work.
- Abiding by the safety and security rules on the work site at all times.
- Following industry standard installation practices.

*** END OF SECTION ***